FINAL

REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
SAMPLING AND ANALYSIS PLAN
FOR OPERABLE UNIT NO. 1
(SITES 78, 21, AND 24)

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

MARCH 11, 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. 1 (Site 78 - Hadnot Point Industrial Area, Site 21 - Transformer Storage Lot 140, and Site 24 - Industrial Area Fly Ash Dump) at Marine Corps Base (MCB), Camp Lejeune, Jacksonville, North Carolina.

SECTION I

FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY FIELD SAMPLING AND ANALYSIS PLAN FOR OPERABLE UNIT NO. 1 (SITES 78, 21, AND 24) MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Standards Testing Methods
Baker	Baker Environmental, Inc.
bgs	below ground surface
bls	below land surface
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLEJ	Camp Lejuene
CLP	Contract Laboratory Program
COD	chemical oxygen demand
CS	Characterization Study
1,2-DCE	1,2-Dichloroethene
DO	dissolved oxygen
DoN	Department of the Navy
DOT	Department of Transportation
DQOs	data quality objectives
D	duplicate
ECBSOPQAM	Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual
ECD	electron capture detector
ER	equipment rinseate
ESE	Environmental Science and Engineering, Inc.
EPA	United States Environmental Protection Agency
FB	field blank
FID	flame ionization detector
FSAP	Field Sampling and Analysis Plan
FFA	Federal Facilities Agreement
FMF	Fleet Marine Force
ft	feet
ft/ft	foot per foot
GC	gas chromatograph
HPIA	Hadnot Point Industrial Area
IAS	Initial Assessment Study
IDW	investigative derived wastes
IRP	Installation Restoration Program

LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LANTNAVFACENGCOM	Atlantic Division, Naval Facilities Engineering Command
GW	groundwater
MCAS	Marine Corp Air Station
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MEK	methyl ethyl ketone
MeOH	methanol
MS/MSD	matrix spike/matrix spike duplicate
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants Program
N.C. DEHNR	North Carolina Department of Environment, Health and Natural Resources
NCWQS	North Carolina Water Quality Standards
NEESA	Naval Energy and Environmental Support Activity
NTU	net turbidity units
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
NWI	National Wetlands Inventory
OU	Operable Unit
PAHs	polynuclear aromatic hydrocarbons
PA/SI	Preliminary Assessments/Site Investigations
PB	preservative blank
PCBs	polychlorinated biphenyls
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PVC	polyvinylchloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SA,SC	surface water classifications, North Carolina
SCS	Supplemental Characterization Study
SB	soil boring
SD	sediment
SW	surface water
TAL	Target Analyte List
TB	trip blank
TBC	to be considered
TC	thermal conductivity
TCE	trichloroethylene

TCL	Target Compound List
TCLP	toxicity characteristic leachate procedure
TDS	total dissolved solids
TP	test pit
TRC	Tracer Reseach Corporation
TSS	total suspended solids
TVS	total volatile solids
TOC	total organic carbon
TPH	total petroleum hydrocarbons
µg/L	micrograms per liter
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	underground storage tank
VOA	volatile organic analyses
VOCs	volatile organic compounds
WT	waste

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) effective November 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (N.C.DEHNR), and the United States Department of the Navy (DoN) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune.

The scope of the FFA included the implementation of a remedial investigation/feasibility study (RI/FS) at 23 sites throughout MCB Camp Lejeune. An RI/FS Work Plan has been prepared for three of the 23 sites: Site 78 (Hadnot Point Industrial Area); Site 21 (Transformer Storage Lot 140); and, Site 24 (Industrial Area Fly Ash Dump). Collectively these sites are identified as Operable Unit No. 1.

This Field Sampling and Analysis Plan (FSAP) describes the proposed RI field activities that are to be conducted at Operable Unit No. 1: Site 78 (Hadnot Point Industrial Area); Site 21 (Transformer Storage Lot 140); and, Site 24 (Industrial Area Fly Ash Dump) at the Marine Corps Base, 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 RI/FS Work Plan for Operable Unit No. 1 (Baker, 1992). The guidance also helps to ensure that sampling and data collection activities are carried out in accordance with EPA 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 identifies the Data Quality Objectives (DQOs) for each of the field sampling programs described in the RI/FS Work Plan (Baker, 1992). The media, number and types of samples, and the frequency of sampling are discussed in Section 3.0 (Sampling Locations and Frequency). Section 4.0 (Sample Designation) describes the sample numbering scheme to be followed for identifying and tracking the samples. The investigative procedures (e.g., drilling, groundwater sampling, decontamination, etc.) are presented in Section 5.0 (Investigative Procedures). Sample handling and analysis is described in Section 6.0 (Sample Handling and Analysis). Section 7.0 (Site Management) focuses on the organization and responsibilities of personnel associated with the field sampling events.

In addition, background documents associated with Operable Unit No. 1 have been summarized in the RI/FS Work Plan that is associated with this document.

1.1 Site Description and Setting

This section briefly describes the description and setting of Operable Unit No. 1. A more detailed description of each site is provided in Section 2.0 in the RI/FS Work Plan associated with this document.

1.1.1 Marine Corps Base Camp Lejeune

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

1.1.1.1 Location and Setting

MCB Camp Lejeune is located within the coastal plain in Onslow County, North Carolina. The facility covers approximately 170 square miles and is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean. The eastern border of Camp Lejeune is the Atlantic shoreline. The western and northwestern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders 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 April 1941 at Hadnot Point, where the major functions of the base are centered. Development at the 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. Marine

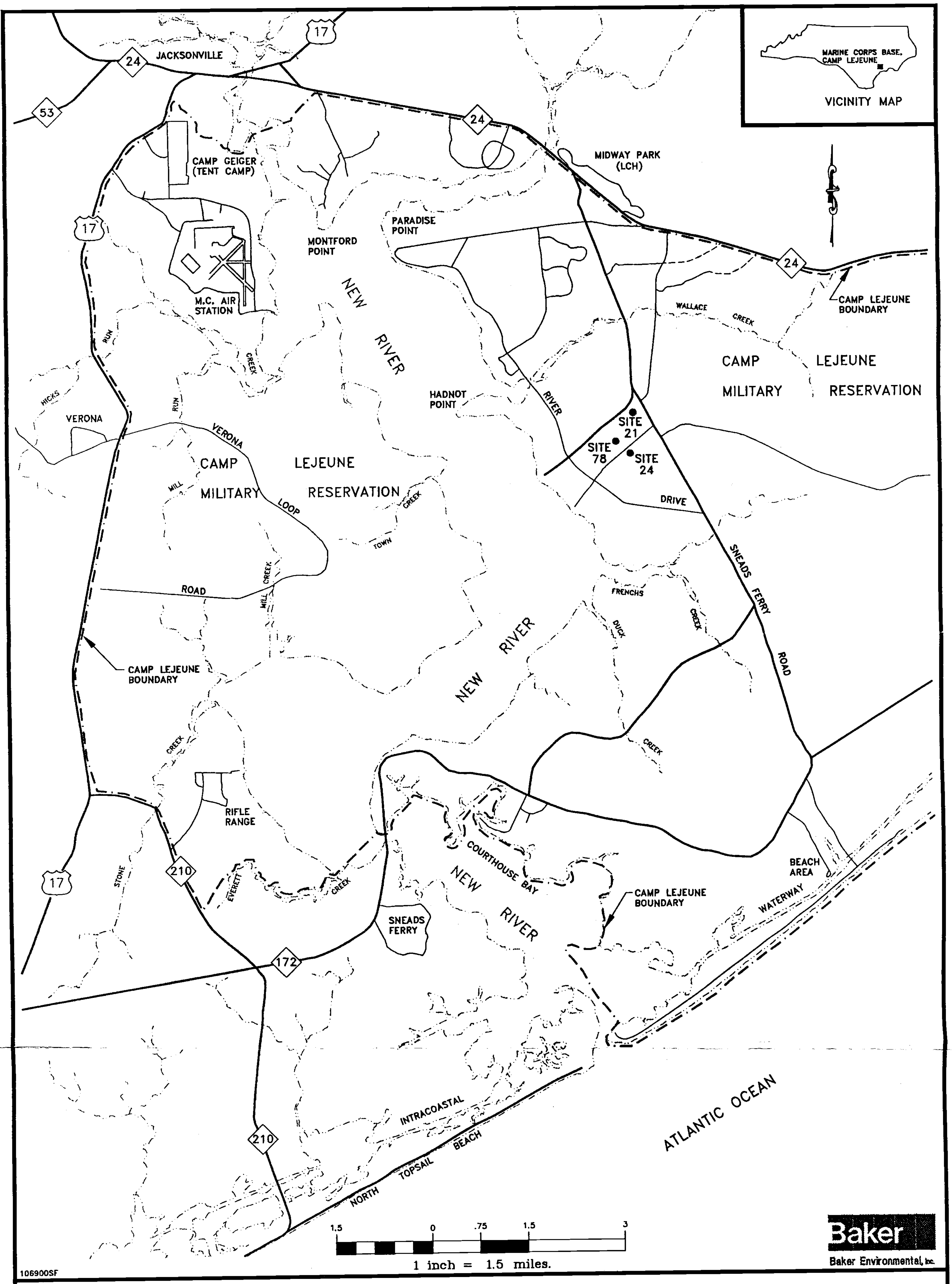


FIGURE 1-1
LOCATION MAP
SITES 78, 21 AND 24

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

Corps Air Station (MCAS) New River, a helicopter base, is a separate command on the west side of the New River (WAR, 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 Camp Lejeune is between 20 and 40 feet above msl (WAR, 1983).

Drainage at Camp Lejeune is generally toward the New River, except for areas near the coast, which drain into the Atlantic Ocean via the Intracoastal Waterway. In developed areas, natural drainage has been altered by asphalt, storm sewers, and drainage ditches.

1.1.1.4 Regional Geology

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

1.1.1.5 Regional Hydrogeology

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

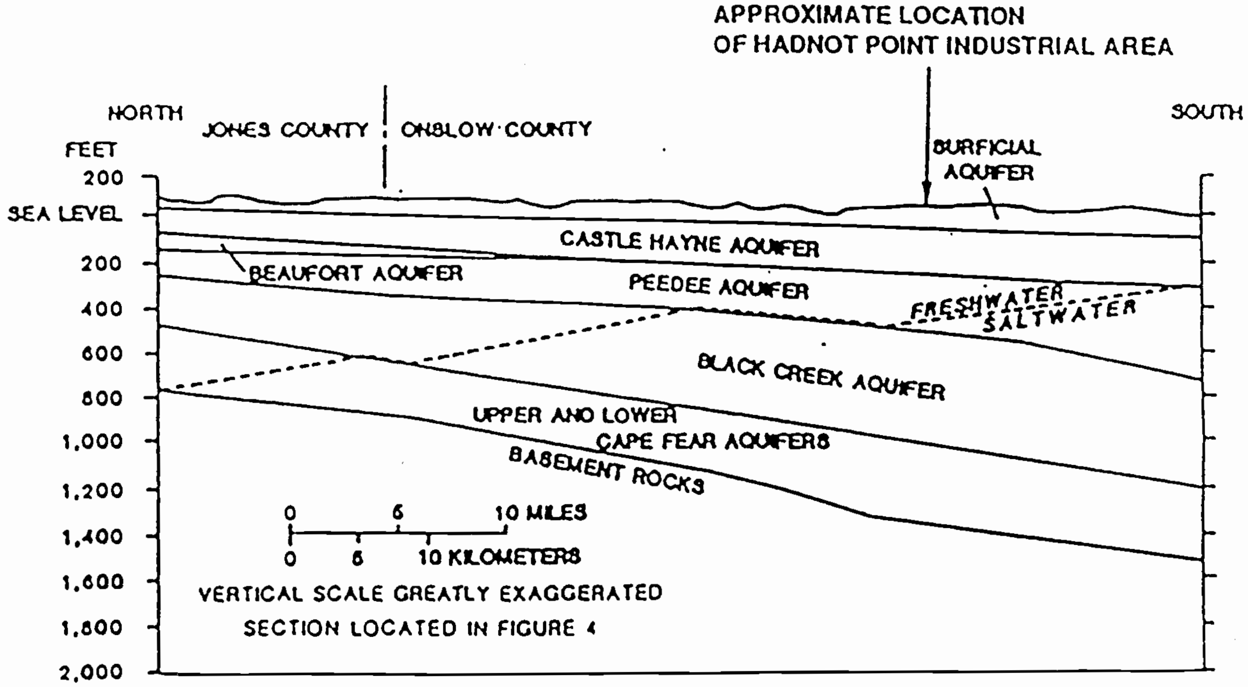
TABLE 1-1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA

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

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

Source: USGS, 1989



SOURCE: ESE, 1991

Baker
Baker Environmental, Inc.

FIGURE 1-2
GENERALIZED HYDROGEOLOGIC CROSS-SECTION
JONES AND ONSLOW COUNTIES, NORTH CAROLINA

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

The surficial aquifer is a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. No laterally extensive clay confining units have been encountered in this interval during previous subsurface investigations. This unit is not used for water supply in this part of the Base. The principal water supply aquifer for the Base is the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is known as the Castle Hayne aquifer. The Castle Hayne aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina (USGS, 1989). Previous investigations in this area indicate that the Castle Hayne aquifer and the surficial aquifer are in hydraulic communication with one another.

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

Water levels in wells tapping the surficial aquifer vary seasonally. The surficial aquifer receives more recharge in the winter than in the summer when much of the 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 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 that is not drained by the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is connected to the Atlantic Ocean by Bear Inlet, Brown's Inlet, and the New River Inlet. (WAR , 1983).

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

Hadnot Point area. The rest of the New River at MCB Camp Lejeune falls into the SA classification (ESE, 1992).

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°F to 53°F in the winter (i.e., January) and 71°F to 88°F in the summer (i.e., July). Winds are generally south-southwesterly in the summer and north-northwesterly in the winter (WAR , 1983).

1.1.1.8 Natural Resources and Ecological Features

The Camp Lejeune complex is predominantly tree-covered, with large amounts of softwood (shortleaf, longleaf, pond, and primarily lloblolly pines) and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of Camp Lejeune are under forestry management. 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 (WAR, 1983).

Aquatic ecosystems on MCB Camp Lejeune consist of small lakes, the New River estuary, numerous tributaries, creeks, and part of the Intracoastal Waterway. A wide variety of freshwater and saltwater fish species exist here. Freshwater ponds are under management to produce optimum yields and ensure continued harvest of desirable fish species (War , 1983).

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: pond pine or pocosin; sweet gum/water oak/cypress and tupelo; sweet bay/swamp black gum and red maple; tidal marshes; and coastal beaches (WAR, 1983).

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

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

1.1.1.9 Land Use

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

1.1.1.10 Water Supply

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

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

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

As shown on Figure 1-3, there are eight potable water supply wells located within or nearby Operable Unit No. 1. The depths of these wells range from 160 to 225 feet. They are screened in intervals ranging from 45 feet to 225 feet. Pertinent well information for these eight supply wells are summarized on Table 1-2.

1.1.2 Site 78 - Hadnot Point Industrial Area

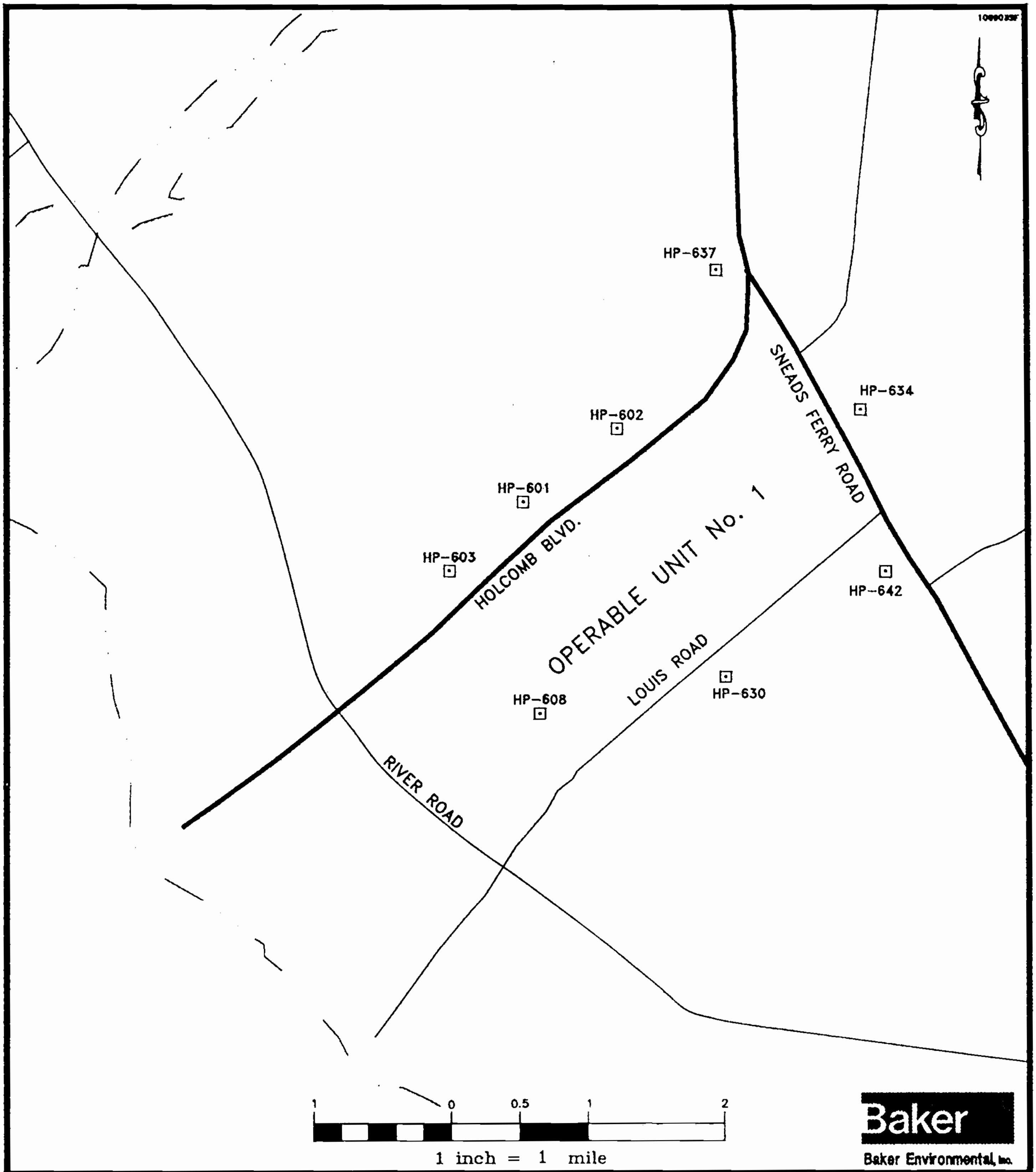
This section addresses the background and setting of Site 78 - the Hadnot Point Industrial Area (HPIA). The soil, surface water/sediment and groundwater throughout the HPIA has been impacted by various activities (sources) throughout the site. Based on review of existing information, the following are areas of concern (potential source areas) within the HPIA:

- Building 903 - Underground Storage Tanks (USTs)
- Buildings 1502 and 1601 - USTs
- Building 1300 - Polychlorinated biphenyls (PCBs)/Pesticides
- Buildings 1103 and 1601 - Pesticide contamination
- Buildings northeast of Louis Road - Various activities (e.g., USTs, solvent usage)
- Buildings southeast of Louis Road - Various activities (e.g., USTs, solvent usage)
- Buildings along Michael Road - Various activities (e.g., USTs, solvent usage)

1.1.2.1 Site Location and Settings

HPIA is defined as the area bounded by Holcomb Boulevard (to the west), Sneads Ferry Road (to the north), Duncan Street (to the east), and the Main Service Road (to the south). HPIA is comprised of light industry and residential areas. Much of the area is paved (e.g., roadways, parking lots, loading dock areas, storage lots); however, there are many lawns associated with the individual buildings at HPIA and along stretches of roadways. In addition, there are many areas of open unpaved lots and wooded areas. The site map for Site 78 is presented on Figure 1-4.

Building 903 is located in the northern section of HPIA. The building is bordered by Sneads Ferry Road on the northeast, Building 902 to the northwest, Building 901 to the west. Most of



LEGEND

HP-608 ⊡ POTABLE WATER SUPPLY WELL

FIGURE 1-3
LOCATION OF NEARBY POTABLE WATER SUPPLY WELLS
OPERABLE UNIT No. 1

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

TABLE 1-2

SUMMARY OF POTABLE WATER SUPPLY WELL INFORMATION

Supply Well Number	Well Depth (feet)	Screened Intervals (feet)	Well Diameter (inches)
HP-601	195	45-60 95-100 115-130 175-195	8
HP-602	160	70-80 100-105 120-125 145-150 155-160	8
HP-603	195	70-80 100-110 130-140 160-170 190-195	8
HP-608	161.5	61.5-81.5 91.5-101.5 121.5-131.5 151.5-161.5	8
HP-630	176	62-67 87-92 107-117 127-142 152-162	8
HP-634	225	65-70 73-78 83-88 93-98 107-117 124-129 135-140 153-163 170-175 195-200 215-225	8
HP-637	172	90-98 102-114 120-128 140-148 156-172	8
HP-642	210	112-124 136-144 157-163 174-178 188-196	8

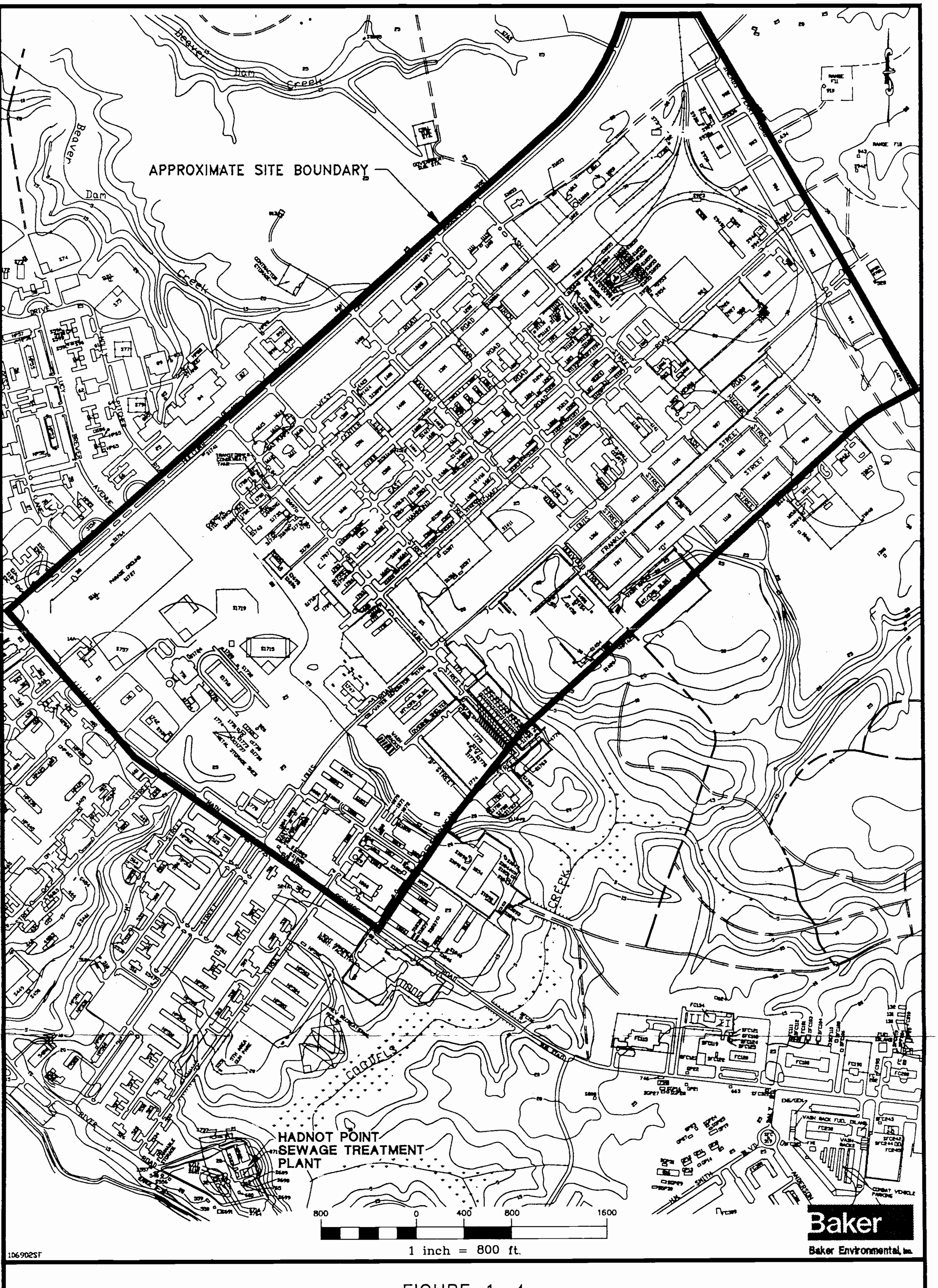


FIGURE 1-4
SITE MAP
SITE 78-HPIA

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, FEBRUARY 1992

the area associated with Building 903 is paved, except for a grassy area on the northern side of the building (the grassy area extends approximately 40 feet from the building).

Building 1103 is located on the corner of Birch Street and East Road. The areas on all sides of the building are lawns which extend approximately 40 feet from the building. The areas beyond the grassy areas are paved parking areas and roads.

Building 1300 is located on the corner of Center Street and Cedar Road. The entire lot surrounding the building is paved, except for small portions of the northeast and southwest areas adjacent to the building which are grass covered. These areas extend approximately 30 feet from the building.

Building 1502 is located on the corner of Elm Street and East Road. Building 1601 is located adjacent to Building 1502. The areas on all sides of the buildings are lawns which extend approximately 40 feet from the buildings. Beyond these grassy areas are paved parking areas and roads on all sides of the buildings, except for the northern side of Building 1502 where there is a paved working and parking area.

In addition to the described areas of concern, there are several buildings to the northeast and southeast of Louis Road and along Michael Road that, according to records of past practices, may represent possible contaminant source areas and may require investigation. These buildings can be described as being located in the same type of setting as the other areas of concern identified in the HPIA (i.e., light industry and residential areas).

1.1.2.2 Site Topography and Drainage

The site is situated at an elevation of approximately 5 feet above mean sea level (msl). The land is primarily flat, but dips sharply at the very edge of the property to the shoreline of the New River. Overland drainage is unlikely over most of the site due to the flat topography. Drainage along the edge of the property, beginning where saplings and brush border the banks of the New River, is toward the New River. Most surface water drainage is through a system of storm sewers.

No wetland areas were identified at Site 78, based on a review of National Wetlands Inventory (NWI) maps.

1.1.2.3 Site History

Base personnel have indicated that degreasing operations occurred in the vicinity of Building 903. Additionally, the Initial Assessment Study (IAS) identified the presence of an empty 440-gallon underground tank at Building 901. This tank formerly had been used for the storage of TCE used to degrease engines; however, during the recent Weston Geophysical field survey in 1992 this tank could not be located, and therefore Building 901 will not receive any further investigation. Another UST was located adjacent to the northern side of Building 903. The tank has been reported as being either empty or filled with sand.

The area encompassed by Buildings 1502 and 1601 has been used as a vehicle maintenance and repair facility since initial construction (circa 1943). The IAS identified the presence of an underground trichloroethylene (TCE) storage tank at Building 1601, however, during the geophysical survey by Weston Geophysical this tank was not located. The geophysical survey has determined that there are probably two areas (both located in the southeastern lawn areas of the building) in which tanks were formally located, but appear to have been removed. In addition, Building 1502 appears to have two tanks located in the southeastern lawn of the building. Another UST that is currently inactive, but in place, is located on the west side of the building. The Characterization Study records search documented heavy solvent and petroleum, oil, and lubricant (POL) usage in this area.

Building 1300 is currently used as a cold storage facility and contains a maintenance shop. It was included in the original investigation as a separate potential source of contamination; however, no further background information concerning the history of this area is available. PCBs and pesticides have been detected on this site.

Buildings 1103 and 1601 are suspected potential areas of concern due to the presence of a grease rack at Building 1103, and to the probable presence of an inactive UST at Building 1601. In addition, pesticides have been detected in soils associated with these areas. No further background information concerning the history of this area is available.

The buildings northeast and southeast of Louis Road and along Michael Road, according to records of past practices and aerial photographs, may have many areas of concern, e.g., inactive USTs, past/present solvent usage, POL usage and other practices which may have included use of hazardous chemicals.

1.1.2.4 Site Geology and Hydrogeology

Site specific geologic information is limited to information obtained during the installation of monitoring wells. Twenty seven (27) shallow (25 ft.) monitoring wells, seven (7) intermediate (50 ft.) monitoring wells and six (6) deep (100+ ft.) monitoring wells have been installed at HPIA.

The subsurface at HPIA is composed primarily of unconsolidated sand, silt and clay. A geologic cross-section, generated from lithologic information obtained during previous investigations is presented in Figure 1-5. No laterally continuous clay confining units have been encountered in the HPIA subsurface. It is thus expected that the shallow (25 ft.) and deeper (100+ ft.) portions of the aquifer are in hydraulic communications.

Based on water level measurements from the numerous monitoring wells at the HPIA, groundwater flow is generally to the southwest, toward the New River. Table 1-3 presents water elevation measurements collected on January 25, 1991 and February 20, 1991 from 42 monitoring wells. Well information (depth, size, screened interval) is also listed on this Table. Some groundwater mounding occurs in the southern part of the site. This may be the result of variations in groundwater recharge throughout the site due to urban features (buildings, parking lots, storm drains).

1.1.3 Site 21 - Transformer Storage Lot 140

This section addresses the background and setting of Site 21 - Transformer Storage Lot 140.

1.1.3.1 Site Location and Setting

Site 21 is located in the northwest section of Site 78 (HPIA). It is bordered by Ash Street to the southwest, Center Road to the southeast and a wooded area to the northwest A dirt road surrounds most of the site. Site 21 is basically an open lot. The southern portion of the site (approximately 220 feet by 900 feet) has several fenced in areas, while the northern section (approximately 500 feet long) is an open area. The lot consists of grassy, gravel-covered and concreted areas. The site map for Site 21 is presented on Figure 1-6.

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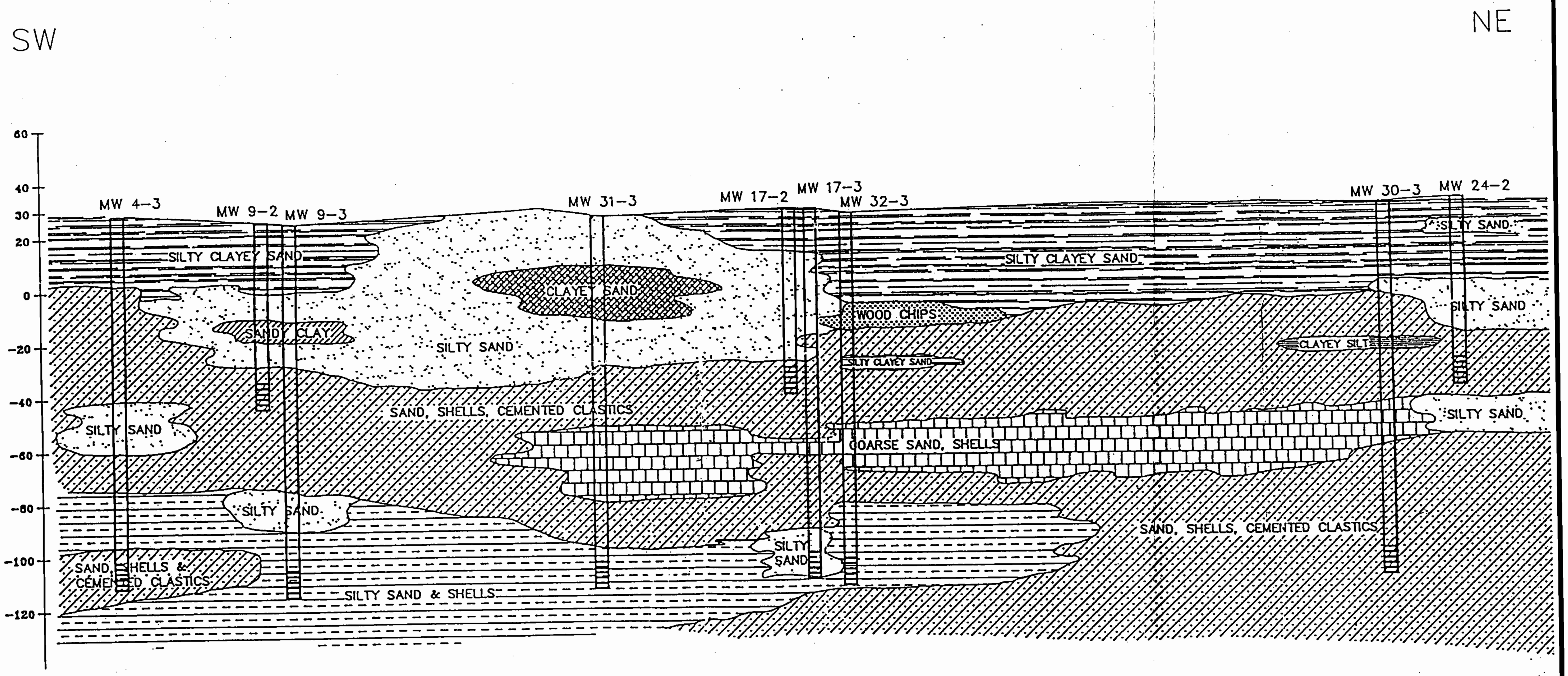


Baker Environmental, Inc.

SOURCE: ESE, 1992

400 0 200 400 800

1 inch = 400 ft.

HORIZONTAL SCALE

40 0 20 40 80

1 inch = 40 ft.

VERTICAL SCALE

FIGURE 1-5
GENERALIZED CROSS SECTION
HADNOT POINT INDUSTRIAL AREA

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

TABLE 1-3

SITE 78 MONITORING WELL INFORMATION AND MEASURED WATER LEVELS

Well I.D.	Well Depth (feet)	Screened Intervals (feet)	Well Diameter (inches)	Water Elevation (MSL)	
				1/25/91	2/20/91
HPGW1	25	5-25	2	NM	8.57
HPGW2	20	5-20	2	25.56	24.08
HPGW3	25	5-25	2	9.68	11.81
HPGW4	24.5	4.5-24.5	2	8.48	8.91
HPGW4-2	78	65-78	4	8.68	9.09
HPGW4-3	153	140-153	4	NM	9.09
HPGW5	25	5-25	2	14.47	15.15
HPGW6	25	5-25	2	9.32	10.41
HPGW7	25	5-25	2	11.08	11.42
HPGW8	25	5-25	2	12.63	13.09
HPGW9	25	5-25	2	NM	11.52
HPGW9-2	75	55-75	2	10.03	10.55
HPGW9-3	150	130-150	2	NM	10.94
HPGW10	25	5-25	2	13.39	13.47
HPGW11	25	5-25	2	11.97	12.55
HPGW12	25	5-25	2	16.31	16.43
HPGW13	25	5-25	2	11.83	12.18
HPGW14	25	5-25	2	13.68	14.10
HPGW15	25	5-25	2	NM	15.47
HPGW16	25	5-25	2	17.99	18.27
HPGW17	25	5-25	2	16.11	16.49
HPGW17-2	73	53-73	2	15.63	16.10
HPGW19	25	5-25	2	19.33	19.06
HPGW20	25	5-25	2	14.52	14.65
HPGW21	25	5-25	2	19.41	21.07
HPGW22	25	5-25	2	NM	22.23
HPGW23	25	5-25	2	NM	19.35
HPGW24	25	5-25	2	23.77	23.97
HPGW24-2	76.5	56.5-76.5	2	16.00	16.26
HPGW24-3	148	128-148	2	18.38	19.31
HPGW25	25	5-25	2	22.28	23.01
HPGW26	25	5-25	2	NM	22.73
HPGW29	25	5-25	2	NM	6.46
HPGW30-2	78	65-78	4	16.45	17.34
HPGW30-3	153	140-153	4	16.30	16.83
HPGW31-2	78	65-78	4	13.06	13.53
HPGW31-3	153	140-153	4	13.12	13.46
HPGW32-2	77	64-77	4	15.16	15.59
HPGW32-3	153	140-153	4	14.69	15.31
21GW1	NA	NA	NA	NM	18.68
22GW1	NA	NA	NA	19.83	20.65
22GW2	NA	NA	NA	19.08	18.91

NOTES:
MSL = Mean Sea Level
NM = Not Measured
NA = Information is Not Available

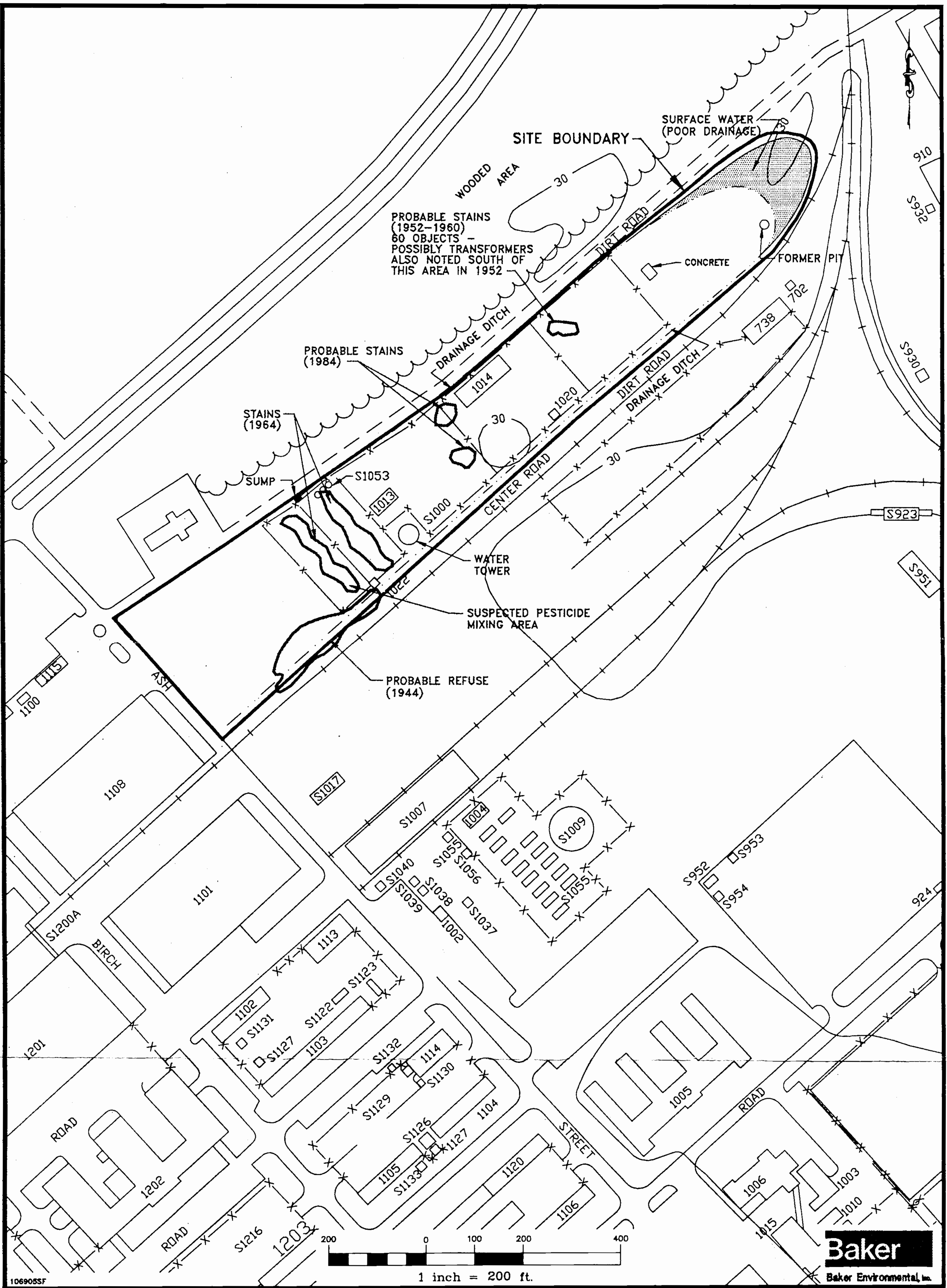


FIGURE 1-6
SITE MAP
SITE 21

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, FEBRUARY 1992

1.1.3.2 Site Topography and Drainage

The land within Site 21 is flat (approximately 25 to 30 feet above msl) and is unpaved except for a few concreted areas. Ditches which lie on all sides of the site collect surface drainage. Previous reports have indicated that these drainage ditches flow towards Bearhead Creek (ESE, 1990). However, based on the site visit performed by Baker, this does not appear to be the case, the water drainage from the site appeared to mound in the northeastern section of Site 21. In addition, if there was any surface water drainage, it appears it would discharge into Beaver Dam Creek. Water from the southwestern portion of the site appears to flow southwest most probably into drainage sewers associated with the area.

No wetland areas were identified at Site 21, based on a review of NWI maps.

1.1.3.3 Site History

Site 21 has a history of pesticide usage and transformer oil storage and disposal.

Lot 140 was used as a pesticide mixing area and as a cleaning area for pesticide application equipment from 1958-1977. This area was reportedly located in the southeast corner of the lot. Small spills and indiscriminate disposal of washout is believed to have occurred at this site (ESE, 1990).

A transformer oil disposal pit is located in the northeastern portion of the site. The disposal of transformer oils occurred in 1950-1951 (ESE, 1990).

1.1.3.4 Site Geology and Hydrogeology

A sequence of sandy gravel (fill material), sandy silt and sandy clay underlies the site. Note that since Site 21 is located within Site 78, the geology and hydrogeology of Site 21 should be similar to that of Site 78. The water table was measured at a depth of 9 feet. The depth quoted is based on the installation of one monitoring well (ESE, 1990).

Based on other information available for the HPIA (Site 78), it can be estimated that groundwater from Site 21 flows generally to the south.

1.1.4 Site 24 - Industrial Area Fly Ash Dump

This section addresses the background and setting of Site 24 - Industrial Area Fly Ash Dump.

1.1.4.1 Site Location and Setting

Site 24 is approximately 100 acres in size and is wooded and somewhat overgrown by vegetation. The western portion of the site is bound by Louis Road. The eastern and southern portions of the site lie adjacent to upstream tributaries of Cogdels Creek. The northern portion of the site is bounded by Dogwood, Duncan and "O" Streets. Dirt roads are interspersed throughout the site. The site consists of four types of potential disposal areas; fly ash disposal area, spiractor sludge disposal area, borrow and debris disposal areas, and buried metal disposal areas. Mounds indicating potential areas of disposal have been observed in the fly ash dump area. The site map for Site 24 is presented on Figure 1-7.

1.1.4.2 Site Topography and Drainage

Site 24 is hilly (approximately ranging between 5 to 30 feet above msl) and is unpaved. Grass covered and woody plant areas make up the ground surface. The topography at Site 24 slopes downward where site drainage is towards Cogdels Creek. Based on a review of NWI maps, the immediate areas around Cogdels Creek are identified as wetlands.

1.1.4.3 Site History

Site 24 was used for the disposal of fly ash, cinders, solvents, used paint stripping compounds, sewage sludge, and water treatment spiractor sludge from the late 1940s to 1980 (ESE, 1990). Spiractor sludge from the wastewater treatment plant and sewage sludge from the sewage treatment plant were reportedly disposed at this site since the late 1940s. Construction rubble was reportedly disposed at the site in the 1960s. During 1972 to 1979, fly ash and cinders were dumped on the ground surface, and solvents used to clean out boilers were poured onto these piles. Furniture stripping wastes were also disposed of at this area during this time period.

Previous reports have identified four separate disposal areas within the site: a spiractor sludge disposal area, a fly ash disposal area, and two borrow and debris areas. The recent geophysical survey investigation conducted at the site confirmed the general location of three of these disposal areas in addition to locating two buried metal areas (Figure 1-7). One of the

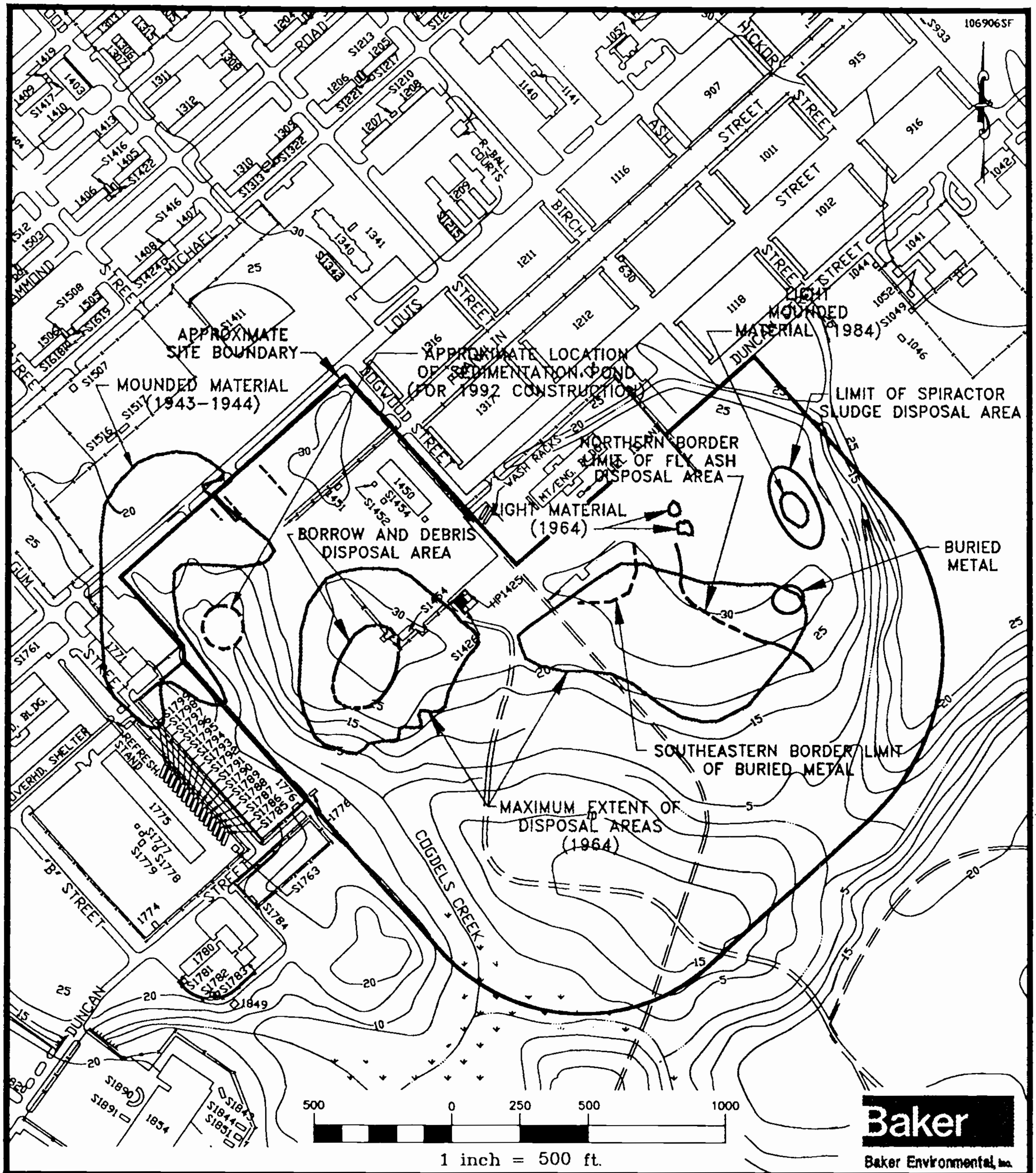


FIGURE 1-7
SITE MAP
SITE 24

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991

borrow and debris areas could not be identified. Based on a review of the EPIC aerial photographs of the site, the second borrow and debris area may have been a mound of material that was present at the site during 1943-1944. No other activities were noted in this area, so it is possible that it might not have been a disposal area.

Site 24 is not currently used for disposal of wastes. Construction activities are currently taking place within the portion of the site along Louis Road.

1.1.4.4 Site Geology and Hydrogeology

A sequence of sand and silty sand, with limited amounts of sandy gravel underlies the site. The surface of shallow groundwater ranges in depth from 2 to 10 feet below ground surface. Groundwater flow tends to be generally towards the drainage ditches in the south and southwest portions of the site (ESE, 1990).

1.2 Site Background

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

1.2.1 Site 78 - Hadnot Point Industrial Area

1.2.1.1 Types and Volumes of Waste Present

Soil, groundwater and surface water/sediment throughout HPIA have apparently been impacted by a variety of activities and sources of contamination. The total volume of waste present in the various media throughout HPIA cannot be estimated using existing environmental data for this site. Wastes present in the environmental media include volatile organic chemicals (VOCs), semivolatile organic chemicals (SVOCs), pesticides/PCBs, and inorganics.

The following subsections present a brief summary of the types and volumes of waste present at the areas of concern within HPIA identified in Section 1.1.2.

Building 903

Building 903 and associated with it are degreasing operations which have taken place in the area in the past. The soils associated with Building 903 have been found to contain various polyaromatic hydrocarbons (PAHs), trichloroethene, dichloroethane and toluene. The shallow groundwater has been found to contain various PAHs, oil and grease, carbon disulfide, benzene, ethylbenzene, toluene, xylene (BTEX), trans-1,2-dichloroethene, TCE, lead and other metals.

Based on the limited number of soil samples collected at this area, an estimation of the vertical and horizontal extent of soil contamination of this area cannot be made. Therefore, the volume of waste present at this area cannot be estimated.

Buildings 1502 and 1601

Heavily stained soils were reportedly observed in the vicinity of these buildings. Soil gas survey data indicated high levels of TCE contamination in the soils adjacent to the buildings, resulting in a high-priority classification of this location for the remainder of the investigation. As a result of the soil gas investigation, soil borings were installed in the vicinity of Building 1502, 1601, and 1602. Pesticides were found in the soil associated with Building 1601. Building 1602 had one estimated detected value for chloromethane, and since there is no indication of the presence of USTs, 1602 will no longer be investigated under this CTO.

Based on the limited number of soil samples collected at these two building areas, an estimation of the vertical and horizontal extent of soil contamination of this area cannot be made. Therefore, the volume of waste present at this area cannot be estimated.

Building 1300

No monitoring wells were installed to specifically characterize local groundwater conditions in the Building 1300 area. This building has remained an area of concern due to the detection of PCB Aroclor-1260 to a depth of 6 feet. In addition, 4,4'-DDE 4,4'-DDT, chlorobenzene and various PAHs were detected in this area.

Based on the limited number of soil samples collected in this area, an estimation of the vertical and horizontal extent of soil contamination of this area cannot be made. Therefore, the volume of waste present at this area cannot be estimated.

Buildings 1103 and 1601

Soil borings taken in the area of these buildings were sampled and laboratory results detected pesticides.

Based on the limited number of soil samples collected in this area, an estimation of the vertical and horizontal extent of soil contamination of this area cannot be made. Therefore, the volume of waste present at this area cannot be estimated.

Buildings Northeast and Southeast of Louis Road and along Michael Road

The buildings identified in the areas northeast and southeast of Louis Road and along Michael Road as potential areas of concern by Baker have not been investigated for types of wastes present. Table 1-4 presents the areas of concern within the HPIA to be investigated.

Since no soil samples have been collected in this area, an estimation of the vertical and horizontal extent of soil contamination of this area cannot be made. Therefore, the volume of waste present at this area cannot be estimated.

1.2.1.2 Potential Transport and Exposure Pathways

Based on the evaluation of existing conditions at Site 78, the following potential contaminant transport exposure pathways have been identified:

Transport Pathways

- Surface water runoff from Site 78 off site to Beaver Dam Creek, Wallace Creek, Cogdels Creek, and the New River
- Migration of soil contaminants to surface water and sediments
- Migration/leaching of soil contaminants

TABLE 1-4

AREAS OF CONCERN WITHIN THE HPIA TO BE FURTHER INVESTIGATED

Building No.	Building Type	Comments and Concerns
903	Warehouse	Identified UST
907	Warehouse	Potential active UST (hydraulic oil)
908	Paint Storage	Storage of large amounts of paint and painting chemicals
909	Equipment Shop	Wastes, solvents, oils; stressed vegetation; degreasers used
915	Warehouse	Solvent drain from wash line; stressed vegetation
916	Warehouse	Drum storage outside of building (kerosene, oil, gasoline)
926	Admin/Warehouse	Past - Kerosene tank leaked; contaminated soil removed
927	Admin/Warehouse	Past - Kerosene tank leaked; contaminated soil removed
928	Auto Maintenance/ Warehouse	Past - Kerosene tank leaked; contaminated soil removed
1011	Warehouse	No chemicals used or stored; oil tank with soil contamination
1012	Warehouse	Leaking kerosene tank; soil contamination
1103	Natural Resources	Old grease rack
1106	Wood Shop	Potential active UST (used oil); aerial photography study results
1116	AC/S Logistics	Engineers area stores caustics and other organic detergents
1117	Warehouse/Armory	Armory; solvent usage
1205	Vehicle Service	Potential inactive UST (used oil); solvent usage; waste oil; aerial photography results
1206	Vehicle Service	Service area; solvent usage; waste oil; aerial photography results
1300	Cold/Frozen Storage	Refrigeration maintenance shop; solvent storage/usage
1310	Auto Maintenance/ Equipment Storage	Potential inactive USTs; visible oil in ditch; aerial photography results
1407	MT Office/Warehouse	Past spills in wash pit; aerial photography results
1408	Warehouse/Equipment Storage	Past spills in wash pit; aerial photography results
1450	Vehicle Service	Potential active UST (diesel, used oil); solvent usage
1502	Base Maint. Motor Repair	Potential inactive USTs (No. 2 fuel/gasoline/ used oil/diesel); solvents/oils use
1505	Auto Shop	Potential inactive USTs; aerial photography results

TABLE 1-4 (Continued)

AREAS OF CONCERN WITHIN THE HPIA TO BE FURTHER INVESTIGATED

Building No.	Building Type	Comments and Concerns
1601	Maintenance	Potential inactive UST (used oil); use of chemicals highly suspected
1604	Auto Shop	Potential inactive USTs; aerial photography results
1750	Heavy Equipment Maint.	Potential inactive UST (used oil); past and present solvent usage
1755	Heavy Equipment Maint.	Potential inactive UST (used oil); past and present use of solvents
1765	Maintenance	Potential active UST (No. 2 fuel oil)
1775	Heavy Equipment Maint.	Potential active USTs (gasoline/used oil/diesel); past/present solvent usage
1780	Heavy Equipment Maint.	Potential active USTs (used oil); past/present solvent usage; waste area
1804	Storage/Maintenance	Potential active USTs (used oil); past vehicle repair; solvent usage now minimal
1808	Storage Building	Past vehicle repair - solvent use??; present - no signs of chemical usage
1810	Admin Office	Former vehicle maint. shop - past solvent use likely
1812	Not Identified	Potential inactive UST (No. 2 fuel oil)
1815	Auto Shop	Empty building; potential inactive UST (diesel fuel)
1817	Auto Shop	Previous washing area; contaminated soils
1826	Auto Shop	Old grease rack with drain to ditch; waste oil tank at grease rack
1828	Auto Shop	Waste oil tank contaminated surrounding soils
1854	Multipurpose Facility	Potential active USTs (used oil, diesel); past and present solvent usage
1841	Heavy Equipment Maint.	Potential inactive USTs (gasoline/used oil/diesel); wide use of solvents
1860	Maintenance	Potential active UST (used oil); solvent usage in garage and shop areas
1880	Heavy Equipment Maint.	Potential active USTs (used oil/diesel); large amounts of chemicals used.

- Groundwater discharge to surface water (Cogdels Creek, Beaver Dam Creek and the New River)

- Groundwater infiltration to the deeper aquifer

Exposure Pathways

- Indirect aquatic and terrestrial exposure via groundwater discharge to streams or the New River.

- Aquatic and terrestrial exposure to contaminants due to incidental sediment and soil ingestion and surface water contact

- Human exposure to contaminants due to incidental soil and sediment ingestion

- Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply)

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

- Human dermal exposure to contaminants due to future potential direct contact with soil, groundwater, or surface water

- Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife

1.2.1.3 Present Database Limitations

The purpose of this section is to define data limitations with respect either to 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 during previous investigations at the site are not available or adequately documented, (with the exception of the Pre-Scoping Sampling conducted by Baker personnel in July, 1992). Consequently, the existing data are 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.

Soil

The results of previous sampling efforts at Site 78 indicate the presence of contaminants in the soil. Contaminants detected in soil at Site 78 include: VOCs - TCE, 1,2-DCE; SVOCs - phenanthene, fluoranthene, and pyrene; pesticides/PCBs - dieldrin, heptachlor epoxide, endosulfan I, 4, 4'-DDE, 4, 4'-DDT, and Aroclor-1260.

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

The results of previous sampling efforts at Site 78 indicate the presence of contaminants in the groundwater. Contaminants detected in the shallow aquifer groundwater include: VOCs (such as TCE, 1,2-DCE, vinyl chloride), oil and grease, and various metals including lead. Analysis of samples from intermediate wells revealed some of the same contaminants (i.e., 1,2-DCE, vinyl chloride, BTEX and metals; in addition to some SVOCs (such as naphthalene, 2-methylnaphthalene, acenaphthene, and carbon disulfide). The deep aquifer was found to contain low levels of toluene, ethylbenzene, xylene, carbon disulfide, and methyl ethyl ketone.

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

Surface Water

There have not been any previous sampling efforts at Site 78 concerning surface water (Beaver Dam, Cogdels Creek and the New River) that may be impacted by contamination found at Site 78. Therefore, data will be required to adequately characterize surface water contamination, approximately delineate areas of concern, assess human health and ecological risks, evaluate the extent of soil runoff, and evaluate potential remedial technologies.

Surface Water Sediment

There have not been any previous sampling efforts at Site 78 concerning surface water sediment on site. Therefore, data will be required to adequately characterize surface water sediment contamination, approximately delineate areas of concern, assess human health and ecological risks, evaluate the extent of soil runoff, and evaluate potential remedial technologies.

Aquatic Life

No aquatic/ecological surveys will be conducted at the site unless the results from the surface water and sediment sampling indicate that the site is potentially impacting the environment. Based upon the results of the surface water/sediment investigations, the need for any aquatic/ecological surveys will be assessed in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

1.2.2 Site 21 - Transformer Storage Lot 140

1.2.2.1 Types and Volumes of Waste Present

Lot 140 was a pesticide mixing area and an equipment clean-up during the period from 1958 to 1977. It is reported that the chemicals stored in this site included diazinon, chlordane dust, lindane, 4,4'-DDT dust, malthion (46% solution), mirex, 2,4-D, silvex, dalpon and dursban. Documented overland discharge of washout from the equipment cleaning process is estimated to be a volume of 350 gallons per week (ESE, 1990). It is not clear how long this discharge of washout occurred. In addition, for a one-year period (1950-52), an on-site pit was used as a drainage receptor for transformer oils. Sand was mixed in whenever standing oil was found in the pit. The amount of oil disposed in this manner is unknown. In addition, surface discharge of transformer oils had been reported as having occurred in the past; as a result, the upper four inches of soil was sampled. One parts per million (ppm) of PCBs or less was detected (WAR, 1983); however, no information regarding sampling locations , QA/QC protocols or data results is available.

Groundwater and soil samples were collected at Site 21 in 1984 and additional samples were collected in 1986. Based on the results of these sampling events it appears that the soils and groundwater represent the affected media at this site. In 1984, oil and grease and the pesticide, 2,4-D, were detected in the groundwater, while aldrin, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT and heptachlor were detected in the soil. The most prevalent contaminants detected in the soil in the 1986 sampling event were 2,4-D, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT and PCBs (ESE, 1990).

Based on the limited number of soil samples collected at Site 21, an estimation of the vertical and horizontal extent of soil contamination at this site cannot be made. Therefore, the volume of waste present at the site cannot be estimated.

1.2.2.2 Potential Transport and Exposure Pathways

Based on the evaluation of existing conditions at Site 21, the following potential contaminant transport and exposure pathways have been identified:

Transport Pathways

- Surface soil runoff from Site 21 to drainage ditches
- Sediment migration in drainage ditch to Beaver Dam Creek
- Migration of sediment contaminants to surface water
- Migration/leaching of soil contaminants to groundwater
- Off-site groundwater migration

- Groundwater discharge to Beaver Dam Creek

- Groundwater infiltration to the deep aquifer

Exposure Pathways

- Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion and surface water contact

- Human exposure to contaminants due to incidental soil and sediment ingestion

- Potential human exposure to contaminants due to future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply)

- Human dermal exposure to contaminants due to future potential direct contact with, soil, groundwater, or surface water

- Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife

1.2.2.3 Present Database Limitations

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

Soil

The soil analyses to date indicate that contaminants are present to a depth of at least 5 feet. The interval from 5 feet below ground surface (bgs) to the groundwater table has not been investigated. The locations of previous sampling efforts and the depths at which samples were obtained are uncertain. In addition, the soil samples were only analyzed for pesticides, herbicides, PCBs, and tetrachlorodioxin.

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

Groundwater

Previous sampling efforts have detected the presence of the pesticide 2,4-D and oil and grease in groundwater; however, the quality of existing groundwater data is unknown. Additional analytical data will be required in order to more fully characterize groundwater contamination, approximately delineate plumes, assess human health and ecological risks, and evaluate remedial technologies.

Sediment

No previous sampling efforts within the ditches associated with Site 21 have been performed. In order to evaluate the source and extent of contamination and human health and ecological risks, sediment samples would need to be collected from all ditches. In addition, if Beaver Dam Creek is being affected by groundwater and/or surface water discharge from the site, sediment will need to be sampled in these areas.

Surface Water

Samples have not been previously collected from Beaver Dam Creek or from the ditches associated with the site. Therefore, sampling is required so that sufficient data is available to assess surface water quality and human health and ecological risks in Beaver Dam Creek and the ditches associated with the site.

Aquatic Life

No aquatic/ecological surveys will be conducted at the site unless the results from the surface water and sediment sampling indicate that the site is potentially impacting the environment.

The need for any aquatic/ecological surveys will be determined based on the results of the investigations in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

1.2.3 Site 24 - Industrial Area Fly Ash Dump

1.2.3.1 Types and Volumes of Waste Present

Site 24 consists of several disposal areas in which disposal occurred between the late 1940s to 1980. Groundwater and surface water/sediment were sampled in 1984 and 1986. As a result of this investigation, it appears that the affected media at Site 24 are groundwater, surface water and sediment. Arsenic, chromium, chromium^{+6}, copper, lead, nickel, selenium, zinc, benzene, chloroform and methylene chloride were detected in the groundwater at this site. The surface water was found to contain arsenic, chromium, chromium^{+6}, copper, lead, zinc, TCE, and trans-1,2-DCE. Sediment samples were found to contain arsenic, cadmium, chromium, lead, copper, nickel and zinc. (ESE, 1990).

Based on the limited number of soil samples collected at Site 24, an estimation of the vertical and horizontal extent of soil contamination at this site cannot be made. Therefore, the volume of waste present at the site cannot be estimated.

1.2.3.2 Potential Transport and Exposure Pathway

Based on the evaluation of existing conditions of Site 24, the following potential contaminant transport and exposure pathways have been identified:

Transport Pathways

- Soil contaminant runoff from the former disposal areas to off-site low-lying areas
- Migration/leaching of soil contaminants to the shallow aquifer
- Soil contaminant runoff from the site to sediments in the intermittent tributary to Cogdels Creek
- Contaminated sediment migration from the intermittent tributaries to Cogdels Creek

- Leaching of sediment contaminants to surface water
- Groundwater discharge to Cogdels Creek or intermittent tributaries
- Groundwater infiltration to the deeper aquifer

Exposure Pathways

- Aquatic and terrestrial wildlife exposure to contaminants due to surface water ingestion
- Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment ingestion
- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to contaminants in soil and sediment
- Human exposure to contaminants due to incidental soil ingestion
- Human exposure to contaminants due to incidental sediment ingestion
- Human exposure to contaminants due to future potential groundwater ingestion
- Human exposure to VOCs due to volatilization from groundwater and surface waters
- Human dermal exposure to contaminants due to future potential direct contact with groundwater and direct contact with surface waters
- Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife

1.2.3.3 Present Database 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. The analytical methods and the level of Quality Assurance/Quality Control to which the analytical results were subjected during previous investigations at the site are not available or are inadequately documented (with the exception of the Pre-Scoping Groundwater Sampling conducted by Baker personnel in July 1992). Consequently, the existing data is not suitable to characterize the site or to make an assessment of human health of ecological risks. A summary of media-specific data limitations are presented below.

Soil

No previous soil sampling has occurred at Site 24. Data is required to adequately delineate the extent of contamination, assess human health and ecological risks that may be due to Site 24, and evaluate potential remedial alternatives.

Groundwater

Existing data has identified the presence of VOCs and inorganics in the shallow groundwater only at Site 24, therefore, no data is available to determine the nature and extent of contamination. Data is also needed to determine what area of concern within Site 24 is a source (s) of groundwater contamination. Additionally, data is required to adequately assess human health and ecological risks due to these areas of concern.

Sediment

Existing data has confirmed the presence of inorganics in the sediments of Cogdels Creek. Additional analytical data will be needed in order to more fully characterize sediment contamination, approximately delineate areas of concern, and assess human health and ecological risks due to contaminated sediments at Site 24.

Surface Water

VOCs and inorganics were detected in surface water samples collected from Cogdels Creek. In order to more fully characterize the surface water quality and to assess human health and ecological risks, additional surface water samples representing the entire length of the creek will be required.

Aquatic Life

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

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 that 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 of the site to identify contaminant transport and exposure pathways, and the development of objectives for further data collection efforts.

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

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

The remaining portions of this Section document the establishment of DQOs for the RI/FS at Operable Unit No. 1.

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 Section 1.1 and 1.2 of this FSAP. From this review and evaluation, a conceptual site model was developed for each site by identifying the potential sources of contamination, the contaminant migration pathways, and potential receptors. A conceptual site model for each site is presented in Table 2-1. Based on the conceptual contaminant transport/migration model for each site, specific RI/FS objectives

TABLE 2-1

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1 MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
78	Building 903 (USTs)	● Surface soil runoff from tank area off site	● Assess the horizontal extent of surface soil contamination near the tank area.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the tank area. ● Assess groundwater quality near the tank area.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Beaver Dam Creek, Cogdels Creek and New River)	● Assess groundwater quality near the tank area. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality associated with the tank area.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality near the tank area.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
78 (cont.)	Buildings 1502 and 1601 (USTs)	● Surface soil runoff from tank areas off site	● Assess the horizontal extent of surface soil contamination near the tank areas.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the tank areas. ● Assess groundwater quality associated with the tank areas.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Beaver Dam Creek, Cogdels Creek and New River)	● Assess groundwater quality near the tank areas. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality near the tank areas.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality associated with the tank areas.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
78 (cont.)	Building 1300 (PCBs/Pesticides)	● Surface water runoff from Building 1300 off site	● Assess the horizontal extent of surface water contamination near Building 1300.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the Building 1300. ● Assess groundwater quality near Building 1300.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Beaver Dam Creek, Cogdels Creek and New River)	● Assess groundwater quality associated with Building 1300. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment.	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality associated with Building 1300.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality associated with Building 1300.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
78 (cont.)	Buildings 1103 and 1601 (Pesticides)	● Surface soil runoff from Buildings 1103 and 1601 off site	● Assess the horizontal extent of surface soil contamination near Buildings 1103 and 1601.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination associated with Buildings 1103 and 1601. ● Assess groundwater quality near Buildings 1103 and 1601.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Beaver Dam Creek, Cogdels Creek, and New River)	● Assess groundwater quality near Buildings 1103 and 1601. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) or dermal contact	● Assess groundwater quality associated with Buildings 1103 and 1601.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality associated with Buildings 1103 and 1601.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
78 (cont.)	Buildings Northeast of Louis Road	• Impact to environmental media by contaminants	• Use soil gas investigation as a screening tool to detect presence/absence of contaminants.
	Buildings Southeast of Louis Road	• Impact to environmental media by contaminants	• Use soil gas investigation as a screening tool to detect presence/absence of contaminants.
	Buildings along Michael Road	• Impact to environmental media by contaminants	• Use soil gas investigation as a screening tool to detect presence/absence of contaminants.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
21	Former PCB Disposal Pit	● Surface soil runoff from former PCB disposal pit area off site	● Assess the horizontal extent of surface soil contamination near the former PCB disposal pit area. ● Assess the level and nature of contamination in surface water/sediments.
		● Surface sediment migration in drainage ditch to Beaver Dam Creek	● Assess the level and nature of contamination in surface water/sediments.
		● Migration of sediment contaminants to surface water	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the former PCB disposal pit area. ● Assess groundwater quality associated with the former PCB disposal pit area.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Beaver Dam and Wallace Creeks)	● Assess groundwater quality associated with the former PCB disposal pit area. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
21 (cont.)	Former PCB Disposal Pit	● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality near the former PCB disposal pit area.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality near the former PCB disposal pit area.
		● Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife	● Qualitatively evaluate impacts/stresses to communities.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
21 (cont.)	Former Pesticide Mixing Area	• Surface soil runoff from former pesticide mixing area off site	• Assess the horizontal extent of surface soil contamination near the former pesticide mixing area. • Assess the level and nature of contamination in surface water/sediments.
		• Surface sediment migration in drainage ditch to Beaver Dam Creek	• Assess the level and nature of contamination in surface water/sediments.
		• Migration of sediment contaminants to surface water	• Assess the level and nature of contamination in surface water/sediments.
		• Migration/leaching of soil contaminants to groundwater	• Assess the vertical extent of soil contamination in the former pesticide mixing area. • Assess groundwater quality associated with the former pesticide mixing area.
		• Off-site groundwater migration	• Evaluate off-site groundwater quality in the shallow aquifer.
		• Groundwater discharge to surface water (Cogdels Creek and New River)	• Assess groundwater quality near the former pesticide mixing area. • Assess the level and nature of contamination in surface water/sediments.
		• Vertical groundwater migration to the deep aquifer	• Evaluate groundwater quality in the deep aquifer.
		• Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion	• Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		• Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	• Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		• Human exposure to contaminants due to incidental soil and sediment ingestion	• Assess the level and nature of contamination in sediments and soils (surface and subsurface).

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
21 (cont.)	Former Pesticide Mixing Area	● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality associated with the the former pesticide mixing area.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality near the former pesticide mixing area.
		● Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife	● Qualitatively evaluate impacts/stresses to communities.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24	Spiractor Sludge Disposal Area	● Surface soil runoff from spiractor sludge disposal area	● Assess the horizontal extent of surface soil contamination near the spiractor sludge disposal area. ● Assess the level and nature of contamination in surface water/sediments.
		● Surface sediment migration in drainage ditch to Cogdels Creek	● Assess the level and nature of contamination in surface water/sediments.
		● Migration of sediment contaminants to surface water	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the spiractor sludge disposal area. ● Assess groundwater quality near the spiractor sludge disposal area.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Cogdels Creek and New River)	● Assess groundwater quality near the spiractor sludge disposal area. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Spiractor Sludge Disposal	● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality near the spiractor sludge disposal area.
		● Potential human exposure to VOCs due to volatilization from groundwater/surface water	● Assess groundwater and surface water quality near the spiractor sludge disposal area.
		● Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife	● Qualitatively evaluate impacts/stresses to communities.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Fly Ash Disposal Area	● Surface soil runoff from fly ash disposal area off site	● Assess the horizontal extent of surface soil contamination near the fly ash disposal area. ● Assess the level and nature of contamination in surface water/sediments.
		● Surface sediment migration in drainage ditch to Cogdels Creek	● Assess the level and nature of contamination in surface water/sediments.
		● Migration of sediment contaminants to surface water	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of soil contaminants to shallow groundwater	● Assess the vertical extent of soil contamination in the fly ash disposal area. ● Assess groundwater quality associated with the fly ash disposal area.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Cogdels Creek and New River)	● Assess groundwater quality near the fly ash disposal area. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Fly Ash Disposal Area	● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality associated with the fly ash disposal area.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality associated with the fly ash disposal area.
		● Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife	● Qualitatively evaluate impacts/stresses to communities.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Buried Metal Areas	● Surface soil runoff from buried metal areas off site	● Assess the horizontal extent of surface soil contamination near the buried metal areas. ● Assess the level and nature of contamination in surface water/sediments.
		● Surface sediment migration in drainage ditch to Cogdels Creek	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of sediment contaminants to surface water	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the buried metal areas. ● Assess groundwater quality near the buried metal areas.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Cogdels Creek and New River)	● Assess groundwater quality associated with the buried metal areas. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Buried Metal Areas	● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality associated with the buried metal areas.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality near the buried metal areas.
		● Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife	● Qualitatively evaluate impacts/stresses to communities.

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Borrow and Debris Disposal Area	● Surface soil runoff from borrow and debris areas off site	● Assess the horizontal extent of surface soil contamination near the borrow and debris disposal area. ● Assess the level and nature of contamination in surface water/sediments.
		● Surface sediment migration in drainage ditch to Cogdels Creek	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of sediment contaminants to surface water	● Assess the level and nature of contamination in surface water/sediments.
		● Migration/leaching of soil contaminants to groundwater	● Assess the vertical extent of soil contamination in the borrow and debris area. ● Assess groundwater quality near the borrow and deris disposal area.
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer.
		● Groundwater discharge to surface water (Cogdels Creek and New River)	● Assess groundwater quality associated with the borrow and debris disposal area. ● Assess the level and nature of contamination in surface water/sediments.
		● Vertical groundwater migration to the deep aquifer	● Evaluate groundwater quality in the deep aquifer.
		● Aquatic and terrestrial wildlife exposure to contaminants due to incidental sediment and soil ingestion	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Terrestrial wildlife (e.g. burrowing animals) dermal exposure to contaminants in soil and sediment	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).
		● Human exposure to contaminants due to incidental soil and sediment ingestions	● Assess the level and nature of contamination in sediments and soils (surface and subsurface).

TABLE 2-1 (continued)

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 1
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
24 (cont.)	Borrow and Debris Disposal Areas	● Potential human exposure to contaminants from future potential groundwater ingestion (the shallow aquifer is not used as a potable water supply) and/or dermal contact	● Assess groundwater quality associated with the borrow and debris disposal area.
		● Potential human exposure to VOCs due to volatilization from groundwater and surface water	● Assess groundwater and surface water quality near the borrow and debris disposal area.
		● Human exposure to contaminants due to ingestion of contaminated aquatic organisms and terrestrial wildlife	● Qualitatively evaluate impacts/stresses to communities.

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

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

2.2 Stage 2 - Identification of Data Needs

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

Soil

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

Groundwater

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

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

Sediments

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

Surface Water

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

Drums/Waste

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

The type of data and the quality of data to meet the criteria listed above are summarized on Table 2-2. The data quality levels differ with respect to the end use of the data. Level IV data quality are generally required for 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. For this RI/FS, Environmental Protection Agency (EPA) methods and Contract Laboratory Program (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 the need to obtain a representative measure to characterize the nature and extent of contamination, assess human health and environmental risks, and develop and evaluate remedial alternatives. For the various field investigations for Operable Unit No. 1, 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 programs for Operable Unit No. 1 have been designed to meet the objectives identified in Table 2-1. Section 5.4 of the RI/FS Work Plan provides a general description of the various sampling programs for the four sites. Section 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
OPERABLE UNIT NO. 1, MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Sampling Criteria/Purpose	Data Types	Data Quality Level
Soil	Assess extent of surface and subsurface soil contamination within reported disposal areas	TCL Organics TAL Inorganics Subsurface Features (Geophysical Methods)	IV IV II
		TCL Organics TAL Inorganics	IV IV
	Assess extent of surface soil contamination due to surface runoff	Grain Size Moisture Density TOC Residual Chlorine Total Fluoride Organic Nitrogen	III III III III III III
	Identify physical properties of soil to evaluate migration potentials and remedial technologies	TCL Organics TAL Inorganics	IV IV
	Identify chemical properties of soil to assess potential human health and environmental risks, and to evaluate remedial technologies	Total TCLP Alkalinity Reactivity Corrosivity Ignitability	III III III III III
	Identify chemical properties associated with disposal and treatment requirements		
Groundwater	Assess extent and nature of onsite and offsite groundwater contamination in shallow and/or deep aquifers	TCL Organics TAL Inorganics	IV IV
	Identify 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

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
OPERABLE UNIT NO. 1, MCB CAMP LEJEUNE, NORTH CAROLINA

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

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS
OPERABLE UNIT NO. 1, MCB CAMP LEJEUNE, NORTH CAROLINA

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

Notes:

TCL - Target Compound List
TAL - Target Analyte List
TOC - Total Organic Carbon

3.0 SAMPLING LOCATIONS AND FREQUENCY

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

3.1 Site 78 - Hadnot Point Industrial Area

There are six general areas of concern at Site 78 that will be investigated: the buildings with associated USTs (Buildings 903, 1502, and 1601); Building 1300; Buildings 1103 and 1601; buildings southeast of Louis Road; buildings northeast of Louis Road; and several buildings along Michael Road. Samples will be collected from all these areas of concern. The various sampling and investigation programs include: surveying; waste characterization; soil gas surveying; soil investigation; groundwater investigation; surface water/sediment investigation. Figure 3-1 shows the potential or known areas of concern with HPIA.

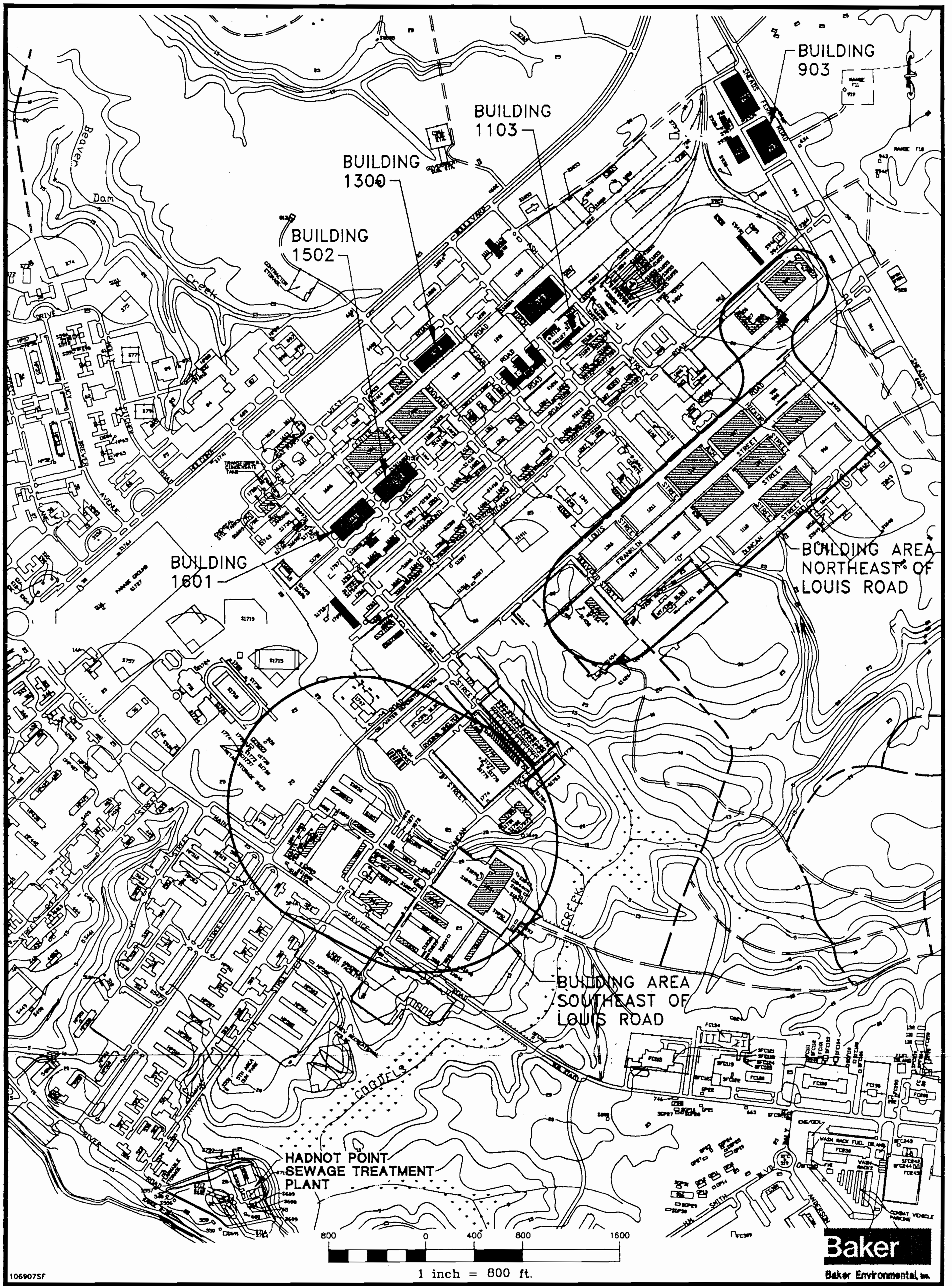
3.1.1 Surveying

All existing monitoring wells and any wells installed during the investigation at Site 78 will be surveyed. The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. The latitude, longitude, elevation in feet of mean sea level, accuracy, and survey methods will be recorded. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be within 0.1 foot. In addition, soil sampling locations (i.e., boreholes) and surface water/sediment sample locations will be surveyed to a horizontal accuracy of 1 foot.

3.1.2 Soil Gas Survey

Based on a review of background information, there are three groups of buildings within HPIA which may be potential areas of concern (due to past and/or present solvent usage/storage). These buildings have not been subjected to any previous investigations to determine whether they are a source of contamination at the HPIA.

A soil gas survey will be conducted northeast and southeast of Louis Road and along Michael Road in an attempt to evaluate whether these areas are areas of concern. Initially, soil gas samples will be collected around each of the buildings. The buildings to be included in the soil gas survey are shown on Figure 3-1. The area northeast of Louis Road includes Buildings 907,



LEGEND

▨ POTENTIAL AREAS OF CONCERN

■ AREAS OF CONCERN PREVIOUSLY INVESTIGATED

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 3-1
POTENTIAL OR KNOWN AREAS OF CONCERN
WITHIN HPIA (SITE 78)
HADNOT POINT INDUSTRIAL AREA

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

915, 916, 1011, 1012, 1116, 1117, and 1450. In addition, Buildings 908, 909, 926, 927 and 928 will be included in this area. The buildings to be investigated in the southeast area include Buildings 1750, 1755, 1765, 1775, 1780, 1804, 1808, 1810, 1812, 1815, 1817, 1826, 1828, 1841, 1854, 1860 and 1880. Please note that Buildings 1750, 1755, and 1812 could not be located on the existing maps for Camp Lejeune and, therefore, are not identified on Figure 3-1. The buildings along Michael Road that will be included in the soil gas survey include Buildings 1106, 1205, 1206, 1310, 1407, 1408, 1505, and 1604.

A minimum of five soil gas samples will be collected around each of the above-mentioned buildings. To collect the soil gas samples, a small hole will be produced by using a drive rod. Where pavement is present, an electric hammer drill will be used to penetrate the paving material prior to using the drive rod. The sampling system will be purged with ambient air, a sampling probe will be inserted to the full depth of the hole, and sealed off from the atmosphere. A sample of in-situ soil gas will be withdrawn through the probe and encapsulated in a pre-evacuated container. The sample will be analyzed on site using TCE, vinyl chloride, BTEX, and 1,2-DCE, as the reference gas.

3.1.3 Soil Investigation

Soil investigations will be conducted at the following areas of concern within HPIA: (1) underground storage tank (UST) locations identified during the geophysical survey investigation, (2) Building 1300, and (3) Buildings 1103 and 1601. Background soil samples will also be collected. In addition, soil samples may be collected at areas of concern identified by the soil gas survey. Soil samples will also be collected if any new monitoring wells are installed.

3.1.3.1 UST Locations

The geophysical investigation conducted in June 1992, identified potential UST locations at Building 903, 1502 and 1601. No potential UST areas were identified at Building 1202.

Table 3-1 summarizes the soil sampling programs for the UST locations at Site 78.

As shown on Figures 3-2 and 3-3, three soil borings will be installed around each of the suspected UST locations at Buildings 903, 1502 and 1601.

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24 MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 78	Soil - UST Areas	1 boring/2 to 3 samples(2)	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 351.4	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
		15 borings/15 samples(2) (surface soils)	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
		15 borings/15 to 30 samples(2) (subsurface soils)	TCL Organics	IV	4,5,6	Routine
	Soil - Building 1300	3 borings/3 samples(2) (surface soils)	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
		3 borings/3 to 6 samples(2) (subsurface soils)	TCL Pesticides	IV	6	Routine
			Chlorinated Herbicides	IV	EPA 8150	Routine
			TCL PCBs	IV	6	Routine
		2 borings/2 samples(2) (surface soils)	TCL Organics	IV	4, 5, 6	14 days
			TAL Inorganics	IV	7	14 days
		2 borings/2 to 4 samples(2) (subsurface soils)	TCL Pesticides	IV	6	14 days
			Chlorinated Herbicides	IV	EPA 8150	14 days
			TCL PCBs	IV	6	14 days

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 78 (Continued)	Soil - Buildings 1103 and 1601	4 borings/4 samples (surface soils)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		4 borings/4 samples (subsurface soils)	TCL Pesticides Chlorinated Herbicides	IV IV	6 EPA 8150	Routine Routine
		6 borings/6 samples (surface soils)	TCL Organics TAL Inorganics	IV IV	6 EPA 8150	14 days 14 days
		6 borings/6 samples (subsurface soils)	TCL Pesticides Chlorinated Herbicides	IV IV	4, 5, 6 7	14 days 14 days
	Soil Gas Survey	38 building areas/5 samples per building (estimated); 190 samples	TCE, vinyl chloride, BTEX(9), 1,2-DCE	II	Field GC	Daily
	Soil -Soil Gas Survey	5 borings per location/2 to 3 samples per boring(2)(10)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine
	Soil - Background	2 borings/4 to 6 samples (2)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine
	Groundwater	42 samples from existing wells (29 shallow, 7 intermediate, 6 deep)	TCL Volatiles TAL Inorganics	IV IV	EPA 601/602 7	Routine Routine
		5 samples from existing wells (3 shallow, 1 intermediate, 1 deep)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		Newly-installed wells(10)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine
		4 samples (shallow): 2 existing wells and 2 newly-installed wells	BOD COD TOC TSS TDS TVS	III	EPA 405.1 EPA 410.1 EPA 415.1 EPA 160.2 EPA 160.1 EPA 160.4	Routine Routine Routine Routine Routine Routine

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24 MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 78 (Continued)	Surface Water Cogdels Creek and New River	20 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
	Surface Water Beaver Dam Creek	7 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
	Sediment - Cogdels Creek and New River	20 stations/40 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
	Sediment - Beaver Dam Creek	7 stations/14 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 21	Soil - Former Pesticide Mixing Area	16 borings/16 samples (surface soils)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		10 borings/10 to 20 samples(2) (subsurface soils)	TCL Pesticides Chlorinated Herbicides	IV IV	6 EPA 8150	Routine Routine
		4 borings/4 to 8 samples(2) (subsurface soils)	TCL Pesticides Chlorinated Herbicides PCBs	IV IV IV	6 EPA 8150 6	14 days 14 days 14 days
		2 borings/2 to 4 samples(2) (subsurface soils)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine
		1 boring/2 to 3 samples(2)	Grain Size Moisture Density Total TCLP Chlorine, Residual Total Fluoride Nitrogen (organic) Alkalinity (total) Corrosivity Ignitability Reactivity TOC	III III III III III III III III III III III	ASTM D422 ASTM D698 40 CFR 261 EPA 330.5 SM 4500-F EPA 351.4 SM 2320-B 40 CFR 261 40 CFR 261 40 CFR 261 EPA 415.1	Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine Routine
	Soil - MW Boreholes - Pesticide Mixing Area	1 boring/3 to 4 samples (surface and subsurface soils)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
	Soil - Transformer Oil Pit	11 borings/11 samples (surface soils)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		2 borings/2 to 4 samples(2) (subsurface soils)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		5 borings/5 to 10 samples(2) (subsurface soils)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	14 days 14 days
		3 borings/3 to 6 samples(2) (subsurface soils)	PCBs	IV	6	Routine
		1 boring/1 to 2 samples(2) (subsurface soils)	PCBs	IV	6	14 days

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 21 (Continued)	Soil - Transformer Oil Pit (Cont.)	1 boring/2 to 3 samples(2)	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTMD698	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (Organic)	III	EPA 351.4	Routine
			TOC	III	EPA 415.1	Routine
		1 boring/1 composite sample	Total TCLP	III	40 CFR 261	Routine
			Alkalinity (Total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
	Soil - MW Boreholes - Transformer Oil Pit	1 boring/2 samples (21GW2)	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
		1 boring/3 to 4 samples (21GW3)	TCL Organics	IV	4,5,6	Routine
			TAL Inorganics	IV	7	Routine
	Groundwater	3 samples (3 existing wells) (shallow)	TCL Pesticides/Herbicides	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
		4 samples (3 new wells, 1 existing well) (shallow)	TCL Volatiles	IV	EPA 601/602	Routine
			TCL Organics	IV	5, 6	Routine
			TAL Inorganics	IV	7	Routine
		3 samples (3 newly installed wells) (shallow)	BOD	III	EPA 405.1	Routine
			COD	III	EPA 410.1	Routine
			TSS	III	EPA 160.2	Routine
			TDS	III	EPA 160.1	Routine
			TVS	III	EPA 160.4	Routine
			TOC	III	EPA 415.1	Routine

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 21 (Continued)	Surface Water Site Drainage Ditch	7 stations/7 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		10 stations/10 samples	TCL Pesticides/Herbicides PCBs	IV IV	4, 5, 6 6	Routine Routine
	Sediment - Site Drainage Ditch	7 stations/14 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine
		10 stations/20 samples	TCL Pesticides/Herbicides PCBs	IV IV	4, 5, 6 6	Routine Routine

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis[8]	Data Quality Level	Analytical Method	Laboratory Turnaround Time[3]
Site 24	Soil - Spiractor Sludge Area	6 borings/12 to 18 samples[2]	TCL Organics	IV	4,5,6	Routine
			TAL Inorganics	IV	7	Routine
		4 borings/8 to 12 samples[2]	TCL Organics	IV	4,5,6	14 days
			TAL Inorganics	IV	7	14 days
		1 boring/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 351.4	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
	Soil - MW Boreholes - Spiractor Sludge Area	2 borings/4 samples (24GW7, 24GW8)	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
	Soil - Fly Ash Disposal Area	4 borings/8 samples	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
		4 borings/8 samples	TCL Organics	IV	4, 5, 6	14 days
			TAL Inorganics	IV	7	14 days
		7 borings/14 samples	TAL Inorganics	IV	7	Routine
		1 boring/2 samples	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 351.4	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 24 (Continued)	Soil - MW Boreholes - Fly Ash Area	1 boring/2 samples (24GW9)	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
	Soil - Test Pits - Buried Metal Areas	7 test pits (estimated) 1 sample per test pit	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
	Waste - Test Pits - Buried Metal Areas	1 sample per test pit (if drums or wastes are present)	Total TCLP	III	40 CFR 261	Routine
			RCRA Hazardous Characteristics	IV	40 CFR 261	Routine
	Soil - Borrow and Debris Disposal Area	4 borings/8 to 12 samples(2)	TCL Organics	IV	4, 5, 6	Routine
			TAL Inorganics	IV	7	Routine
		6 borings/12 to 18 samples(2)	TAL Inorganics	IV	7	Routine
		4 borings/8 to 12 samples(2)	TCL Organics	IV	4, 5, 6	14 days
			TAL Inorganics	IV	7	14 days
		1 boring/2 to 3samples(2)	Grain Size	III	ASTM D422	Routine
			Moisture Density	III	ASTM D698	Routine
			Total TCLP	III	40 CFR 261	Routine
			Chlorine, Residual	III	EPA 330.5	Routine
			Total Fluoride	III	SM 4500-F	Routine
			Nitrogen (organic)	III	EPA 351.4	Routine
			Alkalinity (total)	III	SM 2320-B	Routine
			Corrosivity	III	40 CFR 261	Routine
			Ignitability	III	40 CFR 261	Routine
			Reactivity	III	40 CFR 261	Routine
			TOC	III	EPA 415.1	Routine
	Soil - MW Boreholes - Borrow and Debris Area	1 boring/2 samples (24GW10)	TCL Organics	IV	4,5,6	Routine
			TAL Inorganics	IV	7	Routine

TABLE 3-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)
Site 24 (Continued)	Groundwater	5 samples (existing wells) (shallow)	TAL Inorganics	IV	7	Routine
		4 samples (new wells) (shallow)	TCL Volatiles	IV	EPA 601/602	Routine
			TCL Organics	IV	5, 6	Routine
			TAL Inorganics	IV	7	
		4 samples (new shallow wells)	BOD	III	EPA 405.1	Routine
			COD	III	EPA 410.1	Routine
			TSS	III	EPA 160.2	Routine
			TDS	III	EPA 160.1	Routine
			TVS	III	EPA 160.4	Routine
			TOC	III	EPA 415.1	Routine

(1) Baseline number of samples do not include field QA/QC samples.

(2) Assumes 2 to 3 samples per borehole.

(3) Routine analytical turnaround is 28 days following receipt of sample.

(4) Purgeable Organic Compounds - EPA 8240/EPA 624

(5) Base/Neutral Acid Extractables - EPA 3510/EPA 625

(6) Pesticides and PCBs - EPA 3510/3550/EPA 608

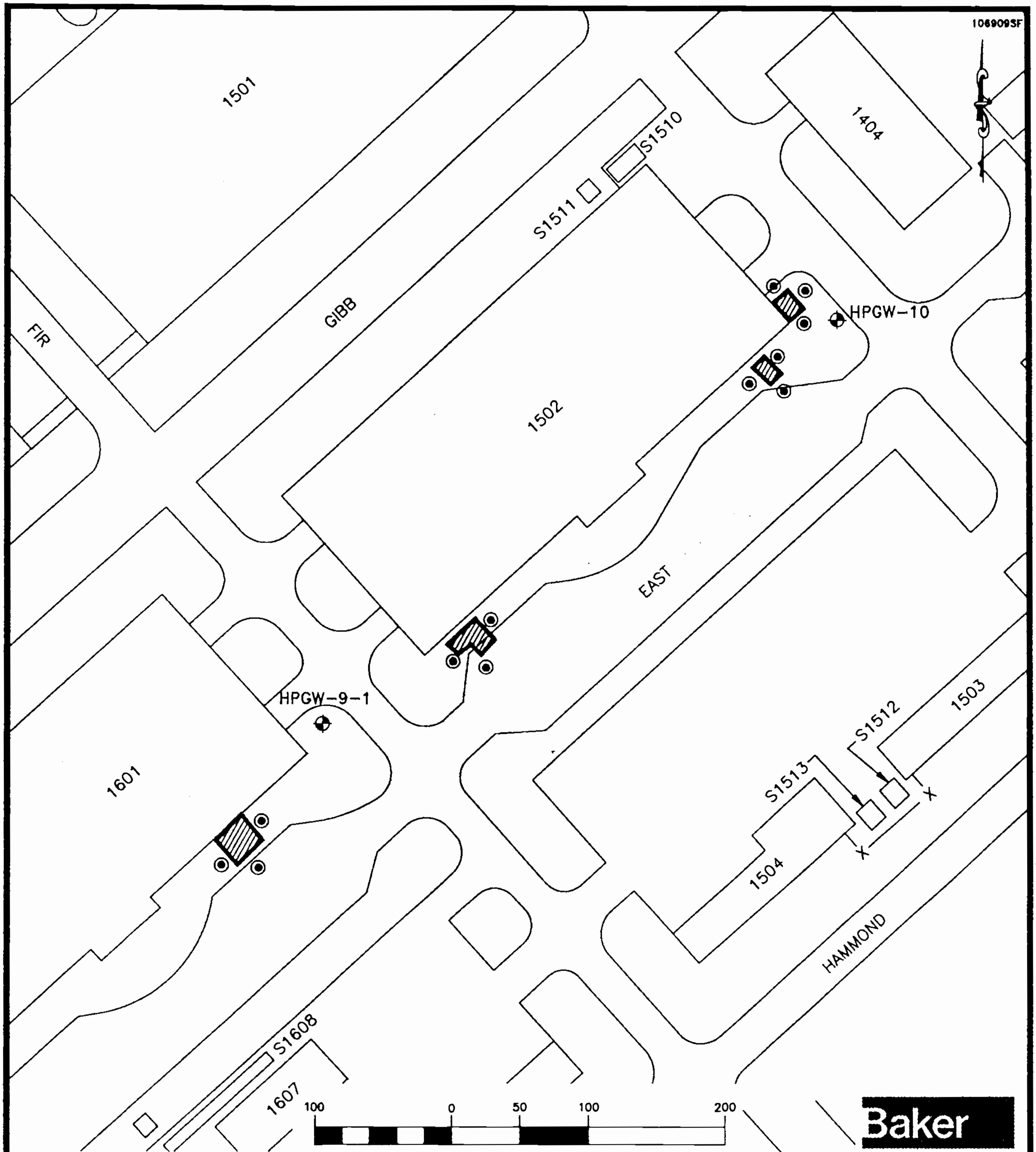
(7) TCL Inorganics:

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

(8) BOD - Biological Oxygen Demand (SM 5210)
COD - Chemical Oxygen Demand (EPA 410.1)
TSS - Total Suspended Solids (EPA 160.2)
TDS - Total Dissolved Solids (EPA 160.1)
TVS - Total Volatile Solids (EPA 160.4)
TOC - Total Organic Carbon (EPA 415.1)

(9) BTEX - Benzene, Toluene, Ethylbenzene, Xylenes

(10) Actual number of samples is unknown and will be based on the soil gas survey.



SOURCE: LANTDIV, OCT. 1991

1 inch = 100 ft.

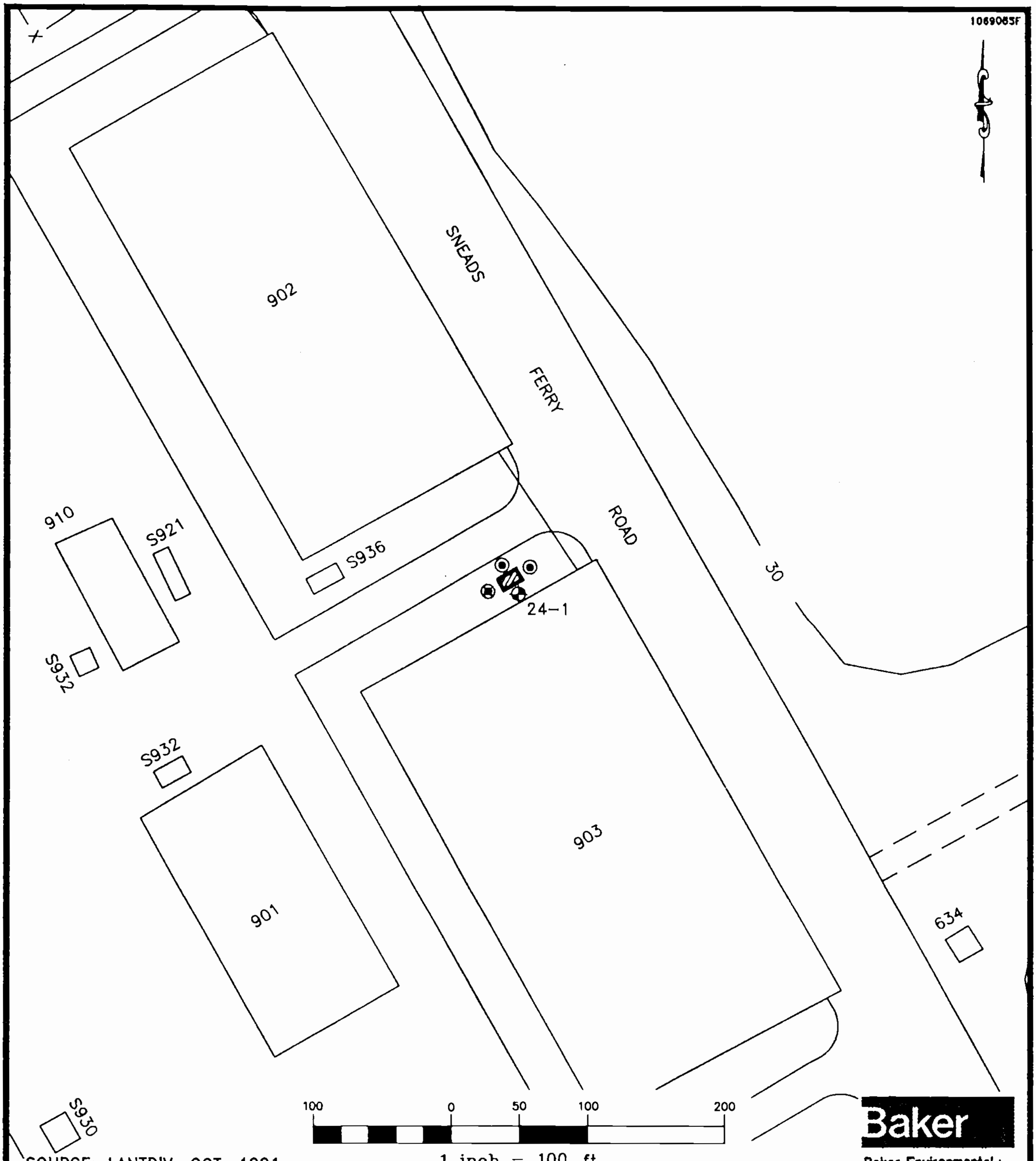
Baker Environmental, Inc.

	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
▨	TANK AREA	–	–
●	SOIL BORING (CONTINUOUS – SS TO 10 FEET)	TCL ORGANICS	ROUTINE (28–40 DAYS)
HPGW -10 ⊕	EXISTING MONITORING WELL	–	–

NOTE: ALL SURFACE SOIL SAMPLES WILL BE ANALYZED FOR FULL TCL ORGANICS/TAL INORGANICS (ROUTINE TURNAROUND)

FIGURE 3-3
SOIL INVESTIGATION AT
SUSPECTED BURIED TANK AREAS
BUILDING 1502 AND 1601
SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA



SOURCE: LANTDIV, OCT. 1991

Baker Environmental, Inc.

	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
▨	TANK AREA	–	–
●	SOIL BORING (CONTINUOUS – SS TO 10 FEET)	TCL ORGANICS	ROUTINE (28–40 DAYS)
◉	SOIL BORING (CONTINUOUS – SS TO 10 FEET)	FULL TCL/TAL ENGINEERING PARAMETERS	ROUTINE (28–40 DAYS)
24–1 ⊕	EXISTING MONITORING WELL	–	–

NOTE: ALL SURFACE SOIL SAMPLES WILL BE ANALYZED FOR FULL TCL ORGANICS/TAL INORGANICS (ROUTINE TURNAROUND)

FIGURE 3–2
SOIL INVESTIGATION AT SUSPECTED BURIED TANK AREAS
BUILDING 903
SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

Test borings will be augered and soil samples collected using ASTM Method D1586-84 at each sample station. The borings will initially be hand augered to reduce the possibility of rupturing an existing tank and/or line. A total of fifteen boreholes (three at Building 902, nine at Building 1502 and three at Building 1601) will be augered. Samples will be collected from the ground surface (top 6 inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately 5 to 10 feet below ground surface across the site. The bottom most sample will be collected from just above the water table. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

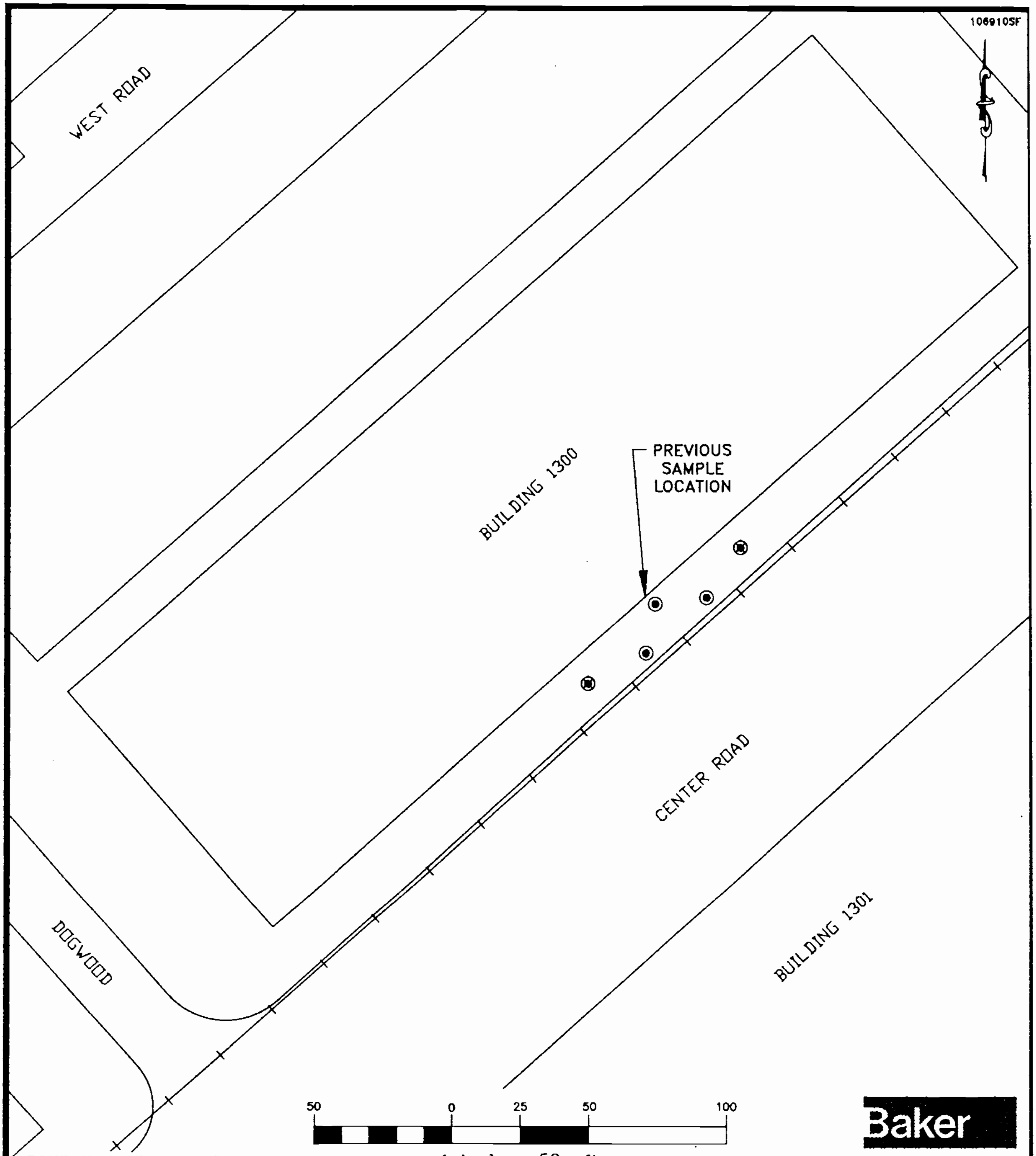
All surface soil samples will be analyzed for full Target Compound List (TCL) organics and Target Analyte List (TAL) inorganics via Contract Laboratory Program (CLP) protocol. These samples will serve to assess human health and environmental risks and will provide data to more fully characterize surface and subsurface soils. The subsurface soil samples will be analyzed for full TCL volatiles under CLP protocol (Level IV data quality). The surface and subsurface samples will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround).

As shown on Figure 3-2, samples from one boring at Building 903 will be analyzed to evaluate engineering parameters. All samples from this boring will be analyzed for grain size, moisture density, total organic carbon (TOC), total TCLP, residual chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction and solidification/fixation or off-site treatment and disposal options.

3.1.3.2 Building 1300

Table 3-1 summarizes the soil sampling programs for Building 1300.

During previous investigations, a PCB, Aroclor-1260, was detected at a soil boring located at Building 1300 to a depth of 6 feet. In addition, low levels of the pesticides heptachlor epoxide and endosulfan I were detected in this soil boring. In an attempt to assess the extent of this contamination at Building 1300, or to confirm that there is not a contamination problem , five soil borings (shown on Figure 3-4) will be installed along the eastern side of the building.



SOURCE: LANTDIV, OCT. 1991

Baker Environmental, Inc.

	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
◉	SOIL BORING (CONTINUOUS – SS TO 10 FEET)	TCL PESTICIDES/ HERBICIDES/PCBS	ROUTINE (28–40 DAYS)
●	SOIL BORING (CONTINUOUS – SS TO 10 FEET)	TCL PESTICIDES/ HERBICIDES/PCBS	QUICK TURNAROUND

NOTE: ALL SURFACE SOIL SAMPLES WILL BE ANALYZED FOR FULL TCL ORGANICS/TAL INORGANICS (ROUTINE TURNAROUND)

FIGURE 3–4
SOIL INVESTIGATION AT BUILDING 1300
SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

Test borings will be augered and soil samples collected using ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately 5 to 10 feet below ground surface across the site. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

The surface soil samples will be analyzed for full TCL organics and TAL inorganics via CLP protocol yielding Level IV data quality. The subsurface soil samples will be analyzed for PCBs and pesticides/herbicides via EPA Methods 608 and 8150 (Level IV data quality).

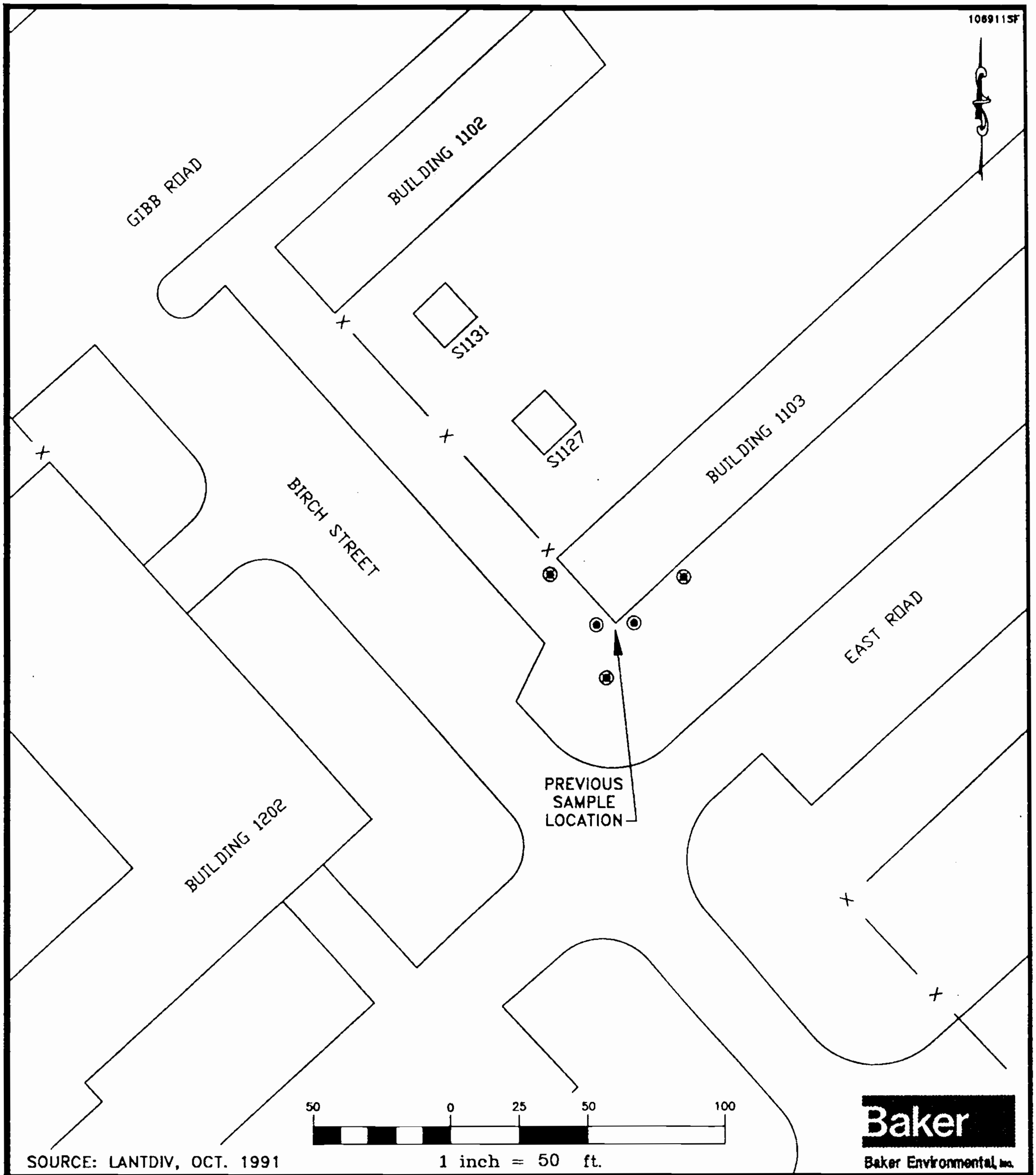
Samples from three of the borings will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround). Samples from the other two borings will be analyzed within 14 days. These samples will be used to assess whether further soil sampling is required to further delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation in consultation with EPA Region IV, the N.C. DEHNR, and LANTDIV.

3.1.3.3 Buildings 1103 and 1601

Table 3-1 summarizes the soil sampling programs for Building 1103 and 1601

During previous investigations, pesticides including dieldrin, 4, 4-DDT,and and 4,4-DDE were detected at a soil boring located at Building 1103 and at a soil boring located across from Building 1601. Pesticides were detected at a depth of 0 to 2 feet at both of these locations. While these findings may only represent the result of periodic applications, an attempt to assess the extent of this contamination at these two buildings, or to confirm that there is not a contamination problem, will include five soil borings (shown on Figures 3-5 and 3-6) at both buildings.

Test borings will be hand augered and soil samples collected using ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and from the 2 to 4-feet range (composite sample) for subsequent laboratory analysis.



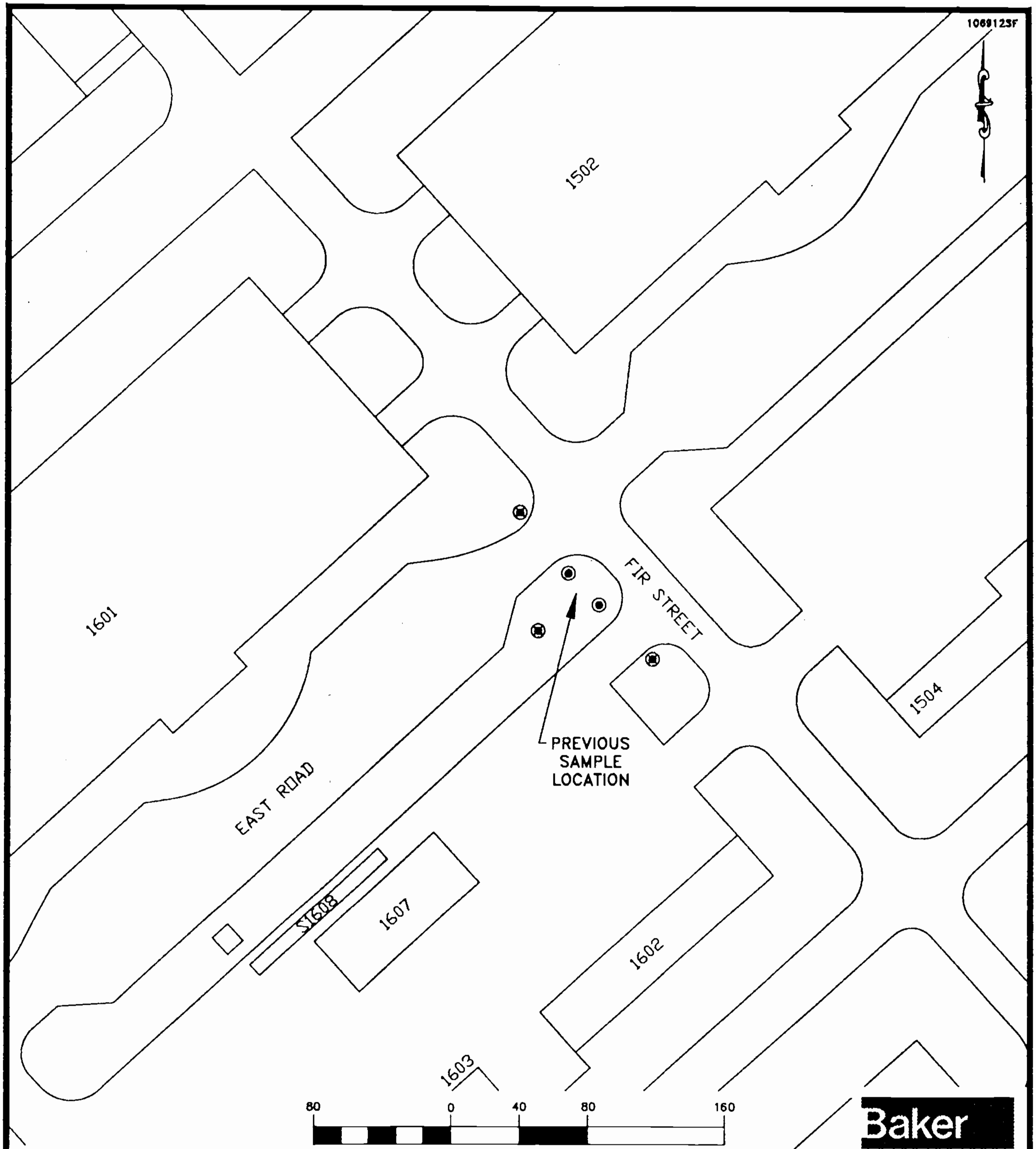
SOURCE: LANTDIV, OCT. 1991

	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
⊗	SOIL BORING (0-6 INCHES 2-4 FEET COMPOSITE)	TCL PESTICIDES/ HERBICIDES	ROUTINE (28-40 DAYS)
◉	SOIL BORING (0-6 INCHES 2-4 FEET COMPOSITE)	TCL PESTICIDES/ HERBICIDES	QUICK TURNAROUND

NOTE: ALL SURFACE SOIL SAMPLES WILL BE ANALYZED FOR FULL TCL ORGANICS/TAL INORGANICS (ROUTINE TURNAROUND)

FIGURE 3-5
SOIL INVESTIGATION AT BUILDING 1103 SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA



SOURCE: LANTDIV, OCT. 1991

1 inch = 80 ft.

	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
⊗	SOIL BORING (0–6 INCHES 2–4 FEET COMPOSITE)	TCL PESTICIDES/ HERBICIDES	ROUTINE (28–40 DAYS)
◉	SOIL BORING (0–6 INCHES 2–4 FEET COMPOSITE)	TCL PESTICIDES/ HERBICIDES	QUICK TURNAROUND

NOTE: ALL SURFACE SOIL SAMPLES WILL BE ANALYZED FOR FULL TCL ORGANICS/TAL INORGANICS (ROUTINE TURNAROUND).

FIGURE 3–6
SOIL INVESTIGATION AT
BUILDING 1601
SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

The surface soil samples will be analyzed for full TCL organics and TAL inorganics via CLP protocol yielding Level IV data quality. The subsurface soil samples will be analyzed for TCL and pesticides/herbicides via EPA Methods 608 and 8150 (Level IV data quality).

Samples from two of the borings will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround). Samples from the other three borings will be analyzed within 14 days. These samples will be used to assess whether further soil sampling is required to further delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

3.1.3.4 Soil Gas Survey Soil Samples

Approximately five (5) soil borings will be installed at areas of concern identified by the soil gas survey. These areas of concern will be determined during the field investigation in consultation with EPA Region IV, the N.C. DEHNR, and LANTDIV. Therefore, the total number of soil borings to be installed and sampled cannot be estimated at this time.

The borings will be augered and soil samples collected via ASTM Method D1586-84. Samples will be collected from the ground surface (top six inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately five to ten feet below ground surface.

The soil samples will be analyzed for full TRCL organics and TAL inorganics under CLP protocols (Level IV data quality). The samples will be analyzed within the maximum allowable holding times. Table 3-1 summarizes this soil sampling program for the soil gas survey soil samples.

3.1.3.5 Background

Table 3-1 summarizes the soil sampling program for background soil samples. Two background soil borings will be augered in the area immediately west of the site - along Lucy Brewer Street (exact locations will be identified following utility clearance). The borings will be augered and soil samples collected using ASTM Method D1586-84. Samples will be collected from the ground surface and at 2- to 5-foot intervals until the water table is reached.

Samples will be analyzed for full TCL organics and TAL inorganics using CLP protocols (Level IV data quality). The samples will undergo routine turnaround (28-40 days).

Note that the results from these background soils samples will be used to represent background soil conditions for the entire Operable Unit No. 1.

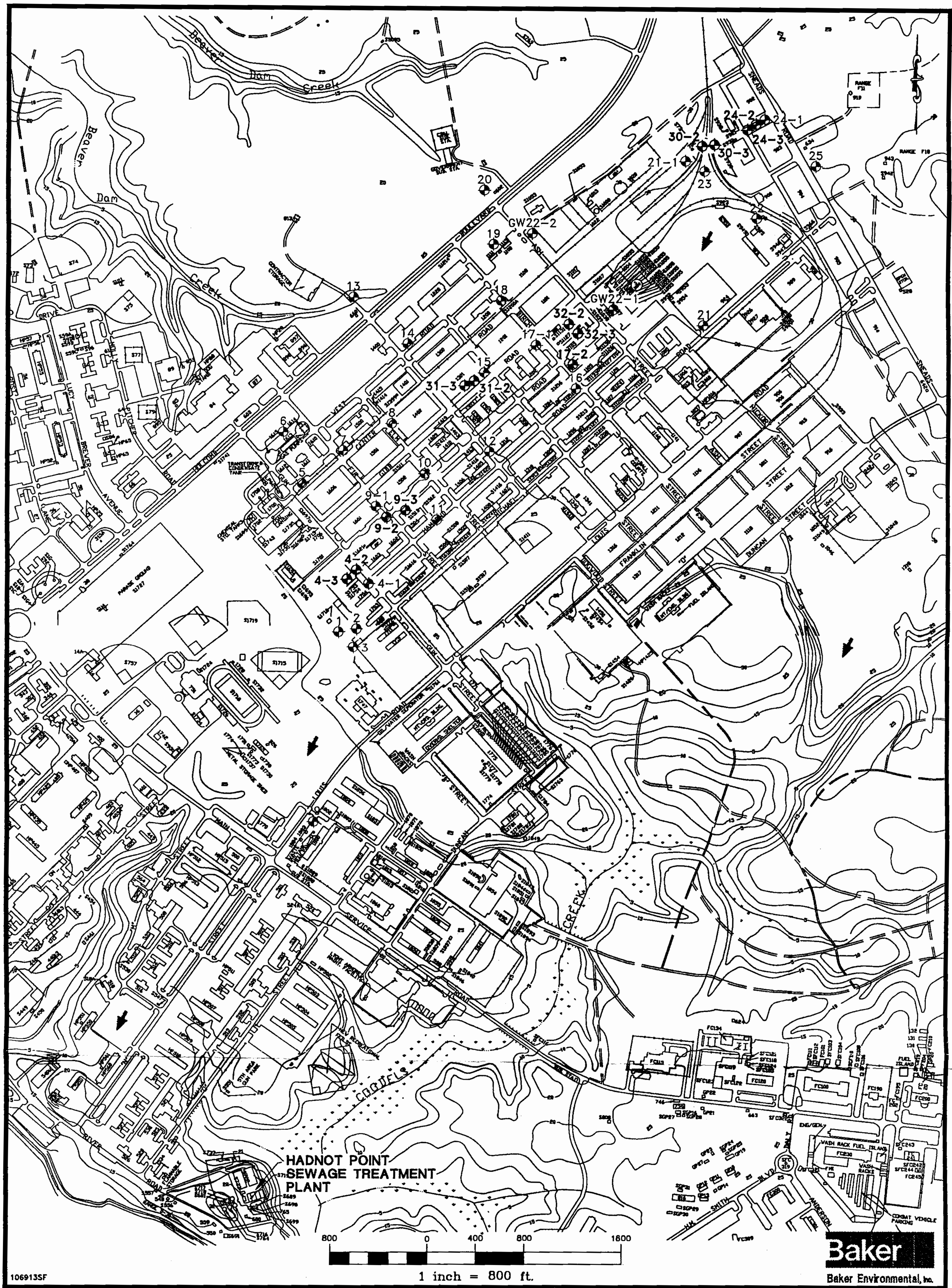
3.1.4 Groundwater Investigations

Groundwater investigations will be conducted at Site 78 to assess groundwater quality at HPIA. The groundwater investigations will consist of the collection of one round of groundwater samples and water level measurements from all existing wells at the site (Figure 3-7). Note that based on the results of the soil gas survey to be conducted for the potential areas of concern east of Louis Road and along Michael Road, additional groundwater monitoring wells may be installed at the site. If additional wells are installed, they will be constructed according to standard operating procedures for monitoring well installation and will be included in the sampling round.

Forty monitoring wells were previously installed at Site 78 to monitor groundwater quality. This included 27 shallow monitoring wells, 7 intermediate wells, and 6 deep wells. In addition, two shallow monitoring wells (22GW1and 22GW2) installed for Site 22 have been used to monitor the groundwater quality at Site 78. The location of all these wells are shown on Figure 3-7. Well construction details for these wells have been previously presented on Table 1-3. Table 3-1 summarizes the sampling and analytical programs for the groundwater investigations.

3.1.4.1 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each existing well within HPIA (this includes 42 wells). Groundwater samples collected from the existing wells will be analyzed for TCL volatiles using Method 601/602 and TCL inorganics via CLP protocol (Level IV data quality). The analytical results from several previous investigations have identified volatiles as the contaminants of concern in the groundwater. In addition, some of the intermediate and deep wells within HPIA were recently sampled (July 1992) for full TCL organics and TAL inorganics.



LEGEND

20 ● EXISTING SHALLOW MONITORING WELL

24-2 ● EXISTING INTERMEDIATE MONITORING WELL

24-3 ● EXISTING DEEP MONITORING WELL

→ APPROXIMATE GROUNDWATER FLOW DIRECTION

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 3-7
GROUNDWATER SAMPLING LOCATIONS
SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

Approximately, ten percent of the existing monitoring wells and any newly-installed monitoring wells will be analyzed for full TCL organics under CLP protocol (Level IV data quality). The sample will be analyzed within the maximum allowable holding times. These samples will allow an assessment of human health and environmental risks to be made and will provide data to more fully characterize the groundwater.

Four of the wells will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include biological oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS), and total volatile solids (TVS).

3.1.4.2 Water Level Measurements

Static water levels measurements will be collected from each well during the sampling event. Water level measurements shall be collected within a 4-hour period, if possible. Groundwater level data will be used to evaluate groundwater flow direction.

3.1.4.3 Aquifer Testing

An aquifer test will be conducted at Site 78, under a separate project, in order to assess aquifer parameters and the extent of influence on the aquifer resulting from groundwater pumping.

3.1.5 Surface Water/Sediment Investigations

Surface water and sediment investigations will be conducted on several drainage tributaries around Site 78 to assess possible environmental impacts to Cogdels Creek and the New River and to Beaver Dam Creek and Wallace Creek. [This discussion of surface water and sediment investigations is being included under Site 78, although it pertains to the entire operable unit (Sites 78, 21, and 24).] The branches of Beaver Dam Creek (which discharge to Wallace Creek) may potentially receive runoff/discharge from Site 21 and Site 78. Runoff from Site 24 and Site 78 may drain into the branches/tributaries of Cogdels Creek (which discharges to the New River).

3.1.5.1 Tributaries of Cogdels Creek and the New River

Table 3-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

As shown on Figure 3-8, twenty (20) surface water and sediment sampling stations have been identified to characterize potential impacts from Site 24 and portions of Site 78. If water is present at the time of sampling, one surface water sample will be collected from the bank of the tributary, creek or river at each of the sampling stations. A surface (top six inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, and pouring the sample directly into the appropriate sample bottles.

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

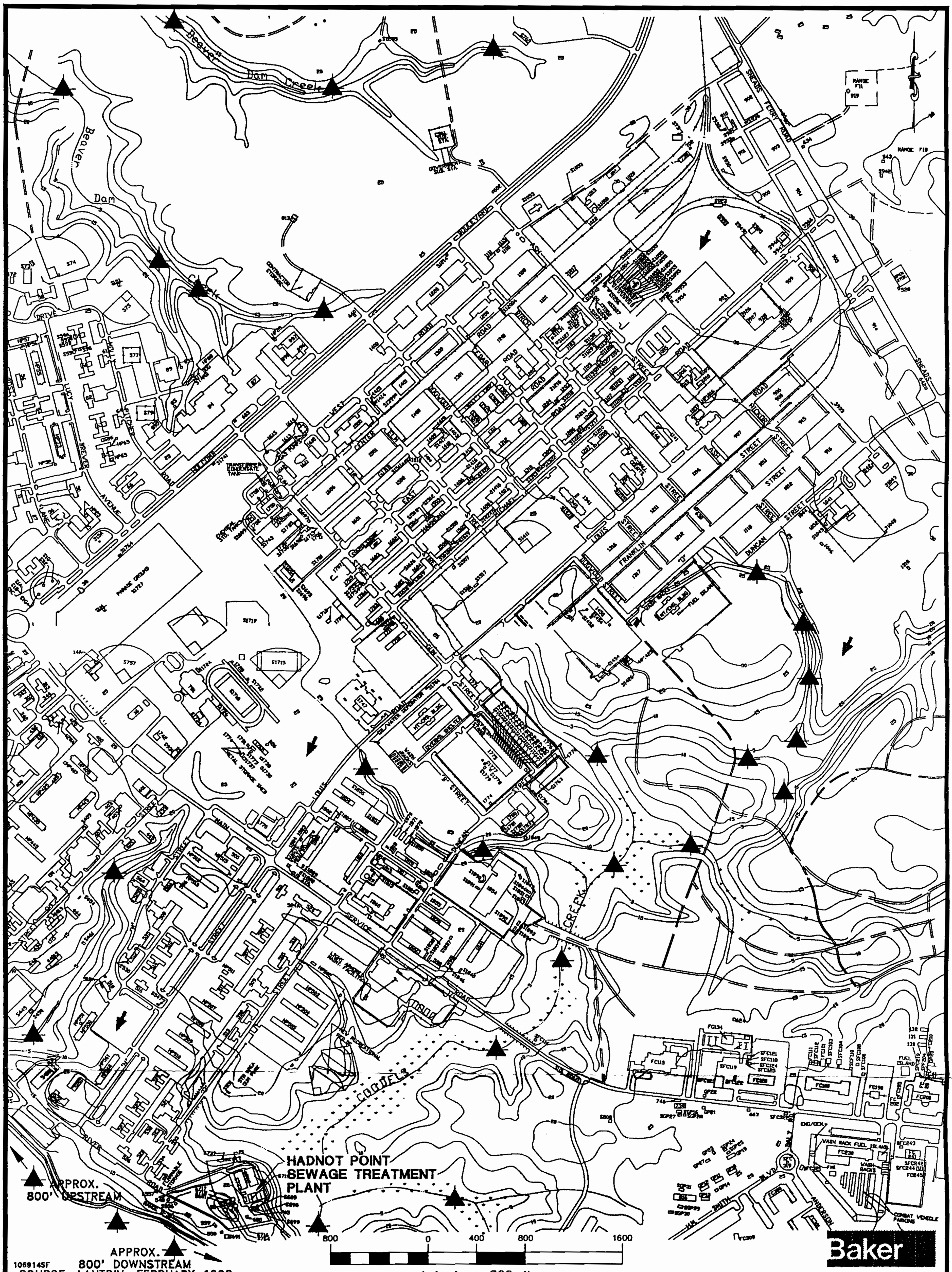
The surface water and sediment samples will be analyzed for full TCL organics and TAL inorganics under CLP protocols producing Level IV data quality. In addition, all surface water samples will be analyzed in the field for dissolved oxygen (DO), temperature, specific conductivity, and pH (Level I data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

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

3.1.5.2 Branches of Beaver Dam Creek

Table 3-1 summarizes the sampling and analytical programs for the surface water and sediment investigations.

As shown on Figure 3-8, seven (7) surface water and sediment sampling stations have been identified to characterize potential impacts from Site 21 and portions of Site 78, and



SOURCE: LANTDIV, FEBRUARY 1992

	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
SURFACE WATER/SEDIMENT SAMPLE ▲	SURFACE WATER	FULL TCL/TAL	ROUTINE (28-40 DAYS)
	SEDIMENT	FULL TCL/TAL	ROUTINE (28-40 DAYS)
➔	APPROXIMATE GROUNDWATER FLOW DIRECTION		

FIGURE 3-8
SURFACE WATER/SEDIMENT INVESTIGATION
SITE 78

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

downgradient conditions. If water is present at the time of sampling, one surface water sample will be collected from each branch of the creek at each of the sampling stations. A surface (top 6 inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected from the bank at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample and pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid inclusion of disturbed sediment in the water sample. In addition, the further downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device.

The surface water and sediment samples will be analyzed for full TCL organics and TAL inorganics using CLP Methods (Level IV data quality). In addition, all surface water samples will be analyzed in the field for DO, temperature, specific conductivity, and pH (Level I data quality).

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

3.2 Site 21 - Transformer Storage Lot 140

There are two areas of concern at Site 21: the former pesticide mixing area and the former transformer oil disposal pit. Samples will be collected from both areas of concern. The various sampling and investigation programs include: surveying; soil investigation; groundwater investigation; surface water/sediment investigation.

3.2.1 Surveying

All existing monitoring wells and any wells installed during the investigation at Site 21 will be surveyed. The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be within 0.1 foot. In addition, soil sampling locations (i.e., boreholes) and surface water/sediment sample locations will be surveyed to a horizontal accuracy of 1 foot.

3.2.2 Soil Investigation

The following subsections describe the soil sampling locations and analytical requirements at Site 21.

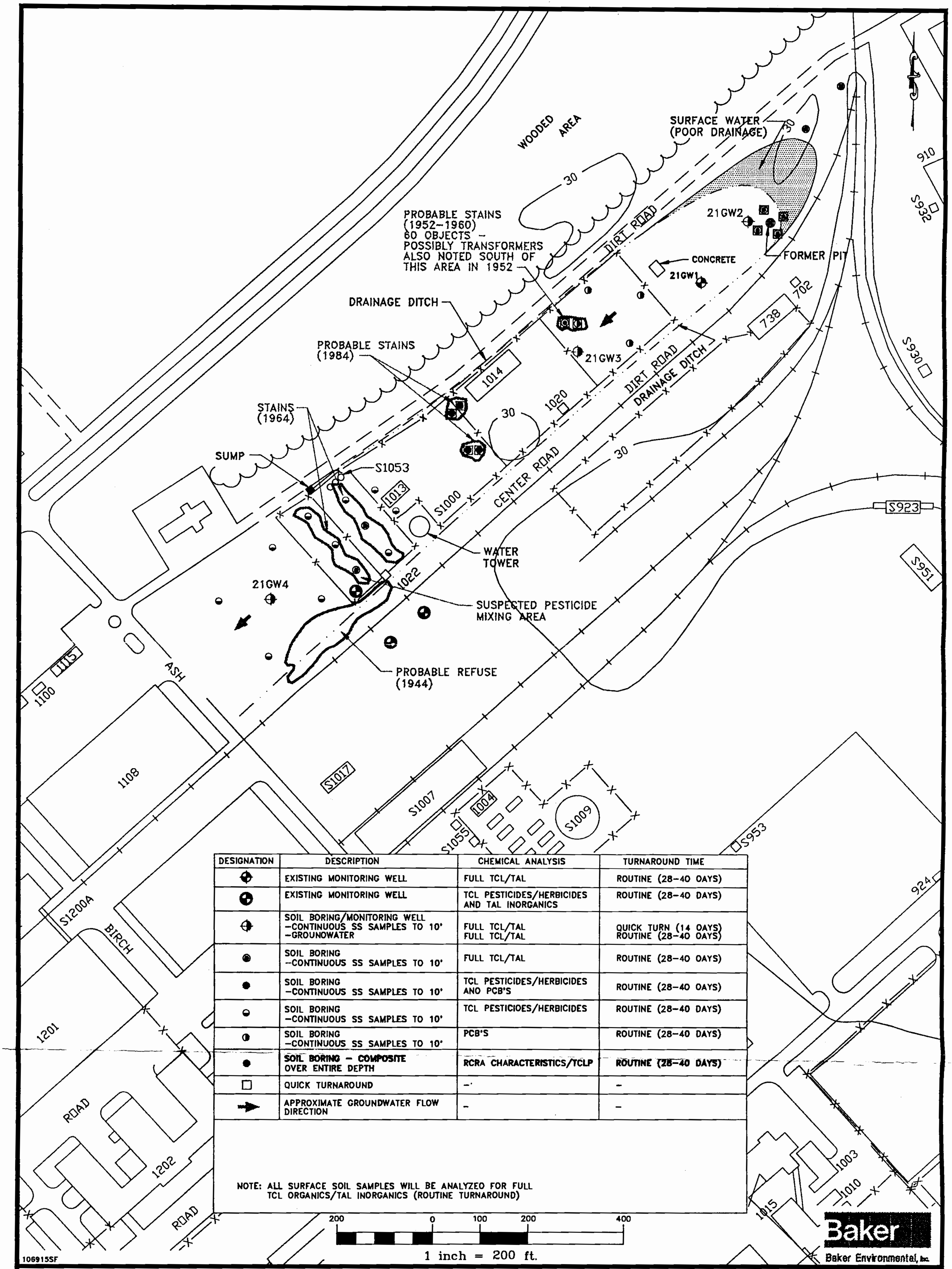
3.2.2.1 Former Transformer Oil Disposal Pit

The number of samples, analytical requirements, data quality level and analytical turnaround time are included in Table 3-1.

Soil sampling locations are presented on Figure 3-9. Fourteen (14) soil borings (including two soil boring/monitoring wells) will be installed at Site 21 for purposes of characterizing the extent of contamination at the former transformer oil disposal pit and the surrounding area.

Test borings will be augered and soil samples collected using ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately 5 to 10 feet below ground surface across the site. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis. For soil boring/monitoring well 21GW3, an additional sample will be collected just below the water table. For soil boring/monitoring well 21GW2, only two samples will be collected; one just above the water table and one just below the water table.

Surface soil samples collected from eleven of the borings will be analyzed for full TCL organics and TAL inorganics per CLP protocol. In addition, the subsurface soil samples from seven (7) of the borings will be analyzed for full TCL organics and TAL inorganics using CLP protocols (Level IV data quality). Samples from two of these borings (near the northern end of the site) will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround of 28 to 40 days). Samples from the other five borings (located near the former disposal pit and the 1952-1960 probable stain area) will be analyzed for quick laboratory turnaround (i.e., 14 days). These samples will be used to assess whether further soil sampling is required to adequately delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.



DESIGNATION	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
⊕	EXISTING MONITORING WELL	FULL TCL/TAL	ROUTINE (28-40 OAYS)
◕	EXISTING MONITORING WELL	TCL PESTICIDES/HERBICIDES AND TAL INORGANICS	ROUTINE (28-40 DAYS)
⊕	SOIL BORING/MONITORING WELL -CONTINUOUS SS SAMPLES TO 10' -GROUNOWATER	FULL TCL/TAL FULL TCL/TAL	QUICK TURN (14 OAYS) ROUTINE (28-40 OAYS)
◉	SOIL BORING -CONTINUOUS SS SAMPLES TO 10'	FULL TCL/TAL	ROUTINE (28-40 OAYS)
●	SOIL BORING -CONTINUOUS SS SAMPLES TO 10'	TCL PESTICIDES/HERBICIDES ANO PCB'S	ROUTINE (28-40 OAYS)
◒	SOIL BORING -CONTINUOUS SS SAMPLES TO 10'	TCL PESTICIOES/HERBICIDES	ROUTINE (28-40 DAYS)
◑	SOIL BORING -CONTINUOUS SS SAMPLES TO 10'	PCB'S	ROUTINE (28-40 DAYS)
●	SOIL BORING - COMPOSITE OVER ENTIRE DEPTH	RCRA CHARACTERISTICS/TCLP	ROUTINE (28-40 DAYS)
☐	QUICK TURNAROUND	-'	-
➡	APPROXIMATE GROUNDWATER FLOW DIRECTION	-	-

NOTE: ALL SURFACE SOIL SAMPLES WILL BE ANALYZEO FOR FULL TCL ORGANICS/TAL INORGANICS (ROUTINE TURNAROUND)

200 0 100 200 400

1 inch = 200 ft.

FIGURE 3-9
GROUNDWATER AND SOIL INVESTIGATION
SITE 21

SOURCE: LANTDIV, FEBRUARY 1992

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

The subsurface soil samples collected from four of the borings (in the area where possible transformers were identified in 1952) will be analyzed for PCBs only. Samples from one of these borings will receive quick turnaround in the laboratory. These samples will be used to determine whether further soil sampling is required to delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. Areas requiring further investigation will be determined in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

One composite sample collected from the soil boring located at the center of the pit area will be analyzed for RCRA characteristics and TCLP in order to determine if the material is classified as hazardous. Samples from a nearby boring will be used to evaluate engineering parameters. All samples from this boring will be analyzed for grain size, moisture density, residual chlorine, total fluoride, organic nitrogen, and TOC. The above-mentioned analyses will help in evaluating potential applicable technologies such as thermal destruction, solidification/ fixation, and off-site treatment and disposal options.

3.2.2.2 Former Pesticide Mixing Area

The number of samples, analytical requirements, data quality level and analytical turnaround time are included in Table 3-1.

As shown on Figure 3-9, seventeen (17) soil borings (including one soil boring/monitoring well) will be installed at Site 21 for purposes of characterizing the extent of contamination at the former pesticide mixing area.

Test borings will be augered and soil samples collected via ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately 5 to 10 feet below ground surface across the site. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis. An additional sample just below the water table will be collected from the soil boring/monitoring well (21GW4).

The soil samples collected from this area will be analyzed for various compounds. Surface soil samples collected from all 17 borings (including 21GW4) will be analyzed for full TCL organics and TAL inorganics per CLP protocol. Subsurface soil samples from ten of the borings will be analyzed for TCL pesticides and herbicides. Subsurface soil samples from four of the borings (northeast of the water tower) will be analyzed for TCL pesticides/herbicides and PCBs. Subsurface soil samples from two of the borings (in the formerly stained areas within the suspected pesticide mixing area) will be analyzed for full TCL organics and TAL inorganics. These samples will provide data required to assess human and ecological risks and will more fully characterize surface and subsurface soils. The soil samples collected from the newly-installed monitoring well will be analyzed for full TCL organics and TAL inorganics. The monitoring well samples will receive quick turnaround analysis (14 days). All of the samples will be analyzed per CLP protocols (Level IV data quality).

The samples collected from the two probable stain areas in the 1984 aerials will receive quick turnaround analysis (14 days) so that the determination as to whether additional wells are needed in this area. Areas requiring further investigation will be determined during the field investigation in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

Samples from one boring in the pesticide mixing area will be analyzed to evaluate engineering parameters. All samples from this boring will be analyzed for grain size, moisture density, TCLP, organic chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, ignitability, and reactivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction, solidification/fixation, or off-site treatment and disposal options.

3.2.2.3 Monitoring Well Test Borings

Two soil samples from soil boring/monitoring well 21GW2 will be collected for chemical analysis. One sample will be from the interval just above the water table; the other sample from just below the water table. These samples will be analyzed for full TCL organics and TAL inorganics. The samples collected from soil borings/monitoring wells 21GW3 and 21GW4 (one surface and up to three subsurface samples each) will be analyzed for full TCL organics and TAL inorganics.

3.2.3 Groundwater Investigation

Groundwater investigations will be conducted at Site 21 to assess groundwater quality at the former pesticide mixing area and at the former transformer oil disposal pit area. The proposed well locations are shown on Figure 3-9. The groundwater investigations will consist of the construction of monitoring wells within the site and the collection of one round of groundwater samples and water level measurements.

3.2.3.1 Monitoring Well Construction

One monitoring well (21GW1) was previously installed at Site 21 as shown on Figure 3-9 to monitor groundwater quality. In addition, three other monitoring wells (well numbers not known) were previously installed near the southeast portion of the site. These other three wells may have been installed as part of the product recovery system associated with Site 22 (Hadnot Point Fuel Farm). The well construction details for the four existing wells are not known. Since there are areas that need further evaluation at the site, specifically the oil pit and the pesticide mixing area, at least three shallow monitoring wells (21GW2 through 21GW4) will be installed during the RI.

The shallow wells will be constructed of 4-inch PVC to a depth of at least 15 feet below the top of the water table. Four-inch wells are proposed since they can easily by converted into extraction wells if required. Well screens will be a standard 10-foot length. This well depth and screen length will allow for seasonal fluctuations in the water table and will provide groundwater samples that are representative of the surficial aquifer at the site.

3.2.3.2 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each existing well. Groundwater samples collected from the three existing monitoring wells within the former pesticide mixing area will be analyzed for TCL pesticides/herbicides and TAL inorganics. The groundwater samples collected from the newly-installed monitoring wells and existing well 21GW1 near the former transformer oil pit will be analyzed for full TCL organics and TAL inorganics. TCL volatiles will be analyzed using Method 601/602. All other organic and inorganic analysis will be analyzed using CLP protocols. Inorganic samples will be analyzed for total (unfiltered) constituents.

The three newly-installed wells will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include BOD, COD, TSS, TDS, TOC, and TVS.

3.2.3.3 Water Level Measurements

Static water levels measurements will be collected form each well during the sampling event. Water level measurements will be collected within a 4-hour period, if possible. Groundwater level data will be used to evaluate groundwater flow direction.

3.2.4 Surface Water/Sediment Investigations

Table 3-1 summarizes the sampling and analytical programs for the surface water and sediment investigations. Surface water and sediment investigations will be conducted in the drainage ditch surrounding Site 21 to assess possible impacts to this drainage ditch from the two areas of concern at the site. This section outlines the sampling and analytical requirements for the surface water/sediment investigations.

3.2.4.1 Former Pesticide Mixing Area

As shown on Figure 3-10, twelve (12) surface water and sediment sampling stations have been identified to adequately characterize potential impacts from the former pesticide mixing area at Site 21 and downgradient conditions. If water is present at the time of sampling, one surface water sample will be collected from the drainage ditch at each of the sampling stations. A surface (top 6 inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid the inclusion of disturbed sediment in the water sample. In addition, the further downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device.

As indicated on Figure 3-10, the surface water and sediment samples will be analyzed for pesticides/herbicides and PCBs or else for full TCL organics and TAL inorganics using CLP Methods, (Level IV data quality). In addition, all surface water samples will be analyzed in the field for dissolved oxygen, temperature, specific conductivity, and pH (Level I data quality).

No aquatic/ecological surveys will be conducted at the site unless the results from the surface water and sediment sampling indicate that the site is potentially impacting the environment. Based on the investigation results, a determination of the need for any aquatic/ecological surveys will be made in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

3.2.4.2 Former Transformer Oil Disposal Area

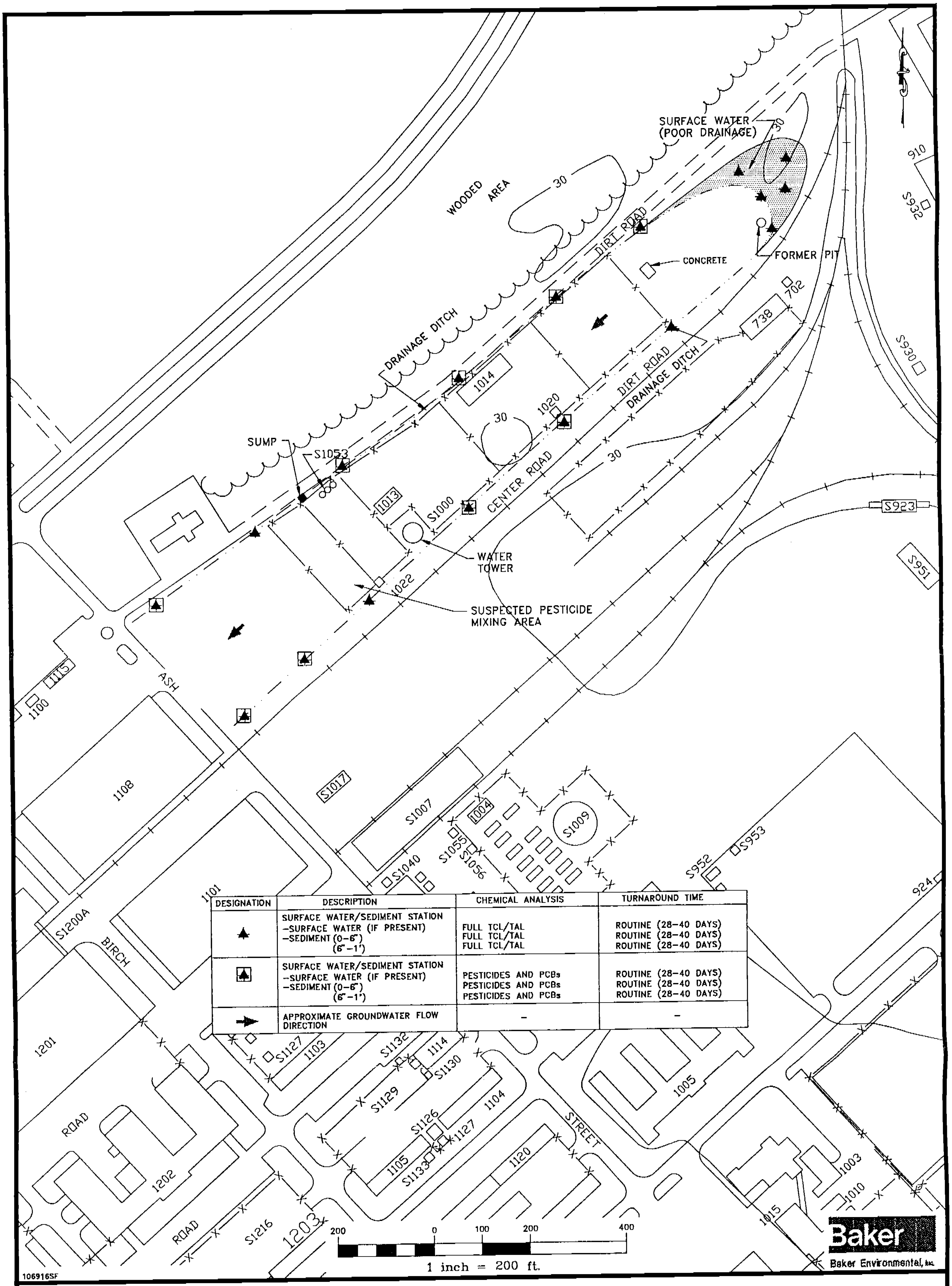
As shown on Figure 3-10, five (5) surface water and sediment sampling stations have been identified to adequately characterize potential impacts from the former transformer oil disposal pit Area at Site 21. If water is present at the time of sampling, one surface water sample will be collected from the drainage ditch at each of the sampling stations. A surface (top 6 inches) and a subsurface (6 to 12 inches below ground surface) sediment sample will be collected at each station. Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, then pouring the sample directly into the appropriate sample bottles.

Surface water samples will be collected at each station prior to obtaining the sediment sample to avoid the inclusion of disturbed sediment in the water sample. In addition, the further downstream samples will be collected first, with subsequent samples taken moving upstream. Sediment samples will be obtained using a hand coring device.

The surface water and sediment samples collected at this portion of the site will be analyzed for full TCL organics and TAL inorganics using CLP Methods, (Level IV data quality). In addition, all surface water samples will be analyzed in the field for dissolved oxygen (DO), temperature, specific conductivity, and pH (Level I data quality).

3.3 Site 24 - Industrial Area Fly Ash Dump

There are four areas of concern at Site 24: spiractor sludge disposal area; fly ash disposal area; borrow and debris disposal area; and buried metal disposal areas. Samples will be collected from all areas of concern. The various sampling and investigation programs include: pre-investigation sampling; surveying; waste characterization; soil investigation; groundwater investigation.



DESIGNATION	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
▲	SURFACE WATER/SEDIMENT STATION –SURFACE WATER (IF PRESENT) –SEDIMENT (0–6") (6"–1')	FULL TCL/TAL FULL TCL/TAL FULL TCL/TAL	ROUTINE (28–40 DAYS) ROUTINE (28–40 DAYS) ROUTINE (28–40 DAYS)
▲	SURFACE WATER/SEDIMENT STATION –SURFACE WATER (IF PRESENT) –SEDIMENT (0–6") (6"–1')	PESTICIDES AND PCBs PESTICIDES AND PCBs PESTICIDES AND PCBs	ROUTINE (28–40 DAYS) ROUTINE (28–40 DAYS) ROUTINE (28–40 DAYS)
➔	APPROXIMATE GROUNDWATER FLOW DIRECTION	–	–

106916SF

FIGURE 3–10
SURFACE WATER AND SEDIMENT INVESTIGATION
SITE 21

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, FEBRUARY 1992

3.3.1 Pre-Scoping Sampling

As part of the scoping process for this RI/FS, Baker personnel collected groundwater samples from site monitoring wells 24GW1, 24GW2, 24GW3, 24GW4, and 24GW6. The samples were collected in July, 1992 and were analyzed for TCL organic and TAL inorganic parameters. Lead exceeded the Federal Maximum Contaminant Level (MCL) of 15 migrograms per liter (µg/L). Iron and manganese exceeded the North Carolina groundwater standards of 300 µg/L for iron and 50 µg/L for manganese. The Pre-Scoping Sampling results are presented in Appendix A. The results of the Pre-Investigation Sampling have been utilized to develop the RI/FS objectives.

3.3.2 Surveying

All existing monitoring wells and any wells installed during the investigation at Site 24 will be surveyed. The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be within 0.1 foot. In addition, soil sampling locations (i.e., boreholes) and surface water/sediment sample locations will be surveyed to a horizontal accuracy of 1 foot.

3.3.3 Soil Investigation

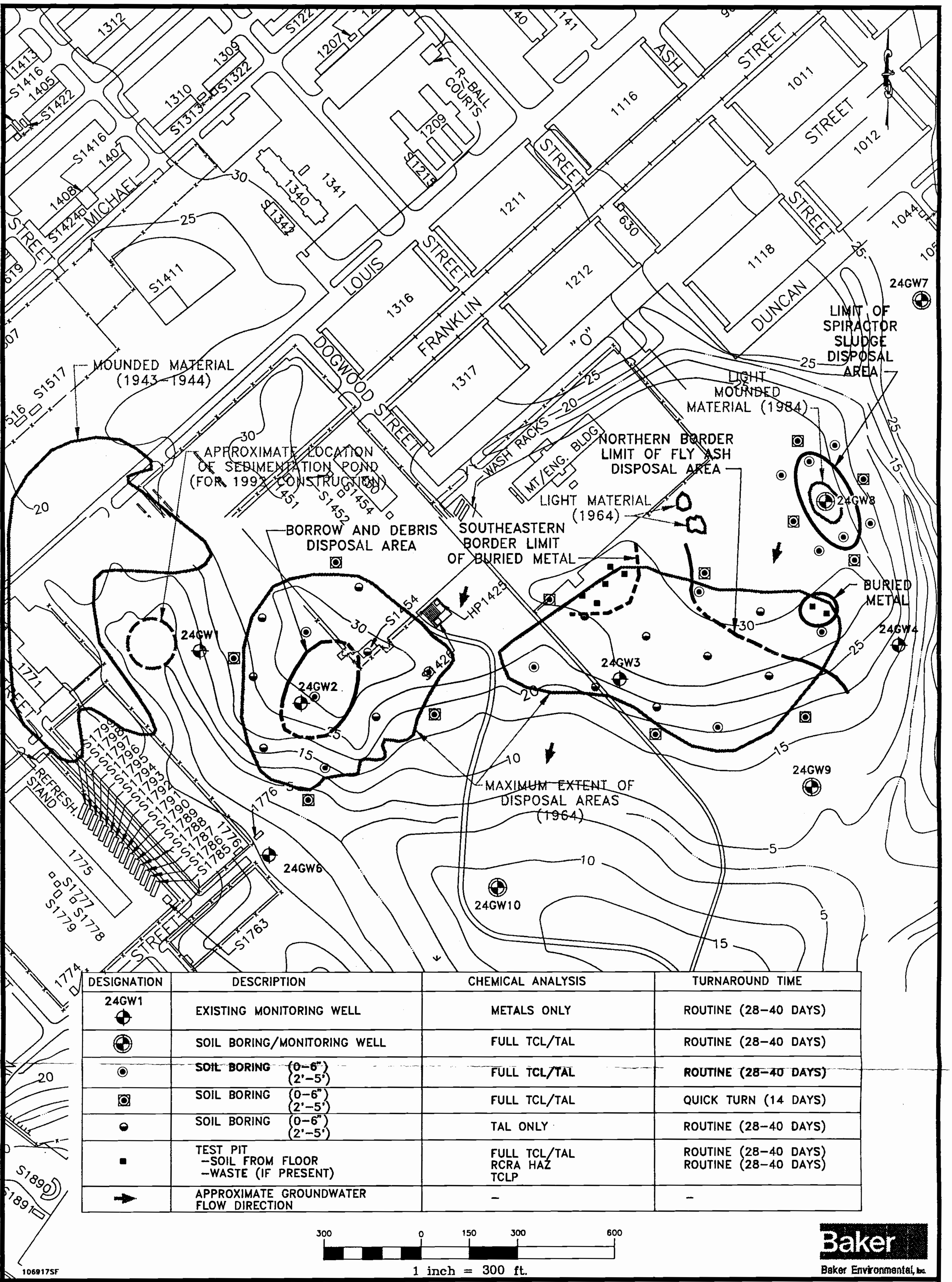
The following subsections describe the soil sampling locations and analytical requirements of the areas of concern at Site 24.

3.3.3.1 Spiractor Sludge Disposal Area

Table 3-1 summarizes the soil sampling program for the spiractor sludge disposal area at Site 24.

As shown on Figure 3-11, eleven (11) soil borings (including one soil boring/monitoring well) will be installed at Site 24 for purposes of adequately characterizing the extent of contamination at the spiractor sludge disposal area. In addition, one soil boring/monitoring well will be installed upgradient of the site as a background sample location.

Test borings will be augered and soil samples collected using ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and at 5-foot



DESIGNATION	DESCRIPTION	CHEMICAL ANALYSIS	TURNAROUND TIME
24GW1 ⊕	EXISTING MONITORING WELL	METALS ONLY	ROUTINE (28–40 DAYS)
⊕	SOIL BORING/MONITORING WELL	FULL TCL/TAL	ROUTINE (28–40 DAYS)
◉	SOIL BORING (0–6") (2'–5')	FULL TCL/TAL	ROUTINE (28–40 DAYS)
▣	SOIL BORING (0–6") (2'–5')	FULL TCL/TAL	QUICK TURN (14 DAYS)
◒	SOIL BORING (0–6") (2'–5')	TAL ONLY	ROUTINE (28–40 DAYS)
■	TEST PIT –SOIL FROM FLOOR –WASTE (IF PRESENT)	FULL TCL/TAL RCRA HAZ TCLP	ROUTINE (28–40 DAYS) ROUTINE (28–40 DAYS)
→	APPROXIMATE GROUNDWATER FLOW DIRECTION	–	–

FIGURE 3–11
GROUNDWATER AND SOIL INVESTIGATION
SITE 24

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, FEBRUARY 1992

intervals to the top of the water table, which is estimated to be approximately 5 to 10 feet below ground surface across the site. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

Soil samples will be analyzed for TCL organics and TAL inorganics using CLP protocols (Level IV data quality). The samples from eight (8) of the borings will be analyzed within the maximum allowable holding times (i.e., routine analytical turnaround of 28 to 40 days). Samples from several of the borings surrounding the suspected limits of the disposal area will be analyzed within 14 days. These samples will be used to assess whether further soil sampling is required to further delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

The samples collected from the soil boring/monitoring well located at the center of the spiractor sludge disposal area will be analyzed for RCRA characteristics and TCLP in order to determine if the material is classified as hazardous. Samples from this same boring will be used to evaluate engineering parameters. All samples from this boring will be analyzed for grain size, moisture density, residual chlorine, total fluoride, organic nitrogen, alkalinity, corrosivity, and TOC. These parameters will help in evaluating potential applicable technologies such as thermal destruction, solidification/fixation, and off-site treatment and disposal options.

3.3.3.2 Fly Ash Disposal Area

Table 3-1 summarizes the soil sampling program for the fly ash disposal area at Site 24.

As shown on Figure 3-11, sixteen (16) soil borings [including one soil boring/monitoring well (24GW9)] will be installed at Site 24 for purposes of adequately characterizing the extent of contamination at the fly ash disposal area.

Test borings will be augered and soil samples collected using ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and from the 2 to 5-foot interval (unless the water table is reached). Due to the dense vegetation, these samples will be hand augered.

Soil samples collected from nine of the borings (including 24GW9) will be analyzed for full TCL organics and TAL inorganics using CLP protocols (Level IV data quality). Samples from four (4) of the borings will be analyzed within 14 days. These samples will be used to assess whether further soil sampling is required to adequately delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation in consultation with EPA Region IV, N.C. DEHNR, and LANTDIV.

Soil samples collected from seven (7) of the borings will be analyzed for TAL inorganics only. These samples will be analyzed within the maximum allowable holding times and will be analyzed under CLP protocols.

The samples collected from one of the soil borings located within the limits of the disposal area will be analyzed for RCRA hazardous waste characteristics (including TCLP) in order to determine if the material is classified as hazardous. Samples from this same boring will be analyzed to evaluate engineering parameters. All samples from this boring will be analyzed for grain size, moisture density, TOC, organic chlorine, total fluoride, organic nitrogen, alkalinity, and corrosivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction, solidification/fixation, and off-site treatment and disposal options.

3.3.3.3 Buried Metal Areas

Test pits will be excavated in areas of suspected waste disposal. Test pit locations are presented on Figure 3-11. The number of samples, analytical requirements, data quality level and analytical turnaround time are included in Table 3-1.

One representative soil sample will be collected from the floor of each test pit excavation. These samples will be analyzed for TCL organic and TAL inorganic parameters. A representative soil sample from one of the test pits will be analyzed for Engineering/Feasibility Study (FS) parameters.

The contents of drums (if the integrity of the drums has been destroyed) will be sampled and visibly contaminated soil that are excavated. All samples will be analyzed for RCRA

Hazardous Waste Characteristics including full Toxicity Characteristic Leachate Procedure (TCLP).

3.3.3.4 Borrow and Debris Disposal Area

Table 3-1 summarizes the soil sampling program for the borrow and debris disposal area.

Fifteen (15) soil borings [including one soil boring/monitoring well (24GW10)] will be installed at Site 24 for purposes of characterizing the extent of contamination at the borrow and debris disposal area (Figure 3-11).

Test borings will be augered and soil samples collected using ASTM Method D1586-84 at each sample station. Samples will be collected from the ground surface (top 6 inches) and at 5-foot intervals to the top of the water table, which is estimated to be approximately 5 to 10 feet below ground surface across the site. Therefore, it is possible that as many as three soil samples and no less than two soil samples will be collected from each borehole for subsequent laboratory analysis.

Soil samples collected from nine (9) of the borings (including 24GW10) will be analyzed for TCL organics and TAL inorganics using CLP protocols (Level IV data quality). Samples from four of the borings surrounding the suspected limits of the disposal area will be analyzed within 14 days. These samples will be used to assess whether further soil sampling is required to more fully delineate the extent of surface or subsurface soil contamination. Areas where elevated levels of contaminants are detected will be further investigated. These areas will be determined during the field investigation in consultation with EPA Region IV and LANTDIV.

Soil samples collected from six (6) of the borings will be analyzed for TAL inorganics only. These samples will be analyzed within the maximum allowable holding times and will be analyzed under CLP protocols.

The samples collected from the soil boring located at the center of the disposal area will be analyzed for RCRA hazardous waste characteristics (including TCLP) in order to determine if the material is classified as hazardous. Samples from this same boring will also be analyzed to evaluate engineering parameters. All samples from this boring will be analyzed for grain size, moisture density, TOC, organic chlorine, total fluoride, organic nitrogen, alkalinity, and corrosivity. These parameters will help in evaluating potential applicable technologies such as thermal destruction, solidification/fixation, and off-site treatment and disposal options.

3.3.3.5 Monitoring Well Test Borings

Two soil samples from each monitoring well test boring will be collected for chemical analysis. One sample will be from the interval just above the water table; the other sample from just below the water table. These samples will be analyzed for full TCL organics and TAL inorganics.

3.3.4 Groundwater Investigation

Groundwater investigations will be conducted at Site 24 to assess groundwater quality at the four areas of concern at the site. The groundwater investigations will consist of the construction of monitoring wells within the site and the collection of one round of groundwater samples and water level measurements from the newly installed wells in addition to all existing wells at the site.

3.3.4.1 Monitoring Well Construction

Six monitoring wells (24GW1 through 24GW6) were previously installed at Site 24 to monitor groundwater quality. These wells are each 25 feet deep. No other construction details are known. The location of these wells (with the exception of 24GW5) are shown on Figure 3-11. These wells are each 25 feet deep. No other construction details are known. Well 24GW5 was not found during the recent site visit conducted in June 1992. Since there are areas within Site 24 that need to be further evaluated at the site, specifically the suspected disposal areas, at least four shallow monitoring wells (24GW7 through 24GW10) will be installed during the RI. Well 24GW7 will be identified as a "background" well for the entire Operable Unit No. 1.

The shallow wells will be constructed of 4-inch PVC to a depth of at least 15 feet below the top of the water table. Four-inch wells are proposed since they can easily be converted into extraction wells if required. Well screens will be a standard 10-foot length. This well depth and screen length will allow for seasonal fluctuations in the water table and will provide samples that are representative of the surficial aquifer at the site.

3.3.4.2 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each existing well (24GW1, 24GW2, 24GW3, 24GW4, and 24GW6). All of the groundwater samples will be analyzed for TAL inorganics using CLP protocols. These wells were recently sampled (July 1992) for full TCL organics and TAL inorganics.

One round of groundwater samples will be collected from each of the newly installed wells. All of these samples will be analyzed for full TCL organics and TAL inorganics. TCL volatiles will be analyzed using Method 601/602. All other organic and inorganic analysis will be analyzed using CLP protocols. Inorganic samples will be analyzed for total (unfiltered) constituents.

The new wells will also be sampled for analysis of engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include: BOD, COD, TSS, TDS, TOC, and TVS.

3.3.4.3 Water Level Measurements

Static water level measurements will be collected from each well during the sampling event. Water level measurements will be collected within a 4-hour period, if possible. Groundwater level data will be used to evaluate groundwater flow direction.

3.4 QA/QC Samples

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

- Trip Blanks

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

- Equipment Rinsates

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

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

- Field Blanks

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

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

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

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

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

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

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

- Preservation Blanks

One preservation blank will be submitted at the beginning and at the end of the field program.

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

The sample designation format is as follows:

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

An explanation of each of these identifiers is given below.

Site #	Sites included in this investigation are 2 and 74.
Media	SB = Soil Boring (soil sample from a boring) TP = Test Pit (soil sample from test pit) 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

Under this sample designation format the sample number 4-GW-3-1D refers to:

24-GW-3-1D	Site 24
24--GW-3-1D	Groundwater sample
24-GW-3-1D	Monitoring well #3
24-GW-3-1D	Round 1
24-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

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

5.1 Soil Sample Collection

Surface and subsurface soil samples will be collected throughout Operable Unit No. 1. 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. Some soil samples will be collected from test pits excavated by a backhoe.

5.1.1 Soil Borings Advanced by Hand Auger

Hand augering is the most common manual method used to collect subsurface samples. Typically, 4-inch bucket augers with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger is related to the material being sampled. In this investigation, hand augers will be used to collect discrete grab samples of soil from the 0 to 6 inch and 2 to 4 foot intervals.

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

5.1.2 Soil Borings and Monitoring Well Boreholes

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

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

Selected split-spoon samples will be submitted to the laboratory for analysis. The soil samples will be collected from the ground surface at 5-foot intervals to the top of the water table and will be submitted to the laboratory for analysis. For human health risk assessment purposes, only the 0 to 6 inch interval of the first split-spoon sample (0 to 2 feet) will be submitted for 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. Only the top 6 inches will be submitted to the laboratory for analyses.

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

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

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

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

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

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

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

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

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

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

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

5.1.3 Test Pits

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

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

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

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

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

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

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

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

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

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

- Upon completion, test pits shall be immediately backfilled.

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

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

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

5.2 Monitoring Well Installation

Shallow monitoring wells will be installed on site to monitor the shallow (water table) aquifer. It is estimated that these wells will be 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 8 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.

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

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

- 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. A PVC slip-cap vented to the atmosphere, will be placed at the top of the riser.

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

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

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

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

- The monitoring wells will be completed at the surface. The aboveground section of the PVC riser pipe will be protected by installation of a 6-inch diameter, 5-foot long steel casing (with locking cap and lock) into the cement grout. The bottom of the surface casing will be placed at a minimum of 2-1/2, but not more than 3-1/2 feet below the ground surface, as space permits, 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 shall not fully penetrate the bentonite seal.

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

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

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

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

All monitoring wells will be developed as specified in the ECBSOPQAM. 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 shall not be initiated until a minimum of 24 hours has elapsed subsequent 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.

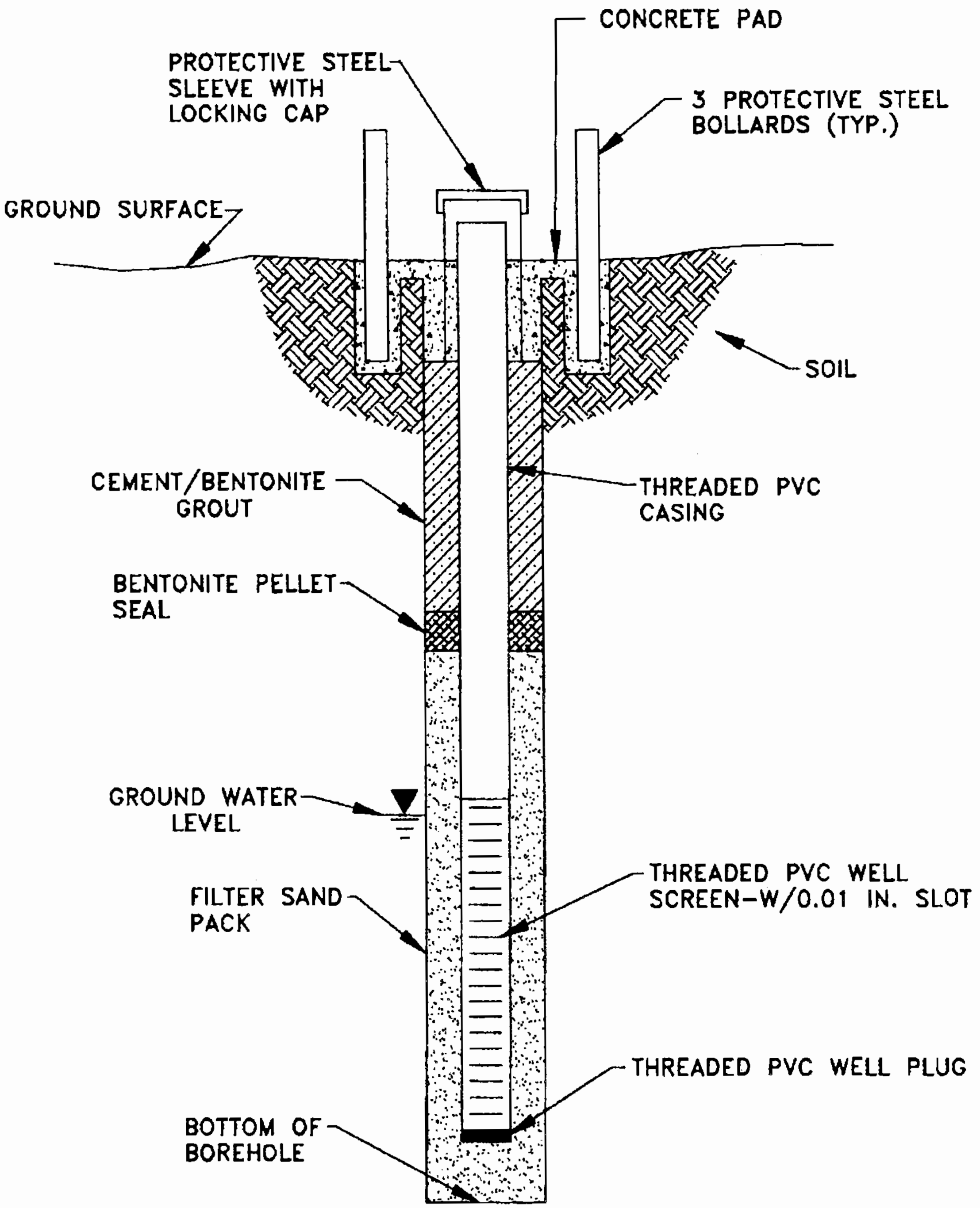
All wells shall be developed until well water runs relatively clear of fine-grained materials. Note that the water in some wells does not clear with continued development. Typical limits placed on well development may include any one of the following:

- 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).



N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5-1
TYPICAL SHALLOW GROUNDWATER
MONITORING WELL CONSTRUCTION DIAGRAM

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

- Clarity based on turbidity measurements [typically less than 50 Net Turbidity Units (NTU)].

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

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

5.3 Groundwater Sample Collection

5.3.1 Groundwater Samples Collected from Monitoring Wells

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

The collection of a groundwater sample includes the following steps:

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

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

3. Lower purging equipment (bailer or submersible pump) 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 using a bucket and stopwatch.

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

6. Record measurements of specific conductance, temperature, and pH during purging 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. Samples for VOC analysis will be collected first. Sample bottles will be filled in the same order for all monitoring wells.

Sample preservation handling procedures are outlined in Section 6.

5.4 Surface Water Sample Collection

The following procedures will be used for the collection of surface water samples at stations located on site. At each station, samples will be collected at the approximate mid-vertical point or near the bank of the surface water body. Care will be taken to ensure that the sampler does not contact and/or stir up the sediments, while still being relatively close to the sediment-water interface.

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

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

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

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

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

The sampling location will be marked by placing a wooden stake and bright colored flagging at the nearest bank or shore. The sampling location will be marked with indelible ink on the stake. In addition, the distance from the shore and the approximate location will be estimated using triangulation methods, and recorded and sketched in the field log book. If permission is granted, photographs will be taken to document the physical and biological characteristics of the sampling location.

The following information will be recorded in the field logbook:

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

Sample preservation and handling procedures are outlined in Section 6.

5.5 Sediment Sample Collection

The following procedures will be used for the collection of sediment samples at stations located on site. At each station, surface and near surface sediment samples will be collected at a depth of 0-6 inches, and 6-12 inches. These intervals of sediment will be collected using a stainless steel hand-held coring instrument. A new or decontaminated stainless steel liner tube, fitted with an eggshell catcher to prevent sample loss, will be used at each station.

The coring device will be pushed into the sediments to a minimum depth of fifteen inches, or until refusal, whichever is encountered first. The sediments in the 0 to 6-inch interval and 6 to 12-inch interval will be extruded with a decontaminated extruder into the appropriate sample containers. If less than twelve inches of sediments are obtained, the first six inches will be placed in the 0 to 6-inch container, and the remaining sediment will be placed into the 6 to 12-inch container.

The sampling procedures for using the hand-held coring instrument are outlined below:

1. Inspect and prepare the corer:

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

   b. Check the flutter valve for ease of movement.

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

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

2. Get in position for the sampling operation -- keeping in mind that, if the purpose is to obtain samples containing fauna or stratified sediments, disturbance of the bottom area to be sampled should be avoided.

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

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

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

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

7. Secure and identify the new sample. Unscrew the nose cone. Pull the liner out. Push out any extra sediments (greater than 12 inches). Push out the sediments within the 6 to 12 inch interval and place it in a sample jar. Push out the 0 to 6 inch sediment interval into another sample jar.

8. Seal all sample jars tightly.

9. Label all samples.

5.6 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 covers, etc.

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

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

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

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

4. Rinse equipment thoroughly with deionized water.

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

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

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

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

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

5.6.1.2 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 10 percent nitric acid.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with deionized water.

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

7. Cap with aluminum foil or Teflon® film.

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

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

5.6.1.4 Plastic Reusable Composite Sample Containers

1. Proceed with the cleaning procedures as outlined in Section 5.6.1.3 but omit the solvent rinse.

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

5.6.1.5 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 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. Equipment should be placed 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 on all drilling activities.

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

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

2. Rinse thoroughly with tap water (potable).

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

3. Rinse thoroughly with deionized water.

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

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

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

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

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

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

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

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

Cleaning and decontamination of all equipment shall occur at a designated area on the site, downgradient, and downwind from the clean equipment drying and storage area. All cleaning of drill rods, auger fights, well screen and casing, etc., will be conducted above the plastic sheeting using saw horses or other appropriate means. At the completion of the drilling activities, the pit shall be backfilled with the appropriate material designated by the Site

Manager, but only after the pit has been sampled, and the waste/rinse water has been pumped into 55-gallon drums. No solvent rinsates will be placed in the pit unless prior approval is granted. All solvent rinsates shall be collected in separate containers for proper disposal.

5.7 Surveying

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

- Surveying sampling grid for soil investigation.
- Surveying nongrid sampling points (monitoring wells, test pits, surface water/sediment locations).

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

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

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

5.8 Drum Sampling

5.8.1 Procedures

Drums which will require sampling may be encountered during excavation of test pits at Site 24. Prior to sampling, drums will be visually inspected to gain as much information as possible about their contents. Items to consider during inspection include:

- Symbols, wording, labels, or other marks on the drum indicating that its contents are hazardous, e.g., radioactive, explosive, corrosive, toxic, or flammable.
- Symbols, wording, labels, or other marks on a drum indicating that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume individual containers.
- Signs of deterioration such as corrosion, rust, and leaks.
- Signs of the chemical nature of the contents, such as residue, crystal buildup, etc. at bung opening, etc.
- Signs that the drum is under pressure such as swelling and bulging.
- Special drum types.
- Configuration of the drumhead.
- Drum standing upright, tilted, or lying on its side.
- Accessibility of the drum.

Monitoring will be conducted around the drums using instruments such as a gamma radiation survey instrument, organic vapor monitor (OVA or HNu), colorimetric tubes (Dräger tubes), and a combustible gas meter. The results can be used to classify the drums into categories such as radioactive, leaking/deteriorating, bulging, explosive/shock-sensitive, or laboratory packs. Until drum contents are characterized, sampling personnel will assume that unlabeled drums contain hazardous materials. Personnel also should be aware that drums are frequently mislabeled and may not contain the material identified.

Drums encountered during test pitting will be removed and placed in a roll-off box if already crushed, destroyed, or leaking. If the drums still contain material, the material will be sampled. Soils excavated during the test pit operation will be placed in a separate roll-off box. If intact drums are encountered, the drums will be removed, sampled, overpacked, and identified. The drums will then be placed in a secure area managed by the Environmental Management Division at Camp Lejeune.

5.9 Handling of Site Investigation Generated Wastes

5.9.1 Responsibilities

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

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

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

5.9.2 Sources of Investigation Derived Wastes (IDW)

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

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

- Drilling and monitoring well construction (drill cuttings)
- Monitoring well development (development water)
- Groundwater sampling (purge water)
- 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)

5.9.3 Designation of Potentially Hazardous and Nonhazardous IDW

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

5.9.3.1 Drill Cuttings

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

5.9.3.2 Monitoring Well Development and Purge Water

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

5.9.3.3 Decontamination Fluids

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

5.9.3.4 Personal Protective Equipment

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

5.9.4 Labeling

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

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

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

5.9.5 Container Log

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

5.9.6 Container Storage

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

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

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

5.9.7 Container Disposition

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

5.9.8 Disposal of Contaminated Materials

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

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

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

5.10 Water Level Measurements

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

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

5.11 Soil Gas Survey

The following subsections are from the standard operating procedures provided by Tracer Research Corporation (TRC). They outline the soil gas survey and soil gas sample collection procedures.

5.11.1 Soil Gas Sampling Procedure

Probe Placement

A. A clean probe (pipe) is removed from the storage tube on top of the van.

B. The soil gas probe is placed in the jaws of hydraulic pusher/puller mechanism.

C. A sampling point is put on the bottom of the probe.

D. The hydraulic pushing mechanism is used to push the probe into the ground.

E. If the pusher mechanism will not push the probe into the ground a sufficient depth for sampling, the hydraulic hammer is used to pound the probe into the ground.

Sample Extraction

A. An adaptor is put onto the top of the soil gas probe.

B. The vacuum pump is hooked onto the adaptor.

C. The vacuum pump is turned on and used to evacuate soil gas.

D. Evacuation will be at least 30 seconds, but never more than 5 minutes for samples having evacuation pressures less than 15 inches of mercury. Evacuation times will be at least 1 minute, but no more than 5 minutes for probes reading greater than 15 inches of mercury.

E. Gauges on the vacuum pump are checked for inches of mercury.

   1. 'Gauge must read at least 2 inches of mercury less than maximum vacuum to be extracting sufficient soil gas to collect a valid sample.

Sample Collection

A. With vacuum pump running, a hypodermic syringe needle is inserted through the silicone rubber and down into the metal tubing of adaptor.

B. Gas samples should only contact metal surfaces and never contact potentially sorbing materials (i.e., tubing, hose, pump diaphragm).

C. The syringe is purged with soil gas then, without removing syringe needle from adapter, a 2-10 mL soil gas sample is collected.

D. The syringe and needle are removed from the adaptor and the end of the needle is capped.

E. If necessary, a second 10 mL sample is collected using the same procedure.

Deactivation of Sampling Apparatus

A. The vacuum pump is turned off and unhooked from the adaptor.

B. The adaptor is removed and stored with equipment to be cleaned.

C. Using the hydraulic puller mechanism, the probe is removed from the ground.

D. The probe is stored in the '"dirty" probe tube on top of the van.

E. The probe hole is backfilled, if required.

Log Book and U.S. EPA Field Sheet Notations for Sampling

A. Time (military notation).

B. Sample number (use client's numbering system).

C. Location (approximate description - i.e., street names).

D. Sampling depth.

E. Evacuation time before sampling.

F. Inches of mercury on vacuum pump gauge.

G. Probe and adaptor numbers.

H. Number of sampling points used.

I. Observations (i.e., ground conditions, concrete, asphalt, soil appearance, surface water, odors, vegetation, etc.).

J. Backfill procedure and materials, if needed.

Other Recordkeeping

A. Client-provided data sheets are filled out, if required.

B. Sample location is marked on the site map.

Determination of Sampling Locations

A. Initial sample locations will be determined by client (perhaps after consultation with TRC personnel) prior to start of job.

B. Remaining sample locations may be determined by:

1. Client
   a. Entire job sampling locations set up on grid system.
   b. Client decides location of remaining sample locations based on results of initial study, or

2. Client and TRC personnel
   a. Client and TRC personnel decide location of remaining sample locations based on results of initial sample locations.

5.11.2 Analytical Procedures

Varian 3300 Gas Chromatograph

A. Equipped with Electron Capture Detectors (ECD), Flame Ionization Detectors (FID), Photo Ionization Detectors (PID) and/or Thermal Conductivity (TC) Detectors.

B. The chromatographic column used by TRC for the analysis of halocarbons is a 1/8-inch diameter packed column containing Alltech OV-101. This nicely separates most of the tri-chloro and tetra-chloro compounds that are encountered in soil gas investigations. The di-chloro compounds tend to elute ahead of the tri-chloro and tetra-chloro compounds, thus creating no interference. In the event that assurance of the identity of a compound in any particular sample is needed, it will be analyzed on a SP-1000 column after the OV-101 analysis.

Two Spectra Physics SP4270 Computing Integrators

The integrators are used to plot the chromatogram and measure the size of the chromatographic peaks. The integrators compute and record the area of each peak. The peak areas are used directly in calculation of contaminant concentration.

Chemical Standards from ChemServices, Inc. of Westchester, Pennsylvania

A. TRC uses analytical standards that are preanalyzed, of certified purities and lot numbered for quality control assurance. Each vial is marked with an expiration date. All analytical standards are the highest grade available. Certified purities are typically 99%.

B. The Quality Assurance procedures used by ChemServices were described by the Laboratory Supervisor, Dr. Lyle Phipher:

    1. The primary measurement equipment at ChemServices, the analytical balance, is serviced by the Mettler Balance Company on an annual basis and recalibrated with NBS traceable weights.

    2. All chemicals purchased for use in making the standards are checked for purity by means of gas chromatography using a thermal conductivity detector. Their chemicals are purified as needed.

    3. The information on the purification and analysis of the standards is made available upon request for any item they ship when the item is identified by lot number. All standards and chemicals are shipped with their lot numbers printed on them. The standards used by TRC are made up in a two-step dilution of the pure chemical furnished by ChemServices.

Analytical Supplies

A. Sufficient 2 and 10 cc glass and Hamilton syringes, so that none have to be reused without first being cleaned.

B. Disposable lab supplies, where appropriate.

C. Glassware to prepare aqueous standards.

D. Miscellaneous laboratory supplies.

5.11.3 QA/QC Procedures

Standards

A. A fresh standard is prepared each day. The standards are made by serial dilution.

   1. First, a stock solution containing the standard in methanol is prepared at TRC offices in Tucson. The stock solution is prepared by pipetting the pure chemical into 250 mL of methanol in a volumetric flask at room temperature. The absolute mass is determined from the product of volume and density calculated at room temperature. Hamilton microliter syringes, with a manufacturer's stated accuracy of + of - 1%, are used for pipetting. Information on density is obtained from the CRC Handbook of Physics and Chemistry. Once the stock solution is prepared, typically in concentration range of 50-1000 mg/L, a working standard is prepared in water each day. The solute in the stock solution has a strong affinity to remain in methanol so there is no need to refrigerate the stock solution. Additionally, the solute tends not to biodegrade or volatilize out of the stock solution.

   2. The working standards are prepared in 40 mL VOA septum vials by diluting the appropriate µg/L quantity of the standard solution in 40 mL of water.

B. The standard water is analyzed for contamination before making the aqueous standard each day.

C. The aqueous standard is prepared in a clean vial using the same syringe each day. The syringe should only be used for that standard.

D. Final dilution of the calibration standards are made in water in a volatile organic analysis (VOA) vial having a Teflon®-coated septum cap instead of in a volumetric flask in order to have the standard in a container with no air exposure. The VOA bottle permits mixing of the standard solution and subsequent syringe sampling all day long without opening the bottle or exposing it to air. The measurement uncertainty inherent in the use of a VOA bottle instead of a volumetric flask is approximately + or - 1%.

E. The aqueous standard will contain the compounds of interest in the range of 5 to 100 µg/L depending on the detectability of the individual components. The standard will be analyzed at least three times at the beginning of each day to determine the mean response factor (RF) for each component. The standard will be injected again after every fifth sample to check detector response and chromatographic performance of the instrument throughout the day.

F. The RF allows conversion of peak areas into concentrations for the contaminants of interest. The RF used is changed if the standard response varies 25%. If the standard injections vary by more than 25%, the standard injections are repeated. If the mean of the two standard injections represents greater than 25% difference, then a third standard is injected and a new RF is calculated from the three standard injections. A new data sheet is started with the new RFs and calibration data.

$$\% \text{ difference} = \frac{\text{A area - B area}}{\text{A area}}$$

Where: A = mean peak area of standard injection from first calibration.
B = peak area of subsequent standard injection.

G. The low µg/L aqueous standards that are made fresh daily need not be refrigerated during the day because they do not change significantly in a 24-hour period. On numerous occasions the unrefrigerated 24-hour old standards have been compared with fresh standards and no difference has been measurable. If the standards were made at high ppm levels in water, the problem of volatilization would probably be more pronounced in the absence of refrigeration.

H. Primary standards are kept in the hotel room when on a project.

I. A client may provide analytical standards for additional calibration and verification.

System Blanks

A. System blanks are ambient air drawn through the probe and complete sampling apparatus (probe adaptor and 10 cc syringe) and analyzed by the same procedure as a soil gas sample. The probe is above the ground.

B. One system blank is run at the beginning of each day and compared to a concurrently sampled air analysis.

C. A system blank is run before reusing any sampling system component.

Ambient Air Samples

A. Ambient air samples are collected and analyzed a minimum of two times daily to monitor safety of the work environment and to establish site background concentrations, if any, for contaminants of interest.

B. All ambient air samples shall be documented.

Samples

A. All unknown samples will be analyzed at least twice.

B. More unknown samples will be run until reproducibility is within 25%, computed as follows:

$$\text{Difference} = \frac{A - B}{(A + B)/2}$$

Where: A is first measurement result.
B is second measurement result.

If the difference is greater than .25, a subsequent sample will be run until two measurements are made that have a difference of .25 or less. Those two measurements will be used in the final calculation for that sample.

C. The injection volume should be adjusted so that mass of analyte is as near as possible to that which is contained in the standard, at least within a factor of ten.

D. Whenever possible, the attenuation for unknown samples is kept constant through the day (so as to provide a visual check of integrations).

E. A water plug is used as a gas seal in µL syringes.

F. A seal is established between syringes when subsampling.

G. At very high concentrations, air dilutions are acceptable once concentration of contaminants in air have been established.

H. All sample analysis are documents.

I. Separate data sheets are used if chromatographic conditions change.

J. Everything is labeled in µg/L, mg/L, etc., parts per million (ppm) and parts per billion (ppb) notations are to be avoided.

Daily System Preparation

A. Integrators parameters are initialized.

1. Pt. evaluation
2. Attenuation
3. Peak markers
4. Auto zero
5. Baseline offset (min. 10% of full scale)

B. The baseline is checked for drift, noise, etc.

C. System parameters are set.

1. Gas flows (Note: N_2 (nitrogen), air, H_2 (hydrogen), tank pressure)

2. Temperatures
    a. Injector
    b. Column
    c. Detector

D. After last analysis of the day, conditioned septa are rotated into injection ports used during the day and replaced with fresh septa.

E. Column and injector temperatures are run up to bake out residual contamination.

F. Syringes are cleaned each day.

1. 2 and 10 cc syringes are cleaned with Alconox or equivalent detergent and brush.

2. µL syringes are cleaned daily with IPA or methanol (MeOH) and purged with N_2. Syringe Kleen is used to remove metal deposits in the barrel.

3. Syringes are baked out overnight in the oven of the gas chromatograph at a minimum temperature of 60°C.

Sample Splits

If desired, TRC's clients or any party, with the approval of TRC's client, may use sample splits to verify TRC's soil gas or groundwater sampling results.

A. Sample splits may be collected in two valve, flow-through-type, all-glass or internally electroplated, stainless steel containers for analysis within 10 days of collection.

1. Flow-through sample collection bottles should be cleaned by purging with nitrogen at 100°C for at least 30 minutes. Once clean, the bottles should be stored, filled with nitrogen at ambient pressure.

2. Sample bottles are filled by placing them in the sample stream between the probe and the vacuum pump. Five sample bottle volumes should be drawn through the container before the final sample is collected. The sample should be at ambient pressure.

B. Sample splits can be provided in 10 cc glass syringes for immediate analysis in the field by the party requesting the sample splits.

C. Splits of the aqueous standards or the methanol standards used by TRC for instrument calibration may be analyzed by the party requesting sample splits.

6.0 SAMPLE HANDLING AND ANALYSIS

6.1 Sample Program Operations

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

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

6.2 Chain-of-Custody

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

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

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

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

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

TABLE 6-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis[8]	Data Quality Level	Analytical Method	Laboratory Turnaround Time[3]	Field QA/QC Samples [9]
							Field Duplicate
Site 78	Soil - UST Areas	1 boring/2 to 3 samples[2]	Grain Size	III	ASTM D422	Routine	1
			Moisture Density	III	ASTM D698	Routine	
			Total TCLP	III	40 CFR 261	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (organic)	III	EPA 351.4	Routine	
			Alkalinity (total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
			TOC	III	EPA 415.1	Routine	
		15 borings/15 samples[2] (surface soils)	TCL Organics	IV	4, 5, 6	Routine	2
			TAL Inorganics	IV	7	Routine	
		15 borings/15 to 30 samples[2] (subsurface soils)	TCL Organics	IV	4,5,6	Routine	2-3
	Soil - Building 1300	3 borings/3 samples[2] (surface soils)	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
		3 borings/3 to 6 samples[2] (subsurface soils)	TCL Pesticides	IV	6	Routine	1
			Chlorinated Herbicides	IV	EPA 8150	Routine	
			TCL PCBs	IV	6	Routine	
		2 borings/2 samples[2] (surface soils)	TCL Organics	IV	4, 5, 6	14 days	1
			TAL Inorganics	IV	7	14 days	
		2 borings/2 to 4 samples[2] (subsurface soils)	TCL Pesticides	IV	6	14 days	1
			Chlorinated Herbicides	IV	EPA 8150	14 days	
			TCL PCBs	IV	6	14 days	

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 78 (Continued)	Soil - Buildings 1103 and 1601	4 borings/4 samples (surface soils)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine	1
		4 borings/4 samples (subsurface soils)	TCL Pesticides Chlorinated Herbicides	IV IV	6 EPA 8150	Routine Routine	1
		6 borings/6 samples (surface soils)	TCL Organics TAL Inorganics	IV IV	6 EPA 8150	14 days 14 days	1
		6 borings/6 samples (subsurface soils)	TCL Pesticides Chlorinated Herbicides	IV IV	4, 5, 6 7	14 days 14 days	1
	Soil Gas Survey	38 building areas/5 samples per building (estimated); 190 samples	TCE, vinyl chloride, BTEX(10), 1,2-DCE	II	Field GC	Daily	19
	Soil -Soil Gas Survey	5 borings per location/2 to 3 samples per boring(2)(11)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine	1-2 per location
	Soil - Background	2 borings/4 to 6 samples (2)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine	1
	Groundwater	42 samples from existing wells (29 shallow, 7 intermediate, 6 deep)	TCL Volatiles TAL Inorganics	IV IV	EPA 601/602 7	Routine Routine	5
		5 samples from existing wells (3 shallow, 1 intermediate, 1 deep)	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine	1
		Newly-installed wells(11)	TCL Organics TAL Inorganics	IV IV	4,5,6 7	Routine Routine	Unknown
		4 samples (shallow): 2 existing wells and 2 newly-installed wells	BOD COD TOC TSS TDS TVS	III	EPA 405.1 EPA 410.1 EPA 415.1 EPA 160.2 EPA 160.1 EPA 160.4	Routine Routine Routine Routine Routine Routine	1

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24 MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 78 (Continued)	Surface Water Cogdels Creek and New River	20 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine	2
	Surface Water Beaver Dam Creek	7 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine	1
	Sediment - Cogdels Creek and New River	20 stations/40 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine	4
	Sediment - Beaver Dam Creek	7 stations/14 samples	TCL Organics TAL Inorganics	IV IV	4, 5, 6 7	Routine Routine	2

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 21	Soil - Former Pesticide Mixing Area	16 borings/16 samples (surface soils)	TCL Organics	IV	4, 5, 6	Routine	2
			TAL Inorganics	IV	7	Routine	
		10 borings/10 to 20 samples(2) (subsurface soils)	TCL Pesticides	IV	6	Routine	1-2
			Chlorinated Herbicides	IV	EPA 8150	Routine	
		4 borings/4 to 8 samples(2) (subsurface soils)	TCL Pesticides	IV	6	14 days	1
			Chlorinated Herbicides	IV	EPA 8150	14 days	
			PCBs	IV	6	14 days	
		2 borings/2 to 4 samples(2) (subsurface soils)	TCL Organics	IV	4,5,6	Routine	1
			TAL Inorganics	IV	7	Routine	
		1 boring/2 to 3 samples(2)	Grain Size	III	ASTM D422	Routine	1
			Moisture Density	III	ASTM D698	Routine	
			Total TCLP	III	40 CFR 261	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (organic)	III	EPA 351.4	Routine	
			Alkalinity (total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
			TOC	III	EPA 415.1	Routine	
	Soil - MW Bore-holes - Pesticide Mixing Area	1 boring/3 to 4 samples (surface and subsurface soils)	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 21 (Continued)	Soil - Transformer Oil Pit	11 borings/11 samples (surface soils)	TCL Organics	IV	4, 5, 6	Routine	2
			TAL Inorganics	IV	7	Routine	
		2 borings/2 to 4 samples(2) (subsurface soils)	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
		5 borings/5 to 10 samples(2) (subsurface soils)	TCL Organics	IV	4,5,6	14 days	1
			TAL Inorganics	IV	7	14 days	
		3 borings/3 to 6 samples(2) (subsurface soils)	PCBs	IV	6	Routine	1
		1 boring/1 to 2 samples(2) (subsurface soils)	PCBs	IV	6	14 days	1
	Soil - Transformer Oil Pit (Cont.)	1 boring/2 to 3 samples(2)	Grain Size	III	ASTM D422	Routine	1
			Moisture Density	III	ASTMD698	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (Organic)	III	EPA 351.4	Routine	
			TOC	III	EPA 415.1	Routine	
		1 boring/1 composite sample	Total TCLP	III	40 CFR 261	Routine	1
			Alkalinity (Total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
	Soil - MW Boreholes - Transformer Oil Pit	1 boring/2 samples (21GW2)	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
		1 boring/3 to 4 samples (21GW3)	TCL Organics	IV	4,5,6	Routine	1
			TAL Inorganics	IV	7	Routine	

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 21 (Continued)	Groundwater	3 samples (3 existing wells) (shallow)	TCL Pesticides/Herbicides	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
		4 samples (3 new wells, 1 existing well) (shallow)	TCL Volatiles	IV	EPA 601/602	Routine	1
			TCL Organics	IV	5, 6	Routine	
			TAL Inorganics	IV	7	Routine	
		3 samples (3 newly installed wells) (shallow)	BOD	III	EPA 405.1	Routine	1
			COD	III	EPA 410.1	Routine	
			TSS	III	EPA 160.2	Routine	
			TDS	III	EPA 160.1	Routine	
			TVS	III	EPA 160.4	Routine	
			TOC	III	EPA 415.1	Routine	
	Surface Water Site Drainage Ditch	7 stations/7 samples	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
		10 stations/10 samples	TCL Pesticides/Herbicides	IV	4, 5, 6	Routine	1
			PCBs	IV	6	Routine	
	Sediment - Site Drainage Ditch	7 stations/14 samples	TCL Organics	IV	4, 5, 6	Routine	2
			TAL Inorganics	IV	7	Routine	
		10 stations/20 samples	TCL Pesticides/Herbicides	IV	4, 5, 6	Routine	2
			PCBs	IV	6	Routine	

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 24	Soil - Spiractor Sludge Area	6 borings/12 to 18 samples(2)	TCL Organics	IV	4,5,6	Routine	2
			TAL Inorganics	IV	7	Routine	
		4 borings/8 to 12 samples(2)	TCL Organics	IV	4,5,6	14 days	1-2
			TAL Inorganics	IV	7	14 days	
		1 boring/2 to 3 samples(2)	Grain Size	III	ASTM D422	Routine	1
			Moisture Density	III	ASTM D698	Routine	
			Total TCLP	III	40 CFR 261	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (organic)	III	EPA 351.4	Routine	
			Alkalinity (total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
			TOC	III	EPA 415.1	Routine	
	Soil - MW Boreholes - Spiractor Sludge Area	2 borings/4 samples (24GW7, 24GW8)	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
	Soil - Fly Ash Disposal Area	4 borings/8 samples	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
		4 borings/8 samples	TCL Organics	IV	4, 5, 6	14 days	1
			TAL Inorganics	IV	7	14 days	
		7 borings/14 samples	TAL Inorganics	IV	7	Routine	2
		1 boring/2 samples	Grain Size	III	ASTM D422	Routine	1
			Moisture Density	III	ASTM D698	Routine	
			Total TCLP	III	40 CFR 261	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (organic)	III	EPA 351.4	Routine	
			Alkalinity (total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
			TOC	III	EPA 415.1	Routine	

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 24 (Continued)	Soil - MW Boreholes - Fly Ash Area	1 boring/2 samples (24GW9)	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
	Soil - Test Pits - Buried Metal Areas	7 test pits (estimated) 1 sample per test pit	TCL Organics	IV	4, 5, 6	Routine	1
			TAL Inorganics	IV	7	Routine	
	Waste - Test Pits - Buried Metal Areas	1 sample per test pit (if drums or wastes are present)	Total TCLP	III	40 CFR 261	Routine	1
			RCRA Hazardous Characteristics	IV	40 CFR 261	Routine	
	Soil - Borrow and Debris Disposal Area	4 borings/8 to 12 samples(2)	TCL Organics	IV	4, 5, 6	Routine	1-2
			TAL Inorganics	IV	7	Routine	
		6 borings/12 to 18 samples(2)	TAL Inorganics	IV	7	Routine	1-2
		4 borings/8 to 12 samples(2)	TCL Organics	IV	4, 5, 6	14 days	1-2
			TAL Inorganics	IV	7	14 days	
		1 boring/2 to 3samples(2)	Grain Size	III	ASTM D422	Routine	1
			Moisture Density	III	ASTM D698	Routine	
			Total TCLP	III	40 CFR 261	Routine	
			Chlorine, Residual	III	EPA 330.5	Routine	
			Total Fluoride	III	SM 4500-F	Routine	
			Nitrogen (organic)	III	EPA 351.4	Routine	
			Alkalinity (total)	III	SM 2320-B	Routine	
			Corrosivity	III	40 CFR 261	Routine	
			Ignitability	III	40 CFR 261	Routine	
			Reactivity	III	40 CFR 261	Routine	
			TOC	III	EPA 415.1	Routine	
	Soil - MW Boreholes - Borrow and Debris Area	1 boring/2 samples (24GW10)	TCL Organics	IV	4,5,6	Routine	1
			TAL Inorganics	IV	7	Routine	

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 78, 21, and 24
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis(8)	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 24 (Continued)	Groundwater	5 samples (existing wells) (shallow)	TAL Inorganics	IV	7	Routine	1
		4 samples (new wells) (shallow)	TCL Volatiles TCL Organics TAL Inorganics	IV IV IV	EPA 601/602 5, 6 7	Routine Routine	1
		4 samples (new shallow wells)	BOD COD TSS TDS TVS TOC	III III III III III III	EPA 405.1 EPA 410.1 EPA 160.2 EPA 160.1 EPA 160.4 EPA 415.1	Routine Routine Routine Routine Routine Routine	1

(1) Baseline number of samples do not include field QA/QC samples.

(2) Assumes 2 to 3 samples per borehole.

(3) Routine analytical turnaround is 28 days following receipt of sample.

(4) Purgeable Organic Compounds - EPA 8240/EPA 624

(5) Base/Neutral Acid Extractables - EPA 3510/EPA 625

(6) Pesticides and PCBs - EPA 3510/3550/EPA 608

(7) TCL 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

(8) BOD - Biological Oxygen Demand (SM 5210)
COD - Chemical Oxygen Demand (EPA 410.1)
TSS - Total Suspended Solids (EPA 160.2)
TDS - Total Dissolved Solids (EPA 160.1)
TVS - Total Volatile Solids (EPA 160.4)
TOC - Total Organic Carbon (EPA 415.1)

(9) Trip Blank - 1 per cooler (VOCs only)
Equipment Rinsate - 1 per day for each matrix sampled
Matrix Spike/Matrix Spike Duplicate - 1 per 20 samples

(10) BTEX - Benzene, Toluene, Ethylbenzene, Xylenes

(11) Actual number of samples is unknown and will be based on the soil gas survey.

FIGURE 6-1

CHAIN-OF-CUSTODY RECORD

Project Name: ____________________
S. O. Number: ____________________

Sampler: ____________________
(Print)

Signature: ____________________

Sheet _____ of _____

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

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

General Remarks:

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

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

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

Shipment/Transportation Details:

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

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

Shipment/Transportation Details:

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

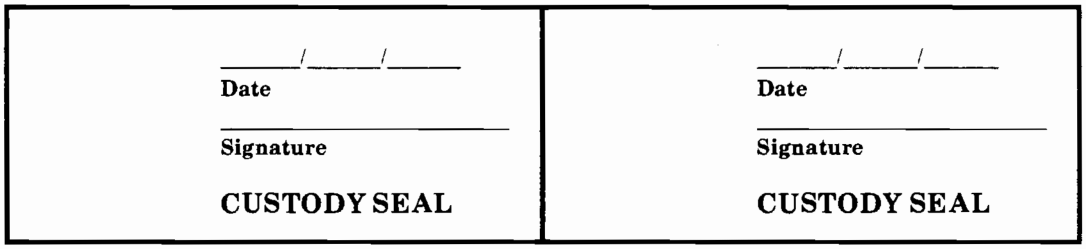
Received By (Sign):
Date: Time:
Remarks:

Shipment/Transportation Details:

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

FIGURE 6-2

EXAMPLE CUSTODY SEAL



______/______/______
Date

____
Signature

CUSTODY SEAL

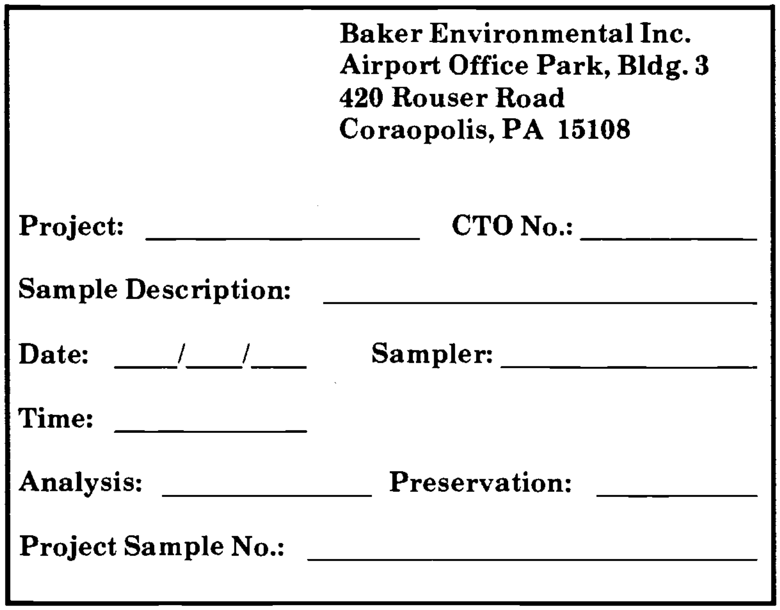
______/______/______
Date

____
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.: _______________________________

submitted to the field sampling task leader, for filing upon completion of the assignment. The cover of each logbook will contain:

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

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

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: Test Pit Record (Figure 6-4), Field Test Boring Record (Figure 6-5), and Test Boring and Well Construction Record (Figure 6-6).

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 6-7) 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

TEST PIT RECORD

Baker Environmental, Inc.

PROJECT: ______________________________

CTO NO.: ______________ TEST PIT NO.: ______________

COORDINATES: EAST ______________ NORTH: ______________

SURFACE ELEVATION: ______________ WATER LEVEL: ______________

WEATHER: ______________ DATE: ______________

REMARKS: ______________________________

DEFINITIONS

HNU = Photo Ionization Detector Reading

OVA = Organic Vapor Analyzer Reading

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

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

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

CONTRACTOR: ______________ BAKER REP.: ______________

EQUIPMENT: ______________ EST PIT NO.: ______________ SHEET 1

FIGURE 6-5

FIELD TEST BORING RECORD

Baker
Baker Environmental, Inc

PROJECT: ____________________
CTO NO.: ____________________ BORING NO.: ____________________
COORDINATES: EAST: ____________________ NORTH: ____________________
ELEVATION: SURFACE: ____________________ TOP OF STEEL CASING: ____________________

RIG:					DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
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	Lab. M.C. %	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*		*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 6-6

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Building P-64
S.O. NO.: 19010-51-SRN   BORING NO.: MW-1
COORDINATES: EAST: ______   NORTH: ______
ELEVATION: SURFACE: 13.94   TOP OF PVC CASING: 13.66

RIG: Mobile B-57					DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8" ID		6-1/4" ID		5/29/91	14.0	sunny, 70°-80° F	---	---
LENGTH	2.0'		5.0'		5/30/91	---	sunny, 80°-90° F	6.64	24 hrs.
TYPE	STD		HSA						
HAMMER WT.	140 lb.								
FALL	30"								
STICK UP									

REMARKS: Advanced boring to 14 ft. taking continuous 2-foot split-spoon samples; monitoring well installed at 14.35 ft.

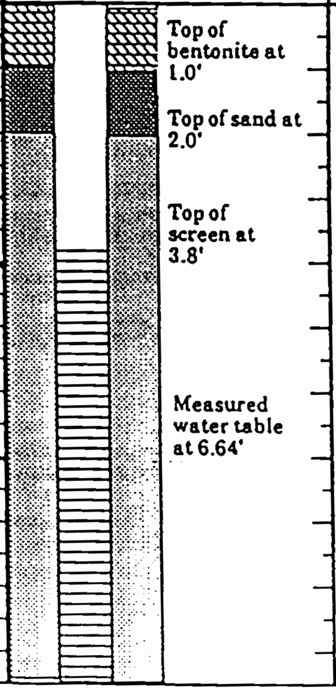
SAMPLE TYPE

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	2"	Sch. 40 PVC, flush-jointed	0.28	3.8
Well Screen	2"	Sch. 40 PVC, flush-jointed	3.8	13.9

Depth (Ft.)	Sample Type and No.	Samp. Rec. Ft. & %	SPT or RQD	Lab. Class. or Pen. Rate	PID (ppm)	Visual Description	Well Installation Detail	Elevation Ft. MSL
2.0	S-1	1.2/2.0 60%	16 12 6 5		0	SAND, fill material, trace gravel; brown-gray; medium dense; dry	Top of bentonite at 1.0' Top of sand at 2.0'	
4.0	S-2	1.4/2.0 70%	4 4 4 3		0	SAND, fill material, trace carbon frags; brown-gray-black; loose; dry 3.0' SAND, fine-grained, trace gravel, trace silt; gray-brown; very loose; damp to moist 4.0'	Top of screen at 3.8'	10.94' 9.94'
6.0	S-3	1.8/2.0 90%	1 1 1 1		0	SAND, fine to medium - grained, trace silt, trace clay; gray-brown; very loose; damp to moist; water table at 5.5' - 6.0'		
8.0	S-4	2.0/2.0 100%	1 2 3 5		1-3	SAND, fine to medium - grained, trace silt; gray-white; loose; wet; petroleum odor noted in spoon sample 7.0'	Measured water table at 6.64'	7.30' 6.94'
10.0	S-5	.95/2.0 48%	3 1 1 1		0.5	SAND, medium to coarse-grained, trace silt; gray-white-brown; loose; wet; petroleum odor noted in spoon sample Match to Sheet 2		



DRILLING CO.: ATEC Associates   BAKER REP.: R. Bonelli
DRILLER: M. Miller   BORING NO.: MW-1   SHEET 1 OF 2

Figure 6-7

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 one field team. All field activities will be coordinated by a Site Manager.

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

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

7.2 Reporting Requirements

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

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

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

8.0 REFERENCES

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APPENDIX A

PRE-SCOPING GROUNDWATER SAMPLING DATA
JULY 1992

ORGANIC CONTAMINANTS IN GROUNDWATER
SITES 2, 24, 74 AND HPIA
MCB CAMP LEJEUNE, NORTH CAROLINA
JULY 1992

Baker Sample Number:	2GW2	2GW3	2GW3 DUP	2GW5	24GW1	24GW2	24GW3	24GW4	24GW6	74GW1	74GW2	GW9-2	GW9-2 DUP	GW9-3	PW-602
Date Sampled:	7/9/92	7/9/92	7/9/92	7/9/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/8/92	7/8/92	7/8/92	7/9/92
Dilution Factor:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Concentration Units:	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Chemical															
TCL Volatiles															
Methylene Chloride	2 B	58 B	14 B	7 B	10 U	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA
Toluene	10 U	67 U	8 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA
Ethylbenzene	10 U	190	190	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA
Total Xylenes	5 J	1800 J	1900 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA
TCL Semivolatiles															
2,4-Dimethylphenol	22 U	10 J	12 J	NA	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Naphthalene	22 U	24 J	24	NA	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
2-Methylnapthalene	22 U	15 J	15 J	NA	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Acenaphthene	22 U	67 U	3 J	NA	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Di-n-Butylphthalate	22 U	67 U	22 U	NA	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	13 BJ
bis(2-Ethylhexyl)Phthalate	5 B	18 B	6 B	NA	8 B	NA	3 B	13 B	9 B	20 U	20 U	20 U	20 U	20 U	7 B
TCL Pesticides/PCBs	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
NA = Not Analyzed
ND = Not Detected at Method Detection Limit
Semivolatile and pesticide/PCB analysis not conducted on sample 2GW5. Sample bottle was broken in shipment.
Semivolatile analysis not conducted on sample 24GW2. Sample was lost during extraction.
Volatile analysis conducted on sample 2GW3 was done at 6.7X dilution factor.
Volatile analysis conducted on sample 2GW3 DUP was done at 5X dilution factor.

Data Qualifiers:
J - The associated numerial value is estimated
U - The material was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
B - Not detected substantially above the level reported in laboratory blanks.

VOLATILE ORGANICS IN GROUNDWATER
SITES 2, 24, 74 AND HPIA
MCB CAMP LEJEUNE, NORTH CAROLINA
JULY 1992

Baker Sample Number:	GW9-2	GW9-2DUP	GW9-3	GW24-2	GW24-3	GW31-2	GW31-3	GW32-2	GW32-3	PW-602	PW-637
Date Sampled:	7/8/92	7/8/92	7/8/92	7/9/92	7/9/92	7/8/92	7/8/92	7/8/92	7/8/92	7/9/92	7/9/92
Dilution Factor:	1	1	1	1	1	1	1	1	1	1	1
Concentration Units:	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Chemical											
EPA 601											
Methylene chloride	ND	1 B	ND	1 B	4 B	ND	ND	ND	ND	ND	3 B
EPA 602											
Benzene	ND	1	ND	ND	ND	ND	ND	28	6	2	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	2	9	ND	ND
Xylenes	ND	ND	ND	ND	ND	ND	ND	2	17	ND	5

Notes:
ND = Not Detected at Method Detection Limit
B = Not detected substantially above the level reported in laboratory blanks
Analytical results reported with validation qualifiers

TAL TOTAL METALS IN GROUNDWATER
SITES 2, 24, 74, AND HADNOT POINT
MCB CAMP LEJEUNE, NORTH CAROLINA
JULY 1992

Baker Sample Number:	2GW2	2GW3	2GW3 DUP	2GW5	24GW1	24GW2	24GW3	24GW4	24GW6	74GW1	74GW2	GW9-2	GW9-2 DUP	GW9-3	PW-602
Date Sampled:	7/9/92	7/9/92	7/9/92	7/9/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/8/92	7/8/92	7/8/92	7/8/92
Dilution Factor:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Concentration Units:	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Analyte															
Aluminum	149000	1120	891	2390	3820	4020	4250	1090	3560	1980	233 U	87 U	76 U	2860	149 U
Antimony	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	50 J	49 U	49 U	49 U	49 U	49 U	49 U
Arsenic	711	2 U	2 U	2 U	2 U	2 U	2 U	64.5	13.10	2 U	2 U	2 U	2 U	2 U	2 U
Barium	85 J	28 J	31 J	100 J	35 J	68 J	145 J	43 J	54 J	28 J	32 J	25 J	25 J	34 J	21 U
Beryllium	18 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Cadmium	148	3 U	3 U	3 U	3 U	4 U	4 U	5 U	7 U	3 U	3 U	5 U	3 U	3 U	3 U
Calcium	25600	6880	7840	20900	1370 U	785 U	92300	57000	90100	1030 U	3460 U	110000	107000	106000	81300
Chromium	39	5 U	5 U	5 U	7 U	18 U	13 U	9 U	16 U	5 U	5 U	5 U	5 U	5 U	5 U
Cobalt	13 J	8 J	6 U	7 J	6 J	6 U	45 J	6 U	13 J	6 U	6 U	6 U	6 U	7 J	7 J
Copper	10 J	5 J	6 J	4 U	4 J	4 J	4 U	4 U	4 U	4 J	4 U	4 U	4 U	4 J	392
Iron	814000	2610	2600	8310	843	13400	3190	13100	25100	301	41 J	627	664	13 U	21800
Lead	85.4	3.1 U	2.4 U	1.7 U	4.6 U	9.4 U	6.4 U	9.4 U	19.2 U	3 U	5.4 U	8.4 U	15 U	6.5 U	100
Magnesium	725 J	921 J	991 J	4310 J	2110 J	1450 J	24500	3210 J	2620 J	1030 J	957 J	2290 J	2360 J	57 J	5320
Manganese	1 U	9 J	9 J	42	3 U	22	201	10 J	257	4 U	2 U	28	27	1 U	300
Mercury	0.2 U	0.2 U	0.24	0.24	0.2 U	0.52	0.2 U	0.2 U	0.82	0.2 U	0.24	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	17 U	17 U	17 U	17 U	17 U	17 U	50	17 U	19 J	17 U	17 U	17 U	17 U	17 U	17 U
Potassium	1940 J	960 J	1160 J	2550 J	1210 J	1370 J	10500 J	1130 J	1690 J	923 J	605 J	1070 J	1220 J	4060 J	1950 J
Selenium	25 U	5 U	5 U	5 U	5 U	5 U	6.6	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Silver	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Sodium	25300	5820	6560	8870	6110	11100	16700	5200	8270	3860 J	2900 J	5610	5910	5340	13000
Thallium	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Vanadium	1550	5 U	5 U	5 U	5 J	17 J	11 J	6 J	12 J	5 J	5 U	5 U	5 U	5 U	5 U
Zinc	252	26 U	17 U	4 U	8 U	22 U	357	12 U	70	17 U	4 U	43 U	34 U	18 U	1010

Qualifiers:

U - The analyte was analyzed for, but was not above the sample quantitation limit.

TAL DISSOLVED METALS IN GROUNDWATER
SITES 2, 24, 74, AND HADNOT POINT
MCB CAMP LEJEUNE, NORTH CAROLINA
JULY 1992

Baker Sample Number:	2GW2	2GW3	2GW3 DUP	2GW5	24GW1	24GW2	24GW3	2GW4	24GW6	74GW1	74GW2	GW9-2	GW9-2 DU	GW9-3	PW-602
Date Sampled:	7/9/92	7/9/92	7/9/92	7/9/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/7/92	7/8/92	7/8/92	7/8/92	7/8/92
Dilution Factor:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Concentration Units:	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Analyte															
Aluminum	59 U	77 U	84 U	1240	138 U	115 U	262 U	59 U	59 U	125 U	224 U	59 U	59 U	2140	59 U
Antimony	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U	49 U
Arsenic	2.2 U	2 U	2 U	2 U	2 U	2 U	2 U	6.8 U	2 U	2 U	2 U	2 U	2 U	2 U	2.3 U
Barium	21 J	21 U	22 J	75 J	32 J	31 J	122 J	24 J	32 J	27 J	32 J	23 J	22 J	31 J	21 U
Beryllium	4 U	4 U	4 U	4 U	4 U	4 U	3 U	3 U	3 U	3 U	4 U	3 U	3 U	3 U	4 U
Cadmium	3 U	4 U	3 U	4 U	3 U	3 U	3 U	3 U	4 U	3 U	5 U	3 U	3 U	3 U	3 U
Calcium	24900	7250	7340	18000	1460 J	925 J	76900	54300	87200	2100 J	3780 J	109000	105000	101000	81100
Chromium	5 U	9 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	5 U	5 U	5 U
Cobalt	6 U	6 U	6 U	6 U	6 U	6 U	36 J	7 J	7 J	6 U	6 U	6 U	6 U	6 U	6 U
Copper	17 J	5 J	5 J	9 J	4 U	4 U	4 U	4 U	4 J	4 U	4 J	9 J	7 J	11 J	4 U
Iron	169	1860	1920	6460	135	10 U	990	15 J	21 J	10 U	10 U	370	272	11 J	536
Lead	6 U	1.8 J	2.8 J	2.3 J	8.4 J	5.8 J	7.4 J	5 J	18 J	8.6 J	4.6 J	7.6 J	3.1 J	7.9 J	4.9 J
Magnesium	959 J	1010 J	1030 J	3860 J	2030 J	1200 J	20900	2860 J	2350 J	916 J	936 J	2370	2310 J	118 J	5530
Manganese	7 J	8 J	8 J	36	3 U	7 J	166	9 J	206 J	3 U	2 U	28	26	1 U	273
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	17 U	17 U	17 U	17 U	17 U	17 U	37 J	17 U	17 U	17 U	17 U	17 U	17 U	17 U	17 U
Potassium	3370 J	1150 J	1030 J	2350 J	1260 J	1200 J	9070	982 J	1380 J	913 J	703 J	1100 J	1300 J	4870 J	1880 J
Selenium	25 U	5 U	5 U	5 U	5 U	5 U	6.6	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Silver	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Sodium	4780 J	6300	6350	7380	5430	10800	15800	4580 J	7850	3850 J	2970 J	5860	5700	5760	13100
Thallium	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Vanadium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Zinc	37 U	23 U	31 U	21 U	17 U	18 U	264 J	4 U	9 U	39 U	10 U	6 U	5 U	4 U	13 U

Qualifiers:

U - The analyte was analyzed for, but was not above the level of sample quantitation.

J - The associated value is an estimated quantity.

APPENDIX B

JUSTIFICATION CRITERIA FOR USE OF PVC AS WELL CASING MATERIAL

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

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

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

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

	Maximum Groundwater Organic Concentrations (µg/L)
Site 78	
Benzene	43
Trans-1,2-DCE	1,200
Ethylbenzene	1,100
Toluene	330
1,1,1-TCA	13
TCE	14,000
Vinyl Chloride	250
Xylenes	4,500
1,1-DCA	42,000
Site 21	
2,4-D	1.17
Oil/Grease	400
Site 24	
Benzene	3
Chloroform	1
Methylene Chloride	2

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

References for Attachment A:

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

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

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