01130

FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN FOR OPERABLE UNIT NO. 7 (SITES 1, 28, AND 30)

MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0160

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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
CTO	Contract Task Order
CTVs	critical toxicity values
1,2-DCE	1,2-Dichloroethene
DO	dissolved oxygen
DON	Department of the Navy
DOT	Department of Transportation
DQOs	data quality objectives
EPIC	Environmental Photographic Interpretation Center
EDB	Ethylene dibromide
EMD	Environmental Management Department
ESD	Environmental Services Division
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
IDW	Investigation Derived Waste
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
MCON	Marine Construction
MEK	methyl ethyl ketone
MIBK	methyl isobutyl ketone
MGD	million gallons per day
MS/MSD	matrix spike/matrix spike duplicate
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
NTU	Net Turbidity Units
NWI	National Wetlands Inventory
OG	Oil and Grease
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OVA	Organic Vapor Analyzer
PAHs	polynuclear aromatic hydrocarbons
PA/SI	Preliminary Assessments/Site Investigations
PCBs	polychlorinated biphenyls
PID	photoionization detector
POL	petroleum, oil, and lubricants
ppb	parts per billion
PRG	Preliminary Remediation Goals
PVC	polyvinyl chloride
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
SI	Site Investigation
SQC	Sediment Quality Criteria
SSV	Sediment Screening Values
SVOAs	semivolatile organic compounds

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
VOAs	volatile organics
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 (NC DEHNR), and the United States Department of the Navy (DON) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at 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.

1.1 Objective of RI/FS Work Plan

The objective of this RI/FS Work Plan is to identify and describe the tasks required to implement an RI/FS for Operable Unit No. 7 (OU No. 7) (Sites 1, 28 and 30) at MCB Camp Lejeune. The various studies or investigations required to collect appropriate data are also described in this Work Plan. In addition, the Work Plan documents the scope and objectives of the RI/FS activities. The preparation and contents of the RI/FS Work Plan is based on the scoping process, which is described below.

1.2 RI/FS Scoping

Scoping is the initial planning stage of the RI/FS and of eventual site remediation. The result of the scoping process is documented in the RI/FS Work Plan. Scoping begins once the background information is reviewed and evaluated and consists of the following activities:

- Preliminarily assessing human health and ecological risks, based on existing information.
- Identifying potential interim actions which may need to be undertaken early in the program to mitigate potential threats to the public health and the environment.
- Identifying contaminants of concern.
- Identifying potential contaminant migration pathways.
- Identifying Federal and State Applicable or Relevant and Appropriate Requirements (ARARs).
- Identifying potential technologies/alternatives for mitigating site problems.
- Determining the type, amount, and data quality objectives (DQOs) needed to assess human health and ecological risks, and to effectively evaluate feasible technologies/alternatives.
- Identifying the sampling strategies for the collection of data.
- Defining the optimum sequence of site activities.

The background information reviewed included a number of existing environmental assessment reports, which are identified in Section 8.0 (References), and information collected by conducting site visits at all three sites.

As part of the scoping process, Baker personnel conducted pre-investigation sampling at Sites 1, 28, and 30 during which groundwater samples were collected from selected monitoring wells. Results of sample analyses were used in the design of the RI. The findings of this pre-investigation sampling are in Section 2.2.5.6 (Site 1) Section 2.3.5.1 (Site 28) and

Section 2.4.5.1 (Site 30). Project meetings were also conducted with the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) to discuss the proposed RI/FS Scope of Work for each site, and to obtain technical and administrative input from LANTDIV.

1.3 RI/FS Work Plan Format

The following elements are presented in this Work Plan.

Section 2.0 - Site Background and Setting
Section 3.0 - Evaluation of Existing Information
Section 4.0 - RI/FS Objectives
Section 5.0 - RI/FS Tasks
Section 6.0 - Project Staffing
Section 7.0 - Project Schedule
Section 8.0 - References

Section 2.0 includes information regarding the location and setting of each site, along with a summary of what studies were conducted in the past at each site and their respective findings. The purpose of this section is to define the physical and known environmental characteristics of each site.

Section 3.0 documents the evaluation of background information. This section focuses on identifying potential and/or confirmed contamination, identifying migration pathways, identifying potential (or known) impacts to the public health and environment, listing Federal and/or State applicable or relevant and appropriate requirements (ARARs), and identifying potential remedial technologies/alternatives for mitigating site problems. The purpose of this evaluation is to define site-specific RI/FS objectives. Data or information deemed necessary to identify migration pathways, assess environmental and human health risks, or evaluate the feasibility of remedial actions are presented in this section.

Section 4.0 presents the RI/FS objectives for each site. Data or information required to meet the objectives are subsequently identified and documented in this section. This data may consist of chemical analyses, hydrogeologic information, or engineering analyses.

Section 5.0 identifies and describes the tasks and field investigations that will need to be implemented to complete the RI/FS at each site in terms of meeting the site-specific objectives. These tasks generally follow the description of tasks identified in USEPA's RI/FS Guidance Document (OSWER Directive 9355.3-01). The collection methods for obtaining this

information are also identified and described in general terms (more detailed descriptions of the field investigations are documented in the Field Sampling and Analysis Plan). This section provides the rationale for development of this Work Plan.

Section 6.0 discusses project staffing for implementing the RI/FS for OU No. 7. The RI/FS schedule is provided in Section 7.0 and references used in developing the RI/FS approach are provided in Section 8.0.

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize existing background and setting information pertaining to MCB Camp Lejeune, OU No. 7. The current understanding of the physical setting of the sites, the history of the sites, and the existing information related to previous environmental investigative activities are described. This section specifically addresses the location and setting of the three sites, historical events associated with past usage or disposal activities, topography and surface drainage, regional geology and hydrogeology, site-specific geology and hydrogeology, surface water hydrology, climatology, natural resources, ecological features, and land use.

Additional site information regarding the above can be found in the following documents:

- Initial Assessment Study (IAS) of Marine Corps Base Camp Lejeune, North Carolina (WAR, 1983).
- Final Site Summary Report, Marine Corps Base, Camp Lejeune (ESE, 1990).
- 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 (ESE, 1988).
- Final Remedial Investigation Report for Hadnot Point Industrial Area Operable Unit Shallow Soils and Castle Hayne Aquifer, Marine Corps Base, Camp Lejeune, North Carolina. Volumes 1, 2, and 3 (ESE, 1992).
- Draft Final Risk Assessment for Hadnot Point Industrial Area Operable Unit Shallow Soils and Castle Hayne Aquifer, Marine Corps Base, Camp Lejeune, North Carolina (ESE, 1991).
- 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 (Baker, 1992a).
- 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 (Baker, 1992b).
- Hydrogeology of Aquifers in Cretaceous and Younger Rocks in the Vicinity of Onslow and Southern Jones Counties, North Carolina (USGS, 1990a).
- Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina (USGS, 1990b).
- Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina (USGS, 1989).

2.1 Marine Corps Base Camp Lejeune

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

2.1.1 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 2-1.

2.1.2 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 OU 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 2-1.

2.1.3 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.

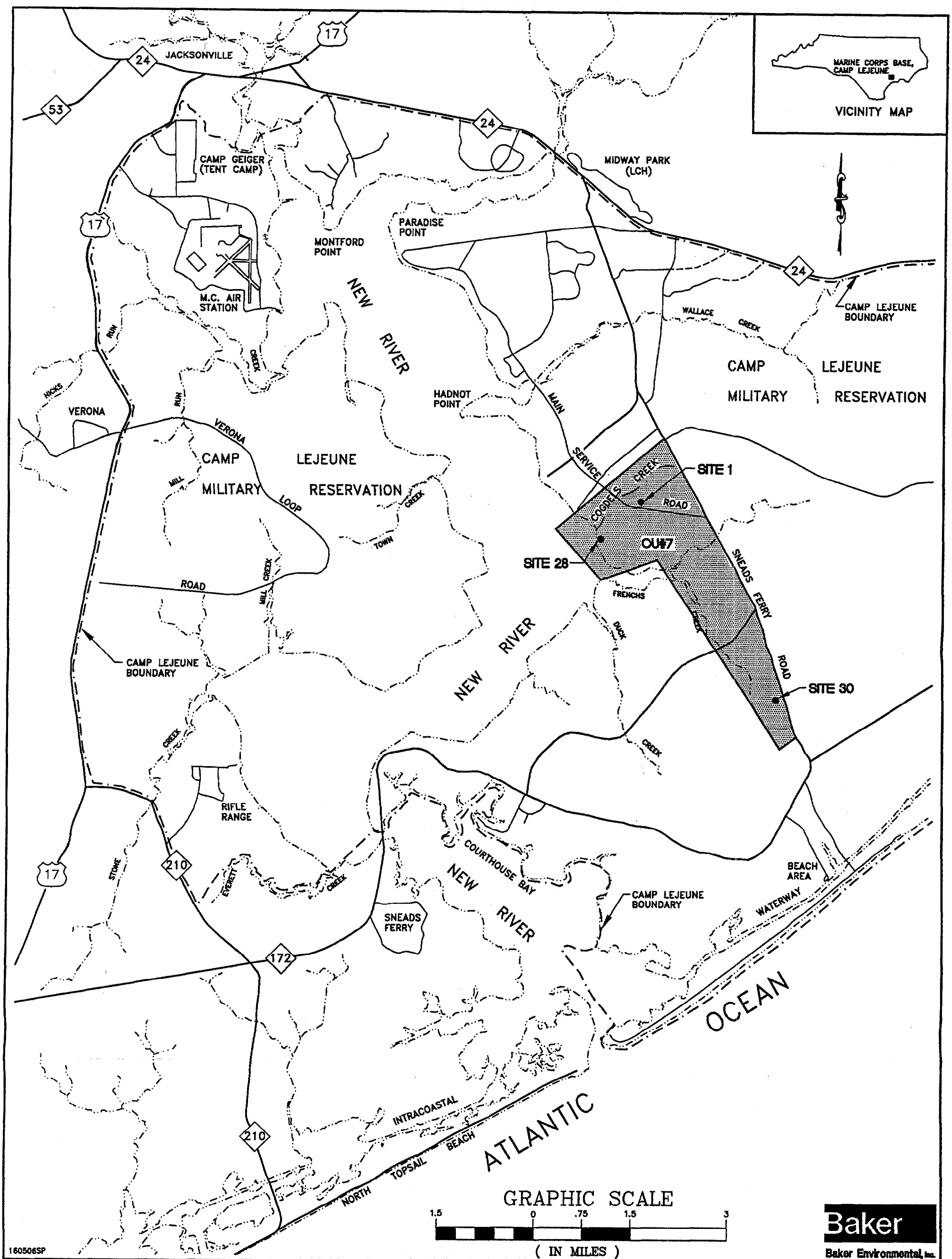

FIGURE 2-1
LOCATION MAP FOR OPERABLE UNIT NO. 7
SITES 1, 28, AND 30
REMEDIAL INVESTIGATION CTO-0160

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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 the 100-year floodplain at Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (WAR, 1983).

2.1.4 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 2-1 presents a generalized stratigraphic column for this area (ESE, 1992).

2.1.5 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 2-2 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).

TABLE 2-1

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.

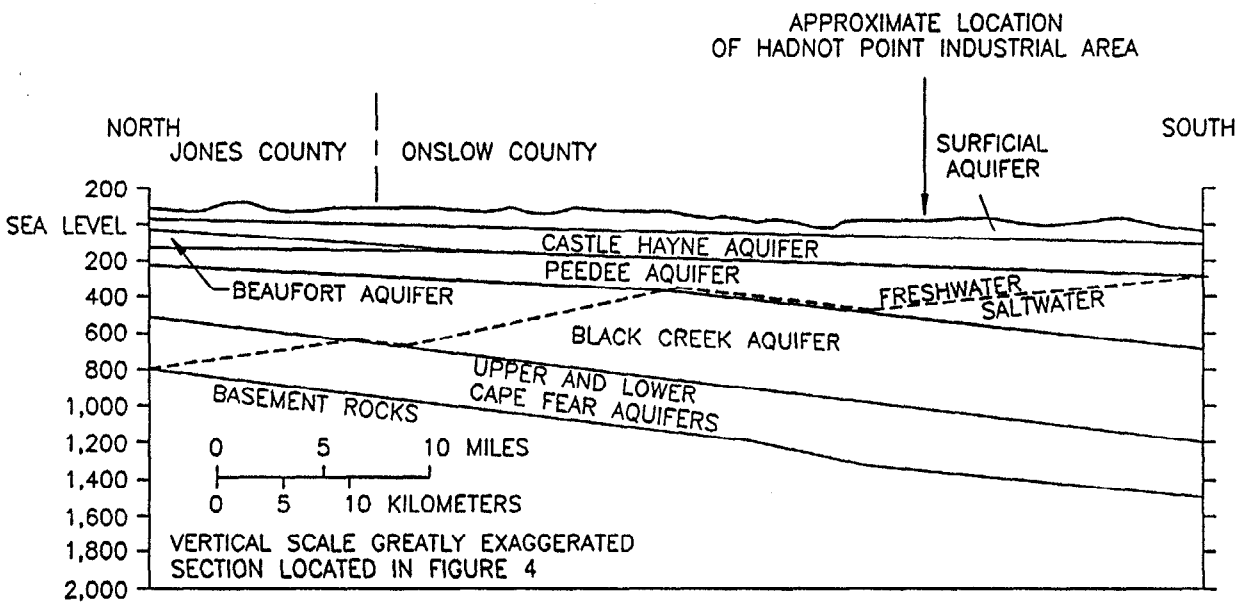

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FIGURE 2-2
GENERALIZED HYDROGEOLOGIC CROSS-SECTION
JONES AND ONSLOW COUNTIES, NORTH CAROLINA
REMEDIAL INVESTIGATION CTO-0160

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: HARNED, et. al., 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 (typically encountered deeper than 100 feet) and the surficial aquifer (typically encountered less than 50 to 100 feet) are in hydraulic communication.

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).

2.1.6 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).

Water quality criteria for surface waters in North Carolina have been published under Title 15 of the North Carolina Administrative Code. At MCB Camp Lejeune, the New River falls into two classifications, SC (estuarine waters not suited for body contact sports or commercial shellfishing) and SA (estuarine waters suited for commercial shellfishing). The SC classification applies to three areas of the New River at MCB Camp Lejeune including the Hadnot Point area. The rest of the New River at MCB Camp Lejeune falls into the SA classification (ESE, 1992).

2.1.7 Climatology

MCB Camp Lejeune experiences mild winters and hot, humid summers. The average yearly rainfall is greater than 50 inches, and the potential evapotranspiration in the region varies from 34 to 36 inches of rainfall equivalent per year. The winter and summer seasons usually receive the most precipitation. Temperature ranges are reported to be 33 to 53°F in the winter (i.e., January) and 71 to 88°F in the summer (i.e., July). Winds are generally south-southwesterly in the summer and north-northwesterly in the winter (WAR, 1983).

2.1.8 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 MCB 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).

2.1.9 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.

2.1.10 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.

2.2 Site 1 - French Creek Liquids Disposal Area

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

2.2.1 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 2-3). 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 the 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.

2.2.2 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 USFWS as a wetland and has the following classification: Palustrine (system), forested (class), and deciduous (subclass).

2.2.3 Site History

Both Sites 1-N and 1-S were used by different Marine units from the late 1940s to the mid-1970s. These units consisted of mechanized units, armored unit, 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.

2.2.4 Site Geology and Hydrogeology

Site specific geologic information is limited to information obtained during the installation of monitoring wells. Six (6) 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 Final Site Summary Report provided in Appendix A. 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.

From 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.

2.2.5 Previous Investigations and Findings

2.2.5.1 Initial Assessment Study - Site 1

In response to the passage of CERCLA, the DON initiated the Navy Assessment and Control of Installation Pollutants Program (NACIP) to identify, investigate, and clean up past hazardous waste disposal sites at Navy installations. The NACIP investigations were conducted by the Naval Energy and Environmental Support Activity (NEESA) and consisted of Initial Assessment Studies (IAS) and Confirmation Studies. IAS are similar to the USEPA

Preliminary Assessments/Site Investigations (PA/SI). Confirmation Studies are similar to USEPA's RI/FS. When SARA was passed in 1986, the DON dissolved the NACIP in favor of the Installation Restoration Program (IRP), which adopted USEPA Superfund terminology and procedures.

The IAS for Camp Lejeune was conducted by WAR in 1983. The IAS identified a number of sites at MCB Camp Lejeune as potential sources of contamination, including the sites discussed in this RI/FS Work Plan. Based on historical records, aerial photographs, field inspections, and personnel interviews, the IAS identified 76 sites at MCB Camp Lejeune as potential sources of contamination. Of these 76 sites, 27 of them were evaluated (based on contamination characteristics, migration pathways, and pollutant receptors) to warrant further investigation to assess potential long-term impacts. Sites 1, 28, and 30 were among these 27 sites.

2.2.5.2 Confirmation Study for FCLDA

As a result of the IAS, Environmental Science and Engineering, Inc. (ESE) was contracted by LANTDIV to further investigate the FCLDA. ESE conducted a two part confirmation study which focused on the potential source areas at FCLDA identified in the IAS. The study was conducted from July 1984 through November 1986. During this study, geological and groundwater quality investigative efforts were conducted at specific study areas adjacent to the FCLDA (areas identified by the IAS). The findings from this step are described below.

2.2.5.3 Groundwater Investigation

Six wells (1GW1 through 1GW6) were installed and sampled in the vicinity of Sites 1-N and 1-S. Of the six wells, three (1GW3, 1GW4, and 1GW5) were installed downgradient of the disposal areas. Additionally, water supply well HP-636 which is located in the vicinity of 1-S, was sampled in 1984. All six shallow monitoring wells and water supply well HP-636 are depicted on Figure 2-4.

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 Organic Compounds (VOCs)
- 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.

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
- TAL Inorganics

Analytical findings from the 1993 round are presented in Appendix D.

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. Wells 1GW1, 1GW2, 1GW3, and 1GW6 showed contamination above the current Maximum Contaminant Level (MCL) for cadmium [5 micrograms per liter (µg/l)], and the action level of 15 µg/l 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.

In the round of sampling conducted in 1993 (O&C was not a parameter analyzed for in the 1993 round) wells 1GW1, 1GW2, 1GW4, and 1GW6 all showed very low concentrations of pesticide and SVOCs contaminants. Well 1GW1 showed detections of both cadmium and mercury. The cadmium concentration was above both Federal MCLs and North Carolina Water Quality Standard (NCWQS), and the mercury concentration (1.1 µg/l) surpassed the NCWQS. Wells 1GW2, and 1GW6 also showed detections for mercury concentrations which exceeded the NCWQS. Finally, well 1GW4 showed a detection for zinc above the NCWQS. All groundwater samples from the 1993 round were subject to full TCL/TAL analysis under CLP protocols and Level IV data quality.

2.2.5.4 Surface Water and Sediment Investigation

One surface water and one sediment sample was collected from Cogdels Creek and a second surface water and sediment sample was collected from a tributary to Cogdels Creek in November 1986. The surface water samples were analyzed for the same parameters as the groundwater samples. Sediment samples were analyzed for the following:

- Cadmium
- Chromium
- Hexavalent Chromium
- Lead
- Antimony
- Oil and Grease (O&G)
- Total Phenols
- Ethylene Dibromide (EDB)

Surface water samples 1SW1 and 1SW2 exhibited low concentrations of phenols (3.0 to 1.5 µg/l) and chromium (<5.4 to 7.3 µg/l) as depicted on Figure 2-4. Volatiles were not detected in either sample. Moreover, sediment samples collected 1SE1 and 1SE2 also indicated the presence of phenols (<90 to 116 µg/l) and chromium (3.69 to 20.8 µg/l). No levels of VOCs were detected in the sediment samples.

In May 1993, Baker conducted a surface water and sediment investigation of Cogdels Creek under the RI/FS being performed for Operable Unit (OU) No. 1. The review of this data from

OU No. 1 is in progress. Note that the results of the May 1993 investigation will be used (i.e., human health and ecological risk assessments) in conjunction with the upcoming RI investigation data to characterize Cogdels Creek (and the New River). Portions of Cogdels Creek and the New River near Site 1 that were not previously sampled will be investigated under the RI for OU No. 7.

2.2.5.5 Soil Investigation

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. Samples 01SB0100 and 01SB1716 had detectable amounts of toluene (1.0J µg/kg) and benzo(a)pyrene (860 µg/kg) 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. Analytical tables from this investigation are provided in Appendix A.2.

2.3 Site 28 - Hadnot Point Burn Dump

2.3.1 Site Location and Setting

The Hadnot Point Burn Dump (HPBD), which covers approximately 23 acres, is located east of the Mainside Sewage Treatment Plant extending across both sides of Cogdels Creek (Figure 2-5). The southwest boundary of the site is the New River. 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 which is known as Orde Pond.

2.3.2 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.

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 Orde Pond which is classified as a Palustrine (system). The third wetland is the New River and has the following classification; Estuarine (system), subtidal (subsystem), and open water.

2.3.3 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.

2.3.4 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 Orde 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 the Final Site Summary Assessment Report provided in Appendix B (ESE, 1990).

2.3.5 Previous Investigations and Findings

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. Existing monitoring wells are depicted on Figure 2-6.

Three rounds of analytical data are available for these wells: two of the data sets are from previous investigations while the third was obtained in April 1993 in preparation for work plan development. Analytical results for the first two rounds can be found in Appendix B and results for the third record can be found in Appendix E.

Well 28GW1, located near the sewage plant outfall on the New River, appears to be the most contaminated well on site. Results of all three sampling events (1984, 1986, and 1993) indicated concentrations of VOCs, including 1,2-dichloroethene (range from 2.0 to 38 µg/l), TCE (range from ND to 15 µg/l), and vinyl chloride (range from 6.0 to 22 µg/l). In general, the concentrations of these compounds decreased from 1984 to 1993. The pesticide 4,4'-DDD was detected (ranging from 0.024 to 0.12 µg/l) in well 28GW1 in two of the sampling rounds (including the most recent) and 4,4'-DDE (0.015 µg/l) and dieldrin (0.003 µg/l) were detected during the 1984 sampling event.

Among the inorganic contaminants of concern are arsenic (ranging from 9.5 to 18 µg/l), lead (ranging from 140 to 234 µg/l), and mercury (ranging from 0.2 to 0.3 µg/l), all of which were detected at levels above those normally seen in background. Well 28GW1 surpassed the Federal MCLs and NCWQS for lead in sampling rounds two and three (1986 and 1993).

Well 28GW2, also located along the New River but away from the treatment plant, indicated less impact than 28GW1. No volatile organics have been detected with the exception of a small number of SVOCs in the most recent sampling event at low concentrations. The pesticides 4,4'-DDD (ranging from 0.018 to 0.093 µg/l) and 4,4'-DDE (ranging from ND to 0.028 µg/l) were detected in previous rounds (1984 and 1986) but were not confirmed in the recent sampling. Metal concentrations were relatively minor in sampling rounds one and two. Although in round three (1993), the Federal MCLs and NCWQS were exceeded for lead (concentration of 197 µg/l) and the NCWQS for mercury (concentration of 1.4 J µg/l) was also exceeded.

Wells 28GW3 indicated some pesticides [4,4'-DDE (0.22 µg/l) and 4,4'-DDE (0.007 µg/l)] at low levels and elevated chromium (330 µg/l) and lead (336 µg/l) concentrations during the July 1984 investigations. Both chromium and lead concentrations exceeded Federal MCLs and NCWQS in the 1984 investigation. The 1993 sampling event showed a chromium concentration (140 µg/l) above the Federal MCLs and NCWQS.

Well 28GW4 did not indicate any volatiles, semivolatile, 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 NCWQS and Federal MCL for chromium during the 1986 and 1987 investigation (92.6 and 54 µg/l, respectively). The 1993 investigation revealed a chromium (122 µg/l) concentration which exceeded the Federal MCLs and NCWQS.

Surface Water/Sediment

Seven surface water/sediment sampling stations (Figure 2-6) were sampled as part of the investigation. Two of the seven sampling locations were sampled in August 1984; 28SW1 in the north central portion of the filled area where Cogdels Creek passes through the landfill and 28SW2 in Cogdels Creek downstream of the filled area near the intersection with the New River. During the December 1986 investigation, five new sampling locations were added, four in the New River and one in Cogdels Creek upstream of the filled area. The surface water samples were analyzed for the same parameters as the groundwater samples. Appendix B presents the analytical data for all analytes that were detected over the method detection limit.

Pesticides alpha-BHC (ranging from ND to 0.01 µg/l), Beta-BHC (ranging from 0.0009 to 0.002 µg/l), and Delta-BHC (ranging from ND to 0.004 µg/l), were present in the December 1984 samples from 28SW1 and 28SW2. These pesticides were not detected in any of the December 1986 samples. However method detection limits in 1986 increased and the absence of detectable levels of the BHC isomers in 1986 may be attributable to this factor.

Trichloroethene was detected [28SW1 (1.3 µg/l) and 28SW2 (1.1 µg/l)] in both of the Cogdels Creek surface water samples in 1984 but were not detected in any of the 1986 samples. This VOC was also detected in the samples collected from well 28GW1 in both 1984 and 1986 as discussed in previous paragraphs.

Zinc was detected in surface water samples collected in 1984 from 28SW1 (32 µg/l) and 28SW2 (20 µg/l). It was not detected at 28SW1 or 28SW2 in the 1986 samples, and was present in only 28SW4 in 1986. Mercury was not detected in 1984 samples but was present in the 1986 samples for all three locations in Cogdels Creek at levels greater than (ranging from 0.5 to 0.8 µg/l) the water quality standard of 0.2 µg/l. Since mercury was present upstream of the site (28SW3), this may indicate that the source is upstream of the Hadnot Point Burn Dump.

Chromium was not detected in Cogdels Creek but was present in two of the four samples (28SW4 and 28SW6) taken from the New River (ranging from ND to 17.8 µg/l). Cadmium was detected at sampling station 28SW2 in August 1986 but was not detected in December 1986.

Seven sediment locations corresponding to the surface water sampling locations were sampled as part of the investigation (Figure 2-6). The sediment samples were analyzed for the following parameters:

- Metals
- Organochlorine pesticides (OCP)
- Polychlorinated Biphenyls (PCBs)
- Oil and Grease (O&G)
- Tetrachlorodioxin (TCDD) (1986 only)
- Hexavalent Chromium

Analytical results for the sediment samples are presented in Appendix B. Only those parameters detected above method detection limits were reported. Chlordane was the only parameter detected in the sediment that was not detected in either the groundwater or the surface water. Chlordane was detected in all three samples from Cogdels Creek during the December 1986 sampling effort (concentrations ranging from 0.298 to 0.595 mg/kg). In addition 4,4'-DDE was detected in 1984 (0.0005 to 0.0012 mg/kg) and 1986 (0.0619 to 0.243 mg/kg) in both 28SE1 and 28SE2.

O&G levels were higher in 1986 than in 1984 within Cogdels Creek. Similar concentrations were identified in the New River samples.

Detectable levels of arsenic, cadmium, chromium, lead, nickel and zinc were identified in most of the samples in both Cogdels Creek and the New River. Nickel was the only metal of those listed that was not present in all four of the New River samples.

Tissue

Two samples from fish tissue were obtained from the HPBD pond at the north terminus of Site 28 in 1984 only. The tissue samples were analyzed for orthochlorine pesticides (OCP) and PCBs. Listed below are the analytical results of the sampling effort performed on July 17, 1984:

	Concentration (µg/l)	
Parameter	28TI1	28TI2
PCBs, Total	11	8
BCH, Alpha-	0.10	0.1

PCBs were not detected elsewhere in the investigation. PCBs are bioaccumulated in the foodchain and may or may not have originated from the site depending on the origin of the fish in the pond. The Alpha-BHC, a data for tissue indicate that this compound was present in this area of Site 28 and may be discharging to Cogdels Creek, as indicated by the surface water chemical data. Levels of PCBs and Alpha-BHC were below acute toxicity levels.

2.4 Site 30 - Sneads Ferry Road Fuel Tank Sludge Area

2.4.1 Site Location and Setting

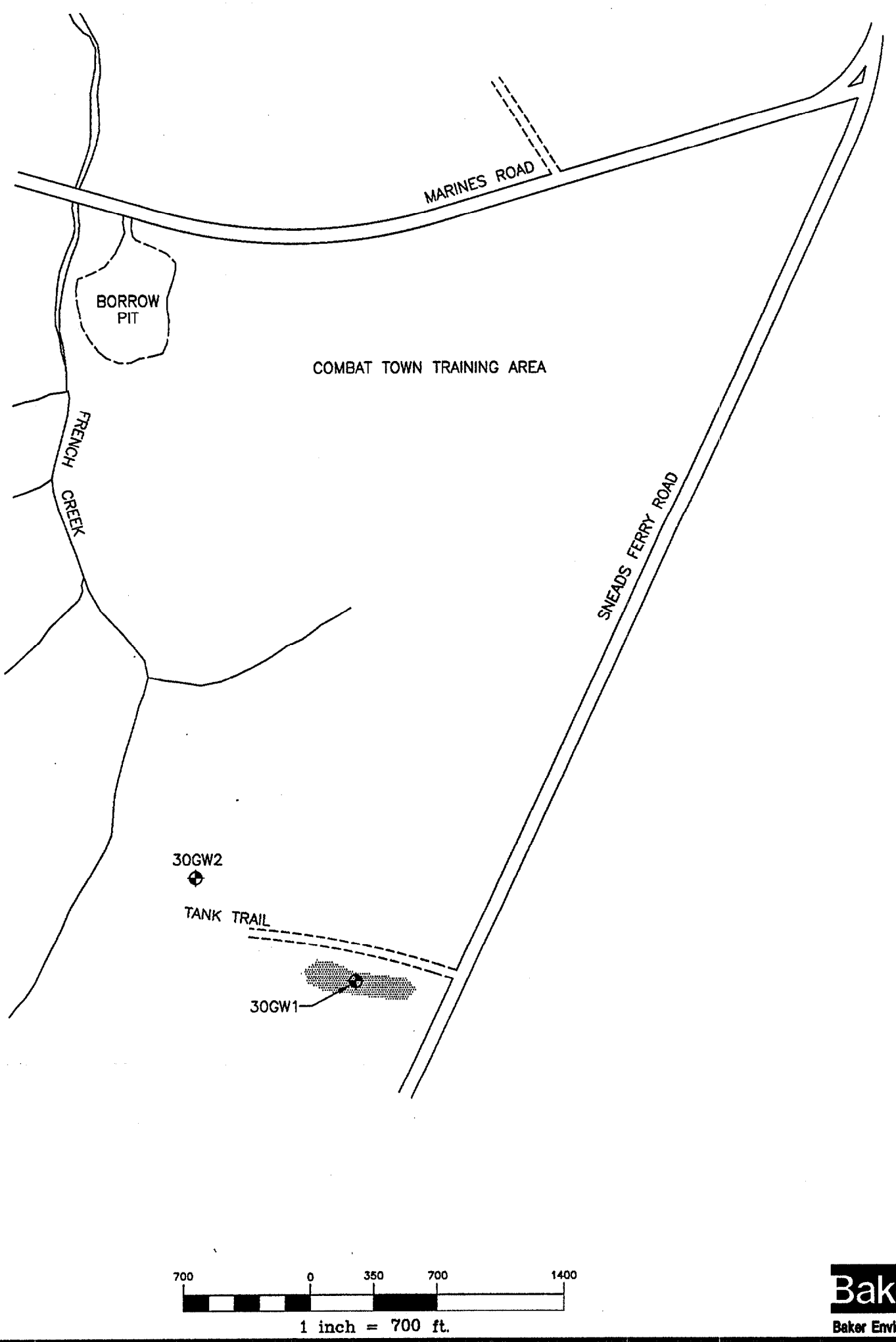
The Sneads Ferry Road Fuel Tank Sludge Area (FTSA) is located along a tank trail which intersects Sneads Ferry Road from the west approximately 6000 feet south of the intersection with Marines Road (Figure 2-7). To the west of the site, lies one of the two streams which comprise the headwaters of French Creek (Figure 2-1).

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 takes place.

2.4.2 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).



LEGEND

30GW2 – EXISTING MONITORING WELL

– APPROXIMATE LOCATION OF SNEADS FERRY ROAD FUEL TANK SLUDGE AREA

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

FIGURE 2-7
SITE PLAN
SITE 30 – SNEADS FERRY ROAD
FUEL TANK SLUDGE AREA
REMEDIAL INVESTIGATION CTO-0160
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2.4.3 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 the 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 tank 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.

2.4.4 Site Geology and Hydrogeology

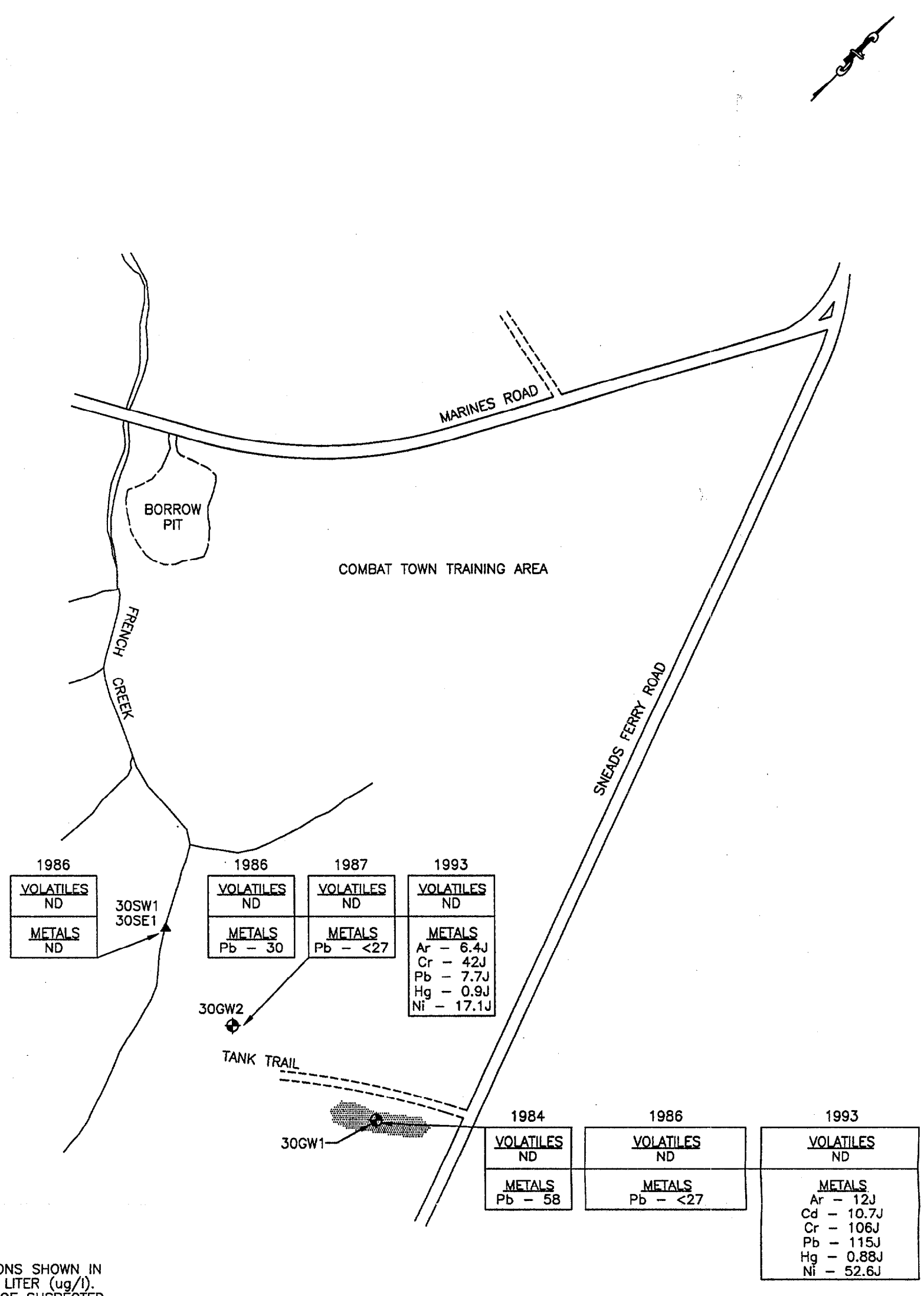
Based on information obtained from the installation of monitoring wells, the site is underlain by layers of sand, silty sand, and gravelly sand. Groundwater occurs within the upper layer of silty sand at depths from approximately four to eight feet. Based on the limited information available, it appears 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 Final Site Summary Report provided in Appendix C (ESE, 1990).

2.4.5 Previous Investigations and Findings

2.4.5.1 Groundwater

Preliminary investigations at the site included the installation of two groundwater monitoring wells and the collection of groundwater and surface water/sediment samples.

Figure 2-8 shows the location of site monitoring wells and results from previous groundwater sampling.



NOTES:
- ALL CONCENTRATIONS SHOWN IN MICROGRAMS PER LITER (ug/l).
- CONCENTRATIONS OF SUSPECTED LABORATORY CONTAMINANTS (e.g., ACETONE, METHYLENE CHLORIDE, CHLOROFORM) ARE NOT PRESENTED.

700 0 350 700 1400

1 inch = 700 ft.

160512RI

Baker
Baker Environmental, Inc.

LEGEND

30SW1 30SE1 ▲ – PREVIOUS SURFACE WATER AND SEDIMENT SAMPLE POINT (1986).

30GW2 ⊕ – EXISTING MONITORING WELL

• – SELECTED METALS SHOWN

▒ – APPROXIMATE LOCATION OF SNEADS FERRY ROAD FUEL TANK SLUDGE AREA

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

FIGURE 2--8
AREAS OF CONTAMINATION IDENTIFIED FROM PREVIOUS INVESTIGATIONS – SITE 30
SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
REMEDIAL INVESTIGATION CTO–0160
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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. 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 (by-product of chlorination; chlorinated water may have been used by the laboratory during the volatile analysis accounting for the presence of chloroform). 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 (Federal MCL/NCWQS-50 µg/l)
- Chromium at 106µg/l (Federal MCL-100 µg/l/NCWQS-50 µg/l)
- Cadmium at 10.7 µg/l (Federal MCL/NCWQS-5.0 µg/l)

Mercury was detected in well 30GW1 at concentration of 0.88 µg/l; the NCWQS for mercury is 1.2 µg/l.

It was the general conclusion of the previous studies that:

- It was unclear whether the actual disposal site had been located
- The lead detected may be waste related
- The oil and grease found may not be site related
- The site contamination seen may be related to frequent heavy vehicle traffic and not actual waste disposal

3.0 EVALUATION OF EXISTING INFORMATION

The existing information was evaluated to provide an understanding of the nature and extent of contamination in order to aid in the design of RI tasks. For this evaluation, this section contains the following: (1) types and volume of known wastes at each site, (2) potential migration and exposure pathways, (3) preliminary ARARs applicable to the sites, (4) potential remedial technologies, and (5) data limitations.

3.1 Site 1 - French Creek Liquids Disposal Area

3.1.1 Types and Volume 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. No amounts of actual batteries being disposed of were located during the records search.

3.1.2 Potential Exposure Pathways

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

- Aquatic and terrestrial exposure to contaminants due to sediment and soil ingestion.
- Airborne fugitive particles released from potentially contaminated surface soil.
- Air pathways involving exposure to VOCs.
- 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.

3.1.3 Preliminary Public Health and Ecological Health Impacts

At this time, a risk assessment has not been conducted, although it is recommended that upon completion of this RI/FS for FCLDA that one be conducted.

3.1.4 Preliminary Identification of ARARs

3.1.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Site 1, it appears that the contaminated media include groundwater (VOCs and various inorganics) and soils (pesticides/PCBs, VOCs, and PAHs). No surface water or sediment samples have been collected in the past, but should be collected to assess potential impacts. Chemical-specific ARARs that may be applicable to the FCLDA include the North Carolina Water Quality Standards (NCWQS), the North Carolina Surface Water Standards, the Federal MCLs established under the Safe Drinking Water Act, and the Federal Toxic Substances Control Act (TSCA) regulations. There are no North Carolina or Federal ARARs for soil or sediment; however, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a To Be Considered (TBC) ARAR when evaluating ecological impacts in surface waters and sediment in the risk assessment.

3.1.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical locations. At this time, the only location-specific ARARs identified for the FCLDA may include wetland and floodplain restrictions for areas around Cogdels Creek, Beaver Dam Creek and the New River. In addition, all applicable regulations promulgated in

the North Carolina Administrative Code Title 15 pertaining to coastal areas and wetlands are potential location-specific ARARs for the site.

3.1.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for the FCLDA will not be identified until potential remedial action technologies have been identified. Depending on the selected alternative, some potential action-specific ARARs for the site may include RCRA land disposal restrictions (40 CFR 268) and North Carolina disposal regulations.

3.1.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial action technologies for each affected medium at the site in order to determine what data may be necessary to better evaluate the technologies during the FS.

3.1.5.1 Groundwater

Previous investigations have detected the presence of phenols and various inorganics in the shallow aquifer at the FCLDA. A number of pump and treat technologies may be potentially feasible for the remediation of this type of contamination including: biological (trickling filter), air stripping, carbon adsorption, thermal treatment, chemical reduction, chemical precipitation, and gravity separation.

3.1.5.2 Soil

Previous investigative studies have identified the presence of benzo(a)pyrene and various inorganics. Although further investigations are needed to fully characterize the extent of contamination from suspected source areas and/or areas of concern, some remedial technologies have been identified for areas at FCLDA. These technologies include: thermal treatment, soil washing, biodegradation, vacuum extraction, and stabilization/fixation (e.g., in-situ vitrification). Each of these technologies will require specific data to evaluate their effectiveness, implementability, and cost.

3.1.5.3 Surface Water/Sediment

Previous investigations have detected the presence of phenols, oil and grease, and inorganics (e.g., chromium). For surface water, several collection and treatment technologies may be potentially feasible for the remediation of these types of contaminants including: carbon adsorption, chemical reduction/oxidation, and chemical precipitation. For sediments, the technologies which may be potentially feasible for the remediation of these types of contaminants include dredging and off-site disposal; and stabilization/fixation. Each of these technologies will require specific data to evaluate their effectiveness, implementability, and cost.

3.1.6 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. Information pertaining to the analytical methods and the level of quality assurance/quality control (QA/QC) used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks which may be present as a result of 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 this Work Plan.

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

3.1.6.1 Groundwater

The overall quality of the existing groundwater data as well as the level of QA/QC to which it was subjected are unknown for the 1984 and 1986 rounds. Therefore, additional analytical data is required to fully characterize groundwater contamination, assess human health and ecological risks, and evaluate remedial technologies.

3.1.6.2 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.

At this time, existing soil data at Site 1 is limited to the vicinity near Site 1-S. Moreover, the sampling effort conducted in this area was concerned with future building sites (i.e., construciton purposes) and was not intended to investigate the source of contamination associated with the POL/acid disposal area. 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.

3.1.6.3 Surface Water/Sediment

Previous 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. In order to evaluate if the FCLDA has impacted the surface water/sediments in these areas and to assess the sediment quality and the human health and ecological risks, data needs to be collected from these waterways, in a manner that will determine source and extent.

3.1.6.5 Aquatic Life

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

3.2 Site 28 - Hadnot Point Burn Dump

3.2.1 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.

3.2.2 Potential Exposure Pathways

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

- Aquatic and terrestrial wildlife exposure to VOCs, semivolatiles, pesticides, and inorganics, due to sediment and soil ingestion.
- Airborne fugitive particles released from potentially contaminated surface soil.
- Air pathways involving exposure to VOCs.
- 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).
- Human dermal exposure to VOCs, semivolatiles, pesticides, and inorganics due to future potential direct contact with groundwater and surface water.
- Human exposure to PCBs, pesticides, and other contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife.

3.2.3 Preliminary Public Health and Ecological Health Impacts

There have not been any public or ecological risk assessments conducted for HPBD to date. Therefore, based on Baker's preliminary risk evaluation of HPBD, there may be potential

human and ecological risk to receptors due to the contamination detected at this site. Military personnel, Camp Lejeune residents and trespassers have been identified as the probable human receptors. The nonhuman population of receptors includes but is not limited to, small animals such as raccoon, fox, deer, birds, reptiles, and aquatic organisms such as fish and benthic invertebrates.

3.2.4 Preliminary Identification of ARARs

3.2.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for HPBD, it appears that the contaminated media include groundwater (VOCs, semivolatiles, pesticides, inorganics, oil and grease), soils which have not been characterized, surface water/sediment (VOCs, semivolatiles, pesticides, inorganics, oil and grease), and aquatic organisms (pesticides and PCBs). Chemical-specific ARARs that may be applicable to HPBD include the NCWQS, the North Carolina Surface Water Standards, the Federal MCLs established under the Safe Drinking Water Act, and the Federal TSCA regulations. There are no North Carolina or Federal ARARs for soil or sediment; however, USEPA Region IV's "Water Quality and Sediment Screening Values" will be used as a TBC ARAR when evaluating ecological impacts in surface waters and sediment in the risk assessment.

3.2.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical locations. At this time, the only location-specific ARARs identified for the HPBD may include the three identified wetland areas and floodplain restrictions for areas around Cogdels Creek, and the New River. As stated in Section 3.1.4.2, North Carolina Administrative Code Title 15 regulations may also be potential location-specific ARARs for the site.

3.2.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for HPBD will not be identified until potential remedial action technologies have been identified.

3.2.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial action technologies for each affected medium at the site in order to identify what data may be necessary to better evaluate the technologies during the FS. Some potential action-specific ARARs may include RCRA land disposal restrictions and North Carolina disposal regulations.

3.2.5.1 Groundwater

Limited investigations have detected the presence of VOCs, semivolatiles, pesticides, inorganics, oil and grease in the shallow aquifer at HPBD. A number of pump and treat technologies may be potentially feasible for the remediation of this type of contamination including: carbon adsorption, thermal treatment, chemical reduction/oxidation, and chemical precipitation.

3.2.5.2 Soil

There are no previous investigative studies that have sampled the HPBD soil. A soil investigation is proposed for the HPBD in Section 5.0 of this report.

Surface water/Sediment

Limited investigations have detected the presence of VOCs, semivolatiles, pesticides, inorganics, oil and grease in the surface water/sediment in Cogdels Creek and the New River. A number of pump and treat technologies may be potentially feasible for the remediation of this type of contamination including: carbon adsorption, chemical reduction/oxidation, and chemical precipitation. Each of these technologies will require specific data to evaluate their effectiveness, implementability, and cost.

Aquatic Life

Limited investigations have detected the presence of pesticides and PCBs in aquatic organisms. Since in this case contamination of aquatic organisms is a function of the environment that they are in, the applicable remedial techniques would first require that the source effecting the aquatic organisms be identified, then followed by the evaluation of feasible remedial technologies.

3.2.6 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. Consequently, the data provided is not suitable for use to fully characterize the site or to make an assessment of human health or ecological risks due to the 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 this Work Plan.

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

3.2.6.1 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. Most importantly, the overall quality of the existing groundwater data as well as the level of QA/QC to which it was subjected are unknown. Therefore, additional analytical data is required to fully characterize groundwater contamination, delineate the extent of contamination, assess human health and ecological risks, and evaluate remedial technologies.

3.2.6.2 Soil

Additional analytical data has been recommended for this site and is described in Section 5 of this Work Plan.

3.2.6.3 Surface Water/Sediment

Surface water/sediment samples have been collected from Cogdels Creek and the New River during previous investigations. In order to further evaluate if site activities have impacted these surface waters/sediments, and to assess the human health and ecological risks, additional data needs to be collected from both site groundwater and soils to see if these media are effecting the surface water/sediments. Also, 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.

3.2.6.4 Aquatic Life

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

3.3 Site 30 - Sneads Ferry Road Fuel Tank Sludge Area

3.3.1 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.

3.3.2 Potential Exposure Pathways

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

- Human exposure to contaminants due to incidental soil ingestion.
- Airborne fugitive particles released from potentially contaminated surface soil.
- Air pathways involving exposure to VOCs.
- 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.

- Human dermal exposure to contaminants due to future potential direct contact with groundwater.

3.3.3 Preliminary Public Health and Ecological Health Impacts

There have not been any public or ecological risk assessments conducted for FTSA to date. Therefore, based on Baker's preliminary risk evaluation of Site 30, there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and trespassers have been identified as the probable human receptors. The nonhuman population of receptors includes but is not limited to, small animals such as raccoon, fox, deer, birds, and reptiles.

3.3.4 Preliminary Identification of ARARs

3.3.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Site 30, it appears that the contaminated media include groundwater (VOCs and various inorganics). No soil samples have been collected, and only one surface water/sediment sample was collected resulting in non-detectable contaminants. Chemical-specific ARARs that may be applicable to the FTSA include the NCWQS, the North Carolina Surface Water Standards, the Federal MCLs established under the Safe Drinking Water Act, and the Federal TSCA regulations. There are no North Carolina or Federal ARARs for soil or sediment; however, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a TBC ARAR when evaluating ecological impacts in surface waters and sediment in the risk assessment.

3.3.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical locations. At this time, the only location-specific ARARs identified for Site 30 may include wetland and floodplain restrictions for areas around the French Creek Tributary. As previously stated, North Carolina Administrative Code Title 15 regulations may also be potential location-specific ARARs for the site.

3.3.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Site 30 will not be identified until potential remedial action technologies have been identified. Some potential action-specific ARARs may include RCRA land disposal restrictions and North Carolina disposal regulations.

3.3.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial action technologies for each affected medium at the site in order to identify what data may be necessary to better evaluate the technologies during the FS.

3.3.5.1 Groundwater

Limited investigative studies have identified the presence of VOCs and various inorganics in the groundwater. Although further investigations are needed to fully characterize the contamination from the suspected disposal area within this site, a few remedial technologies have been identified for these areas. These technologies include: carbon adsorption, chemical reduction/oxidation, and chemical precipitation. Each of these technologies will require specific data to evaluate their effectiveness, implementability, and cost.

3.3.5.2 Soil

Presently, no soil samples have been obtained to use as criteria for determining applicable remedial technologies, although a soil investigation of Site 30 has been recommended. Once this data is reviewed, applicable remedial technologies will be recommended, if necessary.

3.3.5.3 Surface Water/Sediment

Presently only one surface water/sediment location has been analyzed. From the results it appears that there is no contamination present. A more detailed surface water/sediment investigation of the French Creek tributary is recommended. Once this data is reviewed, remedial technologies will be recommended if necessary. Limited investigations have detected the presence of VOCs and various inorganics in the surface water in the upper portion of Cogdels Creek at Site 24. A number of pump and treat technologies may be potentially

feasible for the remediation of this type of contamination including: carbon adsorption, chemical reduction/oxidation, and chemical precipitation. Each of these technologies will require specific data to evaluate their effectiveness, implementability, and cost.

3.3.6 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 provided is 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 the 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 this Work Plan.

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

3.3.6.1 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 horizontal and vertical extent of contamination. In addition, the set of analyzed parameters from previous investigations has been limited. Most importantly, the overall quality of the existing groundwater data as well as the level of QA/QC to which it was subjected are unknown. Therefore, additional analytical data is required to fully characterize groundwater contamination, delineate the extent of contamination, assess human health and ecological risks, and evaluate remedial technologies.

3.3.6.2 Soil

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.

3.3.6.3 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.

4.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES

The purpose of this section is to define the site-specific RI/FS objectives in order to fulfill the goals of characterizing the problems at each site, assessing potential impacts to the public health and environment, and providing feasible alternatives for consideration in the preparation of the Record of Decision (ROD). The site-specific remedial objectives presented in this section have been identified based on the review and evaluation of existing background information, assessment of potential risks to the public health and environment, and the consideration of potential feasible technologies/alternatives.

For each site-specific objective identified, the criteria necessary to meet each objective is identified, along with a general description of the study or investigation required to obtain the information.

4.1 Site 1 - French Creek Liquids Disposal Area

The project objectives, criteria for meeting the objectives, and general investigative methods for Site 1 - French Creek Liquids Disposal Area are presented on Table 4-1.

4.2 Site 28 - Hadnot Point Burn Dump

The project objectives, criteria for meeting the objectives, and general investigative methods for Site 28 - Hadnot Point Burn Dump are presented on Table 4-2.

4.3 Site 30 - Sneads Ferry Road Fuel Tank Sludge Area

The project objectives, criteria for meeting the objectives, and general investigative methods for Site 30 - Sneads Ferry Road Fuel Tank Sludge Area are presented on Table 4-3.

TABLE 4-1
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 4-1 (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

TABLE 4-2
SITE 28 - HADNOT POINT BURN DUMP RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Soil	1a. Assess the extent of soil contamination at the former burn dump areas.	Characterize contaminant levels in surface and subsurface soils at former burn dump area.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface and subsurface soils at the site.	Soil Investigation Risk Assessment
	1c. Determine whether organic or inorganic contamination from soils is migrating to groundwater.	Characterize groundwater quality in the burn dump areas.	Groundwater 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
3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments in Cogdels Creek, Orde Pond, and the New River.	Characterize the nature and extent of contamination in sediment.	Sediment Investigation in Cogdels Creek, Orde Pond, and the New River Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments in Cogdels Creek, Orde Pond, and the New River.	Qualitatively evaluate stress to benthic and fish communities.	Evaluation of Surface Water and Sediment Investigation
	3c. Determine the extent of sediment contamination for purposes of identifying areas potentially requiring remediation.	Identify extent of sediment contamination where contaminant levels exceed risk-based action levels or EPA Region IV TBCs for sediment.	Sediment Investigation in Cogdels Creek, Orde Pond, and the New River Risk Assessment
4. Surface Water	4a. Assess the presence or absence of surface water contamination in Cogdels Creek, Orde Pond, and the New River.	Determine surface water quality, if present, in Cogdels Creek, Orde Pond, and the New River.	Surface Water Investigation

TABLE 4-3
SITE 30 - SNEADS FERRY ROAD FUEL TANK SLUDGE 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 of soil contamination at the sludge disposal area.	Characterize contaminant levels in surface and subsurface soils.	Soil Investigation
	1b. 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
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 and 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
3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments in French Creek.	Characterize the nature and extent of contamination in sediment.	Sediment Investigation in French Creek and Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments in French Creek.	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 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 French Creek.	Determine surface water quality along French Creek.	Surface Water Investigation
	4b. Assess impacts to Cogdels Creek from groundwater discharge from Operable Unit No. 7.	Determine surface water quality in French Creek.	Surface Water Investigation
		Assess groundwater quality from Operable Unit No. 8.	Groundwater Investigation

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section identifies the work elements needed to complete RI/FS activities at Operable Unit No. 7 (Sites 1, 28, and 30).

5.1 Task 1 - Project Management

Project management activities involved under Task 1 include such activities as daily technical support and guidance; budget and schedule review and tracking; preparation and review of invoices; manpower resources planning and allocation; and communication with LANTDIV and the Activity.

5.2 Task 2 - Subcontract Procurement

Task 2 involves the procurement of subcontractor services such as drilling, surveying, and laboratory analysis. In the event that treatability studies are warranted, procurement services for bench-scale or pilot-scale studies will be performed under this task.

5.3 Task 3 - Site Background Record Search and Literature Review

Task 3 involves researching and reviewing available site background records and current literature pertaining to such items as regional geology, regional hydrogeology, etc. Included in the review will be aerial photographs (if available), history of the site (i.e., past and current activities), utility location drawings, and previous investigation data to provide information regarding past and current disposal activities, potential contaminants, potential receptors, groundwater flow patterns, etc.

5.4 Task 4 - Field Investigations

The field investigations will be conducted under Task 4. An overview of the field investigations to be conducted, and their rationale, at each of the three sites is presented in the following subsections. Specific details with respect to the investigative and analytical methods are provided in the Field Sampling and Analysis Plan (FSAP) and the Quality Assurance Project Plan (QAPP). The field investigations described are designed to provide data to meet the overall RI/FS objectives presented in Section 4.0 of this RI/FS Work Plan.

5.4.1 Site 1 - French Creek Liquids Disposal Area (FCLDA)

The following investigations and support activities will be conducted at Site 1 (refer to Figure 2-1):

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

Each of these activities is described below.

5.4.1.1 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 locations of the former disposal areas [based on previous information obtained from the Final Site Summary Report (see Appendix A)], and surveying areas at the site which have undergone changes (e.g., new buildings, outfall piping) to update current site plans. These surveying activities will assist in developing the drilling and sampling strategies for the field investigations.

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

During the 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.

5.4.1.2 Soil Investigations

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 (1-S) of the site; (2) the acid and POL disposal area located within the northern portion (1-N) of the site (Figure 5-1). The following provides a detailed discussion regarding the soil investigation to be conducted at Site 1.

Acid and POL Disposal Area Grid 1-S

As described in Section 5.4.1.1, an initial site survey will be conducted to locate the outer boundary of the former disposal area. The approximate boundary of the disposal area will be identified, and survey stakes will be placed around the area to assist in establishing a sample grid. The sample grid will be established based on the locations of the surveyed disposal area. The location of the disposal area to be surveyed is based on information obtained from the Final Site Summary Report (see Appendix A). An attempt will be made to obtain historical aerial photographs of the area (under Task 3) to further assist in delineating the boundary of the disposal area.

Following the establishment of the disposal boundary, exploratory test borings may be augered and soil samples may be collected (using ASTM Method D 1586-84) to access the thickness of possible fill material which may have been backfilled on top of the original ground (and disposal) surface. 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. Approximately four (4) soil borings will be advanced within the boundary area to confirm the thickness of the potential fill material. Tentative locations for these borings are shown on Figure 5-1. The locations are designed to provide an adequate areal distribution of measurement points capable of developing the requisite information. Drilling locations will be finalized based upon the site Phase I survey and upon the locations of underground utilities which will be identified by Camp Lejeune personnel.

A projected total of 18 soil borings will be installed as part of the sample grid established (following confirmation of the thickness of fill material) within and around the suspected disposal area as shown on Figure 5-1. Additionally, a total of up to five (5) borings 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. Samples collected north of the site will be considered as background samples (located in a wooded area) and samples collected east (near wash racks) and south (adjacent to H.M. Smith Boulevard) will be considered as control samples. The final number of borings advanced, however, will be determined in the field based on survey information and potential above and below ground utilities at proposed drilling sites. The purposes of the borings are to: (1) characterize any waste which may be present (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.

The borings will be augered and soil samples collected using ASTM Method D 1586-84. Up to eight (8) borings will be installed in the area which is believed to have been subjected to the most significant disposal to characterize the potential source of contamination and up to 10 borings will be installed around the outside of any suspected disposal area to evaluate the extent of the contamination. Samples collected from the perimeter soil borings and two samples collected from borings located near the suspected center (area of concern) will be subjected to "quick" analytical turnaround (7 days) from the laboratory so that the need for additional borings (samples) further evaluate the extent of contamination may be established.

Samples will be collected from the ground 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 (7) to 17 to feet below ground surface (bgs) across the site. The samples collected from the surface and just above the water table, and possibly a third sample will be retained for laboratory analysis. The selection of the third sample will be based on any visual indications of contamination 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.

The analytical program to be initiated for the soil investigation was developed to focus on the contaminants of concern as indicated from previous investigations and based on information regarding previous disposal practices. Soil samples will be analyzed for total petroleum hydrocarbons (TPH) using EPA Extraction Methods 5030/3550 (analyzed by Method 8015) (per North Carolina regulations) to evaluate the extent of potentially petroleum contaminated soil and to evaluate potential applicable treatment and disposal technologies. Samples will also be analyzed for full Target Compound List (TCL) organics, (volatiles, semivolatiles, PCBs, and pesticides) and Target Analyte List (TAL) metals using Contract Laboratory Program

(CLP) protocols (Level IV data quality). These samples will allow an assessment of human health and ecological risks to be made and will provide data to more fully characterize the extent of soil contamination. Specific details regarding the analytical parameters, analytical methods, and data validation are discussed in the FSAP and QAPP.

Samples from two (2) borings (from Grid 1-S) will be subject to additional analyses to evaluate 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 from one boring will be tested for grain size (soil classification and Atterberg Limits); and moisture density [if applicable (i.e., clayey soils)] characteristics, and samples from the second boring will be analyzed for full (i.e., organics and metals) toxicity characteristic leaching procedures (TCLP), residual chloride, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, reactivity, and total organic carbon (TOC). These parameters will help in evaluating potential applicable remedial technologies such as thermal destruction and solidification/fixation, or off-site treatment and disposal options. Engineering parameter samples will be composites of soils collected from ground surface to the top of the water table. Table 5-1 summarizes the soil sampling programs for the suspected disposal locations at Site 1.

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 outer 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 (Appendix A).

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

TABLE 5-1

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	Analytical Method	Laboratory Turnaround Times (3)
Site 1	Surface Soils	37 Borings/37 Samples	TCL Organics TAL Metals TPH	IV IV III	CLP (4) CLP EPA Extractions 3550/5030 - analyzed by 8015	Routine Routine Routine
		5 Background Borings/ 5 Samples	TCL Organics TAL Metals	IV IV	CLP CLP	Routine Routine
	Subsurface Soils	18 Borings/ 18 to 36 Samples (2)	TCL Organics TAL Metals TPH	IV IV III	CLP CLP EPA Extractions 3550/5030 - analyzed by 8015	Routine Routine Routine
		19 Borings/ 19 to 38 Samples	TCL Organics TAL Metals TPH	IV IV III	CLP CLP EPA Extractions 3550/5030 - analyzed by 8015	7 days 7 days Routine
		5 Background Borings/ 5 to 10 Samples	TCL Organics TAL Metals	IV IV	CLP CLP	Routine Routine
		11 Monitoring Well Borings/ 11 to 22 Samples	TCL Organics TAL metals TPH	IV IV III	CLP CLP EPA Extractions 3550/5030 - analyzed by 8015	Routine Routine Routine
		2 Borings/ 2 Composite Samples	Total TCLP Chlorine, Residual Total Fluoride Nitrogen, Organic Alkalinity, Total Corrosivity Ignitability Reactivity TOC(11)	III III III III III III III III III	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
		2 Borings/ 2 Composite Samples	Grain Size Moisture Density - Optional Atterberg Limits	III III III	ASTM D 422 ASTM D 698 --	Routine Routine Routine

TABLE 5-1 (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	Analytical Method	Laboratory Turnaround Times (3)
Site 1	Groundwater	14 Monitoring Wells	Volatiles	IV	EPA 601/602	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine
		4 Monitoring Wells	Volatiles	IV	EPA 601/602	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TCL PCBs/Pesticides	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine
		1 Supply Well	Volatiles	IV	EPA 601/602	14 days
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine
		1 Monitoring Well	BOD (7)	III	EPA 405.1	Routine
			COD (8)	III	EPA 410.1	Routine
			TSS (9)	III	EPA 160.2	Routine
			TDS (10)	III	EPA 160.1	Routine
	Surface Water	2 Stations/2 to 4 Samples	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
	Sediment	2 Stations/4 Samples	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
Site 28	Surface Soils	18 Borings/18 Samples	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
		1 Boring/1 Sample	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
			TPH	III	EPA Extractions 3550/5030 - analyzed by 8015	Routine
		14 Borings/14 Samples	TAL Metals	IV	CLP	Routine
		3 Borings/3 Samples	TAL Metals	IV	CLP	Routine
			TPH	III	EPA Extractions 3550/5030 - analyzed by 8015	Routine
		3 Background Borings/ 3 Samples	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine

TABLE 5-1 (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	Analytical Method	Laboratory Turnaround Times (3)
Site 28	Subsurface Soils	10 Borings/ 10 to 20 Samples	TCL Organics TAL Metals	IV IV	CLP CLP	7 days 7 days
		8 Borings/ 8 to 16 Samples	TCL Organics TAL Metals	IV IV	CLP CLP	Routine Routine
		1 Boring/ 1 to 2 Samples	TCL Organics TAL Metals TPH	IV IV III	CLP CLP EPA Extractions 3550/5030 - analyzed by 8015	Routine Routine Routine
		3 Borings/ 3 to 6 Samples	TAL Metals TPH	IV III	CLP EPA Extractions 3550/5030 - analyzed by 8015	Routine Routine
		5 Borings/ 5 to 10 Samples	TAL Metals	IV	CLP	7 days
		9 Borings/ 9 to 18 Samples	TAL Metals	IV	CLP	Routine
		2 Background Borings/ 2 to 4 Samples	TCL Organics TAL Metals	IV IV	CLP CLP	Routine Routine
		7 Monitoring Borings/ 7 to 14 Samples	TCL Organics TAL Metals	IV IV	CLP CLP	Routine Routine
		2 Borings/ 2 Composite Samples	Total TCLP Chloride, Residual Total Fluoride Nitrogen, Organic Alkalinity, Organic Corrosivity Ignitability Reactivity TOC(11)	III III III III III III III III III	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
		2 Borings/ 2 Composite Samples	Grain Size Moisture Density Atterberg Limits	III III III	ASTM D 422 ASTM D 698 --	Routine Routine Routine

TABLE 5-1 (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	Analytical Method	Laboratory Turnaround Times (3)
Site 28	Groundwater	12 Monitoring Wells	Volatiles	IV	EPA 601/602	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TCL Pesticides	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine
		2 Monitoring Wells	BOD	III	EPA 405.1	Routine
			COD	III	EPA 410.1	Routine
			TSS	III	EPA 160.2	Routine
			TDS	III	EPA 160.1	Routine
	Surface Water	14 Stations/14 to 28 Samples	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
	Sediment	14 Stations/28 Samples	TCL Organics	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
	Ecologic/ Aquatic - Fish/Benthic	6 Stations (5)	TCL Organics	IV	SAS (6)	Routine
			TAL Metals	IV	SAS	Routine
Site 30	Surface Soils	11 Borings/11 Samples	TCL Volatiles	IV	CLP	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
		5 Background Borings/ 5 Samples	TCL Volatiles	IV	CLP	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals	IV	CLP	Routine
	Subsurface Soils	5 Borings/ 5 to 10 Samples	TCL Volatiles	IV	CLP	7 days
			TCL Semivolatiles	IV	CLP	7 days
			TAL Metals	IV	CLP	7 days
			TPH	III	EPA Extractions 3550/5030 - analyzed by 8015	7 days

TABLE 5-1 (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	Analytical Method	Laboratory Turnaround Times (3)
Site 30	Subsurface Soils	6 Borings/ 6 to 12 Samples	TCL Volatiles TCL Semivolatiles TAL Metals TPH	IV IV IV III	CLP CLP CLP EPA Extractions 3550/5030 - analyzed by 8015	Routine Routine Routine Routine
		5 Borings/ 5 to 10 Borings	TCL Volatiles TCL Semivolatiles TAL Metals	IV IV IV	CLP CLP CLP	Routine Routine Routine
		1 Monitoring Well Boring	TCL Volatiles TCL Semivolatiles TAL Metals	IV IV IV	CLP CLP CLP	Routine Routine Routine
		1 Boring/1 Composite	Total TCLP Chlorine, Residual Total Fluoride Nitrogen, Organic Alkalinity, Total Corrosivity Ignitability Reactivity TOC(11)	III III III III III III III III III	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
		1 Boring/1 Composite	Grain Size Moisture Density - Optional Atterberg Limits	III III III	ASTM D 422 ASTM D 698 --	Routine Routine Routine

TABLE 5-1 (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	Analytical Method	Laboratory Turnaround Times (3)
Site 30	Groundwater	3 Monitoring Wells	Volatiles	IV	EPA 601/602	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine
		1 Monitoring Well	BOD	III	EPA 405.1	Routine
			COD	III	EPA 410.1	Routine
			TSS	III	EPA 160.2	Routine
			TDS	III	EPA 160.1	Routine
	Surface Water	3 Stations/3 to 6 Samples	Volatiles	IV	CLP	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine
	Sediment	3 Stations/6 Samples	Volatiles	IV	CLP	Routine
			TCL Semivolatiles	IV	CLP	Routine
			TAL Metals - Total and Dissolved	IV	CLP	Routine

(1) Baseline number of samples do not include field QA/QC samples
(2) Assumes 2 to 3 samples per borehole
(3) Routine analytical turnaround is between 28 days to 40 days following receipt of sample
(4) CLP - Contract Laboratory Procedures
(5) Includes 2 stations in the New River, 3 Stations in Cogdels Creek, and 1 Station in Orde Pond
(6) SAS - Special analytical services conduct of Marine Environmental Sampling and Analysis (OSWER, 1991)
(7) BOD - Biological Oxygen Demand
(8) COD - Chemical Oxygen Demand
(9) TSS - Total Suspended Solids
(10) TDS - Total Dissolved Solids
(11) TOC - Total Organic Carbon

(described in the following paragraphs). Approximately three (3) borings are proposed within the boundary area to confirm the thickness of the potential fill material. Tentative locations for these borings are shown on Figure 5-1. 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 will be installed within and around the boundary of the suspected disposal areas as shown on Figure 5-1. 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 will be advanced at locations east, south, and north of the site outside the areas of concern to collected site specific background analytical data.

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 of the FSAP.

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 (7) to 17 feet bgs across the site. The samples collected from the surface and just above the water table, and possibly a third sample will 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

Samples will also be analyzed for TPH (EPA Extraction Methods 3550/5030, analyzed by Method 8015), TCL organics, and TAL metals. These analyses will serve to assess human health and environmental risks and will provide data to more fully characterize subsurface soils. The surface soil samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround time). Specific details regarding the analytical parameters, analytical methods, and data validation are discussed in the FSAP and QAPP.

Samples from two (2) borings from grid 1-N will be analyzed for selected chemicals 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 and (soil classification) Atterberg limits and possibly moisture density [if applicable (i.e., clayey soils)]; 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.

5.4.1.3 Groundwater Investigations

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

Monitoring Well Construction

There are presently 10 shallow wells at Site 1, seven of which will be resampled during this RI. Five 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 (note that well 1GW5 is damaged and cannot be resampled). There are also three

unknown wells, one of which will be sampled (1GW14), 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 depth, screen interval, etc.) for these wells is unknown at this time but they are likely shallow wells (less than 25 feet with 10-foot screens). Lastly, a single unknown well (identified on Figure 5-2 as 1GW15), which will be sampled, was identified near a surface water runoff collection pond located behind Building FC134. The purpose and well construction information for this well is also unknown. Since there are areas that need further evaluation at the site, specifically downgradient from the disposal areas, at least nine (9) shallow wells (including the two shallow wells installed as part of the well cluster) will be installed during the RI. The proposed well locations are shown on Figure 5-2. Table 5-2 provides the rationale and purpose for each proposed well location.

Seven shallow monitoring wells will be installed to further evaluate the extent of shallow groundwater contamination. 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. The justification for the use of PVC constructed wells is provided in Appendix B of the FSAP. 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 screen length will allow for seasonal fluctuations in the water table which are known to vary from 2 to 4 feet at Camp Lejeune. Detailed well construction information and well installation procedures are provided in the FSAP. Note that the two unknown wells, 1GW14 and 1GW15, will be redeveloped during the investigation.

Additionally, up to two (2) shallow/deep well clusters (i.e., one shallow and one deep well installed side by side; identified as 1GW16S/D and 1GW17S/D on Figure 5-2) 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. 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 the FSAP.

TABLE 5-2

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 Well* (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
HP-636 (Supply Well)	South Side of Main Service Road	Monitor deep groundwater quality

Note: * - Denotes existing monitoring well
- Note that two well clusters [i.e., shallow (1GW16S and 1GW17S) and deep wells (1GW16D and 1GW17D) side-by-side] will also be installed to evaluate shallow and deep groundwater quality in the most contaminated areas.

(1) See Figure 5-2 for existing and proposed well locations.

Staff Gauge Installation and Stream Monitoring

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.

Groundwater Sampling and Analysis

One round of groundwater samples will be collected from seven (7) of the 10 existing wells and all newly installed wells within Site 1. 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 metals, volatiles, and semivolatiles. Groundwater samples collected from 12 of the 16 shallow wells (1GW1 through GW3, 1GW5 through 1GW10, and 1GW12 through 1GW15), proposed deep wells 1GW16D and 1GW17D, 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).

Four (4) of the shallow wells (1GW4, 1GW11, 1GW16S, and 1GW17S) will be analyzed for full TCL organics (including volatiles, semivolatiles, PCBs, and pesticides) and TAL metals (total and dissolved) under CLP protocols (Level IV data quality). These samples will allow an assessment of human health and environmental risks to be made and will provide data to characterize the groundwater. Note that for the risk assessment, only the total metals data will be used. Wells 1GW4, 1GW16S and 1GW17S were selected for full analysis since they located are near a suspected disposal area (i.e., contaminated area), and well 1GW11 was selected for full analysis 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 the FSAP. Groundwater level data will be used to evaluate groundwater flow direction.

5.4.1.5 Surface Water/Sediment Investigations

Surface water and sediment investigations will be conducted on Cogdels Creek to 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 OU No. 1. The locations of these sample stations are presented on Figure 2-4. Data gathered from the OU No. 1 investigation will be utilized to characterize this site (i.e., evaluation of human health and ecological risk assessment) during this RI. Two (2) surface water and sediment samples (denoted as 1SW/SD1 and 1SW/SD2) will be taken from the unnamed tributary since this tributary was not sampled under the investigation for OU No. 1. The locations of these sampling stations are shown on Figure 5-2. The samples collected from surface water and sediment locations will be analyzed for full TCL organics and TAL metals under CLP protocols (Level IV data quality).

As shown on Figure 5-2, two (2) surface water and sediment sampling stations have been identified to characterize potential impacts from Site 1. 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 collecting water containing disturbed sediments. In addition, upstream samples will be collected first, with subsequent samples taken moving downstream. Sediment samples will

be obtained using a hand coring device. The FSAP discusses both surface water and sediment sampling procedures.

The surface water and sediment samples will be analyzed for full TCL organics and TAL metals under CLP protocols producing Level IV data quality. In addition, all surface water samples will be analyzed in the field for dissolved oxygen (DO), temperature, specific conductivity, and pH (Level I data quality). Specific details on the analytical methods and data validation are provided in the QAPP.

Table 5-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

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 EPA Region IV, NC DEHNR, MCB Camp Lejeune EMD, and LANTDIV.

5.4.2 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 activity is described below.

5.4.2.1 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 locations of the two former burn dump areas (based on review of historical aerial photographs), and surveying areas at the site which have undergone changes (e.g., new building) to update current site

plans. 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 locations of these sampling points and monitoring wells will depend on the Phase I survey which will identify the locations of the former burn dump areas.

During the Phase II 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.

5.4.2.2 Soil Investigations

Test boring investigations producing soil samples will be conducted throughout Site 28 but will primarily focus on two areas of concern; the two former burn dump areas (28-E and 28-W). The following provides a detailed discussion regarding the soil investigation to be conducted at Site 28.

As described in Section 5.4.2.1, an initial site survey will be conducted to locate 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). Upon review, the approximate 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. The sample grid will be established based on the locations of the surveyed disposal area.

Following the establishment of the burn dump boundaries, exploratory test borings may be augered and soil samples collected (using ASTM Method D 1586-84) 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. 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. Approximately eight (8) soil borings will be advanced within the boundary areas at random locations to confirm the thickness of the fill material. The final drilling locations, however, will be contingent upon the locations of underground utilities which will be identified by Camp Lejeune personnel.

Approximately 36 soil borings will be installed (following confirmation of the thickness of fill material) within and around the boundaries of the burn dump areas as shown on Figure 5-3. Additionally, three (3) borings will be advanced northwest of the site outside the areas of concern to collect site specific background information. The final number of borings advanced will be determined in the field because of the potential for above and below ground utilities at proposed drilling areas. The purposes of the borings are to: (1) characterize 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.

The borings will be augered and soil samples collected using ASTM Method D 1586-84. Samples collected from the perimeter soil borings and a few of the samples collected from borings located near the suspected center (area of concern) will undergo a "quick" analytical turnaround (7 days) from the laboratory to allow an assessment of the need for additional borings (samples) to further evaluate the extent of contamination.

Samples will be collected from the ground surface (top 12 inches from ground surface or below asphalt/concrete/base coarse 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. A sample will be collected of the waste material (if encountered) and at the bottom of the boring (estimated to be 20 feet) 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. Note that some of the samples collected may be collected below the water table because of the shallow groundwater depth (less than 10 feet). 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.

The analytical program to be initiated for the soil investigation was developed to focus on the contaminants of concern based on the results of previous investigations and information regarding disposal practices. Soil samples will be analyzed for full TCL organics, and TAL metals using CLP protocols (Level IV data quality) and TPH (EPA Extraction Methods

3550/5030, analyzed by Method 8015). These samples will provide the data needed to assess human health and ecological risks and to characterize any contamination present in surface and subsurface soils. Additionally samples of the waste, if encountered, will be subjected to full TCLP analysis. Specific details on the analytical program, analytical methods, and data validation are discussed in the FSAP and QAPP.

The samples from two (2) borings at each of the burn dump areas (28-E and 28-W) will be subject to additional analyses to evaluate engineering parameters. Samples from one boring will be tested for grain size [(soil classification and Atterberg limits; and moisture density (if applicable)] characteristics, and samples from the second boring will be analyzed for full TCLP, residual chloride, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, reactivity, and TOC. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation, or off-site treatment and disposal options. Engineering parameter samples will be composites of soils collected from ground surface to the top of the water table. Table 5-1 summarizes the soil sampling programs for the suspected disposal locations at Site 28.

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 if the material identified (i.e., through visual inspection) during the drilling program is less than five (5) feet from ground surface. 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 (i.e., the samples will be collected directly from the backhoe bucket). 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. Samples collected from the test pit will be analyzed for full TCLP and RCRA hazardous waste characteristics.

5.4.2.3 Groundwater Investigations

Groundwater investigations will be conducted at Site 28 to assess groundwater quality at the Hadnot Point Burn Dump. 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 the groundwater investigation activities.

Monitoring Well Construction

As shown on Figure 5-4, 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 to assess groundwater quality associated with the burn dump areas. Additionally, 14 monitoring wells are present north of the site 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 evaluation at the site, specifically west and east from the burn dumps, at least four shallow and three deep wells will be installed during the RI. The proposed well locations are shown on Figure 5-4. Table 5-3 provides the rationale and purpose for each proposed well location.

Four (4) shallow monitoring wells (28GW5, 28GW6, 28GW7S, and 28GW8S) will be installed to further evaluate the horizontal extent of contamination east and west of the site, and to characterize the nature of the contamination within the burn dump areas. 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 of the FSAP. 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 screen length, based upon previous experience at the site, will allow for seasonal fluctuations in the water table. Detailed well construction information and well installation procedures are provided in the FSAP.

Three (3) deep monitoring wells (28GW7D, 28GW8D, and 28GW9D) will be installed to further evaluate the vertical extent of contamination within the two burn dump areas and also to evaluate background conditions. Wells 28GW7D and 28GW8D will be installed within the burn dump areas and 28GW9D will be installed to evaluate background conditions. The deep wells will be constructed of 2-inch PVC with a 10 to 20-foot long no. 10 slotted screen sections. Final determination for the length of screen to be used will depend on the thickness of moderately yielding water producing zones (i.e., the Castle Hayne aquifer).

The final depths of wells will be determined in the field based on the following factors:

TABLE 5-3

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

Well Designation	General Location(1)	Purpose
28GW1*, 28GW2*, 28GW3*, and 28GW6	South and west of Hadnot Point Burn Dump Areas	Monitor groundwater quality downgradient from Burn Dump Areas
28GW4* and 28GW5	North and east 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

- Volatile organic levels [to be monitored by performing head space screening with a photoionization detector (PID) or organic vapor analyzer (OVA)] in soils collected via split-spoon sampling during advancement of the borehole.

- Depth to the geologic formation which contains the main water supply aquifer (Castle Hayne) for Camp Lejeune

- Depths of moderately yielding groundwater flow zones; these zones will be evaluated to determine if a sufficient amount of groundwater can be obtained for analysis

- Depths of confining layers which may display low enough permeability that may impede vertical groundwater movement

Staff Gauge Installation and Stream/River Monitoring

Two (2) to four (4) staff gauges will be installed in Cogdels Creek, Orde 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.

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 metals (e.g., chromium) as the primary contaminants of concern in the groundwater with some low levels of volatiles, semivolatiles, and pesticides. Subsequently, groundwater samples to be collected from all existing and newly installed wells will be analyzed for volatiles (using EPA Method 601/602), TCL semivolatiles, TCL pesticides, and TAL metals (total and dissolved) using CLP

protocols (Level IV data quality). Note that for the risk assessment, only the total metals data will be used. 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. Wells 28GW1 and 28GW8D were selected because they are located in areas 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.

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. In addition, automatic data loggers will be installed in two wells (one shallow and one deep) to monitor water levels over a 24-hour period. Detailed measurement techniques are described in the FSAP. In addition, staff gauges will be monitored during each groundwater level measurement event. Groundwater level data will be used to evaluate groundwater flow direction.

5.4.2.4 Surface Water/Sediment Investigations

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

New River

As shown on Figure 5-5, 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. Upstream samples will be collected first, with subsequent samples taken moving downstream. Sediment samples will be obtained using a hand coring device. The FSAP discusses both surface water and sediment sampling procedures in detail.

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 DO, temperature, specific conductivity, and pH (Level II data quality).

Table 5-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

Cogdels Creek

As shown on Figure 5-5, 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. Upstream samples will be collected first, with subsequent samples taken moving downstream. Sediment samples will be obtained using a hand coring device. The FSAP discusses both surface water and sediment sampling procedures.

The surface water and sediment samples collected at this portion of the site 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 DO, temperature, specific conductivity, and pH (Level I data quality).

Table 5-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

Orde Pond

As shown on Figure 5-5, 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. The FSAP discusses both surface water and sediment sampling procedures.

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 DO, temperature, specific conductivity, and pH (Level II data quality).

Table 5-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

Aquatic/Ecological Survey

Aquatic/ecological surveys will be conducted in the New River, Cogdels Creek, unnamed tributaries to Cogdels Creek, and Orde 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 metals.

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, Cogdels Creek, and Orde Pond: upgradient of Site 28, adjacent to Site 28; and downgradient of Site 28 (see Figure 5-5). 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 electroshocking procedures, seining, and/or gill nets.

Specific sampling and analysis procedures are described in the FSAP.

5.4.3 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 activity is described below.

5.4.3.1 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 location of the former fuel sludge disposal area [based on previous information obtained from the Final Site Summary Report (see Appendix C)]. These surveying activities will assist in developing the drilling and sampling strategies for the field investigations.

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

During the Phase II surveying activities, all existing 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.

5.4.3.2 Soil Investigations

Soil investigations conducted at Site 30 will primarily focus on the main area of concern which is the former fuel sludge disposal area. The following provides a detailed discussion regarding the soil investigation to be conducted at Site 30.

As described in Section 5.4.3.1, an initial site survey will be conducted to locate the former Fuel Sludge Disposal Area. The location to be surveyed will be based on information obtained in the Final Site Summary Report (Appendix C). Additionally, an attempt will be made to obtain historical aerial photographs of the area to further assist in locating the area of suspected disposal. The approximate boundary of the former disposal area will be staked to assist in establishing the sample grid for the soil investigation.

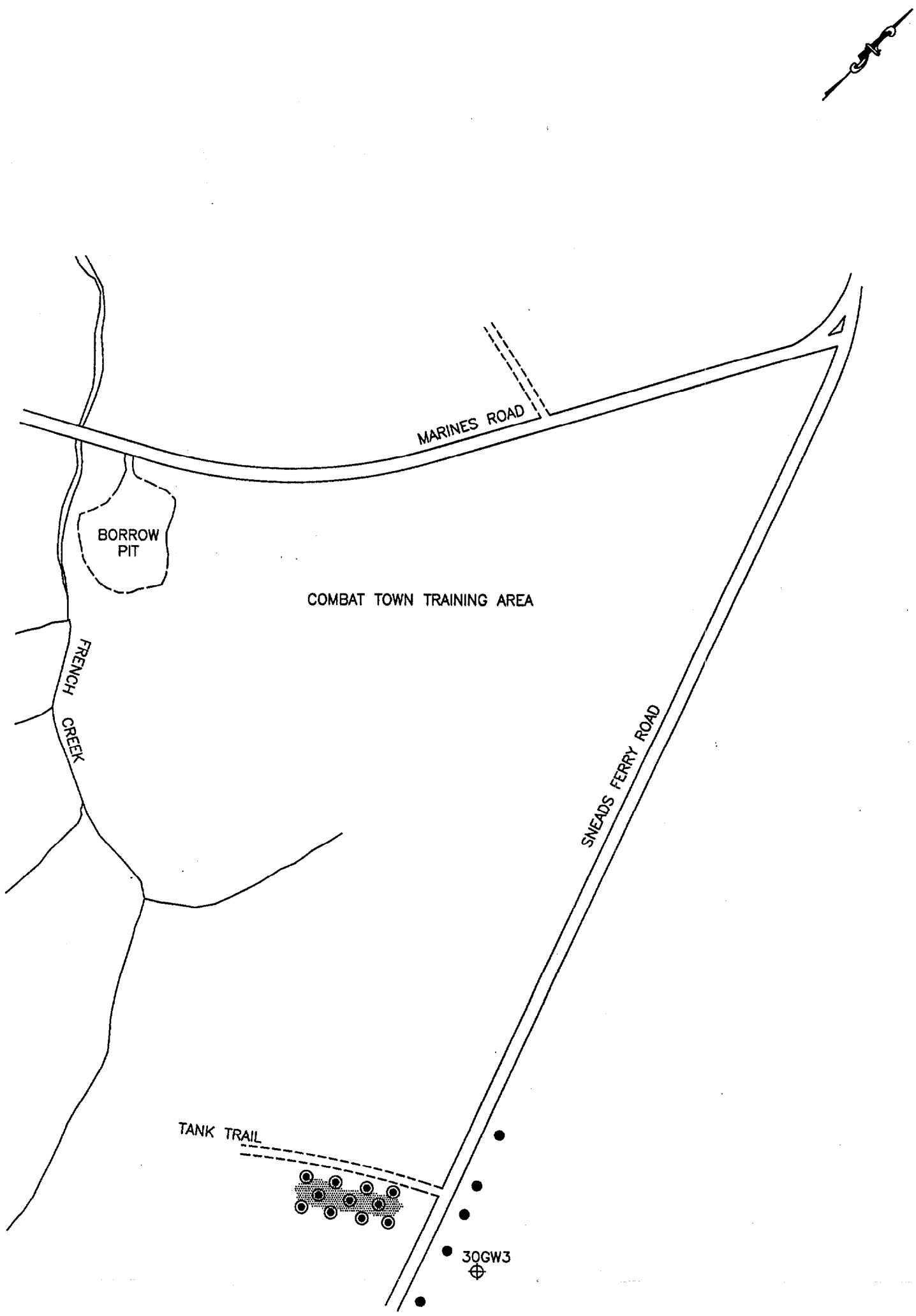
Following the establishment of the disposal boundaries, exploratory test borings may be augered and soil samples will be collected using ASTM Method D 1586-84 to verify the thickness of potential fill material which may have been placed on top of the disposal area. The purpose of establishing the thickness of the fill material is 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. Approximately four (4) soil borings will be advanced within the boundary areas to assess the thickness of the fill material. The final number of these borings will depend on whether the thickness of fill material can be determined.

Approximately 11 soil borings will be installed (following assessment of the thickness of fill material) within and around the boundary of the former disposal area as shown on Figure 5-6. Additionally, six (6) borings (one will include a soil boring for monitoring well installation) will be advanced approximately 900 feet east of the site (upgradient) outside the area of concern to collect site specific background samples. The purposes of the borings are to: (1) characterize the waste 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.

The borings will be advanced using a drill rig as described previously. Samples collected from the perimeter soil borings and three of the samples collected from borings located near the suspected center (area of concern) will undergo a "quick" analytical turnaround (7 days) from the laboratory to allow an assessment to be made of the need for additional borings (samples) to further evaluate the extent of contamination.

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 the surface and 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. 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.

The analytical program to be initiated for the soil investigation was developed to focus on the contaminants of concern based on the results of previous investigations and assumed disposal practices. Soil samples will be analyzed for TPH using EPA Extraction Methods 5030/3550 (analyzed by Method 8015) (per North Carolina regulations) to evaluate the extent of potentially petroleum contaminated soil and to evaluate potential applicable treatment and disposal technologies. Additionally, ten percent of the surface and subsurface (areally distributed) soil samples will be analyzed for full TCL organics, and TAL metals using CLP protocol (Level IV data quality). These samples will be used in an assessment of human health and ecological risks and will provide data to characterize the surface and subsurface soils. Specific details on the analytical parameters, analytical methods, and data validation are discussed in the FSAP and QAPP.



700 0 350 700 1400

1 inch = 700 ft.

160513RI

Baker
Baker Environmental, Inc.

LEGEND

- ◉ – PROPOSED SOIL BORING LOCATIONS
- ● – PROPOSED SOIL BORING BACKGROUND LOCATIONS
- ▒ – APPROXIMATE LOCATION OF SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
- 30GW3 ⊕ – PROPOSED SOIL BORING FOR MONITORING WELL

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

FIGURE 5-6
SOIL INVESTIGATION
SITE 30 – SNEADS FERRY ROAD
FUEL TANK SLUDGE AREA
REMEDIAL INVESTIGATION CTO-0160
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

The samples from two (2) borings (located near the center of the area of concern) will be subjected to additional analyses to evaluate engineering parameters. Samples from one boring will be tested for grain size [soil classification and Atterberg limits; moisture density (if applicable)] characteristics, and samples from the second boring will be analyzed full TCLP, residual chloride, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, reactivity, and TOC. These parameters will help in evaluating potential applicable remedial technologies such as thermal destruction and solidification/fixation, or off-site treatment and disposal options. Engineering parameters samples will be composites of soils collected from ground surface to the top of the water table. Table 5-1 summarizes the soil sampling programs for the suspected disposal locations at Site 30.

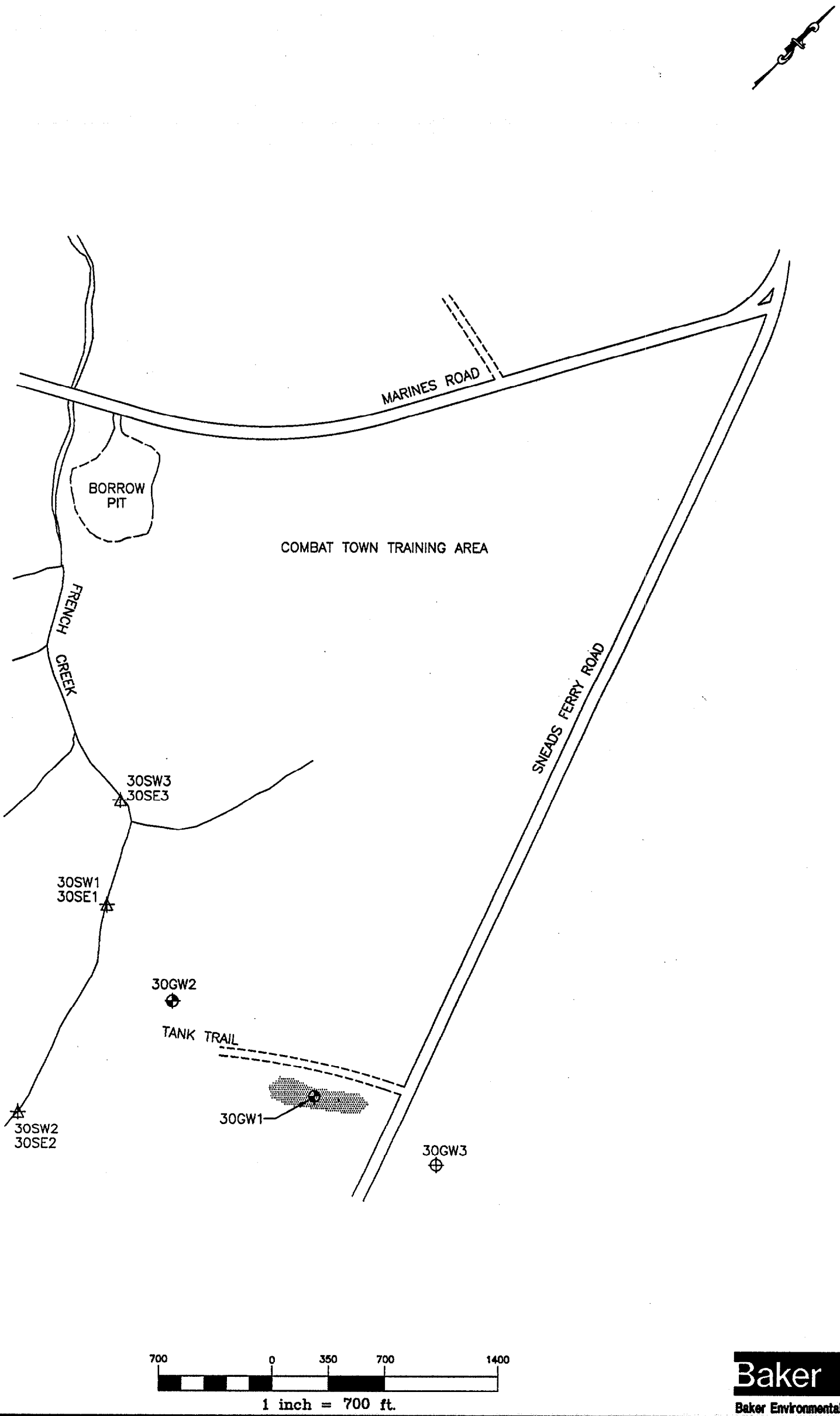
5.4.3.3 Groundwater Investigations

Groundwater investigations will be conducted at Site 30 to assess groundwater quality at the former Fuel Sludge 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.

Monitoring Well Construction

As shown on Figure 5-7, two (2) existing monitoring wells are present at Site 30. The two wells, 30GW1 and 30GW2, were installed as part of the Initial Site Assessment to assess groundwater quality associated with the former disposal area. These wells were installed to a depth of 25 feet with 10-foot screen sections. 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 are shown on Figure 5-7 and a summary of the monitoring well rationale is provided on Table 5-4.

The shallow monitoring well (30GW3) will be installed to further evaluate the extent of potentially impacted groundwater east (upgradient) of the site. Additional shallow wells may also be installed downgradient of the disposal area if quick turnaround soil samples indicate levels of contamination. This 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. Justification for



160514RI

Baker
Baker Environmental, Inc.

LEGEND

30SW3 30SE3 – PROPOSED SURFACE WATER AND SEDIMENT LOCATIONS

30GW3 – PROPOSED SHALLOW MONITORING WELL LOCATION

30GW2 – EXISTING MONITORING WELL LOCATION

– APPROXIMATE LOCATION OF SNEADS FERRY ROAD FUEL TANK SLUDGE AREA

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

FIGURE 5-7
GROUNDWATER, SURFACE WATER, AND SEDIMENT INVESTIGATION – SITE 30
SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
REMEDIAL INVESTIGATION CTO-0160
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

TABLE 5-4

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

the use of PVC well construction material is provided in Appendix B of the FSAP. 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 the FSAP.

Deep monitoring wells are not proposed for Site 30 based on the results of the three sampling events. Groundwater data (1984, 1986, and 1993) have identified lead as the primary contaminant of concern at the site. Lead is an analyte which is not extremely mobile in groundwater, especially in terms of vertical migration. Accordingly, the evaluation of vertical extent of contamination is not required.

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. All staff gauges will be surveyed to establish vertical and horizontal control.

Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each existing (two total) and newly installed (one total) well. Well 30GW3 located approximately 400 feet east of Site 30 will be sampled to serve as a background well. Two of the groundwater samples (30 GW1 and 30 GW2) will be analyzed for volatiles (using EPA Methods 601/602), TCL semivolatiles, and TAL metals (total and dissolved) using CLP protocols (Level IV data quality). Note that for the risk assessment, only the total metals data will be used. The analytical results from previous investigations have identified volatiles and inorganics (i.e., metals) as the contaminants of concern in the groundwater. The data from the most recent sampling episode is provided in Appendix F of this work plan and will be evaluated during the RI/FS process.

One of the samples (background sample from well 30GW3) will be analyzed for full TCL organics under CLP protocols (Level IV data quality). This sample will be used in an assessment of human health and environmental risks and to provide data to more fully characterize the groundwater.

Additionally, one of the wells (existing well 30GW1) will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. 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.

5.4.3.4 Surface Water/Sediment Investigation

Surface water and sediment investigations will be conducted in French Creek to assess possible environmental impacts to this creek from site disposal activities. This section outlines the sampling and analytical requirements for these investigations. Specific sampling procedures can be found in the FSAP.

As shown on Figure 5-7, three (3) surface water and sediment sampling stations have been identified to characterize potential impacts downgradient from the disposal area. A surface and a subsurface 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 bottle.

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. The FSAP discusses both surface water and sediment sampling procedures in detail.

The surface water and sediment samples will be analyzed for full TCL organics (including PCBs, pesticides and semivolatiles) and TAL metals using CLP protocols, which results in Level IV data quality. In addition, all surface water samples will be analyzed in the field for DO, temperature, specific conductivity, and pH (Level II data quality).

Table 5-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

5.5 Task 5 - Sample Analysis and Validation

Task 5 includes efforts relating to the following post-field sampling activities:

- Sample Management
- Laboratory Analysis
- Data Validation

Sample management activities involve coordination with subcontracted laboratories, tracking of analyses received, and tracking of samples submitted and received from a third party validator. Sample management also involves resolving potential problems (reanalysis, resubmission of information, etc.) between Baker, the laboratory, and the validator.

Validation begins when the "raw" laboratory data is received by the validator from Baker. Baker will first receive the data from the laboratory, log it into a data base for tracking purposes, and then forward it to the validator. A validation report will be expected within three weeks following receipt of laboratory data packages (Level IV) by the validator. Level IV data will be validated per the National Functional Guidelines as outlined in the following documents:

- USEPA, Hazardous Site Control Division, Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, February 1, 1988.

- USEPA, Office of Emergency and Remedial Response, Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, June 13, 1988.

5.6 Task 6 - Data Evaluation

This task involves efforts related to the data once it is received from the laboratory and is validated. It also involves the evaluation of any field-generated data including: water level measurements, test boring logs, test pit logs, and other field notes. Efforts under this task will include the tabulation of validated data and field data, development of test boring logs and monitoring well construction logs, completion of geologic cross-section diagrams, and the generation of other diagrams associated with field notes or data received from the laboratory (e.g., sampling location maps, isoconcentration maps).

5.7 Task 7 - Risk Assessment

This section of the Work Plan will serve as the guideline for the baseline risk assessments (BRAs) to be conducted for MCB Camp Lejeune during the RI.

Baseline risk assessments evaluate the potential human health and/or ecological impacts that would occur in the absence of any remedial action. The risk assessment will provide the basis for determining whether remedial action is necessary and the justification for performing remedial actions.

The risk assessments will be performed in accordance with USEPA guidelines. The primary documents that will be utilized include:

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), USEPA 1989.

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), USEPA 1991.

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), USEPA 1991.

- Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual, USEPA 1989.

- Supplemental Guidance to RAGS: Standard Default Values, USEPA 1991a.

- Superfund Exposure Assessment Manual, USEPA 1988.

- Exposure Factors Handbook, USEPA 1989b.

- Guidance for Data Usability in Risk Assessment, USEPA 1990.

- Supplemental Region IV Risk Assessment Guidance, USEPA 1991.

USEPA Region IV will be consulted for Federal guidance, and the NC DEHNR will be consulted for guidance in the State of North Carolina.

The technical components of the BRA are contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The objectives of the risk assessment process can be accomplished by:

- Characterizing the toxicity and levels of contaminants in relevant media (e.g., groundwater, surface water, soil, sediment, air, and biota).
- Characterizing the environmental fate and transport mechanisms within specific environmental media.
- Identifying potential human and/or environmental receptors.
- Identifying potential exposure routes and the extent of the actual or expected exposure.
- Defining the extent of the expected impact or threat.
- Identifying the levels of uncertainty associated with the above items.

As outlined in the Scope of Work,the quantitative BRAs to be performed at MCB Camp Lejeune for Sites 1, 28, and 30 are to utilize all available data to date that has been properly validated in accordance with USEPA guidelines plus all data to be collected from additional sampling during this RI.

5.7.1 Human Health Evaluation Process

5.7.1.1 Site Location and Characterization

A background section will be presented at the beginning of each risk assessment to provide an overview of the characteristics of each site. This section will provide a general site description and the site-specific chemicals as discussed in past reports. The physical characteristics of the site and the geographical areas of concern will be discussed. This site description will help to characterize the exposure setting.

5.7.1.2 Data Summary

Because decisions regarding data use may influence the resultant risk assessment, careful consideration must be given to the treatment of those data. For purposes of risk evaluation, the sites at MCB Camp Lejeune may be partitioned into zones or operable units for which chemical concentrations will be characterized and risks will be evaluated. Sites will be grouped into operable units if they are close to one another, have similar contamination, and/or may impact the same potential receptors. In selecting data to include in the risk assessment, the objective is to characterize, as accurately as possible, the distribution and concentration of chemicals in each operable unit.

Data summary tables will be developed for each medium sampled (e.g., surface water, sediment, groundwater, soil). Each data summary table will indicate the frequency of detection, observed range of concentrations, average background concentrations (inorganics) and the means and upper 95 percent confidence limit value for each contaminant detected in each medium. The arithmetic or geometric mean and the upper 95 percent confidence limit of that mean will be used in the summary of potential chemical data. The selection of arithmetic or geometric means will depend on whether the sample data are normally or log- normally distributed. In the calculation of the mean, concentrations presented as "ND" (nondetect) will not be incorporated.

5.7.1.3 Identifying Chemicals of Potential Concern

The criteria to be used in selecting the Contaminants of Potential Concern (COPC) from the constituents detected during the sampling and analytical phase of the investigation are: historical information, prevalence, mobility, persistence, toxicity, comparison of the Applicable, Relevant, and Appropriate Requirements (ARARs), comparison to blank data or base-specific naturally occurring levels (i.e., background), and comparison to anthropogenic levels. The criteria chosen to establish the COPC are derived from the USEPA's Risk Guidance for Superfund (USEPA, 1989).

All of the available sample data will undergo review upon initiation of the risk assessment. Common laboratory contaminants such as acetone, methylene chloride, phthalate esters, toluene, and methyl ethyl ketone will be addressed only if concentrations are 10 times greater than the corresponding blanks. In addition, chemicals that are not common laboratory

contaminants will be evaluated if they are greater than five times the laboratory blank. The number of chemicals analyzed in the risk assessment will be a subset of the total number of chemicals detected at a site based on the elimination criteria discussed previously.

Tables will be prepared that list chemical concentrations for all media by site. Data will be further grouped according to organic and inorganic species within each table.

5.7.1.4 Exposure Assessment

The objectives of the exposure assessment at MCB Camp Lejeune will be to characterize the exposure setting, identify exposure pathways, and quantify the exposure. When characterizing the exposure setting, the potentially exposed populations will be described. The exposure pathway will identify: the source and the mechanism of medium for the released chemical (e.g., groundwater), the point of potential human contact with the contaminated medium, and the exposure route(s) (e.g., ingestion). The magnitude, frequency, and duration for each exposure pathway identified will be quantified during this process.

The identification of potential exposure pathways at the four sites will include the activities described in the subsections that follow.

Analysis of the Probable Fate and Transport of Site- Specific Chemicals

To determine the environmental fate and transport of the chemicals of concern at the site, the physical/chemical and environmental fate properties of the chemicals will be reviewed. Some of these properties include volatility, photolysis, hydrolysis, oxidation, reduction, biodegradation, accumulation, persistence, and migration potential. This information will assist in predicting potential current and future exposures. It will help in determining those media that are currently receiving site-related chemicals or may receive site-related chemicals in the future. Sources that may be consulted in obtaining this information include computer databases (e.g., AQUIRE, ENVIROFATE), as well as the open literature.

The evaluation of fate and transport may be necessary where the potential for changes in future chemical characteristics is likely and for those media where site-specific data on the chemical distribution is lacking.

Identification of Potentially Exposed Human Populations

Human populations, that may be potentially exposed to chemicals at the MCB Camp Lejeune, include base personnel and their families, base visitors, and on-site workers and recreational fishermen/women. The Base Master Plan will be consulted to confirm or modify these potential exposures. Nonworking residents who might be exposed to site-specific chemicals could include spouses and/or children of base personnel and resident workers. Resident and nonresident workers could be exposed to chemicals as they carry out activities at any of the sites located at MCB Camp Lejeune. The list of potential receptors and pathways to be evaluated will be refined during discussions with regulators prior to performing the BRA.

Identification of Potential Exposure Scenarios Under Current and Future Land Uses

The exposure scenarios will be developed after consulting with the Base Master Plan, EPA and the State of North Carolina. Generally, exposure pathways will be considered preliminarily as follows:

- Soil Pathway
  - Direct ingestion (worker, resident, recreational fishermen/women)
  - Inhalation of dust (worker, resident)
  - Dermal contact (worker, resident, recreational fishermen/women)
  - Air Pathways (worker, resident)
- Sediment Pathway
  - Dermal contact (worker, resident, recreational fishermen/women)
  - Ingestion of shellfish (worker, resident, recreational fishermen/women)
  - Air Pathways (worker, resident, recreational fishermen/women)
- Surface Water
  - Dermal contact (worker, resident, recreational fishermen/women)
  - Ingestion of contaminated fish (worker, resident, recreational fishermen/women)
  - Air Pathways (worker, resident, recreational fishermen/women)
- Groundwater
  - Direct ingestion (base personnel, on-site resident, on-site worker, visitor)
  - Inhalation (base personnel, on-site resident, on-site worker, visitor)
  - Dermal contact (base personnel, on-site resident, on-site worker, visitor)
  - Air Pathways (base personnel, on-site resident, on-site worker, visitor)

Exposure Point Concentrations

After the potential exposure points and potential receptors have been defined, exposure point concentrations must be calculated. The chemical concentrations at these contact points are

critical in determining intake and, consequently, risk to the receptor. The data from site investigations will be used to estimate exposure point concentrations.

The means and the upper 95 percent confidence limits of the means will be used throughout the risk assessment. If the data are log- normally distributed, the means will be based on the geometric mean rather than the arithmetic mean. In cases where maximum concentrations are exceeded by upper 95 percent confidence limit, the maximum concentrations will be used.

Exposure doses will be estimated for each exposure scenario from chemical concentrations at the point of contact by applying factors that account for contact frequency, contact duration, average body weight, and other route-specific factors such as breathing rate (inhalation). These factors will be incorporated into exposure algorithms that convert the environmental concentrations into exposure doses. Intakes will be reported in milligrams of chemical taken in by the receptor (i.e., ingested, inhaled, etc.) per kilogram body weight per day (mg/kg-day). Intakes for potentially exposed populations will be calculated separately for the appropriate exposure routes and chemicals.

5.7.1.5 Toxicity Assessment

Toxicity values (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be used in conjunction with the intake determinations to characterize risk. Toxicity values may be taken or derived from the following sources (note that the most up-to-date toxicity information obtained from IRIS and/or HEAST will be used in the exposure assessments):

- Integrated Risk Information System - The principal toxicology database, which provides updated information from EPA on cancer slope factors, reference doses, and other standards and criteria for numerous chemicals.

- Health Effects Assessment Summary Tables - A tabular summary of noncarcinogenic and carcinogenic toxicity information contained in IRIS.

For some chemicals, toxicity values (i.e., reference doses) may have to be derived if the principal references previously mentioned do not contain the required information. These derivations will be provided in the risk assessment for review by EPA Region IV. The toxicity assessment will include a brief description of the studies on which selected toxicity values

were based, the uncertainty factors used to calculate noncarcinogenic reference doses (RfDs), the EPA weight-of-evidence classification for carcinogens, and their respective slope factors.

5.7.1.6 Risk Characterization

Risk characterization involves the integration of exposure doses and toxicity information to quantitatively estimate the risk of adverse health effects. Quantitative risk estimates based on the reasonable maximum exposures to the site contaminants will be calculated based on available information. For each exposure scenario, the potential risk for each chemical will be based on intakes from all appropriate exposure routes. Carcinogenic risk and noncarcinogenic hazard indices are assumed to be additive across all exposure pathways and across all of the chemicals of concern for each exposure scenario. Potential carcinogenic risks will be evaluated separately from potential noncarcinogenic effects, as discussed in the following subsections.

Carcinogenic Risk

For the potential carcinogens that are present at the site, the carcinogenic slope factor (q_1*) will be used to estimate cancer risks at low dose levels. Risk will be directly related to intake at low levels of exposure. Expressed as an equation, the model for a particular exposure route is:

$$\text{Excess lifetime cancer risk} = \text{Estimated dose x carcinogenic slope factor; or CDI x } q_1^*$$

Where: CDI = Chronic daily intake

This equation is valid only for risk less than 10^{-2} (1 in 100) because of the assumption of low dose linearity. For sites where this model estimates carcinogenic risks of 10^{-2} or higher, an alternative model will be used to estimate cancer risks as shown in the following equation:

$$\text{Excess lifetime cancer risk} = 1 - \exp(-\text{CDI x } q_1^*)$$

Where: exp = the exponential

For quantitative estimation of risk, it will be assumed that cancer risks from various exposure routes are additive. Since there are no mathematical models that adequately describe antagonism or synergism, these issues will be discussed in narrative fashion in the uncertainty analysis.

Noncarcinogenic Risk

To assess noncarcinogenic risk, estimated daily intakes will be compared with RfDs for each chemical of concern. The potential hazard for individual chemicals will be presented as a hazard quotient (HQ). A hazard quotient for a particular chemical through a given exposure route is the ratio of the estimated daily intake and the applicable RfD, as shown in the following equation:

$$HQ = EDI/RfD$$

Where: HQ = Hazard quotient
EDI = Estimated daily intake or exposure (mg/kg-day)
RfD = Reference dose (mg/kg-day)

To account for the additivity of noncarcinogenic risk following exposure to numerous chemicals through a variety of exposure routes, a hazard index (HI), which is the sum of all the hazard quotients, will be calculated. Ratios greater than one, or unity, indicate the potential for adverse effects to occur. Ratios less than one indicate that adverse effects are unlikely. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect. In some cases when the HI exceeds unity it may be appropriate to segregate effects (as expressed by the HI) by target organ since those effects would not be additive. As previously mentioned, where information is available about the antagonism or synergism of chemical mixtures, it will be appropriately discussed in the uncertainty analysis.

5.7.1.7 Uncertainty Analysis

There is uncertainty associated with any risk assessment. The exposure modeling can produce very divergent results unless standardized assumptions are used and the possible variation in others are clearly understood. Similarly, toxicological assumptions, such as extrapolating from chronic animal studies to human populations, also introduce a great deal of uncertainty

into the risk assessment. Uncertainty in a risk assessment may arise from many sources including:

- Environmental chemistry sampling and analysis.
- Misidentification or failure to be all-inclusive in chemical identification.
- Choice of models and input parameters in exposure assessment and fate and transport modeling.
- Choice of models or evaluation of toxicological data in dose-response quantification.
- Assumptions concerning exposure scenarios and population distributions.

The variation of any factor used in the calculation of the exposure concentration will have an impact on the total carcinogenic and noncarcinogenic risk. The uncertainty analysis will qualitatively discuss non-site and site-specific factors that may produce uncertainty in the risk assessment. These factors may include key modeling assumptions, exposure factors, assumptions inherent in the development of toxicological end points, and spatio-temporal variance in sampling.

This section discusses the Preliminary Remediation Goals (PRGs) (ARAR-based and/or risk-based) which are determined using information on media and chemicals of potential concern, the most appropriate future land use, potential exposure pathways, toxicity information, and potential ARARs. The development of PRGs will assist in the initiation of remedial alternatives and in the selection of analytical limits of detection. Risk-based PRGs established at this time are initial, and do not establish that clean up to meet these goals is warranted. Therefore, a risk-based PRG will be considered a final remediation level only after appropriate analysis in the RI/FS and ROD.

The initial step in developing PRGs is to identify media of potential concern. Important media at these sites include groundwater, soil, surface water and sediment. Chemicals of Potential Concern include any chemical reasonably expected to be at the sites. These chemicals may have been previously detected at the site, may be present based on site history, or may be present as degradation products. Identifying future land use for the site is used to determine risk-based PRGs. In general, residential land use should be used as a conservative estimation

for the PRGs. Chemical-specific ARARs are evaluated as PRGs because they are often readily available and provide preliminary indication about the goals that a remedial action may have to attain. For groundwater SDWA maximum contaminant levels (MCLs), state drinking water standards, and Federal Water Quality Criteria (FWQC) are common ARARs.

FWQCs and state water quality standards (WQS) are common ARARs for surface water. Sediment Screening Values (SSVs) developed by National Oceanic and Atmospheric Administration (NOAA) can be used as ARARs for the evaluation of biological effects for aquatic organisms. In general, chemical-specific ARARs are not available for soil, however, some states have promulgated soil standards (i.e., PCB clean up levels) that may be criteria appropriate to use as PRGs. Risk-based PRGs will be obtained from USEPA, Region III, Risk-Based Concentration Table (USEPA, 1993). The risk-based PRGs will be reviewed and modified after the completion of the baseline risk assessment. This modification will involve adding or subtracting chemicals of concern, media, pathways or revising individual chemical-specific goals. Tables 5-5, 5-6, and 5-7 provide PRGs for each media at Sites 1, 28, and 30, respectively.

5.7.2 Ecological Risk Assessment

5.7.2.1 Purpose and Approach

The purpose of an ecological risk assessment is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of contamination at MCB Camp Lejeune. It would focus on identifying potential adverse effects of area-specific contamination on selected/targeted flora and fauna at each site, or group of sites (operable unit). The technical approach parallels that used in the human health risk assessment; however, since the protocols for evaluating the ecological risk have not been sufficiently developed, the ecological risk assessment may be more qualitative than its human health counterpart. In general, the approach to be taken in the conduct of the ecological risk assessments at MCB Camp Lejeune will be comparing sampled media concentrations to existing toxicological endpoints for selected target species. In addition, incomplete exposure pathways and data gaps will be identified. If this comparison indicates the potential for significant ecological risks, the conduct of a quantitative biosurvey may be recommended as Phase II of the RI.

The primary technical guidance for the performance of the ecological risk assessment is offered by the following sources:

TABLE 5-5

PRELIMINARY REMEDIATION GOALS
SITE 1
REMEDIAL INVESTIGATION - CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Remediation Goal	Unit	Basis of Goal
Groundwater	Toluene	1,000	µg/L	MCL
	1,2-Dichloroethene	0.38	µg/L	NC WQS
	1,1-Dichloroethene	729	µg/L	MCL
	Ethylbenzene	0.7	µg/L	NC WQS
	Tetrachloroethene	200	µg/L	NC WQS
	1,1,1-Trichloroethane	2.8	µg/L	NC WQS
	Trichloroethene	1.0	µg/L	NC WQS
	Benzene	400	µg/L	NC WQS
	Xylenes	22,000	µg/L	NC WQS
	Phenol	50	µg/L	Risk - Ingestion
	Beryllium	4	µg/L	MCL
	Chromium	50	µg/L	MCL
	Lead	15	µg/L	NC WQS
	Mercury	1.1	µg/L	MCL
	Nickel	100	µg/L	NC WQS
	Zinc	5,000	µg/L	MCL
	Cadmium	5.0	µg/L	NC WQS
				NC WQS
Soil	Benzene	41	mg/kg	Risk - Soil Ingestion
	Toleune	16,000	mg/kg	Risk - Soil Ingestion
	Ethylbenzene	7,800	mg/kg	Risk - Soil Ingestion
	Xylenes	160,000	mg/kg	Risk - Soil Ingestion
	Cadmium	39	mg/kg	Risk - Soil Ingestion
	Chromium (III)	78,000	mg/kg	Risk - Soil Ingestion
	Zinc	23,000	mg/kg	Risk - Soil Ingestion
Surface Water	Phenol	1.0	µg/L	NC WQS
	Chromium (total)	50	µg/L	NC WQS
Sediment	Cadmium	9	mg/kg	Sediment - Screening Value

TABLE 5-6

PRELIMINARY REMEDIATION GOALS
SITE 28
REMEDIAL INVESTIGATION - CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Remediation Goal	Unit	Basis of Goal
Groundwater	1,2-Dichloroethane	0.38	µg/L	NC WQS
	Trichloroethene	2.8	µg/L	NC WQS
	Vinyl Chloride	0.015	µg/L	NC WQS
	Arsenic	50	µg/L	NC WQS
	Chromium	50	µg/L	NC WQS
	Lead	15	µg/L	NC WQS
	Mercury	1.1	µg/L	NC WQS
	Nickel	100	µg/L	NC WQS
	Zinc	5,000	µg/L	NC WQS
	4,4'-DDD	0.33	µg/L	Risk - Ingestion
	4,4'-DDE	0.23	µg/L	Risk - Ingestion
	Dieldren	0.005	µg/L	Risk - Ingestion
Soil	Benzene	5.4	µg/L	Risk - Protection of Groundwater
	4,4'-DDD	5.0	mg/kg	Risk - Soil Ingestion
	4,4'-DDE	3.5	mg/kg	Risk - Soil Ingestion
	4,4'-DDT	3.5	mg/kg	Risk - Soil Ingestion
	Dieldrin	0.075	mg/kg	Risk - Soil Ingestion
	Barium		µg/L	
	Cadmium	39	mg/kg	Risk - Soil Ingestion
	Chromium (III)	78,000	mg/kg	Risk - Soil Ingestion
	Zinc	23,000	mg/kg	Risk - Soil Ingestion
Surface Water	Trichloroethene	92.4	µg/L	NC WQS
	Cadmium	2.0	µg/L	NC WQS
	Mercury	0.012	µg/L	NC WQS
	Zinc	50	µg/L	NC WQS
Sediment	4,4'-DDD	20	µg/kg	Sediment Screening Value
	4,4'-DDE	15	µg/kg	Sediment Screening Value
	Chlordane	6	µg/kg	Sediment Screening Value
	Arsenic	85	mg/kg	Sediment Screening Value
	Beryllium	None	mg/kg	Sediment Screening Value
	Cadmium	9	mg/kg	Sediment Screening Value
	Chromium	145	mg/kg	Sediment Screening Value
	Nickel	50	mg/kg	Sediment Screening Value
	Zinc	270	mg/kg	Sediment Screening Value

TABLE 5-7

PRELIMINARY REMEDIATION GOALS
SITE 30
REMEDIATION INVESTIGATION - CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Remediation Goal	Unit	Basis of Goal
Groundwater	Arsenic	50	µg/L	NC WQS
	Cadmium	5	µg/L	NC WQS
	Chromium	50	µg/L	NC WQS
	Lead	50	µg/L	NC WQS
	Mercury	1.1	µg/L	NC WQS
	Nickel	100	µg/L	MCL
Soil	Benzene			
	Toluene			
	Ethylbenzene			
	Xylenes			
	Lead			
	Toluene	16,000	mg/kg	Risk - Soil Ingestion
	Ethylbenzene	7,800	mg/kg	Risk - Soil Ingestion
	Xylenes	160,000	mg/kg	Risk - Soil Ingestion
	Lead	0.0078	mg/kg	Risk - Soil Ingestion
Surface Water	None			
Sediment	None			

- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (EPA, 1989b).

- Risk Assessment Guidance for Superfund -- Volume II, Environmental Evaluation Manual (EPA, 1989c).

- User's Manual for Ecological Risk Assessment (Oak Ridge National Laboratory, 1986).

The subsections that follow describe the general approach proposed to evaluate potential ecological impacts associated with contamination found at MCB Camp Lejeune. It focuses on environmental receptors that may be affected directly or indirectly by contamination associated with particular areas of concern, and the likelihood and extent of those effects. At each site or operable unit, potential target organisms, populations, and/or communities will be identified and the potential exposure pathways determined.

5.7.2.2 Selection of Chemicals of Potential Concern

The objective of this subtask is to evaluate the available information on contamination present at MCB Camp Lejeune, and to identify contaminants of potential concern on which to focus subsequent risk assessment efforts.

The selection of chemicals of concern will be based on prevalence, comparison to background concentrations, persistence of the chemical, bioaccumulation potential, and the availability of toxicological information (to the selected target species) for those chemicals. Because of the differential toxicity of some chemicals to ecological as compared with human receptors, the chemicals of potential concern for ecological receptors may differ from those selected in the human health risk assessment.

5.7.2.3 Exposure Assessment

The objectives of the exposure assessment are to:

- Identify habitats that may have detected exposure point concentrations

- Identify plants, fish, and/or wildlife that may be potentially exposed to the contaminants of concern

- Identify significant pathways/routes of exposure

- Select target species, and/or communities of potential concern

- Estimate potential exposure concentrations for contaminants of concern

In general, an ecological exposure assessment evaluates the potential magnitude and frequency of contact with the contaminants specific to the area through all appropriate exposure pathways for the selected species and/or communities. The first step of the exposure assessment is to identify (1) potential pathways of exposure specific to the individual areas of concern and (2) the habitats potentially affected by those areas of concern.

Pathway Identification and Habitat Evaluation

Chemical migration pathways and habitats that may be potentially affected by area-specific contamination will be identified. No modeling will be performed to evaluate the exposure assessment. Information that may be used in determining potential chemical migration pathways include:

- Location of contamination sources
- Local topography
- Local land use
- Media-specific and area-specific contamination data
- Persistence and mobility of area-specific chemicals
- Qualitative prediction of contaminant migration

To conduct this evaluation, the ecological exposure assessment will consist of a literature search to characterize the populations, communities, and/or habitats in the potentially affected area. The characterizations will be developed from existing reports on the ecological systems of the areas. Literature searches of "reference" areas, site surveys and/or a reconnaissance in the region also will be performed to establish an ecological "baseline" from which comparisons can be made. If the data permits, a comparison will be made between

reference areas and study site areas to determine the extent to which habitat function and structure at the site may have been impaired.

The determination of which habitats warrant special attention will be based on the importance of each habitat within the environmental system, incorporating factors such as:

- Resource use by fish and wildlife
- Probable species using these habitats
- Availability and quality of substitute habitats
- Importance of species using these habitats
- Regulatory status

Specific attention will be devoted to aquatic and terrestrial environmentals that may be impacted by site-related contamination (i.e., creeks and wetlands).

Selection of Target Species

As available from the literature, ecological exposure scenarios will be developed. These will include scenarios involving the existing and future land use of the area. Identification of the plant, fish, and wildlife species and/or communities that may be potentially exposed to contaminants will be determined for terrestrial and aquatic habitats. From this list of potential ecological receptors, target species will be based on the following criteria:

- A species that is threatened, endangered, or of special concern

- A species that is valuable for recreational or commercial purposes

- A species that is important to the well being of either or both of the above groups

- A species that is critical to the structure and function of the particular ecosystem which it inhabits

- A species that is a sensitive indicator of ecological change

To help identify potential target species, data collected from information provided through contact with State and Federal natural resource agencies will be reviewed.

Estimation of Exposure Point Concentrations

After the potential contamination migration pathways and affected habitats have been defined and potential target receptors identified, points of likely exposure will be described. The concentrations at these contact points (i.e., exposure point concentrations) are critical in evaluating contaminant exposure and subsequent risk to the receptor.

Exposure Estimation

Exposure potential will be estimated for each terrestrial and aquatic exposure pathway from the conduct of an ecological characterization for each of the target species. This characterization will identify tropic level, habitat utilization, and potential exposure points and routes for the selected target species.

5.7.2.4 Toxicity Assessment

The toxicities of the contaminants of concern will be assessed by using AWQC and, if possible, Sediment Quality Criteria (SQC) for aquatic life, terrestrial wildlife, and vegetation where relevant. In addition, scientific literature and regulatory guidelines will be reviewed for media-specific and/or species-specific toxicity data. To the extent literature data allow, a range of toxicological responses or endpoints also will be evaluated. These data will be used to determine critical toxicity values (CTVs) for the contaminants of concern, which will be compared with media concentrations or estimated daily intakes. Toxicity values from the literature are derived using the most closely related species, where possible. Toxicity values selected for the assessment are the lowest exposure doses reported to be toxic or the highest doses associated with no adverse effect. Data for chronic or subchronic toxicity are used wherever available.

Potential sources of toxicity data for the ecological assessment include:

- AQUIRE database
- PHYTOTOX database
- ENVIROFATE database
- Hazardous Substances Database (HSDB)
- RTECS

5.7.2.5 Risk Characterization

A risk characterization integrates the exposure and toxicity assessments to estimate the potential risk to the environmental receptors. The media concentrations or estimated daily intakes will be compared with critical toxicity values using toxicity data that are expressed in terms of medium concentrations (e.g., Ambient Water Quality Criteria, species-specific toxicity data, phytotoxicity data, sediment biological effects data). In these cases, comparing predicted environmental media exposure point concentrations with media-specific and/or species-specific toxicity data will be made. If this comparison indicates the potential for significant ecological risks to the target receptors, the conduct of a quantitative biosurvey may be recommended as Phase II of the RI.

$$HQ = C/CTV$$

Where: C = Concentration of chemical (mg/kg, mg/l).

CTV = Critical toxicity value for the same chemical in the same medium (mg/kg, mg/l).

Anything over the number one (1), indicates potential significant risks to the species.

5.7.2.6 Data Gaps

Incomplete exposure data gap pathways will be identified and recommendations for addressing same will be provided.

5.7.2.7 Uncertainty Analysis

An ecological risk assessment, like a human health risk assessment, is subject to a wide variety of uncertainties. Virtually every step in the risk assessment process involves numerous assumptions that contribute to the total uncertainty in the ultimate evaluation of risk. Assumptions are made in the exposure assessment regarding potential for exposure and exposure point locations. An effort is made to use assumptions that are conservative, yet realistic. The interpretation and application of toxicological data in the toxicity assessment is probably the greatest source of uncertainty in the ecological risk assessment. The uncertainty

analysis will attempt to address the factors that affect the results of the ecological risk assessment.

5.8 Task 8 - Treatability Study/Pilot Testing

This task includes the efforts to prepare and conduct bench- or pilot-scale treatability studies should they be necessary. This task begins with the development of a Treatability Study Work Plan for conducting the tests and is completed upon submittal of the Final Report. The following are typical activities:

- Work plan preparation
- Test facility and equipment procurement
- Vendor and analytical service procurement
- Testing
- Sample analysis and validation
- Evaluation of results
- Report preparation
- Project management

Based on the preliminary information pertaining to Sites 1, 28, and 30, the following bench or pilot studies may be considered for soils:

Site 1: Solidification/fixation of soils
Thermal treatment
Soil washing/biodegradation

Site 28: Soil washing/biodegradation
Thermal treatment
In-situ solidification/fixation

Site 30: None at this time since on-site soil investigations and soil characteristics are unknown.

Bench- or pilot-scale treatability studies for groundwater may be required to assess pretreatment options (e.g., metal reduction).

5.9 Task 9 - Remedial Investigation Report

This task is intended to cover all work efforts related to the preparation of the document providing the findings once the data have been evaluated under Tasks 5 and 6. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final RI Report. This task ends when the Final RI report is submitted.

5.10 Task 10 - Remedial Alternatives Screening

This task includes the efforts necessary to select the alternatives that appear feasible and require full evaluation. The task begins during data evaluation when sufficient data are available to initiate the screening of potential technologies. For reporting and tracking purposes, the task is defined as complete when a final set of alternatives is chosen for detailed evaluation.

5.11 Task 11 - Remedial Alternatives Evaluation

This task involves the detailed analysis and comparison of alternatives using the following criteria:

- Threshold Criteria: Overall Protection of Human Health and the Environment
  - Compliance With ARARs
- Primary Balancing Criteria: Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility, and Volume Through Treatment
  - Short-Term Effectiveness
  - Implementability
  - Cost
- Modifying Criteria: State and EPA Acceptance
  - Community Acceptance

5.12 Task 12 - Feasibility Study Report

This task is comprised of reporting the findings of the Feasibility Study. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final FS report. This task ends when the Final FS report is submitted.

5.13 Task 13 - Post RI/FS Support

This task involves the technical and administrative support to LANTDIV to prepare a Draft, Draft Final, and Final Responsiveness Summary, Proposed Remedial Action Plan, and Record of Decision. These reports will be prepared using EPA applicable guidance documents.

5.14 Task 14 - Meetings

This task involves providing technical support to LANTDIV during the RI/FS. It is anticipated that the following meetings will be required:

- Technical Review Committee (TRC) meeting to present the RI/FS Work Plan
- A TRC meeting to present the findings of the RI/FS
- Public meeting to present the proposed remedial alternatives
- RI start-up meeting between LANTDIV and Baker
- Meeting between Baker and LANTDIV to discuss the RI and risk assessment following submission of the preliminary draft RI report
- Meeting between Baker and LANTDIV to discuss the FS following submission of the preliminary draft FS report

5.15 Task 15 - Community Relations

This task includes providing support to LANTDIV during the various public meetings identified under Task 13. This support includes the preparation of fact sheets, meeting

minutes, coordination with Camp Lejeune EMD in contacting local officials and media, and the procurement of a stenographer.

This task also includes updating the existing Community Relations Plan (CRP) with respect to changes in personnel, contacts, phone numbers, or the addition of information relevant to this RI/FS. An addendum to the CRP will be prepared which summarizes these changes. Replacement pages to the existing CRP will be issued.

6.0 PROJECT MANAGEMENT AND STAFFING

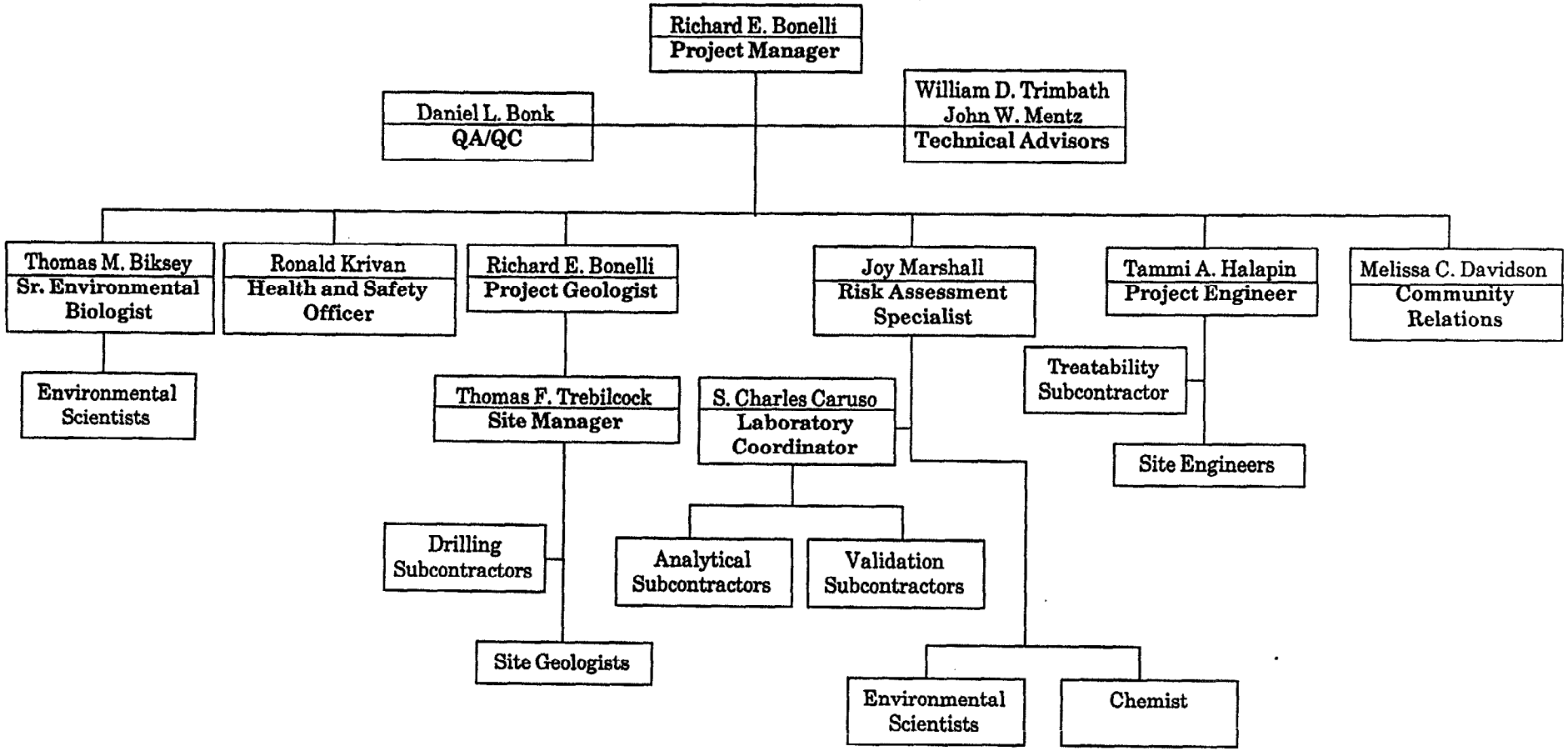
The proposed management and staffing of this RI/FS is depicted in Figure 6-1. The primary participants for this project include:

- Mr. Raymond P. Wattras, Activity Coordinator
- Mr. Richard E. Bonelli, Project Manager/Project Geologist
- Mr. Daniel L. Bonk, QA/QC
- Mr. Thomas F. Trebilcock, Site Manager
- Ms. Tammi A. Halapin, Project Engineer
- Ms. Joy Marshall, Risk Assessment
- Dr. S. Charles Caruso, Laboratory Coordinator
- Mr. Thomas M. Biksey, Environmental Assessment
- Mr. Ronald Krivan, Health and Safety Officer
- Ms. Melissa C. Davidson, Community Relations Specialist

From a responsibility and coordination standpoint, Mr. Richard E. Bonelli, Mr. Thomas F. Trebilcock, Ms. Joy Marshall, and Mr. Thomas Biksey will have the overall responsibility of completing the RI Report. Ms. Tammi Halapin will be responsible for overseeing the preparation of the FS report. These personnel will report directly to the Project Manager and the Activity Coordinator. They will be supported by geologists, engineers, biologists, chemists, data technicians, and clerical personnel.

Overall field and reporting QA/QC will be the responsibility of Mr. Daniel L. Bonk. Mr. William D. Trimbath, P.E. and Mr. John W. Mentz will provide Program-level technical and administrative support.

FIGURE 6-1
PROJECT ORGANIZATION
RI/FS AT OPERABLE UNIT NO. 1
(SITES 1, 28, AND 30)
MCB CAMP LEJEUNE, NORTH CAROLINA



7.0 SCHEDULE

The project schedule based on the requirements of the Federal Facilities Agreement and Fiscal Year 1994 Site Management Plan is presented in Tables 7-1. Table 7-2 depicts an expedited project schedule, which is a non-contractual schedule to expedite the duration of the RI/FS.

Table 7 - 1: Site Management Schedule

Sites 1, 28, and 30 (Operable Unit No. 7), MCB Camp Lejeune, NC

Task	Days	Start	Finish
RI/FS Project Plans	215d	3/1/93	12/26/93
Prepare Prelim Draft RI/FS Project Plans	60ed	3/1/93	4/30/93
Submit Prelim Draft RI/FS Project Plans	0ed	4/30/93	4/30/93
LANTDIV Review	30d	4/30/93	6/10/93
Prepare Draft RI/FS Project Plans	30ed	5/30/93	6/29/93
Submit Draft RI/FS Project Plans	0ed	6/29/93	6/29/93
Agency Review	60ed	6/29/93	8/28/93
Prepare Draft Final RI/FS Project Plans	60ed	8/28/93	10/27/93
Submit Draft Final RI/FS Project Plans	0ed	10/27/93	10/27/93
Agency Review	30ed	10/27/93	11/26/93
Prepare Final RI/FS Project Plans	30ed	11/26/93	12/26/93
Submit Final RI/FS Project Plans	0ed	12/26/93	12/26/93
Field Investigation	63ed	1/3/94	3/7/94
Sample Analysis / Validation	119ed	1/3/94	5/2/94
Data Evaluation	21ed	5/2/94	5/23/94
Risk Assessment	42ed	5/23/94	7/4/94
RI Report	200d	6/6/94	3/11/95
Preliminary Draft RI Report	42ed	6/6/94	7/18/94
Comment Period	28ed	7/18/94	8/15/94
Draft RI	28ed	8/15/94	9/12/94
Comment Period	60ed	9/12/94	11/11/94
Draft Final RI Report	60ed	11/11/94	1/10/95
Comment Period	30ed	1/10/95	2/9/95
Final RI	30ed	2/9/95	3/11/95

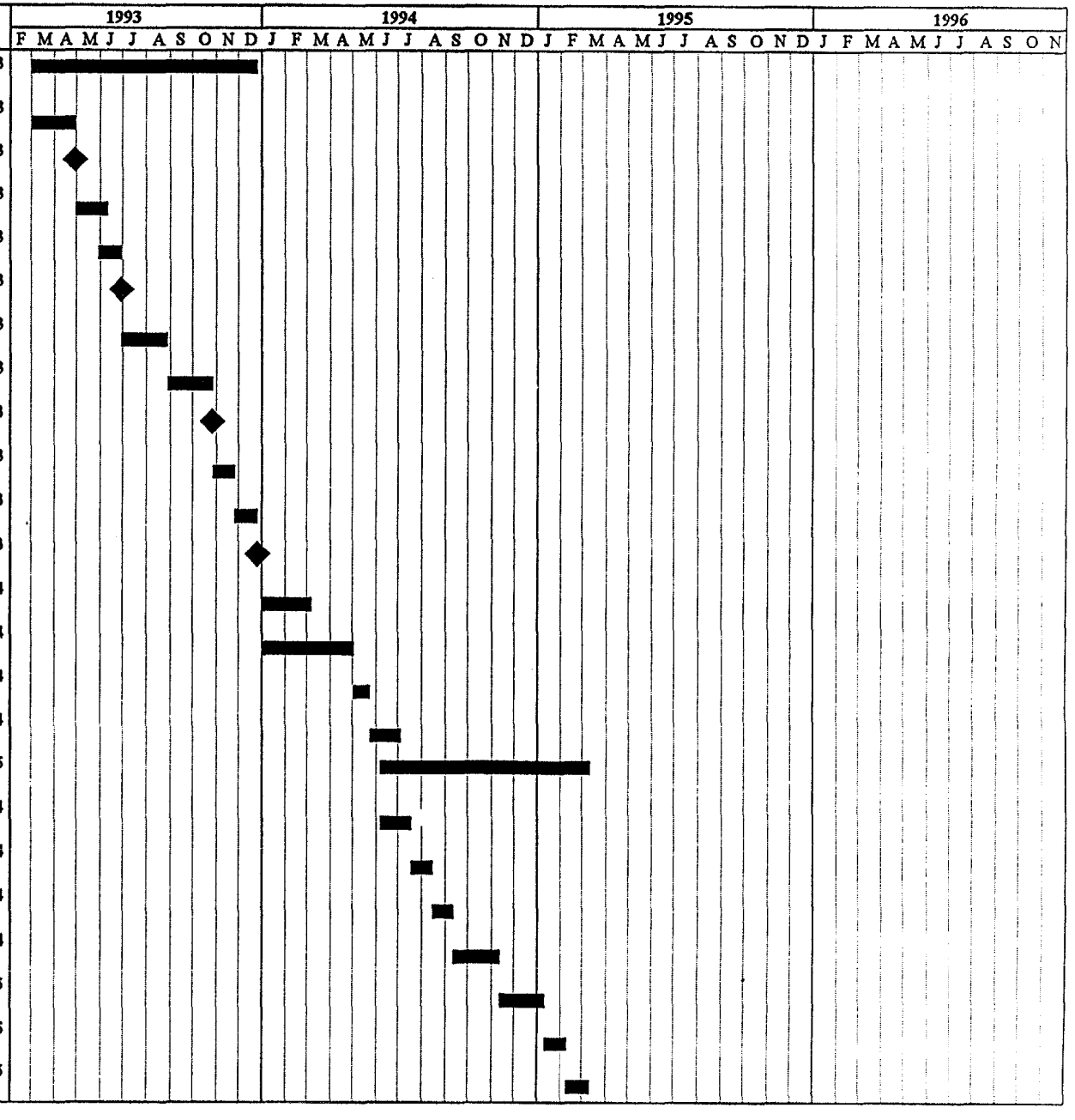


Table 7 - 1: Site Management Schedule

Sites 1, 28, and 30 (Operable Unit No. 7), MCB Camp Lejeune, NC

Task	Days	Start	Finish
FS Report / PRAP	220d	7/4/94	5/8/95
Preliminary Draft FS / PRAP	42ed	7/4/94	8/15/94
Comment Period	28ed	8/15/94	9/12/94
Draft FS / PRAP	28ed	9/12/94	10/10/94
Comment Period	60ed	10/10/94	12/9/94
Draft Final FS / PRAP	60ed	12/9/94	2/7/95
Comment Period	30ed	2/7/95	3/9/95
Final FS / PRAP	30ed	3/9/95	4/8/95
Public Comment Period	30ed	4/8/95	5/8/95
ROD	181d	9/9/94	5/22/95
Preliminary Draft ROD	28ed	9/9/94	10/7/94
Comment Period	28ed	10/7/94	11/4/94
Draft ROD	21ed	11/4/94	11/25/94
Comment Period	60ed	11/25/94	1/24/95
Draft Final ROD	58ed	1/24/95	3/23/95
Comment Period	30ed	3/23/95	4/22/95
Final ROD	30ed	4/22/95	5/22/95
Remedial Design (1,2)	398ed	5/22/95	6/23/96
Procure RA Contractor	60ed	6/23/96	8/22/96
Begin RA (1,2)	0ed	8/22/96	8/22/96

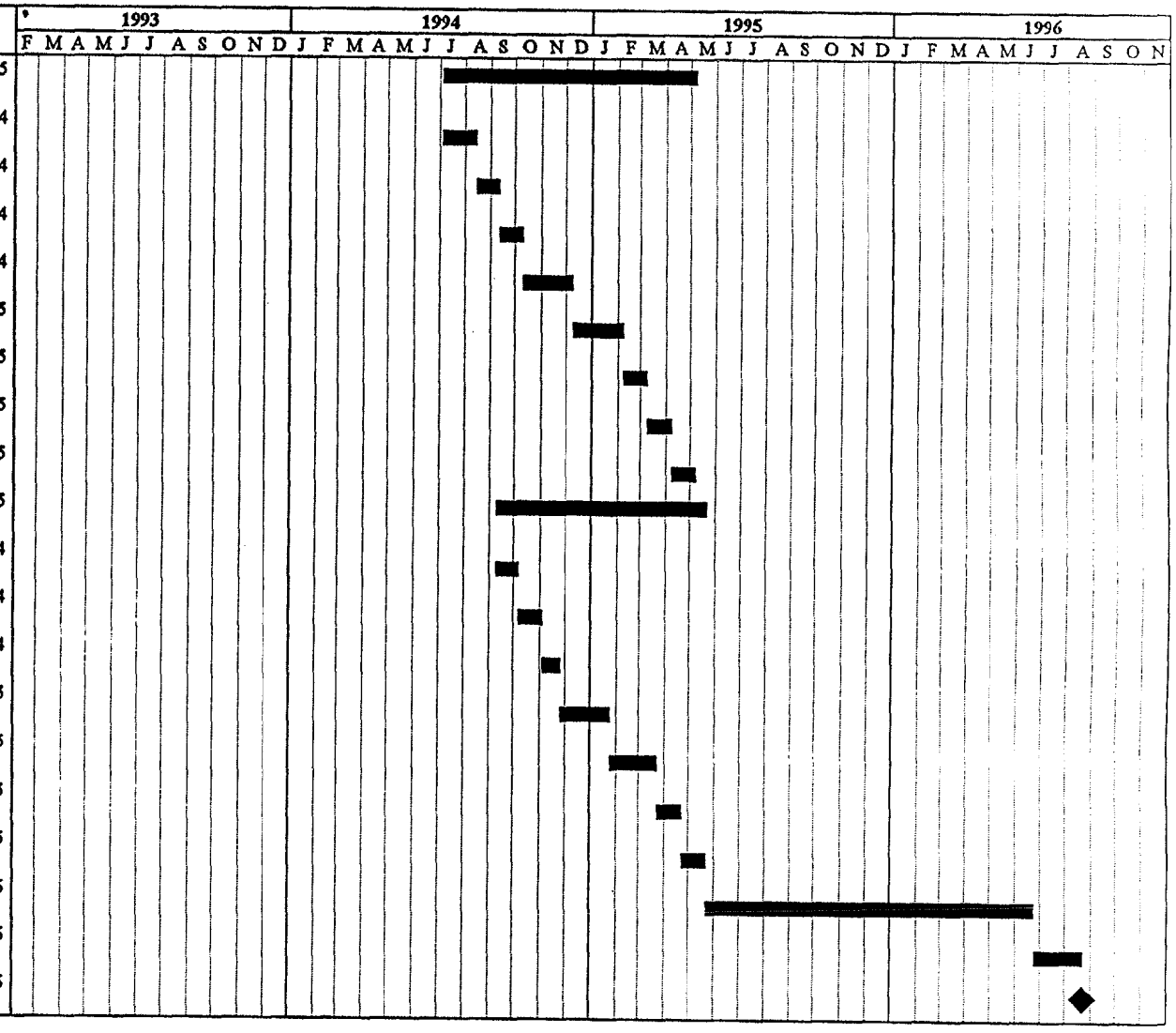


Table 7 - 2: Expedited Site Management Schedule

Sites 1, 28, and 30 (Operable Unit No. 7), MCB Camp Lejeune, NC

Task	Days	Start	Finish
RI/FS Project Plans	160d	3/1/93	10/9/93
Prepare Prelim Draft RI/FS Project Plans	60ed	3/1/93	4/30/93
Submit Prelim Draft RI/FS Project Plans	0ed	4/30/93	4/30/93
LANTDIV Review	30d	4/30/93	6/10/93
Prepare Draft RI/FS Project Plans	30ed	5/30/93	6/29/93
Submit Draft RI/FS Project Plans	0ed	6/29/93	6/29/93
Agency Review	30ed	6/29/93	7/29/93
Prepare Draft Final RI/FS Project Plans	30ed	7/29/93	8/28/93
Submit Draft Final RI/FS Project Plans	0ed	8/28/93	8/28/93
Agency Review	21ed	8/28/93	9/18/93
Prepare Final RI/FS Project Plans	21ed	9/18/93	10/9/93
Submit Final RI/FS Project Plans	0ed	10/9/93	10/9/93
Field Investigation	63ed	1/3/94	3/7/94
Sample Analysis / Validation	119ed	1/3/94	5/2/94
Data Evaluation	21ed	5/2/94	5/23/94
Risk Assessment	42ed	5/23/94	7/4/94
RI Report	144d	6/6/94	12/23/94
Preliminary Draft RI Report	42ed	6/6/94	7/18/94
Comment Period	28ed	7/18/94	8/15/94
Draft RI	28ed	8/15/94	9/12/94
Comment Period	30ed	9/12/94	10/12/94
Draft Final RI Report	30ed	10/12/94	11/11/94
Comment Period	21ed	11/11/94	12/2/94
Final RI	21ed	12/2/94	12/23/94

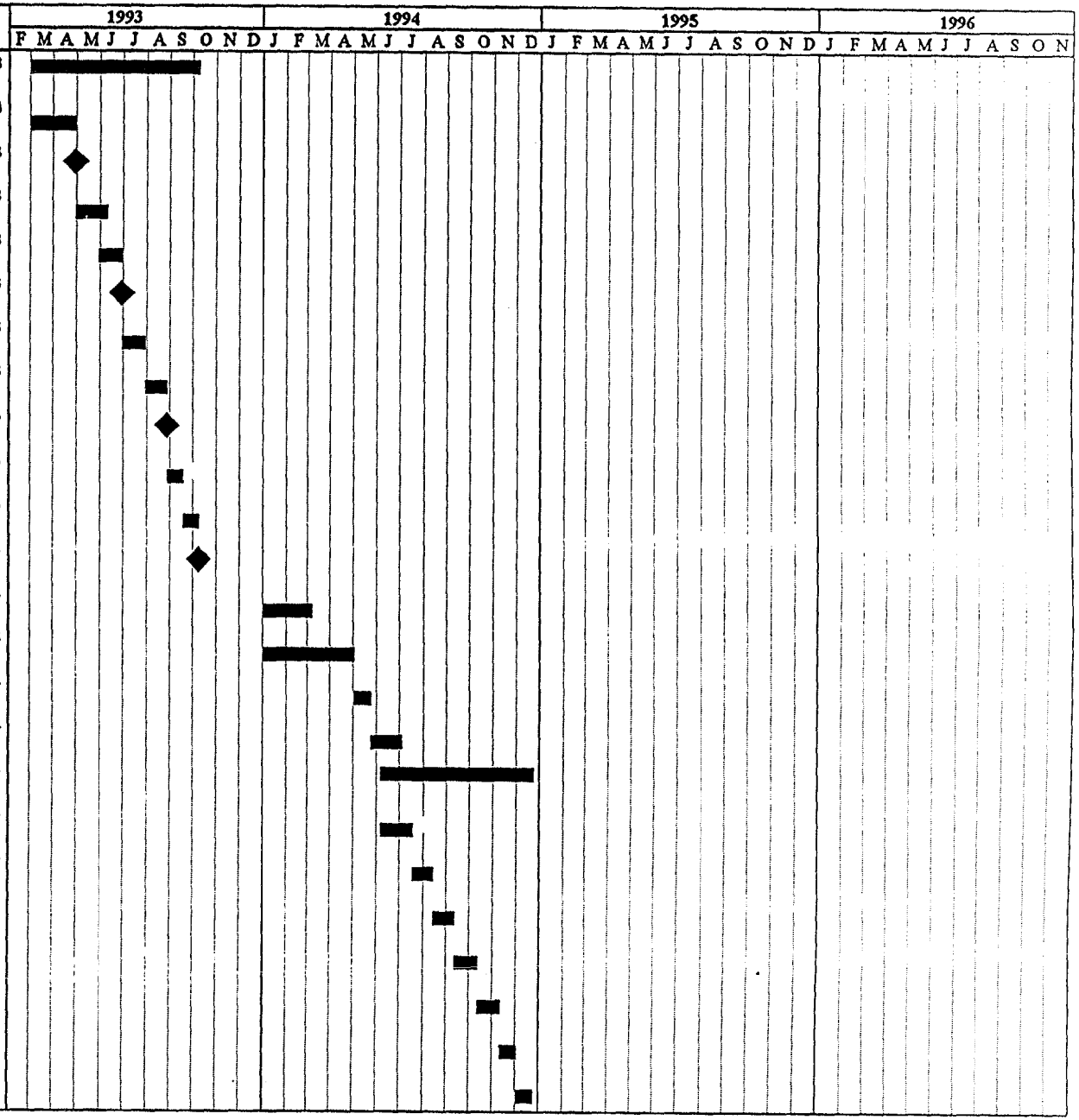
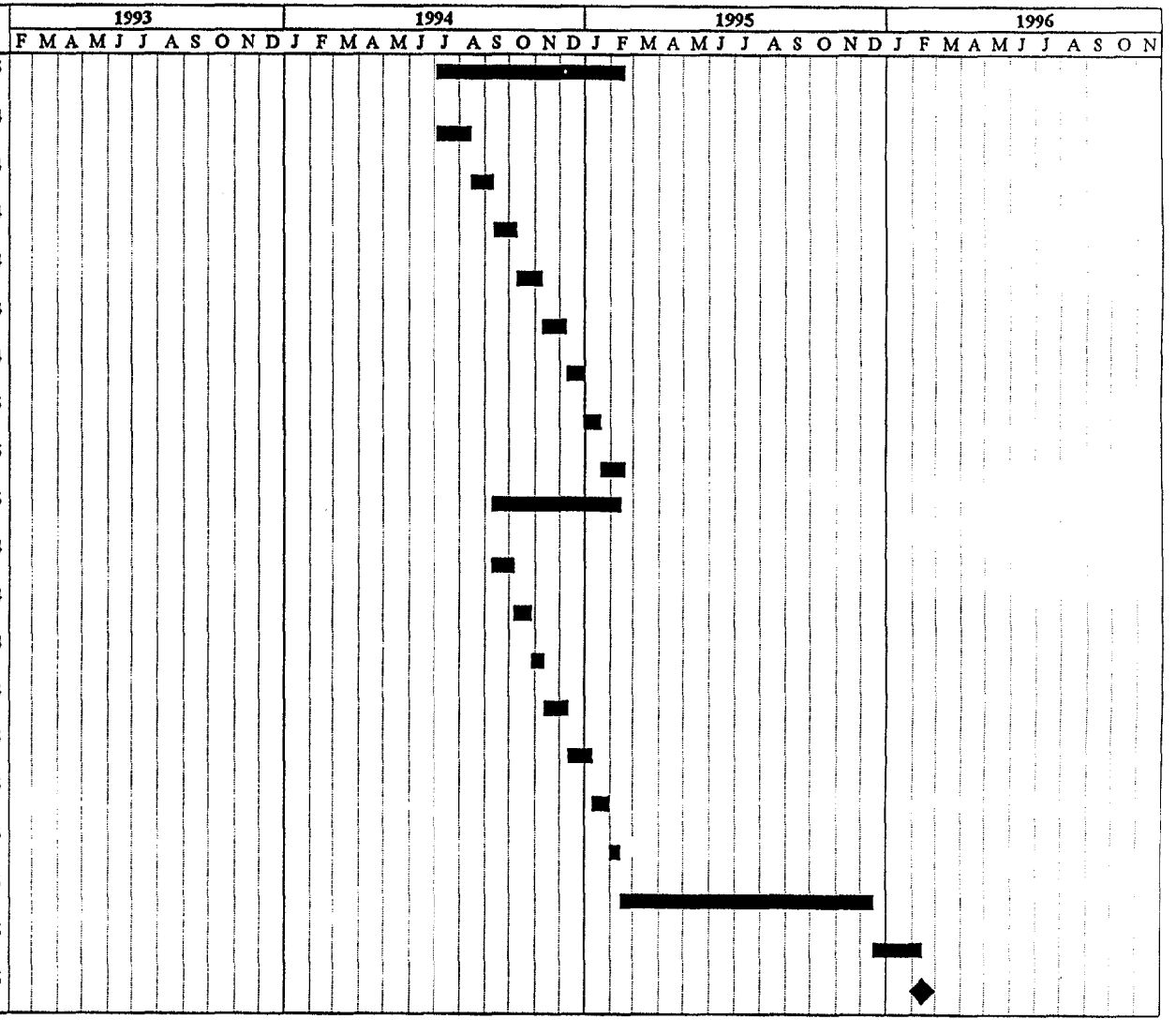


Table 7 - 2: Expedited Site Management Schedule

Sites 1, 28, and 30 (Operable Unit No. 7), MCB Camp Lejeune, NC

Task	Days	Start	Finish
FS Report / PRAP	165d	7/4/94	2/19/95
Preliminary Draft FS / PRAP	42ed	7/4/94	8/15/94
Comment Period	28ed	8/15/94	9/12/94
Draft FS / PRAP	28ed	9/12/94	10/10/94
Comment Period	30ed	10/10/94	11/9/94
Draft Final FS / PRAP	30ed	11/9/94	12/9/94
Comment Period	21ed	12/9/94	12/30/94
Final FS / PRAP	21ed	12/30/94	1/20/95
Public Comment Period	30ed	1/20/95	2/19/95
ROD	112d	9/9/94	2/14/95
Preliminary Draft ROD	28ed	9/9/94	10/7/94
Comment Period	21ed	10/7/94	10/28/94
Draft ROD	14ed	10/28/94	11/11/94
Comment Period	30ed	11/11/94	12/11/94
Draft Final ROD	30ed	12/11/94	1/10/95
Comment Period	21ed	1/10/95	1/31/95
Final ROD	14ed	1/31/95	2/14/95
Remedial Design (1,2)	305ed	2/14/95	12/16/95
Procure RA Contractor	60ed	12/16/95	2/14/96
Begin RA (1,2)	0ed	2/14/96	2/14/96



8.0 REFERENCES

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APPENDIX A.1
FINAL SITE SUMMARY REPORT
SITE 1

3.0 NATURE AND EXTENT OF CONTAMINATION

3.1 SITE 1 - FRENCH CREEK LIQUIDS DISPOSAL AREA

3.1.1 SITE BACKGROUND

This AOC is located on both the north and south sides of Main Service Road at the western edge of the Gun Park Area and Force Troops Complex (PWDM Coordinates 11, C7/D7). The total area for the AOC is approximately 7 to 8 acres (Figure 1-1). Site 1 has been used by many different Marine organizations since the 1940's. Liquid wastes from vehicle maintenance activities were poured on the ground as part of routine operations. Batteries and used battery acid were also disposed of at this location. Suspected quantities of waste are estimated to be: 5,000 to 20,000 gallons of waste petroleum, oil, and lubricants (POL) and 1,000 to 10,000 gallons of battery acid.

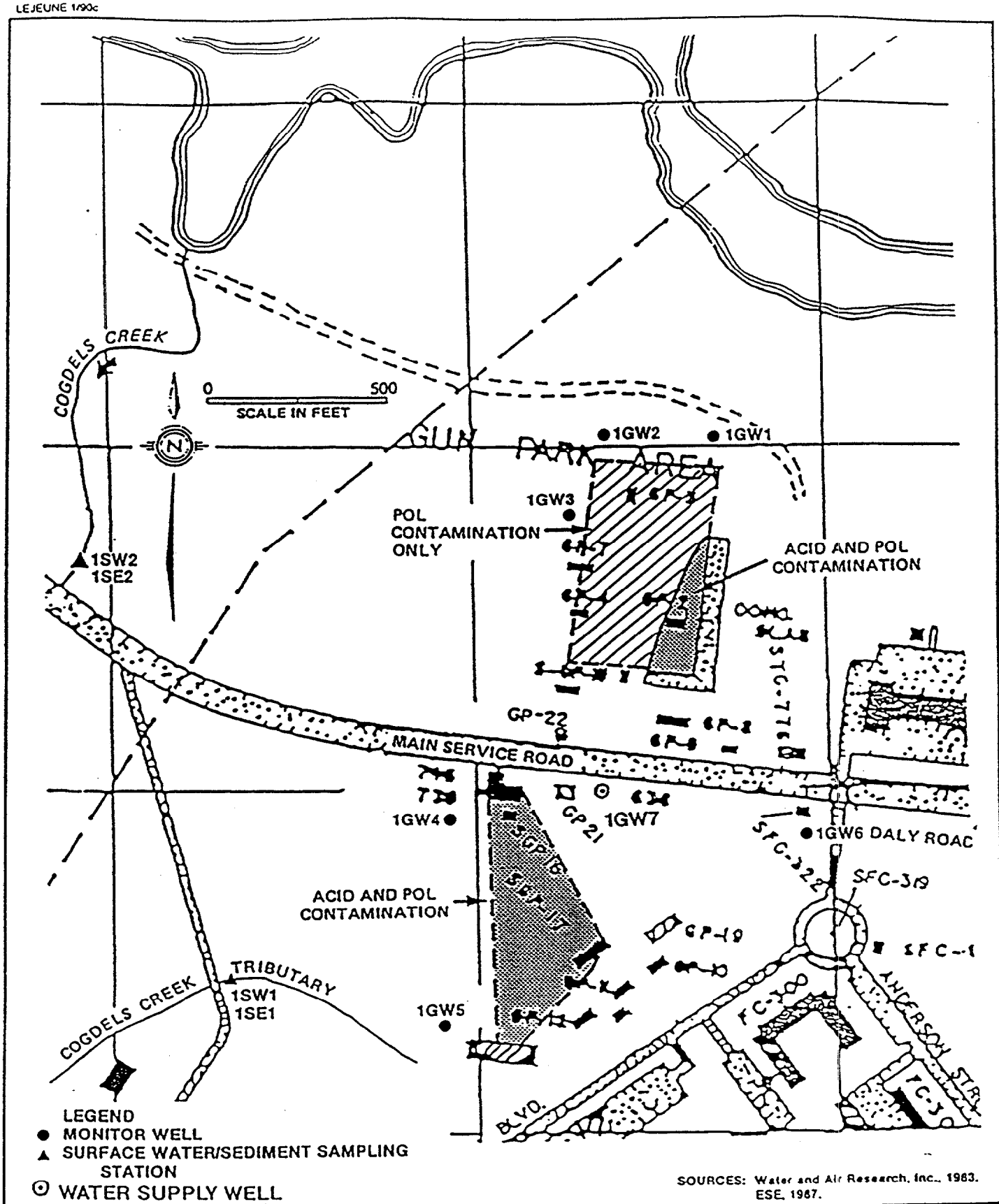
The area is underlain by silty and clayey sand. Gravelly sand and a limestone marl were also encountered during previous drilling efforts. A geologic cross section (Figure 1-2) has been drawn on a north-south line (Figure 1-3). The surface of the shallow groundwater lies within the silty sand at a depth of 7 to 17 feet below land surface. Groundwater flow is generally to the west towards Cogdels Creek at a dip of approximately 1/2 degrees (Figure 1-4).

3.1.2 SITE INVESTIGATION

GROUNDWATER

Six shallow monitoring wells were installed to characterize the groundwater at this site (Figure 1-1); 5 of the wells were installed downgradient and one upgradient (1GW6). Groundwater from the six wells was sampled in July 1984 and again in November 1986. An onsite water supply well, 1GW7 (No. 636) was also sampled in July 1984. The groundwater samples were analyzed for the following analytes:

LEJEUNE 1/90c



SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 1-1
SAMPLING LOCATIONS, SITE 1—
FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE
CAMP LEJEUNE

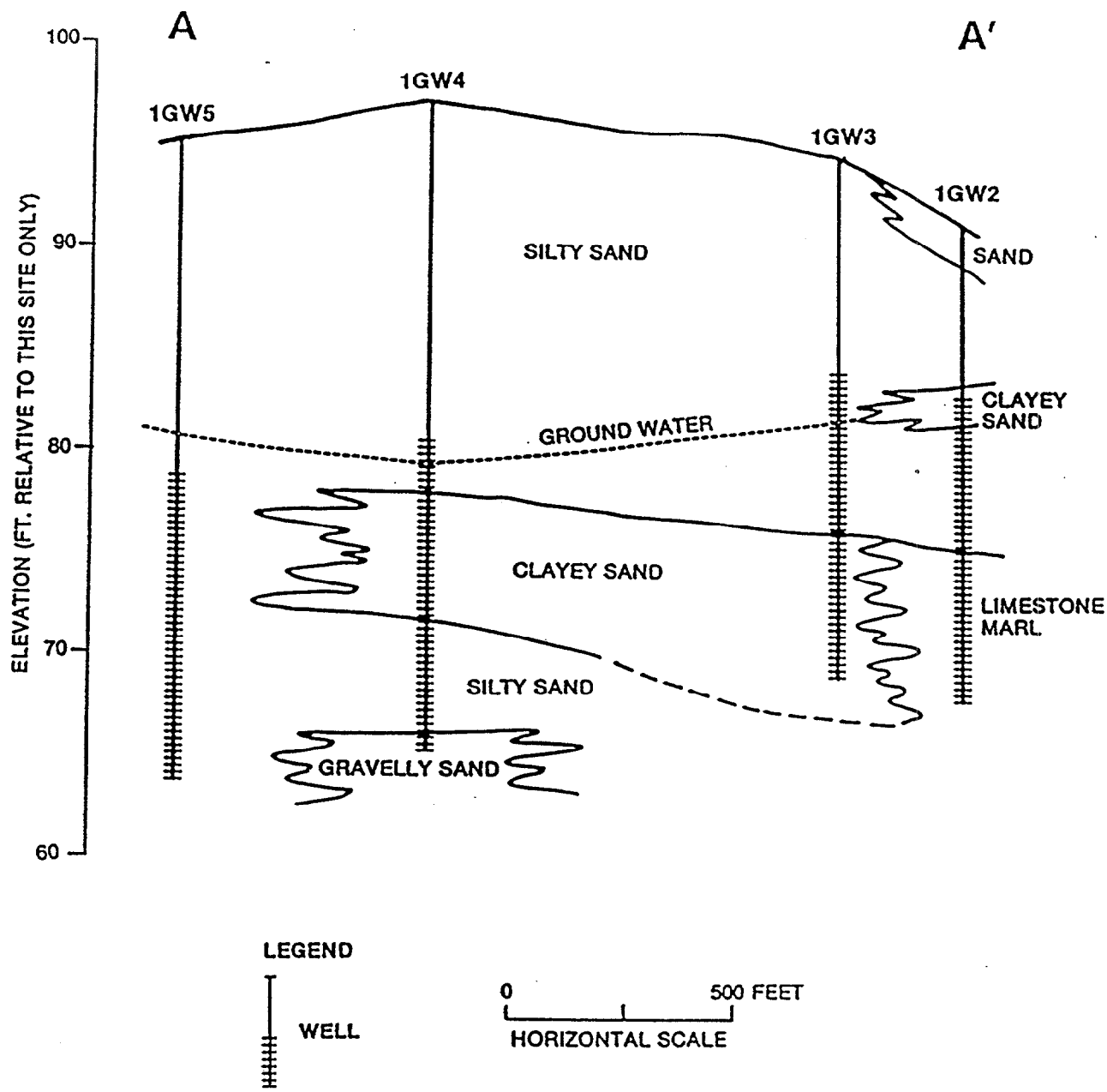


Figure 1-2
GEOLOGIC CROSS SECTION, SITE 1—
FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE
CAMP LEJEUNE

LEJEUNE 1/90c

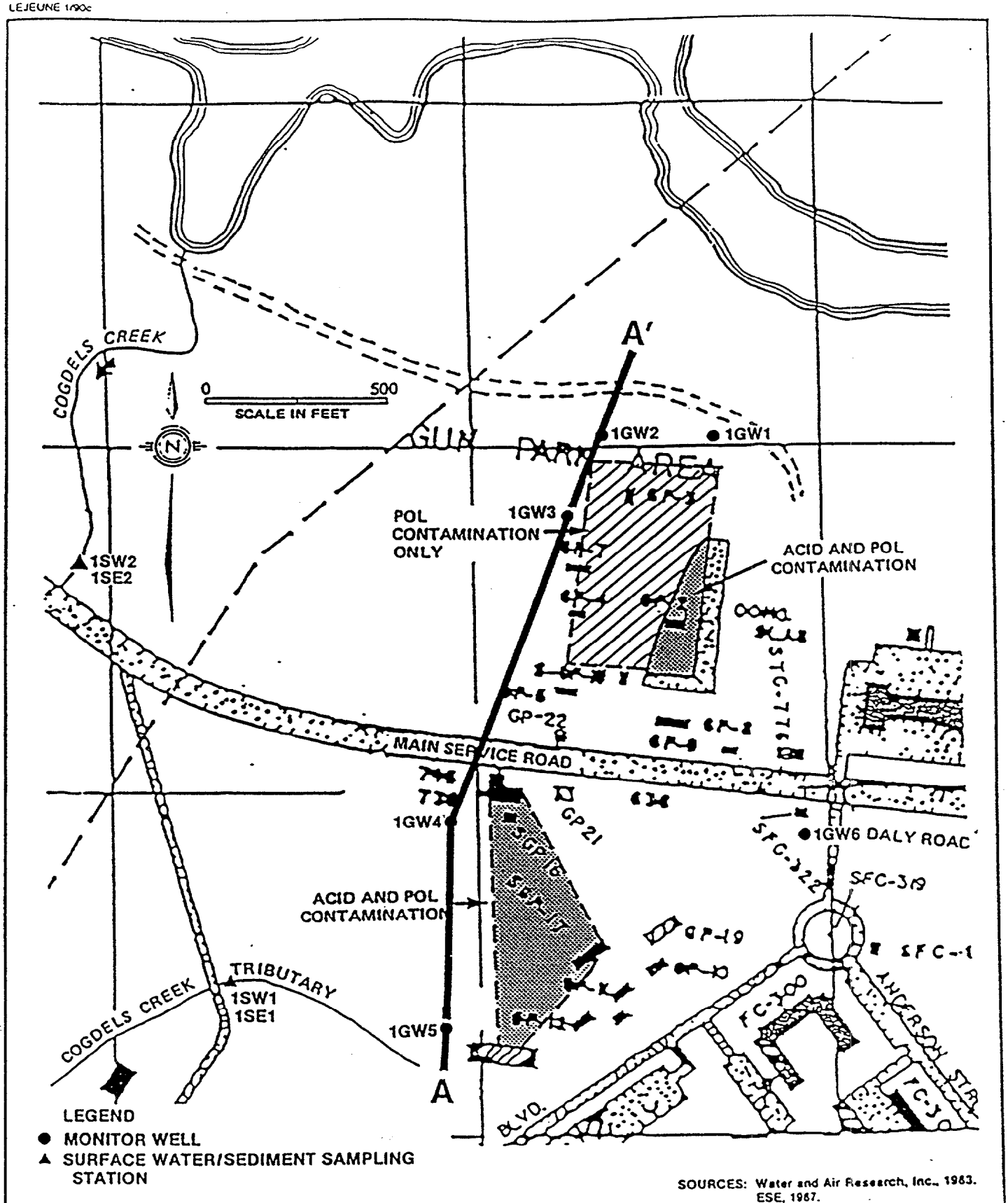


Figure 1-3
GEOLOGIC CROSS SECTION LOCATION, SITE 1—
FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE
CAMP LEJEUNE

LEJEUNE 1/90c

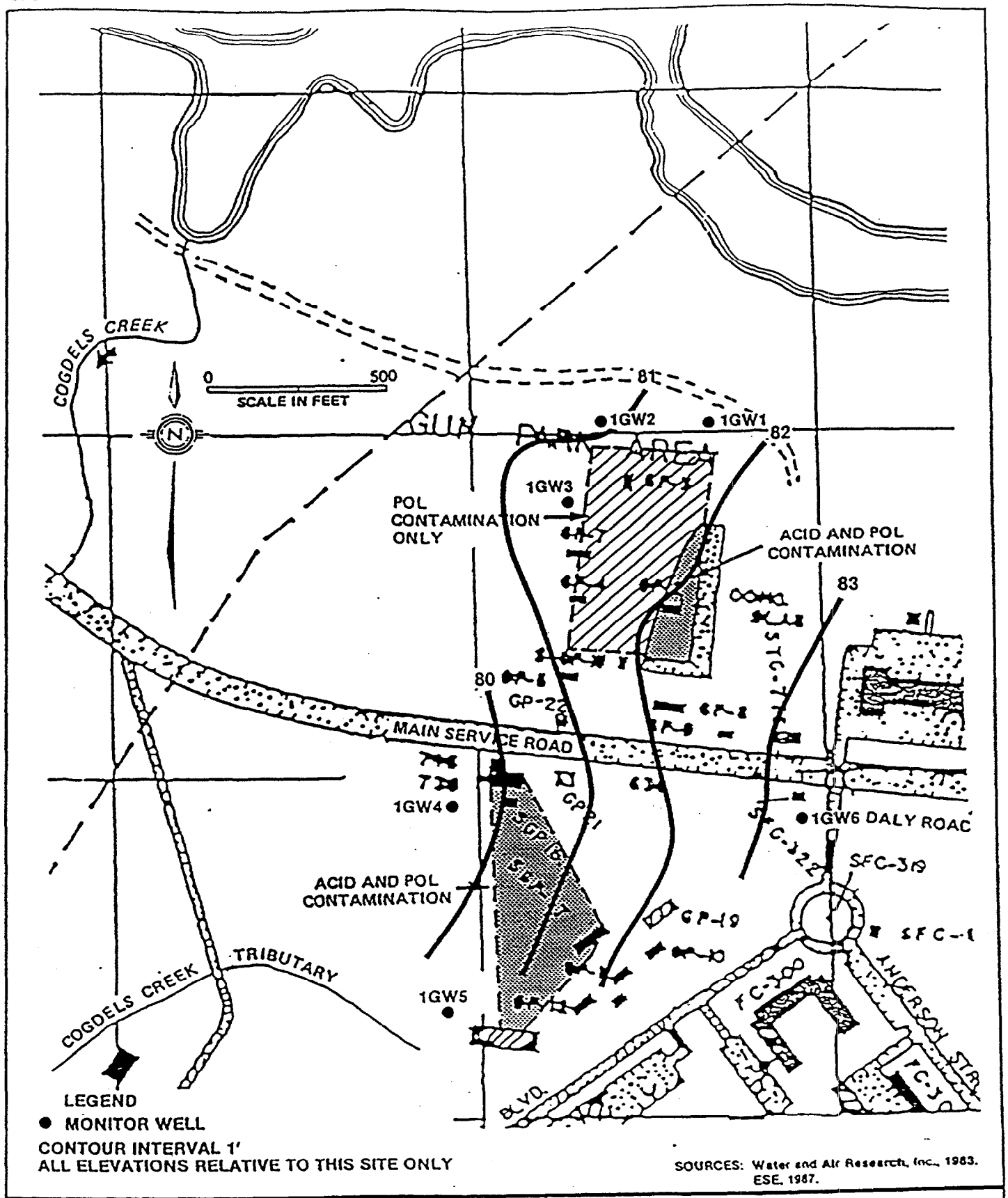


Figure 1-4
GROUND WATER CONTOUR MAP—
SHALLOW AQUIFER, SITE 1—
FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE
CAMP LEJEUNE

- Cadmium
- Chromium
- Hexavalent Chromium (1986 only)
- Lead
- Antimony
- Oil & Grease (O&G)
- Volatile organics (VOC)
- Total Phenols
- Xylene (1986 only)
- Methylethyl ketone (MEK) (1986 only)
- Methyl isobutyl ketone (MIBK) (1986 only)
- Ethylene dibromide (EDB) (1986 only)

Appendix A presents a complete listing of all target analytes and their abbreviations.

Table 1-1 presents the analytical data from both rounds of sampling. Only those target analytes that were detected above the method detection limit are reported on the table.

As shown in Table 1-1, several VOCs were detected in samples collected from Well 1GW5 during both rounds of sampling. This well is located on the southernmost portion (farthest downgradient) of the site. Wells 1GW1, 1GW2, and 1GW6 all had trace levels of VOCs, including phenols detected in samples collected in July 1984 and November 1986. Well 1GW6 is the "upgradient" well.

All of the groundwater samples from the six monitoring wells contained quantifiable amounts of cadmium, chromium and lead. The sample collected from the water supply well (1GW7) did not contain VOCs or metals above detection limits. Because all six monitor wells at Site 1 were found to contain similar quantities of contaminants, it appears that areas hydraulically upgradient were either subjected to the same disposal history as the pit(s) within Site 1 or an additional contaminant source of similar

TABLE 1-1. SITE 1 - FRENCH CREEK LIQUIDS DISPOSAL AREA
DETECTED TARGET ANALYTES
GROUNDWATER SAMPLES

PARAMETER / DATE	NC GW STANDARD	1GW1 7/5/84	1GW1 11/18/86	1GW2 7/5/84	1GW2 11/18/86	1GW3 7/5/84	1GW3 11/19/86	1GW4 7/5/84	1GW4 11/18/86	1GW5 7/7/84	1GW5 11/18/86	1GW6 7/5/84	1GW6 11/18/86	1GW7 7/5/84
BENZENE	1	0.5	<4.4	<0.3	<4.4	<0.3	<1.0	<0.3	<4.4	<0.3	<4.4	<0.3	<4.4	<0.3
1,1-DICHLOROETHANE	NONE	<0.5	<4.7	<0.5	<4.7	<0.5	<4.7	<0.5	<4.7	2.7	6.7	<0.6	<4.7	<0.5
1,1-DICHLOROETHYLENE	7	<1.0	<2.8	<1.0	<2.8	<1.1	<2.8	<1.0	<2.8	1.1	2.8	<1.2	<2.8	<1.1
T-1,2-DICHLOROETHENE	70	1.0	3.4	<1.0	2.0	<1.0	<1.6	<1.0	<1.6	2.4	2.4	<1.2	<1.6	<1.0
1,1,2,2-TETRACHLORO														
ETHANE	NONE	<0.7	<4.1	<0.7	<4.1	<0.8	<4.1	<0.7	<4.1	4	<4.1	<0.8	<4.1	<0.8
TETRACHLOROETHENE	NONE	<1.5	<4.1	<1.5	<4.1	<1.5	<3.0	<1.5	<4.1	6.8	<4.1	<1.7	<4.1	<1.5
1,1,1-TRICHLOROETHANE	200	<1.0	<3.8	<1.0	<3.8	<1.0	<3.8	<1.0	<3.8	<1.0	<3.8	14	<3.8	<1.0
TRICHLOROETHENE	NONE	2	4.6	1.3	3.2	<1.2	<3.0	<1.1	<1.9	5.2	2.2	<1.3	<1.9	<1.2
TOLUENE	1000	<0.5	<6.0	<0.5	<6.0	0.6	<6.0	<0.5	<6.0	0.9	<6.0	<0.6	<6.0	<0.5
CADMIUM	5	<6.0	<6.0	7	<6.0	10	<6.0	7	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
CHROMIUM	50	94	23.6	160	110	29	26.6	49	54.3	7	<15	34	28.8	<6.0
LEAD	50	43	<36	136	49.1	33	48.7	<40	<36	<40	<36	31	<36	<40
OIL & GREASE	NONE	2	<0.2	2	<0.2	3	0.4	2	<0.2	<0.7	<0.2	<0.8	<0.2	<0.8
PHENOLS	NONE	2	4	<1	4	2	3	2	<2	2	6	<6	19	<5

Values reported are concentrations in micrograms per liter (ug/L); this approximates parts per billion (ppb).

Note: Well 1GW6 is the upgradient well; Well 1GW7 is the supply well.

Source: ESE, 1990.

DOC.No.:CLEJ-00214-1.02-09/01/90

chemical character exists east of Site 1. In either case, the contaminants detected downgradient of Site 1 are consistent with the disposal history of Site 1, suggesting that the pits at Site 1 are/were a source of the detected contamination. However, additional pits or non-point sources of the detected contamination may also be present.

Oil & grease (O&G) was identified in samples collected from Wells 1GW1, 1GW2, 1GW3, and 1GW4. This target analyte was detected more often in the samples collect in July 1984 than in samples collected in November 1986. Well 1GW6 is the "upgradient" well.

SURFACE WATER/SEDIMENT

Two surface water and sediment samples were collected from Cogdels Creek and a tributary to the creek. These samples were collected only during the November 1986 round of sampling. The surface water samples were analyzed for the same parameters as the groundwater samples. Sediment samples were analyzed for the following:

- Cadmium
- Chromium
- Hexavalent Chromium
- Lead
- Antimony
- Oil & Grease (O&G)
- Total Phenols
- Ethylene dibromide (EDB)

Table 1-2 presents the analytes detected for the surface water samples. Detected target analytes in the sediment samples are presented in Table 1-3. All of the samples contained total chromium, phenols and O&G.

3.1.3 SUMMARY AND CONCLUSIONS

The groundwater contour map (Figure 1-4) indicates that flow in the shallow aquifer is from Site 1 toward Cogdels Creek. The measured gradient suggests that the site is characterized by low natural groundwater gradients. Based

TABLE 1-2. SITE 1 - FRENCH CREEK LIQUIDS DISPOSAL AREA
DETECTED TARGET ANALYTES
SURFACE WATER SAMPLES

DATE PARAMETER	NC SW STANDARD	1SW1 11/18/86	1SW2 11/18/86
CHROMIUM	50	7.3	<5.4
OIL & GREASE	NONE	0.8	0.2
PHENOLS	1	13	3

Values reported are concentrations in micrograms per liter (ug/L); this approximates parts per billion (ppb).

Source: ESE, 1990.

TABLE 1-3. SITE 1 - FRENCH CREEK LIQUIDS DISPOSAL AREA
DETECTED TARGET ANALYTES
SEDIMENT SAMPLES

DATE PARAMETER	1SE1 11/18/86	1SE2 11/18/86
CHROMIUM	20.8	3.69
OIL & GREASE	712	1460
PHENOLS	116	<90

Values reported are concentrations in micrograms per gram (ug/g); this approximates parts per million (ppm).

Note: There are no NC sediment standards.

Source: ESE, 1990.

on site maps, it appears that the shallow aquifer eventually discharges into the New River. Organic contaminants and several metals were detected in samples collected from the shallow aquifer. These contaminants however were not noted in the deeper aquifer sample; thus the data suggest that vertical migration is not occurring.
The levels of cadmium found in the samples collected from Wells 1GW2 and 1GW4 (7 ug/l) and 1GW3 (10 ug/l) were above the North Carolina groundwater standard established for this metal (5 ug/l). The groundwater standard for chromium (50 ug/l) was exceeded in samples collected from Wells 1GW1 (94 ug/l), 1GW2 (160 ug/l), and 1GW4 (54.3 ug/l). Groundwater samples from Wells 1GW2 and 1GW3 were also above the established standard for lead (50 mg/l).

O&G has been found in all media sampled at this AOC. This is not surprising since waste petroleum, oil and lubricants (POL) were known to be disposed of at this location. The O&G identified in the surface water and sediment samples seem to be associated with the past activities at this site. These contaminants may be impacting Site 28 located further downstream on Cogdels Creek.

3.1.4 RECOMMENDATIONS

The existing monitor well network at Site 1 has identified low levels of VOCs and metals. Of special concern is the presence of tetrachloroethane (1GW5) at a concentration of 6.8 micrograms per liter (ug/l) which is in excess of the state standard of 0.7 ug/l. In addition, cadmium, chromium, and lead were detected at levels greater than the applicable state groundwater standards. It should be noted that all existing monitor wells are located on the downgradient edge of the suspected center of contamination. It is possible that greater concentrations of detected contamination are present within the former disposal features. Although contamination of the shallow aquifer has been documented, sampling of adjacent deep water supply wells indicate that this contamination has not migrated vertically.
In order to provide an adequate database for completion of the RI/FS at this AOC, additional groundwater quality characterization is required within the specific disposal features identified by the IAS effort. This

characterization may be difficult to accomplish because of the presence of a large building and concrete paving over most of the area. Additional data needs of the RI/FS include chemical characterization of any affected unsaturated soils. To date, no chemical sampling of the soils have been conducted. Following adequate characterization of the affected environmental media, a Risk Assessment should be conducted to determine if the detected contamination represents a unacceptable risk to health and the environment.

APPENDIX A.2
ANALYTICAL SUMMARY FROM SOIL INVESTIGATION SITE 1

SUMMARY OF TCL ORGANICS ABOVE IDLs

Compound	Sample 01SB0100 (µg/kg)	Sample 01SB03135 (µg/kg)	Sample 01SB1716 (µg/kg)
Methylene Chloride	ND	11	ND
Toluene	1 J	ND	ND
Benzo (a) pyrene	ND	ND	860

J = Analyte present. Reported value may not be accurate or precise.
ND = Not detected above instrument detection levels.
IDL = Instrument detection level.

TABLE 3-2 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO.	1	1	2	2	3	3	4
BAKER SAMPLE NO.	01SB0100	01SB0114	01SB0200	01SB0214	01SB0300	01SB03135	01SB0400
COMPU CHEM SAMPLE NO.	432995	433013	433002	433012	433005	433010	433007
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Aluminum	6350	7320	1930	5970	6080	3750	1910
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	2.2	ND	ND	ND	ND	ND	ND
Barium	13.3	12	4.1	8.2	9.5	7.8	6.0
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND
Calcium	122	ND	176	ND	193	ND	262
Chromium	6.7	8.3	3.6	7.3	6.8	4.4	3.4
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	1.9	2.7	7.6	2.3	1.4	1.3	9.2
Iron	1860	1200	897	1640	1490	971	916
Lead	5.4 J	7.3 J	4.0 J	3.7 J	8.0 J	2.5 J	26.8 J
Magnesium	281	212	ND	224	179	146	ND
Manganese	6.0	3.5	6.6	8.4	5.2	5.5	11.3
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	2.8	4.9	2.3	2.9	2.3	4.8	2.5
Potassium	259	421	ND	460	ND	ND	ND
Selinium	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	8.1	6.5	2.8	6.1	6.6	3.2	2.8
Zinc	3.5	4.2	4.3	3.4	3.4	4.7	71.2
Cyanide	ND	ND	ND	ND	ND	ND	ND

Flags:

ND - Not detected above instrument detection level
J - Analyte present. Reported value may not be accurate or precise.

TABLE 3-2 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO.	4	5	5	6	6	7	7
BAKER SAMPLE NO.	01SB04145	01SB0500	01SB05135	01SB0600	01SB0613	01SB0700	01SB0713
COMPU CHEM SAMPLE NO.	433011	433008	433420	433423	433424	433425	433426
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Aluminum	3770	3290	4070	2640	4400	2610	4510
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	1.1	ND	ND	ND	ND
Barium	6.9	6.1	5.3	4.6	7.8	8.6	11.3
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND
Calcium	ND	261	ND	154	ND	28500	104
Chromium	4.6	3.4	6.7	2.7	6.1	6.1	3.8
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	2.0	1.4	1.8	ND	1.2	2.8	1.3
Iron	801	1260	1190	1090	1300	1350	598
Lead	2.9 J	3.8 J	2.5 J	2.4 J	3.1 J	13.5 J	4.1 J
Magnesium	156	102	127	79.8	174	547	ND
Manganese	4.8	6.9	2.5	4.9	3.8	22.5	4.7
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	3.9	3.7	2.7	3.4	2.4	7.7	4.8
Potassium	ND	ND	323	ND	305	303	ND
Selinium	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	0
Sodium	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	3.6	4.4	6.7	3.5	6.0	6.3	2.6
Zinc	3.3	1.9	1.6	1.7	2.4	11.0	2.3
Cyanide	ND	ND	ND	ND	ND	ND	ND

TABLE 3-2 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO.	8	8	9	9	10	10	11
BAKER SAMPLE NO.	01SB0800	01SB0813	01SB0900	01SB0913	01SB1000	01SB1016*	01SB1100
COMPU CHEM SAMPLE NO.	433427	433428	433429	433430	433910	433957	433908
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Aluminum	3630	8280	4920	4190	1730	6150	2060
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	1.8	ND	ND
Barium	8.7	11.1	9.8	6.7	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	0.84	ND	ND
Calcium	393	ND	6490	ND	488000 J	ND	17300 J
Chromium	4.4	9.3	6.9	4.1	8.1 J	8.8 J	3.7 J
Cobalt	ND	ND	ND	ND	1.4	1.6	ND
Copper	2.0	ND	1.8	ND	1.9	2.0	2.7
Iron	1720	1120	1940	565	3910	597	1100
Lead	9.5 J	5.1 J	19.8 J	8.7 J	9.3 J	2.2	13.3
Magnesium	ND	280	291	ND	3350	ND	ND
Manganese	10.7	3.4	12.8	2.4	156	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	3.3	5.2	4.1	ND	6.7	3.8	ND
Potassium	ND	299	341	ND	1010	ND	ND
Selinium	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	4.8	6.6	8.4	2.9	28.0	3.1	4.3
Zinc	9.2	3.2	5.5	2.1	ND	ND	ND
Cyanide	ND	ND	ND	ND	ND	ND	ND

* Sample is listed as 01SB0913 (date of receipt by lab 7/27)in Appendices D & E

TABLE 3 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO.	11	12	12	13	13	14	14
BAKER SAMPLE NO.	01SB1116	01SB1200	01SB1216	01SB1300	01SB1316	01SB1400	01SB1416
COMPU CHEM SAMPLE NO.	433909	433439	433444	433431	433433	433435	433445
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Aluminum	1650	2020	904	3880	2730	3050	3770
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	1.1	ND	ND	ND	ND	ND
Barium	ND	ND	ND	8.9	5.8	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND
Calcium	ND	65000 J	ND	31300	ND	20100 J	ND
Chromium	2.7 J	4.6 J	1.6 J	7.6	3.5	7.8 J	5.2 J
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	1.1	16.0	1.6	3.2	ND	3.8	1.2
Iron	544	1740	132	2160	519	1810	2260
Lead	1.4	9.6	1.4	17.6 J	1.8 J	32.7	2.5
Magnesium	ND	1030	ND	544	ND	ND	ND
Manganese	ND	27.1	ND	13.6	1.6	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	3.0	ND	2.6	3.1	2.3	ND
Potassium	ND	ND	ND	ND	ND	ND	ND
Selinium	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	2.2	4.5	ND	6.3	2.1	4.6	5.2
Zinc	ND	ND	ND	21.3	1.6	ND	ND
Cyanide	ND	ND	ND	ND	ND	ND	ND

TABLE 3-2 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO.	15	15	15	16	16	17	17
BAKER SAMPLE NO.	01SB1500	01SB1500D	01SB1516	01SB1600	01SB1616	01SB1700	01SB1716
COMPU CHEM SAMPLE NO.	433913	433911	433912	433916	433914	433915	433918
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Aluminum	5740	5510	6120	4510	3560	911	2770
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	1.4	ND	1.4	ND	ND	ND
Barium	ND	ND	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND
Calcium	ND	ND	ND	4580 J	768 J	ND	2300 J
Chromium	7.5 J	7.3 J	5.6 J	6.4 J	4.2 J	1.3 J	4.8 J
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	1.2	1.6	1.4	1.2	1.4	0.93	1.5
Iron	3110	2930	659	2370	939	408	2000
Lead	5.0	5.3	1.9	4.7	3.1	2.7	3.7
Magnesium	ND	ND	ND	ND	ND	ND	ND
Manganese	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	2.9	2.1	3.1	ND	2.2	2.3	ND
Potassium	ND	ND	ND	ND	ND	ND	ND
Selinium	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	8.8	8.8	2.6	6.8	2.8	1.3	3.2
Zinc	ND	ND	ND	ND	ND	26.0 J	ND
Cyanide	ND	ND	ND	ND	ND	ND	ND

TABLE 3-2 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO.	18	18	RINSATE	CONCENTRATION RANGE	AVERAGE CONCENTRATION
BAKER SAMPLE NO.	01SB1800	01SB1816	01R0820		
COMPU CHEM SAMPLE NO.	433917	434350	438953		
UNITS	MG/KG	MG/KG	ug/L	MG/KG	MG/KG
Aluminum	925	1990	ND	904 - 8,280	3772
Antimony	ND	ND	ND		
Arsenic	ND	1.5	ND	1.1 - 2.2	1.50
Barium	ND	ND	9.5	4.1 - 13.3	8.13
Beryllium	ND	ND	ND		
Cadmium	ND	ND	ND	0.84	0.84
Calcium	ND	ND	27700	104 - 488,000	37000
Chromium	1.1 J	3.2	ND	1.1 - 9.3	5.23
Cobalt	ND	ND	ND	1.4 - 1.6	1.50
Copper	ND	6.4	ND	0.93 - 16	2.81
Iron	312	1020	ND	132 - 3,910	1363
Lead	1.9	2.1	ND	1.4 - 32.7	6.9
Magnesium	ND	139	2210	79.8 - 3,350	462
Manganese	ND	ND	ND	1.6 - 156	14.7
Mercury	ND	ND	ND		
Nickel	ND	ND	ND	2.1 - 7.7	3.49
Potassium	ND	ND	1290	259 - 1,010	413
Selinium	ND	ND	ND		
Silver	ND	ND	ND		
Sodium	ND	ND	7830		
Thallium	ND	ND	ND		
Vanadium	1.1	5.3	ND	1.1 - 28	5.36
Zinc	ND	8.0	63.2 J	1.6 - 71.2	8.90
Cyanide	ND	ND	ND		

TABLE 3-2 SUMMARY OF TAL INORGANIC DATA ABOVE IDLs

BORING NO. BAKER SAMPLE NO. COMPU CHEM SAMPLE NO. UNITS	MEDIAN CONCENTRATION MG/KG
Aluminum	3750
Antimony	
Arsenic	1.4
Barium	8
Beryllium	
Cadmium	0.84
Calcium	1534
Chromium	4.8
Cobalt	1.5
Copper	1.8
Iron	1190
Lead	4.0
Magnesium	212
Manganese	5.75
Mercury	
Nickel	3.05
Potassium	323
Selinium	
Silver	
Sodium	
Thallium	
Vanadium	4.55
Zinc	3.45
Cyanide	

APPENDIX B
FINAL SITE SUMMARY REPORT
SITE 28

3.8 SITE 28 - HADNOT POINT BURN DUMP

3.8.1 SITE BACKGROUND

The Hadnot Point Burn Dump (Figure 28-1) is located east of the Mainside Sewage Treatment Plant (STP) and is on both sides of Cogdels Creek (PWDM Coordinates 10,Q13-14/R13-14). A variety of solid wastes including mixed industrial waste, trash, garbage, oil-based paint, and refuse was burned and subsequently covered with dirt on this 23 acre disposal area which was in operation from 1946 to 1971. Upon its closure in 1971, the surface was graded and grass was planted. The volume of fill is estimated at 185,000 to 379,000 cubic yards. Since the waste was burned, no approximation of the remaining amount of specific substances can reasonably be made. The site is currently used as a recreational area including a stocked fishing pond.

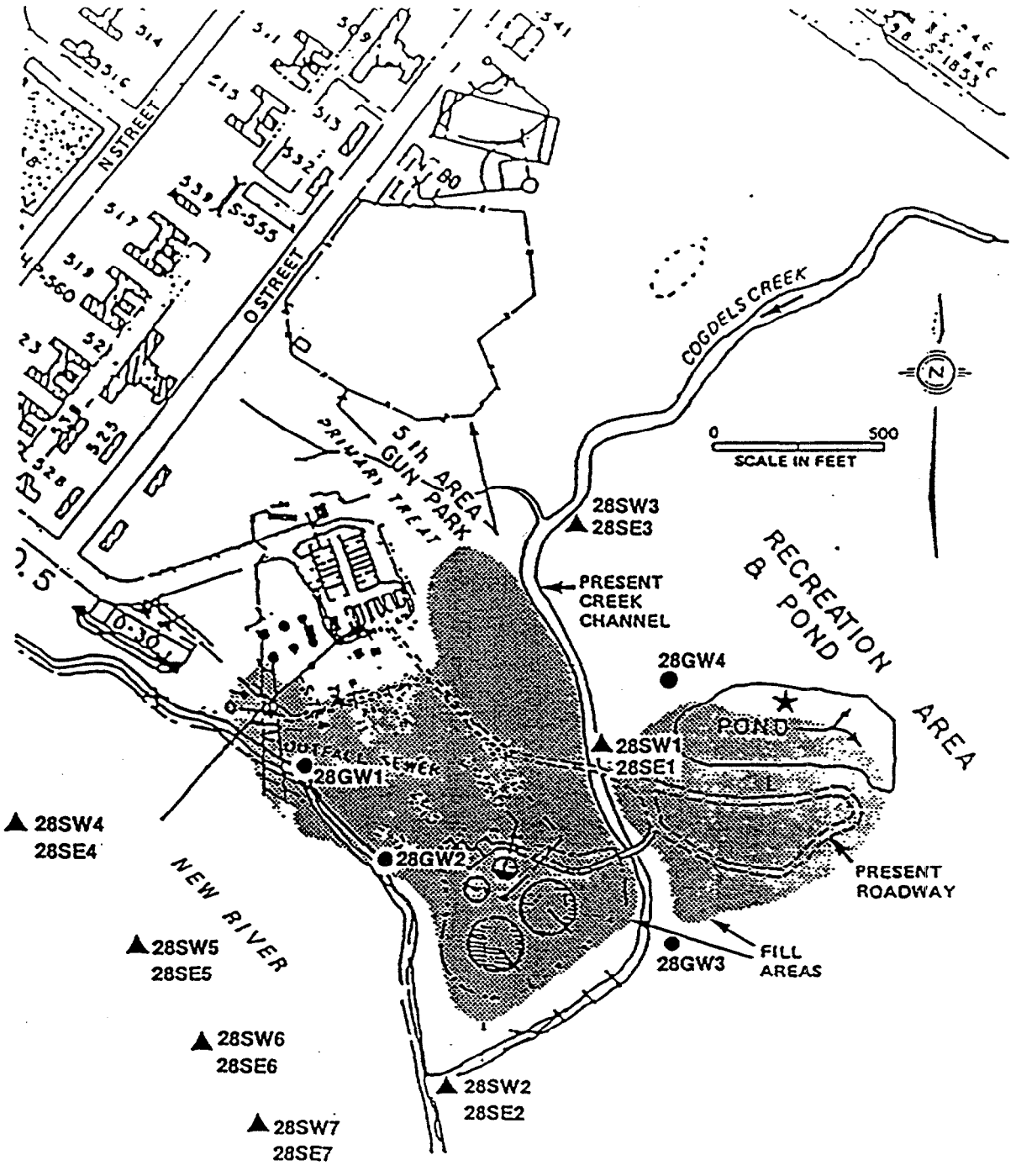
Site 28 is underlain primarily by silty sand, however sandy, gravelly fill material and debris from the former disposal activities were encountered during drilling activities. Figure 28-2 presents a geologic cross section of the area drawn on a northwest-southwest line (Figure 28-3).

The surface of the shallow groundwater at this site ranges in depth from 1.48 to 3.35 feet below land surface and lies within the silty sand and the debris. The cross section and groundwater contour map (Figure 28-4) show the pond and Cogdels Creek to be potential sources of recharge at this site. Groundwater flow is to the west toward the New River at a gradient of approximately 0.002 ft/ft.

3.8.2 SITE INVESTIGATION

GROUNDWATER

Four shallow monitoring wells were installed (Figure 28-1) and sampled as part of the 1984 groundwater investigation. Three wells were installed in 1984; Well 28GW1 and Well 28GW2 on the downgradient side of the site at the shoreline of the New River, and Well 28GW3 on the downgradient side of the eastern portion of the site, east of Cogdels Creek. One monitoring well (28GW4) was installed in 1986 upgradient of the filled areas and the recreational pond. Table 28-1 presents the analytical data from the July



LEGEND
● MONITOR WELL
▲ SURFACE WATER/SEDIMENT SAMPLING STATION

SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 28-1
SAMPLING LOCATIONS, SITE 28—
HADNOT POINT BURN DUMP

MARINE CORPS BASE
CAMP LEJEUNE

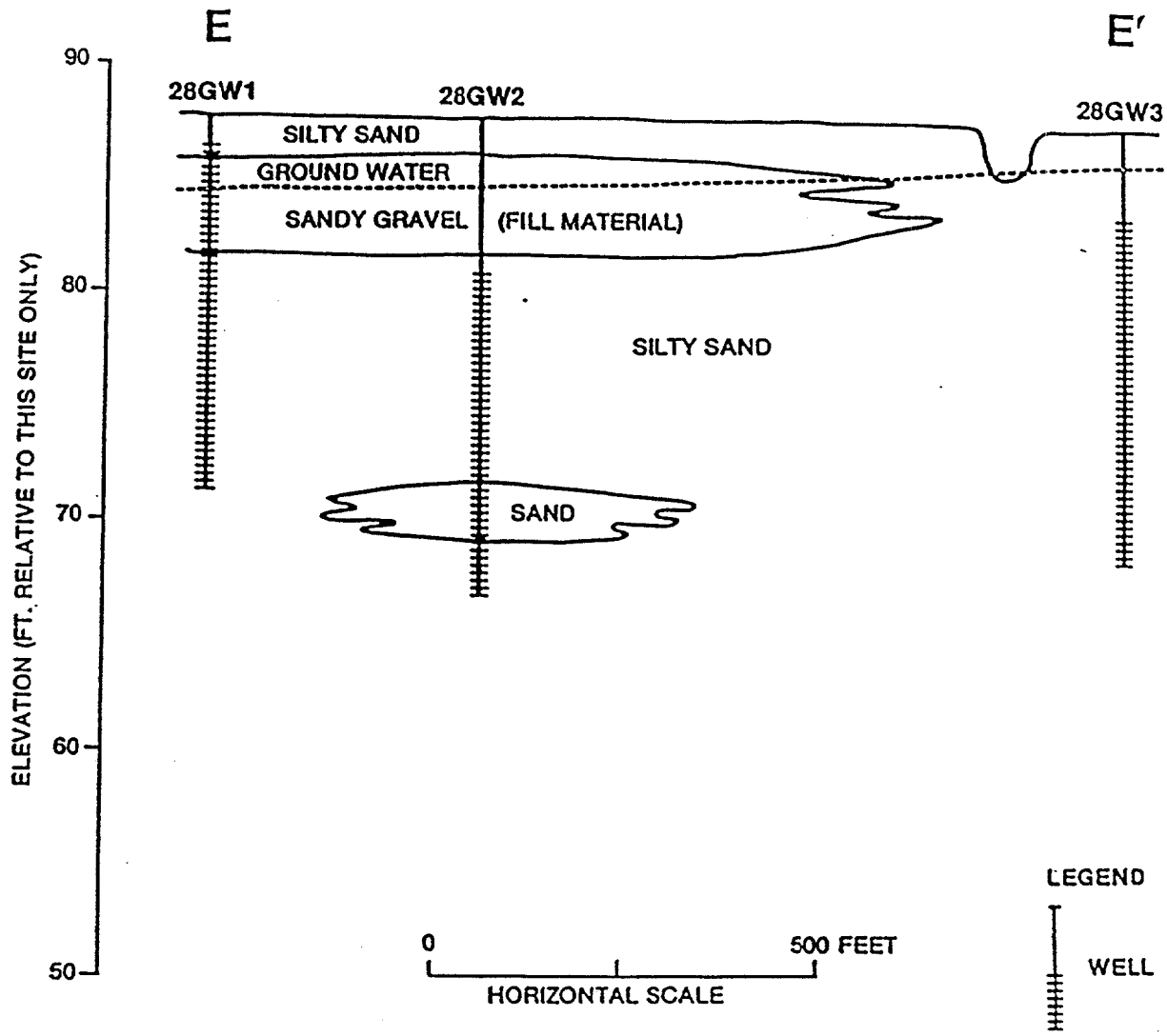
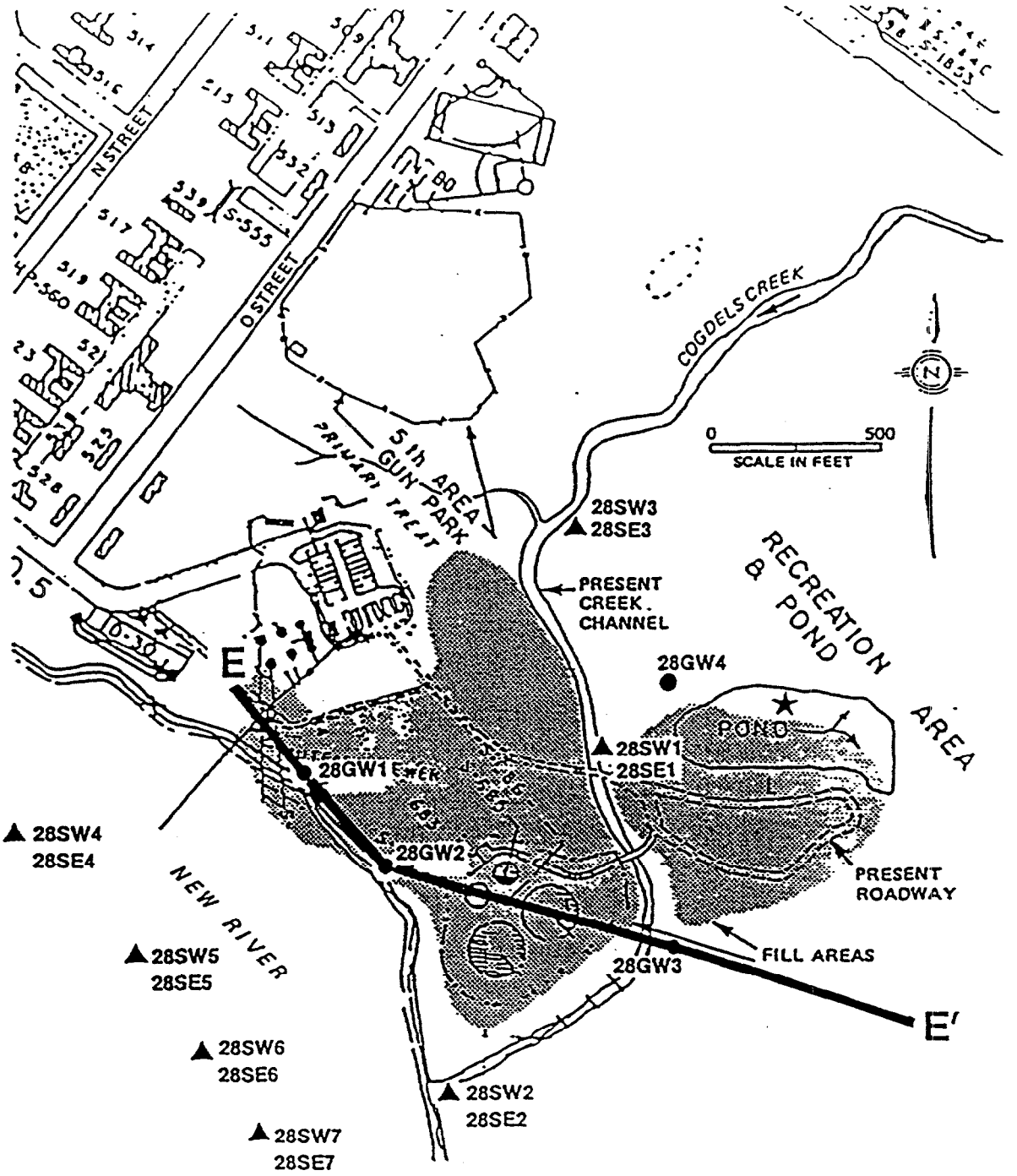


Figure 28-2
GEOLOGIC CROSS SECTION, SITE 28—
HADNOT POINT BURN DUMP

MARINE CORPS BASE
CAMP LEJEUNE



LEGEND

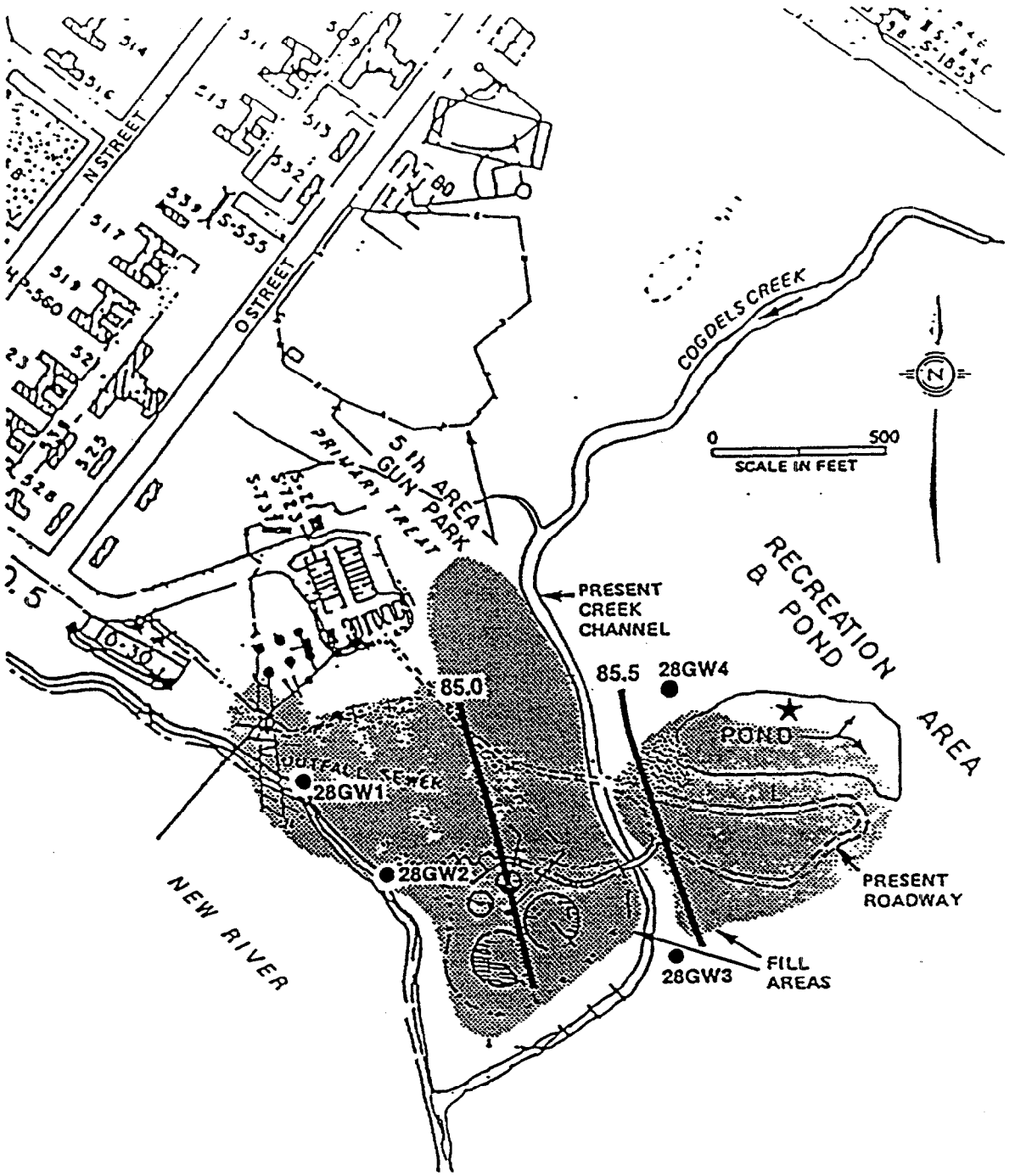
● MONITOR WELL

▲ SURFACE WATER/SEDIMENT SAMPLING STATION

SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 28-3
GEOLOGIC CROSS SECTION LOCATION, SITE 28—HADNOT POINT BURN DUMP

MARINE CORPS BASE
CAMP LEJEUNE



LEGEND

● MONITOR WELL

CONTOUR INTERVAL 0.5'
ALL ELEVATIONS RELATIVE TO THIS SITE ONLY

SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 28-4
GROUND WATER CONTOUR MAP—
SHALLOW AQUIFER, SITE 28—
HADNOT POINT BURN DUMP

MARINE CORPS BASE
CAMP LEJEUNE

TABLE 28-1. SITE 28 - HADNOT POINT BURN DUMP
DETECTED TARGET ANALYTES
GROUND WATER SAMPLES

DATE	NC GW STANDARDS	28GW1 7/7/84	28GW1 12/16/86	28GW2 7/7/84	28GW2 12/16/86	28GW3 7/7/84	28GW3 12/11/86	28GW4 12/11/86	28GW4 3/4/87
PARAMETER									
T-1,2-DICHLORO									
ETHENE	70	38	14	<1.3	<1.6	<1.5	<1.6	<1.6	<1.6
TRICHLOROETHENE	NONE	15	4.9	<1.4	<1.0	<1.7	<3.0	<3.0	<3.0
VINYL CHLORIDE	0.015	22	13	<1	<1.0	<1	<1.0	<1.0	<1.0
DDD,PP'	NONE	0.12	<0.013	0.093	0.018	0.22	<0.013	<0.013	<0.006
DDE,PP'	NONE	0.015	<0.013	0.028	<0.013	0.007	<0.013	<0.013	<0.006
DIELDRIN	NONE	0.003	<0.013	<0.001	<0.013	<0.001	<0.013	<0.013	<0.006
OIL & GREASE	NONE	5	8	2	0.4	0.8	<0.3	<0.09	9
ARSENIC	50	18	9.5	<1	<2.1	21	INTF	INTF	12.1
CHROMIUM	50	<6	12	<6	<9.4	330	15.8	92.6	54
CHROMIUM(+6)	NONE	NA	<10	NA	<10	NA	<10	46.4	<10
LEAD	50	<40	140	<40	38	336	<27	<27	<27
MERCURY	1.1	0.3	0.2	<0.2	0.3	<0.2	0.8	0.7	0.5
NICKEL	150	<15	<22	<15	<22	39	<22	43.1	16
ZINC	5000	<3	58	<3	39	143	12.3	142	77

INTF: interference
NA: not analyzed

Values reported are concentrations in micrograms per liter (ug/L); this approximates parts per billion (ppb).

Source: ESE, 1990.

DOC.No.:CLEJ-00214-1.02-09/01/90

1984, December 1986 and March 1987 sampling efforts. Only those parameters that were detected above the method detection limits are reported in the table. The groundwater samples were analyzed for the following analytes:

- o Metals B
- o Hexavalent chromium (Cr^{+6})
- o Organochlorine pesticides (OCP)
- o Polychlorinated Biphenyls (PCB)
- o Oil and Grease (O&G)
- o Volatile organic compounds (VOC)
- o Tetrachlorodioxin (TCDD) (1986/87 only)
- o Xylene (1986/87 only)
- o Methylethyl ketone (MEK) (1986/87 only)
- o Methyl isobutyl ketone (MIBK) (1986/87 only)

Appendix A presents a full listing of all target analytes and their abbreviations. In July 1984 detectable levels of DDD and DDE were identified in all three monitoring well samples. No pesticides were detected in the 1986 or 1987 samples.

Trace levels of VOCs were detected in the 1984 sample from Well 28GW1 located at the New River shore line downgradient of the filled area in the western portion of Site 28. Vinyl chloride was also detected in this well at a level which exceeded the 10^{-5} risk level (2 ug/L for drinking water only). Three VOCs (trans-1,2-dichloroethene, vinyl chloride, and trichloroethene) were also detected in Well 28GW1 in December 1986. The levels of trans-1,2-dichloroethene detected in 1984 and 1986 were below the groundwater standard of 70 ug/L. The levels of trichloroethene are above the N.C. Groundwater Standard of 2.8 ug/L.

Metals were detected in the July 1984 samples from Wells 28GW1 and 28GW3. The highest concentration of metals found were in Well 28GW3; chromium and lead exceeded the applicable groundwater standards. Mercury was detected in Well 28GW1 at concentrations below the N.C. Groundwater Standard of 1.1 ug/L. A number of metals were detected in all four monitoring wells in the 1986 and

1987 samples, suggesting a relatively uniform disposal pattern throughout the site. Of the detected metals, total chromium was detected above the groundwater standard in Wells 28GW3 and 28GW4. Hexavalent chromium was detected in the 1986 sample from Well 28GW4, but not in the March 1987 sample. Arsenic was detected in Wells 28GW1, 28GW3, and 28GW4 in the July 1984, December 1986 and March 1987 samples where the analysis did not encounter matrix interference.

Low levels of O&G were detected in all three monitoring well samples collected in 1984, and in all four well samples collected in 1986 and 1987 except for Well 28GW3 in 1986.

The levels and mix of detected analytes in the two rounds of sampling are somewhat different. Of the greatest significance is the lack of pesticides detected in the 1986 and 1987 samples suggesting that the occurrence of these analytes in the groundwater is subject to time variance. The levels of VOCs detected in Well 28GW1 in 1986 are in similar proportion to those detected in 1984, but are slightly reduced. The levels of metals detected in all 1986/87 samples are generally similar to the 1984 samples, although there appears to be a general lowering of metal concentrations in the 1986/87 samples overall.

SURFACE WATER

Seven surface water sampling stations (Figure 28-1) were sampled as part of the investigation. Two of the seven sampling locations were sampled in August 1984; 28SW1 in the north central portion of the filled area where Cogdels Creek passes through the landfill and 28SW2 in Cogdels Creek downstream of the filled area near the intersection with the New River. During the December 1986 investigation, five new sampling locations were added, four in the New River and one in Cogdels Creek upstream of the filled area. The surface water samples were analyzed for the same parameters as the groundwater samples. Table 28-2 presents the analytical data for all analytes that were detected over the method detection limit.

TABLE 28-2. SITE 28 - HADNOT POINT BURN DUMP

DETECTED TARGET ANALYTES

SURFACE WATER SAMPLES

	NC SW	28SW1	28SW1	28SW1	28SW2	28SW2	28SW2	28SW3	28SW4	28SW5	28SW6	28SW7
DATE	STANDARDS	8/3/84	8/4/86	12/11/86	8/3/84	8/4/86	12/11/86	12/11/86	12/15/86	12/15/86	12/15/86	12/15/86
PARAMETER												
BHC,A	NONE	0.01	<0.001	<0.035	<0.001	<0.001	<0.035	<0.035	<0.013	<0.025	<0.013	<0.013
BHC,B	NONE	0.0009	<0.0001	<0.013	0.002	<0.0001	<0.013	<0.013	<0.013	<0.025	<0.013	<0.013
BHC,D	NONE	0.004	<0.0003	NR	<0.0003	<0.0003	NR	NR	<0.013	<0.025	<0.013	<0.013
CADMIUM	2	<4	NA	<2.9	<4	8.4	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9
CHROMIUM	50	<3	NA	<9.4	<3	<5	<9.4	<9.4	17.8	<9.4	10.7	<9.4
MERCURY	0.2	<0.2	NA	0.8	<0.2	<0.2	0.5	0.6	<0.2	<0.2	<0.2	<0.2
ZINC	50	32	NA	<5.9	20	29	<5.9	<5.9	8.9	<5.9	<5.9	<5.9
TRICHLOROETHENE	NONE	1.3	NA	<3	1.1	NA	<3	<3	<3	<3	<3	<3

NA: not analyzed.

NR: not reported.

Values reported are concentrations in micrograms per liter (ug/L); this approximates parts per billion (ppb).

Source: ESE, 1990.

DOC.No.:CLEJ-00214-1.02-09/01/90

The water chemistry data for the surface water differed significantly from the groundwater data indicating that the analytes detected in the surface water may be attributed to activities upstream of the site or of a unique disposal at the far northern portion of the site. BHC,A, BHC,B and BHC,D were present in the December 1984 samples from 28SW1 and 28SW2 but were not identified in the groundwater during that same time. These pesticides were not detected in any of the December 1986 samples. However method detection limits in 1986 increased and the absence of detectable levels of the BHC isomers in 1986 may be attributable to this factor.

Trichloroethene was detected in both of the Cogdels Creek surface water samples in 1984 but were not detected in any of the 1986 samples. This VOC was also detected in the samples collected from Well 28GW1 in both 1984 and 1986.

Zinc was detected in surface water samples collected in 1984 from 28SW1 and 28SW2. It was not detected at 28SW1 or 28SW2 in the 1986 samples and was present in only 28SW4 in 1986. Mercury was not detected in 1984 samples but was present in the 1986 samples for all three locations in Cogdels Creek at levels greater than the water quality standard of 0.2 ug/L. Since mercury was present upstream of the site (28SW3), this may indicate that the source is upstream of the Hadnot Point Burn Dump. Chromium was not detected in Cogdels Creek but was present in two of the four samples taken from the New River. Cadmium was detected at sampling station 28SW2 in August 1986 but was not detected in December 1986.

SEDIMENT

Seven sediment locations corresponding to the surface water sampling locations were sampled as part of the investigation (Figure 28-1). The sediment samples were analyzed for the following parameters:

- Metals B
- Organochlorine pesticides (OCP)
- Polychlorinated Biphenyls (PCB)

- o Oil and Grease (O&G)
- o Tetrachlorodioxin (TCDD) (1986 only)
- o Hexavalent Chromium

Appendix A lists the individual target analytes and their abbreviations. Analytical results for the sediment samples are presented in Table 28-3. Only those parameters detected above method detection limits were reported. Chlordane was the only parameter detected in the sediment that was not detected in either the groundwater or the surface water. Chlordane was detected in all three samples from Cogdels Creek during the December 1986 sampling effort. In addition DDE was detected in 1984 and 1986 in both 28SE1 and 28SE2.

O&G levels were higher in 1986 than in 1984 within Cogdels Creek. Similar concentrations were identified in the New River samples.

Detectable levels of arsenic, cadmium, chromium, lead, nickel and zinc were identified in most of the samples in both Cogdels Creek and the New River. Nickel was the only metal of those listed above that was not present in all four of the New River samples.

TISSUE

Two samples from fish tissue were obtained from the fresh water pond at the north terminus of Site 28 in 1984 only. The tissue samples were analyzed for OCP and PCB. Listed below are the analytical results of the sampling effort performed on July 17, 1984:

	Concentration (ug/L)	
Parameter	28TI1	28TI2
PCBs, Total	11	8
BCH,A	0.10	0.1

PCBs were not detected elsewhere in the investigation. PCBs are bioaccumulated in the foodchain and may or may not have originated from the

TABLE 28-3. SITE 28 - HADNOT POINT BURN DUMP
DETECTED TARGET ANALYTES
SEDIMENT SAMPLES

DATE	28SE1 8/3/84	28SE1 12/11/86	28SE2 8/3/84	28SE2 12/11/86	28SE3 12/11/86	28SE4 12/15/86	28SE5 12/15/86	28SE6 12/15/86	28SE7 12/15/86
PARAMETER									
CHLORDANE	<0.0023	0.298	<0.0041	0.347	0.595	<0.0639	<0.0645	<0.0661	<0.0645
DDD,PP'	0.084	<0.0159	0.0022	<0.0351	<0.0459	<0.0128	<0.0129	<0.0132	<0.0129
DDE,PP'	0.0012	0.243	0.0005	0.0619	<0.0597	<0.155	<0.156	<0.160	<0.156
OIL & GREASE	474	1520	1440	2750	4630	238	177	<176	144
ARSENIC	1.50	6.86	<0.1	10.3	10.4	<0.561	<0.757	1.32	0.645
CADMIUM	0.100	3.15	<0.1	<1.94	4.47	<0.617	<0.459	<0.473	<0.452
CHROMIUM	10	22.5	0.4	18.2	27.4	2.38	3.53	2.69	2.77
LEAD	46	190	2	42.1	135	<5.75	<4.27	4.52	4.75
NICKEL	2	13.4	0.8	<14.7	<20.1	<4.68	<3.48	<3.590	<3.430
ZINC	16	675	1	79.1	167	4.38	3.73	6.06	4.98

Values reported are concentrations in milligrams per kilogram (mg/kg); this approximates parts per million (ppm).

Note: There are no NC soil standards.

Source: ESE, 1990.

DOC.No.:CLEJ-00214-1.02-09/01/90

site depending on the origin of the fish in the pond. The BHC,A data for tissue indicate that this compound was present in this area of Site 28 and may be discharging to Cogdels Creek, as indicated by the surface water chemical data. Levels of PCB and BHC,A were below acute toxicity levels.

3.8.3 SUMMARY AND CONCLUSIONS

The groundwater contour map (Figure 28-4) strongly indicates that groundwater from the shallow aquifer directly discharges to the New River and discharges indirectly through Cogdels Creek. Target analytes in the shallow groundwater have been detected in excess of applicable groundwater standards. Table 28-1 includes a comparison of target analytes found in the shallow groundwater to applicable State of North Carolina groundwater standards contained in Title 15 of the North Carolina Administrative Code. This indicates that contaminants from Site 28, are discharging to the New River.

The surface waters and sediments of Cogdels Creek were also found to contain contaminants at concentrations greater than applicable freshwater standards. By the continuous discharge of surface waters into the New River and through the episodic sediment scour of the creek bottom during high flow conditions, contaminated waters and sediments are migrating to the New River from Site 28.

Metals appear to be the most prevalent contaminant group encountered since they were detected during both rounds of sampling in the groundwater, surface water and sediment samples. All detected metals appear to have their source within the site except for possibly mercury. Groundwater concentrations of the metals appear to be generally lower as time progressed from one round of sampling to the next. Concentrations in sediment samples from Cogdels Creek, however, seemed to have increased with time. Cadmium concentrations in the surface water (28SW2) exceed the state water quality standards for freshwater classes (2.0 ug/L). Mercury levels in the surface water (28SW1, 28SW2, and 28SW3) exceed the standard of 0.20 ug/L.

An upstream sampling station (28SW3 and 28SE3) was sampled in December 1986. Mercury was detected in the surface water at this location and also in Wells 28GW1, 28GW3, and 28GW4. This may indicate that mercury contamination is not only present at the site but is also migrating from an upstream location. Chlordane was detected in only sediment samples from Cogdels Creek during 1986. This may also be migrating from an upstream location since it was only detected in the sediments of Cogdels Creek with the highest concentrations upstream of the site.

Pesticides (BHC,A, BHC,B, BHC,D) were detected in the surface water in Cogdels Creek in 1984 but were not detected in the groundwater at that time. This suggests that these analytes may have originated from activities upstream of the site or from a unique disposal operation at the far northern portion of the site. These pesticides were not detected in the December 1986 sampling effort.

O&G appear to be a consistent contaminant throughout the site. It was detected in both rounds of sampling in the groundwater and sediment samples.

VOCs were detected in 28GW1 in both rounds of sampling but were not detected elsewhere in the site. This may suggest that the disposal of volatiles was limited to the area around 28GW1.

Tissue samples were taken from fish from the recreational pond and concentrations of BHC,A, and PCBs were detected. This suggests that pesticides may be present in the northern reaches of the site, or migrated from upgradient of the site. No conclusion can be drawn from the PCB levels found in the tissue. PCBs were not detected in any other samples taken from Site 28.

3.8.4 RECOMMENDATIONS

The surface water and sediment of the recreational pond have not been sampled to date. It is recommended that analysis for the same parameters as the other surface water and sediment samples be performed. This will provide more data

for the origin of PCB in the tissue samples. It will also provide data on the other analytes that are not bioaccumulated and may be originating from the far northern portion of the site, such as BHC,A, BHC,B, and BHC,D.

Chlordane and mercury were detected at the upstream sampling location within Cogdels Creek. These parameters were not detected at Site 24, the nearest site upstream of the Hadnot Point Burn Dump. Additional sampling of surface water and sediments should be performed within Cogdels Creek between Sites 28 and 24. These results will provide data which can be used to determine the source of these contaminants. Metals were also detected in the upstream samples from Cogdels Creek, and in the groundwater and other surface water and sediment samples of Site 28. It is apparent that metals are a concern at this AOC. Metal analyses should be added to any upstream samples to better evaluate migration from an upstream source.

A grid of soil sampling stations should be installed throughout the filled area of Site 28 to determine the volume of contaminated soil, and to determine the strength of the contamination in the soil matrix. Additional monitor wells should be installed in the shallow aquifer to determine if contaminant strength is greater than that identified in the existing monitor wells. Installation of deep monitor wells is also warranted to determine is the water supply aquifer is impacted by the shallow contamination detected to date.

When characterization of the contamination has been completed, a Risk Assessment should be conducted to determine remedial goals to be utilized by the FS.

APPENDIX C
FINAL SITE SUMMARY REPORT
SITE 30

3.9 SITE 30 - SNEADS FERRY ROAD FUEL TANK SLUDGE AREA

3.9.1 SITE BACKGROUND

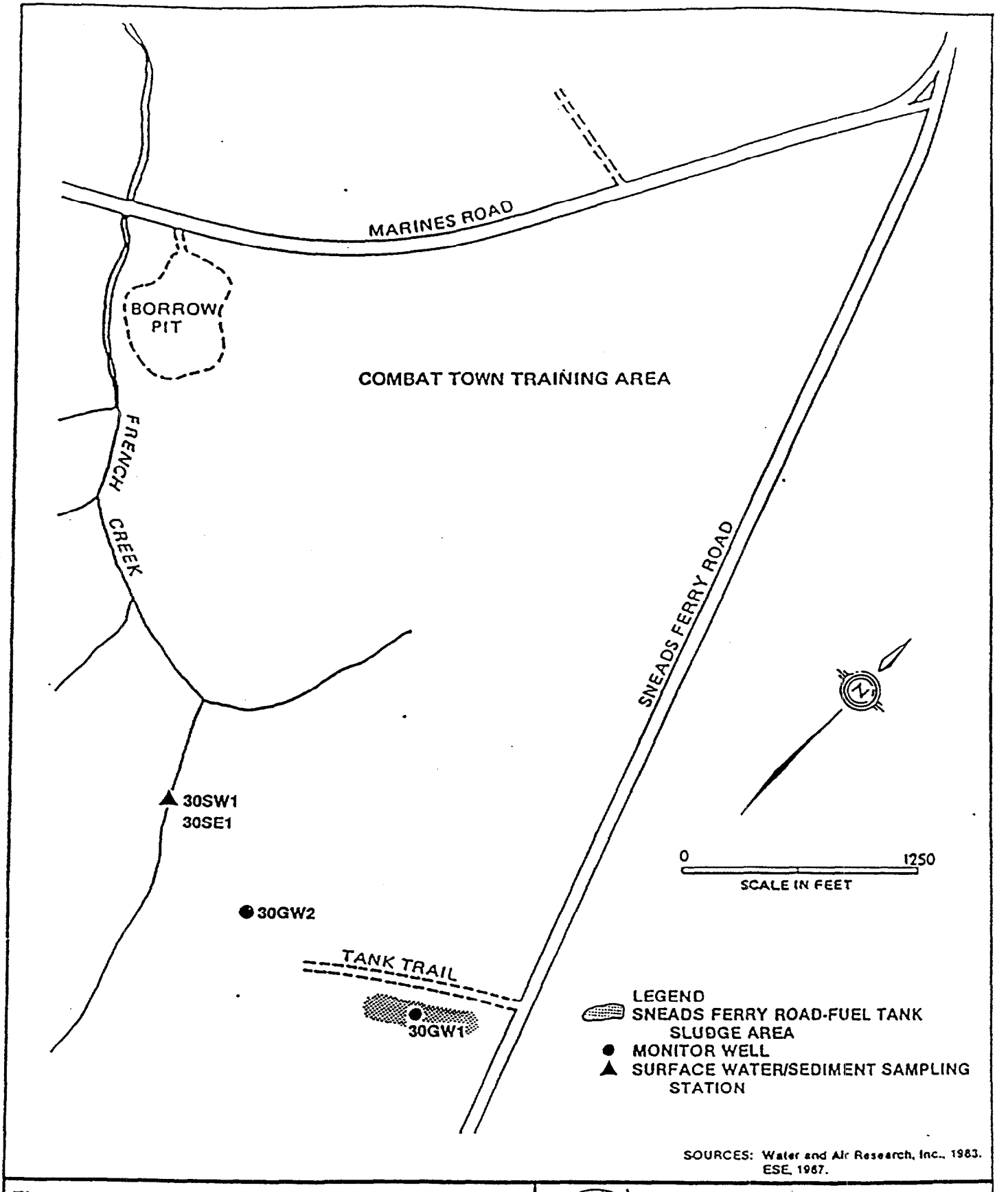
The Sneads Ferry Road Fuel Tank Sludge Area (Figure 30-1) located along a tank trail which intersects Sneads Ferry Road from the west, about 6,000 feet south of the intersection with Marines Road (PWDM Coordinates 18,GW12). The site is located approximately 1500 feet east of French Creek. In 1970, sludge from fuel storage tanks storing leaded gasoline containing tetraethyl lead and related compounds, and tank washout waters were disposed of at the site by a private contractor. It is estimated that at a minimum, 600 gallons of sludge or tank bottom deposits were dumped at the site. Two 12,000-gallon tanks were pumped out while the type of fuel stored was changed. The 600 gallon estimate is based on tank capacity below the tank outflow ports. Additional washout water may also have been present. Additional information suggests that the site had also been used for similar wastes from other tanks. Composition of the sludge and/or washout is unknown and may vary from containing substantial amounts of tetraethyl lead to containing mostly cleaning compounds.

Site 30 is underlain by layers of sand, silty sand, and gravelly sand. Figure 30-2 presents the geologic cross section of the area drawn on a east-west line (Figure 30-3). The surface of the shallow groundwater at this site lies within the upper layer of silty sand at depths ranging from 4.32 to 8.06 feet below land surface. The groundwater contour map (Figure 30-4) indicates that groundwater flow is to the northwest towards the unnamed tributary of French Creek at a gradient of approximately 0.004 ft/ft.

3.9.2 SITE INVESTIGATION

GROUNDWATER

Two shallow groundwater monitoring wells were installed as part of the 1984 and 1986 site investigations. Well 30GW1 was installed in 1984 and Well 30GW2 was installed in 1986 topographically downhill from the suspected disposal site. Figure 30-1 illustrates the locations of these wells. The wells were sampled and analyzed for the following target compounds:



SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 30-1
ROUND TWO SAMPLING LOCATIONS, SITE 30—
COMBAT TOWN TRAINING AREA

MARINE CORPS BASE
CAMP LEJEUNE

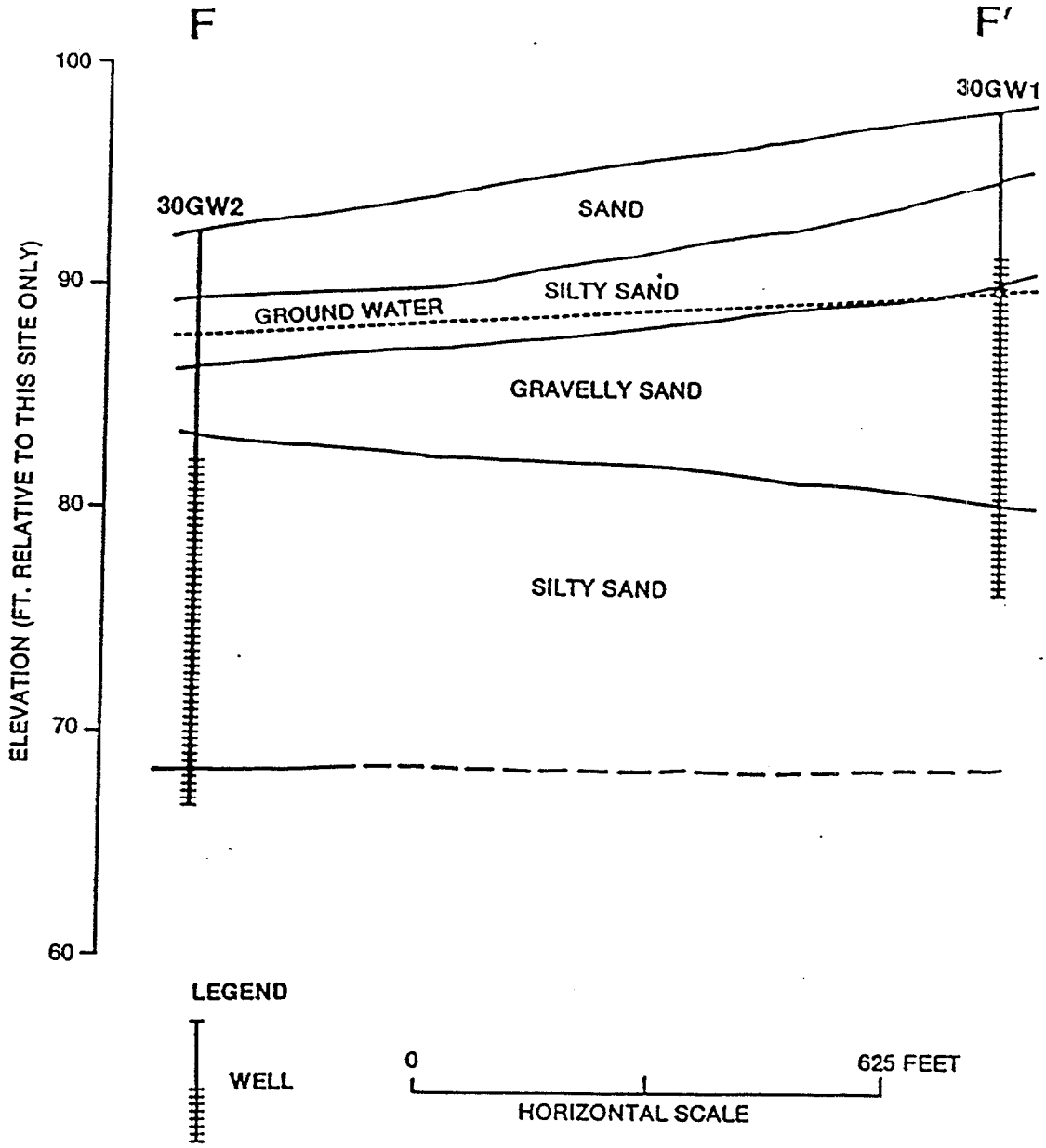
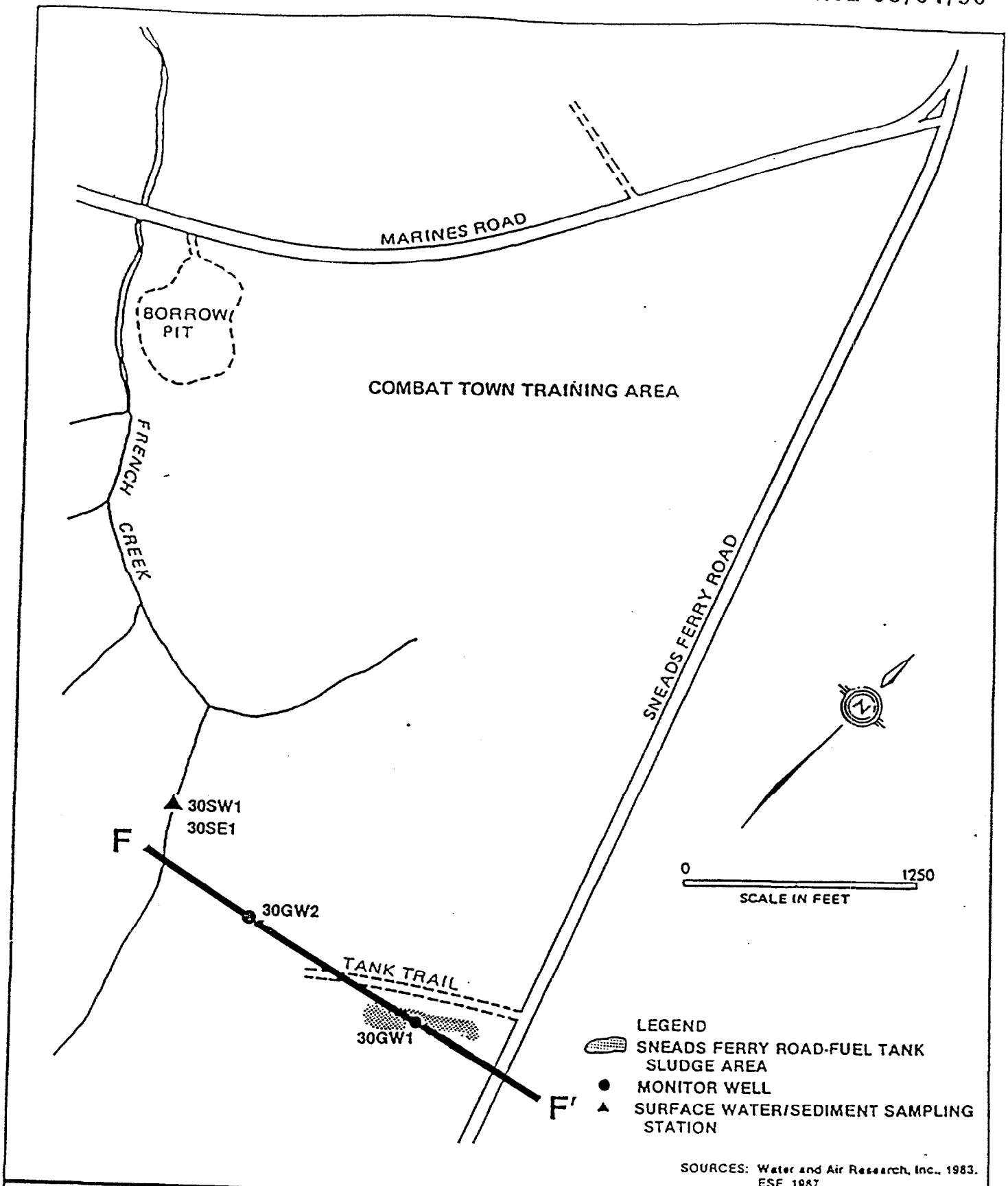


Figure 30-2
GEOLOGIC CROSS SECTION, SITE 30—
COMBAT TOWN TRAINING AREA

MARINE CORPS BASE
CAMP LEJEUNE

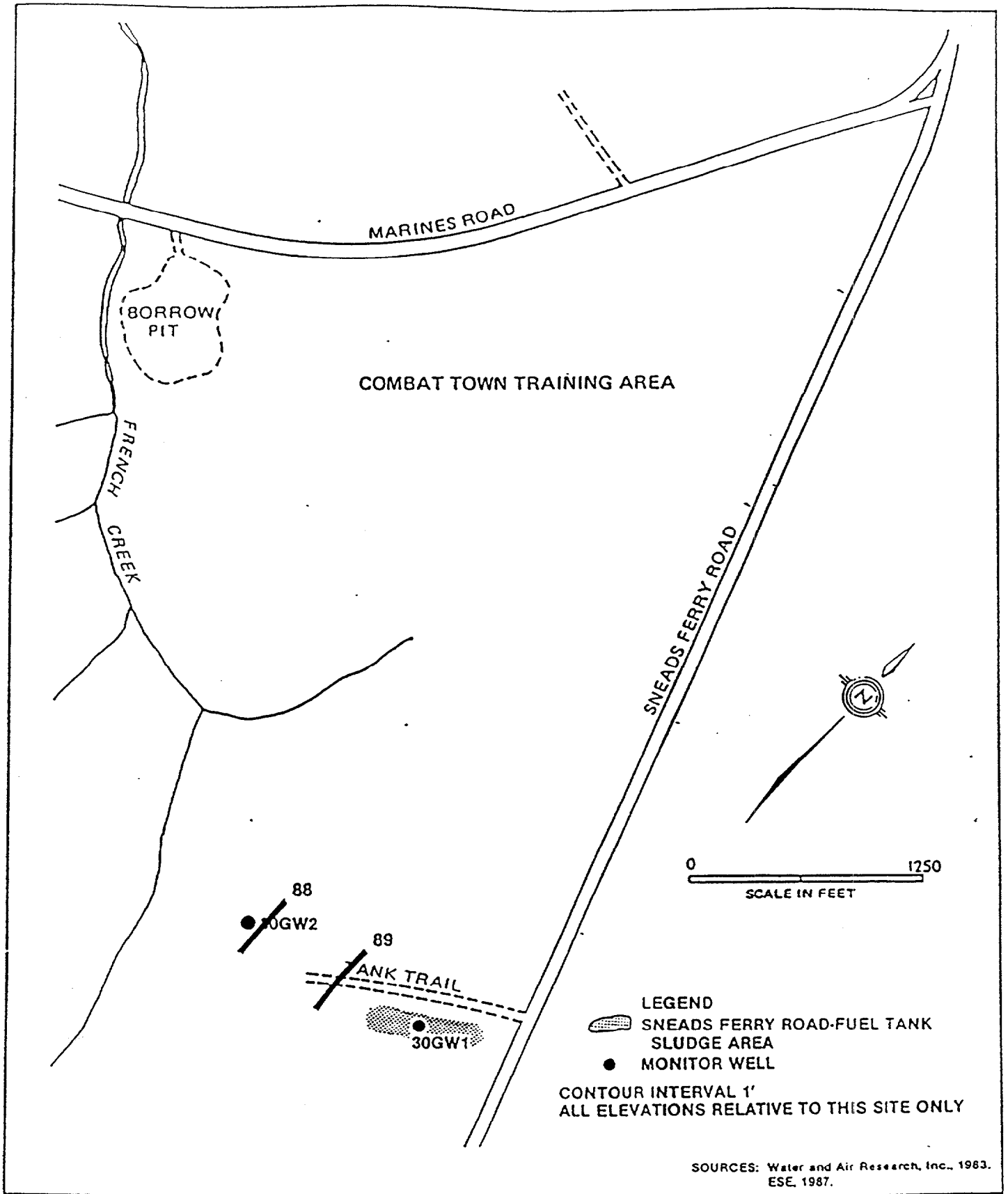


SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 30-3
GEOLOGIC CROSS SECTION LOCATION, SITE 30—COMBAT TOWN TRAINING AREA

MARINE CORPS BASE
CAMP LEJEUNE

LEJEUNE 1/90c



SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 30-4
GROUND WATER CONTOUR MAP—
SHALLOW AQUIFER, SITE 30—
COMBAT TOWN TRAINING AREA

MARINE CORPS BASE
CAMP LEJEUNE

- Lead
- Volatile Organics (VOA)
- Oil and Grease (O&G)
- Xylene (1986/87 only)
- Methylethyl ketone (MEK) (1986/87 only)
- Ethylene dibromide (EDB) (1986/87 only)
- Methyl isobutyl ketone (MIBK) (1986/87 only)

Appendix A contains a full list of all target analytes and their abbreviations. Table 30-1 presents the analytical data for those analytes that had concentrations above the applicable method detection limits. Trace levels of chloroform were detected in Well 30GW1 and methylene chloride was detected in Well 30GW2 in 1986. Since neither analyte was detected in the 1984 sampling it is possible that these levels were laboratory artifacts and do not represent environmental contamination. This does not eliminate the potential presence of VOCs in the groundwater. However, if VOCs are present, it is estimated that the concentrations are very low.

Lead was detected in Well 30GW1 in 1984 and Well 30GW2 in 1986. O&G was detected in both monitoring wells in 1986/87 but was not detected in 30GW1 in 1984. This may be attributed to a lowering of detection limits in the 1986/87 analyses. The presence of O&G in the groundwater may suggest low levels of contamination resulting from the alleged disposal of gasoline and washwaters at this AOC. However, O&G appears to be ubiquitous at Camp LeJeune so a determination that Site 30 is a point source for O&G can not be definitely determined based on existing data.

SURFACE WATER

A single surface water sample was taken in December 1986 from the unnamed tributary to French Creek (Figure 30-1). The sample was analyzed for the same parameters as the groundwater samples from this site. No detectable levels of any target compounds were identified in the sample.

TABLE 30-1.

SITE 30 - SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
(COMBAT TOWN TRAINING AREA)
DETECTED TARGET ANALYTES
GROUND WATER SAMPLES

DATE	NC GW STANDARDS	30GW1 7/6/84	30GW1 12/4/86	30GW2 12/4/86	30GW2 3/6/87
PARAMETER					
LEAD	50	58	<27	30	<27
OIL & GREASE	NONE	<700	600	100	9000
CHLOROFORM	0.19	<1.2	2.6	<1.6	<1.6
METHYLENE CHLORIDE	5	<1	<2.8	3.3	<2.8

Values reported are concentrations in micrograms per liter (ug/L); this approximates parts per billion (ppb).

Source: ESE, 1990.

DOC.No.:CLEJ-00214-1.02-09/01/90

SEDIMENT

A single sediment sample was taken from the unnamed tributary to French Creek in 1986 (Figure 30-1). The sample was analyzed for lead, O&G, and ethylene dibromide. Only O&G was detected at a concentration of 373 ug/g.

3.9.3 SUMMARY AND CONCLUSIONS

Site 30 is located on the edge of a small stream valley and the groundwater contour map (Figure 30-4) indicates that flow in the shallow aquifer is to the southeast, toward the channel of the stream (unnamed tributary to French Creek). The geochemical data indicate that O&G is present in both the estimated central area of the site (30GW1) and downgradient (30GW2), and in the stream bed sediment. Because the Combat Town Training Area which borders the Sneads Ferry Road Fuel Tank Sludge Area, is subject to heavy vehicular traffic, it is not clear whether the presence of O&G in the environment is attributed to the disposal area or the result of emergency vehicle maintenance in the Combat Town Training Area.

The one-time presence of common laboratory VOCs in one set of groundwater samples does not support the conclusion that the disposal practices at Site 30 contributed VOCs to the site contamination. Lead was detected in Well 30GW1 in the estimated central area in 1984, and Well 30GW2 downgradient of the disposal area in 1986. This may be attributed to the disposal practices but sufficient data are not available to make this conclusion.

3.9.4 RECOMMENDATIONS

At this time, it is unclear if the location of the alleged spill/disposal at Site 30 has been accurately determined. There are no surface indicators of the specific disposal site. Unless additional information can be identified which will more accurately locate the disposal area, it is recommended that an additional set of samples be collected, and that a Risk Assessment be initiated to determine if the trace levels of contamination detected to date represent an unreasonable risk to health or the environment.

APPENDIX D
SUMMARY OF APRIL 1993 SAMPLING EPISODE
SITE 1

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

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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:
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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.

APPENDIX E
SUMMARY OF APRIL 1993
SAMPLING EPISODE
SITE 28

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 F
SUMMARY OF APRIL 1993 SAMPLING EPISODE
SITE 30

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
INORGANICS		
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.
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
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

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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.