01566

FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN
OPERABLE UNIT NO. 9 (SITES 65 AND 73)

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0249

MARCH 7, 1995

Prepared for:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
AST	aboveground storage tank
AWQC	ambient water quality criteria
bgs	below ground surface
bls	below land surface
BOD	biological oxygen demand
BRA	baseline risk assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLEJ	Camp Lejeune
CLP	Contract Laboratory Program
COD	chemical oxygen demand
DOD	Department of the Defense
DON	Department of the Navy
DQO	Data Quality Objective
EMD	Environmental Management Division (Camp Lejeune)
ESE	Environmental Science and Engineering, Inc.
°F	degrees Fahrenheit
FFA	Federal Facilities Agreement
FFM	Fleet Marine Force
FMF	Fleet Marine Force Atlantic
FSSG	Force Service Support Group
FSAP	Field Sampling and Analysis Plan
ft	feet
ft/ft	foot per foot
FWSV	Freshwater Screening Values
gpm	gallons per minute
GSRA	Greater Sandy Run Area
HEAST	Health Effects Assessment Summary Tables
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

MAG	Marine Air Ground
MARFORLANT	Marine Forces Atlantic
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCL	maximum contaminant level
mgd	million gallons per day
mg/L	milligram per liter
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NC DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NCSPCS	North Carolina State Plans Coordinate System
NCWQS	North Carolina Water Quality Standard
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic Atmosphere Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
OU	operable unit
PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	perchloroethylene (tetrachloroethylene)
POL	petroleum, oil, and lubricant
POTW	publicly owned treatment works
ppb	parts per billion
ppm	parts per million
PRAP	Proposed Remedial Action Plan
PRGs	Preliminary Remediation Goals
QA/QC	quality assurance/quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SGS	soil gas survey
SI	site inspection
SMCL	Secondary Maximum Contaminant Level
SQC	Sediment Quality Criteria
SSV	Sediment Screening Value
STP	sewage treatment plan

TAL	Target Analyte List
TBC	To be Considered
TCA	trichloroethane
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristics Leaching Procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
TSS	total suspended solids
TVHC	total volatile hydrocarbon
μg/L	micrograms per liter
μg/kg	micrograms per kilogram
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
WAR	Water and Air Research, Inc.
WOE	weight-of-evidence

1.0 INTRODUCTION

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) National Priorities List (NPL) effective November 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR), and the United States Department of the Navy (DON) entered into a Federal Facilities Agreement (FFA) for MCB, Camp Lejeune. The primary purpose of the FFA is to ensure that environmental impacts associated with past and present activities at the MCB are thoroughly investigated, and that appropriate CERCLA and Resource Conservation Recovery Act (RCRA) responses are developed and implemented as necessary to protect the public health and welfare, and the environment (MCB, Camp Lejeune FFA, 1989).

The scope of the FFA includes the implementation of a remedial investigation/feasibility study (RI/FS) at thirteen Operable Units (OUs) and twenty-seven sites across MCB, Camp Lejeune. RIs will be implemented at these OUs to determine the nature and extent of the threat to the public health and welfare and the environment caused by the release and threatened release of hazardous substances, pollutants, contaminants or constituents at the site, and to establish requirements for the performance of FSs. Feasibility studies will be conducted to identify, evaluate, and select alternatives for the appropriate CERCLA responses to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, contaminants, or constituents at the site in accordance with CERCLA/Superfund Amendments and Reauthorization Act of 1986 (SARA) and applicable State law (FFA, 1989).

This RI/FS Work Plan addresses OU No. 9 which consists of Site 65 (Engineer Dump Area) and Site 73 (Courthouse Bay Liquids Disposal Area). In addition, this Work Plan addressed underground storage tanks (USTs) within Site 73 in accordance with Title 15A, Subchapters 2N and 2L of the North Carolina Administrative Code.

1.1 Objective of RI/FS Work Plan

The objective of this RI/FS Work Plan is to identify the tasks required to implement an RI/FS for OU No. 9 at MCB, Camp Lejeune. The various studies or investigations required to collect appropriate data are described in this Work Plan. In addition, the Work Plan describes the scope and objectives of the individual RI/FS and UST site assessment activities. It serves as a tool for assigning responsibilities and establishing the project schedule and cost. The preparation and contents of the RI/FS Work Plan are based on the scoping process, which is described below.

1.2 RI/FS Scoping

Scoping is the initial planning stage of the RI/FS. The result or outcome 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:

- Preliminary assessment of 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 environment.

- Identifying potential contaminant migration pathways.

- Identifying contaminants of potential concern.

- Identifying Federal and State Applicable or Relevant and Appropriate Requirements (ARARs).

- Defining the optimum sequence of investigation activities.

- Identifying the sampling strategies for the collection of data.

- Determining the type, amount, and data quality objectives (DQOs) to assess human health and environmental risks, and to effectively evaluate feasible technologies/alternatives.

- Identifying potential technologies/alternatives for mitigating site problems.

- Identifying the remedial alternatives suitable to site conditions.

The background information available to initiate the RI/FS process included a number of existing environmental assessment reports, which are identified in Sections 2.0 (Background and Setting) and 7.0 (References), and information collected during planning visits at each site.

As part of the scoping process, project meetings were conducted with the Atlantic Division, Naval Facilities Engineering Command (LANTDIV), MCB, Camp Lejeune Environmental Management Division (EMD), USEPA Region IV, and the NC DEHNR 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 RI/FS Work Plan.

- Section 2.0 - Background and Setting
- Section 3.0 - RI/FS Data Quality and Sampling Objectives
- Section 4.0 - RI/FS Tasks
- Section 5.0 - Project Management and Staffing
- Section 6.0 - Project Schedule
- Section 7.0 - References

Section 2.0 discusses site-specific background information and the setting of each site. The purpose of this section is to define the physical and known environmental characteristics of each site. This section focuses on identifying potential and/or confirmed contaminant migration pathways, identifying potential (or known) impacts to public health and environment, listing Federal or State ARARs, and evaluating potential remedial technologies/alternatives for mitigating site problems.

Section 3.0 defines site-specific RI/FS data quality and sampling objectives. Data or information deemed necessary to identify migration pathways, assess environmental and human health risks, or evaluate feasibility or remedial actions are presented 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 investigation methods are documented in the Field Sampling and Analysis Plan (FSAP) for OU No. 9].

Section 4.0 identifies and describes the tasks and field investigation activities that will be implemented to complete the RI/FS at the sites in terms of meeting the site-specific objectives. These tasks generally follow the description of tasks identified in USEPA's RI/FS Guidance Document (OSWER Directive 955.3-01).

Section 5.0 discusses project staffing for implementing the RI/FS. The RI/FS schedule is provided in Section 6.0. References used in developing the RI/FS Work Plan are provided in Section 7.0.

Appendix A contains profiles of the various underground storage tanks.

2.0 BACKGROUND AND SETTING

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize and evaluate existing information pertaining to MCB, Camp Lejeune, OU No. 9. The analysis of existing information will provide a preliminary understanding of the nature and extent of contamination which will assist 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 herein.

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 and ecological features, and land use.

Additional background information is presented 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)
- Site Inspection Report, Site 65 - Engineer Area Dump, Marine Corps Air Station New River, North Carolina (Baker Environmental, Inc., 1994)
- Site Assessment Report, Building A47, Amphibious Vehicle Maintenance Facility Underground Storage Tank System SA-21, Marine Corps Air Station New River, North Carolina (Baker Environmental, Inc., 1992)
- Site Assessment Report, Additional Assessment Activities at Building A47, Amphibious Vehicle Maintenance Facility, Underground Storage Tank System SA-21, MCB Camp Lejeune, North Carolina (Baker Environmental, Inc., 1993)
- Leaking Underground Storage Tank Comprehensive Site Assessment, Building A-47 Pumps, Marine Corps Base, Camp Lejeune, North Carolina (Richard Catlin and Associates and Law Engineering, Inc., 1994)
- Master Plan, Camp Lejeune Complex, North Carolina (Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia, 1988)

2.1 MCB, Camp Lejeune, North Carolina

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

2.1.1 Location and Setting

MCB, Camp Lejeune is located within the Coastal Plain Physiographic Province. It is located in Onslow County, North Carolina, approximately 45 miles south of New Bern and 47 miles north of Wilmington. The facility covers approximately 236 square miles. This includes the recent acquisition of approximately 64 square miles west of the facility within the Greater Sandy Run Area (GSRA) of the county. The military reservation is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean.

The eastern and southern border of MCB, Camp Lejeune is the Atlantic shoreline. The western and northern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders MCB, Camp Lejeune to the north. MCB, Camp Lejeune is depicted in Figure 2-1.

The GSRA is located in the southeast portion of Onslow County, North Carolina, near the Pender-Onslow County border. The GSRA is approximately 31 miles northeast of Wilmington, North Carolina; 15 miles south of Jacksonville, North Carolina; and 5 miles northwest of the Atlantic Ocean. The GSRA is located south and west of MCB, Camp Lejeune, sharing a common boundary along Route 17 between Dixon and Verona.

MCB Camp Lejeune consists of 12 identifiable developed areas. Of the developed areas, Hadnot Point comprises the most concentrated area of development. This area includes the organizational offices for the Host Activity and for the Headquarters, 26 Marine Expeditionary Unit, as well as the Headquarters and regimental areas for the 2nd Division of the Marine Crops, 2nd Marine Expeditionary Force, 6th Marine Expeditionary Brigade, 22nd Marine Expeditionary Unit, 24th Marine Expeditionary Unit, the Central Exchange & Commissary and the Naval Dental Clinic Headquarters. Directly north of Hadnot Point are the family housing areas concentrated throughout the wooded areas of the central Complex and along the shores of the New River. Also located in this north central area are major personnel support land uses, including the newly-constructed Naval Hospital, school sites, recreational areas, as well as additional family housing areas (quarters developments, Midway Park and Tarawa Terrace I and II).

MCB Camp Lejeune contains five other areas of concentrated development, all of which are much smaller in size and population than the Hadnot Point, Marine Corps Air Station (MCAS), New River, and the Camp Geiger areas. The oldest of these is the Montford Point area, which is bounded by the New River to the south and west and by Route 24 on the north. New development in Montford Point has been limited, with most of the facilities for troop housing, maintenance, supply and personnel support having been converted from their original uses. A majority of the Base training schools requiring classroom instruction are located here and use surrounding undeveloped areas for training operations when required. The French Creek area located directly south of Hadnot Point is occupied by the 2nd Force Service Support Group (2nd FSSG). Its activities are directed toward providing combat service and technical support as required by Headquarters, II Marine Amphibious Force. Expansion of the French Creek Complex is constrained by the Ordnance Storage Depot explosives safety arc on the south and by the regimental area of Hadnot Point. Onslow Beach,

located along the Onslow Bay, east of the New River Inlet, presents assets for amphibious training as well as recreational use. Courthouse Bay, where OU No. 9 is situated, is located on one of a series of small bays which are formed by the New River. This area is used for maintenance, storage and training associated with amphibious vehicles and heavy engineering equipment. The Engineering School, also located here, conducts training activities in the large open area located to the southeast of the Courthouse Bay. Another concentrated area of development is the Rifle Range. This area is located on the southwest side of the New River, is singular in purpose and has only a small number of assigned personnel. It was constructed in the early stages of Base development and is used solely for rifle qualification training. The small group of barracks, located at the Rifle Range, are used for two-week periods by troops assigned to range training.

2.1.2 History and Mission

Construction of MCB, Camp Lejeune began in 1941 with the objective of developing the "World's Most Complete Amphibious Training Base." Construction of the base started at Hadnot Point, where the major functions of the base are centered. Development at Camp Lejeune is primarily in five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area. Sites 65 and 73 are located in the Courthouse Bay.

Camp Lejeune functions as the host command to Marine Forces Atlantic (MARFORLANT) tenant activities -- Headquarters of the II Marine Expeditionary Force, 2d Marine Division and the 2d Force Service Support Group (FSSG). Its mission is to provide housing, training facilities, logistical support and certain administrative support for tenant units and for other units assigned to MCB, Camp Lejeune and to conduct specialized schools and other training maneuvers, as directed.

2.1.3 Previous Investigations

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

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

2.1.4 Topography and Surface Drainage

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

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

The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at MCB, Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (WAR, 1983); this increases downstream to 11 feet above msl near the coastal area (WAR, 1983).

2.1.5 Regional Geology

MCB, Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments lay in interfingering beds and lenses that gently dip and thicken to the southeast. These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time and overlie igneous and metamorphic basement rocks of pre-Cretaceous age (ESE, 1991). Table 2-1 presents a generalized stratigraphic column for this area.

United States Geological Survey (USGS) studies at MCB, Camp Lejeune indicate that the Base is underlain by seven sand and limestone aquifers separated by confining units of silt and clay. These include the water table (i.e., surficial, water-bearing layer), Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear aquifers. The combined thickness of these sediments is approximately 1,500 feet. Less permeable clay and silt beds function as confining units or semiconfining units which separate the aquifers and impede the flow of groundwater between aquifers. A generalized hydrogeologic cross-section illustrating the relationship between the aquifers in this area is presented in Figures 2-2 and 2-3.

2.1.6 Regional Hydrogeology

The following summary of regional hydrogeology which was originally presented in a report published by the USGS (Harned et al., 1989).

The surficial water table aquifer is comprised of a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. The thickness of the surficial aquifer in the vicinity of MCAS, New River is less than 40 feet. This aquifer is not used for water supply at MCB, Camp Lejeune because of its low production rate.

The principal water-supply aquifer for MCB, Camp Lejeune is found in the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is referred to as the Castle Hayne Formation, associated with the Castle Hayne aquifer. This aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina.

Clay layers occur in both of the aquifers. The layers, however, are thin and discontinuous in most of the area, and no continuous clay layer separates the surficial aquifer from the Castle Hayne aquifer. The clay layers range from 5 to 30 feet thick and comprise between 15 and 24 percent of the combined thickness of the two aquifers. The clay layers appear to be thicker and more continuous in the northwestern part, particularly in the area of the MCAS. It is inferred from their generally thin and discontinuous nature that considerable leakage of groundwater occurs across and around the clay layers, particularly in the upper part of the Castle Hayne aquifer.

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

The aquifers that lie below the Castle Hayne lie in a thick sequence of sand and clay. Although some of these aquifers are used for water supply elsewhere in the Coastal Plain, they contain saltwater in the MCB Camp Lejeune area and are not used.

Rainfall in the MCB Camp Lejeune area 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, groundwater 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.

The water table varies seasonally. The water table receives more recharge in the winter than in the summer when much of the water evaporates or is transpired by plants before it can reach the water table. Therefore, the water table generally is highest in the winter months and lowest in summer or early fall.

In confined aquifers, water is under excess hydraulic (i.e., head) pressure and the level to which it rises in a tightly cased well is called the potentiometric surface. The hydraulic head in a confined or semiconfined aquifer, such as the Castle Hayne, shows a different pattern of variation over time than that in an unconfined aquifer. Some seasonal variation also is common in the water levels of the Castle Hayne aquifer, but the changes tend to be slower and over a smaller range than for water table wells.

2.1.7 Surface Water Hydrology

The following summary of surface water hydrology was originally presented in the IAS report (WAR, 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 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 into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB, Camp Lejeune not associated with the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is

connected to the Atlantic Ocean by Bear Inlet, Brown's Inlet, and the New River Inlet. The New River, the Intracoastal Waterway, and the Atlantic Ocean meet the New River Inlet.

Water quality criteria for surface waters in North Carolina have been published under Title 15 of the North Carolina Administrative Code. At MCB, Camp Lejeune, the New River falls into two classifications: SC (estuarine waters not suited for body-contact sports or commercial shellfishing) and SA (estuarine waters suited for commercial shellfishing). The SC classification applies to three areas of the New River at MCB, Camp Lejeune, including the Rifle Range area; the rest of the New River at MCB, Camp Lejeune falls into the SA classification (ESE, 1991).

2.1.8 Climatology

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

2.1.9 Natural Resources and Ecological Features

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

MCB, Camp Lejeune is predominantly tree-covered with large amounts of softwood including shortleaf, longleaf, pond, and pines (primarily loblolly), and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of MCB, 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 (WAR, 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. Both recreational and commercial fishing are practiced in the waterways of the New River and its tributaries.

Wetland ecosystems at MCB, Camp Lejeune can be categorized into five habitat types: (1) pond pine or pocosin; (2) sweet gum, water oak, cypress, and tupelo; (3) sweet bay, swamp black gum, and red maple; (4) tidal marshes; and, (5) coastal beaches. Pocosins provide excellent habitat for bear and deer because these areas are seldom disturbed by humans. The presence of pocosin-type habitat at MCB, 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. Deer, bear, turkey, and waterfowl are commonly found in this type of habitat. Sweet bay, swamp black gum, and red maple habitat exist in the floodplain areas of MCB, Camp Lejeune. Fauna including waterfowl, mink, otter, raccoon, deer, bear, and gray squirrel frequent this habitat. The tidal marsh at the mouth of the New River is one of the few remaining North Carolina coastal areas relatively free from filling or other manmade changes. This habitat, which consists of marsh and aquatic plants such as algae, cattails, saltgrass, cordgrass, bulrush, and spikerush, provides wildlife with food and cover. Migratory waterfowl, alligators, raccoons, and river otter exist in this habitat. Coastal beaches along the Intracoastal Waterway and along the outer banks of MCB, 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 ecologically sensitive coastal barrier dunes. The coastal beaches provides habitat for many shorebirds (WAR, 1983).

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

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

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

2.1.10 Land Use and Demographics

MCB, Camp Lejeune presently covers an area of approximately 236 square miles. Military and civilian population is approximately 73,000. During World War II, MCB, Camp Lejeune was used as a training area to prepare Marines for combat. This has been a continuing function of the facility during the Korean and Vietnam conflicts, and the recent Gulf War (i.e., Desert Storm). Toward the end of World War II, the camp was designated as a home base for the Second Marine Division. Since that time, Fleet Marine Force (FMF) units also have been stationed here as tenant commands.

The existing land use patterns in the various geographic areas within the MCB are described in this section and listed, per geographic area, on Table 2-2. The areas described below are depicted on Figure 2-1. In addition, the number of acres comprising each land use category has been estimated and provided on the table. The following is a summary of land use for the Courthouse Bay area and the MCB.

2.1.10. 1 Courthouse Bay

Courthouse Bay is located south of Hadnot Point, on the eastern shore of the New River. The area is accessible via Marine's Road and North Carolina Route 172. Courthouse Bay was selected for the Engineers' School and the 2nd Amphibious Tractor Battalion (AMTRAC) because of its protected natural harbor with direct water access.

The 255 acres of development at Courthouse Bay are distributed on the north and south sides of the Bay itself, with major land uses in three clusters on the south side. Training facilities, which account for the largest single land use, cover about 73 acres of land. Classroom training facilities and supply and storage buildings for heavy equipment are located in two irregular areas on the south side of the Bay, while personnel support, administration, medical facilities, some supply buildings, and all of the existing troop housing facilities overlook the New River. Nine family housing quarters are cited along the New River on a peninsula of land which forms the entrance to the Bay. Large land areas for heavy equipment training are located further to the southeast and are used by the Engineers' School. An area of maintenance and supply buildings located on the north side of the Bay are solely used by the AMTRAC Battalion for maintenance and storage of large vehicles. The area includes a wharf along the Bay and a vehicle loading ramp.

2.1.10.2 Base-Wide

Present military population of MCB, Camp Lejeune is approximately 40,928 active duty personnel. The military dependent community is in excess of 32,081. About 36,086 of these personnel and dependents reside in base housing units. An additional 4,412 civilian employees perform facilities management and support functions. The population of Onslow County has grown from 17,739 in 1940, prior to the formation of the base, to its present population of 121,350.

2.1.11 Water Supply

Potable water for MCB, Camp Lejeune 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 MCB, Camp Lejeune. The average water supply well at the base has a depth of 162 feet, a casing diameter of eight 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 gpm in municipal and industrial wells in the MCB, Camp Lejeune area. The water retrieved is typically a hard, calcium bicarbonate type.

Table 2-3 provides a summary of the supply wells within a one-half mile radius of Sites 65 and 73. The locations of these supply wells are depicted on Figure 2-4.

2.2 Site 65 - Engineer Area Dump

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrology for Site 65.

2.2.1 Site Location and Setting

The Engineer Area Dump (Site 65) refers to a four to five acre former land disposal site situated in the Courthouse Bay section of MCB Camp Lejeune (see Figure 2-5). Courthouse Bay is located south of State Route 172 along the eastern shore of the New River. It is one of a series of small bays which are formed by the New River.

Site 65 is a primarily wooded area located immediately west of the Marine Corps Engineer School which occupies property between Site 65 and the bay. The school is used for maintenance, storage, and operator training of amphibious vehicles and heavy construction equipment. The school also utilizes a several acre parcel located just east of Site 65 to conduct heavy equipment training activities.

2.2.2 Site Topography and Drainage

Site 65 is situated in a topographically high area that is gently pitched to the south-southeast with an average elevation of about 40 feet above mean sea level (msl). Stormwater runoff tends to drain radially to the east, south, and west, away from the site or collect in local surface depressions. Immediately east of Site 65 is the equipment training area which occupies the area between Site 65 and two small ponds located to the southeast. Portions of the area surrounding the ponds are marshy and wetland-like.

2.2.3 Site History

Site 65 reportedly operated from 1952 to 1972. Two separate disposal areas have been reported including: (1) a battery acid disposal area; and, (2) a liquids disposal area. There are no maps or figures which depict the location of the disposal areas, and neither area is currently discernible due to heavy overgrowth. Aerial photographs are available at the base Forestry Division for the years 1962, 1964, 1970, 1973, 1978, 1983, and 1989. The photos up through 1973 depict disturbed areas west of the Engineer School which represent perhaps the best available means for approximately locating the site. In addition, Camp Lejeune base maps, available via Computer-Aided Design Drafting (CADD), indicate the location of a burn area which was identified as part of Site 65 under the Initial Assessment Study (IAS) by Water and Air Research (WAR, 1983). Like the disposal area, the location of the burn area is not currently discernible from the surrounding landscape. Beginning in 1970, the area located immediately east of Site 65 where equipment training exercises are currently conducted, also appears to be disturbed in aerial photographs.

The types of liquids which were reportedly disposed at Site 65 include petroleum, oil, and lubricant products (POL). The IAS did not indicate that hazardous wastes were disposed at Site 65. Site Inspection (SI) Project Plans prepared by NUS Corporation (NUS, May 1991) identify both POL wastes and batteries as having been disposed at Site 65; however, the basis for the inclusion of batteries is not known since no other background report or document references the disposal of batteries at this site.

2.2.4 Site Geology and Hydrogeology

The subsurface soil encountered during the SI consisted primarily of loose to dense, fine- to coarse-grained sand with some clay and traces of silt. Some debris was found in the samples obtained during drilling which consisted of glass chips, wood chips, and rusted metal. This observation correlates with the history of the site which was reportedly used for disposal of construction debris.

During the SI, groundwater was encountered at depths ranging from 5 feet to 13 feet below the ground surface (bgs). Based on static water levels, groundwater flow is to the south toward the New River.

2.2.5 Summary of Previous Investigations

As indicted previously, Site 65 is mentioned in the IAS Report (WAR, 1983) as a site not requiring further confirmation. However, a decision to perform a Site Inspection of the site was subsequently made by the DON in 1991.

On January 31, 1994, Baker published the results of the Final Site Inspection that was conducted for Site 65 in July and August, 1991. The objectives of the SI were to: (1) determine whether there was a release or potential release of hazardous substances and the nature of the associated threats; (2) preliminarily assess the extent of contamination and the volume/type of wastes at the site; and, (3) determine if further action or investigations are required.

Figure 2-6 identifies the sample locations for activities conducted during the SI at Site 65. The activities included the installation of three shallow monitoring wells to approximately 20 feet bgs and the advancement of five, 15-foot deep soil borings. Soil samples were collected from each of the monitoring well borings and the soil borings. The wells were developed and subsequently sampled. Three surface water/sediment samples were also collected from the two on-site ponds and the adjacent marsh area.

Each of the groundwater, soil, surface water and sediment samples were analyzed for Target Compound List (TCL) organics and the Target Analyte List (TAL) inorganics (Level IV data quality). Validation of all samples was in accordance with United States Environmental Protection Agency (USEPA) protocols.

Groundwater samples collected from the three monitoring wells all exhibited metal contaminants (e.g., arsenic, beryllium, chromium, copper, lead and manganese) above either North Carolina groundwater regulations and/or federal primary/secondary drinking water regulations (Figure 2-7). No organic contaminants were detected in the groundwater samples with the exception of low levels of 4,4'-DDD (0.53 μg/L) in well MW02. Low levels of polynuclear aromatic hydrocarbons (PAHs) were detected in two of the eight surface soil samples. The pesticides 4,4'-DDD, 4,4'-DDE and 4,4'-DDT were detected in three of the eight surface soil samples at levels ranging from 18 to 72 μg/kg. One subsurface soil sample exhibited low levels of 4,4'-DDD (58 μg/kg). Aroclor-1254 was also detected in one subsurface soil sample at 230 μg/kg (Figure 2-8).

Federal surface water standards were exceeded for lead, copper, and iron. Barium and chromium exceeded state standards. One sediment sampled collected from the marsh was contaminated with low levels of 4,4'-DDD and 4,4'-DDE and elevated levels of metals. Sediment samples collected from the ponds exhibited low levels of phenolic constituents (76 μg/kg of phenol and 930 μg/kg of

4-methylphenol). Elevated metals which were observed in the marsh sediment, were not observed in either pond. Sediment screening values for the protection of biota were also exceeded in the marsh sample for copper, lead, zinc, 4,4'-DDD and 4,4'-DDE (see Figure 2-9).

The SI recommended that (1) a remedial investigation/feasibility study be conducted to provide data for the evaluation of the nature and extent of soil and groundwater contamination, and a base line human health and ecological risk assessment; (2) historical aerial photographs be obtained to determine the locations where disposal activities occurred; (3) background and upgradient shallow groundwater quality be assessed to better determine whether inorganic contamination of the shallow aquifer is due to disposal operations; and (4) groundwater quality in the deeper portions of the shallow aquifer as well as the Castle Hayne be assessed including the possible influence of the supply wells on groundwater flow.

Aerial photographs of the site from 1962 through 1989 were reviewed by Baker staff at the base Forestry Department. Particular observations were as follows:

- Aerial photographs from 1962 and 1964 appear unchanged. A large kidney-shaped disturbed area and a smaller rounded disturbed area to the east are visible in the general area where Site 65 was reportedly located.

- The aerial photograph from 1970 depicts for the first time a disturbed area which today is the equipment training area. Roadways to the area are not as obvious as in earlier views.

- The aerial photograph from 1973 depicts a very distinctive "heavy equipment training area" (track marks are evident) that is slightly larger than the same area noted in the 1970 photograph. The kidney-shaped disturbed area is beginning to recede in size.

- The aerial photograph from 1978 shows the "heavy equipment training area" only. The kidney-shaped disturbed area has become overgrown.

- The aerial photograph from 1983 is similar to the 1978 photo except for some apparent disturbance in the vicinity of the previously identified kidney-shaped disturbed area.

- In the last aerial photograph available, dated 1989, the heavy equipment training area is clearly visible, however, the kidney-shaped disturbed area is indistinguishable.

2.3 Site 73 - Courthouse Bay Liquids Disposal Area

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrogeology for Site 73. The information presented in this section was obtained from WAR (1983), ATEC (1991), Baker (1992 and 1993), GSI (1993), and Law-Catlin (1993).

2.3.1 Site Location and Setting

The Courthouse Bay Liquids Disposal Area (Site 73) refers to an area where waste oil and battery acid were reported disposed. The site is situated within the boundaries of the Amphibious Vehicle Maintenance Facility located in the Courthouse Bay section of MCB, Camp Lejeune (see Figure 2-1). Site 73 is bounded by State Route 172 (Sneads Ferry Road) to the north, the New River to the south, and unnamed tributaries of the New River to the east and west (see Figure 2-10). Courthouse Road, which bisects the study area, is used to enter the complex.

The primary maintenance area is associated with Building A47. This area is secured by a fence and covered with concrete (see Figure 2-11). The area where waste oils and battery acid disposal reportedly occurred encompasses part of this maintenance complex (i.e., area enclosed by the fence surrounding Building A47), along with much of the area surrounding this complex (see Figure 2-11). The POL and battery acid disposal area is situated just to the northeast of Building A47. Neither area is visually apparent with respect to its history of waste disposal. For example, most of the reported disposal area is covered with concrete, buildings, or roads.

The study area consist of numerous buildings, aboveground storage tanks (ASTs), underground storage tanks (USTs), vehicle wash racks, and oil/water separators. Most of the USTs are or were located (some USTs have been removed) within the fenced area around Building A47. An area where non-petroleum type wastes are routinely handled is an active Haznot Storage area located near UST A47/3. Other USTs are or were located near Buildings A1, A2, and A10. Appendix A contains profiles of the various USTs.

Amphibious vehicles are parked primarily within the fenced area around Building A47. In general, the study area is congested with buildings and roadways.

No visible evidence of contamination was noted in the UST A47/3 area, the UST SA-21 area, the five oil/water separators located throughout the site, or the two streams which flow into Courthouse Bay and border Site 73 to the southwest and northeast. A vehicle roadway and drainage ditch was observed at the extreme southwestern edge of the site. Baker personnel observed two distinct locations in this area where a seep was discharging onto the ground surface. The origin and characteristics of this seep were not known.

2.3.2 Site Topography and Drainage

The terrain at Site 73 is primarily flat. Stormwater runoff tends to drain directly south to Courthouse Bay or to two small unnamed tributaries located northeast and southwest of the facility which ultimately discharge to Courthouse Bay. A broad marshy area is associated with the southern stream. Directly north of the site is another large marshy area with a stream that discharges north into the New River. This marshy area is separated from the site by State Route 172 which represents a local topographic high and a surface water runoff divide.

2.3.3 Site History

The Amphibious Vehicle Maintenance Facility started operations in 1946 and is currently active. Available information indicates that an estimated 400,000 gallons of waste oil was drained directly onto the ground surface at this facility, primarily near the Building A47 complex. In addition to the waste oil, approximately 20,000 gallons of waste battery acid was also reportedly disposed in the

area northeast of the A47 complex. The waste battery acid was poured into shallow hand-shoveled holes which were then backfilled. A previous report (Law-Catlin, 1993) indicated that solvents may have also been disposed at this site. No information was provided as to where these solvents may have disposed.

The facility harbors several active and former petroleum product underground storage tanks (USTs). At least one former UST at the site may have been used for the storage of solvents. An area where non-petroleum type wastes are routinely handled is an active Hazmat storage area located near UST A47/3. Throughout the years, some of the USTs have been filled with sand and left in place, removed, or decommissioned.

2.3.4 Site Geology and Hydrogeology

Site Geology and Hydrogeology

Approximately 66 boreholes were drilled during the investigations of UST SA-21 and A47/3 to investigate the shallow geology at the sites. The soils in the vicinity of UST A47/3 are reported by Law-Catlin to consist of interfingering layers of sand, silty sand, clayey sands, silts and clays to an approximate depth of 19 to 20 feet. A continuous silt/clay confining unit is reported to have been identified at a depth of 19 to 20 feet, however, the thickness of the confining unit was not reported. No debris was encountered during the drilling activities. The groundwater in the area is reported to be approximately four to six feet bgs and the flow direction was calculated to be towards the east and southeast. The hydraulic conductivity for the groundwater was estimated to be 40 feet/day (Law-Catlin, 1993).

The soils in the vicinity of UST SA-21 appear to correlate with the descriptions reported by Law-Catlin fairly well. The dominant lithology at the site is a mixture of silt and sand with a confining unit, consisting primarily of clay, observed at a depth of 15 to 20 feet. The clay is reported to be approximately five feet thick and appears to be continuous. The groundwater was encountered at four to eight feet bgs in the vicinity of UST SA-21 and the flow direction is estimated to flow east across the site. Hydraulic conductivity tests conducted during the investigation and the average conductivity for the shallow aquifer was reported to be 7.9 feet/day (2.6×10^{-3} cm/sec) and the average groundwater flow velocity was calculated to be 60 feet/year.

2.3.5 Summary of Previous Site Investigations

Seven previous environmental investigations have been conducted at this site to date including an Initial Assessment Study (WAR, 1983), Confirmation Study by Environmental Science and Engineering, Inc. (ESE, 1990) and UST investigations conducted by ATEC Associates, Inc. (ATEC, 1991), Baker (1992 and 1993), Groundwater Technology Government Services, Inc. (GSI, 1993), and Law-Catlin (1993).

The first UST investigation was conducted in 1991 by ATEC Environmental Consultants (ATEC) of UST SA-21. In 1992 and 1993, Baker Environmental, Inc. (Baker) performed additional investigations on the same UST. The second investigation was focused on UST A47/3 by Groundwater Technology Government Services, Inc. (GSI) in April 1993 and Law-Catlin in October 1993. Both USTs where reported to be leaking. UST SA-21 was a steel 30,000 gallon capacity tank which held diesel fuel. This tank was installed in 1959 and subsequently removed in 1991. UST A47/3 was a steel 30,000 gallon capacity tank which held diesel fuel. Available information

indicates that this UST was installed in 1986. A hydrostatic test was performed on A47/3 in late 1992. UST A47/3 was subsequently replaced with a fiberglass tank.

2.3.5.1 Confirmation Study (ESE, 1990)

During the Confirmation Study, ESE installed four shallow groundwater monitoring wells in 1984 and a fifth shallow monitoring well in 1986. Two rounds of groundwater samples were collected and analyzed for volatile organics, cadmium, chromium, lead, antimony, oil and grease, and total phenols (analytical methods are not available). The first round was collected in 1984 from the four newly installed wells and the existing supply well (designated 73GW5 for the 1984 sampling effort). The second round was collected in 1987 from all five ESE wells including the newly installed 73MW5. The previous set of compounds were analyzed with the addition of xylene, methyl ethyl ketone, methyl isobutyl ketone, ethylene dibromide, and hexavalent chromium. Results from the groundwater sampling showed positive detections of organic and inorganic compounds. The most significant contaminants detected were benzene (17 μg/L; 73GW4), 1,1-dichloroethylene (2.3 μg/L; 73MW4), trans-1,2-dichloroethene (360 μg/L; 73MW3), toluene (4 μg/L; 73GW4), vinyl chloride (74 μg/L; 73MW4), cadmium (10 μg/L; 73MW2), chromium (95 μg/L; 73MW1), lead (109 μg/L; 73MW1), and oil and grease (2,000 μg/L, 73MW1 and 73MW2). Location of the groundwater monitoring wells and the surface water/sediment sampling stations are provided on Figure 2-10.

Surface water/sediment samples were collected from three locations offshore in Courthouse Bay as part of the study in 1986/7. The results of the sampling effort identified the presence of cadmium (0.69 mg/kg; 73SD3), chromium (11.8 to 53 mg/kg), lead (8.5 to 22.2 mg/kg), phenols (0.207 to 1.56 mg/kg) and oil and grease (314 to 1,510 mg/kg) in the sediment. Chromium was detected in the surface water but was reported that the levels were below the freshwater standard of 50 μg/L.

2.3.5.2 UST SA-21 Investigation (ATEC, 1991 and Baker, 1992 and 1993)

Investigations were conducted in the vicinity of UST SA-21 by ATEC (1991) and Baker (1992 and 1993). ATEC advanced eight subsurface soil borings for the purpose of collecting soil samples and investigation the shallow geology at the site. Upon completion of the borings, groundwater monitoring wells were installed and sampled for total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene, and total xylenes (BTEX). The locations of the ATEC monitoring wells are provided on Figure 2-12.

The highest levels of detectable concentrations in the soils were as follows: TPH (490 mg/kg), ethylbenzene (1,000 μg/kg), and total xylenes (4,000 μg/kg). Benzene and toluene were not detected above 50 μg/kg. The highest levels of detectable concentrations in the groundwater samples were as follows: TPH (0.39 mg/L; MW-3), benzene (45 μg/L; MW-7), toluene (56 μg/L; MW-7), ethylbenzene (9 μg/L; MW-3), and total xylenes (13 μg/L; MW-7). Based on the previously stated concentrations, ATEC recommended that additional soil sampling be conducted around the MW-3 location to determine the extent of soils contaminated by petroleum hydrocarbons and that an additional groundwater investigation be conducted in the vicinity of MW-3 and MW-7 to determine the extent of benzene contamination.

Baker conducted two investigations at the site. The first was conducted in 1992 and Baker drilled 13 boreholes and collected two samples from each soil boring and analyzed for total petroleum hydrocarbons (TPH). Seven boreholes were converted to shallow Type II groundwater monitoring wells and sampled in order to investigate the shallow aquifer and two borings were converted to

deep Type III monitoring wells and sampled to investigate the upper portion of the Castle Hayne aquifer. In addition, seven groundwater samples were collected via the hydropunch method. Groundwater samples were analyzed for BTEX and total VOCs. The locations of the soil borings, Type II and Type III monitoring wells, and the hydropunch samples are illustrated on Figure 2-12. The results are provided on Figures 2-13, 2-14, and 2-15. Figure 2-13 provides soil sample results for low to medium boiling point hydrocarbons. Figure 2-14 provides soil sample results for medium to high boiling point hydrocarbons.

The second investigation was conducted in 1993 and Baker collected 36 subsurface soil samples from 18 soil borings for TPH analysis. Five of the boreholes were converted into shallow Type II groundwater monitoring wells and two were converted into deep Type III monitoring wells. One recovery well was installed for conducting a pump test and eventual remediation of the site. An eight-hour pump test yielded a pumping rate of approximately three gallons per minute (gpm). Groundwater samples for collected for analysis of BTEX and total VOCs. Groundwater contamination was not detected in the wells or hydropunches advanced during this investigation. Locations of all samples are provided on Figure 2-16 and soil sample results are provided on Figures 2-17 and 2-18.

2.3.5.3 UST A47/3 Investigation (GSI, 1993 and Law-Catlin, 1993)

UST A47/3 was formerly located southeast of Building A47. It was investigated by GSI and Law-Catlin in 1993. GSI advanced seven soil borings from which seven soil samples were collected for TPH analysis. The borings were later converted into shallow Type II groundwater monitoring wells and sampled for BTEX analysis. TPH was detected in the soils at a range of 440 to 3,000 mg/kg. The highest levels of detectable concentrations in the groundwater samples were as follows: benzene (1.7 μg/L), toluene (0.6 μg/L), ethylbenzene (3.8 μg/L) and total xylenes (3.0 μg/L).

Law-Catlin conducted an additional investigation of the site in which 48 subsurface soil samples were collected from 16 soil borings for TPH analysis. The soil borings were later converted into 12 shallow Type II groundwater monitoring wells, three deep Type III monitoring wells and one pumping well. In addition to the groundwater samples collected from the monitoring wells, ten samples were collected via hydropunch procedure. All groundwater samples were analyzed for BTEX. Locations of the hydropunch samples, subsurface soil samples and the groundwater monitoring wells are provided on Figure 2-19 and results are provided on Figures 2-20 and 2-21.

Richard Catlin & Associates subsequently obtained groundwater samples from shallow wells A47/3-8 and A47/3-9 and analyzed them for non-fuel specific compounds via EPA Method 502.2. The results, reported in a letter report dated March 22, 1994, revealed the presence of elevated levels of several chlorinated organic compounds (e.g., vinyl chloride, trichloroethylene); however, only benzene was detected in excess of State of North Carolina groundwater standards.

2.3.5.4 Aerial Photography Review

Aerial photographs of the site from 1964 through 1989 were reviewed by Baker staff at the base Forestry Department. Two additional aerial photographs dated 1964 and 1970 were also reviewed by Baker. These latter photographs were obtained from the USEPA. Specific observations were as follows:

- Aerial photographs from 1964 through 1983 appear to be virtually identical indicating the lack of substantial modifications to the site. No evidence of the surface disposal of liquid wastes is apparent.

- The aerial photograph from 1989 depicts the new main Building A47. The construction of this structure represented a significant alteration to the site which included the paving of a substantial portion of the northeast section of the site. The paved area includes a large portion of the area where waste oil disposal is suspected to have occurred.

2.3.4.5 Preliminary Investigation

A soil gas survey and groundwater sample screening program was recently conducted at Site 73 by Baker from June 7 through June 14, 1994. This preliminary investigation was performed so as to provide additional data regarding the presence or absence of organic contaminants across the site and to better define source areas of contamination prior to the preparation of project plans. Baker subcontracted Tracer Research Corporation (Tracer) of Monmouth, New Jersey to execute the program. A grid of sampling points was laid out across the site by a survey subcontractor, Colbert Associates (Colbert) of Baltimore, Maryland. In general, the sampling locations were laid out along a 200-foot by 200-foot grid across the site in areas where sampling was not concentrated under previous investigations. Additional sampling locations were concentrated around other suspected source areas such as oil/water separators, active and former USTs, and miscellaneous areas such as active and former vehicle washdown basins. Tracer obtained a shallow groundwater sample from each sampling location. An attempt was also made to obtain a soil gas sample from each sampling location; however, at some locations the close proximity of the shallow groundwater surface to the top of ground surface precluded the successful collection of soil gas samples.

Each soil gas and groundwater sample obtained was analyzed by Tracer in the field via mobile gas chromatograph for benzene, toluene, ethyl benzene, total xylenes, total volatile hydrocarbons (TVHC: C4 to C9 range and C10 to Cx range where C followed by a number indicates how many carbon atoms comprise the hydrocarbon compound), trichloroethane (TCA), trichloroethene (TCE), tetrachloroethylene (PCE), and methylene chloride. These parameters were selected to provide a broad range of petroleum hydrocarbons and solvents which comprise the two classes of organic contaminants of concern at this site. The results of the program are presented on Figures 2-22 and 2- 23.

Using the results of the preliminary investigation and previous investigations, Baker subdivided Site 73 into nine distinct areas of concern (AOCs), in order to segregate potential sources of contamination and identify future ecological sampling zones. These AOCs are depicted on Figure 2-24 along with all existing sample locations. The total area encompassed by the AOCs measures approximately 48 acres and are described as follows:

AOC #1 The general area identified in the Camp Lejeune Site Summary Report (ESE, 1990) where over 400,000 gallons of POL may have been disposed. A previous report also indicated that solvents may have been disposed in this area. USTs A-47/1, A-47/5, and A-47/4 are located within this AOC.

AOC #2 A vehicle roadway/ditch area at the extreme southwestern edge of the site which leads into Courthouse Bay. During the site visit, Baker observed

two distinct areas of random discharge into the road/ditch from seeps located on both sides of the road/ditch. Although the seeps were brownish in appearance, samples obtained during the preliminary investigation indicated no detectable levels of volatile organic compounds were present.

AOC #3 Former location of UST SA-26, a 550-gallon UST utilized to hold waste oils. This UST was removed after it was determined to be leaking. Adjacent to this former UST is a vehicle washdown area that is connected to an oil/water separator.

AOC #4 UST SA-21 area that previously contained a 30,000-gallon UST for the storage of diesel fuel and gasoline. This area was previously investigated by ATEC and Baker.

AOC #5 The general area identified in the Camp Lejeune Site Summary Report (ESE, 1990) where over 20,000 gallons of waste battery acid may have been disposed. This area is also part of the area where waste oil may have been disposed.

AOC #6 UST A47/3 area that previously contained a 30,000-gallon UST used to store diesel fuel. This UST area was previously investigated by GSI and Law-Catlin.

AOC #7 Unnamed stream which borders Site 73 on the southeast. This surface water body may be a receptor of shallow groundwater and/or surface water run-off.

AOC #8 The area of Courthouse Bay which could be impacted by Site 73 shallow groundwater recharge and surface water run-off.

AOC #9 Unnamed stream which borders Site 73 on the southwest. This surface water may be a possible receptor of surface groundwater and/or surface soil run-off.

SECTION 2.0 TABLES

TABLE 2-1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0249
MCB CAMP LEJEUNE, 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]
	Palocene	Beaufort Formation	Beaufort Aquifer
Cretaceous	Upper Cretaceous	Peedee Formation	Peedee Confining Unit
			Peedee Aquifer
		Black Creek and Middendorf Formations	Black Creek Confining Unit
			Black Creek Aquifer
		Cape Fear Formation	Upper Cape Fear Confining Unit
			Upper Cape Fear Aquifer
			Lower Cape Fear Confining Unit
			Lower Cape Fear Aquifer
	Lower Cretaceous[1]	Unnamed Deposits[1]	Lower Cretaceous Confining Unit
			Lower Cretaceous Aquifer[1]
Pre-Cretaceous Basement Rocks		--	--

(1) Geologic and hydrologic units probably not present beneath Camp Lejeune.
(2) Constitutes part of the surficial aquifer and Castle Hayne confining unit in the study area.
(3) Estimated to be confined to deposits of Paleocene age in the study area.
Source: USGS, 1989.

TABLE 2-2

LAND UTILIZATION: DEVELOPED AREAS LAND USE[1]
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0249
MCB, CAMP LEJEUNE, NORTH CAROLINA

Geographic Area	Oper.	Training (Instruc.)	Maint.	Supply/ Storage	Medical	Admin.	Family Housing	Troop Housing	CM	CO	Recreat.	Utility	Total
Hadnot Point	31 (2.9)	15 (1.4)	154 (14.3)	157 (14.4)	10 (0.9)	122 (11.3)	22 (2.0)	196 (18.1)	115 (10.7)	36 (3.3)	182 (16.9)	40 (3.7)	1,080 (100)
Paradise Point	1 (0)		3 (0.4)	1 (0)			343 (34)	19 (1.9)	31 (3.1)		610 (60.4)	2 (0.2)	1,010 (100)
Berkeley Manor/ Watkins Village							406 (80)		41 (8.1)	1 (0.2)	57 (11.2)	2 (0.5)	507 (100)
Midway Park		1 (0.4)		2 (0.7)		2 (0.7)	248 (92.2)		8 (3.0)	3 (1.1)	4 (1.5)	1 (0.4)	269 (100)
Tarawa Terrace I and II			3 (0.5)			1 (0.3)	428 (77.4)		55 (9.9)	11 (2.0)	47 (8.5)	8 (1.4)	553 (100)
Knox Trailer							57 (100)						57 (100)
French Creek	8 (1.4)	1 (0.2)	74 (12.7)	266 (45.6)	3 (0.5)	7 (1.2)		122 (20.9)	22 (3.8)	6 (1.0)	74 (12.7)		583 (100)
Courthouse Bay		**73 (28.6)**	**28 (10.9)**	**14 (5.5)**		**12 (4.7)**	**12 (4.7)**	**43 (16.9)**	**15 (5.9)**	**4 (1.6)**	**43 (16.9)**	**11 (4.3)**	**255 (100)**
Onslow Beach	6 (9.8)	1 (1.6)	3 (4.8)	2 (3.2)	1 (1.6)	2 (3.2)		2 (3.2)	12 (19.3)		25 (40.3)	8 (13.0)	62 (100)
Rifle Range		1 (1.3)	1 (1.3)	7 (8.8)	1 (1.3)	5 (6.3)	7 (8.8)	30 (37.5)	5 (6.3)	1 (1.3)	9 (11.3)	13 (16.3)	80 (100)
Camp Geiger	4 (1.9)	15 (6.9)	19 (8.8)	50 (23.1)		23 (10.6)		54 (25.0)	27 (12.5)	2 (1.0)	16 (7.4)	6 (2.8)	216 (100)
Montford Point	6 (2.6)	48 (20.5)	2 (0.9)	4 (1.7)	2 (0.9)	9 (3.9)		82 (35.2)	20 (8.6)	1 (0.4)	49 (21.0)	10 (4.3)	233 (100)
Base-Wide Misc.	1 (0.8)			87 (68.0)		3 (2.3)			19 (14.8)			18 (14.1)	128 (100)
TOTAL	**57 (1.1)**	**155 (3.1)**	**287 (5.7)**	**590 (11.7)**	**17 (0.38)**	**186 (3.7)**	**1,523 (30.2)**	**548 (10.8)**	**370 (7.4)**	**65 (1.3)**	**1,116 (22.2)**	**119 (2.4)**	**5,033 (100)**

[1]Upper number is acres, lower number is percent.

TABLE 2-3

SUMMARY OF SUPPLY WELLS IN THE VICINITY OF OPERABLE UNIT NO. 9
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS, CTO-0249
MCB, CAMP LEJEUNE, NORTH CAROLINA

Well No.	USGS I.D. No.	Approximate Distance/Direction Site to Well	Year Drilled	Depth (feet)	Driller	Screen Interval (feet below surface)	Well Diameter (inches)	Static Water Level (feet below land surface)
A-5	3435300772234.1	1,320 feet northwest (Site 73)	1942	116	Layne Atlantic Company	46.5 - 61.5 101 - 116	8	8.3
BB-43	3434550772148.1	1,630 feet southwest (Site 65)	1942	60	Layne Atlantic Company	30 - 69	8	10.4
BB-44	3435040772143.1	1,200 feet west (Site 65)	1942	62	Layne Atlantic Company	32 - 62	8	13.4
BB-45	3434560772148.1	1,630 feet southwest (Site 65)	1983	150	East Coast Construction Company	40 - 55 102 - 125	--	10.1
BB-220	3435140772136.1	1,800 feet north (Site 65)	1975	150	Carolina Well and Pump Company	55 - 70 85 - 95 130 - 145	--	10.2
BB-221	3435220772122.1	1,500 feet northeast (Site 65)	--	200	Carolina Well and Pump Company	60 - 80 135 - 155	--	--
BB-222	3500010772049.1	3,000 feet east (Site 65)	1985	185	Carolina Well and Pump Company	64 - 94 148 - 168	10	--
T-20	345040772124.1	792 feet southwest (Site 65)	1959	121	Heater Well Co.	--	--	--
T-21	3434530772135.1	1,584 feet north (Site 65)	1959	120	Heater Well Co.	--	--	--

SECTION 2.0 FIGURES

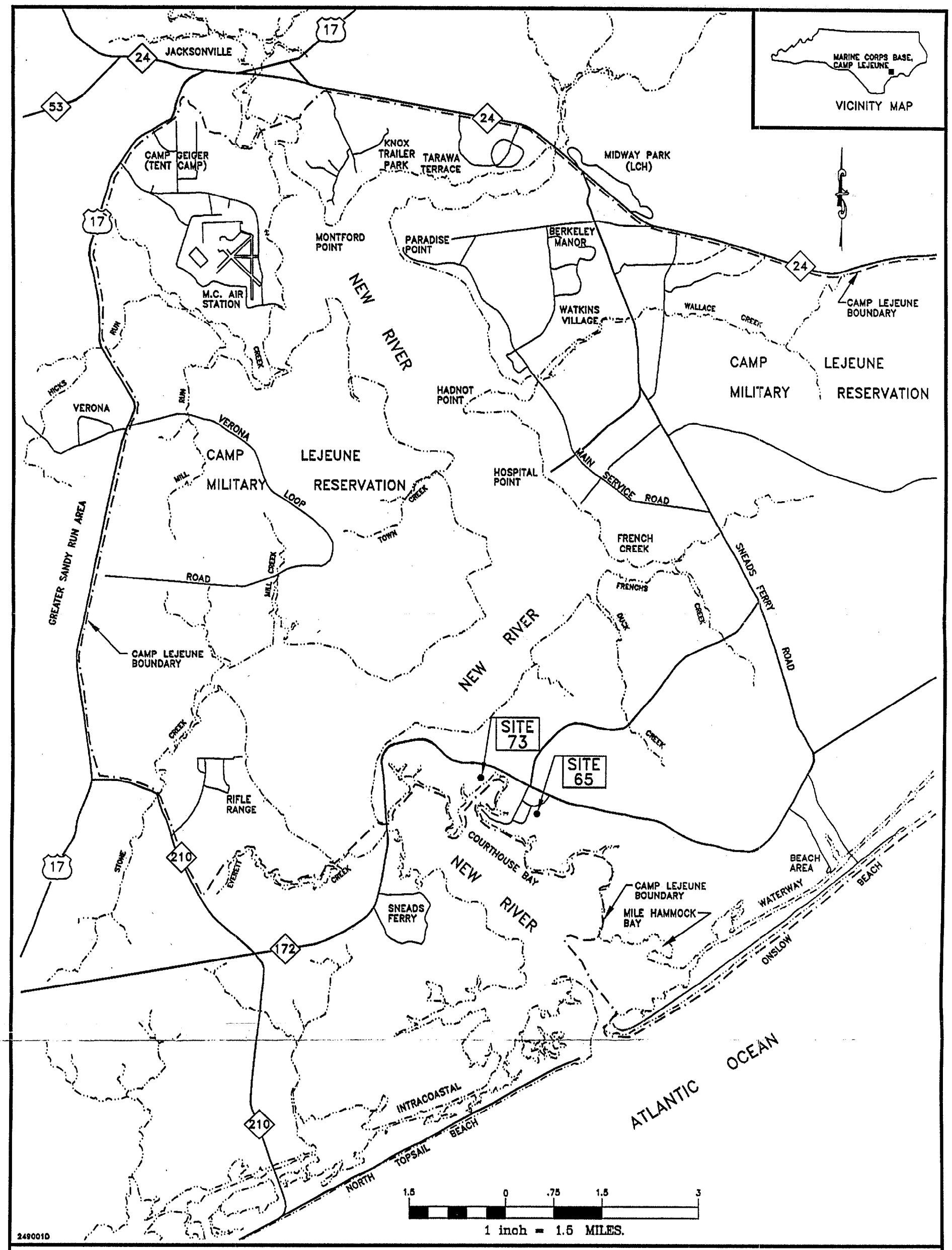
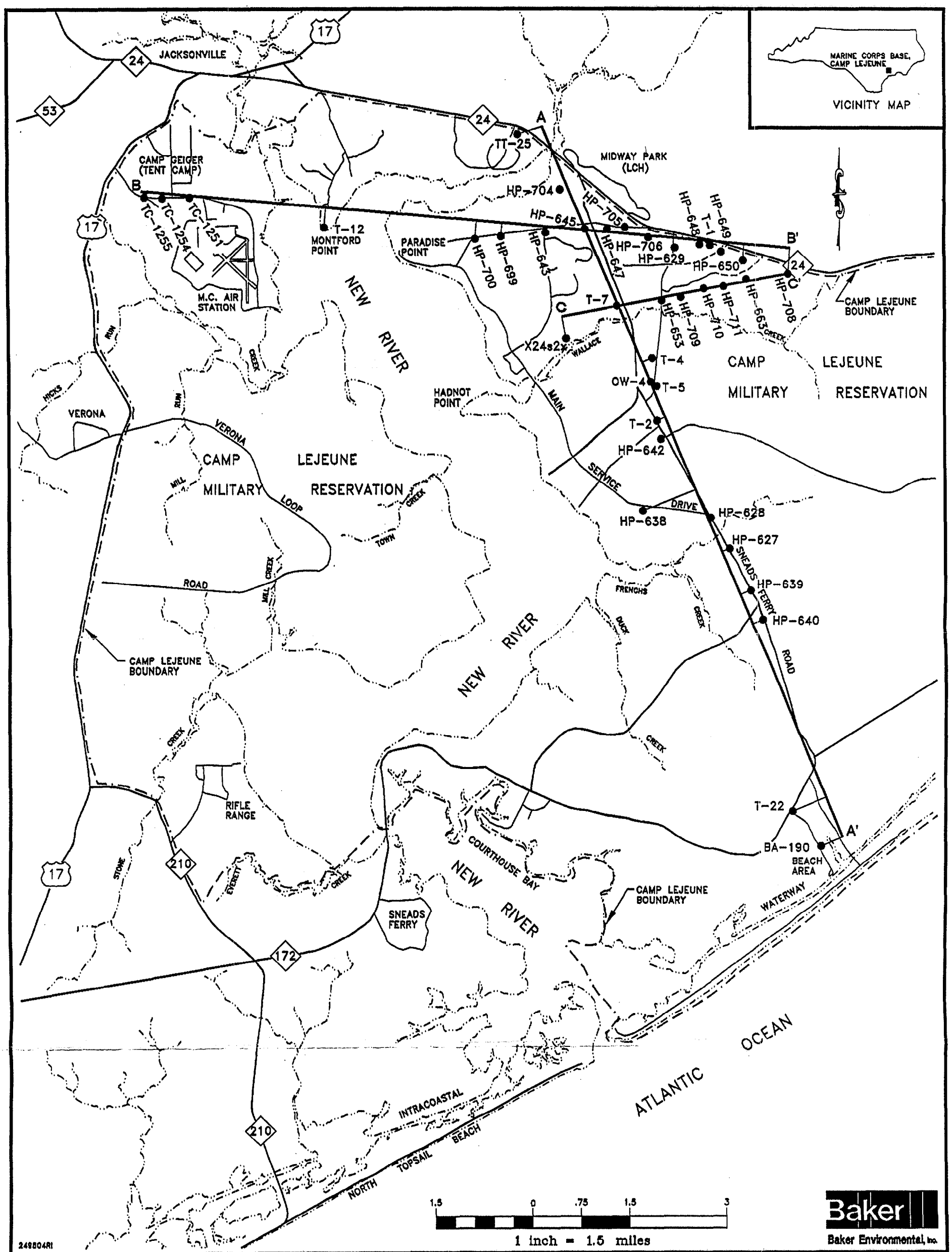


FIGURE 2-1
LOCATION MAP
SITE 65 - ENGINEER AREA DUMP
SITE 73 - COURTHOUSE BAY LIQUIDS DISPOSAL AREA
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



SOURCE: DEPT. OF INTERIOR, WATER-RESOURCES INVESTIGATIONS REPORT, 89-4096, PLATE 4

FIGURE 2-2
LOCATION OF HYDROGEOLOGIC CROSS-SECTIONS
MARINE CORPS BASE, CAMP LEJEUNE
CTO-0249

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

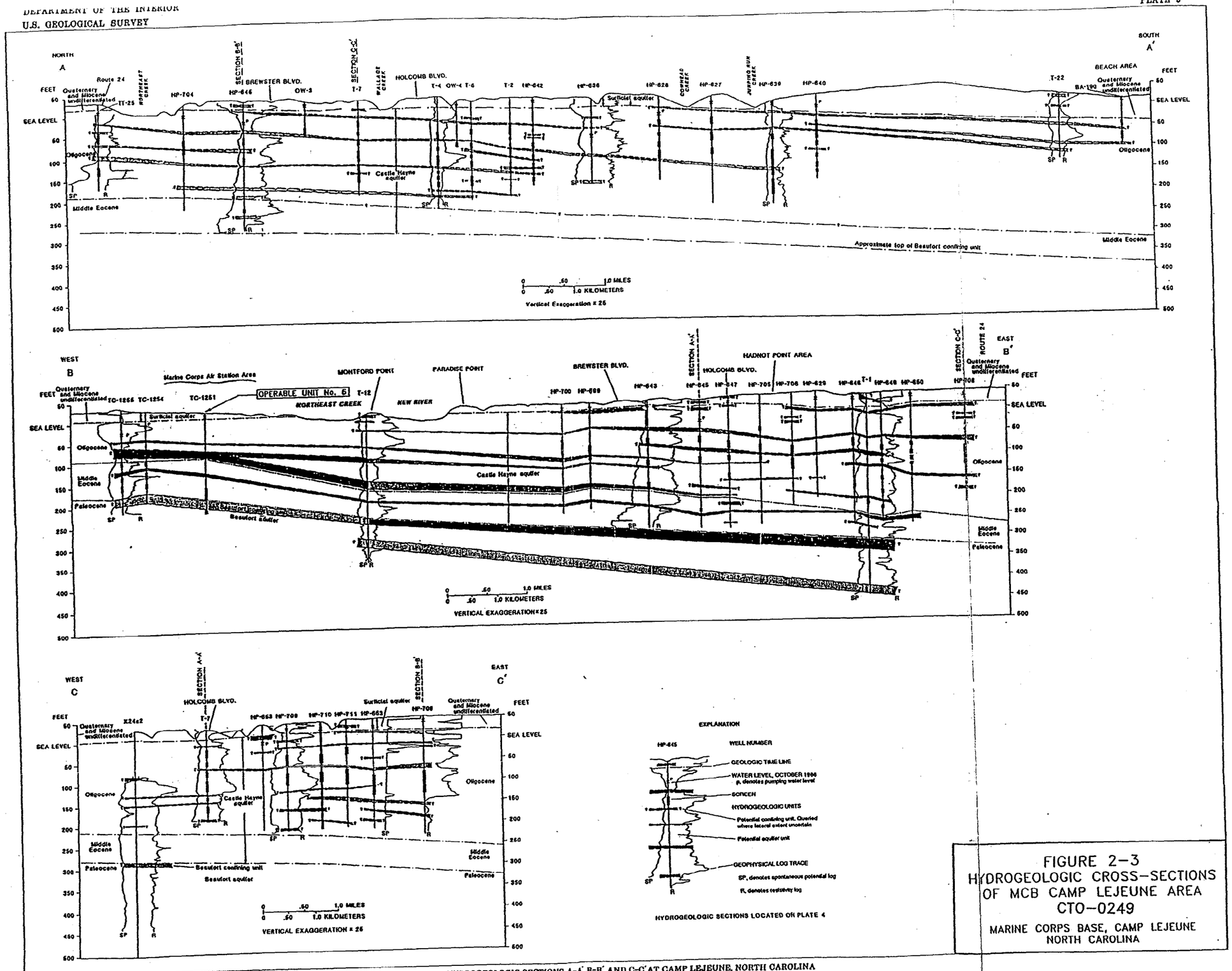
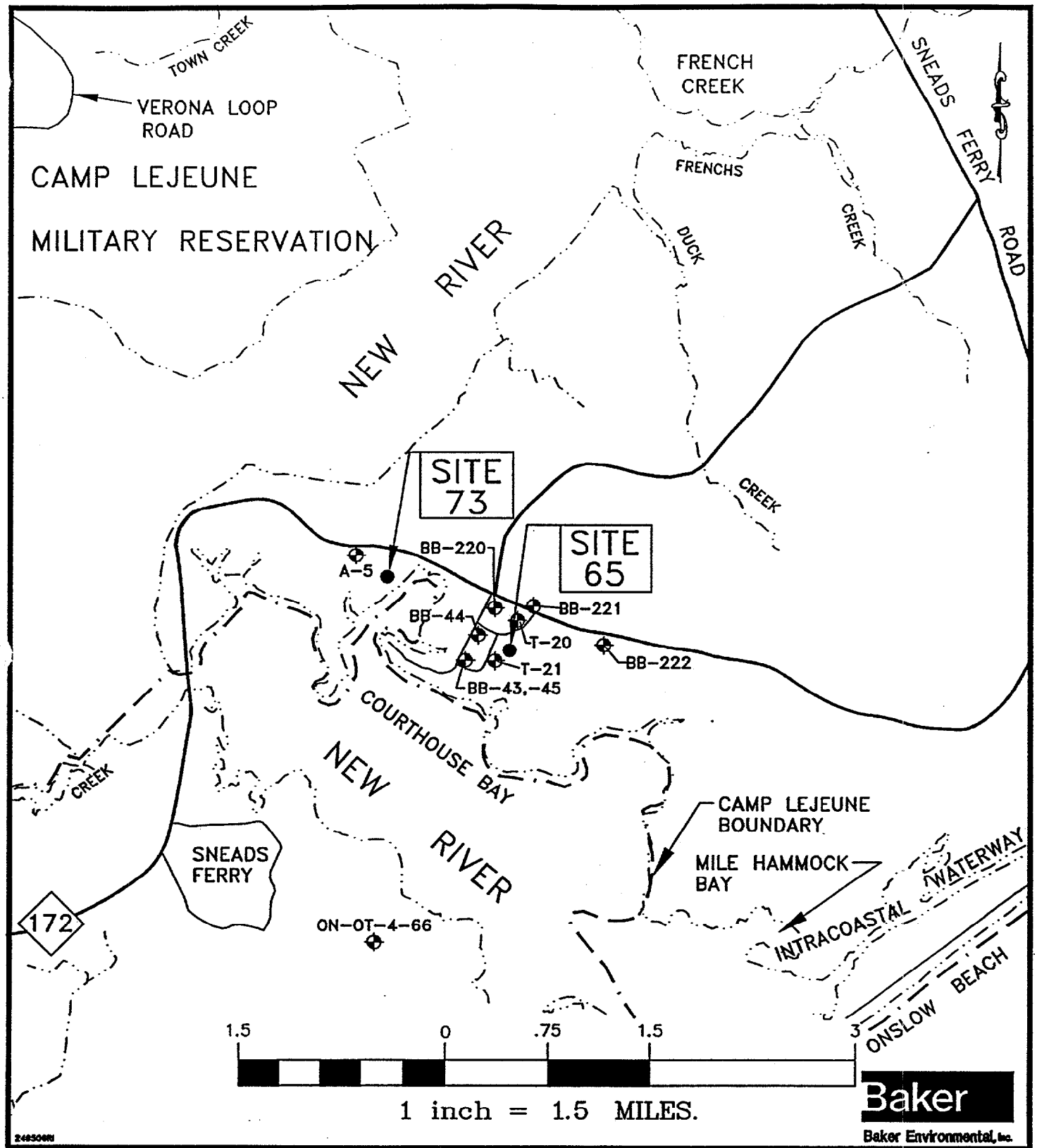


FIGURE 2-3
HYDROGEOLOGIC CROSS-SECTIONS OF MCB CAMP LEJEUNE AREA
CTO-0249

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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



LEGEND

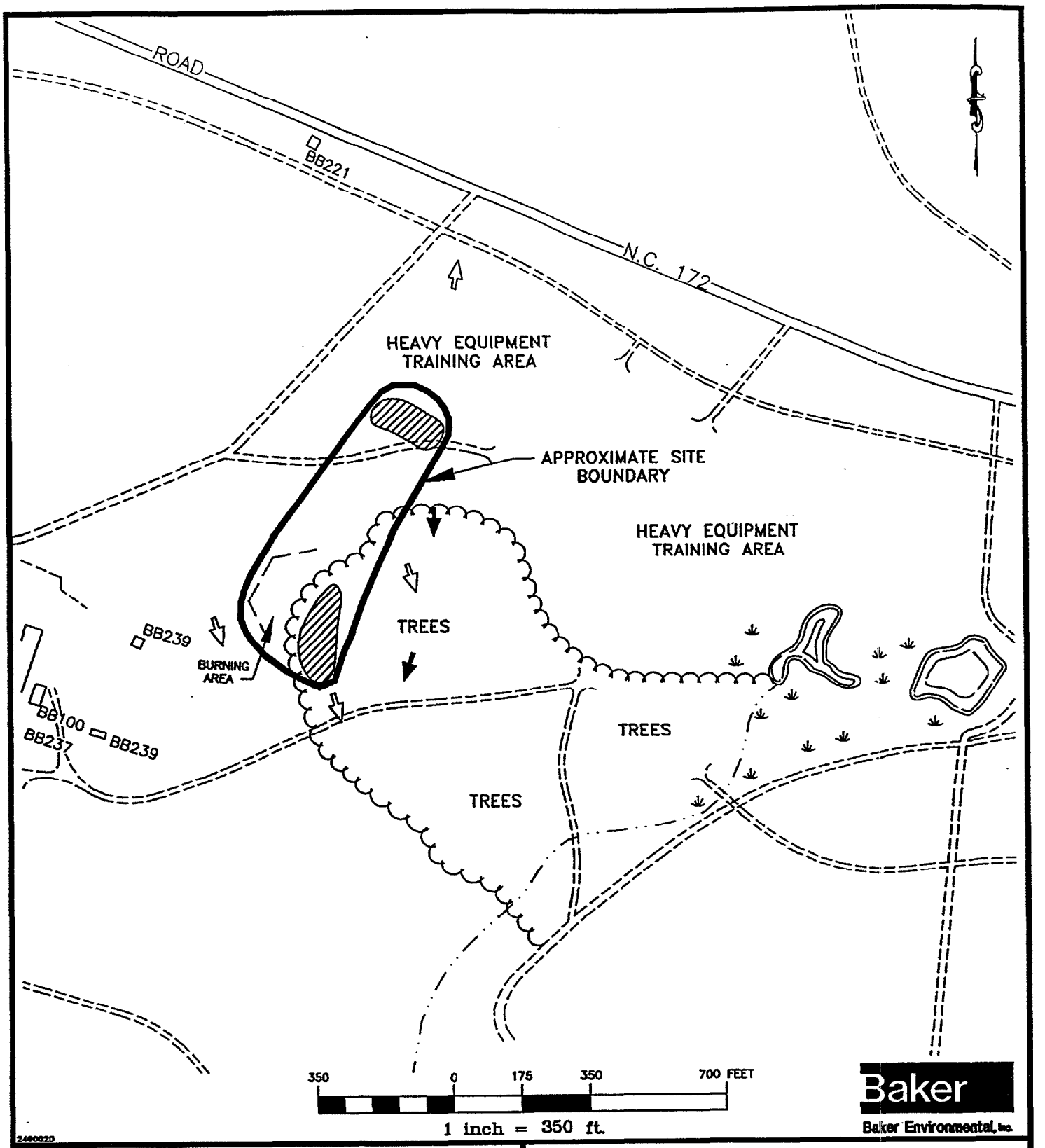
● – SITE

BB-221 – SUPPLY WELL

SOURCE: GEOPHEX, 1983.

FIGURE 2-4
PLAN OF NEARBY SUPPLY WELLS
SITES 65 AND 73

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

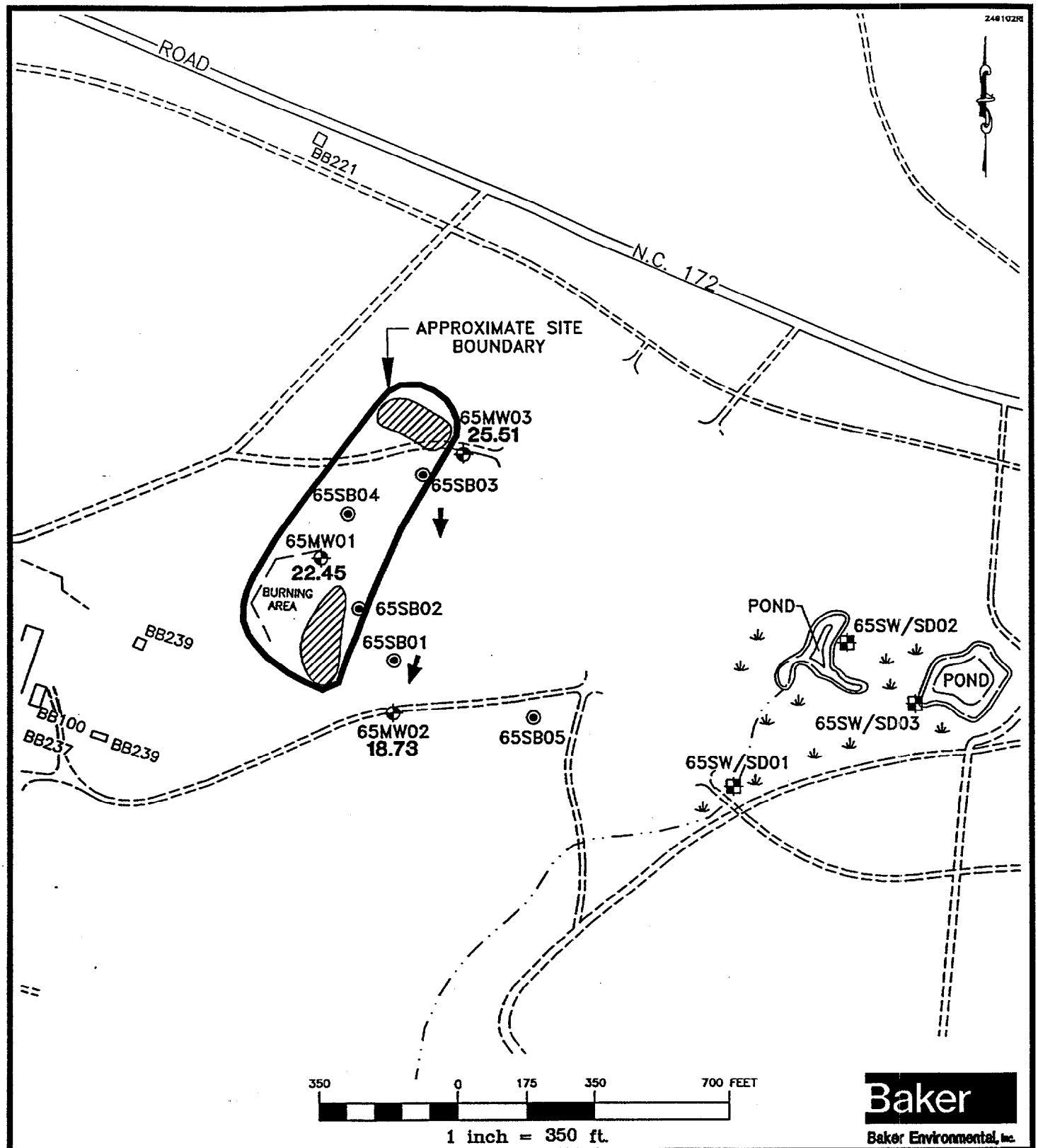


LEGEND

- APPROXIMATE EXTENT OF WOODED AREA
- APPROXIMATE LOCATION OF VISIBLE DEBRIS PILES
- MARSH
- APPROXIMATE INTERMITTENT STREAM LOCATION
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- SURFACE DRAINAGE PATTERN

FIGURE 2-5
SITE MAP
ENGINEER AREA DUMP
SITE 65

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



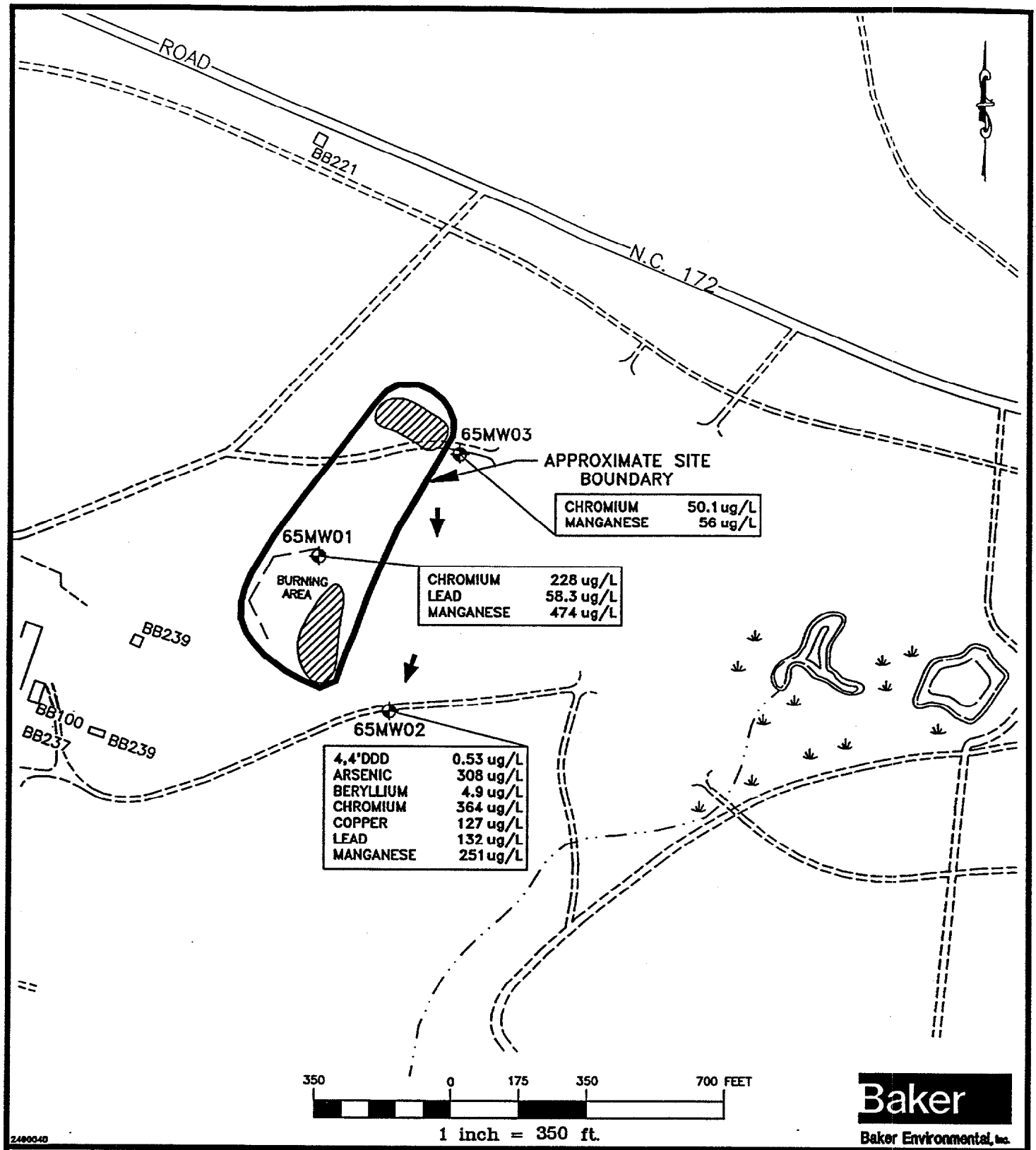
LEGEND

- SURFACE WATER/SEDIMENT SAMPLE LOCATION
- SOIL BORING LOCATION
- MONITORING WELL LOCATION
- APPROXIMATE LOCATION OF VISIBLE DEBRIS PILES
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- 18.73 GROUNDWATER ELEVATION (FEET/MSL)
- APPROXIMATE INTERMITTENT STREAM LOCATION

* SOIL BORING AND SURFACE WATER/SEDIMENT LOCATIONS WERE NOT SURVEYED

FIGURE 2-6
SI SAMPLE LOCATION MAP
ENGINEER AREA DUMP
SITE 65

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

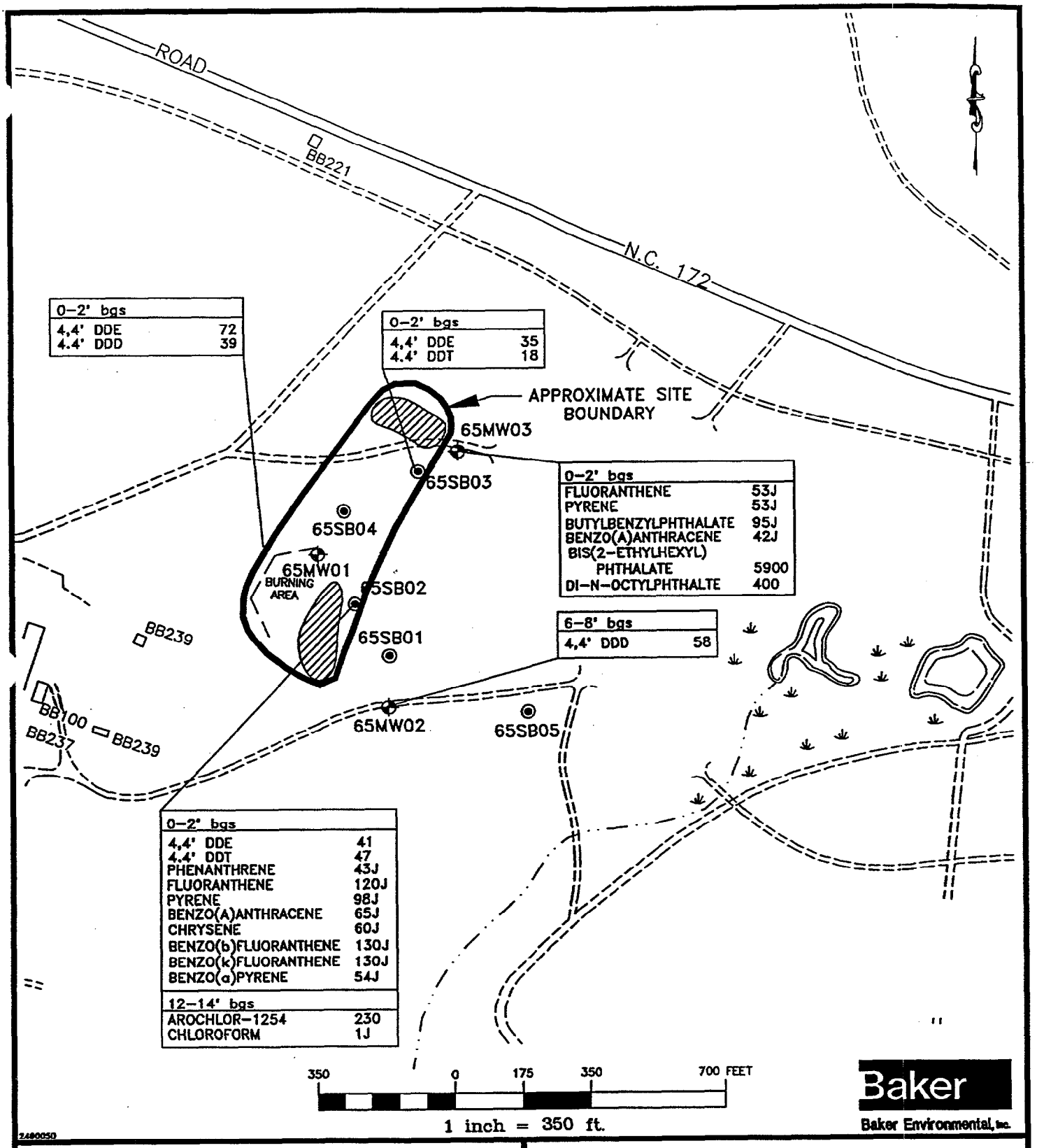


LEGEND

- MONITORING WELL LOCATION
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- ug/L MICROGRAMS PER LITER (ppb)
- APPROXIMATE INTERMITTENT STREAM LOCATION
- APPROXIMATE LOCATION OF VISIBLE DEBRIS PILES

NOTE: ONLY INORGANICS ABOVE STATE OR FEDERAL DRINKING WATER STANDARDS ARE INCLUDED

FIGURE 2-7
DISTRIBUTION OF ORGANIC AND INORGANIC CONTAMINANTS IN GROUNDWATER
ENGINEER AREA DUMP
SITE 65
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



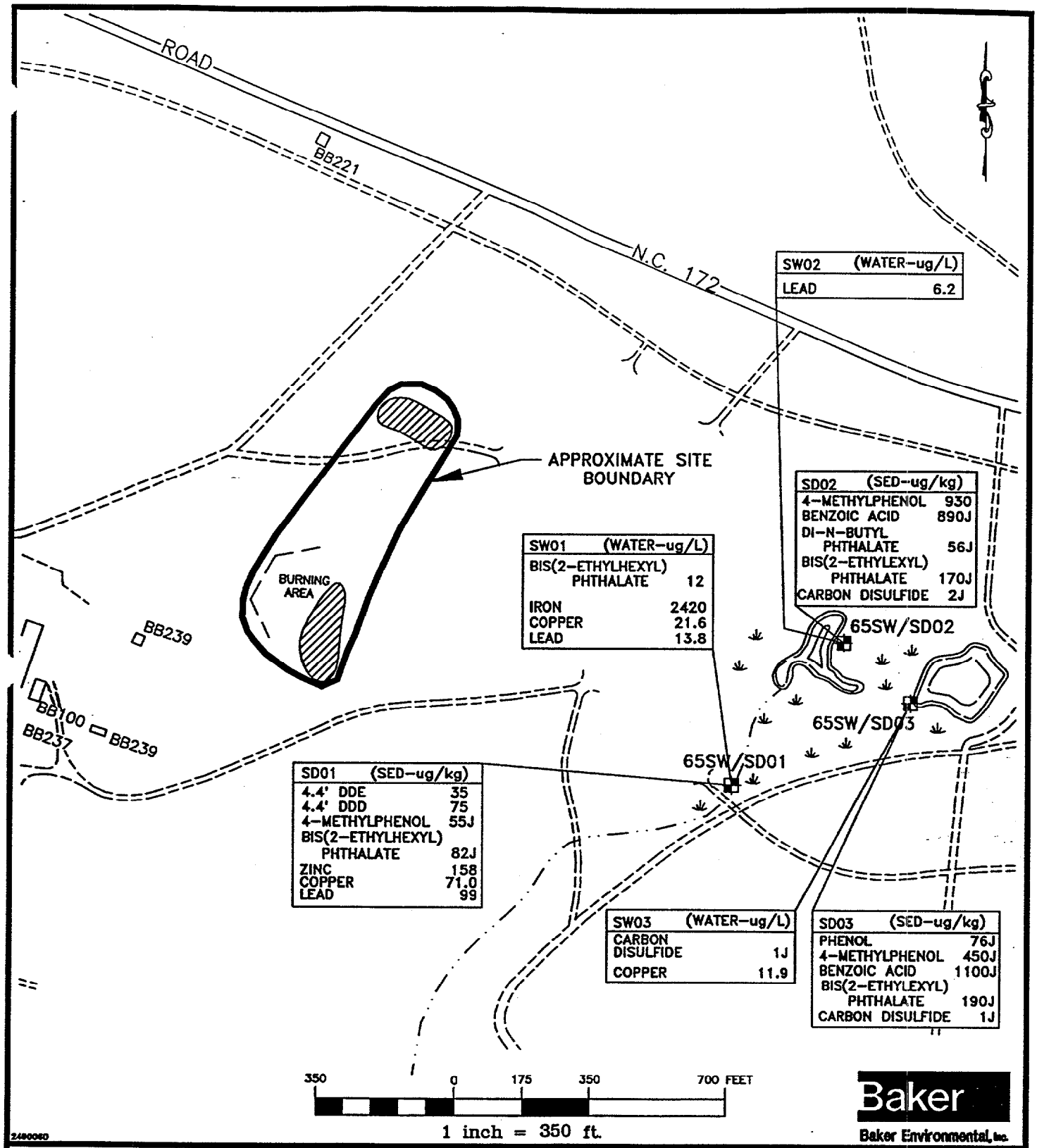
LEGEND

- SOIL BORING LOCATION
- MONITORING WELL LOCATION
- J — ANALYTE PRESENT. REPORTED VALUE MAY NOT BE ACCURATE OR PRECISE
- APPROXIMATE INTERMITTENT STREAM LOCATION
- 0–2' bgs — SAMPLE INTERVAL DEPTH BELOW GROUND SURFACE
- APPROXIMATE LOCATION OF VISIBLE DEBRIS PILES

NOTE: ALL RESULTS REPORTED IN MICROGRAMS PER KILOGRAM (ppb)

FIGURE 2–8
DISTRIBUTION OF ORGANIC CONTAMINANTS IN SOIL
ENGINEER AREA DUMP
SITE 65

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

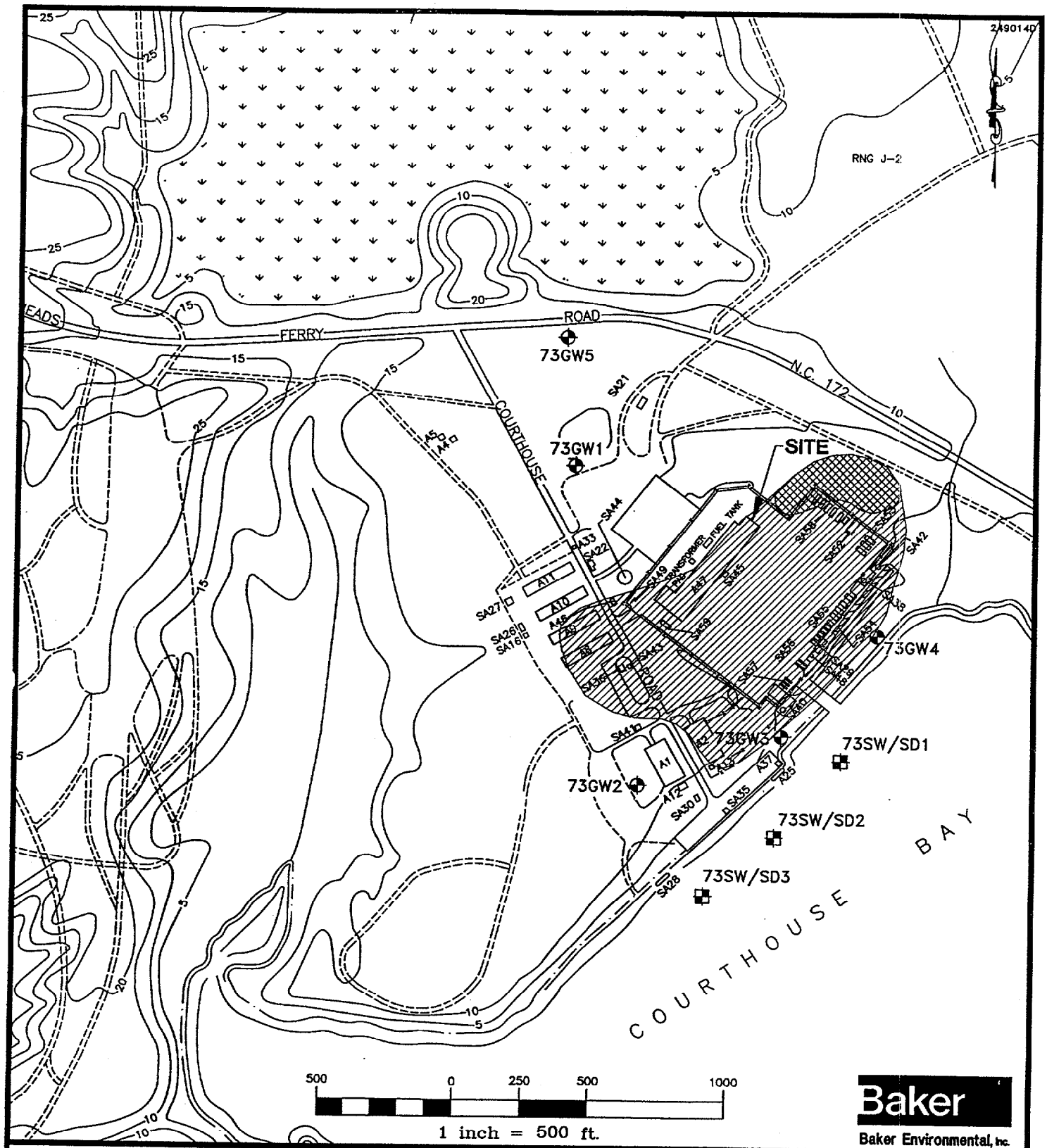
- SURFACE WATER/SEDIMENT SAMPLE LOCATION
- APPROXIMATE LOCATION OF VISIBLE DEBRIS PILES
- J — ANALYTE PRESENT, REPORTED VALUE MAY NOT BE ACCURATE OR PRECISE
- APPROXIMATE INTERMITTENT STREAM LOCATION
- ug/L — MICROGRAMS PER LITER (ppb)
- ug/kg — MICROGRAMS PER KILOGRAM

NOTES:
1. ONLY INORGANICS (SEDIMENTS) ABOVE SEDIMENT SCREENING VALUES ARE INCLUDED.
2. ONLY INORGANICS ABOVE STATE AND/OR FEDERAL SURFACE WATER STANDARDS ARE INCLUDED.

* SOIL BORING AND SURFACE WATER/SEDIMENT LOCATIONS WERE NOT SURVEYED

FIGURE 2-9
DISTRIBUTION OF ORGANIC AND INORGANIC CONTAMINANTS IN SURFACE WATER AND SEDIMENT
ENGINEER AREA DUMP
SITE 65

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

73GW1 SHALLOW GROUNDWATER MONITORING WELL INSTALLED BY ESE (1984 AND 1986)

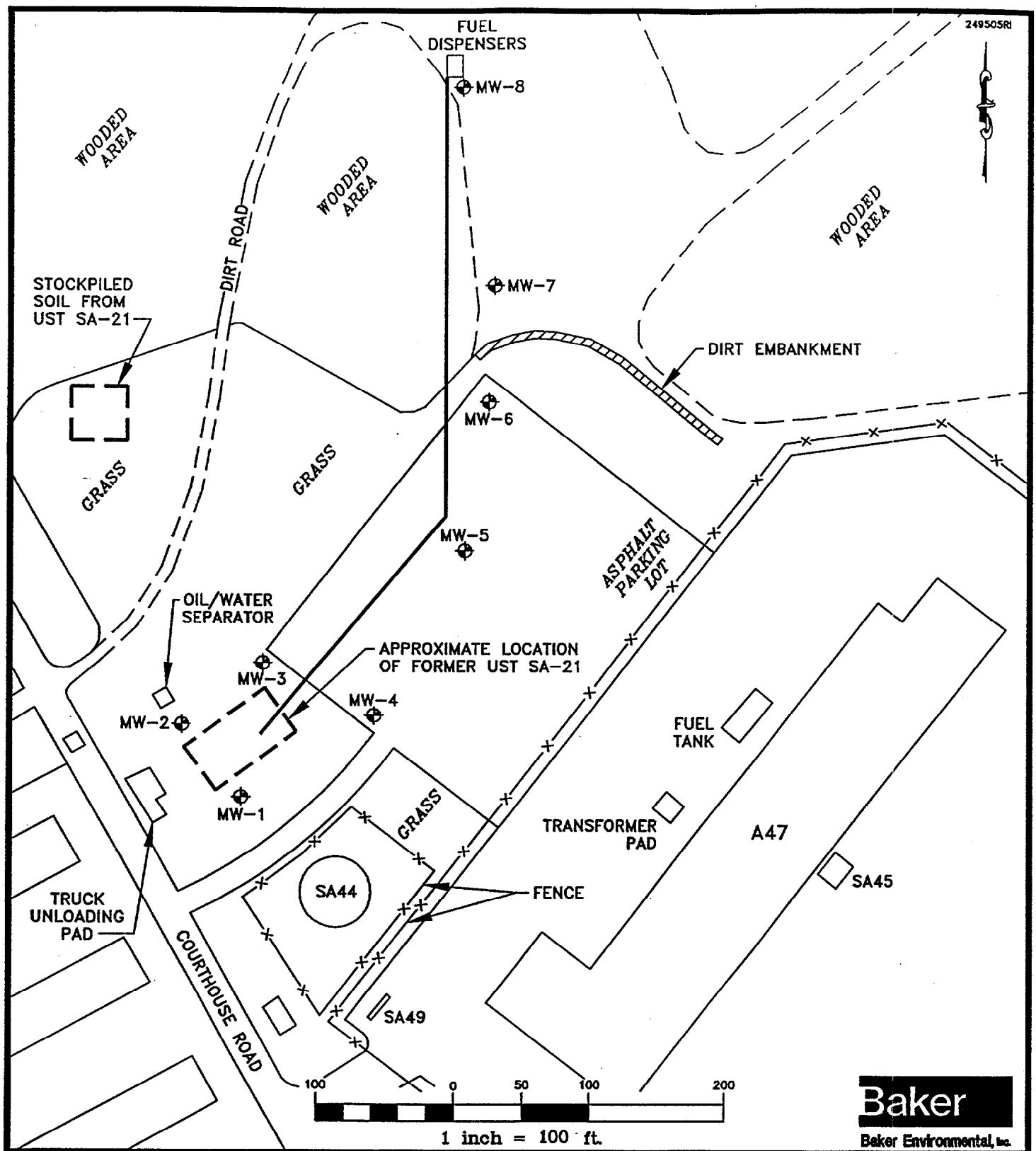
73SW/SD1 SURFACE WATER/SEDIMENT SAMPLE LOCATION BY ESE (1984)

~~AREA OF SUSPECTED POL CONTAMINATION BY WAR (1983)~~

~~AREA OF SUSPECTED POL AND ACID CONTAMINATION BY WAR (1983)~~

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-10
SITE MAP
AMPHIBIOUS VEHICLE
MAINTENANCE AREA
SITE 73
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

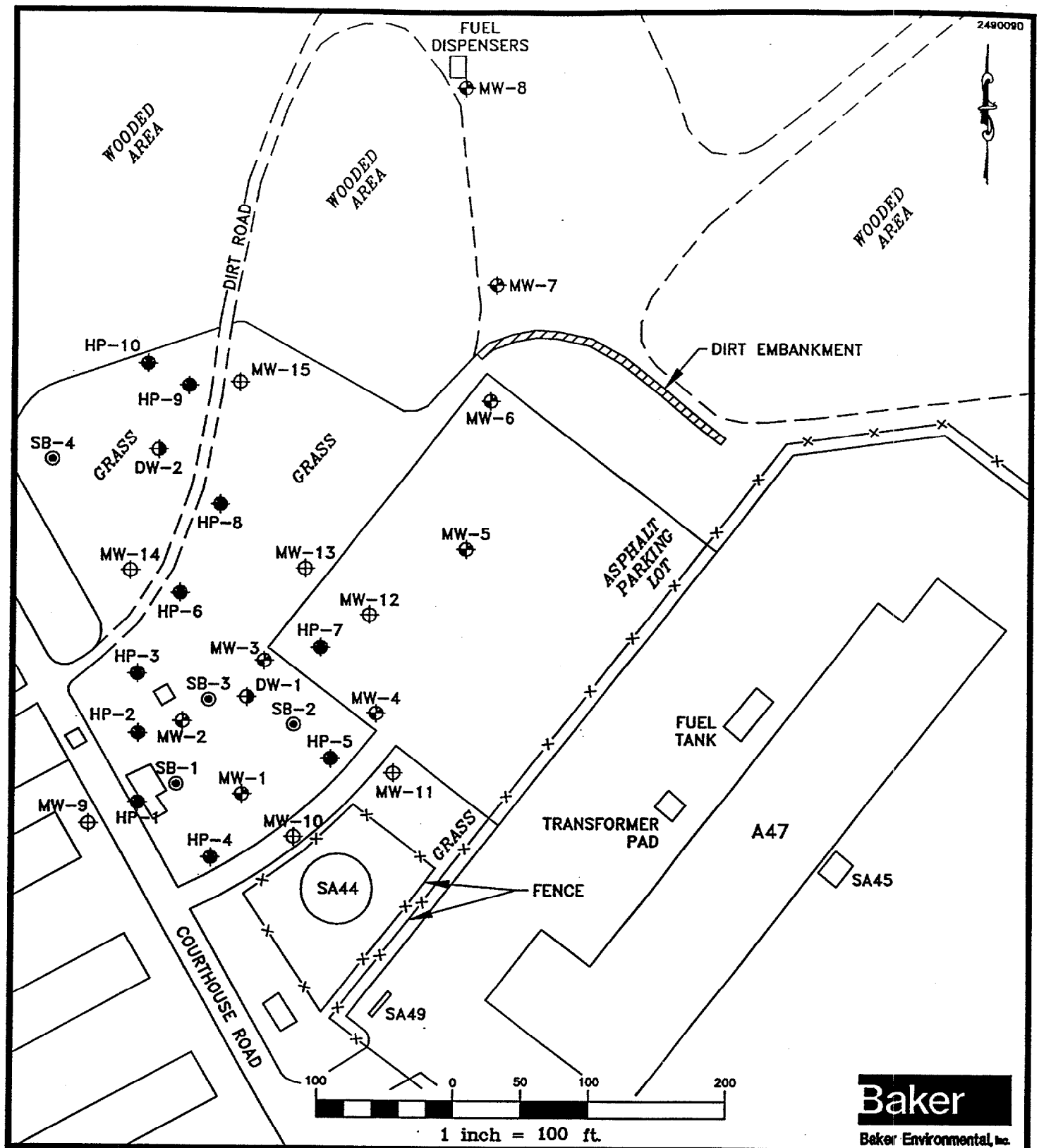
MW-1 EXISTING TYPE II GROUNDWATER MONITORING WELL INSTALLED BY ATEC ASSOC., AUGUST 1991

APPROXIMATE LOCATION OF UNDERGROUND FUEL DISTRIBUTION LINE

SOURCE: FINAL SITE ASSESSMENT REPORT BUILDING A-47 BY BAKER ENVIRONMENTAL, INC., OCT. 12, 1992.

FIGURE 2-11
SITE PLAN
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA

MARINE CORPS BASE, CAMP LEJEUNE
CAMP LEJEUNE, NORTH CAROLINA



LEGEND

MW-1 EXISTING TYPE II GROUNDWATER MONITORING WELL INSTALLED BY ATEC ASSOC., AUGUST 1991

MW-9 SHALLOW TYPE II GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992

DW-1 DEEP TYPE III GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992

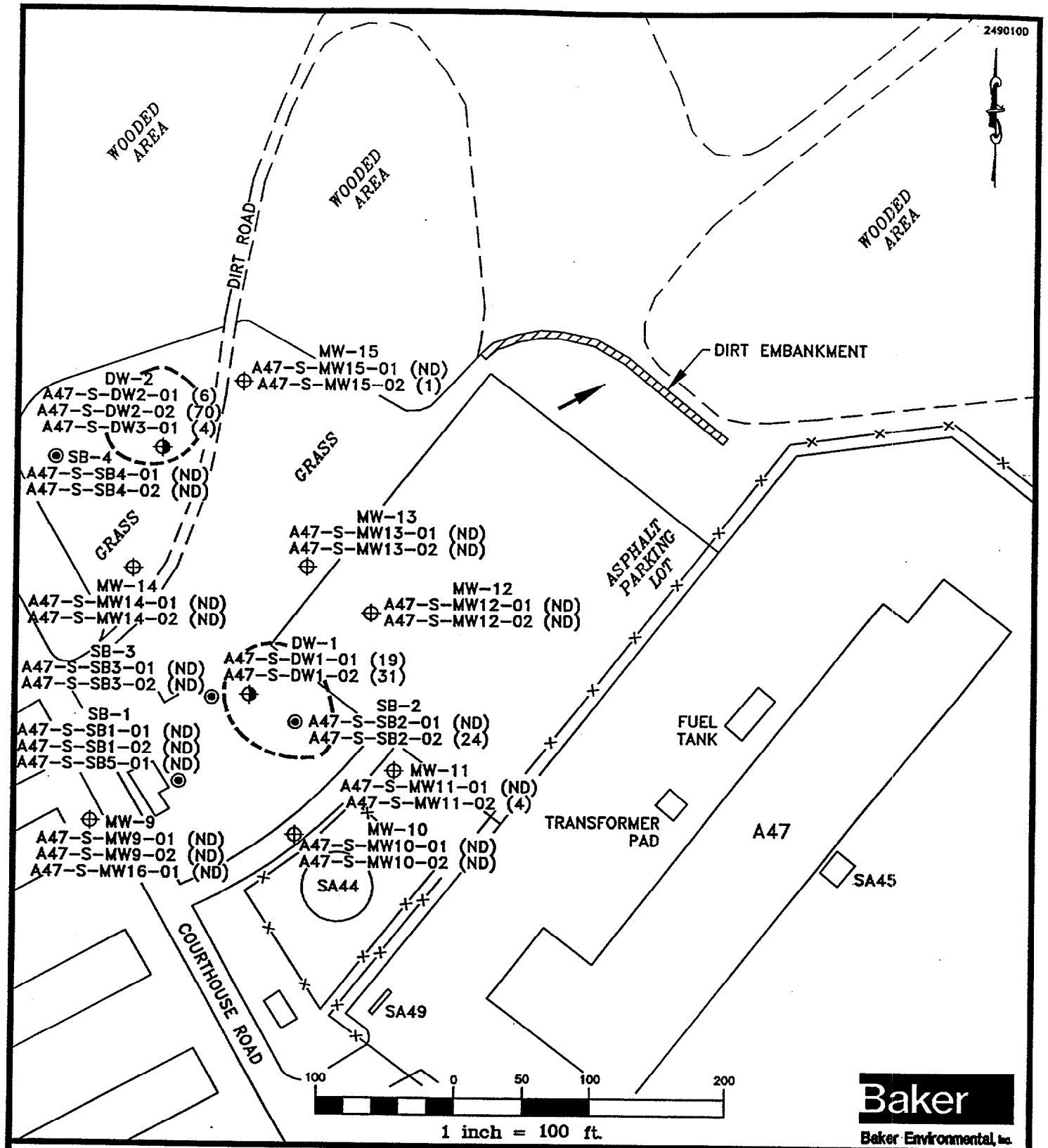
SB-1 SOIL BORING INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992

HP-3 HYDROPUNCH PENETROMETER INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-12
PLAN OF SAMPLE LOCATIONS (BAKER, 1992)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



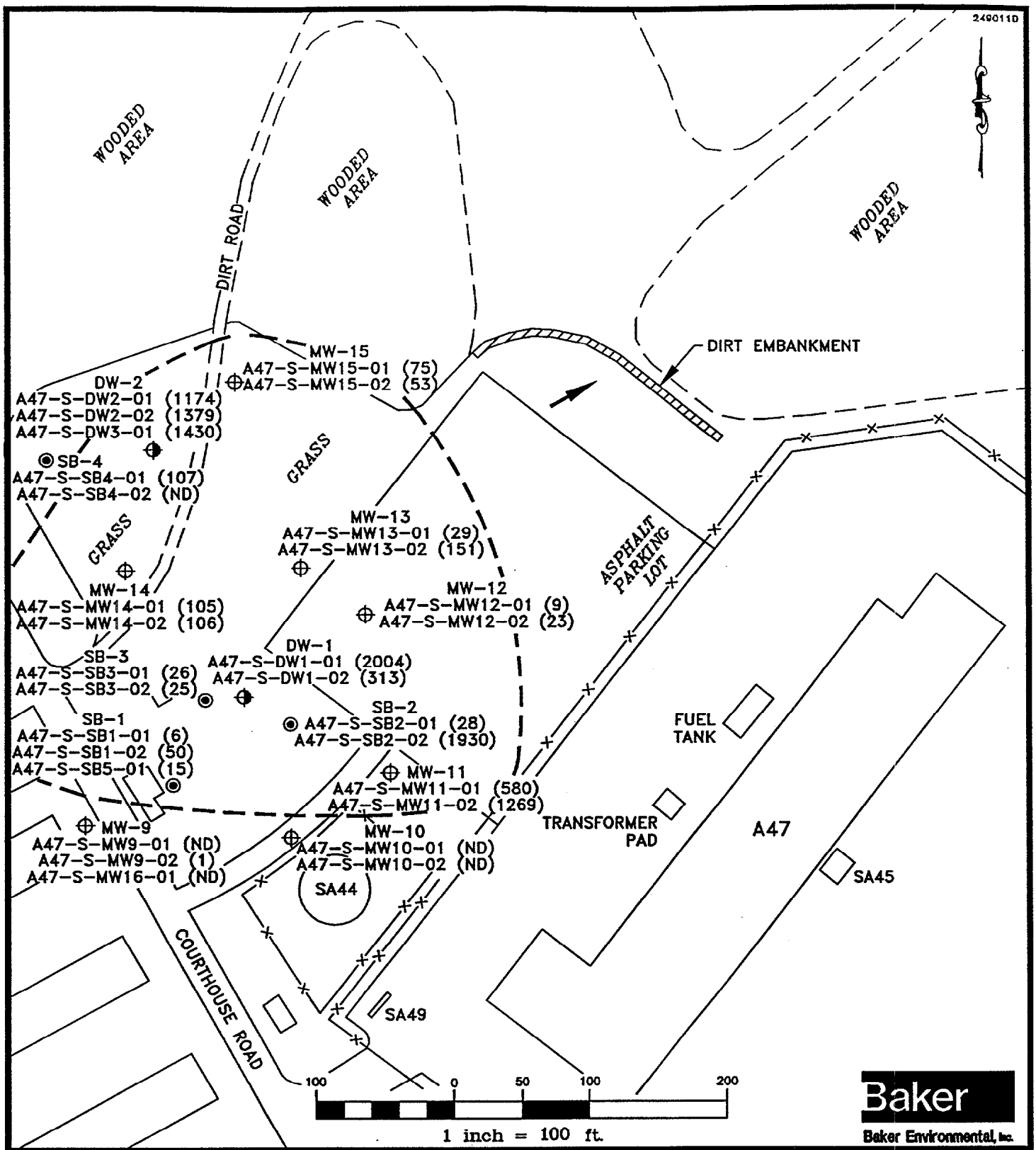
LEGEND

- MW-9 — SOIL BORING FOR SHALLOW GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- DW-1 — SOIL BORING FOR DEEP GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- SB-1 — SOIL BORING INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- A47-S-MW9-01 (ND) — SOIL SAMPLE NUMBER AND TPH CONCENTRATION IN mg/kg (ppm)
- ND — NOT DETECTED AT METHOD DETECTION LIMITS
- ESTIMATED GROUNDWATER FLOW DIRECTION
- ESTIMATED EXTENT OF TPH CONTAMINATION (>10.0 mg/kg)

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-13
TPH (LOW-MED) CONCENTRATIONS IN SOILS (BAKER, 1992)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



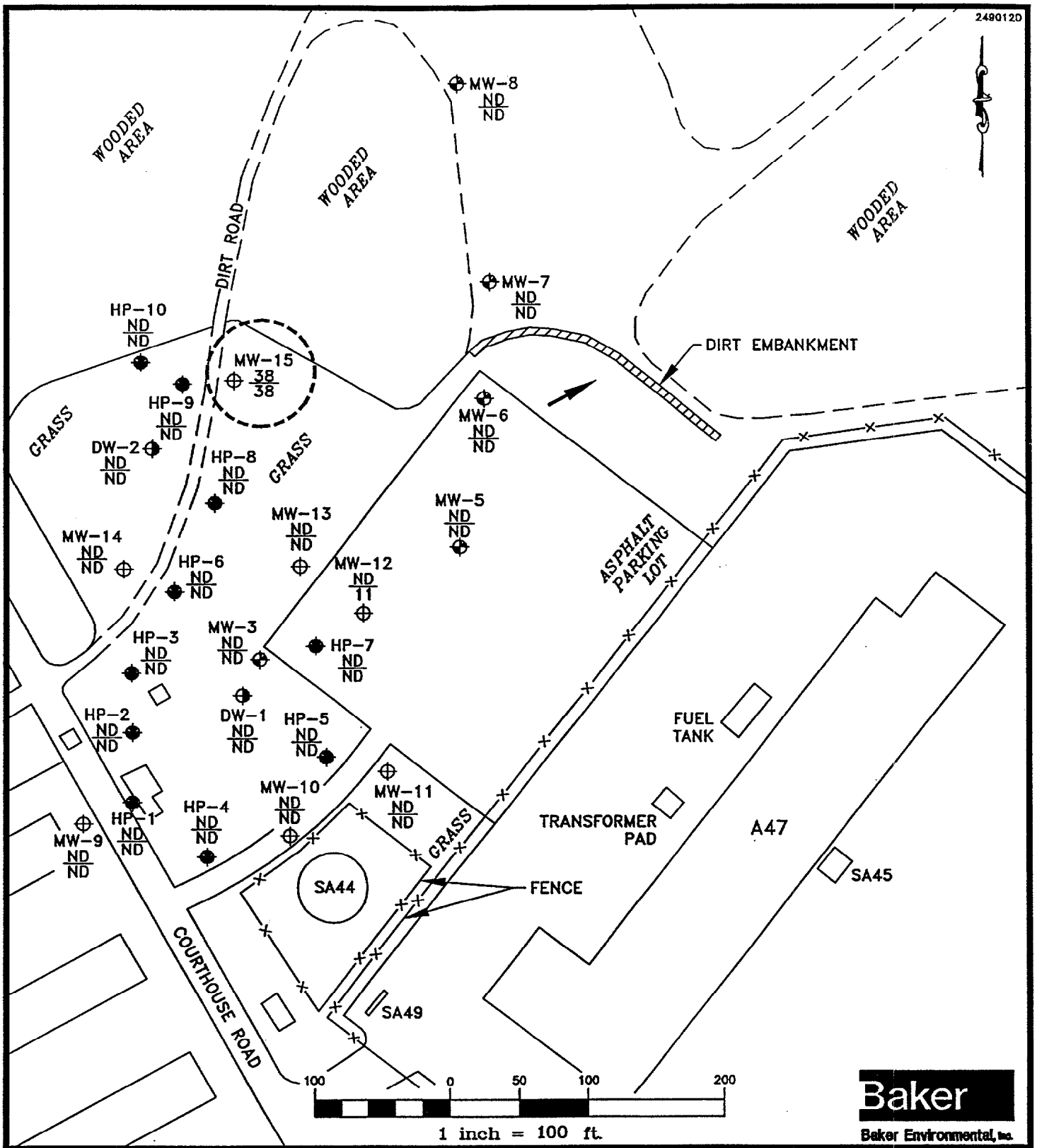
LEGEND

- MW-9 ⊕ SOIL BORING FOR SHALLOW GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- DW-1 ⊕ SOIL BORING FOR DEEP GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- SB-1 ◉ SOIL BORING INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- A47-S-MW9-01 (ND) SOIL SAMPLE NUMBER AND TPH CONCENTRATION IN mg/kg (ppm)
- ND NOT DETECTED AT METHOD DETECTION LIMITS
- ESTIMATED GROUNDWATER FLOW DIRECTION
- ESTIMATED EXTENT OF TPH CONTAMINATION (>10.0 mg/kg)

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-14
TPH (MED-HIGH) CONCENTRATIONS IN SOILS (BAKER, 1992)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



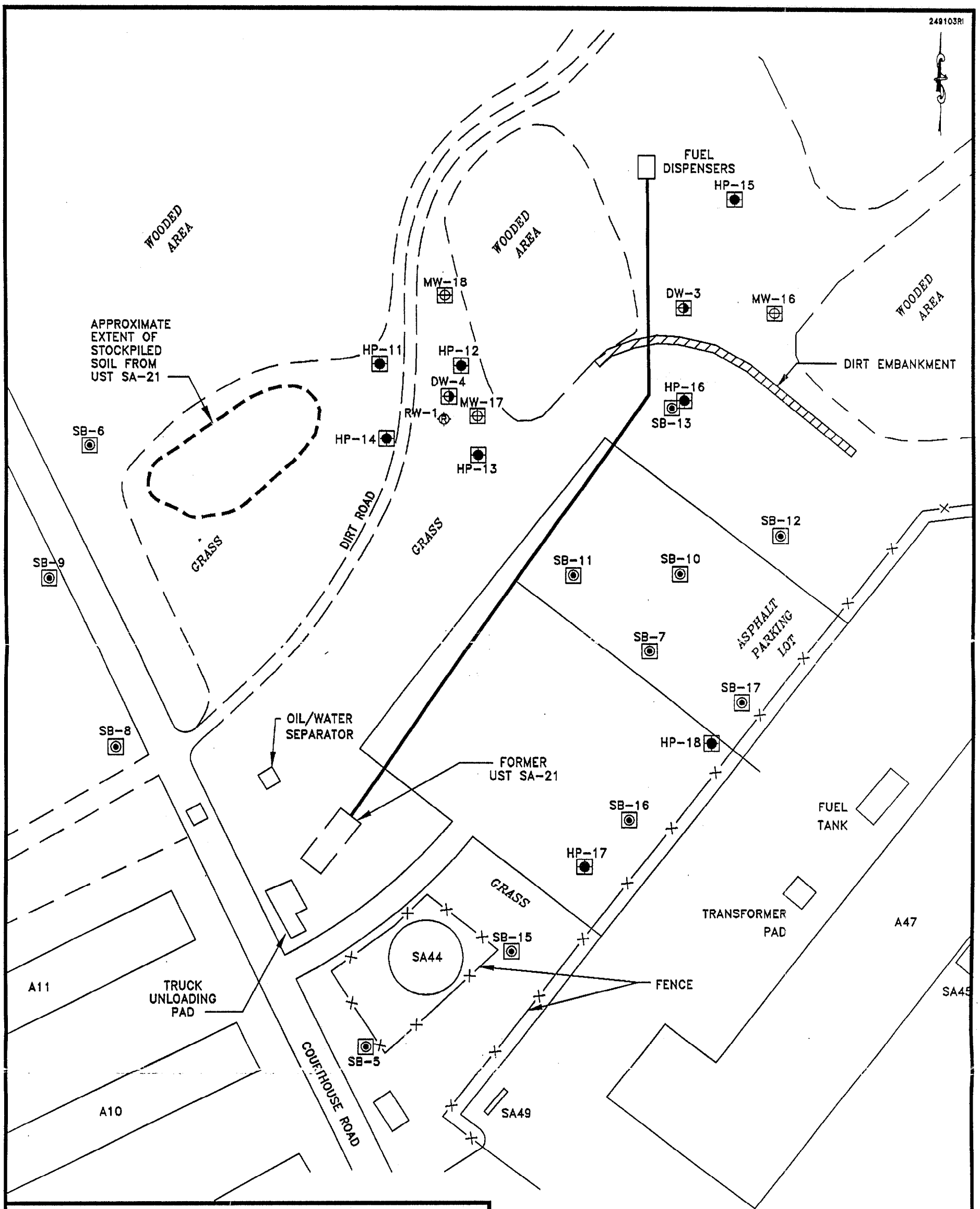
LEGEND

- MW-1 — EXISTING TYPE II GROUNDWATER MONITORING WELL INSTALLED BY ATEC ASSOC., AUGUST 1991
- MW-9 — SHALLOW TYPE II GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- DW-1 — DEEP TYPE III GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- HP-3 — HYDROPUNCH PENETROMETER INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- 32/38 — BENZENE CONCENTRATION IN ug/l (ppb) / TOTAL VOC CONCENTRATION IN ug/l (ppb)
- ND — NOT DETECTED AT METHOD DETECTION LIMITS
- ESTIMATED GROUNDWATER FLOW DIRECTION
- ESTIMATED EXTENT OF BENZENE CONTAMINATION (> 5.0 ug/l)

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-15
BENZENE AND TOTAL VOC CONCENTRATIONS IN GROUNDWATER (BAKER, 1992)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

MW-16 SHALLOW TYPE II GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993

DW-3 DEEP TYPE III GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993

HP-11 HYDROPUNCH INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993

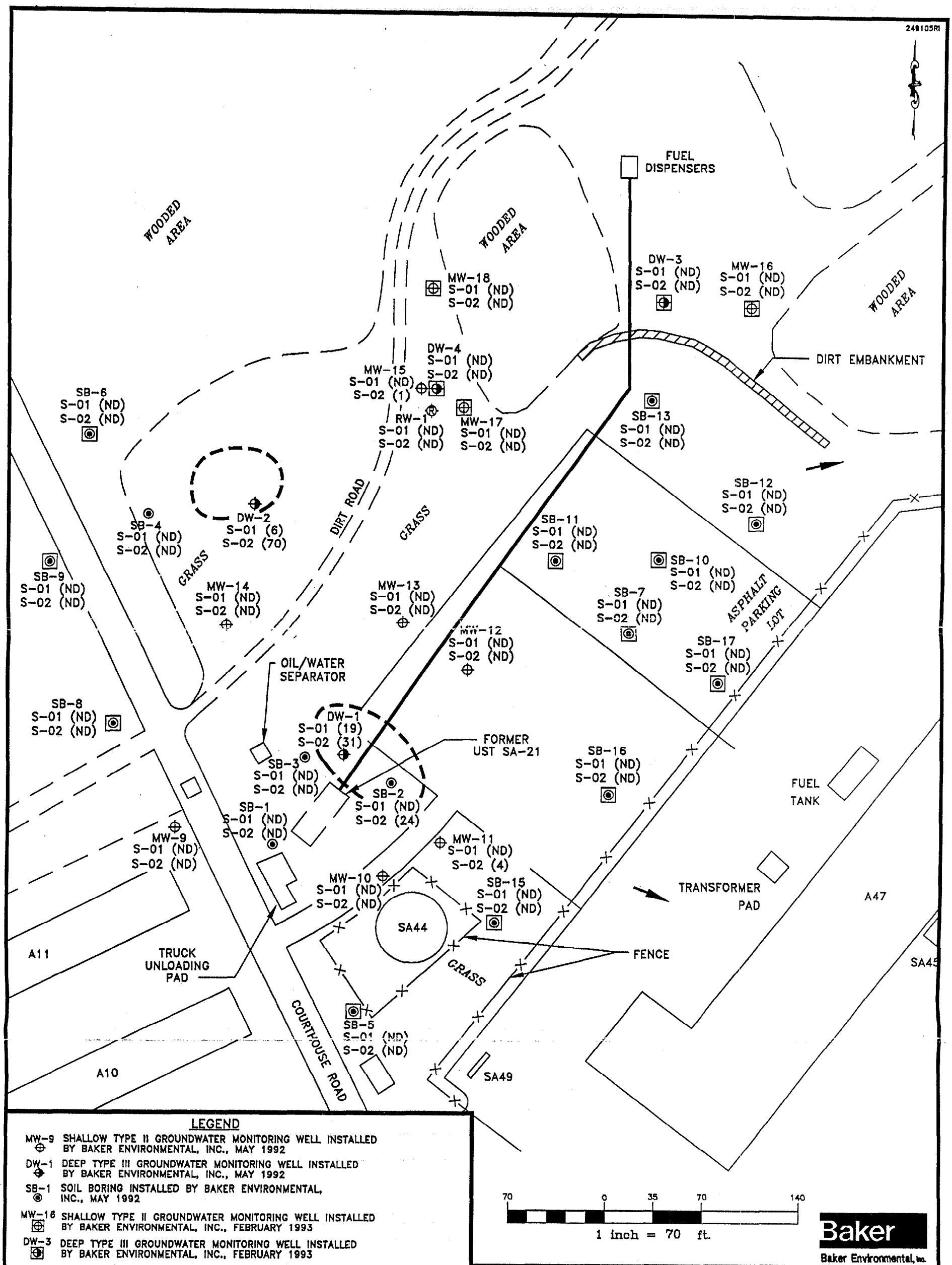
RW-1 RECOVERY/PUMPING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993

SB-5 SOIL BORING INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-16
PLAN OF SAMPLE LOCATIONS (BAKER, 1993)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- MW-9 — SHALLOW TYPE II GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- DW-1 — DEEP TYPE III GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- SB-1 — SOIL BORING INSTALLED BY BAKER ENVIRONMENTAL, INC., MAY 1992
- MW-16 — SHALLOW TYPE II GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993
- DW-3 — DEEP TYPE III GROUNDWATER MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993
- RW-1 — RECOVERY/PUMPING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993
- SB-5 — SOIL BORING INSTALLED BY BAKER ENVIRONMENTAL, INC., FEBRUARY 1993
- S-01 (ND) — SOIL SAMPLE NUMBER AND TPH CONCENTRATION IN mg/kg (ppm)
- ND — NOT DETECTED AT METHOD DETECTION LIMITS
- ESTIMATED GROUNDWATER FLOW DIRECTION
- ESTIMATED EXTENT OF TPH CONTAMINATION (>10.0 mg/kg)

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-17
TPH (LOW-MED) CONCENTRATIONS
IN SOILS (BAKER, 1993)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA
MARINE CORP BASE, CAMP LEJEUNE
NORTH CAROLINA

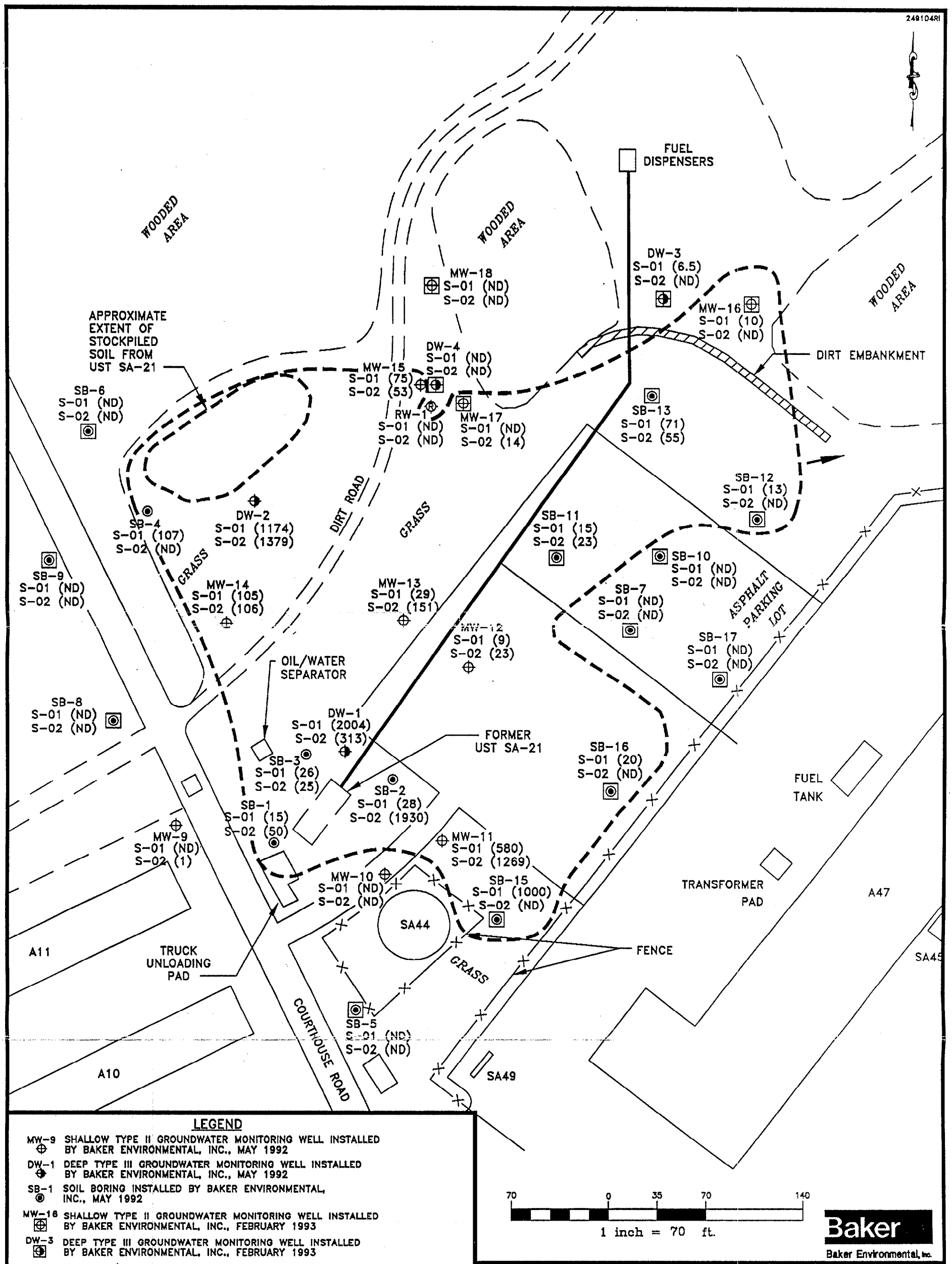
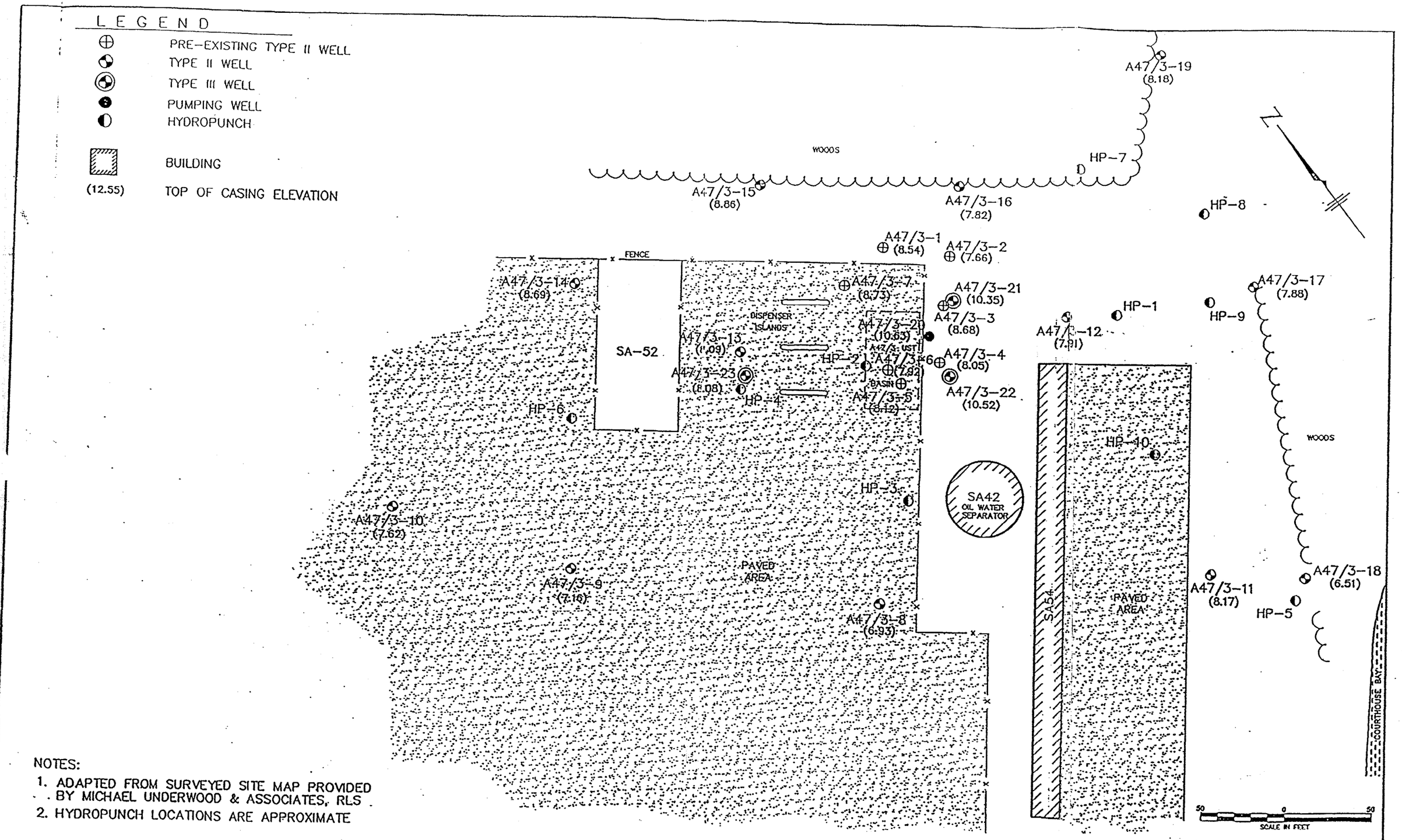


FIGURE 2-18
TPH (MED-HIGH) CONCENTRATIONS
IN SOILS (BAKER, 1993)
UST SYSTEM SA-21
AMPHIBIOUS VEHICLE MAINTENANCE AREA
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



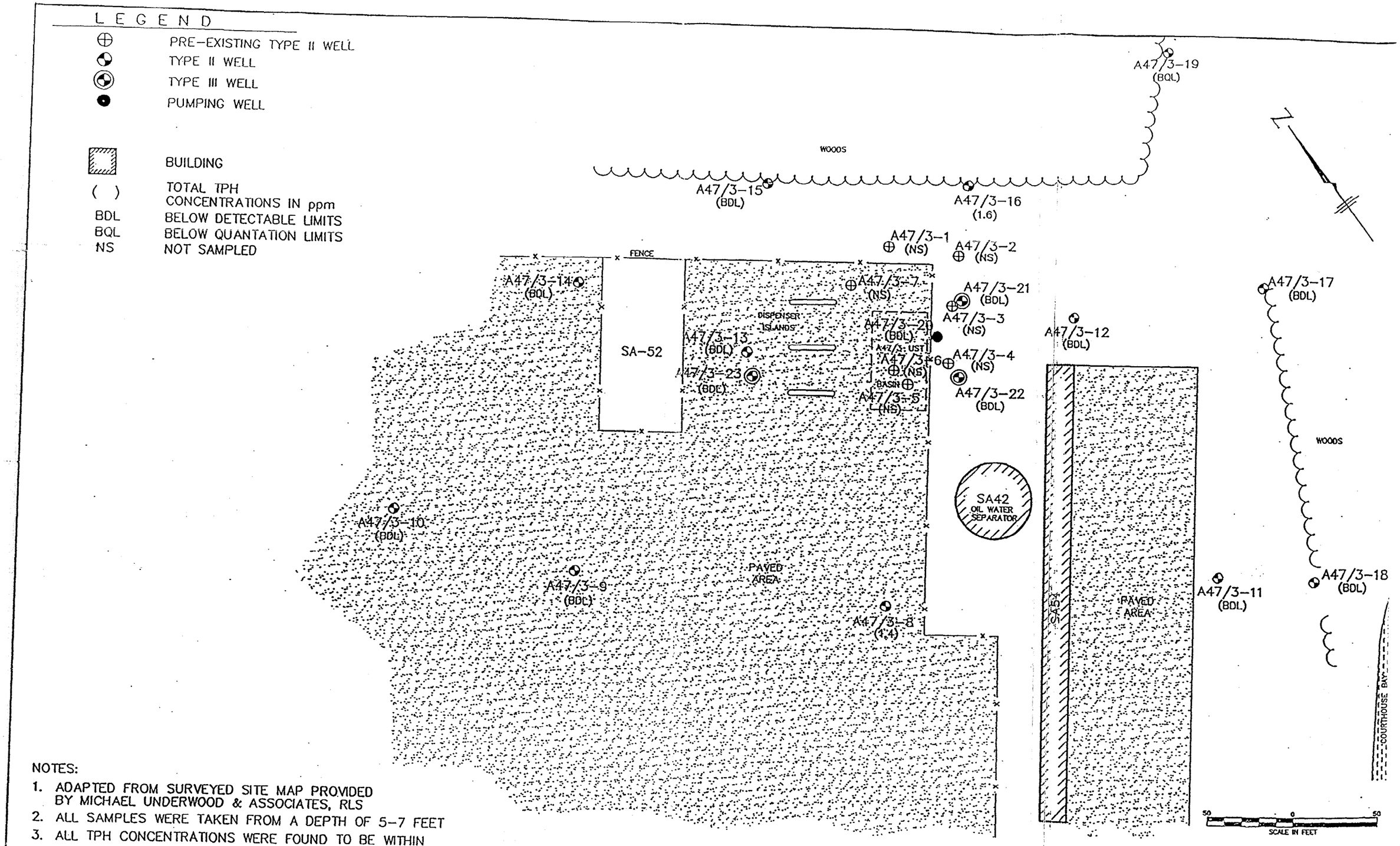
NOTES:

1. ADAPTED FROM SURVEYED SITE MAP PROVIDED BY MICHAEL UNDERWOOD & ASSOCIATES, RLS
2. HYDROPUNCH LOCATIONS ARE APPROXIMATE

SOURCE: RICHARD CATLIN & ASSOCIATES, DECEMBER 1993

Baker
Baker Environmental, Inc.

FIGURE 2-19
SITE MAP AND SAMPLE LOCATIONS PLAN
UST A-47/3
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:

1. ADAPTED FROM SURVEYED SITE MAP PROVIDED BY MICHAEL UNDERWOOD & ASSOCIATES, RLS
2. ALL SAMPLES WERE TAKEN FROM A DEPTH OF 5-7 FEET
3. ALL TPH CONCENTRATIONS WERE FOUND TO BE WITHIN STATE STANDARDS, THEREFORE WERE NOT CONTOURED.

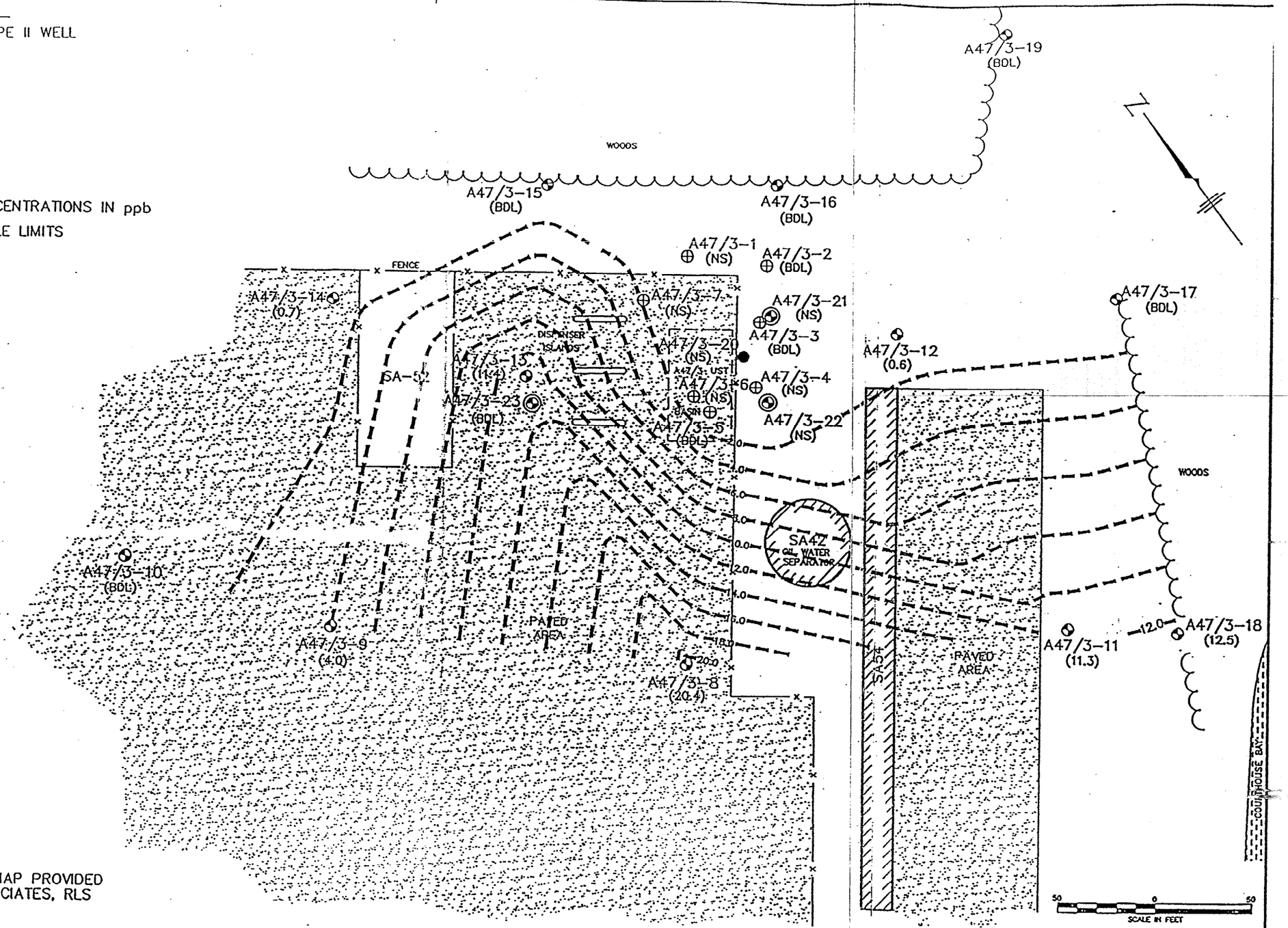
SOURCE: RICHARD CATLIN & ASSOCIATES, DECEMBER 1993

Baker
Baker Environmental, Inc.

FIGURE 2-20
TPH CONCENTRATIONS - SOIL
UST A-47/3
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

LEGEND

- PRE-EXISTING TYPE II WELL
- TYPE II WELL
- TYPE III WELL
- PUMPING WELL
- BUILDING
- ( ) TOTAL BTEX CONCENTRATIONS IN ppb
- BDL BELOW DETECTABLE LIMITS
- NS NOT SAMPLED



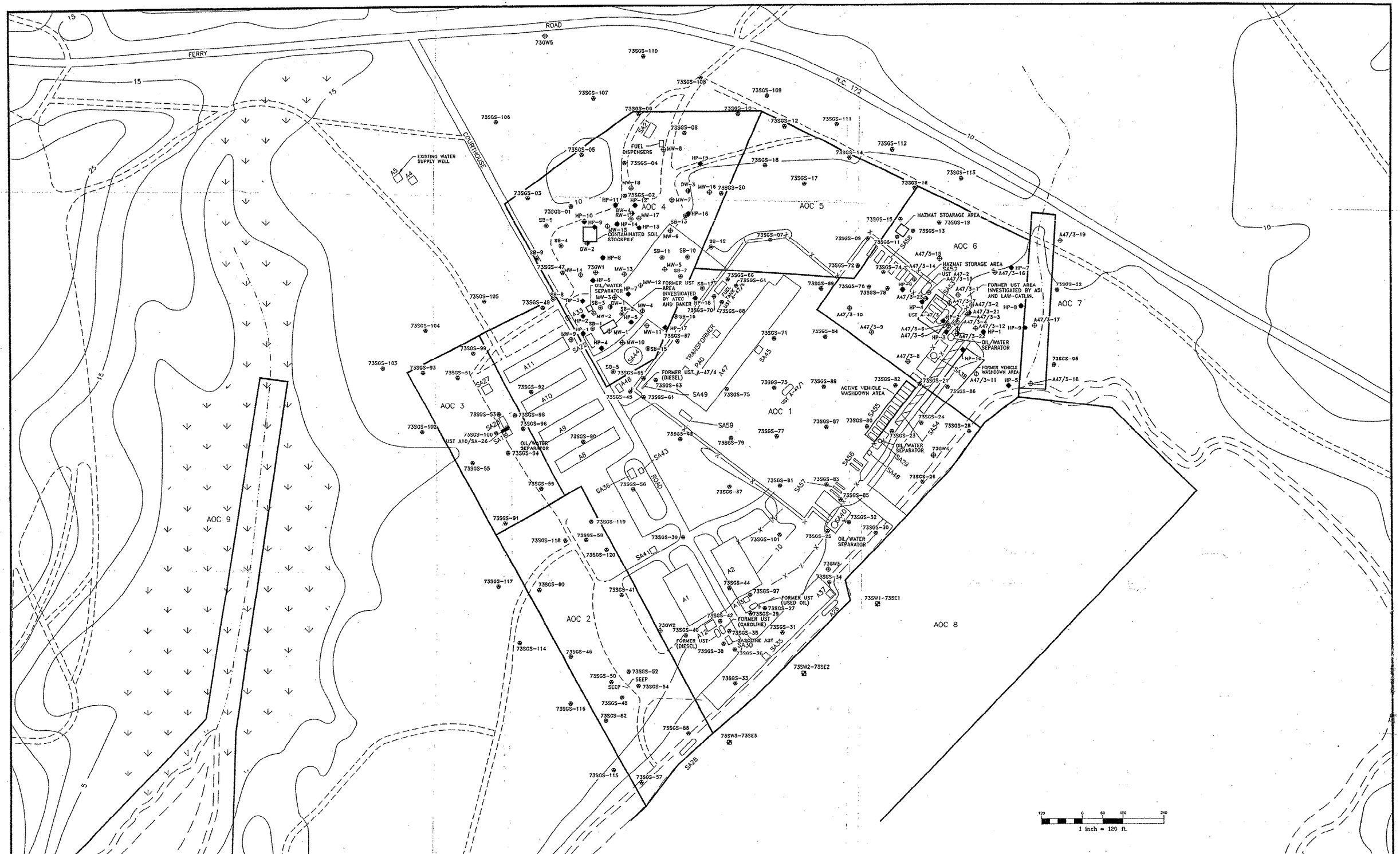
NOTES:

1. ADAPTED FROM SURVEYED SITE MAP PROVIDED BY MICHAEL UNDERWOOD & ASSOCIATES, RLS
2. CONTOUR INTERVAL = 2 ppb

SOURCE: RICHARD CATLIN & ASSOCIATES, DECEMBER 1993

Baker
Baker Environmental, Inc.

FIGURE 2-21
TOTAL BTEX
CONCENTRATIONS – WATER
UST A-47/3
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- EXISTING SHALLOW MONITORING WELL LOCATION
- EXISTING DEEP MONITORING WELL LOCATION
- EXISTING SURFACE WATER/SEDIMENT SAMPLE LOCATION
- EXISTING HYDROPUNCH SAMPLE LOCATION
- EXISTING SOIL BORING LOCATION
- SOIL GAS AND GROUNDWATER SAMPLE SCREENING LOCATIONS, BAKER 1994

DATE	NOVEMBER 1994
SCALE	1"=120'
DRAWN	REL
REVIEWED	DLB

NORTH

SITE 73
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL Inc.

Baker
Baker Environmental, Inc.

EXISTING SAMPLING LOCATIONS
OPERABLE UNIT No.9 (SITE 73)

FIGURE No.
2-24

3.0 DATA QUALITY AND SAMPLING OBJECTIVES

3.0 DATA QUALITY AND SAMPLING OBJECTIVES

The purpose of this section is to define the site-specific RI/FS data quality and sampling objectives in order to fulfill the overall goals of characterizing the problems at each site, assessing potential impacts to the public health and environment, and identifying feasible remedial alternatives for remediating the sites, if necessary. The site-specific RI/FS objectives presented in this section have been identified based on review and evaluation of existing background information.

3.1 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that ensure data of known and appropriate quality are obtained during the RI/FS. The DQOs associated with each field sampling and analysis program are discussed and presented in this section. The DQOs were developed using the following three stages:

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

Stage 1 of the DQO process takes place during the scoping of the RI/FS. This stage involves the evaluation of existing information and the development of objectives for field data collection efforts.

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

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

3.1.1 Stage 1 - Identification of Decision Types

As part of the Stage 1 DQO process, available information from previous site investigations and other sources (e.g., USGS) were reviewed in order to describe current site conditions, evaluate existing data, and assess the adequacy of the data. This was documented in Section 2.0 of this Work Plan. From this review and evaluation, RI/FS objectives have been developed to (1) assess the nature of the threat posed by the release or potential release of hazardous substances; (2) characterize the site with respect to the environmental setting; and (3) evaluate potential remedial alternatives. These objectives are presented in Section 3.2.

3.1.2 Stage 2 - Identification of Data Uses/Needs

In Stage 2 of the DQO process, the data quality and quantity required to support the RI/FS objectives developed during Stage 1 are identified. With respect to the RI/FS objectives, data will be required to address specific environmental media at each site. Data uses for each environmental media are presented in Section 3.1.2.1. Site-specific data needs are discussed in Section 3.1.2.2.

3.1.2.1 Data Uses for Environmental Media

RI/FS data uses can be described in general purpose categories. These categories include the following:

- Site Characterization - Data are used to determine the nature and extent of contamination at a site. Site characterization data are generated through the sampling and analysis of waste sources and environmental media.

- Health and Safety - Data are typically used to establish the level of protection needed for investigators or workers at a site, and if there should be an immediate concern for the population living within the site vicinity.

- Risk Assessment - Data are used to evaluate the threat posed by a site to public health and the environment. Risk assessment data are generated through the sampling and analysis of environmental and biological media, particularly where the potential for human or ecological exposure is great (e.g., sediments, surface soil, potable groundwater supplies).

- Evaluation of Alternatives - Data are used to evaluate various remedial technologies. Engineering data are collected in support of remedial alternative evaluation and to develop cost estimates for remediating the site. This may involve conducting bench or pilot-scale studies to determine the effectiveness or implementability of the technology.

- Engineering Design of Alternatives - Data collected during the RI/FS can be used for engineering purposes to develop a preliminary data base in reference to the performance of various remedial technologies. Data types collected during the RI/FS which are applicable to the remedial design (RD) process include waste characterization and preliminary volume estimates (these estimates can be further defined during the remedial design/remedial action via additional field verification sampling).

The above discussion of data uses was extracted from the document entitled Data Quality Objectives for Remedial Response Activities: Development Process (OSWER Directive 9355.0-7B). It has been presented in this Work Plan to provide the user with an understanding of the rationale for determining the site-specific RI/FS objectives as well as the rationale for the proposed sampling and analytical program for each site investigation.

With respect to the above data uses, an understanding of the site background, site history, and contaminant migration and exposure pathways are required in order to define the data needs (or data limitations). This "background" information was presented in Section 2.0 for each site. The site-specific data needs are presented in Section 3.1.2.2. RI/FS objectives, which have been formed to meet the data needs, are presented in Section 3.2.

3.1.2.2 Site-Specific Data Needs

Site 65 - Engineer Dump Area

- Determine the physical and chemical characteristics of surface and subsurface soil within the boundaries of Site 65, in the area downgradient of Site 65, in the adjacent heavy equipment training area, and in an upgradient location. This data is needed to determine the nature and extent of contamination (if any) in soil and to support a human health and ecological risk assessment and evaluation of remedial alternatives.

- Determine the extent of PCB contamination in the vicinity of existing soil boring 65SB02 where, during the SI, PCBs (230 ppb of Arochlor-1254) were detected at 12 to 14 feet bgs.

- Determine the physical composition and chemical characteristics of the various piles of earth and debris located within the Site 65 boundary. This data is needed to afford an evaluation of the debris piles as a potential source of contamination, to support a human health and ecological risk assessment, and evaluation of remedial alternatives.

- Obtain surface water, sediment, fish and benthic samples from the surface water bodies (i.e., ponds, marsh, and intermittent stream) located east of the site. This data is needed primarily to support a human health and ecological risk assessment as well as to afford an evaluation of the presence or absence of contamination in these media.

- Obtain additional data regarding the presence or absence of contamination in shallow (i.e., at the water table surface) groundwater downgradient (south) of Site 65 and west of existing shallow monitoring well 65MW02A. A shallow monitoring well in this area is needed to add confidence that the downgradient perimeter of Site 65 has been sufficiently investigated.

- Obtain shallow groundwater data from the area east of Site 65 and west of the surface ponds. This data is needed to evaluate the environmental impact of ongoing activities at the heavy equipment training area. If contamination is identified in the surface water bodies west of Site 65, this data will be used to evaluate whether the source is Site 65 or the heavy equipment training area.

- Obtain shallow groundwater data from an upgradient location to provide for a comparison to data obtained from other locations potentially impacted by Site 65.

- Determine the chemical characteristics of the groundwater zone situated below shallow (water table surface) groundwater at three locations across the site including near the center of the suspected Site 65 disposal area, and downgradient and upgradient of Site 65. This data is needed to confirm the presence or absence of the vertical migration of contaminants from the shallow zone to a deeper zone.

Ideally the deeper zone to be investigated should correspond to the upper-most screened intervals of the nearest water supply wells. Data from this zone will also be used to support a human health risk assessment since supply water is drawn from this zone from nearby wells for human consumption.

Site 73 - Courthouse Bay Liquids Disposal Area

- Determine the source and nature and extent of apparent fuel and solvent contamination identified in AOC #1 during the preliminary investigation between Building A47 and Courthouse Bay.

- Characterize the nature and extent of soil and groundwater contamination at six UST locations within AOC #1. The six UST locations include five former locations where the USTs have either been removed or filled with sand and one active UST location. The active UST (diesel) is located north of Building A-47 (UST A-47/5). The five former USTs include two (one diesel and one gasoline) immediately south of Building A1 (UST A-12-1 and A-12-2), one (used oil) south of Building A2 (UST A-2), one (diesel) northwest of Building A47 (UST A-47/4) and one (unknown contents) south of Building A-47 (UST A-47/1). If contamination in these areas is confirmed, determine its extent via additional soil borings/monitoring wells and the results of the preliminary investigation.

- Determine the presence or absence of fuel contamination at other potential sources within AOC #1 including oil/water separators SA-40 and SA-29, the active vehicle washdown area SA-35, and oil/water separator located within the adjacent AOC #5.

- Determine the chemical characteristics of the brownish-colored seeps observed in AOC #2 along with the shallow groundwater in the immediate vicinity.

- Characterize the nature and extent of soil and shallow groundwater contamination in the vicinity of UST A10/SA-26 located within AOC #3.

- Define the nature and extent of fuel contamination within AOC #5, the area of suspected former POL and waste battery acid disposal.

- Confirm the presence or absence of apparent solvent contamination identified in the northern-most portion of AOC #4 during the preliminary investigation.

- Determine the physical and chemical characteristics of surface and subsurface soil and shallow groundwater from an upgradient location to provide for a comparison to data obtained from impacted areas at Site 73.

- Determine the chemical characteristics of the groundwater zone situated below the shallow (water table surface) zone across the site. This data is needed to confirm the presence or absence of the vertical migration of contaminants from the shallow zone to a deeper zone. Ideally the deeper zone to be investigated should correspond to the upper-most screened interval of the nearby existing water supply well (A5).

Data from this zone will also be used to support a human health risk assessment since supply water is typically drawn from this zone for human consumption.

- Obtain surface water, sediment, fish, crab, and benthic samples from the surface water bodies nearest Site 73 (AOC #7, 8, and 9). This data is needed primarily to support a human health and ecological risk assessment as well as to afford an evaluation of the presence or absence of contamination in these media.

The type and quality of data required to meet the criteria listed above are presented in Section 4.0. The data quality levels differ with respect to the end use of the data. Level IV data quality are generally required in risk assessments, characterizing the nature and extent of contamination, and to support subsequent investigations. Level III data quality is appropriate for risk assessments, site characterization, and evaluating treatment alternatives. Level II data quality is appropriate for field screening. Level I data is appropriate for field measurements such as static water level, specific conductance, and pH. The analytical methods also differ with respect to the end use of the data. For this RI/FS, USEPA methods and Contract Laboratory Program (CLP) methods will be used when applicable.

3.1.3 Stage 3 - Design Data Collection Program

The data collection programs for Sites 65 and 73 have been designed to meet the objectives outlined in the following sections. Section 4.0 of the RI/FS Work Plan provides a general description of the various sampling programs for the four sites. Sections 3.0 through 5.0 of the FSAP provide the specific details of these sampling programs.

3.2 Study Objectives

For each site, specific study objectives, the criteria necessary to meet each objective, and a brief description of the proposed study or investigation required to obtain the information is presented in Table 3-1.

SECTION 3.0 TABLES

TABLE 3-1

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 9
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 65 - Soil	1a. Assess the extent of soil contamination in the former dump area, the area near the ponds and the area presently used for heavy equipment training.	Characterize contaminant levels in surface and subsurface soils at the former dump area, the area near the ponds, and the heavy equipment training area.	Drill soil borings and obtain surface and subsurface soil samples
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface and subsurface soils at the site.	Conduct human health and ecological risk assessment
	1c. Determine the composition and chemical nature of debris piles located throughout the site.	Observe the internal materials comprising the debris piles and obtain soil samples.	Excavate test pits and obtain soil samples
	1d. Evaluate remedial alternatives.	Characterize areas of concern above action levels. Evaluate effectiveness and implementability of treatment technologies.	Analyze selected soil samples for engineering parameters. Evaluate alternatives under FS. Conduct treatability study, if needed.
Site 65 - Groundwater	2a. Determine whether soil contamination is migrating to groundwater.	Characterize shallow groundwater quality across the site.	Install shallow groundwater wells.
	2b. Assess the extent of shallow and intermediate zone groundwater contamination across the site.	Determine the horizontal and vertical extent of shallow groundwater contamination; determine if shallow contamination has migrated vertically to a lower zone.	Install shallow and intermediate zone groundwater wells.
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow and intermediate aquifers (flow direction, transmissivity, permeability, etc.).	Perform field aquifer tests.
	2d. Assess health risks posed by potential future usage of the shallow and intermediate zone groundwater.	Evaluate groundwater quality and compare to ARARs and health-based action levels.	Conduct human health risk assessment.

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 9
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Site 65 - Sediment	3a. Assess human health and ecological risks associated with exposure to sediments in the unnamed creek and ponds.	Characterize nature and extent of contamination in sediment.	Obtain sediment samples from the unnamed creek and ponds. Conduct a risk assessment.
	3b. Assess potential ecological impacts posed by contaminated sediments in the unnamed creek and ponds.	Qualitatively evaluate stress to benthic and fish communities.	Obtain fish and benthic samples from the unnamed creek and ponds. Conduct an ecological risk assessment.
4. Site 65 - Surface Water	4a. Assess the presence or absence of surface water contamination in the unnamed creek and ponds.	Characterize surface water quality.	Obtain surface water samples from the unnamed creek and ponds.

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 9
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 73 - Soil	1a. Assess the extent of soil contamination at the Courthouse Bay Liquids Disposal Area, including all UST locations (former and present).	Characterize contaminant levels in surface and subsurface soils at the Courthouse Bay Liquids Disposal Area and UST locations.	Drill soil borings and obtain surface and subsurface soil samples.
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface and subsurface soils at the site.	Obtain surface soil samples. Conduct human health and ecological risk assessment.
	1c. Evaluate treatment alternatives.	Characterize areas of concern above action levels. Evaluate effectiveness and implementability of treatment technologies.	Analyze selected soil samples for engineering parameters. Evaluate alternatives under FS. Conduct treatability study, if needed.
2. Site 73 - Groundwater	2a. Determine whether contamination from soils is migrating to groundwater.	Characterize shallow groundwater quality in the area.	Install shallow groundwater wells.
	2b. Assess the extent of shallow and intermediate zone groundwater contamination across the site, and at each known UST location (former and current).	Determine the horizontal and vertical extent of shallow groundwater contamination; determine if shallow contamination has migrated vertically to a lower zone; determine the presence or absence of petroleum product or constituents in groundwater at each UST location.	Install shallow and intermediate zone groundwater wells.
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow and intermediate aquifers (flow direction, transmissivity, permeability, etc.).	Perform field aquifer tests.
	2d. Assess health risks posed by potential future usage of the shallow and intermediate zone groundwater.	Evaluate groundwater quality and compare to ARARs and health-based action levels.	Conduct human health risk assessment.

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 9
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Site 73 - Sediment	3a. Assess human health and ecological risks associated with exposure to sediments in the unnamed creeks and Courthouse Bay.	Characterize nature and extent of contamination in sediment.	Obtain sediment samples from unnamed creeks and Courthouse Bay. Conduct a risk assessment.
	3b. Assess potential ecological impacts posed by contaminated sediments in the unnamed creeks and Courthouse Bay.	Qualitatively evaluate stress to benthic, crab, and fish communities.	Obtain fish, crab, and benthic samples from the unnamed creeks and Courthouse Bay. Conduct an ecological risk assessment.
4. Site 73 - Surface Water	4a. Assess the presence or absence of surface water contamination in the unnamed creeks and Courthouse Bay.	Characterize surface water quality.	Obtain surface water samples from the unnamed creeks and Courthouse Bay

4.0 REMEDIAL INVESTIGATION / FEASIBILITY STUDY TASKS

4.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section identifies the tasks and field investigations required to complete RI/FS activities at Sites 65 and 73.

4.1 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, personnel resources planning and allocation, preparation of monthly progress reports, and communication with LANTDIV and the Activity.

4.2 Task 2 - Subcontract Procurement

Task 2 involves the procurement of services such as drilling, IDW removal, surveying, laboratory analysis, data validation, and data management. Procurement of these services will be performed in accordance with the Navy Clean Contract Procurement Manual.

4.3 Task 3 - Record Search and Literature Review

Task 3 will involve conducting record searches and literature reviews of site-related information. This task also involves conducting interviews with Base or government personnel. Information gathered during this task will be used for preparing the RI and FS reports

4.4 Task 4 - Field Investigations

The field investigations will be conducted under Task 4. An overview of the field investigations to be conducted at each of the sites is presented in the following subsections. Specific details with respect to the sampling procedures, locations and number of samples, and analytical methods are provided in the FSAP and the Quality Assurance Project Plan (QAPP). The field investigations described below will provide data to meet the overall RI/FS objectives presented in Section 3.0 of this RI/FS Work Plan. Table 4-1 summarizes the sampling and analytical requirements, as well as the data quality levels.

4.4.1 Site 65 - Engineer Dump Area

The following investigations and support activities will be conducted at Site 65.

- Surveying
- Soil Investigation (including trench excavations)
- Groundwater Investigation
- Ecological Investigation (including surface water, sediment, fish, and benthic sampling)

Each activity and investigation is described in the following subsections.

4.4.1.1 Surveying

This activity will involve the surveying of the current site features including roads, surface water bodies such as ponds and marshes and any significant features which were noted during the site visit. The locations of proposed soil borings, monitoring wells, surface water and sediment sample stations and trench excavations will be established by the survey subcontractor prior to commencing the field program. Each location will be marked with a stake allowing the field teams to identify the location and the corresponding designation for each activity. Ground surface elevations and the horizontal control of each sampling location will be established.

Following the completion of the field program, all existing and newly installed monitoring wells, staff gauges, the trench excavations and any sample locations that were relocated during the field program will be surveyed. A reference point on the top of the PVC riser, and the ground elevation will be surveyed for each monitoring well. The vertical elevation and horizontal control for the staff gauges, and the horizontal control of the trench excavations will also be established.

Survey points will include a latitude coordinate, a longitude coordinate, and an elevation expressed in feet of mean sea level. The vertical accuracy of the survey will be within 0.01 feet and the horizontal accuracy will be within 0.1 feet. All survey points will be referenced to the North Carolina State Plane Coordinate System (NCSPCS).

4.4.1.2 Soil Investigation

A soil investigation will be conducted at Site 65 to provide surface and subsurface soil data to evaluate areas of concern identified by the preliminary investigation, determine the nature and extent of soil contamination at the site, support a baseline human health and ecological risk assessment and evaluate remedial action alternatives. The following subsections describe the tasks proposed for the field program.

4.4.1.2.1 Sampling Locations

The soil investigation involves the drilling of 13 soil borings and the excavation of seven test pits. Seven of the borings will be completed as shallow and deep groundwater monitoring wells. These are discussed in Section 4.4.1.3 of this Work Plan.

The locations of the proposed soil borings are depicted on Figure 4-1. Three proposed soil borings (65SB06, 07, and 08) are located in the vicinity of existing soil boring 65SB02 where PCBs (Aroclor-1254) was detected at 230 μg/kg in a subsurface soil obtained during the SI from a depth of 12 to 14 feet bgs. Groundwater was reportedly encountered at a depth of 12.9 feet in boring 65SB02, at 6.9 feet bgs in boring 65SB01 located approximately 100 feet to the southeast, and at 10.9 feet bgs in monitoring well 65MW01A located approximately 100 feet to the northwest. Consequently, the proposed soil borings will be drilled to a depth of 14 feet bgs and continuously sampled even if groundwater is encountered at a shallower depth. Three unsaturated soil samples will be obtained from each of these proposed soil borings including one from the surface (0 to 12 inches), one from the interval 12 to 14 feet bgs, and a third based on visual observations and field screening performed via photoionization detector.

The remaining proposed soil borings (65SB09, 10, and 11) are located in the area between Site 65 and the two surface ponds. Borings 65SB09 and 10 are located directly within the heavy equipment

training area. This area is used to train operators of large earth-moving equipment (i.e., bulldozers, scrapers) and is regularly disturbed. Baker observed the ground surface in this area to be four to six feet below the surrounding grade. The purpose of the two proposed borings in this area is to provide data regarding the presence or absence of soil contamination. This data will be used to evaluate the source of contamination (if encountered) in the surface water bodies located to the east. These borings will be drilled to the top of the groundwater surface, however, it is difficult to predict the thickness of the soil zone above the groundwater surface in this area. Three soil samples will be obtained from proposed borings 65SB09 and 10 if six feet or more of unsaturated soil is encountered. This includes one surface (0 to 12 inches) soil sample, one from the interval located just above the groundwater surface, and a third based on visual observations and field screening performed via photoionization detector. If less than six feet of unsaturated soil is encountered, only two soil samples will be collected including a surface soil sample and another soil sample from the interval located just above the groundwater surface.

Proposed soil boring 65SB11 will be located along a strip of undisturbed ground situated between the heavy equipment training and the surface ponds. Two or three soil samples will be obtained depending on the depth to the groundwater as described in the preceding paragraph. Similarly, two to three soil samples will be obtained from proposed shallow groundwater monitoring well borings 65MW04A, 05A, 06A, and 07A which are located in areas not previously investigated. No soil samples are needed from proposed intermediate groundwater monitoring well boring 65MW04B because this data will be obtained from the adjacent proposed shallow groundwater monitoring well boring 65MW04A.

Only surface soil samples will be obtained from proposed intermediate groundwater monitoring well borings 65MW01B and 65MW02B. These borings will be located adjacent to existing shallow groundwater monitoring wells (65MW01A and 65MW02A) from which subsurface soil samples were obtained under the SI, but surface soil samples were not.

In addition to the seven proposed soil borings, the soil investigation include seven proposed test pits. These are depicted on Figure 4-1. Each proposed test pit will be approximately 10 feet long and 10 feet deep or to the top of the water table (whichever is encountered first). Proposed test pits 65TP01 and 02 are located in the area between the approximate site boundary (as per the SI) and the approximate expanded site boundary (based on aerial photos). These test pits will provide data pertaining to the nature and characteristics of the subsurface soils in areas that were not investigated under the SI. The remaining proposed test pits 65TP03 through 07 are intended to provide data regarding the composition and chemical characteristics of the various piles of earth and debris located with the Site 65 boundary. A single composite soil sample will be obtained from each proposed test pit. If grossly contaminated soil is encountered in any of proposed test pits, an additional sample will be obtained to characterize and classify (i.e., hazardous/nonhazardous) the contamination.

Section 5.1 in the SAP discusses the procedures for the collection and preparation of the soil samples collected during drilling and trenching activities.

4.4.1.2.2 Analytical Requirements

Samples collected from the soil borings (including borings completed as monitoring wells) will be analyzed for full Target Compound List (TCL) organics and Target Analyte List (TAL) metals. A single composite sample of drill cuttings shall be obtained and analyzed in accordance with TCLP

and for RCRA hazardous waste characteristics in order to assess disposal options. One composite sample from SB06 will be analyzed for the following engineering parameters in addition to the previously stated analyses: total organic carbon (TOC), alkalinity, biological oxygen demand (BOD), redox potential (Eh), chemical oxygen demand (COD), microbial enumeration, nitrogen (TKN), total phosphorus, Atterberg Limits, and particle-size distribution.

All soil samples obtained from the proposed test pits will be analyzed for full TCL organics and TAL metals in accordance with Contract Laboratory Program (CLP) methods. In addition, each soil sample will be analyzed for TPH via EPA Methods 8015 and 3550/5030. If grossly contaminated soil is encountered within the test pits, a second sample will undergo analysis for full TCL organics, TAL metals, TPH, full toxic characteristic leaching procedure (TCLP) and RCRA hazardous waste characterization (i.e., corrosivity, reactability, ignitability, etc.).

4.4.1.3 Groundwater Investigation

A groundwater investigation will be conducted at Site 65 to characterize shallow and intermediate groundwater zones upgradient, directly beneath, and downgradient of the site. In addition, shallow groundwater will be characterized in the area located east of Site 65 and west of the nearby surface ponds. This area, for the most part, is used for training heavy equipment operators. The data will be used to determine the nature and extent of groundwater contamination, support a baseline human health and ecological risk assessment, and evaluate remedial alternatives.

4.4.1.3.1 Sampling Locations

For this investigation, three shallow (65MW04A, 65MW05A, 65MW06A, and 65MW07A) and three intermediate (65MW01B, 65MW02B, and 65MW04B) monitoring wells are proposed. The proposed wells will be installed northeast (upgradient [65MW04A and 65MW04B]) of the site, adjacent to or within the site boundaries (65MW01B, 65MW02B, and 65MW05A) and on the outer edges of the heavy equipment training area (65MW06A and 65MW07A). The locations of the proposed wells are illustrated on Figure 4-1.

The shallow monitoring wells (Type II well construction) will be installed to depths ranging from approximately 20 to 30 bgs. The well screens for the shallow wells will be 15 feet in length and will intercept the water table (approximately 8 feet bgs). The intermediate wells (Type III well construction) will be installed beneath the first semi-confining (i.e., subsurface soil zone exhibiting considerably lower hydraulic conductivity than the zone in which the water table surface is contained) unit approximately 60 to 70 feet bgs. If a semi-confining unit is not encountered, then a Type II well will be installed in the upper portion of the Castle Hayne Aquifer. The screen length of the intermediate monitoring wells will be 10 to 20 feet and will intercept the zone in which the nearby water supply wells are screened. Well construction details for the proposed shallow Type II and Type III monitoring wells are illustrated on Figures 5-1 and 5-2 in Section 5.0 of the FSAP. Well installation procedures and well construction materials are discussed in Section 5.2 of the FSAP.

4.4.1.3.2 Analytical Requirements

One round of groundwater samples will be collected from the three existing (65MW01A, 65MW02A, and 65MW03A) and seven newly installed monitoring wells (65MW01B, 65MW02B, 65MW04A, 65MW04B, 65MW05A, 65MW06A, and 65MW07A). Samples will be collected

approximately one week following the development of the newly installed wells. All samples will be analyzed for full TCL organics, TAL metals (total metals plus 5 percent of the samples for dissolved metals) and total suspended solids (TSS). In addition, a sample from one monitoring well (65MW07A) will be analyzed for TSS, total dissolved solids (TDS), BOD, COD, TOC, TKN, total phosphorus, microbial enumeration, and alkalinity. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3 of the FSAP.

4.4.1.3.3 Water Level Measurements

A minimum of two rounds of groundwater and surface water level measurements will be obtained from all site monitoring wells and staff gauges. All measurements will be obtained within a four hour period. Tn addition, the water levels in one shallow and one intermediate well will be monitored continuously for a 24- to 48-hour period to evaluate the affects of tidal changes on groundwater at the site.

4.4.1.4 Ecological Investigation

Surface water and sediment samples were obtained from the surface water bodies (i.e., ponds, marsh, and stream) located east of the site under the SI. However, in order to conduct an ecological risk assessment, fish and benthic macroinvertebrate samples need to be obtained and analyzed concurrently with surface water and sediment samples. An ecological investigation will be conducted as part of the RI/FS at Site 65 and will consist of collecting surface water, sediment, fish tissue and benthic macroinvertebrate samples concurrently from each of the two surface ponds located east of the site, from one sampling station along the intermittent stream channel that carries excess flow from the ponds/marsh. A total of four stations (65SW/SD04 through 65SW/SD07) will be sampled. One surface water and two sediment samples (obtained from depths 0 to 6 inches and 6 to 12 inches) will be collected from each sampling station. Proposed sampling stations are depicted on Figure 4-1. Specific details on the procedures for collecting and preparing surface water and sediment samples are presented in Sections 5.4 and 5.5 of the FSAP, respectively. Sample procedures for fish and benthic microinvertebrate samples are provided in Section 5.6 of the FSAP.

All surface water and sediment samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods. Sediment samples will also be analyzed for TPH. Surface water samples will also be analyzed for hardness. One 0 to 6-inch interval sediment sample will be submitted for grain size analysis and one sediment sample (0 to 6 inches and 6 to 12 inches intervals) will be analyzed for TOC.

Surface water elevations will be obtained from the ponds and the unnamed tributary during the field investigation. Staff gauges will be installed and used to measure surface water levels which will be correlated with groundwater level measurements from monitoring wells. A minimum of two rounds of staff gauge readings well be obtained.

Benthic macroinvertebrate samples will be collected at each of the surface water/sediment sample stations. These samples will be collected by the ecological sampling staff in accordance with the collection procedures identified in Appendix H of the FSAP.

Fish samples will also be collected from three surface water/sediment/benthic sampling stations (65SW/SD04 and 65SW/SD05) in accordance with the procedures identified in Appendix H of the FSAP. The ecological staff shall attempt to obtain at lease 10 of the following types of fish: top

carnivores (e.g., bass, blue gill, or sunfish), forage fish (e.g., minnows, chubs), and bottom feeders (e.g., catfish). The samples will be analyzed for full TCL organics and TAL inorganics via CLP Methods.

4.4.2 Site 73 - Courthouse Bay Liquids Disposal Area

The following investigations and support activities will be conducted at Site 73.

- Surveying
- Soil Investigation
- Groundwater Investigation
- Ecological Investigation (including surface water, sediment, fish, crab, and benthic sampling)

Each activity and investigation is described in the following subsections.

4.4.2.1 Surveying

The site survey will involve the surveying of the current site features including roads, buildings, fence lines, vehicle wash racks, existing USTs and ASTs, tank paths, surface water bodies such as creeks, marsh areas and the edge of Courthouse Bay, the location of the previously identified seep and any significant features which were noted during the site visit.

The locations of proposed soil borings, monitoring wells, and surface water and sediment sample stations will be established by the survey subcontractor prior to commencing the field program. Each location will be marked with a stake allowing the field teams to identify the location and the corresponding designation for each activity. Ground surface elevations and the horizontal control of each sampling location will be established.

Following the completion of the field program, vertical and horizontal control will be established for all of the existing and the newly installed monitoring wells, staff gauges and any sample locations that were relocated during the field program. A reference point on the top of the PVC riser, and the ground elevation will be surveyed for each monitoring well.

Survey points will include a latitude coordinate, a longitude coordinate, and an elevation expressed in feet of mean sea level. The vertical accuracy of the survey will be within 0.01 feet and the horizontal accuracy will be within 0.1 feet. All survey points will be referenced to the NCSPCS.

4.4.2.2 Soil Investigation

A soil investigation will be conducted at Site 73 to provide surface and subsurface soil data to evaluate areas of concern identified by the preliminary investigation, determine the nature and extent of soil contamination at the site, support a baseline human health and ecological risk assessment and evaluate remedial action alternatives. The investigation will focus on the specific areas identified in the Work Plan. The following subsections describe the tasks proposed for the field program.

4.4.2.2.1 Sampling Locations

A projected 48 soil borings (including shallow and intermediate depth groundwater monitoring wells) will be drilled to characterize the shallow stratigraphy at the site and to collect samples for laboratory analysis. Thirty-four borings will be completed as groundwater monitoring wells (including 29 shallow and 5 intermediate monitoring wells). The shallow wells will be installed at an estimated depth of 25 feet and the intermediate wells at an estimated depth of 70 feet. The remaining 14 soil borings will be advanced to the water table (an estimated maximum depth of 8 feet). Additional soil borings may be required based on the analytical results of soil samples obtained from the proposed borings. The proposed drilling locations are identified on Figure 4-2. Rationale for the proposed borings is presented in Table 4-2.

Three unsaturated soil samples will be obtained from each soil boring if 6 feet or more of unsaturated soil is encountered. This includes one surface (0 to 12 inches) soil sample, one from the interval located just above the groundwater surface, and a third sample based on visual observations and field screening performed via photoionization detector. If less than 6 feet of unsaturated soil is encountered only two soil samples will be collected including a surface soil sample and another soil sample from the interval located just above the groundwater surface.

Two upgradient borings will be drilled northwest of the site in an area not believed to have been impacted by previous activities. One surface and one or two subsurface samples will be collected from one of the borings following the same protocol previously indicated and will be submitted for analysis. Both of the borings will be converted to groundwater monitoring wells. One of the wells will be constructed such that the screened portion will intercept the water table (shallow zone) and the other will monitor the upper portion of the Castle Hayne Aquifer (intermediate zone). At other locations where both shallow and intermediate depth groundwater wells are constructed together to form a well cluster, soil samples will be obtained from only one of the borings.

Section 5.1 of the FSAP discusses the procedures for the collection and preparation of the soil samples collected during drilling and test pit evacuation activities.

4.4.2.2.2 Analytical Requirements

All soil samples collected from the soil borings will be analyzed in accordance with Table 4-2. A minimum of two composite samples of drill cuttings shall be obtained and analyzed in accordance with the Toxic Characteristic Leaching Procedure (TCLP) and for RCRA hazardous waste characteristics in order to assess disposal options.

4.4.2.3 Groundwater Investigation

The purpose of the groundwater investigation is to determine the nature and extent of groundwater contamination in the shallow (water table) and intermediate (approximately 60 feet bgs) groundwater zones across the site, and to provide data to support a baseline human health and ecological risk assessment, and evaluation of remedial action alternatives. The following subsections describe the tasks proposed for the field program.

The results of the preliminary investigation (soil gas and groundwater screening) indicate that organic chemical contamination is present at various locations across the site. It is anticipated that 29 soil borings will be completed as shallow groundwater monitoring wells (Type II well

construction). The proposed locations are presented on Figure 4-2. The wells will be installed to depths ranging from approximately 15 to 30 feet bgs. The well screens for the shallow wells will be 15 feet in length and will intercept the water table (approximately 4 to 8 feet bgs). Rationale for the locations of the proposed monitoring wells is presented in Table 4-2.

In addition to the shallow groundwater monitoring wells, a minimum of five intermediate monitoring wells will be installed to delineate the extent of vertical contaminant migration (if any) at this site. The intermediate zone is defined as approximately 60 feet bgs corresponding to the depth of the upper screened portion of the water supply well (A5) located nearest the site. If a semi-confining unit (i.e., subsurface soil zone exhibiting considerably lower hydraulic conductivity than the zone in which the water table surface is contained) is encountered during advancement of the borehole, the well will be constructed as a Type III monitoring well. If a semi-confining unit is not encountered, then a Type II well will be installed at the specified depth. The screen length of the intermediate monitoring wells will be 10 to 20 feet. Well construction details for the proposed shallow Type II and Type III monitoring wells are illustrated on Figures 5-1 and 5-2 in Section 5.0 of the FSAP. Well installation procedures and well construction materials are discussed in Section 5.2 in the FSAP.

Seventeen existing groundwater monitoring wells (A-5 [supply well], 73GW2, 73GW3, 74GW4, 73GW5, DW-2, MW-8, MW-9, MW-13, MW-16, MW-18, A47/3-8, A47/3-9, A47/3-11, A47/3-13, A47/3-16, and A47/322), installed during previous investigations, will be resampled as part of this investigation.

4.4.2.3.1 Sampling and Analysis

One round of groundwater samples will be collected from the 34 newly installed monitoring wells and the 17 existing wells. Samples will be collected approximately one week following the development of the wells. Samples will be collected in accordance with Table 4-2. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3 in the FSAP.

4.4.2.3.2 Water Level Measurements

A minimum of two rounds of groundwater and surface water level measurements will be obtained from all newly installed monitoring wells, the 17 existing wells sampled as part of this investigation and staff gauges. All measurements will be obtained within a four hour period. Additionally, two rounds of staff gauge readings will be collected during a 12-hour period at one hour increments to determine the tidal affect on the creeks and the portion of the Courthouse Bay adjacent to the site. The water levels in two shallow and two intermediate wells will be monitored continuously for a 24- to 48-hour period to evaluate the affects of tidal changes on groundwater at the site.

4.4.2.4 Ecological Investigation

An ecological investigation will be conducted at Site 73 and will consist of collecting surface water, sediment, fish, crab and benthic samples from various locations at AOCs 7, 8 and 9. A total of twelve stations (SW/SD01 through SW/SD12) will be sampled. One surface water and two sediment samples (0 to 6 inches and 6 to 12 inches) will be collected from each sampling station. Specific details on the procedures for collecting and preparing surface water and sediment samples are presented in Sections 5.4 and 5.5 of the FSAP, respectively. Sampling procedures for fish, crab and

benthic macroinvertebrate samples are provided in Section 5.6 of the FSAP. Proposed locations are presented in Figure 4-2. An additional surface water sample will be obtained from the seeps observed during the Preliminary Investigation in AOC #2.

All surface water, sediment, fish, crab, and benthic samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods. Sediment samples will also be analyzed for TPH. Surface water samples will also be analyzed for hardness. The 0 to 6-inch sediment sample will be submitted for grain size analysis and both samples (0 to 6 inches and 6 to 12 inches) will be analyzed for total organic carbon (TOC).

Surface water elevations will be obtained from Courthouse Bay and the two unnamed creeks on each side of Site 73 leading to Courthouse Bay during the field investigation. Staff gauges will be installed and used to measure surface water levels which will be correlated with groundwater level measurements from monitoring wells. A minimum of two rounds of staff gauge readings well be obtained.

4.4.3 Management of Investigation Derived Waste

Investigation derived waste (IDW) will be generated during the field program at Operable Unit No. 9. IDW to be generated will include soil and mud cuttings, development and purge groundwater, spent decontamination fluids, and personal protective equipment (PPE) and clothing (PPC). Specific details regarding IDW handling, sampling, and disposal are provided in Section 3.4 of the FSAP.

4.5 Task 5 - 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 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 technical or administrative 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 tracking purposes, and then forward it to the validator. A validation report will be expected within three weeks following receipt of laboratory data packages by the validator. CLP data will be validated per the CLP criteria as outlined in the following documents:

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

- USEPA, Hazardous Site Evaluation Division, Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, 1988.

All other data will be validated in accordance with the method of analysis using the National Functional Guidelines as a reference.

4.6 Task 6 - Data Evaluation

This task involves efforts related to the data once it is received from the laboratory and is validated. It also involves the evaluation of any field-generated data including: water level measurements, in-situ permeability tests, test boring 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).

4.7 Task 7 - Risk Assessment

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

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

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

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), USEPA 1989.
- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), USEPA 1991.
- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), USEPA 1991.
- Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual, USEPA 1989.
- Supplemental Guidance to RAGS: Standard Default Values, USEPA 1991a.
- Supplemental Guidance to RAGS: Calculating the Concentration Term, USEPA 1992.
- Superfund Exposure Assessment Manual, USEPA 1988.

- Exposure Factors Handbook, USEPA 1989b.
- Guidance for Data Usability in Risk Assessment, USEPA 1990.
- Supplemental USEPA Region IV Risk Assessment Guidance, USEPA Region IV, 1991.

USEPA Region IV will be consulted for Federal guidance, and the NC DEHNR will be consulted for guidance from 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 current and future 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, a separate BRA will be performed at MCB, Camp Lejeune for OU No. 9. The BRA will utilize all available data to date that has been properly validated in accordance with USEPA guidelines plus all data to be collected from additional sampling during this RI.

4.7.1 Human Health Evaluation Process

4.7.1.1 Site Location and Characterization

A background section will be presented at the beginning of each risk assessment to provide an overview of the characteristics of each site. This section will provide a site location, 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.

4.7.1.2 Data Summary

Decisions regarding data use may influence the resultant risk assessment, therefore, 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 operable units, sites, and areas of concern for which

chemical concentrations will be characterized and risks will be evaluated. Sites will be grouped into operable units if they are close to one another, have similar contamination, and/or may impact the same potential receptors. In selecting data to include in the risk assessment, the objective is to characterize, as accurately as possible, the distribution and concentration of chemicals in each operable unit.

Data summary tables will be developed for each medium sampled (e.g., surface water, sediment, groundwater, soil). Each data summary table will indicate the frequency of detection, observed range of concentrations, average background concentrations (inorganics), and the means and upper 95 percent confidence limit value for each contaminant detected in each medium. The arithmetic or geometric mean and the upper 95 percent confidence limit of that mean will be used in the summary of potential chemical data. The selection of arithmetic or geometric means will depend on whether the sample data are normally or log-normally distributed. In the calculation of the mean, concentrations presented as "ND" (nondetect) will be incorporated.

4.7.1.3 Identifying Chemicals of Potential Concern

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

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

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

4.7.1.4 Exposure Assessment

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

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

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

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 also 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 finalized after consulting with the Base Master Plan, USEPA and the State of North Carolina. Generally, current and future exposure pathways will be considered preliminarily as follows:

- Soil Pathway
  - Direct ingestion (current base personnel, current/future residents, future construction worker)
  - Inhalation of dust (worker, resident)
  - Dermal contact (worker, resident)

- Sediment Pathway
  - Dermal contact (current base personnel, current/future resident, current recreational user)
  - Ingestion (current base personnel, current/future resident, current recreational user)

- Surface Water
  - Dermal contact (current base personnel, current/future resident, current recreational user)
  - Ingestion (current base personnel, current/future resident, current recreational user)

- Groundwater
  - Direct ingestion (base personnel, future residents)
  - Inhalation (base personnel, future residents)
  - Dermal contact (base personnel, future residents)

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 upper 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 (e.g., 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.

4.7.1.5 Toxicity Assessment

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

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

- Health Effects Assessment Summary Tables (HEAST) - A tabular summary of noncarcinogenic and carcinogenic 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 USEPA 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 USEPA weight-of-evidence (WOE) classification for carcinogens, and their respective slope factors.

4.7.1.6 Risk Characterization

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

Carcinogenic Risk

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

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

Where: CDI = Chronic daily intake

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

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

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.

4.7.1.7 Uncertainty Analysis

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

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

The variation of any factor used in the calculation of the exposure concentration will have an impact on the total carcinogenic and noncarcinogenic risk. The uncertainty analysis will qualitatively discuss non-site and site-specific factors that may 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.

4.7.1.8 Preliminary Remediation Goals

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

The initial step in developing PRGs is to identify media of potential concern. Important media at these sites include groundwater, soil, surface water, and sediment. Chemicals of potential concern includes any chemical reasonably expected to be at the sites. These chemicals may have been previously detected at the site, may be presented based on site history, or may be present as

degradation products. Identifying future land use for the site is used to determine risk-based PRGs. In general, residential land use should be used as a conservative estimation for the PRGs. Chemical-specific ARARs are evaluated as PRGs because they are often readily available and provide preliminary indication about the goals that a remedial action may have to attain. For groundwater SDWA maximum contaminant levels (MCLs), state drinking water standards, and Federal Water Quality Criteria (FWQC) are common ARARs.

FWQCs and state water quality standards (WQS) are common ARARs for surface water. Sediment Screening Values (SSVs) developed by National Oceanic and Atmospheric Administration (NOAA) can be used as ARARs for the evaluation of biological effects for aquatic organisms. In general, chemical-specific ARARs are not available for soil, however, some states have promulgated soil standards (e.g., PCB clean-up levels) that may be criteria appropriate to use as PRGs. Risk-based PRGs will be obtained from USEPA, Region III, Risk-Based Concentration Table (USEPA, 1994). The risk-based PRGs will be reviewed and modified after the completion of the baseline risk assessment. This modification will involve adding or subtracting chemicals of concern, media, pathways or revising individual chemical-specific goals. Tables 4-4 and 4-5 provide PRGs for each media at Sites 65 and 73, respectively, based on data available to date.

4.7.2 Ecological Risk Assessment

The overall purpose of an ecological risk assessment is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of exposure to one or more physical or chemical stressors. This assessment will evaluate the potential effects of contaminants on sensitive or critical habitats or environments and protected species. The assessment will also employ a phased approach to determine potential adverse effects of contamination on the terrestrial and aquatic receptors (e.g., flora and fauna) on or adjacent to each site at MCB, Camp Lejeune. Phase I will consist of a comparison of analytical results for soils, surface water, or sediments to available ecological standards or criteria. The Phase I approach will provide a conservative evaluation of the potential ecological effects associated with site contamination. If contaminant concentrations in environmental media exceed appropriate standards or criteria, additional phases of evaluation may be necessary to fully characterize potential ecological effects at a site.

The risk assessment methodologies will be consistent with those outlined in the Framework for Ecological Risk Assessment (USEPA, 1992b). In addition, information found in the following documents will also be consulted.

- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (USEPA, 1989e)
- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (USEPA, 1989a)

The following sections describe the general technical approach that will be used to evaluate the likelihood that adverse ecological effects could occur as a result of exposure to one or more physical or chemical stressors. The ecological risk assessment will consist of five components. These are: problem formulation; characterization of exposure; characterization of ecological effects; risk characterization; and uncertainty analysis.

4.7.2.1 Problem Formulation

Problem formulation is the first step of an ecological assessment and requires an understanding of site habitats, potential receptors, and potential endpoints. Problem formulation will be based on historical information and on the findings of the site visit conducted for each site. Data needs and regulatory issues will also be considered. The components of the problem formulation phase consist of stressor characteristics, ecosystems potentially at risk, ecological effects, endpoint selection, and a conceptual model.

The selection of chemical stressors or COPCs will be based on frequency of detection, background comparison, persistence of the contaminant, bioaccumulation potential, and the toxicity of the contaminant. Because of the differential toxicity of some contaminants to ecological verses human receptors, the COPCs for ecological receptors may differ from those selected for the human health risk assessment. Physical stressors including temperature and hydrologic changes and habitat alteration will also be taken into consideration.

Based on the site visit and historical information, ecological receptors will be identified, and the stressor-ecosystem-receptor relationship will be used to develop exposure scenarios in the characterization of exposure phase. Properties of the ecosystem that may be considered in the problem formulation phase include the abiotic environment (e.g., climatic conditions and soil or sediment properties), ecosystem structure (e.g., abundance and trophic level relationships), and ecosystem function (e.g., energy source, energy utilization, and nutrient processing). In addition, types and patterns of historical disturbances may be used to predict ecological receptor-stressor responses. Spatial and temporal distribution may also be used to define the natural variability in the ecosystem. The potential for indirect effects (e.g., reduction in prey availability or habitat utilization) will also be considered in the selection of ecosystem components.

Ecological effects data will be compiled for the physical and chemical stressors identified. Most of these data are available in the literature. Application of laboratory-based tests to field situations and to the interpretation of field observations that may be influenced by natural variability or non-site stressors that are not the focus of the ecological risk assessment will also be considered. The information compiled will be used to select ecological endpoints or characteristics of an ecological component that may be affected by exposure to a stressor.

A conceptual model of the site will then be developed. This conceptual model will consist of a series of working hypotheses regarding how the stressor might affect ecological components of the ecosystem potentially at risk.

4.7.2.2 Characterization of Exposure

The interaction of the stressor with the ecological component will be evaluated in the characterization of exposure. A quantitative evaluation of exposure will be developed that estimates the magnitude and spatial and temporal distributions of exposure for the various ecological components selected during the problem formulation and serve as input to the risk characterization.

4.7.2.3 Characterization of Ecological Effects

The relationship between the stressors and the assessment and measurement endpoints identified during problem formulation will be quantified and summarized in a stressor-response profile. The

stressor-response profile will be used as input to the risk characterization. Scientific literature and regulatory guidelines will be reviewed for media-specific and/or species specific toxicity data. On-line databases will be accessed, such as AQUIRE and PHYTOTOX, to obtain current stressor-response data. Toxicity values will be from the most closely related species, where possible. If necessary, laboratory and in-field exposure response studies including acute and chronic toxicity tests of exposure to individual or multiple stressors may be used to supplement the available toxicological databases. Field studies and biosurveys may also be used to establish whether adverse ecological effects have occurred at the site.

4.7.2.4 Risk Characterization

Risk characterization is the final phase of the ecological risk assessment and integrates the results of the exposure and ecological effects analyses. The likelihood of adverse effects occurring as a result of exposure to a stressor will be evaluated.

Individual endpoints may be evaluated by using single effects (e.g, media-specific and/or species specific toxicity data) and exposure values (e.g., dose units or exposure point concentrations) and comparing them using the quotient method for both media exposure and uptake exposure.

For exposure point concentrations that were monitored or modeled in the Characterization of Exposure, water criteria from either the state or from the USEPA will be compared using the quotient method to the ambient surface water concentrations. Likewise, sediment screening values from NOAA will be compared to measured sediment concentrations. These screening values will evaluate the potential for chemical constituents in both the surface water and sediments to cause adverse biological effects. Toxicity values from the literature that represent the toxicological effects on plants and/or invertebrates inhabiting soils will be compared to surface soil concentrations.

For dose unit exposure, terrestrial reference values, developed from No-Observed-Adverse-Effect-Levels (NOAELs) or Lowest-Observed-Adverse-Effect-Levels (LOAELs), will be compared to an estimate of total exposure to soils, surface water, and vegetation via calculation of a CDI. The exposure parameters used in the CDI equation will represent feeding rates, incidental soil ingestion rates, drinking water rates, body weights, and home range input for selected terrestrial receptors known to inhabit the areas of concern.

Population and community endpoints will be assessed by considering species representation by trophic group, taxa, or habitat. Site-specific field studies and biosurveys, if conducted, on and adjacent to the areas of concern may be compared to either historical population and community endpoint information or project-specific field studies and biosurveys.

The ecological significance of the risks characterized at the site will be discussed considering the types and magnitudes of the effects and their spatial and temporal patterns. Ecologically significant risks will be defined as those potential adverse risks or impacts to ecological integrity that affect populations, communities, and ecosystems, rather than individuals (i.e. measured impacts to individuals does not necessarily indicate impacts to the ecosystem).

4.7.2.5 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 ecological effects data 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.

4.7.2.6 Data Gaps

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

4.8 Task 8 - Remedial Investigation Report

This task is intended to cover all work efforts related to the preparation of the document providing the findings once the data have been evaluated under Tasks 5 and 6. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final RI Report. The RI Report will contain individual Comprehensive Site Assessment (CSA) reports for each UST investigated within Site 73. The CSA reports will be appended to the RI. CSA reports will be prepared in accordance with North Carolina DEHNR guidelines. This task ends when the Final RI report is submitted.

4.9 Task 9 - Remedial Alternatives Screening

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

4.10 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 USEPA Acceptance
  - Community Acceptance

4.11 Task 11 - Feasibility Study Report

This task is comprised of reporting the findings of the Feasibility Study. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final FS report. The FS will also contain (as appendices) individual Corrective Action Plans (CAPs) for each UST. The CAPs will be prepared in accordance with North Carolina DEHNR guidelines. This task ends when the Final FS report is submitted.

4.12 Task 12 - Post RI/FS Support

This task involves the technical and administrative support to LANTDIV to prepare a Draft, Draft Final, and Final Responsiveness Summary, Proposed Remedial Action Plan (PRAP), and Record of Decision (ROD). A PRAP and ROD will be prepared for the OU. These reports will be prepared using USEPA applicable guidance documents.

4.13 Task 13 - Meetings

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

- Meeting between Baker and LANTDIV/Camp Lejeune EMD to discuss the RI/FS conclusions following submission of the Preliminary Draft RI/FS Report.
- A remedial project management (RPM) meeting with LANTDIV/Camp Lejeune EMD, USEPA Region IV, and the North Carolina DEHNR.
- A technical review committee (TRC) meeting to present the findings of the RI/FS.

The meetings will be attended by the Baker Activity Coordinator, Project Manager, and Project Engineer or Risk Assessment Specialist. It is presumed that all meetings will be conducted at MCB, Camp Lejeune, North Carolina.

SECTION 4.0 TABLES

TABLE 4-1

SUMMARY OF SAMPLING AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Soil Borings	SB06, SB07, SB08, SB09, SB10, SB11, MW01B, MW02B, MW04A, MW05, MW06A, and MW07A	2 to 3 samples per borehole, depending on the depth to the water table (24 to 36 soil samples)	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
	SB06	1 composit sample	TOC	EPA 415.1	Routine
			Alkalinity	SM 403	Routine
			BOD	SM 507, EPA 405.1	Routine
			Redox Potential	ASTM 1498	NA
			COD	EPA 410.1	Routine
			Microbial Count	SM 907	Routine
			Nitrogen (TKN)	EPA 351.3	Routine
			Total Phosphorus	EPA 365.2	Routine
			Atterberg Limits	ASTM D4943-89	Routine
			Particle Size	ASTM D422-63	Routine
Test Pit	TP-01 through TP-07	1 composite sample from each test pit; 7 sample total	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TPH	EPA 8015	Routine
	TP-01 through TP-07	1 sample of waste or discolored soil encountered during test pitting; number of samples to be determined based on field observations	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			Full TCLP	8240, 8270, 8080, 8150, and 6010	Routine
			Reactivity	SW 846 9012, 9030	Routine
			Corrositvity	SW 846 9010	Routine
			Ignitability	SW 846 1010	Routine
			TPH	EPA 8015	Routine

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Groundwater	MW01A, MW01B, MW02A, MW02B, MW03, MW04A, MW04B, MW05, MW06A, and MW07A	1 round = 10 samples	TCL Organics	CLP/SOW	14 days
			TAL Metals	CLP/SOW	Routine
			TSS	EPA 160.2	Routine
	MW07A	1 round	TDS	EPA 160.1	Routine
			BOD	EPA 405.1	Routine
			COD	EPA 410.1	Routine
			TOC	EPA 415.1/9060	Routine
			TKN	EPA 351.3	Routine
			Total Phosphorus	EPA 365.2	Routine
			Microbial Count	SM 907	Routine
			Alkalinity	EPA 310.1	Routine
Surface Water	SW04, SW05, SW06, and SW07	1 round; 4 samples	TCL Organics	CLP/SOW	Routine
			TCL Metals	CLP/SOW	Routine
			Hardness	EPA 130.2	Routine
Sediment	SD04, SD05, SD06, and SD07	Two samples per location; 8 samples total	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TPH	EPA 8015	Routine
			TOC	EPA 415.1	Routine
	SD04	One surface sediment	Grain Size	ASTM D422-63	Routine
Fish	SW04, SW05, and SW06	1 whole body carnivore 1 fillet carnivore 1 whole body forrage 1 fillet forrage 1 whole body bottom feeder 1 fillet bottom feeder	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Soil - UST A-47-1 Area and AOC No. 1	MW-13, DW-03, MW-14, MW-29, MW-12, SB-04, SB-05, SB-06, and MW-15.	2 to 3 samples per borehole; 18 to 27 samples total	Volatile Organics	8021 and 8240	Routine
			TCL Semi-volatiles	CLP/SOW	Routine
			TCL Pesticides/PCBs	CLP/SOW	Routine
			Oil and Grease	9071	14 days
			TPH	8015 (5030 and 3550)	14 days
			TAL Metals	CLP-SOW	Routine
	MW-13	1 composite sample	TOC	EPA 403	Routine
			Alkalinity	SM 403	Routine
			BOD	SM507, EPA 405.1	Routine
			Redox Potential	ASTM 1498	NA
			COD	EPA 410.1	Routine
			Microbial count	SM 907	Routine
			Nitrogen (TKN)	EPA 351.3	Routine
			Total Phosphorus	EPA 365.2	Routine
			Atlerburg Limits	ASTM D4943-89	Routine
			Particle Size	ASTM D422-63	Routine
Soil - UST A47/2, UST A-2, UST A-10/SA26, AOC 6 and AOC 3	SB-03, MW-28, MW-10, MW-04, MW-23, SB-07, SB-01, MW-02, MW-03, and A-5	2 to 3 samples per boring; 12 to 18 samples total	Oil and Grease	9071	14 days
			Volatile Organics	8021	Routine
			TCL Semivolatiles	CLP/SOW	Routine
			TCL Pesticides/PCBs	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TPH	8015 (5030 and 3550)	14 days
Soil - UST A47/3, UST A47/4, UST A47/5, and UST A12-1	MW-17, MW-16, MW-26, MW-27, MW-11, SB-02, and MW-08	2 to 3 soil samples per boring; 14 to 21 samples total	TPH	8015 (5030 and 3550)	14 days

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Soil UST A12/2	MW-25 and MW-09	2 to 3 soil samples per boring, 4 to 6 samples total	TPH	8015 (5030 and 3550)	14 days
Soil - AOC 4 and 5	SB-13, SB-14, MW-18, MW-19, SB-08, SB-09, SB-10, SB-11, SB-12, MW-20, MW-21 MW-24	2 to 3 samples per boring; 24 to 36 samples total	TPH	8015 (5030 and 3550)	14 days
			Oil and Grease	9071	14 days
			TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
Soil - AOC 2	MW-05, MW-06, MW-07, and MW-22	2 to 3 samples per boring, 8 to 12 samples total	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TPH	8015 (5030 and 3550)	14 days
Soil IDW	Roll-off boxes	1 composite sample per roll-off box; 2 samples total	TCLP Volatiles	1311/8240	Routine
			TCLP Semi-volatiles	1311/8270	Routine
			TCLP Metals	1311/6010	Routine
Groundwater - UST Area A47/1 and AOC No. 1	MW-13, MW-14, MW-11, MW-29, DW-03, MW-15, DW-04, MW-12, 73GW3, 73GW4, A47/3-8, and A47/3-9	1 round; 12 samples	Volatile Organics (including xylenes, MTBE, EDB and isopropyl ether)	601/602	14 days
			Semi-volatile organics	625	Routine
			TCL Pesticides/PCBs	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TSS	EPA 160.2	Routine
	MW-13	One round	TDS	EPS 160.1	Routine
			BOD	EPA 405.1	Routine
			COD	EPA 410.1	Routine
			TOC	EPA 415.1/9060	Routine
			TKN	EPA 351.3	Routine
			Total Phosphorus	EPA 365.2	Routine
			Microbial Count	SM 907	Routine
			Alkalinity	EPA 310.1	Routine
			Acidity	EPA 305.2	Routine

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Groundwater - USTs A47/3, A47/4, A47/5, A12-1, A12-2 and AOC No. 6	MW-16, MW-26, MW-17, MW-27, MW-25, MW-08, MW-09, A47/3-13, A47/3-16, A47/3-22, A47/3-11, and DW-2	1 round; 12 samples	Volatile Organics, Xylenes, MTBE, EDB, and Isopropyl Ether	601/602	14 days
			Semi-volatile Organics	625	Routine
			TAL Metals	CLP\SOW	Routine
			TSS	EPA 160.2	Routine
	A47/3-13	1 round	TDS	EPS 160.1	Routine
			BOD	EPA 405.1	Routine
			COD	EPA 410.1	Routine
			TOC	EPA 415.1/9060	Routine
			TKN	EPA 351.3	Routine
			Total Phosphorus	EPA 365.2	Routine
			Microbial Count	SM 907	Routine
			Alkalinity	EPA 310.1	Routine
Groundwater - AOC Nos. 4 and 5	Existing: DW-12, MW-19, MW-13, MW-8, MW-18, MW-16 New: MW-18, MW-20, MW-21, MW-24, MW-19, DW-05	1 round; 12 samples	Volatile Organics, Xylenes, MTBE, EDB, and Isopropyl Ether	601/602	14 days
			Semi-volatile Organics	625	Routine
			TAL Metals	CLP/SOW	Routine
			TSS	EPA 160.2	Routine

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Groundwater - AOC Nos. 4 and 5	MW-20	1 round	TDS	EPS 160.1	Routine
			BOD	EPA 405.1	Routine
			COD	EPA 410.1	Routine
			TOC	EPA 415.1/9060	Routine
			TKN	EPA 351.3	Routine
			Total Phosphorus	EPA 365.2	Routine
			Microbial Count	SM 907	Routine
			Alkalinity	EPA 310.1	Routine
Groundwater - AOC No. 2	MW-05, MW-06, MW-07, MW-22, MW-23, MW-01, DW-01, and 73GW2	1 round; 8 samples	Volatile Organics	601/602	14 days
			Semi-volatile Organics	625	Routine
			TCL Pesticides/PCBs	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TSS	EPA 160.2	Routine
Groundwater - AOC 3, UST A10/SA-26, and UST A-2	MW-02, MW-03, MW-04, MW-23, MW-01, MW-01, DW-01, MW-28, and MW-10	1 round; 9 samples	Volatile Organics	502.2	14 days
			Semi-volatile Organics	625	Routine
			TAL Metals	CLP/SOW	Routine
			TSS	EPA 160.2	Routine
Surface Water	SW-01 through SW-12, and the seep (AOC 2)	1 round; 13 samples	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			Hardness	EPA 130.2	Routine

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, AND ANALYTICAL OBJECTIVES
OPERABLE UNIT NO. 9, SITES 65 AND 73
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Investigation	Sample Locations	Number of Samples	Analysis	Method	Turnaround Time
Sediment	SD-01 through SD-12	2 samples per station; 24 samples total	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine
			TPH	8015 (5030 and 3550)	Routine
			TOC	415.1	Routine
	SD-01 through SD-12	1 sample per station	Particle Size	ASTM D442-63	Routine
Fish/Crab	F/C-01, F/C-02, F/C-03	1 Whole Carnivore 1 Fillet Carnivore 1 Whole Forrage Fish 1 Fillet Forrage Fish 1 Whole Bottom Feeder 1 Fillet Bottom Feeder 1 Crab	TCL Organics	CLP/SOW	Routine
			TAL Metals	CLP/SOW	Routine

TABLE 4-2

RATIONALE FOR PROPOSED RI/FS SOIL BORINGS AT SITE 73
OPERABLE UNIT NO. 9, SITES 65 AND 73
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Boring No.	Purpose
SB-01	Confirm presence or absence of soil contamination directly adjacent to UST A10/SA-26.
SB-02	Confirm presence or absence of soil contamination directly adjacent to the former USTs at Building A-12.
SB-03	Confirm presence or absence of soil contamination directly adjacent to the former UST at Building A-13.
SB-04	Confirm presence or absence of soil contamination directly adjacent to oil/water separator SA-40.
SB-05	Confirm presence or absence of soil contamination directly adjacent to oil/water separator SA-29.
SB-06	Confirm presence or absence of soil contamination between active and former vehicle washdown areas.
SB-07	Confirm presence or absence of soil contamination directly adjacent to oil/water separator SA-38.
SB-08 through 12	Confirm presence or absence of soil contamination within AOC #5, where POL and waste acids were reportedly disposed.
SB-08, -12, -13, and -14	Confirm presence or absence of soil contamination near the former pond (surface impoundment) where wastes may have been disposed.

TABLE 4-3

RATIONALE FOR PROPOSED RI/FS MONITORING WELLS AT SITE 73
OPERABLE UNIT NO. 9, SITES 65 AND 73
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Boring No.	Purpose
MW-01, DW-01	Upgradient shallow and intermediate zone monitoring wells.
MW-02, 03, 04	Shallow monitoring wells placed around UST A10/SA-26 and adjacent oil/water separator SA-16 to confirm results of soil gas and groundwater screening where elevated levels of total volatile hydrocarbons (TVHC) were detected.
MW-05	Shallow monitoring well located where an unidentifiable organic was reportedly detected at an elevated concentration in a groundwater screening sample obtained under the preliminary investigation.
MW-06, 07	Shallow monitoring wells placed in the general vicinity of the suspected seep area.
MW-08, 09, 10, 25, 28, DW-02	Shallow and intermediate zone monitoring wells placed in the vicinity of the former USTs located adjacent to Buildings A12 and A13 to confirm where elevated levels of solvents, BTEX, and TVHC were detected.
MW-12	Shallow monitoring well located in an area where elevated levels of BTEX and TVHC were detected in soil gas samples.
MW-11, 13, 14, 15, 27, 29, and DW-03, 04	Shallow and intermediate zone monitoring wells located to provide data regarding an area of suspected TVHC, BTEX, and solvents contamination located between Building A-47 and Courthouse Bay. This area also contains UST A-47/1.
MW-16 and -26	Shallow monitoring wells located adjacent to a former UST A-47/4 and upgradient of suspected contamination located between Building A-47 and Courthouse Bay.
MW-17	Shallow monitoring well located adjacent to an active UST A-47/5 where elevated levels of BTEX and TVHC were detected during groundwater screening.

TABLE 4-3 (Continued)

RATIONALE FOR PROPOSED RI/FS MONITORING WELLS AT SITE 73
OPERABLE UNIT NO. 9, SITES 65 AND 73
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Boring No.	Purpose
MW-18	Shallow monitoring well located in area upgradient of former UST SA-21 where elevated levels of BTEX and TVHC were detected during groundwater screening.
MW-19	Shallow monitoring well placed upgradient of an area of suspected solvent contamination based on soil gas and groundwater screening results.
MW-20, DW-05	Shallow and intermediate zone monitoring wells placed near center of AOC #5 where elevated levels of TVHC were detected during groundwater screening.
MW-21	Shallow monitoring well placed in area where elevated levels of BTEX and TVHC were detected during groundwater screening.
MW-22	Shallow well placed in area where surface seeps were observed.
MW-23	Shallow well placed in area where elevated levels of total solvents were detected based on groundwater screening results.
MW-24	Shallow well placed upgradient from suspect VOC plume, based on groundwater screening results.

TABLE 4-4

PRELIMINARY REMEDIATION GOALS
SITE 65 - ENGINEER AREA DUMP
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Arsenic	50	µg/L	NCWQS[1]
	Beryllium	4	µg/L	MCL[3][4]
	Chromium	50	µg/L	NCWQS
	Copper	7	µg/L	NCWQS
	Lead	15	µg/L	MCL
	Manganese	50	µg/L	NCWQS/MCL
Soil	4,4'-DDD	2,700	µg/kg	Risk-Soil Ingestion[2]
	PCBs	10	mg/kg	TOSCA[8]
Surface Water	Lead	25	µg/L	NCWQS
	Copper	1,000	µg/L	NCWQS
Sediment	Copper	70/390	mg/kg	NOAA SSV[5]
	Lead	35/110	mg/kg	NOAA SSV
	Zinc	120/270	mg/kg	NOAA SSV
	4,4'-DDD	0.002/0.02	µg/kg	NOAA SSV
	4,4'-DDE	0.002/0.015	µg/kg	NOAA SSV

Notes:
(1) NCWQS - North Carolina Water Quality Standard
(2) Region III Risk-Based Concentration
MCL - Maximum Contaminant Level
(4) MCL is an action level
(5) NOAA SSV - National Oceanic and Atmospheric Administration Sediment Screening Value (USEPA, Region IV, 1992)
(6) ER-L - Effects Range-Low; if contaminant concentrations fall below the ER-L, adverse aquatic effects are considered unlikely.
(7) ER-M - Effects Range-Medium; if contaminant concentrations fall above the ER-M, adverse aquatic effects are considered probable.
(8) Toxic Substances Control Act

µg/L - microgram per liter
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram

TABLE 4-5

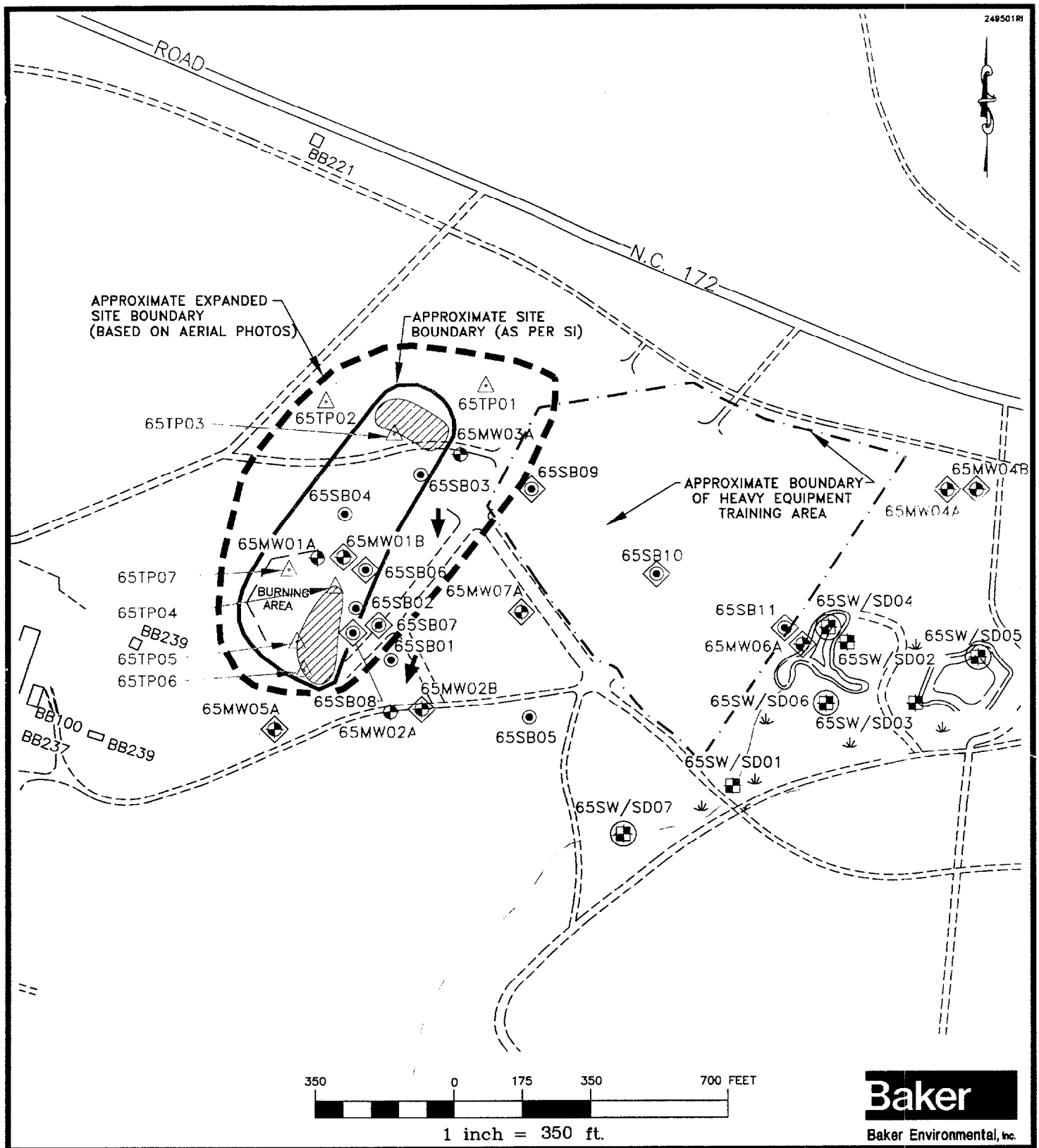
PRELIMINARY REMEDIATION GOALS
SITE 73 - COURTHOUSE BAY LIQUIDS DISPOSAL AREA
REMEDIAL INVESTIGATION/FEASIBILITY STUDY, CTO-0249
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Benzene	1	µg/L	NCWQS
	Toluene	1,000	µg/L	NCWQS/MCL[1][3]
	Ethylbenzene	29	µg/L	NCWQS
	Total Xylenes	530	µg/L	NCWQS
	Lead	15	µg/L	NCWQS
	Chromium	50	µg/L	MCL
	Trichloroethylene	2.8	µg/L	NCWQS
Soil	Benzene	22	mg/kg	Risk-Soil Ingestion[4]
	Toluene	16,000	mg/kg	Risk-Soil Ingestion[4]
	Ethylbenzene	7,800	mg/kg	Risk-Soil Ingestion[4]
	Total Xylenes	160,000	mg/kg	Risk-Soil Ingestion[4]
	Chromium	78,000	mg/kg	Risk-Soil Ingestion[4]
	Trichloroethylene	12	mg/kg	Risk-Soil Ingestion
Sediment	Chromium	80/145	mg/kg	NOAA SSV[9]
	Lead	35/110	mg/kg	NOAA SSV
Surface Water	Lead	25	µg/L	NCWQS
	Chromium	50	µg/L	NCWQS

Notes:
(1) MCL - Maximum Contaminant Level
(2) NCWQS - North Carolina Water Quality Standard
(3) MCL is an action level
(4) Region III Risk-Based Concentration
(5) ER-L - Effects Range-Low; if contaminant concentrations fall below the ER-L, adverse aquatic effects are considered unlikely.
(6) ER-M - Effects Range-Medium; if contaminant concentrations fall above the ER-M, adverse aquatic effects are considered probable.
(7) NOAA SSV - National Oceanic and Atmospheric Administration Sediment Screening Value (USEPA, Region IV, 1992)
(8) North Carolina Surface Water Standards for Freshwater (NCAC, 1993).
(9) NOAA SSV - National Oceanic and Atmospheric Administration Sediment Screening Value (USEPA Region IV, 1992).

µg/L - microgram per liter
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram

SECTION 4.0 FIGURES



LEGEND

- SI SURFACE WATER/SEDIMENT SAMPLE LOCATION
- SI SOIL BORING LOCATION
- SI MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED MONITORING WELL LOCATION
- APPROXIMATE LOCATION OF VISIBLE DEBRIS PILES
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- APPROXIMATE INTERMITTENT STREAM LOCATION
- PROPOSED SURFACE WATER/ SEDIMENT/FISH AND BENTHIC SAMPLE LOCATION
- PROPOSED TEST PIT LOCATION

FIGURE 4-1
PROPOSED AND EXISTING SAMPLE LOCATION MAP
ENGINEER AREA DUMP
SITE 65
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

5.0 PROJECT MANAGEMENT AND STAFFING

5.0 PROJECT MANAGEMENT AND STAFFING

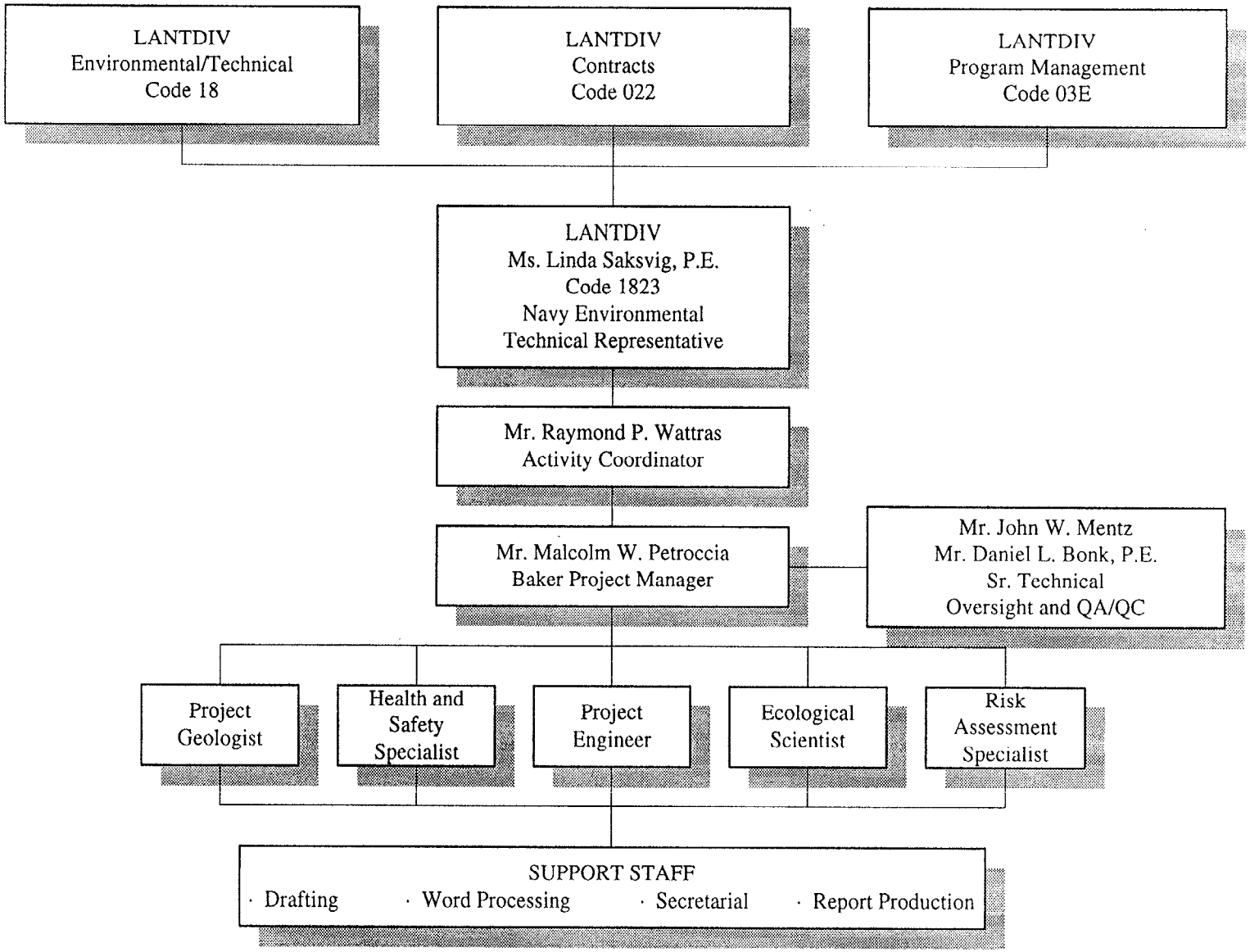
The Baker Project Team will be managed by Mr. Malcolm W. Petroccia with Senior Technical Oversight by Mr. Daniel L. Bonk, P.E. The primary responsibilities of the Project Manager will be to monitor the technical performance, cost, and schedule, and to maintain close communication with the Navy Technical Representative, Ms. Linda Saksvig, P.E. The Project Manager will report to Mr. Raymond P. Wattras (Activity Coordinator). Mr. John W. Mentz will be responsible for overall quality assurance/quality control.

The Project Team will consist of a Risk Assessment Specialist, Project Engineer, Project Geologist, Health and Safety Specialist, Ecological Scientist, and technical support staff as shown in Figure 5-1.

SECTION 5.0 FIGURE

FIGURE 5-1

PROJECT ORGANIZATION



6.0 SCHEDULE

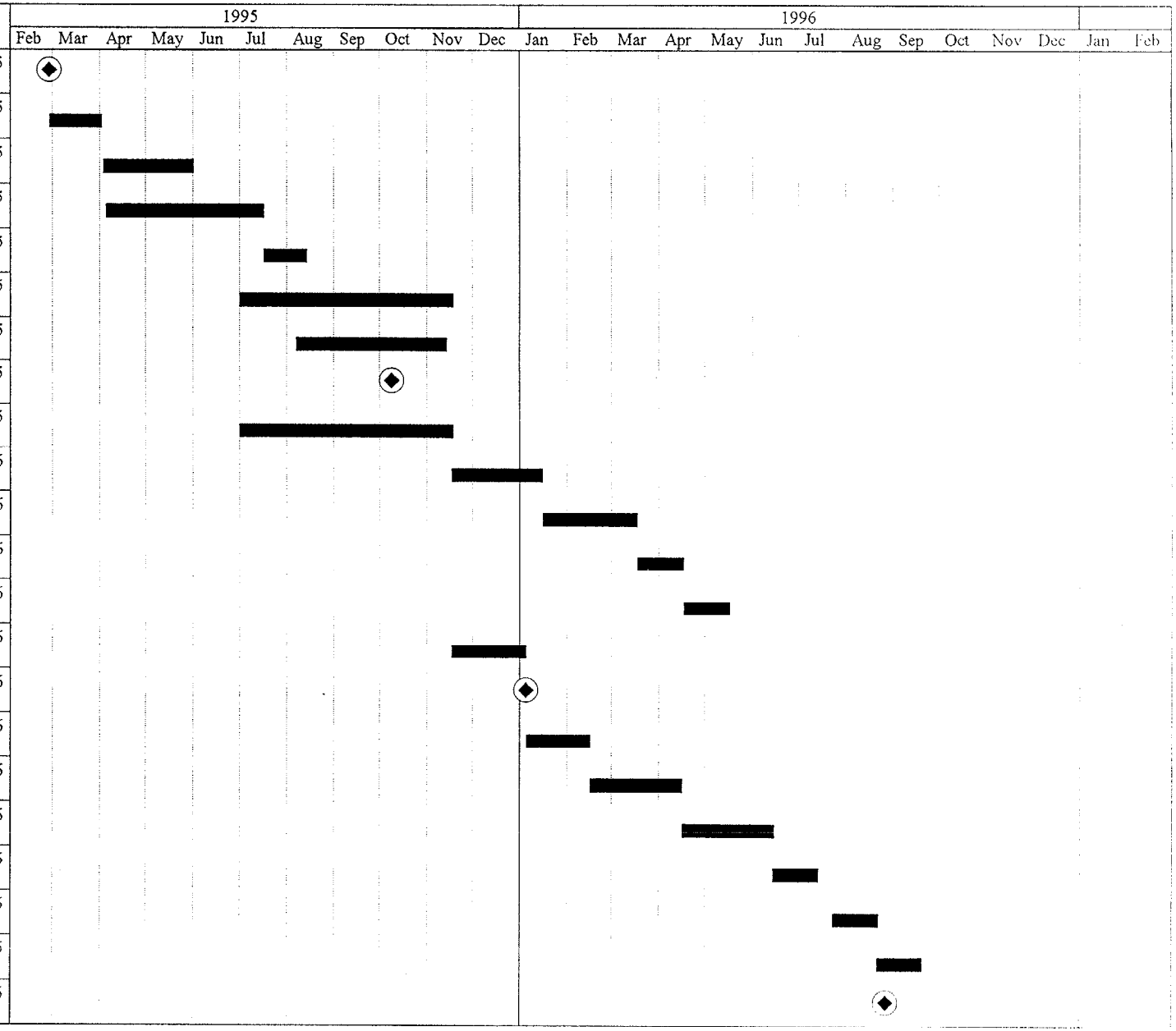
6.0 SCHEDULE

The proposed schedule for this project has been prepared in accordance with the FFA, and is presented as Figure 6-1. The projected start up of the RI/FS field investigation (April 3, 1995) is based on finalization of the RI/FS Project Plans on or before March 10, 1995, as noted in the Fiscal Year 1994 Site Management Plan (FY94 SMP) for MCB, Camp Lejeune, North Carolina. The FY94 SMP is based on the requirements established in the Federal Facilities Agreement and between the Navy/Marine Corps, USEPA Region IV, and the NC DEHNR.

SECTION 6.0 FIGURE

Figure 6 - 1: Proposed RI/FS Schedule
Operable Unit No. 9 (Sites 65 and 73)
MCB, Camp Lejeune, NC

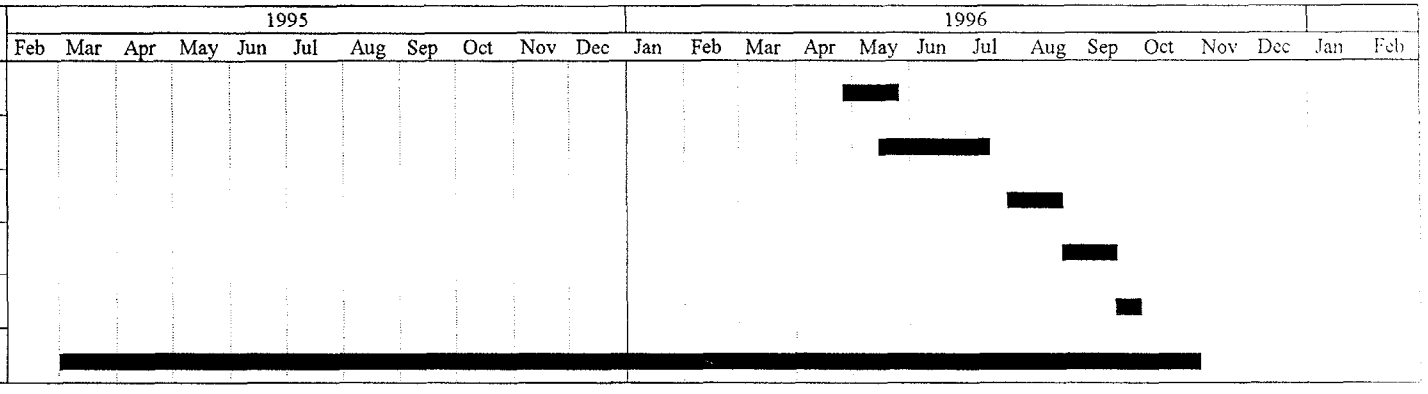
Task	Days	Start	Finish
Notice to Proceed	0ed	2/27/95	2/27/95
Mobilization	34ed	2/27/95	4/2/95
Environmental Field Investigation	59ed	4/3/95	6/1/95
Sample Analysis/Validation	103ed	4/5/95	7/17/95
Data Management	28ed	7/17/95	8/14/95
Data Evaluation	140ed	7/1/95	11/18/95
Risk Assessment	99ed	8/7/95	11/14/95
RI Meeting	0ed	10/9/95	10/9/95
Draft RI	140ed	7/1/95	11/18/95
Comment Period	60ed	11/17/95	1/16/96
Draft Final RI	62ed	1/16/96	3/18/96
Comment Period	30ed	3/18/96	4/17/96
Final RI	30ed	4/17/96	5/17/96
Remedial Alt Screen/Evaluation	49ed	11/17/95	1/5/96
FS Meeting	0ed	1/5/96	1/5/96
Draft FS/PRAP	42ed	1/5/96	2/16/96
Comment Period	60ed	2/16/96	4/16/96
Draft Final FS/PRAP	60ed	4/16/96	6/15/96
Comment Period	30ed	6/14/96	7/14/96
Final FS/PRAP	30ed	7/23/96	8/22/96
Public Comment Period	30ed	8/21/96	9/20/96
Public Meeting	0ed	8/27/96	8/27/96



Planned Time

Figure 6 - 1: Proposed RI/FS Schedule
Operable Unit No. 9 (Sites 65 and 73)
MCB, Camp Lejeune, NC

Task	Days	Start	Finish
Draft ROD	30ed	4/26/96	5/26/96
Comment Period	60ed	5/15/96	7/14/96
Draft Final ROD	30ed	7/23/96	8/22/96
Comment Period	30ed	8/21/96	9/20/96
Final ROD	14ed	9/19/96	10/3/96
Project Management	614ed	3/1/95	11/4/96



Planned Time

7.0 REFERENCES

7.0 REFERENCES

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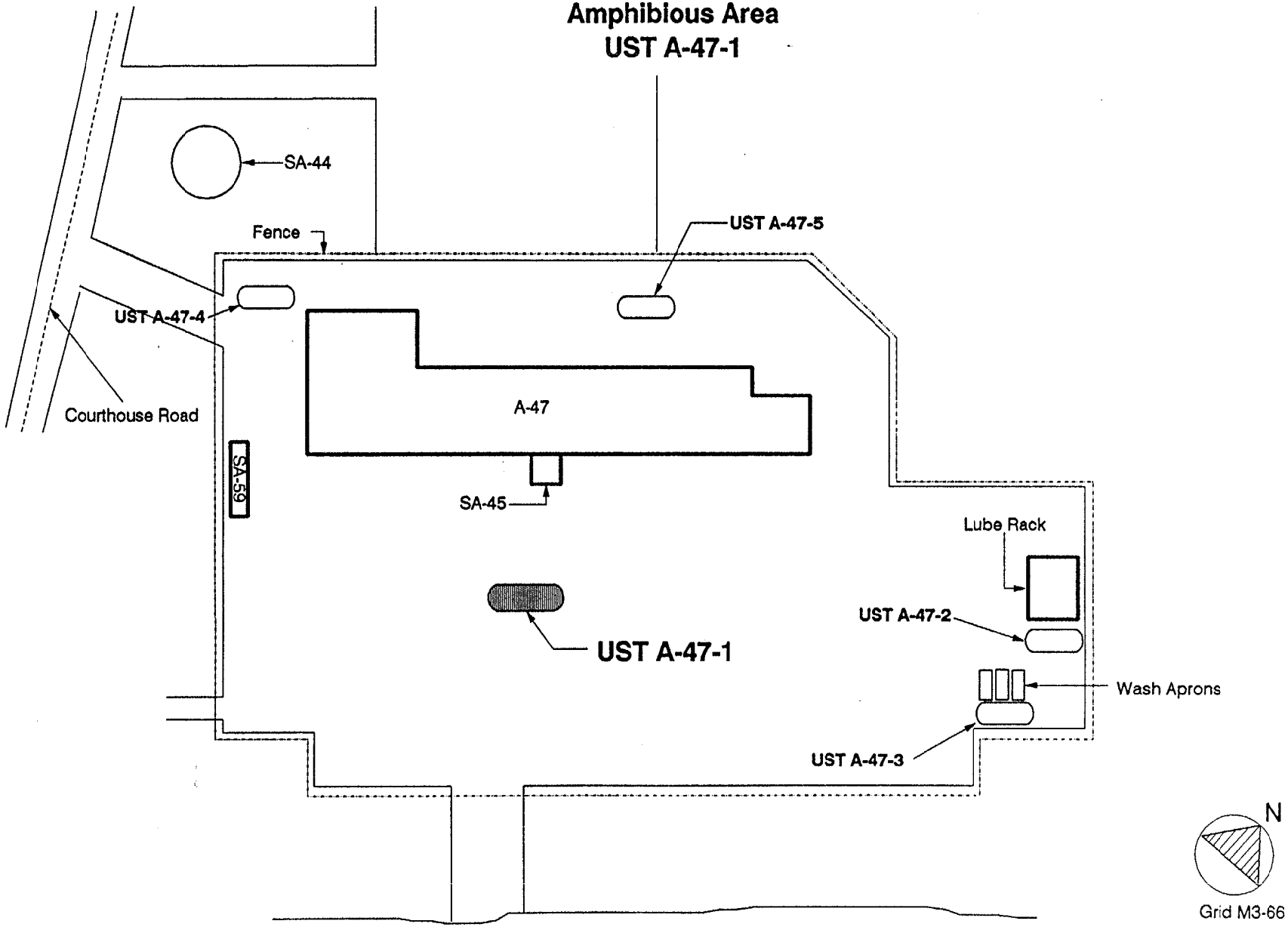
APPENDIX A -- UST PROFILES

APPENDIX A
UST PROFILES

Camp Lejeune
Amphibious Area
UST A-47-1



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

CAMP LEJEUNE AMPHIBIOUS AREA
INACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-47-1
2.	Facility Name:	LTV Maintenance Shop
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Inactive
5.	Installation Date:	1950
	Deactivation Date:	Unavailable
6.	Volume:	2000 Gallons
7.	Contents:	Empty
8.	System Use:	Military Outlet
9.	Facility Drawing Number(s):	452436, 957742, 4052567, 13816
10.	Tank Construction:	
	Material:	Steel
	Containment:	Single Walled
	Corrosion Protection:	None
	Cathodic Protection:	None
11.	Product Piping	
	Type:	American Suction
	Size:	1.50 Inch(es)
	Length:	Unavailable
	Location:	Below Grade
	Construction Material:	Steel
	Corrosion Protection:	None
	Cathodic Protection:	None

2. Site Characteristics

1. Surrounding Soil:

pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity	High
Sulfides Present:	No

2. Surface Finish:	Concrete
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Light

3. General Comments

The field inspection was conducted on July 7, 1991. This tank was originally associated with building A-3, which no longer exists. It is now located in the middle of the parking lot for building A-47. Two holes exist in the concrete parking lot to mark tank location. Base personnel indicated that the tank has been filled with sand. The volume and age of tank are unknown. It is believed that at least two USTs were associated with building A-3, it is not known if either of these systems were removed. Not enough evidence was available to determine which UST this is. All building A-3 markings are presently covered with concrete. Base personnel indicated that UST A-47-1 is scheduled for removal.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-47-2
2.	Facility Name:	Maintenance Shop
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Regulated
	Regulating Agency:	Federal, State
	EPA Reported:	No
	Permit Number:	Not Applicable
6.	Installation Date:	1986
7.	Volume:	2000 Gallons
8.	Contents:	Used Oil
9.	System Use:	Used Product Storage
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	4098888, 4098895, 4098889

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	None
Cathodic Protection:	Sacrificial Metal

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	Present
Gauge Port:	None
Vent Pipe:	Present
Manway:	None

3. Volumetric Chart: None

4. Drop Tube: None

5. Spill and Overfill Equipment: Catch Basin

6. Release Det. Equipment: None

7. Release Det. Method/Sched.: None

8. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: Not Applicable

3. Piping Characteristics

1. Product Piping:

Type:	Gravity
Size:	3.00 Inch(es)
Length:	100 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	None
Cathodic Protection:	None

2. Release Det. Method/Sched.: None

3. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

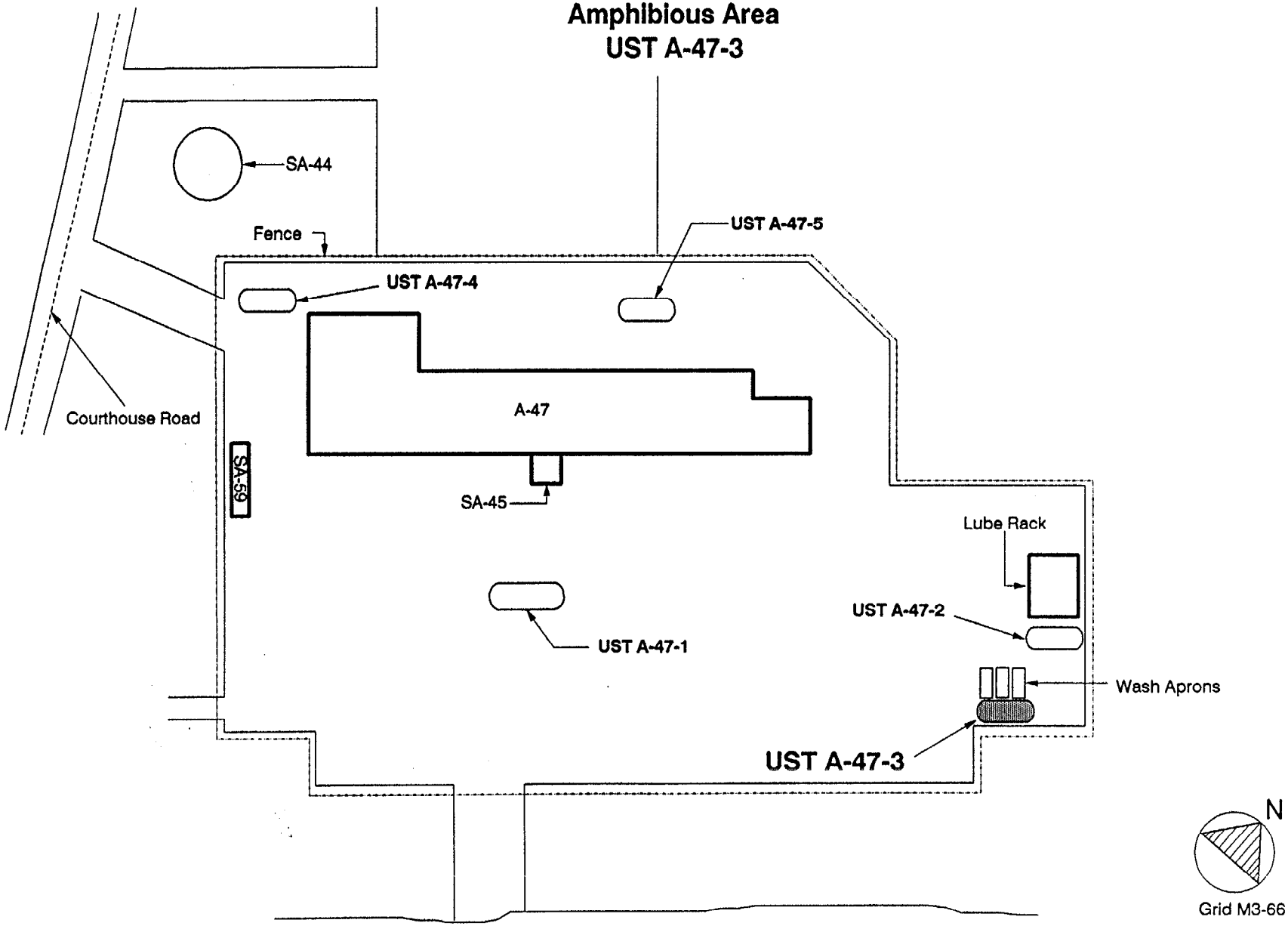
pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Concrete
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Heavy

5. General Comments

The field inspection was conducted on July 17, 1991. There is a vent pipe along the fence. What appears to be heavy oil stains exist in the vicinity of the fill port. Base personnel have indicated that UST A-47-2 is scheduled for removal.

Camp Lejeune
Amphibious Area
UST A-47-3



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-47-3
2.	Facility Name:	Maintenance Shop
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Regulated
	Regulating Agency:	Federal, State
	EPA Reported:	No
	Permit Number:	Not Applicable
6.	Installation Date:	1986
7.	Volume:	30000 Gallons
8.	Contents:	Diesel
9.	System Use:	Military Outlet
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	4098888, 4098895

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	Coated
Cathodic Protection:	Sacrificial Metal

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	None
Gauge Port:	Present
Vent Pipe:	Present
Manway:	Present

3. Volumetric Chart: Available

4. Drop Tube: None

5. Spill and Overfill Equipment: Catch Basin

6. Release Det. Equipment: None

7. Release Det. Method/Sched.: Inventory Control/Daily

8. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: Daily

3. Piping Characteristics

1. Product Piping:

Type:	American Suction
Size:	2.00 Inch(es)
Length:	45 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	Coated/Wrapped
Cathodic Protection:	None

2. Release Det. Method/Sched.: None

3. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

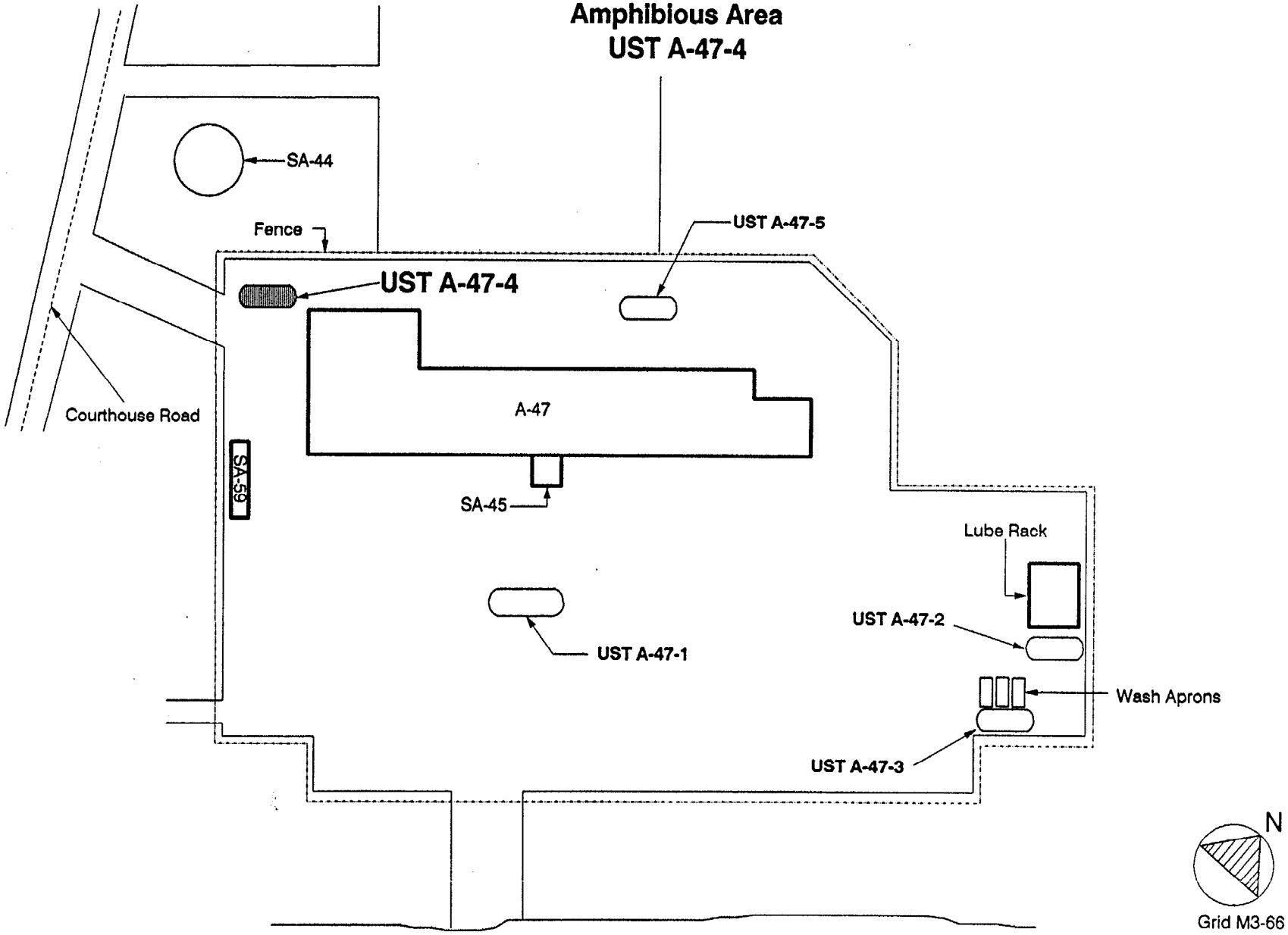
pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Concrete
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Heavy

5. General Comments

The field inspection was conducted on July 7, 1991. At the time of the inspection, the fill port was locked. The system utilizes a whistle vent alarm system assocaited with the vent pipe which is located along the adjacent fence. Base personnel indicated that the tank is "sticked" daily for volume and water and that UST A-47-3 is scheduled for removal.

Camp Lejeune
Amphibious Area
UST A-47-4



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-47-4
2.	Facility Name:	Maintenance Shop
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Regulated
	Regulating Agency:	Federal, State
	EPA Reported:	No
	Permit Number:	Not Applicable
6.	Installation Date:	1986
7.	Volume:	5000 Gallons
8.	Contents:	Diesel
9.	System Use:	Military Outlet
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	4098888, 4098895

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	Coated
Cathodic Protection:	Sacrificial Metal

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	None
Gauge Port:	Present
Vent Pipe:	Present
Manway:	Present

3. Volumetric Chart: None

4. Drop Tube: None

5. Spill and Overfill Equipment: None

6. Release Det. Equipment: None

7. Release Det. Method/Sched.: None

8. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: Daily

3. Piping Characteristics

1. Product Piping:

Type:	American Suction
Size:	2.00 Inch(es)
Length:	40 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	Coated/Wrapped
Cathodic Protection:	None

2. Release Det. Method/Sched.: None

3. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

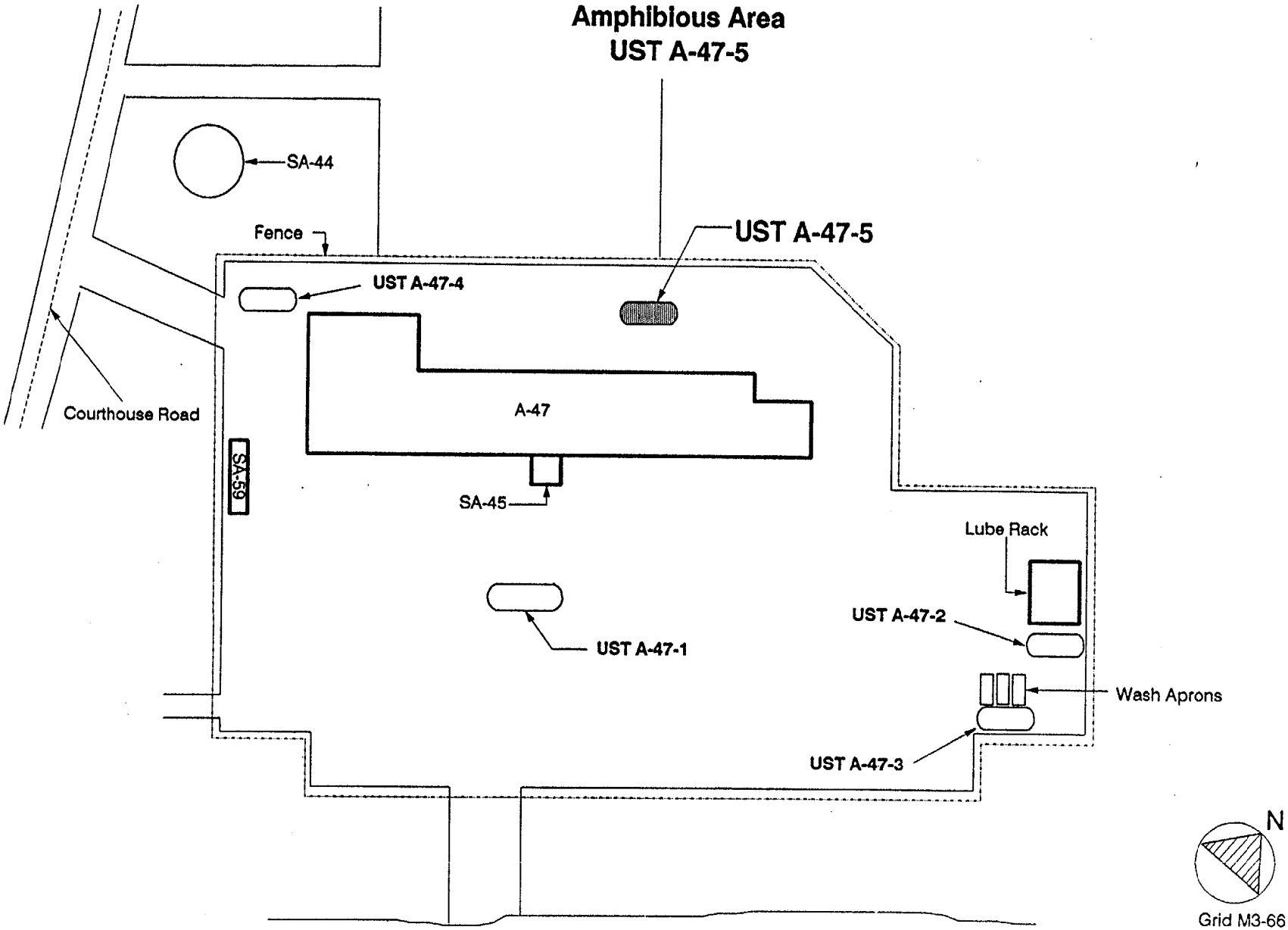
pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Concrete
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Medium

5. General Comments

The field inspection was conducted on July 17,1991. This UST is used to fill smaller service vehicles. The tank is "sticked" for volume and water daily by A-47 personnel. Without the use of a volumetric chart to reconcile "stick" measurements this method of monitoring the tank volume does not meet the regulations for daily inventory control. UST A-47-4 is located in east corner of the compound. Base personnel have indicated that UST A-47-4 is scheduled for removal.

Camp Lejeune
Amphibious Area
UST A-47-5



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-47-5
2.	Facility Name:	Maintenance Shop
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Nonregulated
	Regulating Agency:	
	EPA Reported:	No
	Permit Number:	Unavailable
6.	Installation Date:	1986
7.	Volume:	10000 Gallons
8.	Contents:	Diesel
9.	System Use:	Heat Production
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	4098888, 4098895

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	Coated
Cathodic Protection:	Sacrificial Metal

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	None
Gauge Port:	Present
Vent Pipe:	Present
Manway:	None

3. Volumetric Chart: None

4. Drop Tube: None

5. Spill and Overfill Equipment: Catch Basin

6. Release Det. Equipment: Not Applicable

7. Release Det. Method/Sched.: Not Applicable

8. Current Test Data:

Results:	Not Applicable
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: Not Applicable

3. Piping Characteristics

1. Product Piping:

Type:	American Suction
Size:	Unavailable
Length:	80 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	Coated/Wrapped
Cathodic Protection:	Not Applicable

2. Release Det. Method/Sched.: Not Applicable

3. Current Test Data:

Results:	Not Applicable
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

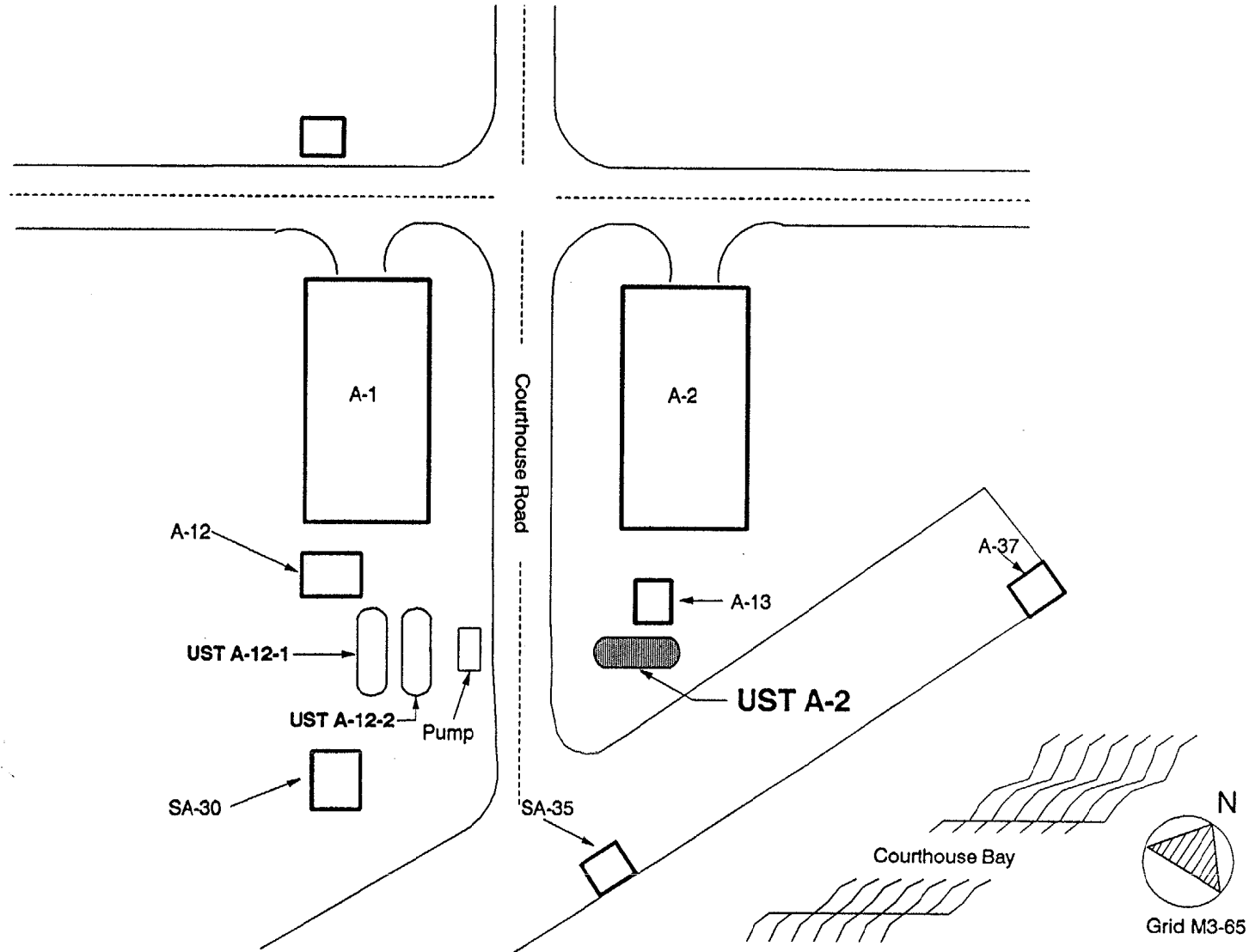
pH:	Unavailable
Permeability:	Rapid
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Unavailable
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	6 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Medium

5. General Comments

The field inspection was conducted on July 17, 1991. The reported system volume is taken from a G&M report. Base personnel reported that product is delivered to this system approximately every two weeks in the winter. Base personnel also indicated that UST A-47-5 is sceduled for removal.

Camp Lejeune
Amphibious Area
UST A-2



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-2
2.	Facility Name:	Maintenance Shed
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Regulated
	Regulating Agency:	Federal, State
	EPA Reported:	No
	Permit Number:	Not Applicable
6.	Installation Date:	1983
7.	Volume:	550 Gallons
8.	Contents:	Used Oil
9.	System Use:	Used Product Storage
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	N62470-91-B-7395 C-4, 4052563

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	None
Cathodic Protection:	None

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	Present
Gauge Port:	Present
Vent Pipe:	Present
Manway:	None

3. Volumetric Chart: None

4. Drop Tube: None

5. Spill and Overfill Equipment: Catch Basin

6. Release Det. Equipment: None

7. Release Det. Method/Sched.: None

8. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: None

3. Piping Characteristics

1. Product Piping:

Type:	Gravity
Size:	2.00 Inch(es)
Length:	25 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	None
Cathodic Protection:	None

2. Release Det. Method/Sched.: None

3. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

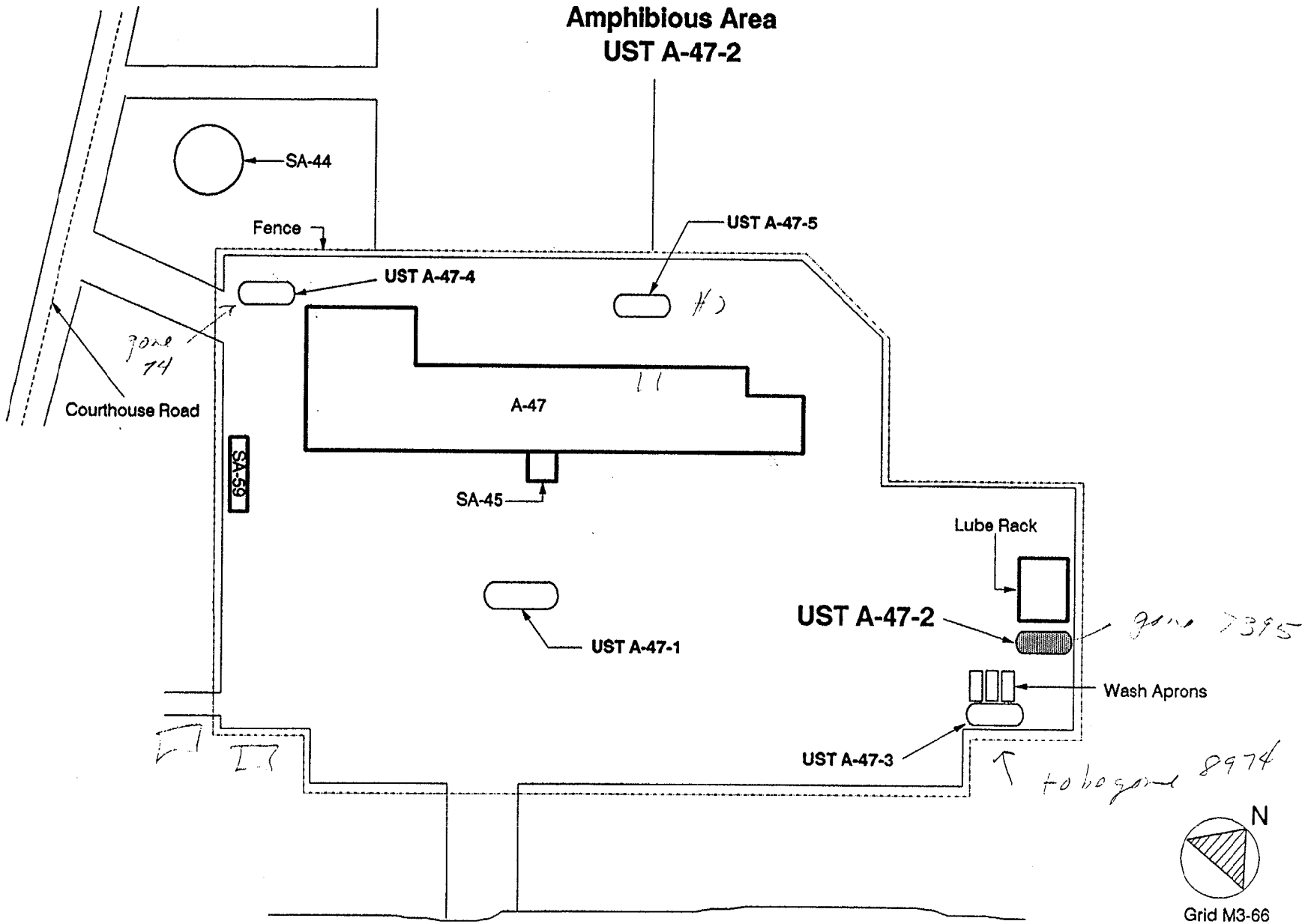
pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Concrete
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Light

5. General Comments

The field inspection was conducted on July 7, 1991. A 500 gallon AGT is on the same location as UST A-2. The tank fill gauge is broken. Apparent oil stains are present on surrounding concrete and catch basin. This system is located close to building A-13. Base personnel have indicated that UST A-2 is to be removed.

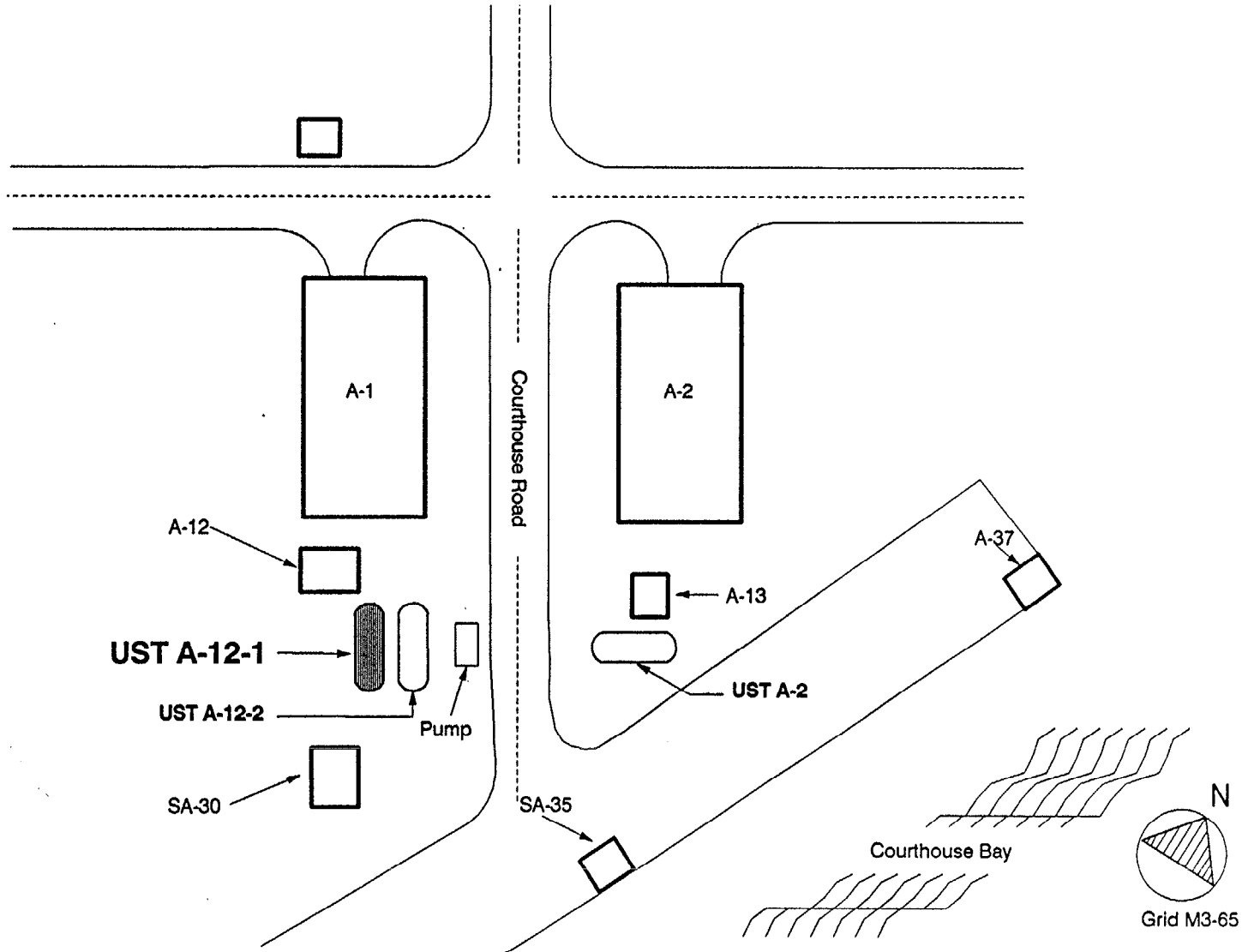
Camp Lejeune
Amphibious Area
UST A-47-2



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

Camp Lejeune
Amphibious Area
UST A-12-1



EG&G Idaho, Inc.

Site sketches are schematic representations indicating approximate locations and orientations.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-12-1
2.	Facility Name:	Fueling Area
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Regulated
	Regulating Agency:	Federal, State
	EPA Reported:	No
	Permit Number:	Not Applicable
6.	Approx. Installation Date:	1950
7.	Volume:	10000 Gallons
8.	Contents:	Diesel
9.	System Use:	Military Outlet
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	452552, 4052563, 267715, 162756

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	None
Cathodic Protection:	None

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	Present
Gauge Port:	None
Vent Pipe:	Present
Manway:	None

3. Volumetric Chart: None

4. Drop Tube: None

5. Spill and Overfill Equipment: None

6. Release Det. Equipment: None

7. Release Det. Method/Sched.: None

8. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: Daily

3. Piping Characteristics

1. Product Piping:

Type:	American Suction
Size:	2.00 Inch(es)
Length:	300 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	None
Cathodic Protection:	None

2. Release Det. Method/Sched.: None

3. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Grass
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Light

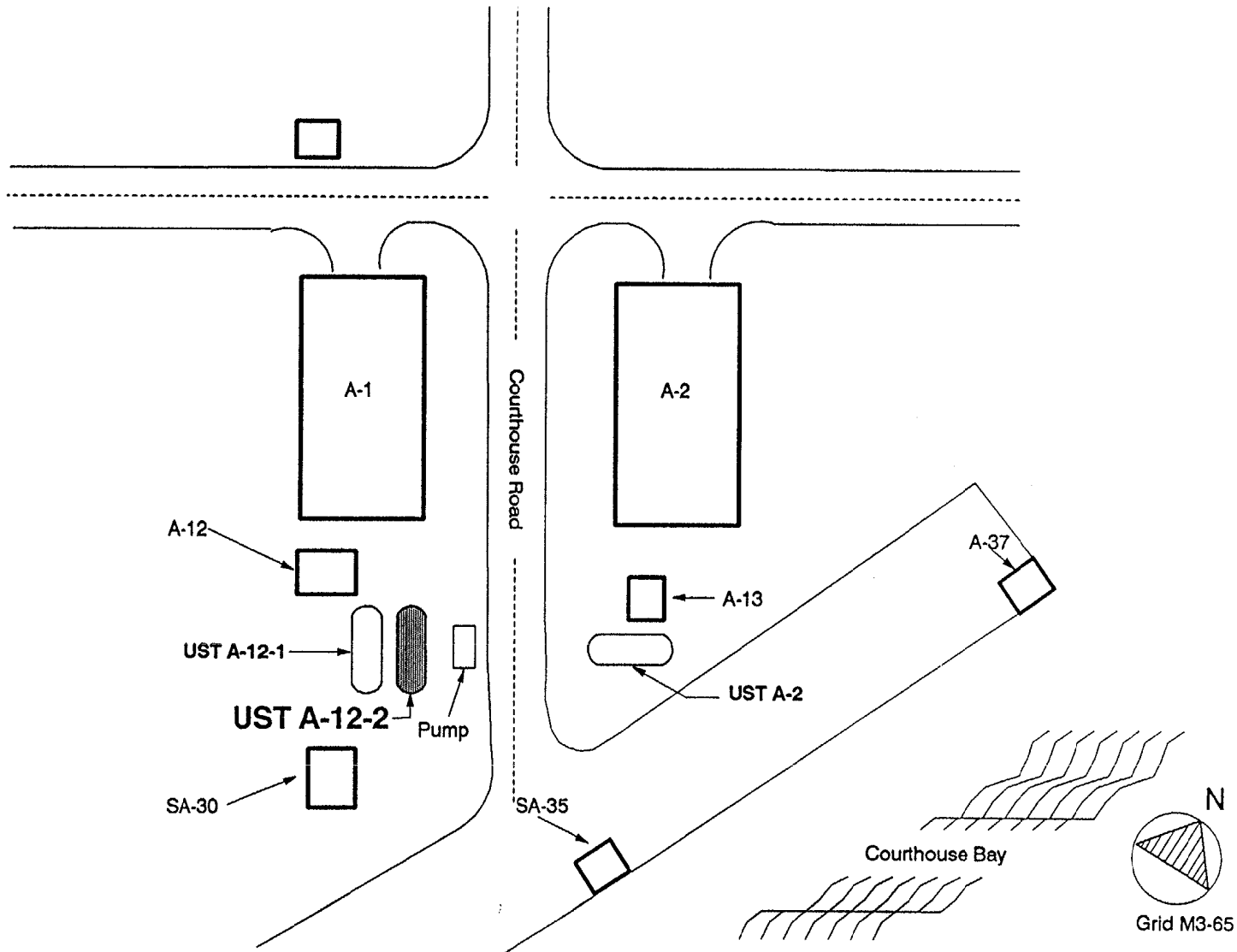
5. General Comments

The field inspection was conducted on July 7, 1991. At the time of the inspection it was noted that the soil cover above the vessel had slumped. A discrepancy exists in that, the Lejeune data base indicates that USTs A-12-2, and A-12-1 are 500 gallons and 2,000 gallons respectively. Construction drawings (listed on previous page) indicated the volume of each tank to be 10,000 gallons. The later figure is assumed to be correct.

Product is piped approximately 300 feet to the waters edge. Three fueling spurs exist at various locations along this path.

Personnel assigned to facility number A-47 are responsible for "sticking" the tanks on a daily basis. Without the use of a volumetric chart to reconcile "stick" measurements this method of monitoring the tank volume does not meet the regulations for daily inventory control. This UST system has been identified by the base in a removal contract.

Camp Lejeune
Amphibious Area
UST A-12-2



EG&G Idaho, Inc.

CAMP LEJEUNE AMPHIBIOUS AREA
ACTIVE UNDERGROUND STORAGE TANK

1. System Characteristics

1.	System Identification Number:	A-12-2
2.	Facility Name:	Fueling Area
3.	Operator Organization:	2nd Marine Division
4.	Operating Status:	Active
5.	Regulatory Status:	Regulated
	Regulating Agency:	Federal, State
	EPA Reported:	No
	Permit Number:	Not Applicable
6.	Approx. Installation Date:	1950
7.	Volume:	10000 Gallons
8.	Contents:	Regular Gasoline
9.	System Use:	Military Outlet
10.	Operational Duty:	5 days/week
11.	Facility Drawing Number(s):	452552, 4052563, 267715, 162756

2. Tank Characteristics

1. Tank Construction:

Material:	Steel
Containment:	Single Walled
Corrosion Protection:	None
Cathodic Protection:	None

2. Tank Openings:

Direct Fill Pipe:	Present
Remote Fill Pipe:	Present
Gauge Port:	None
Vent Pipe:	Present
Manway:	None

3. Volumetric Chart: None

4. Drop Tube: None

5. Spill and Overfill Equipment: None

6. Release Det. Equipment: None

7. Release Det. Method/Sched.: None

8. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

9. In-Tank Water Testing Sched.: Daily

3. Piping Characteristics

1. Product Piping:

Type:	American Suction
Size:	2.00 Inch(es)
Length:	300 Feet
Location:	Below Grade
Construction Material:	Steel
Corrosion Protection:	None
Cathodic Protection:	None

2. Release Det. Method/Sched.: None

3. Current Test Data:

Results:	Not Tested
Date:	
Contractor:	

4. Site Characteristics

1. Surrounding Soil:

pH:	Unavailable
Permeability:	Unavailable
Normal Moisture Content:	Wet
Resistivity:	High
Sulfides Present:	No

2. Surface Finish:	Grass
3. Adjacent Surface Water:	Yes
4. Groundwater Depth:	5 Feet
Velocity:	2920 Feet/Year
Direction:	S
5. Hydraulic Conductivity:	35 Feet
6. Area Traffic:	Light

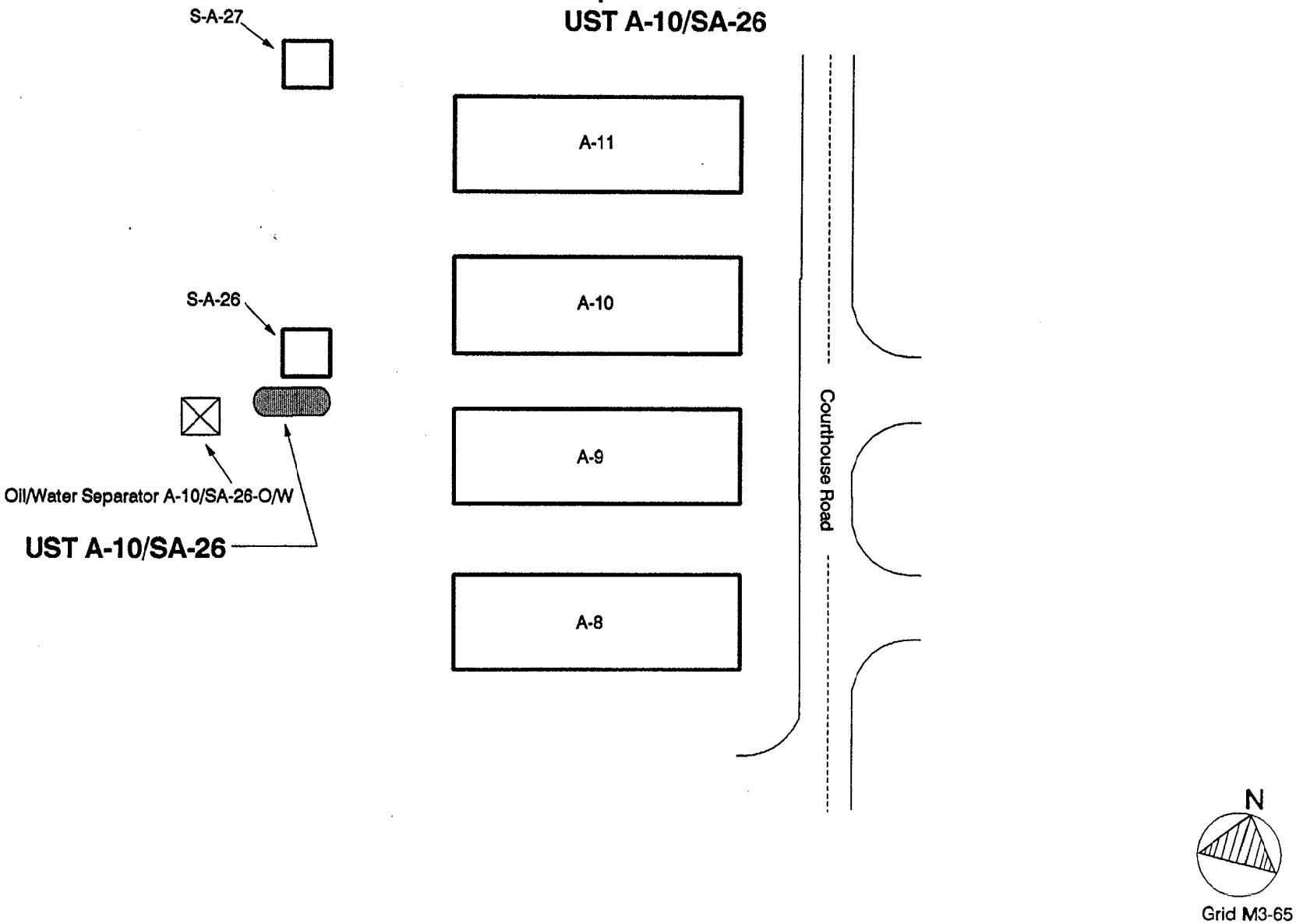
5. General Comments

The field inspection was conducted on July 7, 1991. At the time of the inspection it was noted that the soil cover above the vessel had slumped. A discrepancy exists in that, the Lejeune data base indicates that USTs A-12-2, and A-12-1 are 500 gallons and 2,000 gallons respectively. Construction drawings (listed on previsou page) indicated the volume of each tank to be 10,000 gallons. The later figure is assumed correct.

Product is piped approximately 300 feet to the waters edge. Three fueling spurs exist at various locations along this path.

Personnel assigned to facility number A-47 are responsible for "sticking" the tanks on a daily basis. Without the use of a volumetric chart to reconcile "stick" measurements this method of monitoring the tank volume does not meet the regulations for daily inventory control. This UST system has been identified by the base in a removal contract.

Camp Lejeune
Amphibious Area
UST A-10/SA-26



EG&G Idaho, Inc.

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