M67001.AR.001129
MCB CAMP LEJUENE
5090.3a

FINAL FIELD SAMPLING AND ANALYSIS PLAN FOR OPERABLE UNIT NO. 7 (SITES 1, 28, AND 30) MCB CAMP LEJEUNE NC

12/15/1993

ATLANTIC DIVISION

12/15/93-01129

FINAL

FIELD SAMPLING AND ANALYSIS PLAN FOR OPERABLE UNIT NO. 7 (SITES 1, 28, AND 30)

MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0160

Prepared For:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

DECEMBER 15, 1993

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Standards Testing Materials
Baker	Baker Environmental, Inc.
bgs	below ground surface
BRA	Baseline Risk Assessment
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COD	chemical oxygen demand
COPC	Contaminants of Potential Concern
CRP	Community Relations Plan
CTVs	critical toxicity values
1,2-DCE	1,2-Dichloroethene
DO	dissolved oxygen
DoN	Department of the Navy
DQOs	data quality objectives
EPIC	Environmental Photographic Interpretation Center
EDB	Ethylene dibromide
ESE	Environmental Science and Engineering, Inc.
FCLDA	French Creek Liquids Disposal Area
FSAP	Field Sampling and Analysis Plan
FFA	Federal Facilities Agreement
FMF	Fleet Marine Force
FTSA	Fuel Tank Sludge Area
FWQL	Federal Water Quality Criteria
GC	gas chromatograph
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HPBD	Hadnot Point Burn Dump
HPIA	Hadnot Point Industrial Area
HQ	hazard quotient
IAS	Initial Assessment Study
IRA	Interim Remedial Action
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program

LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LANTNAVFAC-ENGCOM	Atlantic Division, Naval Facilities Engineering Command
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MEK	methyl ethyl ketone
MIBK	methyl isobutyl ketone
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants Program
NC DEHNR	North Carolina Department of Environment, Health and Natural Resources
NCWQS	North Carolina Water Quality Standard
ND	Not Detected
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
NWI	National Wetlands Inventory
OG	Oil and Grease
OU	Operable Unit
OVA	Organic Vapor Analyzer
PAHs	polynuclear aromatic hydrocarbons
PA/SI	Preliminary Assessments/Site Investigations
PCBs	polychlorinated biphenyls
PID	photoionization detector
ppb	parts per billion
PRG	Preliminary Remediation Goals
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SQC	Sediment Quality Criteria
SSV	Sediment Screening Values
TAL	Target Analyte List
TBC	to be considered
TCE	trichloroethylene
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TSS	total suspended solids
TVS	total volatile solids
TOC	total organic carbon
TPH	total petroleum hydrocarbons

TRC	Technical Review Committee
TSCA	Toxic Substance Control Act
T-1,2-DCE	trans-1,2-dichloroethene
μg/l	micrograms per liter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOCs	volatile organic compounds
WAR	Water and Air Research, Inc.

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) effective November 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 (N.C. 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 the MCB are thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives are developed and implemented as necessary to protect the public health, welfare and the environment (FFA, 1989).

The scope of the FFA included provisions for the implementation of a remedial investigation/feasibility study (RI/FS) at 27 sites throughout MCB Camp Lejeune. Remedial investigations will be implemented at these sites to determine fully the nature and extent of the threat to the public health, welfare or the environment caused by the release and threatened release of hazardous substances, pollutants, contaminants or constituents at the site and to establish requirements for the performance of FSs. Feasibility studies will be conducted to identify, evaluate, and select alternatives for the appropriate CERCLA responses to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, contaminants, or constituents at the site in accordance with CERCLA/Superfund Amendments and Reauthorization Act (SARA) and applicable State law (FFA, 1989). This RI/FS Work Plan addresses three of the 27 sites: Site 1 - French Creek Liquids Disposal Area (FCLDA), Site 28 - Hadnot Point Burn Dump (HPBD), and Site 30 - Sneads Ferry Road Fuel Tank Sludge Area (FTSA). These three sites form Operable Unit No. 7.

This Field Sampling and Analysis Plan (FSAP) describes the proposed RI field activities that are to be conducted at Operable Unit No. 7: Site 1, Site 28, and Site 30 at the Marine Corps Base, Camp Lejeune, North Carolina.

The primary purposes of the FSAP is to provide guidance for all field activities by describing in detail the sampling and data collection methods to be used to implement the various field tasks identified in the RI/FS Work Plan for Operable Unit No. 7 (Baker, 1993). The guidance also helps to ensure that sampling and data collection activities are carried out in accordance with USEPA Region IV and Navy Energy and Environmental Support Activity (NEESA) practices so that data obtained during the field investigation are of sufficient quantity and quality to evaluate the nature and magnitude of contamination in various media, estimate human health and environmental risks, and to evaluate potential technologies for remediation of contaminated media.

The remaining portion of this section presents the background and setting of each of the sites. Section 2.0 identifies the Data Quality Objectives (DQOs) for each of the field sampling programs described in the RI/FS Work Plan (Baker, 1993). The media, number and types of samples, and the frequency of sampling are discussed in Section 3.0 (Sampling Locations and Frequency). Section 4.0 (Sample Designation) describes the sample numbering scheme to be followed for identifying and tracking the samples. The investigative procedures (e.g., drilling, groundwater sampling, decontamination, etc.) are presented in Section 5.0 (Investigative Procedures). Sample handling and analysis is described in Section 6.0 (Sample Handling and Analysis). Section 7.0 (Site Management) focuses on the organization and responsibilities of personnel associated with the field sampling events.

In addition, background documents associated with Operable Unit No. 7 have been summarized in the RI/FS Work Plan that is associated with this document.

1.1 Site Description and Setting

This section briefly describes the description and setting of Operable Unit No. 7. A more detailed description of each site is provided in Section 2.0 in the RI/FS Work Plan associated with this document.

1.1.1 Marine Corps Base Camp Lejeune

This section provides an overview of the physical features associated with MCB Camp Lejeune.

1.1.1.1 Location and Setting

MCB Camp Lejeune is located within the coastal plain in Onslow County, North Carolina. The facility covers approximately 170 square miles and is bisected by the New River which flows in a southeasterly direction and forms a large estuary before entering the Atlantic

Ocean. The eastern border of Camp Lejeune is the Atlantic Ocean shoreline. The western and northeastern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders Camp Lejeune to the north. The major areas within MCB Camp Lejeune are depicted in Figure 1-1.

1.1.1.2 History

Construction of MCB Camp Lejeune began in April 1941 with the objective of developing the "Worlds Most Complete Amphibious Training Base". The base was started at the Hadnot Point Industrial Area (HPIA) where the major functions of the base are still centered. Development at the Camp Lejeune complex consists of primarily five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area. The three sites included under Camp Lejeune Operable Unit No. 7 are located at the Mainside area (WAR, 1983). The general location of these three sites within MCB Camp Lejeune are identified on Figure 1-1.

1.1.1.3 Topography and Surface Drainage

The generally flat topography of MCB Camp Lejeune is typical of the seaward portions of the North Carolina coastal plain. Elevations on the base vary from sea level to 72 feet above mean sea level (msl); however, the elevation of most of Camp Lejeune is between 20 and 40 feet above msl (WAR, 1983).

Drainage at Camp Lejeune is generally toward the New River, except for areas near the coast, which drain into the Atlantic Ocean via the Intracoastal Waterway. In developed areas, natural drainage has been altered by asphalt pavement, storm sewers, and drainage ditches. Approximately 70 percent of Camp Lejeune is in the broad, flat interstream areas. Drainage is poor in these areas (WAR, 1983).

Flooding is a potential problem for base areas within the 100-year floodplain. The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (WAR, 1983).

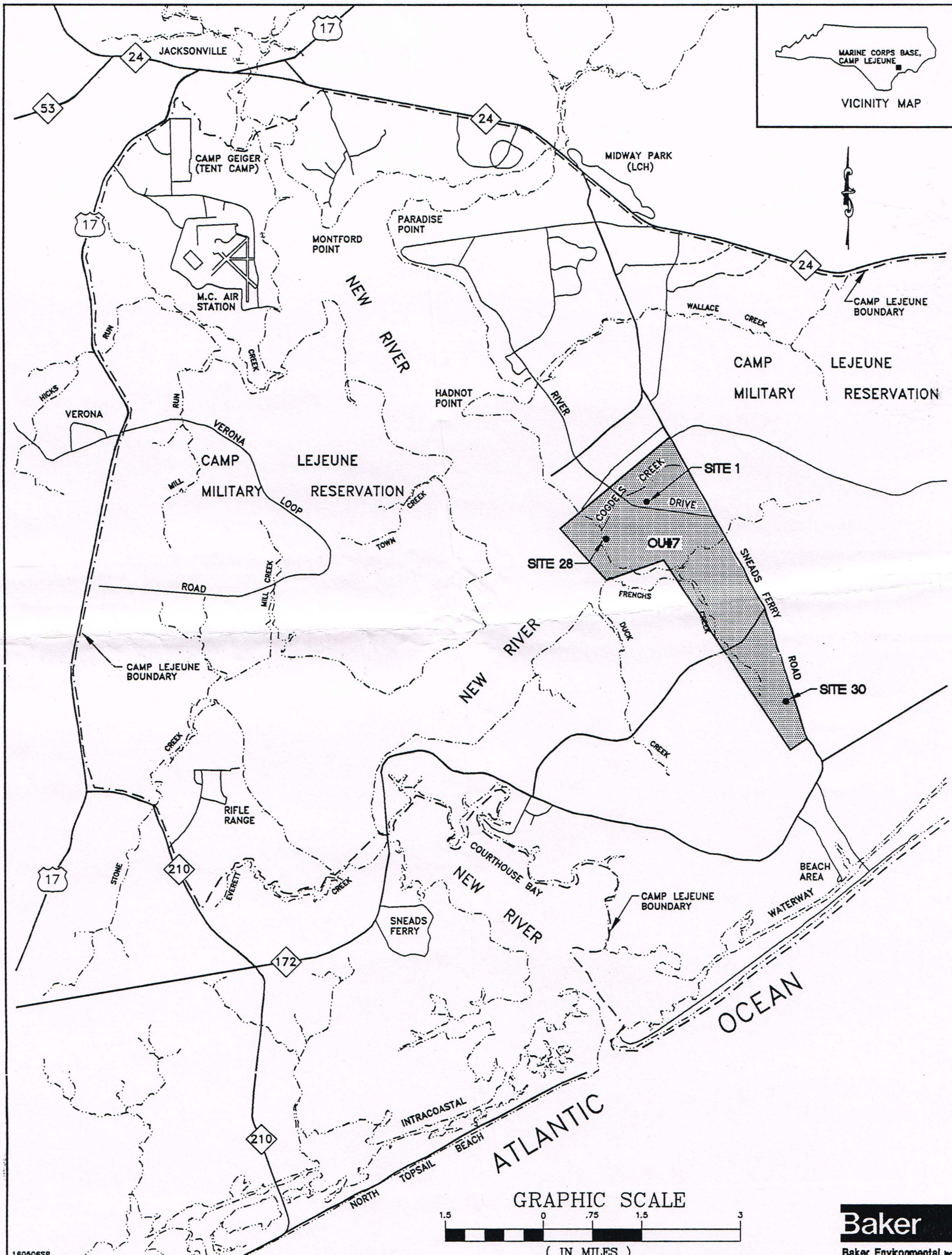


FIGURE 1-1
LOCATION MAP FOR OPERABLE UNIT NO. 7
SITES 1, 28, AND 30
REMEDIAL INVESTIGATION CTO-0160

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

1.1.1.4 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments are layered in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1992). Regionally, they comprise 10 aquifers and nine confining units which overlie igneous and metamorphic basement rocks of pre-Cretaceous age. These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time. Table 1-1 presents a generalized stratigraphic column for this area (ESE, 1992).

1.1.1.5 Regional Hydrogeology

United States Geological Survey (USGS) studies at MCB Camp Lejeune indicate that the Base is underlain by seven sand and limestone aquifers separated by confining units of silt and clay. These include the water table (surficial), Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear aquifers. The combined thickness of these sediments is approximately 1,500 feet. Less permeable clay and silt beds function as confining units or semi-confining units which separate the aquifers and impede the flow of groundwater between aquifers. A generalized hydrogeologic cross-section of this area is presented in Figure 1-2 which illustrates the relationship between the aquifers in this area (ESE, 1992).

The surficial aquifer is a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. No laterally extensive clay confining units have been encountered in this interval during previous subsurface investigations. This unit is not used for water supply in this part of the Base. In some areas, the surficial aquifer is reported to contain water contaminated by waste disposal practices, particularly in the northern and north-central developed areas of the Base (USGS, 1989).

The principal water-supply aquifer for the Base is the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is known as the Castle Hayne aquifer. The Castle Hayne aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina (USGS, 1989). Previous investigations in this area indicate that the Castle Hayne aquifer (defined as deeper than 50 to 100 feet) and the surficial aquifer (defined as less than 50 to 100 feet) are in hydraulic communication.

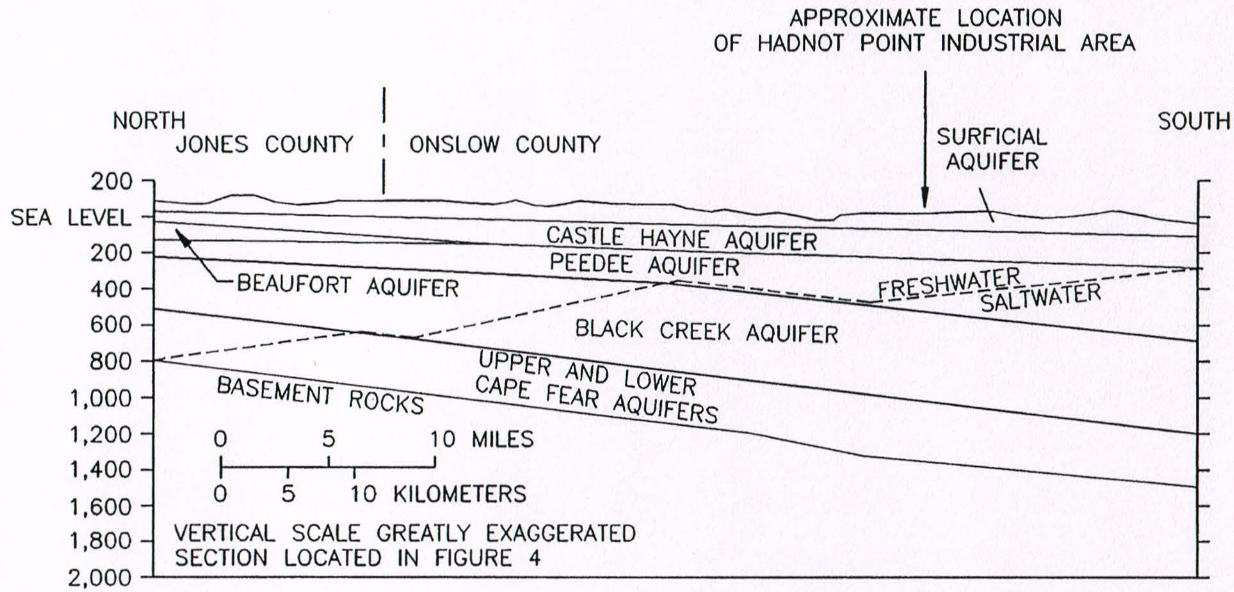
TABLE 1-1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA

GEOLOGIC UNITS			HYDROGEOLOGIC UNITS
System	Series	Formation	Aquifer and Confining Unit
Quaternary	Holocene/Pleistocene	Undifferentiated	Surficial aquifer
Tertiary	Pliocene	Yorktown Formation(1)	Yorktown confining unit
			Yorktown aquifer
	Miocene	Eastover Formation(1)	
			Pungo River confining unit
		Pungo River Formation(1)	Pungo River aquifer
		Belgrade Formation(2)	Castle Hayne confining unit
	Oligocene	River Bend Formation	Castle Hayne aquifer
	Eocene	Castle Hayne Formation	Beaufort confining unit(3)
	Paleocene	Beaufort Formation	Beaufort aquifer
Cretaceous	Upper Cretaceous	Peedee Formation	Peedee confining unit
			Peedee aquifer
		Black Creek and Middendorf Formations	Black Creek confining unit
			Black Creek aquifer
		Cape Fear Formation	Upper Cape Fear confining unit
			Upper Cape Fear aquifer
			Lower Cape Fear confining unit
			Lower Cape Fear aquifer
	Lower Cretaceous(1)	Unnamed deposits(1)	Lower Cretaceous confining unit
			Lower Cretaceous aquifer(1)
Pre-Cretaceous basement rocks		--	--

(1) Geologic and hydrologic units probably not present beneath Camp Lejeune.
(2) Constitutes part of the surficial aquifer and Castle Hayne confining unit in the study area.
(3) Estimated to be confined to deposits of Paleocene age in the study area.

Source: USGS, 1989.



160508SP

Baker Environmental, Inc.

FIGURE 1–2
GENERALIZED HYDROGEOLOGIC CROSS–SECTION
JONES AND ONSLOW COUNTIES, NORTH CAROLINA
REMEDIAL INVESTIGATION CTO–0160

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: [illegible] et. al., 1989

Onslow County and Camp Lejeune lie in an area where the Castle Hayne aquifer contains freshwater, although the proximity of saltwater in deeper layers just below this aquifer and in the New River estuary is of concern in managing water withdrawals from the aquifer since overpumping of the deeper parts of the aquifer could cause saltwater intrusion. The aquifer presently contains water having less than 250 mg/L (milligrams per liter) chloride throughout the area of the Base (USGS, 1989).

The aquifers that lie below the Castle Hayne consist of a thick sequence of sand and clay. Although some of these aquifers are used for water supply elsewhere in the Coastal Plain, they contain saltwater in the Camp Lejeune area (USGS, 1989).

Rainfall that occurs in the Camp Lejeune area (and does not exit the site as surface runoff) enters the ground in recharge areas, infiltrates the soil, and moves downward until it reaches the water table, which is the top of the saturated zone. In the saturated zone, ground water flows in the direction of lower hydraulic head, moving through the system to discharge areas like the New River and its tributaries or the ocean (USGS, 1989).

Water levels in wells tapping the surficial aquifer vary seasonally. The surficial aquifer receives more recharge in the winter than in the summer when much of the precipitation evaporates or is transpired by plants before it can reach the water table. Therefore, the water table generally is highest in the winter months and lowest in summer or early fall (USGS, 1989).

1.1.1.6 Surface Water Hydrology

The dominant surface water feature at MCB Camp Lejeune is the New River. It receives drainage from most of the base. The New River is short, with a course of approximately 50 miles on the central coastal plain of North Carolina. Over most of its course, the New River is confined to a relatively narrow channel entrenched in the Eocene and Oligocene limestones. South of Jacksonville, the river widens dramatically as it flows across less resistant sands, clays, and marls. At MCB Camp Lejeune, the New River flows in a southerly direction and empties into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB Camp Lejeune that is not drained by the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is connected to the Atlantic Ocean by Bear Inlet, Brown's Inlet, and the New River Inlet. (WAR, 1983).

1.1.1.7 Climatology

MCB Camp Lejeune is located within the Coastal Plain physiographic division of North Carolina. Coastal Plain elevations range from 200 feet above msl at the western boundary to generally 30 feet or less in areas of tidal influence to the east. The tidal portion of the Coastal Plain, where Camp Lejeune is situated, is generally flat and swampy.

Although coastal North Carolina lacks distinct wet and dry seasons, there is some seasonal variation in average precipitation. July tends to receive the most precipitation and rainfall amounts during summer are generally the greatest. Daily showers during the summer are not uncommon, nor are periods of one or two weeks without rain. Convective showers and thunderstorms contribute to the variability of precipitation during the summer months. October tends to receive the least amount of precipitation, on average. Throughout the winter and spring months precipitation occurs primarily in the form of migratory low pressure storms. Camp Lejeune's average yearly rainfall is approximately 52 inches.

Coastal Plain temperatures are moderated by the proximity of the Atlantic Ocean. The ocean effectively reduces the average daily fluctuation of temperature. Lying 50 miles offshore at its nearest point, the Gulf Stream tends to have little direct effect on coastal temperatures. The southern reaches of the cold Labrador Current offsets any warming effect the Gulf Stream might otherwise provide.

Camp Lejeune experiences hot and humid summers; however, ocean breezes frequently produce a cooling effect. The winter months tend to be mild, with occasional brief cold spells. Average daily temperatures range from 38° F to 58° F in January and 72° F to 86° F in July. The average relative humidity, between 75 and 85 percent, does not vary greatly from season to season.

Observations of sky conditions indicate yearly averages of approximately 112 days clear, 105 partly cloudy, and 148 cloudy. Measurable amounts of rainfall occur 120 days per year, on the average. Prevailing winds are generally from the south-southwest 10 months of the year, and from the north-northwest during September and October. The average wind speed for MCAS New River is 6.9 m.p.h.

1.1.1.8 Natural Resources and Ecological Features

The Camp Lejeune complex is predominantly tree-covered, with large amounts of softwood (shortleaf, longleaf, pond, and primarily loblolly pines) and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of Camp Lejeune are under forestry management. Timber producing areas are under even-aged management with the exception of those areas along streams and swamps. These areas are managed to provide both wildlife habitat and erosion control. Forest management provides wood production, increased wildlife populations, enhancement of natural beauty, soil protection, prevention of stream pollution, and protection of endangered species (WAR, 1983).

Upland game species including black bear, whitetail deer, gray squirrel, fox squirrel, quail, turkey, and migratory waterfowl are abundant and are considered in the wildlife management programs (WAR, 1983).

Aquatic ecosystems on MCB Camp Lejeune consist of small lakes, the New River estuary, numerous tributaries, creeks, and part of the Intracoastal Waterway. A wide variety of freshwater and saltwater fish species exist here. Freshwater ponds are under management to produce optimum yields and ensure continued harvest of desirable fish species. Freshwater fish in the streams and ponds include largemouth bass, redbreast sunfish, bluegill, chain pickerel, yellow perch, and catfish. Reptiles include alligators, turtles, and snakes (including venomous) (WAR, 1983).

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: pond pine or pocosin; sweet gum/water oak/cypress and tupelo; sweet bay/swamp black gum and red maple; tidal marshes; and coastal beaches. Pocosins provide excellent habitat for bear and deer because these areas are seldom disturbed by humans. The presence of pocosin type habitat at Camp Lejeune is primarily responsible for the continued existence of black bear in the area. Many of the pocosins are overgrown with brush and pine species that would not be profitable to harvest. Sweet gum/water oak/cypress and tupelo habitat is found in the rich, moist bottomlands along streams and rivers. This habitat extends to the marine shorelines. Dear, bear, turkey, and waterfowl are commonly found in this type of habitat. Sweet bay/swamp black gum and red maple habitat exist in the floodplain areas of Camp Lejeune. Fauna including waterfowl, mink, otter, raccoon, deer, bear, and gray squirrel frequent this habitat. The tidal marsh at the mouth of the New River is one of the few remaining North Carolina coastal areas relatively free from filling or other manmade changes. This habitat, which consists of marsh and aquatic plants such as algae, cattails, saltgrass, cordgrass, bulrush, and spikerush, provides wildlife with food and cover. Migratory waterfowl, alligators, raccoons, and river otter exist in this habitat. Coastal beaches along the intracoastal waterway and along the outer banks of Camp Lejeune are used for recreation and to house a small military command unit. Basic assault training maneuvers are also conducted along these beaches. Training regulations presently restrict activities that would impact ecological sensitive coastal barrier dunes. The coastal beaches provide habitat for many shorebirds (WAR, 1983).

The Natural Resources and Environmental Affairs (NREA) Division of MCB Camp Lejeune, the U.S. Fish and Wildlife Service, and the North Carolina Wildlife Resource Commission have entered into an agreement for the protection of endangered and threatened species that might inhabit MCB Camp Lejeune. Habitats are maintained at MCB Camp Lejeune for the preservation and protection of rare and endangered species through the base's forest and wildlife management programs. Full protection is provided to such species and critical habitat is designated in management plans to prevent or mitigate adverse effects of base activities. Special emphasis is placed on habitat and sightings of alligators, osprey, bald eagles, cougars, dusky seaside sparrows, and red-cockaded woodpeckers (WAR, 1983).

Within 15 miles of Camp Lejeune are three publicly owned forests: Croatan National Forest; Hofmann Forest; and Camp Davis Forest. The remaining land surrounding Camp Lejeune is primarily used for agriculture. Typical crops include soybeans, small grains, and tobacco (WAR, 1983).

1.1.1.9 Land Use

Camp Lejeune presently covers an area of approximately 170 square miles. Military and civilian population is approximately 60,000. During World War II, Camp Lejeune was used as a training area to prepare Marines for combat. This has been a continuing function of the facility during the Korean and Vietnam conflicts, and the recent Gulf War (i.e., Desert Storm). Toward the end of World War II, the camp was designated as a home base for the Second Marine Division. Since that time, Fleet Marine Force (FMF) units also have been stationed here as tenant commands.

1.1.1.10 Water Supply

MCB Camp Lejeune water is supplied entirely from groundwater. Groundwater is obtained from approximately 90 water supply wells and treated. There are eight water treatment plants with a total capacity of 15.821 million gallons per day (MGD). Groundwater usage is estimated at over 7 MGD (USGS, 1989).

The water supply wells are all located within the boundaries of the Base. The average water supply well at the base has a depth of 162 feet, a casing diameter of 8 inches, and yields 174 gpm (USGS, 1989).

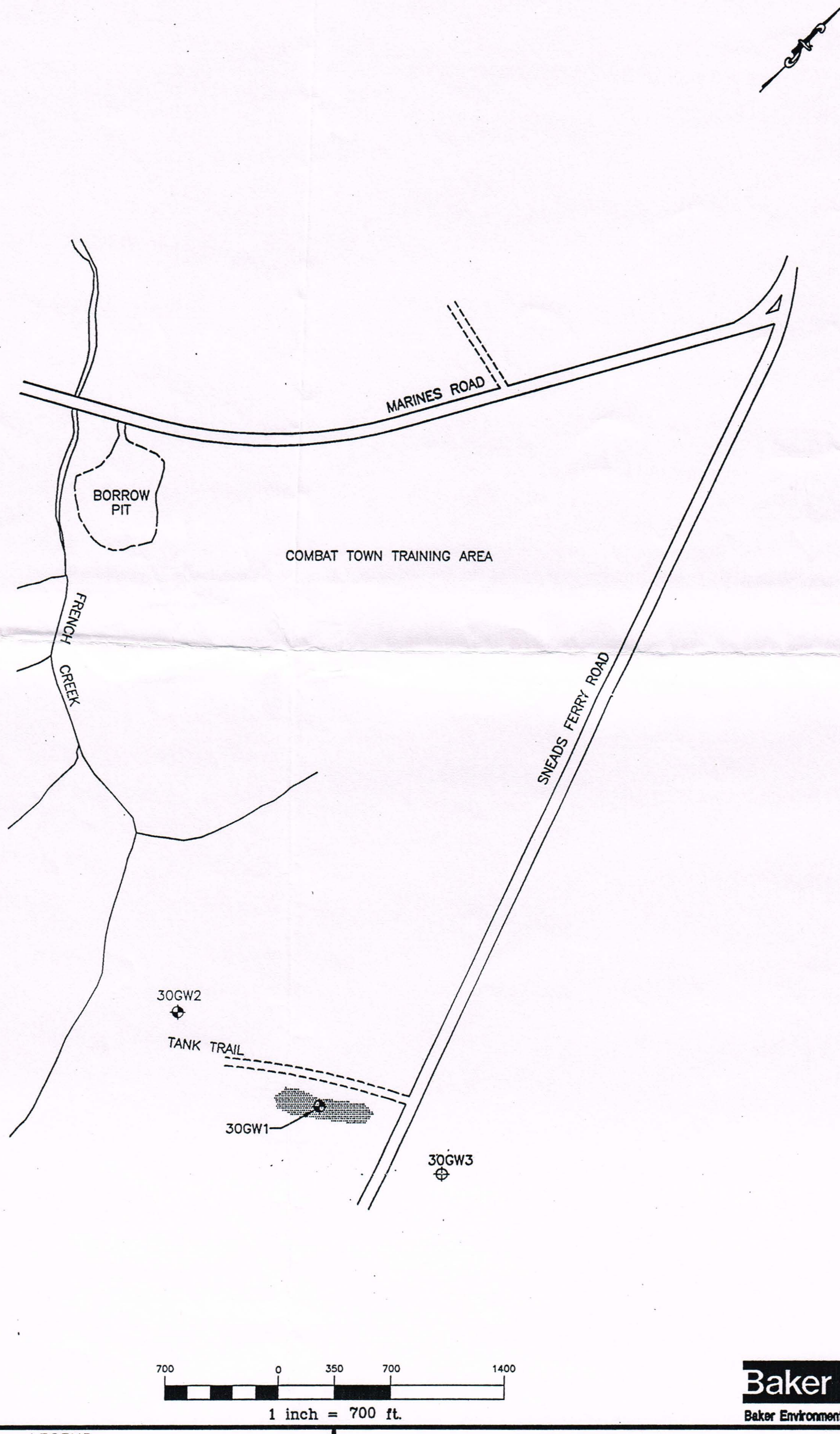
All of the water supply wells utilize the Castle Hayne aquifer. The Castle Hayne aquifer is a highly permeable, semiconfined aquifer that is capable of yielding several hundred to 1,000 gallons per minute in municipal and industrial wells in the Camp Lejeune area. The water retrieved is typically a hard, calcium bicarbonate type.

1.1.2 Site 1 - French Creek Liquids Disposal Area

This section addresses the background and setting of Site 1 - French Creek Liquids Disposal Area (FCLDA).

1.1.2.1 Site Location and Setting

Site 1 (FCLDA) is located on both the north and south sides of the Main Service Road and is bordered to the east by Daly Road and the Gun Park Area and Force Troops Complex to the west (Figure 1-3). For the purposes of clarification in this document, Site 1 has been divided into two site designations. The first site will be referred to as Site 1 North (1-N), and the second site will be referred to as Site 1 South (1-S). The estimated total acreage for both Sites 1-N and 1-S is approximately 7 to 8 acres. Much of area included in 1-N and 1-S is paved (e.g., roadways, parking lots, and storage lots), however there are many lawn areas associated with the individual buildings at 1-N, and large areas of sand surround Site 1-S. In addition, both Sites 1-N and 1-S have a few wooded acres.



Baker
Baker Environmental, Inc.

160507SP

LEGEND

30GW2 – EXISTING MONITORING WELL

– SNEADS FERRY ROAD FUEL TANK SLUDGE AREA

SOURCE: WATER AND AIR RESEARCH, INC., 1983 ESE, 1987.

FIGURE 1–5
SITE PLAN
SITE 30 – SNEADS FERRY
ROAD FUEL TANK SLUDGE AREA
REMEDIAL INVESTIGATION CTO–0160
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

1.1.2.2 Site Topography and Drainage

MCB Camp Lejeune is situated on relatively flat coastal terrain which includes swamps, estuaries, savannas, and forest lands. The land within Site 1 is relatively flat with a downward slope towards Cogdels Creek to the west.

The majority of the area within Site 1 is paved. Natural drainage has been altered by the installation of drainage ditches, storm sewers, a storm water detention pond, and extensive paving. Surface runoff not intercepted by manmade structures from western portions of the site drains to Cogdels Creek.

Cogdels Creek has been identified by U.S. Fish and Wildlife Service (USFWS) as a wetland and has the following classification: Palustrine (system), forested (class), and deciduous (subclass).

1.1.2.3 Site History

Both Sites 1-N and 1-S have been utilized by different Marine organizations since the late 1940s to the mid-1970s. These organizations ranged from motor transport units, armored personnel carriers, tank battalions, and artillery units.

Liquid wastes generated from the maintenance of vehicles were routinely poured onto the ground. These wastes have been reported as petroleum, oil, and lubricants (POL). Also, used battery acid was reported as being poured onto the ground. Quantities of the wastes have been estimated to be 5,000 to 20,000 gallons of POL waste and 1,000 to 10,000 gallons of battery acid waste.

1.1.2.4 Site Geology and Hydrogeology

Site specific geologic information is limited to information obtained during the installation of monitoring wells. Seven (7) shallow (30 foot or less) monitoring wells, have been installed at FCLDA.

Site geology described from previous investigations is a silty and clayey sand, with gravelly sand and limestone marl encountered at deeper depths. A geologic cross section of FCLDA is presented in the Site Summary Report prepared by ESE (1990) which is provided in

Appendix A in the Work Plan. This cross section represents the lithology encountered during well installation operations. Also, the cross section depicts the lithology bisecting the site in the direction of south to north.

During previous investigations, shallow groundwater was encountered at a range of 9.2 to 17.6 feet below ground surface (bgs). Based on water level measurements from the monitoring wells, groundwater flow is predominantly to the west towards the New River, with potential recharge areas being the detention pond located behind the building at Site 1-N, and Cogdels Creek to the west.

1.1.3 Site 28 - Hadnot Point Burn Dump

1.1.3.1 Site Location and Setting

The Hadnot Point Burn Dump (HPBD), which covers approximately 23 acres. The site is bordered on the southwest by the New River, the south by Cogdels Creek and woodlands, the north by the Mainside Sewage Treatment Plant and woodlands, and to the west by woodlands as shown on Figure 1-4. The site is divided into two areas, referred to as 28-W and 28-E, which is separated by Cogdels Creek.

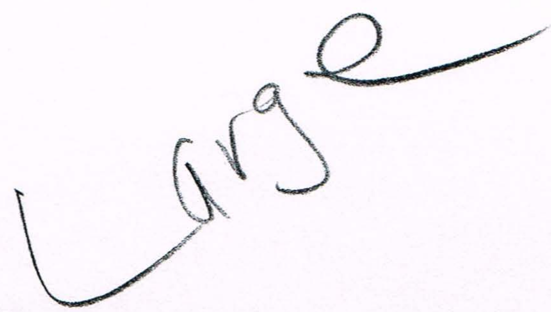
Area 28-W is mostly covered by grass except along the southern boundary where it is a marsh (along the New River and Cogdels Creek). Equalition basins, which are part of the sewage treatment plant, are located near the southern portion of the 28-W. In addition, picnic pavilions are situated near the northeastern boundary.

Area 28-E is also covered by mostly grass except near the northern portion where a pond (referred to as Site Pond) is situated. A lagoon pumping station, a grit chamber, and a equilition lagoon with an aerator is located near the southwestern portion of 28-E.

1.1.3.2 Site Topography and Drainage

The land within Site 28 is gently sloping to the west (approximately 5 to 25 feet above msl) and is unpaved except for the treatment plant located in the southwest corner of the site. Cogdels Creek, which bisects the site collects a majority of the surface drainage and discharges to the New River. Also, the western edge of this site is bordered by the New River which receives some surface drainage.

Figure 1-4



Three wetland areas have been identified by the USFWS HPBD. The first wetland is Cogdels Creek and has the following classification; Palustrine (System), forested (class), and deciduous (subclass). The second wetland is the HPBD pond which classifies as Palustrine (system). The third wetland is the New River and has the following classification; Estuarine (system), subtidal (subsystem), and open water.

1.1.3.3 Site History

A variety of solid wastes including mixed industrial waste, trash, garbage, oil-based paint, and refuse were burned and subsequently covered with "fill" on this site. The total volume of fill is estimated to be 185,000 to 379,000 cubic yards. This estimate is of necessity very broad because the waste volume reduction resulting from the burning operations is essentially an unknown. Waste disposal practices were stopped in 1971 and the site was "closed" by filling and grading the surface soils and planting grass. Currently, the site is used as a recreation area which includes picnic facilities and a stocked fish pond.

1.1.3.4 Site Geology and Hydrogeology

The site, as described from previous investigations, is underlain generally by silty sand; however, sandy, gravelly fill type material is also present in some areas.

The surface of the shallow groundwater at this site ranges in depth from approximately 1.5 feet to 3.5 feet below the land surface. The water table appears to occur in the sandy silt and more gravelly units. It appears that both the pond and Cogdels Creek are recharge areas for the water table aquifer. During periods of high water, it is apparent (based on the presence of an overflow pipe in the pond) that excess pond water flows into the creek. It has been reported that groundwater flow is to the west toward the New River at a gradient of approximately 0.002 ft/ft. The surface of the shallow groundwater at the site has been measured at nine feet bgs (ESE, 1990). A geologic cross section of site lithology is presented in Site Summary Report provided in Appendix B of the Work Plan. The cross section describes the HPBD lithology bisecting the site from a west to east direction.

[Note: The information contained in the above paragraphs was obtained from the Site Summary Report (ESE, 1990)].

1.1.4 Site 30 - Sneads Ferry Road Fuel Tank Sludge Area

1.1.4.1 Site Location and Setting

The Sneads Ferry Road Fuel Tank Sludge Area (FTSA) is located along a tank trail which intersects Sneads Ferry Road from the west approximately 6000 feet south of the intersection with Marines Road (Figure 1-5). To the west of the site, lies one of the two streams which comprise the headwaters of French Creek.

The site is presently used much as it has been in the past, as an area where tank exercises are held. The alleged waste disposal practices which caused the site to be of concern no longer take place.

1.1.4.2 Site Topography and Drainage

The site is mostly flat and is unpaved. The site has small wooded areas intermixed between the tank trails.

Based on a review of NWI maps, the immediate areas around French Creek are identified as wetland areas. Also, this wetland has been characterized as the following: Palustrine (system), forested (class), Broad leaved deciduous and needle-leaved evergreen (subclass).

1.1.4.3 Site History

Sludge from fuel storage tanks that were used to store leaded gasoline (containing tetraethyl lead and related compounds), and wastewater from the washout of these tanks, were disposed of at the site. The work which included waste disposal was performed by a private contractor. It is estimated that, at a minimum, 600 gallons of sludge/tank bottoms were removed from the tankage during a changeover in fuel type stored. This estimate is based on the projected volume of material remaining in the two 12,000 gallon tanks above the tank outflow ports. Additional washout water was also likely to have been disposed. Additional information suggests that the site was also used for the disposal of similar wastes from other tanks. The composition of the waste is unknown but is likely to contain gasoline constituents (including tetraethyl lead) and cleaning compounds.

1.1.4.4 Site Geology and Hydrogeology

Based on information obtained from the installation of monitoring wells, the site is underlain by layers of sand, silty sand, and gravelly sand. Groundwater occurs within the upper layer of silty sand at depths from approximately four to eight feet. Based on the limited information available, it appears that groundwater flow is towards the northwest (toward the unnamed tributary of French Creek) at a gradient of approximately 0.004 ft/ft.

A geologic cross section of the site lithology has been presented in the Site Summary Report provided in Appendix C in the Work Plan. The cross section describes the FTSA lithology, bisecting the site from an east to west direction.

[Note: The information contained in the paragraphs above was obtained from the ESE Site Summary Report of 1990.]

1.2 Site Background

This section summarizes the types and volume of known wastes at each site, probable transport and exposure pathways, and data limitations related to characterizing the sites, assessing human and ecological lists, and evaluating alternatives. This summary of information will be used to define the data quality objectives in Section 2.0.

1.2.1 Site 1 - French Creek Liquids Disposal Area

1.2.1.1 Types and Volumes of Waste Present

Site 1 has been used by a variety of different Marine organizations since the late 1940s. At present, both sites 1-N and 1-S are vehicle storage/maintenance facilities. Liquid wastes from vehicle maintenance activities were poured on the ground as part of routine operations. The waste products were primarily petroleum, oil, lubricants (POL), batteries and used battery acid. Suspected quantities of waste are estimated to be 5,000 to 20,000 gallons of waste (POL) and 1,000 to 10,000 gallons of battery acid. The volume of actual batteries being disposed of was not provided during the records search.

1.2.1.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at FCLDA, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface soil runoff from Cogdels Creek
- Migration of contaminants from disposal areas
- Migration/leaching of soil contamination to shallow groundwater

Exposure Pathways

- Aquatic and terrestrial exposure to contaminants due to incidental sediment and soil ingestion.
- Airborne fugitive particles released from potentially contaminated surface soil
- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to contaminants in soil and sediment.
- Human exposure to contaminants due to incidental soil and sediment ingestion.
- Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply).
- Human dermal exposure to contaminants due to future potential direct contact with groundwater and surface water.
- Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

1.2.1.3 Present Database Limitations

The purpose of this section is to define the present database limitations with respect to either characterizing the site, assessing health and environmental risk, or evaluating potential feasible technologies.

Specific data limitations with respect to soil, groundwater, surface water, sediment, and aquatic life are discussed below.

Groundwater

Five of the wells were placed down gradient of Sites 1-N and 1-S and along with the addition of water supply well HP-636 were sampled in 1984. One well was placed upgradient of 1-S. In 1986, ESE collected one round of groundwater samples and a surface water/sediment sample. In July 1991, Baker conducted a site investigation (SI) of Site 1-S under Contract Task Order (CTO) 0003. The SI was conducted to obtain information for seven military construction (MCON) projects scheduled for the general area in and around Site 1-S. In April 1993, Baker conducted a third round of groundwater sampling at FCLDA under CTO-0160. Findings from these investigative activities are described below.

In July 1984, six groundwater wells were installed and sampled by Water and Air Research, Inc.. Wells 1GW1 through 1GW3 are located near Site 1-N and 1GW4 through 1GW6 are located at Site 1-S. These wells were again sampled in November 1986 and in April 1993. In addition to the six monitoring wells, the water supply well 636 (HP-638) located near Site 1-S was also sampled in July 1984. The groundwater samples in 1984 and 1986 were analyzed for the following analytes:

- Cadmium
- Chromium
- Hexavalent Chromium (1986 only)
- Lead
- Antimony
- Oil and Grease
- Volatile Organics (VOC)
- Total Phenols
- Xylene (1986 only)

- Methyl Ethyl Ketone (MEK) (1986 only)
- Methyl Isobutyl Ketone (MIBK) (1986 only)
- Ethylene Dibromide (EDB) (1986 only)

Analytical findings from the 1984 and 1986 sampling rounds are presented in Appendix A in the Work Plan.

The groundwater samples collected in 1993 were analyzed for the following analytes (Level IV data quality):

- TCL Volatile Organic Compounds
- TCL Semivolatile Organic Compounds
- TCL Pesticides/PCBs
- Target Analyte List Inorganics

Analytical findings from the 1993 round are presented in Appendix A of this FSAP.

In both rounds of sampling conducted in 1984 and 1986 well 1GW5 had several VOC detections, and wells 1GW1, 1GW2, and 1GW6 had trace levels of VOCs and phenols. The water supply well did not show any VOC contamination above detection limits. All of the groundwater samples from the six monitoring wells showed contamination above the current Maximum Contaminant Level (MCL) for cadmium (5 parts per billion {ppb}), and the action level of 15 ppb for lead. Well 1GW2 was the only well that surpassed the current MCL for Chromium (100 ppb). At this time it is unclear as to the method of analysis and data quality level initiated by either Air and Water Research, Inc. or ESE. Oil and grease (O&G) was identified in samples from wells 1GW1, 1GW2, 1GW3, and 1GW4. Concentrations were higher in the 1984 round than in the 1986 round. O&G was not a parameter analyzed for in the 1993 round.

In the round of sampling conducted in 1993 wells 1GW1, 1GW2, 1GW4, and 1GW6 all showed very low concentrations of pesticide and SVOCs contaminants (Appendix A). Well 1GW1 showed detections of both cadmium and mercury. The cadmium concentration was above both Federal and State MCLs, and the mercury concentration surpassed the state MCL. Wells 1GW2, and 1GW6 also showed detections for mercury and in both wells the concentrations exceeded the state MCL. Finally, well 1GW4 showed a detection for zinc above the state MCL. All groundwater samples from the 1993 round were subject to full TCL/TAL analysis under CLP protocols and Level IV data quality.

Soil

The specific source(s) of soil contamination has not been identified during the previous investigations. In addition, several potential areas of contamination have not been previously investigated. Further investigation at these areas is needed to identify the nature and extent of contamination.

Eighteen (18) soil borings were advanced by Baker at Site 1-S in July 1991. Two samples were obtained from each borehole. The first sample coming from the 0-2 foot bgs, and the second coming from the split spoon interval just above the encountered water table, which ranged from 15.9 to 18.7 feet bgs. All soil samples were analyzed for full TCL/TAL parameters using CLP protocols and Level IV data quality. Analytical results from this sampling event is presented in Appendix A. Samples 01SB0100 and 01SB1716 had detectable amounts of toluene and benzo(a)pyrene respectively. Soil borings 1 through 18 all had detectable quantities for chromium and lead. Soil borings 1 through 9, 13 and 17 had detectable quantities for nickel and zinc.

At this time, soil data has only been collected at Site 1-S, and this effort was concerned with future building sites and not the source area or related horizontal and vertical extent. Therefore, additional analytical data is required to characterize soil contamination, delineate areas of concern, assess human health and ecological risks, evaluate the extent of soil runoff, and evaluate remedial technologies.

Surface Water/Sediment

Surface water/sediment sampling of the nearby waterways (Cogdels Creek and an unnamed tributary of Cogdels), Beaver Dam Creek, and the New River) has been conducted as part of the RI/FS at the Hadnot Point Industrial Area (Operable Unit No. 1). In order to evaluate if the FCLDA has impacted the surface water/sediments in these areas and to assess the sediment quality, human health and ecological risks, additional data needs to be collected from these waterways. The data will be collected in a manner that will determine whether contaminants from Site 1 have entered and impacted Cogdels Creek.

Aquatic Life

Data is not available to assess the potential impact to aquatic life in Cogdels Creek. Surface water and sediment data will be evaluated first to determine potential impacts to aquatic life. Based on the results of the surface water and sediment samples, specific analysis of resident organisms or toxicity studies may be needed.

1.2.2 Site 28 - Hadnot Point Burn Dump

1.2.2.1 Types and Volume of Waste Present

The HPBD covers an area of 23 acres and was in operation from 1946 to 1971. A variety of solid wastes including mixed industrial waste, trash, garbage, oil based paint, and refuse were burned at this site. Upon closure in 1971, the area was covered by fill. The area was then graded and grass was planted. Presently HPBD is utilized as a park/picnic area with a stocked fishing pond. Since the waste was burned an accurate volume of waste cannot be obtained, although estimates range from 185,000 to 379,000 cubic yards.

1.2.2.2 Potential Exposure Pathways

Based on the evaluation of existing conditions at HPBD, the following potential contaminant migration exposure pathways have been identified:

Migration Pathways

- Overland surface soil runoff from Site 28 into the New River, Cogdels Creek, and the Site Pond.
- Migration of contamination from burned refuse into subsurface soil.
- Migration/Leaching of soil contamination to shallow groundwater.

Exposure Pathways

- Aquatic and terrestrial wildlife exposure to VOCs, semivolatiles, pesticides, and inorganics, due to incidental sediment and soil ingestion.

- Airborne fugitive particles released from potentially contaminated surface soil.

- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to VOCs, semivolatiles, pesticides, and inorganics in soil and sediment.

- Human exposure to VOCs, semivolatiles, pesticides, and inorganics due to incidental soil and sediment ingestion.

- Potential human exposure to VOCs, semivolatiles, pesticides, inorganics, and oil and grease from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply).

- Potential human exposure to VOCs, due to volatilization from groundwater and surface water.

- Human dermal exposure to VOCs, semivolatiles, pesticides, and inorganics due to future potential direct contact with groundwater and surface water.

- Human exposure to pesticides, PCBs, and other contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

1.2.2.4 Present Database Limitations

The purpose of this section is to define the present database limitations with respect to either characterizing the site, assessing health and environmental risk, or evaluating potential feasible technologies.

Specific data limitations with respect to groundwater, soil, surface water sediment, and aquatic life are discussed below.

Groundwater

Four groundwater monitoring wells have been installed to characterize the groundwater quality at the site. In addition, the set of analyzed parameters has been limited. The following summarizes the previous groundwater sampling activities at Site 28.

A total of four groundwater monitoring wells were installed at the site between 1984 and 1986. Two wells monitor the edge of the fill along the New River while the other two are generally located north-south along Cogdels Creek. One well, 28GW4, was situated along the creek in a location sufficiently north so as to act as a background well.

Well 28GW1, located near the sewage plant outfall on the New River, appears to be the most contaminated well on the site. During all three rounds of sampling, the consistent presence of 1,2-dichloroethene, and trichloroethene, has been detected, albeit at relatively low levels with the most recent round exhibiting the lowest levels found to date. Also vinyl chloride was detected in quantities surpassing both the Federal and state MCLs in all three rounds. The pesticide 4,4'-DDD was detected in two of the sampling rounds (including the most recent); however this compound is ubiquitous at Camp Lejeune and its presence at the low levels may not be cause for concern. Among the inorganic contaminants of concern are arsenic, lead and mercury all of which were detected at levels above those normally found in background samples. Well 28GW1 surpassed the Federal and state MCLs for lead in sampling rounds two and three.

Well 28GW2, also located along the New River but away from the treatment plant, indicated less impact than 28GW1. No organics have been detected with the exception of a small number of SVOCs in the most recent sampling event at low concentrations. The pesticides DDD and DDE were detected in a previous round but were not confirmed in the recent sampling. Metal concentrations were relatively minor in sampling rounds one and two. Although in round three, the Federal and state MCL was exceeded for lead and the state MCL for mercury was exceeded.

Wells 28GW3 showed some pesticides at low levels and elevated chromium and lead concentrations during the July 1984 investigations. Both chromium and lead concentrations exceeded Federal and state MCLs in the 1984 investigation. The 1993 sampling event showed a chromium concentration above the Federal and State MCL.

Well 28GW4 did not show any volatiles, semi-volatile, and pesticide concentrations above the detection limits. Although oil and grease was detected in 28GW4 at low concentrations during the March 1987 investigation. Inorganic contamination showed an exceedence of the state MCL for chromium during the 1986 and 1987 investigation. The 1993 investigation showed the chromium and lead exceeded Federal and state MCLs.

Soil

No previous soil sampling activities were performed at Site 28 to access soil contamination. Accordingly, soil sampling is recommended at Site 28 to evaluate the vertical and horizontal extent of soil contamination. Further, samples of the burned refuse material, if present are needed to characterize the nature of the waste.

Surface Water/Sediment

Seven previous surface water/sediment sampling locations have been collected. A more detailed surface water/sediment sampling program needs to be conducted in order to determine if contamination is coming from offsite or related sources and/or if there are sources that exist effecting site surface water/sediment.

Aquatic Life

Limited data is available to assess the potential impact to aquatic life in the fishing pond at the site. Since previous surface water and sediment data have indicated contamination, an aquatic survey of fish and benthic organisms needs to be completed to determine if these organisms are being impacted. Based on the results, a risk assessment concerning human health and ecological impacts will be conducted.

1.2.3 Site 30 - Sneads Ferry Road Fuel Tank Sludge Area

1.2.3.1 Types and Volume of Waste Present

Site 30 (FTSA) was reportedly used for the disposal of washout waters from leaded gasoline storage tanks in 1970. It is estimated that at a minimum, 600 gallons of tank bottom or sludge deposits were pumped out onto the ground at this site. What is unclear at present, is whether this actual source area has been identified.

1.2.3.2 Potential Mitigation and Exposure Pathways

Based on the evaluation of existing conditions at FTSA, the following potential contaminant mitigation and exposure pathways have been identified:

Mitigation Pathways

- Contaminated soil runoff from the former disposal area.
- Migration/leaching of soil contaminants shallow groundwater.
- Groundwater discharge into French Creek.

Exposure Pathways

- Human exposure to contaminants due to incidental soil ingestion.
- Human exposure to contaminants due to incidental sediment ingestion.
- Human exposure to contaminants due to future potential groundwater ingestion.
- Human exposure to VOCs due to volatilization from groundwater and surface waters.
- Human dermal exposure to contaminants due to future potential direct contact with groundwater.

1.2.3.3 Present Database Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing health and environmental risk, or evaluating potential feasible technologies. The data collected to date are not detailed and extensive enough for use to fully characterize the site or to make an assessment of human health or ecological risks due to potential contamination at the site. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4.0 of the Work Plan.

Specific data limitations with respect to groundwater, soil, and surface water/sediment.

Groundwater

Groundwater wells need to be placed within the suspected disposal areas to characterize and assess the nature and extent of contamination. Also, the wells will be needed to characterize

Groundwater wells need to be placed within the suspected disposal areas to characterize and assess the nature and extent of contamination. Also, the wells will be needed to characterize horizontal and vertical extent of contamination. In addition, the set of analyzed parameters from previous investigations has been limited. The following summarizes the results of previous groundwater sampling activities.

One of the wells was installed through the area suspected of receiving wastes (30GW1 in 1984) while the second well (30GW2) was placed approximately halfway between the disposal area and the tributary to French Creek during a subsequent investigation in 1986. Trace levels of methylene chloride in 30GW1 and state MCL exceedence of chloroform in 30GW2 were found in the 1986 sampling. Neither of these compounds were detected in the 1984 results. It was suggested by ESE that the trace organics seen were laboratory artifacts. Lead was observed in 30GW1 in excess of the North Carolina standard, during the 1984 sampling. No lead was detected in 30GW1 during 1986; however, the 30GW2 did show some lead but at a concentration well below the standard. Oil and grease was detected in the groundwater samples.

In preparation for the work plan development at this site, a round of samples was obtained from both wells in May 1993 (Appendix A). These samples were analyzed for the full TCL/TAL using CLP protocols. A single trace detection of chloroform was seen in the sample from 30GW1. The level would appear to indicate this finding was attributable to laboratory contamination. The metals in 30GW1 were generally on the order of much greater than those found in 30GW2. The three metals of most significance found in 30GW1 were:

- Lead at 115 µg/l (standard is 50 µg/l)
- Chromium at 106 µg/l (standard 50 µg/l)
- Cadmium at 10.7 µg/l (standard 5 µg/l)

Mercury was detected in well 30GW1 at concentration of .88 ; the N.C. Standard for mercury is 1.2 µg/l.

<u>Soil</u>

No previous soil sampling has been conducted at this site. Therefore, analytical data is required to characterize the soil contamination, delineate areas of concern, assess human health and ecological risks, and evaluate remedial technologies.

Surface Water/Sediment

The previous surface water/sediment investigations from the French Creek Tributary had limited analysis. Most importantly, the overall quality of the existing surface water/sediment data as well as the level of QA/QC to which it was subjected are unknown. Therefore, additional analytical data is required to characterize surface water/sediment contamination, delineate areas of concern, assess human health and ecological risks, and evaluate remedial technologies.

2.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that ensure that data of known and appropriate quality are obtained during the RI and FS and will support remedial decisions (EPA, 1987). DQOs associated with each field collection program are discussed and presented in this Section. DQOs were developed using the following three stage process:

- Stage 1 - Identify decision types
- Stage 2 - Identify data needs
- Stage 3 - Design data collection program

Stage 1 of the DQO process takes place during the scoping of the RI/FS. This stage involves the evaluation of existing information, development of a conceptual model for the site to identify contaminant transport and exposure pathways, and the development of objectives for further data collection efforts.

Stage 2 of the DQO process involves definition of the quality and quantity of data that will be required to meet the objectives established in Stage 1.

Stage 3 involves design of a data collection program to meet the requirements identified in Stage 2.

The remaining portions of this Section document the establishment of DQOs for the RI/FS at Operable Unit No. 7.

2.1 Stage 1 - Identification of Decision Types

As part of the Stage 1 DQO process, available information from previous site investigations and other sources (e.g., USGS) were reviewed in order to describe the current site conditions, evaluate existing data, and assess the adequacy of the data. This review has been documented in Section 2.0 of the RI/FS Work Plan and summarized in Sections 1.1, and 1.2 of this FSAP. From this review and evaluation, a conceptual site model was developed for each site by identifying the potential sources of contamination, the contaminant migration pathways, and potential receptors. A conceptual site model for each site is presented in Table 2-1. Based on the conceptual contaminant transport/migration model for each site, specific RI/FS objectives

TABLE 2-1
SITE 1 - FRENCH CREEK LIQUIDS DISPOSAL AREA RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Soil	1a. Assess the extent , if any, of soil contamination at suspected acid and POL disposal area (1-S).	Characterize volatile, semivolatile, metal, and TPH levels in surface and subsurface soils at suspected disposal area.	Soil Investigation
	1b. Assess the extent, if any, of soil contamination at suspected acid and POL disposal area (1-N).	Characterize volatile, semivolatile, metal, and TPH levels in surface and subsurface soils at suspected disposal area.	Soil Investigation
	1c. Assess the extent, if any, of soil contamination at suspected POL disposal area (1-N)	Characterize volatile, semivolatile, and TPH levels in surface and subsurface soil at suspected disposal.	Soil Investigation
	1d. Assess human health and ecological risks associated with exposure to surface soils.	Characterize contaminant levels in surface and subsurface soils.	Soil Investigation and Risk Assessment
	1e. Assess the presence or absence of soil contamination at other potential areas of concern not previously investigated.	Characterize contaminant levels in surface and subsurface soils.	Contingent Soil Investigation
	1f. Determine whether or not the suspected POL and acids are sources of groundwater contamination.	Characterize volatile, semivolatile, metal, and TPH levels in surface and subsurface soils at suspected disposal areas.	Soil Investigation
2. Groundwater	2a. Assess health risks posed by potential future usage of the shallow groundwater.	Evaluate groundwater quality and compare to ARARs and health-based action levels.	Groundwater Investigation Risk Assessment
	2b. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow aquifer (flow direction, transmissivity, permeability, etc).	Groundwater Investigation
	2c. Assess the presence or absence of groundwater contamination at other potential areas of concern not previously investigated.	Characterize contaminant levels in surface and subsurface soils and potentially in groundwater.	Possible Groundwater Investigation

TABLE [illegible] (Continued)
SITE 1 - FRENCH CREEK LIQUIDS DISPOSAL AREA RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments.	Characterize the nature and extent of contamination in sediment.	Sediment Investigation in Cogdels Creek Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments.	Qualitatively evaluate stress to benthic and fish communities.	Evaluation of Surface Water and Sediment Data
	3c. Determine the extent of sediment contamination for purposes of identifying areas of possible remediation.	Identify extent of sediment contamination where contaminant levels exceed risk-based action levels or EPA Region IV TBCs for sediment.	Sediment Investigation and Risk Assessment
4. Surface Water	4a. Assess the presence or absence of surface water contamination in Cogdels Creek.	Determine surface water quality along Cogdels Creek.	Surface Water Investigation
	4b. Assess impacts to Cogdels Creek from groundwater discharge from Operable Unit No. 7.	Determine surface water quality in the creeks.	Surface Water Investigation
		Assess groundwater quality from Operable Unit No. 7.	Groundwater Investigation

have been developed to (1) determine the nature and extent of the threat posed by the release or potential release of hazardous substances, (2) assess human health and environmental risks, and (3) identify and evaluate remedial alternatives. The identification of these objectives, which are also presented in Table 2-1, is the first step toward the development of a program for collection of sufficient data for decision making.

The following section identifies the data requirements to meet the site-specific RI/FS objectives.

2.2 Stage 2 - Identification of Data Needs

In Stage 2 of the DQO process, the data quality and quantity required to support the RI/FS objectives developed during Stage 1 are identified. Data collected during the RI/FS for Operable Unit No. 7 will be used for: site characterization; baseline risk assessment; screening and evaluating alternatives; and remedial design. With respect to the RI/FS objectives identified in the previous section, data will be required to address the following:

Soil

- The extent of surface and subsurface soil contamination within reported disposal areas.
- The extent of surface soil contamination due to surface runoff.
- The physical properties of the soil to evaluate migration potentials and remedial technologies.
- The chemical properties of soil to assess potential human health and environmental risks, and to evaluate remedial technologies.
- The chemical properties associated with disposal and treatment requirements.

Groundwater

- The extent and nature of on site and off-site groundwater contamination in shallow and/or deep aquifers.

- The physical properties of the aquifers and their physical relationship.
- The flow direction and discharge patterns of the aquifers.
- The chemical properties to assess potential human health risks.
- The chemical properties to evaluate compliance with State or Federal drinking water standards.
- The chemical/physical properties that may affect the treatability of the groundwater.

Sediments

- The extent and nature of sediment contamination in drainage areas potentially impacted by site runoff, groundwater discharge, or tidal effects.
- The chemical properties to assess human health and environmental risks due to exposure.
- Evaluate physical/chemical stress to fish or benthic aquatic communities.

Surface Water

- The extent and nature of surface water potentially impacted by site runoff, groundwater discharge, or tidal effects.
- The chemical properties to assess human health and environmental risks.

Acid and POL Disposal Areas

- The extent of subsurface soil contamination at former disposal areas.
- The chemical/physical properties to assess disposal and treatment requirements.

Burn Dump

- The extent of subsurface soil contamination at former disposal areas.

- The chemical/physical properties to assess disposal and treatment requirements.

Fuel Tank Sludge Area

- The extent of subsurface soil contamination at former disposal areas.

- The chemical/physical properties to assess disposal and treatment requirements.

The type of data and the quality of data to meet the criteria listed above are summarized on Table 2-2. The data quality levels differ with respect to the end use of the data. Level IV data quality are generally required in risk assessments, characterizing the nature and extent of contamination, and to support the record of decision (ROD). Level III data quality is appropriate for evaluating treatment alternatives. Level II data quality is appropriate for field screening (i.e., geophysical investigations, soil gas). Level I data is appropriate for field measurements such as dissolved oxygen, temperature, specific conductance, and pH.

The analytical method also differs with respect to the end use of the data. For purposes of assessing health risks and to compare contaminant levels against Federal or State standards, it will be necessary to obtain lower detection levels for selected parameters such as volatile organics. For this RI/FS, Environmental Protection Agency (EPA) methods and Contract Laboratory Program (CLP) protocols will be used when applicable.

The quantity of samples collected is based on obtaining a representative measure to characterize the nature and extent of contamination, assess human health and environmental risks, and develop and evaluate remedial alternatives. For the various field investigations for Operable Unit No. 7, the number and location of samples was determined based on best engineering estimates, visual evaluation of the sites, and a review and evaluation of background information.

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
OPERABLE UNIT NO. 7
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Sampling Criteria/Purpose	Data Types	Data Quality Level
Soil	• Assess extent of surface and subsurface soil contamination within reported disposal areas	TCL Organics TAL Inorganics (Metals)	IV IV
	• Assess extent of surface soil contamination due to surface runoff	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify physical properties of soil to evaluate migration potentials and remedial technologies	Grain Size Moisture Density TOC Residual Chlorine Total Fluoride Organic Nitrogen	III III III III III III
	• Identify chemical properties of soil to assess potential human health and environmental risks, and to evaluate remedial technologies	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical properties associated with disposal and treatment requirements	Total TCLP Alkalinity Reactivity Corrosivity Ignitability	III III III III III
Groundwater	• Assess extent and nature of onsite and offsite groundwater contamination in shallow and/or deep aquifers	TCL Organics (EPA 601/602) TAL Inorganics (Metals)	IV IV
	• Identify physical properties of the aquifers and their physical relationship between one another	Surface Features (lithologic samples) Water Level Elevations (static) Hydraulic Conductivity(1) Transmissivity(1)	II II II II

* Note: (1) Existing information will be reviewed (USGS publications)

TABLE 2-2 (Continued)

**SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
OPERABLE UNIT NO. 7
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA**

Medium	Sampling Criteria/Purpose	Data Types	Data Quality Level
Groundwater (continued)	• Identify flow direction and discharge patterns of the aquifers	Surface Features (lithologic samples) Water Level Elevations (static and pumping) Hydraulic Conductivity Transmissivity	II I I I
	• Identify chemical properties to assess potential human health risks	TCL Organics (EPA 601/602) TAL Inorganics (Metals)	IV IV
	• Identify chemical properties to evaluate compliance with State or Federal drinking water standards	TCL Organics (EPA 601/602) TAL Inorganics (Metals)	IV IV
	• Identify chemical/physical properties that may affect treatment	Total Suspended Solids Total Volatile Solids Biological Oxygen Demand Chemical Oxygen Demand Total Dissolved Solids Temperature Specific Conductance pH	III III III III III I I I
Sediment	• Assess extent and nature of sediment contamination in surface water bodies potentially impacted by site runoff, groundwater discharge, or tidal effects	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical properties to assess human health and environmental risks due to exposure	TCL Organics TOC TAL Inorganics (Metals)	IV III IV

TABLE 2-2 (Continued)

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
OPERABLE UNIT NO. 7
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Sampling Criteria/Purpose	Data Types	Data Quality Level
Surface Water	• Assess extent and nature of surface water potentially impacted by site runoff, groundwater discharge, or tidal effects	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical properties to assess human health and environmental risks	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify physical/chemical properties to assess potential impacts to aquatic life	Dissolved Oxygen Specific Conductance Temperature pH	I I I I
Waste	• Assess extent of subsurface soil contamination at former disposal areas	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical/physical properties to assess disposal and treatment requirements	Total TCLP Reactivity Ignitability Corrosivity Grain Size	III III III III III

Notes:

TCL Target Compound List
TAL Target Analyte List
TOC Total Organic Carbon
TCLP Toxicity Characteristic Leaching Procedure

2.3 Stage 3 - Design Data Collection Program

The data collection programs for Operable Unit No. 7 have been designed to meet the objectives identified in Table 2-1. Section 5.4 of the RI/FS Work Plan provides a general description of the various sampling programs for the three sites. Sections 3.0 through 5.0 of this FSAP provide the specific details of these sampling programs.

3.0 SAMPLING LOCATIONS AND FREQUENCY

This section of the FSAP identifies each sample matrix to be collected and the constituents to be analyzed.

3.1 Site 1 - French Creek Liquids Disposal Area

The following investigations and support activities will be conducted at Site 1:

- Surveying
- Soil investigations
- Groundwater investigations
- Surface water/sediment investigations

Each activity is described below.

3.1.1 Surveying

Surveying tasks at Site 1 will be performed in three phases: Phase I - Initial Site Survey; Phase II - Survey of Proposed Sampling and Monitoring Well Locations; and Phase III - Monitoring Well and Staff Gauge Survey. Phase I will include surveying the outer boundaries of the former disposal areas [based on information obtained from the Final Site Summary Report (see Appendix A in the Work Plan)], and surveying areas at the site which may have undergone physical changes (e.g., new buildings, outfall piping). Survey stakes will be placed around the boundaries of the former disposal areas. These surveying activities will provide updated site drawings and assist in locating the proposed drilling and sampling locations which will be done during the Phase II survey.

Phase II surveying activities will involve surveying the locations of the proposed soil borings, monitoring wells, and surface water/sediment sample stations. The final locations selected for the sampling points and monitoring wells will depend on the results of the Phase I survey which will identify the outer boundaries of the former disposal areas.

During Phase III surveying activities, all existing monitoring wells, and any wells and staff gauges installed during the investigation at Site 1 will be surveyed. The top of the metal protective casing, the top of the PVC well casing (and staff gauge), and the elevation of the ground surface will be surveyed. Latitude, longitude, and elevation in feet of mean sea level will be measured. The vertical accuracy of the survey will be 0.01 feet and the horizontal accuracy will be within 0.1 foot. In addition, soil sampling locations (i.e., boreholes) and surface water/sediment sample locations will be surveyed to a horizontal accuracy of 0.1 foot.

3.1.2 Soil Investigation

Soil investigations will be conducted at two areas of concern (AOC) within the FCLDA which include: (1) the acid, and waste petroleum, oil, and lubricants (POL) disposal area located within the southern portion of the site (1-S); and (2) the acid and POL disposal area located within northern portion of the site (1-N). Soil samples will be taken from test borings and will also be collected during the installation of new monitoring wells (projected number of new wells is seven).

3.1.2.1 Acid and POL Disposal Area Grid 1-S

Sampling Locations

As described in Section 3.1.1, an initial site survey will be conducted to locate the outer boundary of the former disposal area (referred to as grid 1-S). The location of the disposal area to be surveyed is based on information obtained from the Final Site Summary Report (see Appendix A in the Work Plan). The approximate boundary of the disposal area will be identified by placing survey stakes around the outside boundary, as shown on Figures 3-1 and 3-2 (note that all Section 3.0 figures are presented at end of this FSAP).

Following the establishment of the disposal boundary, exploratory test borings may be augered and soil samples collected (using ASTM Method D 1586-84) for visual classification purposes. The purpose of the exploratory borings is to access the thickness of possible fill material which may have been backfilled on top of the original ground (and disposal) surface. Moreover, the purpose of establishing the thickness of the potential fill material is to ensure that samples collected for analytical testing are obtained from depths (with the exception of surface samples) within and below the suspected contaminated source horizons. These borings will be installed if fill material is encountered during installation of the initial borings (described in the following paragraphs). Four (4) borings (SB42 through SB45) are proposed within the boundary area to confirm the thickness of the potential fill material, if required. Tentative locations for these borings are shown on Figure 3-2. The sampling locations are designed to provide an adequate areal distribution of measurement points capable of developing the requisite information. Drilling locations may be finalized in the field based upon the outcome of the Phase I survey and upon the locations of underground utilities which will be identified by Camp Lejeune personnel.

A projected total of 18 borings (SB1 through SB18) will be installed as part of the sample grid established within (eight borings) and around the boundary (10 borings) of the suspected disposal area as shown on Figures 3-1 (surface soils) and 3-2 (subsurface soils). The final number of borings, however, may be determined in the field based on the results of the Phase I survey and potential above and below ground utilities at proposed drilling sites. The borings will be augered and soil samples collected using ASTM Method D 1586-84. Additionally, samples may be collected via a hand auger if underground utilities are suspected in the area or if access with a drill rig is limited. The purposes of the borings are to: (1) characterize the nature of the contamination (i.e., identify contaminants of concern); (2) evaluate the vertical and horizontal extent of the contamination; and (3) characterize the shallow geologic and hydrogeologic conditions within the site. Additionally, a total of up to five (5) borings (SB38 through SB41, and SB49) will be advanced at locations east, south, and north of the site, outside the areas of concern, to collect site-specific background and control samples. Table 3-1 provides a summary of the boring location rationale.

Samples will be collected from the surface (top 12-inches from ground surface or below asphalt/concrete/base coarse surface) then at continuous 2-foot intervals to the top of the water table which is estimated to be approximately seven to 17 to feet below ground surface (bgs) across the site. The sample collected from just above the water table, and possibly a third sample will also be retained from laboratory analysis. The selection of the third sample will be based on any visual indications of contamination and/or elevated organic vapor readings using a PID. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

<u>Analytical Requirements</u>

All surface soil samples will be analyzed for full Target Compound List (TCL) organics (volatiles, semivolatiles, pesticides, and PCBs) and Target Analyte List (TAL) metals via Contract Laboratory Program (CLP) protocols. Samples will also be analyzed for total petroleum hydrocarbons (TPH), via EPA Methods 3550/5030, to provide information for remediation options, if required. It should be noted that two surface soil samples will be

TABLE 3-1

SUMMARY OF SOIL BORING RATIONALE - SITE 1
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Grid Area	Boring Number	Purpose
1-S	SB1 through SB6, SB10, and SB16 through SB18	Evaluate the horizontal extent of soil contamination associated with the former disposal area
	SB7, SB8, SB9, and SB11 through SB15	Characterize the nature of soil contamination within the former disposal area; vertical extent of contamination
	SB42 through SB45	Exploratory borings to investigate subsurface soil conditions and determine the thickness of potential fill material
	SB51 and SB52	Collect composite soil samples for engineering parameters
1-N	SB19 through SB23, SB29 through SB32, SB34, SB37, and SB36	Evaluate the horizontal extent of soil contamination associated with the former disposal area
	SB24 through SB28, SB33 and SB35	Characterize the nature of soil contamination within the former disposal area; vertical extent of contamination
	SB46, SB47, and SB48	Exploratory borings to investigate subsurface soil conditions and determine the thickness of potential fill material
	SB53 and SB54	Collect composite soil samples for engineering parameters
NA(1)	SB38 through SB41, and SB49 (to be converted into well 1GW13)	Collect site specific background soil samples
NA	1GW7 through 1GW12	Borings advanced for monitoring well installation; collect soil samples to correlate with potential groundwater contamination

Note: (1) NA - Not Applicable

analyzed for full TCL organics (including pesticides/PCBs). These samples (full TCL organics and TAL metals) will serve to assess human health and environmental risks and will provide data to more fully characterize surface soils. The proposed surface soil sample stations with the respective analyses and turnaround time are depicted on Figure 3-1.

The subsurface soils will be analyzed for full TCL organics and TAL metals under CLP protocols. Select samples collected from borings (as depicted on Figure 3-2) in the suspected source area will be analyzed on an accelerated basis (i.e., seven day "quick" turnaround) to provide immediate characterization of the acid and POL disposal area. In addition, select samples collected from borings along the perimeter of the acid and POL disposal area also will be analyzed on an accelerated basis to ensure that the horizontal extent of contamination has been accurately defined. Figure 3-2 presents proposed boring locations with respective analytical requirements and turnaround times. Based on the analytical results from samples designated for quick turnaround, the sampling grid may expand to further evaluate the extent of contamination. Remaining subsurface soil samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround).

As shown on Figure 3-2, two (2) borings (SB51 and SB52) from grid 1-S will be analyzed for selected chemical and physical engineering parameters. The engineering boring locations will be confirmed in the field based on quick turnaround analytical results or visual observation of soils. It should be noted that samples collected for engineering parameters will be obtained from areas suspected to contain the greatest amount of contamination, and therefore, are subject to relocation. Samples collected for engineering parameters will be composites of the soil cuttings from the surface to the water table. Samples from one boring will be tested for grain size characteristics and Atterberg limits (note that moisture density testing may be performed if clayey soils are encountered); samples from the second boring will be analyzed for total organic carbon (TOC), full toxicity characteristic leaching procedure (TCLP) parameters, residual chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation or offsite disposal options.

3.1.2.2 POL and Acid and POL Disposal Areas Grid 1-N

A similar approach described for grid 1-S will be implemented at grid 1-N. The approximate boundary of the disposal areas will be located, and survey stakes will be placed around the boundary area to assist in establishing the sample grid. The approximate location of the disposal areas to be surveyed are based on information obtained from the Final Site Summary Report (see Appendix A in the Work Plan).

Following the establishment of the disposal area boundary, exploratory test borings may be augered and soil samples collected (using ASTM Method D 1586-84) for visual classification purposes. The purpose of the exploratory borings is to assess the thickness of possible fill material which may have been backfilled on top of the original ground (and disposal) surface. Moreover, the purpose of establishing the thickness of the potential fill material is to ensure that samples collected for analytical testing are obtained from depths (with the exception of surface samples) within and below the suspected contaminated source horizons. These borings will be installed if fill material is encountered during installation of the initial borings (described in the following paragraphs). Three (3) borings (SB46, SB47, and SB48) are proposed within the boundary area to confirm the thickness of the potential fill material. Tentative locations for these borings are shown on Figure 3-2. The locations are designed to provide an adequate areal distribution of measurement points capable of developing the requisite information. Drilling locations may be finalized in the field based upon the outcome of the Phase I survey and utility locations.

A projected total of 19 borings (SB19 through SB37) will be installed within and around the boundary of the suspected disposal areas as shown on Figures 3-1 and 3-2. The final number of borings, however, may be determined in the field based on the results of the Phase I survey and potential above and below ground utilities at proposed drilling sites. Six borings will be installed within the boundary of the disposal areas to characterize the potential source of contamination. Moreover, up to 13 borings will be installed around the outside boundary of the suspected disposal area to evaluate the extent of any contamination. The purposes of the borings are to: (1) characterize the nature of the contamination (i.e., identify contaminants of concern); (2) evaluate the vertical and horizontal extent of the contamination; and (3) characterize the shallow geologic and hydrogeologic conditions within the site. Additionally, a total of up to five (5) borings (described in Section 3.3.2.1) will be advanced at locations east, south, and north of the site outside the areas of concern to collected site specific background analytical data. Table 3-1 provides a summary of the boring location rationale.

The borings will be augered and soil samples collected using ASTM Method D 1586-84. Additionally, samples may be collected via a hand auger if underground utilities are suspected in the area or if access with a drill rig is limited. Specific drilling and sampling methods are outlined in Section 5.0.

Samples will be collected from the ground surface (top 12 inches) then at continuous 2-foot intervals to the top of the water table which is estimated to be approximately seven to 17 feet bgs across the site. The sample collected from just above the water table, and possibly a third sample will also be retained for laboratory analysis. The selection of the third sample will be based on any visual indications of contamination and/or elevated organic vapor readings using a PID. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

Analytical Requirements

All surface soil samples will be analyzed for full TCL organics and TAL metals via CLP protocols. Samples will also be analyzed for TPH (EPA Methods 3550/5030). It should be noted that two surface soil samples will be analyzed for full TCL organics (including pesticides/PCBs). These sample location points will be selected based on quick turnaround analysis for VOAs and SVOAs. Moreover, these samples (full TCL organics and TAL metals) will serve to assess human health and environmental risks and will provide data to more fully characterize subsurface soils. The proposed surface soil sample stations with the respective analyses and turnaround time are depicted on Figure 3-1. The surface soil samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround time).

The subsurface soils will be analyzed for full TCL organics and TAL metals under CLP protocols. Select samples collected from borings (as depicted on Figure 3-2) in the suspected source area will be analyzed on an accelerated basis to provide immediate characterization of the acid and POL disposal areas. In addition, select samples collected from borings along the perimeter of the acid and POL disposal area will also be on an accelerated analytical turnaround to ensure that the horizontal extent of contamination has been accurately defined. Figure 3-2 presents proposed boring locations with respective analytical requirements and turnaround times. Based on the analytical results from samples designated for quick turnaround the sampling grid may expand to further evaluate the extent of contamination. Remaining subsurface soil samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround time).

Two (2) borings (SB53 and SB54) from grid 1-N will be analyzed for selected chemicals and physical engineering parameters (as shown on Figure 3-2). The engineering boring locations will be confirmed in the field based on quick turnaround analytical results or visual observation of soils. It should be noted that samples collected for engineering parameters will be obtained from areas suspected to contain the greatest amount of contamination, and therefore, are subject to relocation. Samples collected for engineering parameters will be composites of the soil cuttings from the surface to the water table. Samples from one boring will be tested for grain size and Atterberg limits (and possibly moisture density); samples from the second boring will be analyzed for TOC, full TCLP parameters, residual chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation or offsite disposal options.

3.1.3 Groundwater Investigation

Groundwater investigations will be conducted at Site 1 to further assess groundwater quality. The groundwater investigation will consist of the installation of monitoring wells, the collection of one round of groundwater samples, and multiple rounds of water level measurements from all existing and newly installed wells. The following provides a detailed description of groundwater investigation activities.

3.1.3.1 Monitoring Well Construction

As shown on Figure 3-3, seven (7) existing monitoring wells are present at Site 1. Five (5) of the wells, 1GW1 through 1GW4 and 1GW6, were installed as part of the Initial Site Assessment which was conducted to assess groundwater quality associated with the disposal areas. There are also three (3) wells present just north of Building FC120 which are situated around a waste storage area (e.g., waste oils, antifreeze). Well construction information (e.g., well depths, screen intervals, etc.) for these wells is unknown at this time but they are likely shallow wells (less than 25 feet). Lastly, a single well was identified during the site visit near a surface water runoff collection pond located behind Building FC134. The purpose and well construction information for this well are also unknown. Since there are areas that need further assessment at the site, specifically downgradient from the disposal areas, at least seven (7) shallow wells will be installed during the RI. The proposed well locations are shown on Figure 3-3, and Table 3-2 provides the rationale and purpose for each proposed well location.

TABLE 3-2

MONITORING WELL SUMMARY AND RATIONALE
SITE 1
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Well Designation	General Location(1)	Purpose
1GW4*, 1GW5*, 1GW7, 1GW8, and 1GW9	West of 1-S Acid and POL Disposal Area	Monitor shallow groundwater quality downgradient from Acid and POL Disposal Area
1GW1*, 1GW2*, 1GW3*, 1GW10, and 1GW11	West-northwest of 1-N Acid and POL Disposal Area	Monitor shallow groundwater quality downgradient from the Acid and POL Disposal Area
Unknown Wells* (2) (1GW14 and 1GW15)	Within POL Only Disposal Area and POL and Acid Disposal Area	Monitor shallow groundwater quality downgradient and upgradient from disposal areas
1GW6*, 1GW12, and 1GW13	East of POL and Acid Disposal Areas	Monitor shallow groundwater quality upgradient

Note: * - Denotes existing monitoring well

(1) See Figure 5-2 for existing and proposed well locations.
(2) Note that two well clusters (i.e., shallow and deep wells installed side-by-side) will also be installed to evaluate shallow and deep groundwater quality in the most contaminated area.

The shallow monitoring wells will be installed to further evaluate the horizontal extent of shallow groundwater contamination. The wells will be constructed of 2-inch PVC and installed to a depth of at least 12 to 15 feet below the top of the water table. Two-inch wells are proposed since they will serve as monitoring wells only and are not intended to serve as extraction wells. Well screens will be 15-feet in length and will be constructed of No. 10 slotted PVC. This length will allow for seasonal fluctuations in the water table which are known to vary between 2 to 4 feet at Camp Lejeune. Detailed well construction information and well installation procedures are provided in Section 5.0.

Additionally, up to two (2) shallow/deep well clusters (i.e., one shallow and one deep well installed side by side) will be installed within the suspected source areas (grids 1-S and 1-N). The location of these clusters will be based on analytical data obtained from the soil investigation and groundwater data obtained from existing supply well HP-638 which will be sampled during the initial field activities. It is anticipated that the shallow well will be installed at approximately 25 feet (at least 12 to 15 feet below the water table) and the deep well will be installed within the upper portion of the Castle Hayne formation (approximately 100 feet). The final depth of the deep well, however, will be determined in the field. Specific drilling procedures for both shallow and deep wells are outlined in Section 5.0.

3.1.3.2 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from seven (7) of the eight (8) existing [including two of the five unknown wells (note that well 1GW5 is damaged and cannot be sampled)] and newly installed wells within Site 1. Because of the close distance between the three wells identified near the waste storage area, only one of these wells (outside of the disposal area) will be sampled. In addition, the unknown well north of Building FC 134 will be sampled.

The analytical results from previous investigations have identified inorganic constituents (e.g., lead and chromium) as the primary contaminants of a concern in groundwater with some low levels of volatiles and semivolatiles. Accordingly, the groundwater sampling program proposed for Site 1 will primarily focus on inorganics, volatiles, and semivolatiles. Groundwater samples collected from 12 of the 14 shallow wells and supply well HP-638 will be analyzed for volatiles (EPA Methods 601/602), TCL semivolatiles, and TAL metals (total and dissolved) using Contract Laboratory Program (CLP) protocols (Level IV data quality). These shallow wells include: 1GW1 through GW3, 1GW5 through 1GW10, and 1GW12 through 1GW15 as shown on Figure 3-3.

Two (2) of the samples (1GW4 and 1GW11) will be analyzed for full TCL organics (including volatiles, semivolatiles, PCBs, and pesticides) and TAL inorganics under CLP protocols (Level IV data quality). Additionally, groundwater samples collected from the shallow and deep well clusters will also undergo the same analyses. These samples will allow an assessment of human health and environmental risks to be made and will provide data to more fully characterize the groundwater. Well 1GW4 was selected for full analysis since it is located near the center of a suspected disposal area (i.e., contaminated area) and well 1GW11 was selected for full anlaysis since it is representative of site background conditions (note that the well is located in a wooded area upgradient from the site).

Additionally, one of the wells (1GW4) within the area of concern will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include: biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and total dissolved solids (TDS).

Detailed groundwater sampling procedures are provided in the FSAP. Specific details of the analytical methods and data validation are provided in the QAPP.

Water Level Measurements

Static water levels measurements (minimum of two rounds) will be collected from each existing and newly installed well during the groundwater investigation. Water level measurements shall be collected from all wells within a four hour period, if possible. Water level measurement techniques are described in Section 5.0. Groundwater level data will be used to evaluate shallow groundwater flow patterns in the area.

3.1.4 Surface Water/Sediment Investigation

3.1.4.1 Sample Locations

Surface water and sediment investigations will be conducted on Cogdels Creek to further assess possible impacts from Site 1. In May 1993, Baker conducted a surface water and sediment sampling investigation on Cogdels Creek to investigate the impacts from Operable

Unit (OU) No. 1. The locations of these sample stations are presented on Figure 2-4 in the Work Plan. Data gathered from the OU No. 1 investigation will be utilized to characterize this site (i.e., evaluation of human health and ecological impacts). Two surface water and sediment samples will be taken from an unnamed tributary of Cogdels Creek since this tributary was not sampled under the investigation for OU No. 1.

As shown on Figure 3-3, two (2) surface water and sediment sampling stations (SW/SD1 and SW/SD2) have been identified to further characterize potential impacts from Site 1. A surface (top 6-inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, and pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid collecting water containing disturbed sediments. In addition, downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device. Section 5.0 discusses both surface water and sediment sampling procedures.

No aquatic/ecological surveys will be conducted at the site unless the results from the surface water and sediment sampling indicate that the site is potentially impacting the environment. The need for any aquatic/ecological surveys will be determined in consultation with USEPA Region IV, NC DEHNR, and LANTDIV.

3.1.4.2 Analytical Requirements

The surface water and sediment samples will be analyzed for full TCL organics and TAL metals using CLP protocols (Level IV data quality). In addition, all surface water samples will be analyzed in the field for dissolved oxygen, salinity, temperature, pH, and specific conductance (Level I data quality).

3.1.4.3 Staff Gauge Installation

Two (2) to four (4) staff gauges will be installed in Cogdels Creek to monitor surface water levels. This data will be used in conjunction with static water level measurements from monitoring wells to evaluate shallow groundwater flow patterns in the area. In addition to installing staff gauges, surface water level measurements will be monitored over a several day period (up to one week) using automatic data loggers. An attempt will also be made to measure stream velocity which can be used to estimate surface water discharge. All staff gauges will be surveyed to establish vertical and horizontal control.

3.2 Site 28 - Hadnot Point Burn Dump

The following investigations and support activities will be conducted at Site 28:

- Surveying
- Soil investigations (includes optional test pits)
- Groundwater investigations
- Surface water/sediment investigations
- Ecological/aquatic survey

Each of these activities is described below.

3.2.1 Surveying

Surveying tasks at Site 28 will be performed in three phases: Phase I - Initial Site Survey; Phase II - Survey of Proposed Sampling and Monitoring Well Locations; and Phase III - Monitoring Well and Staff Gauge Survey. Phase I will involve surveying the outer boundaries of the two former burn dump areas (based on review of historical aerial photographs provided by EPIC), and surveying areas at the site which may have undergone physical changes (e.g., new building). These surveying activities will assist in developing the drilling and sampling strategies for the field investigation.

Phase II surveying activities will involve surveying the locations of the proposed soil borings, monitoring wells, and surface water/sediment stations. The final locations selected for the sampling points and monitoring wells will depend on the results of the Phase I survey which will identify the outer boundaries of the former burn dump areas.

During Phase III surveying activities, all existing monitoring wells, and any wells and staff gauges installed during the investigation at Site 28 will be surveyed. The top of the metal protective casing, the top of the PVC well casing (and staff gauges), and the elevation of the ground surface will be surveyed. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be within 0.1 foot. In addition, soil sampling locations (i.e., boreholes) and surface water/sediment sample locations will be surveyed to a horizontal accuracy of 0.1 foot.

3.2.2 Soil Investigation

Soil investigations will be conducted throughout Site 28 but will primarily focus on two areas of concern; the two former burn dump areas (grid 28-E and grid 28-W). In addition, soil samples will also be collected from background borings and during the construction of the new monitoring wells (projected number of new wells is eight).

3.2.2.1 Sampling Locations

As described in Section 3.2.2, an initial site survey will be conducted to locate the outer boundaries of the former burn dump areas. The location of the burn dump areas to be surveyed will be based on review and interpretation of historical aerial photographs (years 1949, 1952, 1956, 1960, and 1964) provided by EPIC (1992), and information obtained in the Final Site Summary Report (see Appendix B of the Work Plan). Upon review, the approximate outer boundaries of the burn dump areas will be located, and survey stakes will be placed around the area to assist in establishing the sample grids for the soil investigation.

Following the establishment of the burn dump boundaries, exploratory test borings may be augered and soil samples (using ASTM Method D 1586-84) collected for visual classification purposes. The purpose of the exploratory borings is to assess the thickness of fill material (estimated to be 8 to 10 feet thick) which was reportedly backfilled on top of the burned refuse. Moreover, the purpose of establishing the thickness of the fill material is to ensure that later samples collected for analytical testing are obtained from depths (with the exception of surface samples) within and below (to establish the vertical extent) the burned refuse horizons. Eight (8) borings (SB39 through SB46) will be advanced within the boundary areas at random locations to confirm the thickness of the fill material as shown on Figures 3-5. The final drilling locations, however, may be contingent upon the Phase I survey and upon the locations of underground utilities which will be identified by Camp Lejeune personnel.

A projected total of 36 borings (SB1 through SB36) will be installed (following confirmation of the thickness of fill material) within and around the boundaries of the burn dump areas as shown on Figures 3-4 and 3-5. The final number of borings, however, may be determined in the field because of the potential for above and below ground utilities at proposed drilling areas. Because of above ground structures and tidal marsh areas at Site 28, the borings proposed within the sample grid will be established at non-fixed (i.e., random) distance spacings. The borings will be augered and soil samples collected using ASTM Method D 1586-84. Additionally, samples may be collected via a hand auger if underground utilities are suspected in the area or if access with a drill rig is limited (specific drilling and sampling methods are outlined in Section 5.0). The purposes of the borings are to: (1) characterize the nature of contaminant (i.e., identify contaminants of concern); (2) evaluate the vertical and horizontal extent of the contamination; and (3) characterize the shallow geologic and hydrogeologic conditions within the site. Additionally, three (3) borings (SB37, SB38, and SB51) will be advanced north and east of the site outside the areas of concern to collected site specific background analytical data (boring SB51 will be advanced for monitoring well installation). Table 3-3 provides a summary of boring location rationale.

Samples will be collected from the surface (top 12 inches from ground surface) then at continuous 2-foot intervals. The final depth of the borings, however, will depend on the depth and vertical extent of the waste (i.e., burned refuse, if present) to be determined by the exploratory borings. A sample of the waste material (if encountered) will be collected and at the bottom of the boring (just above the water table) to evaluate the vertical extent of contamination. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis. Samples of the reported fill material placed over the burn area (with the exception of the surface sample) will not be retained for analytical testing.

3.2.2.2 Analytical Requirements

Surface soil samples will be analyzed for full TCL organics and TAL metals, or TAL metals only via CLP protocol (Figure 3-4). These samples will serve to assess human health and environmental risks and will provide data to more fully characterize surface soils. Specific areas of the site have been targeted for TAL metals only due to recent findings from previous investigations (Baker, 1993). Background soil samples (SB37, SB38, and SB51) will also be analyzed for full TCL organics and TAL metals.

The subsurface soils also will be analyzed for full TCL organics and TAL metals, or TAL metals only under CLP protocols (Figure 3-5). Further, if residual waste material is encountered, the samples will undergo analysis for full TCLP. Select samples collected from borings in the suspected source areas will be analyzed on an accelerated basis to provide

TABLE 3-3

SUMMARY OF SOIL BORING RATIONALE - SITE 28
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Grid Area	Boring Number	Purpose
28-W	SB1, through SB5, SB7, SB10, SB13, SB17, SB19, and SB20	Evaluate the horizontal extent of soil contamination associated with the former burn dump area
	SB6, SB8, SB9, SB11, SB12, SB14, SB15, SB16, and SB18	Characterize the nature of soil contamination within the former burn dump area; vertical extent of contamination
	SB39 through SB43	Exploratory borings to investigate subsurface soil conditions and determine the thickness of potential fill material
	SB47 and SB48	Collect composite soil samples for engineering parameters
28-E	SB21 through SB24, SB27, SB28, SB31, SB32, SB35, and SB36	Evaluate the horizontal extent of soil contamination associated with the former burn dump area
	SB25, SB26, SB29, SB30, SB33, and SB34	Characterize the nature of soil contamination within the former burn dump area; vertical extent of contamination
	SB44 through SB46	Exploratory borings to investigate subsurface soil conditions and determine the thickness of potential fill material
	SB49 and SB50	Collect composite soil samples for engineering parameters
NS(1)	SB37, SB38, and SB51 (to be converted into a well)	Collect site specific background soil samples
NA	28GW5, 28GW6, 28GW7S, 28GW7D, 28GW83, 28GW8D, 28GW9D	Borings advanced for monitoring well installation; collect soil samples to correlate with potential groundwater contamination

Note: (1) NA - Not Applicable

immediate characterization of the burn dump disposal areas. In addition, select samples collected from borings along the perimeter of the burn dump disposal area also will be on an accelerated basis to ensure that the horizontal extent of contamination has been accurately defined. Figure 3-5 presents proposed soil boring locations with respective analytical requirements and turnaround times. Based on the analytical results from samples designated for quick turnaround, the sampling grid may expand to further evaluate the extent of contamination. Remaining subsurface soil samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround).

As shown on Figure 3-5, four (4) borings (SB47 through SB50) from the burn dump disposal area (two per grid area) will be analyzed for chemical and physical engineering parameters. The engineering boring locations will be confirmed in the field based on quick turnaround analytical results or visual observation of soils. It should be noted that samples collected for engineering parameters will be obtained from areas suspected to contain the greatest amount of contamination, and therefore, are subject to relocation. The samples for the engineering parameters will be composites of the soil cuttings from the surface to the water table. Samples from two borings (SB47 and SB49) will be tested for grain size characteristics and Atterberg limits (and possible moisture density); samples from two other borings (SB48 and SB50) will be analyzed for TOC, full TCLP parameters, residual chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation or offsite disposal options.

3.2.3.3 Test Pit Trenching (Optional Task)

Test trenching may be performed as an optional task to further characterize the nature of the waste material, if present. Trenches would be excavated to the depth of the waste material identified during the drilling program. The width of the trenches will be dictated by the equipment used and the need for visual examination; OSHA trench access regulations will not apply since no personnel are to enter the trench. All soil material will be staged on plastic sheeting next to the trench to minimize any impact to the surface soils by contact with the excavated material. The trenches will be backfilled with excavated soil material which will be nominally compacted during the replacement. It is anticipated that any trenching activities will be performed using Level B personal protective clothing.

Analytical Requirements

Test pit samples will be obtained from the bottom of the excavation and analyzed for ignitability, corrosivity, reactivity and full TCLP parameters. It is anticipated that samples collected from the excavation will be waste material and, therefore, will be analyzed accordingly.

3.2.3 Groundwater Investigation

Groundwater investigations will be conducted at Site 28 to further assess groundwater quality. The groundwater investigation will consist of the installation of monitoring wells, the collection of one round of groundwater samples, and multiple rounds of water level measurements from all existing and newly installed wells. The following provides a detailed description of groundwater investigation activities.

3.2.3.1 Monitoring Well Construction

As shown on Figure 3-6, four (4) existing monitoring wells are present at Site 28. The four wells, 28GW1 through 28GW4, were installed as part of the Initial Site Assessment which was conducted to assess groundwater quality associated with the former burn dump areas. Additionally, 14 shallow (approximately 15 to 20 feet deep) and four intermediate (approximately 40 feet deep) monitoring wells are present north of Site 28 near Building 21. These wells were installed by Baker in 1992 to assess a suspected leaking underground storage tank. Since there are areas that need further assessment at Site 28, specifically northwest and east from the burn dumps as well as over burn dumps, at least four (4) shallow and three (3) deep wells will be installed during the RI. The proposed well locations are shown on Figure 3-6 and Table 3-4 provides the rationale and purpose for each proposed well location.

Two shallow monitoring wells (28GW5 and 28GW6) will be installed to further evaluate the horizontal extent of contamination east and west of the site. Two additional shallow wells (28GW7S and 28GW8S) will also be installed within the suspected source area. The decision where to install these wells will be made in the field and will be based on analytical data obtained from the soil investigation (i.e., concentrations will be compared to Camp Lejeune background levels for soils). The shallow wells will be constructed of 2-inch PVC and installed to a depth of at least 12 to 15 feet below the top of the water table. Justification for the use of PVC constructed wells is provided in Appendix B. Two-inch wells are proposed since they will

TABLE 3-4

MONITORING WELL SUMMARY AND RATIONALE
SITE 28
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Well Designation	General Location	Purpose
28GW1*, 28GW2*, and 28GW3*	South of Hadnot Point Burn Dump Areas	Monitor groundwater quality downgradient from Burn Dump Areas
28GW4*, 28GW5, and 28GW6	North, east, and west of Burn Dump Areas	Monitor upgradient shallow groundwater quality
28GW7S and 28GW8S; 28GW7D and 28GW8D	Within Hadnot Point Burn Dump Areas	Monitor shallow and deep groundwater quality in the suspected source areas
MW-13*	North of Hadnot Point Burn Dump Area	Monitor shallow groundwater quality upgradient
28GW9D	North of Hadnot Point Burn Dump Area	Monitor deep groundwater quality upgradient

Note: * - Denotes existing monitoring well serve as monitoring wells only and are not intended to serve as extraction wells. Well screens will be 15-feet in length and will be constructed of No. 10 slotted PVC. This screen length, will allow for seasonal fluctuations in the water table which are known to vary between 2 to 4 feet at Camp Lejeune. Detailed well construction information and well installation procedures are provided in Section 5.0.

Three deep monitoring wells (28GW7D, 28GW8D, and 28GW9D) will be installed to further evaluate the vertical extent of contamination within the two burn dump areas (wells 28GW7D and 28GW8D) and also to evaluate background conditions (well 28GW9D). The deep wells will be installed within the upper portion of the Castle Hayne formation to determine if contaminants impacted the drinking water aquifer. The final selection for the locations of wells (28GW7D and 28GW8D) will be determined in the field based on analytical data obtained from the soil investigation (quick turnaround samples). Moreover, wells 28GW7D and 28GW8D will be paired with shallow wells (i.e., well cluster 28GW8S and 28GW9S). The deep wells will be constructed of 2-inch PVC with a 10 to 20-foot long No. 10 slotted screen section. Final determination for the length of screen to be used will depend on the thickness of the upper portion of the Castle Hayne formation. Accordingly, the final depths of deep wells will be determined in the field. Detailed well construction information and well installation procedures are provided in Section 5.0.

3.2.3.2 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each existing (four total) and newly installed (seven total) well within Site 28. Additionally, well MW-13 located approximately 600 feet north of Site 28 (near to previously mentioned UST site) will be sampled to serve as a background well. This well is situated upgradient from the UST and samples collected from this well in January 1993 indicated non-detectable levels of volatiles.

The analytical results from several previous investigations have identified inorganics (e.g., chromium) as the primary contaminants of concern in the groundwater with some low levels of volatiles, semivolatiles, and pesticides. Groundwater samples to be collected from eight of the ten shallow and two of the three deep wells will be analyzed for volatiles (using EPA Method 601/602), TCL semivolatiles, TCL pesticides, and TAL inorganics (total and dissolved) using CLP protocols (Level IV data quality). Further, three of the samples (to be collected from the existing well 1GW1, background well MW-13, and deep well 28GW8D) will be analyzed for full TCL organics and TAL inorganics. These samples will provide data for use in an assessment of human health and environmental risks and to more fully characterize the groundwater.

Additionally, one shallow (28GW1) and one deep (28GW8D) will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. Well 1GW1 was selected because it is located in an area where groundwater remediation may be required based on previous analytical results. These analytical parameters will include: BOD, COD, TSS, and TDS.

Detailed sampling procedures are provided in the FSAP. Specific details of the analytical methods and data validation are provided in the QAPP.

3.2.3.3 <u>Water Level Measurements</u>

Static water levels measurements (minimum of two rounds) will be collected from each existing and newly installed well during the groundwater investigation. Water level measurements shall be collected from all wells within a four hour period, if possible. In addition, automatic data loggers will be installed in two wells (one deep and one shallow) to monitor water levels over a 24-hour period. This information will be used to determine if groundwater levels near the site are influenced by tidal changes. Detailed measurement techniques are described in Section 5.0. Groundwater level data will be used to evaluate shallow and deep groundwater flow patterns in the area.

3.2.4 Surface Water/Sediment Investigation

Surface water and sediment investigations will be conducted in the New River, Cogdels Creek, and in a site pond to assess possible impacts to these surface water bodies and the environment from the two areas of concern at the site. This section outlines the sampling and analytical requirements. Specific sampling procedures can be found in Section 5.0.

3.2.4.1 <u>New River</u>

As shown on Figure 3-7, five (5) surface water and sediment sampling stations have been identified to characterize potential impacts downgradient from the former burn dump areas. A surface (top six inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample and pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid the possibility of disturbed sediments being included with the water sample. Downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device. Section 5.0 discusses both surface water and sediment sampling procedures in detail.

3.2.4.2 Cogdel Creek

As shown on Figure 3-7, seven (7) surface water and sediment sampling stations have been identified as necessary to more fully characterize potential impacts from surface water runoff and possibly discharging groundwater from the site. A surface (top six inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample and pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid obtaining disturbed sediment in the water sample. Downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device. Section 5.0 discusses both surface water and sediment sampling procedures.

3.2.4.3 Site Pond (Orde Pond)

As shown on Figure 3-7, two (2) surface water and sediment sampling stations have been identified to characterize potential impacts from possible direct contact with the waste or waste residues. A surface (top six inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample and pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid the possibility of disturbed sediments being included with the water sample. Sediment samples will be obtained using a hand coring device. Section 5.0 discusses both surface water and sediment sampling procedures.

3.2.4.4 Analytical Requirements

The surface water and sediment samples will be analyzed for full TCL organics and TAL metals using CLP protocols (Level IV data quality). In addition, all surface water samples will be analyzed in the field for dissolved oxygen, salinity, temperature, pH, and specific conductance (Level I data quality).

3.2.4.5 Staff Gauge Installation

Two (2) to four (4) staff gauges will be installed in Cogdels Creek, the site pond, and the New River to monitor surface water levels. This data will be used in conjunction with static water level measurements from monitoring wells to evaluate shallow groundwater flow patterns in the area. In addition to installing staff gauges, surface water levels in both Cogdels Creek and the New River will be monitored over a several day period (up to one week) using automatic data loggers. An attempt will also be made to measure stream velocity in Cogdels Creek. All staff gauges will be surveyed to establish vertical and horizontal control.

3.2.5 Aquatic/Ecological Survey

Aquatic/ecological surveys will be conducted in the New River, Cogdels Creek, unnamed tributaries to Cogdels Creek, and the site pond to evaluate potential ecological impacts from past activities at Site 28. The Aquatic/Ecological Survey will include the collection of benthic macroinvertebrate and fish samples to assess environmental stresses posed by Site 28. To assess ecological stresses to the aquatic community posed by stream quality, faunal densities, species richness, and species diversity will be determined for benthic macroinvertebrates at each sampling station. In addition, fish samples will be collected for population statistics and subsequent laboratory analysis of whole body parts and fillets. Each fish sample chemically analyzed will represent a different trophic levels (if possible) as follows: top carnivores, forage fish, and bottom feeders. All fish analytical samples will be analyzed for TCL organics and TAL inorganics.

A total of six benthic macroinvertebrate and fish stations will be established and samples will be collected from 500-foot stretches (i.e., sampling areas) along the New River (two), Cogdels Creek (three), and the site pond (one): upgradient of Site 28, adjacent to Site 28; and downgradient of Site 28 (see Figure 3-7). The stations will be located to correspond with surface water and sediment sampling locations.

Benthic macroinvertebrates will be collected with a Standard Ponar. Fish will be collected at the stations by a combination of the following methods: electroshocking, seining, gill nets, and/or other fish collecting techniques.

Specific sampling and analysis procedures are described in Section 5.0.

Ecological stresses to the aquatic community posed by water or sediment quality will be assessed by calculating faunal densities, species richness, and species diversity for benthic macroinvertebrates at each sampling station. Population statistics will be determined for fish at each sampling station. In addition, fish samples will be collected for subsequent laboratory analysis of whole body parts and fillets. All fish samples will be analyzed for TAL inorganics and TCL organics.

Specific sampling and analysis procedures are described in Section 5.0.

3.3 Site 30 - Sneads Ferry Road Tank Fuel Sludge Area

The following investigations and support activities will be conducted at Site 30:

- Surveying
- Soil investigations
- Groundwater investigations
- Surface water/sediment investigation

Each of these activities is described below.

3.3.1 Surveying

Surveying tasks at Site 30 will be performed in three phases: Phase I - Initial Site Survey; Phase II - Survey of Proposed Sampling and Monitoring Well Locations; and Phase III -

Monitoring Well and Staff Gauge Survey. Phase I will involve surveying the outer boundary of the former fuel sludge disposal area [based on information obtained from the Final Site Summary Report (see Appendix C in the Work Plan)]. Survey stakes will be placed around the outer boundary of the former disposal area. These surveying activities will assist in locating the proposed drilling and sampling points which will be located during the Phase II survey.

Phase II survey activities will involve surveying the locations of the proposed soil borings, monitoring well, and surface water/sediment sample stations. The final locations selected for the sampling points and monitoring wells will depend on the results of the Phase I survey which will identify the approximate boundary of the former disposal area.

During Phase III surveying activities, all existing and newly-installed monitoring wells, and staff gauges installed during the investigation at Site 30 will be surveyed. The top of the metal protective casing, the top of the PVC well casing (and staff gauge), and the elevation of the ground surface will be surveyed. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be within 0.1 foot. Soil sampling locations (i.e., boreholes) and surface water/sediment sample locations will be surveyed to a horizontal accuracy of 1 foot.

3.3.2 Soil Investigation

The soil investigation to be conducted at Site 30 will primarily focus on the main area of concern which is the former disposal area (Figures 3-8 and 3-9). In addition, soil samples will also be collected from background borings and during the construction of new monitoring wells (projected number of one).

3.3.2.1 Sample Locations

As described in Section 3.3.1, an initial site survey will be conducted to locate the outer boundary of the former disposal area. The location of the former disposal area to be surveyed will be based on information obtained in the Final Site Summary Report (see Appendix C in the Work Plan). The approximate boundary of the former disposal area will be staked to assist in establishing the sample grid for the soil investigation.

Following the establishment of the disposal boundaries, exploratory test borings may be augered and soil samples collected (using ASTM Method D 1586-84) for visual classification purposes. The purpose of the exploratory boring is to verify the thickness of potential fill material which may have been placed on top of the disposal area. Although there is no record of fill material backfilled in this area, the purpose of borings is to confirm the presence or absence of the potential fill material to ensure that samples collected for analytical testing are obtained from depths (with the exception of surface samples) within and below (to establish the vertical extent) the disposal horizon. These borings will be installed if fill material is encountered during installation of the initial borings (described in the following paragraphs). Four (4) borings (SB17 through SB20) will be advanced within the boundary areas to assess the thickness of the fill material. The locations of these borings is shown on Figure 3-9.

Eleven (11) borings (SB1 through SB11) will be installed within and around the boundary of the former disposal area as shown on Figures 3-8 and 3-9. The borings will be installed at approximately 100-foot centers but the final determination for the spacings will depend on the results of Phase I survey. The purposes of the borings are to: (1) characterize the nature and extent of contamination (i.e., identify the contaminants of concern); (2) evaluate the vertical and horizontal extent of the contamination; and (3) characterize the shallow geologic and hydrogeologic conditions within the site. Additionally, up to six borings [SB12 through SB16 and 30GW3 (boring for monitoring well installation)] will be advanced east of the site outside the area of concern to collect site specific background analytical data.

The borings will be advanced using a drill rig as described previously. Specific drilling and sampling methods are outlined in Section 5.0. Table 3-5 provided a summary of the boring location rationale. Samples will be collected from the ground surface (top 12 inches) then at continuous 2-foot intervals to the top of the water table, which is estimated to be approximately four to eight to feet bgs across the site. The sample collected from just above the water table, and possibly a third sample will also be retained for laboratory analysis. The selection of the third sample will be based on visual indications of contamination and/or elevated volatile organic vapor readings using a PID. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

3.3.2.2 Analytical Requirements

All surface and subsurface soil samples will be analyzed for TCL volatiles, semivolatiles and TAL metals via CLP protocols. These samples will serve to assess human health and environmental risks and will provide data to more fully characterize surface and subsurface soils. The proposed surface soil sample stations with the respective analyses and turnaround

TABLE 3-5

SUMMARY OF SOIL BORING RATIONALE - SITE 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Boring Number	Purpose
SB1 through SB8	Evaluate the horizontal extent of soil contamination associated with the former disposal area
SB9 through SB11	Characterize the nature of soil contamination within the former disposal area; vertical extent of contamination
SB17 through SB20	Exploratory borings to investigate subsurface soil conditions and determine the thickness of potential fill material
SB21 and SB22	Collect composite soil samples for engineering parameters
SB12 through SB16	Collect site-specific background soil samples
30GW3	Boring advanced for monitoring well installation; collect soil samples to correlate with potential groundwater contamination

time are depicted on Figure 3-8. The surface soil samples will be analyzed within the maximum allowable holding times (i.e. routine analytical turnaround time). Select subsurface samples collected from soil borings in the source area will be analyzed on an accelerated turnaround time to provide immediate characterization of the fuel tank sludge disposal area (Figure 3-8). In addition, select samples collected from borings along the perimeter of the disposal area will be analyzed on an accelerated basis to ensure that the horizontal extent of contamination (if present) has been accurately defined. Figure 3-9 presents proposed soil boring locations with respective analytical requirements and turnaround times. Based on the analytical results from samples designated for quick turnaround the sampling grid may expand. Remaining subsurface soil samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround).

As shown on Figure 3-8, two borings (SB21 and SB22) from the fuel tank sludge disposal area will be analyzed for engineering parameters. The engineering boring locations will be confirmed in the field based on quick turnaround analytical results or visual observation of soils. It should be noted that samples collected for engineering parameters will be obtained from areas suspected to contain the greatest amount of contamination, and therefore, are subject to relocation. Samples for engineering parameters will be composites of the soil cuttings from the surface to the water table. Samples from one boring will be tested for grain size and Atterberg limits (note that moisture density testing may also be performed if conditions permit - high clay content); samples from the second boring will be analyzed for TOC, full TCLP parameters, residual chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation or offsite disposal options.

3.3.3 Groundwater Investigation

Groundwater investigations will be conducted at Site 30 to assess groundwater quality at the former disposal area. The groundwater investigation will consist of the installation of a single monitoring well, the collection of one round of groundwater samples, and multiple rounds of water level measurements from all existing and newly installed wells. The following provides a detailed description of the groundwater investigation activities.

3.3.3.1 Monitoring Well Construction

As shown on Figure 3-10, two existing monitoring wells are present at Site 30. The two wells, 30GW1 and 30GW2, were installed as part of the Initial Site Assessment (see Appendix C in the Work Plan) to assess groundwater quality associated with the former disposal area. Since the area upgradient (background) from the site needs further evaluation, at least one shallow well will be installed during the RI. The proposed well location is shown on Figure 3-9 and a summary of the monitoring well rationale is provided on Table 3-6.

The shallow monitoring well (30GW3) will be installed to further evaluate the extent of potentially impacted groundwater east (upgradient) of the site. This well will be constructed of 2-inch PVC and installed to a depth of at least 12 to 15 feet below the top of the water table. Two-inch wells are proposed since they will serve as monitoring wells only and are not intended to serve as extraction wells. The well screen will be 15-feet in length and will be constructed of No. 10 slotted PVC. This well depth and screen length has been selected based on previous site exposure to allow for seasonal fluctuations in the water table thereby providing the ability to obtain samples that are representative of the surficial aquifer at the site. Detailed well construction information and well installation procedures are provided in Section 5.0.

3.3.3.2 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each existing and newly installed well within Site 30 (Figure 3-9). Groundwater samples collected from the existing shallow wells and newly installed shallow wells will be analyzed for TCL volatiles in accordance with EPA Method 601/602, TCL SVOAs, and TAL metals (total and dissolved) via CLP protocol (Level IV data quality) to fully characterize groundwater in the vicinity of the fuel tank sludge disposal area. The analytical results from previous investigations have identified metals as the primary contaminants of concern with trace amounts of organics present. It is not anticipated that the deep aquifer is contaminated based on the types of wastes disposed of and previous investigations. Specific sampling methods are described in Section 5.0.

One groundwater sample (30GW3) will be analyzed for engineering parameters. Sample analysis will consist of the following parameters: BOD, TOC, COD, TDS, and TSS. These parameters will help in evaluating potential applicable technologies for remediation of groundwater, if necessary.

TABLE 3-6

MONITORING WELL SUMMARY AND RATIONALE
SITE 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Well Designation	General Location	Purpose
30GW1*	Within suspected disposal area	Monitor shallow groundwater quality within suspected source area
30GW2*	West of disposal area	Monitor shallow groundwater quality downgradient
30GW3	East of disposal area	Monitor shallow groundwater quality upgradient

Note: * - Denotes existing monitoring well

3.3.4.3 Water Level Measurements

Static water level measurements (minimum of two rounds) will be collected from each existing and newly installed well during the groundwater investigation. Water level measurements shall be collected from all wells within a four hour period, if possible. Detailed measurement techniques are described in Section 5.0. Groundwater level data will be used to evaluate shallow groundwater flow patterns in the area.

3.3.4 Surface Water/Sediment Investigation

3.3.4.1 Sample Locations

A surface water and sediment investigation will be conducted in French Creek to assess possible impacts to these surface water bodies and the environment from the area of concern at the site. This section outlines the sampling and analytical requirements. Specific sampling procedures can be found in Section 5.0.

As shown on Figure 3-9, three surface water and sediment sampling stations (SW/SD1 through SW/SD3) have been identified to characterize potential impacts downgradient from the former burn dump areas. A surface (top six inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample and pouring and sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid the possibility of disturbed sediments being included with the water sample. Downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device. Section 5.0 discusses both surface water and sediment sampling procedures in detail.

3.3.4.2 Analytical Requirements

The surface water and sediment samples will be analyzed for TCL organics and TAL metals using CLP Methods (Level IV data quality). In addition, all surface water samples will be analyzed in the field for dissolved oxygen, salinity, temperature, pH, and specific conductance (Level I data quality).

No aquatic/ecological surveys will be conducted at the site unless the results from the surface water and sediment sampling indicate that the site is potentially impacting the environment. Based on the results of the investigations, the need for aquatic/ecological surveys will be determined in consultation with USEPA Region IV, NC DEHNR, and LANTDIV.

3.3.4.3 Staff Gauge Installation

Two staff gauges will be installed in French Creek to monitor surface water levels. This data will be used in conjunction with static water level measurements from monitoring wells to evaluate shallow groundwater flow patterns in the area. Because of the distance between French Creek and the site, extended surface water level monitoring will not be performed at this site. All staff gauges will be surveyed to establish vertical and horizontal control.

3.4 QA/QC Samples

QA/QC requirements for this investigation are presented in the Quality Assurance Project Plan (QAPP) which is Section II of this SAP. The following QA/QC samples will be collected at each of the three sites during field sampling activities:

- Trip Blanks

  Trip blanks are defined as samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic analysis (VOA) samples. One trip blank should accompany each cooler containing samples for volatile organics analysis Trip blanks shall only be analyzed for volatile organics.

- Equipment Rinsates

  Equipment rinsates are the final analyte-free water rinse from equipment decontamination procedures. Equipment rinsate blanks will be collected daily during each sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are found in the rinsate, the remaining samples must be analyzed. The results from the blanks will be used to evaluate the decontamination methods. This comparison is made during data validation and the rinsates are analyzed for the same parameters as the related samples.

One equipment rinsate will be collected per day of field sampling.

- Field Blanks

Field blanks consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each event and each source of water must be collected and analyzed for the same parameters as the related samples.

Two field blanks (ambient condition blanks) will be prepared at the commencement of each sampling event. The field blanks will be prepared by pouring potable water (used for decontamination purposes) into one set of sample bottles and deionized water directly into an additional set of sample bottles.

- Field Duplicates

Field duplicates for soil samples are collected, homogenized, and split. All samples except VOAs are homogenized and split. Volatiles are not mixed, but select segments of soil are taken from the length of the core and placed in 40-ml. glass vials. The duplicates for water samples should be collected simultaneously. The water samples will not be composited.

Field duplicates will be collected at a frequency of 10 percent.

- Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSDs are not field sampling activities, they are laboratory derived.

MS/MSD samples are collected to evaluate the matrix effect of the sample upon the analytical methodology. A matrix spike and matrix spike duplicate must be performed for each group of samples of a similar matrix.

MS/MSD samples will be collected at a frequency of 5 percent.

4.0 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, the depth (soil) or round (groundwater) of sample, and QA/QC qualifiers.

The sample designation format is as follows:

Site # - Media - Location - Depth/Round (QA/QC)

An explanation of each of these identifiers is given below.

Site #	This investigation includes Sites 1, 28, and 30.
Media	SB = Soil Boring (soil sample from a boring) GW = Groundwater SW = Surface Water SD = Sediment WT = Waste
Location	The location numbers identify the sampling location. This would include station number for soil location or monitoring well number for groundwater. Each grid station will be identified with a unique identification number.
Depth/Round	Depth indicators will be used for soil samples. The number will refer to the depth of the top of the sampled interval. For example: 00 = top of sample at ground surface 01 = top of sample is 1 foot below surface 07 = top of sample is 7 feet below surface Round indicator will be used for groundwater samples (round one and round two). For example:
QA/QC	(FB) = Field Blank (D) = Duplicate Sample 01 = round 1 02 = round 2 (TB) = Trip Blank (ER) = Equipment Rinsate

Under this sample designation format the sample number 1GW3-01D refers to:

1-GW-3-01D	Site 1
1-GW-3-01D	Groundwater sample
1-GW-3-01D	Monitoring well #3
1-GW-3-01D	Round 1
1-GW-3-01D	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.

5.0 INVESTIGATIVE PROCEDURES

The investigative procedures to be used for Operable Unit (OU) No. 7 will be discussed in the following sections. This includes: soil sample collection, monitoring well installation (both shallow and deep), staff gauge installation, groundwater sample collection, surface water sample collection, sediment sample collection, fish/benthic sample collection, decontamination procedures, surveying, handling of site investigation generated wastes, and water level measurements. Note that all of these procedures will follow the field methods described in the USEPA, Region IV, Environmental Services Division (ESD), Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (ECBSOPQAM), February 1, 1991. Additional guidance from other sources such as ASTM may be used, but if the ASTM and ESD methods are in conflict, the ESD procedure will be used.

5.1 Soil Sample Collection

Surface and subsurface soil samples will be collected throughout OU No. 7. The majority of the soil samples will be collected from borings advanced by a drilling rig and during the installation of monitoring wells. Soil samples may also be collected from borings advanced by hand auger or power auger. Some soil samples will be collected from test pits (optional task at Site 28) excavated by a backhoe.

5.1.1 Soil Borings Advanced by Hand Auger

Hand augering is the most common manual method used to collect subsurface samples. Typically, 4-inch bucket augers with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger is related to the material being sampled. In this investigation, hand augers will be used to collect discrete grab samples of soil from the 0 to 12 inch and 2 to 4 foot intervals.

When a vertical sampling interval has been established, one auger bucket is used to advance the auger hole to the first desired sampling depth. Since discrete grab samples are to be collected to characterize each depth, a new bucket will be placed on the end of the auger extension immediately prior to collecting the next sample. The top several inches of soil should be removed from the bucket to minimize the chances of cross-contamination of the sample from fall-in of material from the upper portions of the hole. The bucket auger will be decontaminated between samples as outlined in Section 5.6.

5.1.2 Soil Borings and Monitoring Well Boreholes

Soil samples from soil borings advanced by a drilling rig will be collected using a split-spoon sampler. A split-spoon sampler is a steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into unconsolidated materials using a drive weight connected to the drilling rig. A standard split-spoon sampler (used for performing Standard Penetration Tests) is two inches outer diameter (OD) and 1-3/8-inches inner diameter (I.D.). This standard spoon is available in two common lengths providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Split spoons capable of obtaining 24-inch long samples will be utilized during this investigation.

Split-spoon samples will be collected continuously from the ground surface to the ground water table in each soil boring. Soil borings that will be converted into monitoring wells (monitoring well boreholes) will be advanced approximately 12 to 15 feet past the water table. The physical characteristics of the samples will be described by the site geologist. The soil in the sampler will be classified according to the Unified Soil Classification System (USCS). Soil sample descriptions will be recorded in the field geologist's notebook.

Selected split-spoon samples will be submitted to the laboratory for analysis. In general, soil samples will be collected at 2-foot intervals to the top of the water table. Surface soil samples will not be collected using a split-spoon sampler because a sufficient quantity of sample cannot be retained from 0 to 12 inches using this sampling device. Hence, surface samples will be collected using a stainless-steel spoon, hand auger, or by advancing the augers and retaining the cuttings. For borings only, split-spoon samples will be collected from approximately one foot to the top of the water table; for borings advanced for monitoring well installation, split spoon samples will be collected from ground surface (no surface samples will be collected) to the top of the water table.

The following procedures for collecting soil samples in split-spoons will be used:

1. The surface sample will be collected by driving the split-spoon with blows from a 140-pound hammer falling 30 inches in accordance with ASTM D1586-84, Standard

Penetration Test. Only the top 12 inches will be submitted to the laboratory for analyses.

2. Advance the borehole to the desired depth using hollow stem auger drilling techniques. The split-spoon will be lowered into the borehole inside the hollow stem auger (this will ensure that undisturbed material will be sampled).

3. Drive the split-spoon using procedures outlined in 1 above.

4. Repeat this operation until the borehole has been advanced to the selected depth. Split-spoon samples will be collected continuously until groundwater is encountered.

5. Record in the field logbook the number of blows required to effect each six inches of penetration or fraction thereof. The first six inches is considered to be a seating drive. The sum of the number of blows required for the second and third six inches of penetration is termed the penetration resistance, N. If the sampler is driven less than 18 inches, the penetration resistance is that for the last one foot of penetration. (If less than one foot is penetrated, the logs shall state the number of blows and the fraction of one foot penetrated.) In cases where samples are driven 24 inches, the sum of second and third 6-inch increments will be used to calculate the penetration resistance. (Refusal of the SPT will be noted as 50 blows over an interval equal to or less than 6 inches; the interval driven will be noted with the blow count.)

6. Bring the sampler to the surface and remove both ends and one half of the split-spoon such that the soil recovered rests in the remaining half of the barrel. Describe the recovery (length), composition, structure, consistency, color, condition, etc., of the recovered soil; then put into sample jars.

7. Split-spoon samplers shall be decontaminated after each use and prior to the initial use at a site according to procedures outlined in Section 5.6.

The following procedures are to be used for soil samples submitted to the laboratory:

1. After sample collection, remove the soil from the split-spoon sampler. Prior to filling laboratory containers, the soil sample should be mixed thoroughly as possible to ensure that the sample is as representative as possible of the sample interval. Soil

samples for volatile organic compounds should not be mixed. Further, sample containers for volatile organic compounds analyses should be filled completely without head space remaining in the container to minimize volatilization.

2. Record all pertinent sampling information such as soil description, sample depth, sample number, sample location, and time of sample collection in the field logbook. In addition, label, tag, and number the sample bottle(s) as outlined in Section 6.0.

3. Pack the samples for shipping. Attach seal to the shipping package. Chain-of-Custody Forms and Sample Request Forms will be properly filled out and enclosed or attached (Section 6.0).

4. Decontaminate the split-spoon sample as described in Section 5.6. Replace disposable latex gloves between sample stations to prevent cross-contamination of samples.

5.1.3 Test Pits (Optional Task at Site 28)

Test pits will be excavated using a backhoe. The following procedures apply to the excavation and backfilling of a typical test pit.

- The positions of the test pits shall be located in the field by the Field Team Leader or Site Manager. Utility clearance shall be obtained from Activity personnel for all test pit locations prior to excavation.

- Excavation equipment shall be thoroughly decontaminated prior to and after each test pit excavation.

- A safety zone shall be established around the test pit location prior to initiation of excavation.

- Excavation shall commence by removing lifts of no more than approximately 6 to 12 inches of soil.

- Test pit excavation will continue to a depth of 10 feet or to the water table (whichever is encountered first).

- Soil samples will be collected from the floor of the excavation, when the appropriate depth is reached. Samples will be collected form the backhoe bucket using a stainless steel trowel or spoon. Samples from the backhoe bucket will be collected from the center portion of the bucket to avoid contact. These samples will be submitted to the laboratory for analysis.

- Samples of waste material from buried drums (unless drums are intact) and soil samples from the bottom of the pit will be collected.

- The field inspector shall log the test pit soils and record observations and the test pit cross-section shall be sketched in the Field Logbook with notable features identified.

- Test pit depths (and water levels) may be measured using an engineers rule (six foot) or a weighted measuring tape. Depths shall be measured from the ground surface.

- Upon completion, test pits shall be immediately backfilled.

- Test pit locations shall be marked with five wooden stakes; one at each corner and one in the center. The test pit number shall be recorded on the centrally located stake.

Backfilling of trenches and test pits is a normally accepted practice to reduce immediate site hazards and minimize the potential for rainwater accumulation and subsequent contaminant migration.

After inspection and completion of the appropriate test pit logs, backfill material should be returned to the pit under the direction of the field inspector. The test pit cover should be inspected and further regraded, if necessary. Where it is safe to do so, the backhoe bucket should be used to compact each one to 2-foot layer of backfill as it is placed, to reduce settling and compaction.

5.2 Monitoring Well Installation

Shallow monitoring wells will be installed on site to monitor the shallow (water table) water-bearing zone. It is estimated that these wells will be installed from 20 to 35. As described in Section 3.0, the wells will be installed 12 to 15 feet below the water table.

Procedures for the installation and construction of shallow monitoring wells are presented below:

- Activity personnel will approve all monitoring well locations. These locations will be free of underground or overhead utility lines.

- A borehole will be advanced by a drilling rig using hollow stem augers. Initially, the boreholes will be advanced with 3-1/4 inch I.D. augers. After the borehole has been advanced to its final depth, the borehole will be overdrilled with 6-1/4 inch I.D. augers (for well installation only).

- Soil (split spoon) samples will be collected continuously during borehole advancement. Samples will be collected according to the procedures outlined in Section 5.1.2.

- Upon completion of the borehole to the desired depth, monitoring well construction materials will be installed (inside the hollow stem augers).

- PVC is the material selected for monitoring well construction. It was selected on the basis of its low cost, ease of use and flexibility. USEPA Region IV requires justification of using PVC. Appendix B is a project-specific justification for use of PVC (based on existing groundwater quality information) presented in the USEPA Region IV required format.

- Ten feet of 2-inch I.D., Schedule 40, #10 slot (0.010 inch) screen with a bottom cap will be installed. The screen will be connected to threaded, flush-joint, PVC riser. The riser will extend 2 to 3 feet above the surface. A PVC slip-cap vented to the atmosphere, will be placed at the top of the riser.

- The annular space around the screen will be backfilled with a well-graded medium to coarse sand (No. 1 or No. 2 Silica Sand) as the hollow-stem augers are being withdrawn from the borehole. Sand shall be placed from the bottom of the boring to approximately two feet above the top of the screened interval. A lesser distance above the top of the screened interval may be packed with sand if the well is very shallow to allow for placement of sealing materials.

- A sodium bentonite seal at least 24-inch thick, unless shallow groundwater conditions are encountered, will be placed above the sand pack. The bentonite shall be allowed to hydrate for at least 8 hours before further completion of the well.

- The annular space above the bentonite seal will be backfilled with a cement-bentonite grout consisting of either two parts sand per one part of cement and water, or three to four percent bentonite powder (by dry weight) and seven gallons of potable water per 94 pound bag of portland cement.

- The depth intervals of all backfill materials shall be measured with a weighted measuring tape to the nearest 0.1 foot and recorded in the field logbook.

- The monitoring wells will be completed at the surface. The aboveground section of the PVC riser pipe will be protected by installation of a 4-inch diameter, 5-foot long steel casing (with locking cap and lock) into the cement grout. The bottom of the surface casing will be placed at a minimum of 2-1/2, but not more than 3-1/2 feet below the ground surface, as space permits. For very shallow wells, a steel casing of less than 5 feet in length may be used, as space permits. The protective steel casing shall not fully penetrate the bentonite seal.

- The top of each well will be protected with the installation of four, 3-inch diameter, 5-foot long steel pipes which will be installed around the outside of the concrete apron. The steel pipes shall be embedded to a minimum depth of 2.5 feet in 3,000 psi concrete. Each pipe shall also be filled with concrete. A concrete pad shall be placed at the same time the pipes are installed. The pad will be a minimum of 4-feet by 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. The protective casing and steel pipes will be painted with day-glo yellow paint, or equivalent.

- If necessary, in high-traffic areas, the monitoring well shall be completed at the surface using a "flush" man-hole type cover. If the well is installed through a paved or concrete surface, the annular space shall be grouted to a depth of at least 2.5-feet and the well shall be finished with a concrete collar. If the well has not been installed through a paved or concrete surface, the well shall be completed by construction of a concrete pad, a minimum of 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. If water table conditions prevent having a 24-inch bentonite seal and the concrete pad as specified, the concrete pad depth should be decreased. Two weep holes will be drilled into opposite sides of the protective casing just above the concrete pad. The concrete shall be crowned to meet the finished grade of the surrounding pavement, as required. If appropriate, the vault around the buried wellhead will have a water drain to the surrounding soil and a watertight cover.

- All wells will have a locking cap connected to the protective casing. Each well will be tagged which will contain general well construction information and marked as "Test Well - Not For Consumptive Use."

Figure 5-1 is a typical Type II shallow monitoring well construction diagram.

Procedures for the installation and construction of Type II deep wells are presented below:

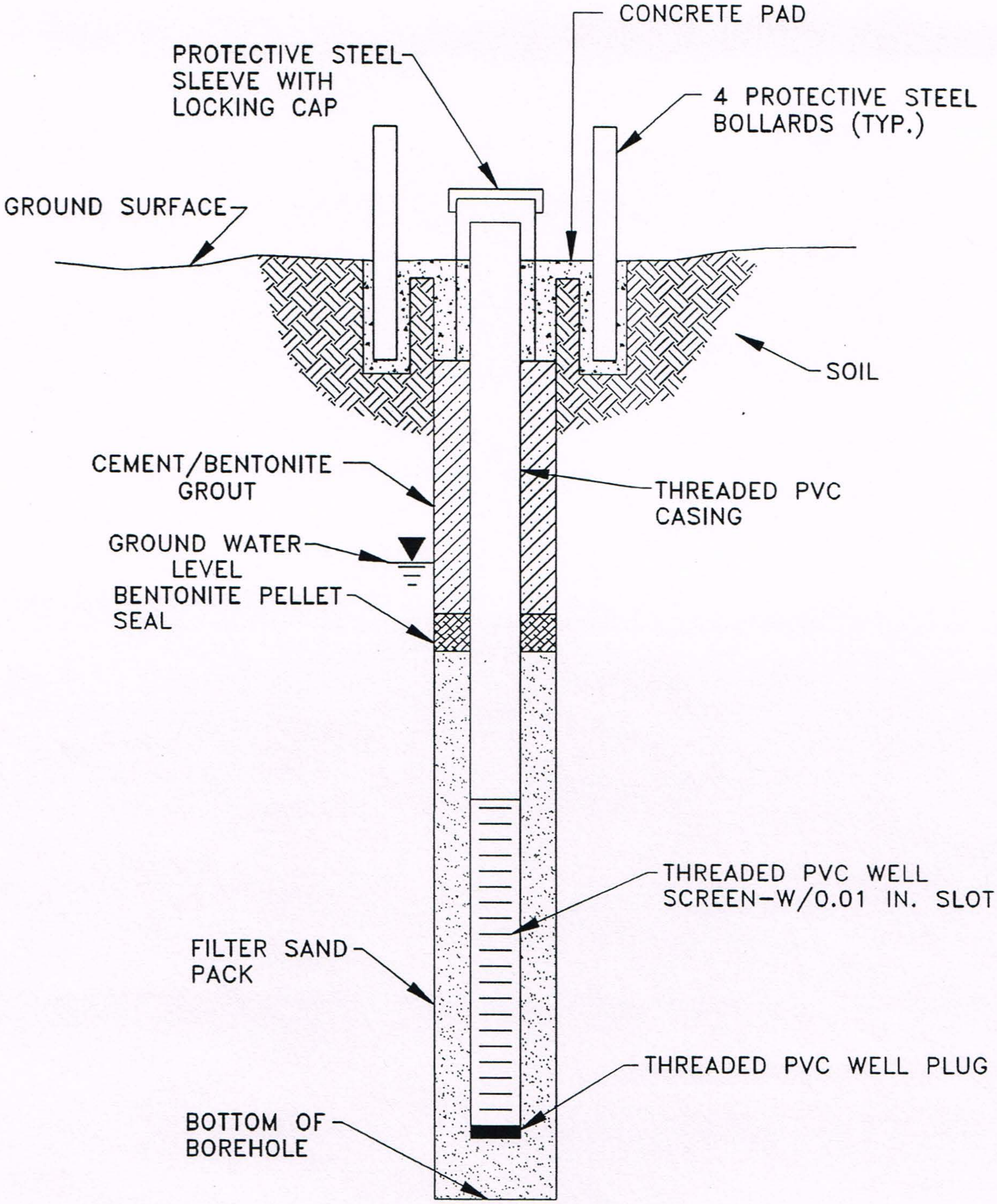
- Activity personnel will approve all monitoring well locations. These locations will be installed free of underground or overhead utility lines.

- A borehole will be advanced initially using hollow stem augers to just below the water table (so that samples can be collected for laboratory analysis). The augers will be nominal 3/4-inch I.D. Continuous 2-foot split-spoon samples will be collected while the borehole is advanced. Samples will be collected according to the procedures outlined in Section 5.1.2.

- The borehole will be further advanced until completion using mud rotary drilling. The reason mud rotary drilling will be used is because of the unconsolidated formation and drilling depths anticipated. A tricon drill bit with a O.D. of 7-7/8 inches will be used for advancing the borehole.

- Split-spoon samples will be collected at approximate 5 to 10-foot intervals during borehole advancement (mud rotary drilling). If a clay layer is encountered which may serve as a potential confining unit, continuous samples will be collected to determine the thickness of the layer. At that time, a decision will be made as to whether a Type III well will be installed (described in the next section). Samples will be collected according to the procedures outlined in Section 5.1.2.

160509SP



N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5-1
TYPICAL SHALLOW AND DEEP ABOVE GRADE TYPE II GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM
SITES 1, 28, AND 30

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- Upon completion of the borehole to the desired depth, monitoring well construction materials will be installed.

- PVC is the material selected for monitoring well construction. It was selected on the basis of its low cost, ease of use and flexibility. USEPA Region IV requires justification of using PVC. Appendix B is a projected-specific justification for use of PVC (based on existing groundwater quality information) presented in the USEPA Region IV required format.

- Ten to twenty feet of 2-inch I.D., Schedule 40, # 10 slot (0.010 inch) screen with a bottom cap will be installed. The final determination for the length of the screen will be decided in the field based on the thickness of the upper portion of the Castle Hayne formation.

- The annular space around the screen will be backfilled with a well-graded medium to coarse sand as (No. 1 or No. 2 silica sand) as the hollow-stem augers are being withdrawn from the borehole. Sand shall be placed from the bottom of the boring to approximately two feet above the top of the screened interval. A lesser distance above the top of the screened interval may be packed with sand if the well is very shallow to allow for placement of sealing materials.

- A sodium bentonite seal (typically bentonite pellets) at least 24-inch thick, unless shallow groundwater conditions are encountered, will be placed above the sand pack. The bentonite shall be allowed to hydrate for at least 2 hours before further completion of the well.

- The annular space above the bentonite seal will be backfilled with a cement-bentonite grout consisting of either two parts sand per one part of cement and water, or three to four percent bentonite powder (by dry weight) and seven gallons of potable water per 94 pound bag of portland cement. The bentonite seal shall be installed using a tremie pipe, if applicable depths are anticipated (i.e., greater than 25 feet).

- The depth intervals of all backfill materials shall be measured with a weighted measuring tape to the nearest 0.1 foot and recorded in the field logbook.

- The monitoring wells will be completed at the surface. The aboveground section of the PVC riser pipe will be protected by installation of a 4-inch diameter, 5-foot long steel casing (with locking cap and lock) into the cement grout. The bottom of the surface casing will be placed at a minimum of 2-1/2, but not more than 3-1/2 feet below the ground surface, as space permits. For very shallow wells, a steel casing of less than 5 feet in length may be used, as space permits. The protective steel casing shall not fully penetrate the bentonite seal.

- The top of each well will be protected with the installation of four, 3-inch diameter, 5-foot long steel pipes which will be installed around the concrete apron. The steel pipes shall be embedded to a minimum depth of 2.5 feet in 3,000 psi concrete. Each pipe shall also be filled with concrete. A concrete pad shall be placed at the same time the pipes are installed. The pad will be a minimum of 4-feet by 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set tow inches into the ground elsewhere. The protective casing and steel pipes will be painted with day-glo yellow paint, or equivalent.

- If necessary, in high-traffic areas, the monitoring well shall be completed at the surface using a "flush" man-hole type cover. If the well is installed through a paved or concrete surface, the annular space shall be grouted to a depth of at least 2.5 feet and the well shall be finished with a concrete collar. If the well has not been installed through a paved or concrete surface, the well shall be completed by construction of a concrete pad, a minimum of 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. If water table conditions prevent having a 24-inch bentonite seal and the concrete pad as specified, the concrete pad depth should be decreased. Two weep holes will be drilled into opposite sides of the protective casing just above the concrete pad. The concrete shall be crowned to meet the finished grade of the surrounding pavement, as required. If appropriate, the vault around the buried wellhead will have a water drain to the surrounding soil and a watertight cover.

- All wells will have a locking cap connected to the protective casing. Each well will be tagged which will contain general well construction information and marked as "Test Well - Not for Consumptive Use."

Figure 5-1 is a typical Type II deep monitoring well construction diagram.

Procedures for the installation and construction of Type III deep wells are presented below. In general, borehole will be advanced and samples collected as described above. Additionally, well materials are the same as those described above.

- If a clay layer (i.e., layer which exhibits a low enough hydraulic conductivity which may impede the vertical migration of contamination) is encountered during borehole advancement, split-spoon samples will be collected at continuous intervals to determine the thickness of the layer.

- If the clay layer is determined to have low enough hydraulic conductivity (based on visual observations) and is at least two feet thick, then the well will be completed as a Type III well (also commonly referred to as a double-cased well).

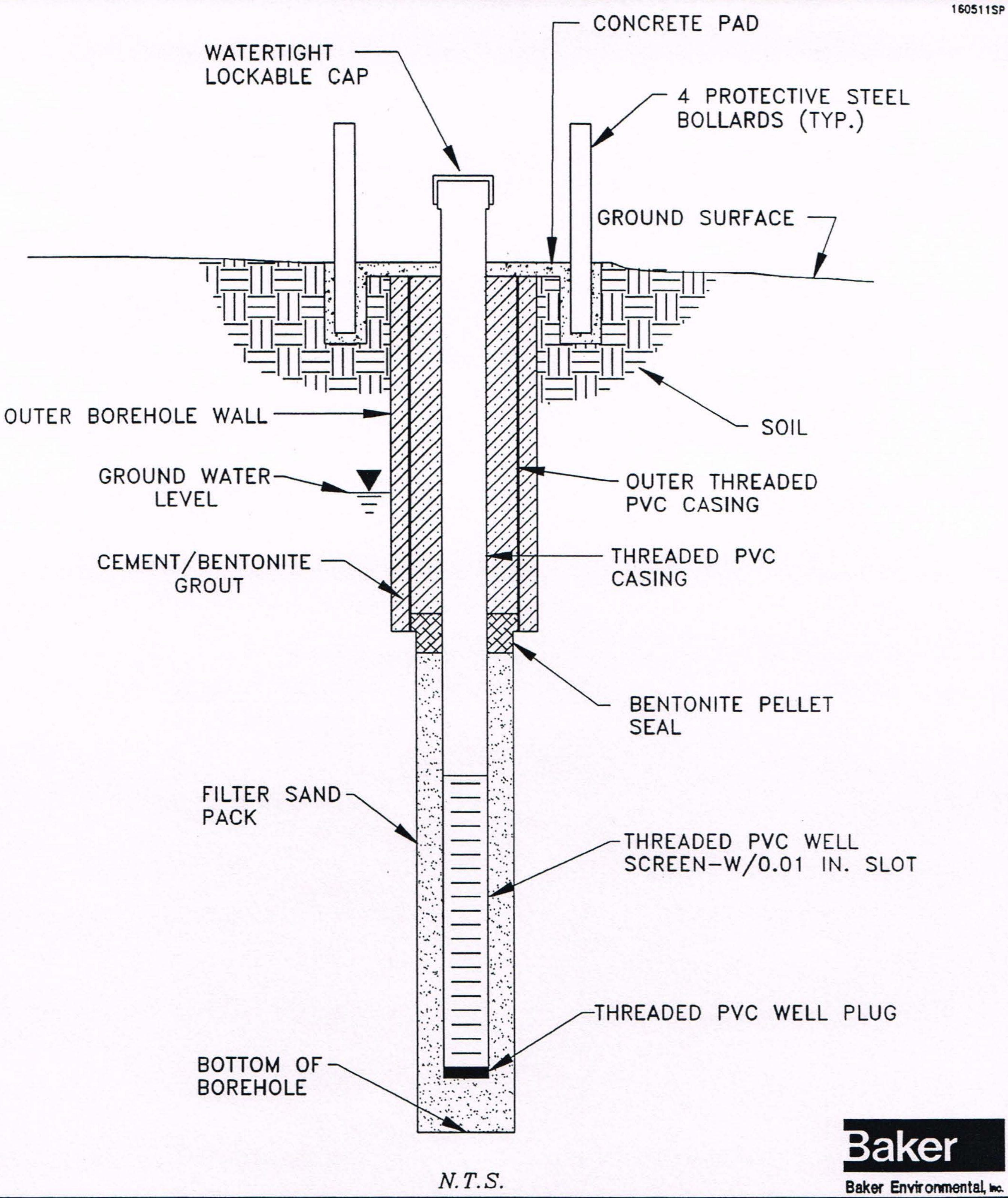
- Once it is determined that the clay layer meets the criteria mentioned above, the clay will be cased-off. Eight inch steel casing will be installed at least one foot into the clay layer. The casing will then be grouted in place. The grout shall consist of a cement-bentonite mixture consisting of either two parts sand per one part of cement and water, or three to four percent bentonite powder (by dry weight) and seven gallons of potable water per 94 pound bag of portland cement.

- The grout will be allowed to set-up for a minimum of 24-hours before the borehole is further advanced.

- Upon completion of the borehole to the desired depth, monitoring well construction materials will be installed as described above.

Figure 5-2 is a typical Type III deep monitoring well construction diagram.

All monitoring wells will be developed as specified in the ECBSOPQAM. 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.



Baker Environmental, Inc.

FIGURE 5-2
TYPICAL DEEP ABOVE GRADE TYPE III GROUNDWATER
MONITORING WELL CONSTRUCTION DIAGRAM
SITES 1, 28 AND 30

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Well development shall not be initiated until a minimum of 48 hours has elapsed subsequent well completion. This time period will allow the cement grout to set. Shallow wells typically are developed using bailers or low-yield pumping in combination with surging using a surge block. Deep monitoring wells are developed using compressed air (equipped with an air filter) in combination with surging. Selection of a development device will be dependent on conditions encountered during monitoring well installation.

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 specific conductance and temperature measurements (typically less than 10 percent change between three successive measurements)
- Clarity based on turbidity measurements [typically less than 50 Net Turbidity Units (NTU)]

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

Usually, a minimum period of one to two weeks should elapse between the end of initial development and the first sampling event for a well. This equilibration period allows groundwater unaffected by the installation of the well to occupy the vicinity of the screened interval.

5.3 Groundwater Sample Collection

5.3.1 Groundwater Samples Collected from Monitoring Wells

Groundwater samples will be collected from existing and newly installed monitoring wells on site.

The collection of a groundwater sample includes the following steps:

1. First open the well cap and use volatile organic detection equipment (HNu or OVA) on the escaping gases at the well head to determine the need for respiratory protection. This task is usually performed by the Field Team Leader, Health and Safety Officer, or other designee.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (decontaminated equipment) and record these data in the field logbook. Calculate the fluid volume in the well.

3. Lower purging equipment [bailer or submersible pump (RediFlo-2® low yielding pumps)] into the well to a short distance below the water level and begin water removal. Purged water will be temporarily stored in DOT-approved 55-gallon drums. Final containment of purged water is addressed in Section 5.9.1.

4. Measure the rate of discharge using a bucket and stopwatch.

5. Purge a minimum of three to five well volumes before sampling. In low permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Allow the well to recharge as necessary, but preferably to 70 percent of the static water level, and then sample.

6. Record measurements of specific conductance, temperature, and pH during purging (i.e., after each volume has been removed) to ensure the groundwater stabilizes. Generally, these measurements are made after three, four, and five well volumes.

7. Lower the teflon bailer into the well, submerge into the groundwater, and retrieve. A teflon coated line (only the portion in contact with the water table) will be used for

lowering the bailer. Pour groundwater from the bailer into the laboratory-supplied sample bottles.

8. Samples for VOC analysis will be collected first, followed by semivolatiles, PCBs, pesticides, and metals. Sample bottles will be filled in the same order for all monitoring wells.

9. Samples collected for dissolved metals analysis will be filtered in the field prior to being submitted for analysis. Filtering will be conducted using a 45-micron filter.

Sample preservation handling procedures are outlined in Section 6.0.

5.3.2 Potable Supply Well Sample Collection

A groundwater sample will be collected from potable supply well HP-638 at Site 1. The well will be sampled in accordance with the USEPA Region IV ECBSOPQAM. The collection of supply well samples includes the following steps:

- The groundwater sample will be collected from a tap located at the pump house. Taps selected for sample collection should be supplied with water from a service pipe connected directly to a water main in the segment of interest.

- The tap will be opened for two to five minutes or for sufficient time to permit clearing the service line; a smooth-flowing water stream at moderate pressure without splashing should be obtained.

- The water samples will be collected and handled as described in Section 5.3.1.

5.4 Surface Sample Collection

The following procedures will be used for the collection of surface water samples at stations located on site. At each station, samples will be collected at the approximate mid-vertical point or near the bank of the surface water body. Care will 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.

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. For those sample bottles that contain preservative (e.g., sulfuric acid), the water will be collected in a clean, decontaminated sampling container, and then slowly transferred into the appropriate laboratory-supplied sample bottle.

The water samples will be collected from near mid-stream at each station. Water samples at the furthest downstream station will be collected first, with subsequent samples taken at the next upstream station(s). Sediment samples will be collected after the water samples to minimize sediment disturbance and suspension.

All sample containers not containing preservative will be rinsed at least 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.

Care will be taken when collecting samples for analysis of volatile organics compounds (VOCs) to avoid excessive agitation that could result in loss of VOCs. VOC samples will be collected prior to the collection of the samples for analysis of the other parameters. Sample bottles will be filled in the same order at all sampling stations.

Temperature, pH, specific conductance, and dissolved oxygen of the surface water will be measured in the field at each sampling location (at each sampling depth), 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. If permission is granted, photographs will be taken to document the physical and biological characteristics of the sampling location.

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

Sample preservation and handling procedures are outlined in Section 6.0.

5.5 Sediment Sample Collection

The following procedures will be used for the collection of sediment samples at stations located on site. At each station, surface and near surface sediment samples will be collected at a depth of 0-6 inches, and 6-12 inches. These intervals of sediment will be collected 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 fifteen inches, or until refusal, whichever is encountered first. The sediments in the 0 to 6-inch interval and 6 to 12-inch interval will be extruded with a decontaminated extruder into the appropriate sample containers. If less than twelve inches of sediments are obtained, the first six inches will be placed in the 0 to 6-inch container, and the remaining sediment will be placed into the 6 to 12-inch container.

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 is 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, if the purpose is to obtain samples containing fauna or stratified sediments, 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 12 inches). Push out the sediments within the 6 to 12 inch interval and place it in a sample jar. Push out the 0 to 6 inch sediment interval into another sample jar.

8. Seal all sample jars tightly.

9. Label all samples.

5.6 Biological and Fish Sample Collection

5.6.1 Biological Sample Collection

Biological samples collected at the stations will consist of fish and benthic macroinvertebrates. Prior to initiating the sampling event, the following sampling area description information will be recorded at each station:

- Project location, date and time
- Tide (low vs. high)
- 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
- Average width, depth and velocity of the water body
- Description of substrate
- Descriptions of other "abiotic" characteristics of the reach such as pools, riffles, runs, channel shape, degree of bank erosion, and shade/sun exposure

- Description of biotic community (i.e., flora, fauna, etc.)

- Description of other "biotic" characteristics of the reach including aquatic and riparian vegetation and wetlands

After the habitat review is complete, the field team leader will define and locate the stations for biological sampling. Every attempt will be made to define stations to exclude atypical habitats such as bridges and mouths of tributaries. In addition, upstream and downstream locations will be selected to be as ecologically similar as possible in their biotic and abiotic characteristics.

Field water quality measurements will be conducted at each station, prior to collection of the samples. These measurements include temperature, pH, dissolved oxygen, specific conductivity and salinity. All instruments will be calibrated in accordance with the manufacturers' instructions prior to conducting the measurements. All measurements, including the calibration procedures, will be recorded on field data sheets.

5.6.1.1 Benthic Macroinvertebrate Sample Collection

Benthic macroinvertebrates will be collected at each station using a Standard Ponar Grab Sampler. Each station will consist of three replicate samples with one grab per replicate.

After the sediments are collected, the contents of the sample will be placed into a small tub. The sediments in the tub will be transferred to a No. 35 sieve (0.500 mm) and washed with water to remove small sediment particles. The remaining contents in the sieve will be transferred into sample jars. Approximately half of the sample jar will be filled with the sample, and 10% (by weight) buffered formalin will be added to fill the remainder of the jar. A 100% cotton paper label will be placed inside the jar, identifying the station location and replicate number. The label will be marked with a pencil. The outside of the jar will be labeled using a black permanent marker with the station location and sample number. All the sample jars will be stored in large plastic tubs until transfer to Baker Ecological Services Laboratory in Coraopolis, Pennsylvania.

5.6.1.2 Processing of Macroinvertebrate Samples

The samples will be returned to the Baker Ecological Services Laboratory for final processing. The samples will be rewashed using a No. 35 sieve (0.500 mm), to remove any remaining fine sediments, and the remaining portion of the sample will be transferred back into the sample jar containing fresh 90% ethanol.

The sediment sample will be sorted under a dissecting microscope. Using a pair of forceps all the remaining organisms will be removed from the sample and placed into glass vials containing 90% ethanol. After all the organisms in a given sample are sorted, 100% cotton paper labels will be placed inside the vials and/or jars, identifying the station location and replicate number. The labels will be marked with a pencil. The vials will be sealed with cotton, and placed into a sample jar containing 90% ethanol. The date, sorting time, and the name of the person who sorted the sample will be recorded on a log sheet.

The same sorting procedures outlined above will be repeated as a QA/QC measure, with any additional species identified, being placed into their respective vials. An environmental scientist will perform this QA/QC measure. Fifty percent of the sample will be resorted. If more than five percent of the individuals are missed during the initial sorting, then the rest of the sample will be resorted. If less than five percent of the individuals are missed during the initial sorting, then the rest of the sample will not be resorted. Any changes to this procedure will be approved by the project manager. The number of additional individuals found in the sample will be recorded. The date, sorting time, number of additional individuals found and the percent of the sample that was QA/QCed will be recorded on a log sheet. All collected individuals will be sent to the appropriate laboratory for taxonomic identification.

5.6.1.3 Analysis of Macroinvertebrates

Results of the benthic macroinvertebrate collection will be used to prepare the following descriptive statistics on a station-by-station basis: (1) a list of taxa collected; (2) a table of numbers of each taxa collected by replicate; and (3) relative pollution tolerance of the species.

The benthic macroinvertebrate communities will be examined using a mathematical expression of community structure (i.e., diversity index). Diversity data are useful because they condense a substantial amount of laboratory data into a single value. Separate values of the diversity index will be computed for sampling areas within the upstream, downstream and adjacent reaches. Analysis of the species diversity will be used to compare the community structure between the stations as well as evaluate the impact that the contaminants from the site may be having on the aquatic community.

The species collected during the aquatic surveys will be evaluated to determine their biological relevance, and pollution tolerance. Biological impairment of the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate species such as Ephemeroptera, Plecoptera, and Trichoptera; excess dominance by any one particular taxon; low overall taxa richness; or appreciable shifts in community composition relative to the reference condition. In addition, a Macroinvertebrate Biotic Index, based on North Carolina Biotic Index of benthic macroinvertebrates, will be used to assess stream quality, as appropriate.

5.6.2 Fish Collection

Fish will be collected at the designated stations using a combination of the following: electrofishing, seining, gill nets, and/or other fish collecting techniques. The following paragraphs discuss the procedures that will be used for collecting the fish.

The fish sampled via electroshocking will be collected using either a boat-mounted Smith-Root, Inc. electrofisher powered by a 5,000-watt portable generator, or a Smith-Root, Inc. backpack electrofisher. The boat-mounted unit will be utilized for deeper waters, while the backpack unit will be utilized in shallow waters. Stunned fish will be collected with one-inch mesh or smaller dip nets handled by members of the field sampling team. The length of shocking time per subsection will be recorded as seconds of applied current.

At each station where haul seines are utilized, a minimum of two haul seines will be conducted. The haul seine will be deployed with one person securing the seine on the shore and another person walking out in a loop. The bottom of the net will be kept in contact with the sediment to prevent fish from swimming under the net. Other field personnel will aid in removing snags from the net and preventing fish from jumping over the net. When the person deploying the net arrives back at shore, the net will be pulled in, making sure the bottom of the net remains in the sediment. After the bag in the middle of the seine reaches the shore, the bag will be lifted and the fish will be carefully transferred into plastic tubs filled with water.

Gill nets also may be used to collect fish. The nets will be deployed either in the evening or the morning and they will be checked for fish within twelve hours after being deployed.

After each fish collection event, the fish will be placed into plastic tubs filled with water. Aerators will be placed into the tubs and the water in the tubs will be replaced periodically often to minimize fish mortality. The collected fish will be separated into different species, and then measured and counted. The small fish (less than 20 mm) will be weighed in groups of 10 or 20 because of their low individual weight; the larger fish will be weighed individually. The proportion of individuals as hybrids and the proportion of individuals with disease, tumors, fin damage, and skeletal anomalies will be recorded at each station.

Most of the fish species will be processed in the field and returned to the water body. Specimens that present taxonomic difficulties, or are too numerous for effective field processing, will be preserved in 10% formalin and transported to the Baker Ecological Services Laboratory for taxonomic work. At a minimum, one representative fish from each species will be preserved in 10% formalin as a voucher specimen.

Three different species will be collected at each station for the tissue analysis (whole-body and fillet). An attempt will be made to collect ten individuals from three different species, with each species being a representative of a different trophic level, if possible. The following are the desired trophic levels for collection: top carnivores, forage fish, and bottom feeders.

However, based on Baker's experience from previous sampling at MCB Camp Lejeune, sampling variability may prevent the same species of fish from being sampled at each station, because either the preferred species will not be captured, or adequate numbers of uniform-size individuals will not be captured. Therefore, if the preferred species are not successfully collected to satisfy the above requirements, a substitute species will be collected that, if possible, exhibited a similar trophic position in the ecosystem.

Specimens submitted to the laboratory for chemical analysis will be placed into sealed plastic bags. A 100% cotton label will be placed inside the bag, identifying the station number. A pencil will be used to mark the label. The outside of the bag also will be labeled with the station number using a black permanent marker. The bags will then be placed on ice in coolers.

5.6.2.1 Analysis of Fish Species

At each station, fish will be collected for population statistics and tissue analysis. All fish will be weighed to the nearest gram and measured to the nearest tenth of a centimeter. The total length of the fish will be measured (i.e., the distance in a straight line from the anterior-most projecting part of the head to the farthest tip of the caudal fin when its rays are squeezed together).

Results of the fish collection effort will be used to prepare the following descriptive statistics on a station by station basis: 1) a list of fishes collected, 2) a table of numbers of each species collected by station (including hybrid and pathology statistics), 3) a table of fish population estimates in numbers per unit effort, and 4) a table of fish biomass estimates in weight per unit effort.

The fish will be processed (e.g., filleted, homogenized) by the laboratory conducting the chemical analyses. If the time between sampling and preparation will be longer than 48 hours, the fish will be frozen.

At least ten individuals from each species, if available, will be composited and analyzed for whole body burdens of chemicals. In addition, fillets of at least ten individuals, if available, from each edible species will be composited and analyzed for chemical constituents. If adequate individuals from each species are not collected for both whole-body analysis and fillet analysis, only the fillets will be analyzed.

5.7 Decontamination Procedures

Equipment and materials utilized during this investigation that will require decontamination fall into two broad categories:

- Field measurement and sampling equipment: water level meters, bailers, split-spoon samplers, hand auger buckets, stainless-steel spoons, etc.

- Large machinery and equipment: drilling rigs and drilling equipment, backhoes, etc.

5.7.1 Field Measurement Sampling Equipment

5.7.1.1 Cleaning Procedures for Teflon® or Glass Field Sampling Equipment used for the Collection of Samples for Trace Organic Compounds and/or Metals Analyses

1. Equipment will be washed thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.

2. The equipment will be rinsed thoroughly with hot tap water.

3. Rinse equipment with at least a 10 percent nitric acid solution.

4. Rinse equipment thoroughly with deionized water.

6. Rinse equipment twice with solvent and allow to air dry for at least 24 hours.

7. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.

8. Rinse the Teflon® or glass sampling equipment thoroughly with tap water in the field as soon as possible after use.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone or hexane to remove the materials before proceeding with Step 1. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded.

Small and awkward equipment such as vacuum bottle inserts and well bailers may be soaked in the nitric acid solution instead of being rinsed with it. Fresh nitric acid solution should be prepared for each cleaning session.

5.7.1.2 Cleaning Procedures for Stainless Steel or Metal Sampling Equipment used for the Collection of Samples for Trace Organic Compounds and/or Metals Analyses

1. Wash equipment thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.

2. Rinse equipment thoroughly with hot tap water.

3. Rinse equipment thoroughly with deionized water.

4. Rinse equipment twice with solvent and allow to air dry for at least 24 hours.

5. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.

6. Rinse the stainless steel or metal sampling equipment thoroughly with tap water in the field as soon as possible after use.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone or hexane to remove the materials before proceeding with Step 1. In extreme cases, when equipment is painted, badly rusted, or coated with materials that are difficult to remove, it may be necessary to steam clean, wire brush, or sandblast equipment before proceeding with Step 1. Any metal sampling equipment that cannot be cleaned using these procedures should be discarded.

5.7.1.3 Reusable Glass Composite Sample Containers

1. Wash containers thoroughly with hot tap water and laboratory detergent, using a bottle brush to remove particulate matter and surface film.

2. Rinse containers thoroughly with hot tap water.

3. Rinse containers with at least 10 percent nitric acid.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with deionized water.

6. Rinse twice with solvent and allow to air dry for at least 24 hours.

7. Cap with aluminum foil or Teflon® film.

8. After using, rinse with tap water in the field, seal with aluminum foil to keep the interior of the container wet, and return to the laboratory.

When these containers are used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the container several times with pesticide-grade acetone before proceeding with Step 1. If these materials cannot be removed with acetone, the container should be discarded. Glass reusable composite containers used to collect samples at pesticide, herbicide, or other chemical manufacturing facilities that produce toxic or noxious compounds shall be properly disposed of (preferably at the facility) at the conclusion of sampling activities and shall not be returned for cleaning. Also, glass composite containers used to collect in-process wastewater samples at industrial facilities shall be discarded after sampling. Any bottles that have a visible film, scale, or discoloration remaining after this cleaning procedure shall also be discarded.

5.7.1.4 Plastic Reusable Composite Sample Containers

1. Proceed with the cleaning procedures as outlined in Section 5.7.1.3 but omit the solvent rinse.

Plastic reusable sample containers used to collect samples from facilities that produce toxic or noxious compounds or are used to collect in-process waste stream samples at industrial facilities will be properly disposed (preferably at the facility) of at the conclusion of the sampling activities and will not be returned for cleaning. Any plastic composite sample containers that have a visible film, scale, or other discoloration remaining after this cleaning procedure will be discarded.

5.7.1.5 Well Sounders or Tapes Used to Measure Ground Water Levels

1. Wash with laboratory detergent and tap water.

2. Rinse with tap water.

3. Rinse with deionized water.

4. Allow to air dry overnight.

5. Wrap equipment in aluminum foil (with tab for easy removal), seal in plastic, and date.

5.7.1.6 Submersible Pumps and Hoses Used to Purge Ground Water Wells

1. Using a brush, scrub the exterior of the contaminated hose and pump with soapy water.

2. Rinse the soap from the outside of pump and hose with tap water.

3. Rinse the tap water residue from the outside of pump and hose with deionized water.

4. Equipment should be placed in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit.

5.7.2 Large Machinery and Equipment

All drilling rigs, drilling and sampling equipment, backhoes, and all other associated equipment involved in the drilling and sampling activities shall be cleaned and decontaminated before entering the designated drill site. All equipment should be inspected before entering the site to ensure that there are no fluids leaking and that all gaskets and seals are intact. All drilling and associated equipment entering a site shall be clean of any contaminants that may have been transported from another hazardous waste site, thereby minimizing the potential for cross-contamination. Before site drilling activities are initiated, all drilling equipment shall be thoroughly cleaned and decontaminated at the designated cleaning/decontamination area. The following requirements and procedures are to be strictly adhered to on all drilling activities.

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) shall be steam cleaned before being brought on the site to remove all rust, soil and other material which may have come from other hazardous waste sites. The drill rig and/or other equipment associated with the drilling and sampling activities shall be inspected to insure that all oil, grease, hydraulic fluid, etc., have been removed, and all seals and gaskets are intact and there are no fluid leaks. No oils or grease shall be used to lubricate drill stem threads or any other drilling equipment being used over the borehole or in the borehole without EPA approval. If drill stems have a tendency to tighten during drilling Teflon® string can be used on the drill stem threads. The drill rig(s) shall be steam cleaned prior to drilling each borehole. In addition, all downhole sampling equipment that will come into contact with the downhole equipment and sample medium shall be cleaned and decontaminated by the following procedures.

1. Clean with tap water and laboratory grade, phosphate-free detergent, using a brush, if necessary, to remove particulate matter and surface films. Steam cleaning and/or high pressure hot water washing may be necessary to remove matter that is difficult to remove with the brush. Hollow-stem augers, drill rods, shelby tubes, etc., that are hollow or have holes that transmit water or drilling fluids, shall be cleaned on the inside and outside. The steam cleaner and/or high pressure hot water washer shall be capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200°F plus).

2. Rinse thoroughly with tap water (potable).

   NOTE: Tap water (potable) may be applied with a pump sprayer. All other decontamination liquids (D.I. water, organic-free water, and solvents), however, must be applied with noninterfering containers. These containers shall be made of glass, Teflon®, or stainless steel. This aspect of the decontamination procedures used by the driller will be inspected by the site geologist and/or other responsible person prior to beginning of operations.

3. Rinse thoroughly with deionized water.

4. Rinse twice with solvent (pesticide grade isopropanol).

5. Rinse thoroughly with organic-free water and allow to air dry. Do not rinse with deionized or distilled water.

   Organic-free water can be processed on site by purchasing or leasing a mobile deionization-organic filtration system.

   In some cases when no organic-free water is available, it is permissible (with approval) to leave off the organic-free water rinse and allow the equipment air dry before use.

6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported. Clean plastic can be used to wrap augers, drill stems, casings, etc., if they have been air dried.

7. All downhole augering, drilling and sampling equipment shall be sandblasted before Step #1 if painted, and/or if there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam and/or high pressure cleaning. All sandblasting shall be performed prior to arrival on site.

8. All well casing, tremie tubing, etc., that arrive on site with printing and/or writing on them shall be removed before Step #1. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can supply materials without the printing and/or writing if specified when materials are ordered.

9. Well casing, tremie tubing, etc., that are made of plastic (PVC) shall not be solvent rinsed during the cleaning and decontamination process. Used plastic materials that cannot be cleaned are not acceptable and shall be discarded.

Cleaning and decontamination of all equipment shall occur at a designated area on the site, downgradient, and downwind from the clean equipment drying and storage area. All cleaning of drill rods, auger fights, well screen and casing, etc., will be conducted above the plastic sheeting using saw horses or other appropriate means. At the completion of the drilling activities, the pit shall be backfilled with the appropriate material designated by the Site Manager, but only after the pit has been sampled, and the waste/rinse water has been pumped into 55-gallon drums. No solvent rinsates will be placed in the pit unless prior approval is granted. All solvent rinsates shall be collected in separate containers for proper disposal.

5.8 Surveying

All surveying activities will be conducted by a qualified surveying subcontractor licensed in the State of North Carolina. Surveying activities will include the following:

- Surveying the boundaries of the former disposal areas
- Resurveying areas at the sites which may have undergone physical changes due to recent construction activities
- Surveying sampling grid for soil investigation.
- Surveying nongrid sampling points (monitoring wells, test pits, surface water/sediment locations).

All grid intersections will be marked with a wooden stake and will be numbered by the surveyor with a unique location number.

All newly-installed monitoring wells will be surveyed. The vertical accuracy shall be surveyed to 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, other sampling stations (test pit, surface water/sediment) will be surveyed for horizontal control within 1 foot accuracy. Control will be established by use of horizontal and vertical control points near the site that are tied into the North Carolina State Plane Coordinate System. If control points cannot be located, two benchmarks/monuments will be surveyed from the closest USGS (or equivalent) benchmarks. The 1929 msl datum will be used as a reference for the vertical elevation.

Surveying of surface water sampling stations may be difficult, especially in deep water. The field team will estimate all locations and mark them on a field map during sampling.

5.9 Handling of Site Investigation Generated Wastes

5.9.1 Responsibilities

LANTDIV - LANTDIV or the facility must ultimately be responsible for the final disposition of site wastes. As such, a LANTDIV representative will usually prepare and sign waste disposal manifests as the generator of the material, in the event off-site disposal is required. However, it may be the responsibility of Baker, depending on the contingency discussions during execution of the investigation to provide assistance to LANTDIV in arranging for final disposition and preparing the manifests.

Project Manager - It is the responsibility of the Project Manager to work with the LANTDIV EIC in determining the final disposition of site investigation wastes. The Project Manager will relay the results and implications of the chemical analysis of the waste or associated material, and advise on the regulatory requirements and prudent measures appropriate to the disposition of the material. The Project Manager also is responsible for ensuring that field personnel involved in site investigation waste handling are familiar with the procedures to be implemented in the field, and that all required field documentation has been completed.

Field Team Leader - The Field Team Leader is responsible for the on site supervision of the waste handling procedures during the site investigations. The Field Team Leader also is responsible for ensuring that all other field personnel are familiar with these procedures.

5.9.2 Sources of Investigation Derived Wastes (IDW)

Field investigation activities often result in the generation and handling of potentially contaminated materials that must be properly managed to protect the public and the environment, as well as to meet legal requirements. These wastes may be either hazardous or nonhazardous in nature. The nature of the waste (hazardous or nonhazardous) will determine how the wastes will be handled during the field investigation.

The sources of waste material depend on the site activities planned for a project. The following types of activities (or sources), typical of site investigations, may result in the generation of waste material which must be properly handled:

- Drilling and monitoring well construction (drill cuttings)
- Monitoring well development (development water)
- Groundwater sampling (purge water)
- Heavy equipment decontamination (decontamination fluids)
- Sampling equipment decontamination (decontamination fluids)
- Personal protective equipment (health and safety disposables)
- Mud rotary drilling (contaminated mud)

5.9.3 Designation of Potentially Hazardous and Nonhazardous IDW

Wastes generated during the field investigation can be categorized as either potentially hazardous or nonhazardous in nature. The designation of such wastes will determine how the wastes will be handled. The criteria for determining the nature of the waste, and the subsequent handling of the waste is described below for each type of investigative waste.

5.9.3.1 Drill Cuttings

Drill cuttings will be generated during the augering of test borings and monitoring well boreholes. All drill cuttings will be containerized in 55-gallon drums or in lined roll-off boxes. As the borehole is augered, and soil samples collected, the site geologist will monitor the cuttings/samples with an HNu photoionization (PID) unit for organic vapors. In addition, the site geologist will describe the soils in a field log book. Upon completion, the soil borings will be backfilled with a cement-bentonite grout.

5.9.3.2 Monitoring Well Development and Purge Water

All development and purge waters shall be containerized in tankers, or large (250-gallon) containers.

5.9.3.3 Decontamination Fluids

Equipment and personal decontamination fluids shall be containerized in 55-gallon drums. The fluids shall be collected from the decon/wash pads. If military vehicle wash racks are used to decon the heavy equipment, no collection of these wastewaters will be necessary since the decontamination waters will be treated at one of the Camp Lejeune treatment facilities (depending upon the location of the vehicle wash racks).

5.9.3.4 Personal Protective Equipment

All personal protective equipment (tyvek, gloves, and other health and safety disposables) shall be placed in the dump box, which will be provided by Camp Lejeune. Camp Lejeune will dispose of these materials when the box is full.

5.9.4 Labeling

If 55-gallon drums are used to containerize drill cuttings, the containers will be consequently numbered and labeled by the field team during the site investigation. Container labels shall be legible and of an indelible medium (waterproof marker, paint stick, or similar means). Information shall be recorded both on the container lid and its side. Container labels shall include, as a minimum:

- LANTDIV CTO (number)
- Project name
- Drum number
- Boring or well number
- Date
- Source
- Contents

If laboratory analysis reveals that containerized materials are hazardous or contain PCBs, additional labeling of containers may be required. The project management will assist LANTDIV in additional labeling procedures, if necessary, after departure of the field team from the facility. These additional labeling procedures will be based upon the identification of material present; EPA regulations applicable to labeling hazardous and PCB wastes are contained in 40 CFR Parts 261, 262 and 761.

5.9.5 Container Log

A container log shall be maintained in the site log book. The container log shall contain the same information as the container label plus any additional remarks or information. Such additional information may include the identification number of a representative laboratory sample.

5.9.6 Container Storage

Containers of site investigation wastes shall be stored in a specially designated, secure area that is managed by the Camp Lejeune Environmental Management Division until disposition is determined. All containers shall be covered with plastic sheeting to provide protection from weather.

If the laboratory analysis reveal that the containers hold hazardous or PCB waste, additionally required storage security may be implemented; in the absence of the investigation team, these will be the responsibility of LANTDIV or the facility, as confirmed by the contingency discussions.

Baker will assist LANTDIV in devising the storage requirements, which may include the drums being staged on wooden pallets or other structures to prevent contact with the ground and being staged to provide easy access. Weekly inspections by facility personnel of the temporary storage area may also be required. These inspections may assess the structural integrity of the containers and proper container labeling. Also, precipitation that may accumulate in the storage area may need to be removed. These weekly inspections by facility personnel of the temporary storage area may also be required. These inspections may assess the structural integrity of the containers and proper container labeling. Also, precipitation that may accumulate in the storage area may need to be removed. These weekly inspections and whatever precipitation removal shall be recorded in the site logbook.

5.9.7 Container Disposition

The disposition of containers of site investigation generated wastes shall be determined by LANTDIV, with the assistance of Baker, as necessary. Container disposition shall be based on quantity of materials, types of materials, and analytical results. If necessary, specific samples of contained materials may be collected identify further characteristics which may affect disposition. Typically, container disposition will not be addressed until after receipt of applicable analytical results; these results are usually not available until long after completion of the filed investigation at the facility.

5.9.8 Disposal of Contaminated Materials

Actual disposal methods for contaminated materials disturbed during a site investigation are the same as for other PCB or hazardous substances: incineration, landfilling, treatment, and so forth. The responsibility for disposal must be determined and agreed upon by all involved parties during negotiations addressing this contingency.

The usual course will be a contractor specialist retained to conduct the disposal. However, regardless of the mechanism used, all applicable Federal, state and local regulations shall be observed. EPA regulations applicable to generating, storing and transporting PCB or hazardous wastes are contained in 40 CFR Parts 262, 263 and 761.

Another consideration in selecting the method of disposal of contaminated materials is whether the disposal can be incorporated into subsequent site cleanup activities. For example, if construction of a suitable on-site disposal or treatment structure is expected, contaminated materials generated during the site investigation may be stored at the site for treatment/disposal with other site materials. In this case, the initial containment (drums or other containers) shall be evaluated for use as long-term storage. Also, other site conditions, such as drainage control, security and soil types must be considered in order to provide proper storage.

5.10 Water Level Measurements

Water level measurements will be collected from soil borings (during drilling), hydropunch locations, test pits and monitoring wells. Static water levels will be measured to the nearest 0.01 foot with a decontaminated electronic water level indicator (E-tape).

Water levels is monitoring wells will be measured from the top of the PVC casing riser. All other water level measurements will be taken from ground surface.

6.0 SAMPLE HANDLING AND ANALYSIS

6.1 Sample Program Operations

Field activities will be conducted according to the guidance of USEPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (February 1, 1991).

The number of samples (including QA/QC samples), analytical method, data quality level and laboratory turnaround times are included in Table 6-1. Preservation requirements, bottle requirements and holding times are included in Section 7.0 of the QAPP which is Section II of this SAP. Collection procedures for field QA/QC samples are outlined in Section 3.3.

6.2 Chain-of-Custody

Chain-of-custody procedures will be followed to ensure a documented, traceable link between measurement results and the sample/parameter that they represent. These procedures are intended to provide a legally acceptable record of sample preparation, storage and analysis.

To track sample custody transfers before ultimate disposition, sample custody will be documented using the chain-of-custody form shown in Figure 6-1. A chain-of-custody seal is shown in Figure 6-2. A sample label is shown in Figure 6-3. In addition, a master logbook will be used as a centralized mechanism for documenting project activities.

A chain-of-custody form will be completed for each container in which the samples are shipped. The shipping containers will usually be coolers. After the samples are properly packaged, the coolers will be sealed and prepared for shipment. Custody seals will be placed on the outside of the coolers to ensure that the samples are not disturbed prior to reaching the laboratory.

6.3 Logbooks and Field Forms

Field notebooks will be used to record sampling activities and information. Field notebooks will be bound, field survey books. Notebooks will be copied and submitted to the field sampling task leader, for filing upon completion of the assignment. The cover of each logbook will contain:

TABLE 6-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time[3]	Field QA/QC Samples [9]: Field Duplicate
Site 1	Soil - Grid 1-N and 1-S	4 borings 8 to 12 samples [2]	Grain Size	III	ASTM D422	Routine	NA
			Moisture Density	III	ASTM D698	Routine	
			Total TCLP	III	40 CFR 261	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (organic)	III	EPA 351.4	Routine	
			Alkalinity (total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
			TOC	III	EPA 415.1	Routine	
		37 borings 37 samples (surface soils)	TCL Organics TAL Metals TPH	IV IV II	4, 5, 7, 10	Routine	3-4
		18 borings 18 to 36 samples[2] (subsurface soils)	TCL Organics TAL Metals TPH	IV IV II	4, 5, 7, 10	Routine	2-4
		11 borings 11 to 22 samples[2] (subsurface soils)	TCL Organics TAL Metals TPH	IV IV II	4, 5, 7, 10	7 days	2-3
		8 borings 8 to 16 samples[2] (subsurface soils)	TCL Organics TAL Metals TPH*	IV IV II	4, 5, 7, 10	7 days	1-2

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time[3]	Field QA/QC Samples [9] Field Duplicate
Site 1 (Cont.)	Soil Back-ground/ Proposed Wells	11 borings 11 samples (surface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	Routine	2
		11 borings 11 to 22 samples[2] (subsurface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	Routine	2-3
	Groundwater	7 samples from existing wells (shallow)	Volatiles (EPA 601/602) TCL Organics TAL Metals	IV IV IV	4, 5, 7	Routine	1
		8 samples from newly installed wells (shallow)	Volatiles (EPA 601/602) TCL Organics TAL Metals	IV IV IV	4, 5, 6, 7	Routine	1
		1 sample from supply well (deep)	Volatiles (EPA 601/602) TAL Metals	IV IV	4, 7	Routine	1
		2 samples (shallow): 2 from newly installed wells	BOD COD TOC TSS TDS	III III III III III	8 8 8 8 8	Routine Routine Routine Routine Routine	NA
	Surface water - Cogdels Creek	2 samples	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	1
	Sediment - Cogdels Creek	2 samples (0-6") (6-12")	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	1

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9) Field Duplicate
Site 28	Soil - Hadnot Point Burn Dump Area	4 borings 8 to 12 samples(2)	Grain Size Moisture Density Total TCLP Chlorine, Residual Total Fluoride Nitrogen (organic) Alkalinity (total) Corrosivity Ignitability Reactivity TOC	III III III III III III III III III III III	ASTM D422 ASTM D698 40 CFR 261 EPA 330.5 SM 4500-F EPA 351.4 SM 2320-B 40 CFR 261 40 CFR 261 40 CFR 261 EPA 415.1	Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine	NA
		18 borings 18 samples (surface soils)	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	2
		8 borings 8 to 16 samples (2) (subsurface soils)	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	1-2
		10 borings 10 to 20 samples(2) (subsurface soils)	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	7 days	1-2
		1 boring 1 sample (surface soils)	TCL Organics TAL Metals TPH	IV IV II	4, 5, 6, 7, 10	Routine	1
		1 boring 1-2 samples(2) (subsurface soils)	TCL Organics TAL Metals TPH	IV IV II	4, 5, 6, 7, 10	Routine	1
		14 borings 14 samples (surface soils)	TAL Metals	IV	7	Routine	2
		5 borings 5 to 10 samples (2) (subsurface soils)	TAL Metals	IV	7	7 days	1
		9 borings 9 to 18 samples (2) (subsurface soils)	TAL Metals	IV	7	Routine	1-2

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 28 (Cont.)	Soil - Hadnot Point Burn Dump Area	3 borings 3 samples (surface soils)	TAL Metals TPH	IV II	7, 10	Routine	1
		3 borings 3 to 6 samples(2)	TAL Metals TPH	IV II	7, 10	Routine	1
	Soil Background	3 borings 3 samples	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	1
		3 borings 3 to 6 samples(2)	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	1
	Groundwater	5 samples from existing wells (shallow)	Volatiles (EPA 601/602) TCL Organics TAL Metals	IV IV IV	4, 5, 6, 7	Routine	1
		4 samples from newly installed wells (shallow)	Volatiles (EPA 601/602) TCL Organics TAL Metals	IV IV IV	4, 5, 6, 7,	Routine	1
		3 samples from newly installed wells (deep)	Volatiles (EPA 601/602) TAL Metals	IV IV	4, 7	Routine	1
		2 samples (shallow); 2 from newly installed wells	BOD COD TOC TSS TDS	III III III III III	EPA 405.1 EPA 410.1 EPA 415.1 EPA 160.2 EPA 160.1	Routine Routine Routine Routine Routine	NA
	Surface water - Cogdels Creek, Site Pond and New River	16 samples	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	2
	Sediment - Cogdels Creek, Site Pond, and New River	16 samples (0-6") (6-12")	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	2

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9) Field Duplicate
Site 30	Soil - Grid 1-N and 1-S	2 borings 2 to 3 samples (2)	Grain Size Moisture Density Total TCLP Chlorine, Residual Total Fluoride Nitrogen (organic) Alkalinity (total) Corrosivity Ignitability Reactivity TOC	III III III III III III III III III III III	ASTM D422 ASTM D698 40 CFR 261 EPA 330.5 SM 4500-F EPA 351.4 SM 2320-B 40 CFR 261 40 CFR 261 40 CFR 261 EPA 415.1	Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine	1
		11 borings 11 samples (surface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	Routine	2
		6 borings 6 to 12 samples(2) (subsurface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	Routine	1
		5 borings 5 to 10 samples(2) (subsurface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	7 days	1
	Soil Background	5 borings 5 samples (surface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	Routine	1
		5 borings 5 to 10 samples(2) (subsurface soils)	TCL Organics TAL Metals	IV IV	4, 5, 7	Routine	1

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 30 (Cont.)	Groundwater	2 samples from existing wells (shallow)	Volatiles (EPA 601/602) TCL Organics TAL Metals	IV IV IV	4, 5, 7	Routine Routine Routine	1
		1 sample from a newly installed well (shallow)	Volatiles (EPA 601/602) TCL Organics TAL Metals	IV IV IV	4, 5, 7	Routine Routine Routine	1
		1 sample (shallow); from newly installed well	BOD COD TOC TSS TDS	III III III III III	8 8 8 8 8	Routine Routine Routine Routine Routine	NA
	Surface Water	3 samples	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	1
	Sediment	3 samples	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	1
	Ecological	To be determined during investigation activities	TCL Organics TAL Metals	IV IV	4, 5, 6, 7	Routine	NA

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 1, 28 and 30
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

(1) Baseline number of samples do not include field QA/QC samples.
(2) Assumes 1 to 2 samples per borehole.
(3) Routine analytical turnaround is 28 days following receipt of sample.
(4) Purgeable Organic Compounds - EPA 8240/EPA 624 (EPA 601/602 for groundwater only)
(5) Base/Neutral Acid Extractables - EPA 3510/EPA 625
(6) Pesticides and PCBs - EPA 3510/3550/EPA 608
(7) TAL Inorganics:

Aluminum	EPA 3010/EPA 200.7	Cobalt	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270.2
Arsenic	EPA 3020/EPA 206	Iron	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Barium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 239	Sodium	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Vanadium	EPA 3010/EPA 200.7
Calcium	EPA 3010/EPA 200.7	Mercury	EPA 3010/EPA 245.1	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7		

(8) BOD - Biological Oxygen Demand (SM 5210)
COD - Chemical Oxygen Demand (EPA 410.1)
TSS - Total Suspended Solids (EPA 160.2)
TDS - Total Dissolved Solids (EPA 160.1)
TOC - Total Organic Carbon (EPA 415.1)
(9) Trip Blank - 1 per cooler (VOCs only)
Equipment Rinsate - 1 per day for each matrix sampled
Matrix Spike/Matrix Spike Duplicate - 1 per 20 samples
(10) TPH - EPA 5030/EPA 3550

* TPH does not require quick turnaround analyses.

FIGURE 6-1

CHAIN-OF-CUSTODY RECORD	Sampler: ______ (Print)	Sheet ____ of ____
...ct Name: ______	Signature: ______	BAKER ENVIRONMENTAL, INC. Airport Office Park - Bldg No. 3 420 Rouser Road Coraopolis, PA 15108 (412) 269-6000
... O. Number: ______		

Baker Sample I.D. No.	Sample Type	Sampled		Sample Storage and Preservation Details*									
				Cooling		HNO_3		H_2SO_4 Cooling		Other		Other	
		Date	Time	No. of Contnr.	Type/ Volume Contnr.	No. of Contnr.	Type/ Volume Contnr.	No. of Contnr.	Type/ Volume Contnr.	No. of Contnr.	Type/ Volume Contnr.	No. of Contnr.	Type/ Volume Contnr.

General Remarks:	*NOTES: Record type of container used with abbreviation P (plastic) or G (glass) Record volume of containers in leters
Relinguished By (Sign): Date: Time: Remarks:	Received By (Sign): Date: Time: Remarks:
Shipment/Transportation Details:	
Relinguished By (Sign): Date: Time: Remarks:	Received By (Sign): Date: Time: Remarks:
Shipment/Transportation Details:	
Relinguished By (Sign): Date: Time: Remarks:	Received By (Sign): Date: Time: Remarks:
Shipment/Transportation Details:	

Distribution:

Original - Sent with samples to lab (return with lab results to Project Manager for filing)

Copy - Retained by sampling personnel for filing

EXAMPLE CUSTODY SEAL

_____/_____/_____ Date ____________________ Signature CUSTODY SEAL	_____/_____/_____ Date ____________________ Signature CUSTODY SEAL

FIGURE 6-3

EXAMPLE SAMPLE LABEL

	Baker Environmental Inc. Airport Office Park, Bldg. 3 420 Rouser Road Coraopolis, PA 15108
Project: ____________________	CTO No.: ____________
Sample Description: ______________________________	
Date: ____/____/____	Sampler: ________________
Time: ______________	
Analysis: _______________	Preservation: ___________
Project Sample No.: ______________________________	

- The name of the person to whom the book is assigned
- The book number
- The project name
- Entry start date
- Entry completion date

Entries will include general sampling information so that site activities may be reconstructed. The beginning of each entry will include the date, sampling site, start time, weather conditions, field personnel present and level of personal protection. Other possible entries would be names and purpose of any visitors to the vicinity during sampling, unusual conditions which might impact the interpretation of the subsequent sampling data, or problems with the sampling equipment. All entries will be in ink with no erasures. Incorrect entries will be crossed out with a single strike and initialed.

Field forms used in association with the logbooks include: Test Pit Record (Figure 6-4), Field Test Boring Record (Figure 6-5), and Test Boring and Well Construction Record (Figure 6-6).

FIGURE 6-4

TEST PIT RECORD

Baker

Baker Environmental, Inc

PROJECT: ______

CTO NO.: ______ TEST PIT NO.: ______

COORDINATES: EAST ______ NORTH: ______

SURFACE ELEVATION: ______ WATER LEVEL: ______

WEATHER: ______ DATE: ______

REMARKS: ______

DEFINITIONS

HNU = Photo Ionization Detector Reading

OVA = Organic Vapor Analyzer Reading

Lab Class. = USCS (ASTM D-2487) or AASHTO (ASTM D-3282)

Lab Moist. = Moisture Content (ASTM D-2216) Dry Weight Basis

Depth (Ft.)	Sample Type and No.	HNU or (OVA) ppm		Lab. Class.	Lab. Moist %	Visual Description (Principal Constituents, Gradation, Color, Moisture Content, Organic Content, Plasticity, and Other Observations)	Elevatic
		Field	Head Space				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

CONTRACTOR: ______ BAKER REP.: ______

EQUIPMENT: ______ TEST PIT NO.: ______ SHEET 1 OF,

FIGURE 6-5

TEST BORING AND WELL CONSTRUCTION RECORD

Baker
Baker Environmental, Inc

PROJECT: Site 6, Storage Lot 201 East, Camp Lejeune RI/FS
CTO NO.: 19133 BORING NO.: 6GW20
COORDINATES: EAST: 2502084.6 NORTH: 346424.3
ELEVATION: SURFACE: 22.5 TOP OF PVC CASING: 25.08

RIG: ATV Mobile B-53	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
SIZE (DIAM.)	1 3/8" ID		3 1/4" ID 8 1/4" ID		10/8/92	0.0-24.0	Sunny, 70°s		
LENGTH	2.0'		5.0'		10/10/92		Sunny, 70°s	5.45	48 hrs.
TYPE	STD		HSA		10/26/92		Cloudy, 70°s	6.28	432 hrs
HAMMER WT.	140#				11/7/92		Cloudy, 50°s	6.67	720 hrs
FALL	30"								
STICK UP									

REMARKS: Adv. borehole to 24' w/3¼" ID HSA; borehole overdrill. 5'-flow. sands; overdrilled borehole 8¼"ID HSA. Type II Monitor. Well inst. to 19'

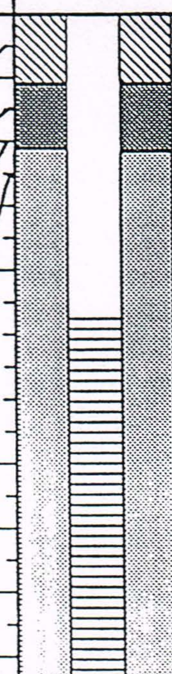
SAMPLE TYPE

- S = Split Spoon
- T = Shelby Tube
- R = Air Rotary
- D = Denison
- A = Auger
- W = Wash
- C = Core
- P = Piston
- N = No Sample

WELL INFORMATION	DIAM	TYPE	TOP DEPTH (FT)	BOTTOM DEPTH (FT)
Well Casing	4"	Schedule 40 PVC	2.25 stick up	4.8
Well Screen	4"	Schedule 40 PVC, 10 slot	4.8	19.4

Depth (Ft.)	Sample Type and No.	Samp. Rec. Ft. & %	SPT or RQD	Lab. Class. or Pen. Rate	PID (ppm)	Visual Description	Elevation
0–2.0	S-1	1.1 55%	1 2 3 4		1.6	Grass and organic material to 6"; brown-grey; dry SAND, fine grained; little organic material, trace silt (SM); brown-grey; loose; dry	22.0 21.0 20.5
2.0–4.0	S-2	1.6 80%	7 9 11 13		1.2	silty-organics (ML); brown to dark brown; dry SAND, fine grained, trace silt, trace organics (SM); brown to dark brown; medium dense; dry to damp	20.0
4.0–6.0	S-3	2.0 100%	13 9 9 18		1	SAND, fine grained, trace silt (SM); grey-brown; medium dense; wet	
6.0–10.0	A-N						

Well Installation Detail



Match to Sheet 2

DRILLING CO.: Hardin-Huber, Inc. BAKER REP.: Richard E. Bonelli
DRILLER: Chad Chism BORING NO.: 6GW20 SHEET 1 OF 2

FIGURE 6-6

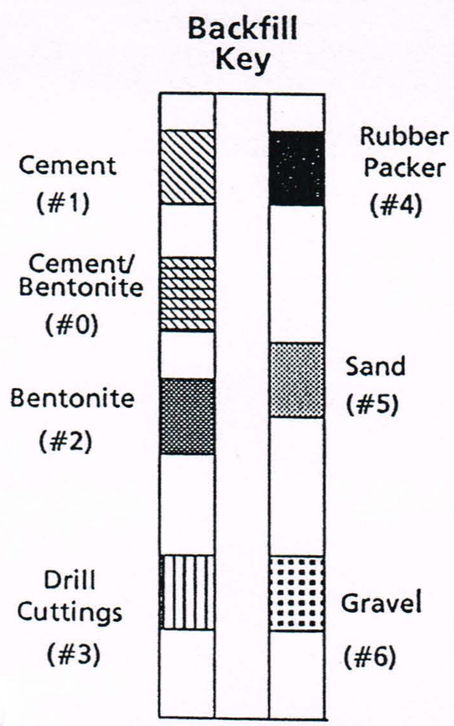
FIELD WELL CONSTRUCTION LOG

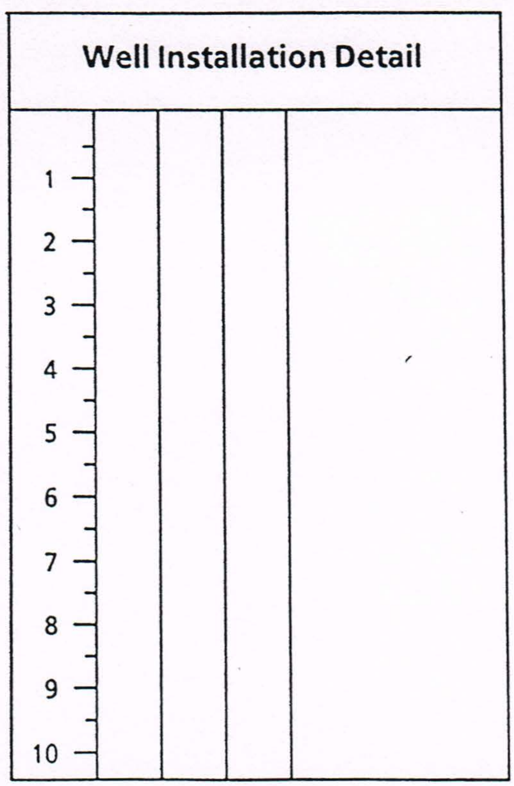
Baker
Baker Environmental, Inc

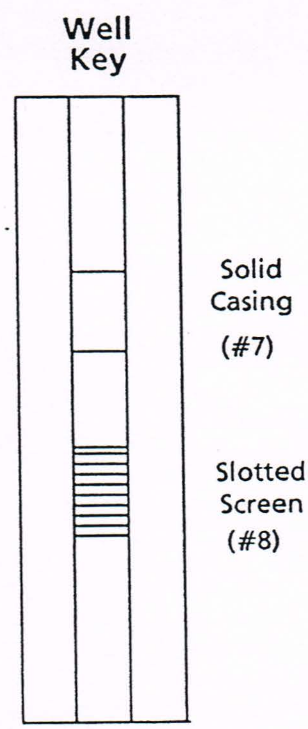
PROJECT: ______________________ DATE: __________
CTO NO.: ______________ BORING NO.: __________
COORDINATES: EAST: __________ NORTH: __________
ELEVATION: SURFACE: __________ TOP OF STEEL CASING: __________

Pay Items			
Item	**Quantity**	**Unit**	**Remarks**

WELL INFORMATION	DIAM. (INCHES)	TYPE	TOP DEPTH (FT.)	BOTTOM DEPTH (FT.)
Well Casing				
Well Screen				







DRILLING CO.: ______________ BAKER REP.: ______________
DRILLER: ______________ BORING NO.: ______________ SHEET ___ OF ___

7.0 SITE MANAGEMENT

This section outlines the responsibilities and reporting requirements of on-site personnel.

7.1 Field Team Responsibilities

The field portion of this project will consist of one field team. All field activities will be coordinated by a Site Manager.

The Field Team will employ one or more drilling rigs for soil boring and monitoring well installation. The rig(s) will be supervised by a Baker geologist. Two sampling technicians will be assigned to the field team.

A Site Manager (or Field Team Leader) will be assigned to manage all field activities. The Site Manager will ensure that all field activities are conducted in accordance with the project plans (the Work Plan, this Field Sampling and Analysis Plan, the Quality Assurance Project Plan, and the Health and Safety Plan).

7.2 Reporting Requirements

The Site Manager will report a summary of each day's field activities to the Project Manager or his/her designee. This may be done by telephone or telefax. The Site Manager will include, at a minimum, the following in his/her daily report:

- Baker personnel on site.
- Other personnel on site.
- Major activities of the day.
- Subcontractor quantities (e.g., drilling footages).
- Samples collected.
- Problems encountered.
- Planned activities.

The Site Manager will receive direction from the Project Manager regarding changes in scope of the investigation. This will be especially critical as the rapid-turnaround laboratory results become available since additional sample locations may be added to the program.

8.0 REFERENCES

Baker Environmental, Inc. (Baker), 1992. Final Interim Remedial Action Remedial Investigation for the Shallow Aquifer at the Hadnot Point Industrial Area Operable Unit, Camp Lejeune Marine Corps Base, Jacksonville, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division.

Baker, 1992b. Final Interim Remedial Action Feasibility Study for the Shallow Aquifer at the Hadnot Point Industrial Area Operable Unit, Camp Lejeune Marine Corps Base, Jacksonville, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division.

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

Environmental Science and Engineering, Inc. (ESE), 1992. Final Remedial Investigation Report for Hadnot Point Industrial Area Operable Unit Shallow Soils and Castle Hayne Aquifer, Marine Corps Base, Camp Lejeune, North Carolina - Characterization Study to Determine Existence and Possible Migration of Specific Chemicals In Situ. Volumes 1, 2, and 3. Prepared for Naval Facilities Engineering Command Atlantic Division. April 1992.

ESE, 1991. Draft Final Risk Assessment for Hadnot Point Industrial Area Operable Unit Shallow Soils and Castle Hayne Aquifer, Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division. December 1991.

ESE, 1990. Final Site Summary Report, Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division. ESE Project No. 49-02036. September, 1990.

ESE, 1988. Characterization Step Report for Hadnot Point Industrial Area - Confirmation Study to Determine Existence and Possible Migration of Specific Chemicals In Situ, Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division.

ESE, 1988. Appendices - Characterization Step Report for Hadnot Point Industrial Area - Confirmation Study to Determine Existence and Possible Migration of Specific Chemicals In Situ, Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division.

National Primary Drinking Water Regulations (NPDWR), 40 Code of Federal Register, Section 141.11-141.16/141.60-141.63.

North Carolina Administrative Code, Title 15, Subchapter 2L, "Classifications and Water Quality Standards Applicable to the Groundwater of North Carolina." December 14, 1989.

U.S. Environmental Protection Agency (USEPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. Office of Emergency and Remedial Response, OSWER Directive 9355.3-01. EPA/540/G-89-004.

U.S. Geological Survey (USGS), 1990a. Hydrogeology of Aquifers in Cretaceous and Younger Rocks in the Vicinity of Onslow and Southern Jones Counties, North Carolina.

USGS, 1990b. Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina.

USGS, 1989. Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina. Water-Resources Investigations Report 89-4096. By Douglas A Harned, Orville B. Lloyd, Jr., and M.W. Treece, Jr. Prepared in cooperation with the Department of the Navy, U.S. Marine Corps, Camp Lejeune, North Carolina.

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.

APPENDIX A
PRE-SCOPING GROUNDWATER SAMPLING DATA
MAY, 1993

SUMMARY OF APRIL 1993 SAMPLING EPISODE SITE 1

GROUNDWATER DATA SUMMARY
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	30-GW1-01	30-GW2-01
Date Sampled:	4/13/93	4/13/93
Units:	ug/l	ug/l
VOLATILES		
CHLOROMETHANE	10 U	10 U
BROMOMETHANE	10 U	10 U
VINYL CHLORIDE	10 U	10 U
CHLOROETHANE	10 U	10 U
METHYLENE CHLORIDE	10 U	10 U
ACETONE	10 U	10 U
CARBON DISULFIDE	10 UJ	10 UJ
1,1-DICHLOROETHENE	10 U	10 U
1,1-DICHLOROETHANE	10 U	10 U
1,2-DICHLOROETHENE	10 U	10 U
CHLOROFORM	2 J	10 U
1,2-DICHLOROETHANE	10 U	10 U
2-BUTANONE	10 U	10 U
1,1,1-TRICHLOROETHANE	10 U	10 U
CARBON TETRACHLORIDE	10 U	10 U
BROMODICHLOROMETHANE	10 U	10 U
1,2-DICHLOROPROPANE	10 U	10 U
CIS-1,3-DICHLOROPROPENE	10 U	10 U
TRICHLOROETHENE	10 U	10 U
DIBROMOCHLOROMETHANE	10 U	10 U
1,1,2-TRICHLOROETHANE	10 U	10 U
BENZENE	10 U	10 U
TRANS-1,3-DICHLOROPROPENE	10 U	10 U
BROMOFORM	10 U	10 U
4-METHYL-2-PENTANONE	10 U	10 U
2-HEXANONE	10 U	10 U
TETRACHLOROETHENE	10 U	10 U
1,1,2,2-TETRACHLOROETHANE	10 U	10 U
TOLUENE	10 U	10 U
CHLOROBENZENE	10 U	10 U
ETHYLBENZENE	10 U	10 U
STYRENE	10 U	10 U
TOTAL XYLENES	10 U	10 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	30-GW1-01	30-GW2-01
Date Sampled:	4/13/93	4/13/93
Units:	ug/l	ug/l
SEMIVOLATILES		
PHENOL	10 U	10 U
BIS(2-CHLOROETHYL) ETHER	10 UJ	10 UJ
2-CHLOROPHENOL	10 U	10 U
1,3-DICHLOROBENZENE	10 U	10 U
1,4-DICHLOROBENZENE	10 U	10 U
1,2-DICHLOROBENZENE	10 U	10 U
2-METHYLPHENOL	10 U	10 U
2,2'-OXYBIS (1-CHLOROPROPANE)	10 U	10 U
4-METHYLPHENOL	10 UJ	10 UJ
N-NITROSODI-N-PROPYLAMINE	10 U	10 U
HEXACHLOROETHANE	10 U	10 U
NITROBENZENE	10 U	10 U
ISOPHORONE	10 U	10 U
2-NITROPHENOL	10 U	10 U
2,4-DIMETHYLPHENOL	10 U	10 U
BIS(2-CHLOROETHOXY) METHANE	10 U	10 U
2,4-DICHLOROPHENOL	10 U	10 U
1,2,4-TRICHLOROBENZENE	10 U	10 U
NAPHTHALENE	10 U	10 U
4-CHLORANILINE	10 U	10 U
HEXACHLOROBUTADIENE	10 U	10 U
4-CHLORO-3-METHYLPHENOL	10 U	10 U
2-METHYLNAPHTHALENE	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	10 UJ	10 UJ
2,4,6-TRICHLOROPHENOL	10 U	10 U
2,4,5-TRICHLOROPHENOL	25 U	25 U
2-CHLORONAPHTHALENE	10 U	10 U
2-NITROANILINE	25 U	25 U
DIMETHYL PHTHALATE	10 U	10 U
ACENAPHTHYLENE	10 U	10 U
2,6-DINITROTOLUENE	10 U	10 U
3-NITROANILINE	25 U	25 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	30-GW1-01	30-GW2-01
Date Sampled:	4/13/93	4/13/93
Units:	ug/l	ug/l
SEMIVOLATILES (Cont.)		
ACENAPHTHENE	10 U	10 U
2,4-DINITROPHENOL	25 U	25 U
4-NITROPHENOL	25 U	25 U
DIBENZOFURAN	10 U	10 U
2,4-DINITROTOLUENE	10 U	10 U
DIETHYL PHTHALATE	10 U	10 U
4-CHLOROPHENYL PHENYL ETHER	10 U	10 U
FLUORENE	10 U	10 U
4-NITROANILINE	25 U	25 U
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U
N-NITRISODIPHENYLAMINE	10 U	10 U
4-BROMOPHENYL PHENYL ETHER	10 U	10 U
HEXACHLOROBENZENE	10 U	10 U
PENTACHLOROPHENOL	25 U	25 U
PHENANTHRENE	10 U	10 U
ANTHRACENE	10 U	10 U
DI-N-BUTYL PHTHALATE	10 U	10 U
FLUORANTHENE	10 U	10 U
CARBAZOLE	10 U	10 U
PYRENE	10 U	10 U
BUTYL BENZYL PHTHALATE	10 U	10 U
3,3-DICHLOROBENZIDINE	10 U	10 U
BENZO(A)ANTHRACENE	10 U	10 U
CHRYSENE	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	10 U	10 U
DI-N-OCTYL PHTHALATE	10 U	10 U
BENZO(B)FLUORANTHENE	10 U	10 U
BENZO(K)FLUORANTHENE	10 U	10 U
BENZO(A)PYRENE	10 U	10 U
INDENO(1,2,3-CD) PYRENE	10 U	10 U
DIBENZ(A,H)ANTHRACENE	10 U	10 U
BENZO(G,H,I)PERYLENE	10 U	10 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

	Sample Id:	30-GW1-01	30-GW2-01
	Date Sampled:	4/13/93	4/13/93
	Units:	ug/l	ug/l
PESTICIDE/PCBS			
ALPHA-BHC		0.050 U	0.050 U
BETA-BHC		0.050 U	0.050 U
DELTA-BHC		0.050 U	0.050 U
GAMMA-BHC(LINDANE)		0.050 U	0.050 U
HEPTACHLOR		0.050 U	0.050 U
ALDRIN		0.050 U	0.050 U
HEPTACHLOR EPOXIDE		0.050 U	0.050 U
ENDOSULFAN I		0.050 U	0.050 U
DIELDRIN		0.10 U	0.10 U
4,4'-DDE		0.10 U	0.10 U
ENDRIN		0.10 U	0.10 U
ENDOSULFAN II		0.10 U	0.10 U
4,4'-DDD		0.10 U	0.10 U
ENDOSULFAN SULFATE		0.10 U	0.10 U
4,4'-DDT		0.10 U	0.10 U
METHOXYCHLOR		0.50 UJ	0.50 UJ
ENDRIN KETONE		0.10 UJ	0.10 UJ
ENDRIN ALDEHYDE		0.10 U	0.10 U
ALPHA CHLORDANE		0.050 U	0.050 U
GAMMA CHLORDANE		0.050 U	0.050 U
TOXAPHENE		5.0 U	5.0 U
PCB-1016		1.0 U	1.0 U
PCB-1221		2.0 U	2.0 U
PCB-1232		1.0 U	1.0 U
PCB-1242		1.0 U	1.0 U
PCB-1248		1.0 U	1.0 U
PCB-1254		1.0 U	1.0 U
PCB-1260		1.0 U	1.0 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
INORGANIC ANALYSES

Sample Id:	30-GW1-01	30-GW2-01
Date Sampled:	4/13/93	4/13/93
Units:	ug/l	ug/l
<u>INORGANICS</u>		
ALUMINUM	123000	53200
ANTIMONY	22.0 R	22.0 R
ARSENIC	12.0 J	6.4 J
BARIUM	396	60.1
BERYLLIUM	2.4	1.0 U
CADMIUM	10.7 J	3.0 U
CALCIUM	11900	1730
CHROMIUM	106 J	42.8 J
COBALT	15.4	7.2
COPPER	42.5	15.8
IRON	41300	24300
LEAD	115 J	7.7 J
MAGNESIUM	7210	3120
MANGANESE	578	78.5
MERCURY	0.88 J	0.9 J
NICKEL	52.6 J	17.1 J
POTASSIUM	4930	2990
SELENIUM	4.2 U	3.9 U
SILVER	3.0 U	3.0 U
SODIUM	8100	5320
THALLIUM	3.0 U	3.0 U
VANADIUM	101	57.0
ZINC	104	79.2
CYANIDE	10.0 U	10.0 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
R - Unreliable result. Analyte may or may not be present in the sample.

GROUNDWATER DATA SUMMARY
CTO-160, QUALITY ASSURANCE SAMPLES
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	160-ER-01	160-ER-02	160-ER-03	160-TB-01	160-TB-02	160-TB-03
Date Sampled:	4/13/93	4/14/93	4/15/93	4/13/93	4/14/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
VOLATILES						
CHLOROMETHANE	10 U	10 U	10 U	10 U	10 U	10 UJ
BROMOMETHANE	10 U	10 U	10 U	10 U	10 U	10 U
VINYL CHLORIDE	10 U	10 U	10 U	10 U	10 U	10 U
CHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
METHYLENE CHLORIDE	10 U	10 U	10 U	10 U	10 U	1 J
ACETONE	10 U	10 U	14	10 U	10 U	10 UJ
CARBON DISULFIDE	10 UJ	10 U	10 U	10 U	10 U	10 U
1,1-DICHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U
1,1-DICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U
CHLOROFORM	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
2-BUTANONE	10 U	10 U	10 U	10 U	10 U	10 U
1,1,1-TRICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
CARBON TETRACHLORIDE	10 U	10 U	10 U	10 U	10 U	10 UJ
BROMODICHLOROMETHANE	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROPROPANE	10 U	10 U	10 U	10 U	10 U	10 U
CIS-1,3-DICHLOROPROPENE	10 U	10 U	10 U	10 U	10 U	10 U
TRICHLOROETHENE	10 U	10 U	10 U	10 U	10 U	1 J
DIBROMOCHLOROMETHANE	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-TRICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
BENZENE	10 U	10 U	10 U	10 U	10 U	10 U
TRANS-1,3-DICHLOROPROPENE	10 U	10 U	10 U	10 U	10 U	10 U
BROMOFORM	10 U	10 U	10 U	10 U	10 U	10 U
4-METHYL-2-PENTANONE	10 U	10 U	10 U	10 U	10 U	10 U
2-HEXANONE	10 U	10 U	10 U	10 U	10 U	10 U
TETRACHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2,2-TETRACHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
TOLUENE	10 U	10 U	10 U	10 U	10 U	10 U
CHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
ETHYLBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
STYRENE	10 U	10 U	10 U	10 U	10 U	10 U
TOTAL XYLENES	10 U	10 U	10 U	10 U	10 U	10 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
NA - Not analyzed.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
CTO-160, QUALITY ASSURANCE SAMPLES
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	160-ER-01	160-ER-02	160-ER-03	160-TB-01	160-TB-02	160-TB-03
Date Sampled:	4/13/93	4/14/93	4/15/93	4/13/93	4/14/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
SEMIVOLATILES						
PHENOL	10 U	10 U	10 U	NA	NA	NA
BIS(2-CHLOROETHYL) ETHER	10 UJ	10 U	10 UJ	NA	NA	NA
2-CHLOROPHENOL	10 U	10 U	10 U	NA	NA	NA
1,3-DICHLOROBENZENE	10 U	10 U	10 U	NA	NA	NA
1,4-DICHLOROBENZENE	10 U	10 U	10 U	NA	NA	NA
1,2-DICHLOROBENZENE	10 U	10 U	10 U	NA	NA	NA
2-METHYLPHENOL	10 U	10 U	10 U	NA	NA	NA
2,2'-OXYBIS (1-CHLOROPROPANE)	10 U	10 U	10 UJ	NA	NA	NA
4-METHYLPHENOL	10 UJ	10 U	10 U	NA	NA	NA
N-NITROSODI-N-PROPYLAMINE	10 U	10 U	1 J	NA	NA	NA
HEXACHLOROETHANE	10 U	10 U	10 U	NA	NA	NA
NITROBENZENE	10 U	10 U	10 U	NA	NA	NA
ISOPHORONE	10 U	10 U	10 U	NA	NA	NA
2-NITROPHENOL	10 U	10 U	10 U	NA	NA	NA
2,4-DIMETHYLPHENOL	10 U	10 U	10 U	NA	NA	NA
BIS(2-CHLOROETHOXY) METHANE	10 U	10 U	10 U	NA	NA	NA
2,4-DICHLOROPHENOL	10 U	10 U	10 U	NA	NA	NA
1,2,4-TRICHLOROBENZENE	10 U	10 U	10 U	NA	NA	NA
NAPHTHALENE	10 U	10 U	10 U	NA	NA	NA
4-CHLORANILINE	10 U	10 U	10 U	NA	NA	NA
HEXACHLOROBUTADIENE	10 U	10 U	10 UJ	NA	NA	NA
4-CHLORO-3-METHYLPHENOL	10 U	10 U	4 J	NA	NA	NA
2-METHYLNAPHTHALENE	10 U	10 U	10 U	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	10 UJ	10 U	10 UJ	NA	NA	NA
2,4,6-TRICHLOROPHENOL	10 U	10 U	10 U	NA	NA	NA
2,4,5-TRICHLOROPHENOL	25 U	25 U	25 U	NA	NA	NA
2-CHLORONAPHTHALENE	10 U	10 U	10 U	NA	NA	NA
2-NITROANILINE	25 U	25 U	25 U	NA	NA	NA
DIMETHYL PHTHALATE	10 U	10 U	10 U	NA	NA	NA
ACENAPHTHYLENE	10 U	10 U	10 U	NA	NA	NA
2,6-DINITROTOLUENE	10 U	10 U	10 U	NA	NA	NA
3-NITROANILINE	25 U	25 U	25 U	NA	NA	NA

Notes:
J - Analyte present. Reported value may not be accurate or precise.
NA - Not analyzed.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
CTO-160, QUALITY ASSURANCE SAMPLES
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	160-ER-01	160-ER-02	160-ER-03	160-TB-01	160-TB-02	160-TB-03
Date Sampled:	4/13/93	4/14/93	4/15/93	4/13/93	4/14/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
SEMIVOLATILES (Cont.)						
ACENAPHTHENE	10 U	10 U	3 J	NA	NA	NA
2,4-DINITROPHENOL	25 U	25 U	25 U	NA	NA	NA
4-NITROPHENOL	25 U	25 UJ	2 J	NA	NA	NA
DIBENZOFURAN	10 U	10 U	10 U	NA	NA	NA
2,4-DINITROTOLUENE	10 U	10 U	2 J	NA	NA	NA
DIETHYL PHTHALATE	10 U	10 U	10 U	NA	NA	NA
4-CHLOROPHENYL PHENYL ETHER	10 U	10 U	10 U	NA	NA	NA
FLUORENE	10 U	10 U	10 U	NA	NA	NA
4-NITROANILINE	25 U	25 U	25 U	NA	NA	NA
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U	25 U	NA	NA	NA
N-NITRISODIPHENYLAMINE	10 U	10 U	10 U	NA	NA	NA
4-BROMOPHENYL PHENYL ETHER	10 U	10 U	10 U	NA	NA	NA
HEXACHLOROBENZENE	10 U	10 U	10 U	NA	NA	NA
PENTACHLOROPHENOL	25 U	25 U	2 J	NA	NA	NA
PHENANTHRENE	10 U	10 U	10 U	NA	NA	NA
ANTHRACENE	10 U	10 U	10 U	NA	NA	NA
DI-N-BUTYL PHTHALATE	10 U	10 U	10 U	NA	NA	NA
FLUORANTHENE	10 U	10 U	10 U	NA	NA	NA
CARBAZOLE	10 U	10 U	10 U	NA	NA	NA
PYRENE	10 U	10 U	1 J	NA	NA	NA
BUTYL BENZYL PHTHALATE	10 U	10 U	10 U	NA	NA	NA
3,3-DICHLOROBENZIDINE	10 U	10 U	10 U	NA	NA	NA
BENZO(A)ANTHRACENE	10 U	10 U	10 U	NA	NA	NA
CHRYSENE	10 U	10 U	10 U	NA	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	10 U	10 U	10 U	NA	NA	NA
DI-N-OCTYL PHTHALATE	10 U	10 U	10 U	NA	NA	NA
BENZO(B)FLUORANTHENE	10 U	10 U	10 U	NA	NA	NA
BENZO(K)FLUORANTHENE	10 U	10 U	10 U	NA	NA	NA
BENZO(A)PYRENE	10 U	10 U	10 U	NA	NA	NA
INDENO(1,2,3-CD) PYRENE	10 U	10 U	10 U	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	10 U	10 U	10 U	NA	NA	NA
BENZO(G,H,I)PERYLENE	10 U	10 U	10 U	NA	NA	NA

Notes:
J - Analyte present. Reported value may not be accurate or precise.
NA - Not analyzed.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
CTO-160, QUALITY ASSURANCE SAMPLES
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	160-ER-01	160-ER-02	160-ER-03	160-TB-01	160-TB-02	160-TB-03
Date Sampled:	4/13/93	4/14/93	4/15/93	4/13/93	4/14/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
PESTICIDE/PCBS						
ALPHA-BHC	0.050 U	0.084 U	0.050 U	NA	NA	NA
BETA-BHC	0.050 U	0.084 U	0.050 U	NA	NA	NA
DELTA-BHC	0.050 U	0.084 U	0.050 U	NA	NA	NA
GAMMA-BHC(LINDANE)	0.050 U	0.084 U	0.050 U	NA	NA	NA
HEPTACHLOR	0.050 U	0.084 U	0.050 U	NA	NA	NA
ALDRIN	0.050 U	0.084 U	0.050 U	NA	NA	NA
HEPTACHLOR EPOXIDE	0.050 U	0.084 U	0.050 U	NA	NA	NA
ENDOSULFAN I	0.050 U	0.084 U	0.050 U	NA	NA	NA
DIELDRIN	0.10 U	0.17 U	0.10 U	NA	NA	NA
4,4'-DDE	0.10 U	0.17 U	0.10 U	NA	NA	NA
ENDRIN	0.10 U	0.17 U	0.10 U	NA	NA	NA
ENDOSULFAN II	0.10 U	0.17 U	0.10 U	NA	NA	NA
4,4'-DDD	0.10 U	0.17 U	0.10 U	NA	NA	NA
ENDOSULFAN SULFATE	0.10 U	0.17 U	0.10 U	NA	NA	NA
4,4'-DDT	0.10 U	0.17 U	0.10 U	NA	NA	NA
METHOXYCHLOR	0.50 UJ	0.84 UJ	0.50 UJ	NA	NA	NA
ENDRIN KETONE	0.10 UJ	0.17 UJ	0.10 UJ	NA	NA	NA
ENDRIN ALDEHYDE	0.10 U	0.17 U	0.10 U	NA	NA	NA
ALPHA CHLORDANE	0.050 U	0.084 U	0.050 U	NA	NA	NA
GAMMA CHLORDANE	0.050 U	0.084 U	0.050 U	NA	NA	NA
TOXAPHENE	5.0 U	8.4 U	5.0 U	NA	NA	NA
PCB-1016	1.0 U	1.7 U	1.0 U	NA	NA	NA
PCB-1221	2.0 U	3.3 U	2.0 U	NA	NA	NA
PCB-1232	1.0 U	1.7 U	1.0 U	NA	NA	NA
PCB-1242	1.0 U	1.7 U	1.0 U	NA	NA	NA
PCB-1248	1.0 U	1.7 U	1.0 U	NA	NA	NA
PCB-1254	1.0 U	1.7 U	1.0 U	NA	NA	NA
PCB-1260	1.0 U	1.7 U	1.0 U	NA	NA	NA

Notes:
J - Analyte present. Reported value may not be accurate or precise.
NA - Not analyzed.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
CTO-160, QUALITY ASSURANCE SAMPLES
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
INORGANIC ANALYSES

Sample Id:	160-ER-01	160-ER-02	160-ER-03	160-TB-01	160-TB-02	160-TB-03
Date Sampled:	4/13/93	4/14/93	4/15/93	4/13/93	4/14/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
INORGANICS						
ALUMINUM	44.0 U	28.3 U	48.9 U	NA	NA	NA
ANTIMONY	22.0 R	22.0 R	22.0 R	NA	NA	NA
ARSENIC	1.0 UJ	1.0 UJ	1.0 UJ	NA	NA	NA
BARIUM	2.0 U	2.0 U	2.0 U	NA	NA	NA
BERYLLIUM	1.0 U	1.0 UJ	1.0 UJ	NA	NA	NA
CADMIUM	3.0 U	3.0 UJ	3.0 UJ	NA	NA	NA
CALCIUM	131 U	120 U	174 U	NA	NA	NA
CHROMIUM	6.0 U	6.0 U	6.0 U	NA	NA	NA
COBALT	3.0 U	3.0 U	3.0 U	NA	NA	NA
COPPER	2.0 U	5.0 J	2.0 U	NA	NA	NA
IRON	26.5 U	30.0 U	12.0 U	NA	NA	NA
LEAD	3.0 U	1.0 UJ	1.0 UJ	NA	NA	NA
MAGNESIUM	23.8 U	30.7 U	16.0 U	NA	NA	NA
MANGANESE	1.2 U	1.0 U	2.5 U	NA	NA	NA
MERCURY	0.13 U	0.13 U	0.23 U	NA	NA	NA
NICKEL	17.0 U	17.0 U	17.0 U	NA	NA	NA
POTASSIUM	140 U	140 U	140 U	NA	NA	NA
SELENIUM	2.0 J	2.0 UJ	2.0 UJ	NA	NA	NA
SILVER	3.0 U	3.0 UJ	3.0 UJ	NA	NA	NA
SODIUM	594.0 U	337 U	326 U	NA	NA	NA
THALLIUM	3.0 U	3.0 U	3.0 U	NA	NA	NA
VANADIUM	3.0 U	3.0 U	3.0 U	NA	NA	NA
ZINC	3.0 U	4.0 U	199.0	NA	NA	NA
CYANIDE	10.0 U	10.0 U	10.0 U	NA	NA	NA

Notes:
J - Analyte present. Reported value may not be accurate or precise.
NA - Not analyzed.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
R - Unreliable result. Analyte may or may not be present in the sample.
ug/l - Microgram per liter.

SUMMARY OF APRIL 1993 SAMPLING EPISODE SITE 28

GROUNDWATER DATA SUMMARY
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	1-GW1-01	1-GW2-01	1-GW3-01	1-GW4-01	1-GW4-01D	1-GW6-01	1-GW6-01D
Date Sampled:	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
VOLATILES							
CHLOROMETHANE	10 UJ	10 U	10 U	10 U	10 U	10 U	10 U
BROMOMETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
VINYL CHLORIDE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
CHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
METHYLENE CHLORIDE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
ACETONE	10 UJ	10 U	10 U	14	12	13	12
CARBON DISULFIDE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1-DICHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1-DICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
CHLOROFORM	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-BUTANONE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,1-TRICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
CARBON TETRACHLORIDE	10 UJ	10 U	10 U	10 U	10 U	10 U	10 U
BROMODICHLOROMETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROPROPANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
CIS-1,3-DICHLOROPROPENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
TRICHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
DIBROMOCHLOROMETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-TRICHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BENZENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
TRANS-1,3-DICHLOROPROPENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BROMOFORM	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-METHYL-2-PENTANONE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-HEXANONE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
TETRACHLOROETHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2,2-TETRACHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
TOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
CHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
ETHYLBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
STYRENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
TOTAL XYLENES	10 U	10 U	10 U	10 U	10 U	10 U	10 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	1-GW1-01	1-GW2-01	1-GW3-01	1-GW4-01	1-GW4-01D	1-GW6-01	1-GW6-01D
Date Sampled:	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
SEMIVOLATILES							
PHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
BIS(2-CHLOROETHYL) ETHER	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	R
2-CHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
1,3-DICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	R
1,4-DICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	R
1,2-DICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	R
2-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
2,2'-OXYBIS (1-CHLOROPROPANE)	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	R
4-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
N-NITROSODI-N-PROPYLAMINE	10 U	10 U	10 U	10 U	10 U	10 U	1 J
HEXACHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	R
NITROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	R
ISOPHORONE	10 U	10 U	10 U	10 U	10 U	10 U	R
2-NITROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
2,4-DIMETHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
BIS(2-CHLOROETHOXY) METHANE	10 U	10 U	10 U	10 U	10 U	10 U	R
2,4-DICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
1,2,4-TRICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	2 J
NAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	R
4-CHLORANILINE	10 U	10 U	10 U	10 U	10 U	10 U	R
HEXACHLOROBUTADIENE	10 U	10 U	10 U	10 U	10 U	10 U	R
4-CHLORO-3-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	3 J
2-METHYLNAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	R
HEXACHLOROCYCLOPENTADIENE	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	R
2,4,6-TRICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	R
2,4,5-TRICHLOROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	R
2-CHLORONAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	R
2-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	R
DIMETHYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	R
ACENAPHTHYLENE	10 U	10 U	10 U	10 U	10 U	10 U	R
2,6-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	R
3-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	R

Notes: J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
R - Unreliable result. Analyte may or may not be present in the sample.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	1-GW1-01	1-GW2-01	1-GW3-01	1-GW4-01	1-GW4-01D	1-GW6-01	1-GW6-01D
Date Sampled:	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
SEMIVOLATILES (Cont.)							
ACENAPHTHENE	10 U	10 U	10 U	10 U	10 U	10 U	2 J
2,4-DINITROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	R
4-NITROPHENOL	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ	R
DIBENZOFURAN	10 U	10 U	10 U	10 U	10 U	10 U	R
2,4-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	R
DIETHYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	R
4-CHLOROPHENYL PHENYL ETHER	10 U	10 U	10 U	10 U	10 U	10 U	R
FLUORENE	10 U	10 U	10 U	10 U	10 U	10 U	R
4-NITROANILINE	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ	R
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	R
N-NITRISODIPHENYLAMINE	10 U	10 U	10 U	10 U	10 U	10 U	R
4-BROMOPHENYL PHENYL ETHER	10 U	10 U	10 U	10 U	10 U	10 U	R
HEXACHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	R
PENTACHLOROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	R
PHENANTHRENE	10 U	10 U	10 U	10 U	10 U	10 U	R
ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	R
DI-N-BUTYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	R
FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	R
CARBAZOLE	10 U	10 U	10 U	10 U	10 U	10 U	R
PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	R
BUTYL BENZYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	R
3,3-DICHLOROBENZIDINE	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	R
BENZO(A)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	R
CHRYSENE	10 U	10 U	10 U	10 U	10 U	10 U	R
BIS(2-ETHYLHEXYL)PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	10 R
DI-N-OCTYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	R
BENZO(B)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	R
BENZO(K)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	R
BENZO(A)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	R
INDENO(1,2,3-CD) PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	R
DIBENZ(A,H)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	R
BENZO(G,H,I)PERYLENE	10 U	10 U	10 U	10 U	10 U	10 U	R

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
R - Unreliable result. Analyte may or may not be present in the sample.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	1-GW1-01	1-GW2-01	1-GW3-01	1-GW4-01	1-GW4-01D	1-GW6-01	1-GW6-01D
Date Sampled:	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
PESTICIDE/PCBS							
ALPHA-BHC	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
BETA-BHC	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
DELTA-BHC	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
GAMMA-BHC(LINDANE)	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
HEPTACHLOR	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
ALDRIN	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
HEPTACHLOR EPOXIDE	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
ENDOSULFAN I	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
DIELDRIN	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
ENDRIN	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
ENDOSULFAN II	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDD	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
ENDOSULFAN SULFATE	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
METHOXYCHLOR	0.50 UJ	0.50 UJ	0.50 UJ	0.50 UJ	0.50 UJ	0.50 UJ	0.50 UJ
ENDRIN KETONE	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ
ENDRIN ALDEHYDE	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
ALPHA CHLORDANE	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
GAMMA CHLORDANE	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
TOXAPHENE	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
PCB-1016	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1221	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
PCB-1232	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1242	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1248	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1254	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1260	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
INORGANIC ANALYSES

Sample Id:	1-GW1-01	1-GW2-01	1-GW3-01	1-GW4-01	1-GW4-01D	1-GW6-01	1-GW6-01D
Date Sampled:	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93	4/15/93
Units:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
INORGANICS							
ALUMINUM	11200	340000	158000	152000	152000	233000	441000
ANTIMONY	22.0 R	22.0 R	22.0 R	22.0 R	22.0 R	22.0 R	22.0 R
ARSENIC	33.6 J	57.4 J	21.8 J	7.2 J	6.8 J	17.8 J	21.6 J
BARIUM	350	849	335	833	864	548	813
BERYLLIUM	18.6 J	43.4	2.7 J	26.0	28.5	3.2 J	5.1 J
CADMIUM	12.9 J	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ
CALCIUM	726000	279000	39800	17200	19900	8850	12100
CHROMIUM	365	612	172	627	674	193	370
COBALT	90.1	90.5	10.1	233	273	15.6	25.7
COPPER	60.7	117	44.6	104	105	64.8	112
IRON	246000	560000	64500	181000	198000	54600	93000
LEAD	41.0 J	176 J	62.8 J	40.8 J	45.8 J	78.8 J	103 J
MAGNESIUM	18700	22800	13600	29300	31100	9400	15900
MANGANESE	1150	1220	125	1720	1980	202	292
MERCURY	1.2 J	1.3 J	0.85 U	0.46 U	2.1 J	1.6 J	1.9 J
NICKEL	169	265	28.5	426	481	51.6	108
POTASSIUM	11400	16800	6940	18200	19400	8750	14200
SELENIUM	10.0 UJ	10.0 UJ	10.0 UJ	2.2 U	2.4 J	10.0 UJ	10.0 U
SILVER	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ
SODIUM	19000	9810	9090	16300	16400	14600	18300
THALLIUM	3.0 UJ	3.0 UJ	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
VANADIUM	332	640	230	517	549	214	412
ZINC	453 U	912 U	244 U	1110	1250	315 U	449 U
CYANIDE	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
R - Unreliable result. Analyte may or may not be present in the sample.
ug/l - Microgram per liter.

SUMMARY OF APRIL 1993
SAMPLING EPISODE
SITE 30

GROUNDWATER DATA SUMMARY
SITE 28, HADNOT POINT BURN DUMP
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	28-GW1-01	28-GW2-01	28-GW3-01	28-GW4-01
Date Sampled:	4/14/93	4/14/93	4/14/93	4/14/93
Units:	ug/l	ug/l	ug/l	ug/l
VOLATILES				
CHLOROMETHANE	10 U	10 U	10 U	10 U
BROMOMETHANE	10 U	10 U	10 U	10 U
VINYL CHLORIDE	6 J	10 U	10 U	10 U
CHLOROETHANE	10 U	10 U	10 U	10 U
METHYLENE CHLORIDE	10 U	10 U	10 U	10 U
ACETONE	10	10 U	10 U	10 U
CARBON DISULFIDE	10 U	10 U	10 U	10 U
1,1-DICHLOROETHENE	10 U	10 U	10 U	10 U
1,1-DICHLOROETHANE	10 U	10 U	10 U	10 U
1,2-DICHLOROETHENE	2 J	10 U	10 U	10 U
CHLOROFORM	10 U	10 U	10 U	10 U
1,2-DICHLOROETHANE	10 U	10 U	10 U	10 U
2-BUTANONE	10 U	10 U	10 U	10 U
1,1,1-TRICHLOROETHANE	10 U	10 U	10 U	10 U
CARBON TETRACHLORIDE	10 U	10 U	10 U	10 U
BROMODICHLOROMETHANE	10 U	10 U	10 U	10 U
1,2-DICHLOROPROPANE	10 U	10 U	10 U	10 U
CIS-1,3-DICHLOROPROPENE	10 U	10 U	10 U	10 U
TRICHLOROETHENE	10 U	10 U	10 U	10 U
DIBROMOCHLOROMETHANE	10 U	10 U	10 U	10 U
1,1,2-TRICHLOROETHANE	10 U	10 U	10 U	10 U
BENZENE	10 U	10 U	10 U	10 U
TRANS-1,3-DICHLOROPROPENE	10 U	10 U	10 U	10 U
BROMOFORM	10 U	10 U	10 U	10 U
4-METHYL-2-PENTANONE	10 U	10 U	10 U	10 U
2-HEXANONE	10 U	10 U	10 U	10 U
TETRACHLOROETHENE	10 U	10 U	10 U	10 U
1,1,2,2-TETRACHLOROETHANE	10 U	10 U	10 U	10 U
TOLUENE	10 U	10 U	10 U	10 U
CHLOROBENZENE	10 U	10 U	10 U	10 U
ETHYLBENZENE	10 U	10 U	10 U	10 U
STYRENE	10 U	10 U	10 U	10 U
TOTAL XYLENES	10 U	10 U	10 U	10 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 28, HADNOT POINT BURN DUMP
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	28-GW1-01	28-GW2-01	28-GW3-01	28-GW4-01
Date Sampled:	4/14/93	4/14/93	4/14/93	4/14/93
Units:	ug/l	ug/l	ug/l	ug/l
SEMIVOLATILES				
PHENOL	10 U	10 U	10 U	10 U
BIS(2-CHLOROETHYL) ETHER	10 UJ	10 UJ	10 UJ	10 UJ
2-CHLOROPHENOL	10 U	10 U	10 U	10 U
1,3-DICHLOROBENZENE	10 U	10 U	10 U	10 U
1,4-DICHLOROBENZENE	10 U	10 U	10 U	10 U
1,2-DICHLOROBENZENE	10 U	10 U	10 U	10 U
2-METHYLPHENOL	10 U	10 U	10 U	10 U
2,2'-OXYBIS (1-CHLOROPROPANE)	10 U	10 U	10 U	10 U
4-METHYLPHENOL	10 UJ	10 UJ	10 UJ	10 UJ
N-NITROSODI-N-PROPYLAMINE	10 U	10 U	10 U	10 U
HEXACHLOROETHANE	10 U	10 U	10 U	10 U
NITROBENZENE	10 U	10 U	10 U	10 U
ISOPHORONE	10 U	10 U	10 U	10 U
2-NITROPHENOL	10 U	10 U	10 U	10 U
2,4-DIMETHYLPHENOL	10 U	10 U	10 U	10 U
BIS(2-CHLOROETHOXY) METHANE	10 U	10 U	10 U	10 U
2,4-DICHLOROPHENOL	10 U	10 U	10 U	10 U
1,2,4-TRICHLOROBENZENE	10 U	10 U	10 U	10 U
NAPHTHALENE	10 U	10 U	10 U	10 U
4-CHLORANILINE	10 U	10 U	10 U	10 U
HEXACHLOROBUTADIENE	10 U	10 U	10 U	10 U
4-CHLORO-3-METHYLPHENOL	10 U	10 U	10 U	10 U
2-METHYLNAPHTHALENE	10 U	1 J	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	10 UJ	10 UJ	10 UJ	10 UJ
2,4,6-TRICHLOROPHENOL	10 U	10 U	10 U	10 U
2,4,5-TRICHLOROPHENOL	25 U	25 U	25 U	25 U
2-CHLORONAPHTHALENE	10 U	10 U	10 U	10 U
2-NITROANILINE	25 U	25 U	25 U	25 U
DIMETHYL PHTHALATE	10 U	10 U	10 U	10 U
ACENAPHTHYLENE	10 U	10 U	10 U	10 U
2,6-DINITROTOLUENE	10 U	10 U	10 U	10 U
3-NITROANILINE	25 U	25 U	25 U	25 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 28, HADNOT POINT BURN DUMP
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	28-GW1-01	28-GW2-01	28-GW3-01	28-GW4-01
Date Sampled:	4/14/93	4/14/93	4/14/93	4/14/93
Units:	ug/l	ug/l	ug/l	ug/l
SEMIVOLATILES (Cont.)				
ACENAPHTHENE	10 U	2 J	10 U	10 U
2,4-DINITROPHENOL	25 U	25 U	25 U	25 U
4-NITROPHENOL	25 U	25 U	25 U	25 U
DIBENZOFURAN	10 U	10 U	10 U	10 U
2,4-DINITROTOLUENE	10 U	10 U	10 U	10 U
DIETHYL PHTHALATE	10 U	10 U	10 U	10 U
4-CHLOROPHENYL PHENYL ETHER	10 U	10 U	10 U	10 U
FLUORENE	10 U	10 U	10 U	10 U
4-NITROANILINE	25 U	25 U	25 U	25 U
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U	25 U	25 U
N-NITRISODIPHENYLAMINE	10 U	10 U	10 U	10 U
4-BROMOPHENYL PHENYL ETHER	10 U	10 U	10 U	10 U
HEXACHLOROBENZENE	10 U	10 U	10 U	10 U
PENTACHLOROPHENOL	25 U	25 U	25 U	25 U
PHENANTHRENE	10 U	1 J	10 U	10 U
ANTHRACENE	10 U	10 U	10 U	10 U
DI-N-BUTYL PHTHALATE	10 U	10 U	10 U	10 U
FLUORANTHENE	10 U	10 U	10 U	10 U
CARBAZOLE	10 U	10 U	10 U	10 U
PYRENE	10 U	10 U	10 U	10 U
BUTYL BENZYL PHTHALATE	10 U	10 U	10 U	10 U
3,3-DICHLOROBENZIDINE	10 U	10 U	10 U	10 U
BENZO(A)ANTHRACENE	10 U	10 U	10 U	10 U
CHRYSENE	10 U	10 U	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	10 U	19 U	10 U	10 U
DI-N-OCTYL PHTHALATE	10 UJ	10 U	10 U	10 U
BENZO(B)FLUORANTHENE	10 UJ	10 U	10 U	10 U
BENZO(K)FLUORANTHENE	10 UJ	10 U	10 U	10 U
BENZO(A)PYRENE	10 UJ	10 U	10 U	10 U
INDENO(1,2,3-CD) PYRENE	10 UJ	10 U	10 U	10 U
DIBENZ(A,H)ANTHRACENE	10 UJ	10 U	10 U	10 U
BENZO(G,H,I)PERYLENE	10 UJ	10 U	10 U	10 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 28, HADNOT POINT BURN DUMP
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
ORGANIC ANALYSES

Sample Id:	28-GW1-01	28-GW2-01	28-GW3-01	28-GW4-01
Date Sampled:	4/14/93	4/14/93	4/14/93	4/14/93
Units:	ug/l	ug/l	ug/l	ug/l
PESTICIDE/PCBS				
ALPHA-BHC	0.050 U	0.050 U	0.050 U	0.050 U
BETA-BHC	0.050 U	0.050 U	0.050 U	0.050 U
DELTA-BHC	0.050 U	0.050 U	0.050 U	0.050 U
GAMMA-BHC(LINDANE)	0.050 U	0.050 U	0.050 U	0.050 U
HEPTACHLOR	0.050 U	0.050 U	0.050 U	0.050 U
ALDRIN	0.050 U	0.050 U	0.050 U	0.050 U
HEPTACHLOR EPOXIDE	0.050 U	0.050 U	0.050 U	0.050 U
ENDOSULFAN I	0.050 U	0.050 U	0.050 U	0.050 U
DIELDRIN	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE	0.10 U	0.10 U	0.10 U	0.10 U
ENDRIN	0.10 U	0.10 U	0.10 U	0.10 U
ENDOSULFAN II	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDD	0.24	0.10 U	0.10 U	0.10 U
ENDOSULFAN SULFATE	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.10 U	0.10 U	0.10 U	0.10 U
METHOXYCHLOR	0.50 UJ	0.50 UJ	0.50 UJ	0.50 UJ
ENDRIN KETONE	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ
ENDRIN ALDEHYDE	0.10 U	0.10 U	0.10 U	0.10 U
ALPHA CHLORDANE	0.050 U	0.050 U	0.050 U	0.050 U
GAMMA CHLORDANE	0.050 U	0.050 U	0.050 U	0.050 U
TOXAPHENE	5.0 U	5.0 U	5.0 U	5.0 U
PCB-1016	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1221	2.0 U	2.0 U	2.0 U	2.0 U
PCB-1232	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1242	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1248	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1254	1.0 U	1.0 U	1.0 U	1.0 U
PCB-1260	1.0 U	1.0 U	1.0 U	1.0 U

Notes: J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
ug/l - Microgram per liter.

GROUNDWATER DATA SUMMARY
SITE 28, HADNOT POINT BURN DUMP
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
INORGANIC ANALYSES

Sample Id:	28-GW1-01	28-GW2-01	28-GW3-01	28-GW4-01
Date Sampled:	4/14/93	4/14/93	4/14/93	4/14/93
Units:	ug/l	ug/l	ug/l	ug/l
INORGANICS				
ALUMINUM	16600	3280	84200	43300
ANTIMONY	22.0 R	22.0 R	22.0 R	22.0 R
ARSENIC	13.0 J	5.4 J	7.2 J	7.4 J
BARIUM	78.8	556	494	576
BERYLLIUM	1.2 J	1.0 UJ	1.8 J	9.3 J
CADMIUM	3.0 UJ	17.3 J	3.0 UJ	3.3 J
CALCIUM	99800	53000	20200	160000
CHROMIUM	39.1 J	9.0 J	140	122
COBALT	3.0 U	3.0 U	3.0 U	29.3
COPPER	19.8	75.4	18.8 J	20.7 J
IRON	15200	16000	65200	35300
LEAD	234.0 J	197 J	20.3 J	22.4 J
MAGNESIUM	11900	26300	6020	11500
MANGANESE	138	304	82.2	206
MERCURY	0.71 U	1.4 J	0.84 U	0.58 U
NICKEL	17.0 U	17.0 U	17.0 U	59.8
POTASSIUM	17800	44900	5790	4810
SELENIUM	2.5 UJ	2.4 UJ	2.4 U	10.0 UJ
SILVER	3.0 UJ	3.0 UJ	3.0 UJ	3.0 UJ
SODIUM	33600	74400	9480.0	37300
THALLIUM	3.0 UJ	3.0 UJ	3.0 UJ	3.0 U
VANADIUM	37.7	6.1	164.0	85.3
ZINC	122 U	423 U	40.2 U	390 U
CYANIDE	10.0 U	10.0 U	10 U	10.0 U

Notes:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected above the level reported in laboratory or field blanks.
UJ - The reported quantitation limits are estimated.
R - Unreliable result. Analyte may or may not be present in the sample.
ug/l - Microgram per liter.

APPENDIX B
JUSTIFICATION CRITERIA FOR USE OF PVC AS WELL CASING MATERIAL

The following is EPA Region IV minimum seven point information requirements to justify the use of PVC as an alternate casing material for groundwater monitoring wells. If requested, justification of the use of PVC should be developed by addressing each of the following items:

1. **The DQOs for the groundwater samples to be collected.**

   Level IV DQOs will be used for analyses of groundwater samples collected during this project. Analytical parameters have been selected to characterize the presence or absence of contamination and to assess any associated risks to human health or the environment.

2. **The anticipated (organic) compounds.**

	Maximum Groundwater Organic Concentrations (µg/L)
Site 1	
Benzene	0.5
1,2-DCE	3.4
Toluene	0.9
1,1,1-TCE	14
TCE	5.2
PCE	6.8
1,1-DCE	2.8
Oil/Grease	3.0
Site 28	
1,2-DCE	38
TCE	15
Vinyl Chloride	22
Oil/Grease	9
Site 30	
Oil/Grease	9,000
Chloroform	2.6
Methylene Chloride	3.3

The concentrations listed above represent maximums at each site. These compounds are not necessarily present in all wells at a site.

There are two primary concerns regarding sample bias associated with use of PVC well casing under these conditions. One is that organic contaminants will leach from the PVC well casing.

The other is that organic contaminants that may be present in the groundwater would adsorb onto the PVC. Either of these could result in biased analytical results.

It is important to note that all stagnant water from inside the well casing is purged immediately before sample collection. The time required to do this is expected to be much less than that required for groundwater sampling bias phenomena (adsorbing/leaching) to develop.

3. **The anticipated residence time of the sample in the well and the aquifer's productivity.**

   Samples collected immediately after purging (i.e "fresh" from the aquifer).

   Aquifer productivity: Subsurface soil samples are mostly fine sand. Hydraulic conductivity is estimated at 0.0001 to 0.01 cm/sec. The wells should recharge (enough to sample) before any sorbing/leaching of organics can occur. Aquifer tests conducted by O'Brien and Gere (1988) provided information of the following aquifer characteristics:

transmissivity:	500 gpd/ft.
well yield:	3 gpm
saturated thickness:	19-22 ft.
radius of influence:	300-400 ft.

4. **The reasons for not using other casing materials.**

   Costs associated with use of stainless steel and teflon casing materials are prohibitive, particularly in 4-inch monitoring wells. PVC strength will be sufficient for this investigation. Existing groundwater quality data indicate that leaching/sorbing of organic materials from/onto the PVC will not be extensive enough to bias future groundwater analysis. PVC is lighter and more flexible than stainless steel.

5. **Literature on the adsorption characteristics of the compounds and elements of interest.**

   The following was originally presented in National Water Well Association (NWWA, 1989):

Miller (1982) conducted a study to determine if PVC exhibited any tendency to sorb potential contaminants from solution. Trichloroethene and 1,1,2-trichloroethane did not sorb to PVC. Reynolds and Gillham (1985) found that 1,1,2,2-tetrachloroethane could sorb to PVC. The sorption was slow enough that groundwater sampling bias would not be significant if well development (purging the well of stagnant water) and sampling were to take place in the same day.

6. **Whether the wall thickness of the PVC casing would require a larger annular space when compared to other well construction materials.**

It will not. Hollow stem augers used during drilling operations will be of sufficient diameter for installation of the PVC casing.

7. **The type of PVC to be used and, if available, the manufacturers specifications, and an assurance that the PVC to be used does not leach, mask, react or otherwise interfere with the contaminants being monitored within the limits of the DQOs.**

Baker will request the appropriate manufacturers specifications and assurances regarding this requirement. This material will be supplied to Baker by the drilling subcontractor.

References for Attachment A:

National Water Well Association, 1989, Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, Dublin, Ohio, 398 pp.

Miller, G.D., 1982, Uptake of lead, chromium and trace level volatile organics exposed to synthetic well casings, Proceedings of the Second National Symposium on Aquifer Restoration and Ground-Water Monitoring, National Water Well Association, Dublin, Ohio, pp. 236-245.

Reynolds, G.W. and Robert W. Gillham, 1985, Absorption of halogenated organic compounds by polymer materials commonly used in ground-water monitors, Proceedings of the Second Canadian/American Conference on Hydrogeology, National Water Well Association, Dublin, Ohio, pp. 125-132.