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FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN FOR OPERABLE UNIT NO. 5 (SITE 2)

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

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ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
bls	below land surface
BOD	biological oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEJ	Camp Lejeune
COD	chemical oxygen demand
DOD	Department of the Defense
DoN	Department of the Navy
DQO	data quality objectives
EMD	Environmental Management Division (Camp Lejeune)
EPA	United States Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ESE	Environmental Science and Engineering, Inc.
FFA	Federal Facilities Agreement
ft	feet
ft/ft	foot per foot
GAC	granular activated carbon
gpm	gallons per minute
GRI	Gas Research Industry
HI	hazard index
HPIA	Hadnot Point Industrial Area
HQ	hazard quotient
IAS	Initial Assessment Study
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/l	milligram per liter
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
N.C. DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NCSWS	North Carolina Surface Water Standard
NCWQS	North Carolina Water Quality Standard

NEESA	Naval Energy and Environmental Support Activity
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
O&M	operation and maintenance
OU	opcrable unit
PAH	polynuclear aromatic hydrocarbon
PCB	Polychlorinated Biphenyls
POTW	publicly owned treatment works
ppb	parts per billion
ppm	parts per million
PRAP	Proposed Remedial Action Plan
QA/QC	Quality Assurance/Quality Control
RA	risk assessment
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SMCL	Secondary Maximum Contaminant Level
SQC	Sediment Quality Criteria
STP	sewage treatment plant
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TSS	total suspended solids
TVS	Total Volatile Solids
µg/L	micrograms per liter
µg/g	micrograms per gram
USGS	United States Geological Survey
VOC	volatile organic compound

1.0 INTRODUCTION

The Marine Corps Base (MCB) Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) effective October 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (EPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (DEHNR), and the United States Department of the Navy (DoN) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at the MCB are thoroughly investigated and appropriate CERCLA response/RCRA corrective action alternatives are developed and implemented as necessary to protect the public health, welfare and the environment (MCB Camp Lejeune FFA, 1986).

The scope of the FFA included provision for the implementation of remedial investigation/feasibility studies (RI/FS) at 18 sites throughout MCB Camp Lejeune. These 18 sites have been grouped into 9 Operable Units. Remedial investigations will be implemented at these Operable Units to fully assess the nature and extent of any threat to the public health, welfare or the environment caused by the release or threatened release of hazardous substances, pollutants, contaminants or constituents at the site and to establish requirements for the performance of FSs. Feasibility studies will be conducted to identify, evaluate, and select alternatives for the appropriate CERCLA responses to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, contaminants, or constituents at the site in accordance with CERCLA/SARA and applicable State law (FFA, 1989). This RI/FS Work Plan addresses one of the 18 sites: Site 2 (Former Nursery/Day Care Center). Site 2 has also been identified as Operable Unit (OU) No. 5 at MCB Camp Lejeune.

1.1 Objective of RI/FS Work Plan

The objective of this RI/FS Work Plan is to identify and describe the tasks required to implement an RI/FS for Site 2 at MCB Camp Lejeune. The various studies or investigations required to collect appropriate data are also described in this Work Plan. In addition, the Work Plan documents the scope and objectives of the RI/FS activities. The preparation and contents of the RI/FS Work Plan is based on the scoping process, which is described below.

1.2 RI/FS Scoping

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

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

The background information reviewed included a number of existing environmental assessment reports, which are identified in Section 8 (References), and information collected by conducting site visits at both sites.

As part of the scoping process, Baker personnel conducted pre-investigation sampling at both Site 2 during which groundwater samples were collected from three of the five monitoring wells. Results of sample analyses were used in the design of the RI. The findings of this pre-investigation sampling are in Sections 2.2.6 (Site 2). Project meetings were also conducted with the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) to discuss the

proposed RI/FS scope of work for each site, and to obtain technical and administrative input from LANTDIV.

1.3 RI/FS Work Plan Format

The following elements are presented in this Work Plan.

- Section 2 - Site Background and Setting
- Section 3 - Evaluation of Existing Information
- Section 4 - RI/FS Objectives
- Section 5 - RI/FS Tasks
- Section 6 - Project Staffing
- Section 7 - Project Schedule
- Section 8 - References

Section 2 includes information regarding the location and setting of each site, along with a summary of what studies were conducted in the past at each site and their respective findings. The purpose of this section is to define the physical and known environmental characteristics of each site.

Section 3 documents the evaluation of background information. This section focuses on identifying potential and/or confirmed contaminant migration pathways, identifying potential (or known) impacts to the public health and environment, listing Federal or State ARARs, and evaluating potential remedial technologies/alternatives for mitigating site problems. The purpose of this evaluation is to define site-specific RI/FS objectives. Data or information deemed necessary to identify migration pathways, assess environmental and human health risks, or evaluate the feasibility of remedial actions are presented in this section.

Section 4 presents the RI/FS objectives for each site. Data or information required to meet the objectives are subsequently identified and documented in this section. This data may consist of chemical analyses, hydrogeologic information, or engineering analyses. The collection methods for obtaining this information are also identified and described in general terms (more detailed descriptions of the field investigations are documented in the Sampling and Analysis Plan). This section provides the rationale for development of this Work Plan.

Section 5 identifies and describes the tasks and field investigations that will need to be implemented to complete the RI/FS at the site in terms of meeting the site-specific objectives.

These tasks generally follow the description of tasks identified in EPA's RI/FS Guidance Document (OSWER Directive 9355.3-01).

Section 6 discusses project staffing for implementing the RI/FS. The RI/FS schedule is provided in Section 7. References used in developing the RI/FS approach are provided in Section 8.

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize and evaluate existing information pertaining to Site 2 at MCB Camp Lejeune. The analysis of existing information provides an understanding of the nature and extent of contamination as it is presently known in order to aid in the design of RI tasks. The current understanding of the physical setting of the sites, the history of the sites, and the existing information related to previous environmental investigative activities are described.

This section specifically addresses the location and setting of the sites, historical events associated with past usage or disposal activities, topography and surface drainage, regional geology and hydrogeology, site-specific geology and hydrogeology, surface water hydrology, climatology, natural resources, ecological features, and land use.

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

- Initial Assessment Study (IAS) of Marine Corps Base Camp Lejeune, North Carolina (Water and Air Research, 1983)

- Final Site Summary Report, Marine Corps Base, Camp Lejeune (Environmental Science and Engineering, Inc., 1990)

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

- Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina (U.S. Geological Survey, 1990)

- Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina (U.S. Geological Survey, 1989)

2.1 Marine Corps Base Camp Lejeune

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

2.1.1 Location and Setting

Marine Corps Base 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. 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders Camp Lejeune to the north. The MCB Camp Lejeune is depicted in Figure 2-1.

2.1.2 History

Construction of MCB Camp Lejeune began in 1941 with the objective of developing the "Worlds Most Complex Amphibious Training Base". The base was started at Hadnot Point where the major functions of the base are still centered. Development at the Camp Lejeune complex consists of primarily five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area.

2.1.3 Topography and Surface Drainage

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

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

Flooding is a potential problem for base areas within the 100-year floodplain. The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at Camp Lejeune at 7.0 feet

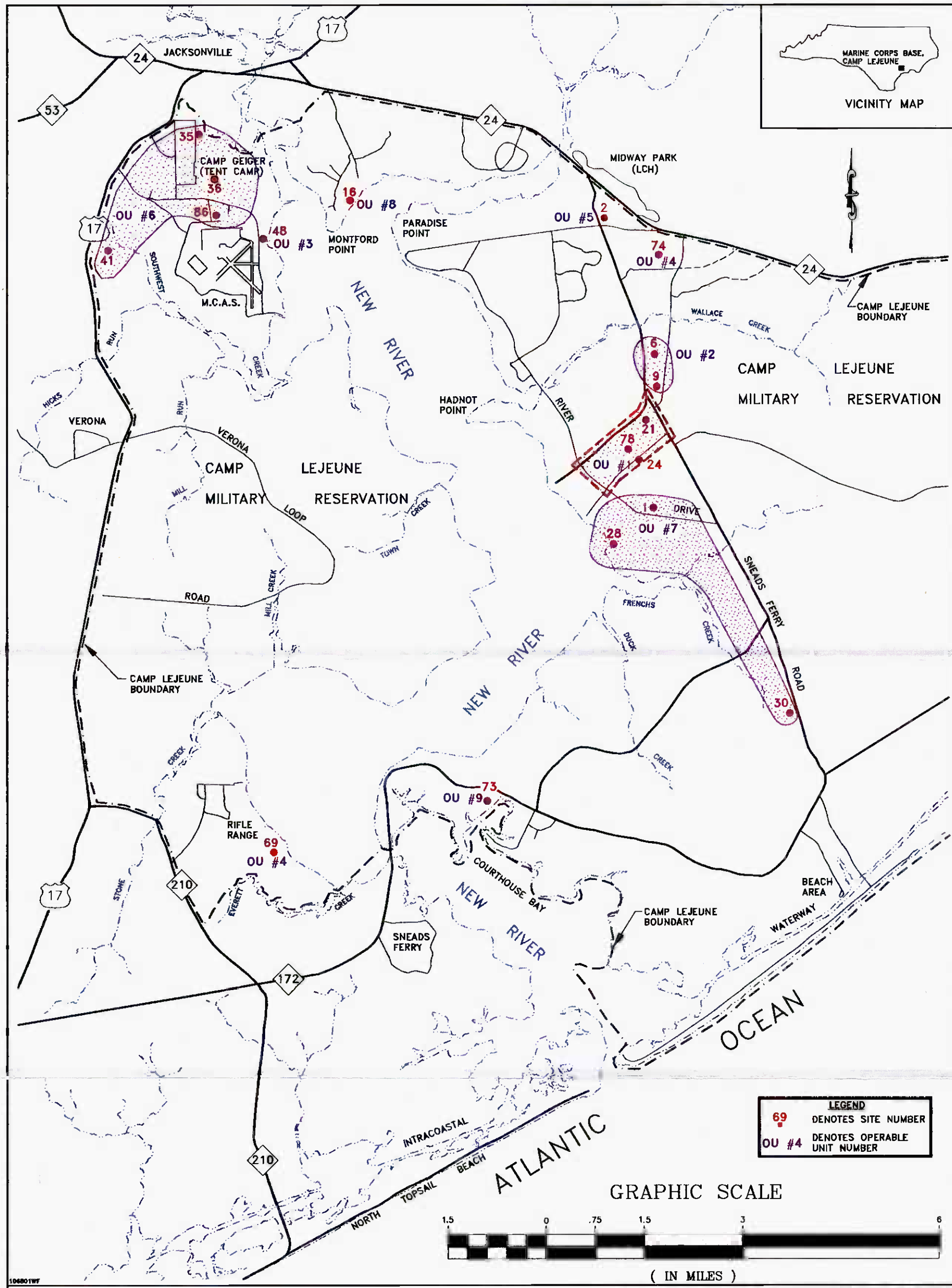

FIGURE 2-1
OPERABLE UNITS AND SITE LOCATIONS AT
MARINE CORPS BASE CAMP LEJEUNE

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: U.S.G.S. WATER-RESOURCES INVESTIGATIONS REPORT 89-4096

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above msl in the upper reaches of the New River (Water and Air Research, 1983). The elevation of the 100-year floodplain increases downstream to 11 feet above msl near the coastal area (Water and Air Research, 1983).

2.1.4 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments are layered in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1991). Regionally, they comprise 10 aquifers and nine confining units which overlie igneous and metamorphic basement rocks of pre-Cretaceous age. These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time. Figure 2-2 presents a generalized stratigraphic column for this area (ESE, 1991).

2.1.5 Regional Hydrogeology

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

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 2-3 which illustrates the relationship between the aquifers in this area (ESE, 1991). A hydrogeologic cross-section of the area near Site 2 is presented in Figure 2-4.

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

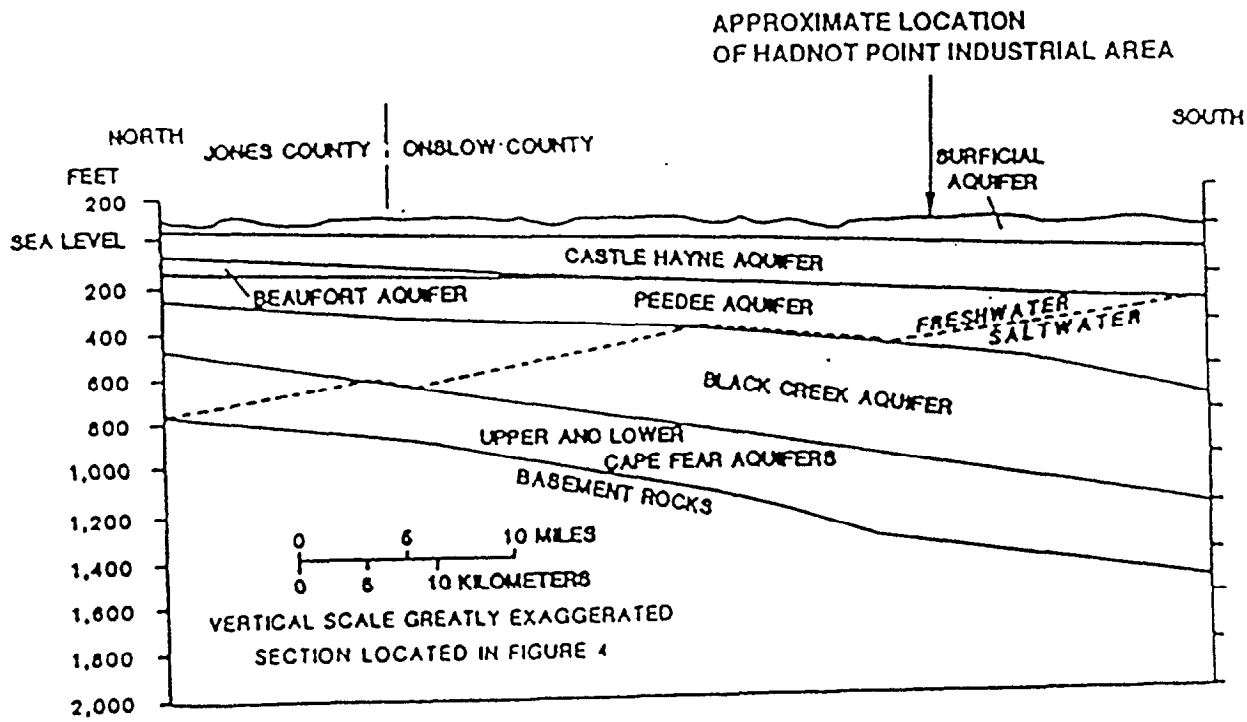
FIGURE 2-2

GEOLOGIC AND HYDROGEOLOGIC UNITS IN
THE COASTAL PLAIN OF NORTH CAROLINA

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

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

Source: Harned et al., 1989.



SOURCE: ESE, 1991

Baker
Baker Environmental, Inc.

FIGURE 2-3
GENERALIZED HYDROGEOLOGIC CROSS-SECTION
JONES AND ONSLOW COUNTIES, NORTH CAROLINA

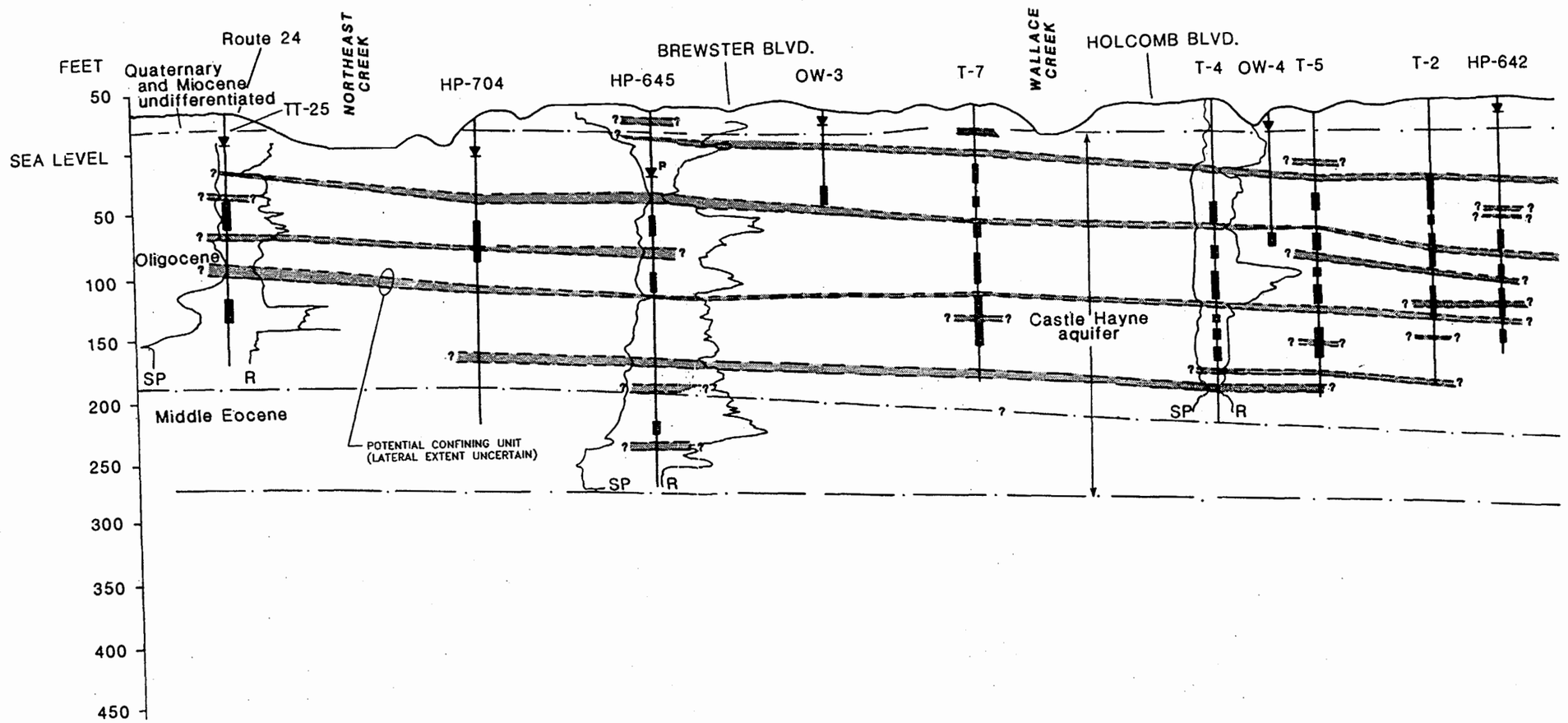
CORPS BASE CAMP LE.
JACKSONVILLE, NORTH CAROLINA

106803WF

(SITE 2)

NORTH

SOUTH



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SOURCE: HARNED, et al. (1989)

.5 0 .25 .5 1

1 inch = 0.5 mile

HORIZONTAL SCALE

25 0 12.5 25 50

1 inch = 25 ft.

VERTICAL SCALE

FIGURE 2-4
HYDROGEOLOGIC CROSS SECTION
NEAR SITE 2

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

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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. Previous investigations in this area indicate that the Castle Hayne Aquifer (defined as deeper than 50 - 100 ft.) and the surficial aquifer (defined as less than 50 - 100 ft.) are in hydraulic communication.

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

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.

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

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

2.1.6 Surface Water Hydrology

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

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

Surface water drainage from Site 2 is predominantly toward Overs Creek. Overs Creek flows into Northeast Creek, which flows into the New River. In the area where Northeast Creek flows into the New River, the New River is classified as SC (ESE, 1991).

2.1.7 Climatology

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

2.1.8 Natural Resources and Ecological Features

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

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

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

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

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: pond pine or pocosin; sweet gum/water oak/cypress and tupelo; sweet bay/swamp black gum and red maple; tidal marshes; and coastal beaches. Pocosins provide excellent habitat for bear and deer because these areas are seldom disturbed by humans. The presence of pocosin type habitat at Camp Lejeune is primarily responsible for the continued existence of black bear in the area. Many of the pocosins are overgrown with brush and pine species that would not be profitable to harvest. Sweet gum/water oak/cypress and tupelo habitat is found in the rich, moist bottomlands along streams and rivers. This habitat extends to the marine shorelines. Dear, bear, turkey, and waterfowl are commonly found in this type of habitat. Sweet bay/swamp black gum and red maple habitat exist in the floodplain areas of Camp Lejeune. Fauna including waterfowl, mink, otter, raccoon, deer, bear, and gray squirrel frequent this habitat. The tidal marsh at the mouth of the New River is one of the few remaining North Carolina coastal areas relatively free from filling or other manmade changes. This habitat, which consists of marsh and aquatic plants such as algae, cattails, saltgrass, cordgrass, bulrush, and spikerush, provides wildlife with food and cover. Migratory waterfowl,

alligators, raccoons, and river otter exist in this habitat. Coastal beaches along the Intracoastal Waterway and along the outer banks of Camp Lejeune are used for recreation and to house a small military command unit. Basic assault training maneuvers are also conducted along these beaches. Training regulations presently restrict activities that would impact ecological sensitive coastal barrier dunes. The coastal beaches provides habitat for many shorebirds (Water and Air Research, 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 (Water and Air Research, 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 (Water and Air Research, 1983).

2.1.9 Land Use

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

2.1.10 Water Supply

MCB Camp Lejeune water is supplied entirely from groundwater. Groundwater is obtained from approximately 90 water supply wells and treated. There are eight water treatment

plants with a total capacity of 15.821 million gallons per day (MGD). Groundwater usage is estimated at over 7 MGD) Harned, et al., 1989).

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

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

There are four water supply wells located in the vicinity of Site 2: 616,645, 646, and 647. The locations of these supply wells are illustrated in Figure 2-5.

2.2 Site 2 - Former Nursery/Day - Care Center

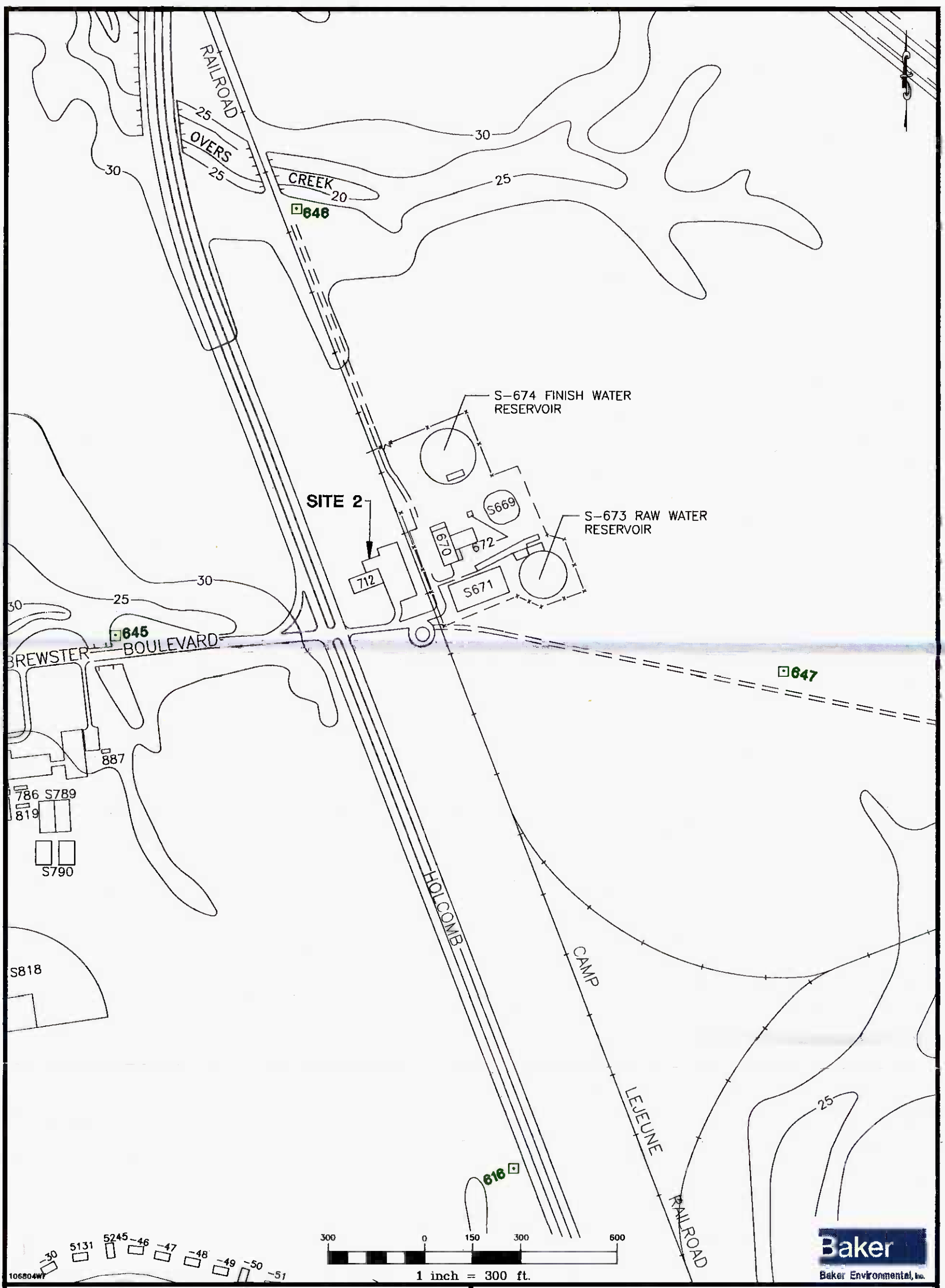
This section addresses the background and setting of Site 2 (Former Nursery/Day - Care Center). An Environmental Photographic Interpretation Center (EPIC) Study was conducted for this site by the USEPA. Site-specific results of this study is included in Appendix A (the entire report covers several sites within MCB Camp Lejeune).

2.2.1 Site Location and Setting

Site 2 is located at the intersection of Holcomb Boulevard and Brewster Boulevard in the northeast portion of Camp Lejeune (see Figure 2-6). The areas of concern are the grass area adjacent to Building 712 (approximately 6,300 square feet), two mixing/wash pads and the Former Storage Area.

2.2.2 Site Topography and Drainage

The land at Site 2 is primarily flat, but dips sharply at the drainage ditches which runs parallel to the Lejeune Railroad (Figure 2-5). There is a drainage ditch on both the east and west side of the railroad tracks. Overland drainage is unlikely over most of the site due to the flat topography. Drainage along the eastern edge of the Building 712 area is toward these drainage ditches which runs in a north-northwest direction towards Overs Creek. Drainage



LEGEND

616 WATER SUPPLY WELL

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-5
SUPPLY WELLS IN THE VICINITY
OF SITE 2

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

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along the western edge of the Former Storage Area is also toward these drainage ditches. Another drainage ditch extends westward from the Building 712 area, underneath Holcomb Boulevard.

2.2.3 Site History

From 1945 to 1958 Building 712 (PWDM Coordinates 5, K10) was used for the storing, handling, and dispensing of pesticides. Building 712 was later used as a children's day care center. Chemicals known to have been used include: chlordane, DDT, diazinon, and 2,4-D. Chemicals known to have been stored on site include dieldrin, lindane, malathion, silvex, and 2,4,5-T. Areas of suspected contamination are the fenced playground, the mixing pad, the wash pad, and railroad drainage ditch. Above ground horizontal storage tanks were detected near the mixing pad area in a 1952 aerial photograph included in the EPIC Study. Contamination is believed to have occurred as a result of small spills, washout and excess product disposal. During the years of operation, it is reasonable to assume several gallons per year were involved; therefore, estimated quantity involved is on the order of 100 to 500 gallons of liquids containing various concentrations of product. Solid residues in cracks and crevasses may total 1 to 5 pounds. Disposal to Overs Creek is undocumented (Water and Air Research, 1983).

The following items, within the Former Storage Area, were identified in aerial photos included in the EPIC Study:

- A railroad siding, extending from the main line into the Form Storage Area.
- A crane, possibly located on the railroad siding, that was apparently used to unload materials from railroad cars.
- An area of possibly stained surface soil, present along the eastern border of this area.

2.2.4 Site Geology and Hydrogeology

Previous investigative efforts at Site 2 did not include geologic investigations. Site specific geologic information is limited to information obtained during the installation of monitoring wells (five have been installed to date) during previous investigations (Section 2.2.5).

The site is reportedly underlain by clayey silt, silty sand, clay and clayey sand, and silty sand and sand. These units overlie a layer of clay found at a depth ranging from 24 to 28 feet. The water table was measured at depths ranging from 7 to 20 feet below land surface. The groundwater flow appears to be generally to the southeast with a gradient of approximately 0.14 foot per foot (ft/ft).

Table 2-1 includes construction specifications for on-site monitoring wells and nearby water supply wells.

2.2.5 Previous Investigations and Findings

In response to the passage of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980, the Department of Navy (DoN) initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program to identify, investigate, and clean up past hazardous waste disposal sites at Navy installations. The NACIP investigations were conducted by the Navy Energy and Environmental Support Activity (NEESA) and consisted of Initial Assessment Studies (IAS) and Confirmation Studies. Initial Studies are similar to the U.S. EPA's Preliminary Assessments/Site Investigations (PA/SI). Confirmation studies are similar to EPA's RI/FS. When the Superfund Amendment and Reauthorization Act (SARA) was passed in 1986, the DoN dissolved the NACIP in favor of the Installation and Restoration Program (IRP), which adopted EPA Superfund terminology and procedures (ESE, 1991).

The IAS was conducted by Water and Air Research, Inc., in 1983. The IAS identified a number of sites at MCB Camp Lejeune as potential sources of contamination, including the sites discussed in this RI/FS Work Plan. As a result of this study, Environmental Science and Engineering, Inc. (ESE) was contracted by LANTDIV to investigate these sites. Since then, Baker Environmental, Inc. (Baker) was contracted in 1991 under DoN's Comprehensive Long-Term Environmental Action Navy (CLEAN) Program to continue RI/FS activities at the sites addressed in this RI/FS Work Plan.

The initial ESE investigation, referred to as a Confirmation Study, focused on those areas identified in the IAS. The Confirmation Study is divided into two investigation steps: the Verification Step and the Characterization Step. A final investigation, referred to as a Supplemental Characterization, was added to collect additional information to complete a Site Assessment (SA). These investigations are summarized in this section. Additional

TABLE 2-1

MONITORING AND SUPPLY WELL CONSTRUCTION SPECIFICATIONS
SITE 2 - FORMER NURSERY/DAY CARE CENTER (BUILDING 712)
MCB CAMP LEJEUNE, NORTH CAROLINA

Well #	Depth (ft.)	Screened Interval(s) (ft.)	Well Diameter (inches)
2GW1	25	10-25	2
2GW2	25	10-25	2
2GW3	25	10-25	2
2GW4	25	10-25	2
2GW5	25	10-25	2
616	170	95-115 130-140 160-170	8
645	245	90-100 138-148 230-240	10
646	270	90-100 240-250 255-265	10
647	200	105-115 138-143 175-190	10

information can be obtained from Site Assessment Report for Sites 2 and 74, Site Summary Report Final (ESE, 1990).

2.2.5.1 Soil Investigation

In August of 1984, as part of the Verification Step, ESE hand augured three soil borings. Exact soil sampling locations are unknown. Three composite soil samples (0-1'(A), 1-2'(B), 2-3'(C)) were collected from each boring and analyzed for organochlorine pesticides and herbicides. Only these contaminants were analyzed for since pesticides and herbicides were reportedly stored at Site 2.

In November of 1986, ESE collected four soil samples. The sampling locations for ESE's samples 2SO-6, 2SO-7, 2SO-8, and 2SO-9 are shown on Figure 2-7. These samples were analyzed for DDD,pp-; DDE,pp-; DDT,pp-; 2,4-D; and 2,4,5-T. The analytical results indicate that DDD,pp was detected in one sample (2SO-9) and DDE,pp and DDT,pp were detected in three samples (2SO-7, 2SO-8, and 2SO-9). The analytical findings (see Table 2-1) indicate that 2,4-D was detected in three samples (2SO-6, 2SO-7, and 2SO-8), and 2,4,5-T was not detected in any of the four soil samples. The maximum detected concentration for each contaminant was: DDD,pp (1.32 µg/g); DDE,pp (0.138 µg/g); DDT,pp (147 µg/g); and 2,4-D (0.131 µg/g). No information is available to assess the analytical methods employed or the Quality Assurance/Quality Control (QA/QC) protocols used in the field or laboratory. In addition, no background soil samples were collected to compare the results. Analytical results are presented in Table 2-1.

2.2.5.2 Groundwater Sampling

As part of the Verification Step conducted in July 1984, five shallow monitoring wells were installed and sampled. In addition, four water supply wells were sampled to characterize the deeper aquifer. The water supply wells are shown on Figure 2-5. The shallow well locations are identified in Figure 2-6. These samples were analyzed for organochlorine pesticides and chlorinated herbicides. Trace amounts of DDD,pp (0.029 µg/L); DDE,pp (0.016 µg/L); and DDT,pp (0.15 µg/L) were reported in monitoring well 2GW1. Detected compounds are presented in Table 2-3. No detected compounds were reported for the supply wells (ESE, 1990).

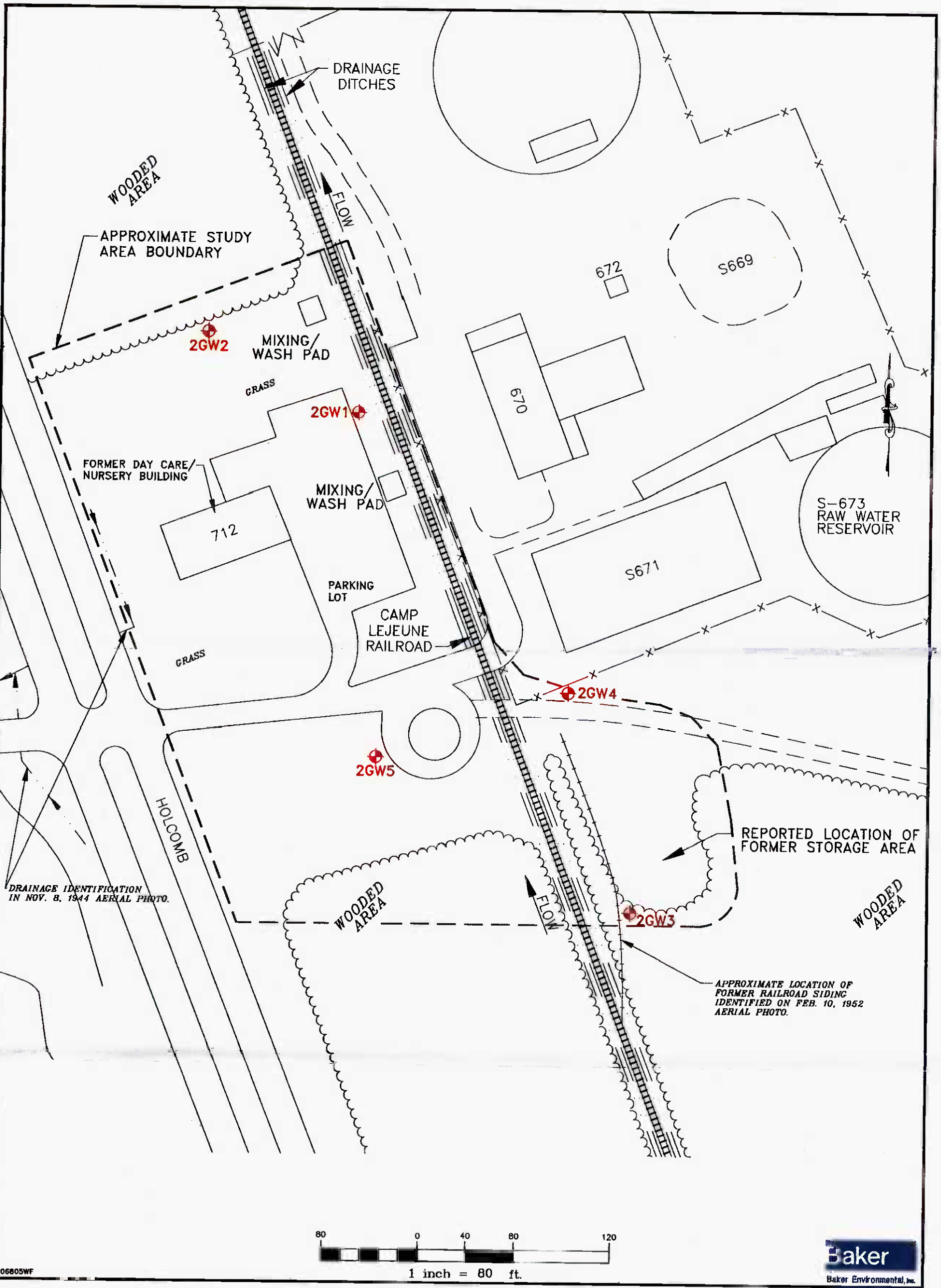
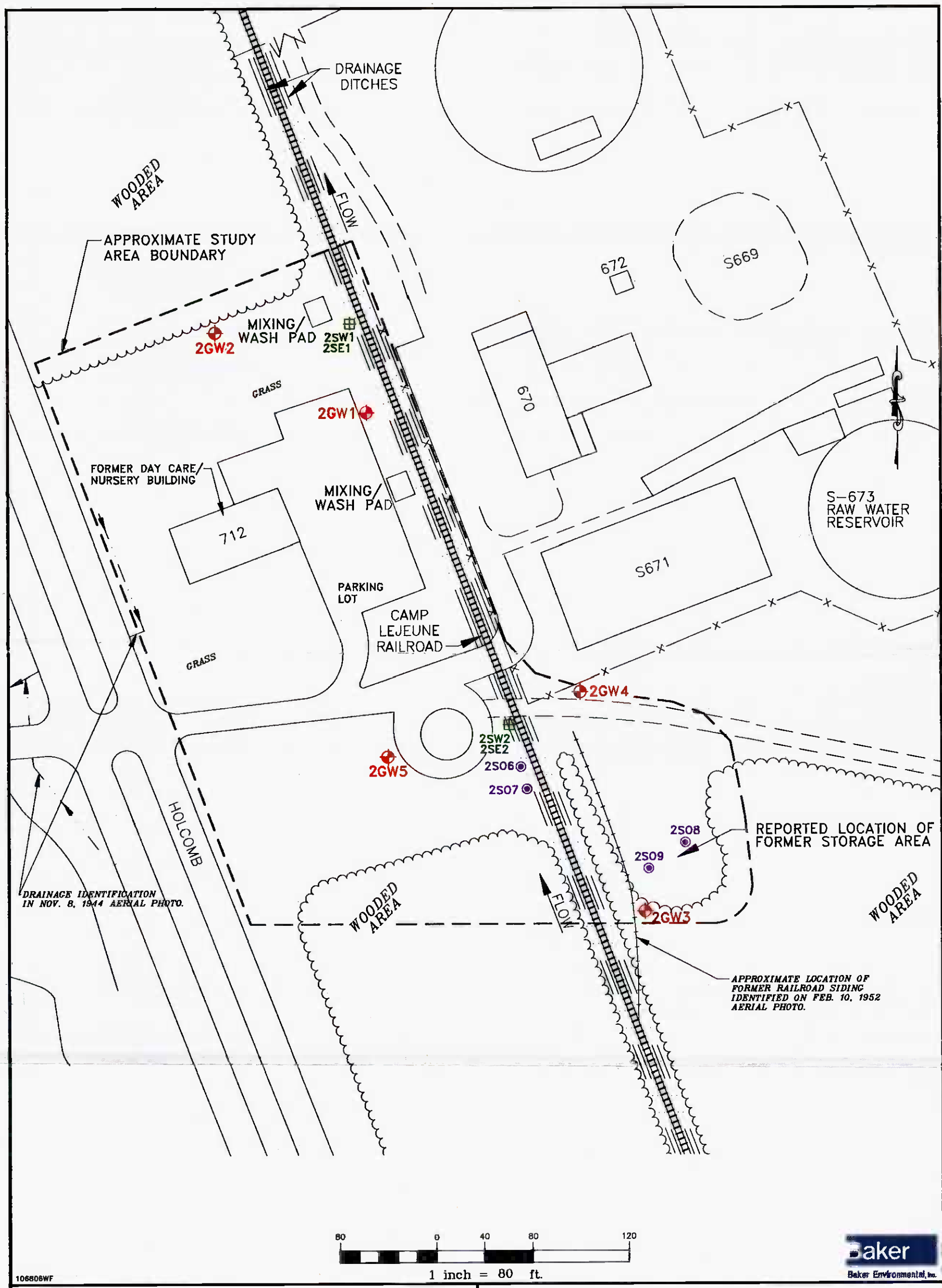


FIGURE 2-6
STUDY AREA
SITE 2
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991



LEGEND

2SW1 / 2SE1 — SURFACE WATER/SEDIMENT SAMPLING LOCATION

2SO6 — SOIL BORING LOCATION

2GW1 — MONITORING WELL LOCATION

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-7
ESE SAMPLE LOCATIONS
SITE 2
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

In December of 1986, a second round of groundwater samples were collected from the five monitoring wells. These samples were analyzed for organochlorine pesticides, chlorinated herbicides, tetrachlorodioxin, and volatile organics. Trace amounts of DDD,pp were reported in monitoring well 2GW1. Trace amounts of DDD,pp; DDE,pp; and DDT,pp were reported in monitoring well 2GW3. In addition, ethylbenzene was reported in monitoring well 2GW3 above the North Carolina Groundwater Standard of 29 µg/L. Toluene was reported in monitoring well 2GW3 at a concentration below the North Carolina Water Quality Standard (NCWQS) of 1000 µg/L. Analytical findings are presented in Table 2-2.

In March of 1987, three monitoring wells (2GW2, 2GW3, and 2GW4) were sampled. Samples were analyzed for organochlorine pesticides, chlorinated herbicides, and volatile organics. Low levels (0.02 µg/L) of DDE,pp were reported in monitoring well 2GW3. Ethylbenzene (330 µg/L) and toluene (12 µg/L) were reported in monitoring well 2GW3. The level of ethylbenzene reported in monitoring well 2GW3 exceeded the NCWQS of 29 µg/L. Analytical findings are presented in Table 2-2.

2.2.5.3 Surface Water Sampling

Two surface water samples were collected in December 1986 from the drainage ditch which parallels the railroad tracks along the eastern boundary of the site (Figure 2-5). The ditch drains in a north-northwest direction towards Overs Creek. The surface water samples were analyzed for organochlorine pesticides, tetrachlorodioxin, and volatile organics.

Low levels of DDD,pp were reported in the surface water sample 2SW1 (0.742 µg/L) and 2SW2 (0.027 µg/L). Additionally, DDT,pp (0.560 µg/L) was detected in sample 2SW1 at a level greater than the North Carolina Surface Water Standard (NCSWS) of 0.00588 µg/L. Analytical findings are presented in Table 2-3.

2.2.5.4 Sediment Sampling

In December of 1986 two sediment samples (2SE1 and 2SE2) were collected from the same locations as the surface water samples (Figure 2-5).

Samples collected in 1986 were analyzed for organochlorine pesticides, chlorinated herbicides, and tetrachlorodioxin. Levels of DDD,pp (0.011 µg/g); DDE,pp (0.056 µg/g); and DDT,pp (0.150 µg/g) were reported in sediment sample 2S4.

TABLE 2-2

DETECTED TARGET CONTAMINANTS IN THE SOIL AT
SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712)
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Sample ID/Date Sampled			
	2SO-6 11/11/86	2SO-7 11/11/86	2SO-8 11/11/86	2SO-9 11/11/86
DDD, 4,4'	<0.0114	<0.0118	0.0115	1.32
DDE, 4,4'	<0.0114	0.0502	0.0259	0.138
DDT, 4,4'	<0.0172	0.115	0.0874	147
2,4 -D	0.0491	0.0489	0.131	<0.0101
2,4,5-T	<0.0399	<0.0443	<0.0445	<0.0404

Values reported are concentrations in micrograms per gram (µg/g).

Note: There are no NC pesticide soil standards.

Source: ESE, 1990.

TABLE 2-3

DETECTED TARGET CONTAMINANTS IN THE GROUNDWATER AT SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712) MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Federal MCLs[1] (µg/L)	North Carolina WQS[2] (µg/L)	Sample ID/Date Sampled							
			2GW1 7/5/84	2GW1 12/02/86	2GW2 7/5/84	2GW2 12/02/86	2GW2 3/03/87	2GW3 7/5/84	2GW3 12/02/86	2GW3 3/03/87
DDD, 4,4'	NS	NS	0.029	0.03	<0.003	<0.013	<0.012	<0.003	0.097	<0.012
DDE, 4,4'	NS	NS	0.016	<0.013	<0.0008	<0.013	<0.012	<0.0008	0.057	0.02
DDT, 4,4'	NS	NS	0.15	<0.013	<0.005	<0.013	<0.012	<0.005	0.554	<0.012
Ethylbenzene	700	29	NRQ	<7.2	NRQ	<7.2	<7.2	NRQ	330	510
Toluene	1,000	1,000	NRQ	<6.0	NRQ	<6.0	<6.0	NRQ	12	<60

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.
(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.
NRQ = Analysis not requested.
NS = No standard established.

Values reported are concentrations in micrograms per liter (µg/L).

Source: ESE, 1990.

TABLE 2-3 (Continued)

DETECTED TARGET CONTAMINANTS IN THE GROUNDWATER AT SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712) MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Federal MCLs[1] (µg/L)	North Carolina WQS[2] (µg/L)	Sample ID/Date Sampled					
			2GW4 7/5/84	2GW4 12/02/86	2GW4 3/03/87	2GW5 7/07/86	2GW5 12/02/86	2GW5 3/03/87
DDD, 4,4'	None	None	<0.003	<0.013	<0.012	<0.003	<0.013	<0.012
DDE, 4,4'	None	None	<0.0008	<0.013	<0.012	<0.0008	<0.013	<0.012
DDT, 4,4'	None	None	<0.005	<0.013	<0.012	<0.005	<0.013	<0.012
Ethylbenzene	700	29	NRQ	<7.2	<7.2	NRQ	<7.2	<7.2
Toluene	1,000	1,000	NRQ	<6.0	<6.0	NRQ	<6.0	<6.0

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.
(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.
NRQ = Analysis not requested.
NS = No standard established.

Values reported are concentrations in micrograms per liter (µg/L).

Source: ESE, 1990.

Table 2-3 presents the analytical findings for the two sediment samples.

2.2.6 Pre-Investigation Sampling and Findings

In July of 1992, Baker Environmental collected groundwater samples from three existing monitoring wells (2GW2, 2GW3, and 2GW5) in order to aid in characterizing current site conditions and design of the RI Field programs. Sample collection locations were selected on the basis of attaining site-wide coverage, previous sampling results, and accessibility.

Groundwater samples collected from these wells were analyzed for full TCL organics and for both total and dissolved TAL inorganics using CLP protocols (Level IV Data Quality).

Ethylbenzene (190 µg/L) and total xylenes (1800 µg/L) were detected in monitoring well 2GW3. Prior investigations also detected ethylbenzene and toluene in this well. The concentration of ethylbenzene and total xylenes exceeds the NCWQS of 29 µg/L and 400 µg/L respectively. Low levels of semivolatile compounds 2,4-dimethylphenol (10 µg/L), 2-methylnaphthalene (15 µg/L), and naphthalene (24 µg/L) were also detected in monitoring well 2GW3. Low levels of total xylenes (5 µg/L) were also detected in monitoring well 2GW2.

Prior to purging and sampling monitoring well 2GW3, a bailer (apparently from a previous investigation) was removed from the well. The bailer contained a considerable amount of silt. The well recharged very slowly during purging with the water produced appearing very turbid. Analytical results for total metals indicated concentrations that were significantly elevated over those expected. The elevated levels of total metals may not correspond with any known site activity. The highest concentrations of total metals were detected in monitoring well 2GW2. The arsenic concentration (711 µg/L) exceeds the NCWQS of 50 µg/L. The cadmium concentration (148 µg/L) exceeds both the Federal MCL (15 µg/l) and the NCWQS (50 µg/L). The lead concentration (85.4 µg/L) exceeded the Action Level for treatment of 15 µg/L. Analyses conducted using dissolved (filtered) samples showed no contaminants in concentrations above MCLs.

The analytical findings are presented in Table 2-4.

A geophysical investigation was conducted at Site 2 in July 1992. The investigation focused on the former storage area. Detailed results of the geophysical investigation are included in

TABLE 2-4

DETECTED TARGET CONTAMINANTS IN THE SURFACE WATER AND SEDIMENTS AT SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712) MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Ambient Water Quality Criteria[1] (µg/L)	North Carolina SWS[2] (µg/L)	Sample ID/Date Sampled			
			2SW1 12/02/86 (µg/L)	2SW2 12/02/86 (µg/L)	2SE1 12/02/86 (µg/g)	2SE2 12/02/86 (µg/g)
DDD, 4,4'	NS	NS	0.742	0.027	4.16	1.570
DDE, 4,4'	NS	NS	NR	NR	0.805	0.861
DDT, 4,4'	1,050	0.001	0.560	<0.013	3.53	0.168
2,4 -D	NS	NS	NRQ	NRQ	<0.0332	<0.0343
2,4,5-T	NS	NS	NRQ	NRQ	<0.0197	0.024

(1) Ambient Water Quality Criteria pursuant to Clean Water Act..
(2) NCSWS - North Carolina Administrative Code, Title 15A, NCAC, Subchapter 2B, Section .0020 - Classification and Water Quality Standards Applicable to Surface Waters of North Carolina. April 1, 1991. Class SW waters.

NS = No standard established.
NRQ = Analysis not requested.
NR = Not Reported.
SW = Surface water samples.
SE = Sediment samples.

Source: ESE, 1990.

Appendix B. The purpose of the investigation was to determine the source of groundwater contamination near monitoring well 2GW3 (e.g. underground storage tank). No subsurface features (tanks, drums) that could serve as sources of groundwater contamination were detected during this investigation. An anomalous subsurface feature was detected near monitoring well 2GW3 (See Appendix B.)

TABLE 2-5

DETECTED TARGET CONTAMINANTS IN THE GROUNDWATER AT
SITE 2 - FORMER NURSERY DAY CARE CENTER (BLDG 712)
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Federal MCLs(1)	North Carolina WQS(2)	Sample Identification/Date Sampled		
			2GW2 7/9/92	2GW3 7/9/92	2GW5 7/9/92
Ethylbenzene	700	29	ND	190	ND
Total Xylenes	10,000	400	5	1,800	ND
2,4-Dimethylphenol	None	None	ND	10	NA
2-Methylnaphthalene	None	None	ND	15	NA
Napthalene	None	None	ND	24	NA
Aluminum	None	None	149,000/ND	1,120/ND	2,390/1,240
Arsenic	50	None	711/ND	ND/ND	ND/ND
Barium	2,000	1,000	85/21	28/ND	100/75
Cadium	5.0	5.0	148/ND	ND/ND	ND/ND
Calcium	None	None	25,600/24,900	6,880/7,250	20,900/18,000
Chromium	100	50	39/ND	ND/ND	ND/ND
Cobalt	None	None	13/ND	8/ND	7/ND
Copper	1,300 (P)	1,000	10/ND	5/ND	ND/9
Iron	None	300	81,400/169	2,610/1,860	8,310/6,460
Lead	15	5.0	85.4/ND	ND/1.8	ND/2.3
Magnesium	None	None	725/959	921/1,010	4,310/3,860
Manganese	None	50	ND/ND	9/ND	42/36
Potassium	None	None	1,940/3,370	960	2,550/2,350
Sodium	None	None	25,300/4,780	5,820/6,300	8,870/7,380
Vanadium	None	None	1,550/ND	ND/ND	ND/ND
Zinc	None	400	252/ND	ND/ND	ND/ND

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.

(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.

(P) = Proposed

ND = Not Detected at Method Detection Limit

NA = Not Analyzed

Total/Dissolved metal concentrations.

Concentrations reported in microgram per liter (µg/L).

Source: Baker Environmental, July 1992.

3.0 EVALUATION OF EXISTING INFORMATION

This section describes the types and volume of known wastes at Site 2, potential migration and exposure pathways, preliminary ARARs, potential remedial technologies, and data limitations. This summary of information will be used to identify the RI/FS objectives (Section 4.0).

3.1 Types and Volumes of Waste Present

Only limited information is available on the former storage, handling, and dispensing activities conducted at this site. Based on the existing analytical database, soil, groundwater, surface water and sediment have been impacted by pesticides, volatile organics, semivolatile organics, and inorganic contaminants. Two areas of concern have been identified: the area surrounding Building 712 (including the mixing pads behind the building); and the area across the railroad tracks that was formerly used as a storage area. The two areas may be unrelated with respect to past waste handling activities. The area associated with Building 712 has documented usage of pesticides and herbicides. With respect to the storage area across the railroad tracks from Building 712, there is no information available to determine what kinds of waste handling activities occurred. However, groundwater at the former storage area is contaminated with ethylbenzene and xylene.

Historical aerial photographs in the EPIC Study (see Appendix A) depict stained soils and bulk materials and containers at the Former Storage Area. A crane, which may have been used to unload cargo from railcars, is also shown in one of the photographs.

Releases to the environment would have occurred as a result of small spills, washout, and excess disposal. During the 15-year use, several gallons of pesticides/herbicides per year were reportedly used. Therefore, the estimated quantity involved is on the order of 100 to 500 gallons of liquids. Solid residues in cracks and crevasses may total 1 to 5 pounds. (Note: Quantity estimates are not based on reliable data and are provided for order magnitude guidance only (ESE, 1990).) Disposal to drainage ditch is undocumented.

Historical photographs depict three horizontal aboveground tanks where one of the two wash/mixing pads are located. These tanks may be 55-gallon drums and therefore, the activated quantity involved may have been underestimated in previous reports.

In general, further evaluation is needed to determine: the extent of soil contamination at the mixing pad area, around Building 712, and former storage area; groundwater contamination at the Former Storage Area and mixing pad area; the source of volatile organic contamination in groundwater; and the extent of sediment and surface water contamination in the drainage ditch. In addition, background soil and sediment data need to be collected to compare with on-site pesticide/herbicide concentration levels.

3.2 Potential Transport and Exposure Pathways

Based on the evaluation of existing conditions at Site 2 the following potential contaminant pathways have been identified.

Transport Pathways

- Surface soil runoff from the pesticide mixing/wash pads to the drainage ditch.
- Surface soil runoff from the Building 712 area to the drainage ditch.
- Surface soil runoff from the Former Storage Area to the drainage ditches.
- Sediment migration in the drainage ditch to Overs Creek.
- Leaching of sediment contaminants to surface water.
- Migration/leaching of contaminants in the concrete mixing and washing pads to the soil.
- Migration/leaching of soil contaminants to groundwater.
- Groundwater infiltration from the shallow aquifer to the deep aquifer

Exposure Pathways

- Wildlife exposure to pesticides due to incidental sediment and soil ingestion.

- Terrestrial wildlife (e.g., burrowing animals) dermal exposure to contaminants in soil and sediment.

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

- Potential exposure to VOCs and pesticides from future potential groundwater ingestion.

- Potential human exposure to VOCs due to volatilization from groundwater.

- Human dermal exposure to VOCs and pesticides due to future potential direct contact with groundwater.

3.3 Preliminary Public Health and Environmental Health Impacts

There may be health risks to human or animal (wildlife) receptors due to the contamination detected at this site. Military personnel and civilians have been identified as the probable human receptors. It should be noted that human exposure is expected to be limited, since current site activities are centered within the building. In addition, the Former Storage Area is vacant and no longer in use. Wildlife receptors include small mammals such as raccoon and fox, deer, birds, reptiles, and aquatic organisms such as fish in Overs Creek.

3.4 Preliminary Identification of ARARs

The purpose of identifying applicable, relevant, and appropriate requirements (ARARs) during the planning stage of the RI/FS is to identify all potential regulations, standards, or non-promulgated advisaries and guidance that will ultimately effect the implementation of site investigation activities, waste handling and disposal activities, conductance of the human health and environmental risk assessment, and remedial actions at the site.

There are several different types of requirements that CERCLA actions may have to comply with. The classification of ARARs described below will allow the user to comply with ARARs during the RI/FS, design, and remedial action phases of the cleanup.

3.4.1 Chemical-Specific ARARs

Chemical-specific ARARs set limits on concentrations of specific hazardous substances, pollutants, and contaminants in the environment. Chemical-specific ARARs that may be applicable to Site 2 include the North Carolina Water Quality Standards (NCWQS), the North Carolina Surface Water Standards (NCSWS), the Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act and the Federal Ambient Water Quality Criteria (AWQC) pursuant to the Clean Water Act. There are no North Carolina or Federal ARARs for soil or sediment. However, EPA Region IV's "Water Quality and Sediment Screening Values" will be used as a "To Be Considered" (TBC) ARAR when evaluating ecological impacts in the surface waters and sediment.

Table 3-1 compares the maximum concentrations of compounds detected in the groundwater at Site 2 with the NCWQS and the Federal MCLs. As shown in the table, the maximum concentration of ethylbenzene (510 µg/L) exceeded the NCWQS of 29 µg/L; however, this concentration was less than the Federal MCL. As shown on Table 3-2 , the maximum concentration of DDT, 4,4' detected in the surface water exceeded the NCSWS and the FAWQC.

3.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of remedial activities in wetlands, floodplains, and historical sites. At this time, there do not appear to be any location-specific ARARs for Site 2.

3.4.3 Action-Specific ARARs

Action-specific ARARs (e.g., EPA Regulations on Land Disposal Restriction (40CFR 268)) are technology-based restrictions by the type of action under consideration. Action-specific ARARs for Site 2 will not be identified until potential remedial action technologies have been identified.

TABLE 3-1

COMPARISON OF CHEMICAL-SPECIFIC ARARs WITH CONTAMINANTS DETECTED IN THE GROUNDWATER MCB CAMP LEJEUNE, NORTH CAROLINA

Chemical	Federal MCLs(1)	North Carolina WQS(2)	Maximum Concentrations Detected in Groundwater Samples	
			Site 2	Site 74
DDD, 4,4'	NS	NS	0.097	ND
DDE, 4,4'	NS	NS	0.057	0.001
DDT, 4,4'	NS	NS	0.554	0.007
Ethylbenzene	700	29	510	ND
Toluene	1,000	1,000	12	ND
Aldrin	NS	NS	ND	0.029

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.

(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.

NS = No standard established.
ND = Not detected.

Values reported are concentrations in micrograms per liter (µg/L).

TABLE 3-2

COMPARISON OF CHEMICAL-SPECIFIC ARARs WITH CONTAMINANTS DETECTED IN THE SURFACE WATER MCB CAMP LEJEUNE, NORTH CAROLINA

Chemical	Ambient Water Quality Criteria(1)	North Carolina SWS(2)	Maximum Concentration Detected in Surface Water Samples
DDD, 4,4'	NS	NS	0.742
DDT, 4,4'	0.00024	0.00588	0.560

(1) Ambient Water Quality Criteria pursuant to Clean Water Act.
(2) NCSWS - North Carolina Administrative Code, Title 15A, NCAC, Subchapter 2B, Section - 0200 - Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina. April 1, 1991. Class SW waters.

NS = No standard established.

Values reported are concentrations in micrograms per liter (µg/L).

Note: No surface water samples were collected at Site 74.

3.5 Potential Remedial Technologies and Alternatives

The purpose of this section is to identify potential remedial technologies for each potentially affected medium at Site 2 in order to identify what data may be necessary to better evaluate the technologies during the Feasibility Study.

3.5.1 Soil and Sediment

Previous investigative studies have identified the presence of pesticide and herbicide residuals in the soil and sediment. Several technologies potentially capable of treating pesticides include thermal destruction (incineration), chemical extraction, dechlorination, stabilization/fixation, biodegradation, and low temperature thermal treatment. These technologies have been preliminary identified as potentially feasible, based on the limited amount of information available for Site 2. This listing will be refined as the RI progresses.

Each of the potentially feasible technologies will require specific data in order to evaluate their effectiveness, implementability, and cost. The review of existing background information did identify four areas within Site 2 where pesticides and herbicides were handled. Data should be collected from these areas to assess remedial technologies. The type and quantity of data needed is described in Section 3.1.6.

3.5.2 Groundwater

Samples collected from monitoring wells have exhibited low levels of pesticides, inorganics, semi-volatile organics, and volatile organic contamination. The source of the volatile and semi-volatile contamination is unknown and will be investigated during the RI/FS. Pesticides were detected in the initial studies at this site; however, samples collected during the Pre-Investigation Sampling (July, 1992) did not exhibit any pesticide contamination. Technologies for groundwater remediation include: vacuum extraction, air stripping, carbon adsorption, in-situ biodegradation,and chemical oxidation. Data relating to the treatability of these contaminants and on the physical characteristics of the aquifer (e.g., transmissivity, flow direction) are required.

3.5.3 Surface Water

Surface water samples collected from the drainage ditch during previous investigations exhibited pesticide contamination. It may well be that, due to the transient potential for surface water contamination from overland transport of material, source and/or migration control at the site will be sufficient to limit the potential for surface water impact.

3.6 Present Database Limitations

The purpose of this section is to define data limitations with the respect to either characterizing the site, assessing health and environment risks, or evaluating potential feasible technologies. The analytical methods and the level of Quality Assurance/Quality Control used for the analyses of the data provided for review were not included in the background information received for this site, and therefore could not be reported in this Work Plan. Consequently, the data provided is generally not suitable for use in making an assessment of human health or ecological risks due to contamination at Site 2. However, the data is useful in characterizing the site and on guiding the scoping of the RI. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4 of this Work Plan.

3.6.1 Soil

A limited amount of soil data has been collected from Site 2. These data, which indicate the presence of pesticide residuals, is only representative of the top 3 feet of soil. In addition, many of the locations of previous sampling efforts are unknown, as well as is the level of QA/QC and overall data quality. Based on the review of existing information, data will be required to: characterize soil contamination at the mixing pads, the lawn areas adjacent to Building 712, and the former storage area; delineate areas of concern; assess human health and ecological risks; evaluate the extent of soil runoff towards the drainage ditches; and evaluate potential remedial technologies.

3.6.2 Groundwater

Previous sampling efforts (conducted by ESE, Inc.) have detected the presence of pesticides and organic volatiles. Volatile organics, semi-volatile organics, and inorganic contaminants were detected in the groundwater samples collected during the 1992 Pre-Investigation

Sampling (conducted by Baker). Volatile contamination was consistently detected in Well 2GW3, which is at the Former Storage Area. The source of volatile organic contamination in the groundwater (near the former storage area) is unknown. Groundwater quality data collected from the site to date has been exclusively from the shallow portion of the aquifer. Consequently, if a plume of contaminated groundwater is present, it has not been defined by the present configuration of wells. Therefore, additional sampling points and analytical data are required in order to adequately characterize groundwater contamination (shallow and deep aquifer), delineate plumes, assess human health and ecological risks, and evaluate remedial technologies.

3.6.3 Sediment

Previous sampling efforts have detected the presence of pesticides and herbicides in the drainage ditch sediment which runs adjacent to the site (on the southwest side of the railroad tracks) . Drainage ditches are present on each side (northeast and southwest) of the railroad tracks. There is also a drainage pathway that extends west of the site, underneath Holcomb Boulevard. It is unknown whether the sediment contamination indicated is due to site-related activities or other activities such as a routine spraying along the ditch for weed and insect control. In order to evaluate the source and extent of contamination and human health and ecological risks, data needs to be collected from the drainage ditches, and Overs Creek. Sediment samples collected to date have been exclusively from the drainage ditch on the southwest side of the railroad tracks. Background sediment samples from the drainage ditch also need to be collected for comparison purposes.

3.6.4 Surface Water

Pesticides were reported in samples collected previously from the drainage ditch adjacent to the railroad tracks. Because only two samples were collected along the entire length of the ditch, and because the overall quality of this data is unknown, insufficient data are available to assess surface water quality and human health and ecological risks associated with the drainage ditch. Surface water samples collected to date have been exclusively from the drainage ditch on the southwest side of the railroad tracks. Additional surface water samples are required in this ditch (southwest and northeast side), the drainage ditch extending west (beneath Holcomb Boulevard) and in Overs Creek to assess extent of contamination and to evaluate any apparent appropriate remedial technologies.

4.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES

The purpose of this section is to define the site-specific RI/FS objectives which than provide the framework for determining what is needed to fulfill the goal of characterizing the problems at the site, assessing potential impacts to the public health and environment, and providing feasible alternatives for consideration in the preparation of the Record of Decision. The site-specific remedial objectives presented in this section have been identified based on the review and evaluation of existing information, assessment of potential risks to the public health and environment, and the consideration of potential feasible technologies/alternatives.

The project objectives, criteria for meeting the objectives, and general investigative methods are presented on Table 4-1 for Site 2 - Former Nursery/Day Care Center.

TABLE 4-1

SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712)
MCB CAMP LEJEUNE, NORTH CAROLINA
RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
Building 712 and Mixing Pad Areas 1. Soil	1a. Assess the extent of pesticide/herbicide contamination at Building 712 and th4e mixing pad areas.	Characterize pesticide and herbicide levels in surface and subsurface soils at areas potentially impacted by pesticide/herbicide storage and handling.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils.	Characterize organic and inorganic contaminant levels in surface and soils.	Soil Investigation Risk Assessment
	1c. Assess areas of surface soil contamination resulting from site runoff.	Characterize contaminant levels in surface soil at downslope drainage areas.	Soil Investigation
Building 712 and Mixing Pad Areas 2. Groundwater	2a. Assess health risks posed by future usage of the shallow groundwater near Site 2.	Evaluate groundwater quality and compare to ARARs and health based action levels	Groundwater Investigation Risk Assessment
	2b. Assess potential impact to groundwater from contaminated soil or unknown releases.	Characterize on-site groundwater quality Identify possible sources of unknown releases	Groundwater Investigation Soil Gas Survey
	2c. Define hydrogeologic characteristics for fate and transport evaluations and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow aquifer (flow direction, transmissivity, permeability).	Groundwater Investigation
Building 712 and Mixing Pad Areas 3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments	Characterize nature and extent of sediment contamination in drainage ditches.	Sediment Investigation in Drainage Ditches and Overs Creek. Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments.	Identify whether site-related contaminants have migrated to Overs Creek.	Sediment Investigation
	3c. Determine the extent of sediment contamination for purposes of identifying areas of remediation.	Identify extent of sediment contamination where pesticide levels exceed health based action levels.	Sediment Investigation (Drainage Ditch Along Lejeune Railroad)
Building 712 and Mixing Pad Areas 4. Surface Water	4a. Assess the presence or absence of surface water contamination in drainage ditch along site.	Determine surface water quality along drainage ditch.	Surface Water Investigation

TABLE 4-1 (Continued)

SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712)
MCB CAMP LEJEUNE, NORTH CAROLINA
RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
Former Storage Area 1. Soil	1a. Assess potential impacts to soil from past storage activities.	Characterize contaminant levels in surface and subsurface soils at the former storage area.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils.	Characterize contaminant levels in surface and subsurface soils.	Soil Investigation Risk Assessment
	1c. Assess areas of surface soil contamination resulting from site runoff.	Characterize contaminant levels in surface soil at downslope drainage area.	Soil Investigation
Former Storage Area 2. Groundwater	2a. Assess health risks posed by future usage of the shallow groundwater near Site 2.	Evaluate groundwater quality and compare to ARARs and health based action levels	Groundwater Investigation Risk Assessment
	2b. Define vertical and horizontal extent of contamination.	Characterize on-site groundwater quality in shallow and deeper positions of the aquifer. Characterize off-site groundwater quality.	Groundwater Investigation
	2c. Assess potential impact to groundwater from contaminated soil or unknown releases.	Characterize on-site groundwater quality Identify possible sources of unknown releases	Groundwater Investigation Geophysical Investigation
	2d. Define hydrogeologic characteristics for fate and transport evaluations and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow aquifer (flow direction, transmissivity, permeability).	Groundwater Investigation
Former Storage Area 3. Sediment	3a. Assess human health and ecological risks associated with exposure to contaminated sediments	Characterize nature and extent of contamination in sediment	Sediment Investigation in Drainage Ditches and Overs Creek. Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments.	Identify whether site-related contaminants have migrated to Overs Creek.	Sediment Investigation
	3c. Determine the extent of sediment contamination for purposes of identifying areas of remediation.	Identify extent of sediment contamination where pesticide levels exceed health based action levels.	Sediment Investigation (Drainage Ditch Along Lejeune Railroad)

TABLE 4-1 (Continued)

SITE 2 - FORMER NURSERY/DAY CARE CENTER (BLDG 712)
MCB CAMP LEJEUNE, NORTH CAROLINA
RI/FS OBJECTIVES

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
Former Storage Area 4. Surface Water	4a. Assess the presence or absence of surface water contamination in drainage ditch along site.	Determine surface water quality along drainage ditch.	Surface Water Investigation

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section identifies the tasks and field investigations required to complete RI/FS activities at Site 2.

5.1 Task 1 - Project Management

Project Management activities involve such activities as daily technical support and guidance, budget and schedule review and tracking, preparation and review of invoices, manpower resources planning and allocation, preparation of monthly progress reports, and communication with LANTDIV and the Activity.

5.2 Task 2 - Subcontract Procurement

Task 2 involves the procurement of services such as drilling, test pit excavations, surveying, laboratory analysis, and data validation. Procurement of these services will be performed in accordance with the Navy Clean Contract Procurement Manual. In the event that treatability studies are warranted, procurement of bench-scale or pilot-scale studies will be performed under this task.

5.3 Task 3 - Field Investigations

This section presents an overview of the field investigations to be conducted at Site 2. Specific details with respect to the investigative methods are provided in the Field Sampling and Analysis Plan (FSAP). The field investigations described in this section will provide data to meet the overall RI/FS objectives presented in Section 4.0 of this RI/FS Work Plan.

Quick (14-day) laboratory analytical turnaround time will be requested for some samples collected from the various environmental media at each site. This will allow for flexibility in the field program with respect to whether additional sampling is required to meet the objectives. As an example, a soil sample from the exterior of a sampling grid may indicate contamination, and that further sampling/analysis is required to determine the extent of contamination. Based on this, Baker can relay recommendations to LANTDIV for changes in the scope of the field program while field activities are still ongoing. All recommended changes to the field program will be discussed with the North Carolina DEHNR and EPA Region IV for approval.

There are two areas of concern at Site 2; the Building 712 area (storing, handling, and mixing of pesticides) and the Former Storage Area (VOC contaminants present in shallow groundwater). For purposes of clarification, the "Building 712" area includes the area immediately surrounding the building itself along with the two concrete mixing pads located behind the building.

The following investigations and activities will be conducted at Site 2:

- Surveying
- Soil Gas Investigation
- Soil Investigation
- Groundwater Investigation
- Surface Water/Sediment Investigation
- Concrete Pad Investigation

5.3.1 Surveying

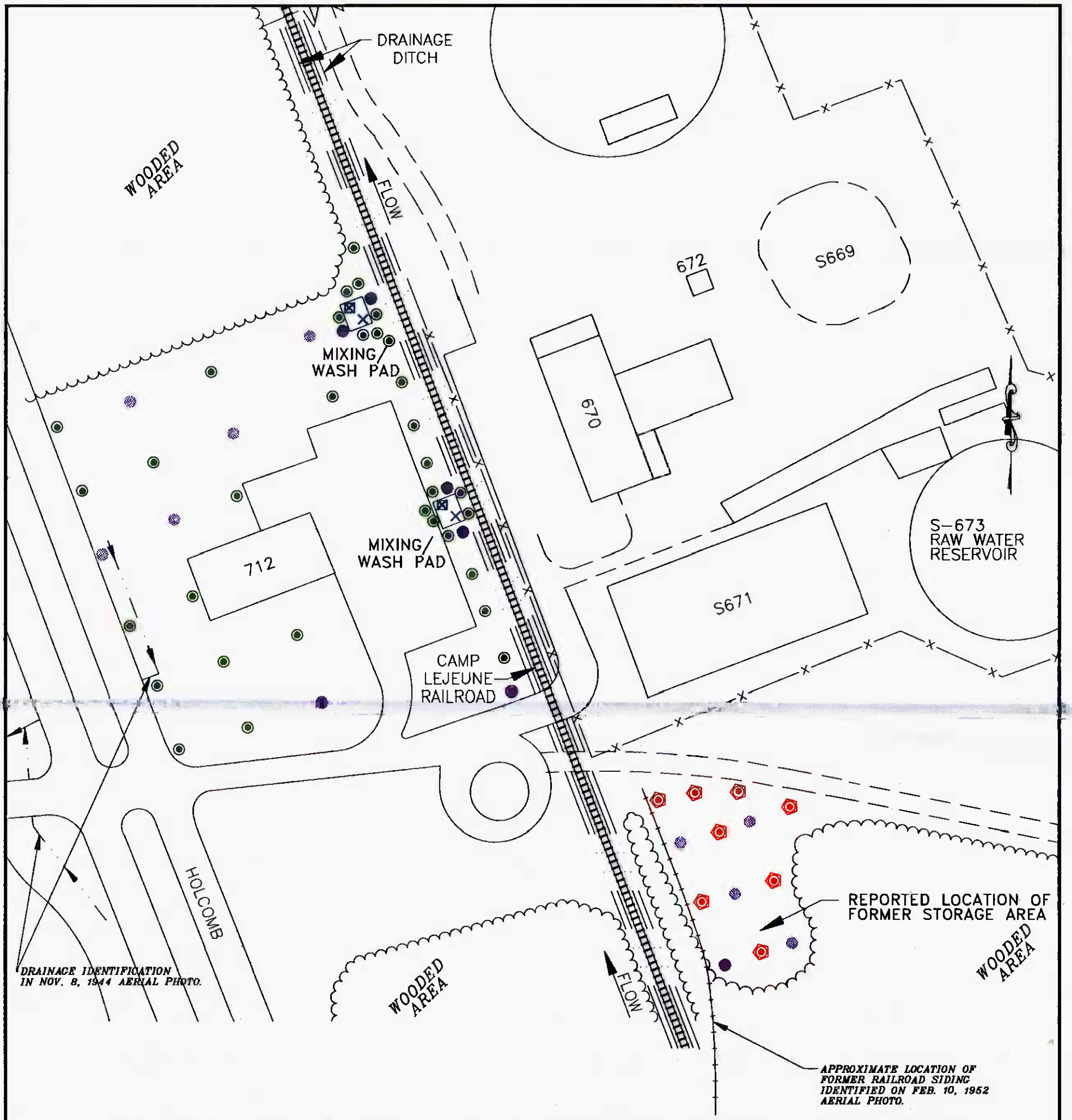
A sampling grid, as shown on Figure 5-1, will be established in the grass area adjacent to Building 712, and in the former storage area where previous waste handling activities have been reported. The sampling grids will be used to locate proposed soil sampling stations.

The sampling grid around Building 712 will be established at 50 foot spacings. This grid will consist of approximately 43 grid points. The grid over the former storage area will be established at approximately 35-foot spacings. This grid will consist of 13 locations.

Following the field investigation, all staff gauges, monitoring wells, and soil and surface water sampling stations will be surveyed.

5.3.2 Soil Investigation

The following subsections describe the soil investigation activities for Site 2. Soil sampling locations and analytical parameters have been selected on the basis of the results of the EPIC Study, other historical information and available information regarding soil quality on site.



DESIGNATION	DESCRIPTION	No. OF LOCATIONS	Estimated No. OF SAMPLES	CHEMICAL ANALYSIS	TURNAROUND TIME
●	SOIL BORING (0-6") (5' INTERVALS TO GROUNDWATER)	36	72-108	CHLORINATED HERBICIDES TCL PESTICIDES	ROUTINE (28-40 DAYS)
⬡	SOIL BORING (0-6") (5' INTERVALS TO GROUNDWATER)	8	16-24	BTEX	ROUTINE (28-40 DAYS)
×	CONCRETE CHIP	4	4	CHLORINATED HERBICIDES TCL PESTICIDES TAL METALS	ROUTINE (28-40 DAYS)
⊠	CONCRETE CHIP/SOIL BORING (0-6") (2'-4')	2	4	CHLORINATED HERBICIDES TCL PESTICIDES	QUICK TURN (14 DAYS) QUICK TURN (14 DAYS)
●	SOIL BORING	13	26-39	FULL TCL/TAL	QUICK TURN (14 DAYS)

80 0 40 80 120

1 inch = 80 ft.

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FIGURE 5-1
SOIL SAMPLING LOCATIONS
SITE 2
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991

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5.3.2.1 Building 712 Area

Twenty-eight soil borings will be augered at fifty-foot grid spacings, as shown in Figure 5-1. Split-spoon soil samples will be collected from the surface (top six inches) and at five-foot intervals to the top of the water table during drilling. All samples collected from this area will be analyzed for chlorinated herbicides using EPA Method 8150 and TCL Pesticides using CLP Protocols (Level IV Data Quality, routine analytical turnaround). Samples collected from seven test borings (see Figure 5-1) will be analyzed for full TCL organics and TAL inorganics using CLP protocols (Level IV Data Quality, 14-day turnaround).

A total of 16 test borings will be augured using ASTM Method D1568-84 around the two concrete pads (8 test borings per pad area). Nine test borings will be augured between the pads and adjacent to the pads. Samples will be collected from the ground surface (top six inches) and at 5-foot intervals to the top of the water table. It is possible that as many as three samples and no less than two soil samples will be collected from each borehole. Samples collected from 20 of the 25 test borings will be analyzed for chlorinated herbicides using EPA Method 8150 and TCL Pesticides using CLP Protocols (Level IV Data Quality, routine analytical turnaround). Soil samples collected from the other five test borings will be analyzed for full TCL organics and TAL inorganics using CLP protocols (Level IV Data Quality, 14-day analytical turnaround). A 14-day laboratory turnaround will be requested for these analyses in order to evaluate whether other additional soil borings are required to more fully define the extent of contamination.

One composite soil sample from the Building 712 area will be analyzed for the following engineering and waste disposal parameters:

Grain Size
Moisture Density
Chlorine (Residual)
Total Fluoride
Nitrogen (Organic)
Alkalinity (Total)
TOC
Reactivity
Corrosivity
Ignitability
Full TCLP

One test boring will be hand-augered under each of the two concrete pads to determine if pesticides/chlorinated herbicides have leached through the concrete. Samples will be collected from the ground surface (top six inches) and from the two to four foot interval beneath the concrete mixing pad. All samples will be analyzed for chlorinated herbicides using EPA Method 8150 and TCL Pesticides under CLP protocols (Level IV Data Quality). Routine analytical turnaround will be requested on all samples.

5.3.3 Former Storage Area

In the open area, where the former storage area was reported to be located, test borings will be augured using ASTM Method D1568-84 at 13 sample stations. 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 seven to ten feet below ground surface. As many as three samples and no less than two soil samples will be collected from each borehole. All samples from this area will be analyzed for benzene, toluene, ethylbenzene and xylenes (BTEX) using EPA Method 8020 (Level III Data Quality). Soil samples collected from five test borings will also be analyzed for full TCL organics and TAL inorganics using CLP Protocols (Level IV Data Quality). In addition, soil samples will be collected from four boreholes which will later be converted to monitoring wells, and analyzed for full TCL organics and TAL inorganics. Routine analytical turnaround will be requested on all samples. One soil sample will be analyzed for engineering parameters.

5.3.4 Groundwater Investigation

A Groundwater Investigation will be conducted at Site 2 to assess the groundwater quality that may be impacted by the past pesticide and herbicide mixing/washing practices conducted at this site. The groundwater investigation will also be conducted to assess the source and extent of volatile contamination detected at the Former Storage Area (Monitoring Well 2GW3).

A soil gas survey will be conducted in the wooded area south of the former storage area. The soil gas survey will be conducted to estimate the extent of BTEX contamination in groundwater south of monitoring well 2GW3. The results of the soil gas survey will be used to

select locations for additional monitoring wells. Soil gas samples will be collected at points on a 100 ft. by 100 ft. grid (Figure 5-2).

The groundwater investigation will consist of sample collection from existing monitoring wells and the construction of at least one deep monitoring well (near well 2GW3) and three shallow monitoring wells. In addition, one background well will be constructed north of the site near Holcomb Boulevard. With the exception of the deep monitoring well and the background monitoring well, the location of three off-site monitoring wells will be based on data obtained during the soil gas survey.

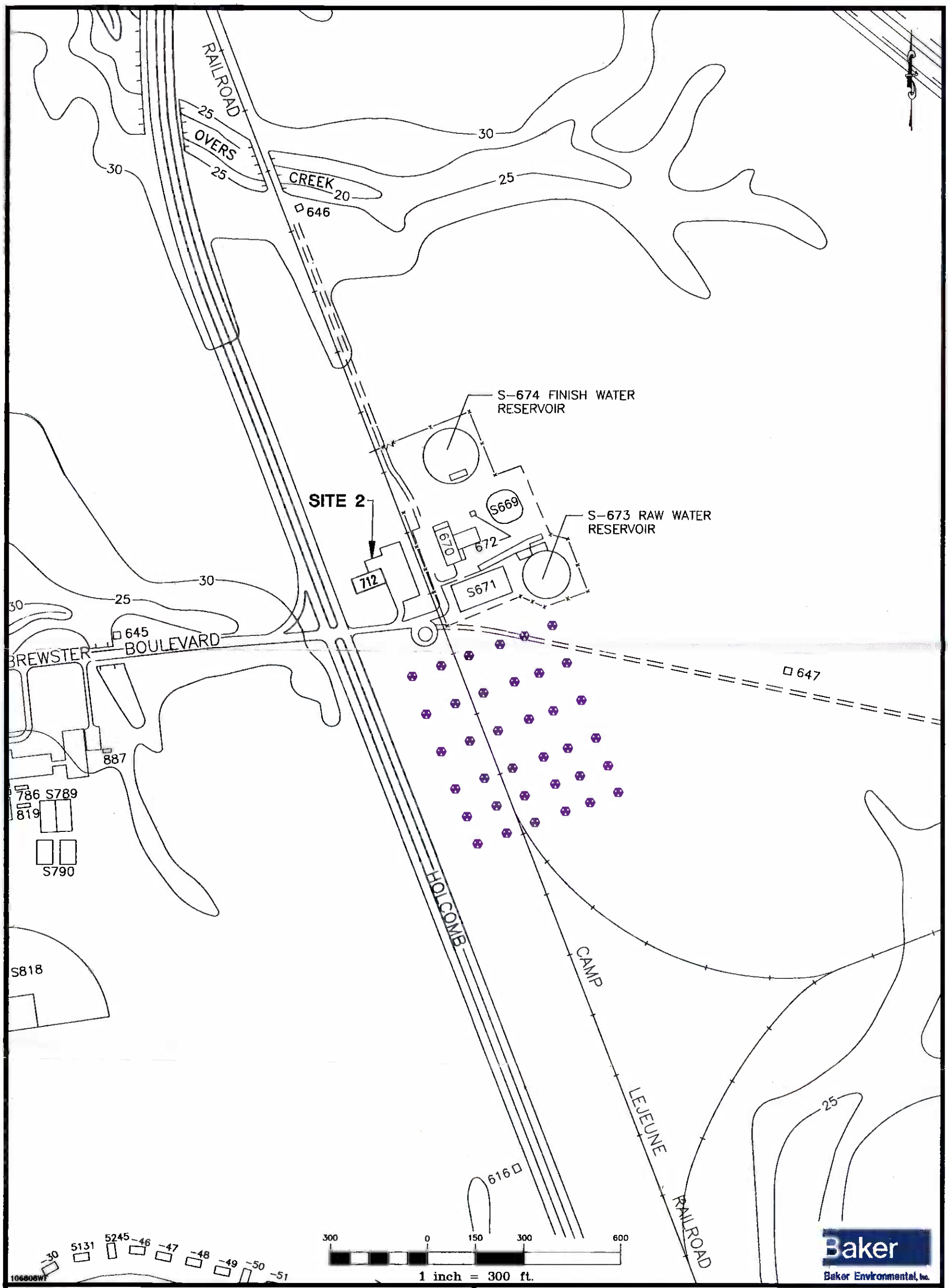
Monitoring Well Construction

Five shallow (approximately 25 feet deep) monitoring wells were previously installed at Site 2 (wells 2GW1 through 2GW5) to monitor groundwater quality. At least four additional shallow monitoring wells and one deep (approximately 100 feet deep) monitoring well will be installed during this RI. The proposed well locations are shown on Figure 5-3; however, well locations for 2GW6, 2GW7, and 2GW8 will be established following the evaluation of data obtained by the Soil Gas Survey.

All shallow wells will be constructed of 4-inch PVC. Four-inch wells are proposed since they can easily be converted into extraction wells, if required. Additionally, pump tests can be conducted more effectively in 4-inch wells. Well screens will be a standard 10 foot length and will be installed to screen the water table surface. This well depth and screen length will allow for seasonal fluctuations in the water table and will represent the surficial aquifer at the site. Detailed well construction procedures are provided in the Field Sampling and Analysis Plan (FSAP).

The deep monitoring well will be installed in the vicinity of the shallow well that exhibits the greatest degree of groundwater quality degradation. It is expected that this will be in the vicinity of 2GW3.

The deep well will be constructed of 4-inch PVC. The well screen length will be 10 feet. The screened interval depth will be selected to characterize the deeper portions of the aquifer in this area. The screen will be installed immediately below the first significant (greater than 6 inches thick) low hydraulic conductivity lithology (i.e., clay) or to a maximum depth of 100



LEGEND

⬢ SOIL GAS SURVEY SAMPLING LOCATION

SOURCE: LANTDIV, OCT. 1991

FIGURE 5-2
SOIL GAS SURVEY SAMPLING LOCATION MAP
SITE 2

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

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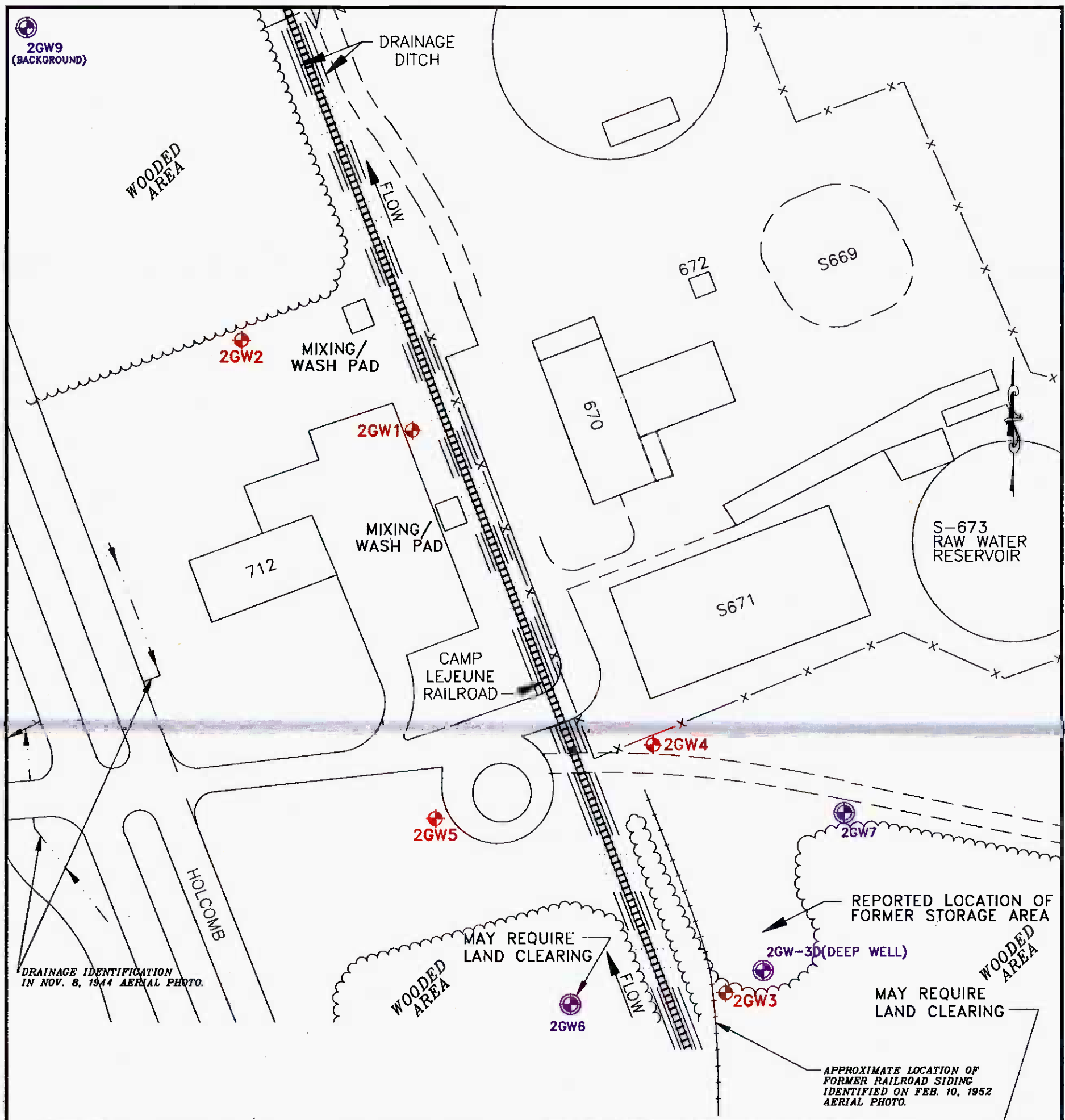

DESIGNATION	DESCRIPTION	No. OF LOCATIONS	TOTAL No. OF SAMPLES	CHEMICAL ANALYSIS	TURNAROUND TIME
2GW1	EXISTING MONITORING WELL	5	5	FULL TCL ORGANICS AND TAL INORGANICS	ROUTINE (28-40 DAYS)
2GW6	SOIL BORING/MONITORING WELL	5	SOIL 10 GROUNDWATER 5	FULL TCL ORGANICS AND TAL INORGANICS	ROUTINE (28-40 DAYS) DEEP WELL-QUICK TURN (14 DAYS)

NOTE: NEW MONITORING WELL LOCATIONS WILL BE SELECTED BASED ON THE RESULTS OF THE SOIL GAS SURVEY.

80 0 40 80 120

1 inch = 80 ft.

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FIGURE 5-3
GROUNDWATER SAMPLING LOCATIONS
SITE 2
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991

feet. Detailed well construction procedures are provided in the Field Sampling and Analysis Plan (FSAP).

Groundwater Sampling and Analysis

One round of groundwater samples will be collected from the existing wells and newly-installed monitoring wells. All samples collected from these monitoring wells will be analyzed for full TCL Organics and TAL Inorganics using CLP protocols (Level IV Data Quality). Routine analytical turnaround will be requested for these analyses.

Groundwater collected from well 2GW3 and 2GW3D also will be analyzed for engineering parameters to evaluate process options for treatment of the groundwater. These analytical parameters will include: biological oxygen demand (BOD), total organic carbon (TOC) chemical oxygen demand (COD), total suspended solid (TSS), total dissolved solids (TDS), and total volatile solids (TVS). Sampling procedures are outlined in the FSAP.

5.3.5 Surface Water and Sediment Investigation

Surface water/sediment sampling will be conducted in the following areas at Site 2:

- The drainage ditches which run adjacent to the Lejeune railroad (east and west side).
- The drainage ditch which runs west from the Building 712 area, under Holcomb Boulevard.
- Overs Creek.

Surface water/sediment sampling locations are presented in Figure 5-4 (proximal to Site 2) and Figure 5-5 (north of Site 2). This section outlines the sampling and analytical requirements. Specific sampling procedures can be found in the FSAP.

Surface water/sediment sampling locations and analytical parameters have been selected on the basis of the results of the EPIC Study, other historical information, and available information regarding surface water/sediment quality on site.

As shown in Figure 5-4 and 5-5, surface water and sediment sampling stations have been identified to characterize the upgradient site conditions, potential impact from the Building 712 area and the former storage area, and the potential migration of contaminants from the site.

Nine sampling stations have been identified on the "east" railroad tracks drainage ditch to evaluate potential impacts from the former storage area. Ten sampling stations have been identified on the "west" drainage ditch to assess potential impacts from the Building 712 area. Both of these drainage pathways discharge into Overs Creek. Three stations have been identified in Overs Creek, as shown on Figure 5-5. Two stations have been located in the drainage ditch that extends west from the site (under Holcomb Boulevard).

One surface water sample will be collected from each location. A surface (top six inches) and a subsurface (6 to 12 inches bgs) sediment sample will be collected from each station.

All surface water and sediment samples will be analyzed for chlorinated herbicides using EPA Method 8150 and TCL Pesticides. In addition surface water and sediment samples collected from seven stations will be analyzed for full TCL organics and TAL inorganics.

Staff gauges will be installed in each drainage ditch and in Overs Creek. These staff gauges will be used to measure surface water elevation.

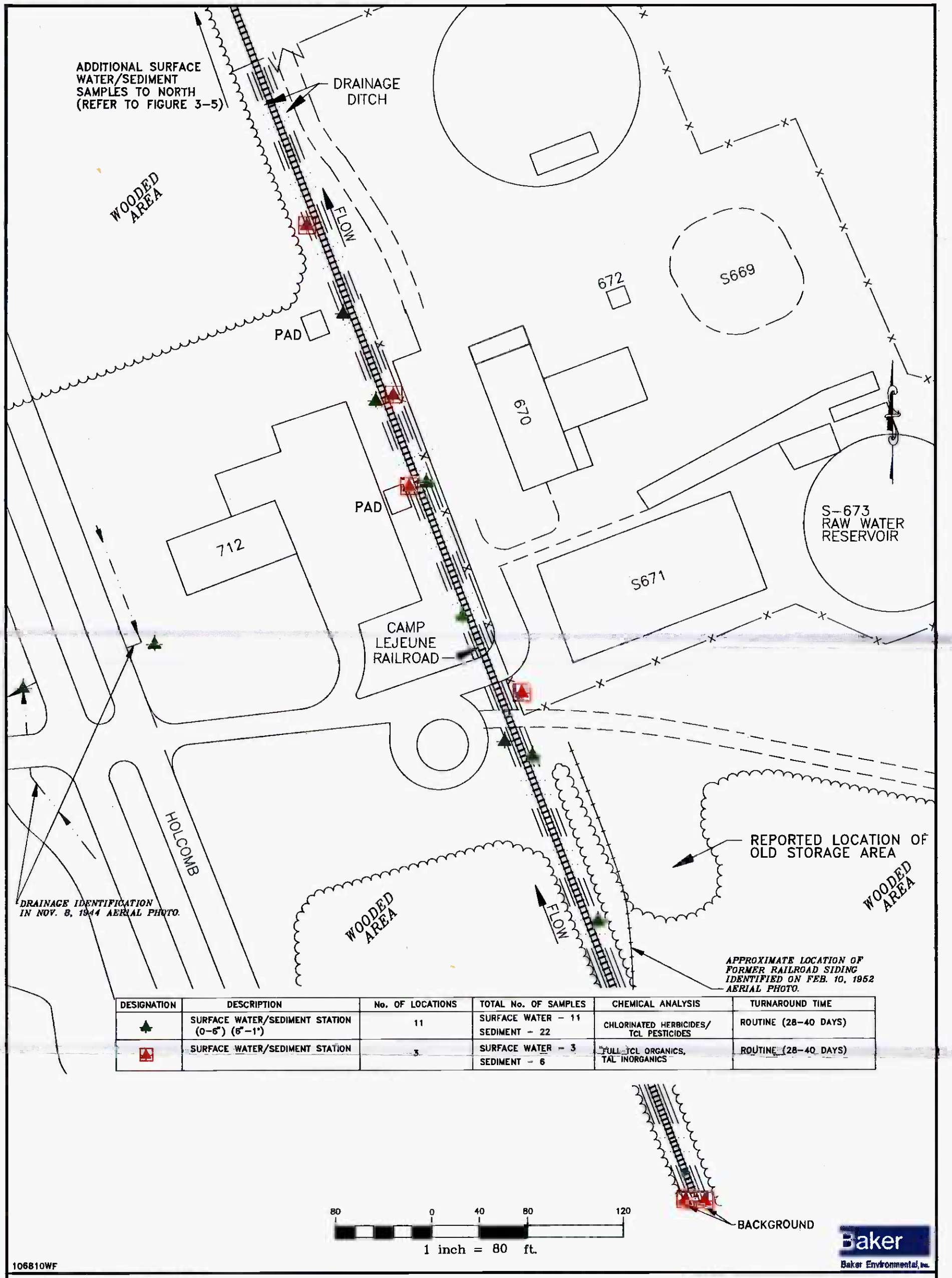
5.3.6 Concrete Pad Samples

A concrete chip sample will be collected from each of the mixing/wash pads at Site 2. The samples will be collected using decontaminated hammer and chisel, or jackhammers.

In order to evaluate potential disposal or remedial options, the concrete chip samples will be analyzed for TCLP pesticides and metals (Level III Data Quality). Routine analytical turnaround time will be requested for all samples.

5.3.7 Background Samples

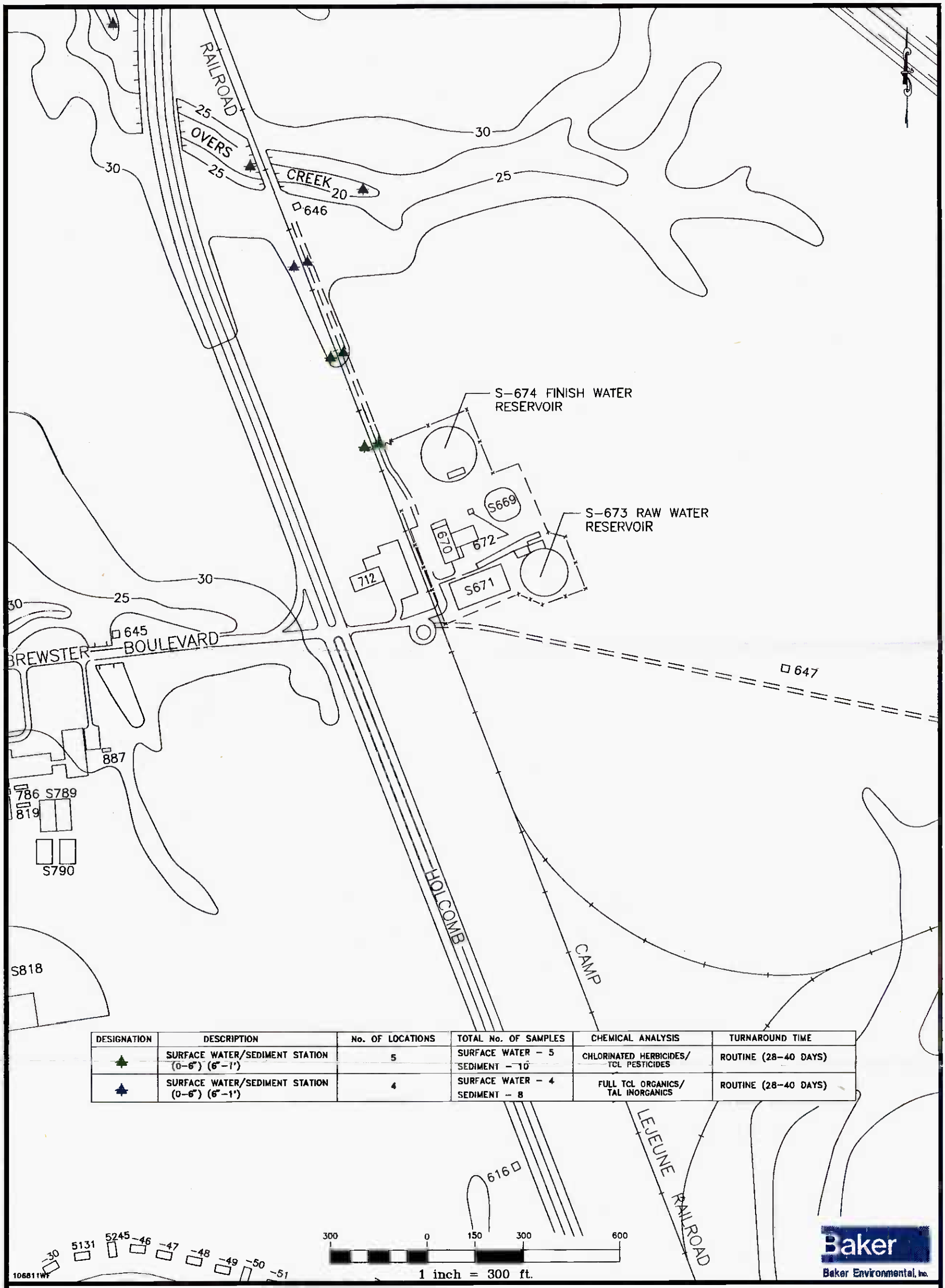
In order to address background conditions at Site 2, background samples will be collected from each media (soil, surface water/sediment, groundwater). All background samples will be



DESIGNATION	DESCRIPTION	No. OF LOCATIONS	TOTAL No. OF SAMPLES	CHEMICAL ANALYSIS	TURNAROUND TIME
▲	SURFACE WATER/SEDIMENT STATION (0-6") (6"-1')	11	SURFACE WATER - 11 SEDIMENT - 22	CHLORINATED HERBICIDES/ TCL PESTICIDES	ROUTINE (28-40 DAYS)
▲	SURFACE WATER/SEDIMENT STATION	3	SURFACE WATER - 3 SEDIMENT - 6	FULL TCL ORGANICS, TAL INORGANICS	ROUTINE (28-40 DAYS)

SOURCE: LANTDIV, OCT. 1991

FIGURE 5-4
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
SITE 2 AREA
MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA



DESIGNATION	DESCRIPTION	No. OF LOCATIONS	TOTAL No. OF SAMPLES	CHEMICAL ANALYSIS	TURNAROUND TIME
▲	SURFACE WATER/SEDIMENT STATION (0–6") (6"–1')	5	SURFACE WATER – 5 SEDIMENT – 10	CHLORINATED HERBICIDES/ TCL PESTICIDES	ROUTINE (28–40 DAYS)
▲	SURFACE WATER/SEDIMENT STATION (0–6") (6"–1')	4	SURFACE WATER – 4 SEDIMENT – 8	FULL TCL ORGANICS/ TAL INORGANICS	ROUTINE (28–40 DAYS)

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FIGURE 5–5
SURFACE WATER/SEDIMENT SAMPLING
LOCATIONS NORTH OF SITE 2 AREA

SOURCE: LANTDIV, OCT. 1991

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

submitted to the laboratory for analysis of TCL organic and TAL inorganic parameters. (Level IV Data Quality)

Two background surface (0 - 6") soil samples will be collected from a lawn area at another (nearby) office building. Two background surface water/sediment sampling locations have been selected for Site 2 (refer to Figure 5-4). A background monitoring well will be installed north of Site 2 (refer to Figure 5-3).

5.3.8 Investigation Derived Waste Handling

Investigation Derived Waste (IDW) expected to be generated during field activities include:

- Drill Cuttings
- Monitoring Well Development Water
- Groundwater Sampling Purge Water
- Decontamination Fluids
- Health and Safety Disposables.

All IDW will be containerized and handled in accordance with procedures outlined in the SAP.

5.4 Task 4 - Sample Analysis and Validation

This task involves efforts relating to the following post-field sampling activities:

- Sample Management
- Laboratory Analysis
- Data Validation

Sample management activities involve coordination with subcontracted laboratories, tracking of samples submitted for analysis, tracking of analyses received, and tracking of information related to samples submitted and received from a third party validator. Sample management also involves resolving potential problems (e.g., reanalysis, resubmission of information).

Laboratory analysis begins when the samples are shipped from the field and received by the laboratory. Validation begins when the "raw" laboratory data is received by the validator from Baker. Baker will first receive the data from the laboratory, log it into a database for

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 2 Bldg. 712 Area	Soil	19 Soil Borings				
		• 26-39 Samples (13 Borings)	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
		• 12-18 Samples (6 Borings)	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	Routine
Site 2 Mixing Pads Area	Soil	25 Soil Borings				
		• 40-60 Samples (20 Borings)	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
		• 10-15 Samples (5 Borings)	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	Routine
		• 1 Composite Sample	Engineering Parameters	III	7	Routine
Background Soil	Soil	2 Samples Total	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	
Site 2 Bldg. 712	Concrete Pads	4 Concrete Chip Samples	TCLP Pesticides, Metals, and Herbicides	III	7	Routine
		4 Soil Samples from Beneath Concrete Pads	Chlorinated Herbicides	IV	4	14 days
			TCL Pesticides	IV	3	14 days
			TAL Inorganics	IV	7	14 days
Site 2 Bldg. 712 Drainage Ditches (RR Tracks)	Surface Water	10 Samples Total				
		• 6 Samples	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
		• 4 Samples	TCL Organics	IV	1,2,3	Routine
			TAL Inorganic	IV	7	Routine

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 2 Bldg. 712 Drainage Ditches (RR Tracks)	Sediment	10 Locations/20 Samples Total				
		• 12 Samples (includes 1 background)	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
			TOC	III	7	Routine
		• 8 Samples	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	Routine
			TOC	III	7	Routine
Site 2 Holcomb Boulevard Drainage Ditch	Surface Water	2 Samples Total	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
Site 2 Holcomb Boulevard Drainage Ditch	Sediment	2 Locations/4 Samples Total	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
			TOC	III	7	Routine
Overs Creek	Surface Water	3 Samples Total	Chlorinated Herbicides	IV	4	Routine
		• 1 Sample	TCL Pesticides	IV	3	Routine
		• 2 Samples	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	Routine

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Overs Creek	Sediment	3 Locations/6 Samples Total				
		• 2 Samples	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
			TOC	III	7	Routine
		• 4 Samples	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	Routine
			TOC	III	7	Routine
Site 2 Former Storage Area	Soil	13 Borings				
		• 16-24 Samples (8 borings)	BTEX	III	5	14 days
		• 10-15 Samples (5 borings)	TCL Organics	IV	1,2,3	14 days
			TAL Inorganics	IV	6	14 days
		• 1 Composite Sample	Engineering/FS Parameters	III	7	Routine
Site 2 Monitoring Well Boreholes	Soil	5 Monitoring Well Test Borings	TCL Organics	IV	1,2,3	Routine
		• 10 Samples (2/borehole)	TAL Inorganics	IV	6	Routine
Site 2 Former Storage Area Drainage Ditches	Surface Water	9 Samples Total (includes 1 background)				
		• 5 Samples	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
		• 4 Samples	TCL Organics	IV	1,2,3	14 days
			TAL Inorganics	IV	6	14 days

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 2 Former Storage Area Drainage Ditch	Sediment	9 Locations/18 Samples Total				
		• 10 Samples	Chlorinated Herbicides	IV	4	Routine
			TCL Pesticides	IV	3	Routine
			TOC	III	8	Routine
		• 8 Samples	TCL Organics	IV	1,2,3	14 days
			TAL Inorganics	IV	6	14 days
			TOC	III	7	Routine
Site 2	Groundwater	5 Existing Wells and 5 New Wells 11 Samples Total (2 Background)	TCL Organics	IV	1,2,3	Routine
			TAL Inorganics	IV	6	Routine
			Engineering Parameters	III	I	Routine

TABLE 5-1
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 2
MCB CAMP LEJEUNE, NORTH CAROLINA

1.	Purgeable Organic Compounds	EPA 8240/EPA 624	
2.	Base/Neutral and Acid Extractables	EPA 3510/3550	EPA 625
3.	Pesticides and PCBs	EPA 3510/3550	EPA 608
4.	Chlorinated Herbicides	EPA 8150	
5.	Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)	EPA 8020	

6. TAL Inorganics

Aluminum	EPA 3010/EPA 200.7	Calcium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Chromium	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Arsenic	EPA 3020/EPA 206	Cobalt	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270
Barium	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Iron	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 234	Vanadium	EPA 3010/EPA 200
Calcium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Cyanide	EPA 3010/EPA 335
		Mercury	EPA 3010/EPA 245.1		

7. Engineering/FS Parameters - Soil

Grain Size	ASTM D422	Reactivity	40 CFR 261
Moisture Density	ASTM D698	Corrosivity	40 CFR 261
Total TCLP	40 CFR 261	Ignitability	40 CFR 261
Chloride	SW 9251		
Total Fluoride	SM 4500-F		
Nitrogen (Organic)	EPA 350.2		
Alkalinity (Total)	SM 2320-B		
TOC	EPA 415.1		

8. Engineering/FS Parameters - Water

Biological Oxygen Demand	SM 5210
Chemical Oxygen Demand	EPA 410.1
Total Suspended Solids	EPA 160.2
Total Dissolved Solids	EPA 160.1
Total Volatile Solids	EPA 160.4
Total Organic Carbon	

tracking purposes, and then forward it to the validator. A validation report will be expected within three weeks following receipt of laboratory data packages (Level IV) by the validator. Level IV data will be validated per the CLP criteria as outlined in the following documents:

- EPA, Hazardous Site Control Division, Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, 1991.

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

5.5 Task 5 - Data Evaluation

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

5.6 Task 6 - Risk Assessment

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

Baseline risk assessments evaluate the potential human health and/or ecological impacts that could occur in the absence of any remedial action. The risk assessment will provide the basis for determining whether or not remedial action is necessary and the justification for performing remedial actions.

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

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

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

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

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

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

- Superfund Exposure Assessment Manual, EPA 1988.

- Exposure Factors Handbook, EPA 1989b.

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

EPA Region IV will be consulted for Federal guidance, and the North Carolina Department of Environment, Health, and Natural Resources will be consulted for guidance in the State of North Carolina.

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

- Characterizing the toxicity and levels of contaminants in relevant media (e.g., groundwater, surface water, soil, sediment, air, and biota).

- Characterizing the environmental fate and transport mechanisms within specific environmental media.

- Identifying potential human and/or environmental receptors.

- Identifying potential exposure routes and the extent of the actual or expected exposure.

- Defining the extent of the expected impact or threat.

- Identifying the levels of uncertainty associated with the above items.

As outlined in the Scope of Work,the quantitative BRAs to be performed at MCB Camp Lejeune for Sites 2 and 74 are to utilize all available data that has been properly validated in accordance with EPA guidelines plus all data to be collected from sampling during this RI.

5.6.1 Human Health Evaluation Process

5.6.1.1 Site Location and Characterization

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

5.6.1.2 Data Summary

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

Data summary tables will be developed for each environmental medium sampled (e.g., surface water, sediment, groundwater, soil). Each data summary table will indicate the frequency of detection, observed range of concentrations, and the means and upper 95 percent confidence limit value for each contaminant detected in each medium. The arithmetic or geometric mean and the upper 95 percent confidence limit of that mean will be used in the summary of potential chemical data. The selection of arithmetic or geometric means will depend on

whether the sample data are normally or log- normally distributed. In the calculation of the mean, concentrations presented as "ND" (nondetect) will be incorporated at one-half the sample detection limit.

5.6.1.3 Identifying Chemicals of Potential Concern

The chemical data will be evaluated to identify site-specific chemicals on which to focus subsequent efforts in the risk assessment process. For example, although numerous chemicals may be detected in surface water or soil samples, they may be unrelated to contamination (i.e., they may be naturally occurring at the levels observed), and/or they may be of relatively little concern toxicologically, such as iron, magnesium, calcium, potassium, and sodium. Therefore, if sufficient background samples are collected, a statistical comparison between background and site data will be performed to determine whether site concentrations exceeded background at a statistically significant level (e.g., 95 percent confidence).

All of the available sample data will undergo review upon initiation of the risk assessment. Common laboratory contaminants such as acetone, methylene chloride, phthalate esters, toluene, and methyl ethyl ketone will be addressed only if concentrations are 10 times greater than those found in the corresponding QA/QC blanks. In addition, chemicals that are not common laboratory contaminants will be evaluated if they are greater than five times the laboratory blank. The number of chemicals analyzed in the risk assessment will be a subset of the total number of chemicals detected at a site based on the elimination criteria discussed previously.

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

5.6.1.4 Exposure Assessment

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

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

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

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

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

Identification of Potentially Exposed Human Populations

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

Identification of Potential Exposure Scenarios Under Current and Future Land Uses

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

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

Exposure Point Concentrations

After the potential exposure points and potential receptors have been defined, exposure point concentrations must be calculated. The chemical concentrations at these contact points are critical in determining intake and, consequently, risk to the receptor. The data from site investigations will be used to estimate exposure point concentrations.

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

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

Intakes for potentially exposed populations will be calculated separately for the appropriate exposure routes and chemicals.

5.6.1.5 Toxicity Assessment

Toxicity values (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be used in conjunction with the intake determinations to characterize risk. Toxicity values may be taken or derived from the following sources:

- Integrated Risk Information System (IRIS, 1992) - The principal toxicology database, which provides updated information from EPA on cancer slope factors, reference doses, and other standards and criteria for numerous chemicals.

- Health Effects Assessment Summary Tables (EPA, 1991b) - A tabular summary of noncarcinogenic and carcinogenic toxicity information contained in IRIS.

For some chemicals, toxicity values (i.e., reference doses) may have to be derived if the principal references previously mentioned do not contain the required information. These derivations will be provided in the risk assessment for review by EPA Region IV. The toxicity assessment will include a brief description of the studies on which selected toxicity values were based, the uncertainty factors used to calculate noncarcinogenic reference doses (RfDs), the EPA weight-of-evidence classification for carcinogens, and their respective slope factors.

5.6.1.6 Risk Characterization

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

Carcinogenic Risk

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

Excess lifetime cancer risk = Estimated dose x carcinogenic slope factor; or CDI x q_1*

Where: CDI = Chronic daily intake

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

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

Where: exp = the exponential

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

Noncarcinogenic Risk

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

$$HQ = EDI/RfD$$

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

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

5.6.1.7 Uncertainty Analysis

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

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

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

5.6.2 Ecological Risk Assessment

5.6.2.1 Purpose and Approach

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

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

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

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

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

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

5.6.2.2 Selection of Chemicals of Potential Concern

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

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

5.6.2.3 Exposure Assessment

The objectives of the exposure assessment are to:

- Identify habitats that may have detected exposure point concentrations.
- Identify plants, fish, and/or wildlife that may be potentially exposed to the contaminants of concern.
- Identify significant pathways/routes of exposure.
- Select target species, and/or communities of potential concern.
- Estimate potential exposure concentrations for contaminants of concern.

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

Pathway Identification and Habitat Evaluation

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

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

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

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

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

- Importance of species using these habitats.
- Regulatory status.

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

Selection of Target Species

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

- A species that is threatened, endangered, or of special concern.
- A species that is valuable for recreational or commercial purposes.
- A species that is important to the well being of either or both of the above groups.
- A species that is critical to the structure and function of the particular ecosystem which it inhabits.
- A species that is a sensitive indicator of ecological change.

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

Estimation of Exposure Point Concentrations

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

Exposure Estimation

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

5.6.2.4 Toxicity Assessment

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

Potential sources of toxicity data for the ecological assessment include:

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

5.6.2.5 Risk Characterization

A risk characterization integrates the exposure and toxicity assessments to estimate the potential risk to the environmental receptors. The media concentrations or estimated daily intakes will be compared with critical toxicity values using toxicity data that are expressed in terms of medium concentrations (e.g., Ambient Water Quality Criteria, species-specific toxicity data, phytotoxicity data, sediment biological effects data). In these cases, comparing

predicted environmental media exposure point concentrations with media-specific and/or species-specific toxicity data will be made. If this comparison indicates the potential for significant ecological risks to the target receptors, the conduct of a quantitative biosurvey may be recommended as Phase II of the RI.

$$HQ = C/CTV$$

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

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

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

5.6.2.6 Data Gaps

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

5.6.2.7 Uncertainty Analysis

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

5.7 Task 7 - Treatability Study/Pilot Testing

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

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

Bench- or pilot-scale treatability studies for groundwater may be required to assess pretreatment options (e.g., metal reduction, etc.). While this is the case, no behavior pilot scale studies are presently planned. During the course of the FS, the need for this type of study will be reviewed and, if necessary, an appropriate test will be proposed.

5.8 Task 8 - Remedial Investigation Report

This task is intended to cover all work efforts related to the preparation of the findings once the data have been evaluated under Tasks 5 and 6. The task includes the preparation of a Draft, Draft Final, and Final RI report.

This task ends when the Final RI reports are submitted.

5.9 Task 9 - Remedial Alternatives Screening

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

5.10 Task 10 - Remedial Alternatives Evaluation

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

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

5.11 Task 11 - Feasibility Study Report

This task involves reporting the findings of the Feasibility Study. The task includes the preparation of a Draft, Draft Final, and Final FS report.

This task ends when the Final FS report is submitted.

5.12 Task 12 - Post RI/FS Support

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

5.13 Task 13 - Meetings

Providing technical support to LANTDIV during the RI/FS is included in this task. It is anticipated that the following meetings will be required:

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

5.14 Task 14 - Community Relations

This task involves providing support to LANTDIV during the various public meetings identified under Task 13. This support includes the preparation of fact sheets, meeting minutes, coordination with Camp Lejeune EMD in contacting local officials and media, and the procurement of a stenographer.

6.0 PROJECT MANAGEMENT AND STAFFING

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

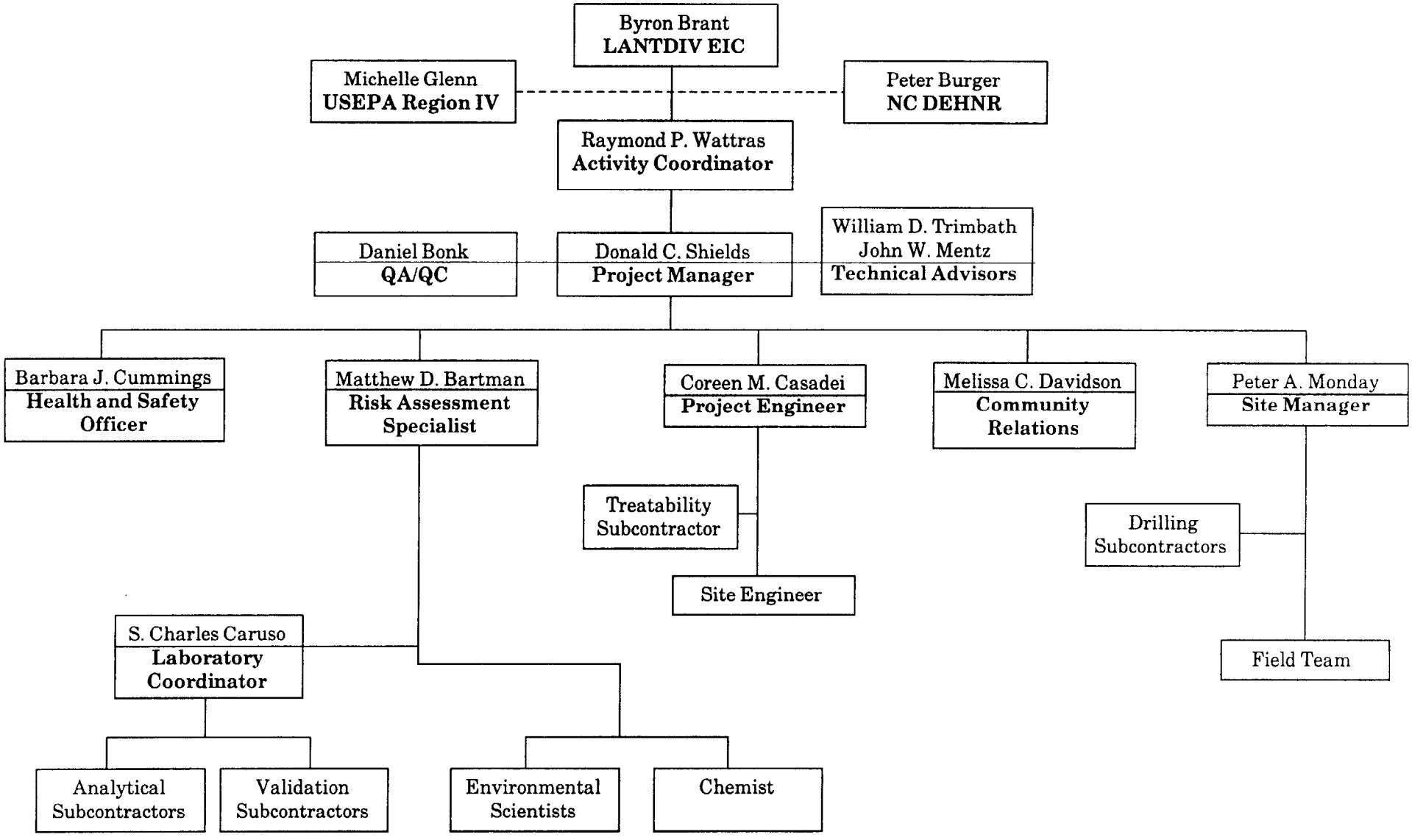
- Mr. Raymond P. Wattras, MCB Camp Lejeune Activity Coordinator
- Mr. Dan Bonk, QA/QC
- Mr. Donald C. Shields, Project Manager/Project Geologist
- Ms. Coreen Casadei, Project Engineer
- Mr. Matthew Bartman, Risk Assessment
- Mr. Charles Caruso, Laboratory Coordinator
- Ms. Barbara J. Cummings, Health and Safety Officer
- Ms. Melissa C. Davidson, Community Relations Specialist

All field activities will be coordinated by Mr. Peter A. Monday, who will act as the field supervisor.

From a responsibility and coordination standpoint, Mr. Shields and Mr. Bartman will have the overall responsibility of completing the RI report. Ms. Casadei will be responsible for overseeing the preparation of the FS report. These personnel will report directly to the MCB Camp Lejeune Activity Coordinator, Mr. Ray Wattras. They will be supported by geologists, engineers, biologists, chemists, data technicians, and clerical personnel.

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

FIGURE 6-1
PROJECT ORGANIZATION
RI/FS AT SITE 2
MCB CAMP LEJEUNE, NORTH CAROLINA



7.0 SCHEDULE

The proposed schedule for this project is presented in Figure 7-1. This schedule is based on reporting requirements in the Federal Facilities Agreement (FFA) and is reflective of the Fiscal Year 1993 Site Management Plan.

Figure 7-1

RI/FS Project Schedule

Sites 2 (Operable Unit No. 5) MCB Camp Lejeune, NC

Task	Activity	Days	Scheduled Start	Scheduled Finish
1	Project Management	292d	4/15/93	5/27/94
2	Subcontractor Procurement	30ed	4/16/93	5/16/93
3	Field Investigation	41d	4/16/93	6/12/93
3a	Mobilization	30ed	4/16/93	5/16/93
3b	Surveying (Pre-Inv.)	5ed	5/10/93	5/15/93
3c	Soil Investigation	24ed	5/17/93	6/10/93
3d	Groundwater Investigation	5ed	5/28/93	6/2/93
3e	SW/SD Investigation	2ed	5/24/93	5/26/93
3f	Surveying (Post-Inv.)	2ed	6/1/93	6/3/93
3g	Aquifer Tests	5ed	6/7/93	6/12/93
4	Sample Analysis/Validation	68d	5/17/93	8/18/93
5	Data Evaluation	21ed	8/18/93	9/8/93
6	Risk Assessment	42ed	9/8/93	10/20/93
7	Treatability Studies	63ed	8/18/93	10/20/93
8	RI Report	147d	9/8/93	4/1/94
8a	Draft RI Report	42ed	9/8/93	10/20/93
	Comment Period	60ed	10/20/93	12/19/93
8b	Draft Final RI	35d	12/21/93	2/7/94
	Comment Period	30ed	2/8/94	3/10/94
8c	Final RI Report	21ed	3/11/94	4/1/94

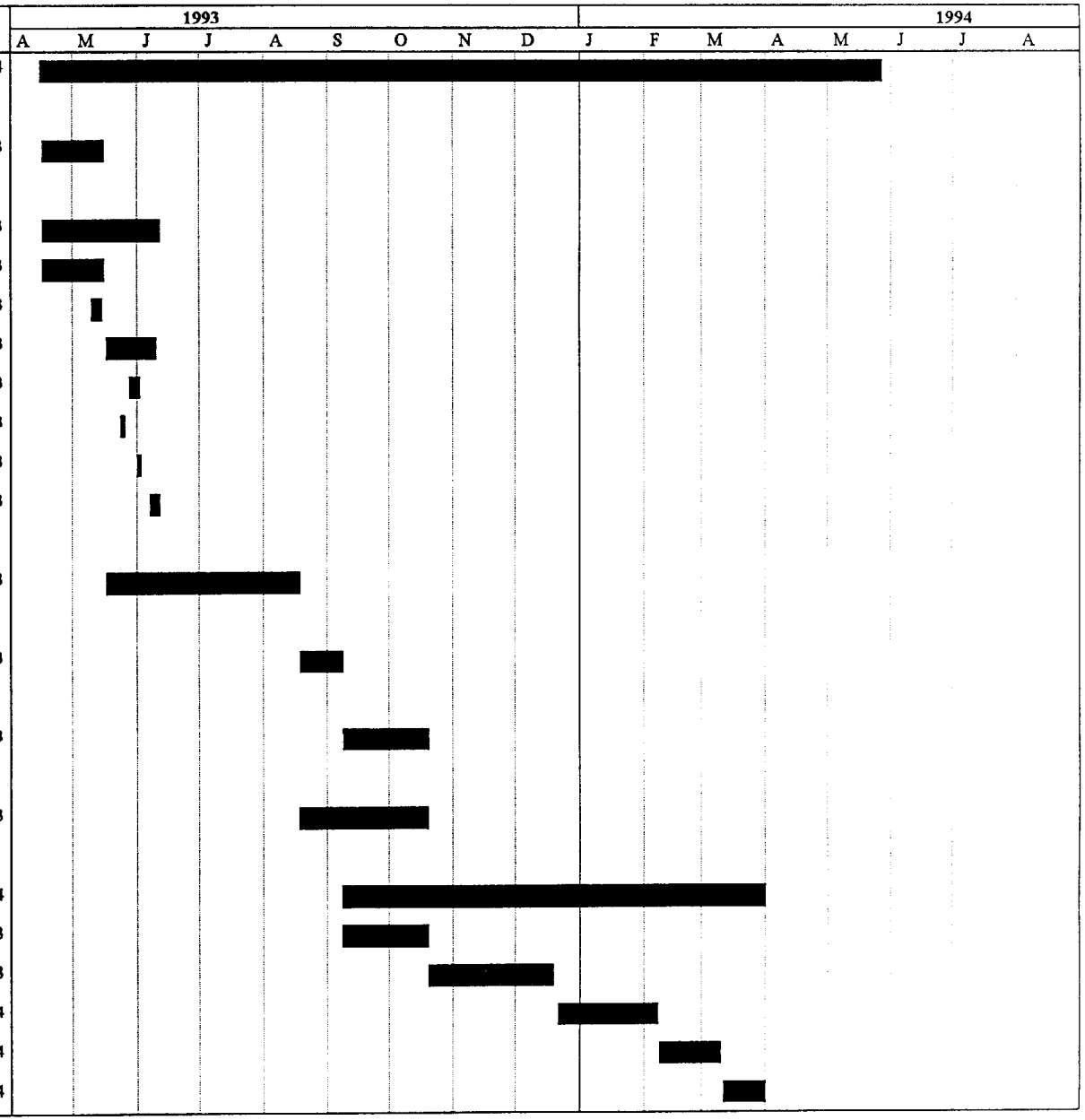
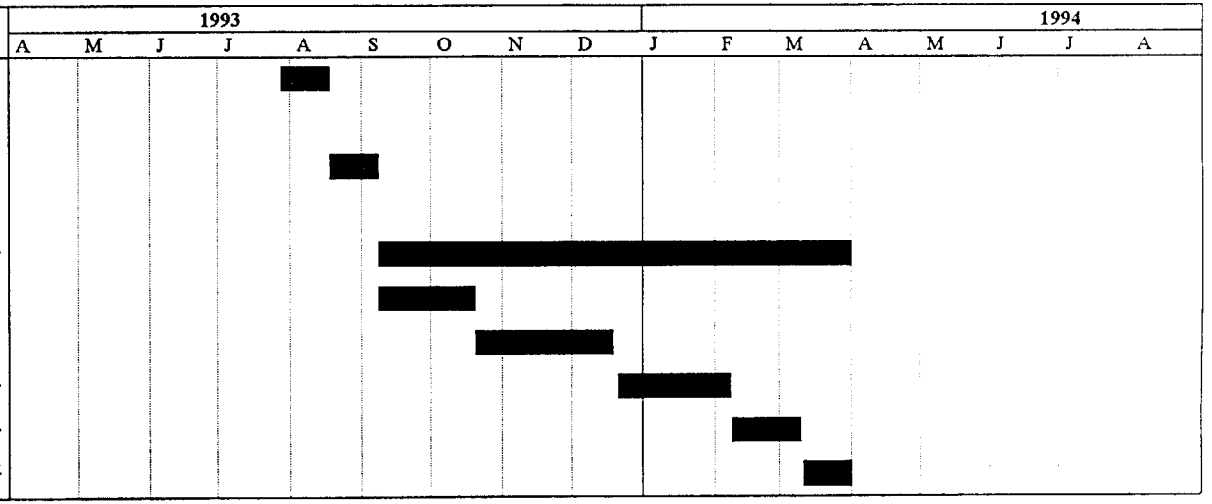


Figure 7-1

RI/FS Project Schedule

Sites 2 (Operable Unit No. 5) MCB Camp Lejeune, NC

Task	Activity	Days	Scheduled Start	Scheduled Finish
9	Alternative Screening	21ed	7/28/93	8/18/93
10	Alternative Evaluation	21ed	8/18/93	9/8/93
11	FS Report	147d	9/8/93	4/1/94
11a	Draft FS/PRAP	42ed	9/8/93	10/20/93
	Comment Period	60ed	10/20/93	12/19/93
11b	Draft Final FS/PRAP	35d	12/21/93	2/7/94
	Comment Period	30ed	2/8/94	3/10/94
11c	Final FS/PRAP	21ed	3/11/94	4/1/94



8.0 REFERENCES

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Appendix A
EPIC Study
Site 2

TS-PIC-92098
August 1992

Site Analysis
Camp Lejeune
Camp Lejeune, North Carolina

Interim Report, Volume 1

by
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Contract No. 68-03-3532

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NOTICE

As an interim product, this document has not gone through the complete EPIC quality assurance cycle. Any errors that are discovered during preparation of the final report will be corrected therein.

ABSTRACT

This report presents an analysis of aerial photography of nine study areas within Camp Lejeune, North Carolina. These study areas were analyzed to assist the Environmental Protection Agency (EPA)'s Region 4 in its assessment of potential sources of contamination and to document past activities within each study area.

Collateral information supplied by EPA Region 4 identified the nine study areas and states that various activities, such as pesticide storage, handling, and dispensing, waste disposal, and fuel leaks, occurred within these study areas.

The EPA's Environmental Photographic Interpretation Center in Warrenton, Virginia, a branch of the Advanced Monitoring Systems Division of the Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, performed this analysis at the request of the Superfund Support Section of EPA Region 4 in Atlanta, Georgia, and the Office of Emergency and Remedial Response in Washington, D.C. This analysis covers the period between 1938 and 1990, and the interim report was completed in August 1992.

CONTENTS

CONTENTS (cont.)

FIGURES

Volume 2 Page

FIGURES (cont.)

INTRODUCTION

An analysis of aerial photography was performed on nine study areas within Camp Lejeune, North Carolina. The nine study areas comprise a total of 439 hectares (1083 acres).

The Environmental Protection Agency (EPA)'s Region 4 requested this analysis to document past activities and disposal practices at Study Areas 2 (Former Nursery/Day Care Center), 6 (Storage Lots 201 and 203), 9 (Fire Fighting Training Pit at Piney Green Road), 24 (Industrial Area Fly Ash Dump), 28 (Hadnot Point Burn Dump), 48 (MCAS New River Mercury Dump Site), 69 (Rifle Range Chemical Dump), 74 (Mess Hall Grease Pit), and 78 (Hadnot Point Industrial Area).

Figure 1 shows the location of Study Areas 2, 6, 9, 24, 28, 74, and 78, keyed to a U.S. Geological Survey (USGS) 1:24,000-scale topographic map. Figures 2A and 2B show the locations of Study Areas 48 and 69, each keyed to a photocopy of a U.S. Geological Survey (USGS) 1:24,000-scale topographic map. Study area boundaries or areas used in this analysis were determined from observations made from the aerial photography in conjunction with collateral data supplied by EPA Region 4 and do not necessarily denote legal property lines or ownership.

Aerial photography of Study Areas 2, 6, 9, 24, 28, 74, and 78 was obtained to represent the period from 1938 to 1990.[1] Black-and-white photography from 1938, 1943, 1944, 1949, 1952, 1956, 1960, 1964, 1970, 1980, 1984, 1988, and 1990 was used for the analysis of these study areas. In 1938, much of the land which is later occupied by Camp Lejeune is undeveloped. No significant activity was noted in 1938, although the photography did provide a look at the study areas prior to development. The 1938 photography and findings will not be discussed further in this analysis. Various dates of photography were reproduced for each study area. Some dates of photography were not reproduced for each study area because the area was not yet active, the

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[1]A complete listing of maps and photography used in this report is provided in the References section.

resolution of the photography was poor and/or there was a lack of significant features, activities, and/or change. Any significant changes noted in those years of photography will be annotated with the following year of photography reproduced in this report.

Aerial photography of Study Area 48 was obtained to represent the period from 1949 to 1970. Black-and-white photography from 1949, 1956, 1958, 1960, 1964, and 1970 was used for the analysis of this study area. Photography from 1949, 1956, and 1958 was analyzed but not reproduced for this report due to the study area not yet being active, the poor resolution of the photography and/or the lack of significant features, activities, and/or change.

Aerial photography of Study Area 69 was obtained to represent the period from 1949 to 1980. Black-and-white photography from 1949, 1956, 1958, 1964, 1970, and 1980 was used for the analysis of this study area. Photography from 1949, 1958, and 1980 was analyzed but not reproduced for this report due to the lack of significant activity and/or change. Significant changes noted in 1958 will be annotated and discussed with the 1964 photography. No significant activities and/or change are noted in 1949 and 1980, therefore; findings from those years are only discussed and not annotated.

Collateral information supplied by EPA Region 4 states that various activities, such as pesticide storage, handling, and dispensing, waste disposal, and fuel leaks occurred at various times within these study areas.

Railroad tracks, fences and access roads are noted throughout the analysis. They will only be annotated when they first appear and will not be annotated thereafter. Drainage is depicted on the first year of photography reproduced for each study area. Only significant changes in drainage will be annotated thereafter. Open storage areas, visible throughout the analysis, generally contain various types of raw materials and equipment. However, other features such as refuse, debris, or stains may also be found within open storage areas. Open storage areas will be annotated but will only be discussed if potential

environmentally significant features such as tanks, drums, stains, debris, refuse, or material are visible within them. Equipment maintenance/wash racks are located in many of the study areas analyzed in this report. Historically, staining and liquid discharges as a result of equipment maintenance are seen near these racks. Due to this fact, these racks will be annotated throughout the analysis, but may not be discussed.

The EPA's Environmental Photographic Interpretation Center in Warrenton, Virginia, a branch of the Advanced Monitoring Systems Division of the Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, performed this analysis at the request of the Superfund Support Section of EPA Region 4 in Atlanta, Georgia, and the Office of Emergency and Remedial Response in Washington, D.C. This analysis covers the period from 1938 to 1990, and the interim report was completed in August 1992.

METHODOLOGY

A search of government and commercial sources was undertaken to obtain the best available aerial photography of the site spanning the desired time frame. The photography and other sources of information used in this report are listed in the References section.

The analysis was performed by viewing backlit transparencies of aerial photography through stereoscopes. Stereoscopic viewing creates a perceived three-dimensional effect which, when combined with viewing at various magnifications, enables the analyst to identify signatures associated with different features and environmental conditions. The term "signature" refers to a combination of visible characteristics (such as color, tone, shadow, texture, size, shape, pattern, and association) which permit a specific object or condition to be recognized on aerial photography.

The terms "possible" and "probable" are used to indicate the degree of certainty of signature identification. "Possible" is used when only a few characteristics are discernible or these characteristics are not unique to a signature. "Probable" is used when incrementally more characteristics are discernible. No qualifying terms are used when the characteristics of a signature allow for a definite feature identification.

Photographic prints were made from those years of aerial photographic coverage that reveal significant information about the site. The analyst's findings are annotated on overlays to prints and/or base maps and described in the accompanying text. Site boundaries or areas used in this analysis were determined from observations made from the aerial photography in conjunction with collateral data supplied by EPA Region 4 and do not necessarily denote legal property lines or ownership.

Due to factors inherent in the photographic printing process, prints do not exhibit the level of detail that is visible in the original aerial photography. Therefore, some features identified from the aerial photography may not be clearly discernible, or even visible, on the photographic prints presented in this report.

AERIAL PHOTO SITE ANALYSIS

Study Area 2 (Former Nursery/Day Care Center)

According to collateral information supplied by EPA Region 4, various types of pesticides were stored, handled, and dispensed in this study area from 1945 to 1958. Significant amounts of Chlordane, DDT, Diazanon, and 2,4-D were used in the study area. Dieldrin, Lindane, Malathion, Silvex, and 2,4,5-T were stored only or used to a minor extent within the study area. A nursery/day care center, which ceased operations in 1982, was the most recent operation within the study area. Contaminated areas include the fenced playground, a mixing pad, and a wash pad. An adjacent drainage ditch may have received washout and spills.

NOVEMBER 8, 1944 (FIGURE 3)

A drainage analysis was performed for this year, with any significant changes noted on subsequent years of photography. Drainage extends northwest from the study area and eventually enters Northeast Creek.

The building (B), located on the west side of the railroad tracks, was first evident in 1943 and remains through 1990. It will continue to be annotated but will not be discussed further. Light-toned (LT) linear objects (O) are visible south of the building. These objects are uniformly situated in the south end of a parking or storage area (not annotated).

OCTOBER 21, 1949 (FIGURE 4)

A pile of light-toned material (M) is visible in the southeast corner of the study area. A crane (not annotated), which is probably used to load or unload the light-toned material from rail cars, is seen near the northwest corner of the piled material. Two dark-toned (DK) square objects which may be some type of structures are noted east of the piled material. Probable stains (ST) appear to emanate from the north edge of the dark-toned objects. Elsewhere, the light-toned linear objects

are no longer visible in the southwestern portion of the study area.

FEBRUARY 10, 1952 (FIGURE 5)

Numerous light-toned linear objects are seen where dark-toned objects and probable staining were noted in 1949. The piled light-toned material is no longer evident. Staining is visible along the east edge of the numerous objects. Possible liquid (LQ) appears to emanate from one light-toned linear object located east of the numerous objects. The area (not annotated) in and surrounding the southeastern portion of the study area has been partially cleared and the ground has been disturbed (not annotated).

Elsewhere, several light-toned linear objects and two similar objects are visible south of the study area boundary and northwest of the numerous linear objects, respectively. In the northern portion of the study area, four possible horizontal tanks (HT) are seen near several parked vehicles (not annotated).

FEBRUARY 1, 1956 (FIGURE 6)

The light-toned linear objects, the associated staining and possible liquid, and the four possible horizontal tanks noted in 1952 are no longer apparent. Two dark-toned linear objects, a pile of probable material, and an associated possible stain are visible in the southeast corner of the study area. The partially cleared and disturbed area (not annotated) in and surrounding the aforementioned corner of the study area has begun to revegetate.

By 1960, no activity or features are noted in the southeastern portion of the study area, and the area is beginning to revegetate. No additional significant activity is noted within the study area through 1990.

Appendix B
Geophysical Report

FINAL

GEOPHYSICAL INVESTIGATION

SITE 2

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

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION AND INVESTIGATION OBJECTIVE

A surface geophysical survey was conducted on August 29, 1992, at Marine Corps Base (MCB) Camp Lejeune, Jacksonville, North Carolina. The survey objective at Site 2 - Former Nursery/Day Care Center was to verify the presence/absence of an underground storage tank (UST) suspected on site. Figure 1-1 shows the location of Site 2.

2.0 METHODS OF INVESTIGATION

Non-invasive geophysical techniques that were utilized to meet the project objective included electromagnetic (EM) terrain conductivity and ground penetrating radar (GPR) techniques.

2.1 Survey Control

Geophysical data obtained during this survey were referenced to a grid established at Site 2, as well as to a road, monitoring well, and other physical and cultural features on site. Figure 2-1 shows the survey grid and surface features noted at the site.

2.2 Electromagnetic Terrain Conductivity

Electromagnetic (EM) terrain conductivity profiling was performed to identify locations of suspected buried metal on site. Instrumentation utilized for this survey included a Geonics model EM-31, with a maximum investigative depth of approximately 15 feet. EM-31 data were evaluated during a reconnaissance survey across the site.

2.3 Ground Penetrating Radar

GPR is an electromagnetic technique that reveals a graphic cross-sectional view of subsurface stratigraphy and buried objects (i.e., drums, pipelines, tanks, boulders, etc.). Data acquisition is continuous along lines of coverage and a graphic recorder provides an immediate view of the data, yielding both horizontal (lateral) and vertical (depth) control information. Penetration (typically 2-8 feet) and resolution are determined by the frequency of the antenna, but overall effectiveness of GPR can be limited by highly reflective materials such as water-saturated clay, salt, slag, or highly conductive inorganic materials.

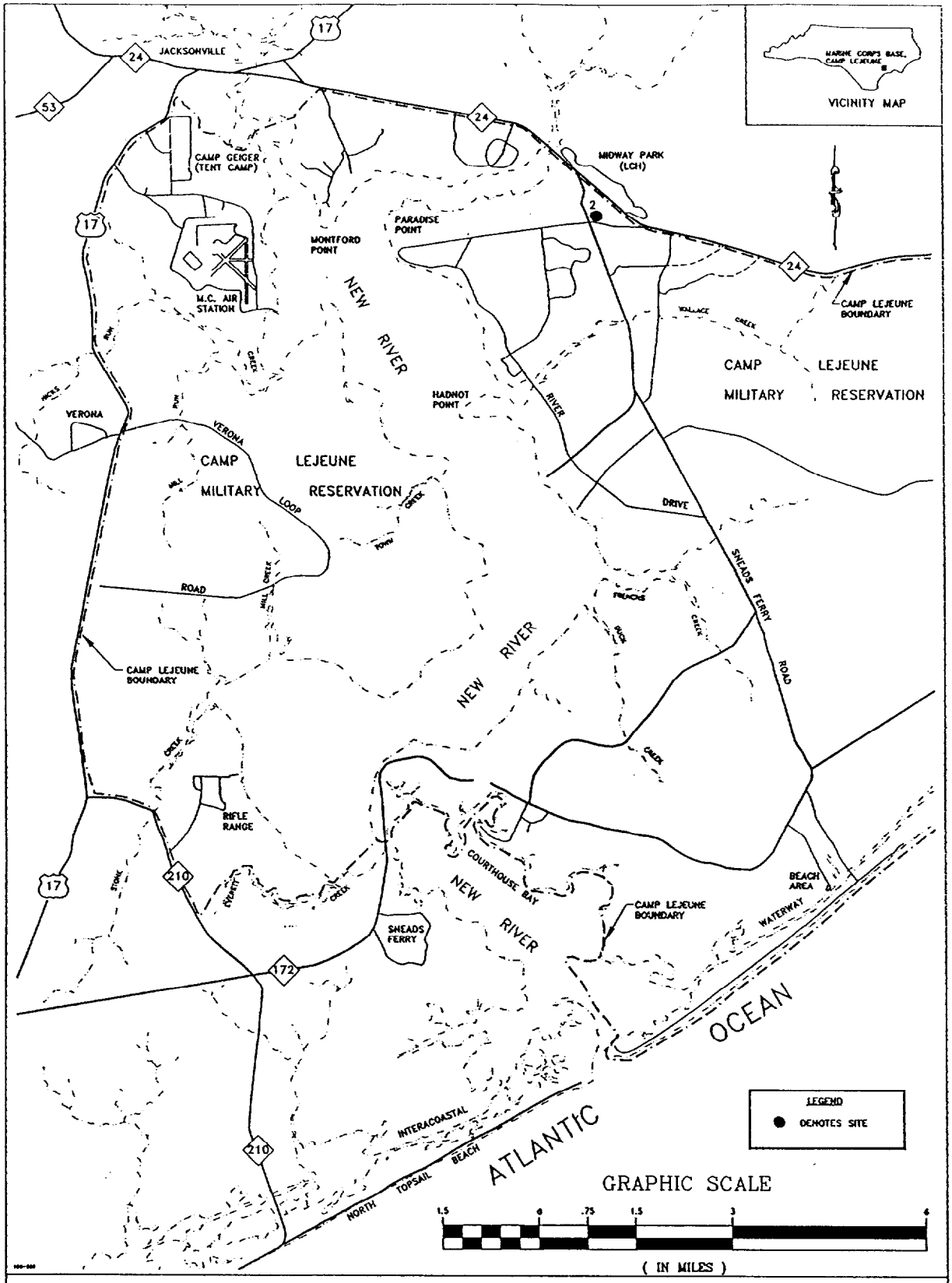
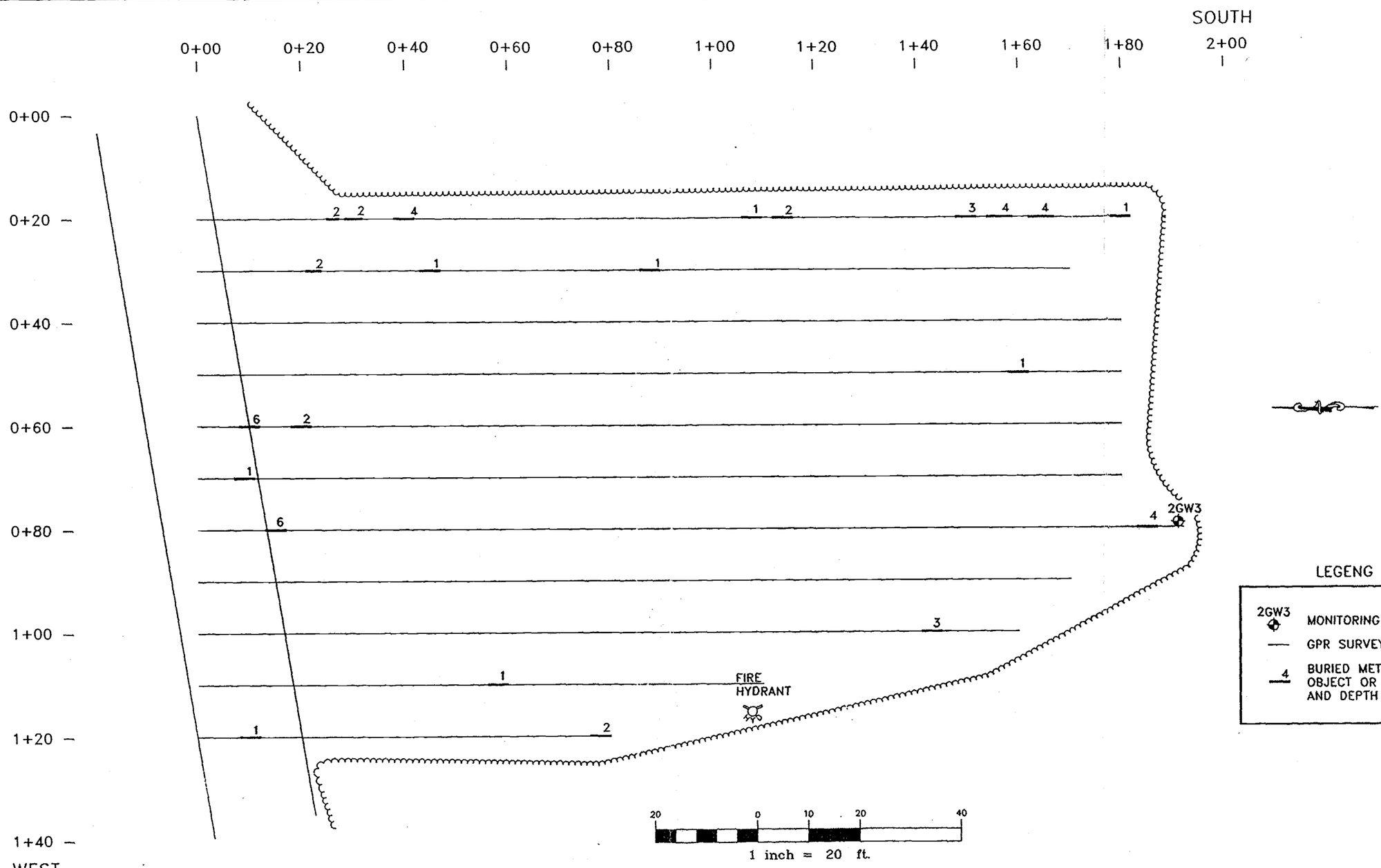


FIGURE 1-1
LOCATION MAP
SITE 2

MARINE CORPS BASE CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA



REVISIONS WESTON GEOPHYSICAL CORP. IS A WHOLLY OWNED SUBSIDIARY OF BAKER ENVIRONMENTAL, INC.	DATE JANUARY 1993 SCALE 1"= 20' DRAWN REL REVIEWED MJN S.O.# 19106-70-SRN CADD# 106-850	GEOPHYSICAL INVESTIGATION MARINE CORPS BASE CAMP LEJEUNE JACKSONVILLE, NORTH CAROLINA WESTON GEOPHYSICAL CORP. Coraopolis, Pennsylvania	Baker Baker Environmental, Inc.	SURVEY COVERAGE AND RESULTS SCALE 1"= 20' DATE JANUARY 1993	FIGURE NO. 2-1

01493EE05Z

GPR profiling was completed with analog instrumentation that consisted of a GSSI SIR-7 mainframe, Adtek graphic recorder, and both 300 and 500 megahertz (MHz) antennas. Two antennas were utilized to provide high-resolution recordings of near surface objects and to yield optimum depth penetration.

GPR profiling was conducted along parallel lines spaced at ten feet. Figure 2-1 shows the GPR traverses.

3.0 DISCUSSION OF RESULTS

The results of the geophysical survey at Site 2 are presented in the following subsection.

3.1 Site 2 - Former Nursery/Day Care Center

Site 2 is located at the intersection of Holcomb and Brewster Boulevards in the northeast portion of MCB Camp Lejeune (see Figure 1-1). The area of investigation is primarily flat and open, measuring approximately 200 by 100 feet. The presence of an underground storage tank was possible given the previous use of this portion of the site as a storage area. Contaminants detected in groundwater samples collected from a nearby monitoring well indicated the possible presence of an underground storage tank.

A geophysical survey grid was established for the site, extending from the paved road to the tree line on the south. Radar data were continuously acquired along traverses oriented north-south and spaced at 10-foot intervals across the site. The area of investigation and specific lines of geophysical coverage are shown on Figure 2-1.

Several buried objects were detected as shown on Figure 2-1. These objects are relatively small and likely consist of scrap metal or miscellaneous buried debris associated with previous structures on site. The buried objects along the paved road are likely associated with utilities. Only along Line 0+80W at station 1+85N did the radar records indicate a larger buried object.

4.0 CONCLUSIONS

A non-invasive geophysical survey was conducted at Site 2 to verify the presence/absence of an underground storage tank. Ground penetrating radar detected several small objects buried

along the site perimeter and tree line. These are likely debris or utilities associated with previous structures on site.

Only at one location on the south end of the site, near monitoring well 2GW3 (MW 192S), did the radar records indicate a large buried object. However, the data was not conclusive to ascertain whether or not it was a tank, large diameter utility line, or other buried structure.