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06.07-05/02/96-02303

FINAL

LONG-TERM MONITORING WORK PLAN

FOR

OPERABLE UNIT NO. 7
SITES 1 AND 28

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0333

MAY 2, 1996

Prepared for:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
ADL	Administrative Deadline Lot
AST	Aboveground Storage Tank
bgs	Below Ground Surface
CCC	calibration check compound
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEJ	Camp Lejeune
CLP	Contract Laboratory Program
COC	chemical of concern
DOD	Department of Defense
DON	Department of the Navy
DQO	data quality objective
EDB	ethylene dibromide
EMD	Environmental Management Division
ESE	Environmental Science and Engineering, Inc.
FFA	Federal Facilities Agreement
ft	feet
ft/ft	foot per foot
GC/MS	gas chromatographic/mass spectometer
HPIA	Hadnot Point Industrial Area
IAS	Initial Assessment Study
IDW	Investigative Derived Wastes
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MEK	methylethyl ketone
MIBK	methylisobutyl ketone
mg/L	Milligrams per Liter
msl	Mean Sea Level
NACIP	Navy Assessment and Control of Installation Pollutants
NC DEHNR	North Carolina Department of Environment, Health and Natural Resources
NCP	National Contingency Plan
NCWQS	North Carolina Water Quality Standards

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

NFESC	Naval Facilities Engineering Service Center
NPL	National Priorities List
O&G	oil and grease
OCP	organochloride pesticides
OU	Operable Unit
PA	preliminary assessment
PA/SI	Preliminary Assessment/Site Investigation
PAH	polynuclear aromatic hydrocarbon
PCB	Polychlorinated Biphenyls
PEM	performance evaluation mixtures
POL	petroleum, oil, lubricants
ppb	parts per billion
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	record of decision
RRF	relative response factor
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
STP	Sewage Treatment Plant
TAL	Target Analyte List
TCCD	tetrachlorodioxin
TCE	trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TSS	total suspended solids
µg/kg	Microgram per Kilogram
µg/L	Microgram per Liter
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WAR	Water and Air Research, Inc.
WQP	water quality parameters

1.0 INTRODUCTION

Marine Corps Base (MCB), Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) on October 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV; the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR); and the United States Department of the Navy (DON) entered into a Federal Facilities Agreement (FFA) for MCB, Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at MCB, Camp Lejeune were thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives were developed and implemented, as necessary, to protect public health, welfare, and the environment (FFA, 1989).

Institutional controls was the selected remedy for Sites 1 and 28. As stated in the Final Record of Decision (ROD) dated December 14, 1995, groundwater samples will be collected on a semiannually basis over a 30 year period at these sites. A 5-year review of the groundwater data will be conducted in order to monitor site conditions to determine if additional actions are required, or if the frequency of monitoring program needs to be increased (i.e., quarterly) or decreased (i.e., annually).

The objective of this Work Plan is to identify the tasks required to implement the long-term monitoring requirements at Sites 1 and 28 as outlined in the Final ROD. The various studies or investigations required to collect the appropriate data are described in this Work Plan and are as follows:

- Section 1.0 - Introduction
- Section 2.0 - Technical Approach
- Section 3.0 - Field Investigation Procedures
- Section 4.0 - Sample Handling and Analysis
- Section 5.0 - Project Schedule
- Section 6.0 - References

Section 1.0 discusses site-specific background information and the setting of each site. A description of each site is provided along with a summary of the RI and pre-work plan sampling results.

Section 2.0 presents an overview of the technical approach.

Section 3.0 identifies and describes the tasks and field investigation activities that will be implemented to complete the long-term monitoring at the sites in terms of meeting the site-specific objectives.

Section 4.0 describes the sample handling and laboratory analysis tasks. This section discusses field sample handling protocols, as well as laboratory procedures and specific protocols.

The long-term sampling schedule is provided in Section 5.0 and the references used for developing this Work Plan are provided in Section 6.0.

1.1 Site Background and Setting

This section describes the physical setting of Sites 1 and 28.

1.1.1 Site 1

Site 1, the French Creek Liquids Disposal Area, is located approximately one mile east of the New River and one mile southeast of HPIA on the Mainside portion of MCB, Camp Lejeune (see Figure 1-1). The site is bisected by the Main Service Road which runs east-west.

The majority of Site 1 is comprised of paved (i.e., asphalt, concrete) or improved (i.e. coarse gravel) road surface, parking lots, storage lots, buildings, and equipment maintenance racks. Figure 1-2 provides a map detailing Site 1 and the surrounding area. As previously mentioned, Main Service Road bisects the site, forming "northern" and "southern" study areas. The northern portion of the site is bordered to the north by woods and a motor-cross training area, to the east by a vehicle storage area associated with Building FC-100, to the south by Main Service Road, and to the west by woods and Building FC-115. Suspected petroleum, oil, and lubricant (POL) and battery acid disposal areas lie within two fenced compounds that are associated with Buildings FC-120 and FC-134, on the northern portion of the site. The remaining portion of the "northern" disposal area is located outside of these fenced compounds, to the west and immediately adjacent to Building FC-134.

Building FC-120, located on the northern portion of the site (see Figure 1-2), serves as a motor transport maintenance facility for the Second Landing Support Battalion. Building FC-134, located to the north of Building FC-120, provides offices and communication equipment storage for the second battalion. Building FC-120 is a two story brick structure with several vehicle maintenance bays and offices; Building FC-134 is a single story brick structure with offices and one garage bay.

Two equipment wash areas are located on the northern portion of the site. The first wash area is located to the east of Building FC-134 and the second lies to the west of Building FC-120. Both equipment wash areas are concrete-lined and employ an oil and water separator collection basin. Another oil and water separator is located to the north of Building FC-120, adjacent to Building SFC-118. Discharge from the three oil and water separators flows into a drainage ditch and sediment retention pond to the north of the study area.

A number of covered material storage areas (i.e., SFC-118, SFC-124, SFC-125, and SFC-145) are located to the north and west of Building FC-120 (see Figure 1-2). These smaller covered structures are used for temporary storage of paint, compressed gasses, vehicle maintenance fluids, spent or contaminated materials, and batteries. In addition to these covered storage structures, an above ground storage tank (AST) area, located adjacent to the northern side of Building FC-120, is utilized to store spent motor oil and ethylene glycol (i.e., anti-freeze).

A gasoline service island, located to the west of Building FC-120, provides fuel for vehicles undergoing maintenance (see Figure 1-2). Two underground storage tanks (USTs) of unknown capacity are associated with this active service island. Building FC-120 and its associated maintenance facilities, including the gasoline service island, were constructed in 1984. The two USTs are scheduled to be replaced with one AST before 1996. During their removal any petroleum contaminated soils are also to be removed.

The southern portion of the site is bordered by Main Service Road to the north, Daly Road and a wooded area to the east, H.M. Smith Boulevard to the south, and a wooded area and Gonzales Boulevard to the west. Within this portion of the site is another suspected POL and battery acid disposal area. Vehicle access to the suspected southern disposal area is via a swing-arm gate along Main Service Road. A portion of the southern disposal area is enclosed within a barbed-wire fence; the vehicle and equipment Administrative Deadline Lot (ADL), the remaining area, is not fenced.

The southern portion of the site has several buildings located adjacent to the suspected POL and battery acid disposal area. The buildings are constructed of either formed metal, concrete block, or wood frame siding. Typically the buildings are set on a poured concrete slab and have raised-seam metal roofs. These buildings house a number of support offices, recreation facilities, machine shops, light-duty vehicle and equipment maintenance bays, and equipment storage areas. Heat is provided to the majority of these buildings by kerosene-fired stoves; kerosene fuel is stored in several ASTs located beside a majority of the buildings.

Three vehicle maintenance ramps are located on the southern portion of the site. The first ramp is located immediately to the south of Building FC-739 and the second lies to the north of Building GP-19 (see Figure 1-2). Both maintenance ramps are constructed of concrete and are used for the upkeep of vehicles and equipment. Two oil and water separator collection basins are also located on the southern portion of the site. One of the separators is located to the south of the Building FC-739 vehicle maintenance ramp, and the other is located to the south of Building FC-816, adjacent to an equipment wash area. Discharge from the separator and wash area, located south of Building FC-816, flows into a stormwater sewer and then into a drainage ditch adjacent to H.M. Smith Boulevard.

A concrete-lined and bermed material storage area is also located on the southern portion of the site, to the north of Building FC-816. This bermed area is used for the temporary storage of vehicle maintenance fluids, spent or contaminated materials, fuel, and batteries. In addition, a number of storage lockers are located throughout the southern portion of the site. These lockers are used to store paints and other flammable materials used by maintenance and machine shop personnel.

The New River is located approximately one mile west of Site 1. A drainage ditch lies adjacent to the southern portion of the site along H.M. Smith Boulevard. The ditch flows west toward the HPIA Sewage Treatment Plant (i.e., near Site 28) and empties into Cogdels Creek, which discharges into the New River. The majority of the site is situated on a topographic high area with surface drainage predominantly to the west.

1.1.2 Site 28

Site 28, the Hadnot Point Burn Dump, is located along the eastern bank of the New River. The site is within the Hadnot Point development area, approximately one mile south of HPIA on the Mainside portion of MCB, Camp Lejeune (see Figure 1-1). Cogdels Creek flows into the New River at Site 28 and forms a natural divide between the eastern and western portions of the site. A majority of the estimated 23 acres that constitute the site are used for recreation and physical training exercises.

The Hadnot Point development area, which includes Site 28, has evolved over a 40-year period to encompass approximately 1,080 acres of land. Recreational areas are scattered throughout Hadnot Point and comprise nearly 18 percent or 196 acres of the Hadnot Point development area.

Administrative buildings are principally situated to the west of Holcomb Boulevard, the main access route to the development area. Troop housing units are located in the western portion of Hadnot Point, toward the New River. Consolidated in the northern portion of Hadnot Point, the industrial area (HPIA), and segregated from administrative buildings and housing units are supply, storage, and maintenance facilities. Administrative and support facilities together account for approximately 29 percent or 310 acres of Hadnot Point land area. Commercial uses, open spaces, and wooded areas constitute the remaining acreage in the Hadnot Point development area (Master Plan, 1988).

The Hadnot Point Sewage Treatment Plant (STP) is located adjacent to Site 28. The facility extends across Cogdels Creek via two 30-inch diameter aqueducts. The STP operates a number of clarifying, settling, and aeration ponds that are located on either side of Cogdels Creek. Both operational areas of the STP are fenced with six-foot chain link. The treated water from the STP discharges into the New River via an outfall pipeline approximately 400 feet from the shoreline. Figure 1-3 depicts the surface features and surrounding conditions at Site 28.

Vehicle access to the site is via Julian C. Smith Boulevard near its intersection with O Street. The site is bordered to the north by the Hadnot Point STP, to the east and south by wooded areas, and to the west by the New River. Site 28 is predominantly comprised of two lawn and recreation areas, known collectively as the Orde Pond Recreation Area, that are separated by Cogdels Creek. The eastern and western portions of the site are served by an improved gravel road. Picnic pavilions, playground equipment, and the stocked fish pond, Orde Pond, located at the site, are regularly used by base personnel and their families. In addition, field exercises and physical training activities frequently take place at the recreation area.

1.2 History

This section describes the operational histories of Sites 1 and 28.

1.2.1 Site 1

Site 1 has been used by several different mechanized, armored, and artillery units since the 1940s. Liquid wastes generated from the maintenance of vehicles were routinely poured onto the ground surface. These wastes have been reported to be primarily petroleum, oil, and lubricants (POL). In addition, battery acid is also reported to have been disposed at this site (Water and Air Research, 1983). The total extent of the suspected disposal area is estimated to be between seven and eight acres.

Acid from dead batteries is reported to have been hand carried from maintenance buildings to a disposal point. At times, holes were dug for waste acid disposal and immediately backfilled. During motor oil changes, vehicles were driven to a disposal point and drained of used oil. The suspected POL and acid disposal areas were not necessarily comparable. Quantities of these wastes have been estimated to be between 5,000 and 20,000 gallons of POL waste and between 1,000 and 10,000 gallons of battery acid waste. The site continues to serve as a vehicle and equipment maintenance/staging area (Water and Air Research, 1983).

1.2.2 Site 28

Site 28 operated from 1946 to 1971 as a burn area for a variety of solid wastes generated on base. Industrial waste, trash, oil-based paint, and construction debris were reportedly burned and subsequently covered with soil. In 1971 the burn dump ceased operations and the area was graded or seeded with grass. Figure 1-3 depicts the location of the suspected burn dump area. The total volume of fill is estimated to be between 185,000 and 375,000 cubic yards, based upon a surface area of 23 acres and a depth ranging from five to ten feet (Water and Air Research, 1983).

1.3 Remedial Investigation Summary

1.3.1 Site 1

Baker conducted the RI (i.e., Round One) at Site 1 from February through May of 1994. A supplemental groundwater study (Round Two), as part of the RI, was also conducted in December of 1994.

Round One - Shallow Groundwater

A total of 16 shallow groundwater samples from Site 1 were submitted for laboratory analysis. The samples were collected from the uppermost portion of the surficial aquifer (i.e., the water table). As indicated in Table 1-1, semivolatile fractions were not detected in any of the shallow groundwater samples. In addition, pesticide and PCB contaminants were not detected in the four shallow groundwater samples (i.e., samples 1-GW04, 1-GW06, 1-GW11, and 1-GW17) submitted for those analyses. However, the analytical results from shallow groundwater samples indicate the presence of volatile organic compounds (VOCs) and metals.

Four shallow monitoring wells, located on the northern portion of the study area, had positive detections of VOCs. Trichloroethene (TCE), 1,2-dichloroethene, vinyl chloride, and total xylenes were detected at least once in the shallow groundwater. Table 1-1 provides a summary of volatile groundwater contamination.

TAL metals, both total and dissolved fractions, were detected in each of the 16 shallow monitoring wells at Site 1. Each of the 23 TAL total metals were detected in at least one groundwater sample at Site 1. Fifteen of 23 TAL dissolved metals were also detected in at least one of the 16 groundwater samples (beryllium, cadmium, chromium, mercury, selenium, silver, and vanadium were not detected). A total of 13 TAL total metals were detected at concentrations in excess of the maximum contaminant levels (MCL) or NC Water Quality Standards (WQS) standards. Although federal and state standards apply strictly to total metal results, TAL dissolved metal analyses were employed as a basis of comparison. Dissolved antimony, iron, manganese, and thallium were each detected in at least one groundwater sample in excess of the MCLs or NCWQS.

Round Two - Shallow Groundwater

During the second sampling round, a total of 15 shallow groundwater samples were submitted for laboratory analysis of total and dissolved metals, total dissolved solids (TDS), and total suspended solids (TSS). Additionally, four of the 15 groundwater samples were also submitted for volatile organic analyses. Groundwater samples were obtained from monitoring wells that exhibited organic contamination from the first sampling round and from those wells with total metal concentrations in excess of water quality standards. The second round of VOC data was used to confirm the presence of organic compounds in those wells that exhibited contamination during the first sampling round.

The volatile compounds trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, vinyl chloride, and total xylenes were detected at least once in the shallow groundwater. Table 1-1 provides a summary of volatile groundwater contamination.

Total and dissolved TAL metal fractions were detected in each of the 15 shallow groundwater samples submitted for analysis from Site 1. A groundwater sample was not obtained from existing monitoring well 1-GW14. Thirteen of the 23 TAL total metals were detected in at least one shallow groundwater sample at Site 1 (antimony, beryllium, cadmium, chromium, copper, nickel, selenium, silver, thallium, and zinc were not detected). Fifteen of 23 TAL dissolved metals were also detected within at least one of the 15 groundwater samples (aluminum, antimony, beryllium, cadmium, chromium, selenium, thallium, and zinc were not detected). Two TAL metals were detected at concentrations in excess of the NCWQS standard, based on total metal analyses. Iron and manganese were detected at concentrations which exceeded the NCWQS in nine and fifteen groundwater samples, respectively.

Round One - Deep Groundwater

A total of three groundwater samples were obtained from the deep aquifer (i.e., the Castle Hayne aquifer) at Site 1. Volatile compounds were not detected in any of the three samples from the deep aquifer. However, the semivolatile compounds phenol and diethylphthalate were detected in deep well 1-GW17DW at estimated concentrations of 6 J and 1 J micrograms per liter (µg/L), respectively. One of the deep groundwater samples, from the water supply well HP-638, was submitted for pesticide and PCB analysis. No pesticide or PCB contaminants were detected.

TAL metals, both total and dissolved fractions, were detected in the deep monitoring wells and the supply well at Site 1. Thirteen of the 23 TAL total metals were detected in at least one of the deep groundwater samples. Eight of 23 TAL dissolved metals were also detected in at least one of the three deep groundwater samples. Only the total metals antimony and iron were detected at concentrations in excess of the MCL (secondary MCL for iron) or NCWQS drinking water standards. As a relative basis of comparison, TAL dissolved metals results were compared to TAL total metal results. In the case of deep groundwater samples from Site 1, no dissolved metals were detected in excess of MCL or NCWQS standards.

Round Two - Deep Groundwater

Samples from the two deep groundwater monitoring wells and the base supply well at Site 1 were submitted for TAL total and dissolved metal analyses as part of the second sampling round. A sample from well 1-GW17DW was also submitted for semivolatile analysis. However, no semivolatile compounds were detected in the sample.

TAL metals, both total and dissolved fractions, were detected in each of the three deep groundwater samples. Eight of the 23 TAL metals, both total and dissolved, were detected at least 1 of the deep groundwater samples. Only the total metal iron was detected at a concentration in excess of NCWQS. Iron was detected in a sample from the supply well, HP-638, at a concentration of 712 µg/L, which exceeds the NCWQS of 300 µg/L.

1.3.2 Site 28

Baker conducted the RI (i.e., Round One) at Site 28 from February through May of 1994. A supplemental groundwater study (i.e., Round Two), as part of the RI, was also conducted in December of 1994.

Round One - Shallow Wells

A total of 10 shallow groundwater samples from Site 28 were submitted for laboratory analysis. The samples were collected from the uppermost portion of the surficial aquifer (i.e., the water table). As indicated in Table 1-2, volatile detections were limited to a temporary well, 28-TGWPA, located near the center of the western disposal area. Chloroform, ethylbenzene, and xylenes were detected in the temporary well at concentrations of 2, 5, and 19 µg/L, respectively.

A total of 16 semivolatile compounds were detected in five shallow monitoring wells located adjacent to or within the western disposal area. The majority of the SVOCs were detected within the temporary well, 28-TGWPA. The highest positive detection of a semivolatile compound was 99 µg/L of naphthalene from the temporary well. Seven of the 16 maximum SVOC detections were less than 5 µg/L.

The pesticides 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, and gamma-chlordane were detected in groundwater samples obtained from monitoring wells located on the western portion of the study area. The maximum pesticide concentration was 6.6 J µg/L of 4,4'-DDE from temporary well, 28-TGWPA. As Table 1-2 depicts, 4,4'-DDE and 4,4'-DDD were the most frequently detected of pesticides. PCB contaminants were not detected in any of the 10 shallow groundwater samples obtained from Site 28.

TAL metals, both total and dissolved fractions, were detected in each of the 10 monitoring wells at Site 28. Each of the 23 TAL total metals were detected in at least one groundwater sample at Site 28. Eighteen of 23 TAL dissolved metals were also detected in at least one of the 10 groundwater samples (beryllium, cadmium, mercury, selenium, and thallium were not detected). Lead and manganese were detected in a groundwater sample from 28-GW07 at concentrations greater than one order of magnitude above their respective base-specific background levels. Lead was also detected above ten times the base-specific background level in a sample from the temporary well.

Round Two - Shallow Wells

During the second sampling round, groundwater samples from each of the nine shallow monitoring wells at Site 28 were submitted for laboratory analysis of total and dissolved metals, TDS, and TSS. Additionally, five of the nine groundwater samples were also analyzed submitted for TCL pesticides. The additional pesticide analyses were obtained from monitoring wells that exhibited pesticide contamination from the first round. No pesticides were detected in any of the five groundwater samples submitted during the round two sampling event, however.

Total and dissolved TAL metals were detected in each of the nine shallow groundwater samples submitted for analysis from Site 28. Fifteen of 23 TAL total metals were detected in at least one shallow groundwater sample from Site 28 (antimony, beryllium, cadmium, chromium, cobalt, selenium, silver, and thallium were not detected). Twelve of 23 TAL dissolved metals were also detected in at least one of the nine groundwater samples (antimony, beryllium, cadmium, chromium, cobalt, mercury, nickel selenium, silver, thallium, and zinc were not detected). Iron, lead, and manganese were detected during the second sampling round at concentrations in excess of either the MCL or NCWQS, based on total metal analyses. Iron exceeded the NCWQS of 300 µg/L in seven of the nine shallow groundwater samples, with a maximum concentration of 40,600 µg/L. Manganese was detected in groundwater samples from each of the nine shallow monitoring wells, with a maximum concentration of 1,450 µg/L. Seven of the nine groundwater samples had positive detections of manganese in excess of the 50 µg/L NCWQS. Lead was detected in only one of the nine groundwater samples in excess of the NCWQS and federal action level of 15 µg/L. Both lead and manganese were detected above the base-specific background levels in only one of the nine shallow groundwater samples.

Round One - Deep Wells

A total of three groundwater samples were obtained from the deep aquifer (i.e., the Castle Hayne aquifer) at Site 28. Volatile, semivolatile, pesticide, and PCB organic compounds were not detected in any of the three samples obtained from the deep aquifer.

TAL metals, both total and dissolved fractions, were detected in each of the three deep monitoring wells at Site 28. Seventeen of the 23 TAL total metals were detected within at least one of the deep groundwater samples. Twelve of 23 TAL dissolved metals were also detected within at least one of the three deep groundwater samples. The total metals iron, lead, and manganese were detected at concentrations in excess of either the MCL or NCWQS in upgradient well 28-GW09DW. Iron and thallium were detected above federal or state standards in well 28-GW01DW.

Round Two - Deep Wells

Groundwater samples from the three deep monitoring wells at Site 28 were submitted for TAL total and dissolved metal, TDS, and TSS analyses as part of the second sampling round. Both total and dissolved TAL metals were detected in each of the three deep groundwater samples. Among the total metal results, manganese was the only potential contaminant identified above MCL or NCWQS levels. The groundwater sample from well 1-GW01DW had a manganese concentration of 66 µg/L, in excess of the 50 µg/L NCWQS and Federal Secondary MCL.

Surface Water

Sixteen of 23 TAL total metals were positively identified in the five surface water samples collected from the New River. Copper, lead, thallium, and zinc were each identified at concentrations in excess of NOAA chronic screening values. As depicted in Figure 1-4, thallium and zinc were detected in excess of surface water screening values in one sample each. Copper, and lead each exceeded screening values in a total of three surface water samples. The thallium concentration in sample 28-NR-SW04, located at the mouth of Cogdels Creek, exceeded the NOAA chronic screening value of 4.0 µg/L by 1.6 µg/L. Copper and lead were detected, among the five New River surface water samples, at maximum concentrations of 181 and 23.4 µg/L, respectively. Both maximum detections of copper and lead were observed in sample 28-NR-SW01, located approximately 100 yards upstream of the study area. The sample 28-NR-SW03, collected adjacent to the western disposal area, had copper, lead, and zinc concentrations of 6.6, 3.1, and 363 µg/L, respectively. Each of these three detections were in excess of the established chronic surface water screening values for copper, lead, and zinc of 6.5, 1.32, and 58.9 µg/L, respectively. No other total metal concentrations in the seven surface water samples exceeded chronic screening values.

Sediment

Nineteen of 23 TAL total metals were positively identified in the ten New River sediment samples (beryllium, cadmium, selenium, and thallium were not detected). Antimony, copper, lead, and silver were each identified at concentrations in excess of NOAA ER-L screening values. As provided in Figure 1-5, each of the four metal contaminants were detected in excess of sediment screening values within two samples retained from the New River. Antimony, copper, and lead were each detected at their respective maximum concentrations among the ten New River samples at station 28-NR-SD01, located upstream of the study area. The copper concentration of 1,340 mg/Kg in sample 28-NR-SD01 exceeded the NOAA screening value of 70 mg/Kg. Antimony and lead were detected at maximum concentrations of 263 and 38,800 mg/Kg, respectively. The NOAA screening values for antimony and lead are 2 and 35 mg/Kg, respectively. Concentrations of silver in samples 28-NR-SD03, 3.4 J mg/Kg, and 28-NR-SD05, 3.1 J mg/Kg, slightly exceeded the NOAA value of 1 mg/Kg. No other total metal concentrations among the ten New River sediment samples exceeded screening values.

1.4 Pre-Work Plan Supplemental Sampling

A supplemental sampling study was conducted in August, 1995 to provide data for determining which monitoring wells would be sampled as part of the long-term monitoring program. The following provides a summary of those findings.

1.4.1 Site 1

Groundwater samples were collected from 14 monitoring wells (11 shallow and 2 deep) and one water supply well. Ten of the fifteen samples were analyzed for Target Compound List (TCL) volatiles and Target Analyte List (TAL) metals (total). The remaining five samples were analyzed for TAL metals only. Furthermore, one shallow monitoring well (1-GW18) was installed within the northern area of the site, northwest of Building FC-120. The purpose of this well was to further evaluate shallow groundwater quality within the suspected disposal area.

Volatile compounds were detected in two of the ten wells sampled. Monitoring well 1-GW10 had detections of 1,2-dichloroethene (total) and trichloroethene (TCE) at 23 and 4J micrograms per liter (μg/L), respectively. Moreover, monitoring well 1-GW12 had detections of toluene, ethylbenzene, and xylenes (total) at 4 J, 4 J, and 150 μg/L, respectively. The detection of TCE in well 1-GW10 exceeds the NCWQS of 2.5 μg/L.

Iron and manganese were the only metals which exceeded Federal (secondary MCLs) and/or NCWQS at Site 1. The maximum iron concentration was detected in monitoring well 1-GW12 (37,700 μg/L); the maximum manganese concentration was detected in monitoring well 1-GW10 (1,220 μg/L).

1.4.2 Site 28

Groundwater samples were collected from eight monitoring wells (six shallow and two deep). All of the samples were analyzed for TCL volatiles and TAL total metals. Furthermore, one existing shallow monitoring well (28-GW08) was abandoned due to well construction problems. A new well was installed approximately 15 feet northwest of the abandoned well.

Volatile compounds were not detected in any of the eight wells sampled.

Iron, manganese, and cadmium were the only metals detected which exceeded Federal (secondary and primary MCLs) and/or NCWQS at Site 28. The maximum iron and manganese concentrations were detected in monitoring well 28-GW13 (50,100 and 454 µg/L, respectively); the maximum concentration of cadmium (only one detection) was detected in monitoring well 1-GW07 (10.7 µg/L).

SECTION 1.0 TABLES

TABLE 1-1

COMPARISON OF GROUNDWATER ANALYTICAL RESULTS
FROM THE REMEDIAL INVESTIGATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Detected Contaminants	Round 1 Results (May, 1994)				Round 2 Results (December, 1994)				Round 3 Results (August, 1995)			
	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location
Volatiles:												
Vinyl Chloride	2	2	1/19	1-GW10	4J	4J	1/4	1-GW10	ND	ND	0/9	NA
1,1-Dichloroethene	ND	ND	0/19	NA	2J	2J	1/4	1-GW10	ND	ND	0/9	NA
1,2-Dichloroethene	1J	10	2/19	1-GW10	21	21	1/4	1-GW10	ND	23	1/9	1-GW10
Trichloroethene	1	27	3/19	1-GW17	8J	18	2/4	1-GW17	ND	4	1/9	1-GW10
Xylenes (total)	3	3	1/19	1-GW12	19	19	1/4	1-GW12	ND	150	1/9	1-GW12
Semivolatiles:												
Phenol	6J	6J	1/19	1-GW17DW	ND	ND	0/1	NA	NS	NS	NA	NA
Diethylphthalate	1J	1J	1/19	1-GW17DW	ND	ND	0/1	NA	NS	NS	NA	NA
Total Metals:												
Aluminum	347	457,000J	18/19	1-GW12	416	1,510	6/18	1-GW12	17.8	596	11/15	1-GW04
Antimony	34.3	88.6J	5/19	1-GW08	ND	ND	0/18	NA	ND	ND	0/15	NA
Arsenic	8.6	330	16/19	1-GW10	8.9	15.2	5/18	1-GW10	2.9	16	7/15	1-GW10
Barium	8.3	2,470	19/19	1-GW10	7.9	76.6	18/18	1-GW17	8.8	114	15/15	1-GW18
Beryllium	1	99.1	12/19	1-GW10	ND	ND	0/18	NA	ND	ND	0/15	NA
Cadmium	3.1	43.1	14/19	1-GW09	ND	ND	0/18	NA	ND	ND	0/15	NA
Calcium	3,270	720,000	19/19	1-GW15	900	137,000	18/18	1-GW15	1517	149000	15/15	1-GW18
Chromium	59.8J	800J	16/19	1-GW12	ND	ND	0/18	NA	6	6.5	2/15	1-GW04
Cobalt	6.5J	306	14/19	1-GW10	14.1	30	2/18	1-GW10	1.3	30	7/15	1-GW10
Copper	6	105	17/19	1-GW12	ND	ND	0/18	NA	6.4	21.2	5/15	1-GW11
Iron	479	417,000	19/19	1-GW09	263	29,200J	9/18	1-GW12	14.6	37700	9/15	1-GW12
Lead	16.6	163	16/19	1-GW14	1.4	2.4	2/18	1-GW08	1.7	4.7	3/15	1-GW17DW
Magnesium	671	30,900	19/19	1-GW15	550	7,090	18/18	1-GW16	820	14100	15/15	1-GW18
Manganese	9.6	2,250	18/19	1-GW11	2.5	1,200	14/18	1-GW10	2.8	1220	14/15	1-GW10

TABLE 1-1 (Continued)

COMPARISON OF GROUNDWATER ANALYTICAL RESULTS
FROM THE REMEDIAL INVESTIGATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

	Round 1 Results (May, 1994)				Round 2 Results (December, 1994)				Round 3 Results (August, 1995)			
Detected Contaminants	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location
Mercury	0.15	0.87	8/19	1-GW09	0.14	1.2	11/14	1-GW04	ND	ND	0/15	NA
Nickel	10	866	17/19	1-GW10	ND	ND	0.18	NA	5.6	13.2	2/15	1-GW10
Potassium	983	21,600J	19/19	1-GW14	305	5,180	18/18	1-GW17	226	5562	15/15	1-GW17
Selenium	4.5	22.6	5/19	1-GW12	ND	ND	0/18	NA	1.7	8.9	5/15	1-GW17
Silver	7.7J	19.9J	4/19	1-GW09	ND	ND	0/18	NA	ND	ND	0/15	NA
Sodium	3,520	13,800	19/19	1-GW12	1,410	19,200J	18/18	1-GW12	1890	16700	15/15	1-GW16
Thallium	4.7	4.7	1/19	1-GW14	ND	ND	0/18	NA	ND	ND	0/15	NA
Vanadium	4.2	811J	17/19	1-GW12	3.6	11.4	2/18	1-GW12	2.5	7.3	3/15	1-GW04
Zinc	9.2	2,410	17/19	1-GW10	ND	ND	0/18	NA	2.6	24	7/15	1-GW10
Dissolved Metals:												
Aluminum	35.6J	797J	10/19	1-GW09	ND	ND	0/18	NA	NS	NS	NA	NA
Antimony	46.6J	90.6J	8/19	1-GW11	ND	ND	0/18	NA	NS	NS	NA	NA
Arsenic	4.4	4.7	2/19	1-GW01	3.9	13.4	4/18	1-GW10	NS	NS	NA	NA
Barium	7.4	54.8	13/19	1-GW14	5.6	79.8	18/18	1-GW17	NS	NS	NA	NA
Calcium	1,690	136,000	19/19	1-GW02	876	127,000	18/18	1-GW15	NS	NS	NA	NA
Cobalt	4.1	35	5/19	1-GW10	13.4	29.6	2/18	1-GW10	NS	NS	NA	NA
Copper	6.8	6.8	1/19	1-GW16	7.0	18.1	18/18	1-GW03	NS	NS	NA	NA
Iron	126J	18,800	8/19	1-GW12	8,220J	24,100J	5/18	1-GW12	NS	NS	NA	NA
Lead	ND	ND	0/19	NA	3.0	3.0	1/18	1-GW11	NS	NS	NA	NA
Magnesium	422	8,990	19/19	1-GW16	587	7,440	18/18	1-GW16	NS	NS	NA	NA
Manganese	1.6	1,070	16/19	1-GW11	2.3J	1,220	12/18	1-GW10	NS	NS	NA	NA
Mercury	ND	ND	0/19	NA	0.13J	0.72	8/12	1-GW16DW	NS	NS	NA	NA
Nickel	8.6	20.8	4/19	1-GW10	15.1	15.1	1/18	1-GW10	NS	NS	NA	NA
Potassium	326J	3,180JJ	19/19	1-GW17	365	5,470	18/18	1-GW17	NS	NS	NA	NA

TABLE 1-1 (Continued)

COMPARISON OF GROUNDWATER ANALYTICAL RESULTS
FROM THE REMEDIAL INVESTIGATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

	Round 1 Results (May, 1994)				Round 2 Results (December, 1994)				Round 3 Results (August, 1995)			
Detected Contaminants	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location	Minimum Concentrations	Maximum Concentrations	Frequency of Detections	Max. Sample Location
Silver	ND	ND	0/19	NA	4.2J	4.2J	1/10	1-GW12	NS	NS	NA	NA
Sodium	3,280	15,000	19/19	1-GW12	1,230	17,400J	18/18	1-GW12	NS	NS	NA	NA
Thallium	4.8	4.8	1/19	1-GW17	ND	ND	0/18	NA	NS	NS	NA	NA
Vanadium	ND	ND	0/19	NA	3.1	3.9	2/18	1-GW12	NS	NS	NA	NA
Zinc	3.9	19.5	11/19	1-GW12	ND	ND	0/18	NA	NS	NS	NA	NA

Notes:

Groundwater concentrations are presented in µg/L (ppb)
J = Estimated
NA = Not applicable
ND = Not detected
NS = Not sampled
Monitoring wells 1-GW16DW and 1-GW17DW are deep wells.

TABLE 1-2

COMPARISON OF GROUNDWATER ANALYTICAL RESULTS FROM THE REMEDIAL INVESTIGATION
SITE 28, HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Detected Contaminants	Round 1 Results (May, 1994)				Round 2 Results (December, 1994)				Round 3 Results (August, 1995)			
	Minimum Concentration	Maximum Concentration	Frequency of Dection	Max. Sample Location	Minimum Concentration	Maximum Concentration	Frequency of Dection	Max. Sample Location	Minimum Concentration	Maximum Concentration	Frequency of Dection	Max. Sample Location
Pesticides:												
4,4'-DDE	0.06J	6.6J	5/13	28-TGWPA	ND	ND	0/5	NA	NS	NS	NA	NA
4,4'-DDD	0.06J	9	6/13	28-GW07	ND	ND	0/5	NA	NS	NS	NA	NA
4,4'-DDT	0.05J	0.37J	2/13	28-TGWPA	ND	ND	0/5	NA	NS	NS	NA	NA
gamma-Chlordane	0.05J	0.05J	1/13	28-GW08	ND	ND	0/5	NA	NS	NS	NA	NA
Total Metals:												
Aluminum	225	100,000J	12/13	28-GW05	420	1,670	3/12	28-GW08	376	376	1/8	28-GW13
Antimony	42.7	5,340	4/13	28-GW07	ND	ND	0/12	NA	ND	ND	0/8	NA
Arsenic	5.2	76.7	11/13	28-GW07	3.7	4.7	3/12	28-GW13	8.1	8.1	1/8	28-GW13
Barium	13.7	1,980	12/13	28-GW07	6.3	759	12/12	28-GW08	11	733	8/8	28-GW02
Beryllium	1.1	9.6	5/13	28-GW04	ND	ND	0/12	NA	ND	ND	0/8	NA
Cadmium	3.2	35.4	10/13	28-GW07	ND	ND	0/12	NA	10.7	10.7	1/8	28-GW07
Calcium	16,100	245,000	12/13	28-GW13	2,890	183,000	12/12	28-GW07	35700	209000	8/8	28-GW13
Chromium	33.2J	308J	10/13	28-GW07	ND	ND	0/12	NA	ND	ND	0/8	NA
Cobalt	4.1	30.4	6/13	28-GW07	ND	ND	0/12	NA	ND	ND	0/8	NA
Copper	12.2	2,250	7/13	28-GW07	14.5	44	2/12	28-GW08	ND	ND	0/8	NA
Iron	417	245,000	11/13	28-GW07	147J	40,600	11/12	280GW07	162	50100	7/8	280GW13
Lead	1.5	4,810	12/13	28-GW07	8.2	126	2/12	28-GW08	3.2	4.7	2/8	28-GW08
Magnesium	498	52,900	12/13	28-GW07	1,190	35,400	11/12	28-GW08	2130	30700	7/8	28-GW08
Manganese	29.6	3,330	11/13	28-GW07	16.9	1,450	11/12	28-GW08	1.5	454	8/8	28-GW13
Mercury	0.16J	2J	9/13	28-GW07	0.14J	0.58J	7/12	28-GW04	ND	ND	0/8	NA
Nickel	10.4	165	9/13	28-GW07	13.5	13.5	1/12	28-GW07	5.4	6.2	2/8	28-GW07DW
Potassium	2,100	63,500	12/13	28-GW07	866	84,700	12/12	28-GW08	1100	65700	8/8	28-GW08
Selenium	5.6J	5.6J	1/13	28-GW07	ND	ND	0/12	NA				

TABLE 1-2 (Continued)

COMPARISON OF GROUNDWATER ANALYTICAL RESULTS
FROM THE REMEDIAL INVESTIGATION
SITE 28, HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Detected Contaminants	Round 1 Results (May, 1994)				Round 2 Results (December, 1994)				Round 3 Results (August, 1995)			
	Minimum Concentration	Maximum Concentration	Frequency of Dection	Max. Sample Location	Minimum Concentration	Maximum Concentration	Frequency of Dection	Max. Sample Location	Minimum Concentration	Maximum Concentration	Frequency of Dection	Max. Sample Location
Silver	5.4J	37.9J	4/13	28-GW07	ND	ND	0/12	NA				
Sodium	6,770	744,000	12/13	28-GW01DW	5,670	803,000	12/12	28-GW01DW	5110	83300	8/8	28-GW01DW
Thallium	6.9J	6.9J	1/13	28-GW01DW	ND	ND	0/12	NA				
Vanadium	13.4	190J	10/13	28-GW01	6.9	6.9	1/12	28-GW07DW				
Zinc	23.1	9,220	10/13	28-GW07	331	331	1/12	28-GW08	14	14	1/8	28-GW08
Dissolved Metals:												
Aluminum	33.4J	706	7/13	28-TGWPA	19.6	105	4/12	28-GW06	NS	NS	NA	NA
Antimony	35.5J	70.2	2/13	28-TGWPA	ND	ND	0/12	NA	NS	NS	NA	NA
Arsenic	3.1	7.8	5/13	28-TGWPA	2	5.6	8/12	28-GW07	NS	NS	NA	NA
Barium	21.5	423	11/13	28-GW02	6.4	606	12/12	28-GW08	NS	NS	NA	NA
Calcium	6,400	187,000	13/13	28-MW13	3,820	195,000	12/12	28-MW13	NS	NS	NA	NA
Chromium	7.5J	7.5J	1/13	28-MW13	ND	ND	0/12	NA	NS	NS	NA	NA
Cobalt	4.5	4.5	1/13	28-GW06	ND	ND	0/12	NA	NS	NS	NA	NA
Copper	11.3	11.3	1/13	28-GW09DW	5.3	17.1	12/12	28-GW08	NS	NS	NA	NA
Iron	57.8	30,200J	7/13	28-GW05	10	32,600	11/12	28-GW07	NS	NS	NA	NA
Lead	1.81	1.8	1/13	28-GW06	6.9	6.9	1/12	28-GW09DW	NS	NS	NA	NA
Magnesium	455	41,200	12/13	28-GW07	1,360	34,400	11/12	28-GW08	NS	NS	NA	NA
Manganese	1.7J	603	12/13	28-GW08	20	1,160	11/12	28-GW08	NS	NS	NA	NA
Nickel	7.1	9.5	3/13	28-GW02	ND	ND	0/12	NA	NS	NS	NA	NA
Potassium	1,070	61,700	12/13	28-GW07	969	89,100	12/12	28-GW08	NS	NS	NA	NA
Silver	7.8	7.8	1/13	28-GW03	ND	ND	0/12	NA	NS	NS	NA	NA
Sodium	7,280	778,000	13/13	28-GW01DW	7,180	785,000	12/12	28-GW01DW	NS	NS	NA	NA
Vanadium	4.2	4.2	1/13	28-GW07DW	6.0	6.0	1/12	28-GW07	NS	NS	NA	NA
Zinc	7.3	44.6	3/13	28-GW06	ND	ND	0/12	NA	NS	NS	NA	NA

TABLE 1-2 (Continued)

COMPARISON OF GROUNDWATER ANALYTICAL RESULTS FROM THE REMEDIAL INVESTIGATION SITE 28, HADNOT POINT BURN DUMP LONG-TERM MONITORING WORK PLAN, CTO-0333 MCB, CAMP LEJEUNE, NORTH CAROLINA

Notes:

Groundwater concentrations are presented in µg/L (ppb)
J = Estimated
NA = Not applicable
ND = Not detected
NS = Not sampled
Monitoring wells 28-GW01DW, 28-GW07DW, and 28-GW09DW are deep wells.

SECTION 1.0 FIGURES

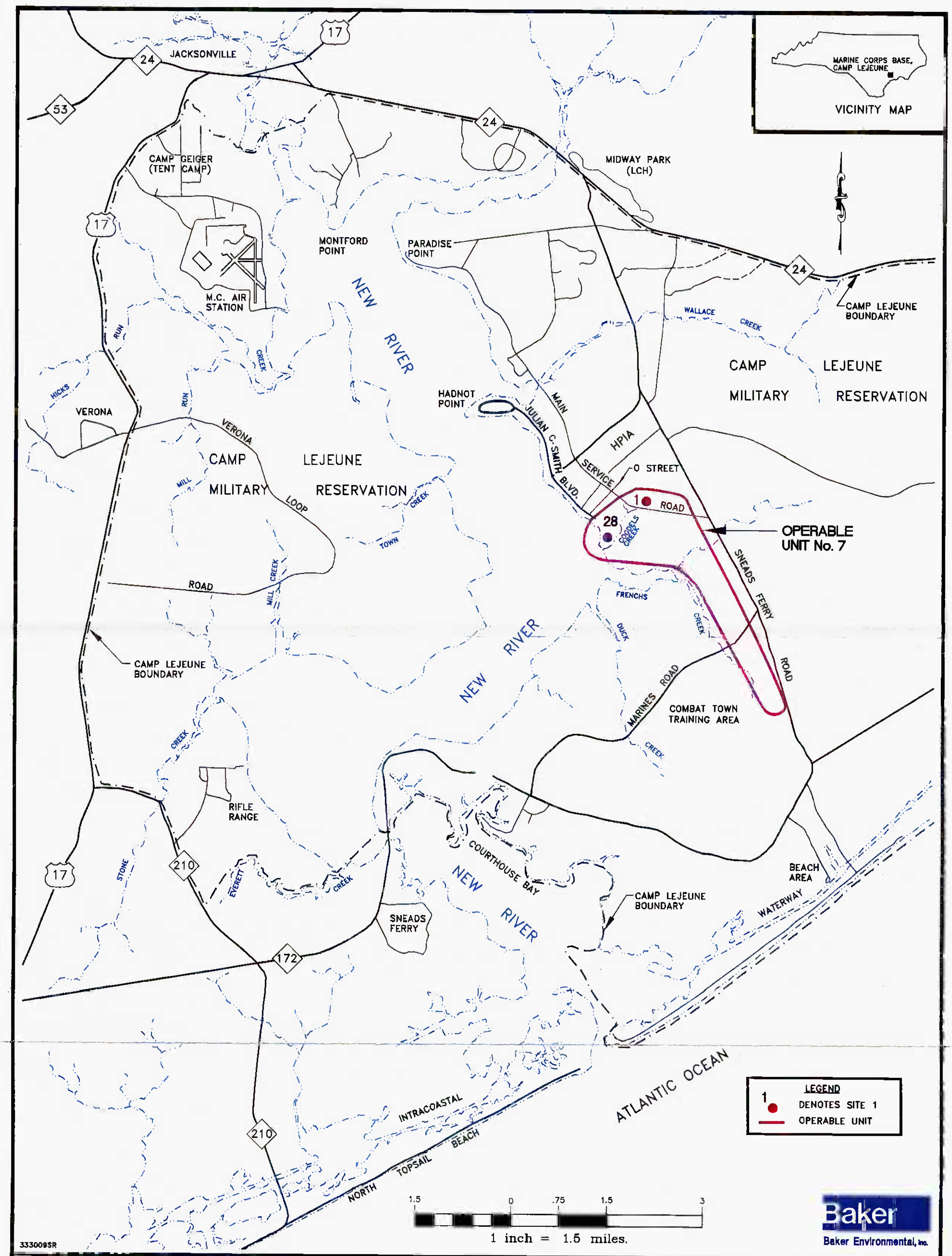
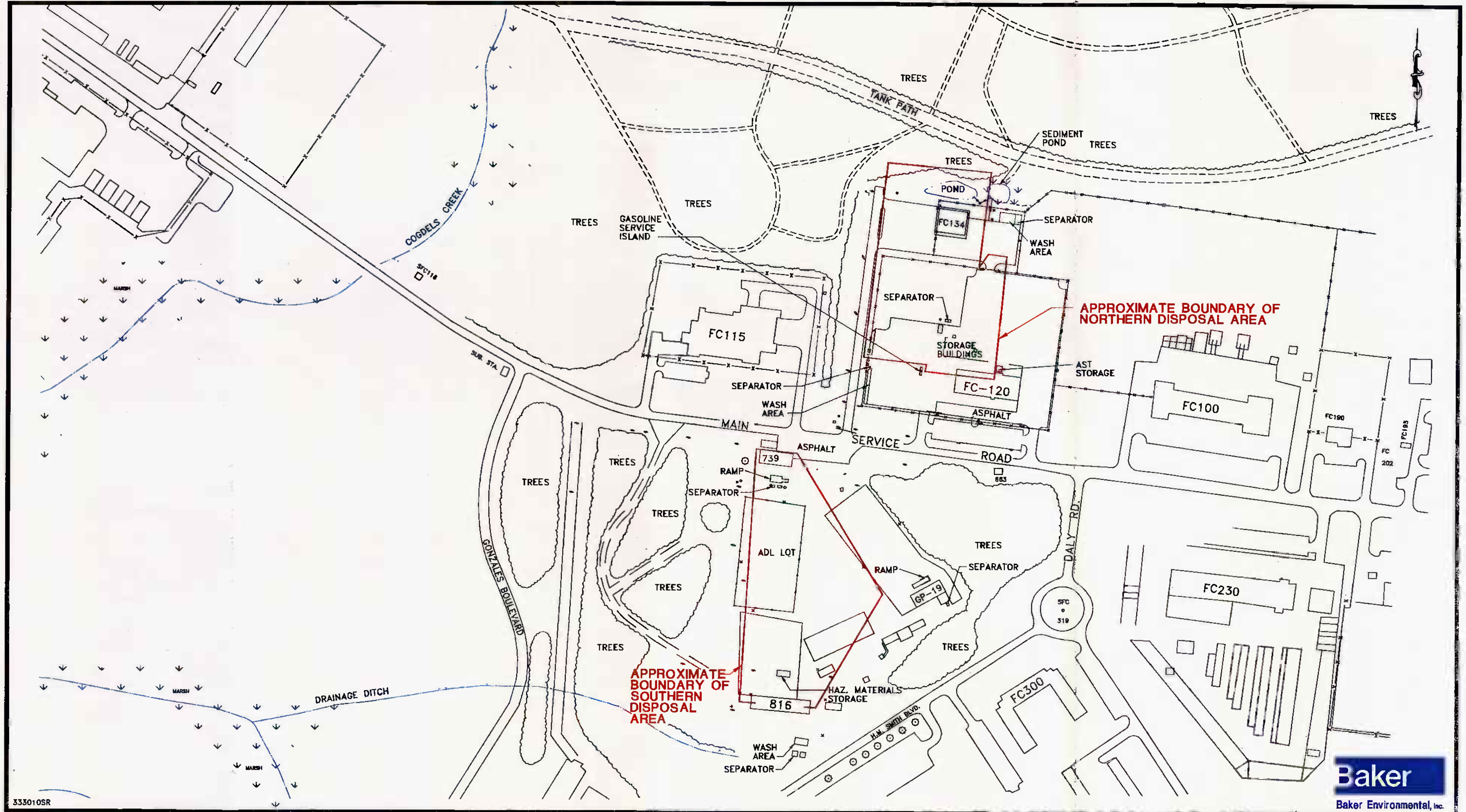


FIGURE 1-1
OPERABLE UNIT No. 7 – SITES 1 AND 28
MARINE CORPS BASE, CAMP LEJEUNE
LONG-TERM MONITORING WORK PLAN CTO-0333

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02303 IIBIV



Baker
Baker Environmental, Inc.

LEGEND

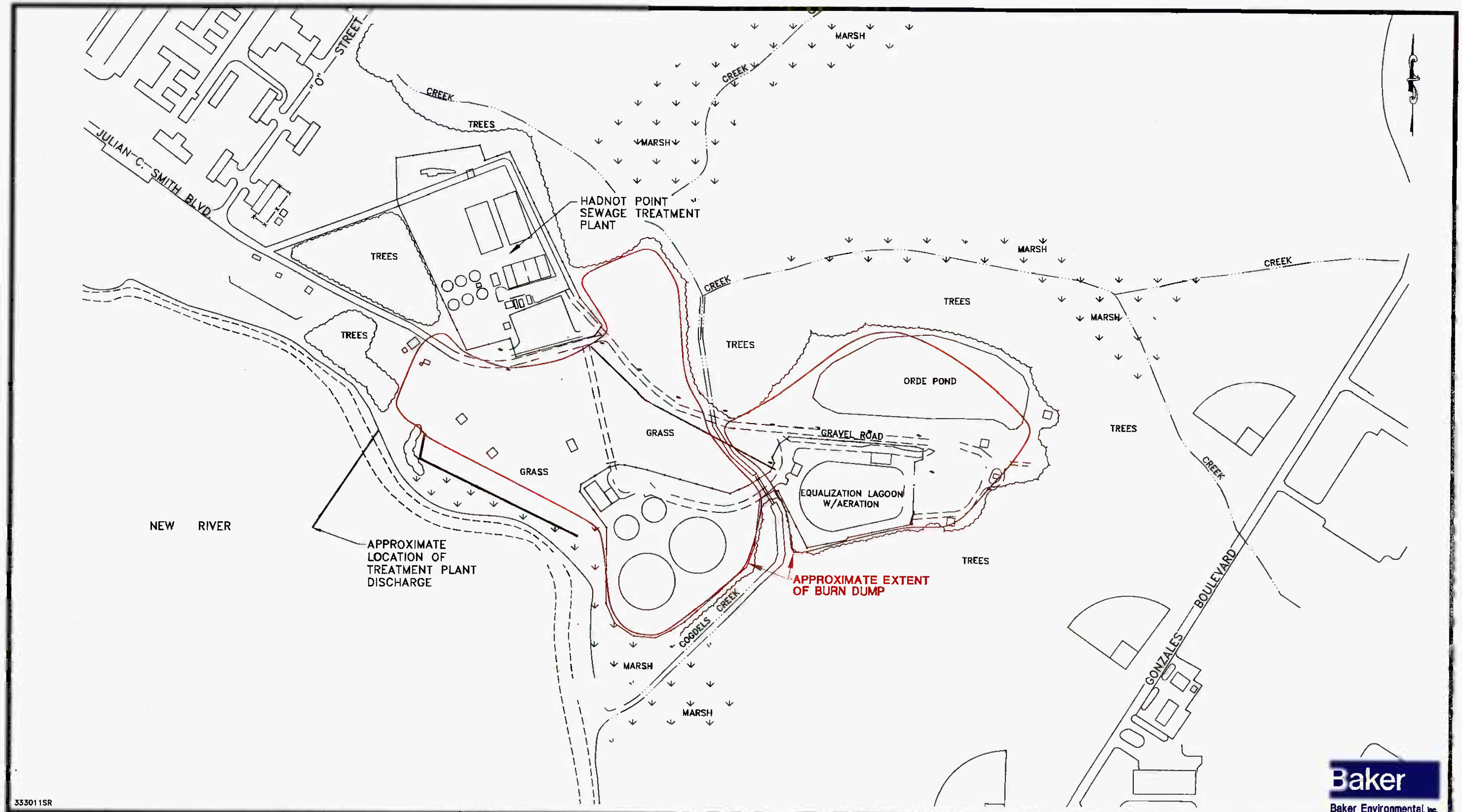
⌒ VEGETATION
—×— FENCE
—— CREEK/DRAINAGE
↓↓ MARSH
= = UNIMPROVED ROAD

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 1-2
SITE 1 – FRENCH CREEK LIQUIDS DISPOSAL AREA
LONG-TERM MONITORING WORK PLAN CTO-0333
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker

Baker Environmental, Inc.

LEGEND

❀	VEGETATION
—x—	FENCE
———	CREEK/DRAINAGE
✓ ✓	MARSH

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

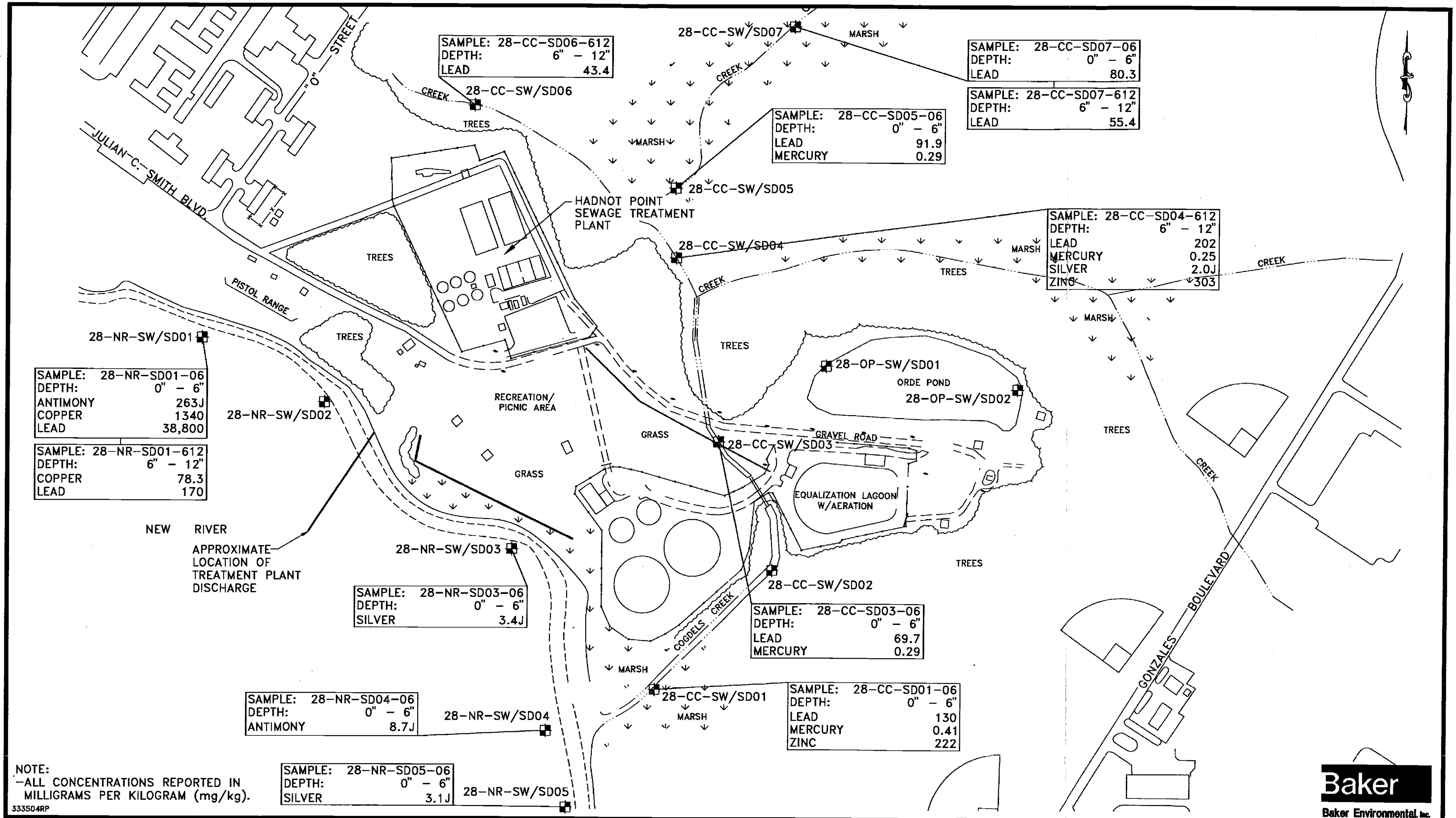
FIGURE 1-3

SITE 28 – HADNOT POINT BURN DUMP

LONG-TERM MONITORING WORKPLAN CTO-0333

MARINE CORPS BASE, CAMP LEJEUNE

NORTH CAROLINA



SAMPLE:	28-CC-SD06-612
DEPTH:	6" - 12"
LEAD	43.4

SAMPLE:	28-CC-SD07-06
DEPTH:	0" - 6"
LEAD	80.3

SAMPLE:	28-CC-SD07-612
DEPTH:	6" - 12"
LEAD	55.4

SAMPLE:	28-CC-SD05-06
DEPTH:	0" - 6"
LEAD	91.9
MERCURY	0.29

SAMPLE:	28-CC-SD04-612
DEPTH:	6" - 12"
LEAD	202
MERCURY	0.25
SILVER	2.0J
ZINC	303

SAMPLE:	28-NR-SD01-06
DEPTH:	0" - 6"
ANTIMONY	263J
COPPER	1340
LEAD	38,800

SAMPLE:	28-NR-SD01-612
DEPTH:	6" - 12"
COPPER	78.3
LEAD	170

SAMPLE:	28-NR-SD03-06
DEPTH:	0" - 6"
SILVER	3.4J

SAMPLE:	28-CC-SD03-06
DEPTH:	0" - 6"
LEAD	69.7
MERCURY	0.29

SAMPLE:	28-NR-SD04-06
DEPTH:	0" - 6"
ANTIMONY	8.7J

SAMPLE:	28-CC-SD01-06
DEPTH:	0" - 6"
LEAD	130
MERCURY	0.41
ZINC	222

SAMPLE:	28-NR-SD05-06
DEPTH:	0" - 6"
SILVER	3.1J

NOTE:
-ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg).

333504RP

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LEGEND

28-CC-SW/SD01 ⊞ SURFACE WATER AND SEDIMENT SAMPLING STATION LOCATION

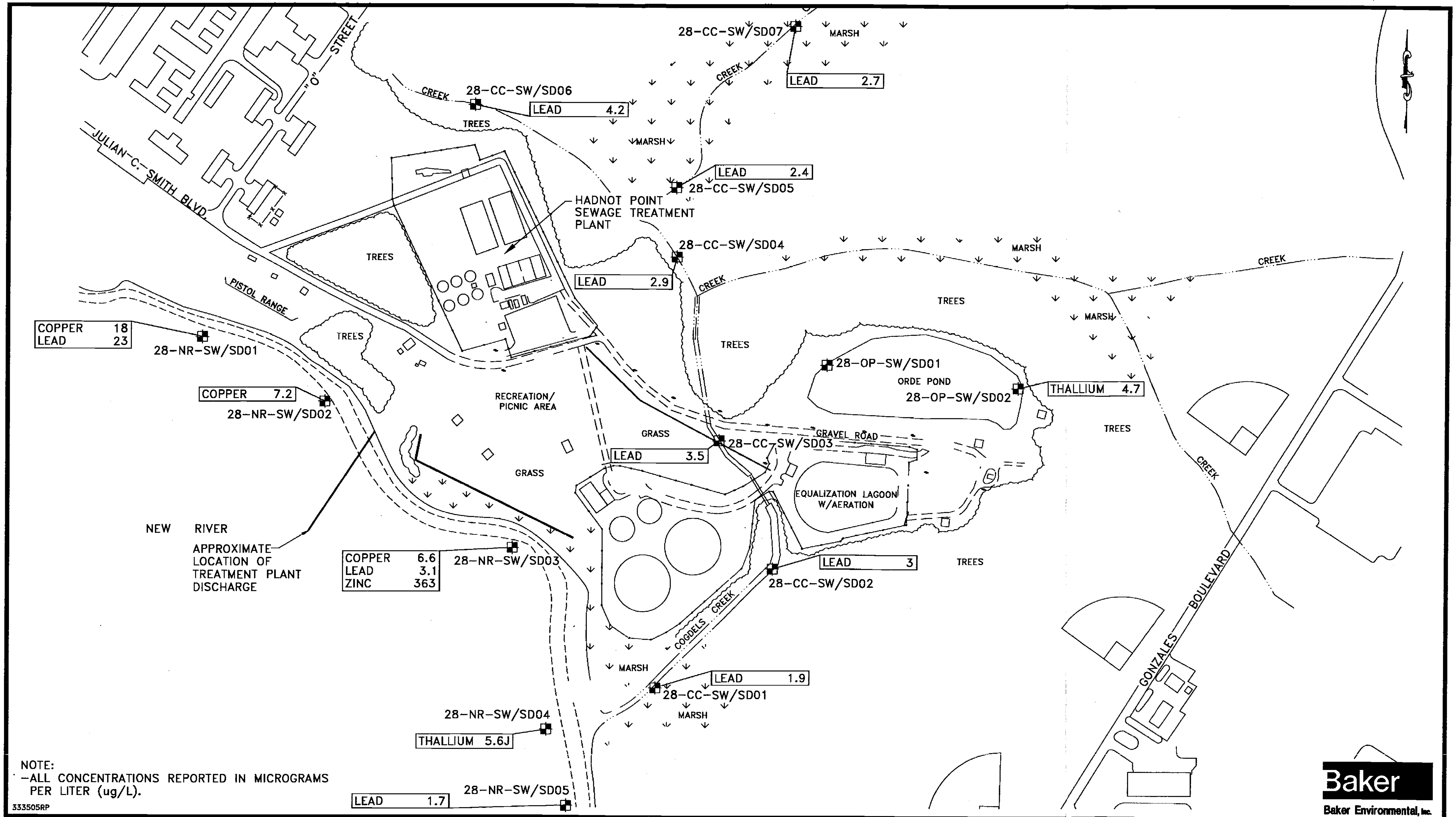
SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 1-4
POSITIVE DETECTIONS OF TAL METALS ABOVE FEDERAL SCREENING VALUES IN SEDIMENT FROM RI
SITE 28 - HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02303JJB2Z



NOTE:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/L).

333505RP

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LEGEND

28-CC-SW/SD01 SURFACE WATER AND SEDIMENT SAMPLING STATION LOCATION

300 0 150 300 600

1 inch = 300 ft.

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

FIGURE 1-5
POSITIVE DETECTIONS OF TAL METALS ABOVE FEDERAL SCREENING VALUES IN SURFACE WATER FROM RI SITE 28 – HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2.0 TECHNICAL APPROACH

To accomplish the overall project objectives, the technical approach will include the following tasks:

- Semiannual Groundwater Monitoring
- Semiannual Reporting
- Five-Year CERCLA Review
- Meetings

2.1 Semiannual Groundwater Monitoring

Groundwater samples will be collected on a semiannual basis (proposed for March and September of each year) at each site as required by the final ROD. The location of the monitoring wells to be sampled are shown on Figures 2-1 and 2-2 for Sites 1 and 28, respectively. The wells selected for long-term monitoring at Site 1 were chosen because they are located in the vicinity of the VOC plume area. At Site 28, wells located within or around the western burn dump were selected for long-term monitoring because the highest levels of metals were detected throughout that area during previous sampling events. At both sites, the surficial and Castle Hayne aquifers will be monitored.

Tables 2-1 and 2-2 summarize the analytical parameters for Sites 1 and 28, respectively. Site 1 groundwater samples will be analyzed for TCL volatiles and Site 28 groundwater samples will be analyzed for TAL metals (total). The parameters selected for each site were based on site history and the suspected contaminants released, and on the results of the RI and pre-work plan sampling results. All groundwater samples will be analyzed by Contract Laboratory Program (CLP) protocols using Level IV data quality [Naval Facilities Engineering Service Center (NFESC Level D)]. Section 3.0 of this Work Plan provides a detailed discussion of the groundwater sampling and well development procedures.

2.2 Semiannual Surface Water and Sediment Sampling (Site 28 only)

Surface water and sediment samples will also be collected on a semiannual basis at the New River, upgradient from Site 28. These locations were selected due to lead detections in surface water and sediment found during the RI which are believed to be associated with an active pistol range located on the New River. As shown on Figure 2-3, 3 surface water/sediment stations will be sampled; one upgradient, one adjacent, and one downgradient of the range. Both surface water and sediment samples will be analyzed for TAL metals by CLP protocols and using Level IV data quality. Section 3.0 provides a detailed discussion of the sampling procedures.

2.3 Semiannual Reporting

Following each round of monitoring, a report summarizing the groundwater sampling activities and results will be prepared by the contractor. The report shall consist of a cover letter, summary tables, and a sample location map. The report shall include a summary of the environmental and QA/QC sample results. Moreover, the report will identify samples which have exceeded a Federal MCL or NCWQS, report significant trends in the data (i.e., are contaminant levels increasing or decreasing), and provide recommendations for future actions (e.g., install new wells or add new wells to be sampled) if required. Summary tables will include the following:

- Positive Detection Summaries

- Comparisons with Federal MCLs and North Carolina Water Quality Standards
- Comparisons with Previous Rounds of Sampling Data
- Groundwater Elevation Summaries
- Field Parameter and Purging Measurements

All tables shall be prepared using the most recent versions of either Lotus or Excel. Additional information to be provided as attachments will include chain-of-custodies, field notes, well development logs, and the raw analytical data (Form 1 or equivalent).

A copy of the site drawings in AutoCADD release 12.0 will be provided to the contractor. Drawings/figure to be presented in the report shall include the following:

- Time Verses Trend Contaminant Plots
- Well Location Map
- Groundwater Contour Maps (Surficial and Castle Hayne aquifers)
- Contaminant Distribution Maps

2.4 Five-Year CERCLA Review

Under CERCLA, a 5-year review is required to evaluate the effectiveness of the selected remedy. The review will consist of preparing a report which will summarize the groundwater data for the first 5 years of monitoring and provide recommendations for continued monitoring, if required, or other alternative actions (e.g., additional wells, remedial action, etc.). The contractor will submit the report to the Officer in Charge, Facilities Support Contracts Branch of the Public Works Department, Camp Lejeune. The Facilities support Contracts Branch will be responsible for sending the reports to EMD for distribution.

2.5 Meetings

A one-day meeting will be conducted on a yearly basis to provide technical updates to LANTDIV and the Activity. The meetings will be conducted in September at the Activity. The contractor will be required to submit written meeting minutes within two weeks of the meeting.

SECTION 2.0 TABLES

TABLE 2-1

PROPOSED MONITORING WELLS TO BE SAMPLED
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

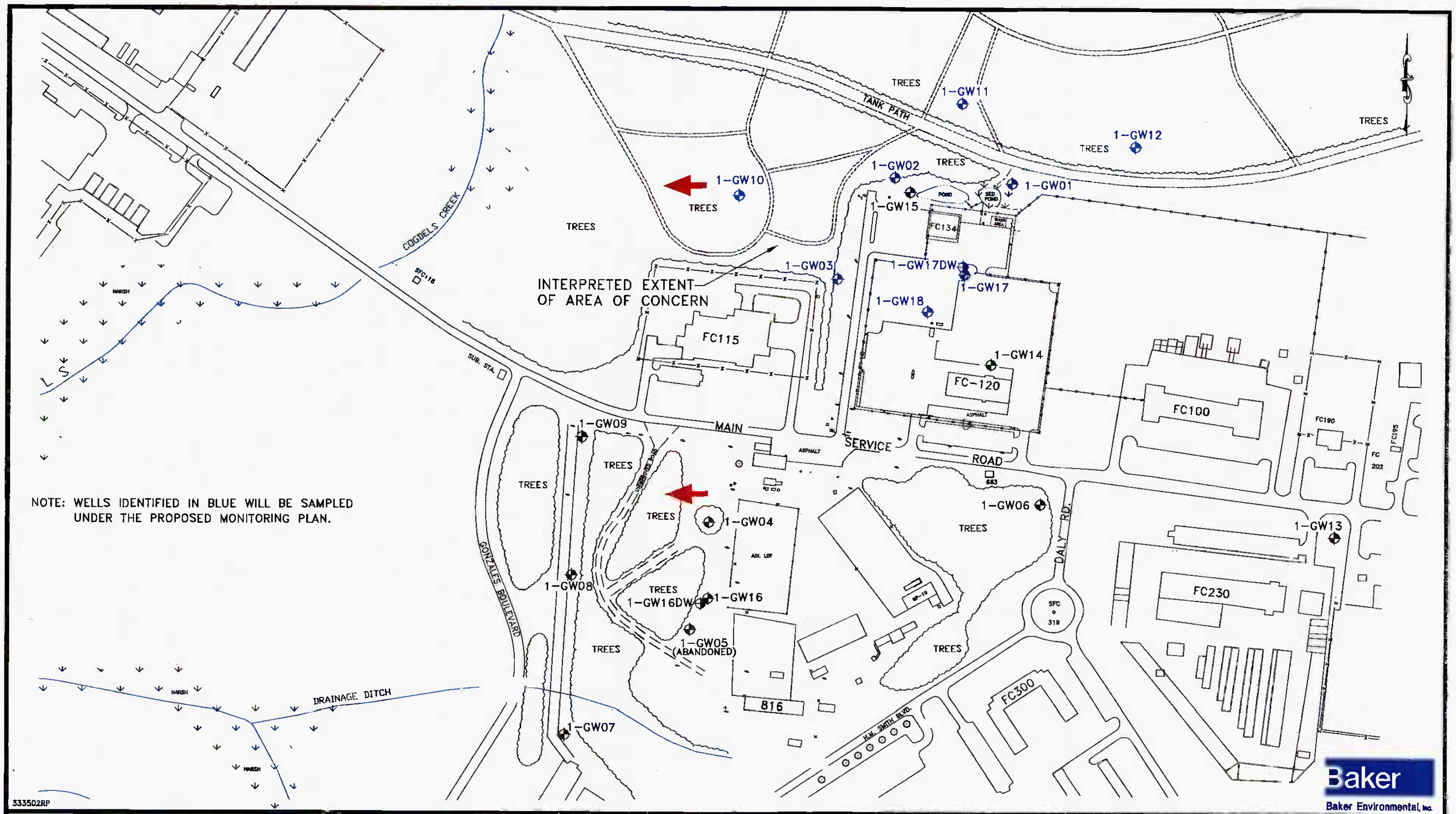
Well No.	Analysis	Rationale
1-GW01	TCL Volatiles	Monitor upgradient conditions in the surficial aquifer
1-GW02	TCL Volatiles	Monitor downgradient conditions in the surficial aquifer
1-GW03	TCL Volatiles	Monitor downgradient conditions in the surficial aquifer
1-GW10	TCL Volatiles	Monitor downgradient conditions in the surficial aquifer
1-GW11	TCL Volatiles	Monitor upgradient conditions in the surficial aquifer
1-GW12	TCL Volatiles	Monitor upgradient conditions in the surficial aquifer
1-GW17	TCL Volatiles	Monitor conditions within the source area in the surficial aquifer
1-GW18	TCL Volatiles	Monitor downgradient conditions in the surficial aquifer
1-GW17DW	TCL Volatiles	Monitor conditions within the source area in the Castle Hayne aquifer

TABLE 2-2

PROPOSED MONITORING WELLS TO BE SAMPLED
SITE 28, HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well No.	Analysis	Rationale
28-GW01	TAL Metals	Monitor conditions downgradient of the burn dump in the surficial aquifer
28-GW02	TAL Metals	Monitor conditions downgradient of the burn dump in the surficial aquifer
28-GW04	TAL Metals	Monitor conditions upgradient of the burn dump in the surficial aquifer
28-GW07	TAL Metals	Monitor conditions within the burn dump in the surficial aquifer
28-GW08	TAL Metals	Monitor conditions upgradient of the burn dump in the surficial aquifer
28-GW01DW	TAL Metals	Monitor conditions downgradient of the burn dump in the Castle Hayne aquifer
28-GW07DW	TAL Metals	Monitor conditions within the burn dump in the Castle Hayne aquifer

SECTION 2.0 FIGURES



NOTE: WELLS IDENTIFIED IN BLUE WILL BE SAMPLED UNDER THE PROPOSED MONITORING PLAN.

Baker

Baker Environmental, Inc.

LEGEND

1-GW07 ⊕ SHALLOW MONITORING WELL

1-GW16DW ⊕ DEEP MONITORING WELL

→ APPROXIMATE DIRECTION OF GROUNDWATER FLOW

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

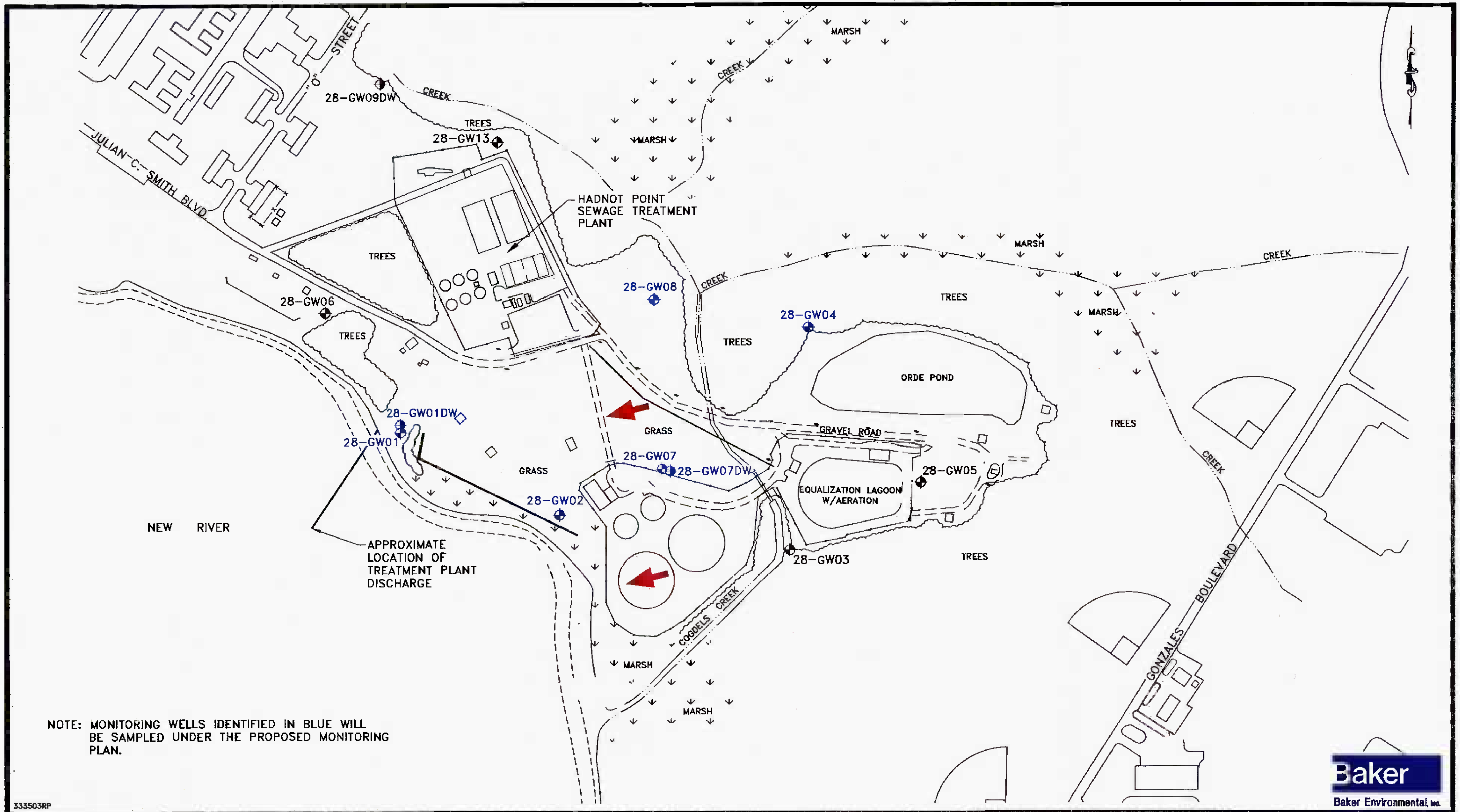
300 0 150 300 600

1 inch = 300 ft.

FIGURE 2-1
PROPOSED MONITORING WELLS
TO BE SAMPLED – SITE 1
LONG-TERM MONITORING WORK PLAN CTO-0333

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02303JJB3Y



NOTE: MONITORING WELLS IDENTIFIED IN BLUE WILL BE SAMPLED UNDER THE PROPOSED MONITORING PLAN.

Baker Environmental, Inc.

LEGEND

28-GW01 ⊕	SHALLOW MONITORING WELL
28-GW01DW ⊕	DEEP MONITORING WELL
➡	APPROXIMATE DIRECTION OF GROUNDWATER FLOW

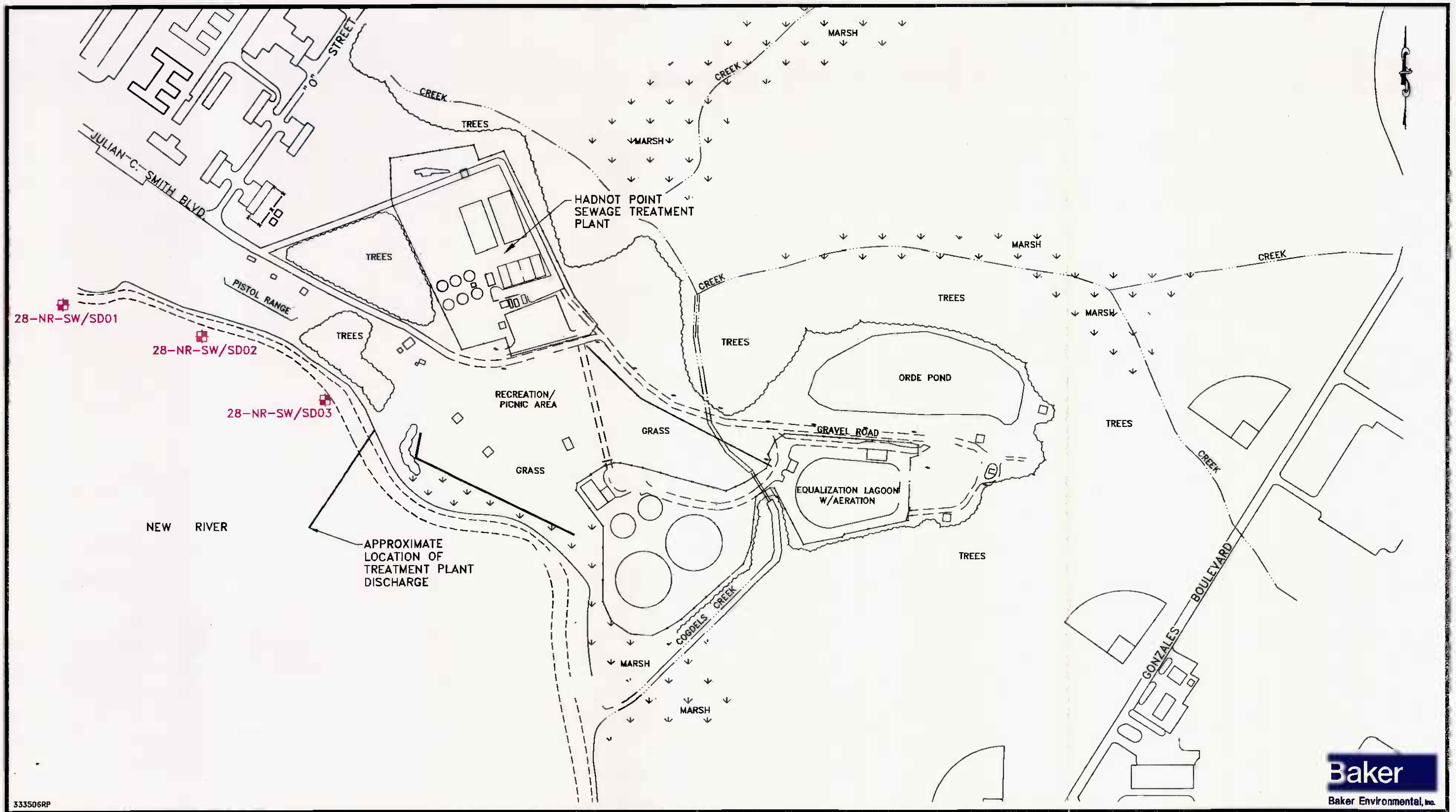
SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 2-2
PROPOSED MONITORING WELLS TO BE SAMPLED – SITE 28
LONG-TERM MONITORING WORK PLAN CTO-0333

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker Environmental, Inc.

LEGEND

28-NR-SW/SD01 PROPOSED SURFACE WATER AND SEDIMENT SAMPLING LOCATION

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 2-3
PROPOSED SURFACE WATER AND
SEDIMENT SAMPLING LOCATIONS
SITE 28 – HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

3.0 FIELD INVESTIGATION PROCEDURES

Section 3.0 provides specific procedures for implementing the field program. Procedures for well development, groundwater sampling, QA/QC sampling, and investigation derived waste management are included in this section.

3.1 Well Development

All monitoring wells will be redeveloped on an annual basis prior to the first groundwater sampling event of the year. The purposes of well development is to stabilize and increase the permeability of the filter pack around the well screen, to restore the permeability of the formation which may have been reduced by the drilling operations, and to remove fine-grained materials that may have entered the well or filter pack during installation. The selection of the well development method typically is based on drilling methods, well construction and installation details, and the characteristics of the formation.

Shallow wells (less than 25 feet in depth) will be developed using a low-yield pump in combination with surging using a surge block. Surging will be initiated during the mid-development stage and will continue for a period of 10 minutes. Hand bailing would be used as the only means of well development to avoid the well going dry due to slow groundwater recharge to the well. due to the bailing action achievement of a final turbidity of 10 units or less may not be possible. Intermediate and deep monitoring wells (deeper than 25 feet in depth) will be developed using compressed air (equipped with an air filter) in combination with surging. All downhole tubing shall be dedicated per well to minimize cross-contamination (e.g., PVC flexhose). Moreover, the groundwater generated during development shall be pumped onto the ground surface.

All wells shall be developed until well water runs relatively clear of fine-grained materials. Note that the water in some wells does not clear with continued development. Typical limits placed on well development may include any one of the following:

- Clarity of water based on visual determination
- A maximum time period (typically one hour for shallow wells)
- A maximum well volume (typically three to five well volumes)
- Stability of pH, specific conductance, temperature and turbidity (most critical parameter; less than 10 turbidity units should be achieved) measurements. Typically less than 10 percent change between three successive measurements are used to determine stability. If a turbidity of 10 or less is not achieved during development within a three hour period, the well will be considered "developed" (this shall be noted in the field logbook).

A record of the well development shall be completed to document the development process.

A minimum period of 48 hours must elapse between the end of development and sampling of a well. This equilibration period allows groundwater unaffected by the installation of the well to occupy the vicinity of the screened interval. Tables 3-1 and 3-2 provide well construction details for the Site 1 and 28 monitoring wells, respectively.

3.2 Groundwater Sample Collection

The monitoring wells will be sampled via low-flow methods. Low-flow is defined as a flow rate similar to the ambient flow rate in the screened formation.

A peristaltic pump will be used to purge the wells and collect the samples. VOC loss through suction degassing is expected to be insignificant due to the very low flow rates to be used. The procedure for collecting groundwater samples is detailed in this section, and has been assembled from ESD guidance and recently published papers and other documents.

3.2.1 Low-Flow Purging Vs. High-Flow Purging

A number of recent studies have demonstrated that low-flow purging and sampling is a preferable to bailing or high-flow purging and sampling. High-rate pumping is described as a rate greater than, or similar to, the development rate. Some findings include:

- High-flow pumping and bailing may overdevelop a well, causing damage to the well and filter pack (USEPA, 1992).
- High-flow pumping and bailing may disturb accumulated corrosion/reaction products, or sediment (USEPA, 1992), or potentially mobilize particulate or colloidal matter from the formation (Barcelona, Wehrmann and Varljen, 1994).
- High-flow pumping may induce flow into the well from groundwater in the formation above the well screen (USEPA, 1992).
- High-flow pumping and bailing may cause loss of VOCs. The velocities at which groundwater enters a bailer can actually correspond to unacceptably high purge rates (USEPA, 1992).
- The use bailers can result in composite averaging by mixing of water across the screen interval (Barcelona, Wehrmann and Varljen, 1994), resulting in unreproducible and unrepresentative data.

3.2.2 Selection of Water Quality Indicator Parameters

The water quality indicator parameters for stabilization will include dissolved oxygen, turbidity, pH, and specific conductance. Use of these water quality parameters has precedence in recent studies. Dissolved oxygen and turbidity are more sensitive indicators of "fresh" groundwater than pH, specific conductance, and temperature (Puls and Powell, 1992). Barcelona, Wehrmann and Varljen, 1994, suggest that dissolved oxygen and specific conductance are good indicators of stabilization with respect to VOC sampling. Puls and Paul, 1995 used dissolved oxygen, turbidity, pH, and specific conductance as indicators of stabilization.

3.2.3 Purge Requirements

Purge volume will not be based on well volume. However, because of the placement of the sampling device intake (discussed below), a minimum of one well volume will be removed. It has been demonstrated that purge volumes were independent of well depth and casing volumes (Puls and

Paul, 1995). Additionally, rules of thumb applied to purge volume requirements (e.g., three to five well volumes) do not necessarily yield representative samples. Stabilization of certain indicator parameters at fixed pumping rates may provide consistent results (Barcelona, Wehrmann and Varljen, 1994). Both studies showed that water quality parameters stabilization was a reasonable predictor of contaminant concentration stabilization. Generally, the contaminant concentrations stabilized before the water quality parameters did.

The sampling device intake was placed within the screened interval of the wells studied in the two studies referenced above. The Puls and Paul study showed that stabilization occurred in all wells studied within two well volumes. The Barcelona, Wehrmann and Varljen study showed that dissolved oxygen and specific conductance stabilized in all wells studied within 50% of one bore volume. The ESD suggests that the intake be placed just below the top of water in the well. Consequently, following this guideline, the stabilization volume may be greater than the stabilization volumes of the referenced studies.

3.2.4 Purging and Sampling Procedure

The following procedures shall be used to conduct the low-flow purge and sampling:

1. The protective casing (for existing wells) will be unlocked, the well cap will be removed, and escaping gases will measured at the well head using a PID or FID. This will determine the need for respiratory protection.

2. The well will be allowed to equilibrate to atmospheric pressure, in the event that a vent hole was not installed in the well.

3. The static water level will be measured. The total depth of the well will not be measured, as not to stir up any sediment. The total depth will be obtained from boring logs. The water volume in the well will then be calculated.

4. The sampling device intake (virgin, 1/4 inch ID polypropylene tubing) will be slowly lowered until the bottom end is 2 to 3 feet below the top of water. Based on historical water levels, this depth will be a point within the screened interval. Next, the water level probe will be placed into the well, just above the water.

5. Purging will then begin. The discharge rate will be measured using a stopwatch and calibrated container. The flow rate will be adjusted to ambient flow conditions (i.e., no drawdown is observed in the well.) Flow rates of less than 1 liter per minute (L/min) are expected.

6. The water quality parameters, including dissolved oxygen, turbidity, temperature, pH, and specific conductance will be measured frequently (e.g., every 2 minutes).

7. Purging will be complete when three successive water quality parameters readings have stabilized within 10%, or there is no further discernable upward or downward trend. At low values certain water quality parameters (such as turbidity and dissolved oxygen) may vary by more than 10%, but have reached a stable plateau.

8. Upon water quality parameters stabilization, groundwater samples will be collected. Samples for volatiles analysis will be collected first, followed by total metals. Sample bottles will be labeled prior to sample collection.

9. Replace the polypropylene and silicon (from pump) tubing between wells.

10. The sample jars will be stored in a cooler with ice (at 4°C) until laboratory shipment. Samples must be shipped within 24 hours of collection.

3.2.5 Water Level Measurements

Water levels in groundwater monitoring wells shall be measured from the top of the PVC casing, using an electronic water level measuring device (water level indicator). Water levels are measured by lowering the probe into the well until the device indicates that water has been encountered, usually with either a constant buzz, or a light, or both. The water level is recorded to the nearest foot (0.01) using the graduated markings on the water level indicator cord. This measurement, when subtracted from the measuring point elevation, yields the groundwater elevation. Measurements will be obtained from all site monitoring wells and shall be collected within a 4-hour period.

3.3 Surface Water Sample Collection

The following procedures will be used for the collection of surface water samples. At each station, samples will be collected at the approximate mid-vertical point or near the bank of the surface water body. Water samples at the furthest downstream station will be collected first, with subsequent samples taken at the next upstream station(s). Care fill be taken to ensure that the sampler does not contact and/or stir up the sediments, while still being relatively close to the sediment-water interface. Sediment samples will be collected after the water samples to minimize sediment disturbance and suspension.

The surface water samples will be collected by dipping the laboratory-supplied sample bottles directly into the water. Clean PVC gloves will be worn by sampling personnel at each sampling station.

All sample containers not containing preservative will be rinsed at lest once with the sample water prior to final sample collection. In addition, the sampling container used to transfer the water into sample bottles containing preservatives will be rinsed once with sample water.

Temperature, pH, specific conductance, salinity, and dissolved oxygen measurements of the surface water will be measured in the field at each sampling location, immediately following sample collection.

The sampling location will be marked by placing a wooden stake and bright colored flagging at the nearest bank or shore. The sampling location will be marked with indelible ink on the stake. In addition, the distance from the shore and the approximate location will be estimated using triangulation methods, and recorded and sketched in the field log book.

The following information will be recorded in the field logbook:

- Project location, date and time
- Weather
- Sample location, number, and identification number
- Flow conditions (i.e., high, low, in flood, etc.)
- On site water quality measurements
- Visual description of water (i.e., clear, cloudy, muddy, etc.)
- Sketch of sampling location including boundaries of the water body, sample location (and depth), relative position with respect to the site, location of wood identifier stake
- Names of sampling personnel
- Sampling technique, procedure, and equipment used

3.4 Sediment Sample Collection

The following procedures will be used for the collection of sediment samples. At each station, a surface sediment sample will be collected at a depth of 0 to 6 inches, using a stainless steel hand-held coring instrument. A new or decontaminated stainless steel liner tube, fitted with an eggshell catcher to prevent sample loss, will be used at each station. The coring device will be pushed into the sediments to a minimum depth of 8 inches, or until refusal, whichever is encountered first. The sediments will be extruded with a decontaminated extruder into the appropriate sample containers.

The sampling procedures for using the hand-held coring instrument (i.e., stainless-steel core sampler) are outlined below:

1. Inspect and prepare the corer:

    a. Inspect the core tube and, if one is being used, the core liner. Core tube and core liner must be firmly in place, free of obstruction throughout its length. Bottom edge of core tube, or of the nose piece, should be sharp and free of nicks or dents.

    b. Check the flutter valve for ease of movement.

    c. Check the flutter valve seat to make sure it si clear of any obstruction that could prevent a tight closure.

    d. Attach a line securely to the core sampler. The line should be free of any frayed or worn sections, and sufficiently long to reach bottom.

2. Get in position for the sampling operation--keeping in mind that disturbance of the bottom area to be sampled should be avoided.

3. Line up the sampler, aiming it vertically for the point where the sample is to be taken.

4. Push the core sampler, in a smooth and continuous movement, through the water and into the sediments--increasing the thrust as necessary to obtain the penetration desired.

5. If the corer has not been completely submerged, close the flutter valve by hand and press it shut while the sample is retrieved. Warning: the flutter valve must be kept very wet if it is to seal properly.

6. Lift the core sampler clear of the water, keeping it as nearly vertical as possible, and handle the sample according to the type of core tube.

7. Secure and identify the new sample. Unscrew the nose cone. Pull the liner out. Push out any extra sediments (greater than 6 inches).

8. Seal all sample jars tightly.

9. Label all samples.

3.5 Quality Control/Quality Assurance Program

Four types of field QA/QC samples will be submitted to the laboratory: trip blanks, equipment rinsates, field blanks, and field duplicates. The results from the field quality control samples will be used to determine the overall quality of the data. A breakdown by type of sample with which the QA/QC samples will be submitted to the laboratories is given in Table 3-3.

3.5.1 Field Blanks

Organic-free water is taken to the field in sealed containers and poured into the appropriate sample containers at pre-designated locations. This is done to determine if any contaminants present in the area may have an affect on the sample integrity. Field blanks should not be collected in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere and originating from a source other than the source being sampled. One field blank per sampling event should be collected.

3.5.2 Trip Blank

Analysis of trip blanks will be performed to monitor possible cross-contamination of volatiles during shipment and collection of samples. Trip blanks are initiated in the laboratory prior to the shipping of sample packs. A corresponding trip blank will be prepared for each set of samples to be analyzed for volatile organic compounds.

Trip blank samples will be prepared by adding four drops of concentrated hydrochloric acid and then filling the container with organic-free deionized water (ASTM Type II). The trip blanks accompany the samples through shipment to the sample site, sample collection, shipment to the laboratory, and storage of the samples.

3.5.3 Equipment Rinsates

Equipment rinsates are the final organic-free deionized water rinse from equipment cleaning collected daily during a sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are found int he rinsate, the remaining samples must be analyzed. The results of the blanks will be used to flag or assess levels of analytes in the samples. This comparison is made during validation. The rinsates are analyzed for the same parameters as the related samples.

3.5.4 Field Duplicates

Duplicate water samples should be collected simultaneously with the environmental sample. Field duplicates should be collected at a frequency of 10% per sample matrix. All the duplicates should be sent to the primary laboratory responsible for analysis.

3.5.5 Spike Analysis

The same samples used for field duplicates shall be split by the laboratory and used by the laboratory as the laboratory duplicate or matrix spike. This means that for the duplicate sample, there will be analyses of the normal sample, the field duplicate, and the laboratory matrix spike/duplicate. Adequate sample volume must be provided to the analytical subcontractor to perform these analyses.

If the analyses indicate contamination of the trip blank, the sample sources may be resampled. If the extent and nature of the contamination does not warrant such actions, the data will be accepted as valid.

3.6 Sample Designation

In order to identify and accurately track the various samples, all samples collected during this investigation, including QA/QC samples, will be designated with a unique number. The number will serve to identify the investigation, the site, the area within the site, the sample media, sampling location, or round of sample, and QA/QC qualifiers.

The sample designation format is as follows:

Site # - Media or QA/QC - Round

An explanation of each of these identifiers is given below.

Site#	This investigation includes Sites 1 and 28.
Media	GW = Groundwater
QA/QC	(FB) = Field Blank (D) = Duplicate Sample (following round) (TB) = Trip Blank (ER) = Equipment Rinsate

Round	Round indicator will be used for groundwater samples (round one and round two). For example:

Under this sample designation format the sample number 1-GW17DW-01D refers to:

1-GW17DW-01D	Site 1
1-GW17DW-01D	Groundwater sample
1-GW17DW-01D	Monitoring well #17
1-GW17DW-01D	Deep well
1-GW17DW-01D	Round 1
1-GW17DW-01D	Duplicate (QA/QC) sample

This sample designation format will be followed throughout the project. Required deviations to this format in response to field conditions will be documented.

3.7 Investigation Derived Waste

Investigation derived wastes (IDW) will be generated during the long-term monitoring program. The IDW to be generated will include purge and development groundwater, personal protective equipment (PPE) and clothing (PPC), and sampling expendables. Table 3-4 summarizes the estimated IDW water quantities per site. The following describes the procedures for IDW management.

3.7.1 Groundwater IDW Management

Groundwater obtained during well development and purging of site wells will be discharged to the ground surface near the monitoring well. If contaminant levels at the sites are determined to consistently increase over time, the water will be temporarily containerized, sampled, and transported off-site to one of the operating groundwater treatment facilities on base (i.e., Hadnot Point or site 82). The decision to containerize the water will be determined by Activity and LANTDIV personnel.

3.7.2 Expendable IDW Management

Expendable supplies/equipment (e.g., spent PVC tubing, tyvex) will be double bagged, labeled, and disposed of as solid waste in a on site refuse container. If the expendables are exposed to potentially hazardous substances or excessively contaminated groundwater, they will be placed in a drum and disposed of in a solid waste landfill.

SECTION 3.0 TABLES

TABLE 3-1

SUMMARY OF WELL CONSTRUCTION DETAILS
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well No.	Date Installed	Top of PVC Casing Elevation (feet, above msl)(1)	Ground Surface Elevation (feet, above msl)	Well Depth (feet, below ground surface)	Screen Interval Depth (feet, below ground surface)	Sand Pack Interval Depth (feet, below ground surface)	Bentonite Interval Depth (feet, below ground surface)	Coordinates	
								East	North
1-GW01	1984	16.50	13.3	24	Unknown	Unknown	Unknown	2502939.82	333939.68
1-GW02	1984	17.95	15.7	23	9-23	Unknown	Unknown	2502581.98	333956.61
1-GW03	1984	21.78	19.7	23	9-23	Unknown	Unknown	2502407.66	333647.24
1-GW04	1984	24.41	22.9	31	17.5-31	Unknown	Unknown	2502017.58	332902.95
1-GW06	1984	27.32	25.1	29	Unknown	Unknown	Unknown	2503031.69	332958.07
1-GW07	4/12/94	23.12	20.2	25	10-24.6	8-26	6-8	2501578.13	332253.49
1-GW08	4/12/94	22.31	19.4	25	10.1-24.3	8-25	6-8	2501598.15	3327470.42
1-GW09	4/10/94	17.62	14.9	21	6.1-20.4	4-21	2-4	2501628.22	333163.09
1-GW10	4/11/94	18.07	15.3	24	9.1-23.4	7-24	5-7	2502105.18	333902.57
1-GW11	4/10/94	13.18	10.4	17	2-16.4	1-17	0.5-1	2502786.13	334181.98
1-GW12	4/10/94	16.33	13.8	17	3.1-17.3	2-17	0.5-1.5	2503317.40	334050.00
1-GW13	4/9/94	32.33	29.5	31	16-30.3	14-32	12-14	2503931.78	332860.01
1-GW16	4/13/94	23.71	20.7	27	12-26.3	10-27	8-10	2502017.42	332670.11
1-GW17	4/19/94	23.00	20.1	25	10-24.3	8-25	6-8	2502796.83	333662.02
1-GW18	8/15/95	21.09	20.8	25	10-25	8-25	6-8	2502683.31	333547.94
1-GW16DW	5/2-4/94	23.50	20.8	122	107-122	103-122	99-103	2501994.83	332654.53
1-GW17DW	5/5-7/94	21.91	19.1	122	105-120	97-122	92-97	2502792.01	333685.99

Notes:

(1) msl = mean sea level

Horizontal positions are referenced to N.C. State Plane Coordinate System (NAD 27) CF = 0.9999216 from USMC Monument Toney.

Vertical datum NGVD 29.

TABLE 3-2

SUMMARY OF WELL CONSTRUCTION DETAILS
SITE 28, HADNOT POINT BURN DUMP
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well No.	Date Installed	Top of PVC Casing Elevation (feet, above msl)$^{(1)}$	Ground Surface Elevation (feet, above msl)	Well Depth (feet, below ground surface)	Screen Interval Depth (feet, below ground surface)	Sand Pack Interval Depth (feet, below ground surface)	Bentonite Interval Depth (feet, below ground surface)	Coordinates	
								East	North
28-GW01	4/20/94	7.34	4.8	17	2.5-16.2	1.5-17	0-1.5	2498347.15	331825.74
28-GW02	1984	5.96	3.8	21	7.7-21	Unknown	Unknown	2498828.72	331574.84
28-GW03	1984	5.90	3.6	20	6.8-20	Unknown	Unknown	2499532.55	331466.91
28-GW04	1986	8.17	4.4	29	Unknown	Unknown	Unknown	2499587.49	332145.07
28-GW05	4/7/94	15.47	15.6	24	9-23.4	7-24	5-7	2499931.97	331673.03
28-GW06	4/7/94	19.98	17.2	30	15-29.3	10-30	8-10	2498117.96	332191.75
28-GW07	4/8/94	6.62	3.8	18	2.5-17.5	0.5-18	0-0.5	2499142.56	331714.78
28-GW08	8/14/95	13.27	10.68	25	10-25	8-25	6-8	2499116.70	332231.42
28-GW13	2/10/93	7.16	4.1	11	1.2-10.9	0.8-11	0.2-0.8	2498640.36	332706.86
28-GW01DW	4/21-23/94	7.49	5.5	133	117-132	111-134	107-111	2498346.58	331858.67
28-GW07DW	4/18, 4/20, 4/26/94	6.03	3.6	131	114-129	109-132	104-109	2499167.46	331708.22
28-GW09DW	4/7-12/94	6.91	4.5	126	111-126	105-126	96-105	2498283.33	332886.18

Notes: (1) msl = mean sea level
Horizontal positions are referenced to N.C. State Plane Coordinate System (NAD 27) CF = 0.9999216 from USMC Monument Toney.
Vertical datum NGVD 29.

TABLE 3-2

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOLID SAMPLES
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Parameter	Container	Preservation	Holding Time
TCL Volatiles	One 4-ounce wide-mouth glass jars	Cool, 4°C	10 days
TCL Semivolatiles	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides/PCBs	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	One 8-ounce wide-mouth glass jar	Cool, 4°C	6 months; Mercury, 28 days

Notes:

TCL = Target Contaminant List
TAL = Target Analyte List

TABLE 3-3

QA/QC SAMPLE FREQUENCY
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Type of Sample	Metal	Organic
Trip Blank (for volatiles only)	NA[1]	One per cooler or one per shipping day
Equipment Rinsate	Every other day	Every other day
Field Blank[2]	One per event	One per event
Field Duplicate	10%	10%
Matrix Spike	NA	5%[3]

Notes:

[1] Not Applicable

[2] Event is defined as one entire sampling effort for both sites.

[3] The duplicate must be taken from the sample which will become the laboratory matrix spike/matrix spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.

TABLE 3-4

ESTIMATED INVESTIGATION DERIVED WASTE QUANTITIES GENERATED DURING VARIOUS SITE ACTIVITIES AT OPERABLE UNIT NO. 6 LONG-TERM MONITORING WORK PLAN, CTO-0333 MCB, CAMP LEJEUNE, NORTH CAROLINA

Site	Activity	Media	Estimated Quantity
1	Well Development	Groundwater	1,500 gallons
	Well Purging	Groundwater	300 gallons
28	Well Development	Groundwater	900 gallons
	Well Purging	Groundwater	300 gallons

4.0 SAMPLE HANDLING AND ANALYSIS

4.1 Sample Presentation

New polyethylene or glass bottles containing the proper preservatives will be provided by the laboratory for sample collection. In addition to the chemical preservatives, samples will be stored on ice at 4°C in a waterproof metal or sturdy plastic cooler, if required (see Table 4-1 for summaries of containers, preservation, and holding times).

4.2 Chain-of-Custody Procedures

4.2.1 Field Chain-of-Custody Procedures

A sample is considered to be in an individual's possession if:

- It is in the sampler's possession or it is in the sampler's view after being in his or her possession.
- It was in the sampler's possession and then locked or sealed to prevent tampering.
- It is in a secure area.

Five kinds of documentation will be used in tracking and shipping the analytical samples:

- Field log book
- Sample labels
- Chain-of-Custody (COC) records
- Custody seals
- Commercial carrier airbills

At a minimum, the label for each sample bottle will contain the following information:

- Site name
- Sample number
- Date and time of collection
- Sample type (grab or composite)
- Matrix
- Sampler's initials

The sample information, as well as the analysis to be performed on the sample, will be entered in the field log book for each sampling point. Additionally, the following items will be entered:

- Dates and times of entry
- Names of field personnel on site
- Names of visitors on site
- Field conditions
- Description of activities
- Sampling remarks and observations
- QA/QC samples collected

Custody of the samples will be maintained by field personnel from the time of sampling until the time they are forwarded to the analytical laboratory.

The sample custody is documented using Chain-of-Custody (COC) records. Field personnel will complete a COC record, in waterproof ink, to accompany each cooler forwarded from the site to the laboratory. Chemical reagents used to preserve the samples will be recorded on the COC record. Any errors on the COC records will not be erased; instead, a line will be drawn through the error and initialed by the person completing the form. The original copy will be placed in a sealable plastic bag and put inside the appropriate cooler, secured to the cooler's lid.

If the sample cooler is to be shipped by commercial air carrier, the cooler must be secured with custody seals so that the seals would be broken if the cooler was opened. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill.

If the sample shipment is hand delivered to the laboratory by field personnel or retrieved by laboratory personnel at the site, then the custody seals are not necessary. The laboratory sample custodian, or his/her designee accepting the sample shipment, whether it is from the air carrier or the field personnel, signs and dates the COC record upon sample receipt. The original COC record will be returned along with the final data report. The laboratory will be responsible for maintaining internal log books and records that provide a custody record during sample preparation and analysis.

4.2.2 Laboratory Chain-of-Custody Procedures

Upon sample receipt the steps below will be performed.

- Samples will be received and unpacked in the laboratory where the staff checks for bottle integrity (loose caps, broken bottles, etc.).
- Samples will be verified with incoming paperwork (packing slip, etc.) by type of bottle and stabilizer. The paperwork must be either signed or initialed.
- Information concerning the sample (from the sampling record, Chain-of-Custody, and observation) will be recorded along with parameters to be analyzed, date of sampling, and date the sample is received in the laboratory.
- Samples will be placed in an appropriate secured storage area until analysis.
- When analysis is complete, samples will be stored for a 30-day period unless otherwise specified.

If collected samples arrive without Chain-of-Custody or incorrect Chain-of-Custody records, the following steps will be taken:

- The laboratory will prepare a nonconformance form stating the problem.
- If the missing information cannot be provided by the field staff, the samples affected will not be analyzed.

Primary considerations for sample storage are:

- Secured storage.
- Maintain prescribed temperature, if required, which is typically four degrees Celsius.
- Extract and/or analyze samples within the prescribed holding time for the parameters of interest.

4.3 Field Logbook

The following sections discuss some of the information which must be recorded in the field logbook. In general, a record of all events and activities, as well as other potentially important information shall be recorded by each member of the field team.

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information must be recorded by each team member.

- Date
- Start time
- Weather
- All field personnel present
- All visitors present
- Other pertinent information (i.e., planned activities, schedule changes, expected visitors, and equipment changes)

During the day, an ongoing record of all site activities should be written in the logbook. The master logbook kept by the field team leader need not duplicate that recorded in other field logbooks, but should summarize the information in other books and, where appropriate, reference the page numbers of other logbooks where detailed information pertaining to a subject may be found.

Some specific information which must be recorded in the logbook includes:

- Equipment used, equipment numbers, calibration, field servicing
- Field measurements
- Sample numbers and time
- Other pertinent information

All entries should be made in indelible ink; all pages numbered consecutively; and all pages must be signed or initialed and dated by the responsible field personnel completing the log. No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single line, initialed, and dated.

4.4 Quality Assurance and Laboratory Protocols

4.4.1 Quality Assurance Objectives for Data Measurement

The purpose of a QA Program is to establish policies for the implementation of regulatory requirements and to provide an internal means for control and review so that the work performed is of the highest professional standards.

4.4.1.1 Project Quality Assurance Objectives

The following is a list of QA objectives which will be implemented at Sites 1 and 28.

- Obtain scientific data of a quality sufficient to meet scientific and legal scrutiny.
- Gather/develop data in accordance with procedures appropriate for its intended use.
- Ensure that data is of acceptable precision, accuracy, completeness, representative-ness, and comparability as required by the project.

The fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment and correction where:

- Prevention of errors through planning, documented instructions and procedures, and careful selection and training of skilled, qualified personnel.
- Assessment of all quality assurance sampling reports furnished by the contract laboratory.
- Correction for prevention of reoccurrence of conditions adverse to quality.

This section presents the project organization and specifies or references technical procedures, documentation requirements and sample custody requirements. These QA/QC requirements have been prepared in accordance with USEPA guidance as presented in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80.

The procedures contained or referred to herein have been taken from:

- "Statement of Work for Organic Analysis," USEPA, OLM01.8, August 1991
- "Statement of Work for Inorganic Analysis," USEPA, ILM03.0, March 1990
- "Test Methods for Evaluating Solid Waste," USEPA SW846, November 1986, 3rd Edition

4.4.1.2 Data Quality Objectives

Data quality objectives (DQOs) are qualitative or quantitative statements developed by the data users to specify the quality of data needed from a particular data collection activity to support a specific decision. The DQOs are expressed in terms of precision, accuracy, representativeness, completeness, and comparability. Definitions for these terms, as well as for the more general term uncertainty, are given in Table 4-2.

All samples for characterizing the site will be analyzed and reported by the laboratory as modified Level IV data (NFESC Level D). The modifications to the Level D package are associated with the data set deliverables for quality assurance. These modifications are being requested to reduce the data packages from the laboratory. Table 4-3 provides the modified data set deliverables. The modification to the Level IV deliverable eliminates the raw chromatogram outputs for each of the analyzed samples. In addition, field parameters including temperature, pH, and specific conductance, turbidity and dissolved oxygen will be Level I (NFESC Level A) data quality.

4.4.2 Calibration Procedures and Frequency

The following section describes calibration procedures and frequency.

4.4.2.1 Field Instruments

One field instrument will be used for health and safety monitoring: the HNu System portable photoionizer. This instrument will be calibrated on site daily according to the manufacturer's instructions in addition to the factory calibration it will receive prior to the start of site sampling. The calibration standards will be recorded in the field log book.

pH, conductivity, turbidity, and dissolved oxygen meters will be used to test groundwater. Procedures from "Test Methods for Evaluating Solid Waste," USEPA, SW846, November 1986, 3rd Edition will be used to calibrate these meters.

4.4.2.2 Laboratory Instruments

The laboratory's procedures for calibration and related quality control measures will be conducted according to the protocols presented in the following documents:

- "Statement of Work for Organic Analysis," USEPA, OLM01.8, August 1991
- "Statement of Work for Inorganic Analysis," USEPA, ILM03.0, March 1990
- "Test Methods for Evaluating Solid Waste," USEPA SW846, November 1986, 3rd Edition

Formal calibration procedures will be established to ensure that instrumentation and equipment used for sample analysis are accurately calibrated and properly functioning. These procedures will apply to all instruments and equipment quantities. All calibrations will be performed by laboratory personnel or external agencies using standard reference materials.

All calibrations will be recorded on in-house calibration forms or instrument vendor forms or in dedicated bound notebooks. The following data will be recorded for all calibrations: the date, target readings, actual readings, instrument identification number, and the analyst's initials. Other data may be recorded depending upon the calibration performed.

Only properly calibrated and operating equipment and instrumentation will be used. Equipment and instrumentation not meeting the specified calibration criteria will be segregated from active equipment whenever possible. Such equipment will be repaired and recalibrated before reuse.

All equipment will be uniquely identified, either by serial number or internal calibration number, to allow traceability between equipment and calibration records. Recognized procedures (ASTM, USEPA, or manufacturer's procedures) will be used for calibration whenever available.

4.4.2.3 Method Calibration

Method calibration will be performed as part of the laboratory analytical procedure (calibration curves, tuning). Calibration curves will be prepared using five standards in graduated amounts across the appropriate range of analysis. New calibration curves will be prepared whenever new reagents or standards are prepared or yearly, whichever is more frequent.

4.4.2.4 GC/MS System Calibration Procedure

This section outlines the requirements for the calibration of GC/MS systems for the determination of organic compounds. The following operations will be performed in support of these requirements:

- Documentation of GC/MS mass calibration and abundance pattern
- Documentation of GC/MS response factor stability
- Internal standard response and retention time monitoring

Tuning and Mass Calibration

It will be necessary to establish that a given GC/MS system meets the standard mass spectral abundance criteria prior to initiating data collection. This will be accomplished through the analysis of p-bromofluorobenzene (BFB) for volatile compounds. The BFB criteria must be met before any blanks, standards, or samples are analyzed.

A GC/MS system used for organic compound analysis will be tuned to meet the criteria specified for BFB analysis (volatile compounds) for an injection of 50 nanograms (ng) of BFB. The analysis must be performed separately from standard or blank analysis. These criteria will be demonstrated every 12 hours of operation. Professional judgment must be used to determine whether background subtraction is required to eliminate column bleed or instrument background (i.e., noise). Calibration documentation will be in the form of a bar graph spectrum and a mass listing.

GC/MS System Calibration

After tuning criteria have been met and prior to sample analysis, the GC/MS system is initially calibrated at five concentrations utilizing the compounds to be analyzed to determine the linearity of response. Internal and surrogate standards will be used with each calibration standard. Standards will be analyzed under the same conditions as the samples.

- Relative Response Factor (RRF) Calculation - The USEPA specifies the internal standard to be used on a compound-by-compound basis for quantification. The relative response factor (RRF) will be calculated for each compound at each concentration level.

- Continuing Calibration - A calibration check standard containing all semivolatile or volatile compounds and surrogates will be run every 12 hours of analysis. A system performance check will also be performed. The criteria will be the same as for the initial calibration system performance check. A calibration check will also be performed. The percent difference will be determined for each Calibration Check Compound (CCC).

The percent Difference for each CCC must be less than or equal to 25.0 percent. The system performance check and calibration check criteria must be met before sample analysis can be performed. The continuing calibration will be recorded on the continuing calibration forms.

4.4.2.5 <u>System Calibration Procedure for Metals Analysis</u>

This section outlines the requirements for the calibration of atomic absorption (AA) and Inductively Coupled Plasma (ICP) systems for the determination of metals. The following will be performed in support of these requirements:

- Documentation of standard response
- Correlation coefficient monitoring

The AA system utilized for direct aspiration technique analysis will be initially calibrated with a calibration blank and five calibration standards. The standard concentrations will be determined as follows. One standard will be at a concentration near, but above, the MDL. The other concentrations will correspond to the expected range of concentrations found in the actual samples. This five-point calibration must be performed daily.

The AA system utilized for graphite furnace technique analysis will be initially calibrated with a calibration blank and three calibration standards. The standard concentrations will be determined as follows. One standard will be at a concentration at the Contract Required Detection Limit (CRDL). The other concentrations will correspond to the expected range of concentrations found in the actual samples. This three-point calibration must be performed daily.

For AA systems, the calibration standards will be prepared fresh each time an analysis is to be performed and discarded after use. The standards contain the same reagents at the same concentrations as will result in the samples following preparation.

The ICP system will be calibrated initially with a calibration blank and one calibration standard. This calibration must be performed daily. In addition, ICP systems must undergo quarterly linearity checks.

<u>Correlation Coefficient Calculation</u>

The data points of the blank and the five calibration standards will be utilized to calculate the slope, the intercept, and the correlation coefficient of the best fit line. An acceptable correlation coefficient must be achieved before sample analysis may begin. An acceptable correlation coefficient will be >0.995 for AA analyses and >0.995 for ICP analysis.

Calibration Verification

The initial calibration curve will be verified on each working day by the measurement of one mid-range calibration standard. The calibration verification acceptance criterion will be as follows:

- ICEP/GFAA - 90 to 110 percent of true value
- Cold Vapor AA - 80 to 120 percent of true value

When measurements exceed the control limits, the analysis will be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.

4.4.2.6 System Calibration Procedure for Inorganic Analyses

This section outlines the requirements that will be used for calibration of colorimetric systems for analyses of inorganic parameters. The following will be performed in support of these requirements:

- Documentation of standard response
- Correlation coefficient monitoring

The system will be initially calibrated with a blank and five calibration standards. Standard concentrations will be at a concentration near, but above, the MDL with additional concentrations corresponding to the expected range of concentrations found in actual samples. Standards contain the same reagents at the same concentrations as will be present in samples following preparation.

Correlation Coefficient Calculation

Data points of the blank and five calibration standards will be utilized to calculate slope, intercept, and correlation coefficient of a best fit line. An acceptable correlation coefficient must be achieved before sample analysis may begin. An acceptable correlation coefficient will be >0.995 for all systems.

Calibration Verification

The initial calibration curve will be verified on each working day by the measurement of two calibration standards. One standard will be at a concentration near the low end of the calibration curve and one standard will be at the high end. The acceptance criteria for recovery of verification standards will be within 10 percent of the expected recovery for other inorganic analyses. When measurements exceed control limits, analysis will be terminated, the problem will be corrected, the instrument will be recalibrated, and calibration will be reverified.

4.4.2.7 Periodic Calibration

Periodic calibration must be performed on equipment required in analyses but not routinely calibrated as part of the analytical methodology. Equipment that falls within this category includes ovens, refrigerators, and balances. The calibration will be recorded either on specified forms or in bound notebooks. Discussed below are the equipment, the calibration performed, and the frequency at which the calibration must be performed.

- Balances will be calibrated weekly with class S weights.

- The pH meter will be calibrated daily with pH 4 and 7 buffer solutions and checked with pH 10 buffer solution.
- The temperatures of the refrigerators will be recorded daily.
- All liquid in glass thermometers will be calibrated annually with the N.B.S. certified thermometer. Dial thermometers will be calibrated quarterly.
- The N.B.S. Certified Thermometer will be checked annually at the ice point.

The following equipment must maintain the following temperatures:

- Sample Storage and Refrigerators - within 2 degrees of 4 degrees Celsius

4.4.3 Analytical Procedures

This next section discusses analytical procedures.

4.4.3.1 Field Analysis

An HNu PI-101 meter will be used to analyze ambient air for health and safety monitoring. The HNu PI-101 detects total organic vapor. The instrument will be operated in accordance with the manufacturer's instructions.

The pH, temperature, conductivity, turbidity, and dissolved oxygen of aqueous samples also will be measured in the field. These analyses will be obtained in accordance with "Handbook for Sampling and Sample Preservation of Water and Wastewater," September 1982, EPA/600/4-82-029.

4.4.3.2 Laboratory Analysis

The samples that will be collected during the long-term monitoring will be analyzed for constituents listed in Table 4-4. Parameters will be analyzed using USEPA methods as noted in Table 4-5. Compounds and the corresponding method performance limits also are listed in Table 4-5.

4.4.4 Internal Quality Control Checks

4.4.4.1 Laboratory Quality Control Checks

This section provides descriptions of the laboratory quality control checks.

Method Blank

Analysis of method blanks will be performed to verify that method interferences caused by contamination in reagents, glassware, solvents, etc. are minimized and known.

Method blanks will be initiated by the analyst prior to the preparation and/or analysis of the sample set. A method blank consists of a volume of organic-free deionized water equal to the sample volume which is carried through the entire analytical procedure. A method blank will be analyzed with each set of samples or at the very least, daily. If the analytical data of the method blank indicates excessive contamination, the source of contaminant will be determined. The samples may be re-analyzed or the data may be processed "as is" depending upon the nature and extent of the contamination.

Replicate Sample Analysis

Replicate sample analysis will be performed to demonstrate the precision of an analysis. An interlaboratory replicate sample is initiated by the analyst prior to sample preparation and carried through the entire analytical procedure. The frequency of interlaboratory replicate analysis for each analyte is summarized in Table 4-5.

Spike Analysis

Spike analysis will be performed to demonstrate the accuracy of an analysis. The analyst initiates the spike prior to sample preparation and analysis by adding a known amount of analyte(s) to a sample. The spike sample is carried through the entire analytical procedure. The frequency of spike analysis for each analyte(s) is summarized in Table 4-5.

Surrogate Standards

Surrogate standard analysis will be performed to monitor the preparation and analyses of samples. All samples and blanks analyzed by GC/MS are fortified with a surrogate spiking solution prior to extraction or purging.

Internal Standards

Internal standard analyses will be performed to monitor system stability. Prior to injection or purging, internal standards are added to all blanks and samples analyzed by GC/MS.

Matrix Spikes and Matrix Spike Duplicates

A matrix spike is an aliquot of a matrix fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery. A matrix spike duplicate is a second aliquot of the same matrix as the matrix spike that is spiked in order to determine the precision of the method. A matrix spike and matrix spike duplicate will be performed at a frequency of 1 per 20 samples for organics.

4.4.4.2 Laboratory Control Limits

Control limits will be established for QC checks (spikes, duplicates, blanks, etc.). CLP control limits for surrogate standards spikes, and duplicates associated with GC/MS. Control limits for spikes, duplicates, and reference samples will be determined internally through statistical analysis.

Whenever an out-of-control situation occurs, the cause is determined. Any needed corrective actions must be taken.

Method Blanks

For metals analyses, the criteria below are used for method blank analysis.

- If the concentration of the method blank is less than or equal to the detection level, no correction of sample results is performed.
- If the concentration of the blank is above the detection level for any group of samples associated with a particular blank, the concentration of the sample with the least concentrated analyte must be ten times the blank concentration. Otherwise, all samples associated with the blank and less than ten times the blank concentration must be redigested (reprepared) and reanalyzed, if possible. If the affected samples cannot be reprepared and reanalyzed within method holding times, the flagged sample result and the blank result are both to be reported. The sample value is not corrected for the blank value.

For GC/MS, analysis, the criteria below are used for method blank analysis:

- A method blank for volatiles analysis must contain no greater than five times the detection limit of common laboratory solvents (common laboratory solvents are: methylene chloride, acetone, toluene, 2-butanone, and chloroform).
- For all other compounds not listed above, the method blank must contain less than the detection limit of any single compound. If a method blank exceeds the criteria, the analytical system is considered to be out of control. The source of the contamination is investigated and appropriate corrective measures are taken and documented before sample analysis proceeds. All samples processed with a method blank that is out of control (i.e., contaminated), are reextracted/repurged and reanalyzed, when possible. If the affected samples cannot be reextracted/repurged and reanalyzed within method holding times, the flagged sample result and the blank result are both to be reported. The sample value is not corrected for the blank value.

Surrogate Standards

For method blank surrogate standard analysis, corrective action will be taken if any one of the conditions below exist.

- Recovery of any one surrogate compound in the volatile fraction is outside the required surrogate standard recovery limit.

Corrective action will include steps listed below:

- A check of: the calculations for errors; the internal standard and surrogate spiking solutions for degradation, contamination, etc.; and instrument performance.
- Recalculation or reinjection/repurging of the blank or extract if the above corrective actions fail to solve the problem.

- Reextraction and reanalysis of the blank. For sample surrogate standard analysis, corrective action will be taken if any one of the following conditions exist:
    - Recovery of any one surrogate compounds in the volatile fraction is outside the surrogate spike recovery limits;

Corrective action will include the steps listed below.

- A check of: the calculations for errors; of the internal standard and surrogate spiking solutions for degradation, contamination, etc.; and of instrument performance.
- Recalculating or reanalysis the sample or extract if the above corrective action fails to solve the problem.
- Reextraction and reanalysis of the sample if none of the above are a problem.

SECTION 4.0 TABLES

TABLE 4-1

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR AQUEOUS SAMPLES
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Parameter	Container	Preservation	Holding Time
TCL Volatiles	Two 40-ml vials with teflon septum caps	Cool, 4°C HCl pH <2	14 days (7 days if unpreserved)
TAL Metals	1-500 ml polyethylene bottle	HNO_3 pH<2	6 months; Mercury 28 days

Notes:

TCL = Target Contaminant List
TAL = Target Analyte List

TABLE 4-2

DEFINITIONS OF DATA QUALITY INDICATORS
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

PRECISION - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is expressed in terms of the standard deviation. Comparison of replicate values is best expressed as the relative percent difference (RPD). Various measures of precision exist depending upon the "prescribed similar conditions".

ACCURACY - The degree of agreement of a measurement (or an average of replicate measurements), X, with an accepted reference or true value, T, expressed as the difference between the two values, X-T. Accuracy is a measure of the bias in a system.

REPRESENTATIVENESS - Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental concern.

COMPLETENESS - A measure of the amount of the valid data obtained from the measurement system compared to the amount that was expected under "normal" conditions.

COMPARABILITY - Expresses the confidence with which one data set can be compared with another.

UNCERTAINTY - The likelihood of all types of errors associated with a particular decision.

TABLE 4-3

DATA SET DELIVERABLES FOR MODIFIED LEVEL D QUALITY ASSURANCE
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Method Requirements	Deliverables
Requirements for all methods:	
Holding time information and methods requested	Signed chain-of-custody forms
Discussion of laboratory problems	Case narratives
Organics:	
Sample results	CLP Form I
Matrix spike/spike duplicate. One spike and spike duplicate per 20 samples of similar matrix	CLP Form III
Metals:	
Sample results	CLP Form 1 or equivalent
Spike sample recovery (one per 20 samples of similar matrix)	CLP Form 5A or equivalent
Duplicates (one per 20 samples will be split and digested as separate samples)	CLP Form 6 or equivalent
LCS	CLP Form 7 or equivalent
Holding times	CLP Form 10 or equivalent

Note:

LCS = laboratory control standard
CLP = contract laboratory program

TABLE 4-4

METHOD PERFORMANCE LIMITS
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Compound	Water CRQL[1] (µg/L)	Method
Volatiles		CLP/SOW[2]
Chloromethane	10	
Bromomethane	10	
Vinyl Chloride	10	
Chloroethane	10	
Methylene Chloride	10	
Acetone	10	
Carbon Disulfide	10	
1,1-Dichloroethene	10	
1,1-Dichloroethane	10	
1,2-Dichloroethene (total)	10	
Chloroform	10	
1,2-Dichloroethane	10	
2-Butanone	10	
1,1,1-Trichloroethane	10	
Carbon Tetrachloride	10	
Bromodichloromethane	10	
1,2-Dichloropropane	10	
cis-1,3-Dichloropropene	10	
Trichloroethene	10	
Dibromochloromethane	10	
1,1,2-Trichloroethane	10	
Benzene	10	
trans-1,3-Dichloropropene	10	
Bromoform	10	
4-Methyl-2-pentanone	10	
2-Hexanone	10	
Tetrachloroethene	10	
Toluene	10	
1,1,2,2-Tetrachloroethane	10	
Chlorobenzene	10	
Ethylbenzene	10	
Styrene	10	
Xylenes (total)	10	

Notes:

(1) CRQL
(2) CLP/SW - reference OLMO.8

TABLE 4-4 (Continued)

METHOD PERFORMANCE LIMITS
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Analyte	Method Number[1]	CRDL[2] (μg/L)	Method Description
Metals			
Aluminum	200.7	200	Inductively Coupled Plasma
Antimony	200.7 204.2	60	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Arsenic	200.7 206.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Barium	200.7	200	Inductively Coupled Plasma
Beryllium	200.7 210.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Cadmium	200.7 213.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Calcium	200.7 215.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Chromium	200.7 218.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Cobalt	200.7	50	Inductively Coupled Plasma
Copper	200.7	25	Inductively Coupled Plasma
Iron	200.7	100	Inductively Coupled Plasma
Lead	200.7 239.2	3	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Magnesium	200.7 242.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Manganese	200.7	15	Inductively Coupled Plasma
Mercury	245.1 245.2 245.5	0.2	Water by manual cold vapor technique Water by automated cold vapor technique
Nickel	200.7	40	Inductively Coupled Plasma
Potassium	200.7 258.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Selenium	200.7 270.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Silver	200.7 272.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Sodium	200.7 273.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Thallium	200.7 279.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Vanadium	200.7	50	Inductively Coupled Plasma
Zinc	200.7	20	Inductively Coupled Plasma

TABLE 4-4 (Continued)

METHOD PERFORMANCE LIMITS
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Notes:

(1) Methods taken from "Statement of Work for Inorganic Analysis," USEPA Contract Laboratory Program, ILM03.0, March 1990.

(2) Contract Required Detection Limit.

(3) Extraction method for arsenic, lead, selenium, and thallium taken from USEPA Method 3020, "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition.

(4) Extraction method for all other metals taken from USEPA Method 3010, "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition.

TABLE 4-5

QA/QC ANALYSIS FREQUENCY
LONG-TERM MONITORING WORK PLAN, CTO-0333
MCB, CAMP LEJEUNE, NORTH CAROLINA

Parameter	Replicate	Spike
Organic		
All analyses by GC/MS	5%	5%
Metals		
Liquids by flame AA or ICP	5%	5%
Solids by flame AA or ICP	5%	10%
All analyses by furnace AA	5%	10%

5.0 PROJECT SCHEDULE

Groundwater samples will be collected on a semiannual basis, during the months of September (to correspond with the end of the Government Fiscal year per the request of the Activity) and March of each year. The report shall be submitted to the MCB, Camp Lejeune Environmental Management Division (EMD) 60 calendar days following the completion of the field sampling effort.

6.0 REFERENCES

Baker Environmental, Inc. 1995. Final Remedial Investigation Report, Operable Unit No. 7. Sites 1, 28, and 30, MCB, Camp Lejeune.

Barcelona, M.J., Wehrmann, H.A., Varljen, M.D. Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Groundwater Sampling. Ground Water vol. 32, No. 1. January-February, 1994.

Camp Lejeune Federal Facility Agreement (FFA). December 6, 1989.

DON, 1988. Mater Plan, Camp Lejeune Complex, North Carolina. COMNAVFACENGCOM, April 8, 1988.

Environmental Science and Engineering, Inc. (ESE), `1990. Final Site Summary Report, Marine Corps Base Camp Lejuene, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic division. ESE Project No. 49-02036. September 1990.

Puls, R.W. and Paul, C.J. Low-Flow Purging and Sampling of Groundwater Monitoring Wells with Dedicated Systems. Groundwater Monitoring and Remediation. Winter, 1995.

U.S. Environmental Protection Agency (USEPA), 1992. RCRA Groundwater Monitoring: Draft Technical Guidance. Office of Solid Waste. EPA/530/R-03/001. November, 1992.

U.S. Environmental Protection Agency (USEPA), Region IV, 1991. Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual. February, 1991.

Water and Air Research, Inc. (WAR). 1983. Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Energy and Environmental Support Activity.