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May 1983

INITIAL ASSESSMENT STUDY OF NAVAL BASE CHARLESTON, CHARLESTON, SOUTH CAROLINA

NEESA Report No. 13-007

NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

Port Hueneme, California 93043

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INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

UIC No. N61466

May 1983

Prepared by:

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC. (ESE)
P.O. Box ESE
Gainesville, Florida 32602

Contract No. N62474-81-C-9383

Initial Assessment Study Team Members

Bruce N. McMaster, Chemist, Project Manager
John D. Bonds, Chemist, Team Leader
Russell V. Bowen, Civil Engineer
Stephen A. Denahan, Hydrogeologist
Ernest E. Frey, Civil Engineer
Charles D. Hendry, Chemist
Carla F. Jones, Historian/Document Coordinator
John H. Wiese, Ecologist

Prepared for:

NAVY ASSESSMENT AND CONTROL
OF INSTALLATION POLLUTANTS (NACIP) DEPARTMENT
Naval Energy and Environmental Support Activity (NEESA)
Port Hueneme, California 93043

EXECUTIVE SUMMARY

This report presents the results of an Initial Assessment Study (IAS) conducted at Naval Base Charleston (NAVBASE Charleston). The purpose of an IAS is to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations.

Based on information from historical records, aerial photographs, field inspections, and personnel interviews, a total of eight potentially contaminated sites were identified at NAVBASE Charleston. Each of the sites was evaluated with regard to contamination characteristics, migration pathways, and pollutant receptors.

The study concludes that, while none of the sites pose an immediate threat to human health or the environment, each warrants further investigation under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, to assess potential long-term impacts. A Confirmation Study, involving actual sampling and monitoring of the eight sites, is recommended to confirm or deny the existence of the suspected contamination and to quantify the extent of any problems which may exist. The eight sites recommended for confirmation are listed below in order of priority:

1. Base Sanitary Landfill, Site No. 1.

2. Chemical Disposal Area, Site No. 2.

3. Oil Sludge Pits, Site No. 3.

4. Polychlorinated Biphenyl (PCB) Storage Area, Site No. 6.

5. Former Pesticide Mixing Area, Site No. 7.

6. Petroleum, Oils, and Lubricants (POL) Transfer Point, Site No. 4.

7. Caustic Pond, Site No. 8.

8. Former Firefighting Training Pit, Site No. 5.

The results of the Confirmation Study will be used to evaluate the necessity of conducting mitigating actions or cleanup operations.

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FOREWORD

The Navy Assessment and Control of Installation Pollutants (NACIP) Program was promulgated by OPNAVNOTE 6240 of 11 Sep 1980 and Marine Corps Order 6280.1 of 30 Jan 1981. The purpose of the Program is to systematically identify, assess, and control contamination from past hazardous material operations which pose a threat to human health or to the environment.

An Initial Assessment Study (IAS) was performed at Naval Base Charleston (NAVBASE Charleston), Charleston, S.C., by a team of specialists under contract to the Naval Energy and Environmental Support Activity (NEESA), Port Hueneme, Calif. Further confirmation studies under the NACIP Program are recommended at several areas at the activity. Sections dealing with significant findings, conclusions, and recommendations are presented in the earlier section of the report. The later technical sections provide more in-depth discussions on important aspects of the study.

For further information, contact the Commanding Officer, 112N, Naval Energy and Environmental Support Activity (NEESA), Port Hueneme, Calif. 93043; AUTOVON 360-3351 or commercial 805-982-3351.

DANIEL L. SPIEGELBERG, LCDR, CEC, USN
Environmental Officer
Naval Energy and Environmental Support Activity

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

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ACKNOWLEDGEMENTS

The Initial Assessment Study (IAS) at Naval Base Charleston (NAVBASE Charleston) could not have been accomplished within its short timeframe without the support and cooperation of numerous Navy personnel. In particular, the IAS team expresses its sincere gratitude to Ms. E. Luecker and Mr. J. McCauley of the Naval Facilities Engineering Command (NAVFAC), Southern Division (SOUTHDIV), and to Mr. J. Sneed and Mr. A. Green from the Naval Shipyard (NSY) Public Works Office.

INITIAL ASSESSMENT STUDY
OF NAVAL BASE CHARLESTON

SECTION 1.0
INTRODUCTION

1.1 PURPOSE OF THE INITIAL ASSESSMENT STUDY

As directed by the Chief of Naval Operations (CNO), the Naval Energy and Environmental Support Activity (NEESA) conducts Initial Assessment Studies (IASs) to collect and evaluate evidence which indicates the existence of pollutants which may have contaminated a site and which may pose a health hazard to people located on or off the installation. These studies represent the first phase of the Navy Assessment and Control of Installation Pollutants (NACIP) Program, which is designed to:

- Identify any environmental contamination resulting from past hazardous material storage, handling, and waste disposal operations at shore installations;
- Assess the impact, or potential for impact, of the contamination on public health and the environment, both at the installation and in surrounding civilian communities; and
- Provide corrective measures, as needed, to prevent contamination from causing any adverse effects on public health or the environment.

1.2 AUTHORITY

The CNO initiated the NACIP Program through OPNAVNOTE 6240 ser 45/733503 of 11 Sep 1980 and Marine Corps Order 6280.1 of 30 Jan 1981.

1.3 SEQUENCE OF EVENTS

1. Naval Base Charleston (NAVBASE Charleston) was designated for an IAS by Commander, Naval Facilities Engineering Command (COMNAVFACENGCOM) message 261410Z January 1981.
2. The Commander of Naval Shipyard Charleston (NSY) was notified by the Chief of Naval Material (CNM) via the Commander of the Naval Sea Systems Command (NAVSEA) and by NEESA of the selection of NAVBASE Charleston for an IAS. The NACIP Program Management Plan, the IAS Statement of Work, and Activity Support Requirements for the IAS were forwarded to the installation to outline assessment scope, provide guidelines to

personnel, and request advance information for review by the IAS team.

3. NAVBASE Charleston and Naval Facilities Engineering Command (NAVFAC), Southern Division (SOUTHDIV) personnel were briefed by a NEESA representative, Mr. Rick Gardner, on 8 Jul 1981, prior to the IAS.

4. Various Government agencies were contacted for documents pertinent to the IAS effort. Agencies contacted include:

   a. NEESA Information Management Department

   b. NEESA Information Services Department

   c. NAVFAC Historian, Naval Construction Batallion Center (NCBC), Port Hueneme, Calif.

   d. South Carolina Geological Survey

   e. South Carolina Agricultural Experiment Station

   f. U.S. Geological Survey (USGS)

   g. The National Archives and Records Service, General Services Administration, Cartographic Branch, Pennsylvania Ave. at 8th St. NW, Washington, D.C.

   h. The National Archives, Washington, D.C., Record Group 80--CNO

   i. The National Archives, Washington, D.C., Record Group 71--Bureau of Yards and Docks

   j. The National Archives, Suitland, Md., Record Group 181--Naval Districts and Shore Establishments

   k. Navy History Office, Washington Navy Yard

   l. SOUTHDIV Facilities Planning and Real Estate Department and Facilities Management Department

   m. Public Works NSY

   n. The National Archives and Records Center, Atlanta, Ga., Record Group 181

   o. Naval Supply Center Charleston (NSC), Management Analysts Office

   p. Naval Security Group Command Headquarters (COMNAVSECGRU)

q. Naval Station Charleston (NAVSTA), Naval Base, Administrative Office

r. Ordnance Environmental Support Office (OESO), Indian Head, Md.

s. NAVFAC Headquarters, Real Estate Branch, Alexandria, Va.

t. NAVSEA, Documents Branch, Alexandria, Va.

u. Department of Defense Explosives Safety Board (DDESB), Alexandria, Va.

v. U.S. Army Corps of Engineers (COE)

w. Defense Mapping Agency, Office of Distribution Services, Washington, D.C.

5. The onsite phase of the IAS was conducted from 27 Jul-6 Aug 1981. The information presented in this report is current, as of the date of the onsite search. The following personnel from ESE, under Contract No. N62474-81-C-9383, were assigned to the IAS team:

   Dr. Bruce McMaster, Chemist, Project Manager
   Dr. John Bonds, Chemist, Team Leader
   Mr. Russell Bowen, Civil Engineer
   Mr. Steve Denahan, Hydrogeologist
   Mr. Ernest Frey, Civil Engineer
   Mr. Charles Hendry, Chemist
   Ms. Carla Jones, Historian/Document Coordinator
   Mr. John Wiese, Ecologist

6. In addition to records reviews, interviews were conducted with current and former employees. Ground and aerial tours of the installation were made, and photographs were taken. The use of "Personal Communication" as a reference citation in this report identifies information received via interviews or through unpublished reports such as interoffice memoranda. Information received from an interview was generally verified by one or more additional interview(s) or by comparison with documented data. In particular, substantiation was obtained for interview data impacting conclusions and recommendations.

1.4 SUBSEQUENT NACIP STUDIES

The second phase of the NACIP Program is the Confirmation Study. During confirmation, extensive sampling and monitoring are conducted to confirm or refute the existence of suspected migrating contamination at sites identified during an IAS. If significant impacts on public health or the environment are found to exist, the study recommends remedial actions to be taken.

A Confirmation Study is recommended only if the following circumstances exist:

1. Sufficient evidence exists to suspect that the activity is contaminated, and

2. The contamination presents a potential danger to:

   a. The health of civilians in nearby communities or personnel within the activity fenceline, or
   b. The environment within or outside the activity.

Further studies are not conducted under the NACIP Program if these criteria are not met.

SECTION 2.0
DISCUSSION OF SIGNIFICANT FINDINGS

This section summarizes the significant findings of the IAS at NAVBASE Charleston with regard to the installation's geohydrology and the characteristics of specific waste disposal and spill sites on the installation. The IAS of NAVBASE Charleston identified eight potentially contaminated areas onbase; the locations of these eight waste disposal and spill sites are shown in figure 2.1-1. The significant findings with regard to each of these eight areas are discussed in the following sections.

Regarding geohydrology, those aspects which are most relevant to potential contaminant migration pathways and potential receptors of contaminants are detailed.

The characteristics of waste disposal and spill sites are described on a site-by-site basis, summarizing those findings which are most significant with respect to the presence of toxic or hazardous contaminants.

SOUTHDIV is conducting a monitoring program under contract to assess contamination at eight sites on NAVBASE Charleston. This program includes the installation and sampling of monitoring wells at six locations: the base sanitary landfill (site 1), the chemical disposal area (site 2), the oil sludge pits (site 3), the polychlorinated biphenyl (PCB) storage area (site 6), the former pesticide mixing area (site 7), and the caustic pond (site 8). A series of shallow soil borings was also made at the oil sludge pits (site 3); the petroleum, oils, and lubricants (POL) transfer point (site 4); the former firefighting training pit (site 5); and the former pesticide mixing area (site 7). In addition, soils were sampled and analyzed for PCB content in the PCB storage area (site 6). These sample sites are shown in figure 2.1-2.

2.1 GEOHYDROLOGY

The soils at NAVBASE Charleston are generally fine-grained and only slowly permeable. This type of soil, combined with the basically level topography, causes drainage problems at the base. The permeability of the organically rich clays underlying the surface soils is also rather low. These highly organic clays, which range in thickness from 15 feet to 50 feet, are very soft, have extremely high water contents, and cause foundation problems on the base. Under these soft clays lies the Cooper Marl, a 200-foot-thick unit of stiff, calcareous clay. Flow in the shallow groundwater system is slow because of the fine-grained nature of the sediments and the low gradient. No use is made of the shallow ground water at NAVBASE Charleston, and there are no downgradient users of the shallow aquifer. The Cooper River and Shipyard Creek, which are the base boundaries, also are the shallow aquifer system boundaries.

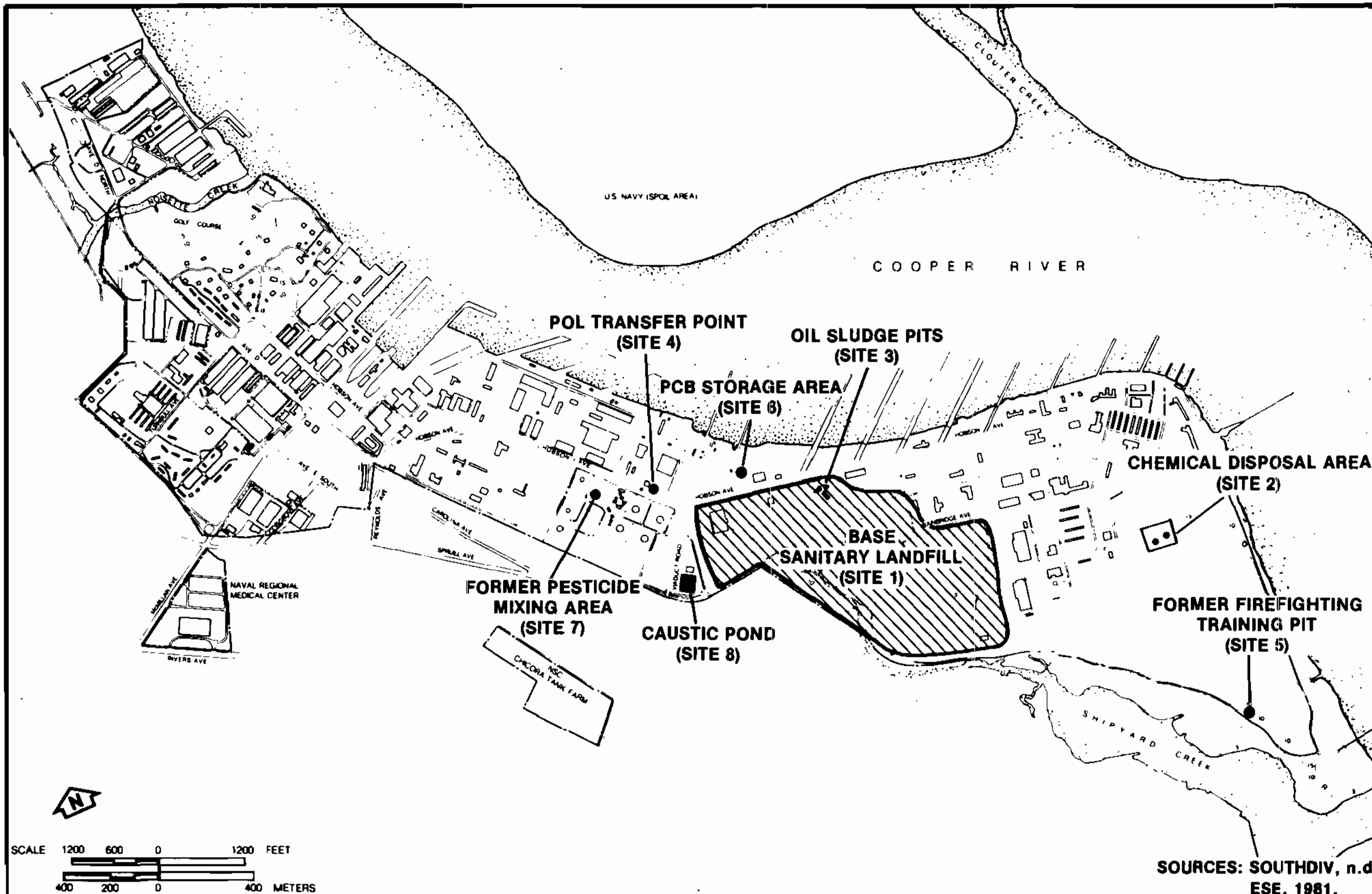


Figure 2.1-1
POTENTIAL CONTAMINATION MAP

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

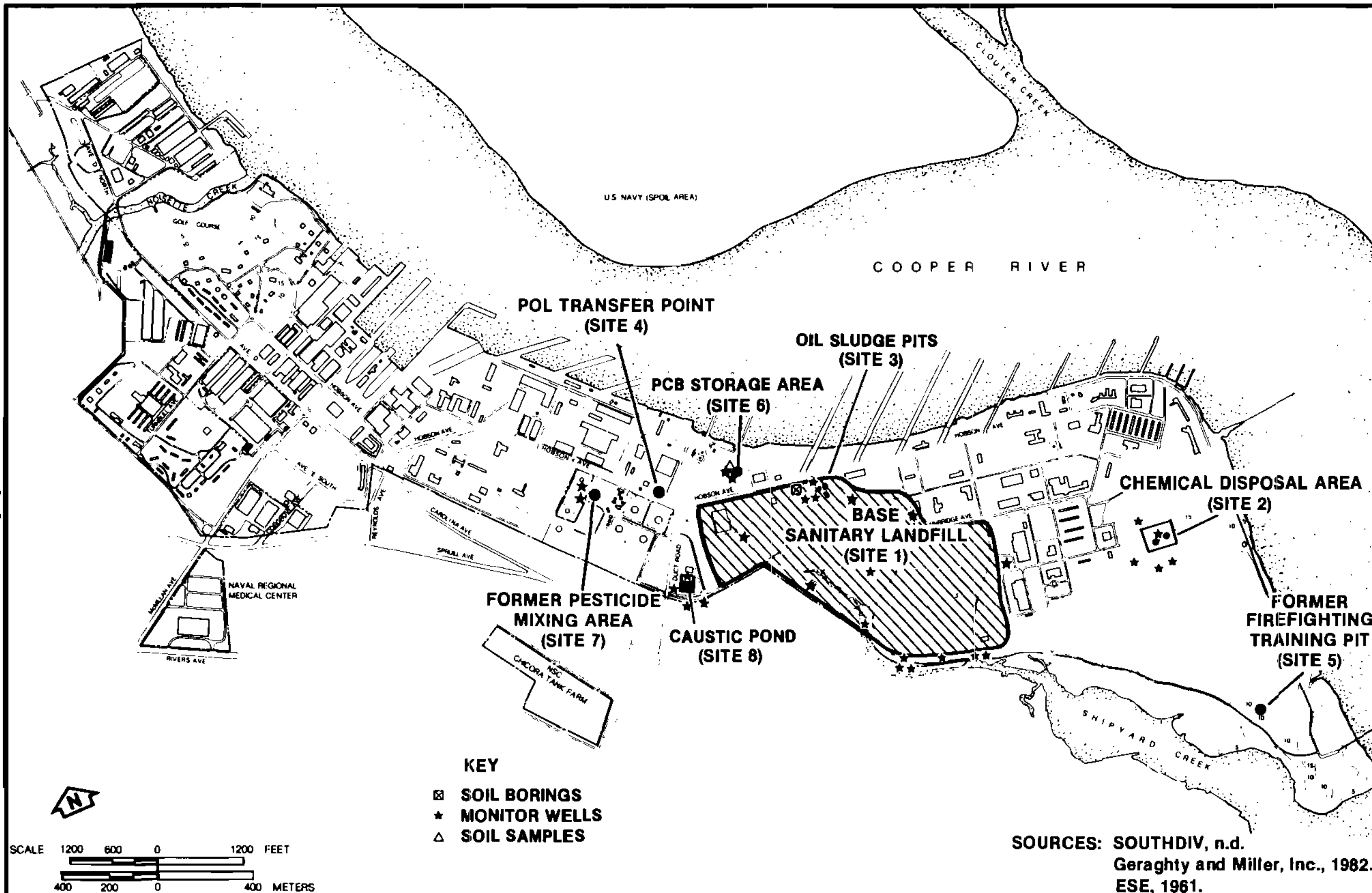


Figure 2.1-2
LOCATIONS OF SAMPLING POINTS IN PRESENT SOUTHDIV MONITORING PROGRAM

INITIAL ASSESSMENT STUDY NAVAL BASE CHARLESTON

Thus, all shallow ground water onsite eventually discharges to the Cooper River, either directly or through its tributaries.

A deeper confined aquifer (beneath the Cooper Marl), known as the Santee Limestone, is not subject to contamination from surface sources because its hydraulic head is above the top of the Cooper Marl, resulting in a net upward flow of water from the Santee into the shallower materials.

The deeper groundwater resources at NAVBASE Charleston are not used for onsite potable water supply, and the deeper aquifer at and in the vicinity of NAVBASE Charleston is not used for potable water supply.

Surface water resources at NAVBASE Charleston include Noisette Creek, Shipyard Creek, and the Cooper River. Potable water for NAVBASE Charleston or the surrounding area is not obtained from any of these sources. These surface waters and the stormwater drainage system provide a potential migratory pathway. Thus, pathways exist on NAVBASE Charleston for contaminants to migrate offsite, either by surface runoff or through the ground water in the shallow aquifer.

2.2 WASTE DISPOSAL AND SPILL SITES

The IAS of NAVBASE Charleston resulted in the location of eight areas within the installation boundaries which are potentially contaminated. The locations of these eight sites are shown in figure 2.1-1. Brief descriptions of the pertinent characteristics of these eight sites are presented in the following subsections.

2.2.1 Base Sanitary Landfill (Site 1)

Since the 1930s, solid wastes, including sludges, were generally disposed of in the base sanitary landfill at the southwestern portion of the installation (see section 6.6.2) until it was closed in 1973. Since 1973, solid wastes generally have been contract hauled offbase.

Waste materials generated on the base that were reportedly landfilled in its southwestern portion included: asbestos, acids, PCBs, waste oils, waste solvents, waste paints, paint sludges, mercury, metal sludge, acid neutralization sludge, various inorganic and organic chemicals, and sanitary wastes. The quantities of these wastes disposed of are unknown, but are believed to be large, based on current generation rates.

No data are available regarding permeability rates or range for soils adjacent to the landfill. However, field inspection of soils in the vicinity of the landfill during the IAS site visit indicated a texture that typically has low permeability. Although a geologic assessment of NAVBASE Charleston indicates that all shallow ground water onbase eventually discharges to the Cooper River either directly or indirectly via its tributaries (e.g., Shipyard Creek), the flow rate in the shallow system is expected to be rather slow due to the fine-grained nature of the sediments and the low gradient. However, the nature of the soils could permit the slow migration of leachates originating at the landfill toward Shipyard Creek and/or the Cooper River.

Leachates entering the shallow ground water do not affect potable water sources. The shallow groundwater system is not developed for potable water use onbase. No potable use is made of the shallow ground water downgradient of NAVBASE Charleston, since the Cooper River and Shipyard Creek surface waters intercept the shallow groundwater flow at the base boundaries. The deeper aquifer (Santee Limestone) is not threatened by potential contamination in the shallow system, because the Santee has a hydraulic head above its confining bed at NAVBASE Charleston, resulting in an upward water flow.

SOUTHDIV has installed groundwater monitoring wells around the landfill (see figure 2.1-2) to characterize the chemical quality of the ground water in the vicinity of the landfill. These wells were initially sampled during July 1981, and the samples were analyzed for several physical and chemical parameters. Subsequent sampling was performed in February 1982, and analyses were conducted for inorganic and organic priority pollutants. The complete results of these sampling efforts were reported in Geraghty and Miller, Inc. (1982); table 2.2-1 summarizes the data for constituents reported above analytical detection. As shown, several trace metals and chlorinated organics are present in the ground water in the vicinity of the landfill. These constituents likely reflect past disposal of metal plating sludges, waste chemicals, and industrial degreasing solvents disposed of in the landfill. Ground water in the vicinity of the landfill is expected to flow toward Shipyard Creek or the Cooper River. It is expected that the soils would provide some degree of attenuation of these pollutants, and substantial dilution would occur upon entering the riverine systems. Quantitative estimates of these processes are not possible with available data.

2.2.2 Chemical Disposal Area (Site 2)

An unknown amount and variety of chemicals, which reportedly include Decontaminating Agent Non-Corrosive (DANC) and DS-2, have been disposed of by burial at the skeet and pistol ranges. DANC consists of separately packaged components of tetrachloroethane and dichloro-dimethyl-hydantoin. DS-2 is a ternary mixture of 70 percent diethylene triamine, 28 percent methyl cellosolve, and 3 percent sodium hydroxide. In 1972 and 1974, construction crews unearthed drums of chemicals in the skeet range, and some workers suffered minor chemical burns. It was also reported that unknown chemicals were buried both at the skeet range and behind the dike at the pistol range. In 1977, ten 5-gallon cannisters of DS-2 were reportedly buried at the skeet range. Due to the suspected small quantities buried, the impermeable nature of the soils, and the low hydraulic gradient in the area, contaminant migration is not believed to be likely. However, construction activities are proposed for the site, and because the types, quantities, and exact locations of these burials are unknown, this area represents a potential

Table 2.2-1
Summary of Trace Metal and Organics Data for the Landfill Monitoring Wells

Constituent	Concentration Range (ug/l)
Metals	
Arsenic (As)	<10-70
Barium (Ba)	370-4,620
Chromium (Cr)	<5-8.2
Mercury (Hg)	<0.1-0.4
Lead (Pb)	<5-22
Acid Organics	
Pentachlorophenol	ND-15
Phenol	--
2,4,6 Trichlorophenol	--
2,4 Dichlorophenol	--
4,6 Dinitro-o-cresol	--
Base/Neutral Organics	
1,4 Dichlorobenzene	--
2,4 Dinitrotoluene	--
N-nitrosodiphenylamine	--
Bis(2-ethylhexyl) phthalate	ND-90
Diethyl phthalate	--
Di-n-butyl phthalate	--
Naphthalene	--
Acenaphthene	--
Anthracene/Phenanthrene	--
Indeno(1,2,3-cd)pyrenee	--
Volatile Organics	
Methylene chloride	ND-1,600
Chlorobenzene	ND-50
Chloroform	ND-5.4
Dibromochloromethane	ND-3.4

ug/l = micrograms per liter.
ND = Not detected.
-- = 1 to 9 ug/l.

Sources: Geraghty and Miller, Inc., 1982.
ESE, 1983.

safety hazard. It may be possible to locate the specific burial areas through the use of geophysical remote-sensing detection techniques.

Geraghty and Miller, Inc. (1982) determined that no contaminant migration is occurring. Several monitor wells were located in the vicinity, and groundwater samples were collected.

2.2.3 Oil Sludge Pits (Site 3)

During the period 1944-71, oil sludges produced on the installation were disposed of in three unlined pits near Bldg. X-10. These pits are readily visible in aerial photographs taken in 1944 and 1951. These aerial photographs are available through NEESA or the Cartographic Branch of the National Archives (see section 1.3 for a complete address). During the period of use, heavy rains would occasionally cause the pits to overflow, creating oil spills in the low areas adjacent to the pits. These areas were subsequently covered with fill, trapping the oil in the subsoil. Two of the pits were covered by 1956. From 1971 to 1974, the remaining pit was open but was not used for the disposal of oil or sludge. In 1974, this pit was pumped to remove the oil and filled with clean, compacted fill. Portions of the area have now been converted into a parking lot.

Geraghty and Miller, Inc. (1982) determined the location of the oil plume. The IAS team observed several test borings in the area and noted that they were filled with oil. Using a post hole digger, the IAS team made several additional test holes in the area which also filled with oil. The areal extent of the oil contamination is unknown; however, based on the inferred groundwater gradient, the oil is suspected to be slowly migrating toward the Cooper River. Several oil slicks of undetermined origin have been reported in the Cooper River near the oil pit area. These may be the result of oil which has migrated from the sludge pit area. Oil leaching into the Cooper River could create environmental degradation.

2.2.4 POL Transfer Point (Site 4)

The POL transfer point is located immediately east of Hobson Ave., directly across from aboveground POL storage tank 3900E. At this location, POL is transferred from railroad tank cars to the storage tanks. During transfer operations, several oil spills have occurred, and oil has leached into the subsoils. In 1981, during the construction of a fence, workers digging holes for fenceposts reported that the holes were filling with oil. The amount of POL in the soil of this area and the areal extent of the contamination are unknown. Subsurface POL could migrate to the Cooper River, resulting in potential environmental degradation.

2.2.5 Former Firefighting Training Pit (Site 5)

An unlined firefighting training pit, reportedly measuring between 30 and 50 feet in diameter, was located on the southern end of

NAVBASE Charleston from 1966-71 and contained waste oil, gasoline, and alcohol burned during firefighting training exercises. The pit area is not readily discernible from the ground, but its location is apparent when viewed from the air. Aerial photographs taken in 1971 clearly show the location of the pit. These photographs are available through NEESA or Public Works NSY. In 1971, the pit was cited by the U.S. Coast Guard for an oil spill following heavy rainfall, which caused the oil in the pit to overflow into Shipyard Creek. The pit was closed in 1972 by leveling and covering with bottom ash, and 4 inches of sludge reportedly lay at its bottom. The amount of oil which may have leached into the subsoil and the areal extent of the pit are unknown. Any oil currently remaining in the soil could leach into Shipyard Creek, resulting in potential environmental degradation.

2.2.6 PCB Storage Area (Site 6)

Out-of-service transformers containing PCB fluids are stored in Bldg. 3902 in the "Old Corral" area. Prior to 1976, out-of-service transformers were brought to the concrete pad on the south side of the building prior to transportation offbase. Transformers were either sold intact or drained prior to sale. The area around this concrete pad shows evidence of past oil spills, which may have contained PCBs. Due to the intermittent drainage of transformer oil and the unknown concentrations of PCBs therein, it is not possible to estimate the total amount of PCBs released to the soil. At the time of the IAS site survey, SOUTHDIV was conducting soil sampling around this concrete pad to determine the extent of PCB contamination.

2.2.7 Former Pesticide Mixing Area (Site 7)

Prior to 1971, pesticide equipment was rinsed at the area to the north of Bldg. 42. Wastewater generated by the cleaning of mixing and spraying equipment was allowed to drain into the soils of this area. Although these activities ceased at this location in 1971, an area measuring approximately 20 square yards remains completely devoid of vegetation, indicating that the soils in this area may be contaminated by unknown quantities of various pesticides.

2.2.8 Caustic Pond (Site 8)

The caustic pond, located near the junction of Bainbridge Ave. and Viaduct Rd., was used for the disposal of calcium hydroxide from the early 1940s through the early 1970s. The calcium hydroxide was generated as a byproduct of the reaction of water with calcium carbide to produce acetylene gas. During operation, water saturated with calcium hydroxide was allowed to settle in the pond, while excess water was discharged to Shipyard Creek. Although part of this pond was filled during the construction of Bainbridge Ave., a section of the pond still remains. The amount and areal extent of the calcium hydroxide is unknown; however, soil borings conducted during the IAS indicate sludge to a depth of 1 foot. Due to the acidity of the soils and ground water, the pH of the ground water is not expected to be elevated by the calcium hydroxide nor is it expected that any problems would occur if the shallow aquifer were used for wells outside the base. No records were found to indicate that the shallow aquifer is being used adjacent to this area and outside the installation.

A variety of plant and animal species were recorded in the caustic pond and on adjoining areas during the IAS site survey. Grasses and herbaceous vegetation extended to the water's edge, and sedges, algae, and other aquatic plants grew in shallow portions of the pond. Tadpoles, fish (*Gambusia affinis*), and insect larvae were observed in the pond.

The greatest potential problem is the possibility of caustic burns if the calcium hydroxide is disturbed by personnel unfamiliar with the area. Such burns could occur if the skin were to come in direct contact with the calcium hydroxide sludge. Geraghty and Miller, Inc. (1982) determined that no contaminant migration is occurring.

SECTION 3.0
CONCLUSIONS

This section presents the conclusions of the IAS investigation of NAVBASE Charleston with regard to installation geohydrology as it relates to potential contaminant migration pathways and receptors and with regard to the potential for contaminant migration from the eight disposal and spill sites discussed in section 2.2. In addition, conclusions are presented for each of the eight sites with regard to contamination and contaminant migration potential. Relevant significant findings are also summarized for each site.

3.1 GEOHYDROLOGY

The potential for contaminant migration by both surface and subsurface pathways exists at NAVBASE Charleston. Potential receptors for migrating contaminants consist of surface waters and ground water. Surface water resources at NAVBASE Charleston include Noisette Creek, Shipyard Creek, and the Cooper River. Potential contamination of these surface waters and subsequent migration of contaminants beyond installation boundaries may occur as a result of direct surface runoff via stormwater drainages or the interception of the shallow ground water by surface waters along Shipyard Creek and the Cooper River. The quantities and concentrations of contaminants potentially entering these surface waters from NAVBASE Charleston cannot be estimated due to several nonpoint sources and the high degree of dilution due to river currents and tidal flushing of Shipyard Creek and the Cooper River.

Leaching rates and subsequent subsurface migration of contaminants are expected to be slow as a result of installation soil and ground water characteristics. The soils at NAVBASE Charleston are generally fine-grained and only slowly permeable. This type of soil, combined with the low gradient due to the basically level topography of the site, lead to slow contaminant migration rates. The permeability of the organically rich clays underlying the surface soils is also rather low. These highly organic clays range in thickness from 15 feet to 50 feet and are underlain by the Cooper Marl, a 200-foot-thick layer of stiff, calcareous clay.

Contaminants reaching the ground water at NAVBASE Charleston could migrate within the boundaries of the installation via the shallow groundwater system. This migration rate would be slow due to the soil texture and low gradient and would terminate at Shipyard Creek and the Cooper River, which represent the downgradient boundaries of the shallow groundwater system. The deep aquifer beneath the Cooper Marl is not subject to contamination from surface sources onbase because its hydraulic head is above the top of the former, resulting in a net upward flow into the shallower system.

As a result, the shallow groundwater system within installation boundaries is the sole potential groundwater migration route for contaminants at NAVBASE Charleston. No human health hazards are expected from the potential presence of contaminants in the shallow groundwater system, because the latter is not used for potable water supply at NAVBASE Charleston. In addition, some contaminants, particularly metals, are likely to be attenuated by adsorption onto clay minerals. Likewise, potential contaminant migration via the shallow groundwater system does not threaten human health offbase, because this flow is intercepted by surface waters at the installation boundaries. In addition, the shallow groundwater system is not significantly developed for potable use in the vicinity of NAVBASE Charleston.

3.2 WASTE DISPOSAL AND SPILL SITES

Each of the eight waste disposal and spill sites identified by the IAS team was evaluated using a Confirmation Study Ranking System (CSRS) developed by NEESA for the NACIP Program. The system is a two-step procedure for systematically evaluating a site's potential hazard to human health and the environment, based on evidence collected during the IAS.

Step 1 of the system is a flowchart, which eliminates innocuous sites from further consideration. Step 2 is a rating model which assigns a numerical score, within a range of 0 to 100, to indicate the potential hazard of a site. Scores are a reflection of the characteristics of the wastes disposed of at a site, potential contaminant migration pathways, and possible contaminant receptors on and off the installation. CSRS scores and engineering judgment are then used to evaluate the need for a Confirmation Study, based on the criteria stipulated in section 1.4. A more detailed description of the CSRS is contained in NEESA Report 20.2-042.

The CSRS system was applied to the eight disposal and spill sites identified at NAVBASE Charleston, and results are summarized in table 3.2-1. Based on the application of the CSRS system and engineering judgment to the eight disposal and spill sites identified at NAVBASE Charleston, all eight sites are recommended for Confirmation Studies. The following subsections summarize the relevant conclusions for each of the eight waste disposal and spill sites evaluated.

3.2.1 Base Sanitary Landfill (Site 1)

From the 1930s until 1973, waste materials generated on the base were landfilled in its southwestern portion. Items reportedly disposed of in this landfill included: asbestos, acids, PCBs, waste oils, waste solvents, waste paints, paint sludges, mercury, metal sludge, acid neutralization sludge, various inorganic and organic chemicals, and sanitary wastes. The quantities of these wastes disposed of are unknown, but are believed to be large, based on current generation rates. Based on an analysis of landfill contents, the subsoils in this

Table 3.2-1
Site Recommendations

Site Number	Site Name	Confirmation Study Recommended?
1	Base Sanitary Landfill	Yes
2	Chemical Disposal Area	Yes
3	Oil Sludge Pits	Yes
4	POL Transfer Point	Yes
5	Former Firefighting Training Pit	Yes
6	PCB Storage Area	Yes
7	Former Pesticide Mixing Area	Yes
8	Caustic Pond	Yes

Source: ESE, 1981.

area are potentially contaminated. Although no data are available regarding permeability rates or range for soils adjacent to the base sanitary landfill, a field inspection of these soils at the landfill indicated which soil typically permits the slow migration of ground water in the shallow system toward Shipyard Creek. As a result, any leachate from the landfill could migrate toward Shipyard Creek.

The potential contamination of the shallow groundwater system by landfill leachates is currently being investigated by SOUTHDIV at a series of monitoring wells located at the southernmost, downgradient portion of the landfill.

3.2.2 Chemical Disposal Area (Site 2)

An unknown amount and variety of chemicals, which reportedly include DANC and DS-2, have been disposed of by burial at the skeet and pistol ranges. In 1972 and 1974, construction crews unearthed drums of chemicals at the skeet range, and some workers suffered minor chemical burns. It also was reported that unknown chemicals were buried both at the skeet range and behind the dike at the pistol range. In 1977, ten 5-gallon cannisters of DS-2 were reportedly buried at the skeet range.

The probability of contaminant migration is unlikely at this site due to the suspected small quantities of chemicals buried and the impermeable nature of the soils and low hydraulic gradient in this area. However, the buried chemicals may represent a potential safety hazard during the proposed excavation and construction activities at this site, because the types, total quantities, and exact locations of these burials are unknown.

SOUTHDIV has installed several monitoring wells in the vicinity of the chemical disposal area to determine if contaminant migration is occurring.

3.2.3 Oil Sludge Pits (Site 3)

During the period 1944-71, oil sludges produced on the installation were disposed of in three, unlined pits near Bldg. X-10. These pits are readily visible in aerial photographs taken in 1944 and 1951. During the period of use, heavy rains would occasionally cause the pits to overflow, creating oil spills in low areas adjacent to the pits. These low areas subsequently were covered with fill, and the oil remained trapped in the subsoil. Prior to 1955, two of the pits were filled. In 1974, the remaining pit was pumped to remove the oil and filled with clean, compacted fill. Portions of the area have now been converted into a parking lot. The IAS team observed several test borings in the area and noted that they were filled with oil. The IAS team made several additional test holes in the area and found oil. The areal extent of the oil contamination is unknown; however, based on the inferred groundwater gradient, oil is suspected to be slowly migrating toward the Cooper River. Oil leaching into the Cooper River could create environmental degradation to the aquatic communities. No impacts to human health are anticipated.

3.2.4 POL Transfer Point (Site 4)

The POL transfer point is located immediately east of Hobson Ave., directly across from aboveground POL storage tank 3900E. At this location, POL is transferred to and from railroad tank cars. During the use of this area, several oil spills have occurred, and oil has leached into the subsoils. In 1981, during the construction of a fence, workers digging holes for fenceposts reported that the holes were filling with oil. The amount of POL in the soil of this area and the areal extent of the contamination are unknown. POL could be migrating to the Cooper River. If POL reaches the Cooper River, it may cause degradation of the Cooper River aquatic communities; however, no adverse impacts on the terrestrial biota of the base are expected.

3.2.5 Former Firefighting Training Pit (Site 5)

An unlined firefighting training pit, reportedly measuring between 30 and 50 feet in diameter, was located on the southern end of NAVBASE Charleston. This pit reportedly existed from 1966-71 and was used to contain waste oil, gasoline, and alcohol burned during firefighting training exercises. The amount of POL which may have leached into the subsoil and the areal extent of residual contamination are unknown. Currently, the pit is separated from Shipyard Creek by a dense zone of shrubs and hardwoods, as well as a roadbed. However, any POL remaining in the soil could leach into Shipyard Creek, resulting in the potential degradation of aquatic and littoral communities.

3.2.6 PCB Storage Area (Site 6)

Out-of-service electrical items such as rectifiers, transformers, and capacitors are stored in Bldgs. 3902 and 1069. Prior to 1976, a number of transformers also were drained near the concrete pad on the south side of Bldg. 3902. As a result, the soil around the pad received transformer oils which possibly contained PCBs. Due to the intermittent drainage of fluids and unknown concentrations of PCBs, it is not possible to estimate the total amount of PCBs released to the soils. SOUTHDIV currently is conducting a study program to determine if these soils are contaminated with PCBs.

3.2.7 Former Pesticide Mixing Area (Site 7)

Prior to 1980, the area to the north of Bldg. 42 was used for pesticide mixing. Wastewater generated by the cleaning of mixing and spraying equipment was allowed to drain into the soils of this area. Although these activities ceased in 1980, an area of approximately 20 square yards remains completely barren. The soils in this area are potentially contaminated by unknown quantities of various pesticides, which could be transported to Shipyard Creek via stormwater runoff.

Such potentially contaminated runoff may cause environmental degradation to aquatic and littoral communities of Shipyard Creek.

3.2.8 Caustic Pit (Site 8)

The caustic pit, located near the junction of Bainbridge Ave. and Viaduct Rd., was used for the disposal of calcium hydroxide sludge during the period of the early 1940s through the early 1970s. Although part of this pond was filled during the construction of Bainbridge Ave., an open section still remains. The amount and areal extent of the calcium hydroxide is unknown.

The caustic pit represents little hazard if left undisturbed and if public access is prohibited. The pit represents a possible safety hazard due to the potential for caustic burns to personnel disturbing the ground.

SECTION 4.0
RECOMMENDATIONS

4.1 INTRODUCTION

Based on the foregoing significant findings and conclusions, eight sites at NAVBASE Charleston are suspected of being potentially contaminated. The geologic and geohydrologic character of the associated soils permits the potential migration of contaminants from the disposal and spill sites, resulting in a potential threat to human health or to the environment. The locations of each of these eight sites are shown in figure 4.1-1.

Additional information regarding the location or extent of the contaminated areas and the potential for contaminant migration is required before the need for action (if any) can be identified. Therefore, it is recommended that a Confirmation Study, Phase II of the NACIP Program, be performed at NAVBASE Charleston.

Eight waste disposal sites at NAVBASE Charleston are recommended for confirmation. Table 4.1-1 identifies these sites and provides a ranking of their relative risk potentials. In general, those sites with higher rankings are of more immediate concern (in particular, site 1) and are of higher priority with regard to the need for confirmation.

It is recommended that the SOUTHDIV Planning Department be advised of the locations of the contaminated areas identified in this IAS and that all new construction at NAVBASE Charleston be coordinated through the SOUTHDIV Facilities Planning and Real Estate Department and the Environmental Branch of the Facilities Management Department.

4.2 CONFIRMATION STUDY

It is recommended that the areas which warrant further investigation under the Confirmation Study include: base sanitary landfill (site 1), chemical disposal area (site 2), oil sludge pits (site 3), POL transfer point (site 4), former firefighting training pit (site 5), PCB storage area (site 6), former pesticide mixing area (site 7), and caustic pond (site 8).

For the reasons presented in the Discussion of Significant Findings (section 2.0), two of these areas [caustic pond (site 8) and chemical disposal area (site 2)] do not pose an environmental threat but represent a safety hazard to base personnel. For these areas, it is recommended that the extent of the contaminated area be defined by the Confirmation Study and the contaminants be removed (or adequately posted as a potential safety hazard).

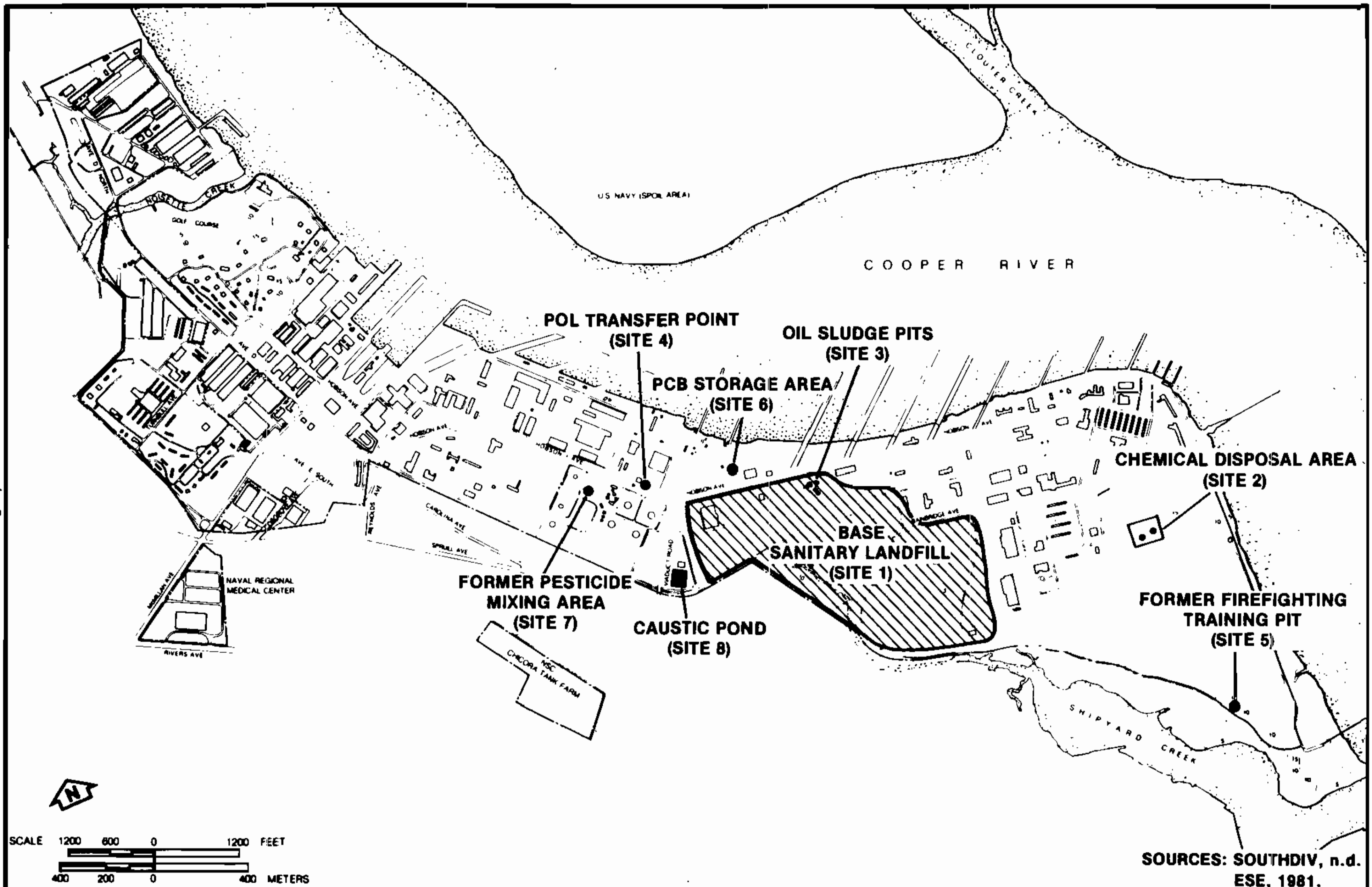


Figure 4.1-1
POTENTIAL CONTAMINATION MAP

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

Table 4.1-1
Summary of Site Recommendations

Site Number	Site Name	CSRS Score	Monitor Wells	Soil Borings	Soil Samples	Field Analytical Techniques	Laboratory Analytical Parameters
1	Base Sanitary	31	7	--	--	--	Heavy metals (As, Ba, Cd, Cr, Cu, Hg, Ni, Pb, Ag, and Zn), cyanides, oil and grease or petroleum hydrocarbons, PCBs, and EPA priority pollutant volatile organic compounds
2	Chemical Disposal Area	26	--	--	--	GPR, magnetometer metal detector, and EM	--
3	Oil Sludge Pits						
	Option 1	26	--	150*	--	Portable GC	Hydrocarbons
	Option 2		--	10*	--	GPR, EM, and portable GC	--
4	POL Transfer Point						
	Option 1	12	--	100*	--	Portable GC	Hydrocarbons
	Option 2		--	10*	--	GPR, EM, and portable GC	--
5	Former Firefighting Training Pit	5	--	5†	5	Portable GC	Hydrocarbons
6	PCB Storage Area	22	--	--	25	--	PCBs

Table 4.1-1
Summary of Site Recommendations
(Continued, Page 2 of 2)

Site Number	Site Name	CSRS Score	Monitor Wells	Soil Borings	Soil Samples	Field Analytical Techniques	Laboratory Analytical Parameters
7	Former Pesticide Mixing Area	13	--	--	5	--	Organochlorine pesticides (aldrin, BHC, lindane, chlordane, DDT, DDE, endrin, heptachlor, heptachlor epoxide, methoxychlor, toxaphene), organophosphate pesticides [diazinon, malathion, parathion, thimet (phorate), trithion], chlorinated phenoxy herbicides [2,4-D, 2,4,5-T, 2,4,5-TP (Silvex)], and total As
8	Caustic Pond	7	--	25-50†	--	--	None

* Power auger.
† Hand auger.
-- = No sampling.

Abbreviations:

As = arsenic.
Ba = barium.
Cd = cadmium.
Cr = chromium.
Cu = copper.
Hg = mercury.
Ni = nickel.
Pb = lead.
Ag = silver.
Zn = zinc.

EPA = U.S. Environmental Protection Agency.
GPR = Ground-penetrating radar.
EM = Electromagnetism.
GC = Gas chromatograph.

Source: ESE, 1981.

The remaining six areas pose a potential environmental threat and require confirmational monitoring before the necessity and/or procedures for corrective action can be determined.

Table 4.1-1 summarizes the recommended monitoring program for the eight areas included in the Confirmation Study. The detailed approach for each area is described below. It is recommended that personnel from Public Works NSY be consulted regarding the locations of contaminant sources prior to the selection of sampling points.

4.2.1 Base Sanitary Landfill (Site 1)

The recommended monitoring program for the base sanitary landfill consists of the evaluation of hydrogeological characteristics (subsurface stratigraphy, permeability, and piezometry) and groundwater quality adjacent to the landfill. It is recommended that six monitor wells be installed around the perimeter of the landfill. One background well should be installed onsite, upgradient of the landfill and away from other potential contaminant sources.

4.2.1.1 Well Installation

It is recommended that all wells be drilled to the top of the Cooper Marl (approximately 20 to 60 feet) and screened over their entire saturated length. Detailed logs of each boring should be made, including well construction diagrams. Shelby tube samples taken during drilling should be tested to determine vertical permeability. Filter pack material should be medium-fine sand, used with an appropriate slot-size screen. The top of the filter packs should be bentonite sealed and the annulus grouted to the surface. Wells should be protected with 8-inch black pipe fitted with locking caps. All wells should be developed to the fullest extent possible and surveyed by a registered surveyor to obtain accurate elevations.

4.2.1.2 Groundwater Monitoring

A two-phased groundwater monitoring effort consisting of verification and characterization phases is recommended. For the verification phase, groundwater sampling would involve the collection of one sample from each well over the entire saturated zone. Water levels should be measured after well development and at the time of sampling. Water level measurements should be made simultaneously at all wells to avoid tidal interferences. Slug tests should be conducted at all wells to determine horizontal permeability and to enable an evaluation of flow rates.

Table 4-1.1 lists the parameters recommended for analysis for the verification phase. The individual chemical parameters recommended for analysis in the water samples obtained from the monitoring wells are keyed to suspected contaminants in the landfill. From among the organic compounds on EPA's priority pollutant listing, only the volatile organics are recommended.

If contamination is detected in the wells during the verification phase, then a characterization phase is recommended. Surface water samples from Shipyard Creek and/or the Cooper River should be collected at probable entry points of landfill leachate into the surface body and analyzed for contaminants present in the monitor wells. Wells which show evidence of contamination on the first sampling should be resampled at several elevations and reanalyzed for contaminants present to allow the development of a vertical profile of contaminant concentration.

4.2.2 Chemical Disposal Area (Site 2)

Migration of contaminants from the chemical disposal area is not anticipated to be a significant problem because of the small quantities of chemicals believed to be buried, the rather impermeable nature of the subsurface, and the low hydraulic gradient. Therefore, groundwater monitoring is not recommended for this disposal area. However, the presence of these buried substances does pose a threat to the safety of base personnel, since future development is planned for this area. Because of the toxic nature of the buried chemicals (which include DS-2 and DANC), the shallowness of the burials, and the fact that regrading of the burial area is planned, safety is a significant problem. It is recommended that individual burial locations in the pistol and skeet ranges be identified using a combination of shallow geophysical techniques. Ground-penetrating radar (GPR), magnetometers, metal detectors, and shallow electromagnetism (EM) would be the most effective geophysical methods for these tasks. As a remedial action, once the chemicals are located, they should be excavated using proper safety procedures and properly disposed of offbase.

4.2.3 Oil Sludge Pits (Site 3)

The extent of the oil contamination in these areas should be delineated by one of two methods. The area which is grossly contaminated (liquid oil in the subsurface) should be mapped separately from the area which exhibits only oily residue in the soil. For either option, the area requiring investigation may need to be expanded, pending the outcome of the initial investigation, since oil may have migrated from the initially contaminated area. Once the contaminated area has been delineated, the oil and oily residue should be removed and disposed of.

As mentioned in section 2.3, oil may be migrating from the former disposal areas to the Cooper River, potentially degrading aquatic habitats. Section 6.7.2.1 describes the potential impacts of oil on aquatic ecosystems in more detail. Several oil slicks have been observed in the Cooper River near the oil pit area.

4.2.3.1 Option 1

Mapping could be accomplished by a large number of shallow borings on a grid system throughout the area of suspected contamination. The area which should be investigated initially is identified in figure 4.1-2. The entire area is potentially contaminated by liquid oil or oily residue due to either disposal of or spills of oil. Approximately 150 shallow borings should be made in the indicated rectangular area. Each boring should be at the center of a rectangular subsection formed by dividing the area under investigation into 150 equal parts. Borings should be to groundwater level and should be made with a tractor-mounted, power post hole auger. Considerable disturbance to the area (now used as a parking lot) would result. Each boring should be visually inspected for the presence of oil. For those borings with no visible liquid oil present, a portable GC should be used to check for hydrocarbons to establish the presence or absence of oily residue.

4.2.3.2 Option 2

An alternative technique to a soil boring network would be to employ geophysical methods to define the extent of the contaminated area. GPR and shallow EM would be the most appropriate methods. The area to be investigated initially would be the same as for option 1 (figure 4.1-2). A small number (approximately 10) of 4-foot soil borings would still be required for verification and calibration purposes, but this approach would cause much less surface disturbance and would take less time. Interpretation of GPR data would probably yield an evaluation of the thickness and location of the liquid oil layer in the ground. The area subtly contaminated (no liquid oil present) could be mapped using a hand auger of small diameter (1 inch) and a portable GC to check for hydrocarbons, a method which would minimize surface disturbance.

4.2.4 POL Transfer Point (Site 4)

The nature of the contamination problem at this area is similar to that of the oil sludge pits (site 3), i.e., the presence of underground oil and oily residue. However, much less information is available regarding the probable source and extent of the problem. A similar program should be undertaken to define the extent of the contaminated area, using either a power auger and a portable GC or geophysical means (GPR and EM) and a portable GC. The area to be investigated should originate at the location where oil has been observed in post holes and expanded outward. Due to the uncertain nature of the monitoring program, the number of borings indicated in table 4.1-1 for either option should be considered approximate. Once the extent of the contaminated area is defined, oil and oily residue should be removed and disposed of, or recycled, if possible.

4.2.5 Former Firefighting Training Pit (Site 5)

The area is suspected to contain oil residue over a 30- to 50-foot circular area. The residue resulted when the pit was closed by mixing a residual sludge with soils and covering the area.

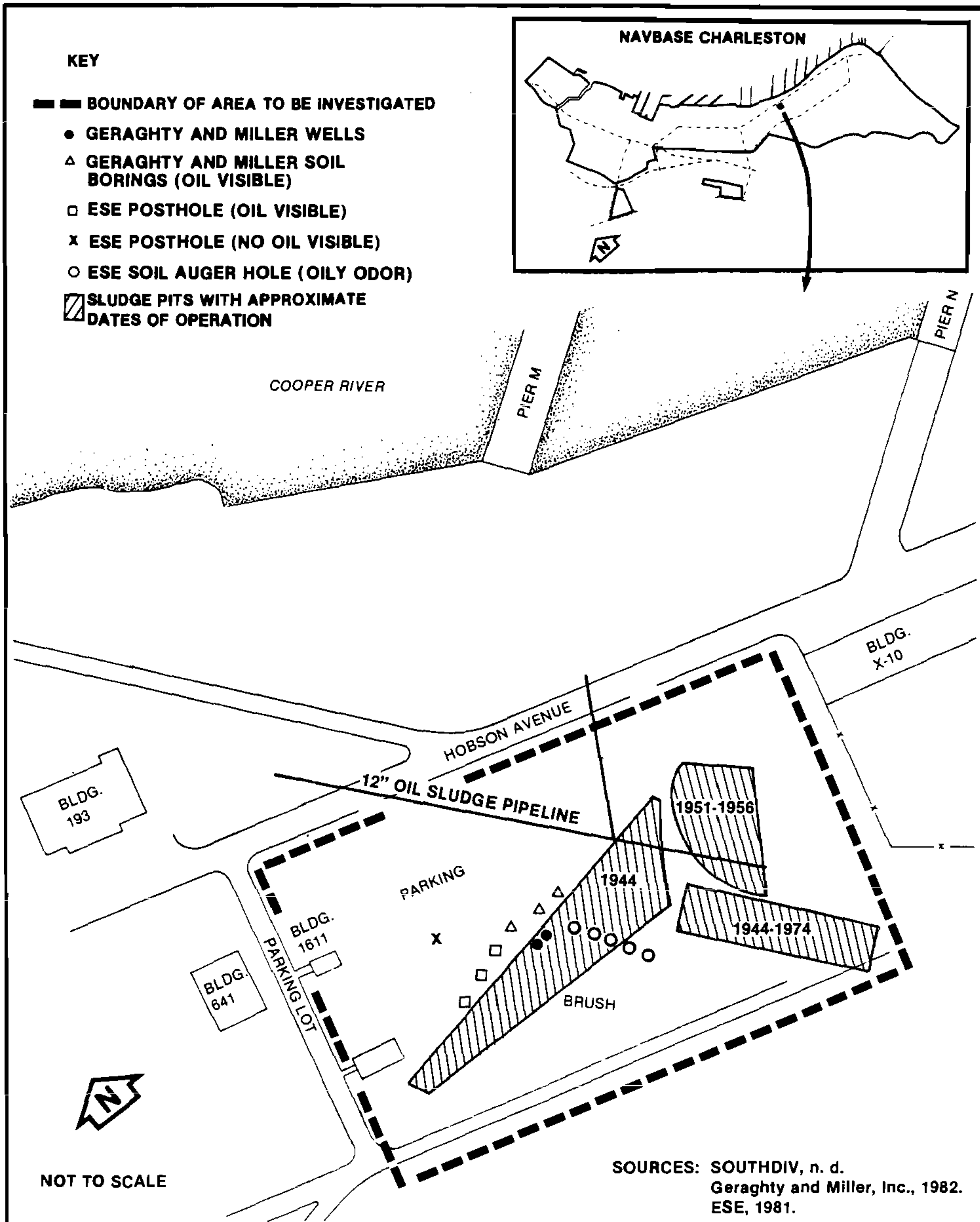


Figure 4.1-2
RECOMMENDED AREA FOR OIL SLUDGE PIT INVESTIGATION (SITE 3)

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

The area is located within 50 feet of the edge of the unpaved road, adjacent to the western boundary of the installation bordering Shipyard Creek (see figure 4.1-1). The area is located approximately 0.2 mile north of the intersection of the unpaved road with Horvath Rd.

Five shallow soil borings should be made with a hand-operated bucket auger in the area of the pit to verify the suspected presence of oily residue in the soil. Samples should be visually inspected and smelled to determine presence of POL. If a portable GC is onsite for use at the oil sludge pit (site 3) or POL transfer point (site 4) areas, then it could also be used to examine soils for hydrocarbon content from this site. If soils are found to be contaminated, they should be removed and disposed of as a remedial measure. Alternatively, it may be possible to degrade the residual sludge biochemically in place by nutrient enrichment and disking.

4.2.6 PCB Storage Area (Site 6)

It is recommended that sampling of the soils for PCB contamination be conducted in the area around the concrete pad located adjacent to Bldg. 3902 in the "Old Corral" area of Public Works NSY. Samples should be taken adjacent to the concrete pad of the top composite 12 inches of soil, which is visibly stained with transformer fluids. These samples should be analyzed as discrete samples (i.e., not composited with other samples). It is also recommended that soil samples be taken within an approximate 50-foot radius of the pad to delineate the extent of possible PCB contamination. A total of approximately 25 samples is recommended.

4.2.7 Former Pesticide Mixing Area (Site 7)

Sampling of the soils is recommended in the area devoid of vegetation in the former pesticide mixing area north of Bldg. 42. The area is roughly rectangular and measures approximately 2 by 10 yards. It is recommended that soil samples be taken of the top composite 12 inches of soil at 5 locations in this area (1 at each of the 4 corners and 1 in the center of the rectangular area) and analyzed for the parameters listed in table 4.1-1. If the analyses for the area indicate that the soils are contaminated, several soil borings should be made and the cores segmented by depth and analyzed to determine the extent of vertical migration, and, ultimately, the volume of soil which is contaminated.

4.2.8 Caustic Pond (Site 8)

Migration of excess alkalinity from this area is not expected to be an environmental threat, due to the low permeability of the subsurface soils, the natural acidity expected to be present in the soils and ground water in the area, and the tendency of the calcium hydroxide sludge to form a crust which limits its solubility. A potential safety hazard to base personnel may exist, if the calcium hydroxide is disturbed by construction personnel or other individuals unfamiliar with the area. Direct contact with newly exposed calcium hydroxide is the only potential problem. During the IAS site visit, the pond and adjoining areas had stabilized and were supporting vegetation and terrestrial and aquatic animals. It is recommended that the location of the residual caustic sludge be defined.

Shallow soil borings should be made around the current pond area to delineate the horizontal and vertical extent of the calcium hydroxide sludge. These borings could be made with a hand-operated soil auger (1 inch) to a depth of approximately 1 foot. Approximately 25 to 50 borings should be adequate to define the location of the residual sludge. No samples need to be analyzed for chemical characteristics, because the appearance of the sludge is visually distinct. The sludge is white and fine-grained and is easily distinguishable from the soils in the area.

Once the location of the residual sludge has been determined, it is recommended that one of the following alternatives be implemented:

1. The contaminated area be permanently identified as a potential hazard, with signs at the actual location and also on the installation base map; or

2. The calcium hydroxide sludge be neutralized in situ by the use of a dilute solution of an appropriate acid (e.g., dilute hydrochloric acid solution). The sludge outside of the ponded area could be repeatedly disked to bring it to the surface and treated with acid solution until neutralized. The sludge in the ponded area could be similarly treated after the pond is drained.

SECTION 5.0
BACKGROUND

5.1 GENERAL

5.1.1 Location and Organization

The Charleston Naval Complex is located in Charleston and Berkeley Counties on South Carolina's central coast, north of the City of Charleston's central business district (see figure 5.1-1). The Complex is divided into two major areas, Naval Base North and Naval Base South. Activities on Naval Base North are outside the scope of this report, however, which deals only with the second area, Naval Base South, hereafter referred to as NAVBASE Charleston. The NAVSTA Annex (RADAR Site) was not included in the study.

NAVBASE Charleston is located on the banks of the Cooper River in Charleston County, S.C., approximately 5 miles north of the City of Charleston. The installation consists of two major areas: an undeveloped spoil area on the east bank of the Cooper River on Daniel Island in Berkeley County, and a developed area on the west bank of the Cooper River. The developed portion of NAVBASE Charleston lies on a peninsula, bounded on the west by the Ashley River and the east by the Cooper River. The western boundary of the developed area adjoins the City of North Charleston, and the eastern boundary the Cooper River between river mile 10 and river mile 14. NAVBASE Charleston facilities adjacent to the main developed area of the base include the Naval Regional Medical Center (NRMC) and the Chicora Tank Farm, both located within 0.5 mile west of the reservation.

NAVBASE Charleston covers approximately 3,300 acres (SOUTHDIV, n.d.). Navy activities and commands which maintain real property on NAVBASE Charleston include:

1.	NSY	1,908.22 acres
2.	NAVSTA	1,153.11 acres
3.	NSC	192.72 acres
4.	NRMC	23.79 acres
5.	Fleet and Mine Warfare Training Center (FMWTC)	10.40 acres

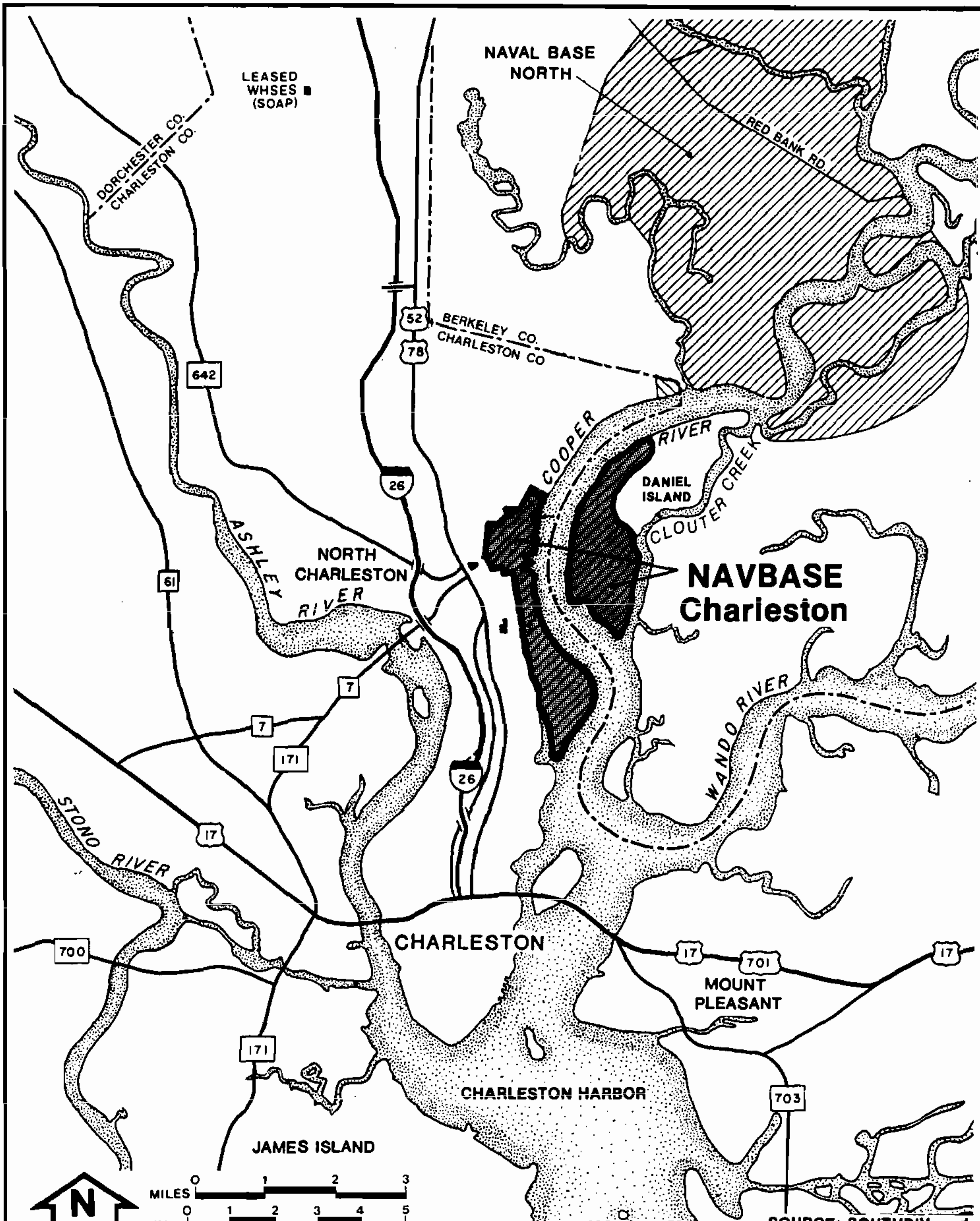


Figure 5.1-1
LOCATION MAP OF NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

6.	Fleet Ballistic Missile Submarine Training Center (FBMSTC)	6.88 acres
7.	Navy Reserve Center (NRC)	4.50 acres
	TOTAL ACREAGE	3,299.62 acres

The locations of these land holdings are shown in figure 5.1-2. NSY controls the spoil area to the east of the Cooper River and the majority of the central one-third of the developed area on the west bank of the river. The southern one-third of developed area of the main base is controlled primarily by NAVSTA. NSC and NAVSTA are the major landholders on the northern one-third of the developed area. NSC also controls the offbase Chicora Tank Farm.

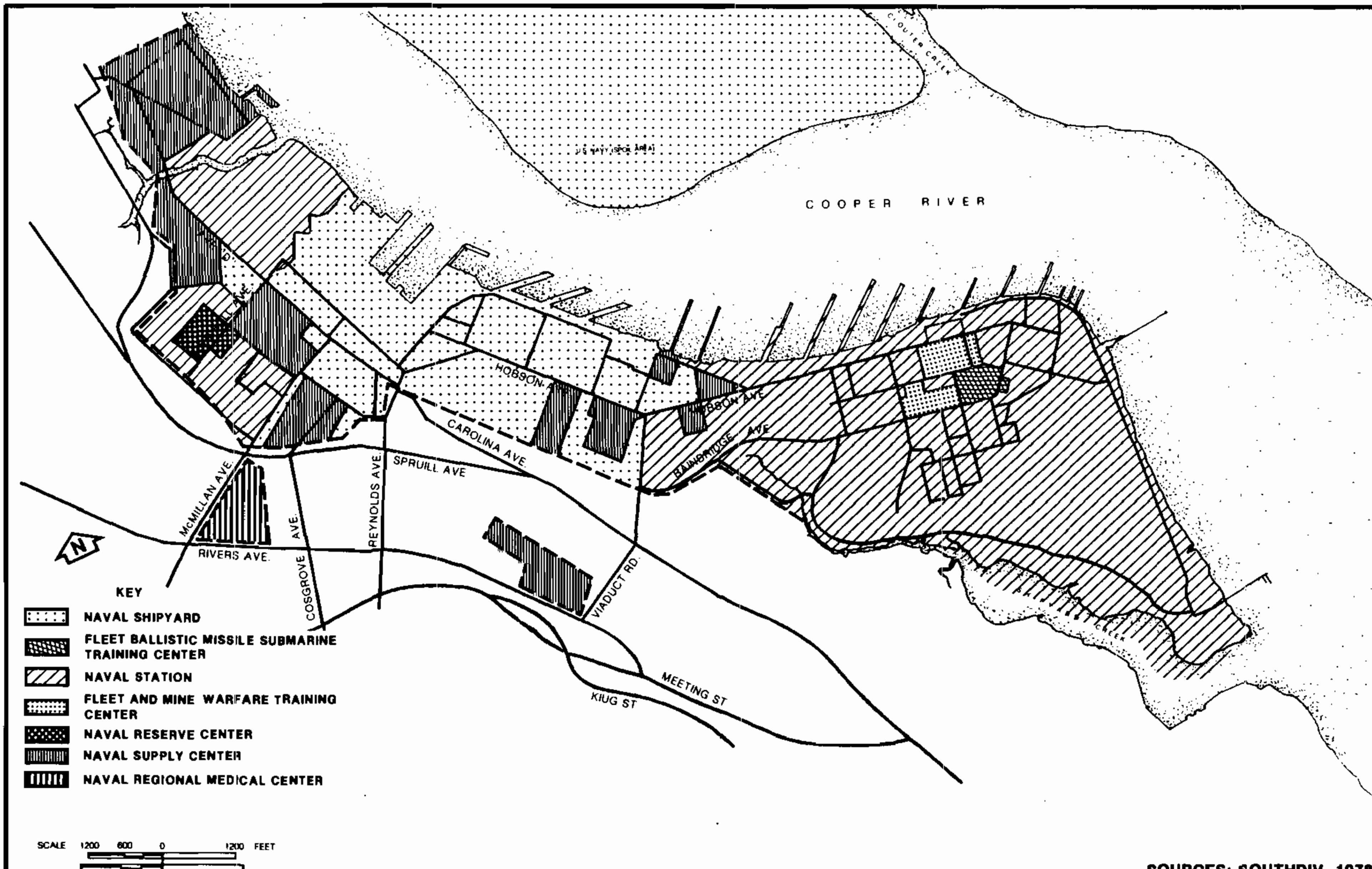
NAVBASE Charleston houses the base Commander, who also functions as CNO Area Coordinator for the Southeastern United States. His general duties as Commander include command of assigned shore activities, coordination of logistic support for fleet units and other naval districts, and area coordination responsibility over designated shore activities. He "represents the Secretary of the Navy (SECNAV) and CNO in assigned matters, exercises area coordination responsibilities over all shore activities and personnel in the Southeastern United States, exercises command of assigned Naval Shore activities, coordinates fleet support matters, coordinates public affairs matters, and performs other functions as directed by CNO" (SOUTHDIV, 1978).

This report is concerned with activities and commands on NAVBASE Charleston, as listed above, as well as the Marine Corps Barracks, the Naval Security Group Activity (NAVSECGRUACT) (tenants on the base), and the Naval Electronics Systems Engineering Center (NESEC), west of the base on Interstate 26 and Gore Rd.

5.1.2 Host/Tenant Relationships and Missions of Specified Activities

Of the nine activities examined in the context of this report, only the Marine Corps Barracks and NAVSECGRUACT are identified as tenants on NAVBASE Charleston, both occupying facilities controlled by NAVSTA. NESEC is located outside the base in a building leased through the General Services Administration (GSA) (Personal Communication, 1981).

The remaining six activities are land owners on the base, with the NAVSTA, NSY, and NSC holding the greatest acreage and serving as hosts for various tenants. Tenants of these activities which are generators of hazardous waste are discussed in section 6.0.



NOTE: THESE LAND OWNERSHIP DIVISIONS ARE THOSE EFFECTIVE IN 1978.

SOURCES: SOUTHDIV, 1978.
ESE, 1981.

Figure 5.1-2
LAND OWNERSHIP ON NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

Official mission statements for each of the nine activities discussed in this report appear below. Refer to section 5.2, Historical Overview, for further details.

1. NAVSTA: Provides, as appropriate, logistic support for the operating forces of the Navy and for dependent activities and other commands as assigned.

2. NSY: Provides logistic support for assigned ships and service craft; performs authorized work in conversion, overhaul, repair, alteration, drydocking, and outfitting of ships and craft as assigned; performs manufacturing research, development, and test work as assigned; and provides services and material to other activities and units as directed by competent authority.

3. NSC: Provides supply and support services to fleet units and shore activities and performs other functions as directed by its major claimant, the Naval Supply Systems Command.

4. FBMSTC: Trains fleet ballistic missile (FBM) personnel in order to bring them to a higher level of proficiency in the skills required to operate FBM submarines and the Polaris/ Poseidon Weapons Systems.

5. FMWTC: Provides general shipboard training, as well as specialized training, in mine warfare (SOUTHDIV, n.d.).

6. NAVSECGRUACT: Performs Naval Security Group functions as directed (COMNAVSECGRU, 1980b).

7. NESEC: Provides electronics support in the maintenance and modification of communications equipment, such as automatic air traffic control equipment, for the Atlantic Naval Fleet and associated shore communication systems (Personal Communication, 1981).

8. Marine Corps Barracks Detachment: Provides perimeter security for the Naval Complex, under the command of the Marine Corps Barracks, Naval Weapons Station (NWS) (Personal Communication, 1981).

9. NRMC: Provides improved patient care through improved utilization of resources, including medical personnel, and commands and coordinates the various Naval medical facilities and programs available to the Charleston military community (SOUTHDIV, n.d.).

5.1.3 Leases and Agreements

Three non-Federal operations currently perform general ship repair work under contract to the Government on property owned by NSY. These include:

1. Braswell Shipyards, Inc.--occupying a 0.290-acre area on Shipyard Creek, west of Bainbridge Ave.;

2. Sandblasters, Inc.--occupying a tract of land measuring 0.28 acre, contiguous to the southern boundary of the Braswell property; and

3. Metal Trades, Inc.--occupying 0.27 acre of land adjacent to Sandblasters, Inc.

Records of the SOUTHDIV Real Estate Office indicate that Metal Trades and Sandblasters have occupied their present sites since 1975, and Braswell has been operating in its present location since 1979. From approximately 1970 to 1979, Braswell was located between Bainbridge and Hobson Aves. The land on which these facilities currently lie was primarily marsh and undeveloped prior to their arrival. The potential for these companies to produce hazardous waste is discussed in section 6.1.1.14.

NSC has issued a grazing lease for 22 acres of land on Chicora Tank Farm, 0.5 mile from the main gate, to Mr. Hyman Moody. The purpose of the lease is to maintain a vegetative ground cover, prevent soil erosion, and reduce maintenance costs. The lessee is obligated to pulverize and spread manure over the area, apply 5-10-10 fertilizer annually at the rate of 400 pounds per acre on a 5-acre area, and apply the EPA-registered herbicide, Round-Up, to the perimeter fence every 2 years.

A search of SOUTHDIV Real Estate Office records indicated that a variety of out licenses and leases have been granted over the years for sewer line easements, local gun club practice ranges, lands used by a local construction company, etc. Records are not sufficiently detailed, however, to permit analysis of the potential for these activities to produce hazardous waste.

Additional information on past permits and licenses was disclosed by a search of Department of the Navy files. Correspondence dating from 1928 was found regarding issuance of a right-of-way to Standard Oil of New Jersey for a suction line runway and pipeline necessary for establishing a loading station across Marsh Island, an area about 500 yards from the southern tip of the base. In 1930, Gulf Refining Co. was granted permission to deposit dredged material on marsh land at the southern end of the base. In May 1934, Maybank Fertilizer

Corp. received a permit to use a 10-foot right-of-way over a small marshy island in the Cooper River.

5.1.4 Legal Claims

According to the base Legal Assistance Office, only one court action has been brought against NAVBASE Charleston. This involved violation of South Carolina's Pollution Control Act by a 250-foot smokestack serving five coal-fired boilers in Bldg. 32 on NSY property. The violation was the result of the malfunctioning of the stack's electrostatic precipitator. Legal action was initiated in May 1979, and the Navy was assessed a fine of $1,700 per month commencing 1 Jul 1979. Payment continued until February 1981, when the stack was determined to be in compliance with the State's allowable emission standards, following repair of the electrostatic precipitator. On 26 Feb 1981, the case against the Navy was dismissed (Personal Communication, 1981).

A number of employees of NSY have attempted to bring suit against various manufacturers of asbestos products used at NSY because of health problems resulting from prolonged exposure to the substance. No asbestosis cases have reached the claims stage, however, and reportedly no claims have been made against NAVBASE Charleston (Personal Communication, 1981).

5.1.5 Adjacent Land Use

As illustrated by figure 5.1-3, the areas surrounding NAVBASE Charleston are heavily developed and characterized by commercial, industrial, residential, and school land uses. Commercial areas are located primarily west of NAVBASE Charleston; industrial areas lie to the north and along the west bank of Shipyard Creek.

Two major industrial areas are sources of potential hazardous waste. The first is located approximately 0.5 mile north of Noisette Creek on Cooper River and includes Sinclair Refining Co. and the Coastal Terminal Co. Tank Farm (see figure 5.1-4). Land across the river houses the AMOCO Chemical Co., which receives monthly visits from two 30,000-ton tankers (SOUTHDIV, 1978).

The western bank of Shipyard Creek is now, and has been for many years, an area of high industrial concentration. Maps dating from early in the 20th century show the presence of railways in this area, a feature which, when combined with nearby waterways, makes the area ideal for heavy industry. Figure 5.1-4 identifies various companies recently in operation in the area. Although ownership changes from time to time, the land remains under the control of chemical, fertilizer, oil refining, metallurgical, and lumber operations. In the last 6 months, Etiwan Fertilizer Co. (see figure 5.1-5) has been replaced by Massey Coal Co. Two years ago, McAlloy Alloys acquired the site shown in figure 5.1-5 as occupied by Pittsburgh Metallurgical Co. McAlloy's plant has been cited for noncompliance with air pollution regulations as

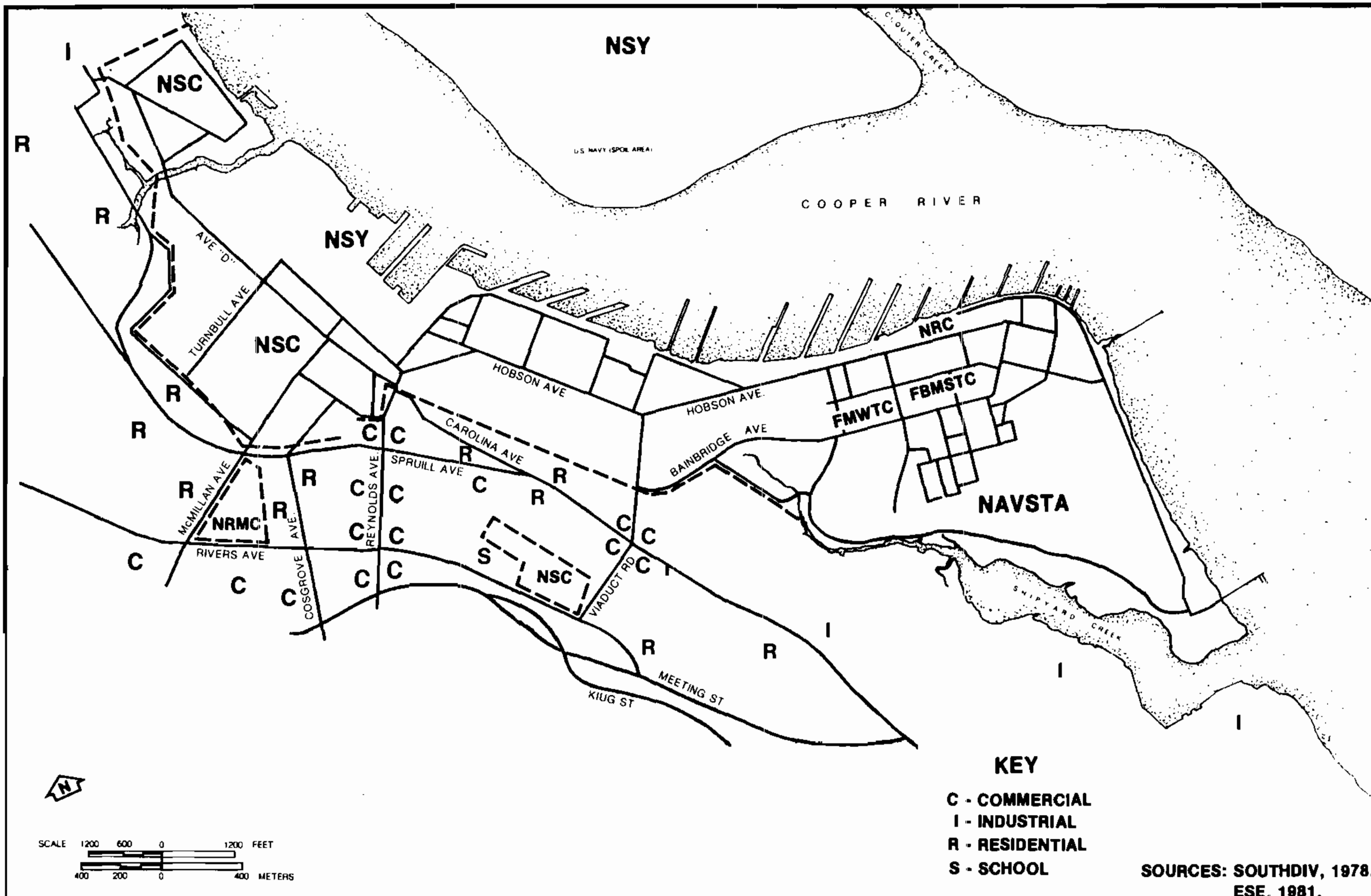


Figure 5.1-3
LAND USE/ZONING IN THE VICINITY OF NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

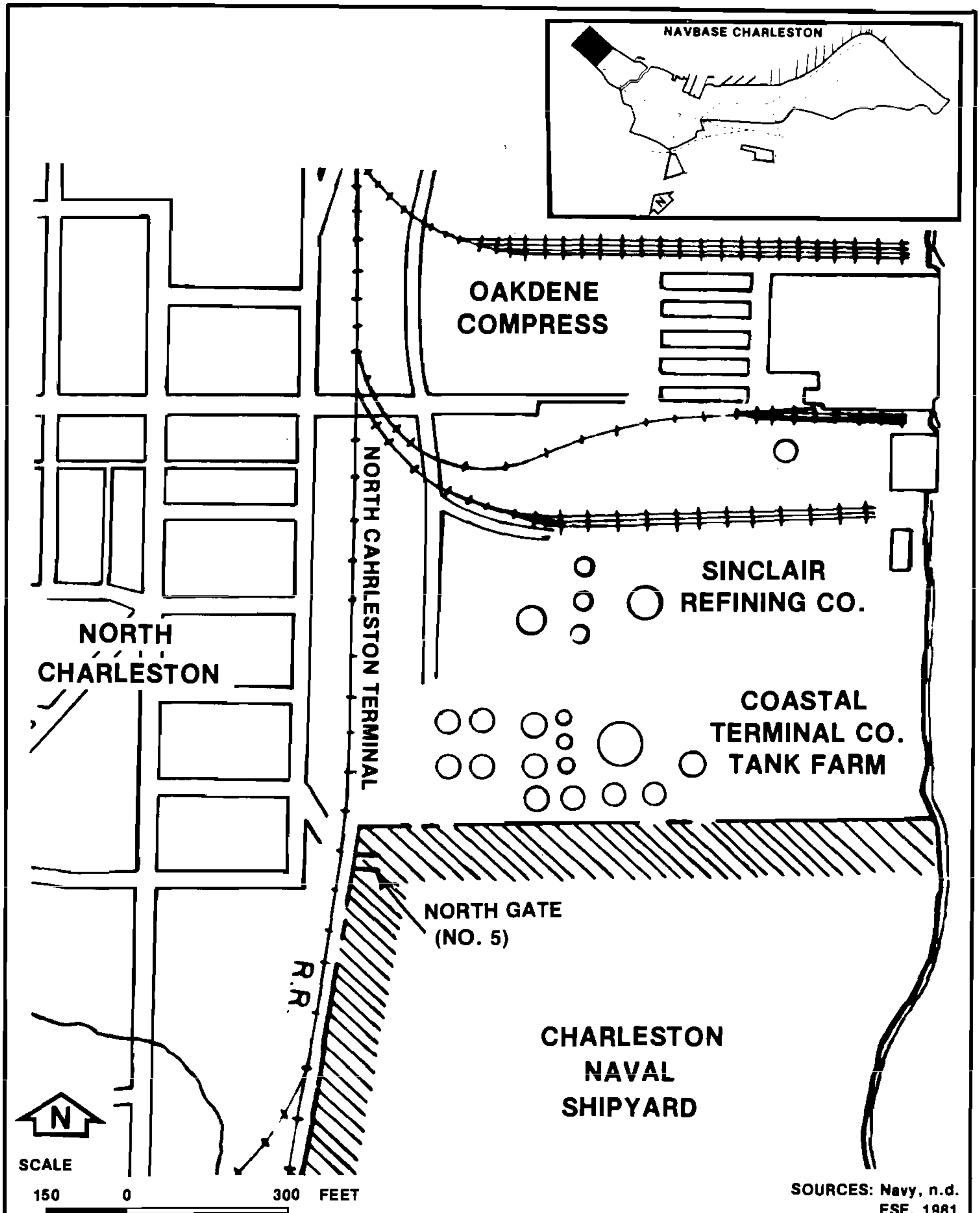
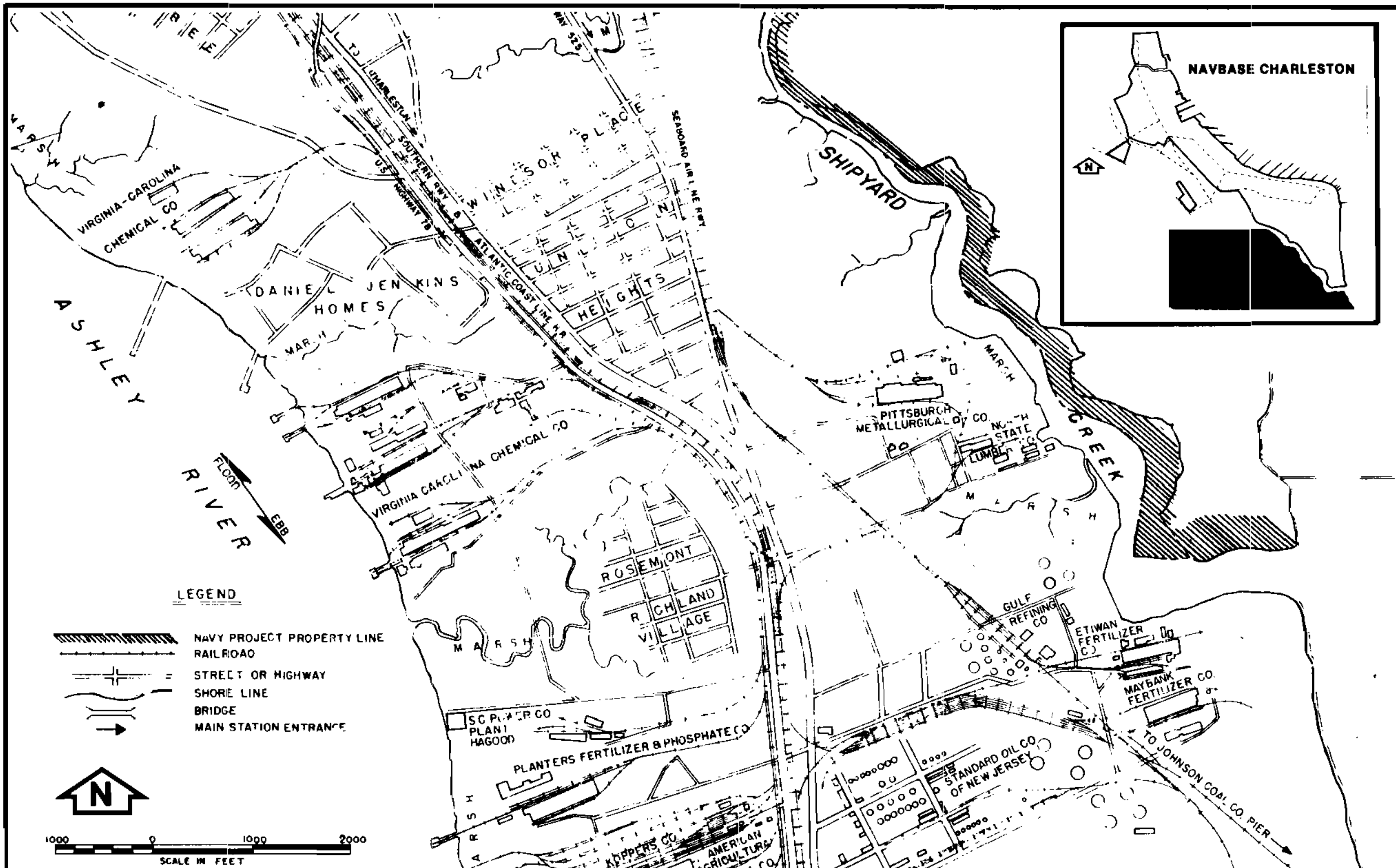


Figure 5.1-4
INDUSTRIAL AREAS TO THE NORTH OF NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY NAVAL BASE CHARLESTON



SOURCES: Navy, n.d.
ESE, 1981.

Figure 5.1-5

INDUSTRIAL AREAS TO THE SOUTHWEST OF NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY NAVAL BASE CHARLESTON

a result of chromium reduction operations (Personal Communication, 1981).

The eastern bank of the Ashley River is also dotted with industries, including Virginia-Carolina Chemical Co., South Carolina Power Co. Plant, Planters Fertilizer and Phosphate Co., Koppers Co., and American Agricultural Chemical Co. (Navy, n.d.).

The east bank of the Cooper River is undeveloped and contains extensive wetlands along Clouter Creek and Thomas Island. Active dredge spoil disposal areas are located on U.S. Naval Reservation property between the Cooper River and Clouter Creek, offsite on the southern portion of Daniel Island, and on Drum Island. Continuous maintenance dredging of Charleston Harbor and the Cooper ship channel removes and deposits approximately 60 million cubic yards of silt annually (SOUTHDIV, n.d.).

5.2 HISTORICAL OVERVIEW

Since the early years of English colonial rule, the area around Charleston Harbor has been a center of naval interest. During the Civil War, northern naval forces established a base at Port Royal on Parris Island south of Charleston. During the Spanish-American War, shops and a drydock were constructed on Port Royal, and the facility became an active docking and repair base. In 1901, however, following consideration by a board of naval officers appointed by SECNAV, a recommendation was made to transfer the naval station from Port Royal to Charleston Neck, an area about 6.5 miles from the tip of the peninsula formed by the Ashley and Cooper Rivers. This new location was preferred over Port Royal due to: (1) the existence of a dredged channel, at least 25 feet deep, which was well marked for navigation; (2) proximity to the strong fortification of Charleston; (3) greater protection from storm tides; (4) ample anchorage for heavy vessels; (5) improved transportation connections, i.e., three railroad lines and regular steamer traffic; and (6) facilities for the importation of unskilled labor. On 31 Aug 1901, therefore, the U.S. Navy took possession of 2,250 acres of hardland and marsh areas and established the U.S. Naval Yard, the mission of which was to make repairs to the smaller vessels of the fleet and supply them with stores. During the period 1901-15, a number of main shops, the powerhouse, the first drydock (No. 1), four piers, administration and storage space, a dispensary, officer quarters, and other miscellaneous facilities were constructed. In 1904 and 1909, marine barracks and officer quarters were constructed to house a contingent of Marines, who arrived 1 Oct 1903.

Work conducted at the Yard at this time involved repairing, limited overhauling, and supplying stores for smaller vessels, and as of 30 Jun 1915, involved 1,240 employees. In 1912, a Machinist's Mates School was established at the Navy Yard to provide vocational training.

The advent of World War I was reflected at the Navy Yard by an expansion of facilities and the implementation of a more diversified mission. Repairs to torpedo craft and other small vessels, major alterations to vessels (including destroyers), and construction of smaller fleet vessels (including gunboats and destroyers) comprised the majority of industrial activities. In addition, machine parts and clothing were manufactured.

In 1916, under an Act of Congress, the channel between Charleston and the Navy Yard was dredged to a depth of 30 feet (low tide). Over $3 million was expended to improve facilities at the Navy Yard through temporary construction of housing, hospital facilities, storage space, shops, ship building facilities, and miscellaneous improvements. Employment rose to 3,600 and the workload increased to include alterations and repairs to 160 vessels and construction of 18 new vessels.

During its development, many low-lying areas of the base were filled with dredged spoil from the Cooper River. Filling operations began about 1918 near Noisette Creek on the northern end of the base and continued through the 1960s, after which time spoil was deposited on the opposite side of the Cooper River. Figure 5.2-1 shows the areas filled by dredged spoil and solid waste and the approximate dates of filling.

Activity throughout the history of the Navy Yard peaked and declined in response to American military involvement. With the return of peace after World War I, the Yard experienced a severe curtailment of workload and facilities development. In fact, on 10 Jul 1922, Franklin Roosevelt, acting SECNAV, issued General Order No. 87 for the closure of the Navy Yard. A tentative closure date of 1 Sep was set but later extended to 1 Nov. Public opinion, represented by the Charleston Chamber of Commerce, however, successfully appealed to the Government in favor of maintaining the Yard. The mission of the Yard was rewritten, as follows:

1. To maintain the Yard in operating condition, available for future use in emergency;

2. To maintain a nucleus working force which would permit expansion when required to undertake ordinary maintenance work of naval vessels and new ship construction; and

3. To keep the nucleus force employed to the best advantage possible in routine maintenance of naval vessels, obtaining greatest productive labor possible with a reduced force without permitting undue deterioration of plant (General Order No. 87).

Although no documentation exists, it is felt by historians of the Navy Yard that the Clothing Factory was disbanded during this time.

The post-World War I era (1920-32) was a period of major reorganization at the Navy Yard. Up to that time, activities were coordinated by about 14 independent Heads of Department. To increase effective authority, these were consolidated into two major divisions:

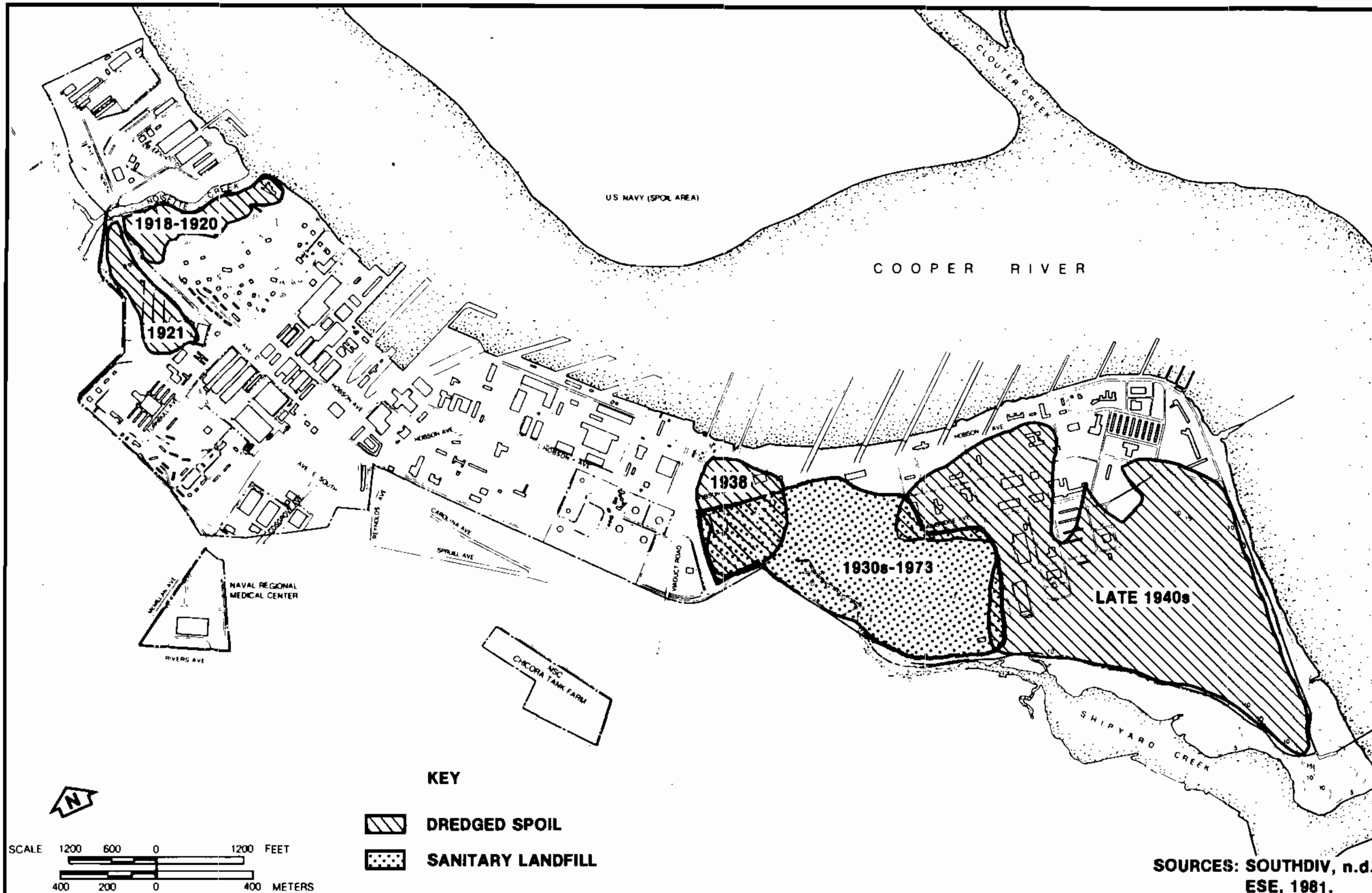


Figure 5.2-1
AREAS FILLED AND APPROXIMATE DATES OF FILLING OPERATIONS

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

industrial activities were placed under one officer named "Manager," and military activities under another officer known as "Captain of the Yard." Since many of the temporary facilities erected during World War I were demolished, many shops were also consolidated. In 1922, the emergency hospital was closed and the dispensary in Bldg. 19 was reoccupied and designated as a hospital. Light repair work continued during this period, and six new vessels were constructed. Employment declined by 1932 to 535 employees.

In 1932, the Coast Guard received a piece of land near pier 317A and a landing field was constructed in the southern part of the Navy Yard. The field appears as a cross-shaped formation on maps dating from 1927.

The slowdown of activities at the Navy Yard did not extend far into the 1930s. In 1933, orders for the construction of many new vessels were received, resulting in increased staffing. The economic depression of the 1930s introduced financial assistance programs, such as Works Projects Administration (WPA) and Public Works Administration (PWA), which provided funds for the extensive buildup of facilities during the period 1933-38. Buildings were torn down, relocated, expanded, or replaced. By the time World War II began, the Charleston Navy Yard had become a first-class naval facility. Its mission was primarily to provide logistic support to the operating forces in the form of efficient and economical new construction, repairs, overhaul, alterations, conversions, and dockings of destroyers and small vessels. Outfitting of ships, related special manufacturing, and necessary replenishment of stores and supplies were made available to nearby ships and shore activities.

A number of significant changes occurred during the World War II era. On 14 Sep 1945, by general order, the U.S. Naval Base, Charleston, S.C., was formally commissioned, and the Navy Yard was redesignated NSY and became a component of the U.S. Naval Base, under the military control of the 6th Naval District. Another important development was the purchase of 196 additional acres of land on the northern and eastern boundaries of NSY for additional storage space. Combined with the reclamation of marsh land in the southern part of NSY, this increased the size of NSY nearly two-fold.

The addition of a variety of new shops, drydocks, and piers and the escalation of military activity during World War II caused this to be the period of greatest military ship construction in NSY history. A total of 256 ships was built between 1939 and 1946, compared to a total of 36 between 1913 and 1938. In July of 1942, the first women were employed at NSY, and, in 1943, employment peaked at 25,948 total employees (Navy, 1981).

Some time between 1938 and 1943, a landing area for lighter-than-air (LTA) craft was established at the southern tip of the base. Two LTA landing circles are visible on maps dating from 1943, but no other documentation of this activity was found.

Following the end of World War II, the work of constructing new vessels was slowed, and the major workload of NSY involved disposing of surplus stock and decommissioning ships. This work was particularly heavy in 1946, but by 1948 normal repair, overhaul, and alteration of active fleet vessels were resumed. In 1948, NSY was designated a submarine repair and overhaul yard, including, by 1958, radiological decontamination. The mission of NSY remained one of providing construction, conversion, overhaul, alteration, repair, drydock overhaul, and outfitting of vessels in support of active and reserve fleet vessels, but a research, development, and testing function was also added at this time. In addition, NSY became the east coast center for mine warfare ship support (Navy, 1981).

In March 1952, fleet training involving firefighting, damage control, etc., became a part of activities on NAVBASE Charleston. In January 1959, responsibility for mine warfare training was moved from Yorktown, Va. to Charleston. These two forms of training were conducted separately until 1972, when they were combined to become the FMWTC, currently a tenant of NAVSTA (Personal Communication, 1981).

In 1961, Polaris submarines were commencing patrols and NSY was given design support responsibilities. These responsibilities continue to the present, and new ships of various classes are continuously assigned to NSY for operational homeporting and shipyard overhaul. To accommodate the demands of these ships, shops on NSY have been expanded and equipped, including a drydock designed for the servicing of FBM submarines and other nuclear-powered ships (Navy, 1981).

The presence of nuclear-powered submarines at NAVBASE Charleston led to the establishment, in 1962, of FBMSTC, a tenant of NAVSTA. Submarines undergo continuous design modification and are, therefore, the only ships which operate on a two-crew concept: while one crew is on board operating the ship, the other is being trained in the repair and operation of the latest equipment, as well as in navigation, weapons, engineering, operations, and tactics (Personal Communication, 1981).

In July 1959, NAVSTA was established as a major element of NAVBASE Charleston, replacing the Naval Receiving Station and Minecraft Support Base. The formation of NAVSTA resulted in the emergence of NAVBASE Charleston as the east coast recipient of the greatest influx of ships. NAVSTA has become the second largest component and landowner of NAVBASE Charleston and currently hosts the largest number of tenants (SOUTHDIV, n.d.). The mission of NAVSTA, which is to provide port services, including berthing, tugs, pilots, cranes, fueling, sludge removal for pollution control, and ammunition handling services to the operating forces of the Navy, has remained constant since its inception. In addition, NAVSTA operates a correctional center for prisoners of the southeast, conducts legal investigations, provides legal assistance, and holds courts-martial for military personnel (SOUTHDIV, 1978).

NSC was dedicated on 2 Jan 1964, following the expansion of the FBM weapons system. It is now one of the largest naval supply centers and functions in support of over 100 active fleet ships and 125 shore installations in the United States and overseas, including the United Kingdom Polaris Missile Program. Services provided by NSC include:

1. Furnishing food, parts, and equipment to customers;

2. Maintaining accounting and payroll services for 104 shore activities in the Southeastern United States;

3. Sending and receiving messages through an Automatic Digital Network (AUTODIN) station;

4. Handling personal property and automobiles for Navy and Marine Corps personnel moving in and out of the Charleston area;

5. Providing contract and purchasing services for Naval units in the Southeastern Contracting Region;

6. Ensuring that ships which come in for overhaul have the proper material aboard to support their equipment through a Supply Operations Assistance Program (SOAP);

7. Operating a program of assistance in food preparation and management for Navy activities in the Southeast;

8. Performing packaging and preservation services; and

9. Operating a petroleum laboratory and providing a quality surveillance of all petroleum products stored and issued (SOUTHDIV, 1978; SOUTHDIV, n.d.; COMNAVSECGRU, 1980a).

NAVSECGRUACT, a tenant of NAVSTA, was established on 21 Apr 1965 to provide security of classified information on NAVBASE Charleston.

Located outside the perimeter of NAVBASE Charleston, NRMC was established 1 Jul 1972 to provide a variety of medical, surgical, and outpatient care services to military personnel in the Charleston area (SOUTHDIV, 1978).

No formal survey for historic or archaeological sites has been conducted on NAVSTA, and no records have been found to indicate that surveys have been made for other areas of NAVBASE Charleston. There are, however, several items of historical interest onsite. Among these is Bldg. 590, known as "Marshlands Plantation House." This house is of historical interest since it was built around 1810 and is reportedly on a historical register. In 1960, plans were made to build drydock No. 5 on the site occupied by this house. The "Marshlands Plantation House" was floated by barge to the State-owned Ft. Johnson when construction of drydock No. 5 commenced (Personal Communication, 1981).

5.3 PHYSICAL FEATURES

5.3.1 Climatology

Due to the proximity of the ocean, the climate of Charleston is mild and temperate. Daily weather is controlled largely by the movement of pressure systems across the country and by the diurnal effects of the land-sea breeze. Exchanges of air masses are relatively few in summer, when masses of warm, humid, maritime-tropical (mT) air persist for long periods under Bermuda high pressure conditions. Winters are characterized by movements of frontal systems and by replacement of mT air with cool, dry, continental-polar (cP) air.

5.3.1.1 Temperature

Average daily temperatures recorded during each month by the National Weather Service at the Charleston Municipal Airport are shown in table 5.3-1. The coldest month is January, when daily temperatures typically range from 37 to 60 degrees Fahrenheit (°F). In July, the warmest month, the average daily temperature extremes vary between 72 and 90°F. The smaller diurnal temperature variation in summer is due to higher moisture content of the atmosphere on the average day. The record high and low temperatures measured at the airport are 102.9° and 8.0°F, respectively. Normally, 60 days per year temperatures will be at 90°F or above, while 33 days of the year freezing temperatures will predominate. The average first occurrence of freezing temperatures is 10 Oct, while the average last occurrence is 19 Feb [Army, 1976c; U.S. Soil Conservation Service (USSCS), 1971; NAVFAC, 1976].

5.3.1.2 Precipitation

The average annual rainfall in Charleston is 49.2 inches, with a summer peak of over 7.5 inches occurring in July. The four summer months (June through September) experience over 50 percent of the annual rainfall. Rain storms during the summer are due to strong convective atmospheric motions, which trigger 72 percent of the average 57 thunderstorms per year. Rainfall during the winter is generally associated with the interface of cP frontal air masses replacing mT air. With the exception of the 7 inches dropped during the winter storm of 10-11 Feb 1973, only traces (less than 0.04 inch) of snow are usually experienced, mostly in January and February (Army, 1976c; USSCS, 1971; NAVFAC, 1976).

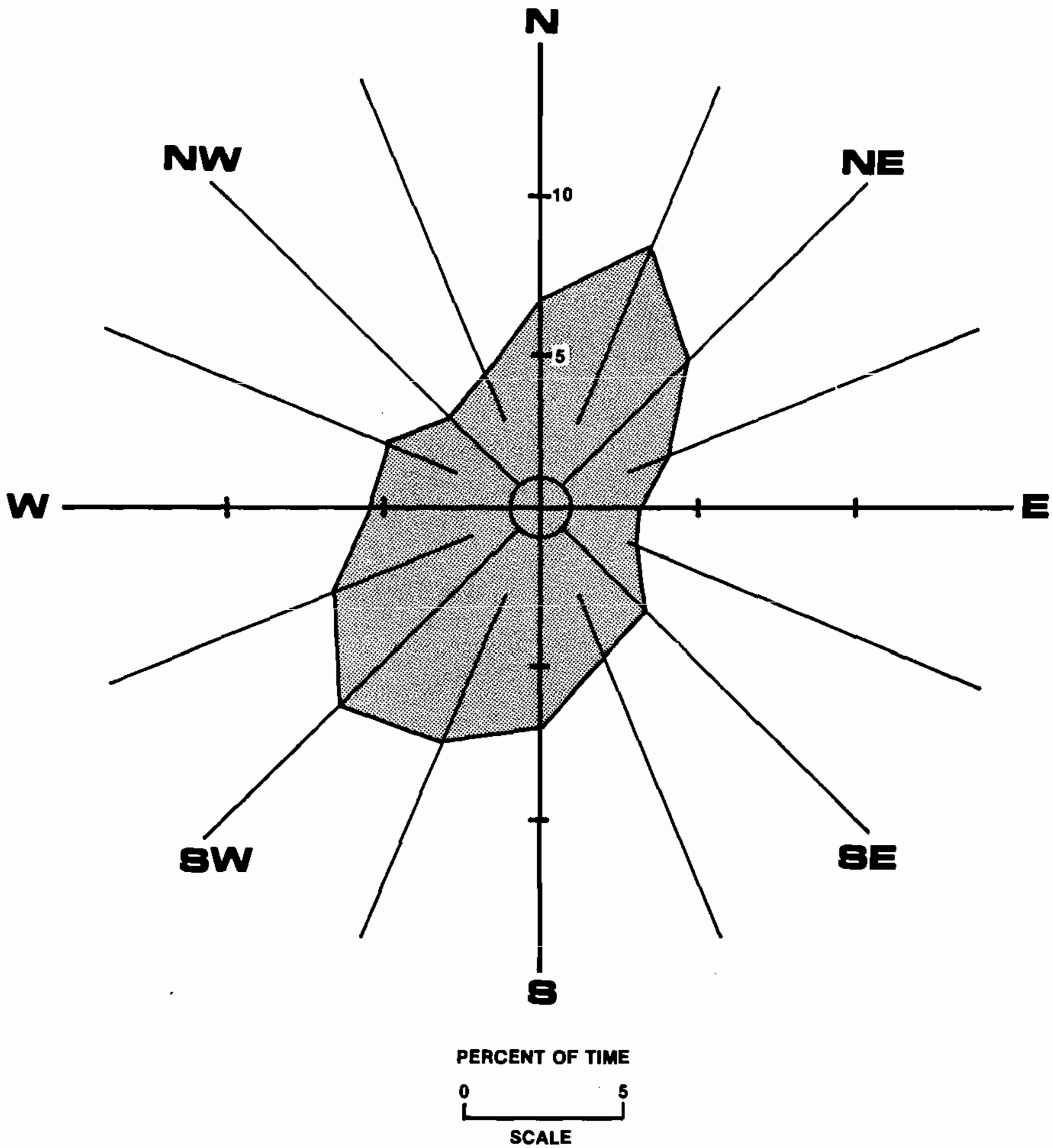
5.3.1.3 Wind

The mean wind speed recorded at the Charleston Airport is 9 miles per hour, with prevailing wind directions (table 5.3-1; figure 5.3-1) of north-northeast during the winter months and south-southwest during the summer months (Army, 1976c; USSCS, 1971; NAVFAC, 1976).

Table 5.3-1
Annual and Monthly Climatological Data Recorded by the National Weather Service at Charleston Municipal Airport, Charleston, S.C.

Time	Normal Daily Temperature, °F Maximum	Normal Daily Temperature, °F Minimum	Normal Total Precipitation (inches)	Prevailing Direction of Winds	Heavy Fog (Days)
Years of Record	1947-76	1947-76	1947-76	1962-76	1956-76
January	61.2	38.3	2.54	SW	4
February	62.5	40.4	3.29	NNE	2
March	68.0	45.4	3.93	SSW	2
April	76.9	52.7	2.88	SSW	2
May	83.9	61.8	3.61	S	2
June	89.2	69.1	4.98	S	2
July	89.2	72.0	7.71	SW	1
August	88.8	70.5	6.61	SW	1
September	84.9	66.2	5.83	NNE	2
October	77.2	55.1	2.84	NNE	3
November	67.9	43.9	2.09	N	4
December	61.3	38.6	2.85	NNE	3
Annual	75.9	54.5	49.16	NNE	28

Source: Army, 1976c.



SOURCES: NAVFAC, 1976.
ESE, 1981.

Figure 5.3-1
TEN-YEAR AVERAGE WIND DIRECTION FOR CHARLESTON AIRPORT, SOUTH CAROLINA

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

5.3.1.4 Storms

There are an average of 66 electrical storms every year, occurring most frequently during the summer convective storm season. Late summer to early fall is the period of maximum threat from hurricanes. Major hurricanes affecting the Charleston area occurred in August of 1885, 1893, 1911, 1940, 1952, and September of 1928 and 1959. A storm tide of 11 feet above mean low water, the highest for which records are available, was recorded during the August 1893 hurricane (Army, 1976c; USSCS, 1971; NAVFAC, 1976). Recently, hurricanes David (September 1979) and Dennis (August 1981) have affected the Charleston area.

5.3.2 Topography

NAVBASE Charleston is located on the eastern edge of a low, narrow finger of land separating the Ashley and Cooper Rivers (see figure 5.1-1). The topography of the area is typical of South Carolina's Lower Coastal Plain, with low relief plains broken only by the meandering courses of the many sluggish streams and rivers flowing toward the coast and by an occasional marine terrace escarpment. Topography at NAVBASE Charleston is essentially flat, with elevations ranging from just over 20 feet in the northwestern part of the base to sea level at the Cooper River (see figure 5.3-2). Much of the original topography of NAVBASE Charleston has been modified by man's activities. The southern end of the base originally was a tidal marsh drained by Shipyard Creek and its tributaries. Over the last 70 years, this area has been filled with both solid wastes and dredged spoil. Most of the base is within the 100-year flood zone, which is below 10 feet in elevation.

5.3.3 Geology

The geology of the Charleston area is typical of the southern part of the Atlantic Coastal Plain. A seaward-thickening wedge of Cretaceous and younger sediments is underlain by older igneous and metamorphic basement rock (see figure 5.3-3). At NAVBASE Charleston, Recent and/or Pleistocene sands, silts, and clays of high organic content are exposed at the surface. These materials are underlain by a plastic calcareous clay known as the Cooper Marl. Figure 5.3-2 shows the depth to the marl at various points on the base, as well as the surface topography. At NAVBASE Charleston, the Cooper Marl is underlain by the Santee Limestone and older rocks. Figure 5.3-4 shows a generalized north-south cross section along the approximate center of the base.

The Charleston area has a history of seismic activity, dominated by the Great Charleston Earthquake of 1886. Four hundred and two earthquakes were recorded in the Charleston area during the period 1754-1970.

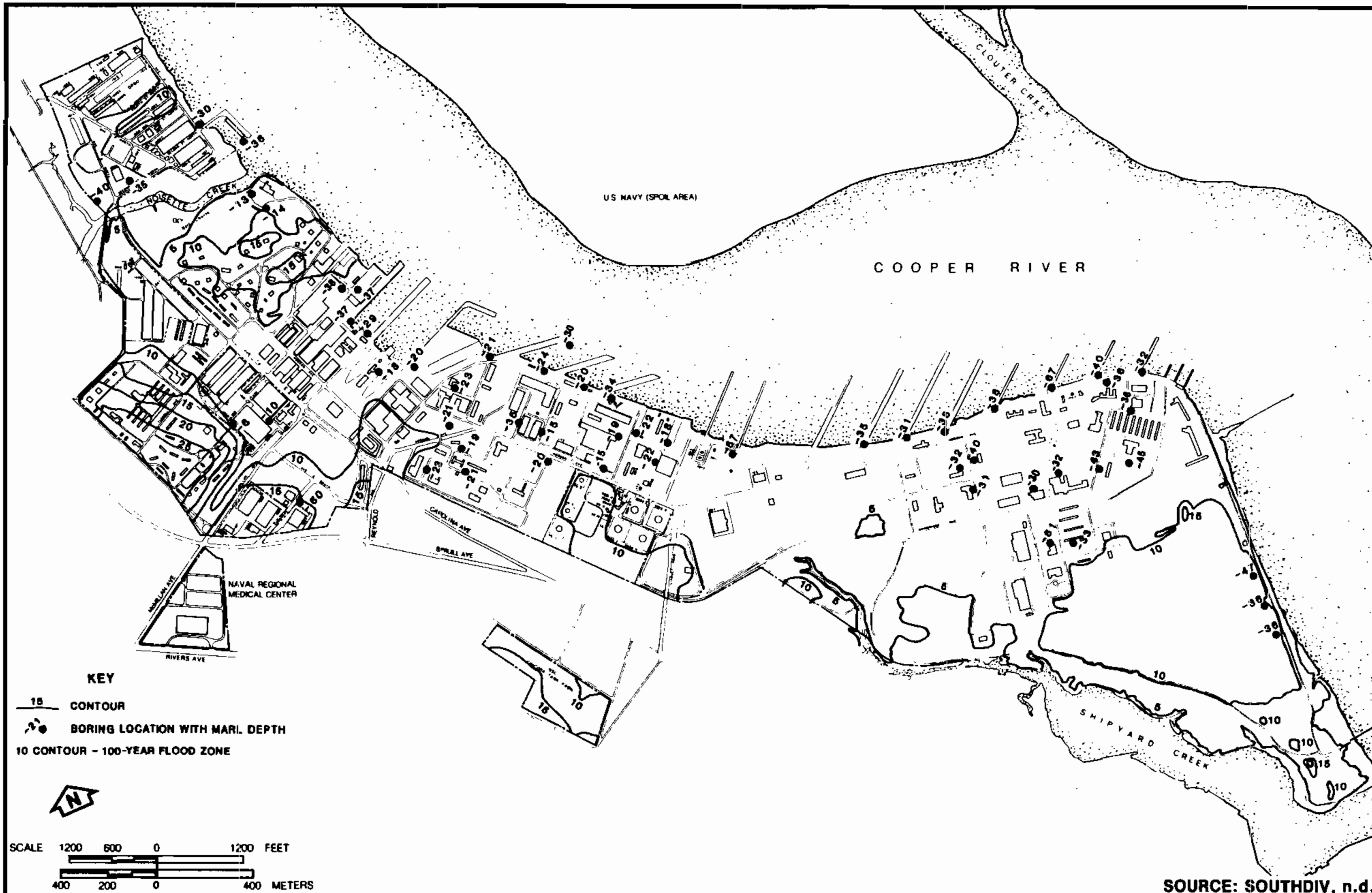
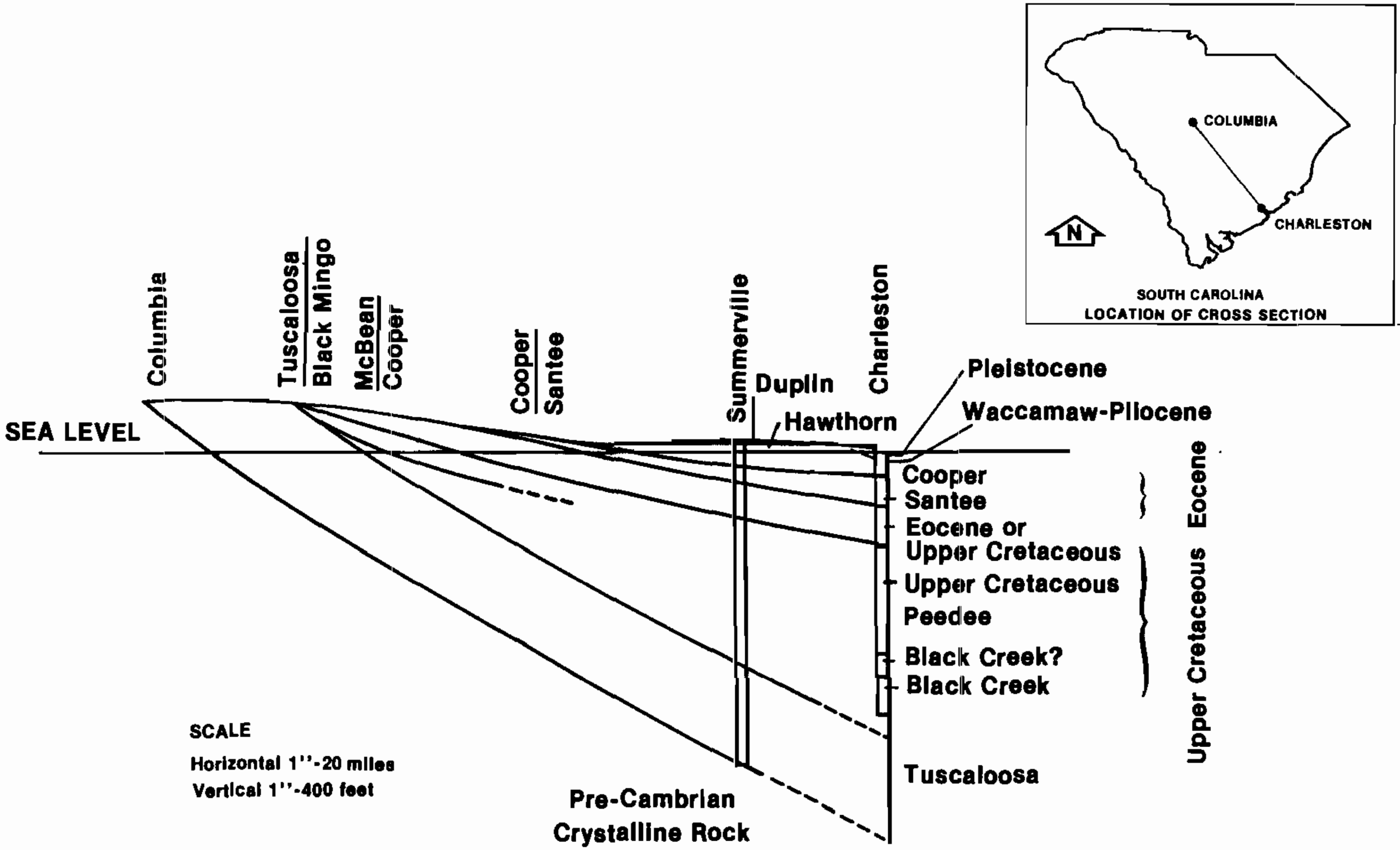


Figure 5.3-2
TOPOGRAPHY AND SUBSOIL OF NAVBASE CHARLESTON

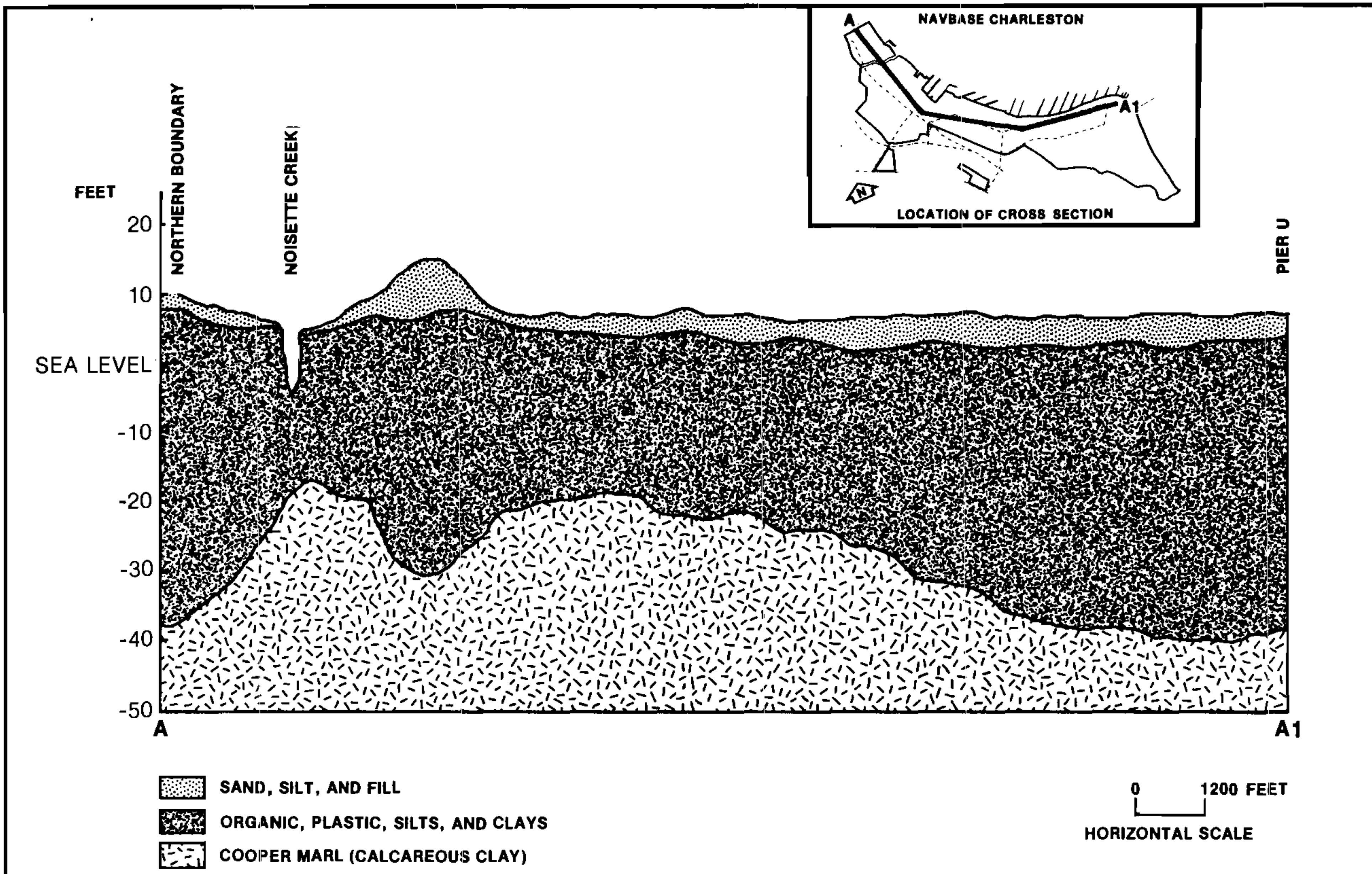
INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON



SOURCES: NAVFAC, 1976.
ESE, 1981.

Figure 5.3-3
EAST-WEST GEOLOGIC CROSS SECTION FROM THE COAST INLAND THROUGH CHARLESTON, S.C.

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON



SOURCE: ESE, 1981.

Figure 5.3-4
GENERALIZED GEOLOGIC CROSS SECTION THROUGH NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

The surface soils on NAVBASE Charleston have been extensively disturbed by a long history of intensive use. The natural surface soils were probably fine-grained materials typical of tidal marsh environments. Most of the southern portion of the base has been covered with dredged spoil. This spoil is an unsorted mixture of sands, silts, and clays. Most areas of the base have been either filled or reworked. No data are available concerning permeability rate and range for the soils at NAVBASE Charleston; however, the permeability of the surface soils is rather low, as evidenced by the fine-grained nature of the soils observed on the site visit and the reported history of poor drainage on NAVBASE Charleston.

5.3.4 Hydrology

5.3.4.1 Surface Hydrology

The southern portion of NAVBASE Charleston is drained by Shipyard Creek and the northern portion by Noisette Creek (figure 5.3-5). Both creeks drain into the Cooper River. Surface drainage in the NSY and NAVSTA areas is directly into the Cooper River, which empties into Charleston Harbor. The stormwater collection system and drainage of the developed areas of the installation are discussed in detail in section 6.6.1.2.

Shipyard Creek is a small tidal tributary, about 2 miles in length, which extends southeastward along the southwest boundary of NAVBASE Charleston to the Cooper River, at a point opposite the southern tip of Daniel Island (river mile 9). Docking facilities are located along the west shore of the lower mile of channel, while the east shore is bounded by tidal marshland along its entire length.

Noisette Creek, which transects the northern portion of NAVBASE Charleston, is a tidal tributary approximately 2.5 miles long. The creek flows almost directly eastward from its headwaters in the City of North Charleston and empties into the Cooper River at river mile 13.

The Cooper River Basin comprises 722 square miles of Coastal Plain in South Carolina. The Cooper River has its origin at the confluence of its east and west branches, from which it flows 31 miles southward to its outlet in Charleston Harbor. Lake Moultrie in the upper part of the Cooper River Basin, approximately 40 miles upstream of NAVBASE Charleston, was constructed by the South Carolina Public Service Authority in 1942 as part of the Santee-Cooper Project. This lake intercepts drainage of about 300 square miles of the Cooper River Basin. Except for short intervening stretches, the west bank of the river is lined with Federal, State, and private docking facilities, including those of NAVBASE Charleston.

Prior to the completion of the Santee-Cooper Project by the State of South Carolina in 1942, Charleston Harbor was considered one of the finest natural harbors on the Atlantic Coast, with depths in many areas exceeding 65 feet. Following completion of the project, the

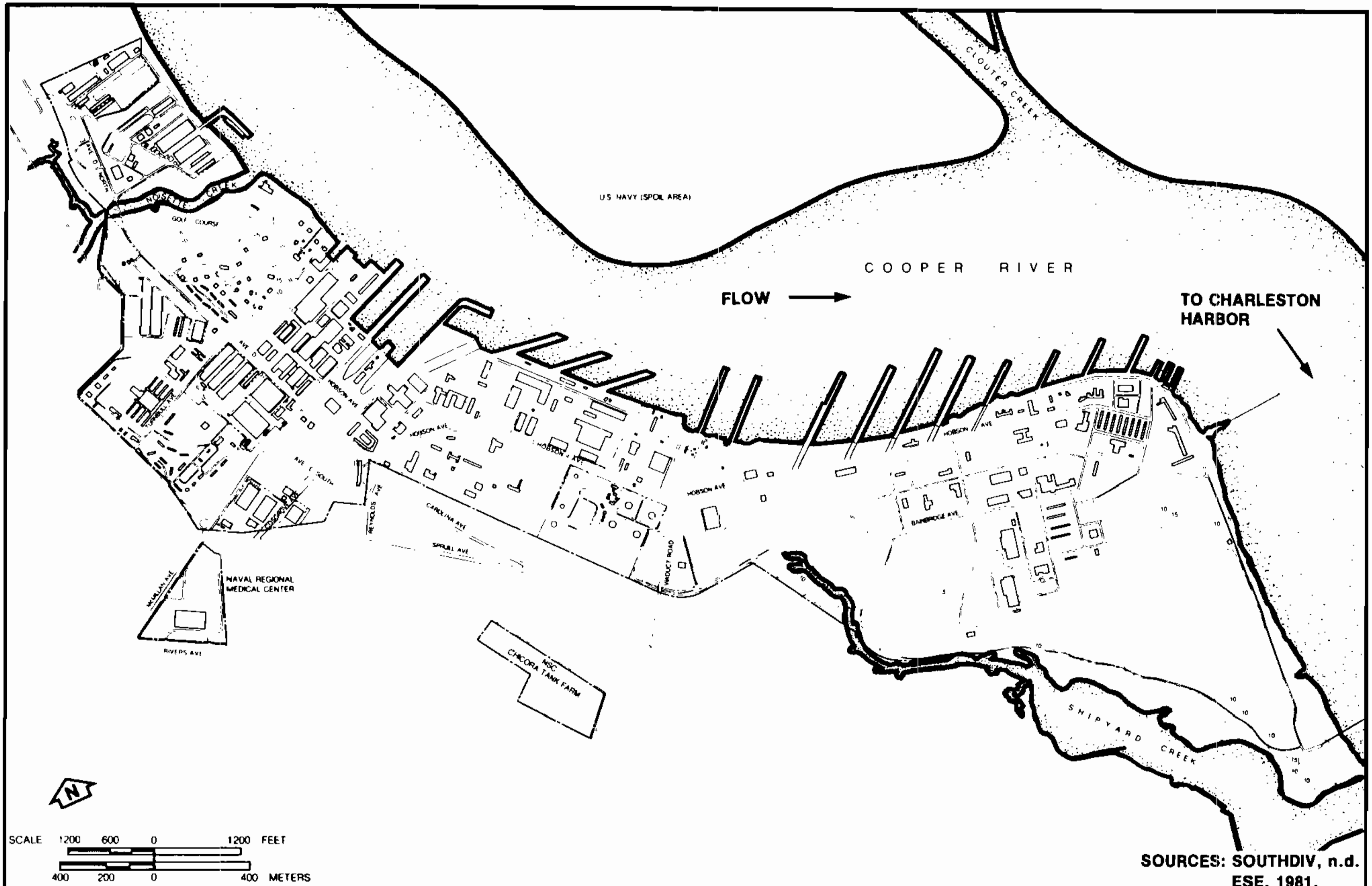


Figure 5.3-5
SURFACE WATERS ON NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

average discharge into the Cooper River increased by a factor of greater than 200, from 528 to 124,174 gallons per second. This resulted in shoaling and silt accumulation in the lower reaches of the Cooper River and in Charleston Harbor. As a result, annual maintenance dredging requirements increased from less than 500,000 cubic yards per day to more than 1 million cubic yards per day. Because of this shoaling problem, the Charleston Harbor estuary has been subject for many years to water quality changes associated with dredging operations. Most of the material creating these shoals is of Piedmont origin, and only a small amount can be attributed to bank erosion. The increased freshwater flow has resulted in the formation of density currents in the harbor which have a predominant upstream bottom flow and, consequently, trap sediment within the harbor.

5.3.4.2 Geohydrology

Most potable water on the Charleston peninsula is supplied by surface water sources (Edisto River). See section 6.3.1 for a discussion of potable water supply. Although both the Cooper Marl and the Santee Limestone function as aquifers in other areas, neither is significantly developed in the Charleston area. In the vicinity of NAVBASE Charleston, the quality of the water from the Santee is not suitable for potable supply; total dissolved solids (TDS) from natural sources range from 1,000 to 1,500 parts per million (ppm).

In the Charleston area, the Cooper Marl is rather impermeable and acts as the confining bed for the Santee, which is not as permeable as in other areas and forms a confined aquifer. Ground water in the Santee, which occurs at about -328 feet mean sea level (MSL) in the Charleston area, flows generally to the southeast. Some wells in the vicinity of NAVBASE Charleston are pumping from the Santee for industrial purposes. In July 1981, the water level of a well in the Santee under NAVBASE Charleston measured 15 feet MSL, indicating that the gradient across the confining bed, the Cooper Marl, is artesian. That is, water from the Santee moves upward through the Cooper to discharge into the incised river valleys.

In the shallow aquifer on NAVBASE Charleston, water flows toward the Cooper River or Shipyard Creek, due to the fine-grained texture of the sediments and the level topography on the naval base. The water table is within 3 to 7 feet of the ground surface. The shallow ground water continually discharges to the Cooper River and Shipyard Creek.

5.3.4.3 Migration Potential

All the shallow ground water at NAVBASE Charleston eventually discharges to the Cooper River either directly or indirectly via its tributaries. Contaminants, if present, in the shallow groundwater system would eventually discharge into the Cooper River if not attenuated by subsurface soils. However, flow rate in the shallow system is expected to be rather slow due to the fine-grained nature of the sediments and the low gradient. Some contaminants, particularly metals, are likely to be attenuated by adsorption onto clay minerals. Furthermore, no potable use is made of the shallow groundwater downgradient of NAVBASE Charleston, since the Cooper River and Shipyard Creek are the base boundaries and also the downgradient boundaries of the shallow groundwater system. It is possible that residential wells in the shallow aquifer exist upgradient of NAVBASE Charleston. However, these wells are not threatened by contaminant migration from NAVBASE Charleston, since they are upgradient and since reversal of the natural gradient by pumpage from any shallow residential wells would be extremely unlikely due to the very small capacity of this type of well. The shallow groundwater system is not used for potable supply at NAVBASE Charleston.

In summary, potential contaminants from installation operations entering the shallow groundwater system do not threaten the health of onbase personnel, since the shallow system is not developed for potable use at NAVBASE Charleston. Likewise, contaminant migration via the shallow groundwater system does not threaten human health off the installation, since shallow groundwater flow is intercepted by surface waters at the installation boundaries and since the shallow system is not significantly developed in the vicinity of NAVBASE Charleston. Contaminants entering the shallow groundwater system at NAVBASE Charleston do, however, represent a potential threat to the environment, since contaminants have the potential to migrate via the shallow system to adjacent surface waters. Although aquatic habitats in the Cooper River, Noisette Creek, and Shipyard Creek may be threatened, human health is not threatened by contaminant migration, since these surface bodies do not function as potable supplies.

The deeper aquifer (Santee Limestone) is not threatened by potential contamination in the shallow system because the Santee has a hydraulic head above its confining bed (the Cooper Marl) at NAVBASE Charleston. Consequently, water flows upward through the Cooper, thus preventing the movement of contaminants into the Santee. Furthermore, water in the Santee is not of potable quality in the vicinity of NAVBASE Charleston, and the aquifer is not significantly developed for potable supply.

Pathways also exist for any surface contaminants present at NAVBASE Charleston to migrate beyond installation boundaries via stormwater drainage. Stormwater is conveyed by natural and manmade drainage channels to the Cooper River or its tidal tributaries. The northern end of the base drains to Noisette Creek or the Cooper River. The heavily industrialized central portion of the base, which includes NSY, drains to the Cooper River. Developed portions of NAVSTA at the southern end of NAVBASE Charleston drain stormwater runoff to the Cooper River. Undeveloped areas of NAVSTA are drained by surface flow to either the Cooper River or Shipyard Creek, depending on the drainage patterns of the area. Thus, surface contaminants at NAVBASE Charleston have the potential to migrate off the installation into the Cooper River either directly or through its tributaries. Potentially migrating surface contaminants represent a threat to the aquatic habitats in the Cooper River, Noisette Creek, and Shipyard Creek but do not threaten human health.

5.4 BIOLOGICAL FEATURES

5.4.1 Regional Ecology

The primary vegetation associations in coastal Charleston County, S.C., are typical of those found along the South Atlantic coastline and range from barren shoreline to outer Coastal Plain forest (Bailey, 1976; Steele, 1974; Shealy and Bishop, 1979). Extensive tidal marshes lie between barrier beaches and uplands and line inlets and river basins. Due to the flat topography of the lower Coastal Plain and the abundance of streams and creeks, tidal marsh covers more than 20 percent of Charleston County (SOUTHDIV, n.d.). Uplands adjoining these tidal marshes contain pine flatwoods, mixed hardwood-pine forests, freshwater marshes, and hardwood swamps.

The wildlife composition of coastal Charleston County is diverse and includes terrestrial, aquatic, and marine mammals; numerous resident and migratory inland and coastal birds; and a variety of reptiles and amphibians. Finfish and shellfish are abundant in the estuarine waters of Charleston Harbor, Cooper River, Wando River, and associated tributaries.

A discussion of vegetation associations and fish and wildlife resources of coastal Charleston County, S.C., is provided in the appendix.

5.4.2 Ecology of NAVBASE Charleston

Industrial and maintenance facilities, storage and refurbishing yards, drydocks, piers, and administrative and housing areas cover most of NAVBASE Charleston's acreage. Interspersed, undeveloped areas consist of improved and semi-improved grounds. However, limited areas of woodland and ruderal tracts are located on the southwestern and southern portion of NAVBASE Charleston, and tidal marsh adjoins Shipyard Creek, Noisette Creek, and sections of the Cooper River. Due to the high degree of development and limited acreage available, the potential for woodland and wildlife resource management is low, and no forest and wildlife management plans are available for NAVBASE Charleston. However, a Natural Resources Conservation Plan is available for the NWS, and a land management plan has been developed for the entire Charleston Naval Base Complex (SOUTHDIV, 1977). This plan is designed to "establish a long-term program required for balanced management and beneficial use of natural resources in accordance with their capability potential and land use requirements" (SOUTHDIV, 1977).

5.4.2.1 Terrestrial Ecosystems

Terrestrial ecosystems on NAVBASE Charleston include ruderal areas, such as old landfill sites and spoil disposal areas, woodlands, and improved and semi-improved grounds. Ruderal areas (defined as disturbed areas covered by weeds and other plant species characteristic of early successional stages) are primarily located on NAVSTA property on the southern and southwestern portions of NAVBASE Charleston and include Clouter Creek spoil disposal areas on the east bank of Cooper River. Ruderal areas south of Bainbridge Ave. and west of the base commissary, north of Shipyard Creek, and southwest of the pistol and skeet ranges are covered by grasses, forbs, shrubs, and scattered trees. A spoil successional forest covers the southern tip of NAVBASE Charleston. Terrestrial ecosystems at NAVBASE Charleston are described in further detail in the appendix.

5.4.2.2 Wetland Ecosystems

Wetlands on NAVBASE Charleston include tidal marshes along Shipyard Creek, Noisette Creek, and sections of the Cooper River; scattered and small freshwater marshes less than 1 acre in size; and several small drainages bordered by shrub thickets. These ecosystems are described in detail in the appendix.

5.4.2.3 Aquatic Ecosystems

Aquatic ecosystems on and in the vicinity of NAVBASE Charleston include the Cooper River, Shipyard Creek, Noisette Creek, Clouter Creek, Wando River, and the upper section of Charleston Harbor. These waters are surrounded by extensive *Spartina-Juncus* marshes and, as a result, are rich in nutrients and detritus. Key characteristics of these streams are listed in the appendix, table A-6.

Charleston Harbor and lower sections of the Cooper and Wando Rivers are important nursery grounds for finfish and shellfish (State of South Carolina, 1972; Lagman *et al*., 1979; Gusey, 1981) and contain important populations of game and commercially important species. The Cooper River annually receives large runs of anadromous fish, which ascend the river to spawn. Such species include striped bass, blueback herring, and shad. Additional game and commercially important fish occurring in Charleston Harbor and the lower Cooper River are listed in the appendix, table A-7.

Invertebrates and mollusks of commercial importance occurring in Cooper River, Wando River, and Charleston Harbor include shrimp, blue crab, and shellfish. Approximately 30 percent of the 1972 South Carolina shrimp production was captured in the Charleston Harbor area (State of South Carolina, 1972), which has also been identified as containing significant amounts of shellfish (Gusey, 1981).

Aquatic mammals recorded in the estuarine ecosystem of Charleston Harbor or lower Cooper River are listed in table A-8. Resident birds and reptiles are discussed in the appendix.

5.4.3 Threatened and Endangered Species

The U.S. Fish and Wildlife Service (FWS) protects Federally listed animal and plant species under the Endangered Species Act of 1973 [Public Law (P.L.) 93-205, as amended] and under section 4 of the Act, Associated Critical Habitats. A list of Federally protected endangered and threatened species is updated and published annually in the Federal Register, most recently on 20 May 1980 (FWS, 1980a).

In addition to Federally listed species, the State of South Carolina protects a number of resident wildlife and fish species under its Nongame and Endangered Species Conservation Act of 1974 (South Carolina Code of Laws, chapter 15, sections 50-15-10 through 50-15-90, 1976). In addition, a number of marine turtles are protected by South Carolina Wildlife and Marine Resources Department Regulation No. 123-150.

A survey of FWS- and South Carolina-protected species lists showed a number of endangered and threatened species occurring or potentially occurring in the vicinity of NAVBASE Charleston and nearby Charleston Harbor. Twelve animal and one plant species occurring or potentially occurring in the vicinity of NAVBASE Charleston are listed as endangered or threatened by FWS and South Carolina Wildlife and Marine Resources Department (WMRD). These species, along with their status and potential for occurrence on NAVBASE Charleston property, are listed in table 5.4-1. No adverse impacts on these species due to installation operations are expected based on their absence or rare occurrence in the NAVBASE Charleston area.

Table 5.4-1
Federal and State of South Carolina Endangered and Threatened Species Occurring or Potentially Occurring in the Vicinity of NAVBASE Charleston

Species	Status Federal/South Carolina	Likelihood of Occurrence on NAVBASE Charleston
Florida manatee (Trichechus manatus)	Endangered/Endangered	Occasional Transient
Florida panther (Felis concolor coryi)	Endangered/Endangered	None
Southern bald eagle (Haliaeetus l. leucocephalus)	Endangered/Endangered	Occasional Transient
Peregrine falcon (Falco peregrinus)	Endangered/Endangered	Occasional Transient
Brown pelican (Pelecanus occidentalis)	Endangered/Endangered	Occasional Transient
Bachman's warbler (Vermivora bachmanii)	Endangered/Endangered	None
Kirtland's warbler (Dendroica kirtlandii)	Endangered/Endangered	None
Red-cockaded woodpecker (Picoides borealis)	Endangered/Endangered	None
American alligator (Alligator mississippiensis)	Threatened/Endangered	Occasional
Green turtle (Chelonia mydas)	Threatened/Endangered	None
Loggerhead turtle (Caretta caretta)	Threatened/Endangered	None
Short-nosed sturgeon (Accipenser brevirostrum)	Endangered/Endangered	Occasional Transient
Bunched arrowhead (Sagittaria fasciculata)	Endangered/Not Listed	None

* Occasional: Area resident, may be expected on or in vicinity of NAVBASE Charleston on occasion. Not expected to nest onsite due to lack of suitable habitat;
Occasional Transient: Occasionally reported from lower Cooper River/Charleston Harbor area. These species are migratory and not expected to remain in vicinity of site;
None: Species reported from vicinity, but suitable habitat lacking on NAVBASE Charleston.

Sources: State of South Carolina, 1976.
ESE, 1981.

SECTION 6.0
ACTIVITY FINDINGS

6.1 INDUSTRIAL OPERATIONS

NAVBASE Charleston is an extensive industrial complex containing virtually all shipyard and dockside operations required to manufacture, repair, overhaul, and refuel naval vessels. There are 19 piers and 5 drydocks at NAVBASE Charleston; however, 1 of the piers (pier A) is currently inactive, and 2 of the drydocks (Nos. 3 and 4) are currently used for storage purposes alone.

This section presents a description of each industrial operation conducted on NAVBASE Charleston. Information is presented for each major NAVBASE Charleston activity, including:

1. Naval Shipyard (NSY)
2. Naval Station (NAVSTA)
3. Naval Supply Center (NSC)
4. Naval Reserve Center (NRC)
5. Fleet and Mine Warfare Training Center (FMWTC)
6. Fleet Ballistic Missile Submarine Training Center (FBMSTC)
7. Naval Electronics Systems Engineering Center (NESEC)
8. Marine Corps Barracks
9. Naval Security Group Activity (NAVSECGRUACT)

In addition to describing industrial operations, wastes generated by each industrial operation are identified. Because the industrial processes have not changed significantly since they began in the early 1900s, the types of wastes currently generated are generally the same as those generated by past industrial operations. Most industrial activities on NAVBASE Charleston began operation during the period of 1901 to 1921 and are still in operation today. For those industrial operations which have significantly modified their processes, the process modifications and resulting changes in types of waste generated are addressed in detail in the sections specifically describing those operations. Moreover, for those operations with a period of operation different from that described above, the period of operation is specifically identified.

Although the types of wastes generated by industrial operations essentially have remained the same over the years, waste generation rates may have fluctuated considerably as a result of varying production requirements. Waste generation rates were presumably the highest during World Wars I and II when production rates of industrial operations were at their peak. Current waste generation rates are identified for most industrial operations. Because of the lack of historical information regarding past generation rates, best engineering judgment was applied where possible to provide a rough estimate of past rates. Generally, it can be inferred that the order of magnitude of past generation rates is generally close to that of current rates.

Between the 1930s and 1973, solid wastes, including sludges, were generally disposed of in the base sanitary landfill (site 1) (see section 6.6.2). Since 1973, solid wastes have been generally contract hauled offbase.

Prior to 1972, disposal of liquid industrial wastes generally involved discharge to a combined sanitary, industrial, and storm wastewater sewer system and ultimately to the Cooper River, until more stringent environmental regulations established in the 1970s precluded this practice. With the installation of a separate sanitary/industrial sewer system in 1972, the sanitary and industrial wastewater discharges were separated from the storm system and routed via a separate sewer system to the North Charleston Consolidated Public Service District (NCCPSD) rather than to the Cooper River (see section 6.6). Industrial pretreatment systems currently in use include oil-water separation, acid neutralization, and metals precipitation.

In 1975, sanitary sewer connections were installed on the piers for the use of docked ships. Improvements to this system were made in 1978. Some ships were not capable of using the dock system because their onboard sanitary system was not compatible with the dock system. Some overboard discharge of sanitary wastewater by docked ships occurred until April 1981, when Federal law prohibited such discharges. Modifications to the collections system and to the ships using the system corrected the condition.

Although waste disposal methods are identified in this section under industrial operations, section 6.6 addresses waste treatment and disposal in more detail.

6.1.1 Naval Shipyard

NSY provides logistic support for assigned ships and service craft, including conversion, overhaul, repair, alteration, drydocking, and outfitting. Other industrial operations performed at NSY include manufacturing, research, development, and testing of equipment used on ships and service craft. Major industrial operations performed at NSY are described in detail below.

6.1.1.1 Foundry

The Foundry is located in Bldg. 9, and it is here that metal parts used in refitting ships assigned to NSY are cast. The Foundry does not produce hazardous waste, and hazardous materials are not used in its operations. There are no records of past hazardous waste-generating operations by the Foundry (Personal Communication, 1981).

6.1.1.2 Shipfitter Shop

The industrial operations performed at the Shipfitter Shop (Bldgs. 2 and 2A) consist of cutting and machining large metal plates used in the initial steps of building or major repair work of ships. Equipment used in this shop is capable of shearing, punching, planing, cutting, and rolling metal plates 1 to 1.5 inches thick. No hazardous wastes are currently generated by these operations or have been generated in the past, because these operations have not changed significantly over the years (Personal Communication, 1981).

6.1.1.3 Sheetmetal Shop

The Sheetmetal Shop performs light-gauge sheetmetal fabrication and a limited amount of degreasing. About 5 years ago, this shop was relocated from Bldg. 44 to its current location in Bldg. 59. No significant quantities of industrial wastes are generated at the Sheetmetal Shop. A minimal volume of cutting oil is used in cutting sheetmetal, and most of it adheres to the sheetmetal and metal shavings. All sheetmetal waste, including metal shavings, is periodically sold to salvaging contractors under the administration of the Defense Property Disposal Office (DPDO). Metal waste generated by past operations was also sold to salvaging contractors.

In 1979, a 400-gallon degreasing tank was installed in the Sheetmetal Shop. It was reported by Sheetmetal Shop personnel that its use is infrequent. Penetone 998®, which primarily consists of phosphoric acid, is used as the degreasing solution in this tank and has yet to become contaminated to the point of requiring disposal. Losses from evaporation are supplemented by the addition of fresh Penetone®. During the onsite investigation of the Sheetmetal Shop, the degreasing tank was inoperable because the electric heaters used to heat the degreasing solution were not functioning. Prior to 1979, degreasing of sheetmetal parts was conducted by the Pickling Shop. Degreasing was accomplished by immersing the sheetmetal into acidic pickling baths (Personal Communication, 1981). The description of the Pickling Shop presented later in this section addresses this degreasing process and related waste disposal practices in greater detail.

6.1.1.4 Boiler Shop

Boilers onboard ships are repaired by Boiler Shop personnel. For the last 6 years, the Boiler Shop has been located in Bldg. 59; during the preceding 50 years, however, it was located in Bldg. 9. In the past, when boilers were relined with asbestos, hazardous wastes were generated during "rip-out" operations in which the firebrick and asbestos lining was chipped away with air hammers. A substitute material is now being used in Navy boilers, and only about 1,000 pounds of asbestos is contract hauled annually from NSY. The amount removed is expected to diminish as the older boilers are replaced. Past quantities of asbestos disposed of in the base sanitary landfill (site 1) were significantly greater than 1,000 pounds per year because of the past lack of substitute materials.

Boiler tubes, preserved with Cosmoline® grease to prevent rust, are received at the Boiler Shop. The Cosmoline® is removed by a bath of kerosene, and all grease is removed in another bath of hot water, trisodiumphosphate, caustic, and detergents. After this second bath, the tubes are steam rinsed. Although this operation does not generate hazardous waste, it does produce approximately 800 gallons of contaminated kerosene semiannually. This material is pumped out by the Temporary Services Shop and put into the NSC waste oil reclamation system. The contents of the second bath are discharged to the sanitary sewer. Prior to the installation of the sanitary sewer, this waste was discharged to the Cooper River via the combined sewer system (Personal Communication, 1981).

6.1.1.5 Welding Shop

The Welding Shop is located in Bldg. 2, where it has been since before World War II. Welding Shop personnel perform welding operations on ships assigned to NSY for repair. This facility does not generate hazardous waste, and hazardous materials are not used in its operation (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980). Past operations were not believed to have generated hazardous wastes, because the welding operations have not changed significantly over the years.

6.1.1.6 Electrical Shop

Electrical Shop operations include the manufacture and repair of industrial electrical equipment used in naval vessels. The Electrical Shop is located in Bldg. 177, where it has been since July 1955. Prior to that time, the Electrical Shop was not a consolidated operation; rather, electrical work was performed in several small electrical shops located throughout NSY. Information on the previous locations of each of these small electrical shops was not available to the IAS team.

Electrical Shop operations which generate waste include the following:

1. Insulation of wire for motor armatures by coating it in vats with varnish,

2. Cleaning metal components with a solvent cleaner,

3. Salvaging spent electrical batteries from naval vessels, and

4. Battery restoring and recharging.

Approximately 300 gallons of waste sludge is currently generated per year by the wire-insulation process. Past sludge generation rates were probably similar to current rates, except during periods of high production (World Wars I and II) when they were significantly higher. Through 1973, when the base sanitary landfill (site 1) was closed, the sludge was removed from the bottom of the varnish vats once a year, placed in 55-gallon drums, hauled to the base sanitary landfill (site 1), and then poured from the drums into the landfill. Since 1974, the sludge has been contract hauled offbase.

Approximately 300 gallons of waste metal-cleaning solvent is generated per year. Past generation rates were probably similar to current rates, except during World Wars I and II when they were significantly higher. Prior to approximately 1972, the spent solvent was discharged to the combined sewer system and ultimately to the Cooper River. Since 1972, the spent solvent has been contract hauled offbase.

Both the battery salvaging operation and the battery restoring and recharging operation generate an acidic waste stream. Although neither operation is located in Bldg. 177 with the Electrical Shop, both are managed by the Electrical Shop. The battery salvaging operation is located adjacent to drydock No. 4, and the battery restoring and recharging operation is located in Bldg. 68. The battery salvaging operation consists of draining the acid electrolyte from spent batteries removed from naval vessels, rinsing the battery casings and electrodes with water, and recovering the lead electrodes. The recovered lead is sold to salvaging contractors. The combined waste stream of waste acid and wastewater is collected and routed to the acid neutralization facility. This facility also receives acidic wastewater from the battery restoring and recharging operation. Small acid spills frequently occur during battery restoring and recharging, and the acid and rinsewater drain to a sump located in Bldg. 68. From the sump, the acidic wastewater is pumped to the previously mentioned acid neutralization facility. The combined wastewater is neutralized by the addition of soda ash and discharged to the sanitary sewer and ultimately to NCCPSD. A more detailed description of the acid neutralization facility is presented in section 6.6.1. Prior to the installation of the acid neutralization facility in the mid-1970s, the acidic waste streams were discharged to the sewer system without treatment. Prior to 1972, the waste streams were discharged to the combined sewer system leading to the Cooper River. From 1972 until the installation of the acid neutralization facility, the acidic wastewater was discharged to NCCPSD without pretreatment.

About 200 gallons of sludge is currently generated every 6 months by the neutralization process and is contract hauled. It was reported that this sludge generation rate is similar to that occurring in the past. Since the mid-1970s, the sludge has been contract hauled offbase.

Although current Electrical Shop operations involving the handling of mercury in electrical equipment (e.g., switches) do not result in the release of significant quantities of mercury to the environment, past operations did. Past operations which generated significant quantities of mercury included the repair of navigational equipment, particularly gyroscopes. Prior to 1973, there were no established procedures for handling mercury to avoid health and environmental problems. As a result, about 2 percent of the mercury contained in electrical equipment being repaired or discarded was lost by spillage in the surrounding work area or by adhering to the interior of discarded equipment. The remaining 98 percent was recovered for reuse. Mercury contained in discarded equipment was either included with scrap metal, sold for reclamation, or included with waste disposed of in the base sanitary landfill (site 1). Currently, more intensive efforts are expended to recover all mercury such that a minimal amount is lost, and virtually all mercury is sold to private contractors for reclamation (Personal Communication, 1981).

6.1.1.7 Electronics Shop

Electronics Shop operations consist of the repair and modification of electronic equipment. Prior to about 1956, the Electronics Shop was located in Bldg. 10. Since then, the shop has been located in Bldg. 177.

The only activity in the Electronics Shop which generates industrial waste is a water curtain spray paint booth. Water is recirculated during painting but requires disposal once every 3 to 4 months because of the buildup of fugitive paint. Prior to the installation of the separate sanitary/industrial wastewater sewer system in 1972, this wastewater was discharged to the Cooper River via the combined sewer system. Since 1972, this wastewater has been discharged to the sanitary/industrial sewer system. Approximately 50 gallons of sludge, accumulated in the water curtain recirculation system, is cleaned out following drainage of the wastewater to the sewer system. Past sludge accumulation rates were probably similar to current rates. Prior to 1973, the sludge was placed in a 55-gallon drum and hauled to the base sanitary landfill (site 1) for disposal. Since 1973, the sludge has been drummed and contract hauled offbase (Personal Communication, 1981).

6.1.1.8 Machine Shop 31

Industrial operations performed at this shop consist of machining and metal electroplating using cadmium, copper, chromium, lead, nickel, and silver and anodizing. Anodizing processes include coating steel piping used in hydraulic equipment with phosphate and treating aluminum with alodine. The machining operation is located in Bldg. 3, and the electroplating operation is located in Bldg. 44.

The primary function of the machining operation is heavy machine work, including lathing, cutting, grinding, drilling, and punching of large metal components. Industrial wastes generated by this shop consist of metal waste and waste oil. The waste oil originates from machining operations and from draining metal components containing oil, such as engines. The metal waste is sold to salvaging contractors through DPDO. The waste oil drains to an underground storage tank. The tank is periodically pumped out, and the waste oil is hauled to the NSC waste oil reclamation facility. About 1,000 gallons of waste oil is removed from the underground storage tank annually.

The only industrial waste generated by the electroplating operation is rinsewater containing fugitive toxic metals and cyanide from the electroplating baths. It was reported that spent plating baths are not a source of wastewater, because plating bath contaminants are removed through filtration, and plating bath losses are augmented by the addition of fresh plating solution. The filtered material has been contract hauled offbase since 1973. Contaminants removed from the plating baths prior to 1973 were probably disposed of in the base landfill (site 1). The quantity of filtered material is minimal compared to the quantity of sludge generated by waste rinsewater pretreatment.

Waste rinsewater is generated when rinsing baths used to clean metal surfaces before and after electroplating become contaminated with fugitive metals requiring disposal. Prior to 1972, untreated rinsewater was discharged to the Cooper River via the combined sewer system. In late 1971 or early 1972, the rinsewater was segregated from stormwater and sanitary wastewater into two waste streams, and a pretreatment system was installed. The pretreatment system services only one of the two waste streams--the one consisting of rinsewaters containing pollutants other than cyanide, particularly chromium and other heavy metals. Metal removal is provided by the pretreatment system through chemical precipitation using soda ash. The other waste stream, consisting of cyanide-bearing rinsewater, receives no pretreatment. Both waste streams are discharged to the sanitary sewer system and ultimately to NCCPSD.

The non-cyanide-bearing waste stream is treated on a batch basis once every 2 weeks. Approximately 1,200 gallons is treated in each batch and then discharged to the sewer, and approximately 250 gallons of sludge is generated as a result of the pretreatment of each batch. Although past wastewater and sludge generation rates have presumably varied considerably due to varying production rates, in general, the order of magnitude of past rates is probably similar to current rates. However, this assumption may not be true for the peak production periods during World Wars I and II when rates were probably much higher.

The sludge generated from 1972, when the metals removal pretreatment system was installed, until 1973 was placed in 55-gallon drums and hauled to the base sanitary landfill (site 1) for disposal. Since 1973, the sludge has been drummed and contract hauled offbase.

The current and past rates of discharge for the cyanide-bearing waste stream are unknown; however, volumes discharged are known to be less than that of the non-cyanide-bearing waste stream.

6.1.1.9 Machine Shop 38

The primary function of Machine Shop 38 is light machine work, including the repair of machinery such as turbines and engines. This shop has been located in Bldg. 80 since the early 1940s. Prior to that time, it was located in Bldg. 44 and was under the operation of Machine Shop 31.

Industrial wastes currently generated by this shop, as well as waste generation rates, are presented in table 6.1-1. Past waste generation rates were probably similar to current rates, except during World Wars I and II when they were much higher. The source of the waste oil is a gravity oil-water separator, which receives waste oil from engines and other machinery, and oily wastewater from cleanup operations. The separator effluent is currently discharged to the sanitary sewer system, and the recovered oil is periodically pumped into a tank truck which transports it to the NSC waste oil reclamation facility. Prior to the installation of the separate sanitary/industrial wastewater sewer system in 1972, the waste oil and oily wastewater were disposed of in the combined sewer system without prior oil-water separation. Since 1972, this waste stream has been discharged to the sanitary/industrial sewer system; however, the oil-water separator was not installed until sometime in the mid-1970s.

Solvents, primarily 1,1,1,-trichloroethane and freon, are used as degreasers and other types of cleaners and are, therefore, generated as wastes. Potassium hydroxide solution originates in oxygen generators used on naval submarines which have been assigned to NAVBASE Charleston since 1948. Hydraulic fluids containing chlorinated organic substances are recovered during the repair of hydraulic equipment used in naval vessels. Prior to 1972, these liquid wastes were discharged to the Cooper River via the combined sewer system. When this disposal practice was discontinued, these wastes were placed in 55-gallon drums and hauled offbase. In addition, disposal of some of these drummed wastes in the base landfill probably occurred shortly before the landfill (site 1) was closed in 1973.

Table 6.1-1
Potentially Hazardous Waste Generation Rates--
Machine Shop 38

Waste	Generation Rate (gal/yr)
Waste oil	500
Solvents (primarily 1,1,1-trichloroethane and freon)	200
Potassium hydroxide solution	40
Hydraulic fluid	15

gal/yr = gallons per year.

Source: Personal Communication, 1981.

6.1.1.10 <u>Pipe Shop</u>

Operations at the Pipe Shop, located in Bldg. 56, include the bending, cutting, and connecting of pipes. Degreasing of pipes and other metal components is performed in the Pickling Shop, which is under the supervision of the Pipe Shop. The Pickling Shop is located in Bldg. 221, and operations conducted there are described in detail in section 6.1.1.15.

No hazardous wastes are generated by Pipe Shop operations; however, hazardous wastes are generated by the Pickling Shop (see section 6.1.1.15). There are no records indicating past generation of hazardous waste by the Pipe Shop (Personal Communication, 1981).

6.1.1.11 <u>Central Tool Shop</u>

The Central Tool Shop, located in Bldg. 43, is responsible for performing the following three main functions:

1. Procurement and storage of lubricants and hydraulic fluids,

2. Lubrication and maintenance of shipyard machinery, and

3. Operation and maintenance of barges and railcars used to store and transport oily waste/waste oil to the NSC waste oil reclamation facility.

The only industrial wastes currently generated by the Central Tool Shop are waste oils, solvents, and hydraulic fluids. Approximately 11,000 gallons of lubricant oil is currently used on an annual basis in lubricating NSY machinery, and as much as 35 percent, or 3,800 gallons, is recovered by draining old oil from machinery. The remaining 7,200 gallons is lost as a result of volatilization and/or spillage occurring during oil changes. Recovered oil is placed in 55-gallon drums and transported to the NSC waste oil reclamation facility (see section 6.1.3). It was reported by Central Tool Shop personnel that, prior to approximately 1966, the waste oil was drummed and sold to private contractors for reclamation. Past generation rates of waste oil were probably similar to current rates, except during World Wars I and II when they were much higher.

The operation and maintenance of the railcars and barges used to store and transport oily waste/waste oil to the NSC waste oil reclamation facility do not generate hazardous wastes. The oily waste/waste oil stored and transported by the railcars and barges is generated in the naval vessels docked at the shipyard piers or located in the drydocks for repairs. The generation and handling of this waste is addressed in more detail in section 6.4.1.

A past operation of the Central Tool Shop which generated hazardous waste was the repair of electrical equipment, such as transformers, containing PCB fluids. This operation was performed until approximately 1976. It was reported by Central Tool Shop personnel that small PCB spills were a common occurrence during electrical equipment repairs. The typical cleanup procedure consisted of placing absorbent material on the spill and depositing the saturated material in trash cans. The trash can contents were then transported to the base sanitary landfill (site 1) for disposal. The amount of PCB-contaminated waste disposed of in this manner is unknown (Personal Communication, 1981).

6.1.1.12 Paint Shop

Sandblasting and painting of ships assigned to NSY and ship components are performed in Bldgs. 223 and 212 by Paint Shop personnel. Prior to 1974, the Paint Shop was located near Bldg. 226. The Paint Shop's previous building has been demolished, and, in June 1974, Paint Shop operations were moved to their current locations.

Currently, two metallic paints are used regularly in the Paint Shop: a lead-based primer and a copper-containing bottom paint. These types of paint are of historical interest because they typify those used as steel primers and bottom paints. A total of 3,000 gallons of paint is used each month in Paint Shop operations. No records exist indicating the past or present application of organo-tin paints at NSY. However, sandblasting operations at NSY have reportedly removed organo-tin paints applied to ship hulls at other locations. Thus, although organo-tin paints have not been applied at NSY, sandblasting grit containing organo-tin paints has been generated at NSY.

Paint wastes are hazardous because they may contain cadmium, chromium, lead, cyanide, toluene, or tetrachloroethylene. The solvents used in the painting process (toluene and tetrachloroethylene) also have the potential of being classified as hazardous on the basis of toxicity and ignitability. About 226 tons of paint wastes and solvents is currently generated on an annual basis and stored on a concrete pad located near Bldg. 223 and adjacent to the Cooper River. This storage facility is described in detail in section 6.4.5. Since the late 1960s, a private contractor has been hired to dispose of all paint wastes, including paints, solvents, and paint sludge. Prior to the use of a disposal contractor, painting wastes were disposed of in the base sanitary landfill (site 1).

Two water curtain spray booths are operated in the Paint Shop. When the water curtain is cleaned, the paint sludge (approximately 1,000 pounds) from the booth is collected and disposed of by private contractor, and the water is discharged to the sanitary sewer. Prior to the 1960s, the paint sludge was disposed of in the base sanitary landfill (site 1), and the wastewater was discharged to the Cooper River prior to the installation of the sanitary sewer.

Waste from sandblasting operations conducted in Bldg. 223 and at outside areas (including drydocks and the area adjacent to Bldg. 223) has been subjected to the Extraction Procedure (EP) Toxicity Test and found to be nonhazardous (Technical Services, Inc., 1980). Waste sandblasting materials are disposed of offsite. Prior to 1974, waste sandblasting materials were disposed of in the base sanitary landfill (site 1) (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.1.1.13 Woodwork Shop

The Woodwork Shop performs all wood sawing, planing, finishing, and fabrication required to maintain, modify, and/or manufacture equipment and furniture for other shipyard operations and naval vessels. Past Woodwork Shop activities have included the use of a 2,500-gallon dip tank to apply a fire retardant solution to wood products. It was reported that the manufacturer of the fire retardant was Para Products, Inc.; however, the composition of the fire retardant is unknown. Fire retardants are generally formulations of salts, the principal ones being borates, phosphates, and ammonium compounds. The application of fire retardant to wood at the Woodwork Shop did not generate any waste. Fresh fire retardant was added to the dip tank to make up for losses due to evaporation and absorption into the treated wood. The application of fire retardant to wood was discontinued in February 1981 when the practice of purchasing wood already treated with fire retardant began. Prior to the time of the site visit, approximately 2,000 gallons of the fire retardant solution, which remained in the dip tank, was contract hauled offbase to an EPA-approved landfill for disposal (Personal Communication, 1981).

6.1.1.14 Supervisor of Shipbuilding Conversion and Repair (SUPSHIP)

SUPSHIP was established in June 1950. The procurement and monitoring of contracted services for shipbuilding conversion and repairs are the sole functions of SUPSHIP personnel. No repair or production services are performed by SUPSHIP itself. Since the early 1970s, the principal contractors procured by SUPSHIP have been Metal Trades, Inc., Braswell Shipyards, and Sandblasting, Inc., all of which have facilities onbase. Since SUPSHIP does not generally establish contractual agreements regarding hazardous waste disposal by contractors, SUPSHIP has no records of quantities of wastes generated by contractors and methods of waste disposal. Contractors are responsible for handling and disposing of hazardous wastes generated by their operations. Records indicate that Metals Trades, Inc. and Sandblasters, Inc. were established onbase after 1975. This period is subsequent to the closure of the base sanitary landfill (site 1) and, consequently, these contractors could not have disposed in the landfill. However, Braswell has been onbase since approximately 1970 and it is likely that some hazardous wastes, such as waste solvents and paints, were disposed of in the base landfill (Personal Communication, 1981). The quantities of wastes generated by these contractors are unknown, but are expected to be small considering the size of the operations.

6.1.1.15 Pickling Shop

The Pickling Shop has been in its current location since the early 1940s. Until May 1970, when Bldg. 221 was constructed, the facility was located out in the open, with only the pickling tanks covered by a roof. The Pickling Shop is under the supervision of the Pipe Shop.

Current operations include degreasing with a "dry cleaning fluid" (Stoddard solvent), hydrochloric acid bath, iridite bath, nitric acid bath, paint stripper bath, bright dip (sodium dichromate), sulfuric acid bath, trisodium phosphate bath, and deoxyisoprep bath. The tanks used for these baths range in size from approximately 1,500 gallons to 2,400 gallons. The baths are changed every 3 to 6 months, depending on the amount of use, and the spent pickling baths are contract hauled. The quantities of waste currently generated in the Pickling Shop on an annual basis are: spent pickling acids and other corrosives (1,375 gallons), bright dip (275 gallons), and trisodium phosphate (1,210 gallons). Since 1974, Public Works NSY has arranged for a private contractor to dispose of spent pickling waste. Prior to that time, the contents of spent pickling baths were discharged to the Cooper River via the storm drainage system (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.1.1.16 Temporary Services Shop

The Temporary Services Shop was established in 1950 and has been located in Bldg. 9 for approximately 6 years. The duties of Temporary Services include draining and cleaning of shipboard tanks, draining of chemical tankage, and wet layup of boilers on NAVBASE Charleston. Approximately 40,000 gallons of flushing solutions is currently generated annually by the Temporary Services Shop.

Shipboard tanks are treated in accordance with prescribed Navy methods, which vary depending on the intended use of the tank. Chemicals used to treat the various tanks are caustic soda, sulfamic acid, trisodium phosphate, nonionic detergent, and calcium and sodium hypochlorite. When these materials are removed from the treated tank, they are disposed of by private contractor. Since February 1981, Public Works NSY has directed the disposal of spent tank-treatment chemicals. Prior to that time, the NSY Quality Control Laboratory directed the neutralization of these materials. After neutralization, the materials were discharged to the storm sewer, which emptied into the Cooper River.

Since February 1981, all tank-treatment chemicals, except chlorinated water, have been contract hauled by an EPA-approved contractor. Chlorinated water, used to treat potable water holding tanks onboard ship, is stored and periodically diluted and discharged to the sanitary sewer.

Wet layup of the ship's boiler requires the use of chemicals such as hydrazine and morpholine. These chemicals, used as corrosion inhibitors and antioxidants while the boilers are not in use, are received and pumped out by Temporary Service Shop personnel. Hydrazine is listed as a hazardous waste under EPA hazardarous waste regulations (EPA, 1980a). Prior to February 1981, wastes containing hydrazine were discharged to the Cooper River; since that time, however, wastes from boiler layup have been contract hauled. Estimates of the volume of boiler layup water generated on an average basis were not available because of the wide fluctuation in boiler layup activities and the lack of pertinent records. However, because the chemicals contained in the layup water are biodegradable and were likely well diffused in the Cooper River following discharge, no adverse environmental impacts are expected as a result of the past disposal of boiler layup water.

Tanks involved in other operations, such as the boiler tube degreasing bath in the Boiler Shop and the oil-water separator in the Central Tool Shop, are also pumped out by Temporary Services Shop personnel. Waste oils are taken to the NSC-operated waste oil reclamation system. This method of waste oil recovery has been used since the establishment of the Temporary Services Shop in 1950 (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.1.1.17 Public Works Naval Shipyard

Public Works NSY has been located at NAVBASE Charleston since the founding of the Naval Yard in 1901. Public Works NSY personnel provide services to NSY and, in some cases, to NAVBASE Charleston as a whole. Services include utilities, large equipment maintenance, pest control, and environmental management.

Public Works NSY areas where hazardous wastes currently are generated include vehicle maintenance (Bldgs. 25, 1199, and 1169), building maintenance (Bldg. 25), and pest control (Bldg. 381). Wastes generated in the vehicle maintenance areas are cleaning solvents and waste oil. Cleaning solvents are disposed of by contractor. No information was available on the past disposal practices of cleaning solvents or waste oil. Waste oils are recycled through the NSC waste oil reclamation facility. The building maintenance group generates paint waste, which is disposed of by contractor along with waste from the Paint Shop (Bldg. 223) (see section 6.1.1.12). Pest control wastes are discussed in section 6.4.3 of this report.

The environmental section of Public Works NSY, in addition to other duties, is responsible for all supervision of NAVBASE Charleston hazardous waste contracting. This group also supervises cleanup of any hazardous waste spill on NAVBASE Charleston, as well as the disposal of the spilled material (Williams-Russell and Assoc., Inc., 1980).

6.1.1.18 Atlantic Fleet Audio Visual, Inc. (AFAV)

A tenant of NSY, AFAV provides photographic and audio visual services for the Atlantic Naval Fleet and NSY. AFAV has been in operation since 1975 and is located in Bldg. 234. Wastes generated by AFAV include waste hypo-solution, which contains silver, black fixer, and developer solution. Approximately 1,500 gallons of waste hypo-solution is generated annually, and silver recovery is provided prior to discharging this solution to the sanitary sewer. An electrolytic silver recovery process is utilized in the silver recovery unit. Cartridges containing recovered silver are reportedly sold to private contractors. In addition, approximately 72 gallons of bleach fixer and 200 gallons of developer solution are discharged to the sanitary sewer annually. Past waste disposal also involved discharge to the sanitary sewer and ultimately to NCCPSD (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.1.2 Naval Station

6.1.2.1 Shore Intermediate Maintenance Activity (SIMA)

A tenant of NAVSTA, SIMA has been located in Bldgs. NS23 and NS26 since its inception in 1958. Periodic maintenance is performed by SIMA personnel on ships, to extend the ships' length of service before extensive maintenance is required at the shipyard.

Current operations generate the following hazardous waste annually: boiler cleaning solution (sulfuric acid or nitric acid) (50,000 gallons), cleaning solvents (chlorinated hydrocarbons) (1,800 gallons), asbestos (2 cubic yards), and boiler test chemicals (mercuric nitrite) (3,400 pounds). The boiler cleaning solution is currently neutralized and discharged overboard. Cleaning solvents, asbestos, and boiler test chemicals are disposed of by contractors engaged by Public Works NSY.

Historical records of waste handling are limited due to the rapid turnover of the SIMA personnel in this activity. By examining current practices, however, it can be assumed that no special handling occurred in the past, liquid wastes were discharged to the combined sewer systems, and solid wastes were sent to the base sanitary landfill (site 1). Ship boiler cleaning solutions were discharged overboard to the Cooper River (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.1.2.2 Public Works Naval Station

Wastes generated by Public Works NAVSTA include waste oil from the vehicle maintenance program and a small amount of degreaser (trichloroethylene) from the lawn-mowing maintenance facility. Waste oils are disposed of by recycling the oil through the NSC waste oil reclamation facility. The degreaser tank, which has reportedly not been emptied to date, will be disposed of by a contractor hired by Public Works NSY when required (Personal Communication, 1981).

6.1.2.3 Commander, Marine Warfare Command (CMWC)

CMWC is strictly an administrative branch of the Commander in Chief of the Atlantic Fleet (CINCLANTFLT) and is a tenant on NAVSTA. The only industrial waste generated at MWC is waste photographic developing solution. Prior to 1972, the waste developing solution was discharged to the Cooper River via the combined sewer system. From 1972 until 1979, the waste solution was discharged to the sanitary sewer. Silver recovery was not practiced prior to discharge to the sewer systems. Since 1979, this waste has been transferred to AFAV (see section 6.1.1.18) for silver recovery. Approximately 60 gallons of this solution is currently generated annually (Personal Communication, 1981).

6.1.2.4 Surface Forces Readiness Support (SFRS)

SFRS coordinates the transferring of ship wastes, other than oily wastes, to land during ship maintenance at NAVSTA. SFRS is located on NAVSTA property. Wastes generated by SFRS operations include dilute solutions of sodium nitrate and mercuric nitrate. The sodium nitrate solution is actually boiler layup water that is pumped off ships; the sodium nitrate is added to the water to prevent rusting. Approximately 15,000 gallons of boiler layup water is currently pumped annually off ships and discharged to the dockside sewer. In the past, boiler layup water was probably discharged overboard.

Approximately 5 gallons of mercuric nitrate solution (maximum concentration of 0.2 grams mercuric nitrate per liter), used in boiler water salinity testing, is currently generated on a monthly basis. Subsequent handling of this solution is conducted by private contractor. Prior to 1972, this waste solution was probably discharged to the Cooper River via the combined sewer system.

6.1.3 Naval Supply Center

NSC is involved in storing chemicals and operating a printing shop, two oil tank farms, and a waste oil reclamation facility. The storage and handling of chemicals by NSC are discussed in section 6.4. A description of the tank farms and waste oil reclamation facility is presented in section 6.4.1. The coal storage area described in section 6.4.6 is on property controlled by NSC, but the coal is owned by NSY.

Since May 1979, the Publication and Printing Service has been located in Bldg. 1628. For approximately 30 years prior to that time, it was housed in Bldg. 35. This service supplies the printing needs of much of the Commander, NAVBASE Charleston (COMNAVBASE) area of cognizance and is a tenant of NSC.

Prior to 1979, wastes generated at Bldg. 35 included an unknown quantity of ferric chloride acid etching bath, lithographic developing solution, and photographic developing solution. Prior to 1971, these wastes were discharged without treatment to the combined sewer system and, hence, to the Cooper River. Since 1972, these wastes have been discharged to the NCCPSD sanitary sewer system with no pretreatment. In addition, solvents are periodically used to clean printing surfaces. Rags, provided by a commercial supplier, are moistened with the solvents and used to wipe down the presses. After use, the rags are returned to the supplier for reuse. No waste solvents are produced.

When the printing service moved to new facilities in 1979 (Bldg. 1628), the ferric chloride operation was discontinued; the photographic developing solution recycling program was instituted; and a silver recovery program was established for photographic developing solution, paper, and film. The lithographic solution is currently discharged to the sanitary sewer along with spent developing fluid. Film and paper are sent to DPDO to be sold for silver recovery (Personal Communication, 1981).

6.1.4 Naval Reserve Center

NRC, a tenant of NAVSTA, provides recruiting and training facilities for naval reserve personnel. No hazardous waste is routinely generated at this facility. Motor oils generated from the vehicle maintenance program are taken to the NSC waste oil reclamation facility. There are no records indicating past generation of hazardous waste by NRC.

6.1.5 Fleet and Mine Warfare Training Center

Operations at FMWTC, which is located on NAVSTA, include a firefighting training school and a laboratory for testing boiler waters. FMWTC has been in operation since approximately 1956.

The firefighting school uses approximately 20,000 gallons of No. 2 diesel oil per year and 2,000 gallons of gasoline per year in training operations. Training exercises include extinguishing ignited diesel oil and gasoline. Diesel oil floating on water in tanks is burned in enclosed, paved areas. Gasoline is burned directly on the ground in a bermed area; however, it is unlikely that significant amounts seep into the ground because most of the gasoline burns or evaporates.

Oily wastewater is periodically removed from the tanks used for diesel fuel-on-water burning and passed through a gravity oil-water separator prior to being discharged to the sanitary sewer leading to NCCPSD. The effluent contains Aqueous Film-Forming Foam (AFFF) used in firefighting exercises. It was reported that the quantity of AFFF used (less than 50 gallons/week) is well below the discharge limitation imposed by NCCPSD. Prior to 1972, the wastewater was probably discharged to the Cooper River via the combined sewer system. Less than 50 gallons of waste oil per month accumulates in the oil-water separator. This waste oil is periodically removed and transported to the NSC waste oil reclamation facility. In the past, the waste oil was transported offsite by private contractors for reclamation.

The boiler water testing laboratory currently generates less than 5 gallons of dilute mercuric nitrate solution per week. This solution is used to train personnel to test the salinity of boiler water. Waste mercuric nitrate solution is picked up by Public Works NSY and contractor hauled. According to FMWTC personnel, this waste solution was handled in the past by private contractors who reclaimed the mercury.

6.1.6 Fleet Ballistic Missile Submarine Training Center

FBMSTC operates a school on NAVSTA to train personnel in the operation of ballistic missile submarines. FBMSTC has been in operation since 1962. Industrial wastes generated by FBMSTC include the following:

1. Oily wastewater from bilges on simulated training submarines,
2. Hydraulic oils,
3. Freon-based degreasing solvent,
4. Monoethanolamine used as a chelating agent in carbon dioxide scrubbers, and
5. Potassium hydroxide solution used in oxygen generators.

Oily wastewater is routed through a gravity oil-water separator prior to being discharged to the sanitary sewer system. Prior to 1972, the wastewater was discharged to the Cooper River via the combined sewer system. Waste oil which accumulates in the separator is periodically removed and transported to the NSC waste oil reclamation facility. Approximately 500 gallons of waste oil is removed from the separator annually (Williams-Russell and Assoc., Inc., 1980). In the past, waste oil was sold to private contractors for reclamation.

Six to ten 55-gallon drums of waste hydraulic oils are currently generated annually. These oils are currently hauled to the NSC waste oil reclamation center. In the past, the waste oils were sold to private contractors for reclamation.

Fewer than five 55-gallon drums of the freon-based degreasing solvent are generated annually. Prior to the early 1970s, the waste solvent was probably discharged to the Cooper River via the combined sewer system. When this disposal practice was discontinued, the waste solvent was placed in 55-gallon drums and hauled to disposal facilities. Disposal of some of this waste in the base sanitary landfill (site 1) probably occurred shortly before the landfill was closed in 1973. Since 1973, these wastes have been contract hauled offbase.

Approximately 9 gallons of waste monoethanolamine and 60 gallons of waste potassium hydroxide solution are currently generated on an annual basis. These wastes have always been diluted and disposed of down laboratory drains. Prior to the early 1970s, these wastes were discharged to the Cooper River via the combined sewer system. Since then, these wastes have been discharged to the NCCPSD sanitary sewer system; however, a different disposal procedure is currently being developed. The new procedure will probably involve contract hauling offsite to an approved disposal facility (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.1.7 Naval Electronics Systems Engineering Center

NESEC primarily provides electronics support in the maintenance and modification of communication equipment, such as automatic air traffic control equipment, for the Atlantic Naval Fleet and associated shore communication systems. NESEC has been in operation since 1966 and is located offbase in North Charleston. The only industrial wastes generated by NESEC are spent nickel-cadmium batteries, which are sold to salvaging contractors. No other wastes have been generated by NESEC operations (Personal Communication, 1981).

6.1.8 Marine Corps Barracks

Marine Corps personnel stationed at NAVBASE Charleston maintain a small motor pool operation, which generates a minimal quantity of waste oil. This waste oil is taken to the NSC waste oil reclamation facility. There are no records indicating past generation of hazardous waste by Marine Corps Barracks personnel.

6.1.9 Naval Security Group Activity

NAVSECGRUACT, which is a tenant of NAVSTA, is responsible for performing Signal Security Operations (SIGSEC) and Electronic Warfare Support Measures/Electronic Intelligence Technical Guidance Unit (ESM/ELINT TGU) functions, as well as providing cryptologic equipment, maintenance, and personnel support to Atlantic Fleet Cryptologic Direct Support Elements Afloat and other mobile units. No hazardous wastes are generated by NAVSECGRUACT, and there are no records of any past operations generating hazardous wastes.

A gas/diesel-fuel-powered incinerator is located behind the building occupied by NAVSECGRUACT (Bldg. NS-84) and is owned and operated by NAVSTA. This incinerator is used to burn classified printed matter (Personal Communication, 1981).

6.1.10 Summary of Hazardous Waste Generation by Industrial Operations

Table 6.1-2 summarizes the types and quantities of industrial wastes generated and the methods of waste treatment and disposal practiced by each industrial operation at NAVBASE Charleston. In some cases, waste generation rates are those presented in the Hazardous Waste Management Survey (HWMS) (3 Dec 1980). Industrial operations, and the resulting types and quantities of wastes generated, have not changed significantly, if at all, since 1980. Thus, for those instances in which waste generation rates were not available during the onsite survey, the 1980 HWMS rates reportedly provide reasonable estimates of current rates.

The waste generation rates presented in table 6.1-2 indicate that the most significant quantities of hazardous wastes which are currently contract hauled offbase include electroplating sludge (generated in the metal plating waste treatment facility), paint waste, and solvents. The most significant quantities of liquid industrial wastes discharged to the sanitary sewer system include electroplating wastewater (effluent from the metal plating waste treatment facility) and boiler layup water (sodium nitrate solution).

6.2 LABORATORY OPERATIONS

6.2.1 Quality Assurance (QA) Laboratory Complex

The QA laboratory at NAVBASE Charleston conducts structural and chemical analyses of materials supplied to or generated by NSY. The laboratory officially has been in existence since 1965, although it was reported that check laboratories have always been associated with NSY. Tests are conducted at the laboratory primarily by instrumental methods, with very little wet chemical types of analyses; reportedly, no hazardous wastes are generated. The laboratory has, in the past, conducted analyses of wastes generated by NSY operations and has provided treatment and disposal guidance (e.g., the neutralization of strong acids or bases before disposal into the sewer).

6.2.2 Dental Clinic Laboratory

The Dental Clinic at NAVBASE Charleston has been in existence for 15 years. For the past 5 years it has been located in Bldg. 675 and prior to that, in Bldg. 79. The Dental Clinic Laboratory generates three hazardous wastes: (1) scrap amalgam (mercury and silver), (2) beryllium and nickel filings, and (3) waste X-ray solution.

Scrap amalgam (mercury and silver) is stored at the clinic until approximately 3 to 5 pounds has accumulated. At that time, Defense Logistics Agency (DLA) is notified, and the amalgam is sent to DLA at Colts Neck, N.J., for recovery. This occurs two or three times per year.

Table 6.1-2
Summary of Industrial Waste Generation Rates and Treatment and Disposal Methods

Operation	Period of Operation	Industrial Wastes	Current Annual Waste Generation Rate ESE*	W-R†	Current Treatment Method	Current Disposal Method	Past Disposal Method
NSY							
Foundry	Early 1900s to date	None	—	—	—	—	—
Shipfitter Shop	Early 1900s to date	None	—	—	—	—	—
Sheetmetal Shop	Early 1900s to date	None	—	—	—	—	—
Boiler Shop	Early 1900s to date	Asbestos	1,000 lbs	ND**	—	Contract Hauled	Base Landfill
		Waste Kerosene	1,600 gal	ND	None	NSC-WORF***	NSC-WORF
Welding Shop	Early 1900s to date	None	—	—	—	—	—
Electrical Shop	Early 1900s to date	Varnish Sludge	300 gal	ND	None	Contract Hauled	Base Landfill
		Solvent	300 gal	ND	None	Contract Hauled	Cooper River
		Acidic Wastewater	NNI††	3,000 gal	Neutralization with Soda Ash	Sanitary Sewer	Cooper River
		Acid Neutralization Sludge	400 gal	ND	None	Contract Hauled	Contract Hauled
		Mercury	ND	ND	None	Sold to Private Contractors	Fugitive Quantities to Base Landfill
Electronics Shop	Early 1900s to date	Paint Wastewater	ND	ND	None	Sanitary Sewer	Cooper River
		Paint Sludge	200 gal	ND	None	Contract Hauled	Base Landfill
Machine Shop 31	Early 1900s to date	Electroplating Wastewater (cyanide and non-cyanide bearing)	<62,400 gal	40,000 gal	Metals Removal	Sanitary Sewer	Cooper River
		Electroplating Sludge	4,200 lbs	12,400 lbs	None	Contract Hauled	Base Landfill
		Waste Oil	1,000 gal	ND	None	NSC-WORF	NSC-WORF
Machine Shop 38	Early 1900s to date	Waste Oil	500 gal	3,000 gal	None	NSC-WORF	NSC-WORF
		Solvents	200 gal	ND	None	Contract Hauled	Cooper River
		Potassium Hydroxide Solution	40 gal	ND	None	Contract Hauled	Cooper River
		Hydraulic Fluid	15 gal	ND	None	Contract Hauled	Cooper River

Table 6.1-2
Summary of Industrial Waste Generation Rates and Treatment and Disposal Methods
(Continued, Page 2 of 4)

Operation	Period of Operation	Industrial Wastes	Current Annual Waste Generation Rate ESE*	W-R†	Current Treatment Method	Current Disposal Method	Past Disposal Method
Central Tool Shop	Early 1900s to date	Lubricating Oil	3,800 gal	ND	None	NSC-WORF	NSC-WORF
		PCB Fluids from Past Operations	NNI	ND	None	—	Base Landfill
Paint Shop	Early 1900s to date	Paint Waste and Solvents	ND	226 tons	None	Contract Hauled	Base Landfill
		Paint Wastewater	ND	ND	None	Sanitary Sewer	Cooper River
Woodwork Shop	Early 1900s to date	None	—	—	—	—	—
SUPSHIP	June 1950 to date	None	—	—	—	—	—
SUPSHIP Contractors	June 1950 to date	Predominantly Paint Waste and Solvents	ND	ND	ND	Contractor's Responsibility	Base Landfill
Pipe Shop	Early 1950s to date	None	—	—	—	—	—
Pickling Shop	Early 1950s to date	Spent Pickling Baths	NNI	1,375 gal	None	Contract Hauled	Cooper River
		Bright Dip (sodium dichromate)	NNI	275 gal	None	Contract Hauled	Cooper River
		Trisodium Phosphate	NNI	1,210 gal	None	Contract Hauled	Cooper River
Temporary Service Shop	1950 to date	Tank Flushing Solutions	NNI	40,000 gal	None	Contract Hauled	Cooper River
Public Works	Early 1950s to date	Waste Oil	ND	ND	None	NSC-WORF	NSC-WORF
		Solvents	ND	ND	None	Contract Hauled	Cooper River
		Paint Waste	ND	ND	None	Contract Hauled	Base Landfill
AFAV	1975 to date	Waste Hypo-Solution	NNI	1,500 gal	Silver Recovery	Sanitary Sewer	Sanitary Sewer
		Bleach Fixer	NNI	72 gal	None	Sanitary Sewer	Sanitary Sewer
		Developer Solution	NNI	200 gal	None	Sanitary Sewer	Sanitary Sewer

Table 6.1-2
Summary of Industrial Waste Generation Rates and Treatment and Disposal Methods
(Continued, Page 3 of 4)

Operation	Period of Operation	Industrial Wastes	Current Annual Waste Generation Rate ESE*	W-RT	Current Treatment Method	Current Disposal Method	Past Disposal Method
NAVSTA SIMA	1958 to date	Boiler Cleaning Solutions	NNI	50,000 gal	Neutralization	Cooper River	Cooper River
		Solvents	NNI	1,800 gal	None	Contract Hauled	Cooper River
		Asbestos	NNI	2 y^3	None	Contract Hauled	Base Landfill
		Mercuric Nitrate Solution	3,400 lbs	ND	None	Sold to Private Contractors	Cooper River
Public Works		Degreaser (trichloroethylene)	Minimal	ND	None	Contract Hauled	Cooper River
		Waste Oil	NNI	55-110 gal	None	NSC-WORF	NSC-WORF
MWC		Photo Developing Solution	60 gal	50-60 gal	Silver Recovery	Sanitary Sewer	Cooper River
SFRS		Boiler Layup Water (Sodium Nitrate Solution)	15,000 gal	15,000 gal	None	Sanitary Sewer	Cooper River
		Mercuric Nitrate Solution	60 gal	400 gal	None	Sold to Private Contractors	Cooper River
Navy Dental Clinic	1966 to date	Silver, Mercury Amalgams	6-15 lbs	ND	None	Turned over to DLA for Recovery	DLA
		Beryllium, Nickel Filings	130 lbs	140	None	Contract Hauled	Base Landfill
		X-Ray Solutions	60 gal	60 gal	Silver Recovery	NRMC	NRMC
Marine Corps Barracks		Waste Oil	ND		None	NSC-WORF	ND

Table 6.1-2
Summary of Industrial Waste Generation Rates and Treatment and Disposal Methods
(Continued, Page 4 of 4)

Operation	Period of Operation	Industrial Wastes	Current Annual Waste Generation Rate ESE*	W-R†	Current Treatment Method	Current Disposal Method	Past Disposal Method
NSC NSC-WORF	1950 to date	Waste Oil	200,000 gal	ND	Oil-Water Separation	Stored Onsite	Oil Sludge Pits
Navy Publication	1950 to date	Photo Developing Solution	ND	ND	Silver Recovery	Sanitary Sewer	Cooper River
		Lithographic Developing Solution	NNI	60 gal	None	Sanitary Sewer	Cooper River
NRC		Waste Oil	Minimal	350 gal	None	NSC-WORF	NSC-WORF
FMWTC	1956 to date	Waste Oil	600 gal	ND	None	NSC-WORF	NSC-WORF
		Mercuric Nitrate Solution	<260 gal	110 gal	None	Sold to Private Contractors	Sold to Private Contractors
FBMSTC	1962 to date	Waste Oil	NNI	500 gal	None	NSC-WORF	NSC-WORF
		Hydraulic Oils	NNI	330-550 gal	None	NSC-WORF	NSC-WORF
		Solvent	ND	<300 gal	None	Contract Hauled	Cooper River
		Monoethanolamine	9 gal	ND	None	Contract Hauled	Cooper River
		Potassium Hydroxide Solution	60 gal	ND	None	Contract Hauled	Cooper River
NRMC	1972 to date	Waste Chemicals and Solvents	300 gal	—	—	Contract Hauled	Contract Hauled
		Infectious Wastes	—	—	—	Incineration	Incineration
		Waste X-Ray Solution	5,500 gal	ND	Silver Recovery	Sanitary Sewer	Sanitary Sewer
NESEC	1966 to date	None	—	—	—	—	—

* Data collected by ESE during site survey.
† Williams-Russell and Assoc., Inc., 1980.
** ND = no data.
†† NNI = no new information.
*** Waste oil reclamation facility.

Source: ESE, 1981.

Beryllium and nickel filings are generated at the clinic during the production of prosthetics. In the past year, these filings have been collected by Public Works NSY and stored at Bldg. 381 for disposal as hazardous waste. It was reported that approximately 15 pounds of filings is generated every 6 weeks. Prior to 1980, these filings reportedly went to the dumpster.

Spent X-ray solution (60 gallons/year) is sent to NRMC for processing.

Hazardous wastes generated by the Dental Clinic Laboratory and disposal methods employed are summarized in table 6.1-2.

6.2.3 Naval Regional Medical Center

Laboratories within NRMC generate: (1) waste chemicals and solvents, (2) infectious wastes, and (3) waste X-ray solutions.

Waste and/or excess solvents and chemicals (35 to 50 gallons every 2 months) are stored at NRMC and collected for disposal by the Public Works NSY hazardous waste contractor (Groce Labs, Greer, S.C.). This procedure reportedly has been practiced for the past 1.5 years. Prior to that, these items were disposed of by contract through hospital supply.

Infectious wastes generated at NRMC, as well as excess pharmaceutical chemicals, are disposed of by incineration.

Spent X-ray solution (15 gallons/day) is disposed of by flushing into the sanitary sewer system following silver removal.

Table 6.1-2 summarizes hazardous wastes generated by NRMC, as well as the disposal methods employed.

6.3 UTILITIES

6.3.1 Potable Water

Since its establishment in 1901, NAVBASE Charleston has received potable water from the City of Charleston. Potable water is supplied to NAVBASE Charleston through four metered lines: one 16-inch, one 12-inch, and two 8-inch. Area distribution is through 8-inch and 10-inch looped systems. The City of Charleston currently treats water by prechlorination, coagulation, filtration, and postchlorination. NAVBASE Charleston monitors chlorine concentrations in the distribution system to maintain a free chlorine residual of 0.2 milligram per liter (mg/1).

A potable water storage capacity of 2.75 million gallons is available to NAVBASE Charleston. Water is stored in two elevated tanks (500,000 gallons and 250,000 gallons) and two ground storage tanks (1,500,000 gallons and 500,000 gallons). A map of the primary water mains is shown in figure 6.3-1 (SOUTHDIV, 1978).

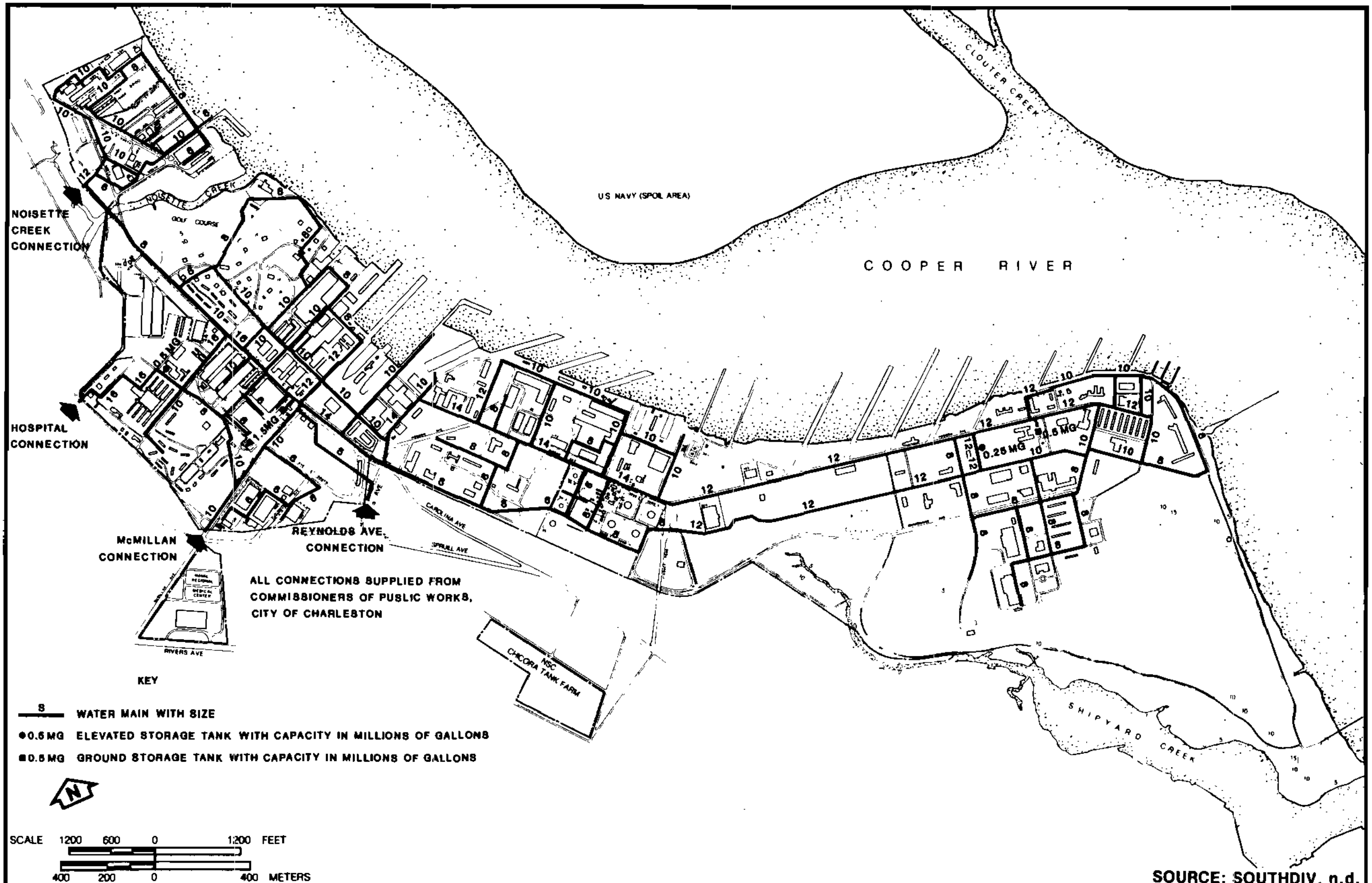


Figure 6.3-1
PRIMARY WATER MAINS ON NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY NAVAL BASE CHARLESTON

6.3.2 Heating

Heat and high pressure steam are supplied by 103 boilers on NAVBASE Charleston. These boilers are of three types: coal automatic stoker-fired, oil-gun-type burners, and gas-gun-type burners. The largest boiler facility is the coal-fired boiler in Bldg. 32, the central power plant. This facility provides 400 pounds per square inch-gauge (psig) steam to the NSY area of NAVBASE Charleston.

Most of the boilers are low-pressure boilers for heating and have not required boiler water treatment. The boilers which provide high-pressure steam require water treatment, using trisodium phosphate, caustic soda, and tannin or sodium sulphite. The boiler blowdown is discharged to the sanitary sewer system. In the past, the sanitary sewer system was accidentally contaminated by oil from broken oil lines within the boiler plant. Oil-water separators have been installed in problem areas to prevent oil contamination of the sanitary sewer system.

Natural gas is supplied to NAVBASE Charleston by South Carolina Electric and Gas Co. NRMC and NSY industrial areas are the primary users of natural gas on NAVBASE Charleston.

6.3.3 Acetylene Production

During the early 1940s, an acetylene production plant was built to provide welding gas for NSY. Acetylene was produced by reacting calcium carbide with water, as shown in the following equation:

$$[CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2]$$

Caustic calcium hydroxide is a byproduct of this reaction. The calcium hydroxide (hydrated lime) was discharged from the plant in the form of a slurry and held in a 2.5-acre disposal pond. This disposal operation continued until the early 1970s, when the plant was closed. The quantity of calcium hydroxide generated by this operation is unknown.

The acetylene used for welding at NAVBASE Charleston has been replaced by MAPP gas, an industrial welding gas.

6.4 MATERIAL HANDLING AND STORAGE

The handling and storage of hazardous materials at NAVBASE Charleston are conducted by NSC (POL and chemicals), Public Works NSY (chemicals, pesticides, paint wastes, and coal), and DPDO (chemicals and PCB items). The discussion of material handling and storage is segregated into material type as follows:

1. POL,

2. Chemicals,

3. Pesticides,

4. PCBs,

5. Paint waste,

6. Coal, and

7. Ordnance.

6.4.1 Petroleum, Oil, and Lubricants

The major storage facilities for POL consist of two tank farms located at NSC. Other POL storage facilities are located elsewhere at NSC and throughout NSY and NAVSTA. Spill Prevention Control and Countermeasure (SPCC) plans have been prepared for the POL storage areas in NSC, NSY, and NAVSTA. In addition to the POL storage areas, there is a waste oil reclamation facility located at NSC.

6.4.1.1 POL Storage

The largest POL storage area exists at NSC, where bulk quantities of diesel oil, Navy Special Fuel Oil (NSFO), and waste oil are stored. The storage areas are concentrated in two tank farms, the Base Tank Farm and the Chicora Tank Farm. Other NSC POL storage areas which are separate from the two tank farms include tanks 3911, 3912, and 14. The locations of the tank farms and other POL storage tanks identified above are shown in figure 6.4-1. The layouts of storage tanks within the Base and Chicora Tank Farms are shown in figures 6.4-2 and 6.4-3, respectively. As shown in figure 6.4-1, the Chicora Tank Farm is located approximately 0.3 mile southwest of NAVBASE Charleston. Table 6.4-1 presents a description of each NSC POL storage tank. The information presented in this table is based on the report entitled "Oily Waste/Waste Oil Management Study" (February 1981) prepared by The Chester Engineers (1981). This report was being reviewed by the Environmental Engineering Division of Public Works NSY for final approval during the IAS.

Tanks 39A and 39D of the Base Tank Farm were constructed in the early 1900s, and the remaining tanks in the Base and Chicora Tank Farms were constructed between 1936 and 1944. The two tank farms are connected by three pipelines: one to convey diesel oil, one to convey NSFO, and one to convey waste oil.

In addition to the POL storage tanks in the Base and Chicora Tank Farms, NSC is also responsible for the operation and maintenance of tanks 3911, 3912, and 14. As shown in table 6.4-1, tanks 3911 and 3912 are used to store lubricating oil, and tank 14 is used to store diesel oil. Tank 14 was used to store diesel oil but has not been used in 3 or 4 years and is currently empty.

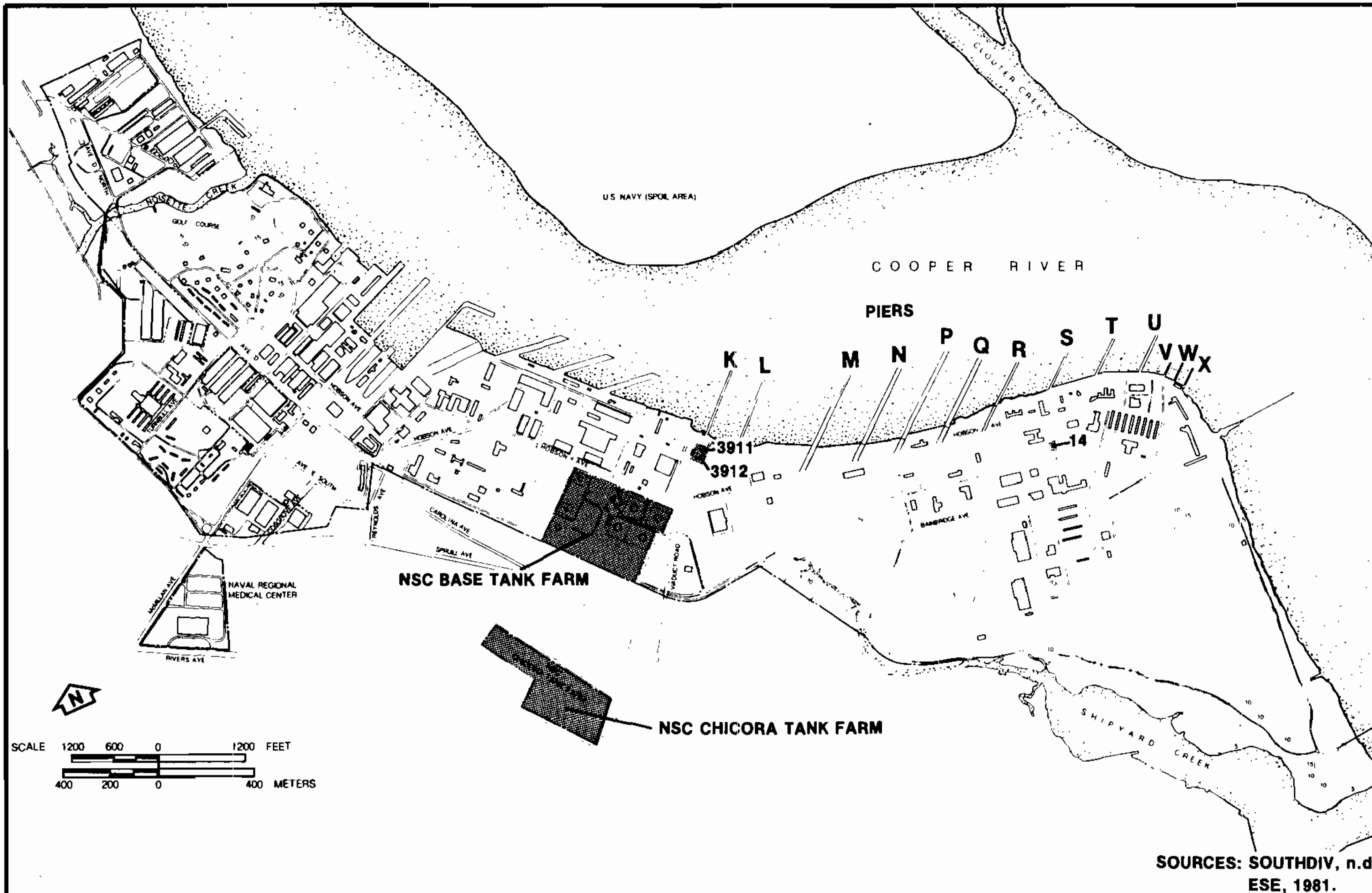


Figure 6.4-1
LOCATIONS OF NSC POL STORAGE AREAS

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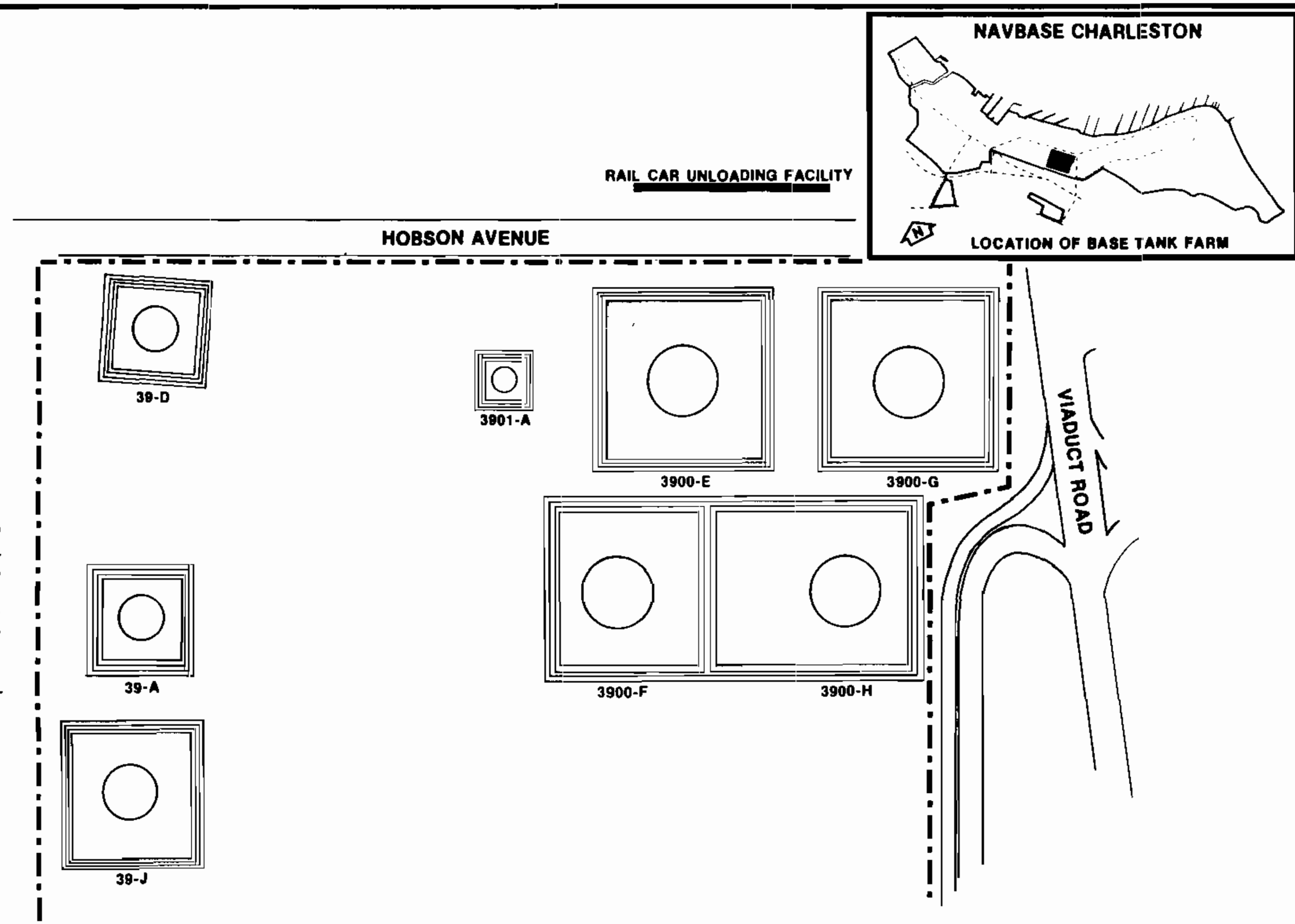
NAVAL BASE CHARLESTON



KEY

TANK	CAPACITY (BARRELS)	FUEL TYPE
39A	17,500	WASTE OIL
39D	17,500	WASTE OIL
39J	17,500	EMPTY
3900E	55,000	DIESEL OIL
3900F	55,000	DIESEL OIL
3900G	55,000	EMPTY
3900H	55,000	EMPTY
3901A	2,500	WASTE OIL

SCALE
100 50 0 100 FEET

SOURCES: SOUTHDIV, 1979.
ESE, 1981.

Figure 6.4-2
BASE TANK FARM LAYOUT

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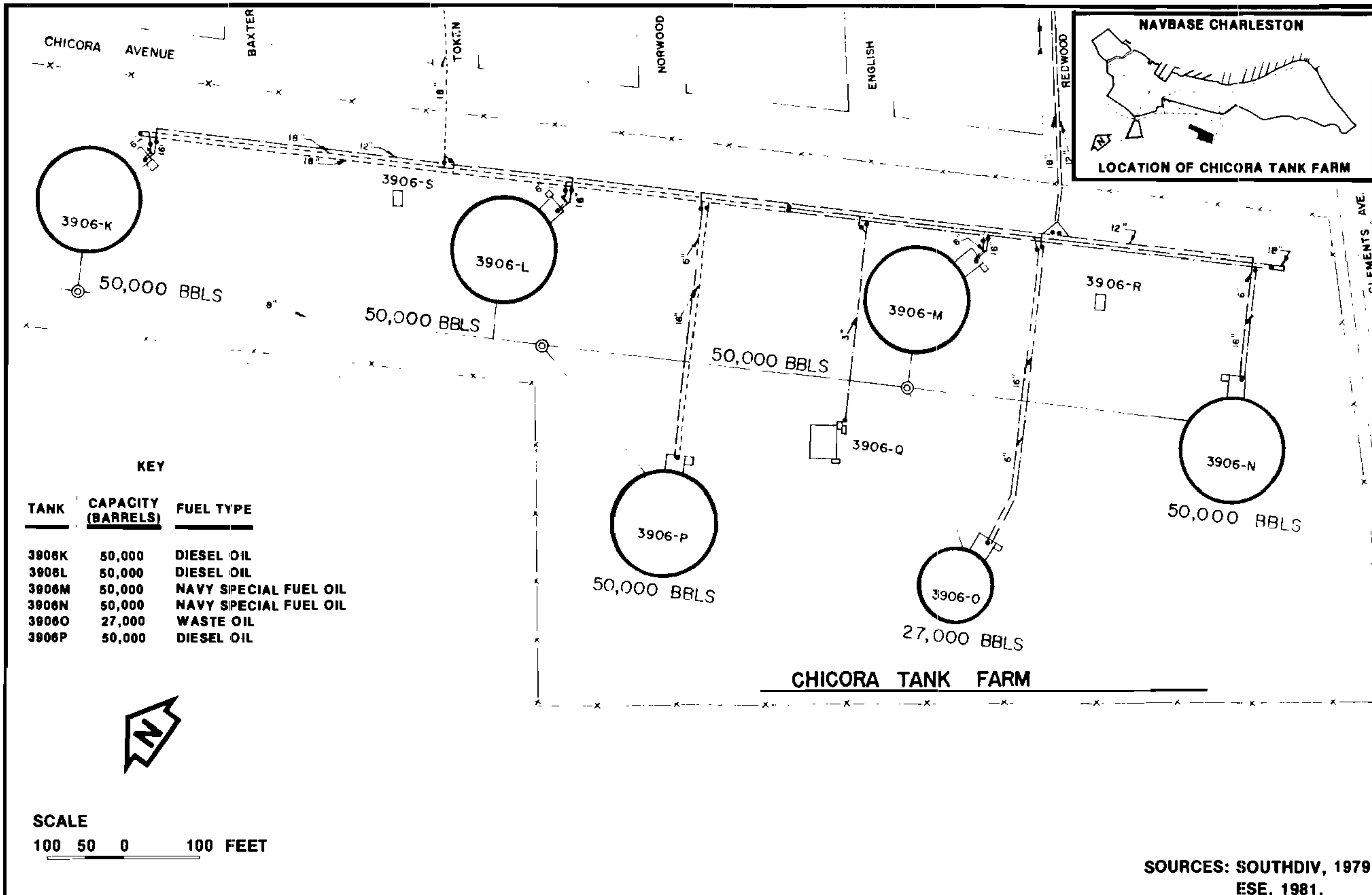
NAVAL BASE CHARLESTON



TANK	CAPACITY (BARRELS)	FUEL TYPE
3906K	50,000	DIESEL OIL
3906L	50,000	DIESEL OIL
3906M	50,000	NAVY SPECIAL FUEL OIL
3906N	50,000	NAVY SPECIAL FUEL OIL
3906O	27,000	WASTE OIL
3906P	50,000	DIESEL OIL

Figure 6.4-3
CHICORA TANK FARM LAYOUT

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NAVAL BASE CHARLESTON

Table 6.4-1
Description of Bulk Storage Tanks in the
Base and Chicora Tank Farms

Tank Identification	Capacity (Barrels)	Fuel Type*	Construction†
39A	17,500	WO	AG-S
39D	17,500	WO	AG-S
39J	17,500	Empty	AG-S
3900E	55,000	D	AG-S
3900F	55,000	D	AG-S
3900G	55,000	Empty	AG-C
3900H	55,000	Empty	AG-C
3901A	2,500	WO	AG-S
3906K	50,000	D	UG-C
3906L	50,000	D	UG-C
3906M	50,000	NSFO	UG-C
3906N	50,000	NSFO	UG-C
3906O	27,000	WO	UG-C
3906P	50,000	D	UG-C
3911	1,190	L	AG-S
3912	1,190	L	AG-S
14	5,238	Empty	AG-S

* D = Diesel Oil.
  L = Lubricant Oil.
  WO = Waste Oil.

† AG = Aboveground.
  UG = Underground.
  S = Steel.
  C = Concrete.

Source: The Chester Engineers, 1981.

The POL storage facilities in NSY and NAVSTA are considerably smaller than those at NSC and generally consist of numerous small to mid-size tanks used to store diesel oil and gasoline. These tanks are located throughout NSY and NAVSTA and are not consolidated in any specific area.

6.4.1.2 POL Distribution

Fuel and waste oil are transferred to the Base and Chicora Tank Farms via underground pipelines leading from pier K. The loading rack adjacent to tanks 3911 and 3912 receives lubricating oil by rail tank car and issues the oil to trucks for distribution. Diesel oil was pumped from tank 14, which is currently empty, to piers S, T, and U, but this practice was discontinued for a number of reasons, including more efficient distribution of diesel oil between the tank farms and pier K. Pier K is the only major fueling pier at NAVBASE Charleston, and it is the only pier where major quantities of waste oil are unloaded from waste oil barges. In the past, pier M was also used for the transfer of fuel and waste oil. All fuel and waste oil lines leading to pier M have been abandoned. Waste oil may consist of either oil, which has become contaminated but is still predominantly oil, or oily wastewater such as that pumped from bilges. Some waste oil generated by industrial operations becomes contaminated with waste solvents, especially in cases where oil-water separators receive spillage from degreasing operations which use solvents. However, the volume of solvent compared to the total volume of waste oil is minimal.

The waste oil unloaded from barges at pier K is pumped to the Base Tank Farm for waste oil reclamation. This facility not only receives waste oil from pier K, but also from the unloading station at the tank farm, which unloads waste oil from tank cars and small mobile containers.

Current practices for the transfer of POL and waste oils to the NSC tank farms and waste oil reclamation facility from ships and industrial operations at NAVBASE Charleston are described below.

6.4.1.2.1 Fuel Oils Removed from Ships

Samples of fuel oils that require removal from ships in the shipyard or at NAVSTA are analyzed by the NSC's petroleum inspector for determination of acceptability. If the oil is acceptable as fuel, it is unloaded into a fuel oil barge or railroad tank cars. Fuel oil from ships at NAVSTA is removed by barge, whether it be returned for credit by defueling barge or for waste oil by waste oil barge. Fuel oil removed from ships in the shipyard may be removed by railroad tank cars or by barge, depending on the quantity removed. Quantities of fuel oil in excess of 15,000 gallons are removed at any berth in the shipyard by pumping into one of two oil barges which transport the fuel oil to pier K, where it is ultimately unloaded and pumped to the NSC tank farms. Quantities of fuel oil less than 15,000 gallons are unloaded by pumping into railroad tank cars which transport the oil to the tank car loading/unloading area adjacent to the NSC Base Tank Farm. If the oil is found to be unacceptable as fuel, it is transported to the NSC waste oil reclamation facility by waste oil barge or by railroad tank cars, as described previously for oil returned for credit.

6.4.1.2.2 Lubricating Oils Removed from Ships

Lubricating oils removed from ships are generally stored at NSY for reuse. The off-loaded lubricating oil is either stored in railroad tank cars or metal holding tanks. Samples of the lubricating oil are removed from the tank car or the metal holding tank for analysis by the Laboratory Division, QA Office, of NSY to determine its acceptability for reuse. If the oil is acceptable for reuse, it is pumped back onto the ship. If the oil is below minimum specifications, it is transported by railroad tank car or in the metal holding tank container to the NSC waste oil reclamation facility.

6.4.1.2.3 Tank Strippings Removal from Ships

The oily waste generated from the cleaning of oil storage tanks on ships is vacuumed into a waste oil barge or railroad tank car for transport to the NSC waste oil reclamation facility.

6.4.1.2.4 Oily Wastewater Removal from Shipyard Ships' Bilges

Ships' bilge water, generated during ship maintenance and overhaul, is collected in 1 or more of 22 vacuum cans located on the piers and drydock areas in NSY. Current vacuum can operations include the manual discharge of the water fraction of the oily wastewater to the sanitary sewer by opening a valve at the bottom of the vacuum can until the first sign of oil appears. At this time, the valve is closed and the vacuum can is ready for use. When no additional water can be bled from the can, it is transported to the NSC waste oil reclamation facility. Once the can is emptied, it is returned to NSY for reuse.

6.4.1.2.5 Oily Wastewater Removal from Naval Station Ships' Bilges

Bilge water removed from ships in NAVSTA is discharged into one or more of five donuts (floating oil-water separators). The oil phase is retained in the donut and water is discharged to the Cooper River. When the donuts become full of waste oil, the waste oil is then transferred to a waste oil barge, which ultimately transports it to pier K where the waste oil is unloaded and transferred to the NSC waste oil reclamation facility.

6.4.1.2.6 Waste Oil Generated by NAVBASE Charleston Industrial Operations

Any waste oil that is generated by industrial operations at NAVBASE Charleston is transported in drums or metal holding tank to the NSC waste oil reclamation facility. Waste oil which accumulates in oil-water separators located throughout NAVBASE Charleston is pumped out into a 500-gallon tank truck and transported to the NSC waste oil reclamation facility.

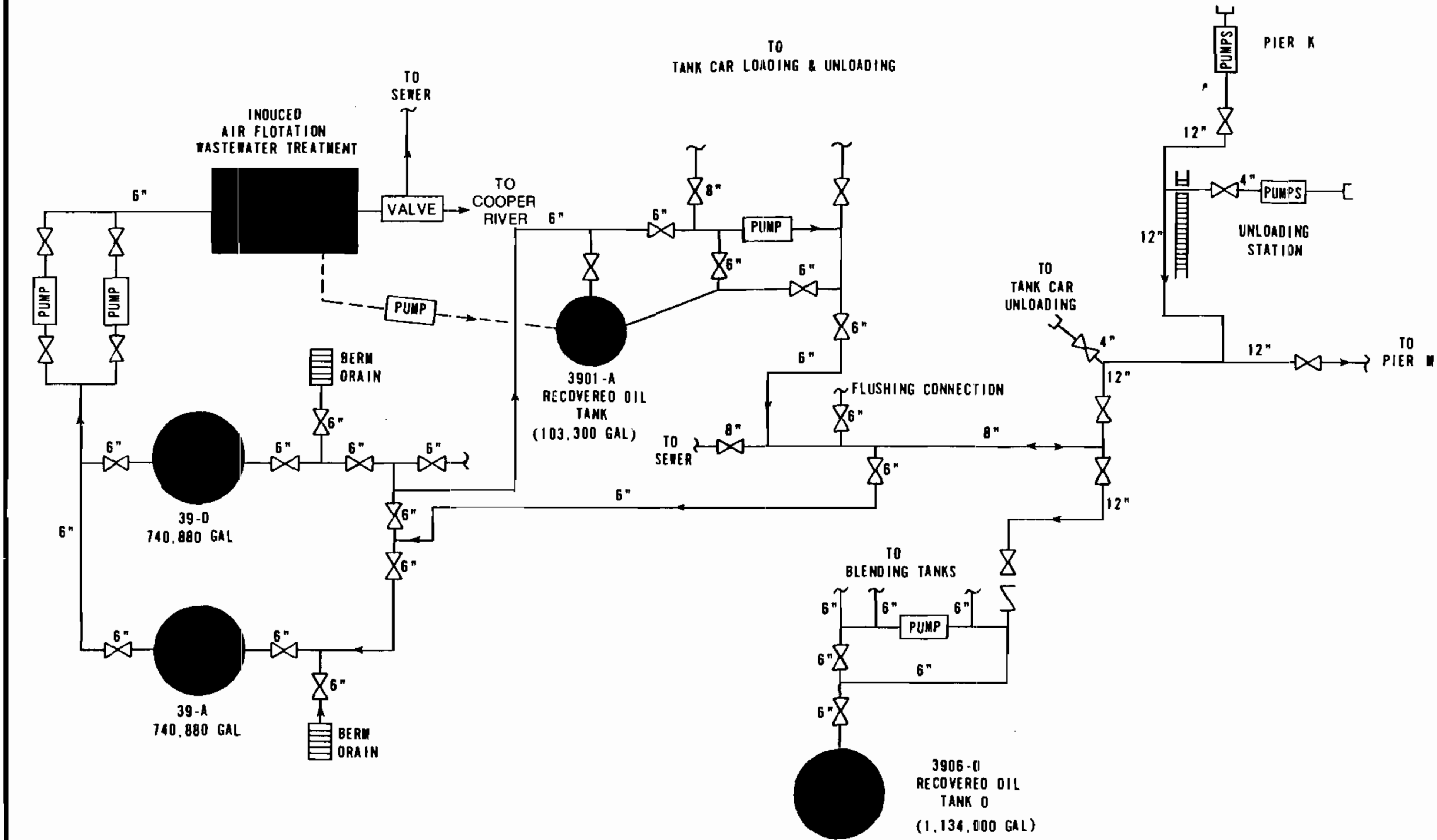
6.4.1.2.7 Oil Spills

Upon discovery of a spill entering a sewer or flowing directly to the Cooper River, NAVSTA is alerted to dispatch oil sorbent/skimming equipment to the spill location. Oil recovered from any spill cleanup is transferred to pier K, where it is unloaded and pumped to the NSC waste oil reclamation facility.

6.4.1.3 Waste Oil Reclamation Facility

The NSC waste oil reclamation facility has been in operation since 1950. Figure 6.4-4 presents a schematic diagram of this facility. All waste oil unloaded either at pier K, the railroad tank car unloading facility, or at the tank truck unloading facility is pumped to the NSC waste oil reclamation facility. The waste oil first enters one of two 740,880-gallon storage tanks (tank 39A or 39D), where gravity oil-water separation occurs. Following gravity oil-water separation, the water phase is drawn off and pumped to the induced air flotation (IAF) unit for additional oil removal. A synthetic polymer coagulant may be manually added to the IAF unit influent to promote removal of emulsified oils. Although the discharge of the IAF unit effluent to the Cooper River is covered under the NAVBASE Charleston National Pollutant Discharge Elimination System (NPDES) permit, the effluent is currently discharged to the sanitary sewer. This disposal method is practiced because the NPDES maximum daily oil and grease limitation of 15 mg/l cannot be met; however, the oil and grease limitation of 100 mg/l for discharge to the North Charleston Sewer District can be met.

Oil which is separated by gravity separation in the two surge tanks is pumped to tank 3906-0 in the Chicora Tank Farm for storage. Oil removed in the IAF unit is pumped to a 103,300-gallon storage tank (tank 3901-A). Subnatant water from tank 3901-A is pumped back to one of the surge tanks for further processing. Supernatant oil from tank 3901-A is pumped to tank 3906-0 in the Chicora Tank Farm. The mixture of oil stored in tank 3906-0 is allowed to separate by gravity settling. Sampling and analysis of the resulting oil layers are conducted to determine the oil fraction acceptable for blending with NSFO. The total volume of waste oil treated by the NSC waste oil reclamation facility between June 1979 and May 1980 was 4.9 million gallons, and the total volume of oil reclaimed during this period was 1.2 million gallons (The Chester Engineers, 1981). It was reported that approximately 27,000 cubic feet of oily sludge, unacceptable for reuse, is currently stored in tank 3906-0. Methods for disposing of this oily sludge are currently being investigated by NSC. This sludge has been accumulating since 1971. Prior to 1971, oily sludge was stored in three unlined, excavated pits (site 3). These sludge pits are described in more detail in section 6.6.2.2. No additional oily sludge accumulations in POL storage tanks were reported.



SOURCE: The Chester Engineers, 1981.

Figure 6.4-4
SCHEMATIC DIAGRAM OF THE NSC WASTE OIL RECLAMATION FACILITY

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

6.4.1.4 POL Spills

It was reported that the only major oil spill occurring in the last 16 years at NSC POL storage facilities occurred in 1971, when oil overflowed the sludge pits during a period of heavy rainfall. This spill is described in more detail in section 6.6.2.2. No other major spills have occurred at NSC, and the tank inspection procedures described in the NSC SPCC plan are reportedly performed on a routine basis. All underground tanks and pipelines are pressure checked annually for leaks (Personal Communication, 1981). All NSC POL aboveground storage tanks with capacities equal to or greater than 660 gallons are bermed with earthen or concrete berms.

One potential problem area associated with NAVBASE Charleston POL storage facilities, other than the past waste oil sludge pits, is the railcar tank unloading area located on NSY-controlled property (POL transfer point, site 4), adjacent to the Base Tank Farm (figure 6.4-5). When holes for fence posts were being dug in this area earlier this year, seepage of oil into the holes occurred approximately 2 feet below the ground surface. Potential causes for this oil contamination include the frequent oil spillage in the railcar tank unloading area and past leakage from currently abandoned underground pipelines (Personal Communication, 1981).

Numerous small oil spills have been observed along the Cooper River shoreline at NAVBASE Charleston. These spills probably resulted from small quantities of POL entering the storm sewer system or from small quantities of POL being discharged directly into the river from dockside or from naval vessels.

An additional area which is potentially contaminated with waste oil is the former firefighting training pit (site 5), located near the southern end of NAVBASE Charleston (figure 6.4-5). The pit was in use from 1965 to 1971. Section 6.6.2.4 contains a more detailed description of the firefighting training pit.

6.4.2 Chemicals

Hazardous chemical items at NAVBASE Charleston are stored, handled, and disposed of by NSC, DPDO, and Public Works NSY.

6.4.2.1 Naval Supply Center

NSC stores, handles, and ultimately transfers for disposal many items used by NAVBASE Charleston and used aboard surface and subsurface naval vessels. The following discussion of NSC concerns only chemical items handled by NSC. A computerized listing of hazardous materials stored by NSC was recently compiled by NSC and is contained in a report by Williams-Russell and Assoc., Inc. (1980).

Excess chemicals (out-of-shelf date) generated by NSC are turned over to DPDO for disposal. DPDO recycles these within the

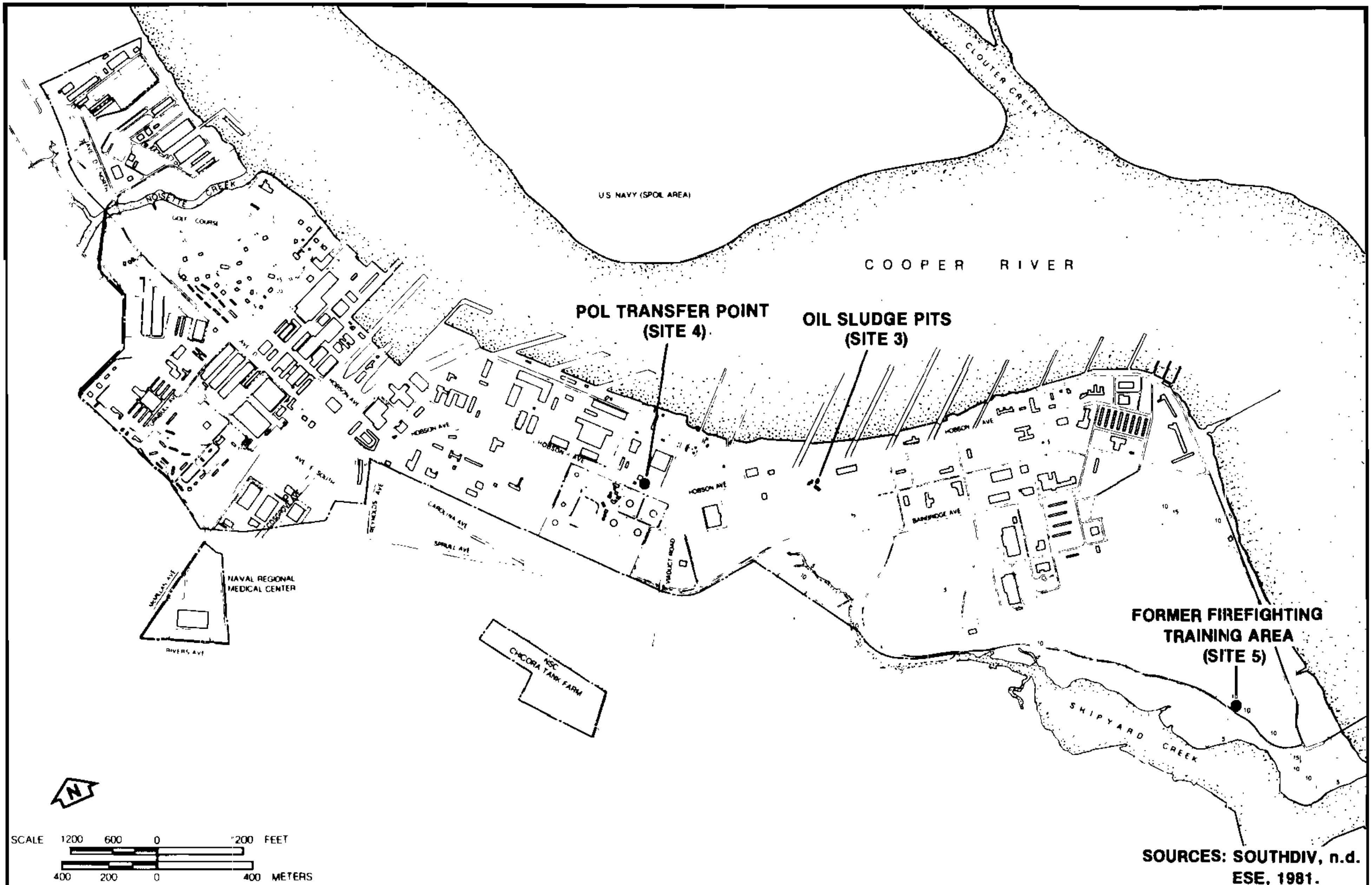


Figure 6.4-5
POL-CONTAMINATED AREAS

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

Department of Defense (DOD) or other Federal agencies, or they are taken by State agencies for use in school and university laboratories. These items also may be sold to chemical contractors for recovery. DPDO will not accept physical custody of certain "hazardous" materials for which NSC requests disposal. DPDO, however, accepts paper accountability and proceeds with processing the recycling or sale of these items as above, with NSC storing the item until transfer elsewhere.

Excess Nuclear Reactor Propulsion (NRP) program water chemicals generated by NSC will not be accepted (physically or paper accountability) by DPDO. These items have been stored by NSC in Bldgs. 1604 and 1605 for approximately the last 10 years. In the past year, these items (28,134 pounds, including over 13,300 pounds of hazardous chemicals) were demilitarized (i.e., labels were removed) by Public Works NSY and disposed of by a hazardous waste contractor (Groce Labs, Greer, S.C.). Prior to about 1971, no records exist on the disposal of these items. NSY began servicing nuclear vessels in 1962, at which time excess NRP water chemicals began accumulating. Considering solid waste disposal procedures practiced at NAVBASE Charleston (see section 6.6.2) prior to 1971, these items are believed to have been disposed of in the base sanitary landfill (site 1), which ceased operations in 1973.

Currently, excess NRP water chemicals are turned over to Public Works NSY for demilitarization and disposal by the hazardous waste contractor (Groce Labs, Greer, S.C.).

6.4.2.2 Defense Property Disposal Office

The DPDO located at NAVBASE Charleston receives excess property from NAVBASE Charleston, as well as from other DOD installations in the area. This property is then recycled within DOD, other Federal or State agencies, or contract sold to the highest bidder. The following discussion of DPDO concerns only the handling and disposal of excess chemicals.

PCBs contained in electrical equipment handled by DPDO are discussed in section 6.4.4.

Chemical items within DOD are categorized into three classes by DPDO: (1) those for which DPDO will take both paper accountability and physical custody, (2) those for which DPDO will take paper accountability but not physical custody, and (3) those for which DPDO will accept neither paper accountability nor physical custody.

Most items fall into the first category. These chemicals are then recycled within DOD or other Federal agencies or taken by State agencies for use in school or university laboratories. These items could also be sold to chemical contractors for recovery.

Chemicals in the second category are designated by DPDO as "hazardous" and will not be physically accepted by DPDO. DPDO does, however, accept paper accountability for these items and proceeds with processing, as described for category 1 chemicals above. These items are retained by the generator (e.g., NSC or Public Works NSY) until the paper work is completed by DPDO and the items are transported off NAVBASE Charleston.

Items in the third category include NRP water chemicals, classified chemicals, and radioactive substances. Disposal of NRP water chemicals is discussed in section 6.4.2.1. Handling, storage, and disposal of radioactive materials are addressed in section 6.4.8.

6.4.2.3 Public Works Naval Shipyard

Public Works NSY receives waste chemicals for storage and disposal from various generators at NAVBASE Charleston. As discussed above, NSC turns over excess NRP water chemicals to Public Works NSY for storage, demilitarization, and disposal by the Public Works NSY hazardous waste contractor (Groce Labs, Greer, S.C.). PCB-containing electrical items taken from service by Public Works NSY are stored by Public Works NSY in Bldgs. 3902 and 1069. Paper accountability for these items is with DPDO. PCBs are discussed in detail in section 6.4.4. Pesticide chemical storage and handling are also under the supervision of Public Works NSY, as discussed in section 6.4.3. Public Works NSY recently compiled a list of hazardous wastes on NAVBASE Charleston. Disposal of chemicals is by the hazardous waste contractor (Groce Labs, Greer, S.C.). PCB disposal will be by DLA, which manages the local DPDO.

6.4.3 Pesticides

Pesticides (insecticides, herbicides, fungicides, and rodenticides) have been and are currently being used throughout NAVBASE Charleston to maintain grounds and structures and to prevent pest-related health problems. Pest control services offered at NAVBASE Charleston include the following: (1) household, structural, health-related, and nuisance insect and rodent control programs; (2) weed control programs at security fences, parking areas, railroad tracks, and utility sites; and (3) programs involving turf areas (e.g., golf course) and ornamental trees and shrubs. The storage, mixing, and application of pesticides at NAVBASE Charleston are under the jurisdiction of shop 07 (maintenance) of the Public Works NSY.

All pesticide chemicals and application rates are recorded monthly on DOD form 1532. Records exist from 1966 to the present regarding pesticide usage. These are on file in the entomologist's office at SOUTHDIV. Examination of these forms over the period of record did not indicate excessive usage of pesticides at NAVBASE Charleston.

6.4.3.1 Storage

Insecticides and rodenticides are currently (since 1980) stored in the Pest Control Shop, Bldg. 381. This is a modern, steel building with a concrete floor. The building is equipped with a bermed storage area for these chemicals. Table 6.4-2 lists the insecticides and rodenticides currently stored in Bldg. 381. Herbicides are stored separately in Bldg. 1316, adjacent to Bldg. 381, which also has a concrete floor. The inventory of herbicides stored in Bldg. 1316 is also given in table 6.4-2. Prior to construction of Bldg. 381 in 1980, all pesticides were stored in Bldg. 42A, a wooden frame building with an unbermed concrete floor.

6.4.3.2 Mixing, Rinsing, and Disposal

Bldg. 381 is equipped with a modern formulation and mixing room. Sink and floor drains are connected to the sanitary sewer system. An equipment rinse area is provided at a wash rack adjacent to Bldg. 381. The wash rack is also connected to the sanitary sewer system. Prior to 1980, Bldgs. 42 and 42A were the Pest Control Shop. An area north of Bldg. 42 was used as a pesticide mixing and equipment rinse area until about 10 years ago. An area (approximately 20 square yards) at the site where mixing occurred and equipment was formerly rinsed (site 7) is devoid of vegetation (see figure 6.4-6). Approximately 10 years ago, operations were moved to the northeast corner of Bldg. 42A, upon completion of a project extending the waterline to this point outside the building. These operations ceased in 1980, when the Pest Control Shop was moved to Bldg. 381. Triple rinsing was required before pesticide container disposal and was done mainly inside Bldg. 42A throughout this time. The drain with this rinse water discharged directly to the ground next to Bldg. 42A. In the early 1970s, this drain was connected to the sanitary sewer.

Since the construction of the new Pest Control Shop, liquid wastes from rinsing, mixing, etc., have gone into the sanitary sewer system. Empty pesticide containers reportedly have always been rinsed, punched with holes, and disposed of as ordinary solid waste.

6.4.3.3 Soil Sampling

Sampling of the soils in the vicinity of Bldg. 42A was conducted by SOUTHDIV in 1977. The results of this sampling are given in table 6.4-3. As shown, two composite soil samples were taken and analyzed. One composite sample was taken at the former mixing discharge area in the immediate vicinity of Bldg. 42A, and the second composite sample was taken from a drainage ditch leading away from Bldg. 42A. The composite sample taken at the discharge area within 20 feet of Bldg. 42A showed detectable levels of the herbicide 2,4-D, as well as arsenic. The composite sample taken from the larger drainage ditch area (20 acres) around the old Pest Control Shop showed no detectable levels of pesticides. The area north of Bldg. 42 (site 7), which was used for equipment rinsing and which is now devoid of vegetation, was not included in the soil sampling.

Until the 1950s, herbicides containing arsenic (sodium arsenite) were in common use as weed killers along railroad tracks in

Table 6.4-2
Pesticides Stored in Bldgs. 381 and 1316 at NAVBASE Charleston

Item	Quantity
Insecticides (Bldg. 381)	
Carbaryl, 80 percent WP	20 lbs
Chlordane, 72 percent EC	50 gal
Diazinon, 2 percent DUST	75 lbs
Diazinon, 47.5 percent EC	3 gal
Dichlorvos, 5 percent	110 gal
Dimethoate (Cygon), 23.4 percent EC	5 gal
Dursban, 41.2 percent EC	5 gal
Malathion, 57 percent EC	15 gal
Malathion, 95 percent CONC	110 gal
Propoxur (Baygon), 2 percent BAIT	45 lbs
Propoxur (Baygon), 15.9 percent EC	14 gal
Pyrethrin, 6 percent	22 gal
Pyrethrin, 3 percent	160 gal
Pentokel	100 gal
Repellant, 71 percent (2-oz bottles)	240 bottles
Rodenticides (Bldg. 381)	
Anticoagulant, 5 percent BAIT	10 lbs
Anticoagulant, 3 percent BAIT	160 lbs
Calcium cyanide, 42 percent DUST	30 lbs
Zinc phosphide, 80 percent CONC	2 flasks
Herbicides (Bldg. 1316)	
Bromacil, 80 percent WP	75 lbs
Dalapon, 85 percent	510 lbs
Diquat, 35.3 percent EC	1 gal
Spike	8 lbs
2,4-D, 4 lb/gal	10 gal
2,4,5-T, 6 lb/gal	25 gal

Note: WP = Wettable powder.
lbs = pounds.
EC = Emulsifiable concentrate.
gal = gallons.
oz = ounce.
lb/gal = pounds per gallon.

Source: Personal Communication, 1981.

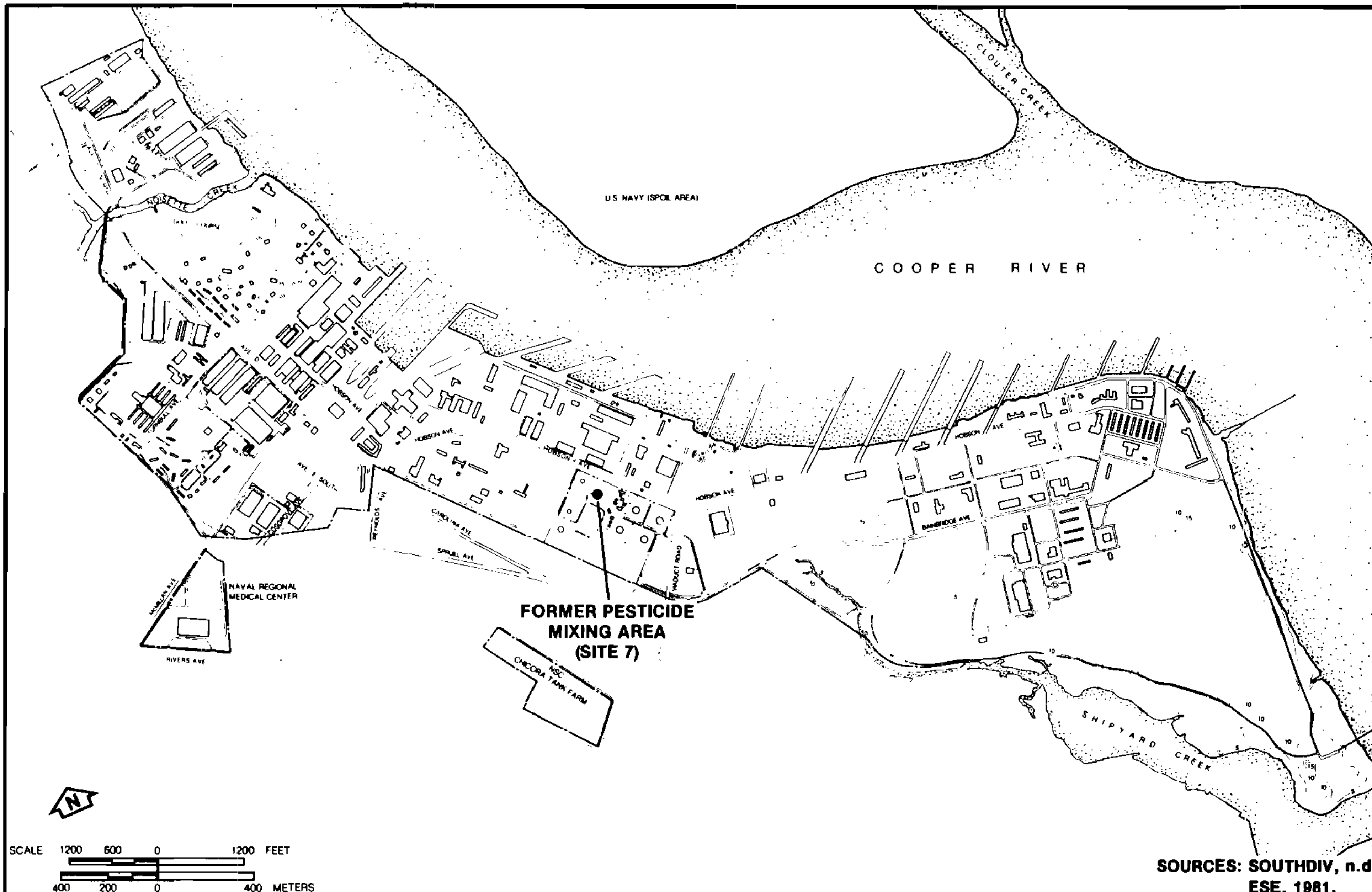


Figure 6.4-6
FORMER PESTICIDE MIXING AREA (SITE 7)

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Table 6.4-3
Results of Pesticide Sampling and Analysis in the Area of the Old Pest Control Shop (Bldgs. 42 and 42A)

Parameter	Charleston Naval Shipyard 31 Aug 1977, Station PS02 Composite Soil Sample Taken Within 20 Feet of Bldg. 42A (in mg/kg)	Charleston Naval Shipyard 31 Aug 1977, Station ST01 Composite Soil Sample Taken in Area of 20 Acres Adjacent to Bldgs. 42 and 42A (in mg/kg)
Chlorinated Hydrocarbons		
Aldrin	<0.002	<0.002
BHC	<0.002	<0.002
Lindane	<0.002	<0.002
Chlordane	<0.005	<0.005
DDT	<0.002	<0.002
DDE	<0.002	<0.002
Endrin	<0.002	<0.002
Heptachlor	<0.002	<0.002
Heptachlor Epoxide	<0.002	<0.002
Methoxychlor	<0.01	<0.01
Toxaphene	<0.01	<0.01
PCB	<0.1	<0.1
Organic Phosphates		
Diazinon	<0.01	<0.01
Malathion	<0.01	<0.01
Parathion	<0.01	<0.01
Thimet (Phorate)	<0.01	<0.01
Trithion	<0.01	<0.01
Chlorinated Phenoxy Herbicides		
2,4-D	0.19	<0.01
2,4,5-T	<0.01	<0.01
2,4,5-TP (Silvex)	<0.01	<0.01
Total Arsenic	33	<0.1

mg/kg = milligrams per kilogram.

Source: Personal Communication, 1981.

the United States. Use of sodium arsenite at NAVBASE Charleston began in 1926 and reportedly ended in the mid-1950s. Arsenic trioxide was reportedly applied at a rate of approximately 20 pounds per mile of track per year. It is expected that the soils near the older railroad rights-of-way would have elevated arsenic levels. Arsenic trioxide is not biodegradable.

6.4.4 Polychlorinated Biphenyls

Control of PCBs began in 1976, when Congress enacted the Toxic Substances Control Act (TOSCA). Section 6(e) of this law required EPA to establish rules to govern the manufacture, use, and disposal of PCBs.

Electrical equipment (transformers, rectifiers, capacitors) containing PCB (greater than 500 ppm) and PCB-contaminated (50 to 500 ppm) fluids have been used and are currently in use at NAVBASE Charleston.

6.4.4.1 In-Service Items

An inventory of in-service electrical items containing PCB fluids was recently (19 Jul 1981) completed by Public Works NSY. A total of 132 items was identified as containing PCBs. Total volume of PCB fluid was estimated at 32,415 gallons. It was reported that all in-service electrical items containing PCBs have been labelled according to EPA regulations (EPA, 1980c).

6.4.4.2 Out-of-Service Items

At the time of the site visit, 57 out-of-service electrical items containing PCB and PCB-contaminated fluids were being stored at NAVBASE Charleston. Table 6.4-4 lists these out-of-service items, their storage location, and PCB concentration. DPDO maintains paper accountability of all PCB electrical items but does not receive physical custody of these items because of the lack of a proper storage facility as required by EPA (1980c). Therefore, all out-of-service PCB items are currently stored by Public Works NSY. Rectifiers containing PCBs are stored in Bldg. 1069, while transformers and capacitors containing PCBs are stored in Bldg. 3902 in the "Old Corral" area. Both storage areas have concrete floors and are bermed.

Out-of-service electrical items containing PCBs have been stored awaiting disposal since about 1976. Currently, DLA is soliciting bids for disposal of these items at NAVBASE Charleston, as well as at other DOD installations.

Prior to 1976, unserviceable electrical items at NAVBASE Charleston were sold by DPDO as excess property to the highest bidder. The buyer of the item was required to transport the item off NAVBASE Charleston. If the buyer had use for the fluid, it usually remained in the electrical equipment and was transported off NAVBASE Charleston. If not (e.g., if the buyer wanted the copper coil in the equipment), the

Table 6.4-4
Inventory of Out-of-Service PCB Items on NAVBASE Charleston

Item	Serial Number	Location	Fluid Type	Fluid Amount (gal)	PCB Concentration (ppm)
1. Rectifier	3880-1	Bldg. 1069	Inerteen	70	>500
2. Rectifier	—	Bldg. 1069	Askerol	70	>500
3. Rectifier	D5154-AB	Bldg. 1069	Askerol	70	>500
4. Rectifier	05154-34A8	Bldg. 1069	Askerol	70	>500
5. Rectifier	—	Bldg. 1069	Askerol	70	>500
6. Rectifier	—	Bldg. 1069	Askerol	70	>500
7. Rectifier	—	Bldg. 1069	Askerol	70	>500
8. Rectifier	05154	Bldg. 1069	Askerol	70	>500
9. Rectifier	05154-27AB	Bldg. 1069	Askerol	70	>500
10. Rectifier	—	Bldg. 1069	Askerol	70	>500
11. Rectifier	3880-9	Bldg. 1069	Inerteen	70	>500
12. Rectifier	—	Bldg. 1069	Askerol	70	>500
13. Rectifier	—	Bldg. 1069	Inerteen	70	>500
14. Transformer	1003R*	Bldg. 1603	80 percent water and 20 percent ethylene glycol	—	>500
15. Transformer	—	Bldg. 3902	Oil	—	>500
16. Transformer	E959201-63P	Bldg. 3902	Oil	15	>500
17. Capacitor	L414021	Bldg. 3902	Oil	10	>500
18. Transformer	—	Bldg. 3902	Oil	—	>500
19. Transformer	6719458	Bldg. 3902	Oil	—	>500
20. Capacitor	L398350	Bldg. 3902	Oil	10	>500
21. Capacitor	L398350	Bldg. 3902	Oil	10	>500
22. Transformer	E687857	Bldg. 3902	Oil	92	>500
23. Transformer	RHA0040	Bldg. 3902	Oil	255	>500
24. Transformer	F12424763P	Bldg. 3902	Oil	310	>500
25. Transformer	31839	Bldg. 3902	Oil	147	>500
26. Transformer	E937127-63P	Bldg. 3902	Oil	—	75
27. Transformer	3100854	Bldg. 3902	Oil	—	301
28. Transformer	933926	Bldg. 3902	Oil	22	111
29. Transformer	384295	Bldg. 3902	Oil	—	112

Table 6.4-4
Inventory of Out-of-Service PCB Items on NAVBASE Charleston
(Continued, Page 2 of 2)

Item	Serial Number	Location	Fluid Type	Fluid Amount (gal)	PCB Concentration (ppm)
30. Transformer	310085	Bldg. 3902	Oil	—	>500
31. Transformer	933927	Bldg. 3902	Oil	32	217
32. Transformer	1747347	Bldg. 3902	Oil	110	414
33. Transformer	3100859	Bldg. 3902	Oil	—	157
34. Transformer	20216	Bldg. 3902	Oil	76	111
35. Transformer	20217	Bldg. 3902	Oil	76	77
36. Transformer	6972180	Bldg. 3902	Oil	18.5	59
37. Transformer	6652519	Bldg. 3902	Oil	—	77
38. Transformer	997619	Bldg. 3902	Oil	56	60
39. Transformer	297893	Bldg. 3902	Oil	—	206
40. Transformer	—	Bldg. 3902	Oil	—	112
41. Transformer	F630565-67P	Bldg. 3902	Oil	—	465
42. Transformer	D572603	Bldg. 3902	Oil	307	>500
43. Transformer	B980241	Bldg. 3902	Oil	375	>500
44. Transformer	437892B	Bldg. 3902	Oil	2	>500
45. Transformer	55J16864	Public Works NAVSTA	Oil	—	87
46. Transformer	RBJ8184	Public Works NAVSTA	Oil	229	>500
47. Transformer	75M115022	Public Works NAVSTA	Oil	—	94
48. Transformer	G856254	Public Works NAVSTA	Oil	110	>500
49. Transformer	69B7739	Public Works NAVSTA	Oil	—	111
50. Transformer	34428	Public Works NAVSTA	Oil	17	180
51. Transformer	34430	Public Works NAVSTA	Oil	17	493
52. Transformer	D322282-59P	Public Works NAVSTA	Oil	—	105
53. Transformer	D381102-59P	Public Works NAVSTA	Oil	—	88
54. Transformer	D362079-59P	Public Works NAVSTA	Oil	—	77
55. Containers	Stock No. 915000 PCB Liquid	Bldg. 3902	Oil	25	>500
56. Containers	Stock No. 915001 PCB Liquid	Bldg. 3902	Oil	3	>500
57. Transformer	6961517	Bldg. 3902	Oil	33	446

* Disposal action currently in process.

-- = Not available.

Source: Personal Communication, 1981.

fluid was drained to reduce the weight of the item. The area around the concrete pad (Bldg. 3902) in the "Old Corral" area (site 6) showed evidence of past oil spills reportedly from the draining of the fluids from electrical equipment (see figure 6.4-7). Due to the intermittent drainage of fluids as discussed above and the unknown concentrations of PCBs, it is not possible to estimate the total amount of PCBs potentially released to the soils in this area. Concurrent with the IAS site visit, Public Works NSY sampled soils from four visibly stained areas adjacent to the concrete pad and subsequently analyzed the soils for PCBs. The analysis (table 6.4-5) did not detect PCBs in these soils at levels that would define them as PCB-contaminated. All levels were below 50 ppm.

6.4.5 Waste Paint and Solvent Storage

About 226 tons of paint wastes and solvents is currently generated on an annual basis (Williams-Russell and Assoc., Inc., 1980). These wastes were stored on an uncovered concrete pad measuring 20 feet wide by 180 feet long, located near Bldg. 223, and adjacent to the Cooper River (see figure 6.4-8). This pad has been in use since 1973.

The paint waste storage area is operated by Public Works NSY. It was reported that the construction of a new storage facility is currently being evaluated by the Environmental Engineering Division of Public Works NSY and SOUTHDIV.

6.4.6 Coal Storage

Since the mid-1940s, the coal for the steam generation plant (Bldg. 32) has been stored on NSC property in the northwest corner of the base (see figure 6.4-9). Although the coal pile is located on NSC-controlled real estate, the coal is the property of NSY. The coal pile, adjacent to the rail supply tracks, is approximately 80 feet wide by 400 feet long.

There are no water quality or sediment data available for Noisette Creek, and no water quality data are available for the Cooper River near the mouth of Noisette Creek. The heavy metals content of sediments in the Cooper River near the mouth of Noisette Creek is not significantly different from those of other locations on the Cooper River (see section 6.7.1).

6.4.7 Firing Ranges and Ordnance

Two firing ranges are located in the south-central area of NAVBASE Charleston (figure 6.4-10). The skeet range, located east of Bldg. 675 (Dental Clinic), consists of the skeet range office (Bldg. 1887) and extensive grasslands. All gauge shotguns are fired, and the field of fire extends southward over grasslands and old spoil areas. The outdoor pistol range is located due east of the skeet range,

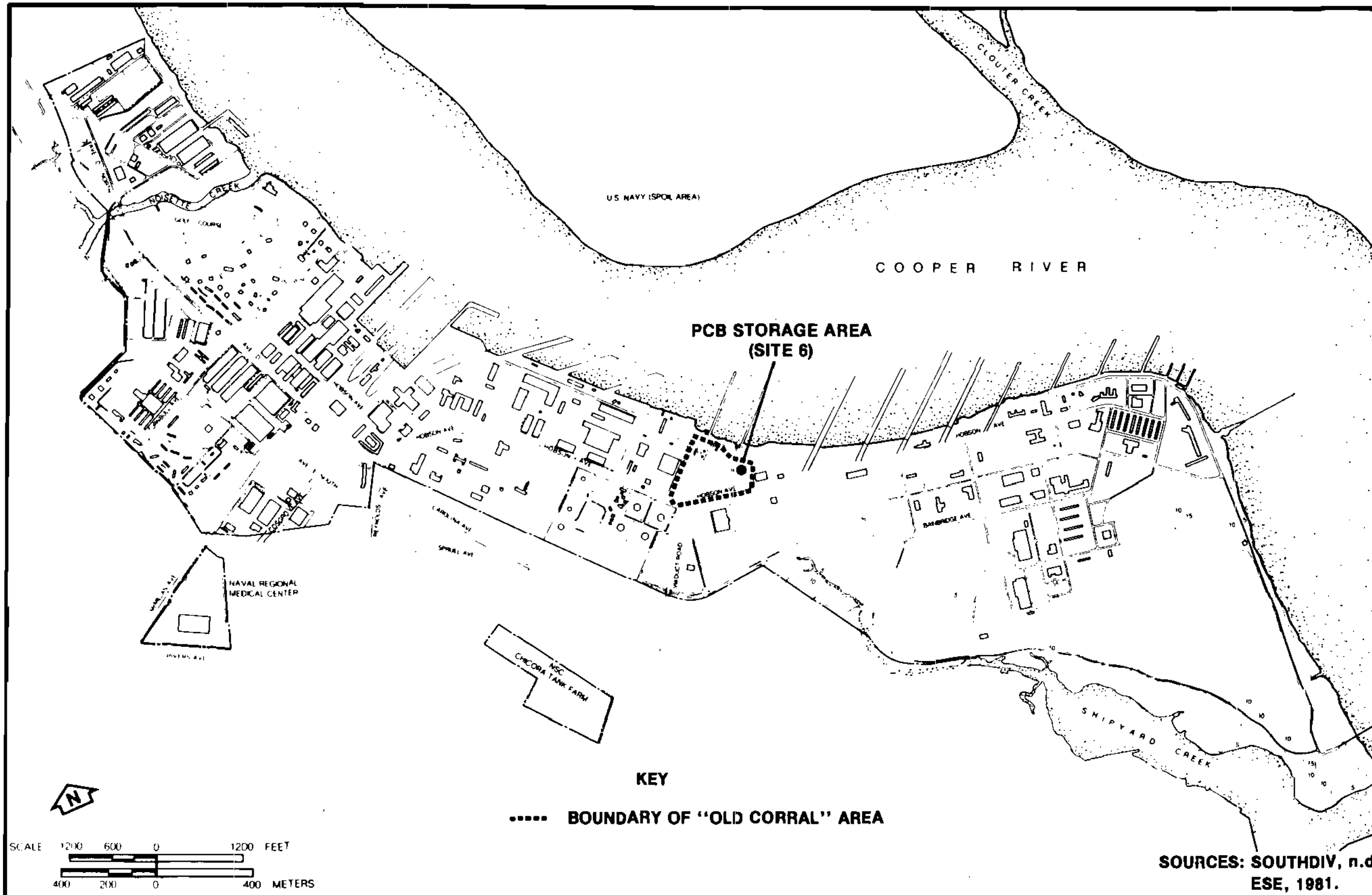

Figure 6.4-7
PCB STORAGE AREA (SITE 6)

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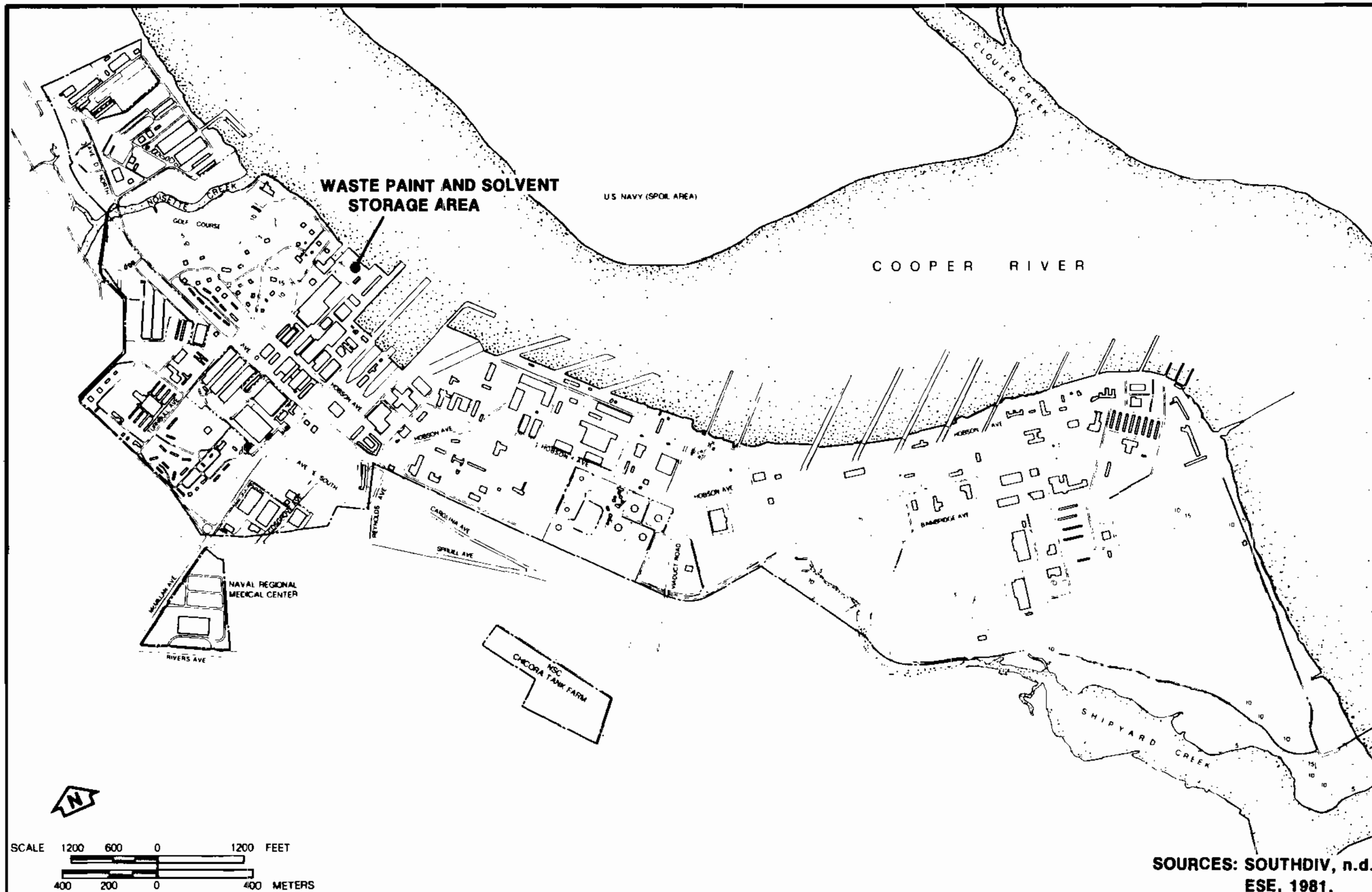
NAVAL BASE CHARLESTON

Table 6.4-5
Results of the Public Works NSY PCB Analysis

Parameter	Sample 1 Taken Within 10 Feet of Bldg. 3902 and 1 Foot from the Slab (4 Inches Deep)	Sample 2 Taken 12 Feet from Sample 1, 5 Feet from the Slab (2 to 4 Inches Deep)	Sample 3 Taken 10 Feet from the Corner of Bldg. 3902, 1 Foot from the Slab (2 to 4 Inches Deep)	Sample 4 Taken 12 Feet from Sample 3, 1 Foot from the Slab (2 to 4 Inches Deep)
Arochlor 1260	0.8 ppm	2.8 ppm	0.9 ppm	35.0 ppm

Source: NSY, 1981.



SOURCES: SOUTHDIV, n.d.
ESE, 1981.

Figure 6.4-8
WASTE PAINT AND SOLVENT STORAGE AREA

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NAVAL BASE CHARLESTON

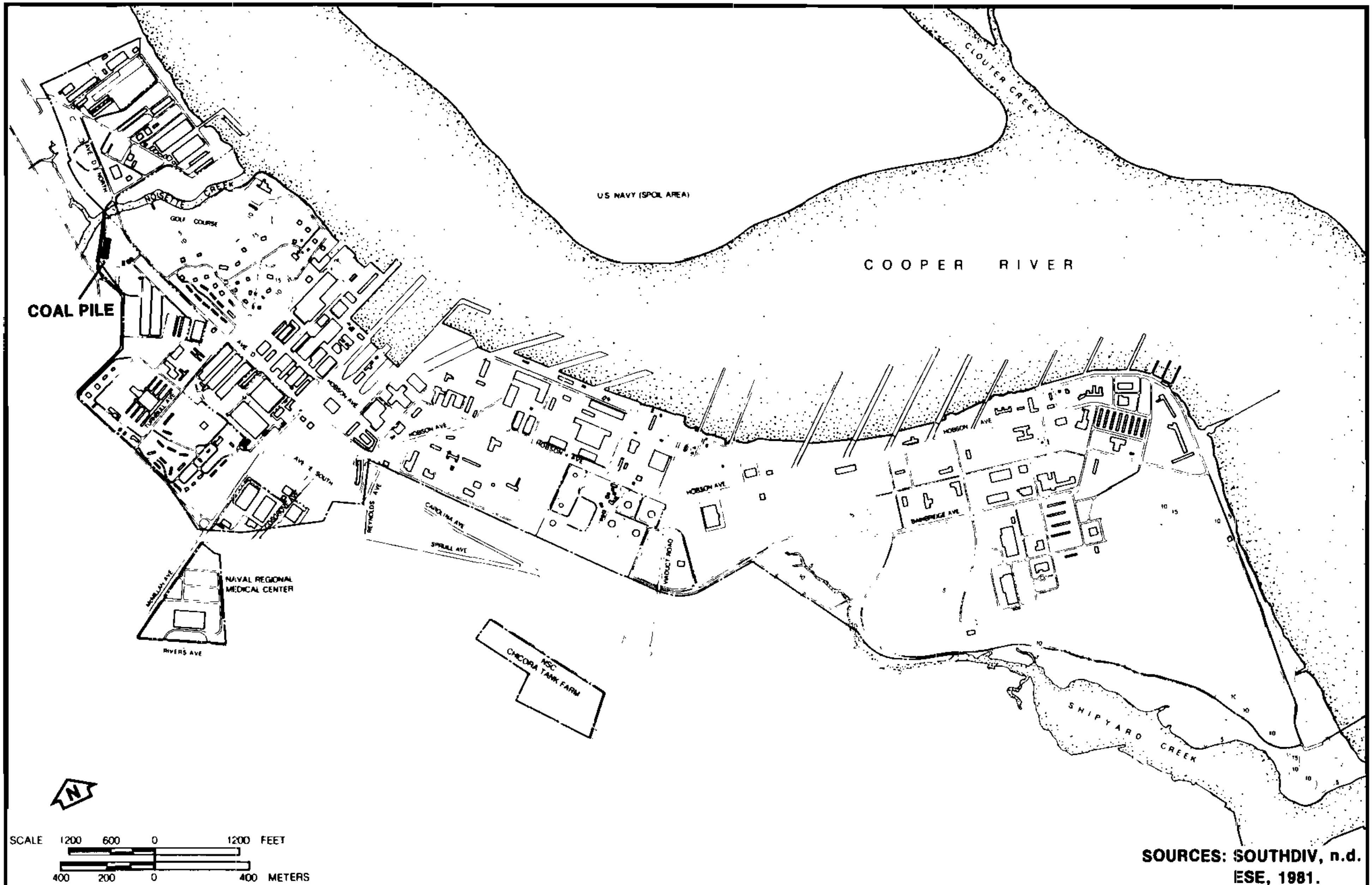

Figure 6.4-9
LOCATION OF THE NSY COAL PILE

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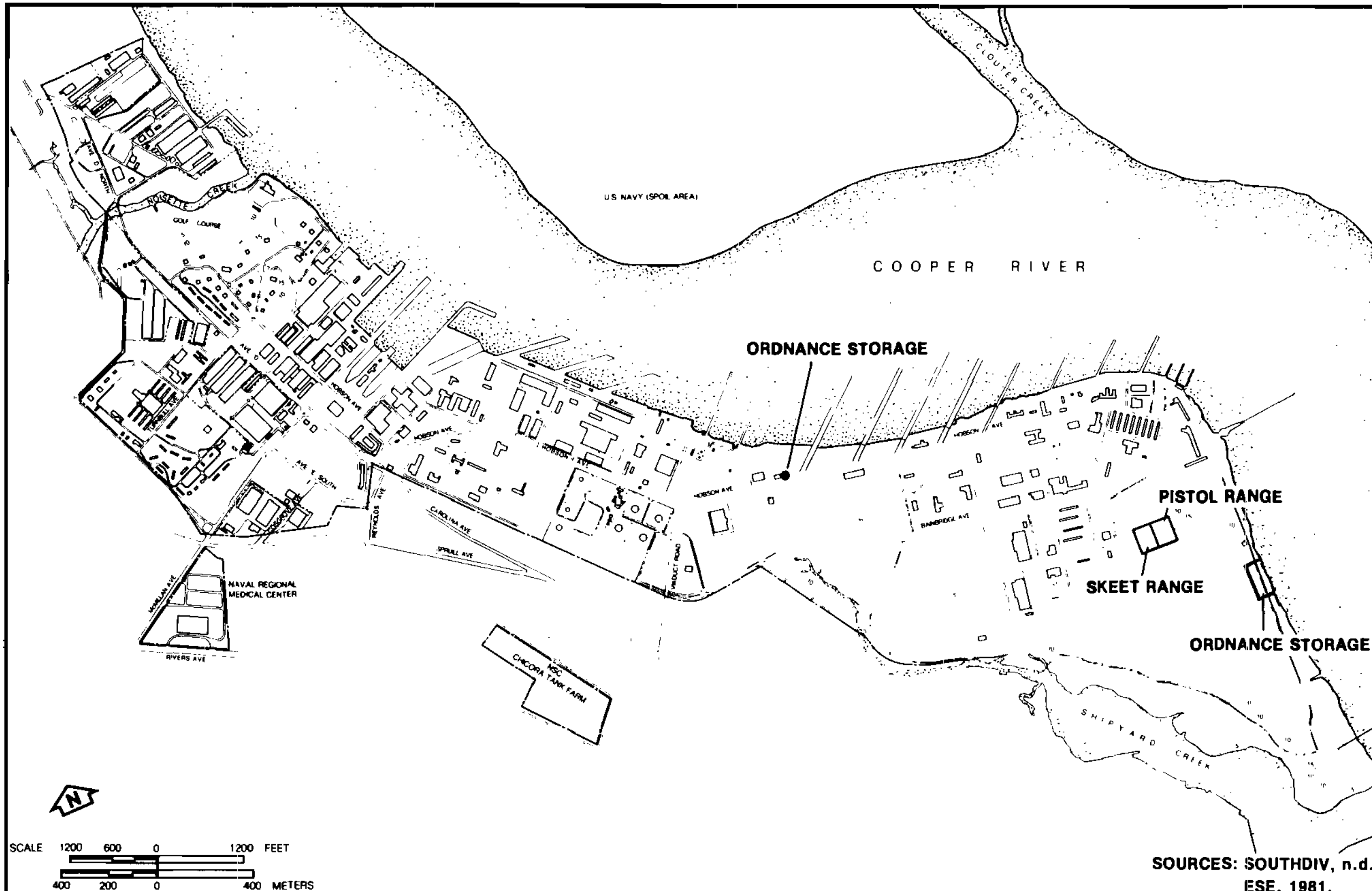


Figure 6.4-10
FIRING RANGES AND ORDNANCE STORAGE AREAS ON NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

next to Bldg. NS-22. The field of fire extends southward into an earth backstop and is separated from the adjoining skeet areas by a steel-plated wall.

Small arms up to and including 7.62-millimeter (mm) and 12-gauge shotguns are fired at the pistol range. Calibers fired include .22, .32, .38, .45, 5.56 (M-16), and 7.62 (M-14, M-60). The pistol range is currently closed.

Conventional ordnance stored at NAVBASE Charleston includes small arms ammunition (12-gauge through 50-caliber), 40-mm solutions charges, some high explosives (HE) fuzes, and mines and torpedoes without HE. HE fuzes are stored in magazine 56, saluting charges and small arms ammunition in magazine 55. Inert torpedoes, containing no HE charges, are stored in Bldg. 132. Mine assembly and storage are performed at FMWTC.

No explosive ordnance disposal (EOD) is performed at NAVBASE Charleston. In the past, limited EOD actions involving black powder projectiles from the Civil War reportedly were performed on the Clouter Creek spoil area across the Cooper River. Three former ordnance storage buildings are located on Daniel Island, east of pier G. These facilities are no longer in use. Two areas in the Cooper River are identified on a map of the base as locations where depth bombs and torpedoes (two each) were dropped during World War II.

Ordnance operations at NAVBASE Charleston consist of limited receiving and transferring munitions to NWS, north of NAVBASE Charleston. NWS (the former Naval Ammunition Depot) provides the material support for assigned weapons and weapons systems, including the support of fleet and shore activities with guided missiles and conventional ammunition (NWS, 1977). The handling and transfer of munitions at NAVBASE Charleston result in Explosive Safety Quantity Distance (ESQD) arcs, which extend across the Cooper River (SOUTHDIV, 1978).

6.4.8 Radiological Materials

A review of operations at the time of the study and historical documents made available to NEESA indicate that the use, handling, storage, and disposal of radioactive materials at NAVBASE Charleston were being conducted in accordance with Federal regulations and presented no known hazard to personnel or the environment (NEESA RASO, 1979a and 1979b). A review of operations dealing with NAVSEA, Code 08, operations were outside the scope of this document.

6.5 TRAINING OPERATIONS

The primary mission of NAVBASE Charleston is to provide supply and support services to fleet units (surface and submarine); logistic support for operating forces of the Navy; and shore activities, as assigned. As a result, training activities at NAVBASE Charleston are limited to:

1. FBMSTC,

2. FMWTC, and

3. NRC.

6.5.1 Fleet Ballistic Missile Submarine Training Center

FBMSTC is charged with training FBM submarine personnel to operate FBM submarines and associated weapons systems. FBMSTC is located on the southeastern portion of NAVBASE Charleston in Bldg. FBM-61 (figure 5.1-3); an operational trainer facility will be located in Bldg. P-114.

Training takes place in classrooms, laboratories, and actual FBM submarine equipment and includes training in navigation, weapons, engineering, operations, and submarine tactics. Wastes generated by FBMSTC are listed in section 6.1.6.

6.5.2 Fleet and Mine Warfare Training Center

FMWTC is comprised of the former Naval Schools of Mine Warfare and the Carner Fleet Training Center. It provides general shipboard training as well as specialized training in mine warfare. FMWTC also operates a firefighting training school and a laboratory for testing boiler waters. Wastes generated by FMWTC and waste handling are discussed in section 6.1.5.

FMWTC is located in the southeastern portion of NAVBASE Charleston (figure 5.1-3). Training and instruction buildings include Bldgs. 202, 643, and 647; mock-up structures are located in area K-18.

6.5.3 Naval Reserve Center

FBMSTC, FMWTC, and NRC conduct training activities at NAVBASE Charleston; no other troop training is performed. NRC is located on the southeastern portion of NAVBASE Charleston in Bldgs. RTC1 and 206. NRC provides recruiting and training facilities for naval reserve personnel along with Destroyer Squadron 34.

6.6 WASTE TREATMENT AND DISPOSAL

6.6.1 Liquid Waste Treatment and Disposal

During the development of NAVBASE Charleston from 1901 to 1972, the sanitary, stormwater, and industrial sewer systems were established as a combined wastewater system. The final discharge points for this system were the many outfalls along the Cooper River.

6.6.1.1 Sanitary Wastewater

With the installation of a separate sanitary sewer system in 1972, sanitary and industrial discharges were separated from the combined system (see figure 6.6-1). The effluent from this separate system was discharged to NCCPSD rather than to the Cooper River. A number of changes to the sanitary sewer system have occurred since its installation. In 1974 and 1976, repairs and alterations included the connection of existing buildings to the sanitary system and the installation of oil-water separators and acid neutralization facilities to pretreat industrial wastewater prior to discharge to the sanitary sewer system.

In 1975, the sanitary sewer connections were installed on the piers for use by docked ships. Improvements to this system were made in 1978. Some ships were not capable of using the dock system because their onboard sanitary system was not compatible with the dock system. Modifications to the collection system and to the ships using the system have remedied this condition.

Some overboard discharge of sanitary wastewater by docked ships occurred until April 1981, when Federal law prohibited such discharges.

NCCPSD requires quarterly monitoring of effluent (North Charleston Sewer District, 1972) from NAVBASE Charleston, and NAVBASE Charleston is currently in compliance with NCCPSD requirements [SOUTHDIV Regional Environmental Support Office (RESO), 1981].

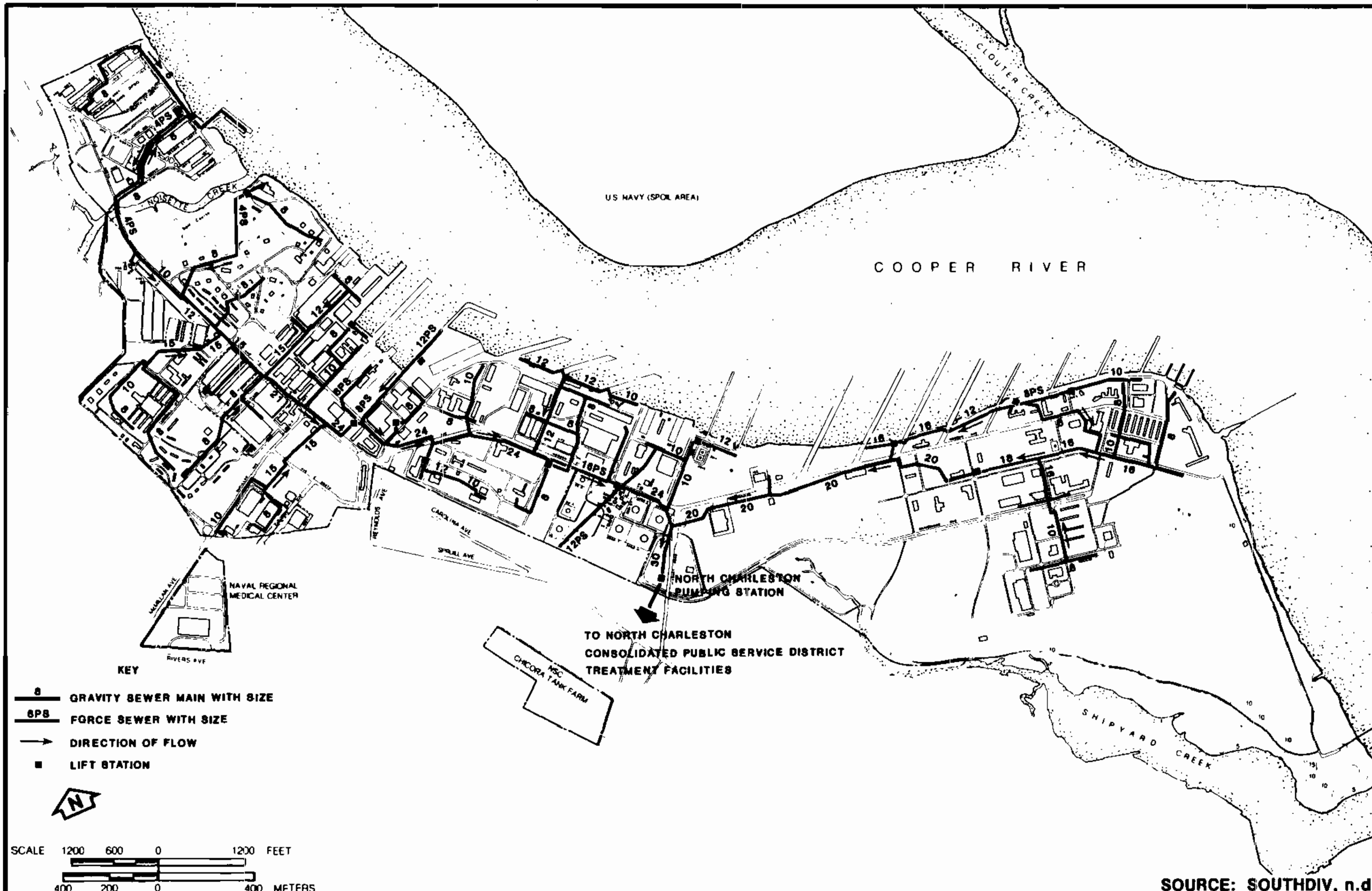
6.6.1.2 Stormwater Drainage

No single collection system exists for the disposal of stormwater runoff. Numerous local systems of inlets and pipes carry runoff by gravity to the nearest natural drainage channels or waterways. The northern NSC area has eight outfalls to the Cooper River and two to Noisette Creek. The developed portion in the center of NAVBASE Charleston is drained to the Cooper River through a variety of piping and area drainage. Developed portions of NAVSTA at the southern end of NAVBASE Charleston drain the stormwater runoff to the Cooper River. Undeveloped areas of NAVSTA are drained by surface flow to either the Cooper River or Shipyard Creek, depending on the drainage patterns of the area.

Stormwater discharges are permitted under NPDES permit SC 0003816. A map of the stormwater drainage system is shown in figure 6.6-2.

6.6.1.3 Industrial Wastewater

As discussed earlier in this section, prior to 1972, a combined wastewater collection system conveyed all wastewaters generated at NAVBASE Charleston, including industrial wastewater, to the Cooper River. Limited industrial wastewater pretreatment was practiced prior



SOURCE: SOUTHDIV, n.d.

Figure 6.6-1
SANITARY SEWER SYSTEM OF NAVBASE CHARLESTON

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NAVAL BASE CHARLESTON

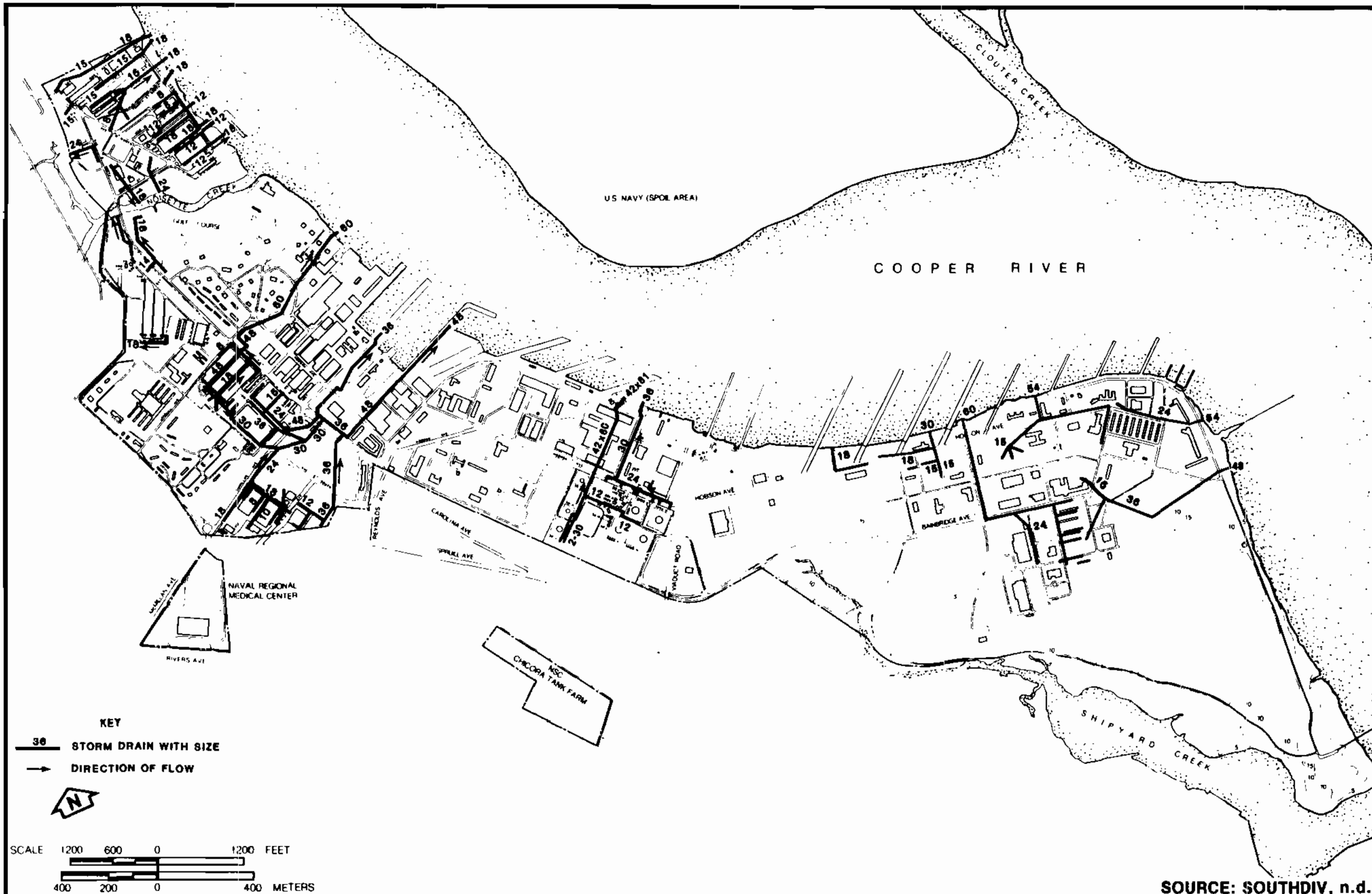


Figure 6.6-2
STORMWATER DRAINAGE SYSTEM OF NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

to 1972. Since 1972, industrial wastewater treatment and disposal have consisted of pretreatment and discharge to the sanitary sewer system, which conveys industrial and sanitary wastewaters to the NCCPSD. Several direct discharging operations, such as vehicle maintenance and cleaning and blowdown from the space heating boiler, are permitted to discharge to the Cooper River under NPDES permit No. SC 0003816.

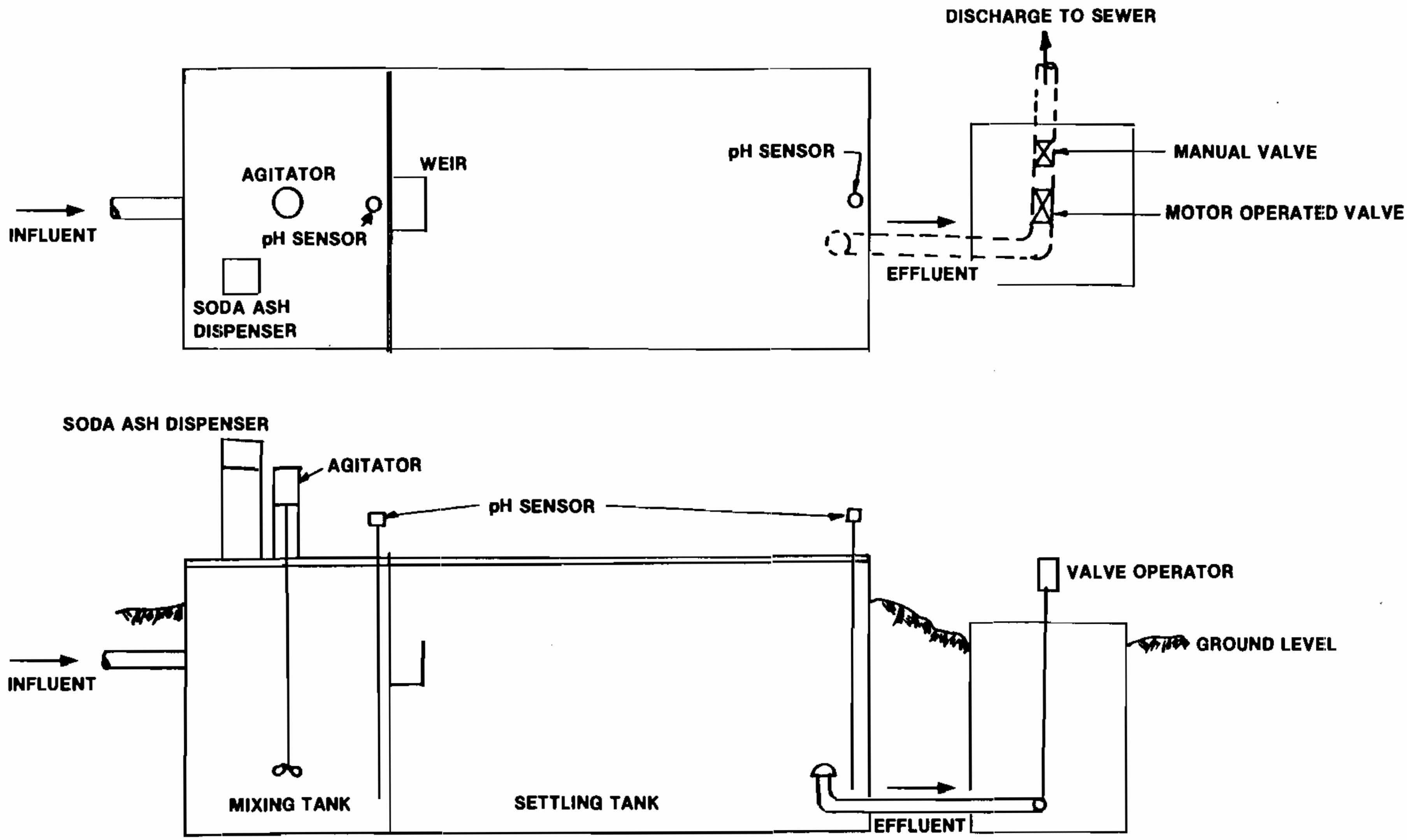
Pretreatment methods include gravity oil-water separation, acid neutralization, or metals removal. Many of the oil-water separators were installed in 1974 and 1976 during alterations made to the sanitary sewer system because of oil contamination problems at the municipal treatment plant. Twelve oil-water separators are currently used in areas where the industrial operations may introduce petroleum products to the sanitary sewers. Each oil-water separator has a holding tank for the oily fraction. This tank is pumped out periodically on an "as needed" basis, and the waste oil is transported to the NSC waste oil reclamation facility.

6.6.1.4 Acid Neutralization

As discussed in section 6.1.1.6, acidic wastewater generated by the battery salvaging and restoring and recharging operations is collected and neutralized prior to being discharged to the sanitary sewer. A sketch of the acid neutralization facility, which is located adjacent to drydock No. 4, is presented in figure 6.6-3. As shown in this figure, the acid neutralization facility consists of a concrete underground tank with two compartments. The first compartment serves as a holding and mixing tank. Acidic wastewater from the battery salvaging operation drains by gravity to the first compartment, and wastewater from the battery restoring and recharging operation is pumped to the first compartment from a sump located in Bldg. 68. When a sufficient volume of wastewater collects in the first compartment, the mechanical agitator is activated, and soda ash is added to adjust the pH to approximately 6.5. Following pH adjustment, the wastewater is transferred to the second compartment, which serves as a settling tank. The suspended material in the wastewater is allowed to settle for about 4 hours, then the clarified wastewater is discharged to the sanitary sewer. Approximately 3,000 gallons of wastewater is treated annually in the acid neutralization facility, and approximately 200 gallons of sludge is removed from both compartments of the facility approximately once every 6 months. The sludge is contract hauled offbase by an EPA-approved contractor (Personal Communication, 1981; Williams-Russell and Assoc., Inc., 1980).

6.6.1.5 Metal Plating Waste Treatment

As discussed in section 6.1.1.8, non-cyanide-bearing rinsewater from the electroplating operation is collected and treated for metals removal prior to being discharged to the sanitary sewer. Cyanide-bearing rinsewater is also collected; however, no pretreatment is provided for this waste stream prior to being discharged to the sanitary sewer. The non-cyanide-bearing rinsewater is generally acidic, and the



SOURCES: Williams-Russell and Assoc., Inc., 1980.
ESE, 1981.

Figure 6.6-3
ACID NEUTRALIZATION FACILITY

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

principal pollutant is chromium; therefore, NAVBASE Charleston personnel refer to the wastewater as chromic acid wastewater.

Figure 6.6-4 presents a sketch of the metal plating waste treatment facility, located between Bldgs. 44 and 5. The treatment facility consists of two underground concrete holding tanks, one for the chromic acid wastewater and one for the cyanide wastewater, and a clarifier. The chromic acid wastewater drains to the chromic acid holding tank, which has a working capacity of 1,200 gallons. Approximately once every 2 weeks, the chromic acid holding tank becomes full, at which time the wastewater is pumped from the holding tank to the clarifier. After pumping the wastewater to the clarifier, soda ash is added and manually mixed with the wastewater to adjust the pH to approximately 8.5 to chemically precipitate chromium and other metals. Following pH adjustment, the suspended material in the wastewater is allowed to settle for approximately 48 hours and then the clarified wastewater is discharged to the sanitary sewer. Sludge accumulating in the bottom of the clarifier is removed. The sludge generated from 1972, when the metals removal pretreatment system was installed, until 1973 was disposed of in the base sanitary landfill (site 1). Since 1973, the sludge has been contract hauled offbase. Approximately 31,200 gallons of chromic acid wastewater is treated annually in the metal waste treatment facility, and approximately 6,500 gallons of sludge is removed from the facility per year.

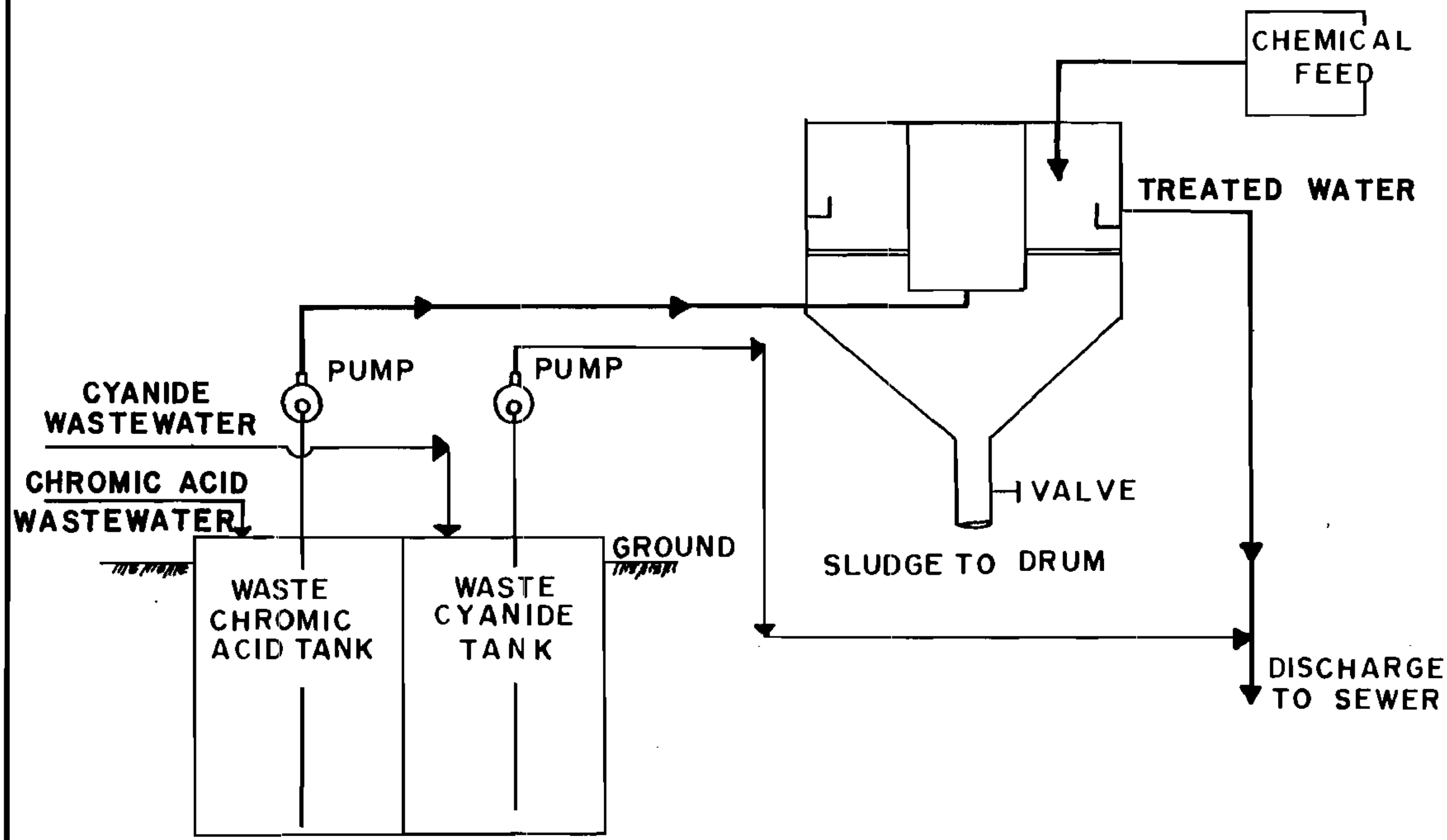
The cyanide wastewater drains to the cyanide waste holding tank, which also has a working capacity of 1,200 gallons. When the holding tank becomes full, the cyanide wastewater is pumped directly to the sanitary sewer. The rate of discharge of cyanide wastewater to the holding tank is extremely variable, such that pumping of the wastewater to the sewer is not performed on a regular basis but rather on an "as-needed" basis. Due to the variability of the cyanide wastewater discharge, the volume of wastewater discharged annually is unknown. However, the cyanide wastewater discharge is known to be less than the annual chromic acid wastewater discharge of 31,200 gallons.

6.6.2 Solid Waste Disposal

6.6.2.1 Base Sanitary Landfill (Site 1)

Most solid wastes currently generated at NAVBASE Charleston are hauled offbase. A small amount of bottom ash from the coal-fired power plant is retained and spread on roads to enhance traction.

Prior to 1973, all solid waste reportedly was disposed of onsite in a landfill. Wastes included household garbage, asbestos, drummed industrial liquid wastes, waste solvents, waste paints, paint sludge, PCBs, metal sludge, acid neutralization sludge, mercury, and other waste chemicals. Most wastes from the industrial shops in NSY were disposed of in the landfill. Table 6.6-1 lists industrial wastes reportedly landfilled. The landfill was operated as an area fill (i.e.,



SOURCES: Williams-Russell and Assoc., Inc., 1980.
ESE, 1981.

Figure 6.6-4
METAL PLATING WASTE TREATMENT FACILITY

Table 6.6-1
Industrial Wastes Disposed of in the Base Sanitary Landfill (Site 1)

Waste	Origin	Current Annual Generation Rate	Years of Disposal
Asbestos	Boiler Shop	1,000 lbs	70
Asbestos	SIMA	2 yds^3	15
Varnish Sludge	Electrical Shop	300 gal	70
Mercury	Electrical Shop	25 lbs	70
Acid Neutralization Sludge	Electrical Shop	400 gal	70
Paint Sludge	Electronics Shop	200 gal	70
Metal Sludge	Machine Shop 31	50,000 lbs	70
PCB Fluids	Central Tool Shop	None	40
Paint Wastes	Paint Shop	226 tons	70
Toxic NRP Water Chemicals	NSC	1,330 lbs	10

yds^3 = cubic yards.

Source: ESE, 1981.

no trenches were dug), and, to reduce the volume, most wastes were burned. The landfill site is located along the western edge of NAVBASE Charleston, south of Viaduct Rd. (see figure 6.6-5). Before landfilling, this area was a tidal marsh bordering Shipyard Creek. Wastes were deposited directly into the marsh and were often flooded by high tides. Materials which would not burn (such as concrete rubble, drums, and metal scrap) were placed on the leading edge of the fill, sometimes in the tidal waters. Combustible waste materials were burned daily, and the burned residue was pushed into the marsh with a bulldozer. Cover material was applied on an irregular, "as-available" basis. Soils from onsite building excavations, spoil dredged from the river, and bottom ash from the power plant were all used as cover material. Landfilling in this area began in the 1930s and continued until 1973.

In the past, boiler rebuilding operations ("rip-out" operations) (see section 6.1.1.4) resulted in a mixture of firebrick and asbestos, which was placed in a trash receptacle and taken to the base landfill. Around 1968, a special procedure involving double bagging of asbestos material was instituted in an attempt to control the disposal of asbestos. The asbestos continued to be disposed of in the base landfill until it was closed in 1973. Currently, special handling procedures are required, and the asbestos is disposed of by an EPA-approved contractor.

The landfill was cited by EPA and the State of South Carolina in 1970 for placement of wastes in tidal waters and for insufficient cover. After final closure, 2 feet of soil cover was applied to the entire fill area.

6.6.2.2 Oil Sludge Pits (Site 3)

From 1944 to 1971, waste oil and sludge from NAVBASE Charleston and from ships in port were disposed of in three unlined pits, which can be located in historical aerial photographs (see figure 6.6-6). These aerial photographs are available through NEESA or the Cartographic Branch of the National Archives (see section 1.3 for a complete address). By 1956, two of the three pits had been covered. There are no records to indicate that oil was removed from these pits prior to the application of a cover. The rectangular oil sludge pit was in regular use between 1944 and 1971 and was permanently closed in 1974. From 1971 to 1974, the rectangular pit remained open but was no longer used for the disposal of oil and sludge. In 1974, the rectangular pit was pumped out and filled with clean, compacted fill. The sludge pumped from the pit was sold to a recycler.

Periodically, heavy rains would cause the oil pits to overflow. No catchment berms were provided to contain spills. Oil generally ran to the west into the marsh/landfill area during these spills. One such spill is evident in an aerial photograph from 1951. During the 1950s, the spills were localized to the area around the pit due to landfilling operations in the adjacent marsh. Another large spill was reported to

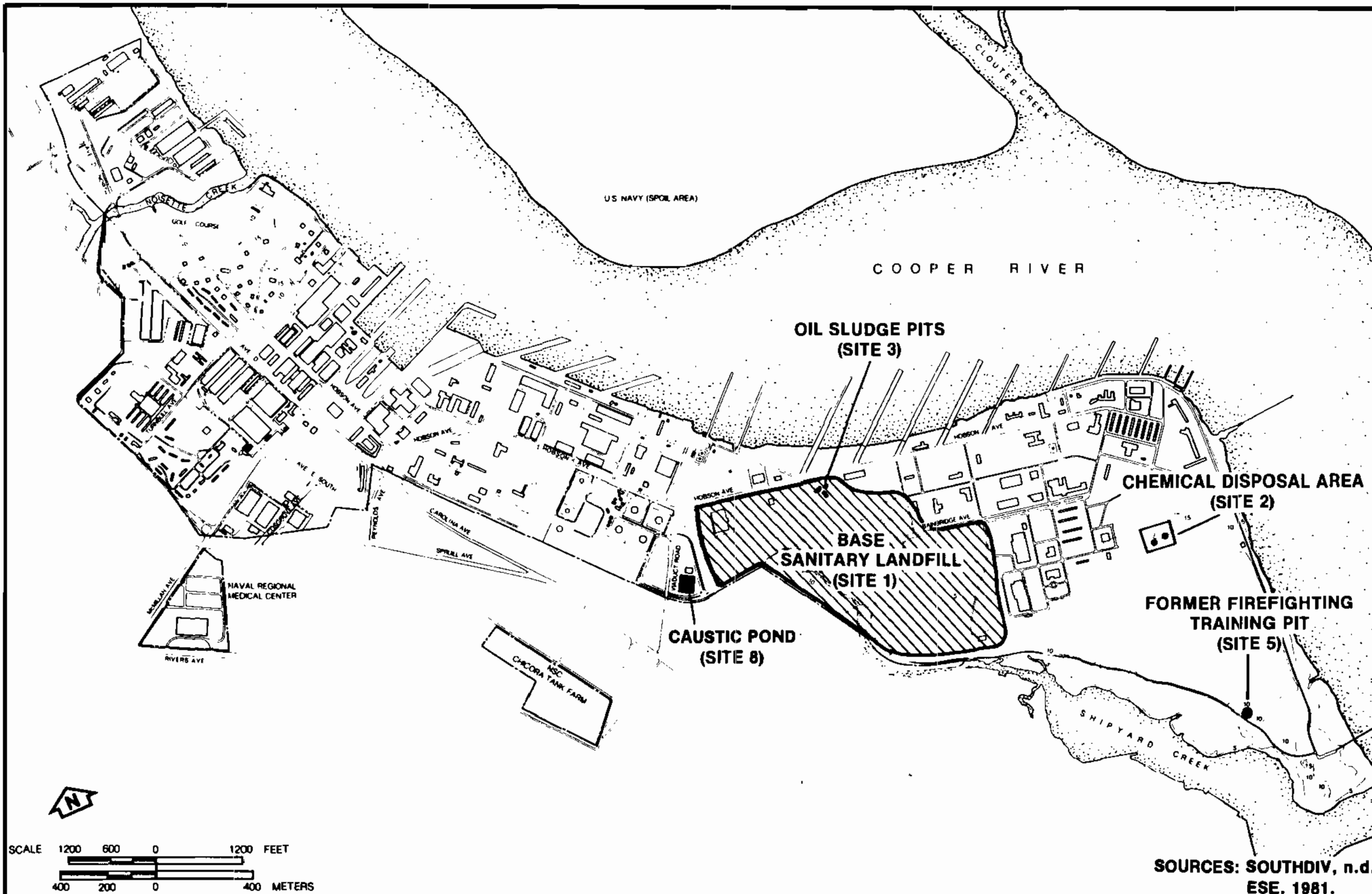


Figure 6.6-5
SOLID WASTE DISPOSAL AREAS

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NAVAL BASE CHARLESTON

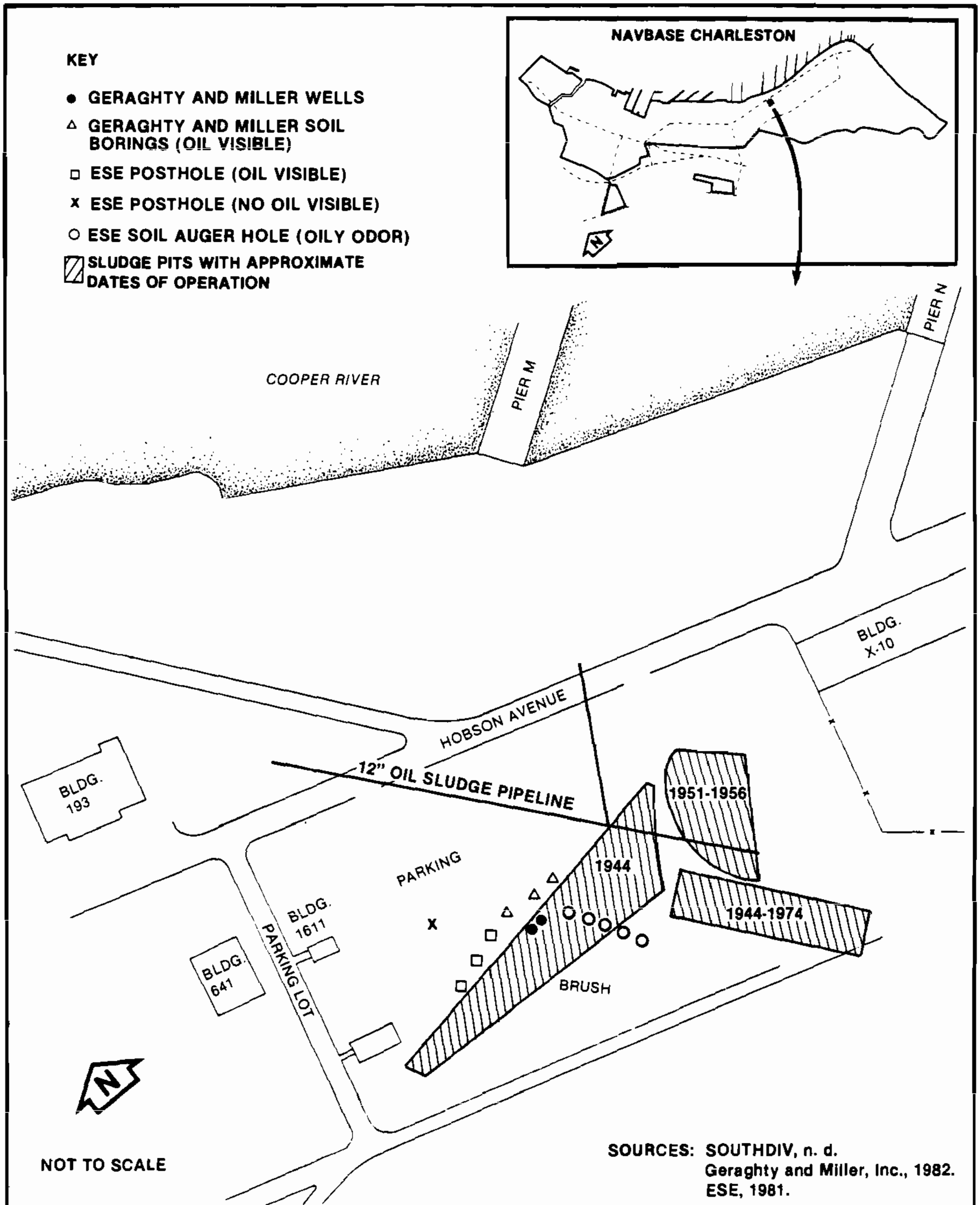


Figure 6.6-6
LOCATIONS OF FORMER OIL SLUDGE PIT AREAS ON NAVBASE CHARLESTON

INITIAL ASSESSMENT STUDY
NAVAL BASE CHARLESTON

have occurred in the summer of 1971. During this spill, oil from the pits reportedly ran across Hobson Ave. and into the Cooper River.

When current groundwater levels are high, due to especially high tides or excessive rainfall, oil reportedly seeps from the ground in this area. At the time of the onsite assessment, the IAS team observed approximately 1 foot of oil floating on the surface of the ground water in the borings in the area of the oil sludge pits. The exact configuration of the oil lens was not determined at the time of the assessment. A noncontact terrain conductivity meter (Geonics EM-31®) was employed to define the extent of the oil lens, but the extreme heterogeneity of the shallow subsurface and the presence of many buried conductors prevented a definitive interpretation of the data. Several shallow holes (2 to 5 feet deep) were dug at conductivity lows, and oil was found in each (see figure 6.6-6).

6.6.2.3 Chemical Disposal Area (Site 2)

Undisclosed amounts of a variety of chemicals, including the decontaminants DANC and DS-2, were reportedly buried in the area of the pistol and skeet ranges (see figure 6.6-5). In 1972 and 1974, construction crews working in the area unearthed drums of chemicals, and minor injuries resulted [NAVBASE Charleston, Code 18(440), 1974; Naval Construction Battalion Unit 412, 1974; NRMC, 1974a; NRMC, 1974b]. Reportedly, in the 1960s, unknown chemicals of several types were buried in the skeet range and the dike behind the pistol range (see figure 6.6-5). In 1977, ten 5-gallon cannisters of DS-2 were reportedly buried in the skeet range.

6.6.2.4 Former Firefighting Training Pit (Site 5)

A circular, unlined pit, measuring 30 to 50 feet in diameter and 18 inches deep, was used from 1966 to 1971 to burn waste oil, gasoline, or alcohol for the training of NAVSTA firefighters. This pit was located near the southern end of NAVBASE Charleston, on the Shipyard Creek side (see figure 6.6-5). Most of the flammable material was burned during each training exercise. This pit was not intended for storage or disposal but strictly for training. Despite the installation of a drain, heavy rains caused the pit to fill with water, displacing the oil and allowing it to flow into Shipyard Creek. Coast Guard citations on these spills led to closure of the pit in 1971, and in 1972, it was leveled and covered with bottom ash. At the time of leveling, there was reportedly 4 inches of oily sludge in the bottom of the pit. No oil or oily residue could be located in the area of the pit during the site assessment. The pit area is not readily discernible from the ground, but its location is apparent from the air and is also clearly shown on aerial photographs taken in 1971. These aerial photographs are available through NEESA or Public Works NSY.

6.6.2.5 Caustic Pond (Site 8)

The caustic pond, located near the junction of Bainbridge Ave. and Viaduct Rd., was used between the early 1940s and the early 1970s for the disposal of lime sludge generated as a byproduct of acetylene production. Water saturated with lime was allowed to settle in a pond, while excess water was discharged to Shipyard Creek. Part of the pond was filled in during construction of Bainbridge Ave. The pond was abandoned rather than closed, and no lime was removed or covered when the acetylene production ceased. The remainder of the pond (the portion which was not filled by the Bainbridge Ave. construction) still exists, and lime sludge can be seen on the water's edge. Trees, shrubs, and grass grow down to the water's edge, and aquatic plants grow in the pond itself. A litmus paper test of the pond water conducted during the onsite assessment yielded a pH of 7. Shallow (2.5-foot) soil borings in the area indicated the presence of approximately 1 foot of lime sludge in the area of the current pond. The pH of water in a fresh exposure of the sludge was 11. The sludge exposed in the pond has apparently formed a carbonate crust, allowing the pond water to remain essentially neutral.

6.7 IMPACTS OF INSTALLATION OPERATIONS

6.7.1 Water Quality

6.7.1.1 Surface Water

NAVBASE Charleston is located on the west bank of the Cooper River, between river miles 9 and 12 (figure 5.3-5). The northern portion of the base is drained by Noisette Creek, while the southern portion is drained by Shipyard Creek; both empty into the Cooper River. The Cooper River is a meandering stream, bordered on the east by backwater marsh and on the west by upland areas with established industry, military facilities, and the cities of Charleston and North Charleston. The Cooper River empties into Charleston Harbor, 4 miles south of NAVBASE Charleston. The South Carolina Department of Health and Environmental Control (SCDHEC) has classified the lower 30 miles of the Cooper River and Charleston Harbor as class SC waters (State of South Carolina, 1971; 1980). Class SC waters are defined as "waters suitable for crabbing, commercial fishing, and for the survival and propagation of marine fauna and flora." Water quality standards for class SC waters are given in table 6.7-1.

Water quality and sediment chemistry data for the Cooper River-Charleston Harbor area are available from several major studies. These studies are listed in table 6.7-2. Each study was reviewed for possible impacts to water quality related to NAVBASE Charleston activities. These are discussed in the following paragraphs.

SCDHEC routinely samples seven water quality monitoring sites along the length of the river to ensure that the waters of the Cooper River maintain State water quality standards. Parameters include

Table 6.7-1
Water Quality Standards for the Lower Cooper River--
Charleston Harbor Area

Items	Specifications*
1. Garbage, cinders, ashes, oils, sludge, or other refuse	None.
2. Toxic wastes, oils, deleterious substances, colored or other wastes	None alone or in combination with other substances or wastes in sufficient amounts as to be injurious to edible fish or the culture or propagation thereof or which in any manner shall adversely affect the flavor, color, odor, or sanitary condition of fish or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.
3. DO	Not less than 4 mg/l.
4. Fecal coliform	Not to exceed a geometric mean of 1,000/100 ml, based on five consecutive samples during any 30-day period; nor to exceed 2,000/100 ml in more than 20 percent of the samples examined during such period (not applicable during or immediately following periods of rainfall).
5. pH	Shall not vary more than one pH unit above or below that of effluent-free waters in the same geological area having a similar total salinity, alkalinity, and temperature, but not lower than 6.75 or above 8.5.

* Class SC water (State of South Carolina, 1971).

DO = dissolved oxygen.
ml = milliliters.

Source: ESE, 1981.

Table 6.7-2
Water Quality and Sediment Chemistry Studies of the Cooper River--Charleston Harbor Area

Parameters*	Sample Type	Sampling Location	Sampling Date	Reference
Phys., C, N	Water	Cooper River--7 Stations Cooper River--7 Stations	1955-79	Inabinet, 1979
Phys., C, N, M, Pest., B	Water	Cooper River--8 Stations	1971	EPA, 1974
Pest.	Water	Cooper River--2 Stations	1971	Gibson, 1974
Phys., C, N	Water	Cooper River--4 Stations Charleston Harbor--1 Station	1973-75	Mathews and Shealy, 1978
Pest., PCBs	Sediment	Cooper River--7 Stations Clouter Creek--2 Stations	1971	Gibson, 1974
Phys., C, N, M	Sediment	Cooper River--9 Stations Clouter Creek--3 Stations	1972	Gibson, 1974
Phys., C, N, M	Sediment	Cooper River--26 Stations Shipyard Creek--4 Stations Charleston Harbor--9 Stations Goose Creek--1 Station	1971	EPA, 1972
Phys., C, N, M	Sediment	Cooper River--2 Stations Shipyard Creek--1 Station Wando River--1 Station Atlantic Ocean--1 Station	1975	Army, 1976a
N, M, Pest., PCBs	Sediment Elutriate	Cooper River--6 Stations Shipyard Creek--1 Station Charleston Harbor--2 Stations Spoil Banks--4 Stations	1979	Jones, Edmunds and Assoc., Inc., 1979

* Phys. = Physical; C = Chemical; N = Nutrients; M = Metals; Pest. = Pesticides; PCBs = Polychlorinated biphenyls; B = Biological.

DO, biochemical oxygen demand (BOD), pH, ammonia-nitrogen (NH_3-N), total Kjeldahl nitrogen (TKN), nitrite plus nitrate (NO_2 + NO_3), total phosphorus (TP), and chloride (CL). Inabinet (1979) recently examined the data collected for the period of record (table 6.7-2) and reported that, in general, the waters of the Cooper River have maintained State water quality standards. In addition, Inabinet (1979) compared the data collected during 1977-78 at the seven SCDHEC stations with those data collected at the same stations averaged over the period of record (1955 to 1977) and found a significant reduction in the nutrient (nitrogen and phosphorus) levels in the Cooper River, as well as a small decrease in the BOD levels throughout the river. This improvement in water quality was attributed by Inabient (1979) to the elimination of all untreated wastewater effluents from the Cooper River, as directed in the early 1970s by State and Federal water pollution control legislation. Untreated sanitary and industrial wastewater effluents into the Cooper River from NAVBASE Charleston were eliminated in early 1972 by pretreatment and diversion to the City of Charleston's sewage treatment plant (STP) (see section 6.6.1.1).

The most recent comprehensive water quality study on the Cooper River was conducted by EPA (1974). This study was published in 1974 by the South Carolina Water Resources Commission as part of the Cooper River Environmental Study (EPA, 1974). The main objective of this study was to develop capability for predicting changes in water quality which might result from rediversion of the Cooper River. To accomplish this, EPA (1974) sampled the river at eight locations during October (high flow) and November (low flow) 1971. Analyses were performed for physical and chemical parameters, including nutrients, metals, pesticides, and biological parameters (coliforms). The water quality of the river, in general, met the State class SC standards (table 6.7-1) during both high- and low-flow conditions at all stations. Several stations exhibited contraventions of pH minimum (less than 6.75) during low-flow conditions in October and November. The low pH values during low-flow conditions were likely attributable to naturally occurring organic (humic and fulvic) acids. No DO values less than the standard (4.0 mg/l) were recorded. The data for chloride indicate that the lower reaches of the river (below river mile 20) are tidally influenced. As expected, the extent of saline ocean water penetration up the river was a function of river flow and tidal cycles.

Concentrations of copper, chromium, lead, zinc, manganese, iron, and mercury were measured at four locations by EPA (1974). Highest concentrations of copper, lead, zinc, manganese, and iron were found at the southernmost station, which was located adjacent to NAVBASE Charleston. EPA water quality criteria for these metals are given in table 6.7-3. Chromium levels at all stations were less than the analytical detection limit (less than 20 ug/l). Levels of copper and zinc were slightly above saltwater aquatic life criteria. Concentrations of mercury and manganese at all stations were less than the saltwater aquatic life criteria. Seawater concentrations of mercury generally range from 0.03 to 0.2 ug/l (Robertson _et al_., 1972), while most surface fresh waters in the United States contain less than 0.1 ug/l mercury (Jenne, 1972).

Table 6.7-3
Water Quality Criteria for Chromium (Cr), Copper (Cu), Lead (Pb), Manganese (Mn), Zinc (Zn), Iron (Fe), and Mercury (Hg)

Parameter	Criteria
Chromium (Cr)	50 ug/1 for domestic water supply;* to protect saltwater aquatic life: 1,260 ug/1, hexavalent; 10,300 ug/1, trivalent.
Copper (Cu)	1,000 ug/1 for domestic water supplies;* to protect saltwater aquatic life: 23 ug/1.
Lead (Pb)	50 ug/1 for domestic water supply;* to protect saltwater aquatic life: 668 ug/1.
Manganese (Mn)	50 ug/1 for domestic water supply;* 100 ug/1 for protection of consumers of marine mollusks.
Zinc (Zn)	5,000 ug/1 for domestic water supplies;* to protect saltwater aquatic life: 170 ug/1.
Mercury (Hg)	2.0 ug/1 for domestic water supply;* to protect saltwater aquatic life: 3.7 ug/1.

* The portion of the Cooper River at NAVBASE Charleston is not classified for use as a potable water source.

Sources: EPA, 1976b.
EPA, 1980f.
EPA, 1981.

The EPA (1974) sampling occurred 1 year prior to the diversion of sanitary and industrial wastewaters from the Cooper River. Due to tidal flow reversals and mixing in the lower stretch of the Cooper River, it is not possible to identify NAVBASE Charleston as the source of these contaminants. No data exist to assess the impact of the subsequent wastewater diversion on metal levels in the river.

Pesticides were analyzed during the October (high-flow) sampling. Eighteen pesticides were analyzed from composite water samples collected at each station. All samples analyzed were below the analytical detection limit for all 18 pesticides (table 6.7-4).

Gibson (1974) also reported data for 15 pesticides and degradation products during a May 1971 sampling at two locations in the Cooper River. One sampling station (PB-10) was located above the "tee," approximately 25 km north of NAVBASE Charleston, while the other station (PB-1) was located at the point of confluence of the Cooper River with Charleston Harbor. All samples were less than analytical detection, except for Silvex, which was just detectable at PB-10. The presence of this herbicide in the river likely was due to agricultural runoff.

Mathews and Shealy (1978) sampled four stations in the Cooper River and one station in Charleston Harbor during 1973-75. Physical, chemical, and nutrient parameters were reported. As expected, salinity and nutrients in the Cooper River increased toward the river mouth. No other analyses were conducted.

6.7.1.2 Sediment Analyses

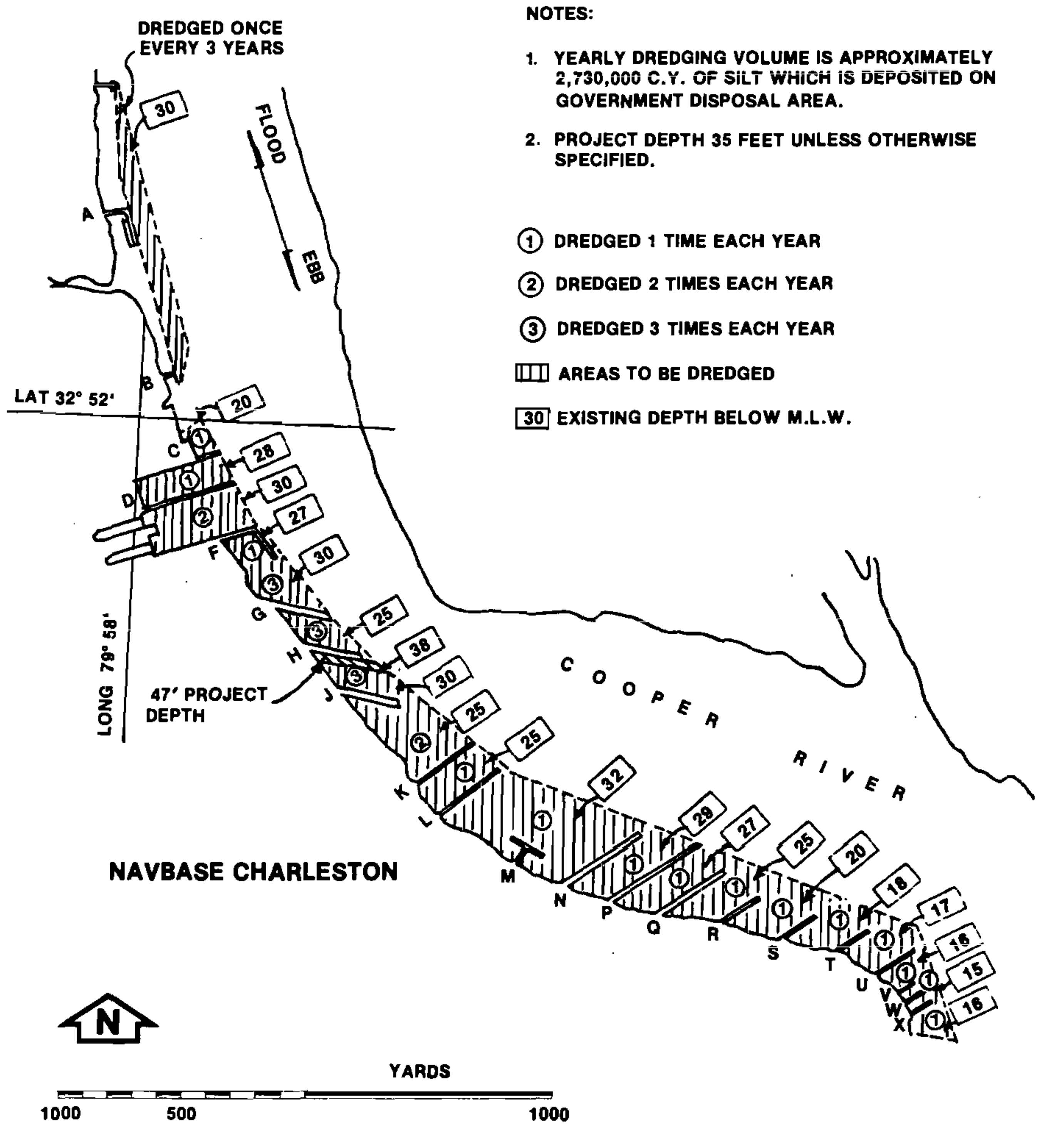
The tidal intrusion of a dense saline wedge into Charleston Harbor and the lighter, nonsaline, Cooper River water overriding this wedge result in decreased river velocities and subsequent settling of suspended matter. Additionally, the presence of a salinity differential between the top and bottom strata of the harbor causes bottom flood currents to predominate over the bottom ebb currents; thus, the resulting upstream movement of bottom currents within the harbor and lower reaches of the Cooper River constitutes an effective sediment trap (Army, 1976b). Dredging operations are conducted annually to maintain the channels in the river and harbor. Additionally, the Navy conducts dredging operations at NAVBASE Charleston to maintain project depths in the areas between the piers (figure 6.7-1). As shown in figure 6.7-1, dredging occurs one, two, or three times per year in this area. Approximately 2,730,000 cubic yards of material is removed annually from the area in front of and between NAVBASE Charleston piers and docks (Army, 1976b). Disposal of dredge material occurs at designated spoil bank areas along the eastern shore of the Cooper River. Most of the southern portion of NAVBASE Charleston was a spoil disposal area during the years 1940-60.

Concern over the effects of the disposal of this spoil material and possible toxic substances associated with this material has resulted

Table 6.7-4
Pesticide Analysis for Cooper River Stations

Pesticide	Concentration (All Stations) (ug/l)
Aldrin	<0.005
Lindane	<0.002
Chlordane	<0.05
Chlorobenzilate	<0.5
DDD	<0.01
DDE	<0.01
DDT	<0.02
Dieldrin	<0.01
Endrin	<0.02
Heptachlor Epoxide	<0.01
Heptachlor	<0.005
Methoxychlor	<0.1
Toxaphene	<0.25
Diazinon	<0.2
Guthion	<0.5
Malathion	<0.2
Methyl Parathion	<0.02
Parathion	<0.04

Source: EPA, 1974.



SOURCE: Army, 1976b.

Figure 6.7-1
NAVAL DREDGING AROUND PIERS AND SLIPS

INITIAL ASSESSMENT STUDY NAVAL BASE CHARLESTON

in several sediment chemistry studies (Gibson, 1974; EPA, 1972; Army, 1976a; Jones, Edmunds and Assoc., Inc., 1979). Table 6.7-2 lists these studies, the parameters measured, and the sampling dates discussed below. These studies were reviewed for possible impacts related to NAVBASE Charleston activities. Each study is discussed in the following paragraphs.

Gibson (1974) reported pesticide and PCB data for sediments collected at seven stations in the Cooper River and two stations in Clouter Creek. Two stations were adjacent to NAVBASE Charleston. PCBs were detected in concentrations which interfered with the pesticide determinations in all but two samples. PCBs appear to be ubiquitous in the Cooper River and were detected well upstream in the river; thus, NAVBASE Charleston cannot be identified as the source of these contaminants.

A cooperative sediment sampling and analysis effort in August 1972 between the South Carolina Water Resources Commission and EPA Region IV was conducted for the Charleston Harbor area, including the Atlantic Intracoastal Waterway (AIWW), Stono River, Wando River, Cooper River, Clouter Creek, and Ashley River (Gibson, 1974). This sampling effort included nine stations in the Cooper River, just upriver of NAVBASE Charleston. The analyses included lead, zinc, and mercury. The average values reported for these metals were neither higher nor lower than average levels found in the sediments of other rivers in the area, as follows:

	Lead mg/kg (wet)	Zinc mg/kg (wet)	Mercury mg/kg (dry)
Ashley River	32.7	45.8	0.45
Cooper River	28.9	25.7	0.29
AIWW	20.8	31.5	0.22
Wando River	23.0	24.2	0.50
Stono River	16.3	17.5	0.27

Since the Cooper River sediments exhibited levels roughly similar to other rivers in the area, NAVBASE Charleston probably was not a significant source of these metals to the sediments.

The most comprehensive sampling and analysis study of the Cooper River sediments was conducted by EPA Region IV (EPA, 1972). During March 1971, the Charleston District COE obtained 41 samples from sites selected by an EPA representative. EPA analyzed these samples for solids, oil and grease, organic nitrogen, TKN, TP, chemical oxygen demand (COD), trace metals, and radioactivity. Radioactivity levels and mercury levels were less than the analytical detection limits for these parameters at the above locations. Average values for lead, zinc, copper, and chromium were calculated from the raw data reported by EPA (1972) for the nine stations (Nos. 1-9) upstream of NAVBASE Charleston, the eight stations (Nos. 10-17) adjacent to NAVBASE Charleston, and the four stations (Nos. 18-21) in Shipyard Creek. These are given in table 6.7-5. In general, the data show higher concentrations of all

Table 6.7-5
Average Concentrations and Standard Deviations
of Trace Metals in Cooper River Bottom Sediments

Location (Station Grouping)	Station No.	No. of Samples	Concentration* (Percent Dry Weight) Lead	Zinc	Copper	Chromium
Cooper River, stations upstream of NAVBASE Charleston*	1-9	9	$32.9^{a\dagger}$ (16.2)	108.2^{b} (47.1)	41.4^{c} (22.4)	59.0^{d} (24.9)
Cooper River, stations adjacent to NAVBASE Charleston	10-17	8	38.9^{a} (10.1)	129.4^{b} (67.7)	44.6^{c} (11.9)	68.5^{d} (24.9)
Shipyard Creek stations	18-21	4	$45.5^{a\dagger}$ (25.1)	140.5^{b} (24.6)	44.3^{c} (2.6)	131.8^{e} (105.9)

* The grouping of the nine stations upstream of NAVBASE Charleston is assumed to be a valid "background" (i.e., representative of sediments not influenced by the installation). This assumption is based on the fact that net flux of sediment mass is in a downstream direction, even though tidal action coupled with low river flow could produce upstream flow vectors in the Cooper River adjacent to the installation.

† Averages of values reported; numbers in parentheses are standard deviations. Means with the same letter superscript are not significantly different at the 0.05 confidence level.

Source: ESE, 1981.

four metals in the sediments of the Cooper River adjacent to NAVBASE Charleston and in Shipyard Creek than upstream of the base. Statistical analysis of the data, however, shows that the values are not significant at the 0.05-confidence level, with the exception of chromium which is significantly higher in Shipyard Creek (131.8 percent) sediments than in Cooper River sediments, both upstream and adjacent to the base (table 6.7-5). The shoreline of Shipyard Creek is highly industrialized, and the source(s) of chromium is unknown. No criteria exist for sediment metal concentration. The source of contaminants, particularly trace metals, found in the sediments cannot be determined due to the presence of numerous industries and manufacturing plants along the Cooper River and Shipyard Creek. Due to extensive system mixing of contaminants from other sources in the adjoining areas in the past and currently, it is impossible to identify the degree of contamination originating from NAVBASE Charleston and to determine the degree of sediment contamination from past operations.

The Charleston District COE sampled the sediments at five locations in the lower Cooper River and Charleston Harbor in December 1975. Two stations were located adjacent to NAVBASE Charleston: station CH-04, in the Cooper River out from the Degaussing Station, and station CH-05 in Shipyard Creek. Analyses included physical and chemical parameters, including trace metals. Lead, zinc, arsenic, chromium, nickel, beryllium, and vanadium were higher at stations CH-04 and CH-05 than at the other stations. Replicate analyses were not performed; thus it is not possible to assess the statistical significance of the data. Levels of mercury and selenium were below analytical detection.

As discussed above, the sediments in the river are dredged annually, with the spoil material deposited on the east shore spoil banks. A bioassay evaluation was recently (1979) conducted of sediments in the lower Cooper River, Charleston Harbor, and dredge spoil areas (Jones, Edmunds and Assoc., Inc., 1979). This study was conducted to evaluate the potential effects of ocean dumping of the spoil material. Nine sites were sampled in Charleston Harbor and the lower Cooper River and four sites in the dredge spoil disposal areas. The sediments were sampled and elutriated with sea water, with bioassays performed on both the solid phase and elutriates. Bioassay test species included grass shrimp (Palaemonetes pugio), mysid shrimp (Mysidopsis bigelowi), copepods (Centropages hamatus), and haustorids (Neohaustorius schmitzi). Jones, Edmunds and Assoc., Inc., (1979) concluded that none of the 13 sediments would exceed any limiting permissible concentrations (LPC), based on suspended particulate or liquid phase bioassays.

6.7.1.3 Ground Water

Groundwater quality data for NAVBASE Charleston are available from USGS chemical analysis of water from a 2,136-foot well located at NSY (Gardner and Johnson, 1974). These data are presented in table 6.7-6. The well penetrates the Black Creek Formation, of which

Table 6.7-6
Chemical Analysis of Ground Water from a
Deep Well (2,136 feet) Located at NSY

Parameter	Date of Sample Collection	
	23 Jun 1962	9 Sep 1966
pH	8.6	8.4
Specific Conductance	1,380	1,540
Color	--	20
Total Hardness (as $CaCO_3$)	6	6
PO_4	--	0
NO_3	0.5	0.2
F	3.0	3.7
Cl	77	78
SO_4	1.4	0
HCO_3	818	836
K	7.0	3.8
Na	390	392
Mg	0.4	0.5
Ca	2.0	1.4
Mn	0.01	0
Fe	0.5	0.5
Al	0.0	0.1
SiO_2	--	15
Total Solids	--	926

Note: All values are in mg/l, except pH (units) and specific conductance (umhos/cm).

-- = Not reported.

Abbreviations:

$CaCO_3$ = calcium carbonate.
PO_4 = phosphate.
NO_3 = nitrate.
F = fluorine.
Cl = chlorine.
SO_4 = sulfate.
HCO_3 = bicarbonate.
K = potassium.
Na = sodium.
Mg = magnesium.
Ca = calcium.
Mn = manganese.
Fe = iron.
Al = aluminum.
SiO_2 = silicon dioxide.
umhos/cm = micromhos per centimeter.

Source: Gardner and Johnson, 1974.

the major producing aquifer is a coarse sand near the bottom of the formation (Gardner and Johnson, 1974). Many wells in the Charleston area have been drilled into this zone. The first was in 1817 in downtown Charleston. The water from these wells is a sodium-bicarbonate-type of water (see table 6.7-6) with high solids content. Gardner and Johnson (1974) reported that fluoride content is also a water quality problem associated with water from this formation. Fluoride in excess of 0.8 mg/l has been found in all water samples from wells greater than 1,000 feet deep. The fluoride content reported for the well at NSY was 3.0 and 3.7 mg/l in the 1962 and 1966 sampling, respectively (table 6.7-6). This level exceeds the national primary drinking water standard for fluoride (EPA, 1976a). The source of this fluoride is believed to be fluorapatite deposits in the producing formation. Seawater contains about 1.0 mg/l fluoride.

6.7.2 Biota

Potential environmental impacts caused by NAVBASE Charleston activities on onsite and surrounding animal life and vegetation communities include:

1. POL in dock areas along the Cooper River and Shipyard Creek, and

2. Dredging and spoil disposal.

6.7.2.1 Petroleum, Oil, and Lubricants

A floating oil sheen was observed along sections of the Cooper River in the dock (shipyard) areas and along the eastern shore of Shipyard Creek. An examination of cordgrass (*Spartina* sp.) along Shipyard Creek showed no damage to this vegetation, and wildlife (waders, fish, and fiddler crabs) was observed nearby. The source of this oil sheen, or type of oil, was not determined.

The impacts of oil spills on terrestrial ecosystems are not expected to be long term, due to degradation by bacteria, yeasts, and molds that attack hydrocarbons, thus improving oil-contaminated soil. In contrast, aquatic ecosystems can be severely affected by oil spills or seepage (FWS, 1978; Food and Agricultural Organization of the United Nations, 1977; Jenkins *et al.*, 1979; EPA, 1981). During an oil spill, oil is released and initially floats on the water surface. Volatile compounds evaporate, but other components of oil or oil degradation products are soluble in water. Some of these components coat fish gills and interfere with oxygen uptake. Heavier components can sink to the bottom and smother benthos.

6.7.2.2 Dredging and Spoil Disposal

The Cooper River and Charleston Harbor have a shoaling problem, and approximately 60 million cubic yards of silt must be removed annually to maintain a 35-foot shipping channel (SOUTHDIV, n.d.). COE is charged with dredging the river channel and NAVBASE Charleston docking berths. Dredged spoil is disposed of on a designated spoil disposal area on the east bank of the Cooper River, due east of NAVBASE Charleston. When filled to capacity, additional upland or wetland areas will be required for a new spoil disposal area.

Maintenance dredging of the river channel may adversely impact aquatic biota through habitat destruction/modification, siltation, or displacement. Spoil disposal in new areas causes the destruction of existing habitats or wetlands. Although such spoil disposal has little benefit to wildlife during early phases, stabilized spoil banks provide valuable roosting and nesting habitats for a variety of shore and water birds (Parnell et al., 1978). Following the establishment of shrub and tree communities (as on the southern portion of NAVBASE Charleston), former spoil areas can provide wildlife habitat for a variety of species.

6.7.2.3 Endangered and Threatened Species

Twelve animal species and one plant species listed as endangered or threatened by FWS and WMRD have been reported from coastal Charleston County (table 5.4-2). Six of these species are occasional transients in the lower Cooper River and associated wetlands along NAVBASE Charleston. No adverse impacts were determined on these species from past or present base activities. None of these six protected species is expected to remain or reproduce in the vicinity of NAVBASE Charleston due to:

1. Absence of extensive areas of suitable feeding habitat (manatee, short-nosed sturgeon), and

2. Absence of suitable nest sites (bald eagle, peregrine falcon, brown pelican, alligator).

6.7.2.4 Summary

Potential impacts from POL, spoil dredging and disposal, surface runoff, and other NAVBASE Charleston activities on onsite and surrounding wildlife and vegetation are partially mitigated or eliminated due to:

1. The presence of highly developed industrial, commercial, and residential areas along the northern, western, and southern boundaries of the base.

2. The high degree of development on NAVBASE Charleston property. As a result, the base lacks extensive tracts of natural terrestrial habitats and has limited amounts of wildlife habitat (ruderal areas, tidal marsh). This is reflected in the onsite species composition, which consists primarily of common species or species adapted to urban habitats.

3. The location of NAVBASE Charleston, which is too far upstream for many estuarine or marine species (such as marine turtles, seals, or cetaceans), yet waters are too saline for most amphibians and *Sagittaria fasciculata* (listed as endangered by FWS).

4. The absence of most protected species listed as endangered or threatened by FWS and the State of South Carolina from NAVBASE Charleston property. A 1979 letter from the FWS Endangered Species Coordinator states that: "Charleston Naval Station/ Naval Base does not have any areas that may be classified as 'critical habitat,' nor does it appear that operation of this facility will present any foreseeable problem for Federally listed endangered and threatened species" (Personal Communication, 1979).

5. The use of existing dredge spoil disposal areas located on the east bank of the Cooper River.

6. Landscaping throughout developed portions of NAVBASE Charleston (SOUTHDIV, 1977), which helps retain surface runoff and provides habitat for several species of wildlife.

REFERENCES

Army, Department of. Engineer District. 1976a. Analyses of Samples Collected from Charleston Harbor on 17 Dec 75. Charleston, S.C.

Army, Department of. Engineer District. 1976b. Final Environmental Statement, Charleston Harbor Deepening Project, Charleston Harbor and Shipyard River, S.C. Charleston, S.C.

Army, Department of. Engineer District. 1976c. Final Environmental Statement: Maintenance Dredging of Charleston Harbor, Ashley River, and U.S. Navy Channels in Cooper River, Charleston and Berkeley Counties, S.C. Charleston, S.C.

Army, Department of. Engineer District. 1977. Final Environmental Statement: Application by the South Carolina State Ports Authority for a Permit to Dredge, Fill, and Construct a Marine Terminal in the Wando and Cooper Rivers, Charleston County, S.C. Charleston, S.C.

Bailey, R.G. 1976. Ecoregions of the United States. U.S. Forest Service, Ogden, Utah.

Batson, W.T. 1974. Vascular Plant Survey of Marsh and Adjacent Highland in Selected Portions of Cooper River and Wando River. In: The Cooper River Environmental Study. F.P. Nelson, Editor. South Carolina Water Resources Commission, Cayce, S.C.

Batson, W.T. and Blackwelder, B.C. 1974. Vertical Distribution of Epiphytic Algae on Spartina Alterniflora from Transects Along the Cooper and Wando Rivers, Summer, 1971. In: The Cooper River Environmental Study. F.P. Nelson, Editor. South Carolina Water Resources Commission, Cayce, S.C.

Burrell, V.G., Jr. and Carson, W.Z. 1979. Low-Flow Study in Wando River, S.C., 1978. In: Cooper River Controlled Low-Flow Study. South Carolina Water Resources Commission, Columbia, S.C.

The Chester Engineers. 1981. Oily Waste/Waste Oil Management Study, 100% Final Report. U.S. Naval Base, Charleston, S.C.

Custer, T.W. and Osborn, R.G. 1975. 1975 Survey of Atlantic Coast Wading Bird Colonies: Atlas. Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, Md.

Food and Agricultural Organization of the United Nations. 1977. Impact of Oil on the Marine Environment. Reports and Studies No. 6.

Forsythe, D.M. 1978. Subphylum Vertebrata: Free Living Vertebrates--Birds. In: An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. R.G. Zingmark, Editor. University of South Carolina Press, Columbia, S.C.

Gardner, R.A. and Johnson, P.W. 1974. Water Supply Evaluation and Proposed Comprehensive Study of the Charleston-Bushy Park Industrial Complex, South Carolina. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

Geraghty and Miller, Inc. 1982. Assessment of Potential Oil and Hazardous Waste Contamination of Soil and Ground Water at Charleston Naval Shipyard, Charleston, S.C. Prepared for Southern Division, Naval Facilities Engineering Command, Charleston, S.C. Tampa, Fla.

Gibbons, J.W. 1978. Subphylum Vertebrata: Free Living Vertebrates--Reptiles. In: An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. R.G. Zingmark, Editor. University of S.C. Press, Columbia, S.C.

Gibson, H.E. 1974. Charleston Area Sediment Samples, January 2, 1973. In: The Cooper River Environmental Study. F.P. Nelson, Editor. South Carolina Water Resources Commission, Cayce, S.C.

Gusey, W.F. 1981. The Fish and Wildlife Resources of the South Atlantic Coast. Shell Oil Co., Houston, Tex.

Hall, R.E. 1981. The Mammals of North America, 2nd Edition. John Wiley and Sons, N.Y.

Harrison, J.R. 1978. Subphylum Vertebrata: Free Living Vertebrates--Amphibians. In: An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. R.G. Zingmark, Editor. University of S.C. Press, Columbia, S.C.

Inabinet, J.R. 1979. Impact of Controlled Low-Flow on the Water Quality of the Cooper River. In: Cooper River Controlled Low-Flow Study. S.C. Water Resources Commission, Columbia, S.C.

Jenkins, R.H., et al. 1979. The Environmental Impact by Refinery Effluents. CONCAWE [Oil Companies' International Study Group for Conservation of Clean Air and Water in Europe] Water Pollution Special Task Force No. 8, Report No. 5/79.

Jenne, E.A. 1972. Mercury in the Waters of the United States, 1970-71. U.S. Geological Survey, Menlo Park, Calif.

Jones, Edmunds and Associates, Inc. 1979. Results of Bioassay Evaluation of Charleston Harbor Sediments C1-C13, Final Report. Gainesville, Fla.

Kurz, H. and Wagner, K. 1957. Tidal Marshes of the Gulf and Atlantic Coasts of Northern Florida and Charleston, South Carolina. Florida State University, Tallahassee, Fla. FSU Studies No. 24.

Lagman, L.H., Nelson, F.P. and Whetstone, B.H., Jr. 1979. Hydrology and Salinity of the Cooper River During a Controlled Low-Flow Study. Cooper River Controlled Low-Flow Study. S.C. Water Resources Commission, Columbia, S.C.

Mathews, T.D. and Shealy, M.H., Jr. 1978. Hydrography of South Carolina Estuaries with Emphasis on the North and South Edisto and Cooper Rivers. S.C. Marine Resources Research Institute, Marine Resources Division Technology, Charleston, S.C., Report No. 30.

Middleswart, E. 1974. Forest Evaluation, Cooper River Environmental Study, Clouter Creek Area. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

Navy, Department of. n.d. Charleston Naval Shipyard and Contiguous Activities, Master Shore Station Development Plan, Regional and Vicinity Map. Charleston, S.C.

Navy, Department of. History Office. 1981. Charleston Naval Shipyard History 1901-1958. Washington, D.C.

Navy, Department of. Charleston Naval Shipyard (NSY). 1981. Pesticide and Polychlorinated Biphenyls (PCBs) Test Results for Soils from the Old Coral Area. Law and Company, North Charleston, S.C.

Navy, Department of. Naval Base Charleston (NAVBASE Charleston), Code 18(440). 1974. Correspondence Concerning Construction Work in the Area of the Decontamination Agent Non-Corrosive Site. Charleston, S.C.

Navy, Department of. Naval Construction Battalion Unit 412. 1974. Correspondence Concerning Industrial Hygiene Survey and Evaluation of Construction Excavation Ditch. Charleston, S.C.

Navy, Department of. Naval Energy and Environmental Support Activity (NEESA), Radiological Affairs Support Office (RASO). 1979a. Report No. 44A. [Port Hueneme, Calif.].

Navy, Department of. Naval Energy and Environmental Support Activity (NEESA), Radiological Affairs Support Office (RASO). 1979b. Report No. 67B. [Port Hueneme, Calif.].

Navy, Department of. Naval Facilities Engineering Command (NAVFAC). 1976. SSBN Atlantic Coast Refit Sites, Candidate Environmental Impact Statement. Alexandria, Va.

Navy, Department of. Naval Facilities Engineering Command, Southern Division (SOUTHDIV). 1977. Long Term Land Management Plan, Naval Base Complex, Charleston, S.C. Charleston, S.C.

Navy, Department of. Naval Facilities Engineering Command, Southern Division (SOUTHDIV). 1978. Charleston Naval Complex Master Plan. Charleston, S.C.

Navy, Department of. Naval Facilities Engineering Command, Southern Division (SOUTHDIV). 1979. Naval Station Fuel Oil, Diesel Oil, Sludge Oil, Distribution Plan. Charleston, S.C.

Navy, Department of. Naval Facilities Engineering Command, Southern Division (SOUTHDIV). n.d. Master Plan, Naval Supply Center, Charleston, S.C. Charleston, S.C.

Navy, Department of. Naval Facilities Engineering Command, Southern Division (SOUTHDIV), Regional Environmental Support Office (RESO). 1981. Naval Environmental Protection Support Service Water Quality Report for Station No. 1S01 at the Charleston Naval Shipyard. Charleston, S.C.

Navy, Department of. Naval Regional Medical Center (NRMC). 1974a. Correspondence Concerning Industrial Hygiene Survey of Excavation Site for Naval Station Self-Help Project 74-166. Charleston, S.C.

Navy, Department of. Naval Regional Medical Center (NRMC). 1974b. Correspondence Concerning Report of Second Incident of Buried Chemicals at Construction Site, Naval Station Self-Help Project 74-166. Charleston, S.C.

Navy, Department of. Naval Security Group Command (COMNAVSECGRU). Headquarters. 1980a. NAVSUPINST 5450.98E--Mission and Functions Assigned to the Naval Supply Center, Charleston, S.C. Washington, D.C.

Navy, Department of. Naval Security Group Command (COMNAVSECGRU). Headquarters. 1980b. NAVSECGRU Instruction 5450.10B--Mission and Functions of the Naval Security Group Activity, Charleston, S.C. Washington, D.C.

Navy, Department of. Naval Station (NAVSTA) n.d. Report of Historical Review of the Naval Station, Charleston, S.C.

Navy, Department of. Naval Weapons Station (NWS). 1977. Natural Resources Conservation, 1974-1976. Charleston, S.C.

North Charleston Sewer District. 1972. Sewage Disposal System, Use and Rate Resolutions. Charleston, S.C.

Osborn, R.G. and Custer, T.W. 1978. Herons and Their Allies: Atlas of Atlantic Coast Colonies, 1975 and 1976. Biological Services Program, U.S. Fish and Wildlife Service. FWS/OBS-77/08.

Parnell, J.F., Dumond, D.M. and Needham, R.N. 1978. A Comparison of Plant Succession and Bird Utilization on Diked and Undiked Dredged Material Islands in North Carolina Estuaries. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. Tech. Report D-78-9.

Project Eutuo (Homewood, Illinois). 1974. Report on "In Situ" Benthic Respiration and Vertical Oxygen: Temperature Profiles. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

Robertson, E.E., et al. 1972. Battelle Northwest Contribution to the IDOE Baseline Study, Battelle Northwest 1972 IDOE Workshop.

Sanders, A.E. 1978. Subphylum Vertebrata: Free Living Vertebrates--Mammals. In: An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. R.G. Zingmark, Editor. University of S.C. Press, Columbia, S.C.

Shade, H.I. 1979. Impact of Low-Flow Test on Cooper River Water Users. In: Cooper River Controlled Low-Flow Study. S.C. Water Resources Commission, Columbia, S.C.

Shealy, M.H., Jr. and Bishop, J.M. 1979. Hydrographic and Biological Studies in Relation to Cooper River, South Carolina Low-Flow Conditions Prior to River Rediversion. In: Cooper River Controlled Low-Flow Study. S.C. Water Resources Commission, Charleston, S.C.

Shell Oil Co. 1981. The Fish and Wildlife Resources of the South Atlantic Coast. Houston, Tex.

Stalter, R. 1974. The Vegetation of Cooper River Estuary. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

State of South Carolina. Department of Health and Environmental Control. 1971. South Carolina Classification Standards. Columbia, S.C. In: Environment Reporter, State Water Laws, 906:0501-0544.

State of South Carolina. Wildlife and Marine Resources Department. 1972. A Study of the Charleston Harbor Estuary with Special Reference to Deposition of Dredged Sediments. Charleston, S.C.

State of South Carolina. Wildlife and Marine Resources Department. 1976. South Carolina Nongame and Endangered Species Act of 1974. South Carolina Code, Chapter 15, Section 50-15-10 through 50-15-90.

State of South Carolina. Wildlife and Marine Resources Department and The Citadel. 1976. Proceedings of the First South Carolina Endangered Species Symposium, No. 11-12, 1976. Charleston, S.C.

Steele, W. 1974. Economic and Demographic Profile, Berkeley and Charleston Counties, South Carolina. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

Technical Services, Inc. 1980. EP Toxicity Test Results for Sandblasting Samples from Sandblasting Operations in Bldg. 232 and Drydocks and Open Areas Adjacent to Bldg. 223 at Charleston Naval Shipyard. Jacksonville, Fla.

Thompson, R.L. (Ed.). 1971. The Ecology and Management of the Red-Cockaded Woodpecker: Proceedings of a Symposium. U.S. Dept. of the Interior, Bureau of Sport Fisheries and the Tall Timbers Research Station (Tallahassee, Fla.).

Turner, W.R. and Johnson, G.N. 1974. Standing Crops of Aquatic Organisms in Tidal Streams of the Lower Cooper River System, S.C. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

U.S. Environmental Protection Agency (EPA). Office of Noise Abatement and Control. 1971. Effects of Noise on Wildlife and Other Animals. Washington, D.C. EPA-NTIS 300.5.

U.S. Environmental Protection Agency (EPA). Region IV. 1972. SANGP-1 Bottom Sediment Samples, Charleston Harbor, Georgetown Harbor and AIWW-EPA's Evaluation and Interpretation for Proper Spoil Disposal. Atlanta, Ga.

U.S. Environmental Protection Agency (EPA), Region IV. 1974. Water Quality Portion of the Cooper River Environmental Study. In: The Cooper River Environmental Study. F.P. Nelson, Editor. S.C. Water Resources Commission, Cayce, S.C.

U.S. Environmental Protection Agency (EPA). 1976a. National Interim Primary Drinking Water Regulations. EPA Office of Water Supply. EPA-570/19-76-003.

U.S. Environmental Protection Agency (EPA). 1976b. Quality Criteria for Water. Washington, D.C. EPA-440/9-76-023.

U.S. Environmental Protection Agency (EPA). 1980a. Hazardous Waste Management System. Federal Register, 45(98):33036-33140.

U.S. Environmental Protection Agency (EPA). 1980b. Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. Federal Register, 45(98):33244.

U.S. Environmental Protection Agency (EPA). 1980c. Polychlorinated Biphenyls (PCBs), Manufacture, Processing, Distribution in Commerce, and Use Prohibitions. Code of Federal Regulations, Title 40, Part 761, pp. 412-440.

U.S. Environmental Protection Agency (EPA). 1980d. Standards Applicable to Generators of Hazardous Waste. Federal Register, 45(98):33143-33144.

U.S. Environmental Protection Agency (EPA). 1980e. Steam Electric Power Generating Point Source Category. Code of Federal Regulations, Title 40, Part 423.42, p. 578.

U.S. Environmental Protection Agency (EPA). 1980f. Water Quality Criteria Documents; Availability. Federal Register, 45(231):79318-79379.

U.S. Environmental Protection Agency (EPA). 1981. Water Quality Criteria; Corrections. Federal Register, 46(156):40919.

U.S. Environmental Protection Agency (EPA). Municipal Environmental Research Lab. 1981. Handbook for Oil Spill Protection and Cleanup Priorities. Cincinnati, Ohio. EPA-600/8-81-002.

U.S. Fish and Wildlife Service (FWS). Biological Services Program. 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and Their Habitats. FWS/OBS-78/29.

U.S. Fish and Wildlife Service (FWS). Eastern Peregrine Falcon Recovery Team. 1979. Eastern Peregrine Falcon Recovery Plan.

U.S. Fish and Wildlife Service (FWS). 1980a. Republication of the Lists of Endangered and Threatened Species and Correction of Technical Errors in Final Rules. Federal Register, 45(99):33768-33781.

U.S. Fish and Wildlife Service (FWS). 1980b. Revision of the Special Rule on the American Alligator, Final Rule. Federal Register, 45(229):78154.

U.S. National Oceanic and Atmospheric Administration (NOAA). Office of Coastal Zone Management. 1979. State of South Carolina Coastal Management Program and Final Environmental Impact Statement.

U.S. Soil Conservation Service (USSCS). 1971. Soil Survey, Charleston County, S.C.

Williams-Russell and Associates, Inc. 1980. Hazardous Materials and Waste Management Survey for the Naval Base, Charleston, S.C. Atlanta, Ga.

Zingmark, R.G. (Ed.). 1978. An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. University of S.C. Press, Columbia, S.C.

APPENDIX

Biota on NAVBASE Charleston and Vicinity

APPENDIX

REGIONAL ECOLOGY

Vegetation associations in coastal Charleston County, S.C., are typical of those found along the South Atlantic coastline and range from barren shoreline to outer Coastal Plain forest (Bailey, 1976; Steele, 1974; Shealy and Bishop, 1979). Along the Atlantic, bare sandy beach separates the surf from sand dunes covered by halophytes such as salt-meadow cordgrass (Spartina patens), sandspur (Cenchrus tribuloides), sea oats (Unicola paniculata), sea rocket (Cakile harperi), and sea-purslane (Sesuvium portulacastrum).

Extensive tidal marshes, dominated by cordgrass (Spartina spp.) and spike rush (Juncus roemerianus), occur between beaches and uplands and along inlets and river basins. Due to the flat topography and numerous streams and creeks, tidal marsh covers more than 20 percent of Charleston County (SOUTHDIV, n.d.). Uplands adjoining these marshes support pine flatwoods and Coastal Plain forest, and contain freshwater marshes and hardwood swamps.

Plant-species composition in coastal Charleston County is determined by proximity to salt water and by degree of inundation. This relationship results in a well-defined vegetation zonation between shoreline and uplands (Kurz and Wagner, 1957). Tidal shoreline areas, frequently inundated by salt water, contain a saltmarsh cordgrass (Spartina alterniflora) zone. An adjoining zone of spike rush grows on slightly higher ground, which is subject to less flooding. A barren zone commonly occurs at the high tide line where phytotoxic salt and chlorine levels exclude most seed plants; less toxic submerged portions of this zone support spikegrass (Distichlis spicata) and glassworts (Salicornia spp.).

Cordgrass and rushes cover the lower portions and shrub communities the higher portions of tidal marshes, spoil banks, and barrier beaches in Charleston County. Groundsel-bush (Baccharis halimifolia), marsh elder (Iva frutescens), youpon (Ilex vomitoria), and wax myrtle (Myrica cerifera) dominate coastal shrub zones. Interspersed trees include live oak (Quercus virginiana), southern red cedar (Juniperus silicicola), and cabbage palm (Sabal palmetto).

Pine flatwoods adjoining tidal marsh are dominated by slash pine (Pinus elliottii) and longleaf pine (P. palustris), with an understory of gallberry (Ilex glabra), wax myrtle, palmetto (Serenoa repens), and wiregrass (Aristida stricta), among others.

Mixed southeastern coastal forest and hardwood swamps are dominated by oaks, pines, gums (Liquidambar styraciflua, Nyssa spp.), hickories (Carya spp.), ashes (Fraxinus spp.), and bays (Magnolia spp., Gordonia sp., Persea sp.). An annotated checklist of the coastal zone vegetation of South Carolina is found in Zingmark (1978).

The wildlife composition of coastal Charleston County is diverse and includes terrestrial, aquatic, and marine mammals; numerous resident and migratory inland and coastal birds; and a variety of reptiles and amphibians. This diversity of vertebrates results from a variety of wildlife habitats, ranging from coastal and estuarine wetlands to upland oak hammocks and pine flatwoods. Due to its location, the South Carolina coastal region also represents the southern- and northernmost range limits for a number of terrestrial and aquatic species (Zingmark, 1978). In addition, this coastal area serves as an important stopover and wintering area for migrant birds following the Atlantic flyway. The South Atlantic region has supported about 40 percent of the Atlantic flyway wintering bird population, with more than 310,000 waterfowl remaining annually in coastal South Carolina during 1977-79 (Gusey, 1981).

Thirty-nine species of terrestrial mammals are native to the coastal region of South Carolina (Sanders, 1978) and may be expected to appear in Charleston Harbor. Marine mammals which occur regularly along the coast include one species each of seal, sirenian (manatee), and cetacean. Nineteen species of cetaceans (whales and dolphins) have been reported in the area from strandings. Excluding feral, extirpated, and accidental species, a total of 67 mammal species have been recorded in the South Carolina coastal area; their status and distributions are listed in Sanders (1978).

Almost 400 species of birds occur in the South Atlantic region between North Carolina and Florida (Gusey, 1981). Of these, 358 species of inland, coastal, and oceanic birds have been reported from coastal South Carolina (Forsythe, 1978).

An abundance of wetlands and aquatic habitats in coastal Charleston County provides excellent breeding and feeding areas for wading, shore, marsh, and water birds. In the vicinity of Charleston Harbor, three nesting colonies (Deveaux Bank, Bird Key, Drum Island) support up to 27,000 pairs of pelicans, herons, egrets, ibis, terns, gulls, skimmers, and oystercatchers (Custer and Osborne, 1975; Osborne and Custer, 1978; Gusey, 1981). Bird composition and population estimates on Drum Island, a spoil bank 1.5 miles south of NAVBASE Charleston, are listed in table A-1.

The herpetofauna of the South Carolina coastal zone contains approximately 83 percent of all species recorded in the state, including 65 species of reptiles and 45 species of amphibians. Although few amphibians occur in tidal habitats, reptiles, especially turtles, are abundant. The diamondback terrapin (Malaclemys terrapin) is the most common turtle in estuaries, saltmarshes, and brackish habitats of Charleston County; Atlantic loggerhead (Caretta caretta) is the most common marine turtle (Gibbons, 1978).

Table A-1
Breeding Bird Composition on Drum Island,
Charleston County, S.C.

Species	No. of Pairs Nesting*	Nesting Period
White ibis (*Eudocimus alba*)	1,500-4,000	Late February - August
Glossy ibis (*Plegadis falcinellus*)	200-2,500	March - late July
Cattle egret (*Bubulcus ibis*)	1,500-2,500	April - early September
Snowy egret (*Egretta thula*)	1,000-2,500	March - August
Little blue heron (*Florida caerulea*)	700-2,000	March - late July
Louisiana heron (*Hydranassa tricolor*)	500-1,500	March - August
Great egret (*Casmerodius albus*)	150-250	February - late July
Black-crowned night heron (*Nycticorax nycticorax*)	75-200	February - late August
Yellow-crowned night heron (*Nyctanassa violacea*)	50-200	February - August
Green heron (*Butorides virescens*)	5-10	March - August
Black-necked stilt (*Himantopus mexicanus*)	1-4	March - June

* Annual fluctuations depending on population, size, and survey dates.

Source: Gusey, 1981.

Protected wildlife species listed as threatened or endangered by FWS and State of South Carolina are discussed below.

Fish and aquatic invertebrates are abundant in the estuarine waters of lower Cooper River, Wando River, and Charleston Harbor. Forty-five species of fish and three species of invertebrates were caught during a 1972 tidal stream survey in the lower Cooper River Estuary (Lagman, et al., 1979). Ten of the 45 fish species constituted 95 percent of the total catch, and 3 species [immature Atlantic croaker (Micropogon undulatus), Atlantic menhaden (Brevoortia tyrannus), and mummichog (Fundulus heteroclitus)] accounted for 75 percent.

Stream surveys in Clouter Creek (two sites) and the Bushy Park industrial area (one site) produced a biomass of 249 pounds per acre. Invertebrates comprised 63 percent of this weight, fish 37 percent. Grass shrimp (Palaemonetes pugio) comprised 52 percent of the total biomass. Six species of fish, including American eel (Anguilla rostrata), striped mullet (Mugil cephalus), Atlantic croaker, Atlantic menhaden, white catfish (Ictalurus catus), and mummichog, composed 75 percent of the total fish biomass.

TERRESTRIAL ECOSYSTEMS

Dominant plant species occurring in open and wooded ruderal areas are listed in table A-2. Vegetation cover in ruderal areas ranges from less than 60-percent coverage in the northern, most recently disturbed areas to 100-percent coverage in the shrub- and tree-covered southern and western portions. The Clouter Creek spoil disposal area consists primarily of bare spoil material.

Nature hardwoods and pines, some measuring more than 3.5 feet in diameter at breast height (dbh), cover the housing area south of the golf course. Oaks and pines comprise the dominant canopy species, laurel and azaleas the dominant understory species in this area (table A-2).

Improved and semi-improved areas are found throughout the developed portions of NAVBASE Charleston. The locations of improved and semi-improved areas are shown in the base management plan (SOUTHDIV, 1977). Such areas consist primarily of maintained (seeded, sodded, mowed) grasslands with planted trees and shrubs.

Wildlife species recorded in these terrestrial habitats during a 3-day site survey of NAVBASE Charleston on 3-5 Aug 1981 consisted of common species and species adapted to urban habitats. Opossum, raccoon, eastern cottontail, marsh rabbit, and gray squirrel were the larger mammals recorded in shrub thickets and spoil successional forests.

Additional mammals expected in onsite terrestrial habitats include bats, moles, shrews, mice, and rats. Gray squirrel was the most conspicuous mammal in the wooded housing area. Due to the urban setting

Table A-2
Dominant Plants Recorded on NAVBASE Charleston

Plant	Common Name	Scientific Name
Ruderal Areas:		
Grasses		
	Broomsedge	(Andropogon viginicus)
	Bluegrasses	(Poa spp.)
	Sedges	(Carex spp.)
	Rushes	(Fimbristylis sp.)
	Curly dock	(Rumex crispus)
Forbs		
	Sheep sorrel	(Rumex acetocella)
	Green ameranth	(Ameranthus viridens)
	Pigweed	(Chenopodium album)
	Morning glory	(Ipomoea trichocarpa)
	Pokeweed	(Phytolacca americana)
	Coffeeweeds	(Cassia spp.)
	Virginia creeper	(Parthenocissus quinquefolia)
	Dogfennel	(Anthemis sp.)
	Poison ivy	(Toxicodendron radicans)
	Trumpet vine	(Campsis radicans)
	Honeysuckle	(Lonicera japonica)
Shrubs and Trees		
	Groundsel bush	(Baccharis halimifolia)
	Marsh elder	(Iva frutescens)
	Wax myrtle	(Myrica cerifera)
	Southern red cedar	(Juniperus silicicola)
	Winged sumac	(Rhus copallina)
	Black cherry	(Prunus serotina)
Spoil Forest		
	Mulberry	(Morus rubra)
	Hackberry	(Celtis laevigata)
	Tallowtree	(Sapium sebiferum)
	Red maple	(Acer rubrum)
Married Officer's Housing Area:		
	Live oak	(Quercus virginiana)
	Water oak	(Quercus niger)
	Pin oak	(Quercus palustris)
	Loblolly pine	(Pinus taeda)
	Longleaf pine	(Pinus palustris)
	Hickory	(Carya sp.)
	Flowering dogwood	(Cornus florida)
	Red cedar	(Juniperus silicicola)
	Southern magnolia	(Magnolia grandiflora)
	Azalea	(Rhododendran spp.)

Source: ESE, 1981.

of the installation, white-tailed deer (Odocoileus virginiana) are not expected to occur on NAVBASE Charleston; however, limited habitat exists on the southern, wooded portion of the base.

Birds were abundant in open ruderal areas, shrub thickets, and woodlands. Terrestrial bird species most commonly observed during the August survey are listed in table A-3. Ospreys (Pandion haliaetus) nest on an antenna on the southern portion of NAVBASE Charleston.

Six-lined racerunner and green anole were common in open spoil and shrub thicket habitats, respectively. Common reptiles expected but not observed include eastern box turtle, southern black racer, and yellow rat snake.

WETLAND ECOSYSTEMS

Tidal marshes along Shipyard Creek, Noisette Creek, and Cooper River are similar and consist of homogeneous expanses of cordgrass (Spartina alterniflora, S. patens). Low sections of these marshes are inundated during high tides, while higher, drier areas support small shrub communities and hardwood stands (table A-4). Cabbage palm and small live oak grow on surrounding, noninundated areas along Shipyard and Noisette Creeks.

A small, freshwater marsh is located between Dyess and Hobson Ave., southeast of Bldg. 161. This marsh is overgrown by dense cattail, mallow, and bladderpod. Willows, shrubs, reeds, and briers surround inundated portions of the marsh, along with numerous tallow and mulberry trees.

Small, onsite drainages are fringed by cordgrass, reeds, and shrubs. Such drainages are located east of the coal storage area south of Noisette Creek, in the upper Shipyard Creek basin, and along the southern boundary road.

The wildlife composition in NAVBASE Charleston wetlands varies with vegetation structure. Based on track sightings, raccoon, marsh rabbit, and muskrat are the most common mammals in onsite marshes, feeding on ubiquitous fiddlercrab (Uca sp.) and marsh vegetation.

Wading birds, rails, blackbirds, marshwrens, and ospreys are commonly observed in onsite Spartina marshes. Migratory waterfowl are expected to utilize these marshes during fall and winter (State of South Carolina, 1972).

Marshes and drainages covered by dense cattail-shrub vegetation contain red-winged blackbirds, common yellowthroats, and catbirds. Bird species diversity in this, as well as in all other NAVBASE Charleston habitats, is expected to increase during spring and fall migratory periods.

Table A-3
Common Terrestrial Mammals, Birds, and Reptiles Recorded on NAVBASE Charleston During an August 1981 Site Survey

Animal	Common Name	Scientific Name
Mammals		
	Opossum	(*Didelphis marsupialis*)
	Raccoon	(*Procyon lotor*)
	Eastern cottontail	(*Sylvilagus floridana*)
	Marsh rabbit	(*Sylvilagus palustris*)
	Gray squirrel	(*Sciurus carolinensis*)
Birds		
	Morning dove	(*Zenaida macroura*)
	Eastern meadowlark	(*Sturnella magna*)
	Bluejay	(*Cyanocitta cristata*)
	Northern mockingbird	(*Mimus polyglottos*)
	Cardinal	(*Cardinalis cardinalis*)
	Gray catbird	(*Dumetella carolinensis*)
	Starling	(*Sturnus vulgaris*)
	Rock dove	(*Columba livia*)
	Yellow-breasted chat	(*Icteria virens*)
Reptiles		
	Six-lined racerunner	(*Cnemidophorus sexlineatus*)
	Green anole	(*Anolis carolinensis*)

Source: ESE, 1981.

Table A-4
Common Plant Species Recorded in NAVBASE Charleston Tidal Areas and Wetlands

Common Name	Scientific Name
Black rush	(*Juncus roemenanus*)
Saltmarsh cordgrass	(*Spartina alterniflora*)
Saltmeadow cordgrass	(*Spartina patens*)
Cattail	(*Typha latifolia*)
Mallow	(*Hibiscus moscheutos*)
Bladderpod	(*Sesbania vesicarium*)
Giant reed	(*Phragmites communis*)
Briers	(*Smilax* spp.)
Spanish bayonet	(*Yucca gloriosa*)
Youpon	(*Ilex vomitoria*)
Groundsel bush	(*Baccharis helimifolia*)
Marsh elder	(*Iva frutescens*)
Cabbage palm	(*Sabal palmetto*)
Chinaberry	(*Melia azedrach*)
Black willow	(*Salix niger*)

Source: ESE, 1981.

Although no reptiles or amphibians were recorded in NAVBASE Charleston marshes during the August survey, the diamondback terrapin (Malaclemys terrapin) is expected to be the most common reptile in tidal marshes (Army, 1977). This commercially valuable species is common in estuaries, saltmarshes, and brackish habitats along the South Carolina coast (Gibbons, 1978).

Common wildlife species observed on NAVBASE Charleston wetlands and marshes are listed in table A-5.

AQUATIC ECOSYSTEMS

Calculations of biomass production, added to these systems annually, are discussed in State of South Carolina, 1972. Seventy fish species were recorded in Charleston Harbor in a 1971 Marine Resource Center study (State of South Carolina, 1972), and 73 fish species have been identified in the Cooper River (Army, 1976b). Numerous bluecrabs and fiddler crabs were observed in inter-tidal areas of NAVBASE Charleston.

Pelicans (Pelecanus occidentalis), gulls, terns, cormorants, and migratory loons, grebes, and waterfowl are the most common and conspicuous birds of the lower Cooper River and Charleston Harbor. Resident and migratory waterbirds recorded in the vicinity of NAVBASE Charleston are listed in Army (1976b; 1977).

The diamondback terrapin is the only resident reptile of estuarine areas, with the exception of an occasional Atlantic loggerhead turtle (Caretta caretta), alligator (Alligator mississippiensis), and occasional snakes (Nerodia spp.) [U.S. National Oceanographic and Atmospheric Administration (NOAA), 1979].

A summary of aquatic ecosystems on NAVBASE Charleston and vicinity appears in table A-6. Tables A-7 and A-8 provide listings of fish and aquatic mammals occurring in Charleston Harbor and/or the Lower Cooper River.

THREATENED AND ENDANGERED SPECIES

South Carolina endangered species are "any species or subspecies of wildlife whose prospects of survival or recruitment within the State are in jeopardy or are likely within the forseeable future to become so," due to habitat destruction or modification; overutilization; effects of disease, pollution, or predation; and natural or manmade factors affecting its prospects for survival or recruitment within the state. It also includes all species on the Federal list (State of South Carolina, 1976).

Additional endangered species occurring along the coast of South Carolina include three species of marine turtles and seven species of cetaceans (Zingmark, 1978; Hall, 1981). These species are not expected

Table A-5
Common Wetland Mammals and Birds Recorded on NAVBASE Charleston During an August 1981 Site Survey

Animal	Common Name	Scientific Name
Mammals		
	Muskrat	(Ondatra zibethica)
	Raccoon	(Procyon lotor)
	Marsh rabbit	(Sylvilagus palustris)
Birds		
	Osprey	(Pandion haliaetus)
	Great egret	(Casmerodius albus)
	Snowy egret	(Egretta thula)
	Little blue heron	(Florida caerulea)
	Clapper rail	(Rallus longirostris)
	Boat-tailed grackle	(Quiscalus major)
	Red-winged blackbird	(Agelaius phoenicus)
	Long-billed marsh wren	(Cistothorus palustris)
	Common yellowthroat	(Geothlypsis trichas)

Source: ESE, 1981.

Table A-6
Aquatic Ecosystems on NAVBASE Charleston and Vicinity

Habitat	Ecology
Cooper River	The Cooper River Basin comprises 720 square miles of Coastal Plain in South Carolina. The Cooper River originates at the confluence of its east and west branches in Berkely County, S.C. and flows 32-miles southward to its outlet in Charleston Harbor. Its flow contains a large volume of water released from Pinopolis Dam for power generation. With the exception of some undeveloped sections, the west bank of the Cooper River is lined with Federal, State, and private docking facilities. Its east bank is largely undeveloped but contains a number of spoil disposal areas.
Shipyard Creek	Shipyard Creek is a small tributary, less than 1 mile in length, extending southeastward along the southwestern boundary of NAVBASE Charleston; it joins the Cooper River at river mile 8.7. Docking facilities are located along its western shore, while tidal marsh covers most of the eastern shoreline.
Noisette Creek	Noisette Creek is a small tributary of the Cooper River traversing the northern-most portion of NAVBASE Charleston. This shallow creek is surrounded by tidal marsh along most of its 2-mile length.
Clouter Creek	Clouter Creek is a small branch of the Cooper River surrounding the Naval spoil disposal area and adjoining marshes between river miles 11 and 15. Both sides of Clouter Creek are lined by extensive tidal marshes.

Table A-6
Aquatic Ecosystems on NAVBASE Charleston and Vicinity
(Continued, Page 2 of 2)

Habitat	Ecology
Wando River	The Wando River is a small coastal stream, with a watershed of approximately 120 square miles. It flows along the eastern shore of Daniel Island and joins the Cooper River at the southern tip of this island, 1 mile north of Grace Memorial (U.S. 17) Bridge. The lower Wando River is bordered by tidal marshes, the upper section by woodland.
Charleston Harbor	Charleston Harbor is a natural harbor, approximately 25 square miles in size and between 10 and 25 feet in depth; the depth in the ship channel is maintained at 35 feet. The City of Charleston is located in the northwestern corner of the harbor; smaller municipalities are located along its eastern shore. Spoil areas, islands, tidal flats, shoals, and extensive saltmarsh communities are located in and around this harbor. As discussed in section 5.4-2, Charleston Harbor provides important summer and wintering habitats for gulls, terns, pelicans, ospreys, and migratory waterfowl and shorebirds. It contains important nursery grounds for a variety of finfish and shellfish and supports an extensive sport and commercial fishery. The Charleston Harbor estuary has been studied to provide a complete inventory and evaluation of associated wetlands to determine their quality and quantity (State of South Carolina, 1972).

Source: Army, 1976b; Army, 1977.

Table A-7
Game and Commercially Important Fin- and Shellfish Occurring in Charleston Harbor and the Lower Cooper River

Animal	Common Name	Scientific Name
Fish		
	Striped bass	(*Marone saxatilis*)
	Blueback herring	(*Alosa aestivalis*)
	Shad	(*Alosa sapidissima*)
	Spot	(*Leiostomus xanthurus*)
	Weakfish	(*Cynoscion* sp.)
	Atlantic croaker	(*Micropogon undulatus*)
	Red drum	(*Sciaenops ocellata*)
	Northern kingfish	(*Menticirrhus sexatilis*)
	Bluefish	(*Pomatomus saltatrix*)
	Summer flounder	(*Paralichthys lethostigma*)
	Catfish	(*Ictalurus* spp.)
Invertebrates and Mollusks		
	White shrimp	(*Penaeus setiferus*)
	Brown shrimp	(*Penaeus aztecus*)
	Blue crab	(*Callinectes sapidus*)
	Scallops	(*Aequipecten* sp.)
	Quahogs	(*Mercenaria* sp.)
	Oyster	(*Crassostrea virginica*)

Sources: Army, 1976b; Army, 1977; Shell Oil Co., 1981.

Table A-8
Aquatic Mammals Recorded in Charleston Harbor or the Lower Cooper River, Charleston County, S.C.

Common Name	Scientific Name
Muskrat	(*Ondatra zibethica*)
River otter	(*Lutra canadensis*)
Harbor seal	(*Phoca vitulina*)
Bottle-nosed dolphin	(*Tursiops truncatus*)
Common dolphin	(*Delphinus delphis*)
Manatee	(*Trichechus manatus*)

Sources: Shell Oil Co., 1981; Army, 1977; ESE, 1981.

to enter Charleston Harbor or the lower Cooper River. The Eskimo curlew (Numenius borealis) and ivory-billed woodpecker (Campephilus principalis) are assumed extirpated in South Carolina (c.f.: Forsythe, 1978; State of South Carolina and The Citadel, 1976). Reported ranges for other South Carolina endangered species lie outside the Charleston County area.

The following species may occur on or in the vicinity of NAVBASE Charleston:

1. Florida manatee (Trichechus manatus)--Listed as endangered by FWS and WMRD, this marine mammal is an uncommon summer resident of South Carolina coastal waters. Manatees are expected to occur in Charleston Harbor and have been observed in the Cooper River along NAVBASE Charleston (Personal Communication, 1981).

2. Florida panther (Felis concolor coryi)--Listed as endangered by FWS and WMRD, some panthers may still exist in large river swamps of the South Carolina Coastal Plain (c.f.: Sanders, 1978; State of South Carolina and The Citadel, 1976). However, recent observations and reports have not been verified. No panthers are expected in the vicinity of NAVBASE Charleston, due to its urban setting and absence of suitable habitat.

3. Southern bald eagle (Haliaeetus l. leucocephalus)--Listed as endangered by FWS and WMRD, bald eagles occur in South Carolina as summer residents and winter migrants. They occur primarily on the Coastal Plain and may be expected along the Cooper River and Charleston Harbor. No nesting is expected at NAVBASE Charleston, due to its urban setting and lack of suitable nesting habitat.

4. Peregrine falcon (Falco peregrinus)--The American peregrine falcon (F. p. anatum) and Arctic peregrine falcon (F. p. tundrius), both listed as endangered by FWS and WMRD, are two subspecies occurring in coastal South Carolina during fall and winter migration periods (State of South Carolina and The Citadel, 1976; FWS, 1979). No nest sites are known from Charleston County, and no release sites or hack sites are planned (FWS, 1979). Due to the scarcity of this species and the absence of suitable feeding habitats, no peregrine falcons are expected at NAVBASE Charleston.

5. Brown pelican (Pelecanus occidentalis)--This species is listed as endangered by FWS and WMRD, but is a common resident of coastal Charleston County. Approximately 1,000 breeding brown pelicans were recorded nesting on Devaux Bank in 1975 and 1976 (Custer and Osborn, 1975). Colonial nesting occurs on coastal islands, and feeding occurs in coastal and estuarine water. No pelicans are expected to

nest in the vicinity of NAVBASE Charleston, and only occasional individuals are expected on the lower Cooper River.

6. Bachman's warbler (Vermivora bachmanii)--This species is listed as endangered by FWS and WMRD. It is the rarest and least known of North American warblers and, unless extirpated, would be expected in wooded swamps of the South Carolina Coastal Plain (Forsythe, 1978). Bachman's warbler is sporadically reported from the I'On Swamp in the Francis Marion National Forest (State of South Carolina and The Citadel, 1976). Due to the scarcity of this species and the absence of suitable habitat in the vicinity of NAVBASE Charleston, this species is not expected to occur onbase.

7. Kirtland's warbler (Dendroica kirtlandii)--This species is listed as endangered by FWS and WMRD and is the second rarest North American warbler. It nests exclusively in northern lower Michigan and is a rare transient on migration through South Carolina (nine records) (State of South Carolina and The Citadel, 1976). Due to its scarcity and to the absence of suitable habitat, this species is not expected on or in the vicinity of NAVBASE Charleston.

8. Red-cockaded woodpecker (Picoides borealis)--Although listed as endangered by FWS and WMRD, this species is fairly common in some areas of South Carolina, including sections of the Francis Marion National Forest (State of South Carolina and The Citadel, 1976; NWS, 1977). This species requires stands of mature pines (80+ years old) with an open understory (Thompson, 1971; State of South Carolina and The Citadel, 1976). Due to the absence of suitable habitat, this species is not expected on NAVBASE Charleston.

9. American alligator (Alligator mississippiensis)--In South Carolina, FWS lists the alligator as threatened in areas east of alternate U.S. Highway 17 between Georgetown and Walterboro and as endangered in areas west thereof (FWS, 1980b); it is listed as endangered by WMRD. Alligators are primarily found in fresh and brackish wetlands but also occur in estuaries. They have been reported from NWS (NWS, 1977) and lower Wando River (Army, 1977). Due to the presence of estuarine habitats on NAVBASE Charleston and the presence of alligators in the lower Cooper-Wando River area, alligators may be occasionally expected on or in the vicinity of NAVBASE Charleston.

10. Atlantic green turtle (Chelonia mydas)--This turtle is listed as threatened by FWS in South Carolina and as endangered by WMRD. This strictly marine turtle is rarely encountered during the summer months off the South Carolina coasts (Gibbons, 1978). It may have formerly nested on State

beaches (State of South Carolina and The Citadel, 1976). This species is not expected to enter the Cooper River, nor is it expected in the vicinity of NAVBASE Charleston.

11. Atlantic loggerhead turtle (Caretta caretta)--This marine turtle is listed as threatened by FWS and as endangered by WMRD. This turtle nests on South Carolina beaches (State of South Carolina and The Citadel, 1976) including Kiawah and Bull Islands (Personal Communication, 1981) and may enter tidal creeks and estuaries (Gibbons, 1978). Although occasionally expected in Charleston Harbor, it is not expected to enter the Cooper River or to occur in water surrounding NAVBASE Charleston.

12. Short-nosed sturgeon (Accipenser breviroshrum)--This small species, listed as endangered by FWS and WMRD, is the only endangered fish species which may occur in the Cooper-Wando River systems (Army, 1977). However, this species has disappeared from most rivers throughout its former range. Since NAVBASE Charleston is located along the Cooper River, this species may be an occasional transient in the study area.

13. Bunched arrowhead (Sagittaria fasciculata)--This wetland species is listed as endangered by FWS and occurs in scattered locations in swamps and bogs of North and South Carolina. This rare species was not recorded during a survey of the vascular flora of the Cooper River estuary (Batson, 1974). During this survey, Sagittaria species were recorded in Cooper River wetlands north of NAVBASE Charleston, north of Goose Creek (Batson, 1974). High salinity apparently excluded species within this genus from the lowermost Cooper River, including NAVBASE Charleston.