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MCB CAMP LEJEUNE
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SECTION I

FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY FIELD SAMPLING AND ANALYSIS PLAN FOR OPERABLE UNIT NO. 4 (SITES 69, 74, AND 41)

MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0106

Prepared For:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

DECEMBER 2, 1993

PREFACE

This Sampling and Analysis Plan (SAP) consists of two sections: a Field Sampling and Analysis Plan (Section I) and a Quality Assurance Project Plan (Section II). These project plans have been prepared for field investigation activities associated with Operable Unit No. 4 (Sites 69, 74, and 41) at Marine Corps Base (MCB), Camp Lejeune, Jacksonville, North Carolina.

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LIST OF ACRONYMS AND ABBREVIATIONS

AMTRAC	Amphibious Tractor Battalion
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
Baker	Baker Environmental, Inc.
bgs	below ground surface
BHC,D	lindane or hexachlorocyclohexane
bls	below land surface
BOD	biological oxygen demand
BRA	baseline risk assessment
BTEX	benzene, toluene, ethylbenzene, xylene
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLEJ	Camp Lejeune
CLP	Contract Laboratory Program
CN	chloroacetophenone
COD	chemical oxygen demand
COPC	contaminants of potential concern
CRQL	contract required quantitation limit
CSM	Chemical Surety Compound
°F	degrees Fahrenheit
DEHNR	Department of Environment, Health and Natural Resources
1,2-DCE	1,2-dichloroethene or 1,2-dichloroethylene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DOD	Department of the Defense
DoN	U. S. Department of the Navy
DQO	Data Quality Objectives
EDI	estimated daily intake or exposure
EM	electromagnetic
EMD	Environmental Management Division (Camp Lejeune)
EPA	United States Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ESE	Environmental Science and Engineering, Inc.
exp	expotential
FFA	Federal Facilities Agreement
FMFLANT	Fleet Marine Force Atlantic
FSAP	Field Sampling and Analysis Plan
ft	feet
ft/ft	foot per foot
FY94 SMP	Fiscal Year 1994 Site Management Plan
GAC	granular activated carbon
gpm	gallons per minute

GRI	Gas Research Industry
GSRA	Greater Sandy Run Area
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HPIA	Hadnot Point Industrial Area
HQ	hazard quotient
HTH	high test hypochlorite
IAS	Initial Assessment Study
IDL	instrument detection limit
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MAGTF	Marine Air Ground Task Force
MEK	methyl ethyl ketone
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/L	milligrams per liter
MIBK	methyl isobutyl ketone
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NC	North Carolina
N.C. DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NCWQS	North Carolina Water Quality Standards
ND	nondetect
NEESA	Naval Energy and Environmental Support Activity
NH_4	ammonia nitrogen
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
OCP	organochloride pesticides
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PC	personal computer
PCB	polychlorinated biphenyls
POL	petroleum, oils, and lubricants
POTW	publicly owned treatment work
ppb	parts per billion
ppm	parts per million
PRAP	Proposed Remedial Action Plan
PVC	polyvinylchloride
QA/QC	quality assurance/quality control

RA	risk assessment
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RDX	cyclotrimethylenetrinitramine
2nd FSSG	2nd Force Service Support Group
SARA	Superfund Amendments and Reauthorization Act
SMCL	Secondary Maximum Contaminant Level
SQL	sample quantitation
STOLS	surface towed ordnance locator system
STP	sewage treatment plant
TAL	Target Analyte List
TBC	to be considered
TCDD	tetrachlorodioxin
TCE	trichloroethylene
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TEU	U.S. Army Technical Escort Unit
TNT	trinitrotoluene
TOC	total organic carbon
TRC	Technical Review Committee
UCL	upper confidence unit
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
UV	ultraviolet
UXO	unexploded ordnance
VOC	volatile organic compound

1.0 INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) describes the proposed Remedial Investigation (RI) field activities that are to be conducted at Sites 69, 74, and 41 at Marine Corps Base (MCB), Camp Lejeune, North Carolina.

The primary purpose of the FSAP is to provide guidance for all field activities by describing in detail the sampling and data collection methods to be used to implement the various field tasks identified in the Remedial Investigation/Feasibility Study (RI/FS) Work Plan for Sites 69, 74, and 41 (Baker, 1993). The guidance also helps to ensure that sampling and data collection activities are carried out in accordance with U.S. Environmental Protection Agency (USEPA) Region IV and Naval Energy and Environmental Support Activity (NEESA) practices so that data obtained during the field investigation are of sufficient quantity and quality to evaluate the nature and magnitude of contamination in various media, estimate human health and environmental risks, and to evaluate potential technologies for remediation of contaminated media.

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

1.1 Site Description and Setting

This section briefly describes the description and setting of the sites. A more detailed description of each site is provided in Section 2.0 in the RI/FS Work Plan (Baker, 1993).

1.1.1 Marine Corps Base Camp Lejeune

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

1.1.1.1 Location and Setting

MCB Camp Lejeune is located within the Coastal Plain Physiographic Province in Onslow County, North Carolina, approximately 45 miles south of New Bern and 47 miles north of Wilmington. The facility covers approximately 236 square miles. This includes the recent acquisition of approximately 64 square miles west of the facility within the Greater Sandy Run Area of the county. The military reservation 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 MCB Camp Lejeune is the Atlantic shoreline. The western and northwestern boundaries are U.S. 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders MCB Camp Lejeune to the north. MCB Camp Lejeune is depicted in Figure 1-1.

1.1.1.2 History

Construction of the base started in 1941 at Hadnot Point, where the major functions of the base are centered. Development at the MCB Camp Lejeune Complex is primarily in 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. Site 69 is located in the Rifle Range Area; Site 74 is located in the Mainside; and Site 41 is located in the Camp Geiger Area (Water and Air Research, 1983).

1.1.1.3 Topography and Surface Drainage

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

Drainage at MCB Camp Lejeune is generally toward the New River, except for areas near the coast, which drain through the Intracoastal Waterway. In developed areas, natural drainage

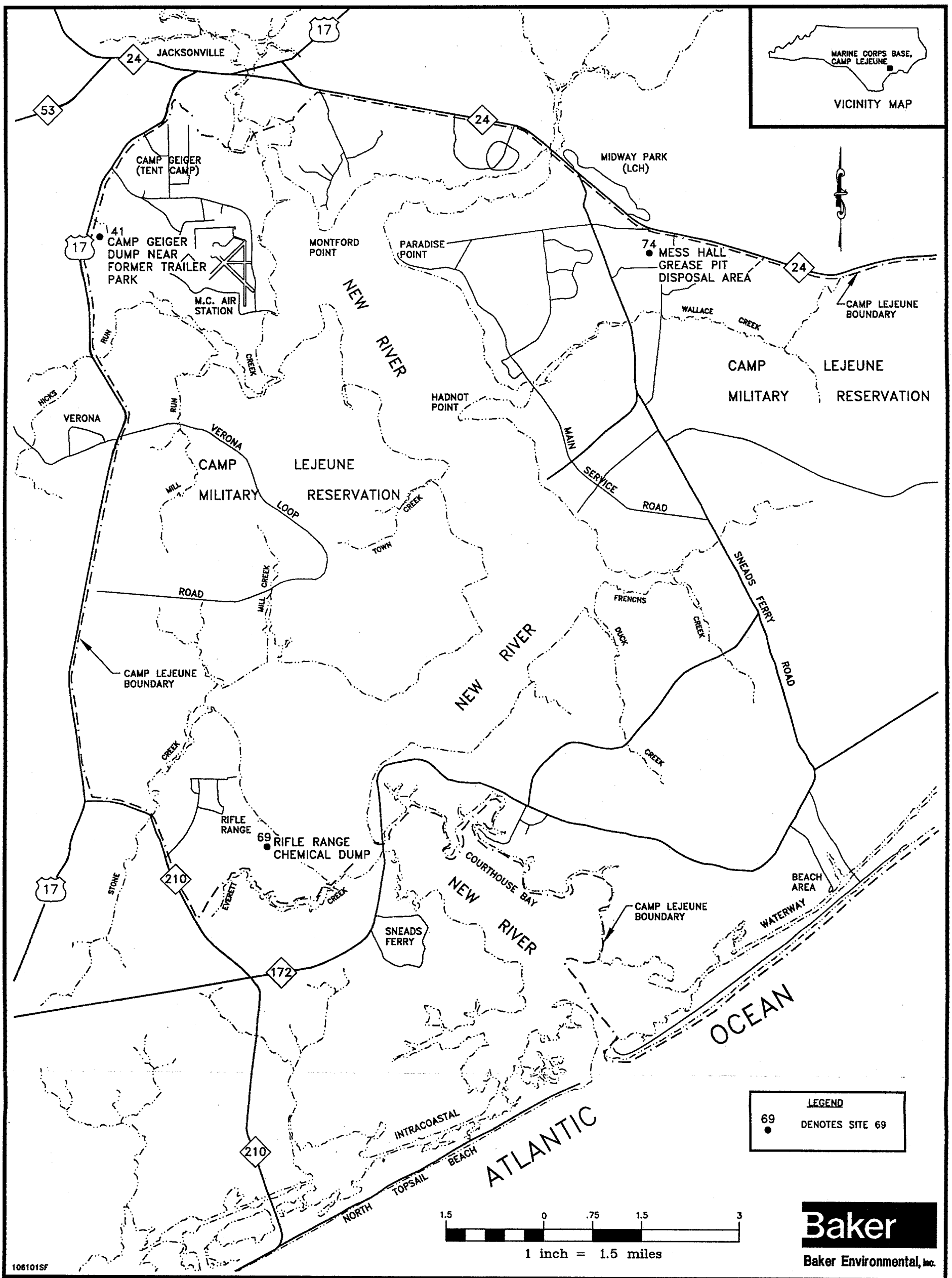

FIGURE 1-1
MCB CAMP LEJEUNE
LOCATION MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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has been altered by asphalt, storm sewers, and drainage ditches. Approximately 70 percent of MCB Camp Lejeune is broad, flat interstream areas. Drainage is poor in these areas (Water and Research, 1983).

The U.S. Army Corps of Engineers has mapped the limits of the 100-year floodplain at MCB Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (Water and Air Research, 1983). The elevation of the 100-year floodplain increases downstream to 11 feet above msl near the coastal area (Water and Air Research, 1983). Neither Sites 41, 69, nor 74 lie within the 100-year floodplain.

1.1.1.4 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments lay in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1991) and 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. Figure 1-2 presents a generalized stratigraphic column for this area (ESE, 1991).

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 (i.e., surficial water-bearing layer), 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 semiconfining units which separate the aquifers and impede the flow of groundwater between aquifers..

1.1.1.5 Regional Hydrogeology

The following summary of regional hydrogeology was originally presented in Harned et al. (1989).

The surficial water-bearing layer (i.e., surficial aquifer) is a water table in 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

FIGURE 1-2

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: Harned et al., 1989

previous subsurface investigations in the area. The clay layers range from 5 to 30 feet thick. This unit is not used for water supply on the Base.

The principal water-supply aquifer for the Base is found in 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 Formation associated with the Castle Hayne Aquifer. This aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina. Figure 1-3 portrays various geologic cross sections of the base. Site 74 is situated along cross section A-A'. Site 41 is located along cross section B-B'. There is no available geologic cross section to represent the Rifle Range area of the base near Site 69.

The aquifers that lie below the Castle Hayne lie in 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 MCB Camp Lejeune area and are not used.

The water table varies seasonally. The water table receives more recharge in the winter than in the summer when much of the water 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.

1.1.1.6 Surface Water Hydrology

The following summary of surface water hydrology was originally presented in the Initial Assessment Study (IAS) Report (Water and Air Research, Inc., 1983).

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. 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 not associated with 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 (Water and Air Research, 1983). The New River, the Intracoastal Waterway, and the Atlantic Ocean meet the New River Inlet.

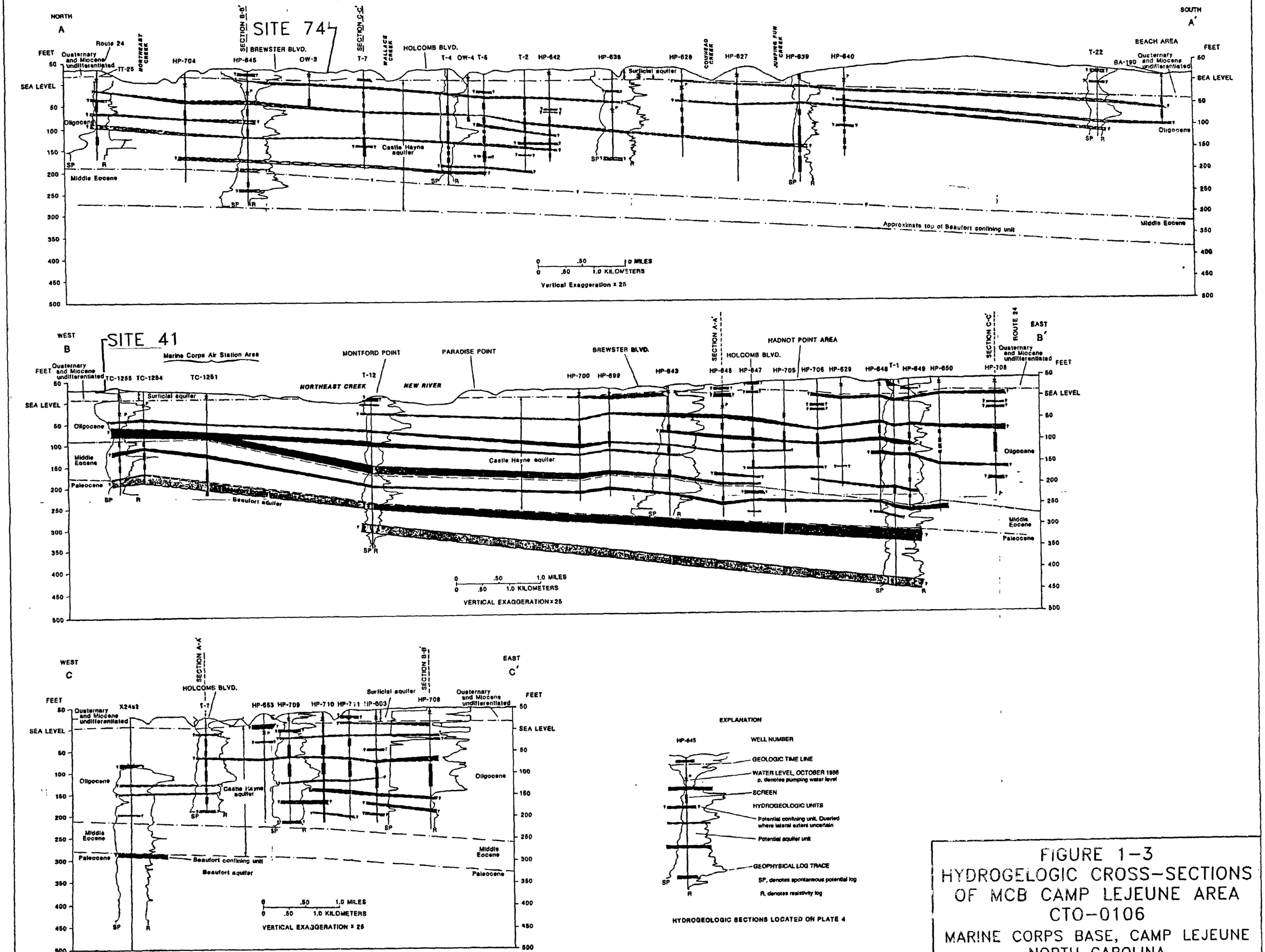


FIGURE 1-3
HYDROGEOLOGIC CROSS-SECTIONS OF MCB CAMP LEJEUNE AREA
CTO-0106
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02586R02X

HYDROGEOLOGIC SECTIONS A-A', B-B', AND C-C' AT CAMP LEJEUNE, NORTH CAROLINA

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 Rifle Range area; the rest of the New River at MCB Camp Lejeune falls into the SA classification (ESE, 1991).

1.1.1.7 Climatology

MCB Camp Lejeune experiences mild winters and hot and humid summers. The average yearly rainfall is greater than 50 inches, and the potential evapotranspiration in the region varies from 34 inches 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 degrees Fahrenheit (°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-northwest in the winter (Water and Air Research, 1983).

1.1.1.8 Natural Resources and Ecological Features

The following summary of natural resources and ecological features was obtained from the IAS Report (Water and Air Research, 1983).

The Camp Lejeune complex is predominantly tree-covered with large amounts of softwood including short leaf, longleaf, pond, and pine, primarily loblolly, and substantial stands of hardwood species. Approximately 60,000 acres of MCB Camp Lejeune are under forestry management. Timber producing areas are under even-aged management with the exception of these 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.

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.

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 (Water and Air Research, 1983). Freshwater fish in the streams and ponds include largemouth bass, red breast sunfish, bluegill, chain pickerel, yellow perch, and catfish. Reptiles include alligators, turtles, and snakes, including venomous. Both recreational and commercial fishing are practiced in the waterways of the New River and its tributaries.

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: (1) pond, pine, or pocosin; (2) sweet gum/water oak/cypress and tupelo; (3) sweet bay/swamp black gum and red maple; (4) tidal marshes; and, (5) coastal beaches.

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 (Water and Air Research, 1983). None of the three sites under investigation are within or in proximity (i.e., one-half mile) to either a natural area or a protected area. Protected areas have only been established for the red-cockaded woodpecker.

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

1.1.1.9 Land Use and Demographics

MCB Camp Lejeune presently covers an area of approximately 236 square miles. Military and civilian population is approximately 77,421. Approximately 36,086 people reside in base housing units. During World War II, MCB Camp Lejeune was used as a training area to

prepare Marines for combat. This has been a continuing function of the facility during the Korean and Vietnam conflicts, and the recent Gulf War (i.e., Desert Storm). Toward the end of World War II, the camp was designated as a home base for the Second Marine Division. Since that time, Fleet Marine Force (FMF) units also have been stationed here as tenant commands.

1.1.2 Site 69 - Rifle Range Chemical Dump

This section addresses the background and setting of Site 69 (Rifle Range Chemical Dump). An Environmental Photographic Interpretation Center (EPIC) study was conducted for this site by the USEPA. Site specific results of this study are included in Appendix B of the RI/FS Work Plan (Baker, 1993).

1.1.2.1 Site Location and Setting

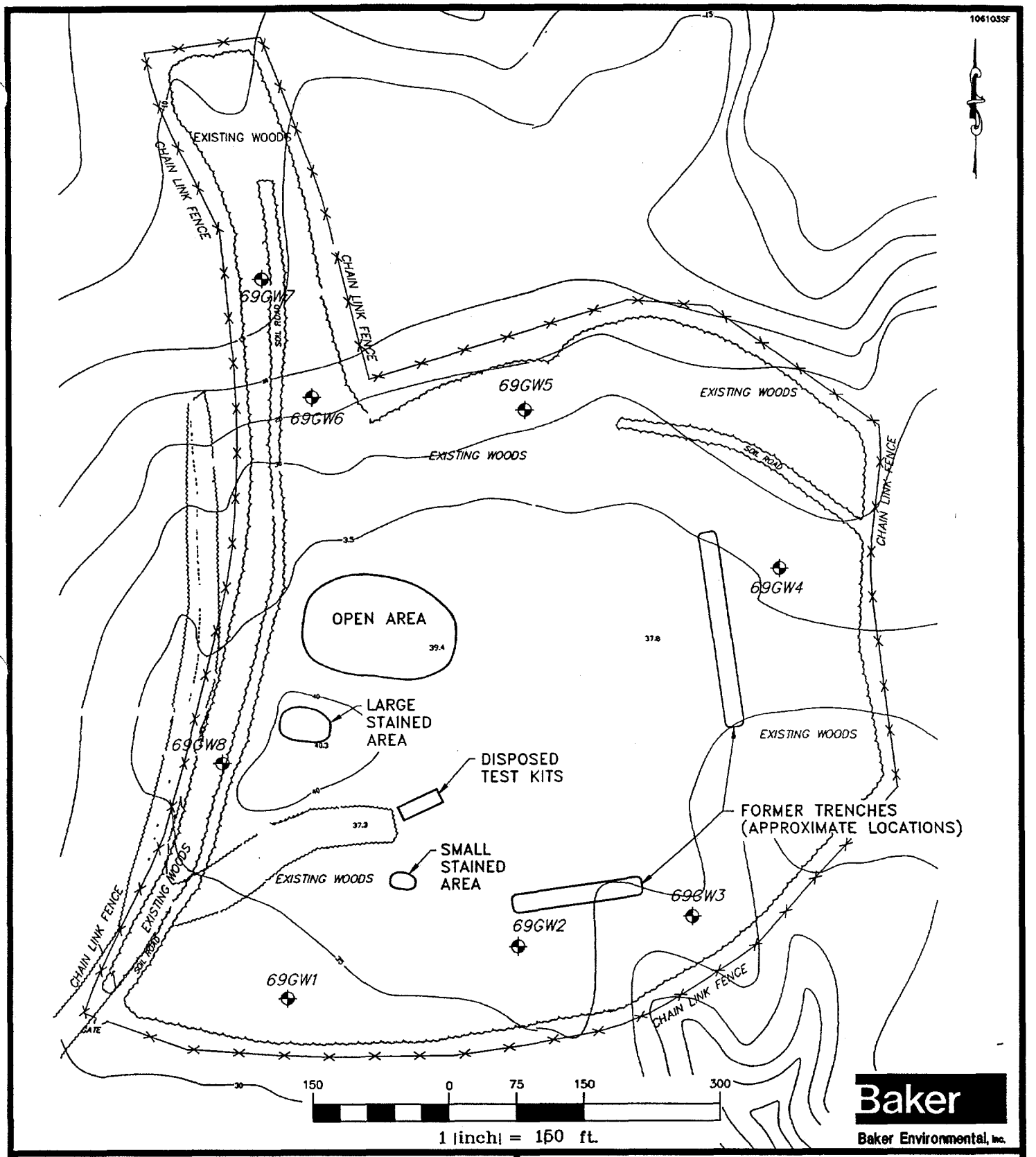
Site 69, the Rifle Range Chemical Dump, is located west of the New River estuary in the area of MCB Camp Lejeune known as the Rifle Range (see Figure 1-1). The site is a former disposal grounds (i.e., landfill) and is approximately 6 acres in size. The site is heavily wooded with several species of trees including pine, dogwood, and oak. The understory is comprised of sparse grasses and shrubs (ESE, 1991). Access is restricted by a 6-foot high chain link fence with a locked entrance gate.

The site is located approximately three miles east-southeast of the intersection of Route 17 and Route 210 (see Figure 1-1). The site is situated where a light-duty, unnamed roadway splits to form a "Y" (see Figure 1-4). This road shall be referred to in this FSAP as the "access road."

The New River is located about one-quarter mile east of the site. Everett Creek is located about one-half mile south of the site. An unnamed tributary to the New River is situated about one-quarter mile north of the site. A light duty road borders the site to the west. Both Everett Creek and the unnamed tributary drain into the New River .

During a site reconnaissance on September 5, 1991, five areas of suspected disposal activities were observed. A brief description of these areas is presented below.

Two areas of stained soils were identified in the south-central portion of the site, as shown on Figure 1-4. Both areas were similar in appearance: dark brown, seeping soils. The first area,



LEGEND

69GW2 EXISTING SHALLOW WELL

FENCE

VEGETATION

TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 1-4
SITE 69
RIFLE RANGE CHEMICAL DUMP
GENERAL ARRANGEMENT MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Stained Soil Area No. 1, is approximately 15 feet by 15 feet in area; the second stained area, Stained Soil Area No. 2, was smaller, and covered an area approximately 7 feet in diameter. High readings on a metal detector were obtained at both of the stained areas. The areas immediately surrounding the two stained locations were covered with undisturbed vegetation and small trees. No particular odors were identified during the site visit.

Immediately north of Stained Soil Area No. 2, the Baker Environmental, Inc. (Baker) team identified what appeared to be a former disposal area approximately 1 to 2 feet wide by 20 feet long. Many glass vials, white powder material, and containers for chemical agent test kits were scattered along the ground surface in this area. The approximate location of this disposal area is identified on Figure 1-4.

Adjacent to this area, a long trench was observed approximately 75 feet long and 4 to 6 feet wide. The trench surface was covered with vegetation. Numerous mounds of soil were located alongside the trench. Readings from the metal detector were elevated at these mounds. The approximate location of the trench is identified on Figure 1-4.

In the northern-central portion of the site, an area evidently disturbed (referred to in this FSAP as Area No. 3) was identified. This area is rectangular in shape and covers approximately 0.25 acre. The ground cover and trees in this area presently consist of an immediate growth of lawn vegetation and saplings; the vegetation immediately around the area is more dense and the trees are more mature. No other signs of contamination, such as staining or odors, were observed at Area No. 3.

1.1.2.2 Topography and Surface Drainage

Site 69 is situated at a topographic high for the immediate surrounding area. Most of the site within the fence is flat; however, the topography surrounding the site slopes gently in all directions. During the September 1991 site reconnaissance, portions of the site area exhibited standing water, which could indicate poor drainage.

Surface water runoff from the northern portion of the site may drain toward the unnamed tributary located to the north; however, the surrounding area is heavily wooded and consists of a dense understory that could inhibit off-site drainage at great distances. Surface runoff from the southeastern portion of the site reportedly drains to unnamed ditches that drain into the New River. Surface runoff from the southwestern portion of the site drains into the Everett

Creek basin, which could potentially drain into Everett Creek and the New River. However, as previously mentioned, the surrounding areas are heavily wooded and consist of a thick understory, which could inhibit overland surface runoff at great distances.

1.1.2.3 Site History

Site 69 was used as a chemical waste dump between 1950 and 1976. The waste materials were reportedly disposed in pits or trenches, 6 to 20 feet deep. Various wastes have been reportedly disposed at the site including polychlorinated biphenyls (PCBs), fire retardants, pentachlorophenol, dichlorodiphenyltrichloroethane (DDT), trichloroethylene (TCE), malathion, diazinon, lindane, calcium hypochlorite, gas cylinders, high-test hypochlorite (HTH), drums of "gas" [possibly training agent containing chloroacetophenone (CN)], chemical agent test kits for chemical warfare, and fired and unfired blank rifle cartridges (Water and Air Research, 1983).

Based on conversations with personnel from the U.S. Army Environmental Center (USAEC) formerly the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) and the U.S. Army Technical Escort Unit (TEU), there is a high probability that chemical agent training kits also are buried at the site. PCBs were reportedly sealed in cement septic tanks prior to disposal at the site. The presence of the fired and unfired rifle cartridges indicate that troop training exercises have occurred in this area (Water and Air Research, 1983).

In 1970, an explosion reportedly occurred at Site 69 during a disposal operation. Containers of DDT, TCE, and calcium hypochlorite were placed in a pit at the site. While the containers were being covered with earthen, an explosion and fire occurred (Water and Air Research, 1983).

The site is inactive at present. Access is restricted by a chain-link fence. No known training activities are presently conducted within the fenced-in area.

1.1.2.4 Site Geology and Hydrogeology

The site is reportedly underlain by silty sand and sandy clay with discontinuous layers of clayey sand, sand, sandy silt, and clayey silt (ESE, 1991). The water table was encountered in silty sand and clayey sand at depths ranging from approximately 5 to 22 feet below ground

surface (bgs) in April 1987 and in silty sand, clayey sand, and sandy clay at depths ranging from approximately 7 to 27 feet bgs in January 1991 (ESE, 1991).

Groundwater flow may be impacted by watershed boundaries. Shallow groundwater flow is reported to be across the site toward the north and northwest. However, a review of the topography of the site as well as the hydrology of the area indicate that groundwater flow under the eastern portion of the furnace dump is east-southeast in the southeast section and east-northeast in the northeast section. Some mounding was reported in the vicinity of well 69GW1; however, it is believed to be localized (ESE, 1991).

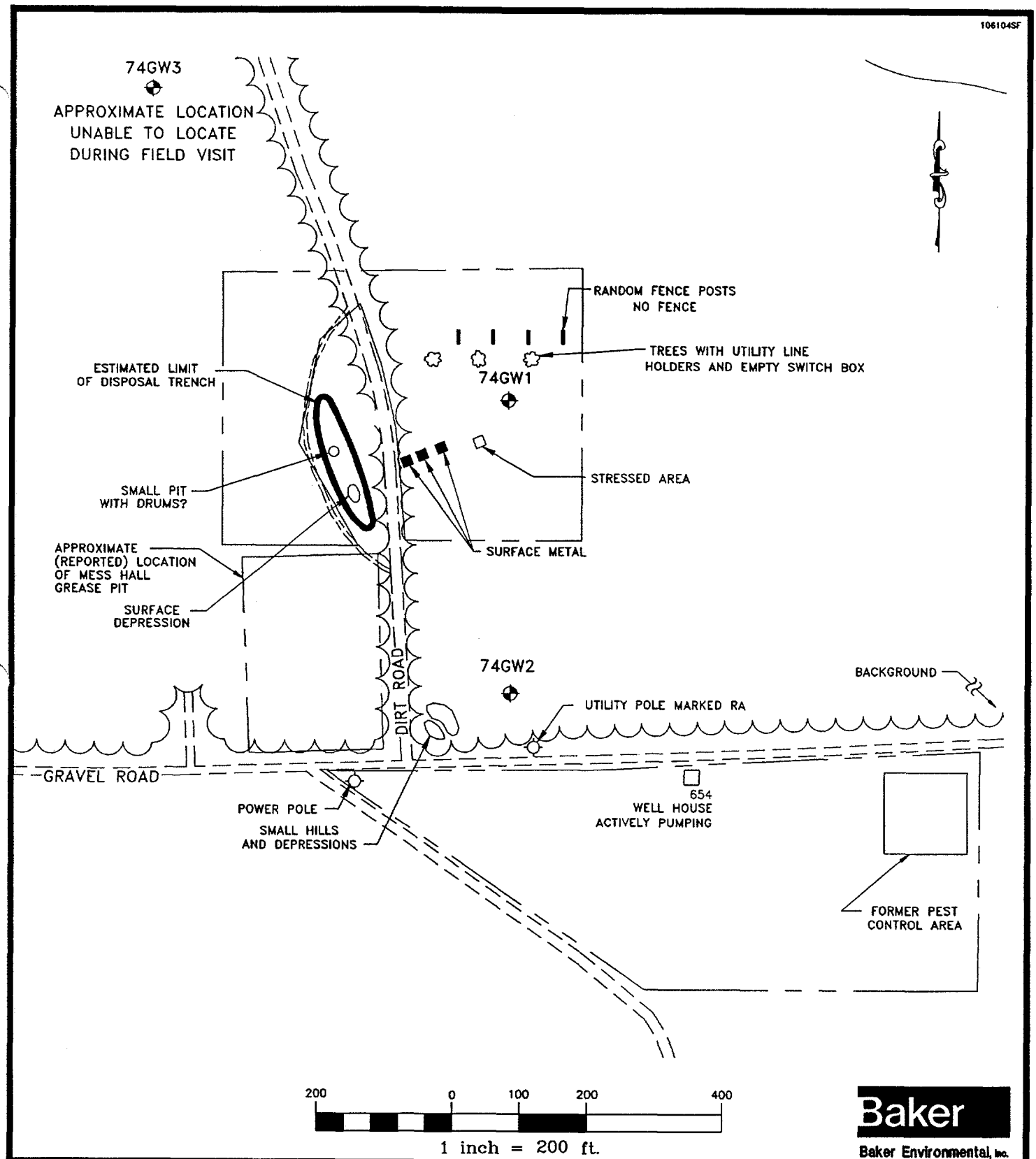
1.1.3 Site 74 - Mess Hall Grease Pit Disposal Area

This section addresses the background and setting of Site 74 (Mess Hall Grease Pit Disposal Area).

1.1.3.1 Site Location and Setting

Site 74 is located in a stand of woods approximately one-half mile east of Holcomb Boulevard in the northeast portion of MCB Camp Lejeune. There are two areas of concern at Site 74: the Grease Pit Disposal Area and the Former Pest Control Area. The Mess Hall Grease Pit Disposal Area is reportedly located just north of the gravel road, and west of the dirt road (i.e., northwest of the intersection of the two roads as shown on Figure 1-5. This grease pit reportedly measures 135 feet long by 30 feet wide by 12 feet deep (ESE, 1991). However, this pit was not observed during the June 1992 site visit, nor was it detected by geophysical techniques. Review of historical aerial photographs indicate that the disposal area is approximately five acres (see Figure 1-5).

The second area of concern, the Former Pest Control Area, is reportedly located about 150 feet east of potable water supply well No. 654 (ESE, 1991). This area reportedly measures an area 100 feet by 100 feet; however, the area was not recognizable during the June 1992 site visit. The general area is heavily overgrown with vegetation and looks similar to the surrounding area. Surrounding the former pest control area is a large tract of land that may also be associated with disposal based on a review of historical aerial photographs. This area encompasses approximately four acres as shown on Figure 1-5. For purposes of this report, this area will be considered as part of the former pest control area.



LEGEND

74GW2 – EXISTING SHALLOW WELL

– VEGETATION

– ROAD (UNIMPROVED)

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 1-5
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
GENERAL ARRANGEMENT MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

To the east of the dirt road, two small mounds of dirt were noted just north of the gravel road. In addition, a small area of stressed vegetation was noted about 150 feet east of the dirt road. Also noted during the site visit were evidence that military training activities may have taken place east of the dirt road (i.e., utility boxes on trees, etc.).

1.1.3.2 Site Topography and Drainage

The land is predominantly flat. There are no significant surface water drainage features (i.e., ditches, streams, etc.) on site. Henderson Pond, which is used for recreational fishing, is located about one-half mile southeast from the site. Surface water runoff is expected to be toward the southeast. However, the area is heavily overgrown with vegetation, which would reduce surface runoff.

1.1.3.3 Site History

There are presently no disposal activities on site. The site was used as a disposal area from the early 1950s until 1960. Mess Hall grease was disposed of in the pit until 1954, when Hurricane Hazel reportedly washed the grease out of the pit. Use of the pit was discontinued at this time. It was reported that on at least one occasion, a volatile substance was used unsuccessfully to burn the grease. Drums containing either pesticides or transformer oil containing PCBs, and pesticide soaked bags were also reportedly disposed of near the grease pit. Drums containing chemical surety materials may also be present since it was reported that drums that were supposed to be disposed at Site 69 were taken to Site 74. No information about the activities at the Former Pest Control Area is available.

1.1.3.4 Site Geology and Hydrogeology

A limited amount of site-specific geologic/hydrogeologic information is available. Site 74 is underlain primarily by sand and silty sand. The depth to groundwater has been measured between 2.01 and 12.20 feet bgs. Shallow groundwater flows east (ESE, 1990).

1.1.4 Site 41 - Camp Geiger Dump Near Former Trailer Park

This section describes the location, setting, and history of Site 41 (Camp Geiger Dump Near Former Trailer Park).

1.1.4.1 Site Location and Setting

Site 41, Camp Geiger Dump Near Former Trailer Park, is located in the Camp Geiger area of MCB Camp Lejeune (see Figure 1-1). The site is situated east of U.S. Highway 17, south of the former Camp Geiger trailer park, west of an unnamed tributary, and north of Tank Creek. The unnamed tributary and Tank Creek flow into Southwest Creek east of the site. Southwest Creek discharges into the New River approximately 3 miles downstream of this confluence.

The area is heavily wooded and vegetated. The former disposal areas physical boundary is barely discernible. Dirt roads are present along the boundary and through the center of the site. Some portions of these roads are overgrown and impassible due to ponding. The area of the former dump is estimated to be approximately 30 acres (Water & Air Research, 1983). Areal photographs of the site confirm this estimation.

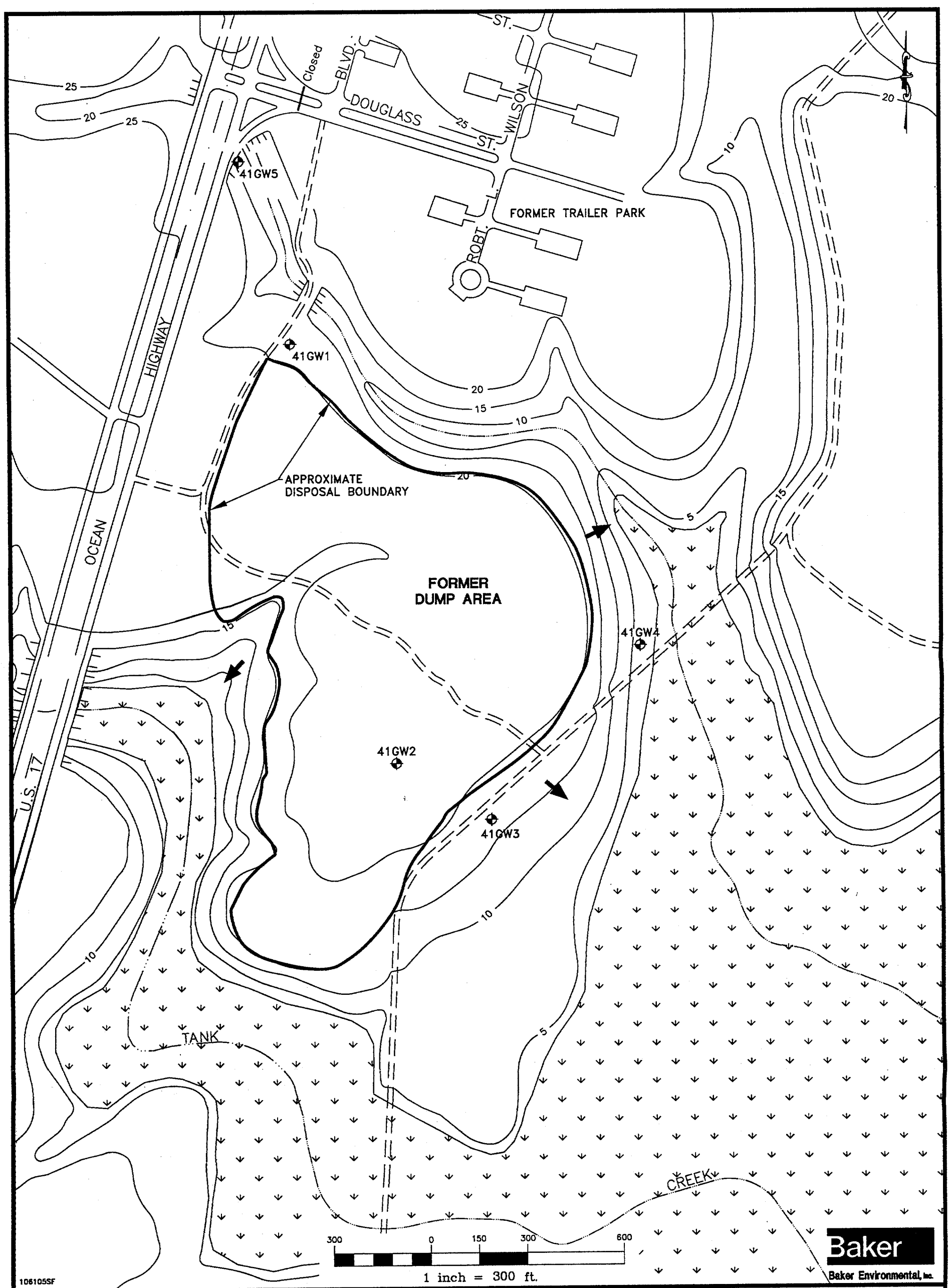
The areas along the eastern and southern boundaries are classified as wooded wetlands. These areas are downslope of the former disposal area. Signs of beaver, deer, and sightings of black snakes, frogs, and turtles were observed during a site reconnaissance conducted as part of the preparation of RI/FS Project Plans.

Throughout the former disposal area are piles of construction debris, mainly metal and concrete. Drums of various sizes (i.e., 5 gallons up to 55 gallons) were noted during the site reconnaissance throughout the disposal area at "random" locations (i.e., one drum or canister was observed at various areas throughout the site). Most of the drums were rusted and unidentifiable. However, one 10-gallon empty canister was labeled "Dry Cleaning Solvent." There were no areas where more than one or two drums were noted on the ground surface.

1.1.4.2 Topography and Surface Drainage

The former dump is situated at a local topographic high area with an elevation of approximately 20 feet msl (see Figure 1-6). This portion of the study area is relatively flat. With the exception of the northwest portion of the study area, which is relatively flat, the area surrounding the former dump is comprised of moderate to steep hillsides which slope toward the unnamed tributary to the north and east, and to Tank Creek to the south and southwest.

Soils identified by the Soil Conservation Service survey (USDA, 1984) identified excavated soils at Site 41. The occurrence of excavated soils at Site 41 would tend to confirm past



LEGEND

41GW1 – EXISTING GROUNDWATER MONITORING WELL
– ESTIMATED DIRECTION OF SHALLOW GROUNDWATER FLOW
– MARSH
5 – TOPOGRAPHIC ELEVATION LINES
– ROAD (IMPROVED)
– ROAD (UNIMPROVED)
– INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 1-6
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
GENERAL ARRANGEMENT MAP
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02586R03Z

disposal activities. Excavated soils are typically poorly drained and lack vertical layering. Surface waters are subject to ponding during the wet seasons of the year. Ponding was observed along old roadways throughout the site.

1.1.4.3 Site History

Site 41 was used as an open burn dump from 1946 to 1970. The dump received construction debris and several types of wastes including petroleum, oil, and lubricants (POL), solvents, batteries, mirex in bags, and ordnance including thousands of mortar shells, one case of grenades, and one 105mm Howitzer shell. In addition, it is reported that in the mid-1960s, at least two waste disposal incidents occurred involving the disposal of drummed wastes from trucks. At such times, a fire truck was present. These wastes were described as being similar to the types of wastes disposed of at Site 69 (Rifle Range Chemical Dump). More definitive information is not available to properly identify these wastes. However, it is known that drums of chemical training agents, which may contain small quantities of blister agents, were disposed of at Site 69. In addition, an incident occurred at Site 69 involving the explosion of containers containing HTH.

1.1.4.4 Site Geology and Hydrogeology

Previous investigations conducted at Site 41 involved the installation of five shallow monitoring wells and the collection of static water levels. The description of the geology and hydrogeology given below was taken from the Final Site Summary Report for MCB Camp Lejeune (ESE, 1990). Boring logs or monitoring well construction diagrams associated with the study are not available (Geologic Cross Sections are provided in the Work Plan).

The site is underlain primarily by silty sand, with discontinuous layers of shelly sand, silty-clayey sand, silt, and clay. The surface of the shallow groundwater lies within the silty sand at depths ranging from 2.56 to 10.75 feet bgs (ESE, 1990). Groundwater flow was reported to be southeast toward Tank Creek and the unnamed tributary. No information was provided with respect to the number of static water level measurements obtained to determine flow direction. Based on the topography of the area, some groundwater mounding would be expected.

1.2 Site 69 - Background Information

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

1.2.1 Types and Volumes of Waste Present

According to documented information in site reports approximately 93,000 cubic yards of hazardous material may have been disposed at Site 69, based on an area of approximately six acres and an assumed depth of 10 feet (Water and Air Research, 1983). The hazardous materials include pentachlorophenol, various pesticides (DDT, malathion, diazinon, lindane), TCE, PCBs, fire retardants, chemical agent test kits, gas cylinders, and rifle cartridges. In addition, approximately 50 drums containing chemical surety training agents are reported to be buried at the site. These materials were disposed in pits or trenches ranging from 6 feet to 20 feet deep (Water and Air Research, 1983). There have been no individual volume estimates made for each type of material disposed at the site.

Several areas of suspected disposal activities were observed at Site 69 during Baker's site reconnaissance: two areas of stained soils, a chemical agent test kit disposal area, a long trench, and a formerly open area. The chemical agent test kits were the only items on the list of disposed materials that were observed during the September 1991 site reconnaissance.

Based on the analytical data collected from the site, volatile organic compounds (VOCs) and various inorganics are present in the groundwater and surface water at the site. Pesticides and pentachlorophenol may be contained in sediments. No soil sampling has been conducted in previous investigations. A more detailed summary of previous analytical results are provided in the RI/FS Work Plan (Baker, 1993).

1.2.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at Site 69, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface soil runoff to drainage ditches.
- Leaching of wastes through drums to subsurface soil.
- Migration of buried wastes to surface soil via volatilization or leachate.
- Contaminate infiltration from the shallow aquifer to the deeper aquifer.
- Groundwater discharge to nearby drainage ditches/springs or streams (i.e., unnamed tributary to the New River, Everett Creek, and New River).

Exposure Pathways

- Human exposure by military personnel working inside the area due to dermal contact or incidental ingestion of surface soil and standing water (currently, access to the area is restricted by a fence).

- Human exposure by military personnel outside the fenced area due to dermal contact or incidental ingestion of surface soil and standing water as a result of runoff from the site.

- Wildlife (i.e., deer and other mammals) exposure due to dermal contact or incidental ingestion of surface and subsurface soil.

- Human exposure due to dermal contact with soil and groundwater ingestion for a future residential scenario (presently, groundwater in this area is not used as a potable water supply).

- Human exposure by military personnel due to dermal contact or incidental soil ingestion which could occur during training/maneuvers, future construction, or future residence (currently, access to the area is restricted by a fence).

1.2.3 Data Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. 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 FSAP. Consequently, the data provided is not suitable to fully characterize the site or to make an assessment of human health or ecological risks.

A summary of media-specific data limitations are presented below.

Waste and Debris

The types of wastes disposed of at Site 69 have been documented in previous studies and Marine Corps memorandums. The quantity of materials disposed of and the areas of disposal is not certain; however, geophysical techniques have been employed to delineate the approximate boundary of the disposal areas. In addition, historical aerial photographs have been reviewed to locate potential disposal areas. The disposal areas identified in these photos correlate with the boundaries determined via the geophysical investigation. No subsurface explorations have been performed to identify the contents of the former landfill. Because of the likelihood that chemical agents are present, and the exact location of buried chemical agents is unknown, no exploratory investigations will be performed at this time. This decision is based on U.S. Army direction since uncovering chemical agents, which do not present a current threat to life or health, causes problems with respect to containment, handling, and storage/disposal (Gegen, 1993).

Soil

No soil sampling has been conducted to date. The type and extent of surface and subsurface contamination due to past disposal practices is unknown. Information is not available to assess potential migration to groundwater, impacts to human health, the ecology, or potential off-site migration due to surface runoff.

Sediment

Existing data have identified the presence of pesticides and pentachlorophenol in the sediments of the two unnamed tributaries. Additional analytical data has been collected to fully characterize sediment contamination in Everett Creek and along the New River in order to evaluate potential impacts from the site. However, drainage areas near the site need further evaluation. In addition, human health and ecological risks due to contaminated sediments at Site 69 need to be assessed.

Groundwater

Elevated levels of VOCs and low levels of inorganic compounds have been detected in groundwater. The wells installed to date are all located near the former disposal area. Off-site groundwater quality is unknown. Groundwater flow directions need to be further evaluated since at least one groundwater divide has been identified by previous investigations. The hydrogeologic characteristics (e.g., transmissivity and storativity) are also unknown. Future potential human health and ecological risks need to be assessed.

Surface Water

VOCs and metals were detected in on-site surface water (standing pools of water) at Site 69. Surface water samples were collected from Everett Creek and the unnamed tributary to the north of the site. In addition, samples were collected from the New River. Overall, surface waters in drainage areas (springs, seeps) have not been fully characterized.

Aquatic Life

Tissues from oysters and mussels in the New River were collected and analyzed during a previous investigation (ESE, 1991). Two volatile contaminants (acetone and chloromethane) and low levels of inorganics were detected in the samples. No background samples (upgradient) samples were collected for comparison. Because no sediment or surface water samples collected from the New River exhibited contamination, the presence of volatiles and inorganics may not be attributable to the site. Further evaluation of aquatic life in the New River has been conducted, along with an evaluation of present day surface water and sediment conditions (conducted by Baker in August 1992). The results of this study will be used to assess human health and ecological risks.

1.3 Site 74 - Background Information

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

1.3.1 Types and Volumes of Waste Present

The volume of waste disposed of in the grease pit is unknown. The grease pit reportedly measures 135 feet long, 30 feet wide and 10 to 12 feet deep; however, historical aerial photographs reveal a larger area of concern.

Drums and pesticides soaked bags were allegedly dumped near the grease pit (ESE, 1990). The area where these materials were disposed may be the area just north of the former grease pit which was noted by Baker personnel during a June 1992 site visit. Detailed information regarding the contents of the drums is not available. Drums may have contained pesticides and/or transformer oil containing PCBs. Best estimates indicate that approximately 500 gallon of pesticides were released from the deposition of the bags. Approximately 2,200 gallons of pesticides, contained in drums, are estimated to have been deposited at the site. It is estimated that 1,100 gallons of PCB containing oil was buried at the site. Limited information is available regarding the volume of pesticide materials handled at the Pest Control Area (ESE, 1990). Another background report, the IAS (Water & Air Research, 1983), indicates that some drums buried at Site 74 were intended to be buried at Site 69 (Rifle Range Chemical Dump). Chemical agents are reportedly buried at Site 69. This possible condition must be taken into consideration for investigations at Site 74.

1.3.2 Potential Migration and Exposure Pathway

Based on the evaluation of existing conditions of Site 74, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface soil runoff from Site 74.
- Leaching of contaminants from buried wastes (e.g., drums, bags) into subsurface soil.
- Migration of soil contaminants in subsurface soils to groundwater.
- Groundwater discharge to surface water.
- Groundwater infiltration from the shallow aquifer to the deeper aquifer.

Exposure Pathways

- Wildlife exposure due to dermal contact or incidental soil ingestion.

- Wildlife (e.g., burrowing animals) exposure due to dermal contact to contaminants in subsurface soil.

- Human exposure due to incidental soil ingestion exposure.

- Human exposure due to future potential dermal contact with soil.

- Human exposure due to future potential groundwater ingestion.

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

- Future potential human exposure (residential).

- Future potential human exposure due to ingestion of contamination wildlife.

1.3.3 Data Limitations

The purpose of this section is to define data limitations with respect either to characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. With the exception of recent groundwater sampling and analysis by Baker in July 1992, the analytical methods and the QA/QC protocols used during previous investigations at the site are not available or are adequately documented. Consequently, most of the existing data is not suitable to fully characterize the site or to make an assessment of human health of ecological risks. A summary of media-specific data limitations are presented below.

<u>Waste and Debris</u>

Evidence of buried drums, depressed surface areas, were observed during a site visit by Baker personnel in June, 1992, and identified in historical photographs. It has been reported that drums containing pesticides and/or PCB-ladened transformer oil and pesticide-soaked bags were buried on site. The contents of the drums, bags and other materials that may have been disposed of on site can only be speculated upon. The extent of the disposal area has been preliminarily delineated using geophysical techniques and by review of historical photographs.

Soil

The results of previous sampling efforts (August, 1984) for Site 74 indicate the presence of pesticides in the soil. Samples were only collected in the vicinity of the Pest Control Area. The level of QA/QC to which the results were subjected and overall quality of this data are unknown.

Based on the review of existing information, data will be required to more fully characterize soil contamination, approximately delineate areas of concern, assess human health and ecological risks, evaluate the extent of soil runoff, and evaluate potential remedial technologies.

Groundwater

Two monitoring wells (74GW1 and 74GW2) were installed on site in 1984 and sampled. Supply well 654 was also sampled at this time. A third monitoring well (74GW3) was installed in 1986. The monitoring wells were sampled in July, 1984 (74GW1 and 74GW2 only), December 1986 and March 1987.

The groundwater samples were analyzed for the following parameters:

- Organochlorine Pesticides
- Organochlorine Herbicides
- Polychlorinated Biphenyls
- Tetrachlorodioxin (1986/87 only)
- Volatile Organic Analysis (1986/87 only)

Pesticides (dichlorodiphenyldichloroethylene [DDE] and DDT) were detected in monitoring well 74GW2. Two of the monitoring wells (74GW1 and 74GW2) were sampled by Baker personnel in July 1992. The samples were analyzed for full Target Compound List (TCL) organics and Target Analyte List (TAL) inorganics in accordance with Contract Laboratory Program (CLP) protocols and USEPA Level IV data quality. No organic or inorganic contaminants were detected above Federal or State Water Quality Standards.

Additional analytical data are required in order to more fully characterize groundwater contamination (particularly in the vicinity of the drum disposal area), approximately delineate potential contaminant plumes, assess human health and ecological risks, and evaluate remedial technologies.

1.4 Site 41 - Camp Geiger Dump Near Former Trailer Park

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

1.4.1 Types and Volume of Waste Present

Wastes including construction debris, industrial wastes which have not been defined, solvents, mirex, and ordnance were reportedly disposed of and possibly burned at the site. In addition, drums of unknown content were also reported to be buried at the site.

Information obtained from the IAS Report (Water & Air Research, 1983) indicated that between 10,000 to 15,000 gallons of solvents were disposed of at the site. Disposal methods (i.e., in drums or bulk disposal) and specific disposal locations are unknown. The IAS also reported that "tons" of mirex in bags were disposed of at the site. The area associated with the disposal of mirex is unknown.

Thousands of mortar shells, a box of grenades, and a 105mm Howitzer shell were also taken to the site and disposed of. It is unknown whether the mortar shells contain live munitions or just empty casings. The box of grenades and Howitzer shell are assumed to be unexploded and dangerous.

The area was used for disposal and burning during the period 1946 to 1970.

1.4.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at Site 41, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface runoff from the site to downslope areas and surface water bodies.
- Leaching of buried wastes to subsurface soils and groundwater.
- Groundwater discharge to surface water bodies or drainage areas.
- Contaminant infiltration from the shallow aquifer to the deeper aquifer.

Exposure Pathways

- Wildlife exposure due to dermal contact or incidental ingestion of soil, surface water, or sediment.

- Human exposure due to dermal contact or incidental soil ingestion which could occur during training/maneuvers, future construction, or future residence.

- Human exposure due to groundwater ingestion for a future residential scenario.

- Future potential human exposure due to ingestion of contaminated wildlife.

1.4.3 Data Limitations

The purpose of this section is to define the data limitations with respect to either characterizing the site, assessing human health and environmental risks/impacts, or evaluating potential remedial technologies or alternatives.

The existing data for Site 41 are limited in nature. The following subsections address the data limitations by media so that RI/FS objectives can be identified and appropriate field investigations can be defined to resolve the data deficiencies.

1.4.3.1 Waste and Debris

The types and quantity of wastes taken to the site have been identified through existing information. However, the following data limitations have been identified.

- The actual locations within the 30-acre dump where wastes have been disposed is unknown.

- The mode of disposal (i.e., burning, drum disposal, bulk dumping, etc.) for these wastes is unknown.

- The placement of wastes with respect to whether the wastes are segregated or combined in one or more areas is unknown.

- The type or types of wastes contained in drums is unknown (refer to previous discussion of fire trucks being present during disposal).

1.4.3.2 Soil

No samples have been collected to assess surface or subsurface soil quality. Potential migration of soil contaminants to groundwater or downslope surface water/sediments cannot be assessed due to the lack of samples. There is no information to assess potential impacts to human health or the environment, or to characterize the waste for subsequent remediation, if required.

1.4.3.3 Groundwater

Groundwater data are limited with respect to evaluating shallow groundwater quality directly under the former dump. Also, the number of data points do not appear to be sufficient, due to the size of the study area, to assess potential off site or vertical migration.

Parameters analyzed to date appear to be limited. No PCB or semivolatile analysis has been conducted during the two sampling rounds. Additionally, there is no information to assess the feasibility of remedial technologies. Hydrogeologic characteristics need to be estimated to evaluate potential migration pathways as well as remedial technologies such as pumping or containment of groundwater.

1.4.3.4 Surface Water/Sediment

The number of samples collected to date are not sufficient to fully characterize environmental impacts to the unnamed tributary or Tank Creek. Also, the parameters analyzed to date are limited to fully assess potential impacts to humans or wildlife.

2.0 DATA QUALITY OBJECTIVES

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

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

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

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

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

The remaining portions of this section document the establishment of DQOs for the RI/FS at Sites 69, 74, and 41.

2.1 Stage 1 - Identification of Decision Types

As part of the Stage 1 DQO process, available information from previous site investigations and other sources (e.g., USGS) were reviewed in order to describe the current site conditions, evaluate existing data, and assess the adequacy of the data. This review has been documented in Section 2.0 of the RI/FS Work Plan and summarized in Sections 1.1, 1.2, 1.3, and 1.4 of this FSAP. From this review and evaluation, a conceptual site model was developed for each site by identifying the potential sources of contamination, the contaminant migration pathways, and potential receptors. A conceptual site model for each site is presented in Table 2-1. Based on the conceptual contaminant transport/migration model for each site, specific RI/FS

TABLE 2-1

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Migration and Exposure Pathways	Site-Specific RI/FS Objectives
69	Former Landfill Area	• Surface runoff from former disposal area to offsite areas	• Assess horizontal extent of soil contamination in offsite downslope areas • Evaluate surface water/sediment quality in drainage areas, nearby streams, and the New River(1)
		• Offsite groundwater migration and discharge to nearby surface waters	• Characterize the extent of off-site groundwater quality in the shallow aquifer • Evaluate surface water/sediment quality in drainage areas, nearby streams, and the new River(1)
		• Direct contact with surface soils by humans and mammals	• Assess the level and nature of surface soil contamination
	Drainage Areas, Nearby Streams, and New River	• Direct contact with surface water and sediment by recreational users and wildlife	• Determine surface water/sediment quality in drainage areas, the New River, and nearby tributaries(1)
		• Ingestion of aquatic life by humans, mammals, and other wildlife (fish, water fowl)	• Determine the presence or absence of site-related contaminants in aquatic organisms (fish and shellfish)(1) • Evaluate impacts to aquatic benthic communities(1)

(1) Environmental Studies (surface water, sediment, aquatic organisms) have been conducted on the New River and nearby tributaries (e.g., Everett Creek); however, further studies of site drainage areas are required.

TABLE 2-1 (Continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Migration and Exposure Pathways	Site-Specific RI/FS Objectives
74	Grease Pit Disposal Area	• Surface soil runoff from Site 74 off site.	• Assess horizontal extent of surface soil contamination in this portion of Site 74.
		• Migration/leaching of contaminants from buried drums and wastes to subsurface soils.	• Evaluate nature and extent of buried material in this portion of Site 74.
			• Evaluate nature and extent of subsurface soil contamination in this portion of Site 74.
		• Migration/leaching of soil contaminants to groundwater.	• Assess the vertical extent of soil contamination within this portion of Site 74.
			• Assess the nature and extent of contamination in the shallow aquifer near this portion of Site 74.
		• Vertical groundwater migration to the deep aquifer.	• Evaluate groundwater quality in the deep aquifer (if contamination is detected in the shallow aquifer).
		• Direct contact with surface soil by humans and animals.	• Assess the level and nature of contamination in surface soils near this portion of Site 74.
		• Direct contact with subsurface soils by burrowing animals.	• Assess the level and nature of contamination in subsurface soils near this portion of Site 74.
		• Human exposure from future potential groundwater ingestion or dermal contact.	• Assess the nature and extent of contamination in the shallow aquifer near this portion of Site 74.
	Pest Control Area	• Surface runoff from Site 74.	• Assess horizontal extent of surface soil contamination in this portion of Site 74.
		• Migration/leaching of soil contaminants to groundwater.	• Assess the vertical extent of the soil contamination within this portion of Site 74.
			• Assess the nature and extent of contamination in the shallow aquifer near this portion of Site 74.
		• Vertical groundwater migration to the deep aquifer.	• Evaluate groundwater quality in the deep aquifer (if the shallow aquifer is contaminated).
		• Direct contact with surface soil by humans and animals.	• Assess the level and nature of contamination in surface soils near this portion of Site 74.

(1) Environmental Studies (surface water, sediment, aquatic organisms) have been conducted on the New River and nearby tributaries (e.g., Everett Creek); however, further studies of site drainage areas are required.

TABLE 2-1 (Continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Migration and Exposure Pathways	Site-Specific RI/FS Objectives
74 (Cont.)	Pest Control Area	• Direct contact with subsurface soils by burrowing animals.	• Assess the level and nature of contamination in subsurface soils near this portion of Site 74.
		• Human exposure from future potential groundwater ingestion or dermal contact.	• Assess the nature and extent of contamination in the shallow aquifer near this portion of Site 74.
41	Former Landfill Area	• Overland surface runoff to downslope areas and drainage areas.	• Characterize downslope soil quality along the surrounding hillside.
			• Characterize surface water/sediment quality in the unnamed tributary and Tank Creek.
		• Migration of buried wastes to subsurface soil and water table.	• Identify the boundary of the former landfill and determine areas associated with surficial waste disposal and buried wastes.
			• Characterize soil quality at locations where surficial debris is present.
			• Determine nature and extent of soil contamination where buried wastes are suspected.
			• Characterize surficial and deep groundwater quality within the former disposal area.
		• Direct contact with surface or subsurface soils by humans or wildlife.	• Assess the level and nature of surface soil and subsurface soil contamination.
		• Vertical and horizontal (off-site) migration of shallow groundwater.	• Assess deep groundwater quality on site and downgradient of the disposal area.
			• Assess surface water quality in nearby creeks or drainage areas.
	Drainage Areas (unnamed tributary and Tank Creek)	• Direct contact with surface water and sediment by wildlife and military personnel.	• Determine surface water/sediment quality in the unnamed tributary and Tank Creek.
			• Characterize human health and ecological risks.
		• Ingestion of aquatic life by wildlife.	• Characterize ecological risks using surface water and sediment data.

(1) Environmental Studies (surface water, sediment, aquatic organisms) have been conducted on the New River and nearby tributaries (e.g., Everett Creek); however, further studies of site drainage areas are required.

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

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

2.2 Stage 2 - Identification of Data Needs

In Stage 2 of the DQO process, the data quality and quantity required to support the RI/FS objectives developed during Stage 1 are identified. Data collected during the RI/FS for Sites 69, 74, and 41 will be used for: human and ecological risk assessment; site characterization; screening and evaluating alternatives; and remedial design. With respect to the RI/FS objectives identified in the previous section, data will be required to address the following:

Soil

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

Groundwater

- The extent and nature of on site and off-site groundwater contamination in shallow and/or deep aquifers.
- The flow direction and discharge patterns of the aquifers.
- The chemical properties needed to assess potential human health risks.
- The chemical properties needed to evaluate compliance with State or Federal drinking water standards.
- The chemical/physical properties that may affect the treatability of the groundwater.

Sediments (Sites 41 and 69 only)

- The extent and nature of sediment contamination in drainage areas potentially impacted by site runoff or groundwater discharge.
- The chemical properties to assess human health and environmental risks due to exposure.

Surface Water (Sites 41 and 69 only)

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

Drums/Waste

- The location of suspected drum landfilling/disposal areas.
- The extent of subsurface soil contamination at former disposal areas (Sites 41 and 74 only).

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

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

The analytical method also differs with respect to the end use of the data. For purposes of assessing health risks and to compare contaminant levels against Federal or State standards, it will be necessary to obtain lower detection levels for selected parameters such as volatile organics (e.g., EPA Method 8020). For this RI/FS, USEPA Methods and CLP protocols will be used when applicable unless a method or protocol does not exist, as in the case of Chemical Surety Compounds (CSM).

The quantity of samples collected is based on obtaining a representative measure to characterize the nature and extent of contamination, assess human health and environmental risks, and develop and evaluate remedial alternatives. For the various field investigations at the three sites, the number and location of samples was determined based on best engineering estimates, visual evaluation of the sites, and a review and evaluation of background information.

2.3 Stage 3 - Design Data Collection Program

The data collection program for Sites 69, 74, and 41 have been designed to meet the objectives identified in Table 2-1. Section 5.3 of the RI/FS Work Plan provides a general description of the various sampling programs for the three sites. Sections 3.0 through 5.0 of this FSAP provide the specific details of these sampling programs.

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
SITES 69, 74, AND 41 MCB CAMP LEJEUNE, NORTH CAROLINA

Media	Sampling Criteria/Purpose	Data Types	Data Quality Level
Soil	Determine extent of surface and subsurface soil contamination within reported disposal areas	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3) Subsurface Features (Geophysical Methods)(1)	IV IV IV IV IV II
	Determine extent of surface soil contamination due to surface runoff	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine physical properties of soil to evaluate migration potentials and remedial technologies	Particle-size Distribution Atterberg Limits Total TCLP Corrosivity Ignitability Reactivity	II II III III III III
	Determine chemical properties of soil to assess potential human health and environmental risks, and to evaluate remedial technologies	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine chemical properties associated with disposal and treatment requirements	Total TCLP Reactivity Corrosivity Ignitability	III III III III

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
SITES 69, 74, AND 41 MCB CAMP LEJEUNE, NORTH CAROLINA

Media	Sampling Criteria/Purpose	Data Types	Data Quality Level
Groundwater	Determine extent and nature of onsite and offsite groundwater contamination in shallow and/or deep aquifers	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine physical properties of the aquifers and their physical relationship between one another	Surface Features (lithologic samples) Water Level Elevations (static and pumping) Hydraulic Conductivity Transmissivity	II II II II
	Determine flow direction and discharge patterns of the aquifers	Surface Features (lithologic samples) Water Level Elevations (static and pumping) Hydraulic Conductivity Transmissivity	II II II II
	Determine chemical properties to assess potential human health risks	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine chemical properties to evaluate compliance with State or Federal drinking water standards	TCL Organics TAL Inorganics	IV IV
	Determine chemical/physical properties that may affect treatment	Microbial Count Total Organic Carbon Nitrogen (NHa) Total Phosphorus Alkalinity Biological Oxygen Demand Chemical Oxygen Demand Temperature Specific Conductance pH	III III III III III III III I I I

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
SITES 69, 74, AND 41 MCB CAMP LEJEUNE, NORTH CAROLINA

Media	Sampling Criteria/Purpose	Data Types	Data Quality Level
Sediment (Site 69 only)	Determine extent and nature of sediment contamination in surface water bodies potentially impacted by site runoff or groundwater discharge	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine chemical properties to assess human health and environmental risks due to exposure	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
Surface Water (Sites 41 and 69 only)	Determine extent and nature of surface water potentially impacted by site runoff or groundwater discharge	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine chemical properties to assess human health and environmental risks	TCL Organics TAL Inorganics Mirex CSM(2) Ordnance(3)	IV IV IV IV IV
	Determine physical/chemical properties to assess potential impacts to aquatic life(4)	Dissolved Oxygen Specific Conductance Temperature pH	I I I I

(1) Geophysical investigations have been previously conducted.
(2) Chemical Surety Degradation Compounds (CSM) include: Thiodigylcol, Hydroxyacetophenone, Methyl phosphonic acid, Isopropyl methyl, Acetophenone, Chloroacetophenone, bis(2-Chloroethyl)disulfide, bis(2-Chloroethyl)trisulfide, Hexachloroethane, Dithiane
(3) Ordnance constituents include: HMX, RDX, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, TNT, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene (EPA Method SW-846 8330).
(4) Ecological studies of the New River and its tributaries have been conducted.

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
SITES 69, 74, AND 41 MCB CAMP LEJEUNE, NORTH CAROLINA

Media	Sampling Criteria/Purpose	Data Types	Data Quality Level
Waste (Site 74 only)	Determine extent of subsurface soil contamination at former disposal areas	TCL Organics TAL Inorganics CSM	IV IV IV
	Determine chemical/physical properties to assess disposal and treatment requirements	Total TCLP Reactivity Ignitability Corrosivity	III III III III
	Determine the location of reported disposal areas	Subsurface Features Historical Photographs (Geophysical Techniques)	II

(1) Geophysical investigations have been previously conducted.
(2) Chemical Surety Degradation Compounds (CSM) include: Thiodigylcol, Hydroxyacetophenone, Methyl phosphonic acid, Isopropyl methyl, Acetophenone, Chloroacetophenone, bis(2-Chloroethyl)disulfide, bis(2-Chloroethyl)trisulfide, Hexachloroethane, Dithiane
(3) Ordnance constituents include: HMX, RDX, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, TNT, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene (EPA Method SW-846 8330).
(4) Ecological studies of the New River and its tributaries have been conducted.

3.0 SAMPLING LOCATIONS AND FREQUENCY

This section of the FSAP identifies the field investigations that will be needed to complete RI activities at Sites 69, 74, and 41.

3.1 Site 69 - Rifle Range Chemical Dump

The following investigations and support activities will be conducted at Site 69:

- Initial Evaluation
- Surveying
- Soil Investigation
- Groundwater Investigation
- Surface Water/Sediment Investigation

These investigations are described below.

3.1.1 Initial Site Evaluation

A two to three day initial evaluation will be conducted at Site 69. The initial evaluation will involve the following activities:

- Visual inspection of surface soil to identify stained areas or seeps, or stressed vegetation for subsequent sampling which will be performed as part of the soil investigation).

- Define and mark the approximate boundary of the disposal area, based on existing geophysical transect identification stakes, and visual identification of former trenches.

- Identification of surface soil sampling locations at the former disposal area.

- Identification of background soil sampling locations.

- Collection of one round of water level measurements from all existing monitoring wells.

- Identification of hydropunch sampling locations along the northeast draw and southeast draw.

- Identification of proposed on site and off-site monitoring well locations.

- Clearance of any surficial obstacles (e.g., trees, vegetation) necessary to perform the off-site groundwater investigation.

- Identification of springs or seeps to be sampled as part of the surface water/sediment investigation.

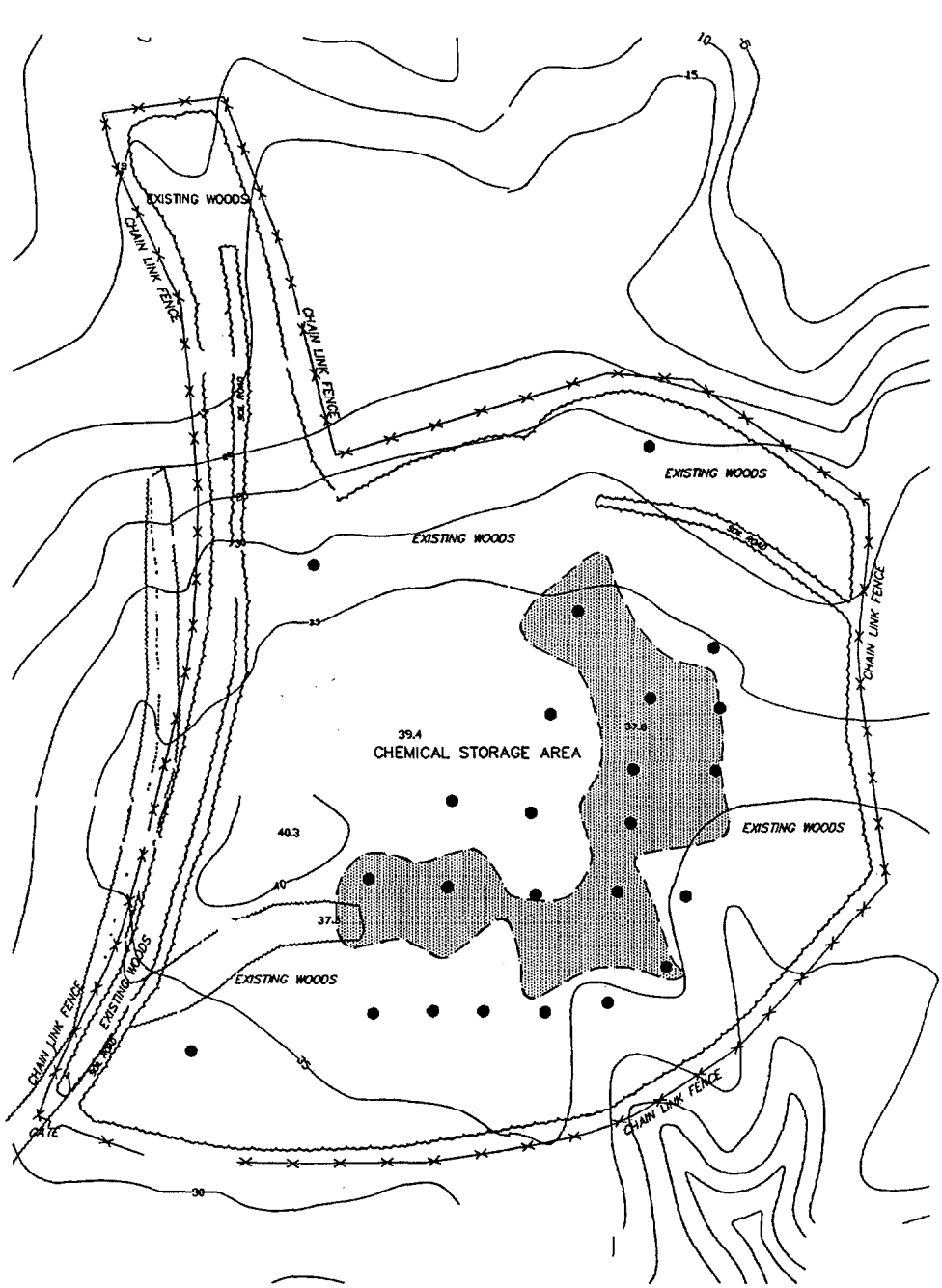
- Surveying of sampling stations identified during this initial evaluation by a licensed surveyor.

3.1.2 Surveying

All existing wells have been surveyed under a separate contract task order. Newly installed monitoring wells, as well as soil and surface water/sediment sampling stations, will be surveyed by a qualified surveyor (i.e., registered to practice in the State of North Carolina). The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. Latitude, longitude, elevation in feet of mean sea level, accuracy, and survey methods will be reported. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be 0.1 foot. In addition, soil sampling locations, hydropunch locations, and surface water/sediment sampling stations will be surveyed to an accuracy of 1 foot.

3.1.3 Soil Investigation

Soil characterization during the RI will comprise of sampling of soils to a depth not to exceed twelve inches. As discussed previously, subsurface soil samples will not be obtained due to the hazard of chemical agents buried at the site. As shown on Figure 3-1, approximately 21 surface samples will be obtained directly over or very near to the suspected disposal area. The actual sampling locations will be based on the initial evaluation of the site which is described in Section 3.1.1.



200 0 100 200 400

1 inch = 200 ft.

Baker

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LEGEND

- SAMPLING STATION FOR SURFICIAL SOIL
- DENOTES PROBABLE BURIED METAL
- FENCE
- VEGETATION
- TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 3-1
SITE 69
RIFLE RANGE CHEMICAL DUMP
PLANNED SOIL SAMPLING LOCATIONS

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Three surface soil samples will be collected outside of the suspected disposal area, but within the fenceline. Four surface soil samples will be collected north and northwest of the site for background soil characteristics.

All samples will be collected using a decontaminated hand trial. The samples will be field screened by the TEU for chemical agents. In the event that chemical agents are identified in the sample, the sample will be handled as a special waste (i.e., hazardous) and will not be analyzed. If no agents are identified, the sample will be handled as a routine environmental sample and submitted for chemical analysis. Sample collection, handling, decontamination, and shipping requirements are provided in Sections 5.0 and 6.0.

All surface soil samples will be analyzed for full TCL organics and TAL inorganics. In addition, the samples will be analyzed for CSM given on Table 3-1. The parameters listed on Table 3-1 are the expected parent degradation products that may be present in the environment. Table 3-2 summarizes the analytical program for the surface soil investigation.

3.1.4 Groundwater Investigation

In order to better characterize on site and off-site groundwater contamination, additional shallow and deep monitoring wells will be required. One on site shallow well is proposed northwest of the suspected disposal area. Since Site 69 is a topographically high area, and a groundwater divide is present at this site, the on site well will be located at the highest elevation within the area as shown on Figure 3-2. The area northwest of the disposal area is a topographic high area.

A second on site well will be paired with shallow well 69GW2, which historically exhibited the highest levels of VOCs. This well will monitor the deeper portion of the surficial aquifer in order to assess vertical contaminant migration. It is estimated that this well will be installed to a depth of approximately 45 to 50 feet below ground surface. The approximate elevation of the site, with respect to the New River which is located east of the site, is about 35 to 40 feet.

In order to assess the extent of off site groundwater contamination in the shallow aquifer, shallow monitoring wells will be installed downgradient from known areas of contamination. To help locate the extent of this contamination, shallow groundwater samples will be obtained from borings by "Hydropunching". Boreholes will be advanced at 50 foot spacings from the site beginning at the fence. This line of borings will advance from the northeast and southeast

TABLE 3-1

TARGET CHEMICAL SURETY COMPOUND
DEGRADATION PARAMETERS
MCB CAMP LEJEUNE, NORTH CAROLINA

Thiodigylcol
Hydroxyacetophenone
Methyl phosphonic acid
Acetophenone
Chloroacetophenone
bis(2-Chloroethyl)disulfide
bis(2-Chloroethyl)trisulfide
Hexachloroethane
Dithiane

Note: These compounds are suspected as a result of disposal at this site; these compounds are not routinely analyzed and require special analytical practices.

BLE 3-2

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 69	Soil - On site	24 surface soil	TCL Organics(2)	IV	CLP/SOW(5)	Routine(6)
			TAL Inorganics(3)	IV	CLP/SOW	Routine
			CSM(4)	IV	Modified EPA 8270	Routine
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
		1	Particle-Size Distribution	II	ASTM D422-63	Routine
		1	Atterburg Limits	II	ASTM D4943-89	Routine
	Groundwater - Hydropunch	14	TCL Volatile Organics	II	EPA 8240	24 hours
	Groundwater - Wells	14 (8 existing, 4 new shallow, 2 new deep wells)	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
		2 (one shallow well and one deep well)	Microbial Count	II	SM 907	Routine
			BOD_5	II	SM 507, EPA 405.1	Routine
			TOC	II	EPA 415.1	Routine
			COD	II	EPA 415.1, Hach	Routine
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine
			Total Phosphorous	II	EPA 365.2	Routine
			Alkalinity	II	SM 403	Routine
	Surface Water-On Site	4 surface water (standing pools)	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
		4 sediment	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Surface Water-Drainage Areas	4 surface water	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
		4 sediment	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine

TABLE 3-2 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 74	Soil - On Site	10 surface soil	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
		1	Particle-Size Distribution	II	ASTM D422-63	Routine
		1	Atterburg Limits	II	ASTM D4943-89	Routine
	Soil - Former Disposal Area	32 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Pest Control Area	19 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
	Groundwater	7 (2 existing, 5 new shallow)	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
		1	Microbial Count	II	SM 907	Routine
			BOD_5	II	SM 507, EPA 405.1	Routine
			TOC	II	EPA 415.1	Routine
			COD	II	EPA 415.1, Hach	Routine
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine
			Total Phosphorous	II	EPA 365.2	Routine
			Alkalinity	II	SM 403	Routine

TABLE 2 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 41	Soil - Downslope	12 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	EPA 8330	Routine
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	EPA 8330	Routine
	Soil - On-site Surficial Character-ization	25 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	EPA 8330	Routine
	Soil - Well Borings	13 borings/3 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inroganics	IV	CLP/SOW	Routine
		2	Particle-Size Distribution	II	ASTM D422-63	Routine
		2	Atterburg Limits	II	ASTMD4943-89	Routine
	Groundwater - Wells	18 (5 existing, 7 new shallow, 6 intermediate wells)	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	EPA 8330	Routine
		2 (one shallow well and one intermediate well)	Microbial Count	II	SM 907	Routine
			BOD_5	II	SM 507, EPA 405.1	Routine
			TOC	II	EPA 415.1	Routine
			COD	II	EPA 415.1, Hach	Routine
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine
			Total Phosphorous	II	EPA 365.2	Routine
			Alkalinity	II	SM 403	Routine

TABLE 3-2 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 41, 69 AND 74
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 41 (cont.)	Surface Water-On Site	10 surface water	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	EPA 8330	Routine
		20 sediment	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	Ordnance	Routine
IDW	Soil Characterization	3 (one composite from each site roll-off box	TCL Organics	IV	CLP/SOW	14-day
			TAL Inorganics	IV	CLP/SOW	14-day
			Full TCLP	III	40 CFR 261	14-day
			Reactivity	III	40 CFR 261	14-day
			Corrosivity	III	40 CFR 261	14-day
			Ignitability	III	40 CFR 261	14-day
	Development/ Purge Water Characterization	3 (one sample from each tanker)	TCL Organics	IV	CLP/SOW	14-day
			TAL Inorganics	IV	CLP/SOW	14-day

(1) Baseline number of samples do not include field QA/QC samples.
(2) TCL Organics: Volatile Organics, Semivolatile Organics, Pesticides/PCBs
(3) TAL Inorganics:

Aluminum	EPA 3010/EPA 200.7	Cobalt	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270.2
Arsenic	EPA 3020/EPA 206	Iron	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Barium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 239	Sodium	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Vanadium	EPA 3010/EPA 200.7
Calcium	EPA 3010/EPA 200.7	Mercury	EPA 3010/EPA 245.1	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7	Cyanide	EPA 3010/EPA 335.2

(4) CSM - Chemical Surety Materials
(5) CLP/SOW - Contract Laboratory Program/Statement of Work
(6) Routine analytical turnaround is 28 days following receipt of sample.
(7) Ordnance constituents include: HMX, ROX, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, TNT, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, 4 amino 2,6 dinitrotoleuen (EPA Method SW-846 8330).

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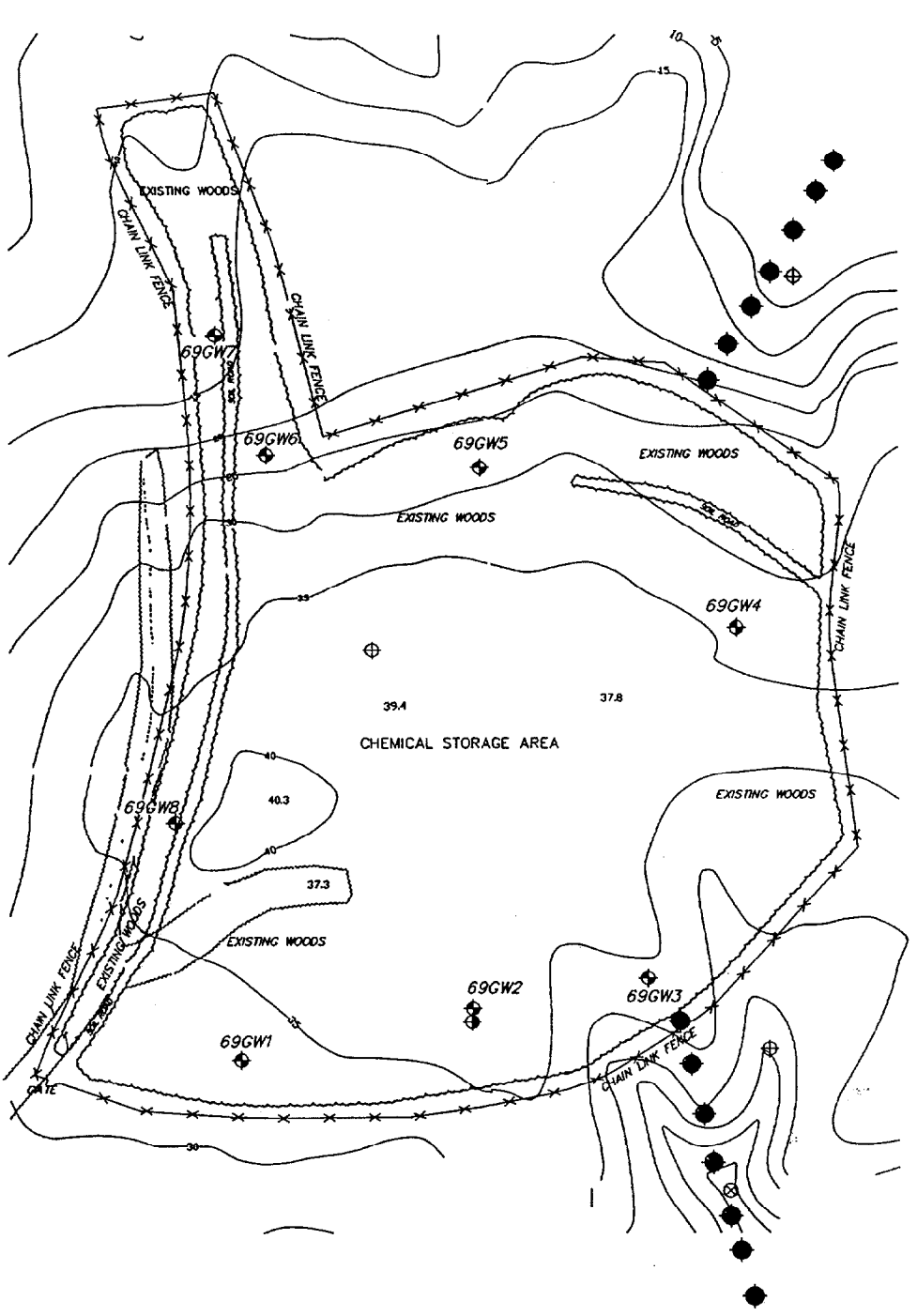

200 0 100 200 400

1 inch = 200 ft.

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LEGEND

69GW2 EXISTING SHALLOW WELLS

PLANNED DEEP WELL

PLANNED SHALLOW WELL

PLANNED PAIR OF SHALLOW AND DEEP WELLS

PLANNED HYDROPUNCH LOCATION

FENCE

VEGETATION

TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 3-2
SITE 69
RIFLE RANGE CHEMICAL DUMP
PROPOSED SHALLOW AND
DEEP WELL LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

areas of the site where topographic drainage patterns are evident (see Figure 3-2). Initially, five to seven borings will be advanced and a sample of the groundwater collected.

The boreholes will be hydraulically pushed to the water table approximately 10 to 15 feet, and a sample of the groundwater will be obtained for field analysis of volatile organics using a field gas chromatograph (GC). The results will be available in 24 hours. If the outermost groundwater sample exhibits elevated levels of VOCs which are above standards, additional borings will be required. This will continue until the extent of contamination in the shallow aquifer can be defined. The extent will be defined when two consecutive hydropunch samples do not exhibit VOC contamination.

At a minimum, one shallow monitoring well will be constructed northeast and southeast of the site, based on the results of the hydropunch investigation. The wells will be located off site in an area believed to be "clean". One shallow well will be installed southeast of the site, approximately 175 feet southeast of well 69GW3, where contamination is likely, based on existing groundwater information. In addition, a second deep monitoring well will be constructed southeast of the site. This well will be paired with the shallow monitoring well to be located in what should be an uncontaminated zone, based on the hydropunch data.

The proposed hydropunch survey lines of investigation as well as the proposed shallow and deep monitoring wells are illustrated on Figure 3-2.

Monitoring well test borings will be augered and soil samples collected using American Society for Testing and Materials (ASTM) Method D1586-84. Soil samples will be collected with a split spoon for 2-foot intervals along 2-foot centers until the first 2-foot interval below the water table. The subsurface soil samples will be submitted for chemical analysis which consists of full TCL organics and TAL inorganics, as shown on Table 3-2. In addition, one subsurface soil sample collected at one of the stations will be submitted for engineering parameters including particle size distribution and Atterberg limits.

All monitoring wells will be constructed of 2-inch polyvinylchloride (PVC) casing and screen. The screen will be schedule 40 and ten feet in length. The shallow wells will be constructed to a depth of approximately 20 to 25 feet so that the screen is set at least 10 feet below the top of the water table. The deeper well will be constructed the same as the shallow well except that it will be set at a depth of approximately 45 to 50 feet bgs. Monitoring well construction details and drilling procedures are provided in Sections 5.0 and 6.0.

One round of groundwater samples will be collected from the eight existing monitoring wells, four proposed shallow monitoring wells, and two proposed deep wells. All groundwater samples will be analyzed for full TCL organics, TAL inorganics (i.e., dissolved and total metals) in accordance with CLP protocols and Level IV data quality. Chemical surety degradation products will also be analyzed through a certified surety laboratory. One shallow and one deep groundwater sample will be collected from well 69GW2 for analysis of engineering parameters including: microbial count, biological oxygen demand (BOD), total organic carbon (TOC), chemical oxygen demand (COD), ammonia nitrogen (NH_4), total phosphorous, and alkalinity. Specific conductance and pH will be measured in the field.

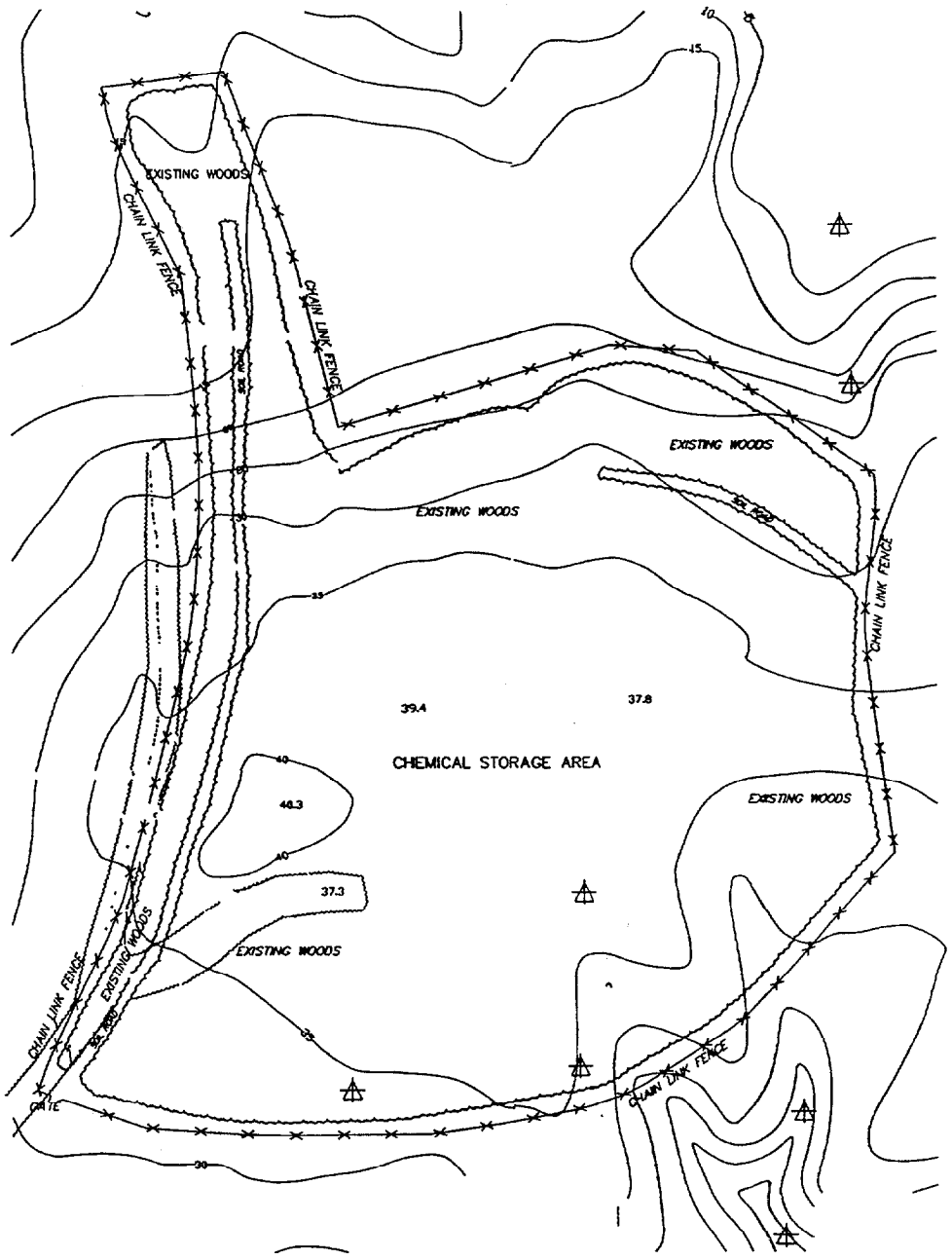
The sampling and analytical program is summarized on Table 3-2.

3.1.5 Surface Water/Sediment Investigation

Surface water/sediment samples will be collected from standing pools of water at Site 69, and from springs/drainage areas northeast and southeast of the site as shown on Figure 3-3. Previous site reconnaissances have noted standing water in various locations of Site 69, particularly near the southern portion of the site near the fence. Three to four pools of standing water, if present during the time of sampling, will be sampled. One surface water and sediment sample in which the sediment is actually a saturated soil sample, will be collected from each pool of standing water.

During the initial evaluation (described under Section 3.1.1), springs or drainage seeps will be identified in the drainage areas northeast and southeast of the site. At least two samples of the water/sediment in these drainage areas will be collected. The first sample will be collected at the location where water is first encountered walking from the site. The second sampling station shall be identified several hundred feet downstream.

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. Sediment samples will be collected using a hand coring device. Sampling procedures, preservation requirements, decontamination, and shipping requirements are described in Sections 5.0 and 6.0.



200 0 100 200 400

1 inch = 200 ft.

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LEGEND

- PLANNED SURFACE WATER/SEDIMENT STATION
- FENCE
- VEGETATION
- TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 3-3
SITE 69
RIFLE RANGE CHEMICAL DUMP
PROPOSED SURFACE WATER/
SEDIMENT SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

All surface water and sediment samples will be analyzed for full TCL organics, TAL inorganics, and CSM. A summary of the proposed sampling and analytical program is given in Table 3-2.

3.2 Site 74 - Mess Hall Grease Pit Disposal Area

The following investigations and support activities will be conducted at Site 74:

- Initial Evaluation
- Surveying
- Soil Investigation
- Groundwater Investigation

These investigations are described below.

3.2.1 Initial Evaluation

The initial evaluation will include a visual inspection of the surface of each area of concern at Site 74 for appearances of soil staining or stressed vegetation. Areas so noted will be considered to reflect subsurface releases of artificially introduced substances representing potentially hazardous materials. One hundred-foot traverses across each area will be walked by two members of the field team.

The initial evaluation will also include the following:

- Identification of at least four background soil sampling locations.

- Surveying of existing monitoring wells.

- Collection of one round of water level measurements from existing wells.

- Calculation of groundwater elevations and representation of groundwater flow, considering the influence of the supply well (well No. 654) located near the former grease disposal area.

- Visual inspection of the area for springs or seeps that may not have been apparent during earlier site reconnaissances.

- Identification and marking of sampling grids (see Soil Investigation).

- Identification and marking of proposed monitoring well locations.

- Clearance of any surficial obstacles (i.e., trees, vegetation) necessary to perform the groundwater investigation or trenching excavation operations.

3.2.2 Surveying

Newly installed monitoring wells, surface soil sampling stations, and trenches will be surveyed by a qualified surveyor (i.e., registered to practice in the State of North Carolina). For the monitoring wells, the top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. Latitude, longitude, elevation in feet of mean sea level, accuracy, and survey methods will be reported. The vertical accuracy will be 0.01 foot and the horizontal accuracy will be 0.1 foot. Test borings will be surveyed to an accuracy of 1 foot.

3.2.3 Soil Investigation

The soil investigation will include the following sampling programs:

- Collection of surficial soil samples (0 to 12 inches)
- Collection of surface and subsurface soil samples from test borings
- Collection of subsurface soil samples from monitoring well boreholes

Surficial Soil Sampling

Surface soil samples will be collected at areas exhibiting stressed vegetation or staining, as noted during the initial evaluation of the site (see Section 3.2.1). If no such areas are identified, five random surface soil samples will be collected near the former disposal area and five random surface soil samples will be collected near the former pest control area. Although the exact number of surface soil samples is unknown and will be determined in the field, ten

locations will be assumed for cost estimating purposes only. Four background soil samples will also be collected. The locations will be located upgradient of the site.

All surface soil samples will be collected using a decontaminated hand trial. Sampling procedures, decontamination procedures, and sample handling and shipping requirements are described in Sections 5.0 and 6.0.

Surface soil samples will be analyzed for full TCL organics and TAL inorganics. Surface soil samples collected near the former disposal area also will be analyzed for CSM degradation products.

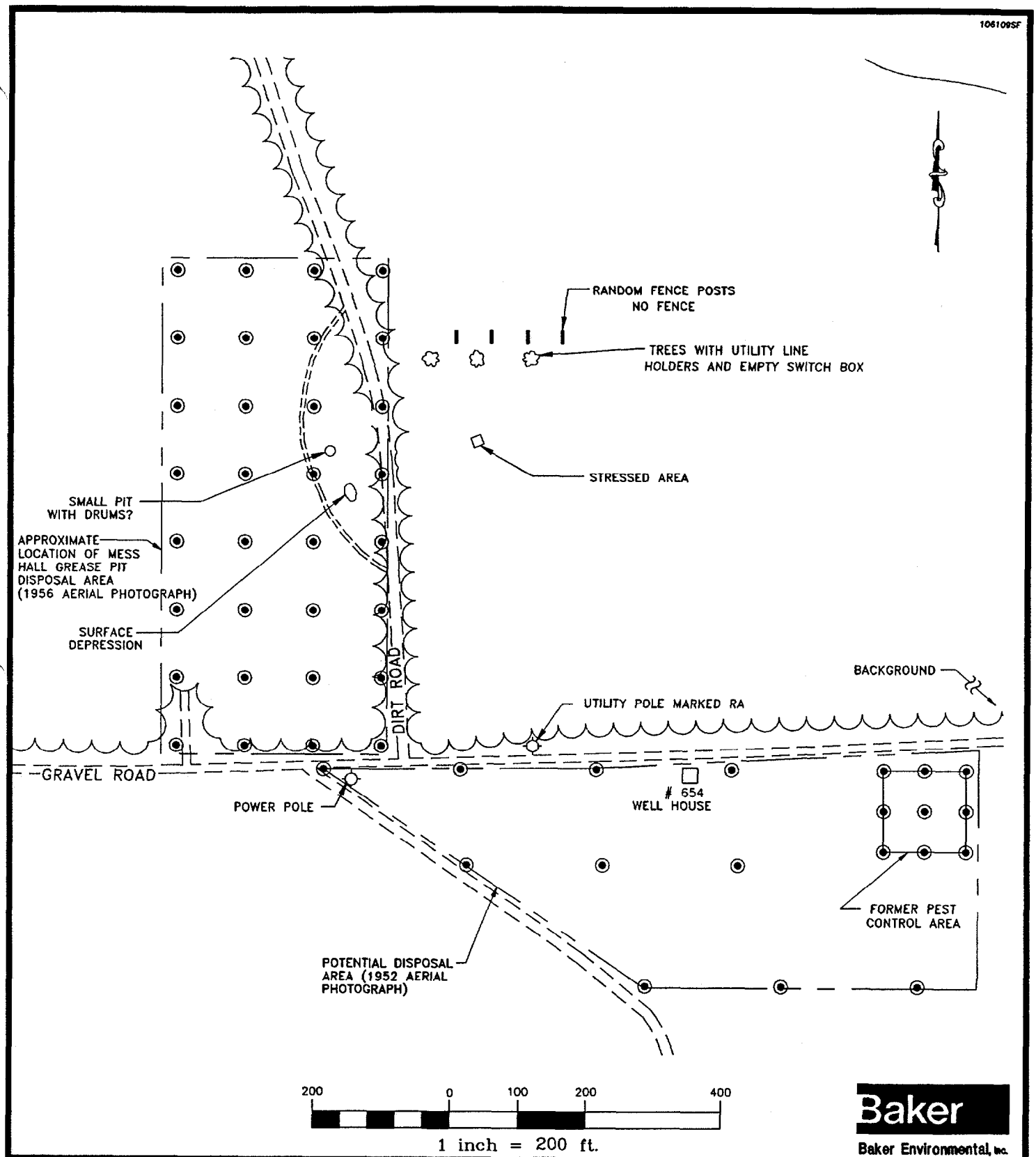
Soil Investigation

A soil investigation will be conducted at the former pest control area, the potential disposal area which surrounds the pest control area, and the former disposal area north of the access road as shown on Figure 3-4. Sampling grids will be established to cover all three areas.

A 50 by 50-foot sampling grid will be established at the former pest control area (a total of nine grid points). A 200 by 200-foot sampling grid (a total of eight grid points) will be established outside of the pest control area to evaluate potential disposal operations which were noted on historical photographs. The area north of the access road (gravel road) will be investigated by establishing a 100 by 100-foot sampling grid (a total of 32 grid points) in the area where trenches were identified in historical aerial photographs.

Test borings will be augered at each grid point in accordance with ASTM Method D1586-84. Soil samples will be collected with a split spoon at 2-foot centers until the first 2-foot interval below the water table. A maximum of three soil samples from each test boring will be submitted for chemical analysis. These samples shall include a surficial soil sample (top 12 inches), a sample from mid-depth between the ground surface and the water table, and a sample from just above the water table. If high water table conditions are encountered (e.g., less than 6 feet bgs), three samples from each borehole will not be attainable. Therefore, samples shall be collected from the surface (0 - 12 inches) and just above the water table.

Monitoring well test borings will be augered and soil samples collected using ASTM Method D1586-84. Soil samples will be collected with a split spoon for 2-foot intervals along 2-foot centers until the first 2-foot interval below the water table. The subsurface soil samples will



LEGEND

⊙ SOIL BORING SAMPLING LOCATIONS

==== ROAD (UNIMPROVED)

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 3-4
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
SOIL INVESTIGATION SAMPLING LOCATIONS

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

be submitted for chemical analysis including full TCL organics, TAL inorganics and CSM as shown on Table 3-2. Samples collected from the pest control area shall not be analyzed for CSM. In addition, one subsurface soil sample collected at one of the stations will be submitted for engineering parameters (i.e., particle size distribution, Atterberg limits).

3.2.4 Groundwater Investigation

The groundwater investigation will involve the following activities:

- Installation of up to five monitoring wells and one replacement well (well 74 GW3 could not be located) at locations selected during the initial evaluation. Approximate locations are shown on Figure 3-5.

- Collection of static water levels and performance of slug tests on all newly installed monitoring wells.

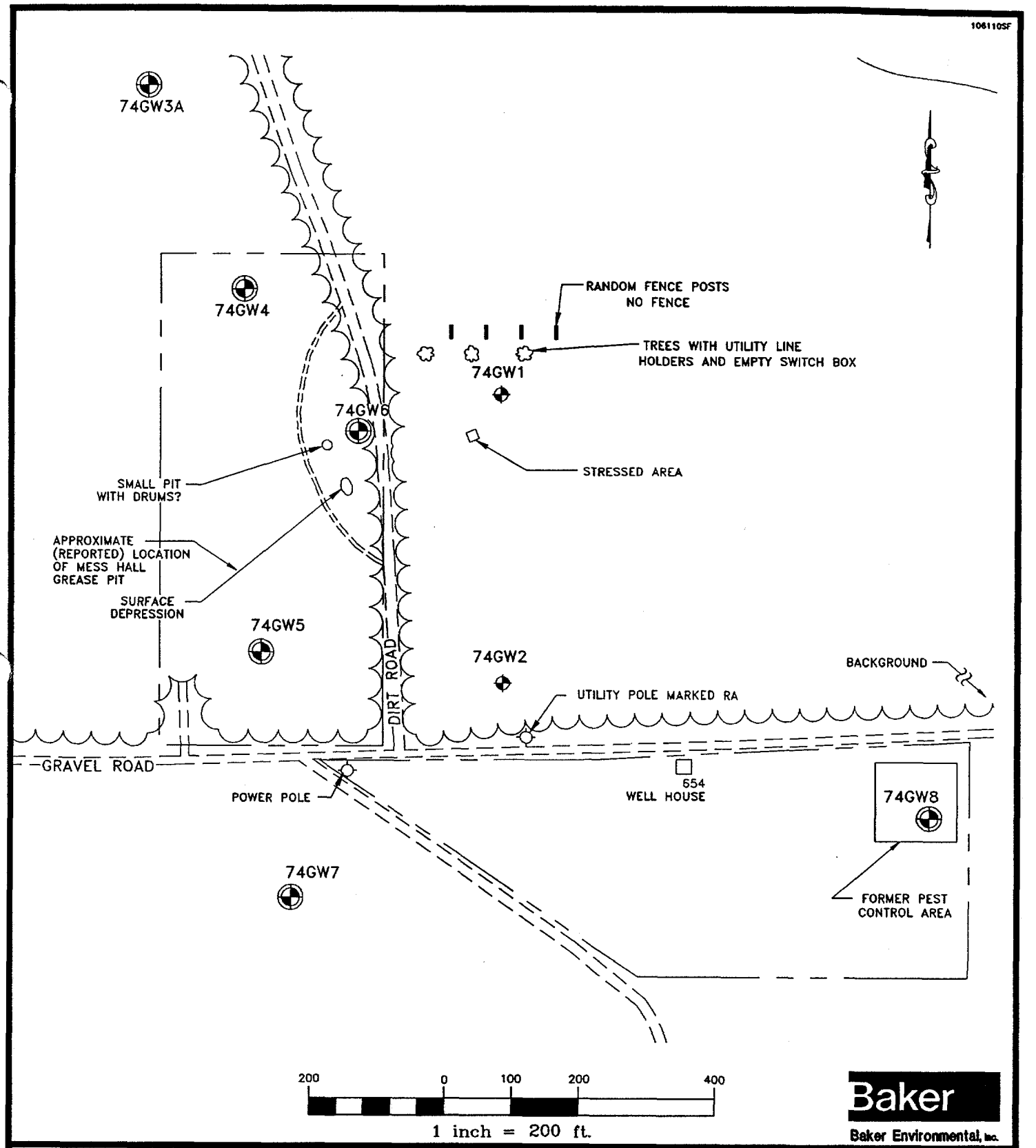
- Collection of one round of samples from all monitoring wells for full TCL organics and TAL inorganics. CSM will also be analyzed for in all wells except well 74GW8. In addition, one groundwater sample will be analyzed for engineering parameters (see Table 3-2).

The principal interest of the investigation will be the shallow water table. Subsidiary indications of the potential distribution of contaminants from the shallow water table to the Castle Hayne aquifer supplying potable water via Supply Well 654 will be addressed by analysis of flow vectors and head relationships. Supply Well 654 is sampled periodically for full organic and inorganic analysis. No contamination has been detected to date.

3.3 Site 41 - Camp Geiger Dump Near Former Trailer Park

The following investigations and support activities will be conducted at Site 41:

- Initial Evaluation
- Surveying
- Site Reconnaissance
- Geophysical Survey
- Soil Investigation



LEGEND

74GW1 – EXISTING SHALLOW WELL

74GW4 – PLANNED SHALLOW MONITORING WELL

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 3-5
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
GROUNDWATER INVESTIGATION
SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- Groundwater Investigation
- Surface Water/Sediment Investigation

These investigations are described below.

3.3.1 Initial Evaluation

The initial site evaluation will be conducted to address and resolve potential problems that may be encountered during the various site investigations. The initial evaluation will be conducted approximately one to two weeks prior to the mobilization of the field team and subcontractors. The initial evaluation will include the following activities:

- Identification of background and downslope soil sampling areas.
- Identification of appropriate surface water/sediment sampling stations.
- Identification of drainage areas between the former disposal area and the unnamed tributary and Tank Creek (i.e., along the hillsides surrounding the site).
- Identification of proposed monitoring well locations.
- Clearance of any surficial obstacles necessary to perform the geophysical survey, or to gain access to monitoring well locations.

3.3.2 Surveying

All existing and newly installed monitoring wells will be surveyed by a qualified surveyor (i.e., registered to practice in the State of North Carolina). The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. Latitude, longitude, elevation in feet of msl, accuracy, and survey methods will be reported. The vertical accuracy will be 0.01 foot and the horizontal accuracy will be 0.1 foot.

All test borings will be surveyed to an accuracy of 1 foot. Traverses spaced at 50 feet across the site will also be established by the surveyor and depicted on the base map. The traverses will be used to perform the site reconnaissance and geophysical survey.

Aerial topographic mapping, by photogrammetic methods, will be produced of a 70-acre area encompassing the former dump and surrounding area. Vertical control shall conform to MSL 1929 datum. Horizontal control shall be based on the MCB Camp Lejeune surveyed coordinate system. A survey baseline will be established at the site to be used as a reference for field location work.

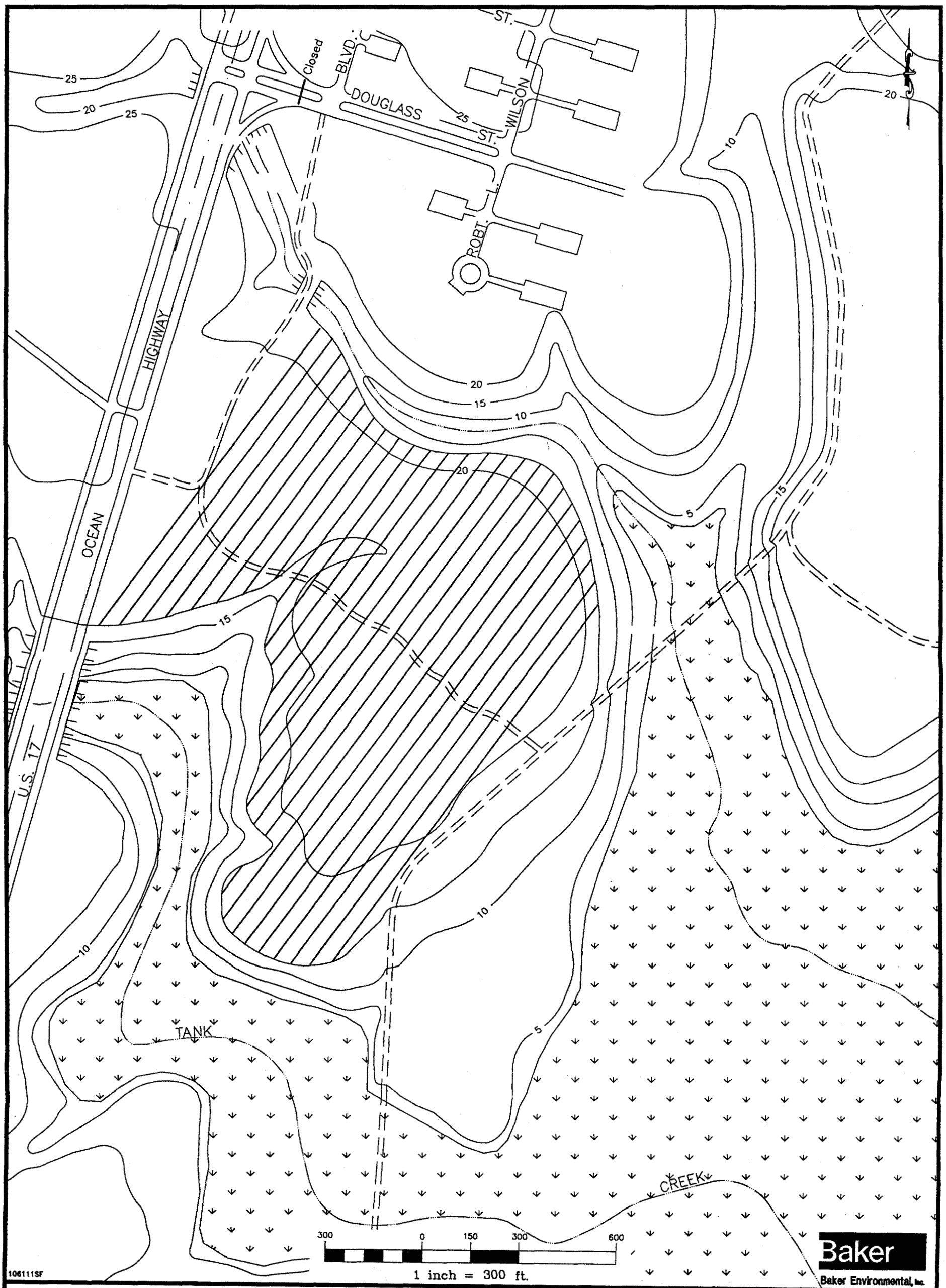
The topographic mapping will be produced at a scale of 1" = 100' with a contour interval of one foot. Additional surveyed locations and elevations will be obtained for detail. The finished products will consist of the following:

- A reproducible mylar drawing of existing conditions.
- One drawing bearing the seal of a certified land surveyor registered to practice in North Carolina.
- A 3-1/2" high density diskette containing the three dimensional file in an AutoCADD, version 12, recognized *.DWG or *.DFX conversion file format.

3.3.3 Site Reconnaissance

A site reconnaissance will be conducted along 50-foot traverses over the former disposal area (see Figure 3-6). The purpose of the site reconnaissance is to identify surficial disposal areas that may have resulted in soil or groundwater contamination. A pre-scoping site visit was conducted in September 1993 by the project team to examine the physical layout of the study area. During the site visit, numerous piles of debris and scattered drums were identified at various locations. However, due to the thick vegetative cover, it was difficult to identify all objects (e.g., drums, canisters, debris) along the ground surface. Based on the initial pre-scoping site visit, piles of debris including a few drums and canisters were observed throughout the site. Further investigation of these areas are warranted.

The reconnaissance will first involve the establishment of 50-foot traverses across the study area. The traverses will also be utilized as part of the geophysical investigation described in Section 3.3.4. Project team members will walk along the traverses and identify all surficial anomalies for subsequent mapping. Those anomalies that may be associated with waste disposal (e.g., canisters or drums, or stressed vegetation) will be marked in the field and investigated as part of the soil investigation. Construction debris areas will not be subject to



LEGEND

- DENOTES GEOPHYSICAL INVESTIGATION TRAVERSE LINE AT 50-FOOT SPACINGS
- MARSH
- 5 – TOPOGRAPHIC ELEVATION LINES
- ROAD (IMPROVED)
- ROAD (UNIMPROVED)
- INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 3-6
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
GEOPHYSICAL COVERAGE
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02586R04Z

subsequent sampling. Based on the project schedule, the field investigation at Site 41 will be conducted in January. Therefore, the vegetative cover should be at a minimum.

3.3.4 Geophysical Investigations

Existing information indicates that wastes including POL, solvents, batteries, ordnance, mirex in bags, and drums were disposed of during the period 1946 to 1970. Currently, there is no information regarding placement of these wastes. Based on discussions with base personnel and experience at other base disposal areas, the wastes are likely buried in shallow trenches. Some of wastes were probably ignited prior to backfilling, based on previous reports (Water & Air Research, 1983). Due to the relatively high water table, the trenches are probably 3 to 10 feet in depth and several feet in width (e.g., 3 to 5 feet).

Geophysical investigations will be conducted at Site 41 to locate former disposal areas, possible buried drums, and ordnance. The results of the geophysical investigations will be used in the soil and groundwater investigations in order to assess the nature and extent of soil and groundwater contamination.

Geophysical techniques will include electromagnetic (EM) terrain conductivity and a newly-developed technique known as Surface Towed Ordnance Locator System (STOLS).

EM is a geophysical technique for delineation of buried, non-metallic wastes abandoned trenches, or anomalies associated with lenses or pockets of different materials. EM surveying also is particularly effective for detection of buried metal objects such as pipelines, drums, tanks, and metal debris. EM data will be acquired by traversing predetermined survey lines spaced 50-feet apart throughout the former disposal area. Where anomalies are detected, "tighter" traversing will be performed to better delineate the areas of concern. Data will be recorded digitally and transferred to a portable computer which will be used to generate conductivity contour maps and/or profiles.

STOL is a second generation system based on a demonstration prototype STOLS developed by the Navy and GEO-CENTERS, INC. under NRL Contract N00014-86-C-2266. STOLS will be employed to locate buried ordnance for which it was developed and drums.

The STOLs is an array of commercial total field magnetometers which is towed by an off-road vehicle. Data are acquired using a computer driven data acquisition search system. Field

data are transferred to a field deployed command center computer for off-line analysis, processing and magnetic anomaly map generation.

The mission objectives of the systems are to:

- Detect and locate buried ordnance with an accuracy of ± 1 meter and depth to approximately 5 meters.
- Carry out analysis of daily survey data, on site and overnight.
- Generate hard copy site reports and target maps.

STOLS offers rapid and accurate survey capability with archival records. It has been demonstrated that large tracts can be swept with quantitative accuracy to yield maps of target locations and covered areas.

The STOLS tow vehicle is a six-wheel, off-road platform custom modified prime movers. Its computerized control unit can acquire and store 4.5 hours of continuous data. This would be comparable to approximately half of one day's survey. An on-board microwave system updates the tow vehicle location each second to $\pm$ 1 meter accuracy.

The STOLS tow platform is a stable four wheel trailer employing nonmagnetic materials for a low magnetic self-signature. Magnetic field sensors are spaced 0.5 meters apart on a folding boom with an effective sweep width of 3 meters (10 feet). The sensors are cesium vapor magnetometers which measure total magnetic field. Custom built interface electronics acquire 20 readings per second from each sensor with 1 gamma resolution.

Because natural fluctuations in the earth's magnetic field can affect survey precision, STOLS incorporates a reference magnetometer base station. Data from a tripod mounted cesium vapor sensor are recorded simultaneously with the magnetometry survey and are stored on a removable data cartridge for post-processing to remove any drift.

Four portable, stand-alone remote microwave navigation stations, deployed on a perimeter of the survey area, relay range locations data to the master navigation system on the tow vehicle.

Field data are transferred by an umbilical cable and/or a personal computer (PC) based storage media from the tow vehicle to the command center for immediate processing. The data are decompressed and contemporaneous reference data are subtracted from the field data to yield residual or anomalous, magnetic field readings. From the Navigation and magnetometer, data are sorted and gridded into a two dimensional array. An image file is constructed from the data array and are displayed as quarter-acre quadrants in either gray scale or pseudocolor on a high resolution color monitor.

The target analysis algorithm is used to estimate initial target location. The initial estimate is used as the seed for a recursive model-matching algorithm which performs a least-square fit of a dipole magnetic model to the field survey data. The derived dipole coordinates are reported as target location and depth, while the dipole moment is used to classify the target as small, medium or large.

STOLS command center software is a menu-driven package written in the C programming language which is widely used in scientific applications and imaging systems. The software allows the user to set up a survey, load data from the tow vehicle or archive tapes, process the data, analyze the data for target estimates, and produce maps and reports of field activities.

3.3.5 Soil Investigation

The investigation of soil conditions at Site 41 will involve three separate investigations, each with a specific objective. These investigations will focus on the following:

- Assessment of surface quality downslope of the former disposal area
- Assessment of background soil quality
- Characterization of surface and subsurface soil quality at suspected disposal areas identified during the site reconnaissance
- Characterization of soil from monitoring well boreholes for correlation to groundwater analyses
- Characterization of soil for engineering parameters

The various components of the soil investigation are described below.

Assessment of Downslope and Background Soil Quality

Because the former disposal area is situated at a topographic high area, downslope soils may be contaminated via surface runoff. In order to assess this, 12 surface soil samples (i.e., top twelve inches) will be collected along the hillside surrounding the former disposal area (see Figure 3-7).

Four soil samples will be collected northeast of the site in a wooded area not believed to be associated with previous disposal activities for purposes of evaluating background soil characteristics.

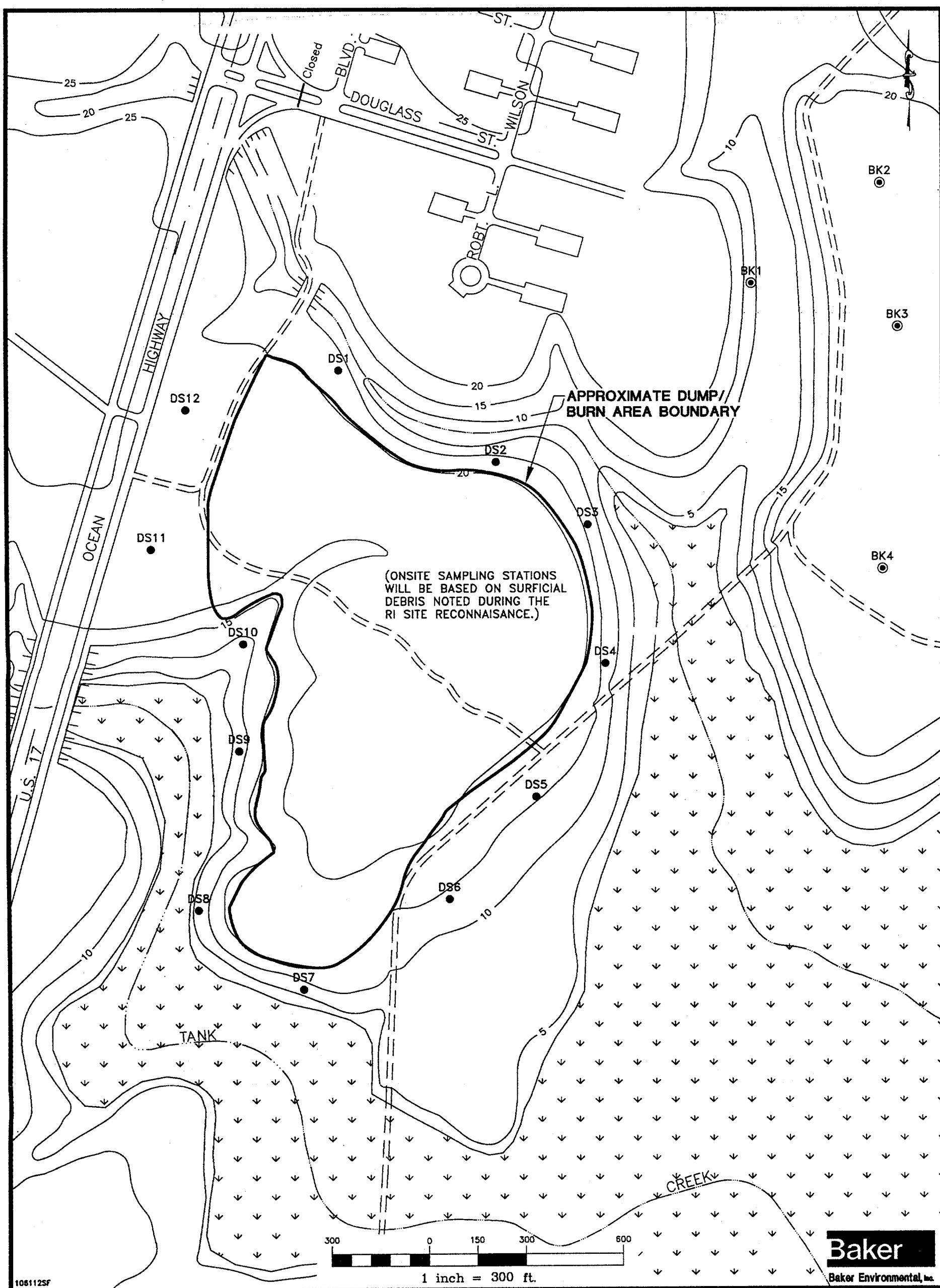
All soil samples will be analyzed for full TCL organics, ordnance constituents, mirex, CSM and TAL inorganics (see Table 3-2).

Characterization of On-site Surface and Subsurface Soil Quality

Areas identified as suspected waste disposal areas via the site reconnaissance and geophysical investigations will be investigated. At each surficial disposal area defined during the site reconnaissance, one surface (0 - 12 inches) and one subsurface soil samples (2 - 4 feet bgs) will be collected by hand augering. The location will be in the central portion of the surficial debris. Prior to sampling, the location will be cleared for buried ordnance by a subcontractor. If buried metal is detected, only a surface soil sample will be obtained.

Areas identified as possible disposal areas via the geophysical investigations will also be investigated. At each area of concern, test borings will be augered and soil samples collected using ASTM Method D1586-84. The number of test borings will be determined in the field based on the size of the anomaly. The boreholes will be placed to collect soil data to assess the horizontal and vertical extent of contamination. However, borings will not be augered through areas where metallic anomalies are detected due to the potential for encountering ordnance, chemical agents in drums, or flammable materials in drums.

Soil samples will be collected with a split spoon at 2-foot centers until the first 2-foot interval below the water table. The surface soil in the top twelve inches and two subsurface soil samples which are mid-depth and the bottom of borehole, will be submitted for analysis. Due



LEGEND

- DS1 ● – DOWNSLOPE SURFACE SOIL SAMPLING STATION
- BK1 ◉ – BACKGROUND SOIL SAMPLING STATION
- – MARSH
- 5 – TOPOGRAPHIC ELEVATION LINES
- – ROAD (IMPROVED)
- – ROAD (UNIMPROVED)
- – INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 3-7
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
SURFACE SOIL SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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to the high water table reported at this site, some boreholes may only produce two soil samples for chemical analysis. The actual number of borings is unknown. However, for costing purposes, it is estimated that this investigation will involve hand augering 25 soil borings. All samples will be analyzed for full TCL organics, mirex, CSM, ordnance constituents, and TAL inorganics (see Table 3-2).

Characterization of Soil in Monitoring Well Boreholes

A minimum of seven shallow boreholes and six intermediate depth boreholes will be drilled for installing monitoring wells at Site 41. Additional boreholes may be augered for subsequent installation of monitoring wells following the evaluation of data collected as part of the geophysical investigations.

Monitoring well test borings will be augered and soil samples collected in accordance with ASTM Method D1586-84. Soil samples will be collected with a split spoon at 2-foot intervals along 2-foot centers to the bottom of the borehole. The shallow boreholes shall be terminated approximately 15 feet below the water table. The intermediate boreholes will be terminated approximately 10 to 15 feet below a clay-limestone-shell formation, which may be encountered approximately 20 to 25 feet below ground surface. This formation is believed to be the upper portion of the Castle Hayne Aquifer.

Soil samples will be collected for chemical analysis from each borehole. The initial 2-foot interval, the approximate middle depth interval, and the interval which encounters the water table will be submitted for full TCL organics and TAL inorganics. In addition, two composite samples (i.e., one composite sample from two borings) will be analyzed for engineering parameters including grain size analysis and Atterberg Limits.

QA/QC samples include field blanks, duplicates, trip blanks, preservation blanks, and equipment rinsate blanks. Laboratory QA/QC samples include matrix spike (MS) and matrix spike duplicate (MSD) samples.

Field duplicate samples will be collected at a rate of one sample per ten soil samples collected. One trip blank will accompany each day's shipment of samples for volatile organic analysis (i.e., one trip blank for each shipment container with samples for volatile organic analysis). Equipment rinsate blanks will be submitted daily. One field blank and one preservation blank will be submitted for the entire investigation. A sample of the drilling mud, if mud

rotary needs to be employed due to site conditions, and bentonite mix will be collected for analysis.

All duplicate samples will be analyzed for the corresponding soil analysis. Blank QA/QC samples will be analyzed for TCL organics and TAL inorganics. Trip blanks will be analyzed for TCL volatile organics only.

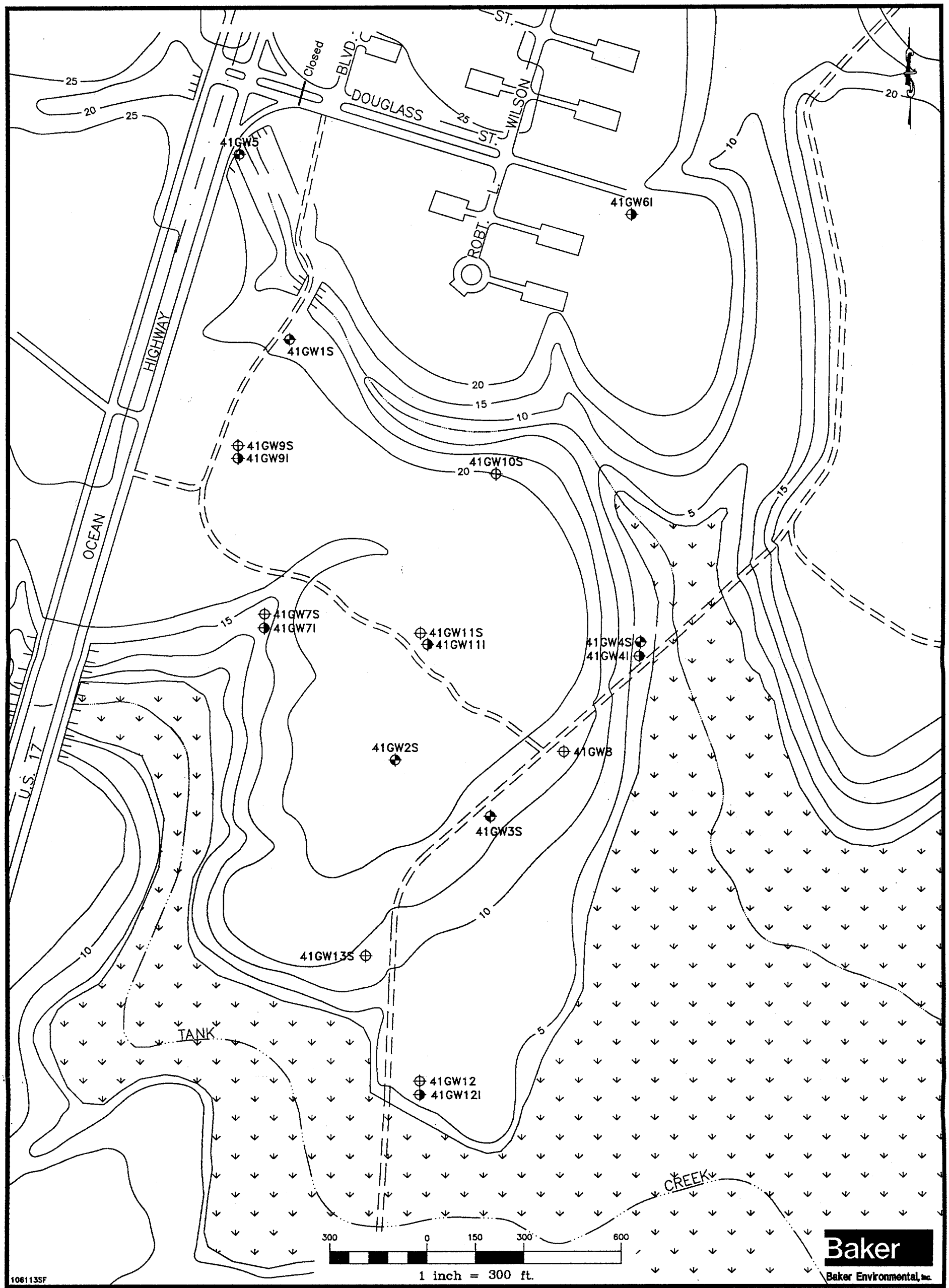
3.3.6 Groundwater Investigation

The groundwater investigation will involve the installation of at least seven shallow monitoring wells to assess groundwater quality in the shallow (i.e.,water table) aquifer. Six "intermediate" wells will be installed in the shell-limestone Castle Hayne formation to assess vertical and horizontal contaminant migration. One of the six intermediate wells will be installed north of the site in an apparent upgradient location for purposes of assessing background groundwater quality in the Castle Hayne. Existing well 41GW5 will be utilized to assess background groundwater quality in the shallow aquifer.

The proposed well locations are shown on Figure 3-8. Additional shallow or intermediate depth monitoring wells may be installed within the former disposal area following the evaluation of geophysical data in order to determine groundwater quality near former trenches or waste burial areas.

Wells 41GW11S and 41GW11I will be located in what appears to be the center portion of the former disposal area. Currently, there are no wells in this portion of the site. Wells 41GW7S through 41GW10S, and well 41GW12S will be positioned at the edge of the former disposal area to assess horizontal migration of groundwater contamination in the shallow aquifer. The current number of wells along the former disposal area boundary are not sufficient to characterize shallow groundwater quality given the size of the study area. Well 41GW12S, which is located near the wetland, will be constructed to monitor shallow groundwater in an apparent discharge zone.

Intermediate depth wells will be paired with shallow wells 41GW9S, 41GW4S, 41GW7S, 41GW11S, and 41GW12S in order to assess groundwater quality in the deeper Castle Hayne aquifer.



LEGEND

- 41GW1 – EXISTING GROUNDWATER MONITORING WELL
- 41GW7S – PROPOSED SHALLOW MONITORING WELL
- 41GW4I – PROPOSED INTERMEDIATE MONITORING WELL
- MARSH
- 5 – TOPOGRAPHIC ELEVATION LINES
- ROAD (IMPROVED)
- ROAD (UNIMPROVED)
- INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 3-8
SITE 41
CAMP GEIGER DUMP NEAR FORMER TRAILER PARK
PROPOSED SHALLOW AND INTERMEDIATE
MONITORING WELL LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02586R062

The monitoring wells will be constructed of 2-inch PVC casing and screen. The screen will be schedule 40 and ten feet in length. The shallow wells will be constructed to a depth of approximately 10 to 15 feet below the top of the water table. The intermediate depth wells will be installed approximately 10 to 15 feet into the shell-limestone formation.

Following proper well development and purging (see Section 5.2.3), two rounds of groundwater samples will be obtained for analysis. The first round of samples will be collected approximately one week following well development. The second round will be collected approximately 3 months following the first round. All groundwater samples will be analyzed for full TCL organics, ordnance constituents, CSM, mirex, and TAL inorganics (i.e., total and dissolved metals). In addition, one sample from a shallow and intermediate monitoring well will be collected for engineering parameters including microbial count, BOD, TOC, COD, NH_4, total phosphorus, and alkalinity.

The initial round of groundwater samples will be analyzed within 14 days in order to determine whether additional shallow or deeper monitoring wells are required to complete the investigation. If additional wells are required, the number, location, and depth of wells will be discussed with the USEPA and state of North Carolina, Department of Environment, Health, and Natural Resources (DEHNR) in conjunction with the Navy/Marines.

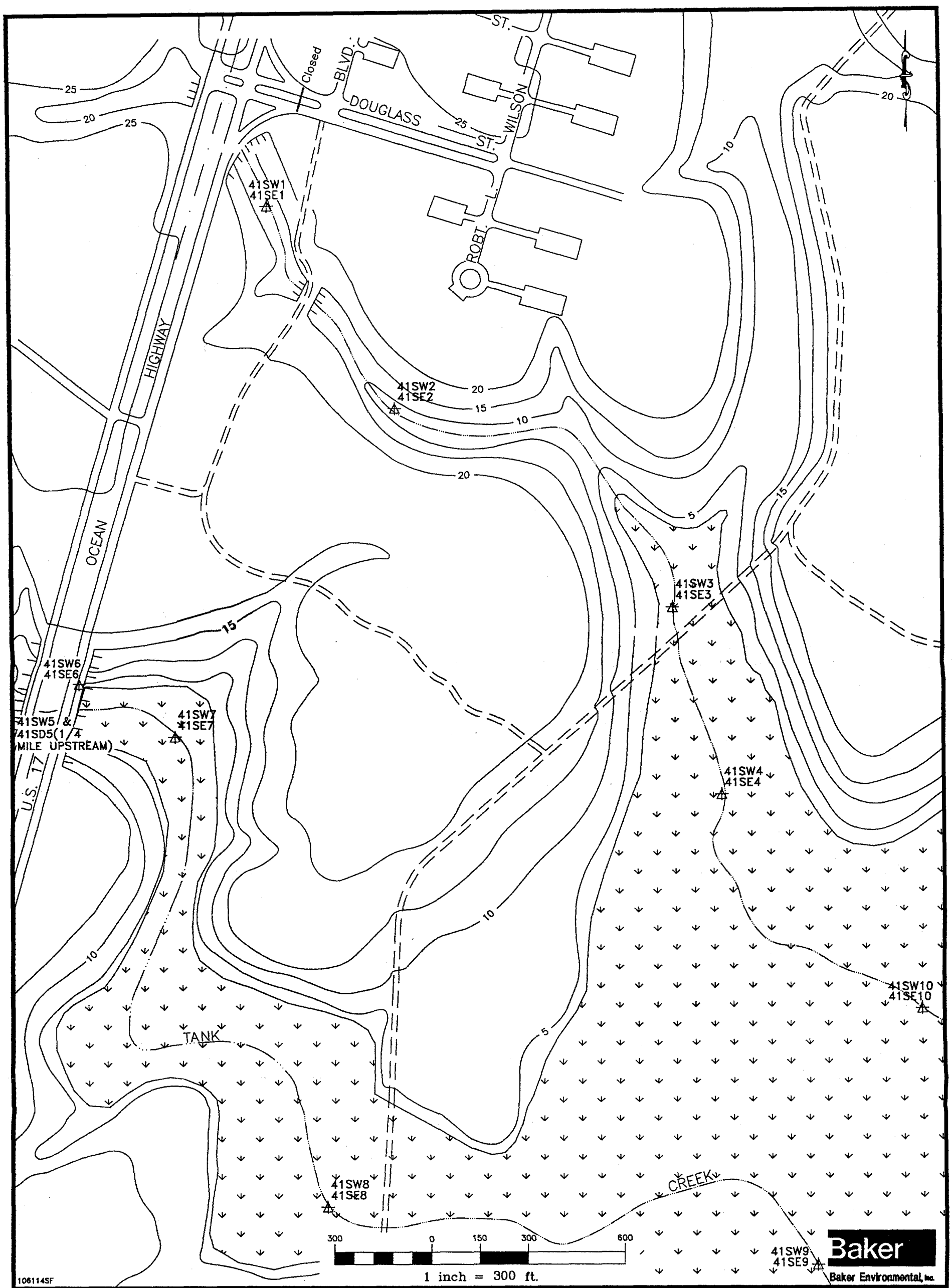
Field measurements will include pH, conductivity, and temperature.

A minimum of two rounds of static water level measurements will also be obtained for determining groundwater flow patterns.

QA/QC samples will consist of field duplicates (e.g., one per ten groundwater samples), equipment rinsate blanks (e.g., one per day), trip blanks (e.g., one per container containing samples for VOA), and MS/MSD laboratory blanks. Preservation blanks and field blanks will be prepared as part of the soil investigation.

3.3.7 Surface Water/Sediment Investigation

The unnamed tributary to Southwest Creek and Tank Creek will be investigated. As shown on Figure 3-9, five sampling stations are proposed along both the unnamed tributary and Tank Creek. At each sampling station, a surface (top six inches) and subsurface (6 to



LEGEND

41SW1 41SE1 – PROPOSED SURFACE WATER/SEDIMENT SAMPLING STATIONS

– MARSH

5 – TOPOGRAPHIC ELEVATION LINES

– ROAD (IMPROVED)

– ROAD (UNIMPROVED)

– INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 3-9
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02586R07Z

12 inches) sediment sample will be collected for analysis. One surface water sample will be collected at each station.

All samples will be analyzed for full TCL organics, ordnance constituents, mirex, and TAL inorganics. In addition, sediment samples will be analyzed for TOC. Field measurements will include pH, conductivity, and temperature.

3.4 Investigative Derived Waste Handling

All drill cuttings will be collected and contained in roll-off boxes. One roll-off box will be assigned to each site. One 1,500 gallon tanker will be stationed at each site for containing groundwater purge and development water. A composite soil sample will be collected from each roll-off box and analyzed for full TCL organics, TAL inorganics, TCLP organics and inorganics, reactivity, corrosivity, and ignitability. One water sample will be collected from each tanker and analyzed for full TCL organics and TAL inorganics. Additional details regarding IDW handling and disposal is provided in the Section 5.8.

3.5 Quality Assurance/Quality Control Samples

QA/QC requirements for this investigation are presented in the Quality Assurance Project Plan (QAPP). The following QA/QC samples will be collected during field sampling activities:

- Trip Blanks

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

- Equipment Rinsates

  Equipment rinsates are the final organic-free deionized water rinse from equipment decontamination procedures. Equipment rinsate blanks will be collected daily during each sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are found in the rinsate, the remaining samples must

be analyzed. The results from the blanks will be used to evaluate the decontamination methods. This comparison is made during data validation. The rinsates are analyzed for the same parameters as the related samples.

- Field Blanks

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

One field blank per source per event will be collected.

- Field Duplicates/Split Samples

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

Field duplicates will be collected at an appropriate frequency of 10 percent.

- Matrix Spike/Matrix Spike Duplicates

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

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

- Preservative Blanks

Preservative blanks are prepared by putting organic-free deionized water in a container and preserving the sample with the appropriate preservative. This sample is submitted to the laboratory for full TCL/TAL analysis. One preservative blank will be collected at the beginning and end of this investigation.

4.0 SAMPLE DESIGNATION

All samples collected during this investigation, including QA/QC samples, will be designated with a unique number. The number will serve to identify the investigation, the site, the area within the site, the sample media, sampling location, the depth for soil or sampling round for groundwater samples, and QA/QC qualifiers.

The sample designation format is as follows:

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

An explanation of each of these identifiers is given below.

Site #	Sites included in this investigation are 69, 74, and 41.
Media	SB = Soil Boring (soil sample from a boring) TR = Trench (soil sample from trench) GW = Groundwater SW = Surface Water SD = Sediment WT = Waste
Location	The location numbers identify the sampling location. This would include station number for soil location or monitoring well number for groundwater. Each grid station will be identified with a unique identification number.
Depth/Round	Depth indicators will be used for soil samples. The number will refer to the depth of the top of the sampled interval. For example: 00 = top of sample at ground surface 01 = top of sample is 1 foot below surface 07 = top of sample is 7 feet below surface Round indicator will be used for groundwater samples (round one and round two).
QA/QC	(FB) = Field Blank (D) = Duplicate Sample (TB) = Trip Blank (ER) = Equipment Rinsate (PB) = Preservative Blank (DM) = Drilling Mud (B) = Bentonite

Under this sample designation format the sample number 69-GW-3-1D refers to:

69-GW-3-1D	Site 69
69-GW-3-1D	Groundwater sample
69-GW-3-1D	Monitoring well #3
69-GW-3-1D	Round 1
69-GW-3-1D	Duplicate (QA/QC) sample

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

5.0 INVESTIGATIVE PROCEDURES

5.1 Soil Sample Collection

Soil samples will be collected throughout the site including both surface and subsurface samples. The majority of the soil samples will be collected from soil borings advanced by a hand auger. Soil samples will also be collected from boreholes advanced by a drilling rig and during the installation of monitoring wells. At Site 74, subsurface soil samples will be collected from trenches excavated by a backhoe.

Procedures for collecting the various types of soil samples are provided in the subsections which follow.

All hand auger or soil boring locations, including monitoring well borings, will be identified in the field by the Field Team Leader or Site Manager. Utility clearance shall be obtained from Activity personnel for all hand augers, soil boring and monitoring well borehole locations.

5.1.1 Soil Borings Advanced by Hand Auger

Hand augering is the most common manual method used to collect subsurface samples. Typically, 4-inch bucket augers with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger is related to the material being sampled. In this investigation , hand augers will be used to collect discrete grab samples of soil from the 0 to 12 inches. The bucket auger will be decontaminated between samples and sampling locations as outlined in Section 5.6.

5.1.2 Monitoring Well Boreholes

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

18-inch or 24-inch long samples, respectively. Split spoons capable of obtaining 24-inch long samples will be utilized during this investigation.

Split-spoon samples will be collected at two-foot centers from the ground surface to the water table in each soil boring. Soil borings that will be converted into monitoring wells (i.e., monitoring well boreholes) will be advanced 10 feet below the water table. The physical characteristics of the samples will be described by the site geologist. The soil in the sampler will be classified according to the Unified Soil Classification System (USCS). Soil sample descriptions will be recorded in the field geologist's notebook.

All subsurface soil samples will be submitted to the laboratory for analysis including the interval immediately above the water table. If the water table is deeper than 10 feet, an additional split-spoon sample, selected by the geologist will be submitted for laboratory analysis.

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

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

2. Advance the borehole to the desired depth using hollow stem auger drilling techniques. The split-spoon will be lowered into the borehole inside the hollow stem auger, this will insure that undisturbed material will be sampled. Soil cuttings will be containerized.

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

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

5. Record in the field logbook the number of blows required to effect each six inches of penetration or fraction thereof. The first six inches is considered to be a seating drive. The sum of the number of blows required for the second and third six inches of penetration is termed the penetration resistance, N. If the sampler is driven less than

18 inches, the penetration resistance is that for the last one foot of penetration. If less than one foot is penetrated, the logs shall state the number of blows and the fraction of one foot penetrated. In cases where samples are driven 24 inches, the sum of second and third 6-inch increments will be used to calculate the penetration resistance. Refusal of the SPT will be noted as 50 blows over an interval equal to or less than 6 inches; the interval driven will be noted with the blow count.

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

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

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

1. After sample collection, remove the soil from the split-spoon sampler. Prior to filling laboratory containers, the soil sample should be mixed thoroughly as possible to ensure that the sample is as representative as possible of the sample interval. Soil samples for VOCs should <u>not</u> be mixed. Further, sample containers for VOCs analyses should be filled completely without head space remaining in the container to minimize volatilization.

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

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

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

5.2 Monitoring Well Installation

5.2.1 Shallow Monitoring Wells

Shallow monitoring wells will be installed at each site to monitor the shallow (water table) aquifer. It is estimated that these wells will be constructed approximately 15 to 25 feet bgs.

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

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

- A borehole will be advanced by a drilling rig using hollow stem augers. The augers will be nominal 6 inch I.D.

- Soil split spoon samples will be collected continuously during borehole advancement. Samples will be collected according to the procedures outlined in Section 5.1.2. Sample submittal to the laboratory for analysis (See Table 3-1) will follow the criteria outlined in Section 5.1.2.

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

- A six-inch layer of sand will be installed at the bottom of the borehole. This layer will serve to provide firm footing for the monitoring well screen and riser.

- PVC is the material selected for monitoring well construction. It was selected on the basis of its low cost, ease of use and flexibility. Justification for using PVC has been forwarded to USEPA under separate cover.

- Ten feet of 4-inch I.D., Schedule 40, #10 slot (0.010 inch) screen with bottom cap will be installed. The screen will be connected to threaded, flush-joint, PVC riser. The riser will extend to 3 feet above the surface. The screened interval will be selected to span the water table surface. A PVC slip-cap vented to the atmosphere, will be placed at the top of the riser.

- The annular space around the screen will be backfilled with a well-rounded medium to coarse-grained siliceous sand as the hollow-stem augers are being withdrawn from the borehole. Sand will be placed from the bottom of the boring to approximately two feet above the top of the screened interval. A lesser distance above the top of the screened interval may be packed with sand if the well is very shallow to allow for placement of sealing materials.

- A sodium bentonite seal at least 2-foot thick will be placed above the sand pack. The bentonite will be allowed to hydrate for at least 8 hours, or the manufacturer's recommended hydration time, whichever is longer before further completion of the well.

- The annular space above the bentonite seal will be backfilled with a cement-bentonite grout consisting of five to ten percent bentonite powder by dry weight and seven gallons of potable water per 94 pound bag of portland cement.

- Two deep monitoring wells will be installed at Site 69 at a depth of approximately 40 to 50 feet. If a potential confining layer (e.g., clay layer) is encountered during drilling, the shallow portion of the aquifer will be cased off to prevent possible aquifer cross contamination.

- Fluid rotary drilling techniques may be utilized for deep well drilling.

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

- The monitoring wells will be completed at the surface. The aboveground section of the PVC riser pipe will be protected by installation of a 6-inch diameter, 5-foot long steel casing with locking cap and lock, seated into the cement grout. The bottom of the surface casing will be placed at a minimum of 2-1/2, but not more than 3-1/2 feet below the ground surface, as space permits, with an inverted taper to protect the casing from frost heaving. For very shallow wells, a steel casing of less than 5 feet in length may be used, as space permits. The protective steel casing must not in any event fully penetrate the bentonite seal.

- The top of each well will be protected with the installation of four, 3-inch diameter, 5-foot long steel pipes into a concrete apron. The steel pipes will be embedded to a minimum depth of 2.5 feet in 3,000 psi concrete. Each pipe will also be filled with concrete. A concrete apron approximately 5 feet by 5 feet by 0.5-feet thick will be placed at the same time the pipes are installed. The protective casing and steel pipes will be painted with day-glo yellow paint, or equivalent.

- If necessary, in high-traffic areas, the monitoring well will be completed at the surface using a "flush" man-hole type cover. If the well is installed through a paved or concrete surface, the annular space will be grouted to a depth of at least 2.5-feet and the well will be finished with a concrete collar. If the well has not been installed through a paved or concrete surface, the well will be completed by construction of a 5-foot by 5-foot by 0.5-foot thick apron made of 3,000 psi concrete. The concrete will be crowned to meet the finished grade of the surrounding pavement, as required. If appropriate, the vault around the buried wellhead will have a water drain to the surrounding soil and a watertight cover.

- All wells will have a locking cap connected to the protective casing.

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

5.2.2 Deep Monitoring Wells

Deep monitoring wells will be installed at Sites 41 and 69 to monitor the deeper portion of the aquifer in this area. It is estimated that these wells will be constructed to a depth of 50 feet bgs.

The procedures for installing or constructing the deep monitoring well are similar to those for the shallow wells (Section 5.2.1), with the following exceptions:

- Mud rotary drilling techniques may be utilized for drilling the deep monitoring well borehole.

- If a significant, greater than six inches thick low, hydraulic conductivity lithology such as clay is encountered during drilling, a six-inch casing will be installed into this lithology and will be grouted in place. This will prevent induced migration of potential contaminants from the shallow aquifer into the deeper portions of the aquifer.

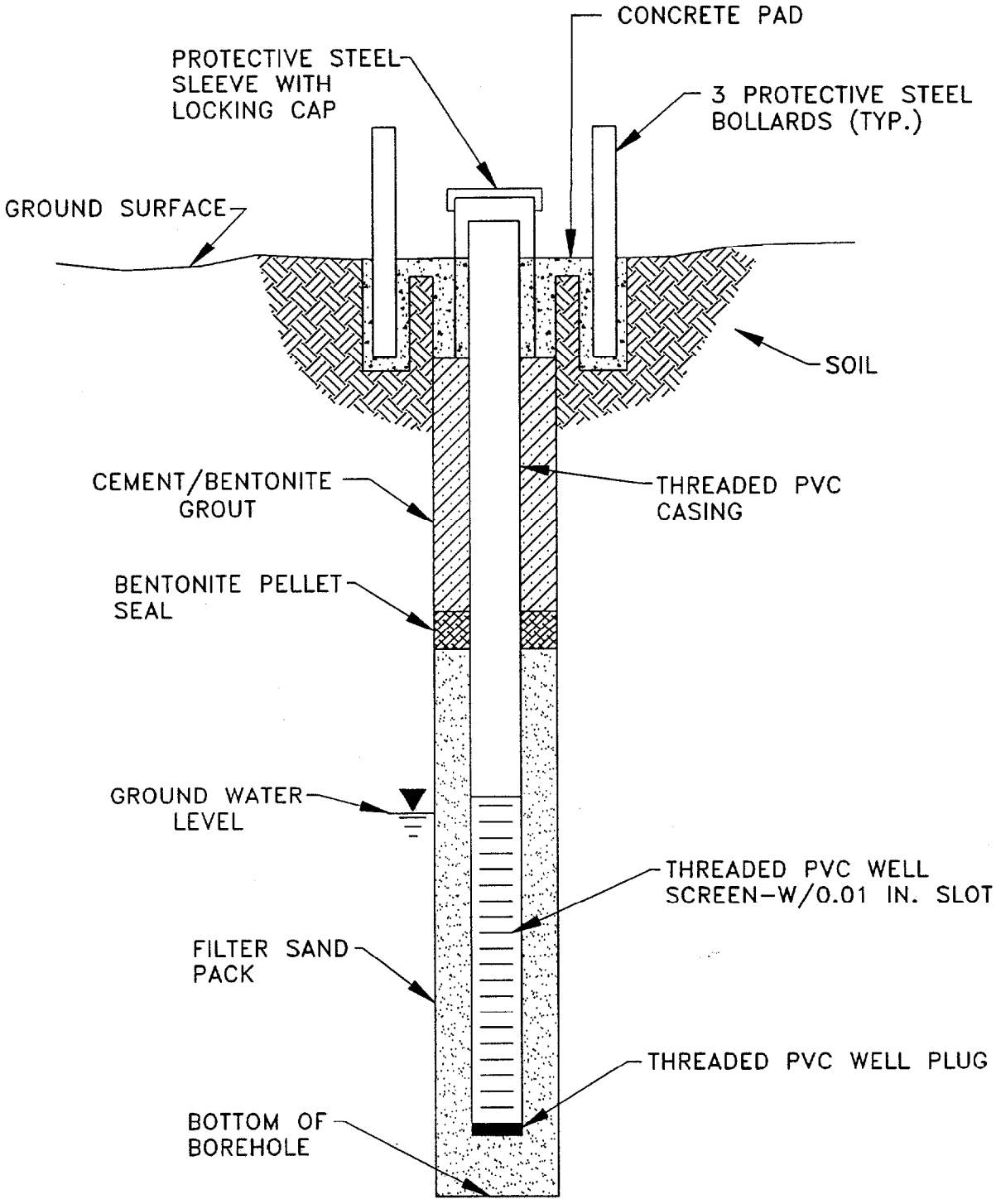


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FIGURE 5-1
TYPICAL SHALLOW GROUNDWATER
MONITORING WELL CONSTRUCTION DIAGRAM

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- The grout will be permitted to set for 12 hours prior to resumption of drilling through the casing.

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

5.2.3 Well Development

All monitoring wells will be developed 24 hours after the surface pad and protective casing have been installed. The purpose of well development is to stabilize and increase the permeability of the filter pack around the well screen, to restore the permeability of the formation which may have been reduced by the drilling operations, and to remove fine-grained materials that may have entered the well or filter pack during installation. The selection of the well development method typically is based on drilling methods, well construction and installation details, and the characteristics of the formation.

Well development will not be initiated until a minimum of 24 hours has elapsed subsequent to well completion. This time period will allow the cement grout to set. Wells typically are developed using bailers, low-yield pumping, or surging with a surge block or air. Selection of a development device will be dependent on conditions encountered during monitoring well installation. Well development water shall be containerized in either 55-gallon drums, steel holding tanks with containment basins, or steel tankers (see Section 5.8).

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

- Clarity of water based on visual determination.
- A maximum time period (typically one hour for shallow wells).
- A maximum well volume (typically three to five well volumes).
- Stability of specific conductance and temperature measurements (typically less than 10 percent change between three successive measurements).

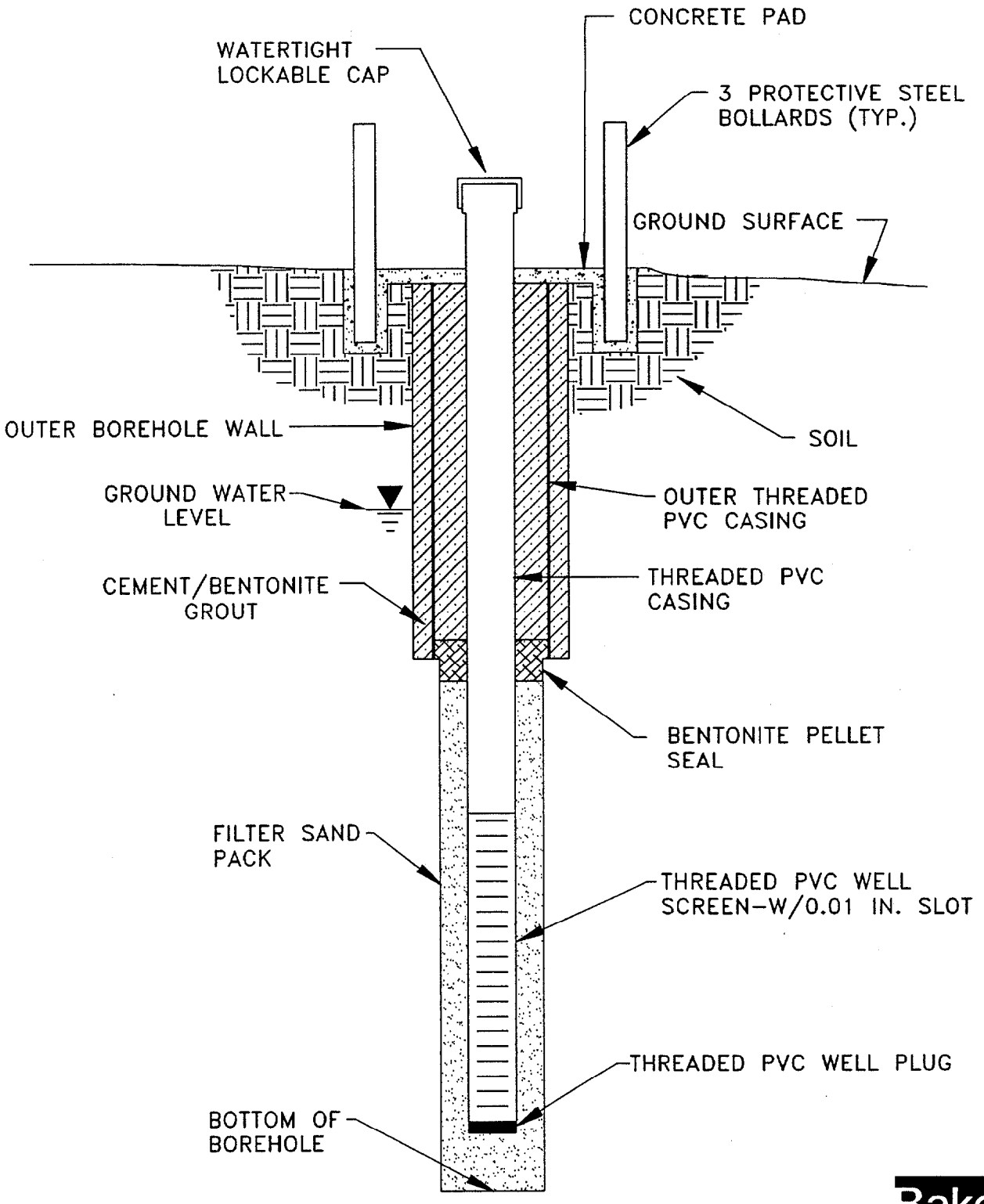

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FIGURE 5-2
TYPICAL DEEP GROUNDWATER
MONITORING WELL CONSTRUCTION DIAGRAM

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- Clarity based on turbidity measurements (typically less than 50 nephelometric turbidity units {NTU}).

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

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

5.3 Groundwater Sample Collection

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

The collection of a groundwater sample includes the following steps:

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

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

3. Lower purging equipment (i.e., bailer or submersible pump) into the well to a short distance below the water level and begin water removal. If necessary, collect the purged water and dispose of it in an acceptable manner (e.g., DOT-approved 55-gallon drum).

4. Measure the rate of discharge.

5. Purge a minimum of three to five well volumes before sampling. In low permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Allow the well to

recharge as necessary, but preferably to 70 percent of the static water level, and then sample.

6. Record measurements of specific conductance, temperature, and pH during purging to ensure the groundwater stabilizes. Generally, these measurements are made after three, four, and five well volumes.

7. Lower the bailer into the well, submerge into the groundwater, and retrieve. Pour groundwater from the bailer into the laboratory-supplied sample bottles.

8. Collect samples for VOC analysis first. Sample bottles will be filled in the same order for all monitoring wells.

Sample preservation handling procedures are outlined in Section 6.0.

5.4 Surface Water Sample Collection

The following procedures will be used for the collection of surface water samples at stations located at Sites 41 and 69.

At each station, samples will be collected at the approximate mid-vertical point of the surface water body. Care will be taken to ensure that the sampler does not contact and/or stir up the sediments, while still being relatively close to the sediment-water interface.

The surface water samples will be collected by dipping the laboratory-supplied sample bottles directly into the water. Clean PVC gloves will be worn by sampling personnel at each sampling station. For those sample bottles that contain preservative (e.g., sulfuric acid), the water will be collected in a clean, decontaminated sampling container, and then slowly transferred into the appropriate laboratory-supplied sample bottle.

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

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

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

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

The sampling location will be marked by placing a wooden stake and bright colored flagging at the nearest bank or shore. The sampling location will be marked with indelible ink on the stake. If permission is granted, photographs will be taken to document the physical and biological characteristics of the sampling location.

The following information will be recorded in the field logbook:

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

Sample preservation and handling procedures are outlined in Section 6.0.

5.5 Sediment Sample Collection

The following procedures will be used for the collection of sediment samples at stations located at Sites 41 and 69.

Surface and near surface sediment samples will be collected at a depth of 0 to 6 inches and 6 to 12 inches, respectively. Note that on-site sampling stations at Site 69 will only require a surface sediment sample. The sediment samples will be collected using a stainless steel hand-held coring instrument. A decontaminated stainless steel scoop, or spoon, will be used at each station.

Since the sediment samples are being collected from drainage ditches or standing pools of water, the easiest way to collect a sediment sample is to scoop the sediment using a stainless steel spoon or scoop. This reduces the potential for cross-contamination. This can be accomplished by wading into the intermittent stream, and while facing upstream into the current, scooping the sample along the stream bottom in the upstream direction.

5.6 Decontamination Procedures

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

- Field measurement and sampling equipment: water level meters, bailers, compositing bottles, hand corers, hydropunch tool, etc.

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

The following decontamination procedures are taken from USEPA IV Standard Operating Procedures (1991).

5.6.1 Field Measurement Sampling Equipment

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

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

2. Rinse equipment thoroughly with hot tap water.

3. Rinse equipment with at least a 5 percent sodium hydroxide solution.

4. Rinse equipment thoroughly with deionized water.

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

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

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

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

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

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

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

2. Rinse equipment thoroughly with hot tap water.

3. Rinse equipment thoroughly with deionized water.

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

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

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

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

5.6.1.3 Reusable Glass Composite Sample Containers

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

2. Rinse containers thoroughly with hot tap water.

3. Rinse containers with at least 5 percent sodium hydroxide.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with deionized water.

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

7. Cap with aluminum foil or Teflon® film.

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

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

5.6.1.4 Plastic Reusable Composite Sample Containers

Follow the cleaning procedures as outlined in Section 5.6.3 but omit the solvent rinse.

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

5.6.1.5 Well Sounders or Tapes Used to Measure Ground Water Levels

1. Wash with laboratory detergent and tap water.

2. Rinse with tap water.

3. Rinse with deionized (D.I.) water.

4. Allow to air dry overnight.

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

5.6.1.6 Submersible Pumps and Hoses Used to Purge Ground Water Wells

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

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

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

4. Place equipment in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit.

5.6.2 Large Machinery and Equipment

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

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

addition, all downhole sampling equipment that will come into contact with the downhole equipment and sample medium shall be cleaned and decontaminated by the following procedures.

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

2. Rinse thoroughly with tap water (i.e., potable).

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

3. Rinse thoroughly with deionized water.

4. Rinse twice with solvent (e.g., pesticide grade isopropanol).

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

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

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

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

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

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

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

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

5.7 Surveying

All surveying activities will be conducted by a qualified surveying subcontractor licensed in the State of North Carolina. Surveying activities will include the surveying of sampling points (i.e., surface soils, surface water/sediment locations) and monitoring wells.

All monitoring wells will be surveyed. The vertical accuracy shall be surveyed to 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, other sampling stations, including test borings, will be surveyed for horizontal control within 1 foot accuracy. Control will be

established by use of horizontal and vertical control points near the site that are tied into the North Carolina State Plane Coordinate System. If control points cannot be located, two benchmarks/monuments will be surveyed from the closest USGS, or equivalent, benchmarks. The 1929 msl datum will be used as a reference for the vertical elevation.

5.8 Handling of Site Investigation Generated Wastes

5.8.1 Responsibilities

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

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

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

5.8.2 Sources of Investigation Derived Wastes

Field investigation activities often result in the generation and handling of potentially contaminated materials that must be properly managed to protect the public and the environment, as well as to meet legal requirements. These wastes may be either hazardous or

nonhazardous in nature. The nature of the waste (i.e., hazardous or nonhazardous) will determine how the wastes will be handled during the field investigation.

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

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

5.8.3 Designation of Potentially Hazardous and Nonhazardous Investigation Derived Waste

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

5.8.3.1 Drill Cuttings

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

Cuttings which, by their appearance or organic vapor readings, appear to be contaminated should be kept separate from those cuttings which do not exhibit "contaminated" or "hazardous" characteristics for purposes of subsequent treatment and/or disposal.

5.8.3.2 Monitoring Well Development and Purge Water

All development and purge waters shall be containerized in tankers, or large (250-gallon) containers. Groundwater purge/development water that exhibits elevated HNu readings should be kept separate from purge/development water that does not exhibit elevated levels for purposes of subsequent treatment and/or disposal.

5.8.3.3 Decontamination Fluids

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

5.8.3.4 Investigation Derived Waste Sampling and Analysis

For each tanker or container of development/purge water, a sample shall be obtained for full TCL organic and TAL inorganic analysis.

For each roll-off box of drill cuttings, a composite sample shall be collected and analyzed for full TCL organic and TAL inorganic analysis, full TCLP (organics and inorganics), and RCRA hazardous waste characteristics (corrosivity, reactivity, and ignitability).

Decontamination fluids collected during the investigation shall be sampled and analyzed for full TCL organics and TAL inorganics.

5.8.3.4 Personal Protective Equipment

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

5.8.4 Labeling

If 55-gallon drums are used to containerize drill cuttings, the containers will be consequently numbered and labeled by the field team during the site investigation. Information shall be stenciled in paint both on the container lid and its side. Container labels shall include, at a minimum:

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

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

5.8.5 Container Log

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

5.8.6 Container Storage

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

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

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

5.8.7 Container Disposition

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

5.8.8 Disposal of Contaminated Materials

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

Another consideration in selecting the method of disposal of contaminated materials is whether the disposal can be incorporated into subsequent site cleanup activities. For example, if construction of a suitable on-site disposal or treatment structure is expected, contaminated materials generated during the site investigation may be stored at the site for treatment/disposal with other site materials. In this case, the initial containment (i.e., drums

or other containers) shall be evaluated for use as long-term storage. Also, other site conditions, such as drainage control, security and soil types must be considered in order to provide proper storage.

5.9 Water Level Measurements

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

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

6.0 SAMPLE HANDLING AND ANALYSIS

6.1 Sample Program Operations

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

The number of samples including QA/QC samples, analytical method, data quality level and laboratory turnaround times are included in Table 6-1. Preservation requirements, bottle requirements and holding times are included in Table 6-2 for water samples and Table 6-3 for soil and sediment samples. Collection procedures for field QA/QC samples are outlined in Section 3.0.

6.2 Chain-of-Custody

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

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

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

A field notebook, containing a master sample log, will be maintained for the site.

TABLE 6-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples (1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 69	Soil - On site	24 surface soil	TCL Organics(2)	IV	CLP/SOW(5)	Routine(6)	3
			TAL Inorganics(3)	IV	CLP/SOW	Routine	3
			CSM(4)	IV	Modified EPA 8270	Routine	3
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
		1	Particle-Size Distribution	II	ASTM D422-63	Routine	0
		1	Atterburg Limits	II	ASTM D4943-89	Routine	0
	Groundwater - Hydropunch	14	TCL Volatile Organics	II	EPA 8240	24 hours	2
	Groundwater - Wells	14 (8 existing, 4 new shallow, 2 new deep wells)	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			CSM	IV	Modified EPA 8270	Routine	2
		2 (one shallow well and one deep well)	Microbial Count	II	SM 907	Routine	0
			BOD_5	II	SM 507, EPA 405.1	Routine	0
			TOC	II	EPA 415.1	Routine	0
			COD	II	EPA 415.1, Hach	Routine	0
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine	0
			Total Phosphorous	II	EPA 365.2	Routine	0
			Alkalinity	II	SM 403	Routine	0
	Surface Water-On Site	4 surface water (standing pools)	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
		4 sediment	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Surface Water-Drainage Areas	4 surface water	TCL Organics	IV	CLP/SOW	Routine	0(9)
			TAL Inorganics	IV	CLP/SOW	Routine	0(9)
			CSM	IV	Modified EPA 8270	Routine	0(9)
		4 sediment	TCL Organics	IV	CLP/SOW	Routine	0(9)
			TAL Inorganics	IV	CLP/SOW	Routine	0(9)
			CSM	IV	Modified EPA 8270	Routine	0(9)

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples (1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 74	Soil - On Site	10 surface soil	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
		1	Particle-Size Distribution	II	ASTM D422-63	Routine	0
		1	Atterburg Limits	II	ASTM D4943-89	Routine	0
	Soil - Former Disposal Area	32 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine	10
			TAL Inorganics	IV	CLP/SOW	Routine	10
			CSM	IV	Modified EPA 8270	Routine	10
	Soil - Pest Control Area	19 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine	6
			TAL Inorganics	IV	CLP/SOW	Routine	6
	Groundwater	7 (2 existing, 5 new shallow)	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
		1	Microbial Count	II	SM 907	Routine	0
			BOD_5	II	SM 507, EPA 405.1	Routine	0
			TOC	II	EPA 415.1	Routine	0
			COD	II	EPA 415.1, Hach	Routine	0
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine	0
			Total Phosphorous	II	EPA 365.2	Routine	0
			Alkalinity	II	SM 403	Routine	0

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 41	Soil - Downslope	12 surface soils	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			CSM	IV	Modified EPA 8270	Routine	2
			Mirex	IV	EPA 8270A	Routine	2
			Ordnance(7)	IV	EPA 8330	Routine	2
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine	0
			TAL Inorganics	IV	CLP/SOW	Routine	0
			CSM	IV	Modified EPA 8270	Routine	0
			Mirex	IV	EPA 8270A	Routine	0
			Ordnance(7)	IV	EPA 8330	Routine	0
	Soil - On-site Surficial Character-ization	25 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine	8
			TAL Inorganics	IV	CLP/SOW	Routine	8
			CSM	IV	Modified EPA 8270	Routine	8
			Mirex	IV	EPA 8270A	Routine	8
			Ordnance(7)	IV	EPA 8330	Routine	8
	Soil - Well Borings	13 borings/3 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine	4
			TAL Inroganics	IV	CLP/SOW	Routine	4
		2	Particle-Size Distribution	II	ASTM D422-63	Routine	0
		2	Atterburg Limits	II	ASTMD4943-89	Routine	0
	Groundwater - Wells	18 (5 existing, 7 new shallow, 6 intermediate wells)	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			CSM	IV	Modified EPA 8270	Routine	2
			Mirex	IV	EPA 8270A	Routine	2
			Ordnance(7)	IV	EPA 8330	Routine	2
		2 (one shallow well and one intermediate well)	Microbial Count	II	SM 907	Routine	0
			BOD_5	II	SM 507, EPA 405.1	Routine	0
			TOC	II	EPA 415.1	Routine	0
			COD	II	EPA 415.1, Hach	Routine	0
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine	0
			Total Phosphorous	II	EPA 365.2	Routine	0
			Alkalinity	II	SM 403	Routine	0

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples (1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 41 (cont.)	Surface Water-On Site	10 surface water	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			Mirex	IV	EPA 8270A	Routine	1
			Ordnance(7)	IV	EPA 8330	Routine	1
		20 sediment	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			Mirex	IV	EPA 8270A	Routine	2
			Ordnance(7)	IV	Ordnance	Routine	2
IDW	Soil Characterization	3 (one composite from each site roll-off box	TCL Organics	IV	CLP/SOW	14-day	0
			TAL Inorganics	IV	CLP/SOW	14-day	0
			Full TCLP	III	40 CFR 261	14-day	0
			Reactivity	III	40 CFR 261	14-day	0
			Corrosivity	III	40 CFR 261	14-day	0
			Ignitability	III	40 CFR 261	14-day	0
	Development/ Purge Water Characterization	3 (one sample from each tanker)	TCL Organics	IV	CLP/SOW	14-day	0
			TAL Inorganics	IV	CLP/SOW	14-day	0

(1) Baseline number of samples do not include field QA/QC samples.
(2) TCL Organics: Volatile Organics, Semivolatile Organics, Pesticides/PCBs
(3) TAL Inorganics:

Aluminum	EPA 3010/EPA 200.7	Cobalt	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270.2
Arsenic	EPA 3020/EPA 206	Iron	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Barium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 239	Sodium	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Vanadium	EPA 3010/EPA 200.7
Calcium	EPA 3010/EPA 200.7	Mercury	EPA 3010/EPA 245.1	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7	Cyanide	EPA 3010/EPA 335.2

(4) CSM - Chemical Surety Materials
(5) CLP/SOW - Contract Laboratory Program/Statement of Work
(6) Routine analytical turnaround is 28 days following receipt of sample.
(7) Ordnance constituents include: HMX, ROX, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, TNT, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, 4 amino 2,6 dinitrotoleuen (EPA Method SW-846 8330).

TABLE 6-2

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR WATER SAMPLES
SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Container	Preservation	Holding Time
TCL Volatiles	Two 40-ml vials with teflon septum caps	Cool, 4°C HCl pH <2	14 days (7 days if unpreserved)
TCL Semivolatiles	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides (including Mirex)/PCBs	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	1-500 ml polyethylene bottle	HNO_3 pH<2	6 months; Mercury 28 days
TAL Cyanide	1-liter polyethylene bottle	NaOH pH>12 Cool, 4°C	14 days
CSM	1-liter polyethylene bottle	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
Ordnance	1-liter amber glass bottle with teflon caps	Cool to 4°C	7 days to extraction; 40 days from extraction for analysis
Total Phosphorous	1-liter polyethylene bottle	Cool, 4°C HCl or H_2SO_4 to pH <2	28 days
Nitrogen	1-liter polyethylene bottle	Cool, 4°C HCl or H_2SO_4 to pH <2	28 days
TOC	1-liter polyethylene bottle	Cool, 4°C HCl or H_2SO_4 to pH <2	28 days
BOD	1-liter polyethylene bottle	Cool, 4°C	48 hours
COD	1-liter polyethylene bottle	Cool, 4°C H_2SO_4 pH <2	28 days
Alkalinity	1-liter polyethylene bottle	Cool to 4°C	14 days
Microbial Count	1-liter polyethylene bottle	Cool to 4°C	48 hours

TCL - Target Contaminant List
TAL - Target Analyte List
TSS - Total Suspended Solids
TVS - Total Volatile Solids
CSM - Chemical Surety Compounds
TDS - Total Dissolved Solids
TOC -Total Organic Carbon
BOD - Biological Oxygen Demand
COD - Chemical Oxygen Demand

TABLE 6-3

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL AND SEDIMENT SAMPLES
SITES 69, 74, AND 41
MCB CAMP LEJEUNE

Parameter	Container	Preservation	Holding Time
TCL Volatiles	Two 4-ounce wide-mouth glass jars	Cool, 4°C	10 days (7 days if unpreserved)
TCL Semivolatiles	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides (including Mirex)/PCBs	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	One 8-ounce wide-mouth glass jar	Cool, 4°C	6 months; Mercury, 28 days
TAL Cyanide	One 8-ounce wide-mouth glass jar	Cool, 4°C	14 days
Ordnance	One 8-ounce wide-mouth glass jar	Cool, 4°C	14 days to extraction; 40 days after extraction for analysis
Total TCLP	Two 8-ounce wide-mouth glass jar	Cool, 4°C	14 days
CSM	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
Grain Size	One 8-ounce wide-mouth glass jar	None	None
Atterberg Limits	One 8-ounce wide-mouth glass jar	None	None
Corrosivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	28 days
Ignitability	One 4-ounce wide-mouth glass jar	Cool, 4°C	28 days
Reactivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	N/A

NOTE: Samples to be tested for TCLP should undergo minimal disturbance prior to analysis.

TCL - Target Contaminant List
TAL - Target Analyte List
CSM - Chemical Surety Compounds
TCLP - Toxicity Characteristic Leaching Procedure
TOC - Total Organic Carbon

FIGURE 6-1

CHAIN-OF-CUSTODY RECORD

Sampler: _____
(Print)

Signature: _____

Sheet ____ of ____

BAKER ENVIRONMENTAL, INC.
Airport Office Park - Bldg No. 3
420 Rouser Road
Coraopolis, PA 15108
(412) 269-6000

ect Name: _____
S. O. Number: _____

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

General Remarks:

*NOTES: Record type of container used with abbreviation P (plastic) or G (glass)
Record volume of containers in leters

Relinguished By (Sign):
Date: Time:
Remarks:

Received By (Sign):
Date: Time:
Remarks:

Shipment/Transportation Details:

Relinguished By (Sign):
Date: Time:
Remarks:

Received By (Sign):
Date: Time:
Remarks:

Shipment/Transportation Details:

Relinguished By (Sign):
Date: Time:
Remarks:

Received By (Sign):
Date: Time:
Remarks:

ıhipment/Transportation Details:

Distribution:
Original - Sent with samples to lab (return with lab results to Project Manager for filing)
Copy - Retained by sampling personnel for filing

FIGURE 6-2

EXAMPLE CUSTODY SEAL

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

FIGURE 6-3

EXAMPLE SAMPLE LABEL

Baker Environmental Inc.
Airport Office Park, Bldg. 3
420 Rouser Road
Coraopolis, PA 15108

Project: _____ CTO No.: _____

Sample Description: _____

Date: ____/____/____ Sampler: _____

Time: _____

Analysis: _____ Preservation: _____

Project Sample No.: _____

6.3 Logbooks and Field Forms

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

- Name of the person to whom the book is assigned
- Book number
- Project name
- Entry start date
- Entry completion date

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

A master sample log will be maintained on site for all samples taken. A full description of the sample, its origin and its condition will be included in the master log entry.

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

6.4 Sample Logbook

The sample logbook is a three-ring binder which contains sample log sheets for each sample collected. A sample log sheet (Figure 6-6) is filled out for each and every sample collected. This form records vital information concerning the sample source, sampling methods, sample conditions and field measurements, and is used for sample validation and report preparation. The sample log sheets are numbered in order when placed in the sample logbook, and the sample number and log sheet page number are recorded on the sample logbook table of contents sheets which is placed at the front of the sample logbook for easy reference and access.

Figure 6-4

FIELD TEST BORING RECORD

Baker

Baker Environmental, Inc.

PROJECT: _____

S.O. NO.: _____ BORING NO.: _____

COORDINATES: EAST: _____ NORTH: _____

ELEVATION: SURFACE: _____ TOP OF PVC CASING: _____

RIG:									
	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT)	WEATHER	TOP OF CASING WATER DEPTH (FT)	TIME
SIZE (DIAM.)									
LENGTH									
TYPE									
HAMMER WT.									
FALL									
STICK UP									

REMARKS: _____

DRILL RECORD							VISUAL DESCRIPTION					
DEPTH	SOIL	Sample ID — Type-No. (N = No Samp.)	Samp. Rec. (Ft. & %)	SPT Blows Per 0.5'	Lab. Class.		Classification (Grain Size, Principal Constituents, Etc.)	Color	Consist. or Density	Moisture Content, Organic Content, Plasticity, and Other Observations	SOIL	ELEVATION
	ROCK			RQD (Ft. & %)	Pen. Rate	PID (ppm)	Classification (Name, Grain Size, Principal Constituents, Etc.)	Color	Hardness	Weathering, Bedding, Fracturing, and Other Observations	ROCK	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

DRILLING CO.: _____ BAKER REP.: _____

DRILLER: _____ BORING NO.: _____ SHEET ___ OF ___

Figure 6-5

Baker

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Site 6, Lot 201 South, RI/FS Camp Lejeune
S.O. NO.: 19133 BORING NO.: 6GW13
COORDINATES: EAST: 2502444.9 NORTH: 344291.7
ELEVATION: SURFACE: 18.1 TOP OF PVC CASING: 20.10

RIG: B-53	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
SIZE (DIAM.)	1 3/8"ID		3 1/4" ID 8 1/4" ID		9-24-92	18'		4'	
LENGTH	2'		5'						
TYPE	STD		HSA						
HAMMER WT.	140#								
FALL	30"								
STICK UP									

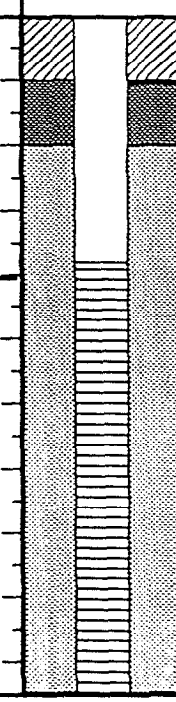
REMARKS: Advanced boring to 18.5' collecting split-spoon samples. Installed a Type II monitoring well at 18'.

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

WELL INFORMATION	DIAM	TYPE	TOP DEPTH (FT)	BOTTOM DEPTH (FT)
Well Casing	4"	Schedule 40 PVC	2.0 stickup	3.8
Well Screen	4"	Schedule 40 PVC, 10 slot	3.8	17.6

Depth (Ft.)	Sample Type and No.	Samp. Rec. Ft. & %	SPT or RQD	Lab. Class. or Pen. Rate	PID (ppm)	Visual Description	Elevation
1	S-1	.91/2.0 45%	6 3 8 5			SAND, fine, little silt(SM), organics; light gray; medium dense; dry	
2							
3	S-2	1.66/2.0 83%	2 3 4 4			SAND, fine, organics; (SM) black; loose; moist Water	
4							
5	S-3	1.33/2.0 67%	4 5 8 11			SAND, fine, some silt (SM); light brown; medium dense; wet	
6							
7	AN						
8							
9							
10							

Well Installation Detail



2.0' of stick-up
Cement
Top of Bentonite 1.0'
Top of Sand 2.0'
No. 2 Sand Pack
Top of Screen 3.8'
Water table at TOC on 9-26-92

DRILLING CO.: Hardin Huber, Inc. BAKER REP.: Kenneth A. Tua
DRILLER: Tom Cramer BORING NO.: 6GW13 SHEET 1 OF 2

Figure 6-6

SAMPLE LOG SHEET

I. SAMPLE IDENTIFICATION

PROJECT SITE NAME: _____

SITE MANAGER: _____

SAMPLE NAME/NUMBER: _____ DATE ___/___/___ TIME: _____ HRS

SAMPLING LOCATION/DEPTH _____ TYPE: ___ GRAB ___ COMPOSITE

SAMPLE MATRIX: ___ SURFACE WATER ___ GROUNDWATER ___ SEDIMENT ___ SOIL

___ WASTE ___ OTHER (SPECIFY) _____

|___| ENVIRONMENTAL SAMPLE |___| HAZARDOUS SAMPLE

SAMPLED BY: (PRINT) _____ (SIGNATURE) _____

II. SAMPLE SOURCE

___ WELL ___ OUTFALL ___ LEACHATE ___ DRUM

___ BORING ___ RIVER/STREAM ___ BLDG/STRUCTURE ___ OTHER

___ TEST PIT/TRENCH ___ IMPOUNDMENT ___ TANK _____ (SPECIFY)

_____

SOURCE DESCRIPTION _____

_____

_____

III. FIELD OBSERVATIONS/MEASUREMENTS

APPEARANCE/COLOR: _____

VOLATILE ORGANIC ANALYSIS (VOA): ____ HNU ____ OVA ____ OTHER

VOA READINGS: OFF SAMPLE _____ RESIPRATORY ZONE _____

LEL/O_2/H_2S READINGS: _____

RADIOACTIVITY (mR/hr): _____

pH: _____ CONDUCTIVITY: _____ TEMPERATURE: _____

SALINITY: _____ OTHER: _____

OBSERVATIONS: _____

_____

_____

IV. SAMPLE DISPOSITION

PRESERVATION: _____

LABORATORY NAME: _____

LABORATORY LOCATION: ___ ON-SITE ___ OFF-SITE

FORWARDED TO LABORATORY: DATE ___/___/___ TIME: _____ HRS

V. ADDITIONAL REMARKS

_____

7.0 SITE MANAGEMENT

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

7.1 Field Team Responsibilities

The field portion of this project will consist of two field teams. Each field team will be supervised by a geologist. The geologist will serve as the Field Team Leader. One sampling technician will be assigned to each field team.

A Site Manager will be assigned to manage all field activities. The Site Manager will ensure that all field activities are conducted in accordance with the project plans. Field Team Leaders will report to the Site Manager. A Site Health and Safety Officer (SHSO) will be present at the site to assist the Site Manager, and to ensure that all field activities are conducted in accordance with the Health and Safety Plan.

7.2 Reporting Requirements

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

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

The Site Manager will receive direction from the Project Manager regarding changes in scope of the investigation.

SECTION II

FINAL

QUALITY ASSURANCE PROJECT PLAN FOR SITES 69, 74, AND 41

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0106

Prepared For:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared By:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

DECEMBER 2, 1993

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been developed for the field investigation of the following sites at Marine Corps Base (MCB) Camp Lejeune, Jacksonville, North Carolina:

- Site 69 - Rifle Range Chemical Dump
- Site 74 - Mess Hall Grease Pit Disposal Area
- Site 41 - Camp Geiger Dump Near Former Trailer Park

Collectively, these three sites comprise Operable Unit No. 4 at MCB Camp Lejeune. The preparation of this QAPP, and other related project plans, is being performed under the Navy CLEAN Contract Task Order 0106. Baker Environmental, Inc., (Baker) a wholly owned subsidiary of the Michael Baker Corporation, is the prime contractor for the implementation of this project.

This QAPP addresses the quality assurance and quality control steps and procedures that will be administered for the sample collection and analysis for this remedial investigation. Detailed information regarding sample handling and analytical methods are provided in Sections 6.0 and 9.0, respectively. Sample collection procedures are provided in the Field Sampling and Analysis Plan (FSAP).

2.0 SCOPE OF QUALITY ASSURANCE PROJECT PLAN

This QAPP addresses sample collection and analysis to be conducted for the field investigation of Sites 69, 74, and 41 of MCB Camp Lejeune, North Carolina. The QAPP has been developed for the Department of Navy (DoN) in accordance with U. S. Environmental Protection Agency (USEPA) guidelines. Contractors will follow Quality Assurance/Quality Control practices and procedures, including chain-of-custody procedures, while conducting all sample collection and analysis activities.

In order to provide adequate QA/QC, this investigation will require:

1. Use of a Naval Energy and Environmental Support Activity (NEESA)-certified analytical laboratory;

2. Use of accepted analytical methods for the samples outlined in the Field Sampling and Analysis Plan (FSAP). Analysis of samples for hazardous constituents parameters will be performed using the following documents:

   - "Statement of Work for Organic Analysis," USEPA, OLM01.6, June 1991;

   - "Statement of Work for Inorganic Analysis," USEPA, ILM02.0, March 1990;

   - "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983;

   - "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136;

   - "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition; and

   - "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886.

- "Midwest Research Institute (MRI) Capabilities, Methods and Reporting Format for Analysis of Chemical Surety Materials (CSM) and CSM Degradation Products," Midwest Research Institute.

3. Performing Field audit(s) during initial sampling activities to verify that sampling is being performed according to the Plan.

The structure of this QAPP and the QA elements addressed are:

- Title Page
- Table of Contents
- Introduction
- QAPP Scope
- Project Description
- Project Organization
- QA Objectives for Data Measurement
- Sampling Procedures
- Sample and Document Custody
- Calibration Procedures and Frequency
- Analytical Procedures
- Data Reduction,Validation, and Reporting
- Internal QC Checks
- Performance and System Audits
- Preventive Maintenance
- Data Measurement Assessment Procedures
- Corrective Action
- QA Reports to Management

3.0 PROJECT DESCRIPTION

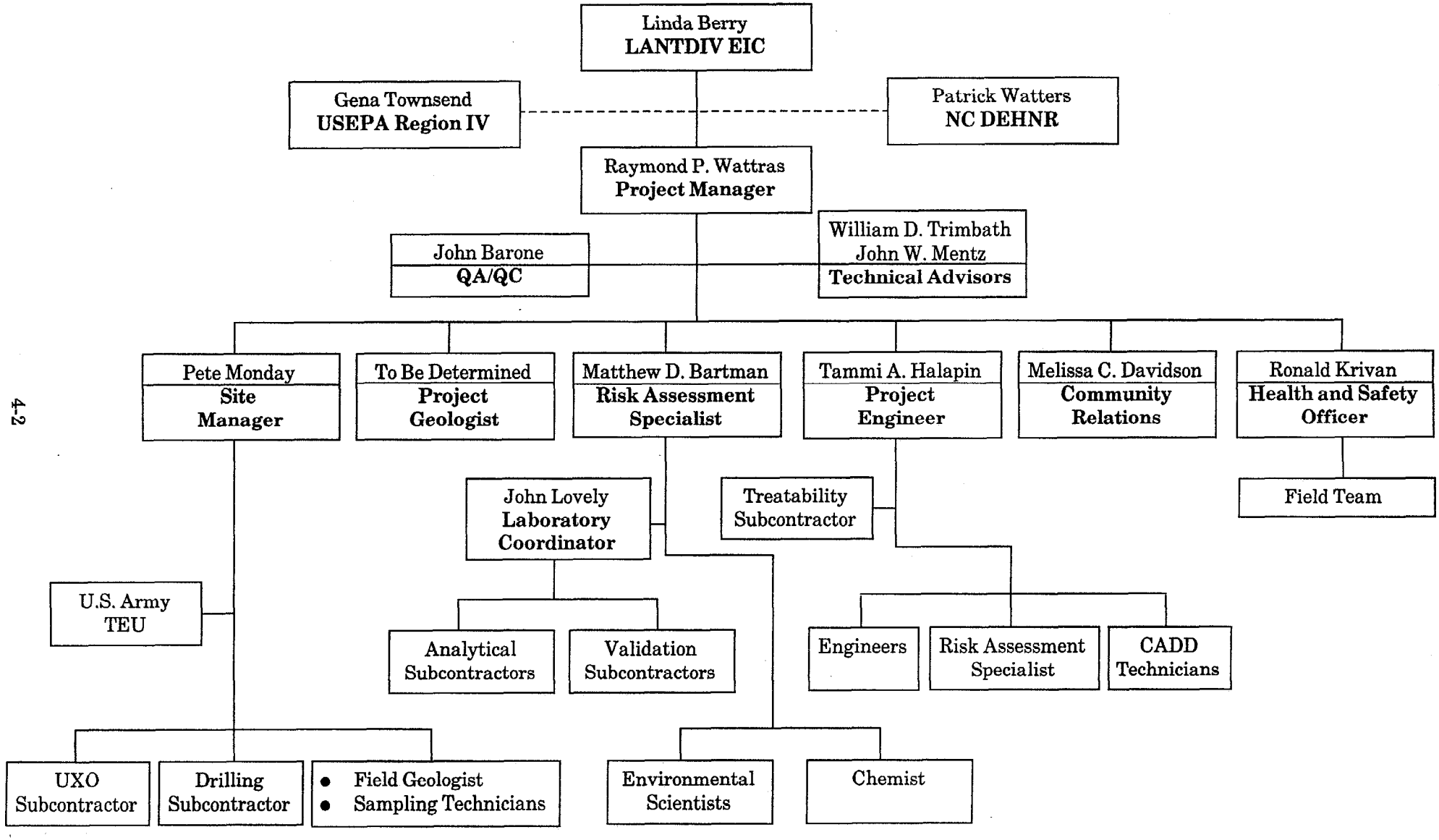
An introduction to the field investigation of Sites 69, 74, and 41 describing the project objectives and tasks are given in Sections 4.0 and 5.0 of the Remedial Investigation/Feasibility Study (RI/FS) Work Plan. These sections discuss the objectives of the RI, and the various field sampling and analytical programs. A detailed description of the field investigations, including sample location and designation, sampling procedures and frequency, is presented in Sections 3.0, 4.0, and 5.0 of the FSAP.

4.0 PROJECT ORGANIZATION

Technical performance of the investigation of Sites 69, 74, and 41 at MCB Camp Lejeune and key personnel responsible for quality assurance throughout its duration are described in Section 6.0 of the RI/FS Work Plan. The contractor will utilize subcontractors to perform laboratory analysis, data validation, drilling and monitoring well installation, ordnance clearance, and surveying. In addition, the U.S. Army Technical Escort Unit (TEU) will assist in the investigations in order to field screen soil samples for the presence of chemical agents. Specific subcontractors have not yet been identified. Figure 4-1 shows the project organization, lines of authority, and support personnel/organizations.

FIGURE 4-1

PROJECT ORGANIZATION
RI/FS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA



5.0 QUALITY ASSURANCE OBJECTIVES FOR DATA MEASUREMENT

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

5.1 Project Quality Assurance Objectives

Project QA objectives are:

- Scientific data will be of a quality sufficient to meet scientific and legal scrutiny;
- Data will be gathered/developed in accordance with procedures appropriate for the intended use of the data; and
- Data will be of acceptable precision, accuracy, completeness, representativeness, and comparability as required by the project.

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

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

This QAPP, prepared in direct response to these goals, describes the QA Program to be implemented and the QC procedures to be followed by the laboratory during the course of the project.

This QAPP presents the project organization and specifies or references technical procedures, documentation requirements, sample custody requirements, audit, and corrective action provisions to be applied to provide confidence that all activities meet the intent of the QA program. This QAPP has been prepared in accordance with USEPA guidance as presented in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80.

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

- "Statement of Work for Organic Analysis," USEPA , OLM01.6, June 1991;
- "Statement of Work for Inorganic Analysis," USEPA , ILM02.0, March 1990;
- "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983;
- "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136;
- "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition;
- "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886; and
- "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," USEPA, (QAMS 005/80).

5.2 Data Quality Objectives

Data quality objectives (DQOs) are qualitative or quantitative statements developed by the data users to specify the quality of data needed from a particular data collection activity to support a specific decision. The DQOs are expressed in terms of precision, accuracy, representativeness, completeness, and comparability. Definitions for these terms, as well as for the more general term uncertainty, are given in Table 5-1.

TABLE 5-1

DEFINITIONS OF DATA QUALITY INDICATORS

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

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

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

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

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

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

The Project Manager, in conjunction with the Navy Engineer-in-Charge (EIC), is responsible for defining the DQOs. The intended use of the data, analytical measurements, and the availability of resources are integral in development of DQOs. DQOs define the level of uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both field sampling error and analytical instrument error. Ideally, zero uncertainty is the goal; however, the variables associated with sampling and analysis contribute to a degree of uncertainty in any data generated. It is an overall program objective to keep the total uncertainty within an acceptable range, so as not to hinder the intended use of the data. To achieve this objective, specific data quality requirements such as detection limits, criteria for accuracy and precision, sample representativeness, data comparability, and data completeness have been specified.

The data collected during the course of the site investigation will be used:

- To assess potential human health and environmental risks;
- To monitor health and safety conditions during field activities;
- To identify releases or suspected releases of hazardous waste and/or constituents;
- To characterize the wastes contained and/or managed; and,
- To screen from further investigation those areas which do not pose a threat to human health or environment.

All samples for characterizing the site, assessing human health and environmental risks, or selecting remedial alternatives will be analyzed and reported by the laboratory as Level IV data. Samples collected to evaluate process options (e.g., Total Organic Carbon {TOC}, Total Suspended Solids {TSS}, etc.) will be analyzed and reported by the laboratory as Level III data quality. Field parameters including temperature for water only and specific conductance will be Level I data quality. In the event treatability studies are conducted, sample analyses will be Level III or IV quality.

6.0 SAMPLING PROCEDURES

Descriptions of the procedures to be used for sampling the groundwater, surface water, sediment and soil at the site are provided in Section 5.0 of the FSAP. The number of samples, sampling locations, and sampling rationale by media also are presented in the FSAP.

7.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Sample custody procedures outlined in this section have been developed from "User's Guide to the Contract Laboratory Program," December 1988, OSWER Directive No. 9240.0-01. These procedures are in accordance with "EPA NEIC Policies and Procedure Manual," May 1978, revised November 1984, EPA 330-78-001-R and "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," December 1980, QAMS-005/80.

The purpose of this section is to outline the sample handling and sample documentation procedures to be used during implementation of the FSAP. The objective of the sample handling procedures is to deliver representative samples to the laboratories for analysis. The objectives of the sample documentation procedures are to: (1) ensure complete analysis of the requested parameters within the required turnaround times; and (2) document the sample from the point of collection to the final data report.

7.1 Sampling Handling

New polyethylene or glass bottles containing the proper preservatives will be provided by the laboratory for sample collection. In addition to the chemical preservatives, samples will be stored on ice at 4 degrees Celsius (°C) in a waterproof metal or sturdy plastic cooler, if required (see Tables 7-1 through 7-3 for summaries of containers, preservation, and holding times for water, soil/sediment, and waste, respectively).

7.2 Chain-of-Custody Procedures

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

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

TABLE 7-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples (1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 69	Soil - On site	24 surface soil	TCL Organics(2)	IV	CLP/SOW(5)	Routine(6)	3
			TAL Inorganics(3)	IV	CLP/SOW	Routine	3
			CSM(4)	IV	Modified EPA 8270	Routine	3
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
		1	Particle-Size Distribution	II	ASTM D422-63	Routine	0
		1	Atterburg Limits	II	ASTM D4943-89	Routine	0
	Groundwater - Hydropunch	14	TCL Volatile Organics	II	EPA 8240	24 hours	2
	Groundwater - Wells	14 (8 existing, 4 new shallow, 2 new deep wells)	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			CSM	IV	Modified EPA 8270	Routine	2
		2 (one shallow well and one deep well)	Microbial Count	II	SM 907	Routine	0
			BOD_5	II	SM 507, EPA 405.1	Routine	0
			TOC	II	EPA 415.1	Routine	0
			COD	II	EPA 415.1, Hach	Routine	0
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine	0
			Total Phosphorous	II	EPA 365.2	Routine	0
			Alkalinity	II	SM 403	Routine	0
	Surface Water-On Site	4 surface water (standing pools)	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
		4 sediment	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Surface Water-Drainage Areas	4 surface water	TCL Organics	IV	CLP/SOW	Routine	0(9)
			TAL Inorganics	IV	CLP/SOW	Routine	0(9)
			CSM	IV	Modified EPA 8270	Routine	0(9)
		4 sediment	TCL Organics	IV	CLP/SOW	Routine	0(9)
			TAL Inorganics	IV	CLP/SOW	Routine	0(9)
			CSM	IV	Modified EPA 8270	Routine	0(9)

TABLE 7-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples (1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 74	Soil - On Site	10 surface soil	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
		1	Particle-Size Distribution	II	ASTM D422-63	Routine	0
		1	Atterburg Limits	II	ASTM D4943-89	Routine	0
	Soil - Former Disposal Area	32 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine	10
			TAL Inorganics	IV	CLP/SOW	Routine	10
			CSM	IV	Modified EPA 8270	Routine	10
	Soil - Pest Control Area	19 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine	6
			TAL Inorganics	IV	CLP/SOW	Routine	6
	Groundwater	7 (2 existing, 5 new shallow)	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			CSM	IV	Modified EPA 8270	Routine	1
		1	Microbial Count	II	SM 907	Routine	0
			BOD_5	II	SM 507, EPA 405.1	Routine	0
			TOC	II	EPA 415.1	Routine	0
			COD	II	EPA 415.1, Hach	Routine	0
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine	0
			Total Phosphorous	II	EPA 365.2	Routine	0
			Alkalinity	II	SM 403	Routine	0

TABLE 7-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 41	Soil - Downslope	12 surface soils	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			CSM	IV	Modified EPA 8270	Routine	2
			Mirex	IV	EPA 8270A	Routine	2
			Ordnance(7)	IV	EPA 8330	Routine	2
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine	0
			TAL Inorganics	IV	CLP/SOW	Routine	0
			CSM	IV	Modified EPA 8270	Routine	0
			Mirex	IV	EPA 8270A	Routine	0
			Ordnance(7)	IV	EPA 8330	Routine	0
	Soil - On-site Surficial Character-ization	25 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine	8
			TAL Inorganics	IV	CLP/SOW	Routine	8
			CSM	IV	Modified EPA 8270	Routine	8
			Mirex	IV	EPA 8270A	Routine	8
			Ordnance(7)	IV	EPA 8330	Routine	8
	Soil - Well Borings	13 borings/3 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine	4
			TAL Inroganics	IV	CLP/SOW	Routine	4
		2	Particle-Size Distribution	II	ASTM D422-63	Routine	0
		2	Atterburg Limits	II	ASTMD4943-89	Routine	0
	Groundwater - Wells	18 (5 existing, 7 new shallow, 6 intermediate wells)	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			CSM	IV	Modified EPA 8270	Routine	2
			Mirex	IV	EPA 8270A	Routine	2
			Ordnance(7)	IV	EPA 8330	Routine	2
		2 (one shallow well and one intermediate well)	Microbial Count	II	SM 907	Routine	0
			BOD_5	II	SM 507, EPA 405.1	Routine	0
			TOC	II	EPA 415.1	Routine	0
			COD	II	EPA 415.1, Hach	Routine	0
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine	0
			Total Phosphorous	II	EPA 365.2	Routine	0
			Alkalinity	II	SM 403	Routine	0

TABLE 7-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples (1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time	Field QA/QC Samples (8) Field Duplicates
Site 41 (cont.)	Surface Water-On Site	10 surface water	TCL Organics	IV	CLP/SOW	Routine	1
			TAL Inorganics	IV	CLP/SOW	Routine	1
			Mirex	IV	EPA 8270A	Routine	1
			Ordnance(7)	IV	EPA 8330	Routine	1
		20 sediment	TCL Organics	IV	CLP/SOW	Routine	2
			TAL Inorganics	IV	CLP/SOW	Routine	2
			Mirex	IV	EPA 8270A	Routine	2
			Ordnance(7)	IV	Ordnance	Routine	2
IDW	Soil Characterization	3 (one composite from each site roll-off box	TCL Organics	IV	CLP/SOW	14-day	0
			TAL Inorganics	IV	CLP/SOW	14-day	0
			Full TCLP	III	40 CFR 261	14-day	0
			Reactivity	III	40 CFR 261	14-day	0
			Corrosivity	III	40 CFR 261	14-day	0
			Ignitability	III	40 CFR 261	14-day	0
	Development/ Purge Water Characterization	3 (one sample from each tanker)	TCL Organics	IV	CLP/SOW	14-day	0
			TAL Inorganics	IV	CLP/SOW	14-day	0

(1) Baseline number of samples do not include field QA/QC samples.
(2) TCL Organics: Volatile Organics, Semivolatile Organics, Pesticides/PCBs
(3) TAL Inorganics:

Aluminum	EPA 3010/EPA 200.7	Cobalt	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270.2
Arsenic	EPA 3020/EPA 206	Iron	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Barium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 239	Sodium	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Vanadium	EPA 3010/EPA 200.7
Calcium	EPA 3010/EPA 200.7	Mercury	EPA 3010/EPA 245.1	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7	Cyanide	EPA 3010/EPA 335.2

(4) CSM - Chemical Surety Materials
(5) CLP/SOW - Contract Laboratory Program/Statement of Work
(6) Routine analytical turnaround is 28 days following receipt of sample.
(7) Ordnance constituents include: HMX, ROX, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, TNT, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, 4 amino 2,6 dinitrotoleuen (EPA Method SW-846 8330).

TABLE 7-2

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR WATER SAMPLES
SITES 41, 69, AND 74
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Container	Preservation	Holding Time
TCL Volatiles	Two 40-ml vials with teflon septum caps	Cool, 4°C HCl pH <2	14 days (7 days if unpreserved)
TCL Semivolatiles	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides (including Mirex)/PCBs	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	1-500 ml polyethylene bottle	HNO_3 pH<2	6 months; Mercury 28 days
TAL Cyanide	1-liter polyethylene bottle	NaOH pH>12 Cool, 4°C	14 days
CSM	1-liter polyethylene bottle	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
Ordnance	1-liter amber glass bottle with teflon caps	Cool to 4°C	7 days to extraction; 40 days from extraction for analysis
Total Phosphorous	1-liter polyethylene bottle	Cool, 4°C HCl or H_2SO_4 to pH <2	28 days
Nitrogen	1-liter polyethylene bottle	Cool, 4°C HCl or H_2SO_4 to pH <2	28 days
TOC	1-liter polyethylene bottle	Cool, 4°C HCl or H_2SO_4 to pH <2	28 days
BOD	1-liter polyethylene bottle	Cool, 4°C	48 hours
COD	1-liter polyethylene bottle	Cool, 4°C H_2SO_4 pH <2	28 days
Alkalinity	1-liter polyethylene bottle	Cool to 4°C	14 days
Microbial Count	1-liter polyethylene bottle	Cool to 4°C	48 hours

TCL - Target Contaminant List
TAL - Target Analyte List
TSS - Total Suspended Solids
TVS - Total Volatile Solids
CSM - Chemical Surety Compounds
TDS - Total Dissolved Solids
TOC -Total Organic Carbon
BOD - Biological Oxygen Demand
COD - Chemical Oxygen Demand

TABLE 7-3

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR WASTE OR IDW SAMPLES

Parameter	Container	Preservation	Holding Time
Corrosivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	14 days
Ignitability	One 4-ounce wide-mouth glass jar	Cool, 4°C	28 days
Reactivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	N/A
Toxicity Characteristic Leaching Procedure (TCLP)	Two 8-ounce wide-mouth glass jar	Cool, 4°C	14 days

NOTE: Samples to be tested for TCLP should undergo minimal disturbance prior to analysis.

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

- Field logbook;
- Sample labels;
- Chain-of-Custody (COC) records;
- Custody seals; and
- Commercial carrier airbills.

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

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

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

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

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

The sample custody is documented using Chain-of-Custody (COC) records. Field personnel will complete a COC record, in waterproof ink, to accompany each cooler forwarded from the site to the laboratory. Chemical reagents used to preserve the samples will be recorded on the

COC record. Any errors on the COC records will not be erased; instead, a line will be drawn through the error and initialed by the person completing the form. The original copy will be placed in a sealable plastic bag and put inside the appropriate cooler, secured to the cooler's lid.

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

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

Laboratory Chain-of-Custody Procedures

Upon sample receipt the steps below are performed.

- Samples are received and unpacked in the laboratory where the staff checks for bottle integrity (i.e., loose caps, broken bottles, etc.).

- Samples are verified with incoming paperwork (i.e., packing slip, etc.) by type of bottle and stabilizer. The paperwork is either signed or initialed.

- Information concerning the sample from the sampling record, COC, and observation is recorded along with parameters to be analyzed, date of sampling, and date the sample is received in the laboratory.

- Samples are placed in an appropriate secured storage area, (e.g. refrigeration), until analysis.

- When analysis is complete, samples are stored for a 30-day period unless otherwise specified.

If collected samples arrive without COC or incorrect COC records, the following steps are taken:

- The laboratory prepares a nonconformance form stating the problem;
- The site supervisor and Project Manager are notified; and
- If the missing information cannot be reconstructed by the Project Manager or field staff, the samples affected are removed from the sampling program.

Primary considerations for sample storage are:

- Secured storage;
- Maintaining prescribed temperature, if required, which is typically 4°C; and
- Extracting and/or analyzing samples within the prescribed holding time for the parameters of interest.

7.3 Document Custody Procedures

Project records are necessary to support the validity of the work, to allow it to be recreated if necessary, and to furnish documentary evidence of quality. The evidentiary value of data is dependent upon the proper maintenance and retrieval of quality assurance records. Therefore, procedures are established to assure that all documents attesting to the validity of work are accounted for when the work is completed.

Records are legible, filled out completely, and adequately identified as to the item or activity involved. Records are considered valid only if initialed, signed, or otherwise authenticated and dated by authorized personnel. These records may either be originals or reproduced copies. Records submitted to the files, with the exception of correspondence, are bound, placed in folders or binders, or otherwise secured for filing.

Following receipt of information from external sources, completion of analyses, and issuance of reports or other transmittals, associated records are submitted to the proper file. In addition, records transmitted are adequately protected from damage and loss during transfer (e.g., hand carrying or making copies prior to shipment).

The following documents will be transferred to the proper files during the course of this project: calculations and checkprints; reports and other data transmittals; copies of proposals, purchase orders for project services, and contracts; correspondence including incoming and outgoing letters, memoranda, and telephone records; and reference material.

All individuals on the project staff are responsible for reporting obsolete or superseded project-related information to the Project Manager. In turn, the Project Manager notifies the project and laboratory staffs of the resulting status change in project documents, such as drawings and project procedures.

In general, outdated drawings and other documents are marked "void." However, the Project Manager may request the copies be destroyed. One copy of void documents is maintained in the project files with the reasons for, and date of voiding clearly indicated.

Documents are marked "preliminary" to denote calculations and other material which have not been formally checked, or based on information which has not been checked, or do not contribute to final project information.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

8.1 Field Instruments

Two field instruments will be used for health and safety monitoring: the Minicam (Model FM-3000) and the HNu System portable photoionizer (PID). These instruments will be calibrated on site daily according to the manufacturer's instructions in addition to the factory calibration they will receive prior to the start of site sampling. The calibration standards will be recorded in the field logbook. Specific procedures for the calibration of air quality instruments are given in Appendix A of this document.

A pH meter and a conductivity meter will be used to analyze groundwater and surface water samples. Procedures from "Test Methods for Evaluating Solid Waste," USEPA, SW-846, November 1986, 3rd Edition will be used to calibrate these meters. Specific procedures for the calibration of water quality instruments are given in Appendix A of this document

8.2 Laboratory Instruments

The laboratory's procedures for calibration and related quality control measures are to be in accordance with the protocols presented in the following documents:

- "Statement of Work for Organic Analysis," USEPA, OLM01.6, June 1991;
- "Statement of Work for Inorganic Analysis," USEPA, ILM02.0, March 1990;
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA, July 1982;
- "Methods and Reporting Format for the Analysis of Chemical Surety Materials (CSM) and CSM Degradation Products," Midwest Research Institute;
- "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983;
- "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136;

- "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition; and

- "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886.

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

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

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

All equipment is uniquely identified, either by serial number or internal calibration number, to allow traceability between equipment and calibration records. Recognized procedures (American Society for Testing and Materials {ASTM}, USEPA, or manufacturer's procedures) are used for calibration whenever available.

8.2.1 Method Calibration

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

8.2.2 GC/MS System Calibration Procedure

This section outlines the requirements for the calibration of gas chromatograph/mass spectrometer (GC/MS) systems for the determination of organic compounds. The following operations are performed in support of these requirements:

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

Tuning and Mass Calibration

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

A GC/MS system used for organic compound analysis is tuned to meet the criteria specified for BFB analysis (volatile compounds) or DFTPP (semivolatile compounds) for an injection of 50 nanograms (ng) of BFB or DFTPP. The analysis is performed separately from standard or blank analysis. These criteria are demonstrated every 12 hours of operation. Background subtraction, if required, is straight forward to eliminate column bleed or instrument background ions. Calibration documentation is in the form of a bar graph spectrum and a mass listing.

GC/MS System Calibration

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

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

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

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

8.2.3 GC System Calibration Procedure for Pesticides/PCBs

This section outlines the requirements for the calibration of GC systems for the determination of pesticides/Polychlorinate Biphyenls (PCBs). The following operations are performed in support of these requirements:

- External standard response and retention time monitoring.

- It is necessary to establish that a given GC system is initially calibrated by an external standard technique containing aldrin, endrin, 4,4'-Dichlorodiphenyltrichloroethane (4,4'-DDT), and dibutylchlorendate at three concentration levels to determine linearity of response.

  Two individual standards containing all individual pesticides and multicomponent standards for toxaphene and Aroclors 1016/1260 are used to establish the retention time window for each 72 sequence.

- Continuing Calibration - A calibration check standard containing pesticides in Evaluation Mix B is to be analyzed after the first group of five samples. Subsequent groups of five samples must be followed by the analysis of pesticides in Individual Mix A or Mix B. If a multiresponse pesticide/PCB is detected in either of the preceding groups of five samples, the appropriate multiresponse pesticide/PCB may be substituted for Individual Mix A or Mix B.

Differences in the Calibration Factors for each of the pesticides in Individual Standard Mix A and B must not exceed 20 percent, 15 percent for any compound used for quantitation, during the 72-hour Primary Analysis. The calibration factors and retention times are recorded on the Pesticide/PCB Standards Summary.

The retention time shift of dibutylchlorendate in any standard or sample must be less than two percent for packed columns, less than 0.3 percent for capillary columns. The dibutylchlorendate shift is recorded on the Pesticide Evaluation Standards Summary.

8.2.4 System Calibration Procedure for GC Purgeable Halocarbons and Aromatics

The system must be calibrated daily by external calibration. A minimum of three concentration levels, of each parameter, is used to prepare a calibration curve. The working calibration curve must be verified on each working day by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than plus or minus ten percent, the test must be repeated using a fresh calibration standard.

The laboratory must spike and analyze a minimum of ten percent of all samples to monitor continuing laboratory performance.

Prior to analysis, the system must be demonstrated to be free from contamination, under the conditions of the analysis, by running a laboratory reagent blank.

The retention time window used to make the identification should be based upon measurements of actual retention time variations of standards over the course of the day.

If the response peak exceeds the working range of the system, prepare a dilution of the sample with reagent water and reanalyze.

8.2.5 System Calibration Procedure for Metals Analysis

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

- Documentation of standard response; and
- Correlation coefficient monitoring.

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

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

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

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

Correlation Coefficient Calculation

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

Calibration Verification

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

- ICEP/GFAA - 90 to 110 percent of true value; and

- Cold Vapor AA - 80 to 120 percent of true value.

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

8.2.6 System Calibration Procedure for Inorganic Analyses

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

- Documentation of standard response; and
- Correlation coefficient monitoring.

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

Correlation Coefficient Calculation

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

Calibration Verification

The initial calibration curve is verified on each working day by the measurement of two calibration standards. One standard is at a concentration near the low end of the calibration curve and one standard is at the high end of the curve. The acceptance criteria for recovery of verification standards is within 15 percent of the expected recovery for cyanide analyses and 10 percent of the expected recovery for other inorganic analyses. When measurements exceed control limits, analysis is terminated, the problem is corrected, the instrument is recalibrated, and calibration is reverified.

8.2.7 Periodic Calibration

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

- Balances are calibrated weekly with class S weights.

- The pH Meter meter is calibrated daily with pH 4 and 7 buffer solutions and checked with pH 10 buffer solution.

- The temperatures of the refrigerators are recorded daily.

- All liquid in glass thermometers are calibrated annually with the National Bureau of Standards (NBS) Certified Thermometer. Dial thermometers are calibrated quarterly.

- The NBS Certified Thermometer is checked annually at the ice point.

The following equipment must maintain the following temperatures:

- Sample Storage and Refrigerators - within 2 degrees of 4°C; and
- Water Bath, Mercury - within 2 degrees of 95°C

9.0 ANALYTICAL PROCEDURES

9.1 Field Analysis

A Minicam (FM-3000), the HNu DL-101, and oxygen/lower explosive limit 0xygen/lower explosive limit (O_2/LEL) meter will be used to analyze ambient air for health and safety monitoring, as well as to screen soil during the soil sampling. The Minicam (FM-3000) detects chemical warfare agents and stimulants. The HNu DL-101 detects total organic vapor. The O_2/LEL meter detects explosive gases that may be present (i.e., methane). These instruments will be operated in accordance with the manufacturer's instructions.

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

9.2 Laboratory Analysis

The samples that will be collected during the investigation will be analyzed for constituents listed in Table 9-1. Parameters will be analyzed using USEPA methods as noted in Table 9-1. Compounds and the corresponding method performance limits also are listed in Table 9-1.

TABLE 9-1
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Aqueous CRQL(1) (µg/l)	Solid CRQL(1) (µg/kg)	Method
Volatiles			CLP/SOW
Chloromethane	10	10	
Bromomethane	10	10	
Vinyl Chloride	10	10	
Chloroethane	10	10	
Methylene Chloride	5	5	
Acetone	10	10	
Carbon Disulfide	5	5	
1,1-Dichloroethene	5	5	
1,1-Dichloroethane	5	5	
1,2-Dichloroethene (total)	5	5	
Chloroform	5	5	
1,2-Dichloroethane	5	5	
2-Butanone	10	10	
1,1,1-Trichloroethane	5	5	
Carbon Tetrachloride	5	5	
Bromodichloromethane	5	5	
1,2-Dichloropropane	5	5	
cis-1,3-Dichloropropene	5	5	
Trichloroethene	5	5	
Dibromochloromethane	5	5	
1,1,2-Trichloroethane	5	5	
Benzene	5	5	
trans-1,3-Dichloropropene	5	5	
Bromoform	5	5	
4-Methyl-2-pentanone	10	10	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Aqueous CRQL(1) (µg/l)	Solid CRQL(1) (µg/kg)	Method
2-Hexanone	10	10	CLP/SOW
Tetrachloroethene	5	5	
Toluene	5	5	
1,1,2,2-Tetrachloroethane	5	5	
Chlorobenzene	5	5	
Ethyl Benzene	5	5	
Styrene	5	5	
Xylenes (total)	5	5	
Semivolatiles			CLP/SOW
Phenol	10	330	
bis(2-Chloroethyl) ether	10	330	
2-Chlorophenol	10	330	
1,3-Dichlorobenzene	10	330	
1,4-Dichlorobenzene	10	330	
Benzyl alcohol	10	330	
1,2-Dichlorobenzene	10	330	
2-Methylphenol	10	330	
bis(2-Chloroisopropyl)ether	10	330	
4-Methylphenol	10	330	
N-Nitroso-di-n-dipropylamine	10	330	
Hexachloroethane	10	330	
Nitrobenzene	10	330	
Isophorone	10	330	
2-Nitrophenol	10	330	
2,4-Dimethylphenol	10	330	
Benzoic acid	50	1600	
bis(2-Chloroethoxyl)methane	10	330	
2,4-Dichlorophenol	10	330	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Aqueous CRQL(1) (µg/l)	Solid CRQL(1) (µg/kg)	Method
1,2,4-Trichlorobenzene	10	330	CLP protocols/ SOW
Naphthalene	10	330	
4-Chloroaniline	10	330	
Hexachlorobutadiene	10	330	
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330	
2-Methylnaphthalene	10	330	
Hexachlorocyclopentadiene	10	330	
2,4,6-Trichlorophenol	10	330	
2,4,5-Trichlorophenol	50	1600	
2-Chloronaphthalene	10	330	
2-Nitroaniline	50	1600	
Dimethylphthalate	10	330	
Acenaphthylene	10	330	
2,6-Dinitrotoluene	10	330	
3-Nitroaniline	50	1600	
Acenaphthene	10	330	
2,4-Dinitrophenol	50	1600	
4-Nitrophenol	50	1600	
Dibenzofuran	10	330	
2,4-Dinitrotoluene	10	330	
Diethylphthalate	10	330	
4-Chlorophenyl-phenyl ether	10	330	
Fluorene	10	330	
4-Nitroaniline	50	1600	
4,6-Dinitro-2-methylphenol	50	1600	
N-nitrosodiphenylamine	10	330	
4-Bromophenyl-phenylether	10	330	
Hexachlorobenzene	10	330	
Pentachlorophenol	50	1600	

(1) Contract Required Quantitation Limit, taken from "Statement ofWork for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Aqueous CRQL(1) (µg/l)	Solid CRQL(1) (µg/kg)	Method
Phenanthrene	10	330	CLP/SOW
Anthracene	10	330	
Di-n-butylphthalate	10	330	
Fluoranthene	10	330	
Pyrene	10	330	
Butylbenzylphthalate	10	330	
3,3'-Dichlorobenzidine	20	660	
Benzo(a)anthracene	10	330	
Chrysene	10	330	
bis(2-Ethylhexyl)phthalate	10	330	
Di-n-octylphthalate	10	330	
Benzo(b)fluoranthene	10	330	
Benzo(k)fluoranthene	10	330	
Benzo(a)pyrene	10	330	
Indeno(1,2,3-cd)pyrene	10	330	
Dibenz(a,h)anthracene	10	330	
Benzo(g,h,i)perylene	10	330	
CSMs			
Pesticides			CLP/SOW
alpha-BHC	0.05	8.0	
beta-BHC	0.05	8.0	
delta-BHC	0.05	8.0	
gamma-BHC (Lindane)	0.05	8.0	
Heptachlor	0.05	8.0	
Aldrin	0.05	8.0	
Heptachlor epoxide	0.05	8.0	
Endosulfan I	0.05	8.0	
Dieldrin	0.10	16.0	
4,4'-DDE	0.10	16.0	
Endrin	0.10	16.0	
Endosulfan II	0.10	16.0	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Aqueous CRQL(1) (µg/l)	Solid CRQL(1) (µg/kg)	Method
4,4'-DDD	0.10	16.0	CLP/SOW
Endosulfan sulfate	0.10	16.0	
4,4'-DDT	0.10	16.0	
Methoxychlor	0.5	80.0	
Endrin ketone	0.10	16.0	
alpha-Chlordane	0.5	80.0	
gamma-Chlordane	0.5	80.0	
Toxaphene	1.0	160.0	
Aroclor-1016	0.5	80.0	
Aroclor-1221	0.5	80.0	
Aroclor-1232	0.5	80.0	
Aroclor-1242	0.5	80.0	
Aroclor-1248	0.5	80.0	
Aroclor-1254	1.0	160.0	
Aroclor-1266	1.0	160.0	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Method Number(1)	CRDL(2) (µg/l)	Method Description
Aluminum	200.7	200	Inductively Coupled Plasma
Antimony	200.7 204.2	60	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Arsenic	200.7 206.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Barium	200.7	200	Inductively Coupled Plasma
Beryllium	200.7 210.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Cadmium	200.7 213.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Calcium	200.7 215.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Chromium	200.7 218.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Cobalt	200.7	50	Inductively Coupled Plasma
Copper	200.7	25	Inductively Coupled Plasma
Iron	200.7	100	Inductively Coupled Plasma
Lead	200.7 239.2	3	Inductively Coupled Plasma Atomic Absorption, Furnace Technique

(1) Methods taken from "Statement of Work for Inorganic Analysis," USEPA Contract Laboratory Program, ILM02.0, March 1990.
(2) Contract Required Detection Limit.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Method Number(1)	CRDL(2) (µg/l)	Method Description
Magnesium		5000	
	200.7		Inductively Coupled Plasma
	242.1		Atomic Absorption, Direct Aspiration
Manganese		15	
	200.7		Inductively Coupled Plasma
Mercury		0.2	
	245.1		Water by manual cold vapor technique
	245.2		Water by automated cold vapor technique
	245.5		Soil/sediment by manual cold vapor technique
Nickel		40	
	200.7		Inductively Coupled Plasma
Potassium		5000	
	200.7		Inductively Coupled Plasma
	258.1		Atomic Absorption, Direct Aspiration
Selenium		5	
	200.7		Inductively Coupled Plasma
	270.2		Atomic Absorption, Furnace Technique
Silver		10	
	200.7		Inductively Coupled Plasma
	272.2		Atomic Absorption, Furnace Technique
Sodium		5000	
	200.7		Inductively Coupled Plasma
	273.1		Atomic Absorption, Direct Aspiration
Thallium		10	
	200.7		Inductively Coupled Plasma
	279.2		Atomic Absorption, Furnace Technique
Vanadium		50	
	200.7		Inductively Coupled Plasma
Zinc		20	
	200.7		Inductively Coupled Plasma
Cyanide		10	
	335.2		Titrimetric, Spectrophotometric

(1) Methods taken from "Statement of Work for Inorganic Analysis," USEPA Contract Laboratory Program, ILM02.0, March 1990.
(2) Contract Required Detection Limit.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Aqueous PQL(1) (µg/l)	Solid PQL(1) (µg/kg)	Method
TCLP Volatiles			EPA Method 3550/ EPA Method 8240
Benzene	5	10	
Carbon Tetrachloride	5	5	
Chlorobenzene	5	5	
Chloroform	5	5	
1,2-Dichloroethane	5	5	
1,1-Dichloroethylene	5	5	
Methyl ethyl ketone	N/A	N/A	
Tetrachloroethylene	5	5	
Trichloroethylene	5	5	
Vinyl Chloride	10	10	
TCLP Semivolatiles			EPA Method 3550/ EPA Method 8270
o-Cresol	10	660	
m-Cresol	10	660	
p-Cresol	10	660	
Cresol	10	660	
1,4-Dichlorobenzene	10	660	
2,4-Dinitrotoluene	10	660	
Hexachlorobenzene	10	660	
Hexachlorobutadiene	10	660	
Hexachloroethane	10	660	
Nitrobenzene	10	660	
Pentachlorophenol	50	3300	
Pyridine	50	660	
2,4,5-Trichlorophenol	10	660	
2,4,6-Trichlorophenol	10	660	

(1) Practical Quantitation Limit, taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

Note: These methods will be used to analyze the Toxicity Characteristic Leaching Procedure (TCLP) extract. The extract will be prepared using Method 1311, described in "Hazardous Waste Management Systems; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52FR 26886.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Aqueous PQL(1) (µg/l)	Solid PQL(1) (µg/kg)	Method
TCLP Pesticides			EPA Method 3550/ EPA Method 8080
Chlordane	0.14	9.4	
Endrin	0.06	4.0	
Heptachor (and its hydroxide)	0.03	2.0	
Lindane	0.04	2.7	
Methoxychlor	1.8	120	
Toxaphene	2.4	160	
Herbicides			EPA Method 3550/ EPA Method 8080
2,4-D	12	800	
2,4,5-TP Silvex	1.7	110	

Analyte	Aqueous PQL(1) (µg/l)	Solid PQL(1) (mg/kg)	Method	Method Description
Metals				
Arsenic	10	30	6010 7060	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Barium	20	1	6010	Inductively Coupled Plasma
Cadmium	1	2	6010 7131	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Chromium	20	4	6010 7191	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Lead	10	2	6010 7421	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Mercury	2	0.002	7470	Water by manual cold vapor technique Water by automated cold vapor technique
Selenium	20	40	6010 7740	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Silver	2	4	6010 7760	Inductively Coupled Plasma Atomic Absorption, Furnace Technique

Note: These methods will be used to analyze the Toxicity Characteristic Leading Procedure (TCLP) extract. The extract will be prepared using Method 1311, described in "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52FR 26886.

(1) Practical Quantitation Limit, taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Aqueous Performance Limit	Solid Performance Limit	Method
RCRA			
pH/Corrosivity	N/A (1)	N/A(1)	SW-846 9010
Ignitability	N/A(1)	N/A(1)	SW-846 1010
Reactive Cyanide	10 mg/l(1)	10 mg/l(1)	SW-846 9012
Reactive Sulfide	50 mg/l(1)	50 mg/kg(1)	SW-846 9030
Engineering Parameters			
Chemical Oxygen Demand (COD)	N/A(2)	N/A(2)	EPA 410.1
Biological Oxygen Demand (BOD)	N/A(2)	N/A(2)	EPA 405.1
Total Organic Carbon (TOC)	N/A(2)	N/A(2)	EPA 415.1
Alkalinity (Total)	N/A	N/A	SM 403
Nitrogen, Organic (as N)	N/A	N/A	Total Kjeldahl
Particle Size Distribution	N/A	N/A	ASTM D 422-63
Atterburg Limits	N/A	N/A	ASTM D 4943-89
Microbial Count	N/A	N/A	SM 907

(1) Practical Quantitation Limit taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

(2) Method Detection Limit taken from "Methods for Chemical Analysis of Water and Wastes," USEPA, 1979, Revised March 1983.

N/A - Not Applicable

TABLE 9-1 (Continued)
METHOD PERFORMANCE LIMITS
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Aqueous PQL (µg/l)	Solid CPQL (µg/kg)	Method
Chemical Surety Compounds			
Dithiane	10	1000	SW-846 8270
Thiodiglycol (TDG)	100	2000	DFIMS(1)
Ethyl methyl phosphonic acid (IMPA)	100	2000	UT02 (water); AAA9 (soil)(2)
Hexachloroethane	10	1000	SW-846 8270
Acetophenone	10	1000	SW-846 8270
Chloroacetophenone	10	1000	SW-846 8270
Hydroxyacetophenone	50	1000	SW-846 8270
Bis(2-chloroethyl)disulfide	50	1000	SW-846 8270
Bis(2-chloroethyl)trisulfide	10	1000	SW-846 8270
Ordnance Constituents			
Octahydro-1,3,5,7 tetranitro-1,3,5,7-tetrazocine (HMX)	0.625	1250	SW-846 8330
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.625	1250	SW-846 8330
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.25	2500	SW-846 8330
1,3-Dinitrobenzene (1,3-DNB)	0.313	625	SW-846 8330
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	3.125	6250	SW-846 8330
Nitrobenzene (NB)	0.313	625	SW-846 8330
2,4,6-Trinitrotoluene (2,4,6-TNT)	1.25	2500	SW-846 8330
2,6-Dinitrotoluene (2,6-DNT)	0.313	625	SW-846 8330
2,4-Dinitrotoluene (2,4-DNT)	0.313	625	SW-846 8330
2-Amino-4,6-dinitrotoluene (2-A-4,6-DNT)	0.625	1250	SW-846 8330
4-Amino-2,6-dinitrotoluene (2-A-2,6-DNT)	0.625	1250	SW-846 8330
2-Nitrotoluene (2-NT)	0.625	1250	SW-846 8330
4-Nitrotoluene (4-NT)	0.625	1250	SW-846 8330
3-Nitrotoluene (3-NT)	0.625	1250	SW-846 8330

(1) Kinney and Sichon. "Direct Aqueous Flow Injection Tandem Mass Spectrometry of Organophosphates and Organoalcohols at Parts per Billion Detection Limits," 38th ASMS Conference on Mass Spectrometry and Allied Topics, 1990.

(2) USATHAMA methods.

10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 Field Data Procedures

Data validation practices as described by "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," USEPA, June 1988, and "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses - Draft," USEPA, June 1991 will be followed to insure that raw data are not altered and that an audit trail is developed for those data which require reduction. The documentation of sample collection will include the use of bound field log books in which all information on sample collection will be entered in indelible ink. Appropriate information will be entered to reconstruct the sampling event, including: site name at the top of each page, sample identification, brief description of sample, date and time of collection, sampling methodology, field measurements and observations, and sampler's initials at the bottom of each page, and dated.

A rigorous data control program will insure that all documents for the investigations are accounted for when they are completed. Accountable documents include items such as logbooks, field data records, correspondence, chain-of-custody records, analytical reports, data packages, photographs, computer disks, and reports. The project manager is responsible for maintaining a project file in which all accountable documents will be inventoried. The project records will be retained for a period of three years after project close-out; then the files will be forwarded to the Navy.

All the field data, such as those generated during field measurements, observations and field instrument calibrations, will be entered directly into a bound field notebook. Each project team member will be responsible for proofing all data transfers made, and the Project Manager or his designee will proof at least ten percent of all data transfers.

10.2 Laboratory Data Procedures

The following procedures summarize the practices routinely used by laboratory staff for data reduction, validation, and reporting. Numerical analyses, including manual calculations, are documented and subjected to quality control review. Records of numerical analyses are legible and complete enough to permit reconstruction of the work by a qualified individual other than the originator.

Laboratory Data Validation

Data validation begins with data reduction and continues through to the reporting of data.

Data processing is checked by an individual other than the analyst who performed the data processing. The checker reviews the data for the following:

- Utilization of the proper equations;
- Correctness of numerical input;
- Correctness of computations; and
- Correct interpretation of raw data (e.g., chromatographs, strip charts, etc.).

The checking process is thorough enough to verify the results.

All entries made in benchbooks, data sheets, computation sheets, input sheets, etc. are made in ink. No entry will be rendered unreadable.

Analytical Reports

The items listed below are required of analytical reports.

- Data is presented in a tabular format.

- Analytical reports are approved by appropriate laboratory personnel.

- The following information is included on the report: client name and address, report date, sample date, analysis dates, number of samples, purchase order number, project number, and project type. All pages are numbered.

- Sample numbers and corresponding laboratory numbers are identified.

- Parameters analyzed, report units, and values are identified.

- Method, trip, and field blank results are reported.

- Matrix spike, matrix spike duplicate, and replicate recoveries are reported.

- Calibration summaries are reported.
- Surrogate recoveries are reported.
- Holding times and sample analysis dates are reported.
- Detection limit of the procedure is identified.
- Consistent significant figures are used.
- Referenced footnotes are used when applicable.
- Letter of transmittal is accompanying the report if any anomalies are associated with the data. The letter specifies these anomalies.

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 Field Internal Quality Control Checks

Field internal QC checks to be used during the this investigation include field duplicates, equipment rinsates, field blanks, and trip blanks. The results from the field quality control samples will be used by the data validator to determine the overall quality of the data.

11.2 Types of Quality Control Samples

Documentation of the analyses of the following types of QC samples is maintained in the laboratory bench notebooks and/or the specific client or project files.

Field Duplicates

Duplicates for soil samples are collected, homogenized, and split. All samples except volatile organic compounds (VOCs) are homogenized, and split. Volatiles are not mixed, but select segments of the soil are taken from the length of the core and placed in 40 milliliter (ml) glass vials. Cores may be sealed and shipped to the laboratory for subsampling if the project deems this appropriate. The duplicate for water samples should be collected simultaneously. Field duplicates should be collected at a frequency of 10 percent per sample matrix for levels D and C. All the duplicates should be sent to the primary laboratory responsible for analysis. The same samples used for field duplicates shall be split by the laboratory and used by the laboratory as the laboratory duplicate or matrix spike. This means that for the duplicate sample, there will be analyses of the normal sample, the field duplicate, and the laboratory matrix spike/duplicate.

Equipment Rinsates

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

Field Blanks

Field blanks consist of the source water used in decontamination, steam cleaning, and drilling. At a minimum, one field blank from each vent and each source of water must be collected and analyzed for the same parameters as the related samples. Organic-free deionized water is taken to the field in sealed containers and poured into the appropriate sample containers at predesignated locations. This is done to determine if any contaminants present in the area may have an affect on the sample integrity.

Preservation Blank

To determine if the preservative used prior and during field operations was contaminated, preservative blanks are prepared. These samples are prepared by putting organic-free deionized water in the container and then preserving the sample with the appropriate preservative.

Trip Blank

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

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

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

Method Blank

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

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

Replicate Sample Analysis

Replicate sample analysis is performed to demonstrate the precision of an analysis. An interlaboratory replicate sample is initiated by the analyst prior to sample preparation and carried through the entire analytical procedure. The frequency of interlaboratory replicate analysis for each analyte is summarized in Table 11-1.

Spike Analysis

Spike analysis is performed to demonstrate the accuracy of an analysis. The analyst initiates the spike prior to sample preparation and analysis by adding a known amount of analyte(s) to a sample. The spike sample is carried through the entire analytical procedure. The frequency of spike analysis for each analyte(s) is summarized in Table 11-1.

Surrogate Standards

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

Internal Standards

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

TABLE 11-1

QC ANALYSIS FREQUENCY

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

Matrix Spikes and Matrix Spike Duplicates

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

11.3 Laboratory Control Limits

Control limits are established for QC checks (e.g., spikes, duplicates, blanks, etc.). CLP control limits for surrogate standards spikes, and duplicates associated with GC/MS analyses and Pesticide/PCB analyses are adopted. Control limits for spikes, duplicates, and reference samples are determined internally through statistical analysis.

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

Method Blanks

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

- If the concentration of the method blank is less than or equal to the detection level, no correction of sample results is performed.

- If the concentration of the blank is above the detection level for any group of samples associated with a particular blank, the concentration of the sample with the least concentrated analyte must be ten times the blank concentration. Otherwise, all samples associated with the blank and less than ten times the blank concentration must be redigested or reprepared and reanalyzed, if possible. If the affected samples cannot be reprepared and reanalyzed within method holding times, the flagged sample result and the blank result are both to be reported. The sample value is not corrected for the blank value.

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

- A method blank for volatiles analysis must contain no greater than five times the detection limit of common laboratory solvents. Common laboratory solvents are: methylene chloride, acetone, toluene, 2-butanone, and chloroform.

- A method blank for semivolatiles analysis must contain no greater than five times the detection limit of common phthalate esters.

- For all other compounds not listed above, the method blank must contain less than the detection limit of any single compound. If a method blank exceeds the criteria, the analytical system is considered to be out of control. The source of the contamination is investigated and appropriate corrective measures are taken and documented before sample analysis proceeds. All samples processed with a method blank that is out of control (i.e., contaminated), are reextracted/repurged and reanalyzed, when possible. If the affected samples cannot be reextracted/repurged and reanalyzed within method holding times, the flagged sample result and the blank result are both to be reported. The sample value is not corrected for the blank value.

- No positive result for pesticides/PCB should be reported unless the concentration of the compound exceeds five times the amount in the blank.

- A method blank for pesticides/PCBs must contain no greater than five times the detection limit for any pesticides/PCBs.

Surrogate Standards

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

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

- Recovery of any one surrogate compound in the semivolatile fraction is outside surrogate standard recovery limits.

Corrective action will include steps listed below.

- A check of: the calculations for errors; the internal standard and surrogate spiking solutions for degradation, contamination, etc.; and instrument performance.

- Recalculation or reinjection/repurging of the blank or extract if the above corrective actions fail to solve the problem.

- Reextraction and reanalysis of the blank. For sample surrogate standard analysis, corrective action is taken if any one of the following conditions exist:

    - Recovery of any one surrogate compounds in the volatile fraction is outside the surrogate spike recovery limits;

    - Recovery of any one surrogate compound in either semivolatile fraction is below ten percent; or

- Recoveries of two or more surrogate compounds in either semivolatile fraction are outside surrogate spike recovery limits.

Corrective action will include the steps listed below.

- A check of: the calculations for errors; of the internal standard and surrogate spiking solutions for degradation,contamination, etc.; and of instrument performance.

- Recalculating or reanalysis the sample or extract if the above corrective action fails to solve the problem.

- Reextraction and reanalysis of the sample if none of the above are a problem.

11.4 Quality Assurance Review of Reports, Plans, and Specifications

Prior to issuance of a final report, it is reviewed by senior-level program staff, the Project Manager, or a designated representative. This review addresses whether:

- Report satisfies the scope of work, client requirements, and pertinent regulatory requirements;

- Assumptions are clearly stated, justified, and documented;

- A reference is cited for any information utilized in report preparation that was originated outside the project;

- Report correctly and accurately presents the results obtained by the work;

- Tables and figures presented in the report are prepared, checked, and approved according to requirements;

- Report figures are signed and dated by the appropriate members of the project staff and project management; and

- Typed report has been proofread and punctuation, grammar, capitalization, and spelling are correct.

11.4.1 Laboratory Quality Assurance

Field Quality Assurance

Four types of field quality assurance/quality control samples will be submitted to the laboratory: trip blanks, equipment rinsates, field blanks, and field duplicates. A breakdown by type of sample with which the QA/QC samples will be submitted to the laboratories is given in Table 11-2. A summary of the number of environmental and QA/QC samples to be submitted for analysis is given in the FSAP.

TABLE 11-2

QA/QC SAMPLE FREQUENCY

Type of Sample	Metal	Organic
Trip Blank (for volatiles only)	NA[1]	One per cooler or one per shipping day
Equipment Rinsate[2]	One per day	One per day
Field Blank	One per source per event[3]	One per source per event[3]
Field Duplicate[4]	10%	10%

1 - Not Applicable

2 - Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.

3 - Source water includes water used in decontamination and steam cleaning.

4 - The duplicate must be taken from the same sample which will become the laboratory matrix spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.

12.0 PERFORMANCE AND SYSTEM AUDITS

A field audit will be conducted during the field investigation to verify that sampling is being performed according to the plan. A report will be submitted within 30 calendar days of completion of the audit. Serious deficiencies will be reported within 24 hours of the time of discovery of the deficiency, including actions taken or to be taken to correct such deficiencies.

The following table (Table 12-1) is used for audits. At the appropriate time, the Project Manager or Program QA/QC designee will conduct field audits.

TABLE 12-1

SYSTEM AUDIT CHECKLIST - FIELD OPERATIONS

Project No. _____ Date _____

Project Name & Location _____ Name & Signature of Auditor _____

Team Members _____ Name & Signature of Field Team _____

Yes _____ No _____ 1. Is there a set of accountable field documents checked out to the Site Manager?
Comments: _____

Yes _____ No _____ 2. Is the transfer of field operations from the Site Manager to field participants documented in a log book?
Comments: _____

Yes _____ No _____ 3. Is there a written list of sampling locations and descriptions?
Comments: _____

Yes _____ No _____ 4. Are samples collected as stated in the project plan or as directed by the Site Manager?
Comments: _____

Yes _____ No _____ 5. Are samples collected in the type of container specified in the project plan or as directed by the Site Manager?
Comments: _____

Yes _____ No _____ 6. Are samples preserved as specified in the project plan or as directed by the Site Manager?
Comments: _____

TABLE 12-1
SYSTEM AUDIT CHECKLIST - FIELD OPERATIONS
PAGE TWO

Yes _____ No _____ 7. Are the number, frequency and type of samples collected as specified in the project plan or as directed by the Site Manager?
Comments: _____

Yes _____ No _____ 8. Are the number, frequency and type of measurements taken as specified in the project plan or as directed by the Site Manager?
Comments: _____

Yes _____ No _____ 9. Are samples identified with sample labels?
Comments: _____

Yes _____ No _____ 10. Are blank and duplicate samples properly identified?
Comments: _____

Yes _____ No _____ 11. Are sample and serial numbers for samples split with other organizations recorded in a log book or on a chain-of-custody record?
Comments: _____

Yes _____ No _____ 12. Are samples listed on a chain-of-custody record?
Comments: _____

Yes _____ No _____ 13. Is chain-of-custody documented and maintained?
Comments: _____

Yes _____ No _____ 14. Are quality assurance checks performed as directed?
Comments: _____

TABLE 12-1
SYSTEM AUDIT CHECKLIST - FIELD OPERATIONS
PAGE THREE

Yes _____ No _____ 15. Are photographs documented in logbooks as required?
Comments: _____
_____
_____

Yes _____ No _____ 16. Are all documents accounted for?
Comments: _____
_____
_____

Yes _____ No _____ 17. Have any documents been voided or destroyed?
Comments: _____
_____
_____

13.0 PREVENTIVE MAINTENANCE

13.1 Field Maintenance

The Minicam (FM-3000), the HNu DL-101, and the O_2/LEL meter are to be used in site characterization and will be maintained as described by the manufacturer's instructions. The pH and specific conductance meters to be used during sampling will be maintained according to Appendix A, Field Water Quality Instruments.

13.2 Laboratory Maintenance

Preventive maintenance is an organized program of actions to prevent instruments and equipment from failing during use and to maintain proper performance of equipment and instruments. A comprehensive preventive maintenance program is implemented to increase the reliability of the measurement system. The preventive maintenance program addresses the following:

- Schedules of important preventive maintenance tasks that are carried out to minimize downtime; and

- Lists of critical spare parts that are available to minimize downtime.

The laboratory maintains histories, in instrument/equipment logs, of all major equipment. Trouble shooting, maintenance, and spare parts inventory are recorded in the logs. Instruments and equipment are maintained periodically in accordance with procedures described in individual analytical methods, manufacturer's recommendation, and/or service contracts.

The modern analytical laboratory depends heavily upon instrumentation and equipment; therefore, cleaning and preventive maintenance are primary considerations in the sustained production of satisfactory data. Specific requirements for proper care of laboratory instrumentation and equipment are contained in the manufacturer's instructions; however, some general guidelines are considered, and are listed below.

- Special precautions are taken to avoid spillage of corrosive chemicals on or around equipment and instrumentation not only to extend the life of the item, but also to eliminate contamination.

- Where available, covers are placed on instrumentation when not in use.

- Instrument parts are cleaned as required (i.e., mirrors, probes, detector cells).

14.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

14.1 Overall Project Assessment

Overall data quality will be assessed by a thorough understanding of the data quality objectives which are stated during the design phase of the investigation. By maintaining thorough documentation of all decisions made during each phase of sampling, performing field and laboratory audits, thoroughly reviewing the analytical data as they are generated by the laboratory, and providing appropriate feedback as problems arise in the field or at the laboratory, data accuracy, precision, and completeness will be closely monitored.

14.2 Field Quality Assessment

To assure that all field data are collected accurately and correctly, specific written instructions will be issued to all personnel involved in field data acquisition by the Project Manager. The Project Manager will perform field audit(s) during the investigation to document that the appropriate procedures are being followed with respect to sample and blank collection. These audits will include a thorough review of the field books used by the project personnel to insure that all tasks were performed as specified in the instructions. The field audits will necessarily enable the data quality to be assessed with regard to the field operations.

The evaluation, or data review, of field blanks, and other field QC samples will provide definitive indications of the data quality. If a problem that can be isolated arises, corrective actions can be instituted for future field efforts.

14.3 Laboratory Data Quality Assessment

As part of the analytical QA/QC program, the laboratory applies precision and accuracy criteria for each parameter that is analyzed. When analysis of a sample set is completed, QC data generated are reviewed and evaluated to ensure acceptance criteria are met. These criteria are method and matrix specific.

QA/QC data review is based on the following criteria:

- Method Blank Evaluation - The method blank results are evaluated for high readings characteristic of background contamination. If high blank values are

observed, laboratory glassware and reagents are checked for contamination and the analysis of future samples halted until the system can be brought under control. A high background is defined as a background value sufficient to result in a difference in the sample values, if not corrected, greater than or equal to the smallest significant digit known to be valid. A method blank must contain no greater than two times the parameter detection limit for most parameters.

- Trip Blank Evaluation - Trip blank results are evaluated for high readings similar to the method blanks described above. If high trip blank readings are encountered (i.e. a value sufficient to result in a difference in sample values, if not corrected, greater than or equal to the smallest significant digit known to be valid), procedures for sample collection, shipment, and laboratory analysis are reviewed. If both the method and the trip blanks exhibit significant background contamination, the source of contamination is probably within the laboratory. Ambient air in the laboratory and reagents are checked as possible sources of contamination.

- Standard Calibration Curve Verification - The calibration curve or midpoint calibration standard, which is a check standard, is evaluated daily to determine curve linearity through its full range and that sample values are within the range defined by the low and high standards. If the curve is not linear, sample values are corrected. If average response factors are used to calculate sample concentrations, these factors are verified on a daily basis. Verification of calibration curves and response factors is accomplished when the evaluated response for any parameter varies from the calibrated response by less than ranges specified in Section 8.0.

- Duplicate Sample Analyses - Duplicate sample analyses are used to determine the precision of the analytical method for the sample matrix. Two types of duplicate samples are analyzed for this project, field, and interlaboratory. Duplicate results are used to calculate precision as defined by the RPD. If interlaboratory duplicate values exceeds the control limit, the sample set are reanalyzed for the parameter in question. Precision limits are updated periodically following review of data.

- Reference Sample Analyses - The results of reference sample analysis are compared with true values, and the percent recovery of the reference sample is calculated. If correction is required (i.e., excessive or inadequate percent recovery), the reference sample is reanalyzed to demonstrate that the corrective action has been successful.

- Surrogate Standard Analyses - Surrogate standard determinations are performed on all samples and blanks for GC/MS analyses. All samples and blanks are fortified with surrogate spiking compounds before purging or extraction to monitor preparation and analysis of samples. Recoveries must meet specific criteria. If acceptance criteria are not met, corrective action is taken to correct the problem and the affected sample is reanalyzed.

- Matrix Spike Analyses - The observed recovery of spike versus theoretical spike recovery is used to calculate accuracy as defined by the percent recovery. If the accuracy value exceeds the control limit for the given parameter, the appropriate laboratory personnel notified and corrective action is taken before the sample set is reanalyzed for the parameter in question.

For completeness, it is expected that the methodology proposed for chemical characterization of the samples will meet QC acceptance criteria for at least 95 percent of all sample data. To ensure this completeness goal, sample data that does not meet the established criteria will be recollected, reextracted, or reanalyzed.

Data representativeness will be ensured through the use of appropriate analytical procedures, and analysis of samples performed within the allowed holding times.

Comparability is a qualitative characteristic of the data. By using standard methods for sampling and analyses, data generated in past or future investigations will be comparable with this investigation data.

14.4 Laboratory Data Validation

Review of analyses will be performed. A preliminary review will be performed by the project manager to verify all necessary paperwork (e.g., chain-of-custodies, traffic reports, analytical reports, and laboratory personnel signatures) and deliverables are present. A detailed quality

assurance review will be performed by a data validation subcontractor to verify the qualitative and quantitative reliability of the data presented. This review will include a detailed review and interpretation of all data generated by the laboratory. The primary tools which will be used by experienced data validation personnel will be guidance documents, established criteria, and professional judgment.

A quality assurance report stating the qualitative and quantitative reliability of the analytical data will be prepared for NEESA. This report will consist of a general introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to be best utilized. The report will reference NEESA 20.2-047B for applicable guidance, format, and standards.

During the data review, a data support documentation package will be prepared which will provide the back-up information that will accompany all qualifying statements present in the quality assurance review.

15.0 CORRECTIVE ACTION

Corrective action is taken whenever a nonconformance occurs. A nonconformance is defined as an event which is beyond the limits established for a particular operation by the plan. Nonconformances can occur in a number of activities. Such activities include sampling procedures, sample receipt, sample storage, sample analysis, data reporting, and computations.

The following personnel are responsible for detecting and reporting nonconformances:

- Project Staff - during testing and preparation and verification of numerical analyses; and

- Laboratory Staff - during the preparation for analyses, performance of analytical procedures, calibration of equipment, and quality control activities.

15.1 Corrective Action

Nonconformances are documented by the person originating or identifying it. Documentation includes the following:

- Identification of the individual(s) originating or identifying the nonconformance;

- Description of the nonconformance;

- Any required approval signatures or initials;

- Corrective action taken; and

- Corrective action completion date.

The NEESA contract representative (NCR), along with the contract project director. will be notified of a nonconformance and corrective action taken, if one of the following is true:

- A nonconformance causes a delay in work beyond the schedule completion date;

- A nonconformance affects information already reported; and

- A nonconformance affects the validity of the data.

15.2 Limits of Operation

The limits of operation that are used to identify nonconformances are established by the contents of the plan and by control limits produced by statistical analyses.

16.0 QUALITY ASSURANCE REPORTING PROCEDURES

The Project Manager will be responsible for assessing the performance of measurement systems and data quality related to the field investigation. A written record will be maintained of: the results of laboratory QC reports and other periodic assessments of measurement, data accuracy, precision, and completeness; performance and system audits; and any significant QA problems and recommended solutions. Each deliverable will contain a QA/QC assessment section. Also, a QA/QC assessment will be performed any time a significant problem is identified.

The Activity Coordinator and the Project Manager will keep in contact with the Navy Technical Representative through informal, verbal reports during the project as well as through monthly progress reports.

APPENDIX A

FIELD WATER QUALITY INSTRUMENTS

APPENDIX A

FIELD WATER QUALITY INSTRUMENTS

A. Calibration and Preventive Maintenance

Activity Before Site Visit

Field meters to be used during sampling, specifically the pH and specific conductance/thermistor meters will be checked against the contractor laboratory meters to insure proper calibration and precision response. Thermometers will be checked against a precision thermometer certified by the National Bureau of Standards. These activities will be performed by the contractor laboratory manager. In addition, buffer solutions and standard KCl solutions to be used to field calibrate the pH and conductivity meters will be laboratory tested to insure accuracy. The preparation date of standard solutions will be clearly marked on each of the containers to be taken into the field. A log which documents problems experienced with the instrument, corrective measures taken, battery replacement dates, when used and by whom for each meter and thermometer will be maintained by the contractor's laboratory manager. Appropriate new batteries will be purchased and kept with the meters to facilitate immediate replacement, when necessary in the field.

All equipment to be utilized during the field sampling will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manuals and the instructions with each instrument to ensure that all maintenance items are being observed. A spare electrode will be sent with each pH meter that is to be used for field measurements. Two thermometers will be sent to each field site where measurement of temperature is required, including those sites where a specific conductance/thermistor meter is required.

Activity at Site

The pH meter must be calibrated a minimum of twice each day using at least two different pH buffer solutions expected to bracket the pH range of field samples. Rinse the probe thoroughly between buffer measurements with distilled water and again after calibration is completed. Record in the field log book what buffer solutions were used. When the meter is moved, check pH reading by measuring the pH value of the buffer solution closest to the expected range of the sample. If the reading deviates from the known value by more than 0.1 standard units,

recalibrate the instrument as described above. If unacceptable deviations still occur, consult the operating manual for remedial course of action.

The specific conductance/thermistor meter is less likely to exhibit random fluctuations and will only require daily checks against a known KCl solution, which should be chosen to be within the expected conductivity range. Note that specific conductance is temperature-dependent and, therefore, the meter readings must be adjusted to reflect the temperature of the standard solution. Thoroughly rinse the probe with distilled water after immersing in KCl standard solution. In addition to daily checks of the conductivity readings, the thermistor readings must also be checked daily. This is accomplished by taking a temperature reading of the KCl standard solution with both the conductivity probe and a mercury thermometer.

Before use, visually inspect the thermometer to assure there is no break in the mercury column. If there is a break, visually inspect the spare thermometer. If both thermometers have a break in the mercury, neither can be used until the break is corrected. This may be done by cooling the bulb until the mercury is all contained in the bulb.

B. Analytical Methods

All field measurements will be obtained in accordance with "Handbook for Sampling and Sample Preservation of Water and Wastewater," EPA-600/4-82-029, September 1982 or "Test Methods for Evaluating Solid Wastes," SW-846, November 1986. The quality assurance procedures for field analysis and equipment are detailed in these documents cited.