03.05-09/25/90-00379

WORK PLAN

FINAL

FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY
AT
HADNOT POINT INDUSTRIAL AREA

AND

LIMITED SCOPE INVESTIGATIONS
AT
SITES 6, 48, AND 69

MARINE CORPS BASE CAMP LEJEUNE
NORTH CAROLINA

Prepared For:

NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION

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ESE PROJECT NO. 49-02036

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1.0 INTRODUCTION

This Work Plan describes a Remedial Investigation/Feasibility Study (RI/FS) for the Hadnot Point Industrial Area (HPIA), and limited scope investigations at Sites 6, 48, and 69, located at the Marine Corps Base (MCB) Camp Lejeune in North Carolina. These investigations are being performed for the Naval Facilities Engineering Command-Atlantic Division (LANTDIV), as authorized under A&E Contract Number N62470-83-C-6106.

1.1 WORK PLAN DESCRIPTION

This Work Plan has been prepared based on a Scope of Work developed by LANTDIV and Hunter/ESE (Hunter). Information provided by a Confirmation Study (Phase II of the Installation Restoration Program) conducted by Environmental Science and Engineering, Inc. (ESE) in 1984-1988 was used to develop the scope of work. The current effort, although a continuation of the Confirmation Study, will be conducted under the regulations, guidelines, and criteria established by the United States Environmental Protection Agency (EPA) for the Superfund Program. The Camp Lejeune site was placed on Superfund's National Priorities List (NPL) in 1989.

This Work Plan addresses shallow and deep groundwater contamination and shallow soils contamination at HPIA, and groundwater, surface water, sediment and fish tissue contamination at Sites 6, 48, and 69.

This Work Plan is organized into 7 major sections. Section 2.0 presents a description of each site, including site location and history. Section 3.0 presents initial evaluations of each site. The evaluations include physical and chemical characterizations, a discussion of Applicable or Relevant and Appropriate Requirements (ARARs), preliminary risk assessments, and scoping of remedial alternatives. Section 5.0 presents the Work Plan rationale, which includes RI/FS and limited scope investigation objectives and Data Quality Objectives (DQOs) for the field activities. Task descriptions for the site investigations are presented in Section 6.0. A project schedule is presented in Section 7.0.

2.0 SITE LOCATIONS, DESCRIPTIONS, AND HISTORIES

The four sites to be investigated are located within MCB Camp Lejeune. MCB Camp Lejeune is a training base for the Marine Corps, located in Onslow County, North Carolina (Figure 2-1).

The facility, which covers approximately 170 square miles, is bounded to the southeast by the Atlantic Ocean, to the west by U.S. 17, and to the northeast by State Road 24. The base is bisected by the New River estuary, which occupies approximately 30 square miles of the total area of the facility.

As a result of Marine operations and activities, substantial quantities of wastes that contain hazardous and toxic organic compounds have been generated at the base. This has resulted in the storage, disposal, and/or spillage of these wastes around the base. Several of the base's water supply wells have been shut down as a result of the presence of organic compounds, thus suggesting that some of the wastes may have entered the groundwater.

The four sites to be investigated are described below.

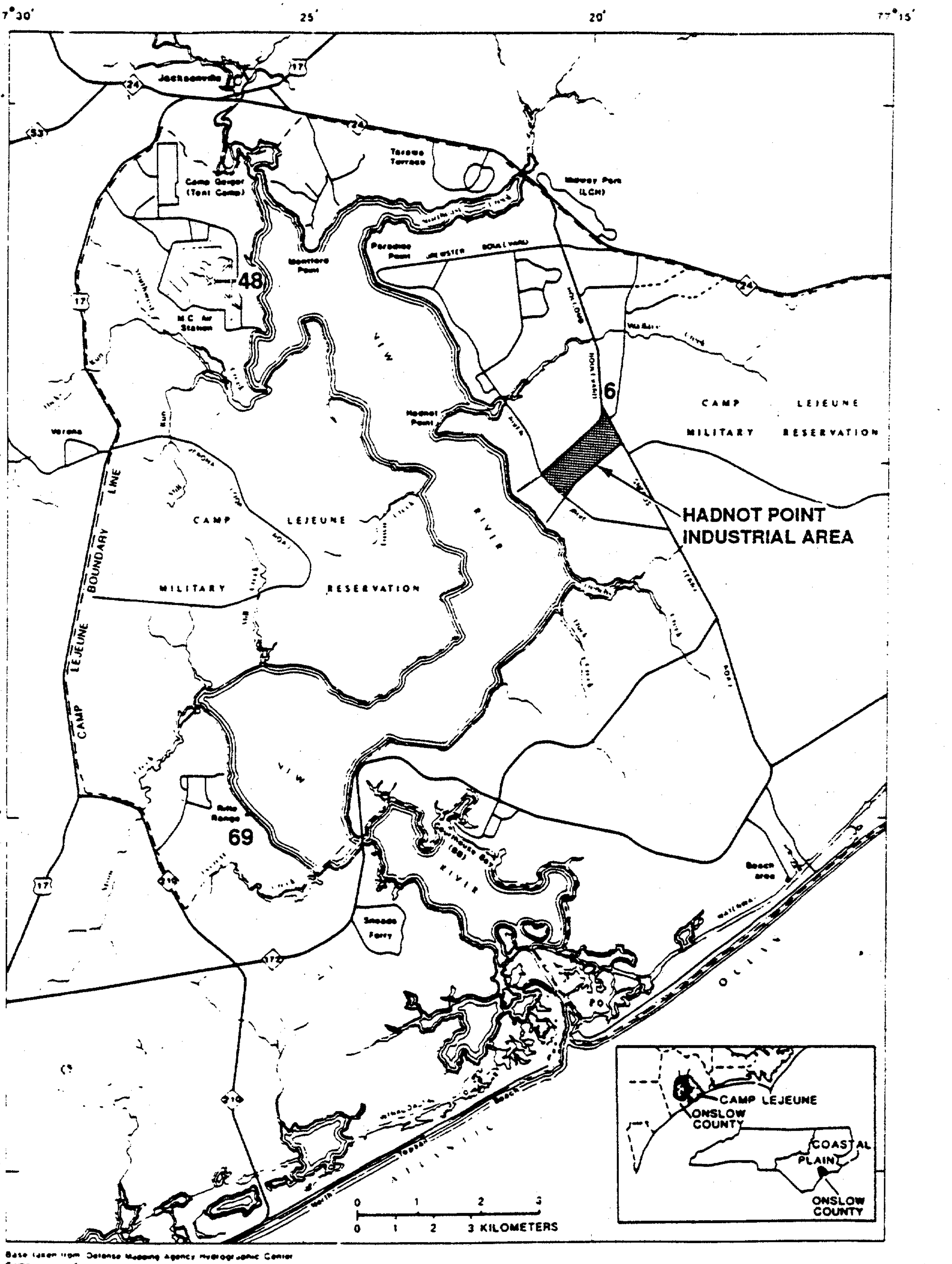
2.1 HADNOT POINT INDUSTRIAL AREA

The Hadnot Point Industrial Area (HPIA) of MCB Camp Lejeune is located on the east side of the New River. For the purposes of this investigation, HPIA is defined as that area bounded by Holcomb Blvd. to the west, Sneads Ferry Road to the north, Louis Street to the east, and the Main Service Road to the south (Figures 2-1 and 2-2).

The HPIA is comprised of approximately 75 buildings/facilities. These include maintenance shops, gas stations, administrative offices, commissaries, snack bars, warehouses, storage yards, and a dry cleaning facility. A steam plant and training facility occupy the southwest portion of HPIA. In addition, numerous underground storage tanks, stormwater drains, and oil/water separators are present.

A transformer storage yard (Site 21) and a fuel tank farm (Site 22) are located within the northern portion of HPIA. These two areas of concern are not included in the proposed RI/FS scope of work presented in this work plan. Sites 21 and 22 will be considered in separate studies at a later date.

The establishment of MCB Camp Lejeune began in the late 1930's with the construction of the HPIA facility. Water supply for the base was furnished by wells which tapped a potable aquifer 50 to 300 feet below the base. In 1941, a water treatment system including 21 water supply wells was placed on-line at HPIA. This system serviced most of the base until the 1950's when additional wells and treatment facilities were



Base taken from Defense Mapping Agency Hydrographic Center Camp Lejeune Special Map 1:50 000

Figure 2-1
SITE LOCATIONS

SOURCE: HARNED *et al.*, 1989.

MARINE CORPS BASE CAMP LEJEUNE

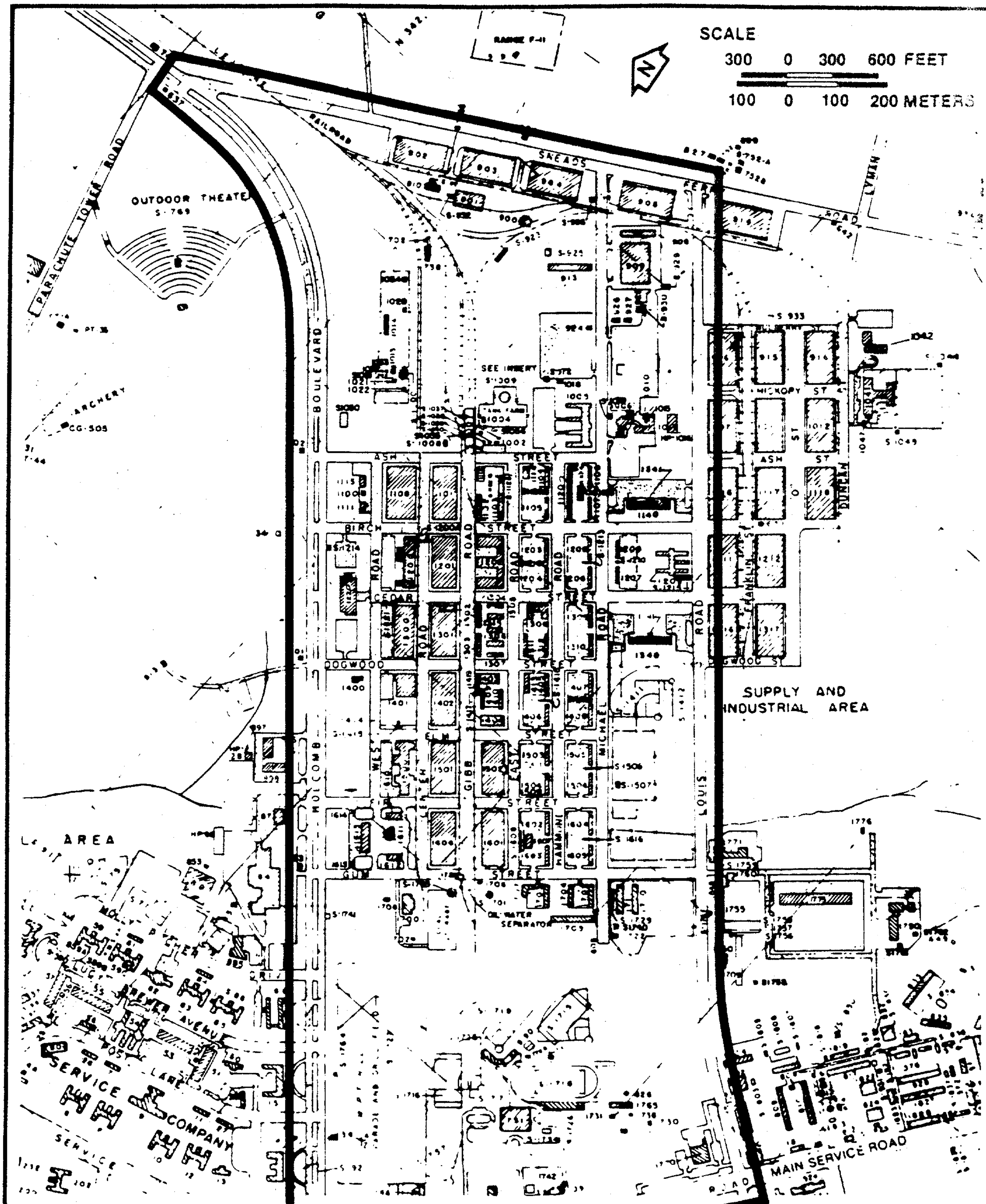


Figure 2-2
HADNOT POINT INDUSTRIAL AREA

SOURCE: CAMP LEJEUNE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE

installed because of the expanding needs of the base. Today, 8 water treatment facilities and over 160 water supply wells serve the MCB at Camp Lejeune.

The Industrial Area Tank Farm (Site 22) in the northern portion of HPIA encompasses approximately 4 acres. It was installed in the 1940's, and contains 14 underground storage tanks and one aboveground tank. Several fuel leaks have occurred throughout the site's history, with the most recent documented release occurring in 1981. This was a 100 gallon release of diesel fuel. A fuel release of approximately 20,000 to 50,000 gallons of diesel and unleaded fuel occurred in an underground distribution line near the tank truck loading facility in 1979.

2.2 SITE 6 - STORAGE LOTS 201 AND 203

Site 6, located just north of HPIA, is comprised of Storage Lots 201 and 203. Storage Lots 201 and 203 are situated on Holcomb Boulevard between Wallace and Bearhead Creeks (Figure 2-1 and 2-3). Lots 201 and 203 are approximately 25 and 46 acres in size, respectively. These lots are used to store hazardous materials. The lot surfaces are relatively flat and unpaved. Surface soils have reportedly been moved about as a result of equipment movement and regrading (Water and Air Research, 1983).

Lots 201 and 203 have long histories of various uses, including disposal and storage of hazardous materials. Hazardous materials are presently being stored at these lots. DDT is reported to have been disposed of at Lot 203 when it served as a waste disposal area in the 1940's. Transformers containing PCB's have also been stored at this site. No spills or leaks at these sites have been reported (Water and Air Research, 1983).

2.3 SITE 48 - MCAS MERCURY DUMP

Site 48 is located on the west side of the New River Estuary, on Longstaff Road next to Building 804 (photo lab) (Figure 2-1). Metallic mercury was periodically drained from the delay lines of radar units and disposed of at Site 48 (Water and Air Research, 1983). The actual disposal area is approximately 20,000 square feet and covers a 100-200 foot wide corridor which extends from the rear of Building 804 to the banks of the New River (Figure 2-4).

Approximately one gallon per year of mercury was disposed of over a 10 year period, resulting in disposal of more than 1,000 pounds of total mercury at Site 48 (Water and Air Research, 1983). The best information available indicates that the mercury was carried by hand and dumped or buried in small quantities at randomly selected spots.

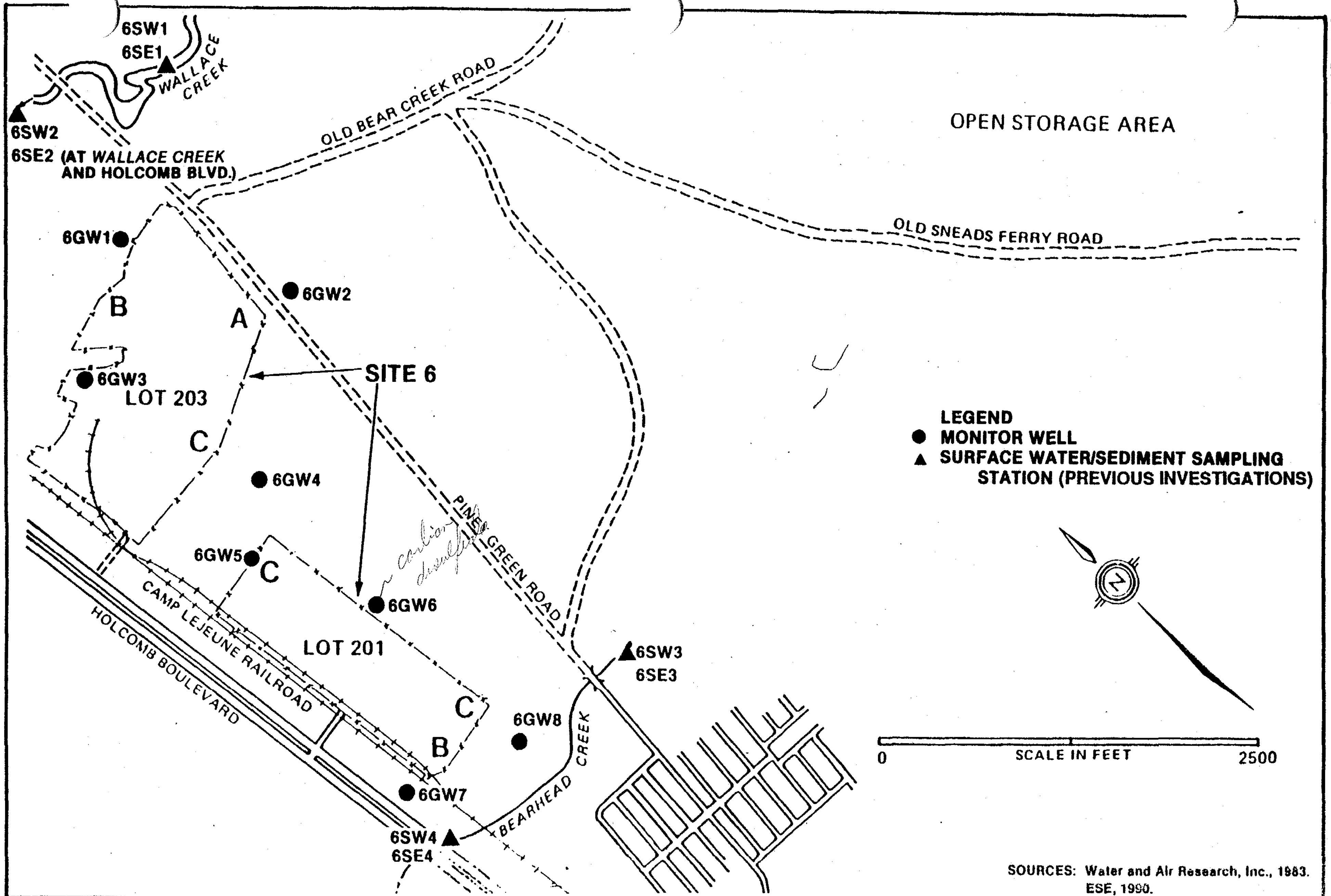


Figure 2-3
SITE 6
STORAGE LOTS 201 AND 203

MARINE CORPS BASE
CAMP LEJEUNE

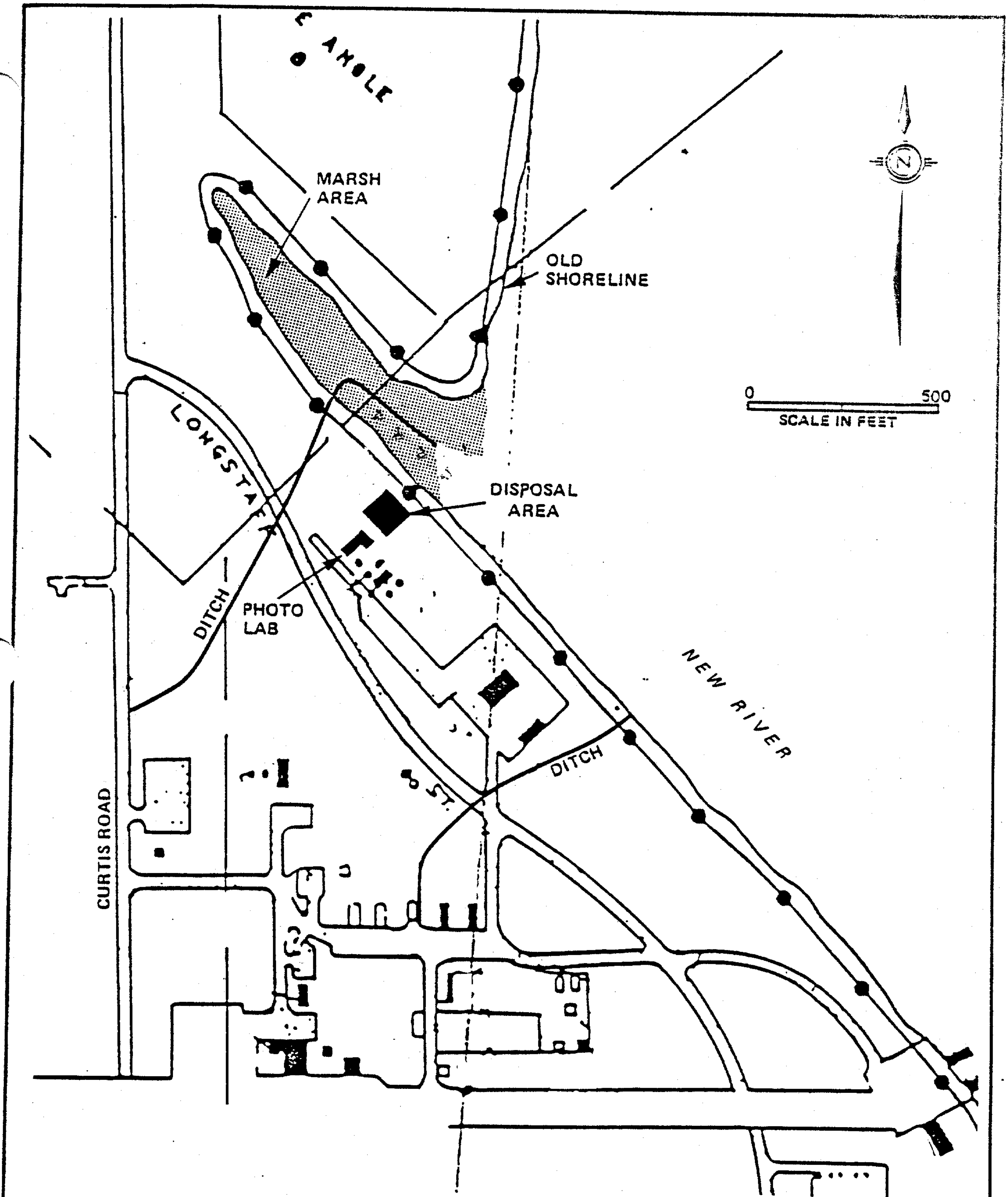


Figure 2-4
SITE 48
MCAS MERCURY DUMP

SOURCES: WATER AND AIR RESEARCH, INC., 1983; ESE, 1984.

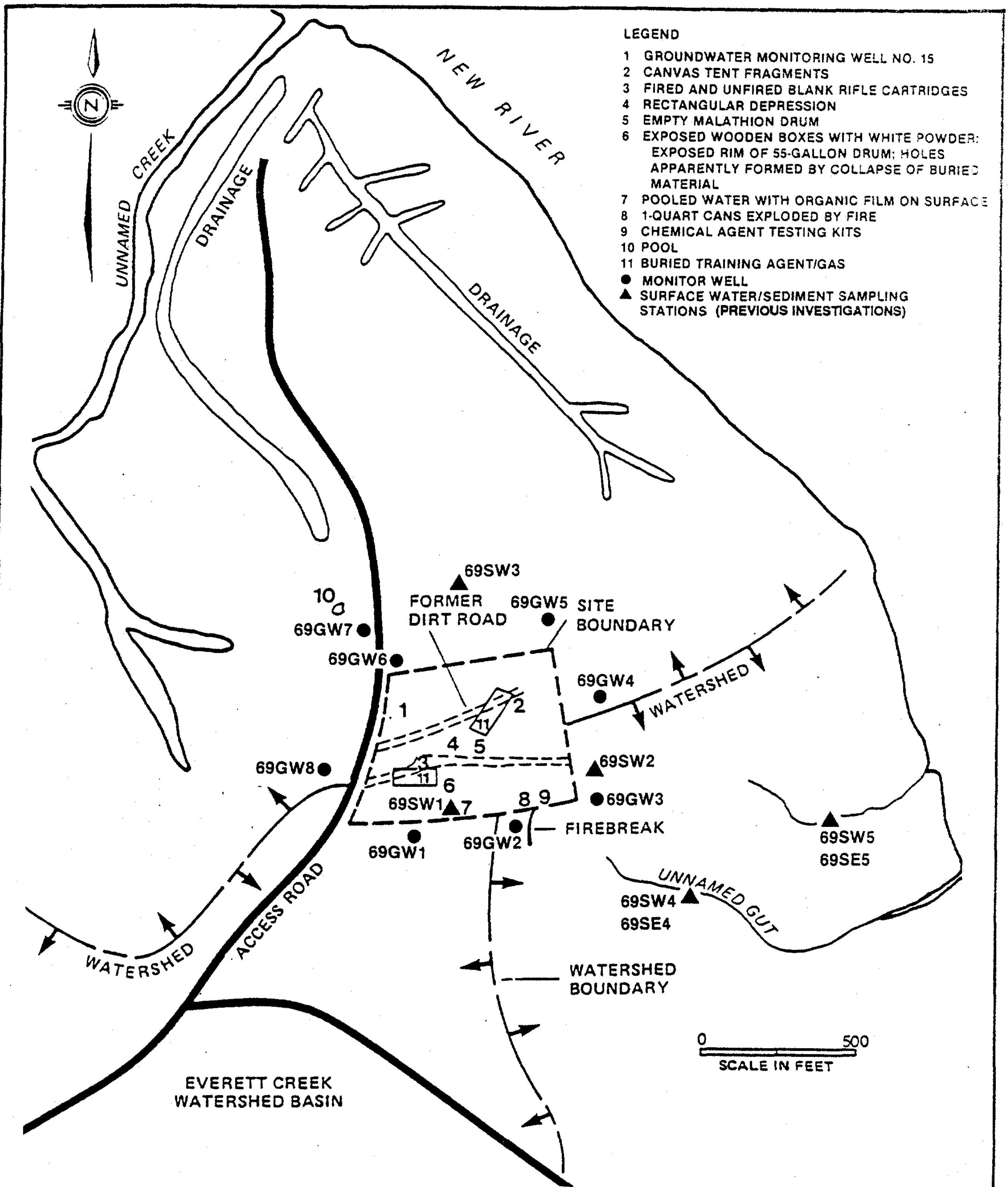
MARINE CORPS BASE
CAMP LEJEUNE

2.4 SITE 69 - RIFLE RANGE CHEMICAL DUMP

Site 69, the Rifle Range Chemical Dump, is also west of the New River Estuary, approximately 9000 feet east of the intersection of Range and Sneads Ferry Roads, north of Everett Creek (Figure 2-1). The site is an estimated six acres in size, containing approximately 93,000 cubic yards of material (Figure 2-5).

Site 69 was an active chemical dump from the early 1950's until 1976. It is reported that the site was utilized as a disposal area for chemical wastes generated at the base. The list of materials disposed of at the site include pentachlorophenol, DDT, trichloroethylene, malathion, diazinon, lindane, gas cylinders, HTH, PCB's, drums that appeared to contain training agent consisting of chloroacetophenone (CN) gas, all other hazardous materials generated or used on the base, and chemical agent test kits for chemical warfare which contain no agent substances (Water and Air Research, 1983).

The disposal of material was conducted in trenches or pits which were between 6 and 20 feet deep. At least twelve different disposal events have been documented at Site 69 (Water and Air Research, 1983).



SOURCES: Water and Air Research, Inc., 1983. ESE, 1990.

Figure 2-5
SITE 69
RIFLE RANGE CHEMICAL DUMP

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3.0 PREVIOUS INVESTIGATIONS

In early 1980 as part of the Department of Defense's Installation Restoration Program, an Initial Assessment Study (IAS) was conducted at MCB Camp Lejeune. The IAS report (Water and Air Research, 1983) identified a number of areas within MCB Camp Lejeune as potential sources of contamination. As a result of this study, ESE was contracted by LANTDIV to investigate these potential source areas.

The ESE investigation is referred to as a Confirmation Study, but is analogous to an RI/FS performed for the EPA on federal Superfund sites. The Confirmation Study focused on those areas identified in the IAS. The Confirmation Study is divided into two investigation steps: the Verification Step and the Characterization Step.

3.1 HADNOT POINT INDUSTRIAL AREA

The Verification Step at HPIA was conducted from April 1984 through January 1985. This step identified the presence of volatile organic compounds (VOCs) within the shallow aquifer in the vicinity of the Hadnot Point Industrial Area Tank Farm (Site 22) and in a single Supply Well (602). Maximum contaminant levels detected in groundwater at Site 22 during this effort include 17,000 micrograms per liter (μg/l) of benzene and 27,000 μg/l of toluene. Benzene was detected in Supply Well 602 at a level of 38 μg/l.

As a result of the Verification step, Camp Lejeune closed Supply Well 602 and sampled other supply wells in the area. Four additional supply wells (601, 608, 634, and 637) were found to be contaminated with VOCs and were also shut down. Maximum levels of contaminants detected in these wells include 230 μg/l of trichloroethylene (TCE) in 601, 110 μg/l of TCE in 608 and 130 μg/l of methylene chloride in 634.

The Characterization Step, performed at HPIA in 1986-1988, was designed to evaluate the extent of the VOC contamination identified in the Verification Step. The Characterization Step consisted of the following 5 tasks:

1) Records search including detailed review of available base records and a physical inspection of each building within HPIA;

2) Soil gas survey targeted to those areas identified by the records search as being potential contamination sources;

3) Installation of 27 shallow (25 feet), 3 intermediate (75 feet), and 3 deep (150 feet) monitoring wells;

4) Sampling of all HPIA monitoring wells (including those previously installed at Site 22) and nearby water supply wells (Figure 3-1), and

5) Aquifer testing to evaluate the hydraulic parameters of the deep aquifer.

Results of the Characterization Step are presented in Section 4.0, INITIAL EVALUATION.

In 1988, ESE conducted a focused Feasibility Study for remediating shallow groundwater at HPIA. The database developed during the Characterization Step effort was utilized to select a cost-effective remedial alternative. A pump and treat alternative was determined to be the most feasible remedial alternative (ESE, 1988). It is anticipated that the groundwater pumped from the shallow aquifer will be treated at the Hadnot Point Sewage Treatment Plant. The effluent from the plant will be discharged to the New River. Additional data required to support this selection will be acquired during the proposed field investigation.

3.2 SITES 6, 48, AND 69:

The ESE investigations at Sites 6, 48, and 69 were less extensive than that conducted at HPIA. These investigations were conducted from 1984-1986, and consisted of the following tasks:

Site 6:

1) Installation of eight shallow monitoring wells (1986);
2) Upstream and downstream surface water sampling of nearby Wallace and Bearhead Creeks (1986), and
3) Soil sampling (0-3 foot composites) in four "most likely contaminated" areas; 5 borings/location (1984).

Site 48:

1) Soil sampling at the soil/water table interface (1984), and
2) Sediment sampling in the marsh area north of Building 804 (1984).

Site 69:

1) Installation of eight shallow monitoring wells (1984), and
2) Surface water and sediment sampling (1984).

Results of these limited investigations are presented in Section 4.0, INITIAL EVALUATION.

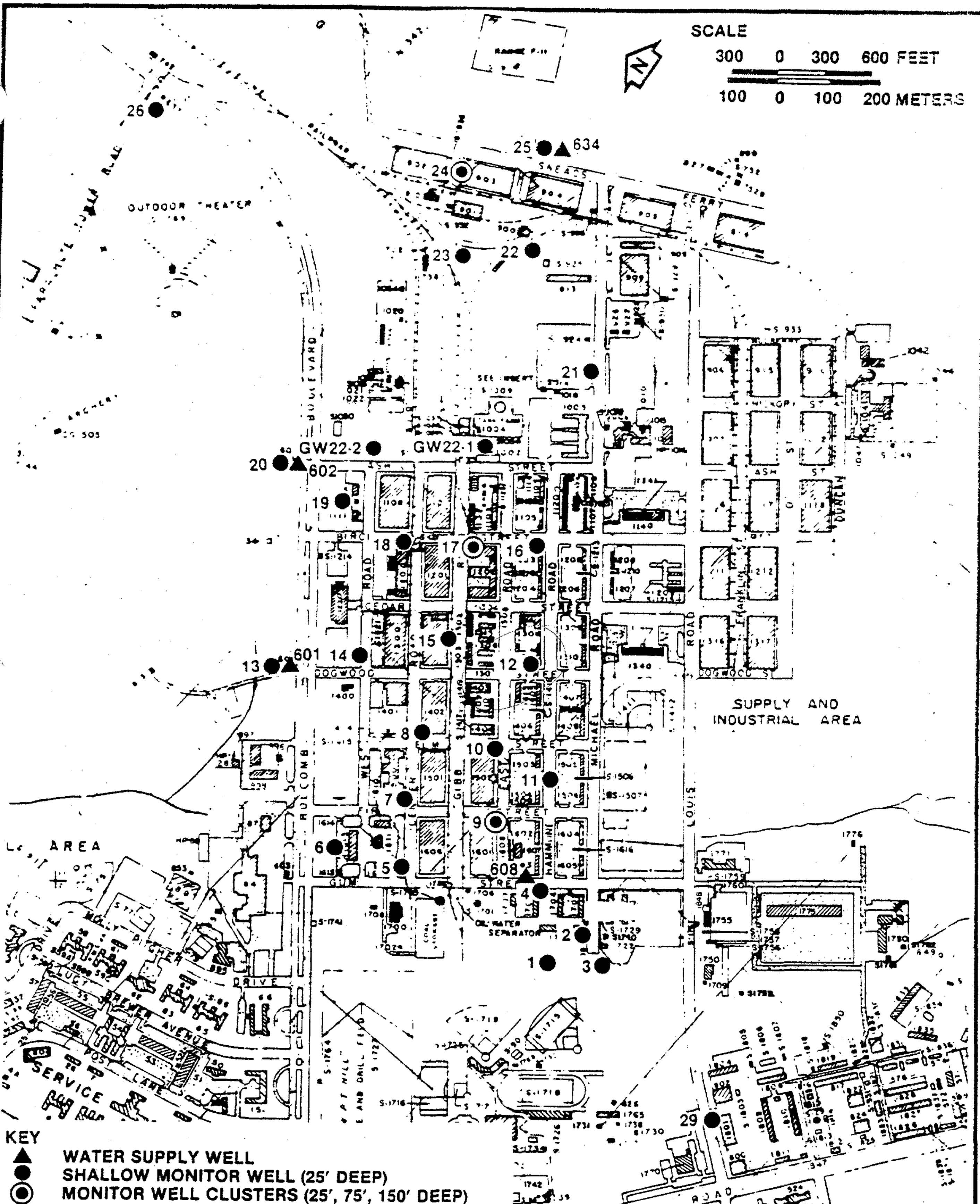


Figure 3-1
MONITORING WELLS AND WATER SUPPLY WELLS AT HADNOT POINT INDUSTRIAL AREA
SOURCE: ESE, 1987.

MARINE CORPS BASE CAMP LEJEUNE

4.0 INITIAL EVALUATION

The information presented below is based on the Confirmation Study conducted by ESE and a hydrogeologic investigation of Camp Lejeune conducted by the USGS (Harned et al., 1989).

4.1 PHYSICAL CHARACTERIZATION

4.1.1 TOPOGRAPHY AND DRAINAGE

MCB Camp Lejeune is situated on relatively flat terrain which includes swamps, estuaries, savannas, and forest lands. Specifically, land surface elevations range from mean sea level (msl) to 72 feet above msl. Average elevations are between 20 and 40 feet above msl.

A 200 to 500 foot wide barrier island complex lies along the coast. The dune fields which are located on these barrier islands have elevations which range from 10 to 40 feet above msl.

The drainage at MCB Camp Lejeune is predominantly toward the New River and its tributaries, although coastal areas drain directly to the Atlantic Ocean via the Intercoastal Waterway. Natural drainage has been changed in developed areas by the installation of drainage ditches and storm sewers, and extensive paving.

4.1.2 REGIONAL GEOLOGY

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments are layered in interfingering beds and lenses that gently dip and thicken to the southeast (Todd, 1983), and can be divided into 10 aquifers and 9 confining units. The sediments are approximately 1500 feet thick, and overlie igneous and metamorphic basement rocks. These sediments were deposited in marine or near marine environments (Brown et al., 1972).

Figure 4-1 presents a generalized stratigraphic column for this area (Harned et al., 1989).

4.1.3 SITE GEOLOGY

MCB Camp Lejeune is underlain by 7 sand and limestone aquifers separated by confining units of silt and clay (Harned et al., 1989). The 7 aquifers are the surficial, Castle Hayne, Beaufort, Peedee, Black Creek, and Upper and Lower Cape Fear (Figure 4-1). Less permeable clay and silt beds separate the aquifers and serve as confining or semi-confining units which impede the flow of groundwater from one aquifer to another. A hydrogeologic cross-section of this area is presented in Figure 4-2

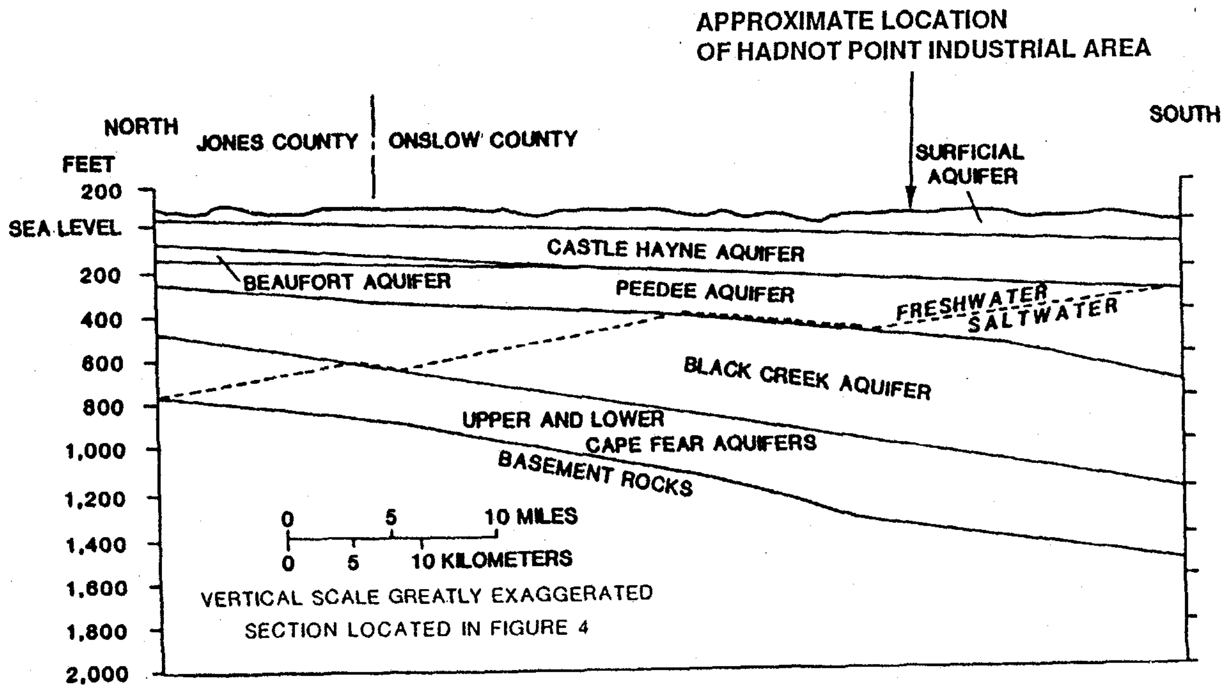
<table>
<tr><th colspan="3">GEOLOGIC UNITS</th><th>HYDROGEOLOGIC UNITS</th></tr>
<tr><th>SYSTEM</th><th>SERIES</th><th>FORMATION</th><th>AQUIFER AND CONFINING UNIT</th></tr>
<tr><td>Quaternary</td><td>Holocene
Pleistocene</td><td>Undifferentiated</td><td>Surficial aquifer</td></tr>
<tr><td rowspan="9">Tertiary</td><td rowspan="2">Pliocene</td><td rowspan="2">Yorktown Formation[1]</td><td>Yorktown confining unit</td></tr>
<tr><td>Yorktown aquifer</td></tr>
<tr><td rowspan="3">Miocene</td><td>Eastover Formation[1]</td><td>Pungo River confining unit</td></tr>
<tr><td>Pungo River Formation[1]</td><td>Pungo River aquifer</td></tr>
<tr><td>Belgrade Formation[2]</td><td>Castle Hayne confining unit</td></tr>
<tr><td>Oligocene</td><td>River Bend Formation</td><td rowspan="2">Castle Hayne aquifer</td></tr>
<tr><td>Eocene</td><td>Castle Hayne Formation</td></tr>
<tr><td rowspan="2">Paleocene</td><td rowspan="2">Beaufort Formation</td><td>Beaufort confining unit[3]</td></tr>
<tr><td>Beaufort aquifer</td></tr>
<tr><td></td><td></td><td></td><td>Peedee confining unit</td></tr>
<tr><td rowspan="9">Cretaceous</td><td rowspan="7">Upper Cretaceous</td><td rowspan="2">Peedee Formation</td><td>Peedee aquifer</td></tr>
<tr><td>Black Creek confining unit</td></tr>
<tr><td rowspan="2">Black Creek and Middendorf Formations</td><td>Black Creek aquifer</td></tr>
<tr><td>Upper Cape Fear confining unit</td></tr>
<tr><td rowspan="3">Cape Fear Formation</td><td>Upper Cape Fear aquifer</td></tr>
<tr><td>Lower Cape Fear confining unit</td></tr>
<tr><td>Lower Cape Fear aquifer</td></tr>
<tr><td rowspan="2">Lower Cretaceous[1]</td><td rowspan="2">Unnamed deposits[1]</td><td>Lower Cretaceous confining unit</td></tr>
<tr><td>Lower Cretaceous aquifer[1]</td></tr>
<tr><td colspan="2">Pre-Cretaceous basement rocks</td><td>--</td><td>--</td></tr>
</table>

[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.

Figure 4-1
GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA

SOURCE: HARNED *et al.*, 1989.

MARINE CORPS BASE CAMP LEJEUNE



CAMP LEJ 5/90M

Figure 4-2
GENERALIZED HYDROGEOLOGIC CROSS-SECTION
JONES AND ONSLOW COUNTIES, NORTH CAROLINA

SOURCE: HARNED *et al.*, 1989.

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(Harned et al., 1989). This cross-section illustrates the relationship between the aquifers in this area.

Fresh water is present in the surficial and Castle Hayne aquifers at MCB Camp Lejeune and are, therefore, the hydrogeologic units of concern with respect to this study. Fresh water extends to a depth of approximately 300 feet (Harned et al., 1989). Aquifers below this depth have been affected by saltwater intrusion.

The surficial aquifer at MCB Camp Lejeune is composed of Quaternary and Miocene sand, silt, and clay. This aquifer ranges in thickness from 0 feet in the channels of the New River and its tributaries to 75 feet in the southeastern portion of Camp Lejeune (Harned et al., 1989).

The Castle Hayne aquifer is composed of sand and limestone of Oligocene and Middle Eocene age (Harned et al., 1989). The upper portion of the aquifer is primarily unconsolidated sand. The lower portion is partially consolidated sand and limestone. Thin clay layers are found throughout the unit. The Castle Hayne aquifer thickens toward the southeast, from 175 feet in the northern portion of the base to 375 feet at the coast. The Castle Hayne aquifer is approximately 340 feet thick in the Hadnot Point Area (Harned et al., 1989).

4.1.3.1 Hadnot Point Industrial Area

Geologic information specific to HPIA was obtained during the Confirmation Study conducted by ESE (May 1988). This investigation focused on a shallow aquifer (upper 25 feet) and a deep aquifer (up to 150 feet). No attempt was made to correlate these units to the regional stratigraphy (e.g. surficial and Castle Hayne aquifers), as this was not necessary to fulfill the objectives of this study.

Cross-sections generated from lithologic information obtained during monitoring well installation at HPIA indicate that the shallow aquifer in this area is primarily silty sand with extensive but discontinuous layers of silty clay and silty sandy clay. These layers dip to the south-southwest. Peat, wood fragments, and plant debris are present in a 1-2 foot layer in the southwest portion of HPIA. Peat was also encountered at a depth of 18 feet in the northwest portion of the site. Marl was noted to be present in some of the boreholes. Layers of fill up to 4 feet thick are present in areas adjacent to construction areas.

Site-specific information on the deeper portion of the aquifer beneath HPIA is limited because only 6 deep boreholes have been drilled to date. Intermediate (75 feet) and deep (150 feet) wells drilled at HPIA penetrated silty sand and sandy clay to depths of 50 feet. At 50 feet, a 35-80 foot thick layer of sand, shells, and cemented clastics was encountered. This was underlain by silty sand and silty clayey sand.

4.1.3.2 Sites 6, 48, and 69:

Site specific geologic information is obtained through monitoring well installation and soil boring at each specific site. The limited extent of these activities at Sites 6, 48, and 69 translates into limited site specific geologic information available for these areas. Based on previous site investigations, the following site-specific geologic information is available for Sites 6, 48, and 69.

Site 6 is underlain by silty sand, sand and coarse sand. Site 69 is primarily underlain by silty sand and sandy clay with discontinuous layers of clayey sand, sand, sandy silt, and clayey silt. No site-specific geologic information is available for Site 48 at this time (ESE, January 1990).

4.1.4 HYDROLOGY

In general, the hydrologic system at Camp Lejeune consists of an unconfined (water table) aquifer and semi-confined aquifers. The unconfined aquifer extends from the water table to the first significant confining unit.

4.1.4.1 Hadnot Point Industrial Area

The water table at HPIA is found at depths ranging from 6.17 to 22.36 feet below land surface (bls) (ESE, May 1988). Water level fluctuations in the area range from 1 to 4 feet and are attributed to seasonal variations (Harned et al., 1989). A potentiometric surface map for the shallow aquifer (<25 feet) is presented in Figure 4-3.

In general, shallow groundwater flows toward the New River. The direction of flow actually ranges from south-southwest in the northern corner of HPIA to west-southwest in the southwest. Groundwater mounding appears to occur in the west-central and southeastern areas. This may be due to increased surface infiltration and a drainage ditch in the west-central and southern sections, respectively (ESE, May 1988). The horizontal flow gradient over most of the area is approximately 0.003 feet/ft, but does increase to 0.02 feet/ft in the southwest corner of the site.

? 0.2 ft/ft in Charact Study

Water levels measured in deep and intermediate wells are similar to those observed in nearby shallow wells. Additional data is required before a potentiometric surface map can be generated for the deep aquifer, however, it is expected that deep groundwater flows to the east-southeast, towards the Atlantic Ocean (ESE, May 1988). Small-scale regional changes in groundwater flow may occur in the deep aquifer due to local pumping of water supply wells. The USGS (Harned et al., 1989) notes that flow gradients may range from 15 feet/mile (0.0028 feet/ft)

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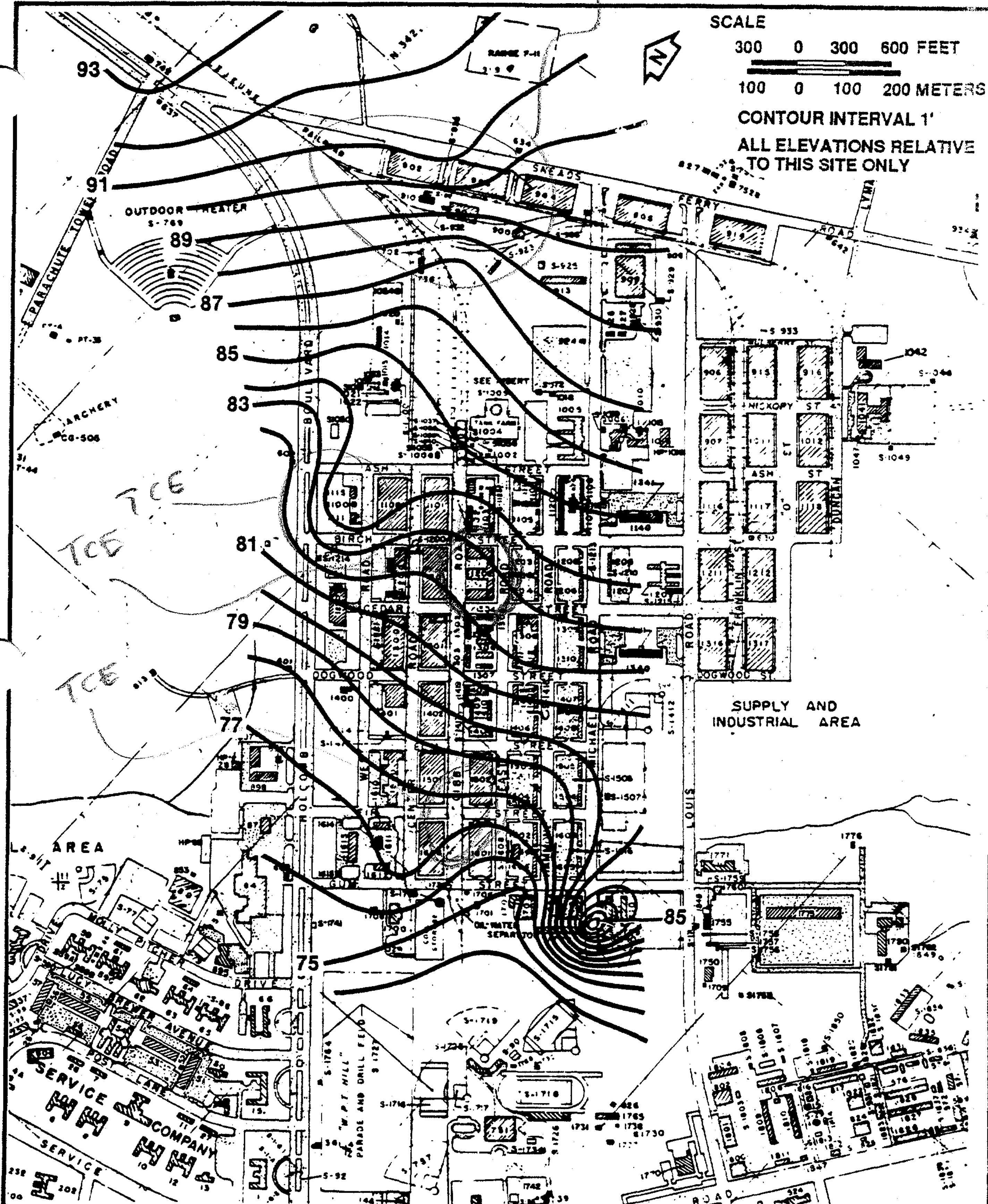

Figure 4-3
POTENTIOMETRIC SURFACE, SHALLOW AQUIFER
HADNOT POINT INDUSTRIAL AREA
(NOTE: WATER LEVELS OBTAINED APRIL 1987.)
SOURCE: HUNTER/ESE, 1990.

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in areas unaffected by pumping to 150-200 feet/mile (0.0284-0.0378 feet/ft) in areas near active water supply wells.

A 72 hour pumping test performed at HPIA by ESE in 1987 indicates average transmissivity and storage coefficient values of 9.6 x 10^3 gallons per day per foot (gpd/ft) and 8 x 10^{-4} respectively, for the limestone portion of the deep (Castle Hayne) aquifer. These values are in general agreement with those reported by the USGS (Harned et al., 1989). Horizontal hydraulic conductivity for the Castle Hayne in this area is reported by the USGS to be an average of 35 ft/day with a range between 19-82 ft/day (Harned et al., 1989).

Further analysis of the ESE pumping test data indicates that the limestone portion of the deep aquifer is semi-confined. Recharge occurs through aclayey layer overlying the aquifer. Vertical hydraulic conductivity for this layer is estimated at 4.6 x 10^{-3} ft/day, typical of silty sands and silty clays.

4.1.4.2 Sites 6, 48, and 69

The water table at Site 6 was encountered within silty sand at depths ranging from 2 to 15 feet bls (ESE, January 1990). A groundwater contour map of Site 6, presented in Figure 4-4, indicates that groundwater flows radially toward Wallace and Bearhead Creeks. Groundwater flow gradients have been estimated to be approximately 0.009 feet/ft (ESE, January 1990).

At Site 69, groundwater is first encountered within silty sand, at depths ranging from 2.11 to 20.24 feet bls (ESE, January 1990). Groundwater flow is broken by watershed boundaries present on this site. Figure 4-5 shows the groundwater divide present on site and the resultant northwest and southeast groundwater flow directions. Groundwater gradients at Site 69 have been estimated to be an average of 0.032 feet/ft (ESE, January 1990).

Site specific groundwater information based on monitoring well data is not available for Site 48. However, the presence of a marshy area to the north of Building 804 and the New River to the northeast of the site indicates a high water table in this area and probable northeast groundwater flow direction.

4.2 CHEMICAL CHARACTERIZATION

4.2.1 HADNOT POINT INDUSTRIAL AREA

Site screening was performed at HPIA by conducting a soil gas survey. To date, groundwater is the only media that was sampled for specific chemical compounds at HPIA. The following is a brief summary of that

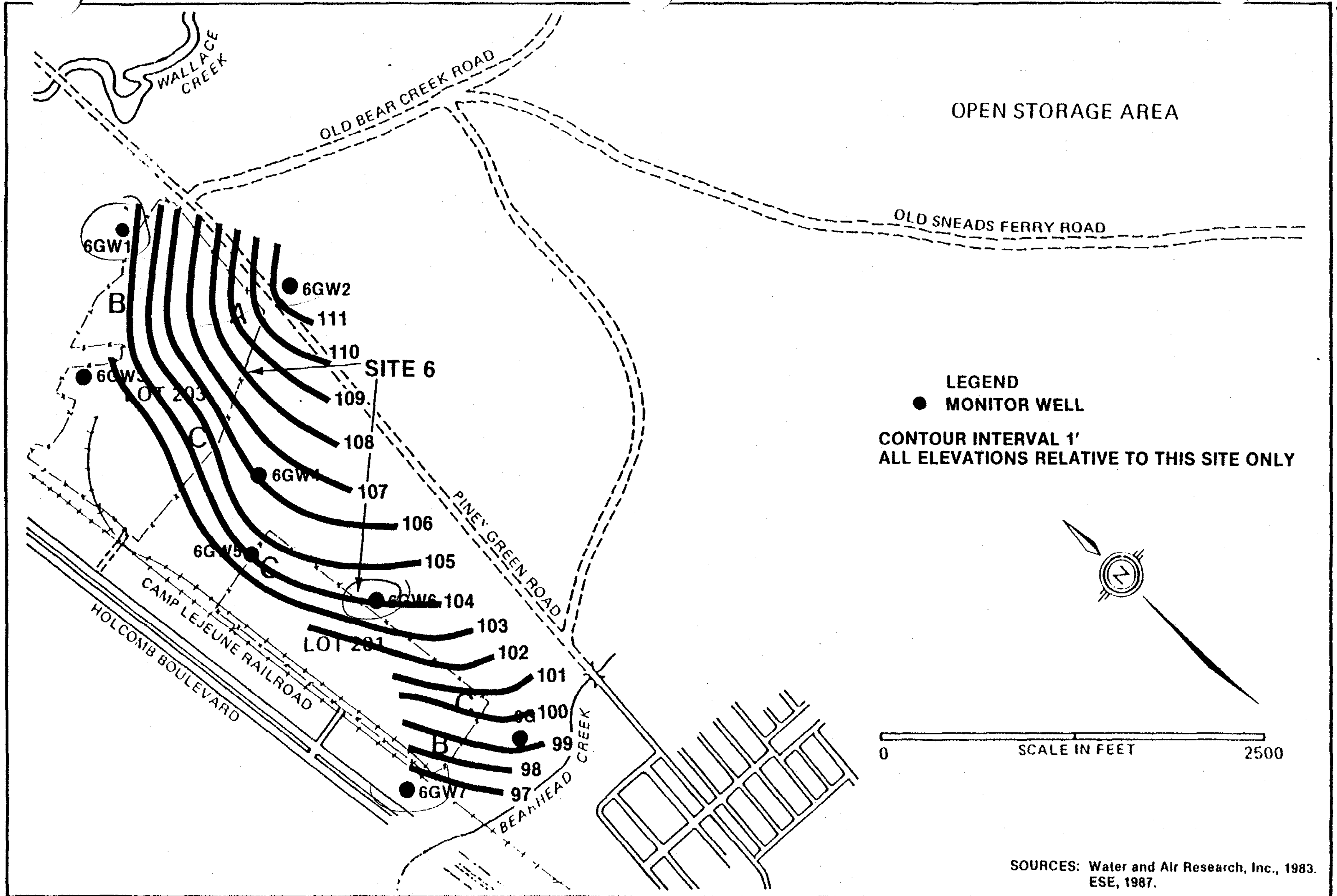

Figure 4-4
SITE 6
POTENTIOMETRIC SURFACE, SHALLOW AQUIFER

MARINE CORPS BASE CAMP LEJEUNE

CAMP LEJ 5/90M

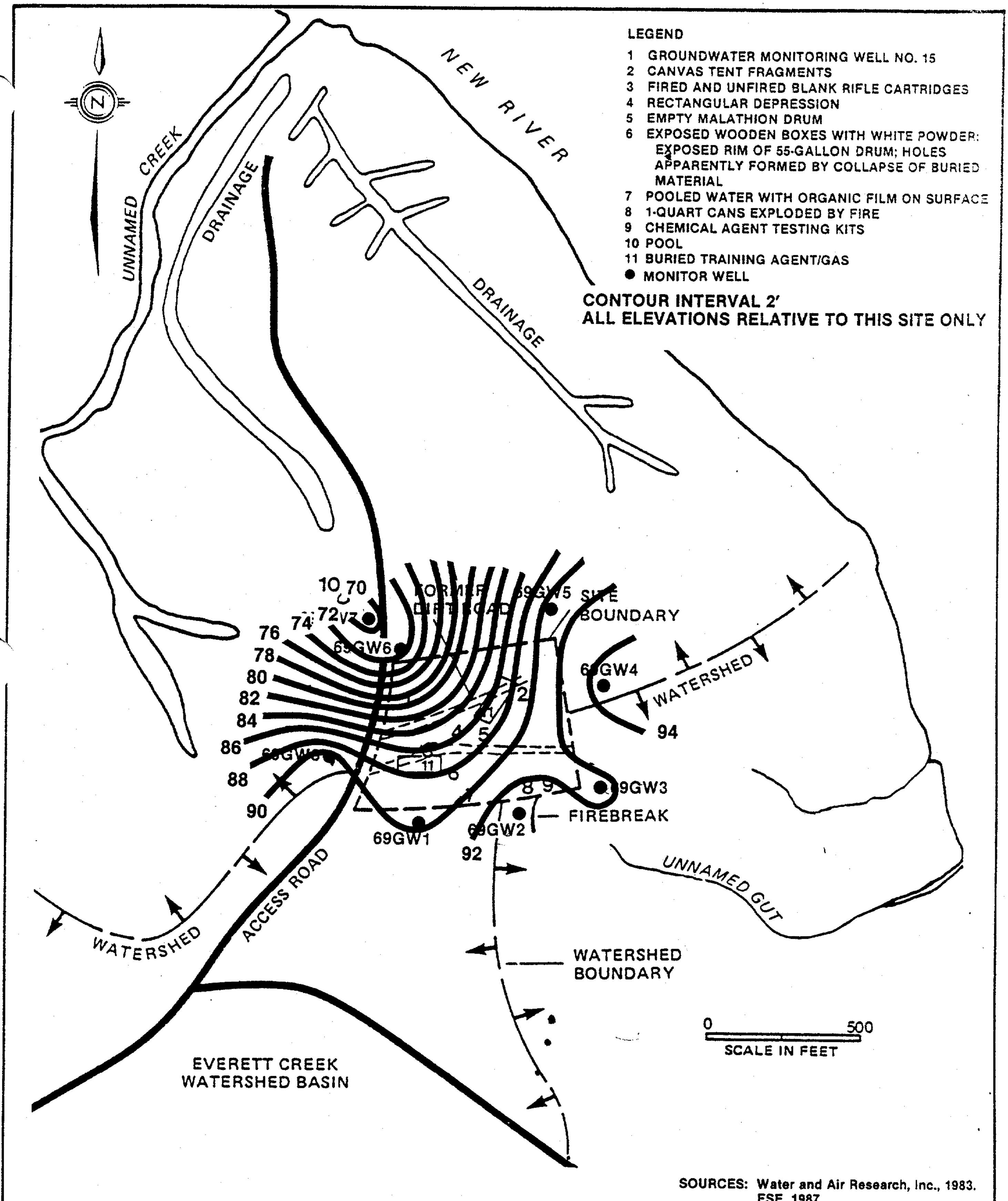

Figure 4-5
SITE 69
POTENTIOMETRIC SURFACE,
SHALLOW AQUIFER

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chemical characterization. A detailed characterization can be found in the "Characterization Step Report at Hadnot Point Industrial Area" (ESE, May 1988).

Five of the areas of concern targeted by the records search portion of the Characterization Step showed elevated levels of VOCs in soil gas. These 5 areas are described below. Concentrations of TCE detected in soil gas samples collected in these areas are presented in Figures 4-6 through 4-9.

1) Buildings 901, 902, and 903: underground storage tank which held trichloroethene (TCE) is located here (Figure 4-6);

2) Building 1100: small service station (Figure 4-7);

3) Buildings 1101, 1102, 1202, 1301, and 1302: Building 1202 is a Base Maintenance Shop; an underground storage tank is present adjacent to this building (Figure 4-8);

4) Buildings 1502, 1601, 1602: vehicle maintenance area; an underground storage tank which held TCE is located adjacent to Building 1601 (Figure 4-9), and

5) Buildings 1709 and 1710: vehicle maintenance area; bags of soil labeled as contaminated were found in this area (Figure 4-10).

Twenty-seven shallow monitoring wells were installed in these areas of concern. These 27 wells plus two monitoring wells previously installed at the Industrial Area Tank Farm (Site 22) were sampled for VOCs and oil & grease in January, March, and May of 1987. Elevated levels of a number of fuel related compounds were detected. These include benzene, xylene, ethylbenzene, trans 1,2-dichloroethene, trichloroethene, oil & grease, and lead.

Figure 4-11 presents an isopleth map of total VOCs detected in shallow groundwater at HPIA. Shallow groundwater contamination at HPIA is distributed in two nodes, one to the northeast in the vicinity of Building 902 and Site 22, and one to the southwest in the vicinity of Buildings 1602 and 1709. Total VOC concentrations reach levels greater than 10,000 $\mu g/l$ in the northeastern node and 1,000 $\mu g/l$ in the southwestern node.

Three intermediate and three deep wells were installed in the vicinity of the three potential source areas indicated by shallow groundwater contamination. These wells were sampled in August 1987. No compounds were detected above the detection limits in the intermediate wells. Methyl ethyl ketone (MEK) was the only compound detected in any of the deep wells. MEK was detected in HPGW9-3 at 140 $\mu g/l$ and in HPGW17-3 at 290 $\mu g/l$. MEK was not detected in any of the shallow monitoring wells.

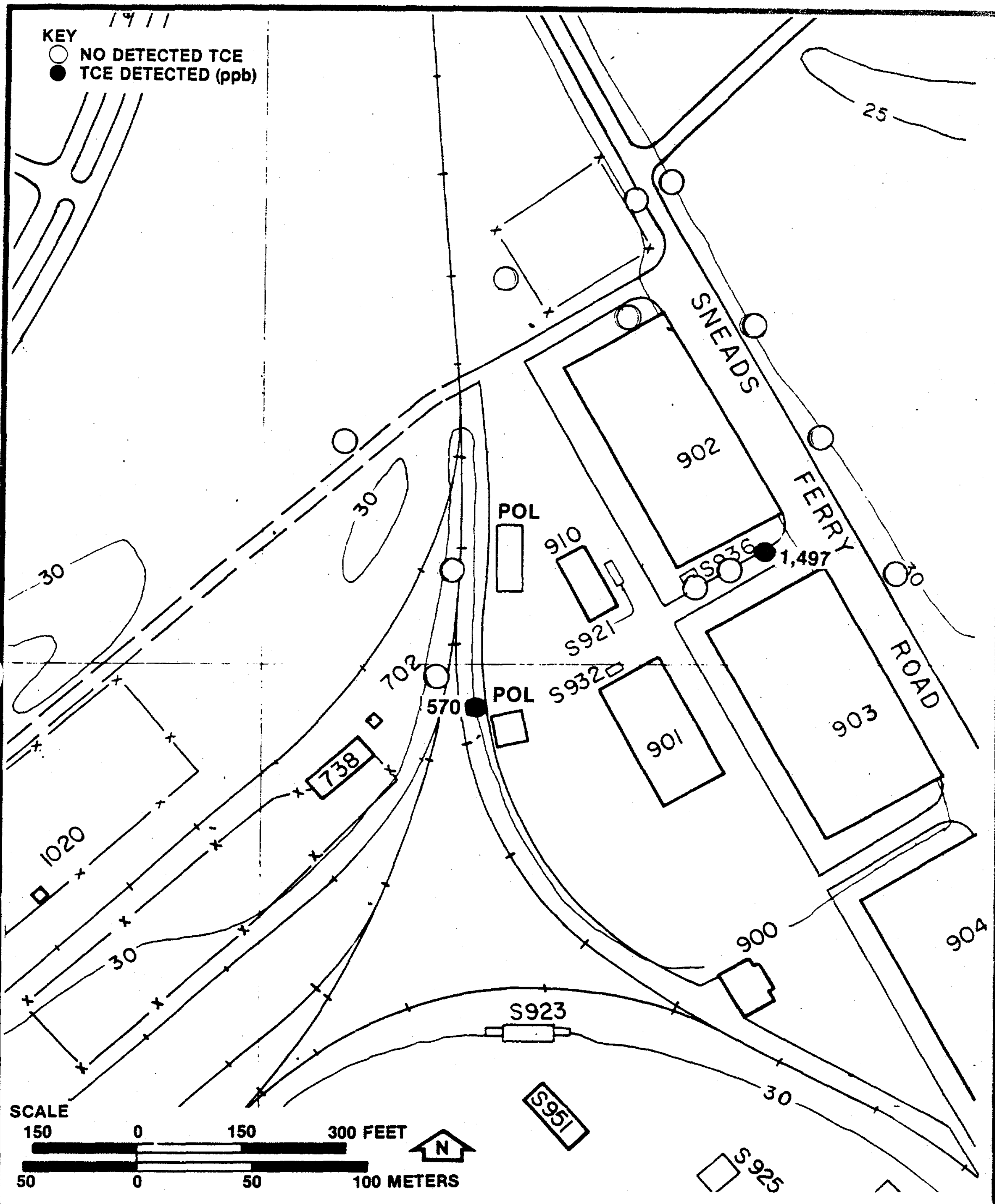


Figure 4-6
SOIL GAS FINDINGS — BLDGS. 901, 902, AND 903

SOURCE: ESE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE

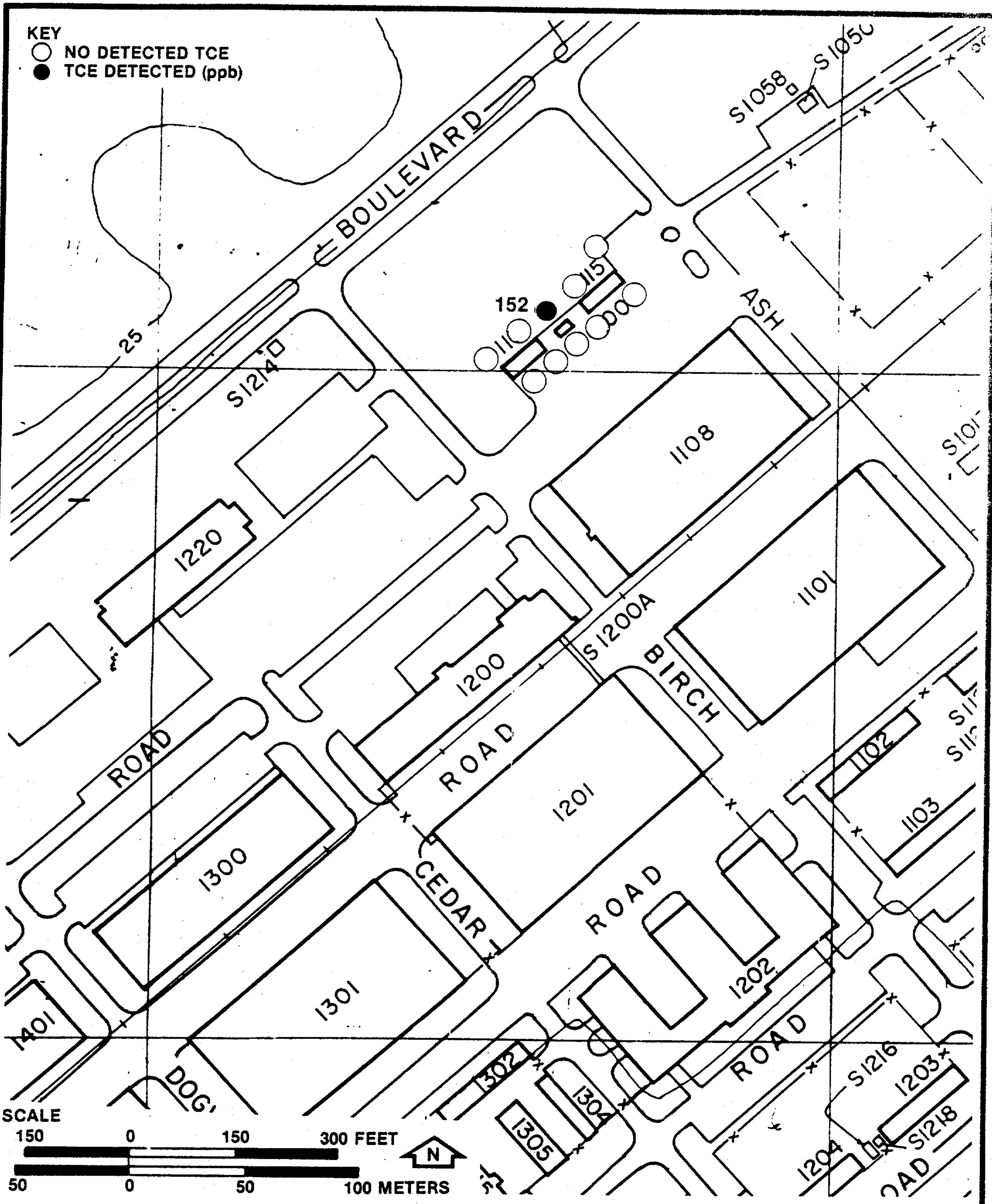


Figure 4-7
SOIL GAS FINDINGS — BLDG. 1100

SOURCE: ESE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE

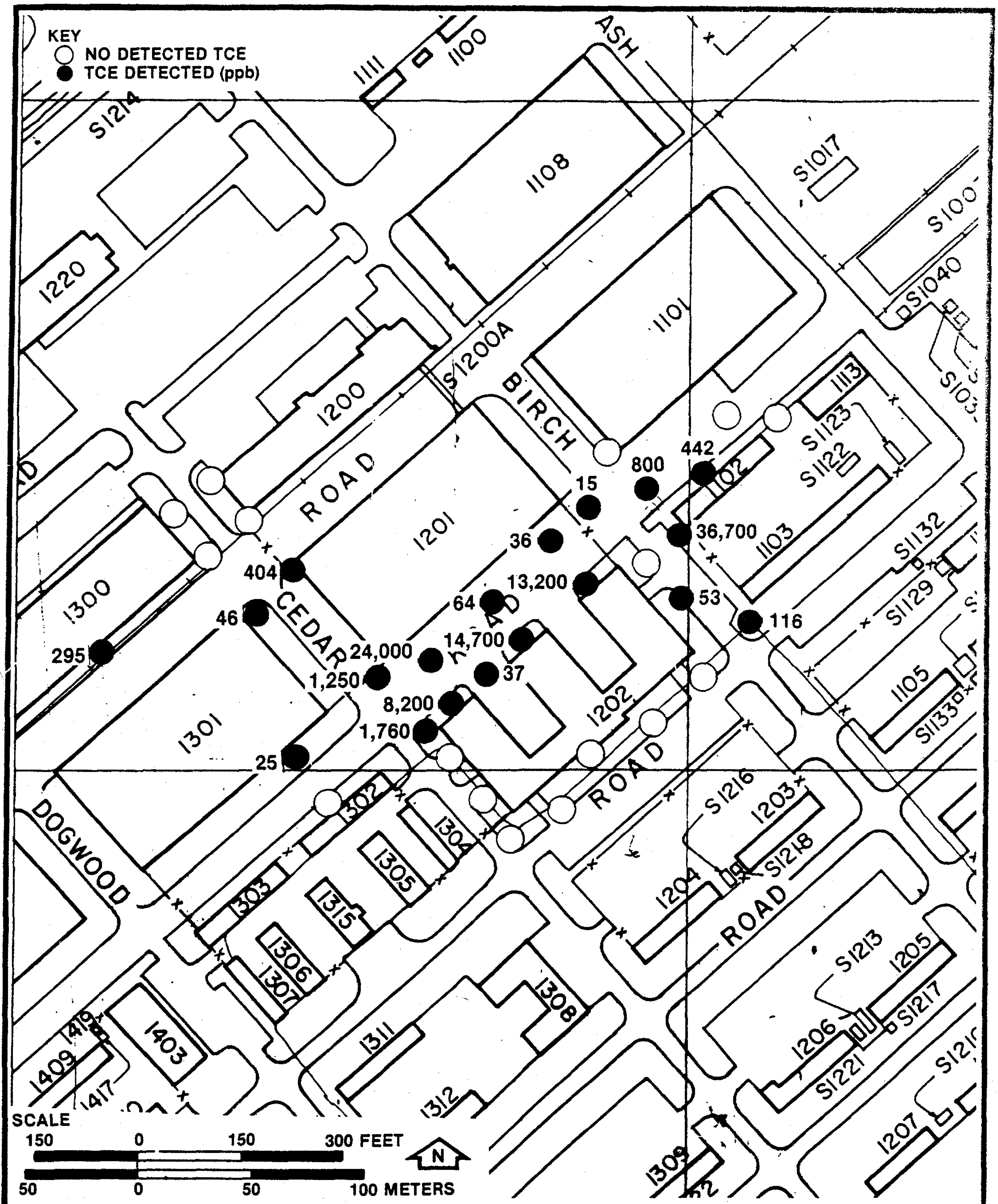


Figure 4-8
SOIL GAS FINDINGS — BLDGS. 1101, 1102, 1202, 1300, 1301, AND 1302

SOURCE: ESE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE

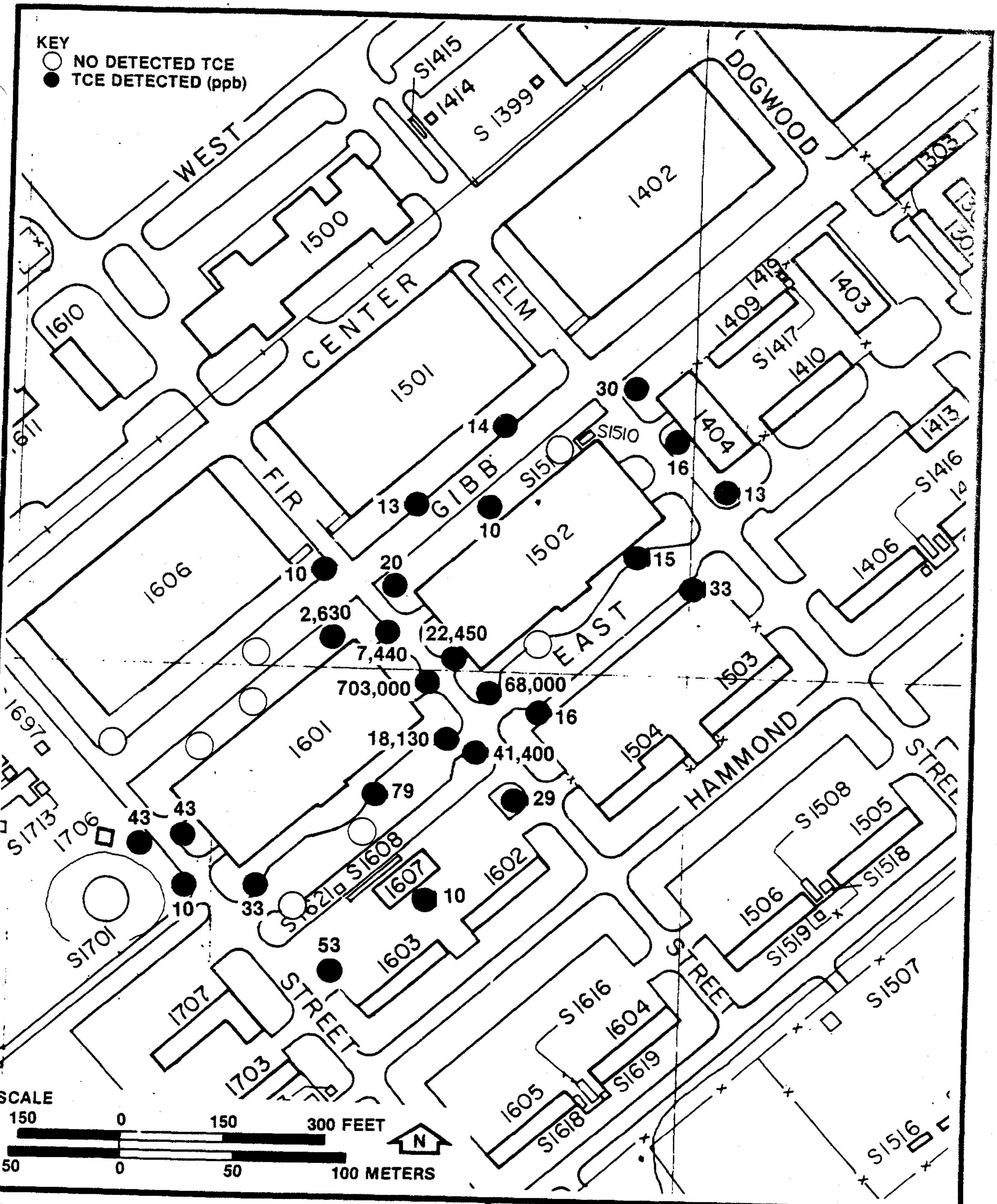


Figure 4-9
SOIL GAS FINDINGS — BLDGS. 1502, 1601, AND 1602

SOURCE: ESE, 1987.

MARINE CORPS BASE CAMP LEJEUNE

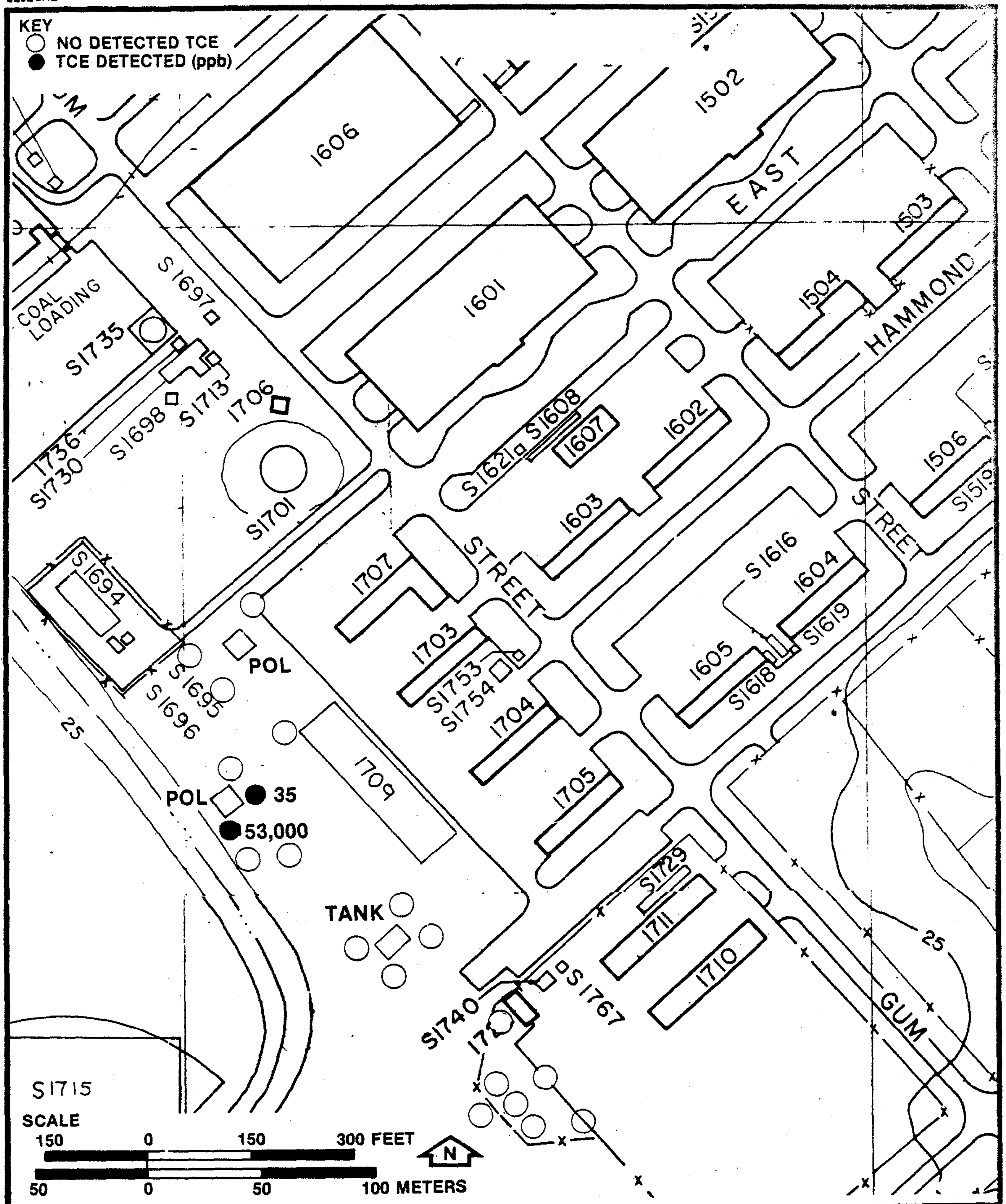
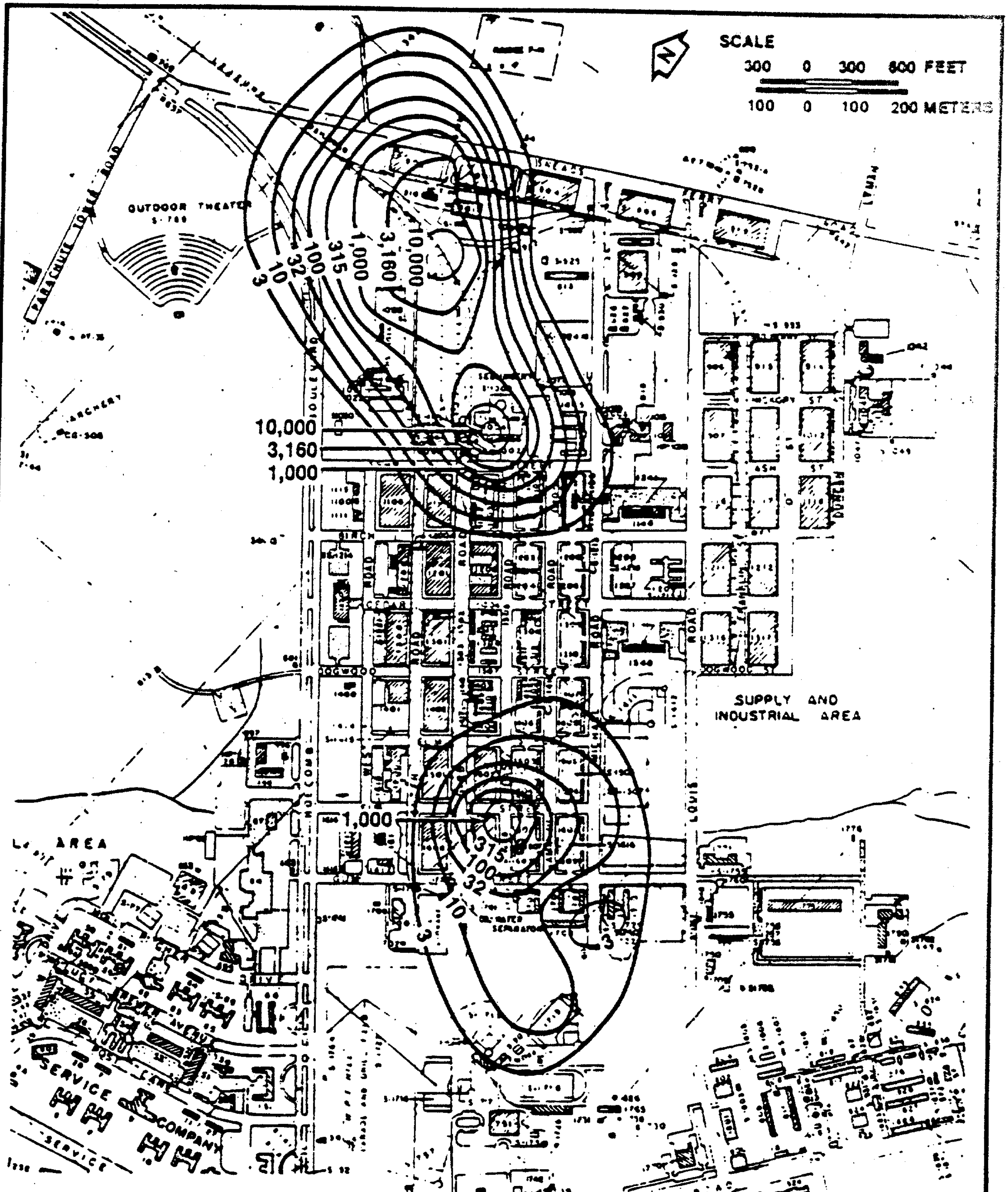


Figure 4-10
SOIL GAS FINDINGS — BLDGS. 1709 AND 1710

SOURCE: ESE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE



NOTE: ALL VALUES ARE PARTS PER BILLION.

Figure 4-11
TOTAL VOLATILE ORGANIC COMPOUND ISOPLETH MAP – SHALLOW AQUIFER HADNOT POINT INDUSTRIAL AREA
SOURCE: ESE, 1988.

MARINE CORPS BASE CAMP LEJEUNE

Water supply wells adjacent to HPIA were sampled a number of times. Those wells were found to contain trace levels of VOCs.

O'Brien and Gere Engineers, Inc. conducted a field investigation at Site 22 in 1988. Their investigation concluded that a 15-foot layer of floating product exists in a monitoring well located on the western edge of the tank farm. The investigation also indicated the presence of a benzene contaminant plume in the vicinity of the tank farm.

4.2.2 SITE 6

Groundwater samples were collected from the eight monitoring wells installed at Site 6 (Figure 2-3) in November 1986 and January 1987. These samples were analyzed for VOCs and pesticides (o,p - and p,p - isomers of DDD, DDE, and DDT). Surface water and sediment samples, collected in November 1986, were analyzed for these same target compounds. Soil samples were analyzed for the pesticides only.

None of the groundwater samples contained DDT or its metabolites. These target compounds were also not detected in the surface water samples collected from the two creeks bordering the site. However, elevated levels of DDT and DDE were noted in sediment samples collected from Bearhead Creek (south side of site). DDT and DDE concentrations were higher in upstream sediment samples suggesting a potential source of contamination east of Piney Creek Road.

Migration of contaminants from Lot 201 may also be the source of pesticides in the creek sediments.

VOCs were detected in two of the eight monitoring wells at Site 6 (benzene and 1,1,2,2 tetrachloroethane in 6GW1 and chloromethane in 6GW6) and in surface water samples from Wallace Creek (trichloroethane, vinyl chlorinated trans-1,2 dichloroethane). The different VOCs detected in groundwater and surface water samples suggests different sources of contamination.

DDT, DDD, and DDE soil contamination is widespread in Lots 201 and 203. Three of the five borings located in the northern portion of Lot 203 contained isomers of DDD, DDE and/or DDT. Soil samples from borings in the southeast portion of Lot 203 showed concentrations of one target compound each, with p, p-isomers being the predominant compound. All soil samples from Lot 201 contained at least one target compound. Target compound concentrations were higher in samples from Lot 201 than Lot 203, reaching levels as high as 770 μg/l.

4.2.3 SITE 48

Soil samples were collected at the soil/groundwater interface in four borings at Site 48 in August 1984. Four sediment samples were also collected at this time from the marsh area north of Building 804. These samples were analyzed for mercury only. All the soil samples and all the sediment samples contained mercury. Concentrations ranged from 0.009 to 0.020 mg/kg in soil samples and 0.02 to 0.03 mg/kg in the sediment samples.

4.2.4 SITE 69

Groundwater, surface water, and sediment samples were collected at Site 69 in July and August 1984 and in December 1986 (Figure 2-5). Samples were analyzed for organochlorine pesticides, PCB's, pentachlorophenol, VOCs, mercury, and residual chlorine in 1984. Tetrachlorodioxin, xylene, methyl ethyl ketone, methyl isobutyl ketone, and ethylene dibromide were added to the target compound list in 1986.

Contamination at Site 69 is extensive. VOCs were identified in all media sampled. Pesticides and pentachlorophenol have been identified in surface water and sediment samples. Contamination at Site 69 appears to be concentrated in the southern portion of the fill area.

4.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

As required by the Superfund Amendments and Reauthorization Act of 1986 (SARA), federal and state regulations will be evaluated during the HPIA RI to determine if they are applicable or relevant and appropriate requirements (ARARs). Potential ARARs and "to be considered" (TBC) requirements will be identified during the RI as site conditions are better defined. ARARs and TBC requirements will be used as a guide in evaluating the feasibility of remedial alternatives proposed at the site. The purpose of this requirement is to make CERCLA responses consistent with pertinent federal and state public health and environmental requirements.

ARARs are identified on a site-specific basis by first determining whether a given requirement is "applicable" to the site. If a requirement is not applicable, it is then evaluated to determine if it is "relevant and appropriate" to the site. Applicable requirements are defined in the National Contingency Plan (NCP) as those federal requirements that would be legally applicable, whether directly or as incorporated by a federally authorized state program, if the response actions were not undertaken pursuant to Section 104 or 106 of CERCLA. SARA has broadened this definition to include state requirements. However, any state standard that precludes in-state land disposal is not applicable unless all of several conditions apply [SARA Sec. 121(d) (2) (C)]. The NCP defines "relevant and appropriate" as "those federal requirements that, while not 'applicable', are designed to apply to problems sufficiently similar to those encountered at CERCLA sites that their application is appropriate" (40 CFR 300.6).

ARARs are generally categorized as ambient or chemical-specific requirements; location-specific requirements; and performance, design, or other action-specific requirements. ARARs may include but are not limited to federal environmental laws such as: the Toxic Substances Control Act (TSCA), the Safe Drinking Water Act (SDWA), the Clean Air Act (CAA), the Clean Water Act (CWA), the Marine Protection Research and Sanctuaries Act (MPRSA), or the Solid Waste Disposal Act (SWDA). In addition, any promulgated state standard, requirement, criteria, or limitation that is more stringent than federal requirements is applicable if such a state requirement is part of a federally delegated program.

Nonpromulgated standards may be determined in considering necessary response objectives (OSWER Directive Number 9234.0-05, July 9, 1987).

TBCs are non-promulgated advisories or guidance issued by federal or state governments. They may be useful in conducting the risk assessment or in determining necessary response objectives for the protection of human health and the environment.

4.3.1 CHEMICAL-SPECIFIC ARARs

A chemical-specific ARAR is a specific concentration limit set by either federal or state environmental laws for a contaminant in a given environmental medium. Examples may include maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) established pursuant to the SDWA; RCRA Subpart F regulations; ambient water quality criteria (AWQC) established pursuant to the CWA; and national ambient air quality standards (NAAQS) established pursuant to the CAA.

4.3.2 LOCATION-SPECIFIC ARARs

Location-specific ARARs are those requirements that establish restrictions on remedial activities or limitations on contaminant levels on the basis of site characteristics or the physical characteristics of the surrounding area. State locational requirements are to be followed only when they are of general applicability and are based on hydrogeological considerations. These requirements should not be intended to restrict land disposal for reasons other than protection of health or the environment. Examples of location-specific ARARs include siting laws for hazardous waste facilities; laws regarding development or other activities in wetlands and floodplains; historic preservation laws; and laws for the protection of endangered species.

4.3.3 ACTION-SPECIFIC ARARs

Action-specific ARARs are standards that establish restrictions or controls on particular kinds of remedial activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities as opposed to the specific chemicals present at a site. Examples of action-specific ARARs include closure regulations, incineration standards, and pretreatment standards for discharges to publicly owned treatment works (POTWs).

4.4 PRELIMINARY RISK ASSESSMENTS

This section presents preliminary assessments of human health and ecological risk at HPIA and Sites 6, 48, and 69. The preliminary assessments are based on data presently available for each site as a result of previous investigations. A preliminary risk assessment (RA) can be helpful in identifying gaps in the existing data base which may be filled during the field investigation phase of the RI.

4.4.1. SELECTION OF PRELIMINARY INDICATOR CHEMICALS

Analytical data were initially screened for contaminant occurrence in each media for each site to determine potential groups of indicator chemicals to be addressed in detail, during the full-scale risk assessments. Specific indicator chemicals will be selected for each site from these broad groups of contaminants based on the frequency of detection; concentrations and toxicity; potential for environmental mobility, persistence, and bioaccumulation; occurrence in possibly critical routes; and the observed concentrations in relation to established ARARS, TBCs, and toxicological data. For the purposes of this initial screening, samples collected at the same location but at different times were counted as different sampling units. Samples collected at the same site on the same date were considered duplicates.

Concentrations greater than detection for each analyte in each media were tabulated from the Site Summary Report (Hunter/ESE, 1990) for Sites 6, 48, and 69, and the Characterization Step Report (ESE, 1988) for Hadnot Point Industrial Area. Available data for Hadnot Point Industrial Area indicated VOCs and lead present in groundwater beneath this site (Tables 4-1 and 4-2).

Of the 37 target analytes analyzed for in groundwater during the Confirmation Study (ESE, 1988), 17 were detected in monitoring wells during the three sampling intervals. VOCs were also detected in soil gas surveys. Each target analyte detected at levels above the MCL may be a potential indicator chemical.

Inorganics were detected in several of the deep aquifer wells during the 1986 sampling program (ESE, 1990). Detections of inorganics (including mercury) were generally within EPA recommended levels for chemicals with MCLs or ambient water criteria (Table 4-3).

The initial screening for indicator chemicals for Site 6 indicated VOCs

Table 4-1. Target Analytes for HPIA Groundwater for Hadnot Point Confirmation Study (ESE, 1988)

Parameter	Detected in 1988 Sampling Program	Max. Contaminant Levels (mg/l)
Lead, Total	X	0.05
Oil and Grease	X	----
Benzene	X	0.005
Bromodichloromethane		0.10[1]
Bromoform		0.10[1]
Bromomethane		----
Carbon Tetrachloride		0.005
Chlorobenzene		----
Chloroethane		----
2-Chloroethylvinyl Ether		----
Chloroform	X	0.10[1]
Chloromethane	X	----
Dibromochloromethane		0.10[1]
1,1-Dichloroethane	X	----
1,2-Dichloroethane	X	0.005
1,1-Dichloroethylene		0.007
trans-1,2-Dichloroethene	X	----
1,2-Dichloropropane		----
cis-1,3-Dichloropropene		----
trans-1,3-Dichloropropene		----
Ethylbenzene	X	----
Methylene Chloride	X	----
1,1,2,2-Tetrachloroethane		----
Tetrachloroethene	X	----
Toluene	X	----
1,1,1-Trichloroethane	X	0.20
1,1,2-Trichloroethane		----
Trichloroethene	X	0.005
Trichlorofluoromethane	X	----
Vinyl Chloride	X	0.002
Acrolein		----
Acrylonitrile		----
Dichlorodifluoromethane		----
Xylene	X	----
Methyl Ethyl Ketone		----
Methyl Isobutylketone		----

[1] = as total trihalomethanes

Source: ESE, 1990.

Table 4-2. Hadnot Point - Summary of Target Analytes Detected in Groundwater.

Chemical	Frequency Shallow Aquifer	Maximum ug/l	Frequency Deep Aquifer	Maximum ug/l
Bis2HEP	N/A	---	1/6	1.3
Benzene	13/81	13000	7/6	720
Chloroform	3/81	3.2	N/A	---
Chloromethane	3/81	7.2	N/A	---
1,1-Dichloroethane	1/81	12	N/A	---
1,2-Dichloroethane	0/81	---	2/6	46
trans-1,2-Dichloroethene	15/81	6400	14/6	700
Ethylbenzene	5/81	1800	1/6	8
Oil and grease	42/81	32000	N/A	---
Lead	16/81	130	N/A	---
Methylene Chloride	7/81	300	3/6	130
Tetrachloroethane	1/81	3.6	4/6	24
Toluene	9/81	24000	3/6	12
1,1,1-Trichloroethane	1/81	13	N/A	---
Trichloroethene	14/81	13000	11/6	1600
Trichlorofluoromethane	2/81	96	1/6	3
Vinyl Chloride	2/81	250	1/6	18
Xylene	6/81	9000	N/A	---
Methyl Ethyl Ketone	0/81	---	2/6	290

N/A = Not Analyzed

Table 4-3. Inorganics Detected at HPIA in ESE, 1986 Sampling.

Chemical	Frequency Shallow Aquifer	Maximum ug/l
Barium (total)	4/4	43.4
Nitrogen (total)	1/4	42
Nitrogen (NO_2)	1/4	42
Total Iron	4/4	15200
Chloride	4/4	68300
Manganese (total)	4/4	134
Sodium (total)	4/4	12300
Sulfate	3/4	5,170,000
Turbidity (FTU/NTU)	4/4	18.0
Chromium	4/4	14.1
Copper	4/4	0.7
Mercury	4/4	3200
Zinc	4/4	

in groundwater and surface water, and pesticides in soil and sediment (Table 4-4). The initial screening for indicator chemicals for Site 48 indicated mercury in all soil and sediment samples collected (Table 4-5). The initial screening for indicator chemicals for Site 69 indicated VOCs and mercury in groundwater and surface water, and pesticides in sediment (Table 4-6).

4.4.2 POTENTIAL EXPOSURE PATHWAYS

The groups of potential indicator chemicals were examined to determine potential exposure pathways which may be evaluated in the risk assessments for each site. Other exposure pathways may be added based on the results of the current RI/FS.

Groundwater and soil are potentially contaminated with VOCs at Hadnot Point Industrial Area. Lead and oil and grease have also been observed. The potential exposure pathways for HPIA include:

- ingestion of VOC or lead contaminated groundwater or soil;
- inhalation of volatilized VOCs from groundwater or soil;
- inhalation of metal-containing fugitive dusts;
- dermal contact with VOCs or metals in groundwater or soil, and
- ecological effects due to exposure to VOCs or metals in groundwater or soil.

The contaminants found at Site 6 include chemicals that tend to volatilize as well as pesticides which bioaccumulate. Inhalation, ingestion, and direct contact pathways must therefore be addressed. At Site 6 the following exposure pathways will be considered:

- ingestion of VOC contaminated groundwater and surface water;
- inhalation of VOCs volatilized from groundwater and surface water;
- dermal exposure to VOCs from direct contact with surface water or groundwater;
- ingestion of aquatic organisms or game exposed to pesticides in soil or sediment, and
- exposure to pesticides and VOCs by aquatic and terrestrial organisms.

Mercury was the major contaminant of concern at Site 48. Mercury, a toxic and bioaccumulative compound, was detected in soil and sediment at this site.

Inhalation, ingestion, and direct contact pathways will be considered as follows:

- ingestion of fish and shellfish exposed to mercury in sediments by human and nonhuman consumers;

ıle 4-4. Initial Screening for Indicator Chemicals for Site 6.

	Frequency and Maximum Detections of Target Analytes in Each Media							
	Groundwater		Surf. Water		Sediment		Soil	
Chemical	Freq	Max[1]	Freq	Max[1]	Freq	Max[2]	Freq	Max[2]
DDT	0/16	---	0/4	---	1/4	219	17/20	426
DDE	0/16	---	0/4	---	2/4	75.8	17/20	770
DDD	0/16	---	0/4	---	0/4	---	15/20	160
Benzene	1/16	3.1	0/4	---	0/4	---	N/A	---
Chloromethane	1/16	6.5	0/4	---	0/4	---	N/A	---
t-1,2 Dichloroethene	0/16	---	2/4	35	0/4	---	N/A	---
1,1,2,2-Tetrachloroethane	1/16	63	0/4	---	0/4	---	N/A	---
Trichloroethene	0/16	---	1/4	26	0/4	---	N/A	---
Vinyl chloride	0/16	---	2/4	3.6	0/4	---	N/A	---

1 micrograms ug/l
2 ug/kg

--- No detections
N/A Not Analyzed

ırce: ESE, 1986 in Hunter/ESE, 1990.

le 4-5. Initial Screening for Indicator Chemicals for Site 48.

	Frequency of Detections in Each Media					
Chemical	Groundwater	Surface Water	Sediment	Max. mg/kg	Soil	Max. mg/kg
Mercury	N/A	N/A	4/4	0.03	5/5	0.03

N/A - Not analyzed

Source: ESE, 1984 in Hunter/ESE, 1990

le 4-6. Initial Screening for Groups of Indicator Chemicals for Site 69.

	Frequency of Detections in Each Media Sampled					
	Ground Water	Max. ug/l	Surface Water	Max. ug/l	Sediment	Max. ug/kg
DDT	N/A	---	0/4	---	0/2	---
DDE	N/A	---	0/4	---	1/2	18.8
DDD	N/A	---	0/4	---	1/2	113
Benzene	3/16	4	1/4	0.4	N/A	---
BHC,A	0/16	---	2/4	0.056	N/A	---
BHC,B	1/16	0.087	4/4	0.18	N/A	---
BHC,D	2/16	2.44	2/4	0.2	N/A	---
1,2 Dibromoethane	2/8	4.74	0/3	---	0/2	---
Chlorobenzene	2/16	55	1/4	2.1	N/A	---
Chloroform	2/16	14	1/4	6	N/A	---
1,2 Dichloroethane	2/16	5.9	1/4	0.9	N/A	---
1,1 Dichloroethylene	2/16	2.7	0/4	---	N/A	---
t-1,2 Dichloroethene	7/16	37000	4/4	410	N/A	---
Mercury	8/16	0.2	1/4	0.2	0/2	---
Methylene Chloride	1/16	10	1/4	8	N/A	---
Pentachlorophenol	N/A	---	2/4	10	1/2	1190
1,1,2,2-Tetrachloroethane	3/16	44	1/4	59	N/A	---
[illegible]achloroethene	1/16	20	0/4	---	N/A	---
[illegible]ene	4/16	14	1/4	11	N/A	---
1,1,2 Trichloroethane	2/16	7.9	1/4	6	N/A	---
Trichloroethene	3/16	710	4/4	63	N/A	---
Vinyl chloride	4/16	440	2/4	41	N/A	---

--- = No Detections
N/A = Not Analyzed

Source: Hunter/ESE, 1990

- ingestion of game exposed to mercury in soils by human and nonhuman consumers;
- inhalation of mercury-containing fugitive dusts, and
- dermal exposure to mercury in sediment and soils.

Additional pathways may be added if the current RI data indicate the presence of mercury in surface water.

Volatiles, pesticides, and mercury were detected in sediment, surface water, and groundwater at Site 69. The following potential pathways will be considered:

- ingestion of VOC and mercury contaminated groundwater and surface water;
- inhalation of VOCs volatilized from groundwater and surface water;
- dermal exposure to VOCs and mercury from direct contact with surface water or groundwater;
- incidental ingestion of organochlorines in sediment;
- dermal exposure to organochlorines in sediment;
- ingestion of aquatic organisms exposed to organochlorines in sediment;
- ingestion of fish and shellfish contaminated with mercury in surface water, and
- exposure to organochlorines, mercury, and VOCs in sediment or surface water by aquatic and terrestrial organisms.

4.5 SCOPING OF REMEDIAL ALTERNATIVES

Remedial Alternatives will be evaluated at HPIA only, as this is the only site undergoing the FS process at this time.

4.5.1 PRELIMINARY REMEDIAL RESPONSE OBJECTIVES

Additional data and a complete risk assessment is required in order to determine if a risk to public health and/or the environment exists at HPIA. However, the present data base can be used to identify preliminary remedial response objectives at this time. These response objectives are useful in planning additional RI activities in that they help ensure that data collected will be sufficient to evaluate remedial technologies during the FS. The preliminary objectives will be evaluated for applicability as site conditions are further defined during the RI. The preliminary response objectives for HPIA are:

- prevent human exposure to contaminated groundwater;
- restore the contaminated aquifer for future use;
- prevent human exposure to contaminated surface soil;
- prevent migration of contaminants from unsaturated soils to the groundwater, and

- prevent migration of contamination from the shallow aquifer to the intermediate and deep aquifers.

4.5.2 PRELIMINARY IDENTIFICATION OF REMEDIAL TECHNOLOGIES

Remedial technologies are identified for several major response actions applicable to the site. These major response actions include no action, containment, onsite treatment, removal, and in situ treatment. Control technologies identified for each of the major response actions fall into two general categories: source control measures and migration control measures.

Source control measures are technologies or actions implemented to control the source of contamination at or near the area where the contamination occurs. Source control measures are required in instances where the contaminants are not adequately contained or controlled to prevent exposure and/or migration into the environment. Source control areas at HPIA may include the HP Fuel Tank Farm (Site 22) and Buildings 902, 1202, and 1602.

Migration control measures are technologies or actions implemented to mitigate the further migration of those contaminants that have already migrated from the original source. These measures also mitigate the effects of these contaminants. The present data base indicates that contaminant migration at HPIA has occurred via groundwater.

A general description of remedial response actions is presented below.

4.5.2.1. No Action Alternative

The NCP and current guidance require that a no-action alternative be developed and carried through the FS process. The no-action alternative represents a baseline against which other response actions can be measured. During the public health evaluation, the effects of the no-action alternative on public health and environmental receptors are evaluated. During the FS, the effectiveness, reliability, and technical feasibility of potential remedial alternatives are compared against the baseline of the no-action alternative.

4.5.2.2 Containment Technologies

Containment technologies such as capping and solidification/stabilization are potentially applicable if contaminated soils are present on site. Capping consists of the placement of impermeable materials, such as clay or synthetic liners, on the surface to prevent direct contact with the contaminated soil. Capping also prevents further migration of contaminants by preventing the infiltration of surface water through the contaminated soil.

Solidification/stabilization binds the contaminated soil into an impermeable, solid matrix. The addition of siliceous materials to the soil combined with setting agents, such as lime or cement, results in a stabilized and solidified matrix. Commercial proprietary fixation agents and processes can be used for both inorganic and organic contaminated soils. The stable, solid matrix produced lessens the availability of the contaminants to receptors along with preventing the further migration of the contaminants.

Containment technologies do not treat or destroy the contaminants. If the contaminated soils at the site are above normal water table fluctuations, the implementation of these technologies is expected to result in compliance with ARARs. However, if the contaminated soils are present below normal water table fluctuations, implementation of the capping technology may not result in compliance with groundwater ARARs.

Containment technologies can also include hydraulic barriers which capture or divert groundwater flow.

4.5.2.3 Onsite Treatment

Onsite treatment technologies for source control such as soil washing, incineration, and aeration may be applicable to contaminated soils at the site. Soil washing consists of mixing contaminated soil with solvents or other chemicals that extract the contaminants from the soil matrix. Physical processes may be required as part of the implementation of this technology. These processes may include classification of the contaminated soil prior to washing, removal of excess moisture from the soil after washing, and recovery of the spent solvent. A wastewater is generated by this technology that will require subsequent treatment.

In precipitation, the contaminated soil is exposed to acids or bases that alter the pH to form insoluble precipitates that adsorb more strongly to the soil matrix. This technology is primarily applicable to metals contamination. Metals can be precipitated as hydroxides, sulfides, carbonates, or other insoluble salts. Hydroxide precipitation with lime is the most common. However, sodium sulfide can also be used.

Mechanical thermal aeration involves the contact with or forcing of air through heated contaminated soil. The contact between air and soil allows the transfer of volatile organics from the soil to the air. Depending on the resulting concentration of contaminants in the air, the air stream can be combusted in an afterburner or passed through activated carbon.

Soils incineration is a process which utilizes different phases of thermal reactions in order to progressively reach complete oxidation of organic substances.

Onsite treatment technologies for source control such as those described above require removal of the contaminated soil and replacement of the soil after treatment. Through the removal of the contaminants from the soil, exposure to the contaminants is prevented as well as the continued migration of the contaminants into the environment. Implementation of these technologies is expected to result in compliance with ARARs.

Potential onsite treatment technologies applicable to the site for migration control include air stripping, steam stripping, carbon adsorption, ion exchange, precipitation, and biological treatment of contaminated groundwater. Air stripping is a mass transfer process in which VOCs in groundwater are transferred to air in the gaseous vapor state. Generally, organic compounds with a Henry's Law constant greater than 0.003 can be effectively removed by air stripping. These compounds include chlorinated hydrocarbons (e.g. tetrachloroethene) and aromatics (e.g. toluene). Steam stripping, another mass transfer process, removes VOCs from groundwater through partial vaporization with steam.

In carbon adsorption, contaminated groundwater is passed through activated carbon, usually contained in packed bed reactors. The contaminants selectively adsorb onto the carbon matrix. The selective adsorption of contaminants is accomplished through a surface attraction phenomenon in which the organic molecules are attracted to the internal pore surfaces of the carbon granules. Activated carbon can be used for the adsorption of both volatile and semivolatile organic contaminants in groundwater.

Ion exchange consists of the replacement of the contaminant ions with non-toxic ions such as sodium (Na^+).

Precipitation for groundwater contaminants is similar to that for soil. An acid or base is added to the groundwater to adjust the pH to a point where the contaminants can be removed at their lowest solubility. Metals can be precipitated from solution as hydroxides, sulfides, carbonates, or other insoluble salts. The resulting residuals are metal sludges and a treatment effluent with an elevated pH.

Biological treatment consists of the use of microorganisms to remove contaminants from the groundwater. These microorganisms utilize the contaminants in their metabolic processes, thus altering them to non-toxic compounds. Rotating biological contactors (RBCs) and activated sludge units are readily mobilized and accommodate a wide variety of flows. The concentration of metals in the groundwater may adversely affect the treatment efficiencies of biological treatment technologies.

Building 22 at HPIA houses the Hadnot Point Sewage Treatment Plant. This plant contains two trickling filters as biological treatment. The use of this on-site facility for treatment of contaminated groundwater will be evaluated during the FS process.

Onsite treatment of groundwater will require the removal of the groundwater via extraction and the subsequent reinjection or discharge of the treated water. Onsite treatment technologies remove and/or destroy the contaminants, thus preventing exposure and further migration. Implementation of these technologies is expected to result in compliance with groundwater ARARs.

4.5.2.4 Removal Technologies

Removal technologies may also be implemented as source-control measures. These technologies remove the contaminants from the source for subsequent treatment or disposal at an offsite facility. Removal technologies may include excavation and landfilling of contaminated soils. However, current and future land ban requirements may limit the potential for removal of site contaminants to a landfill facility.

Removal technologies for migration control at the site include extraction and removal of the contaminated groundwater to an offsite treatment facility. The offsite facility may employ biological, physical, chemical, or thermal treatment technologies. Through removal of the contaminants from the site, both exposure and continual migration is prevented. Implementation of the removal technology for groundwater is expected to result in compliance with ARARs.

4.5.2.5 In Situ Technologies

Potential onsite source control treatment technologies may also be implemented in situ. These technologies include soil washing, precipitation, aeration, solidification/stabilization, bioreclamation, and vacuum extraction.

In situ soil washing consists of the in-place washing of contaminants from the soil with a suitable solvent such as water or a surfactant. The contaminated elutriate is pumped to the surface for removal, recovery of the solvent and recirculation, or onsite treatment and reinjection.

In situ precipitation involves the injection of acids or bases into the soil to alter the pH to form insoluble precipitates that adsorb more strongly to the soil matrix. This technology is primarily applicable to metals contamination. Metals can be precipitated as hydroxides, sulfides, carbonates, or other insoluble salts. Hydroxide precipitation with lime is the most common. However, sodium sulfide can also be used.

Mechanical in situ aeration involves the forcing of heated air through contaminated soil. The contact between heated air and soil allows the transfer of volatile organics from the soil to the air. Depending on the resulting concentration of contaminants in the air, the air stream can be combusted in an afterburner or passed through activated carbon.

In situ solidification/stabilization uses a mechanical mixer/injector to introduce and mix solidification materials directly into the contaminated soil or sludge. The materials are eventually solidified into a stable mass.

In situ bioreclamation is a technique for treating shallow zones of contamination by microbial degradation. Nutrients, and sometimes microorganisms are mixed, in place, into the soil. The need for mixing limits the depth to which this technology is applicable. The basic concepts of bioremediation is the alteration of environmental conditions to enhance microbial metabolism of organic contaminants, resulting in their breakdown and detoxification.

In situ vacuum extraction involves the extraction of soil vapor from areas of contaminated soil. Drawing soil vapor through contaminated soil results in removal of volatile organics from soil surfaces.

In situ technologies prevent or reduce exposure to contaminants as well as prevent further migration of the contaminants into the environment. The implementation of in situ solidification/stabilization at site source areas is expected to result in compliance with ARARs. The effectiveness of in situ aeration is dependent upon the tightness of the soils. The implementation of soil washing and precipitation may not result in compliance with ARARs due to the potential for the chemicals used to pass by the collection system. In addition, future changes in soil pH may result in the remobilization of the precipitated contaminants. The presence of metal contaminants may have an adverse effect on the effectiveness of in situ bioreclamation.

In situ treatment technologies for migration control potentially applicable to the site include bioreclamation and permeable treatment beds. These technologies require the treating agents to be brought to the contaminants as opposed to onsite treatment technologies that bring the contaminants to the treating agents.

In situ bioreclamation consists of the injection of nutrients, and sometimes microorganisms, into the aquifer. The basic concept of bioreclamation is the alteration of environmental conditions to enhance microbial metabolism or organic contaminants, resulting in the breakdown and detoxification of these contaminants.

Permeable treatment beds are trenches constructed at the leading edge of the contaminant plume that contain activated carbon, lime, or other materials that adsorb or react with the contaminants to prevent their further migration.

Implementation of these *in situ* migration control technologies is expected to result in compliance with ARARs. However, the presence of metal contaminants may have an adverse effect on the effectiveness of *in situ* bioreclamation.

The potential remedial technologies identified for HPIA are presented in Table 4-7.

TABLE 4-7

HADNOT POINT INDUSTRIAL AREA
POTENTIAL REMEDIAL TECHNOLOGIES

RESPONSE ACTION	REMEDIAL ALTERNATIVE	CONTROLLING FACTORS
(1) No Action	o groundwater monitoring o fences/warning signs	o Public Health Evaluation
(2) Containment:		
a. Source Control	o capping o solidification/stabilization o encapsulation of tanks	o soil containment/tank containment characteristics; ARARs
b. Migration Control	o hydraulic barriers	o geohydrologic conditions; groundwater contaminant characteristics; ARARs
(3) On-Site Treatment		
a. Source Control	o soil washing o precipitation (metals) o incineration o aeration (volatiles) o bioreclamation (organics)	o soil contaminant characteristics; ARARs
b. Migration Control	o groundwater extraction and treatment: -air stripping (volatiles) -steam stripping (volatiles) -carbon adsorption (organics) -ion exchange (metals) -precipitation (metals) -bioreclamation	o geohydrologic conditions; groundwater contaminant characteristics; ARARs
(4) Removal (and off-site treatment):		
a. Source Control	o landfill excavated soils	o regulatory requirements; identification of available landfill
b. Migration Control	o physical, chemical or biological treatment of groundwater offsite	o regulatory requirements; acceptance by treatment facility
(5) In-Situ Treatment:		
a. Source Control	o soil washing (metals) o precipitation (metals) o aeration (volatiles) o solidification/stabilization o bioreclamation o vacuum extraction	o soil containment characteristics; treatability studies; ARARs
b. Migration Control	o bioreclamation (organics) o permeable treatment beds	o groundwater contaminant characteristics; treatability studies; ARARs

5.0 WORK PLAN RATIONALE

The following subsections describe the overall project objectives and the specific data quality objectives for the HPIA RI/FS, and the limited scope investigations.

5.1 PROJECT OBJECTIVES

The primary objectives of the RI for the Hadnot Point Industrial Area are to:

1) generate data required to perform a risk assessment and feasibility study for shallow soils and deep groundwater at the site, and

2) generate data to facilitate the design of the selected remedial action for shallow groundwater.

These objectives will be fulfilled by collecting discrete shallow soil samples in targeted areas, installing intermediate and deep monitoring wells downgradient of potential source areas, and collecting a complete round of groundwater samples from shallow monitoring wells in order to update the existing data base.

The primary objective of the limited scope investigations at Sites 6, 48, and 69 is to obtain additional data at these sites as part of the on-going RI process. Groundwater, surface water, sediment and fish tissue sampling proposed in this work plan will yield a current data set for these sites.

The proposed scopes of work focus on areas of concern as targeted by the Confirmation Study and previous studies at each site.

The primary objective of the FS for the Hadnot Point Industrial Area is to screen, test, and evaluate remedial alternatives for shallow soils and deep groundwater at the site. The extent to which remediation is desired will be governed by the risk assessment, and the ultimate goal to protect public health and the environment.

5.2 DATA QUALITY OBJECTIVES (DQOs)

Data Quality Objectives (DQOs) are analytical levels/requirements of quality control (QC) necessary to support decisions relative to various remedial actions. Three DQO levels, C, D, and E, have been adopted by the Navy. These DQO levels correlate with EPA DQO levels 3,4, and 5 as described in "Data Quality Objectives for Remedial Response Activities Development Process" (US EPA, 1987). DQO levels are based on the type of site to be investigated, the level of accuracy and precision required, and the intended use of the data.

All data obtained during the HPIA RI/FS as well as the other investigations will be the result of analysis under DQO Level D. DQO Level D correlates to EPA Level 4, and is required for sites that are on or about to be on the NPL. Level D QC includes review and approval of the laboratory QA plan, the site work plan, and the field QA plan.

The laboratory must successfully analyze a performance sample, undergo an audit, correct deficiencies found during the audit, and provide monthly progress reports (MPRs) on QA. These activities will be administered and evaluated by the NEESA Contract Representative (NCR). This audit and the analysis performance sample are in addition to those related to the EPA Superfund Program. The laboratory that performs Level D QC must have passed the performance sample furnished through the Superfund Contract Laboratory Protocol (CLP) and must be able to generate the CLP deliverables. For a Level D site, the CLP methods are used and the CLP data package generated.

6.0 TASK PLAN

The following subsections describe the tasks to be performed for the RI/FS and the limited scope investigations. Tasks 8, 9 and 10 describe tasks associated with an FS and, therefore, only apply to HPIA.

6.1 TASK 1: PROJECT PLANNING

The project planning task includes preparation of the Work Plan, Health and Safety Plan, and Sampling Plan. The Sampling Plan consists of the Field Sampling and Quality Assurance Project Plans.

The Work Plan summarizes the existing data base and documents the decisions and evaluations made during the scoping process. The Field Sampling Plan (FSP) delineates the field sampling and analytical objectives and procedures. The Field Sampling Plan identifies the number, type, and location of samples to be taken, field personnel requirements, and sampling methodologies. The Field Sampling Plan will be developed in accordance with the requirements of the "Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual" (EPA Region IV).

The Health and Safety Plan (HASP) identifies site-specific safety considerations and precautions to be taken during site operations. Decontamination procedures, training requirements, and medical surveillance programs are described in the plan. The Health and Safety Plan will be developed in accordance with the EPA's "Standard Operating Safety Guides" (11/11/89).

The Quality Assurance Project Plan includes a laboratory QA/QC plan and a description of field QA/QC procedures. This document will be developed in accordance with the requirements of the "Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual" (EPA Region IV).

6.2 TASK 2A: FIELD INVESTIGATION - HPIA

This task includes all efforts related to implementing a field investigation at HPIA. The objectives of the field investigation are as follows:

- to collect additional data to facilitate the design of the selected remedial action for shallow groundwater;
- to collect data necessary to conduct a risk assessment and feasibility study for deep groundwater, and

- to collect data necessary to conduct a risk assessment and feasibility study for shallow soil contamination.

Additional data collection to facilitate design of shallow aquifer remediation will include the collection of a complete round of shallow groundwater samples in order to obtain a current data set. Deep groundwater contamination will be further characterized by the installation and sampling of additional intermediate and deep monitoring wells downgradient of potential source areas. The areal and vertical extent of shallow soil contamination will be evaluated by the collection of discrete soil samples in areas of concern.

The field investigation at HPIA will consist of the following subtasks:

1. Subcontracting;
2. Mobilization and Demobilization;
3. Monitoring Well Installation;
4. Groundwater Sampling and Water Level Monitoring;
5. Soil Sampling, and
6. Surveying of Wells.

Table 6-1 presents a summary of the proposed analytical program at HPIA.

6.2.1 SUBCONTRACTING (SUBTASK 1)

This subtask will include the procurement of all subcontracts required to perform the field investigation. Subcontracts for surveying and drilling services will be required to support the HPIA field program. The surveying effort will be limited to establishment of monitoring and water supply well locations and elevations. The drilling effort will include soil boring and monitoring well installation.

6.2.2 MOBILIZATION AND DEMOBILIZATION (SUBTASK 2)

This subtask will consist of field personnel orientation, equipment mobilization, and the staking of sample locations.

Field team members will attend an orientation meeting to become familiar with the history of the site, health and safety requirements, and field procedures.

Equipment mobilization will entail the ordering and purchasing of all sampling equipment necessary for the field investigation. Locations for soil borings and monitoring well clusters will be staked at the start of the field investigation. A decontamination pad may be constructed at this time if an existing facility suitable for equipment decontamination cannot be found.

TABLE 6-1

HADNOT POINT INDUSTRIAL AREA
PROPOSED ANALYTICAL PROGRAM

	MATRIX(a)	FIELD SCREENING(b)	FULL TCL(c) + ketones(d)	TCL VOCs + ketones(d)	TCLP (metals)(e)	PESTICIDES /PCBs
GROUNDWATER:						
Existing Shallow Wells (30)	GW	30	30	-	-	-
Existing Deeper Wells (6)	GW	6	6	-	-	-
New Deeper Wells (8)	GW	8	8	-	-	-
Water Supply Wells (9)	GW	9	9	-	-	-
Duplicate Samples (f)	GW	-	5	3	-	-
TOTAL GROUNDWATER SAMPLES	GW	53	58	23	-	
SOIL:						
Soil Borings (30)	SO	90	9	81	81	81
Duplicate Samples (f)	SO	-	1	8	8	8
TOTAL SOIL SAMPLES	SO	90	10	90	90	90
BLANK SAMPLES (h):						
Equipment Blanks	AQ	-	25	8	8	8
Field Blanks	AQ	-	1	-	1	1
Trip Blanks	AQ	-	-	20	-	-
Drilling Mud Blank	SO	-	1	-	-	-
Deionized Water Blank	AQ	-	2	-	-	-
TOTAL BLANK SAMPLES	AQ	-	29	28	9	9

NOTES: (a) GW = groundwater, SO = soil, AQ = aqueous
(b) Field screening for groundwater: pH, temperature, specific conductivity
Field screening for soils: HNu and/or OVM
(c) Full TCL = TCL VOCs, Extractables (includes BNAs, pesticides and PCBs), Metals and Cyanide
(d) ketones = methyl ethyl ketone and methyl isobutyl ketone
(e) TCLP = Toxicity Characteristic Leaching Procedure (metals only)
(f) Duplicate sample numbers based on a frequency of 10%
(g) Number of soil boring samples presented is approximate due to the variable depth to water (6-22 feet) at HPIA
(h) Equipment blank totals are approximate and based on 1/day/sampling procedure
Trip blank totals are approximate and based on 1/day of aqueous TCL VOC sampling
Deionized water blank totals are approximate and based on 1/lot (batch) of water.

Demobilization will consist of equipment demobilization, and will be performed at the completion of each phase of the field investigation, as necessary.

6.2.3 MONITORING WELL INSTALLATION (SUBTASK 3)

The monitoring well installation program is designed to obtain additional data on deep aquifer conditions downgradient of four areas of concern at HPIA.

Monitoring well clusters will be installed downgradient of Buildings 1602, 902, and 1202, and the Industrial Area Tank Farm (Site 22) (Figure 6-1).

The direction of horizontal groundwater flow within the deeper (>75 feet) portion of the aquifer below HPIA is not known at this time. The downgradient horizontal flow direction will be determined by water level measurements taken in existing deep wells and, if available, water level data obtained from USGS files in Raleigh, N.C.

Monitoring well clusters will consist of two wells each, screened at depths of approximately 75 and 150 feet. Exact screen depths will be determined in the field based on the permeability of the soils at these approximate depths.

Wells will be constructed of 4-inch, Schedule 40 PVC screen and riser pipe. Screens will be 10 feet long with 0.010 inch slots (or of an appropriate slot-size to retain approximately 90% of the filter pack).

Wells will be drilled using the mud rotary method. Split-spoon samples will be obtained every 5 feet in deep well borings for geologic characterization, and at approximate screen intervals in intermediate and deep well borings for effective screen placement.

Following well installation, all wells will be developed by pumping and surging. Well development will continue until development water is visibly free of fines, as determined by the site geologist. Development water will be discharged to the ground surface in the immediate vicinity of the well.

6.2.4 GROUNDWATER SAMPLING AND WATER LEVEL MONITORING (SUBTASK 4)

The groundwater sampling program is designed to obtain water quality data for the shallow and deep aquifers at the site.

Water quality data will be utilized to facilitate remediation design for shallow groundwater and to conduct a risk assessment and feasibility study for deep groundwater.

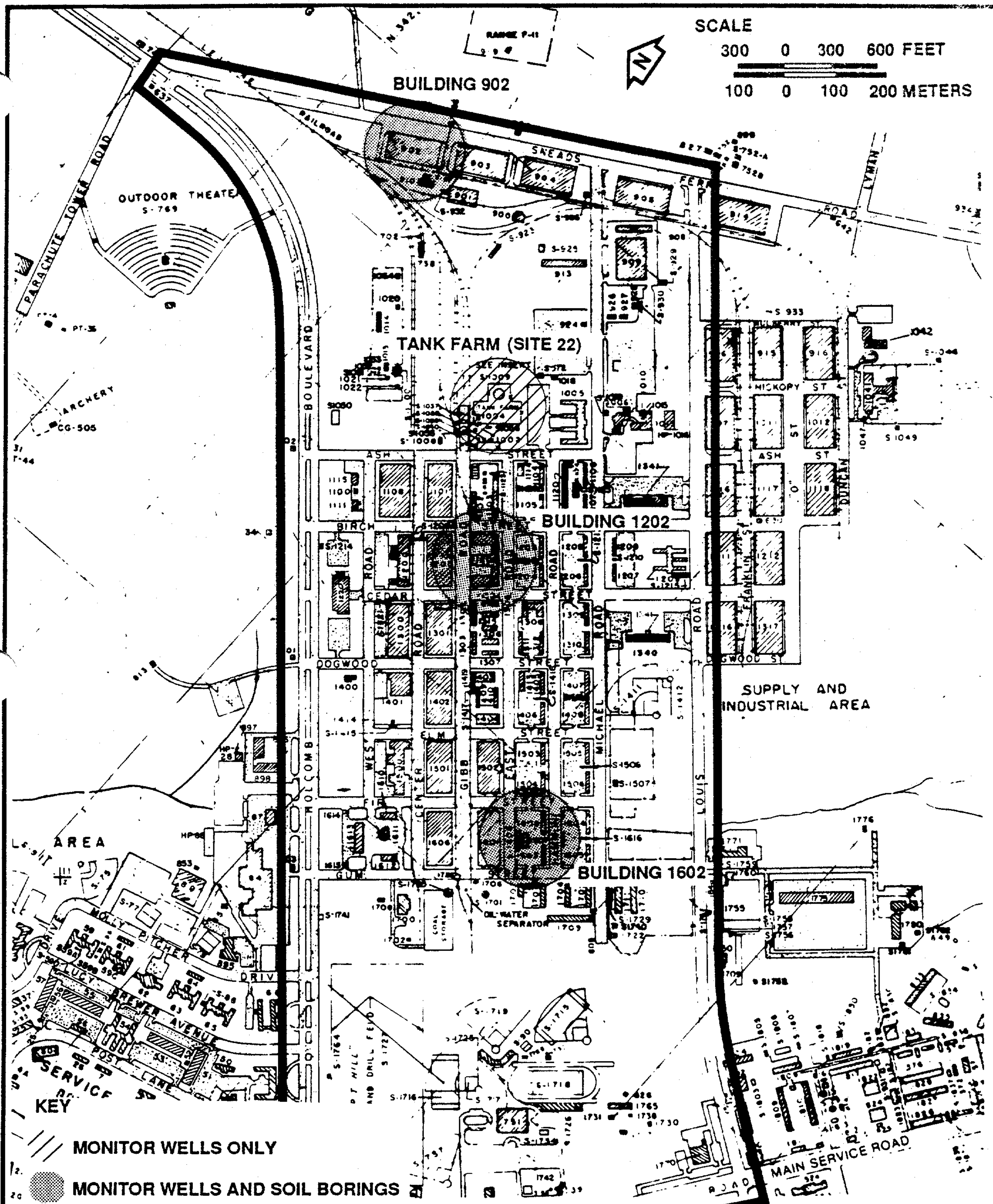


Figure 6-1
AREAS FOR INTERMEDIATE AND DEEP MONITORING WELLS AND SOIL BORINGS
SOURCE: CAMP LEJEUNE, 1987.

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Thirty existing shallow wells (27 at HPIA, 2 at Site 22, and 1 at Site 21) , 8 newly installed intermediate and deep wells, 6 existing intermediate and deep wells, and 9 water supply wells will be sampled during this field investigation. Figure 3-1 shows the locations of the existing wells. The monitoring wells to be sampled include HPGW1 through HPGW26, HPGW29, 22GW-1, 22GW-2, and 21GW-1. The water supply wells to be sampled include 601, 603, 642, 602, 608, 630, 634, 637, and 652.

A minimum stabilization period of 72 hours will be required prior to sampling the new wells. All groundwater samples will be analyzed for full Target Compound List (TCL) parameters.

A minimum of two rounds of water level measurements will be taken during the field investigation to determine horizontal and vertical groundwater flow gradients at the site. Existing shallow wells in the vicinity of newly installed well clusters (screened at intermediate and deep aquifer depths) will assist in vertical flow gradient determination.

6.2.5 SOIL SAMPLING (SUBTASK 5)

The soil sampling program is designed to evaluate shallow soil contamination at HPIA. Previous studies indicate that shallow soil contamination may exist in three areas. These areas are adjacent to Buildings 1602, 902, and 1202 (Figure 6-1). Figures 6-2 through 6-4 show approximate soil boring locations planned in each area.

Soil samples will be collected from 30 soil borings located at the three targeted areas. Soil samples will be collected continuously to the water table (approximately 6-22 feet). Hollow stem augers with 3" O.D. split-spoon samplers will be used to obtain soil samples.

Each soil sample will be screened with a photoionization detector (PID). The three samples with the highest PID readings per boring will be sent to the laboratory for chemical analysis.

Ten percent of all analytical samples (approximately 9 samples) will be analyzed for full TCL parameters. The remaining 90% (approximately 81 samples), will be analyzed for volatile organics plus xylene, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), Toxicity Characteristic Leaching Procedure (TCLP) (metals only), and pesticides/PCB's.

6.2.6 SURVEYING OF WELLS (SUBTASK 6)

This subtask includes the surveying of all existing monitoring and water supply wells and all newly installed monitoring wells at HPIA. The surveying effort will include the establishment of well locations and

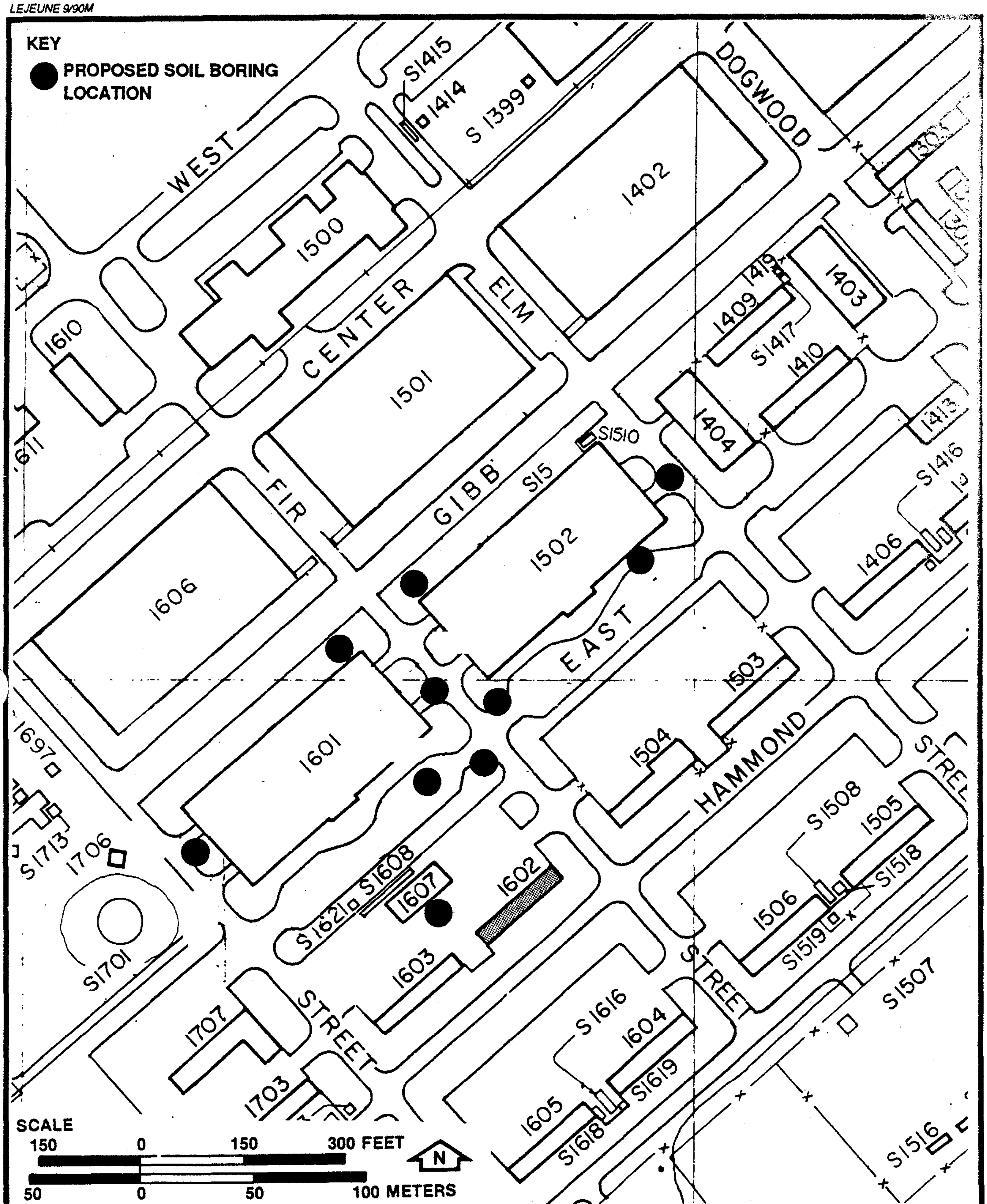

Figure 6-2
APPROXIMATE SOIL BORING LOCATIONS – BUILDING 1602

SOURCE: ESE, 1990.

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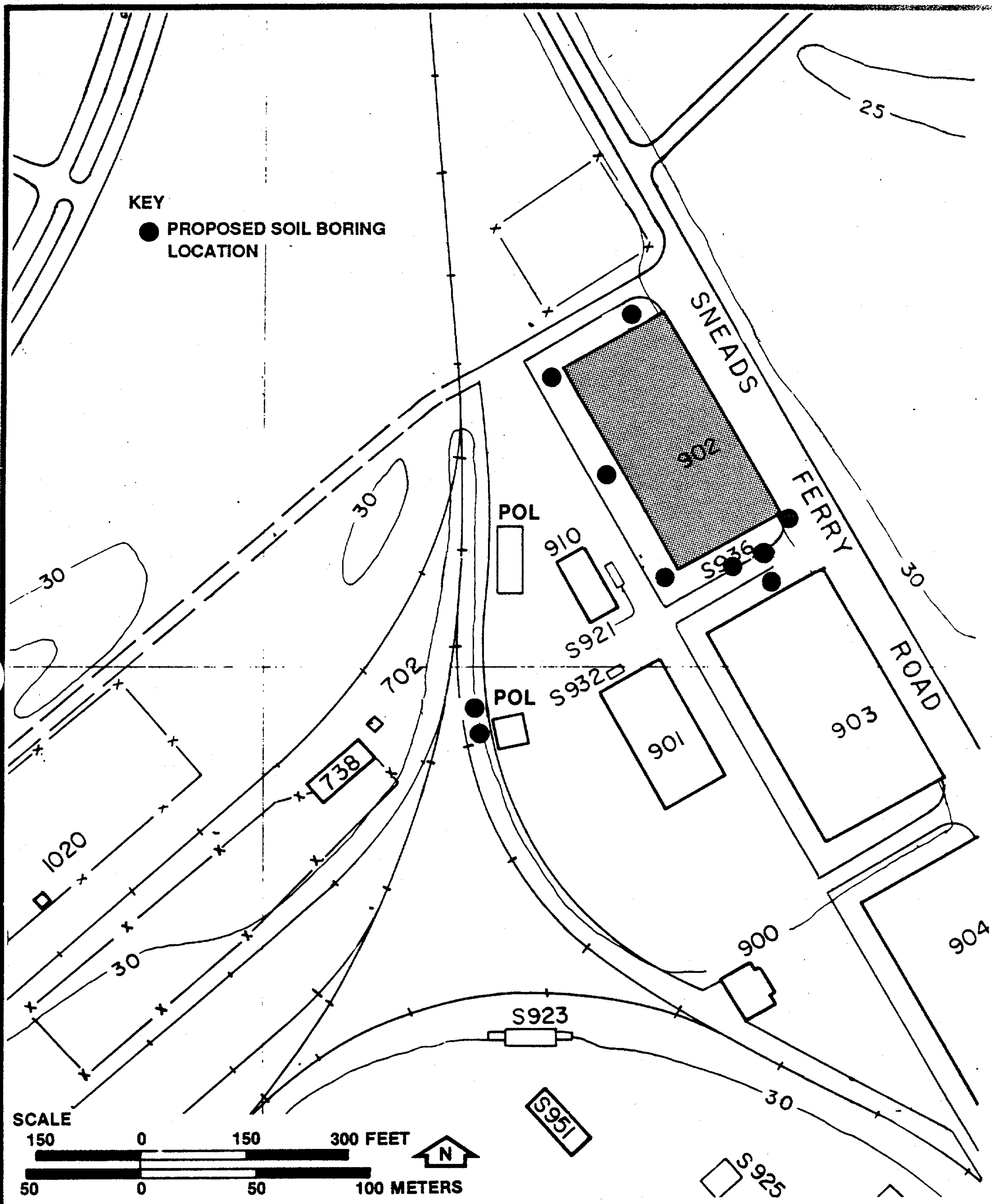

Figure 6-3
APPROXIMATE SOIL BORING LOCATIONS – BUILDING 902

SOURCE: ESE, 1990.

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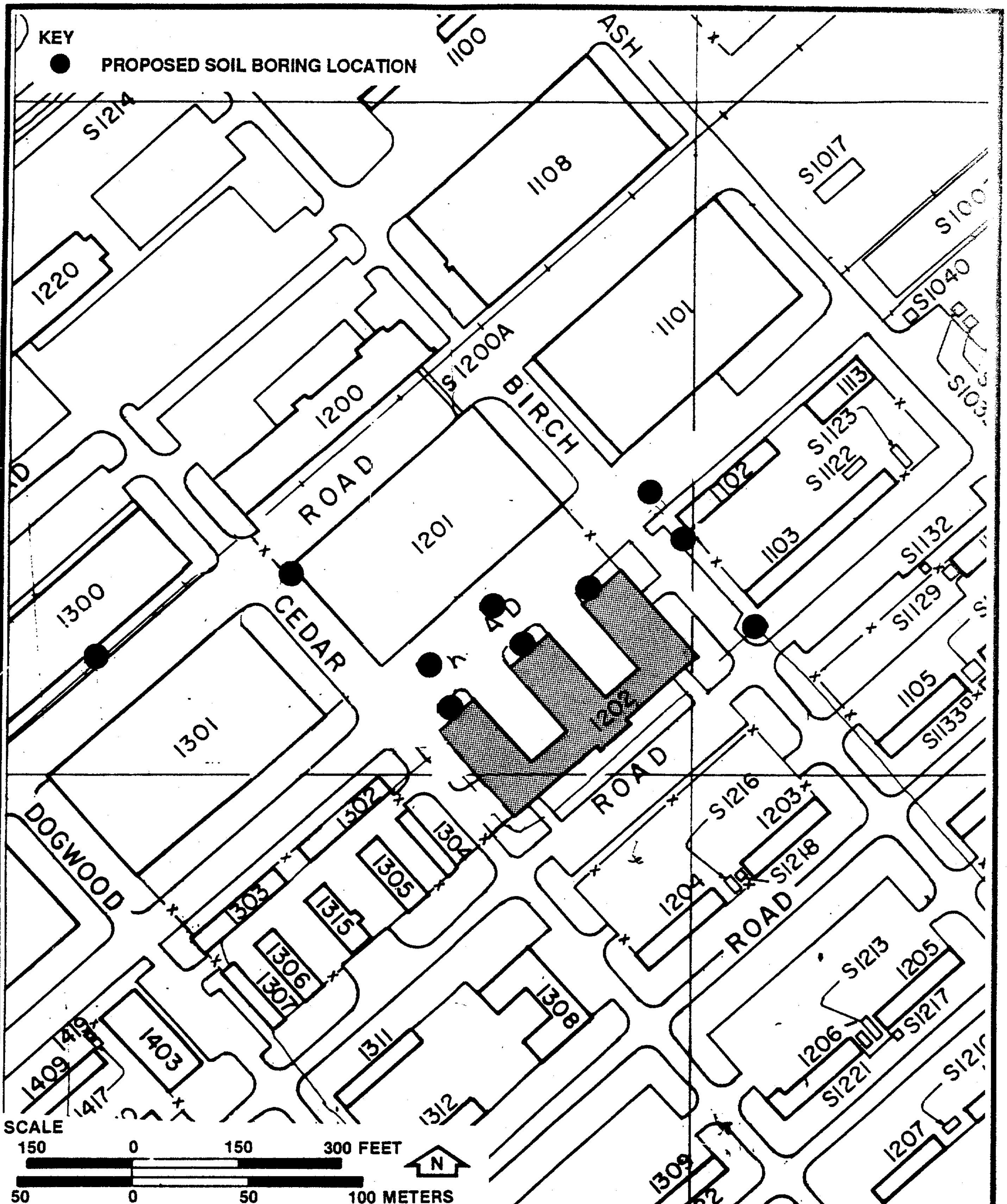

Figure 6-4
APPROXIMATE SOIL BORING LOCATIONS—BUILDING 1202

SOURCE: ESE, 1990.

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CAMP LEJEUNE

elevations. The surveying of existing wells may be scheduled prior to the initiation of field sampling activities in order to determine deep aquifer flow gradients on site, if available USGS data fails to make this determination. Deep aquifer flow gradients are required for placement of proposed well clusters downgradient of targeted areas of concern.

6.3 TASK 2B: FIELD INVESTIGATION - SITE 6

This task includes all efforts related to implementing a field investigation at Site 6. The objective of this investigation is to collect additional data in order to move forward with the RI process at this site.

The Site 6 field investigation will consist of the following tasks:

1. Mobilization and Demobilization;
2. Groundwater Sampling, and
3. Surface Water and Sediment Sampling.

Table 6-2 includes a summary of the proposed analytical program at Site 6.

6.3.1 MOBILIZATION AND DEMOBILIZATION (SUBTASK 1)

It is anticipated that the Site 6 field investigation will occur at the same time as the HPIA field investigation. A separate mobilization/demobilization task for this site investigation will not be necessary. See Section 6.2.2 for a description of the mobilization/demobilization effort.

6.3.2 GROUNDWATER SAMPLING (SUBTASK 2)

Eight existing shallow monitoring wells and two existing water supply wells (651 and 653) will be sampled at Site 6. Figure 2-3 shows the locations of these wells. All groundwater samples will be analyzed for full TCL parameters.

6.3.3 SURFACE WATER AND SEDIMENT SAMPLING (SUBTASK 3)

Surface water and sediment samples will be collected at upstream and downstream locations in Wallace Creek. The Second Round Verification Study conducted by ESE indicated the presence of VOCs in this creek. Figure 2-3 shows the location of Wallace Creek with respect to Site 6. Sediment and surface water samples will be analyzed for full TCL parameters.

TABLE 6-2

SITES 6, 48, and 69
PROPOSED ANALYTICAL PROGRAM

	MATRIX(a)	FIELD SCREENING(b)	FULL TCL(c)	TCL VOCs	TCL METALS
SITE 6:					
Groundwater	GW	10	10	-	-
Surface Water	SW	2	2	-	-
Sediment	SE	2	2	-	-
TOTAL SAMPLES		14	14	-	-
SITE 48:					
Surface Water	SW	11	-	-	11
Sediment	SE	11	-	-	11
Fish Tissue	TI	-	-	-	11
TOTAL SAMPLES		22	-	-	33
SITE 69:					
Groundwater	GW	8	8	-	-
Surface Water	SW	7	7	-	-
Sediment	SE	7	7	-	-
Fish Tissue	TI	-	4	-	-
TOTAL SAMPLES		22	26	-	-
DUPLICATE SAMPLES(d):					
Groundwater	GW	2	2	-	-
Surface Water	SW	2	1	-	1
Sediment	SE	2	1	-	1
Fish Tissue	TI	-	1	-	-
TOTAL SAMPLES		6	5	-	2
BLANK SAMPLES(e):					
Equipment	AQ	16	13	-	3
Field	AQ	1	1	-	-
Trip	AQ	13	-	13	-
TOTAL SAMPLES		30	14	13	3

NOTES: (a) GW = groundwater, SO = soil, SW = surface water, SE = sediment, TI = fish tissue, AQ = aqueous

(b) Field screening for groundwater and surface water: pH, temperature, specific conductivity
Field screening for soils and sediment: HNu and/or OVM

(c) Full TCL = TCL VOCs, Extractables (includes BNAs and pesticides/PCBs), Metals and Cyanide

(d) Duplicate sample numbers based on a frequency of 10%

(e) Equipment blank totals are approximate and based on 1/day/sampling procedure
Trip blank totals are approximate and based on 1/day of aqueous TCL VOC sampling

6.4 TASK 2C: FIELD INVESTIGATION - SITE 48

This task includes all efforts related to implementing a field investigation at Site 48. The objective of this investigation is to collect additional data in order to move forward with the RI process at this site.

The Site 48 field investigation will consist of the following tasks:

1. Mobilization and Demobilization;
2. Surface Water and Sediment Sampling, and
3. Fish (or Shellfish) Tissue Sampling.

Table 6-2 includes a summary of the proposed analytical program at Site 48.

6.4.1 MOBILIZATION AND DEMOBILIZATION (SUBTASK 1)

It is anticipated that the Site 48 field investigation will occur at the same time as the HPIA field investigation. A separate mobilization/demobilization task for this site investigation will not be necessary. See Section 6.2.2 for a description of the mobilization/demobilization effort.

6.4.2 SURFACE WATER AND SEDIMENT SAMPLING (SUBTASK 2)

Surface water and sediment samples will be collected at ten locations within the marsh area north of Building 804 and at one background location. Approximate sample locations are presented in Figure 6-5. These samples will be analyzed for TCL Metals only.

6.4.3 FISH (OR SHELLFISH) TISSUE SAMPLING (SUBTASK 3)

Fish (or shellfish) tissue samples will be collected at the eleven surface water/sediment sample locations described in Section 6.4.2. This task will be performed in accordance with procedures documented in "Ecological Assessment of Hazardous Waste Sites" (USEPA, 1989). Fish tissue samples are planned for Site 48 because mercury, a compound which has a tendency to bioaccumulate, was detected in sediment samples during previous investigations. An attempt will be made to sample only bottom dwelling/feeding organisms as these samples will yield the most reliable information with respect to aquatic conditions at Site 48. Fish tissue samples will be analyzed for TCL Metals.

Non-parametric statistical analyses will be used to determine if chemical levels in fish tissue samples collected at Site 48 are elevated compared to levels in regional (background) fish tissue, as documented in the literature.

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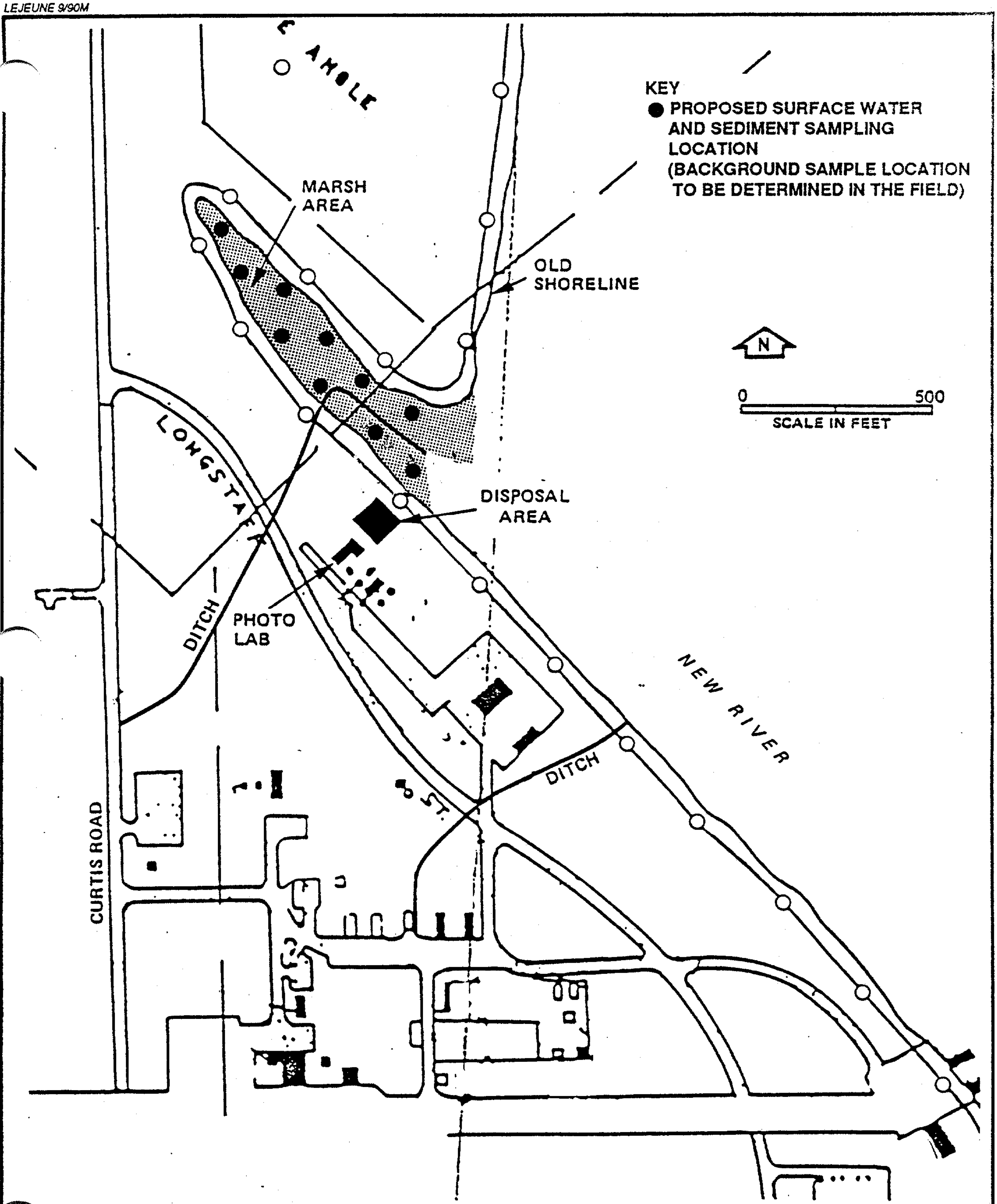

Figure 6-5
APPROXIMATE SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS - SITE 48

SOURCES: WATER AND AIR RESEARCH, INC., 1983; ESE, 1990.

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6.5 TASK 2D: FIELD INVESTIGATION - SITE 69

This task includes all efforts related to implementing a field investigation at Site 69. The objective of this investigation is to collect additional data in order to move forward with the RI process at this site.

The Site 69 field investigation will consist of the following tasks:

1. Mobilization and Demobilization;
2. Groundwater Sampling;
3. Surface Water and Sediment Sampling, and
4. Fish (or Shellfish) Tissue Sampling.

Table 6-2 includes a summary of the proposed analytical program at Site 69.

6.5.1 MOBILIZATION AND DEMOBILIZATION (SUBTASK 1)

It is anticipated that the Site 69 field investigation will occur at the same time as the HPIA field investigation. A separate mobilization/demobilization task for this site investigation will not be necessary. See Section 6.2.2 for a description of the mobilization/demobilization effort.

6.5.2 GROUNDWATER SAMPLING (SUBTASK 2)

Eight existing shallow monitoring wells will be sampled at Site 69. Figure 2-5 shows the well locations. All groundwater samples will be analyzed for full TCL parameters.

6.5.3 SURFACE WATER AND SEDIMENT SAMPLING (SUBTASK 3)

Surface water and sediment samples will be collected at each of seven sampling locations. One sample of each media will be collected at Round Two Report Locations 69SW1, 69SW2, and 69SW3. Two samples of each media will be collected at each of Round Two Report Locations 69SW4/69SW5 and 69SW5/69SE5. The surface water and sediment samples will be analyzed for full TCL parameters. Figure 2-5 shows the sample locations.

6.5.4 FISH (OR SHELLFISH) TISSUE SAMPLING (SUBTASK 4)

Two fish (or shellfish) tissue samples will be collected at each of two Round Two sample locations (69SW4/69SE4 and 69SW5/69SE5) for a total of four tissue samples. Fish tissue samples will be collected in accordance with procedures outlined in the EPA guidance document "Ecological Assessment of Hazardous Waste Sites" (March 1989). Fish tissue samples will be collected in order to evaluate the impact of Site

69 contamination on the aquatic environment. An attempt will be made to sample only bottom dwelling/feeding organisms as these samples will yield the most reliable information with respect to aquatic conditions at the site. These samples will be analyzed for full TCL compounds.

Non-parametric statistical analyses will be used to determine if chemical levels in fish tissue samples collected at Site 69 are elevated compared to levels in regional (background) fish tissue, as documented in the literature.

6.6 TASK 3: SAMPLE ANALYSIS & VALIDATION

All samples collected during the field investigations will be analyzed at the ESE Laboratory. This laboratory fulfills all the requirements outlined in the EPA and Navy Quality Assurance Programs, and has been pre-approved by the Navy. A final quality assurance/quality control (QA/QC) report will be issued at the completion of the field program, as required by the Navy's Quality Assurance Guide.

Sample analysis will be conducted at DQO Level D (see Section 5.2) ensuring that analytical methods comparable to EPA's CLP program will be used. CLP-type data packages will be generated by the lab for each sample.

Data validation will be conducted by ESE. Martin Marietta Energy Systems personnel will review data validation as required by the Navy QA program. The data validation program will confirm that the analytical results obtained are of sufficient quality to perform a risk assessment, and screen and select remedial alternatives.

6.7 TASK 4: DATA EVALUATION

Data collected during the field investigations will be assembled, organized, and reviewed. These data, and previously collected data, will be evaluated in order to satisfy each project site's objectives.

Boring logs will be generated for all completed soil borings and monitoring well borings. Stratigraphic information obtained from the borings will be used to develop cross-sections. Water level measurements taken at HPIA will be used to generate potentiometric surface maps and to estimate horizontal and vertical flow gradients. Analytical data will be used to evaluate contamination in the targeted areas.

All of the data collected at HPIA will be used to support the remedial design for shallow groundwater, and the risk assessment and feasibility study for deep groundwater and shallow soils at HPIA. All data collected at Sites 6, 48 and 69 will be used to support a preliminary risk analysis at each site.

6.8 TASK 5: ASSESSMENT OF RISKS

A baseline human health and ecological risk assessment will be conducted for shallow soils and deep groundwater at Hadnot Point Industrial Area. The risk assessment will include identification of indicator chemicals, exposure assessment, toxicity assessment, and risk characterization. Because of the minimal amount of available data, only preliminary baseline risk assessments can be conducted for Sites 6, 48, and 69. These risk assessments will be smaller in scope than the risk assessment for Hadnot Point Industrial Area, but will include an overall assessment of human and ecological risk to the extent the data allow.

The risk assessments will incorporate relevant historical data as well as any data generated during the current investigation of Hadnot Point and Sites 6, 48, and 69. A site survey will be performed to obtain data relevant to determining human and ecological risks. Information (such as Census data or zoning regulations) will be compiled from various federal and state agencies for use in the exposure assessment.

The risk assessment will be performed utilizing the following references:

"Interim Final Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual", OSWER Directive 9285.7-01a, September 1989;

"Interim Final Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual", OSWER Directive 9285.7-02, March 1989;

"Superfund Exposure Assessment Manual", OSWER Directive 9285.5-1, April 1988, and

"Ecological Assessment of Hazardous Waste Sites", EPA/600/3-89/013, March 1989.

The risk assessment process is described below.

The overall objective of a risk assessment is to provide a determination of the magnitude and probability of actual or potential harm to public health and welfare or to the environment by the threatened or actual release of a hazardous substance or a hazardous waste. The risk assessment process (Figure 6-6) is comprised of four separate components as follows:

- Contaminant Identification---The objective of this component is to screen the information available on all contaminants present in all relevant media (e.g. air, water, soil,

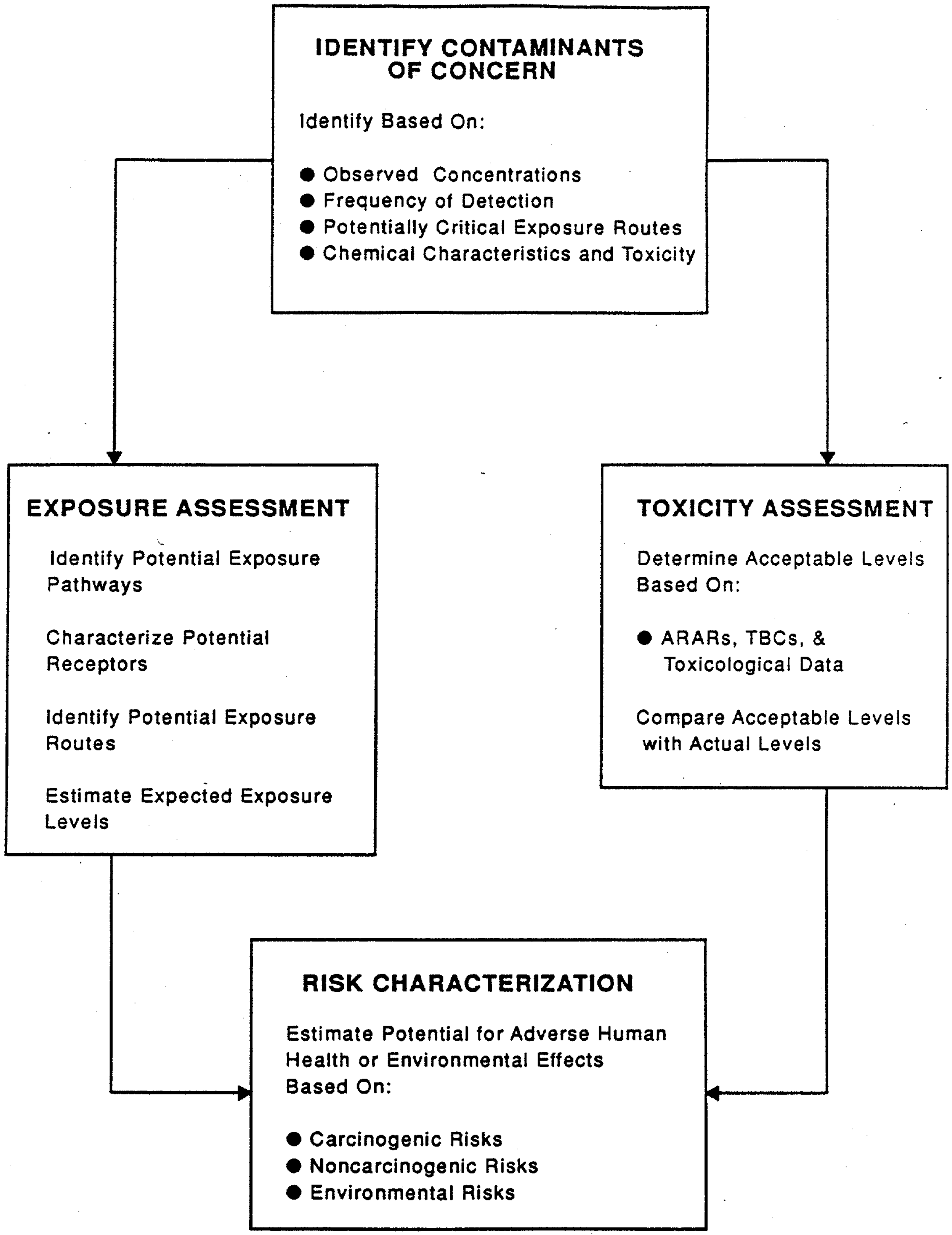

Figure 6-6
RISK ASSESSMENT PROCESS

SOURCE: ESE, 1990.

MARINE CORPS BASE CAMP LEJEUNE

sediment, biota) at the site and to identify contaminants of concern. This screening process is necessary when many site contaminants are identified in order to focus subsequent efforts in the risk assessment process on a small number of selected contaminants. The goal of the selection process

is to identify those contaminants that represent the most toxic, mobile, persistent, and frequently occurring contaminants found on site.

- Exposure Assessment---The objectives of an exposure assessment are to identify actual or potential routes of exposure, characterize the exposed populations, and determine the extent of exposure. These objectives will be attained by performing the following steps:

  - Analyze contaminant release;
  - Analyze environmental fate and transport of contaminants;
  - Analyze populations, sensitive subsets of the human population, and/or fish and wildlife populations at risk, and
  - Determine potential contaminant exposure pathways (e.g. direct contact, inhalation of vapors/dust, ingestion of contaminated water or soil, and ingestion of contaminated aquatic organisms).

- Toxicity Assessment---The objective of the toxicity assessment is to determine the nature and extent of health and environmental hazards associated with exposure to contaminants at the concentrations identified at the site. Toxicity data from scientific literature will be critically evaluated and interpreted, resulting in a toxicity profile for each selected contaminant of concern. Toxicity profiles characterize the adverse health and environmental effects that are the anticipated results of exposure to these contaminants.

- Risk Characterization---Risk characterization is the process of estimating the incidence of an adverse health or environmental effect under the various conditions of exposure defined in the exposure assessment. This objective is attained by integrating all of the information developed during the exposure and toxicity assessments to yield a complete characterization of potential or actual risk. The risk characterization will include:

  - Carcinogenic risks;
  - Noncarcinogenic risks, and
  - Environmental risks.

6.9 TASK 6: TREATABILITY STUDY/PILOT TESTING

Treatability studies/pilot testing are beyond the assigned scope of work and will not be considered at this time. It is proposed that ESE will meet with LANTDIV to discuss the need and suggested scope of treatability studies to be performed once preliminary analytical data become available.

6.10 TASK 7: REMEDIAL INVESTIGATION REPORT/SITE SUMMARY REPORTS

A Remedial Investigation (RI) report will be generated at the completion of this investigation for HPIA. The RI report will be prepared in accordance with "Interim final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (OSWER Directive 9355.3-01, October 1988). Data collected during this investigation, data presented in the existing Characterization Report (May, 1988), and data obtained from the USGS will be incorporated into a single, comprehensive report.

The HPIA Risk Assessment will not be included in the RI report. The RA will be presented under separate cover.

Site assessment reports will be generated for Sites 6, 48, and 69. The reports will include a summary of all available data on each site as well as a discussion of the risk analysis and subsequent recommendations.

6.11 TASK 8: REMEDIAL ALTERNATIVE SCREENING

Screening of remedial alternatives will be conducted for HPIA shallow soils and deep groundwater. The initial screening of remedial alternatives will be based on the risk assessment and subsequently developed remedial response objectives.

References used during the remedial alternative screening will include:

- "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (OSWER Directive 9355.3-01, October 1988), and

- "Basics of Pump-and-Treat Groundwater Remediation Technology" (EPA/600/8-90/003, March 1990).

6.12 TASK 9: EVALUATION OF DETAILED REMEDIAL ALTERNATIVES

The remedial alternatives which pass the initial screening will be evaluated in detail through the process specified in EPA's "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (OSWER Directive 9355-01, October 1988).

The nine criteria to be used in the detailed evaluation of remedial alternatives are as follows:

1) short-term effectiveness
2) long-term effectiveness
3) reduction of toxicity, mobility, and volume
4) implementability
5) cost
6) compliance with ARARs
7) overall protection
8) state acceptance
9) community acceptance

6.13 TASK 10: FEASIBILITY STUDY REPORT

A Feasibility Study (FS) Report on shallow soils and deep groundwater at HPIA will be generated at the completion of Tasks 1 through 9. The FS report will be prepared in accordance with "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (OSWER Directive 9355.3-01, October 1988).

7.0 PROJECT SCHEDULE

The project schedule is presented in Table 7-1.

The project schedule is based on the following assumptions:

- plans and reports will be approved in a timely fashion, and
- all sites will be accessible for sampling.

Table 7-1
<u>CAMP LEJEUNE</u>
<u>Project Schedule</u> *

September 26, 1990	Submit Final Work, Sampling, Health & Safety and Community Relations Plans and Site Summary Report to LANTDIV.
October 15, 1990	Receive LANTDIV approval of Final Work, Sampling, Health & Safety and Community Relations Plans
November 5, 1990	Initiate Field Investigation
February 25, 1991	Submit Initial Draft RI Report for HPIA
March 11, 1991	Submit Initial Draft Site Assessment Reports for Sites 6, 48, and 69.
March 29, 1991	Submit Initial Draft Risk Assessment for HPIA
April 12, 1991	Receive Government comments on Initial Draft RI and RA for HPIA and Initial Draft Site Assessment Reports for Sites 6, 48, and 69. Submit Initial Draft FS for HPIA.
April 29, 1991	Submit Final Draft RI and RA for HPIA and Final Draft Site Assessment Reports for Sites 6, 48, and 69. Receive Government comments on Initial Draft FS for HPIA.
May 20, 1991	Submit Final Draft FS for HPIA.
June 21, 1991	Present Final Draft RI, RA, and FS for HPIA, and Final Draft Site Assessment Reports for Sites 6, 48, and 69 to TRC.
July 5, 1991	Receive government comments on Final Draft documents
July 29, 1991	Submit Final RI, RA, and FS for HPIA, and Final Site Assessment Reports for Sites 6, 48, and 69.

* Dates are tentative and do not include any unforseen circumstances (e.g. extensive review periods, delays in plan approvals, etc.).

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