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INITIAL ASSESSMENT STUDY OF NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

NEESA 13-051

NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

Port Hueneme, California 93043

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INITIAL ASSESSMENT STUDY
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

UIC: N00389

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NAVY ASSESSMENT AND CONTROL
OF INSTALLATION POLLUTANTS (NACIP) DEPARTMENT
Naval Energy and Environmental Support Activity (NAVENENVSA)
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EXECUTIVE SUMMARY

This report presents the results of the Initial Assessment Study (IAS) conducted at Naval Station (NAVSTA), Roosevelt Roads, Puerto Rico. The purpose of an IAS is to identify and assess sites posing a potential threat to human health or to the environment due to contamination from past hazardous waste operations.

Based on information from historical records, aerial photographs, surface and aerial surveys, and personnel interviews, 20 sites were identified at NAVSTA Roosevelt Roads as significant. Each site was assessed with regard to contamination characteristics, migration pathways, and pollutant receptors. The study concludes that while none of the sites investigated pose an immediate threat to human health or the environment, 16 sites were determined to warrant further study under the NACIP Program. The sites for which further investigation has been recommended are listed in priority order below:

- Site 9, PCB Disposal, Dry Dock Area
- Site 7, Station Landfill
- Site 18, Pest Control Shop and Surrounding Area
- Site 12, Two Way Road Fuels Farm
- Site 15, Substation 2
- Site 11, Building 145
- Site 10, Building 25 Storage Area
- Site 3, IRFNA/MAF-4 Disposal Site, Vieques
- Site 13, Tanks 210 to 217
- Site 14, Ensenada Honda Shoreline and Mangroves
- Site 16, Old Power Plant, Building 38
- Site 2, Mangrove Disposal Site, Vieques
- Site 5, Army Cremator Disposal Area
- Site 6, Langley Drive Disposal Site
- Site 1, Quebrada Disposal Site, Vieques
- Site 8, Drone Washdown

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FOREWORD

The Department of the Navy developed the Navy Assessment and Control of Installation Pollutants (NACIP) Program to identify and control environmental contamination from past use and disposal of hazardous substances at Navy and Marine Corps installations. The NACIP Program is part of the Department of Defense Installation Restoration Program, and is similar to the Environmental Protection Agency's Superfund Program authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

In the first phase of the NACIP Program, a team of engineers and scientists conducts an Initial Assessment Study (IAS). The IAS team collects and evaluates evidence of contamination that may pose a potential threat to human health or the environment. The IAS includes a review of archival and activity records, interviews with activity personnel, and an on-site survey of the activity. This report documents the findings of an IAS at Naval Station (NAVSTA) Roosevelt Roads, Puerto Rico.

Confirmation Studies under the NACIP Program were recommended at 16 sites at NAVSTA Roosevelt Roads and on Vieques Island. Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM) will assist NAVSTA Roosevelt Roads, Puerto Rico, in implementing these recommended Confirmation Studies.

Questions regarding this report should be referred to Naval Energy and Environmental Support Activity (NAVENENVSA), Code 112N, at AUTOVON 360-3351, FTS 799-3351, or commercial 805-982-3351. Questions concerning Confirmation Studies or other follow-on efforts should be referred to LANTNAVFACENGCOM, Code 114, at AUTOVON 564-9566, FTS 954-9566, or commercial 804-444-9566.

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In particular, the efforts of the following people who assisted in coordinating and carrying out this study are acknowledged:

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CHAPTER 1. INTRODUCTION

1.1 PROGRAM BACKGROUND. Past hazardous waste disposal methods, although acceptable at the time, have often caused unexpected long-term problems through the release of hazardous pollutants into the soil and ground water. In response to increasing national concern regarding these problems, Congress directed the U.S. Environmental Protection Agency (EPA) to develop a comprehensive national program to manage past disposal sites. The program is outlined in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of December 1980.

1.1.1 Department of Defense (DOD) Program. DOD efforts in this area preceded the nationwide CERCLA program. In 1975 the U.S. Army developed for DOD a pilot program to investigate past disposal sites at military installations. DOD defined the program as the Installation Restoration Program in 1980, and instructed the services to comply with program guidelines.

1.1.2 Navy Program. The Navy manages its part of the program, the Navy Assessment and Control of Installation Pollutants (NACIP), in three phases. Phase one, the Initial Assessment Study (IAS), identifies potential threats to human health or to the environment caused by past hazardous substance storage, handling, or disposal practices at Naval activities. Phase two, the Confirmation Study, analyzes contaminants present at sites of concern and determines their migration paths. Phase three, Remedial Action, provides the required corrective measures to mitigate or eliminate confirmed problems.

1.2 AUTHORITY. The Chief of Naval Operations (CNO) initiated the NACIP Program in OPNAVNOTE 6240 of 11 September 1980; superseded by OPNAVINST 5090.1 of 26 May 1983. Commander, Naval Facilities Engineering Command (COMNAVFACENGCOM) manages the program within the existing structure of the Naval Environmental Protection Support Service (NEPSS), which is administered by the Naval Energy and Environmental Support Activity (NAVENENVSA). NAVENENVSA conducts the program's phase one IASs in coordination with COMNAVFACENGCOM Engineering Field Divisions (EFDs). Activities are selected for an IAS by CNO, based on recommendations by COMNAVFACENGCOM, the EFDs, and NAVENENVSA. CNO specifically approved Naval Station Roosevelt Roads, Puerto Rico, as well as all outlying facilities on the islands of Vieques, Culebra, St. Thomas, St. Croix, and Puerto Rico for an IAS by CNO letter 451/391407 of 31 March 1982 (see Figure 1-1).

1.3 SCOPE.

1.3.1 Past Operations. The NACIP Program focuses attention on past hazardous materials storage, use, and disposal practices on Navy property. Current practices are regularly surveyed for conformity to state and federal regulations and, therefore, are not included in the scope of the NACIP Program. The IAS report addresses operating non-hazardous disposal and storage areas only if they were hazardous waste disposal or storage areas in the past. Similarly, current operations are investigated solely to ascertain what types and quantities of chemicals were used and what disposal methods were practiced in the past.

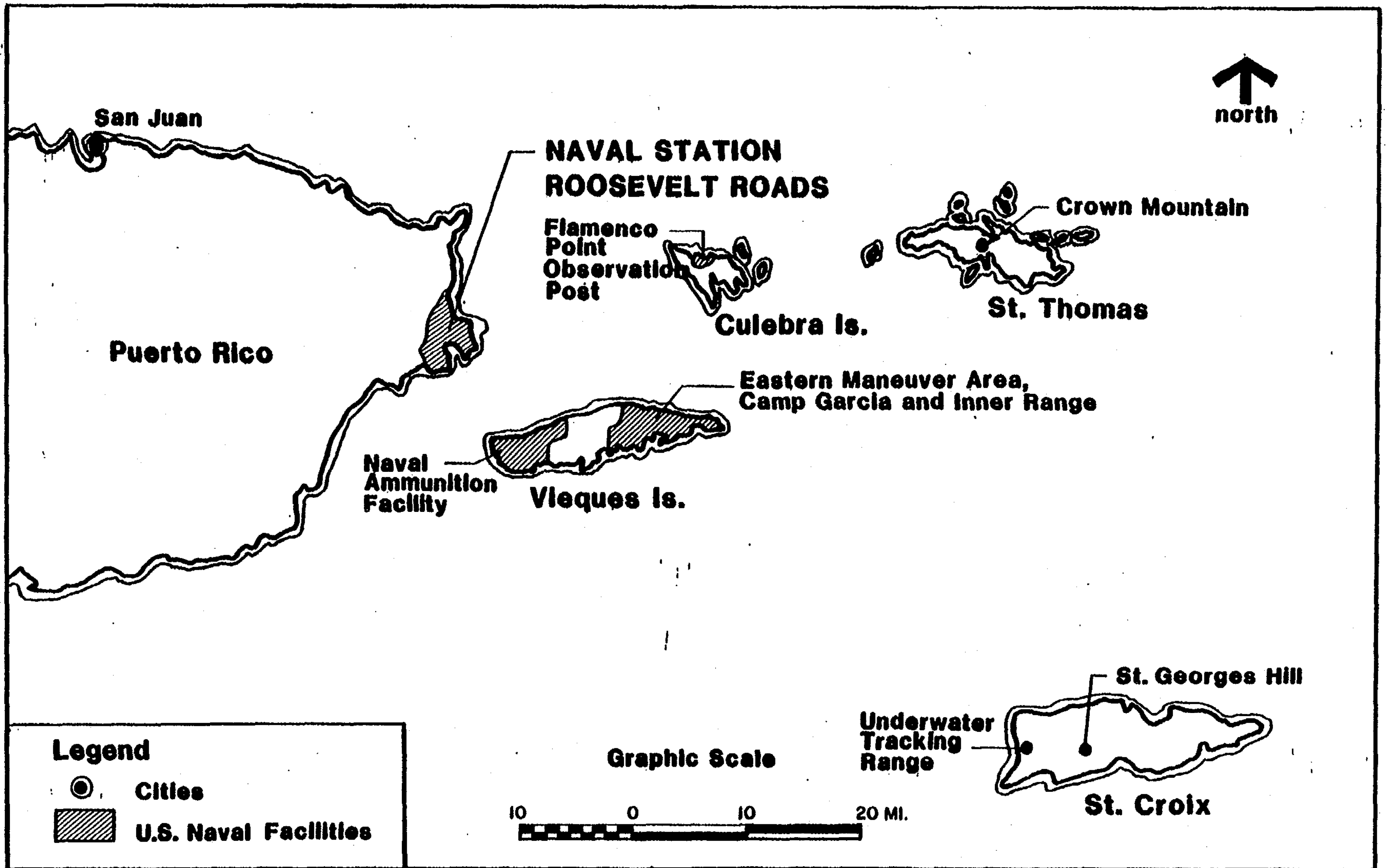

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Figure 1-1. Location of Naval Station Roosevelt Roads and Adjacent Island Installations

1.3.2 Results. An IAS recommends, if necessary, mitigating actions to be performed by the activity or EFD, or sampling and monitoring (Confirmation Studies) to be administered by the EFD under the NACIP Program. Based on these recommendations, COMNAVFACENGCOM schedules Confirmation Studies for those sites determined by scientific and engineering judgment to be potential hazards to human health or to the environment.

1.4 INITIAL ASSESSMENT STUDY (IAS).

1.4.1 Records Search. The IAS begins with a records search at various government agencies, including EFDs, national and regional archives and records centers, and U.S. Geological Survey offices. In this integral step, study team members review records to assimilate information about the activity's mission, industrial processes, waste disposal records, and known environmental contamination. Typical examples of records include activity master plans and histories, environmental impact statements, historical records, and aerial photographs. Appendix A lists the agencies contacted during this study.

1.4.2 On-Site Survey. After the records search, the study team conducts an on-site survey to complete documentation of past operations and disposal practices and to identify potentially contaminated areas. With the assistance of an activity point of contact, the team inspects the activity during ground and aerial tours, and interviews long-term employees and retirees. The on-site survey for Naval Station Roosevelt Roads and other facilities mentioned above was conducted from 15 January to 10 February 1984. Information in this report is current as of those dates.

Information obtained from interviews is verified by data from other sources or corroborating interviews before inclusion in the report. If information for certain sites is conflicting or inadequate, the team may collect a limited number of samples to provide additional clarification. For this study, the IAS team collected a number of samples from closed containers at Site 11, Building 145.

1.4.3 Confirmation Study Ranking System. With the information collected during the study, team members evaluate each site for its potential hazard to human health or to the environment. A two-step Confirmation Study Ranking System (CSRS), developed at NAVENENVSA, is used to systematically evaluate the relative severity of potential problems. As the first step, a flowchart based on type of waste, type of containment, and hydrogeologic characteristics, eliminates innocuous sites from further consideration. If the flowchart indicates a site has potential contamination, a ranking model is applied. The ranking model assigns a numerical score from 0 to 100 to each site. The score reflects the characteristics of the wastes, the potential migration pathways from the site, and possible contaminant receptors on and off the activity.

1.4.4. Site Ranking. After ranking a site, engineering judgment is applied to determine the need for a Confirmation Study or an immediate mitigating action. At sites recommended for further work, CSRS scores are used to develop a priority list for scheduling projects. For a more detailed description, refer to the NAVENENVSA Confirmation Study Ranking System (NEESA 20.2-042).

1.4.5 Confirmation Study Criteria. A Confirmation Study is recommended only for sites at which (1) sufficient evidence exists to indicate the presence of contamination, and (2) the contamination poses a potential threat to human health or to the environment.

1.5 CONFIRMATION STUDY. The EFD conducts the Confirmation Study, which has two phases--verification and characterization. In the verification phase, short-term analytical testing and monitoring determines whether specific toxic and hazardous materials, as identified in the IAS, are present in concentrations considered to be hazardous. If required, a characterization phase, using longer term testing and monitoring, provides more detailed information concerning the horizontal and vertical distribution of contamination migrating from sites, as well as site hydrogeology. If sites require remedial actions or additional monitoring programs, the Confirmation Study includes the necessary recommendations, including design parameters.

1.6 IAS REPORT CONTENTS. In this report, the significant findings and conclusions from the IAS are presented in Chapter 2. Recommendations are presented in Chapter 3. Chapter 4 describes general activity information, history, physical features, and biology. Chapters 5 through 8 trace the use of chemicals and hazardous materials, from storage and transfer, through manufacturing and operations, to waste processing and disposal. Chapters 5 through 8 also provide detailed information to support the findings and conclusions in Chapters 2 and 3.

2. SIGNIFICANT FINDINGS AND CONCLUSIONS

2.1 INTRODUCTION. This chapter summarizes the significant findings and conclusions developed by the Initial Assessment Study (IAS) team for Naval Station (NAVSTA) Roosevelt Roads and the outlying Naval facilities on Vieques, Culebra, St. Thomas, St. Croix, and Puerto Rico. Fourteen sites at NAVSTA Roosevelt Roads and six sites on Vieques were identified where hazardous materials were potentially disposed or spilled. These sites are shown on Figure 2-1 (rear pocket) for NAVSTA Roosevelt Roads and Figure 2-2 for Vieques.

Section 2.2 is a summary of the migration potential of contaminants from disposal and spill areas. Migration potential is related to the characteristics of the disposal sites, the physical and chemical properties of the waste, the soils, and the ground water system in the vicinity of the site. Section 2.3 is a discussion of sites recommended for Confirmation Studies. Section 2.4 is a discussion of the sites not recommended for Confirmation Studies. For each site, the evidence is summarized supporting or refuting the presence of a potential threat to human health or to the environment. More detailed site discussions are presented in Chapter 8.

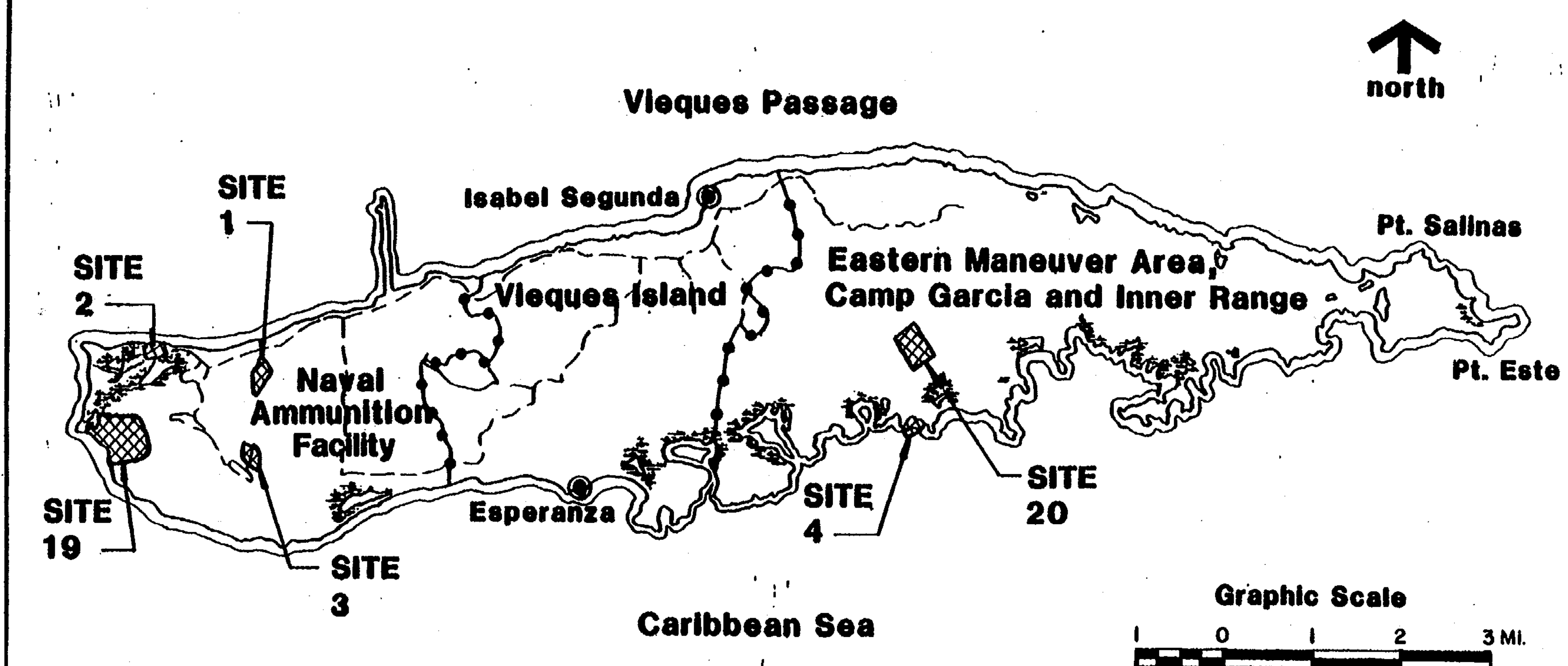
2.2 POTENTIAL FOR CONTAMINANT MIGRATION. Contaminant migration can occur in surface water through streams and ditches or in ground water. Ground water can discharge to surface water bodies such as streams, ditches, lakes, and bays.

The potential for contaminant migration in ground water is related to the physical properties of the aquifer, the chemical properties of the contaminant, and the hydraulic gradient. Migration potential is examined here in terms of a conservative chemical constituent traveling with the ground water. This does not take into account dispersion, dilution, attenuation, chemical reaction, or biological degradation of contaminants.

2.2.1 Vieques. Contaminants at the Naval Ammunition Facility (NAF) on Vieques can migrate by both surface water and ground water. The most likely pathways of surface water migration are from runoff in the quebradas, which are intermittent drainage areas. Runoff in the quebradas along the northern portion of Vieques enters the Vieques Passage. Runoff in the quebradas along the southern portion enters the Caribbean Sea. Other pathways include the areas of mangrove swamp that are subject to tidal inundation and ground water.

Ground water on Vieques flows generally to the northwest in the Valle de Resolución, one of the two main sources of ground water on the island and the only source located within the NAF boundaries. The Valle de Resolución is possibly subject to contamination. However, all potable water from the NAF and most of the rest of the island is supplied by pipeline from Puerto Rico; only a few houses outside the distribution system use ground water from the other source of ground water on the island, the Valle de Esperanza, located to the east outside the boundaries of the NAF.

Potential receptors in and around Vieques include such endangered species as the Caribbean manatee (Trichechus manatus) and the hawksbill, leatherback, green, and loggerhead sea turtles, all of which are found in the Vieques



Legend

Site #	Site Name				
Confirmation Sites		**Non-Confirmation Sites**			
1	Quebrada Disposal Site	4	Fuels Off-Loading Site	—•—•—	Navy Property
2	Mangrove Disposal Site	19	EOD Range	— —	Roads
3	IRFNA/MAF 4 Disposal Site	20	Camp Garcia Disposal	◉	Towns
					Mangroves

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Figure 2-2 Areas of Significant Findings at Vieques Island

Passage. In addition, one spring on NAF property currently leased to a cattlemen's cooperative serves as a water source for wildlife and livestock.

2.2.2 NAVSTA Roosevelt Roads. Contamination at NAVSTA Roosevelt Roads can migrate both by surface water and by ground water. The most likely pathways of surface water migration are from runoff in the drainage ditches, which flow either into the Rio Daguao watershed, which occupies 2,000 acres on the southwestern portion of the base, or into Ensenada Honda, Puerca Bay, Medio Mundo Passage, Port Medio Mundo, or the mangrove swamps found along the shoreline of the station. Contamination from areas within the mangroves enters the surface waters when the swamps are inundated by tidal action. All surface waters from NAVSTA Roosevelt Roads eventually enter the Vieques Passage.

Ground water at NAVSTA Roosevelt Roads flows generally to the southeast. The alluvial aquifers are shallow (less than 30 meters deep) and yield water with high concentrations of iron and manganese from lenticular beds of clay, sand, gravel, and rock fragments. No use is made of ground water on the station; the nearest successful ground water development is approximately 10 kilometers to the north near Fajardo.

Receptors in the area of NAVSTA Roosevelt Roads include such endangered species as the Caribbean manatee; the hawsbill, leatherback, loggerhead, and green sea turtles; the yellow-shouldered blackbird; the Eastern brown pelican; the American peregrine falcon; the Puerto Rican plain pigeon; and the Puerto Rican boa. In addition, contamination may enter the human food chain through consumption of fish, shellfish, and crustaceans caught by base personnel or the local civilian population.

2.3 CONFIRMATION SITES.

2.3.1 Site 1, Quebrada Disposal Site, Vieques. This disposal area is located in the north-central portion of the NAF, Vieques, south of North Shore Road, within and adjacent to a quebrada which discharges to the Vieques Passage and ultimately to the Atlantic Ocean and the Caribbean Sea (see Figure 2-2). The site was in use from the early 1960s to the late 1970s by both civilian and U.S. Navy personnel. The site covers an area approximately 500 feet long by about 20 feet deep, and is about four feet wide. The IAS team estimates that there are about 1,500 cubic yards of trash at the site, including ordnance carriers; cans of oil and lubricants; solvents; paint; rubble; buried and exposed 55-gallon drums; cars; and all types of general base trash. The material apparently was tumbled down the side of the quebrada, and is partially buried. Some material lies on the bottom of the quebrada, where it has been transported further toward the Vieques Passage by the water that floods the quebrada.

No reliable information exists of the amount of material present that may be hazardous. The IAS team has calculated that possibly 15 cubic yards (between 3,000 and 13,000 pounds) of material could be considered hazardous when disposed, primarily solvents and paints (see page 8-1).

The disposal area is approximately 350 meters south of the Vieques Passage, and is about 10 meters above sea level. The slope of the quebrada is about 3%, with the exception of the 50 meters nearest the Vieques Passage, where the slope is about 10%. The soils in the quebrada are in the Coamo-Guarnani-Vives Association, and are moderately permeable (10^{-3} to 10^{-4} cubic meters per second).

Receptors in the Vieques Passage include such endangered species as the Caribbean manatee and the hawksbill, leatherback, green, and loggerhead sea turtles.

Contamination also could enter the human food chain through the consumption of fish caught in this area by base personnel or the local civilian population.

Site 1 is recommended for a Confirmation Study.

2.3.2 Site 2, Mangrove Disposal Site, Vieques. The mangrove disposal site (Site 2) is located in the northwestern portion of Vieques along North Shore Road (Route 70) (see Figure 2-2). The site stretches along North Shore Road for approximately 300 feet, and extends into a seaside mangrove swamp for about 100 feet. The site is located immediately east of the Laguna Kiani bridge, between Laguna Kiani and the Vieques Passage. During the 1960s and 1970s the site was used as a base disposal area. Materials found at the site include all types of trash, cans of oil and lubricants, solvents, paint, and rubble. The site contains an estimated 800 cubic yards of material. The material was piled, burned, and shoved into the mangrove swamp. No reliable information exists regarding the amount of material disposed of at the site that might be hazardous. The IAS team has calculated that possibly eight cubic yards (between 1,600 and 7,000 pounds) of material could be hazardous (see page 8-3).

Any contamination resulting from the waste disposed of at this site washes immediately into the ocean and would affect sea life, including manatee and sea turtle breeding and feeding grounds. The manatee and various species of sea turtles found in the Vieques Passage are listed as endangered or threatened species by the federal and Commonwealth governments. Contaminants also could enter the human food chain through the consumption of seafood caught in this area, especially the soft-shell crabs that are trapped in the vicinity of the Laguna Kiani Bridge.

Site 2 is recommended for a Confirmation Study.

Recommendations were made to remove the trash in the Draft Environmental Impact Statement (TAMS/E & E, 1979) and in the Mangrove Forests of Vieques report (Lewis et al., 1981) to ensure preservation of the mangroves as well as the sea life and and wildlife in the area. However, any cleanup activities should be delayed until completion of the Confirmation Study.

2.3.3 Site 3, IRFNA/MAF-4 Disposal Site, Vieques. In 1975, Weapons Department personnel emptied the fuel from 25 AQM-37A target drones into a quebrada near Building 422 at the NAF, Vieques (see Figure 2-2). A maximum total of 1,775 pounds of mixed amine fuel (MAF-4) and 5,275 pounds of inhibited red fuming nitric acid (IRFNA) were poured into the low area.

The quebrada lies within the surface drainage area for one of the few running springs on Vieques. The spring lies about 1.8 kilometers southeast of the disposal site. The source of the spring is not known; however, the general direction of flow in the Valle de Resolución ground water system is to the northwest, with water-bearing lenses found at a depth of about 30 meters, with no known springs. It is probable that the spring derives its flow primarily from surface recharge, including the drone fuel disposal area. The spring is on the property of the Cooperativa de los Ganaderos, a privately run livestock raising cooperative. The spring is used by both livestock and wildlife. Usually once a year, all other water sources (troughs, tubs, etc.) are removed to force the livestock to the spring, the only available source of water, where they can be captured, counted, or branded by cooperative members.

Site 3 is recommended for a Confirmation Study.

2.3.4 Site 5, Army Cremator Disposal Area. The Army Cremator disposal area (Site 5) is located south of the intersection of the access road to the Ammo Pier and Langley Drive, west and southwest of the Navy Exchange and Bowling Alley, in and near the Ensenada Honda mangrove swamp (U.S. Fish and Wildlife Service, 1978) (see Figure 2-1). Designated as the "Army Cremator" on early station maps, the area was used for waste disposal from the early 1940s through the early 1960s. Specific information concerning the materials disposed of at this site is limited. It is known, however, that most solid waste generated on the base during this time was disposed of at this site. An estimated 100,000 tons of waste material were disposed of here, including scrap metal, batteries, tires, appliances, cars, cables, dry cleaning solvent cans, paint cans, gas cylinders, construction debris, dead animals, and residential waste. During the aerial survey, the IAS team also viewed several large mounds of drums, some of which appeared to be intact in the trees. The material was disposed of by piling and burning, and then compacting. No reliable information exists regarding the amounts of material present in the disposal area that could be hazardous. The IAS team estimates that as much as 1,000 tons of hazardous material could be present in the area (see page 8-5).

Migration of contaminants to the Ensenada Honda mangrove area and ultimately to Ensenada Honda is probable. Some of the disposed material lies directly in the mangrove swamp, and is subject to periodic tidal inundation. The majority of the material lies on soils of the Swamp-Marshes Association, which are poorly drained, and subject to flooding by high tides or following intensive rainfall.

The mangroves are considered an ecologically important area because they provide food and shelter for the minute organisms at the start of the food chain. The disposal area itself is designated by NAVSTA Roosevelt Roads (LANTNAVFACENGCOM, 1981) as habitat for the short-eared owl (see Figure 4-1). The Ensenada Honda mangrove area provides habitat for the following species: the white-crowned pigeon, yellow-shouldered blackbird (a federally listed endangered species), reddish egret, common egret, snowy egret, great blue heron, whimbrel, osprey, and willet. Ensenada Honda provides habitat for the West Indian manatee and several species of sea turtles which are federally designated endangered species. Contamination from the Army Cremator disposal area could affect the food chain for these endangered species, as well as base personnel and civilians through bioaccumulation of contaminants contained in the small fishes and other marine life upon which they feed.

Site 5 is recommended for a Confirmation Study.

2.3.5 Site 6, Langley Drive Disposal Site. The Langley Drive disposal site (Site 6) served as a landfill from approximately 1939 to 1959 (see Figure 2-1).

The volume of waste disposed of at the site is estimated to be 1,700 cubic yards of material and fill. Materials found during site inspection included partially buried metal and concrete objects, old fuel lines, flexible metal hoses, small containers containing pellets, steel cables, hardened tar, rubble, and 10 to 15 full 55-gallon drums which are corroded. The drum contents, usually consisting of a whitish solid with a green outer crust, are exposed. The IAS team estimates that as much as 20,000 pounds of hazardous material could be present at the site (see page 8-7).

The disposed material lies within the perimeter of the Ensenada Honda mangrove area. Surface and subsurface drainage flows directly into the immediate mangrove area and subsequently into Ensenada Honda. Much of the disposed material is partially buried in the mangrove mud; the area visited by the IAS team lies completely within the mangrove swamp and is subject to periodic tidal inundation.

Primary receptors are the flora and fauna, including endangered species which inhabit the mangrove environment (see Section 2.3.4). Stressed vegetation is apparent at the site. Secondary receptors are those species which live at the mangrove-bay exchange zone, including sea turtles and manatees which are listed as threatened and endangered species by the federal government. The site could also present a hazard to the base population through the food chain since the Army Pier, a prime recreational fishing area, is located adjacent to the drainage.

Site 6 is recommended for a Confirmation Study.

2.3.6 Site 7, Station Landfill. This site has been used as the station landfill since the early 1960s, when the Army Cremator disposal area (Site 5) was abandoned (see Figure 2-1). The landfill reportedly has received at least 270,000 tons of waste including paint waste, solvents, polychlorinated biphenyls (PCBs), OTTO Fuel II, Agentine, pesticides, transformers, asbestos, waste oil, dead animals, and other wastes. Prior to 1978, disposal was not regulated. The site encompasses 85 acres, most of which were used for waste disposal prior to 1978.

A number of drums and other containers are piled in the brush around the site. No reliable information exists regarding the amount of material that might be hazardous that was disposed of at this location. At least 200 gallons of PCB dielectric fluids were disposed of here, as well as several 55-gallon drums filled with fluids drained from transformers that could be contaminated with PCB. The IAS team estimates that as much as 2,700 tons of hazardous material could be present at the older portions of the site (see page 8-9).

Contamination from this site could migrate by surface and subsurface flow. The soils of the site are hydraulic fill, which generally consists of sand and mud. The water table in this area is very near the surface, everywhere less than 10 feet, and in places at depths of two feet or less. Ground water flow has not been measured in the area, but can be assumed to be in all directions toward the surrounding bodies of water, e.g., the Ensenada Honda and Puerca Bay.

Ensenada Honda provides habitat for the West Indian manatee and several species of sea turtles designated as endangered species. In addition, the entire Naval

Station, with the exception of built-up areas, has been officially designated as critical habitat for the yellow-shouldered blackbird. Contamination from the old sections of the station landfill could affect the food chain through bioaccumulation of contaminants contained in the small fishes and other marine life upon which these endangered species feed; base personnel and the local population also fish in these areas.

Site 7 is recommended for a Confirmation Study.

2.3.7 Site 8, Drone Washdown. The drone washdown site (Site 8) is located adjacent to Building 860 (see Figure 2-1). During the 1960s and 1970s approximately 4,000 gallons of oil, grease, and JP-4 and JP-5 fuel were disposed of in a drainage ditch adjacent to Building 860. The drainage system flows through mangrove areas to Ensenada Honda. Movement of contaminants from this site would be primarily by surface flow.

Ensenada Honda is a feeding and breeding ground for the endangered West Indian manatee and four species of sea turtles. The mangrove areas contain such receptors as the endangered yellow-shouldered blackbird and is an important habitat for small fishes and other food organisms.

Contamination could also enter the human food chain through bioaccumulation in the fish feeding in this area of the harbor, which could be consumed by base personnel or the local civilian population.

Site 8 is recommended for a Confirmation Study.

2.3.8 Site 9, PCB Disposal, Dry Dock Area. In approximately 1968, 25 five-gallon cans (125 gallons) of Askarel (a PCB dielectric fluid) were disposed of by dropping them into Puerca Bay off the south side of the wharf at the dry dock (see Figure 2-1). Some of the cans, which had been stored in Public Works Building 31, were in a rusted condition at the time of the disposal.

The site is located in an area designated as critical habitat for the manatee (see Figure 4-1), and is also a known habitat for several Commonwealth and federally designated rare and endangered species, including several species of sea turtles. Potential receptors of PCB contamination from this site also include infaunal and sessile benthic organisms (polychaetes, corals, bivalves, clams, and annelides), predators of benthic organisms (fish), and ultimately the people who use the wharf for recreational fishing.

Site 9 is recommended for a Confirmation Study.

2.3.9 Site 10, Building 25 Storage Area. Building 25 was used for temporary storage of Public Works-Supply Department material scheduled to be turned over to the Defense Property Disposal Office (DPDO). Building 25 was used from the 1940s to about 1979, when it collapsed. The site contains material within the collapsed building, around the building, and randomly scattered along the various access roads in the immediate vicinity (see Figure 2-1). Material found included 20 to 25 apparently empty to partially filled 55-gallon drums, 10 to 15 corroded five-gallon pails (the contents of which have been exposed to the environment), asbestos sheeting, transformers (one of which has leaked dielectric fluid), mechanical devices, gas cylinders, and construction rubble. The overgrown areas between the access roads have been used for the disposal of similar material, including containers and large canisters. In addition, adjacent to the northern boundary of the Building 31 transportation lot, approximately 50 drums are present, most of which are full or partially full. Some of the drums are leaking. Some of the containers appear to have been used for the disposal of materials other than their original contents, i.e., they have obviously been opened and reused. Other containers appear to be intact, and may contain the original material. Most original markings on the containers are no longer discernible. The IAS team has concluded, based on the sampling efforts conducted at Site 11, Building 145, that the contents of these containers would be classified as hazardous.

Due to the physical characteristics of the site and the lack of ground water use, ground water contamination is not of great concern, although stressed vegetation was evident in the immediate location of some drums. However, the location of these leaking drums allows direct contact with base personnel, thus representing an immediate health and safety concern. Because of the free access to the area, the primary receptors are base personnel and wildlife.

Site 10 is recommended for a Confirmation Study.

2.3.10 Site 11, Building 145. Building 145 (Site 11) contains an estimated 60 55-gallon drums, about 100 five-gallon pails, and a number of other small containers (see Figure 2-1). The building is a bunker about 60 yards long and about seven feet high and eight feet wide, with three openings to the surface through the roof covered with dilapidated wood structures, and one entrance at ground level. Based on the structure's shape and location, it is probable the building was designed to be used for activities in conjunction with the dry dock.

The drums and other containers have been in the building for some years, probably since 1957. Samples were taken by the IAS team from 21 55-gallon drums, eight five-gallon pails, and three areas of spills or other materials. This left over 75 containers unsampled. The containers sampled ranged from drums with fairly discernible markings and intact bung seals, to drums and pails that had obviously been opened and used for disposal of waste material. Material identified only by sight by the IAS team included spray paint, olive drab paint, black boot polish, and some adhesives. The remaining materials are awaiting analysis by contract laboratories under hire to Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM).

A number of containers that were not opened have rusted through, or are missing tops or bungs. Some containers are intact, and probably contain the original material shipped in them. Other containers have obviously been used for the disposal of materials other than their original contents. Most containers have illegible markings. Some containers have totally disintegrated, and their contents have spilled onto the floor. Based on the nature of the material sampled, and the ambient air characterization readings obtained with various instruments during the sampling effort, the IAS team has concluded that the majority of the material (an estimated 2,000 gallons) could be classified as hazardous.

A number of containers are on the verge of rupturing or leaking. The ambient air characterization conducted by the IAS team indicates that the contents of these containers are highly volatile; additional leaks could lead to an explosive or flammable atmosphere in the building.

The tunnel has water, probably rain water, in the lowest point. Several trees have sunk roots into the water through the roof opening. The concrete floor seems impervious. The building is accessible to base personnel.

Site 11 is recommended for a Confirmation Study.

2.3.11 Site 12, Two Way Road Fuels Farm. A number of fuel storage tanks are located north of Two Way Road on a hill overlooking Ensenada Honda (see Figure 2-1). Spills, leaks, and sludge disposal have occurred here since 1957.

In 1957 or 1958 a fuel line to Tank 82 burst, resulting in a major spill of Bunker C fuel. It is estimated that 420,000 gallons of Bunker C fuel leaked from the storage tank. The oil spill followed a path downhill toward the harbor in a southwesterly direction across Two Way Road and into Ensenada Honda, extending to the shoreline and the Ensenada Honda mangrove swamp across the harbor.

It is also estimated that 420,000 gallons of fuel spilled from Tanks 56A and 56B, located north of Building 54 on Two Way Road, onto the surrounding soil over a 15- to 20-year period. The tanks were removed in February 1984. A dark fuel-stained soil was present around the old tanks. Isolated pools of oil from the spills and leaks were evident on the ground water that seeped into the holes where the tanks had been removed.

Between 1971 and 1972, Tanks 83 and 1080 were cleaned and the Bunker C fuel-sludge was emptied into two pits dug within a 100-foot radius of the tanks. One pit was dug approximately 100 feet in circumference and 10 to 20 feet in depth near Tank 83; the second pit was 50 feet in circumference and 10 to 20 feet in depth near Tank 1080. It is estimated that 3,900 to 7,500 cubic yards of Bunker C fuel-sludge were cleaned from the tanks and disposed of at the site in these pits.

In 1978 a leak occurred at Tank 1080, resulting in the release of about 65,000 gallons of diesel fuel from the tank. It is estimated that about 10,000 gallons were recovered during cleanup operations. Effects from the spill are still present along the approximate 2,000-foot-long, 100- to 200-foot-wide spill corridor. These include stressed vegetation, stained soil devoid of vegetation, constant seepage of fuel into the leaching trench and the harbor, and contaminated shoreline and mangrove swamps.

Contaminants could migrate from the site by surface and subsurface flow. Oil-stained ground at the site clearly depicts the surface flow pattern from the bermed fuel farm through culverts across Two Way Road to an outlet into Ensenada Honda, where oil booms are left in place to catch the oil that still emerges after rainfall. A leaching pit dug to the northwest of the Fuel Pier is filled with oil that is migrating below the surface. Diesel fuel was observed on top of ground water in the holes where Tanks 56A and 56B were removed.

Receptors in this area include wildlife and sea life in the Ensenada Honda mangrove area and Ensenada Honda, including manatees and sea turtles. Contamination may also enter the human food chain through the consumption of fish caught in the harbor by base personnel or the local civilian population.

Site 12 is recommended for a Confirmation Study.

2.3.12 Site 13, Tanks 210 to 217. This site is located within a 300-foot diameter around each of the Tanks 212 to 217 along Manila Bay Road, north of Forrestal Drive (see Figure 2-1). The tanks were constructed in 1948 for the storage of AVGAS, and were cleaned approximately every five years until 1978. (This excludes Tanks 210 and 211, which were abandoned in 1950, and probably cleaned only once.) Tank cleaning normally resulted in the removal of 20 to 30 drums (800 to 1,250 gallons) of leaded sludge per tank. This sludge was disposed of in a series of pits (eight feet by eight feet by eight feet), which were dug by a backhoe within 300 feet of the tank being cleaned. After the sludge settled in the pits, it was covered with three to four feet of soil. It is estimated that 30,000 to 50,000 gallons of leaded sludge were disposed of at these areas over a 40-year period.

The contaminants could migrate from the site by subsurface flow. The disposal pits are located on hillsides at elevations five to 15 meters above the adjacent Machos mangrove swamp. The slope from the tanks to the swamp varies from 10% to 40%. The soils are in the Descalabrado clay loam and Jacana clay series, which have shallow depth to bedrock.

Receptors include the Machos mangrove area, which is a habitat for the yellow-shouldered blackbird. Contaminants would also enter the Vieques Passage, which serves as a breeding and feeding ground for the manatee and sea turtles previously discussed. The mangroves also serve as a habitat for many juvenile fish species.

Contamination may also enter the human food chain through consumption of fish caught in the harbor by base personnel or the local civilian population.

Site 13 is recommended for a Confirmation Study.

2.3.13 Site 14, Ensenada Honda Shoreline and Mangroves. This site is located in Ensenada Honda and along the shoreline adjacent to Berthing Pier No. 3, Community Beach, the mangrove swamp north of Community Beach, and the area south to about Punta Cascajo (see Figure 2-1). It is estimated that 210,000 gallons of diesel fuel spilled into the harbor from the tanker ship, the Arco Prestige, in 1981. Cleanup operations were conducted by the Navy and Crowely Environmental Company. An oil separator barge was used to collect oil from the harbor, and absorbent pads were used to remove oil along the shoreline. Oil-stained sand was also removed from Community Beach. An estimated 20,000 gallons were recovered. The remainder of the fuel was blown ashore or sank. In addition, material from the 1978 diesel spill from Tank 1080 and the 1958 Bunker C fuel spill from Tank 82 drifted into the Ensenada Honda mangroves.

Spilled oil can still be found in the Ensenada Honda mangrove swamp and along the shoreline in proximity to the berthing pier. Contamination may also be present on the bottom of the harbor. Receptors include the manatee and sea turtles previously discussed, the endangered yellow-shouldered blackbird, and the many juvenile and food organisms found in the mangrove swamps. Contaminants may also enter the human food chain through the consumption of fish caught in the harbor by base personnel or the local civilian population.

Site 14 is recommended for a Confirmation Study.

2.3.14 Site 15, Substation 2. This area has been utilized for the repair of electrical transformers since 1964 (see Figure 2-1). From 1964 to 1979 oil drained from transformers was poured onto the ground in the vicinity of Building 90 (Substation 2). It is estimated that a maximum of 3,000 gallons of transformer oil, probably containing PCB, were disposed of at this site.

The soils at this site are probably contaminated with PCB. This site poses a potential threat to the health of the workers who currently work at the site.

Site 15 is recommended for a Confirmation Study.

2.3.15 Site 16, Old Power Plant, Building 38. From 1956 to 1964 Building 38 (Site 16) was used for the repair and storage of electrical transformers (see Figure 2-1). During this period, used oil drained from transformers was poured onto the ground in the vicinity of Building 38. It is estimated that a maximum of 1,600 gallons of transformer fluid probably containing PCB were disposed of in the area.

Contamination from this site could migrate by subsurface flow. The site is at a high point on hydraulic fill with a gentle (3%) slope to the northeast toward Puerca Bay and southwest toward Ensenada Honda, both within 250 meters. The water table is at about a 10-foot depth. Immediately southwest, west, and north of the site is a large rock outcropping 10 meters high surrounding Building 38 on three sides and limiting ground water movement in three directions. Immediately southwest of the disposal site, and running across the width of the peninsula, is a subsurface inlet-outlet tunnel for cooling water for the old power plant, which withdrew water from Ensenada Honda and discharged it to Puerca Bay. Contaminants from the disposal site could migrate to the southeast to the cooling water tunnel, and migrate along the trench to the northeast and southwest.

Both Puerca Bay and Ensenada Honda provide habitat for the endangered West Indian manatee and several endangered sea turtles. Potential receptors include base personnel, who fish in the harbors, and the endangered manatee and sea turtles.

Site 16 is recommended for a Confirmation Study.

2.3.16 Site 18, Pest Control Shop and Surrounding Area. Building 258 served as the Pest Control Shop from the late 1950s through 1983 (see Figure 2-1). Accidental spillage of pesticides occurred in and around the building during this time. The immediate area is devoid of vegetation. Pesticide application equipment was routinely cleaned over a storm drain which discharged to a ditch in back of the building. Excess pesticides were also disposed of in this ditch, where vegetation kills have been reported. According to Annual Pest Management Plan for NAVSTA Roosevelt Roads, pesticides used in the past include

DDT, Paris Green, maldene, malathion, and chlordane. Pesticide odors are very strong in the vicinity of Building 258, even though pesticides have not been stored there since 1983.

No reliable information exists regarding the amount of pesticides used, spilled, or disposed of at the site. The IAS team estimates that at least 10 gallons of malathion from a ruptured 55-gallon drum entered the drainage ditch; other spills, leaks, and rinse water could amount to several hundred gallons of material spilled over the more than 20 years of operation.

The drainage ditch is located within two meters of the storm drain used for equipment washdown, and about 10 meters from the building itself. Areas of stressed vegetation are within one meter of the ditch, which flows into Ensenada Honda. Contaminants could have migrated from the site by surface flow through this system.

Receptors include the endangered species previously discussed, and might include base personnel who consume fish caught in Ensenada Honda.

Site 18 is recommended for a Confirmation Study.

2.4 NON-CONFIRMATION SITES AND OTHER SIGNIFICANT FINDINGS.

2.4.1 Site 4, Fuels Off-Loading Site, Vieques. This site is located off the south coast of Vieques in Ensenada Tanqueray east of Bahia de la Chiva (Blue Beach) (see Figure 2-2). Over a 25-year period, offshore refueling of four fuel tanks (containing diesel fuel, MOGAS, and JP-5 fuel) that were located on a hilltop overlooking the bay occurred a maximum of four times a year. Fuel was pushed through an eight-inch submarine pipeline to remove the saltwater. The seawater/fuels mixture spilled onto the shore as the line was cleared; once fuel pumping was complete, the line was detached from the fuels barge and dropped back into the water.

The effects of spills resulting from the refueling operation were minimal. An extensive environmental survey conducted in 1978 (TAMS/E & E, 1979), shortly after the tanks were dismantled and the refueling halted, failed to find any indications of stressed vegetation or fauna; no oiled beaches or other indications of pollution were found. Because no effects on the environment or to human health could be postulated, Site 4 is not recommended for a Confirmation Study.

2.4.2 Site 17, Crash Crew Fire Training Area. Two unlined fire fighting training pits were used from 1963 to 1983 at the Crash Crew training area (Site 17) located near Building 827 (see Figure 2-1).

The first pit, which was used for about 20 years (1963 to 1983), received approximately 120,000 gallons of waste solvents, fuels, oil-stained absorbent pads, fuel filter elements, trash, wood, oily rags, plastic, and oils from various departments at Roosevelt Roads, including Hangar 200, Aircraft Intermediate Maintenance Division (AIMD), Fleet Composite Squadron Eight (VC-8), Navy Marine Construction Battalion (NMCB), Surface Operations, and the Fuels

Division. A new concrete-lined fire fighting training pit of about the same dimension (40-foot diameter) was constructed in 1983 in the same location as the old pit. Visibly contaminated soils were excavated in the immediate vicinity of the old pit during construction; there are no records of ultimate disposal for this contaminated material. A soil sample was taken of this soil and no PCBs were detected.

Another unlined fire fighting training pit measuring about 200 feet in diameter was only used five or six times in 1983 during the construction of the new pit mentioned above. Approximately 3,000 gallons of waste oil, fuel, oily rags, trash, wood, plastic, and solvents were burned in this area. The majority of material was burned.

Because the contaminated soils associated with the original fire pit were removed during construction of the new pit and no PCBs were detected, and because the temporary pit was used so little, the IAS team has concluded that there is no threat to human health or the environment from this site. No further action under the NACIP Program is warranted.

2.4.3 Site 19, West Explosive Ordnance Disposal (EOD) Range, Vieques. The West EOD Range (Site 19) on Vieques was located on the western edge of the island, on NAF property, within an estimated one-half-mile radius of the old bridge at Punta Boca Quebrada (see Figure 2-2). Other ranges have been used and are being used on Vieques; however, these ranges are outside the scope of the IAS. The West EOD Range was in operation from at least 1969 to 1979, and according to some interviewees, had perhaps been in use since the late 1940s.

The West EOD Range was used for disposal of excess and retrograde ammunition and, on a twice yearly basis, unexploded munitions found around the targets on the Eastern Maneuver Area (EMA). Other sources of materials would be the material from the rework of munitions (loose powder, primers) and ordance items from the Torpedo Shop. Materials disposed of at the site include flares and cartridge-activated devices. The range had a maximum blow limit of 4,000 pounds of TNT equivalent.

The range was closed in 1976 to most uses and swept for a one-mile radius by EOD personnel at least three times. The range was fully closed in 1979.

Currently, only inert items are visible in the area. Due to the limited nature of materials disposed of there (for example, no smoke generating material or other chemicals were disposed of) and the extensive cleanup of the area, the IAS team has concluded that further study of the site under the NACIP Program is not warranted.

2.4.4 Site 20, Camp García Disposal Site, Vieques. The Camp García disposal site (Site 20) is located on high ground approximately 3,000 to 4,000 feet north-northwest of Bahía de la Chiva (Blue Beach) and 1.5 to 2 miles east of Camp García (see Figure 2-2). The site was in operation from approximately 1954 to 1978. It is estimated that 1,800 to 3,120 tons of waste, including paper, corrugated containers, rugs, wood, scrap metal, cans and food packaging materials, and yard waste, were brought to the site and burned (trench method of disposal). No hazardous materials were placed in this disposal area. The materials disposed of at the site present no threat to ground water or to the wildlife and sea life at or in proximity to the site.

Other disposal areas on Camp García include a construction rubble disposal area, a scrap metal disposal area, and an aboveground disposal area for general trash. These areas do not constitute a potential pollution threat. The IAS team has concluded that further investigation under the NACIP Program is not warranted.

2.4.5 Crown Mountain, St. Thomas. The Crown Mountain site facility on St. Thomas is part of the Atlantic Fleet Weapons Training Facility (AFWTF) target tracking and control system, and serves also to track aircraft and surface vessels in conjunction with AFWTF facilities at Pico del Este (see Figure 2-3).

Waste generating activities at the current site (occupied since 1975), and the old site some 100 yards away, have been extremely limited. All solid wastes are disposed of by island authorities. No hazardous materials are used at the contractor-operated site. Because of the insignificant waste generation, the Crown Mountain site does not warrant further study under the NACIP Program.

2.4.6 St. Georges Hill, St. Croix. St. Georges Hill, St. Croix, is part of the AFWTF Electronics Warfare Range (EWR) and is engaged in tracking and controlling targets (drones); tracking missiles, aircraft, and surface vessels; providing a realistic simulated hostile electronic environment for the training of ship and aircraft electronic warfare teams; and supporting exercises on other AFWTF ranges by generating an electronic order-of-battle (see Figure 2-4). The St. Georges Hill complex consists of several trailers and fixed facilities such as Threat Platform Simulators (TPS).

Activities at the complex are such that little waste is generated. The amounts and types of waste, coupled with the facility's location atop 864-foot-high St. Georges Hill, lead the IAS team to conclude that this site is not a potential threat to human health or the environment, and thus does not warrant further study under the NACIP Program.

2.4.7 Underwater Tracking Range (UTR), St. Croix. The UTR is located on the western seashore of St. Croix at Sprat Hole. The UTR provides roughly 69 square miles of deep water fully instrumented for the three-dimensional tracking of ships, submarines, and underwater weapons. The complex consists of a number of trailers and a cable head-in (see Figure 2-4).

The types and amounts of waste generated by activities at the facility are so innocuous that the site does not represent a potential pollution problem. Further study under the NACIP Program is not warranted.

2.4.8 Observation Post (OP), Culebra. The OP on Flamenco Point on Culebra is the only remaining facility of what was once the major gunnery and aircraft bombing range for the Atlantic Fleet. The OP now serves as a communications relay station (see Figure 2-5).

The area adjoining and partially on the OP property is a unique boulder forest, one of two known in the world. The boulder forest is also home to the arboreal nocturnal carniverous giant Culebra anole, an extremely rare species.

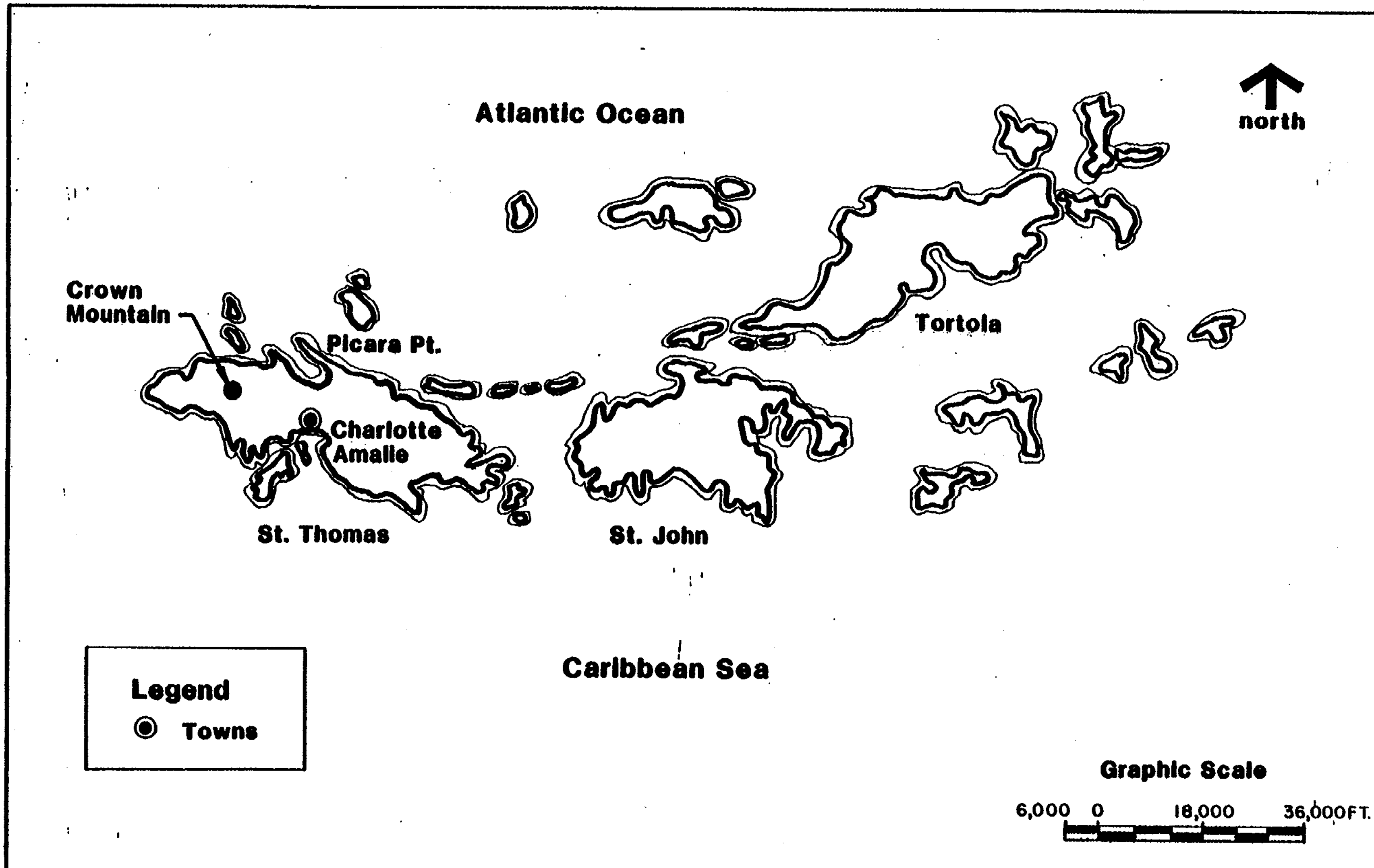

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Figure 2-3. Areas of Significant Findings at St. Thomas Island

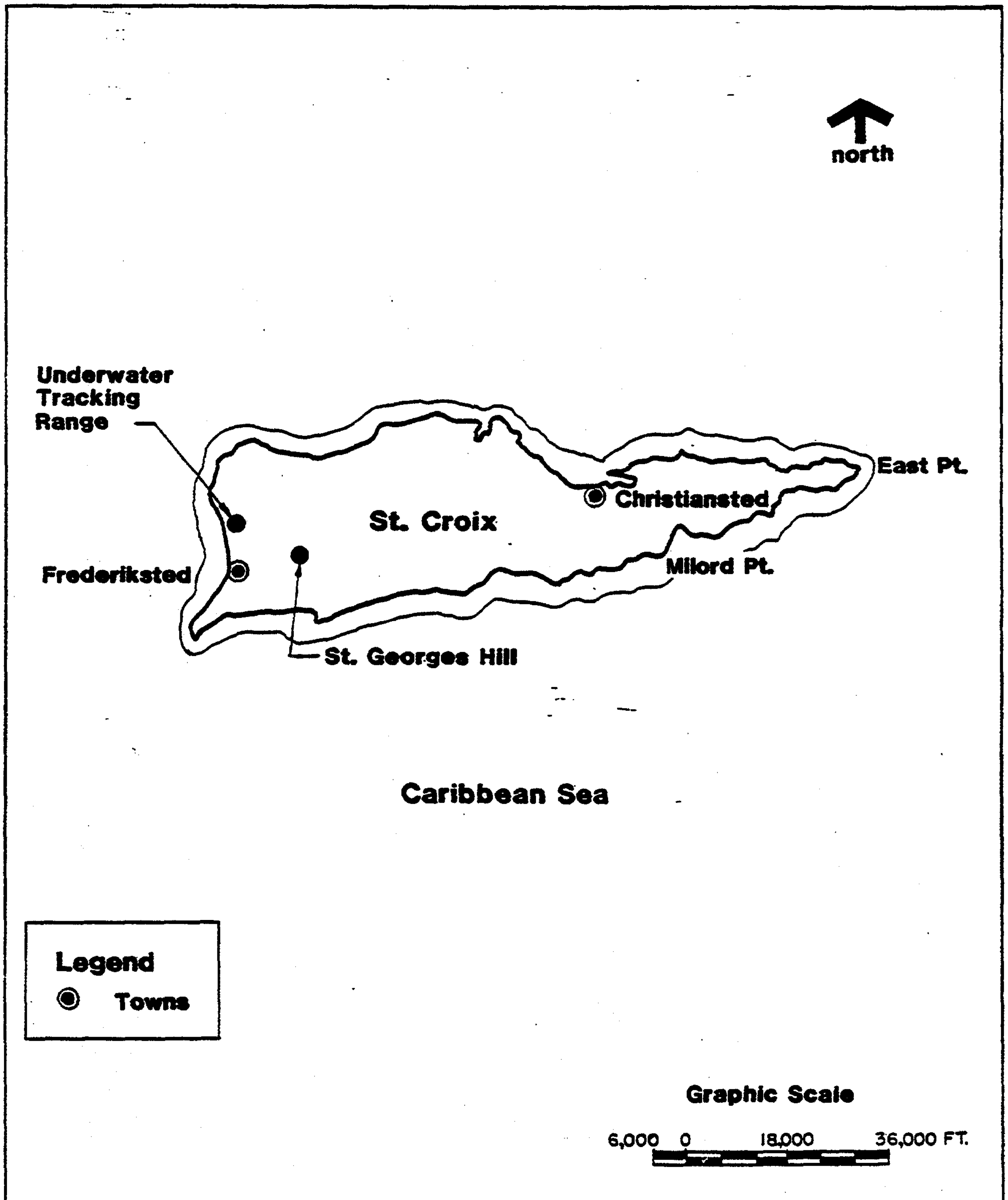

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Figure 2-4.
Areas of Significant Findings at St. Croix

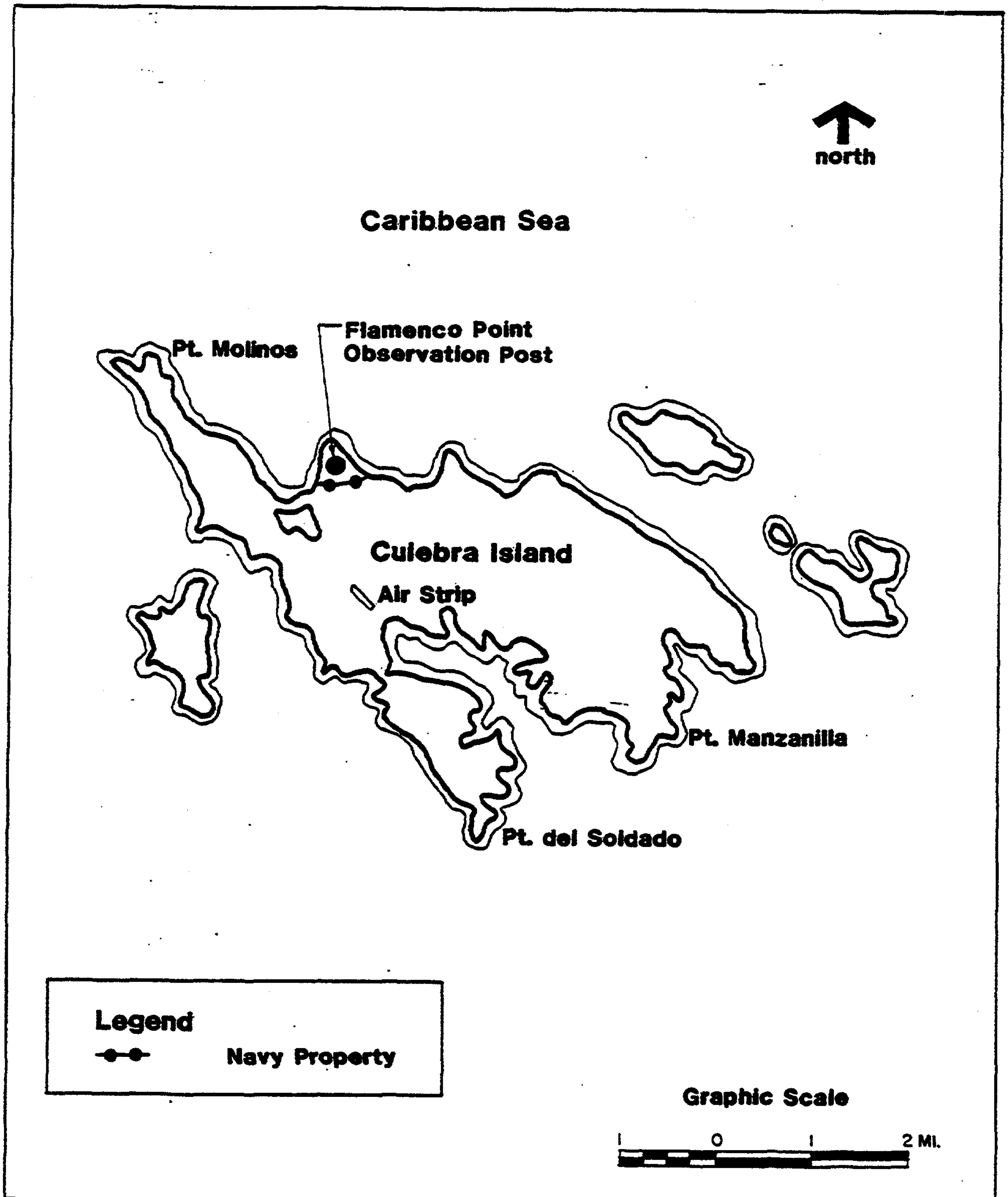

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Figure 2-5.
Areas of Significant Findings at Culebra Island

None of the activities conducted at the OP generated wastes that present a threat to human health or the environment. The IAS team has concluded that the site does not warrant further study under the NACIP Program.

2.4.9 Pico del Este. The AFWTF site at Pico del Este is located in the Luquillo National Forest, and provides air and surface radar coverage for the AFWTF operating area. No hazardous wastes have ever been generated here. The IAS team has determined that further investigation under the NACIP Program is not warranted at this site.

2.4.10 NAVSTA Roosevelt Roads, West Annex, Aguadilla. This facility is located at the former Ramey Air Force Base at Punta Borinquen. Roosevelt Roads currently owns 11 buildings which were excessed by the Air Force in 1973. Two the buildings (Buildings 561 and 703) are leased to the Commonwealth of Puerto Rico, which in turn leases them for commercial use. All of the buildings have been declared excess and are awaiting disposal through the General Services Agency. There were no areas of contamination identified at this site. The IAS team has concluded that further investigation under the NACIP Program is not warranted.

CHAPTER 3. RECOMMENDATIONS

3.1 INTRODUCTION. Based on the significant findings and conclusions, three sites on Vieques and 13 sites at Roosevelt Roads are recommended for Confirmation Studies. No sites on St. Thomas, St. Croix, Culebra, or at the West Annex and Pico del Este were recommended for Confirmation Studies. Table 3-1 presents a summary of the recommended studies. A two-step Confirmation Study Ranking System (CSRS) was used to systematically evaluate the relative severity of potential problems at each site.

3.2 CONFIRMATION STUDY RECOMMENDATIONS.

3.2.1 Site 1, Quebrada Disposal Site, Vieques. See Figure 3-1.

Type of Samples:	Soil borings.
Number of Soil Samples:	Three samples consisting of three borings at each location composited into one sample.
Frequency of Soil Sampling:	Twice; once each during wet and dry periods.
Testing Parameters:	Total organic carbon (TOC); total organic halogens (TOX); pH; oil and grease; purgeable organics; copper, chromium, lead, and zinc (see Table 3-2).

Remarks: One series of three samples upgradient of the major deposits in the quebrada, one series of three samples at the northernmost edge of the deposits, and one series of three samples south of the North Shore Road (Route 70) just before the quebrada crosses underneath the road. Three samples will be taken from zero to six inches at each location and composited.

3.2.2 Site 2, Mangrove Disposal Site, Vieques. The sampling is designed to establish the nature of the material disposed of at the site. See Figure 3-1.

Type of Samples:	Soil borings to determine depth of material disposed; composite split spoon samples.
Number of Soil Samples:	Four in disposal area.
Frequency of Soil Sampling:	One time; positives will dictate the need for additional sampling.
Testing Parameters:	TOX; chromium, copper, lead, and zinc (see Table 3-2).

Table 3-1

SUMMARY OF RECOMMENDATIONS, NAVAL STATION ROOSEVELT ROADS, STUDY NUMBER 051

			Verification (One Time Study)			Characterization (First Year Effort)		
			Sampling			Sampling		
Site Number	Site Name	CSRS* Score	No. Soil Samples	No. Water Samples	Lab Testing Parameters	No. of Wells	No. of Samples	Lab Testing Parameters
051-1	Quebrada Disposal Site	9	6	--	TOC, TOX, pH, oil and grease, purgeable organics, Cu, Cr, Pb, Zn	--	--	--
051-2	Mangrove Disposal Area	10	8	--	TOX, Cr, Cu, Pb, Zn	Dependent on positives from verification effort		
051-3	IRFNA/MAF-4 Disposal Site	17	--	2	Unsymmetrical dimethylhydrazine (Udmh), diethylenetriamine	Dependent on positives from verification effort		
051-5	Army Cremator Disposal Area	9	5	5	For water and soil: TOC, TOX, purgeable organics (water only), pH, chlorides, Cr, Cu, Pb, Zn. For containers: Dependent on sampling team recommendation, on-site characterization, and ultimate disposal requirements. See Section 3.2.4.	5	12	Positives from verification analysis
051-6	Langley Drive Disposal Site	9	Not to exceed 15	--	For soil: TOC, TOX, purgeable organics, pH, chlorides. Same as for Site 051-5 (above), with cadmium, chromium, lead, mercury, nickel, copper, selenium, and zinc.	Soil sampling dependent on positives from container sampling		

Table 3-1 (Cont.)

Site Number	Site Name	CSRS* Score	Verification (One Time Study) Sampling: No. Soil Samples	No. Water Samples	Lab Testing Parameters	Characterization (First Year Effort) Sampling: No. of Wells	No. of Samples	Lab Testing Parameters
051-7	Station Landfill	23	--	8 to 14	For groundwater: Pesticides, PCBs, pH, and specific conductance; purgeable organics, Cr, Cu, Pb, Zn. For "drum ditch": Oil and grease, TOC, and TOX from a grab sample. For containers: See Sites 051-5 and 051-6 (above).	--	--	--
051-8	Drone Washdown	9	7 (5 composite)	--	TOC, oil and grease	--	--	--
051-9	PCB Disposal, Dry Dock Area	28	10 sediment cores with Recommendation 2	--	Recommendation 1: Visual and magnetometer survey of area; sediment grab samples where indicated; PCB analysis. Recommendation 2: 3 samples from each core at 0 to 12 inches, 24 to 36 inches, 48 to 60 inches; PCB analysis.	--	--	--
051-10	Building 25 Storage Area	17	1 (up to an additional 19)	--	For soil: PCBs and positives from containers. For containers: See Sites 051-5 and 051-6 (above). For transformer sample: PCBs.	--	--	--

Table 3-1 (Cont.)

Site Number	Site Name	CSRS* Score	Verification (One Time Study) Sampling: No. Soil Samples	No. Water Samples	Lab Testing Parameters	Characterization (First Year Effort) Sampling: No. of Wells	No. of Samples	Lab Testing Parameters
051-11	Building 145	19	--	1	For containers: See Sites 051-5 and 051-6 (above). For standing water: positives from previous sampling by IAS team.	--	--	--
051-12	Two Way Road Fuels Farm	23	27	--	Soil and leaching pit grab sample: Oil and grease, lead.	--	--	--
051-13	Tanks 210-217	16	50	As encountered	Following infrared photography and terrain conductivity studies, borings to be made in the indicated areas. Soil and any groundwater encountered will be analyzed for purgeable organics, total lead, and TOC.	--	--	--
051-14	Ensenada Honda Shoreline and Mangroves	15	Not more than 10 grab samples	--	Oil and grease following visual inspection.	--	--	--
051-15	Substation 2	20	6	--	PCBs	--	--	--

Table 3-1 (Cont.)

Site Number	Site Name	CSRS* Score	Verification (One Time Study) Sampling: No. Soil Samples	Verification (One Time Study) Sampling: No. Water Samples	Verification (One Time Study) Sampling: Lab Testing Parameters	Characterization (First Year Effort) Sampling: No. of Wells	Characterization (First Year Effort) Sampling: No. of Samples	Characterization (First Year Effort) Sampling: Lab Testing Parameters
051-16	Old Power Plant, Building 38	11	6	--	PCBs, oil and grease	--	--	--
051-18	Pest Control Shop	23	22	--	Pesticides	--	--	--

* Confirmation Study Ranking System

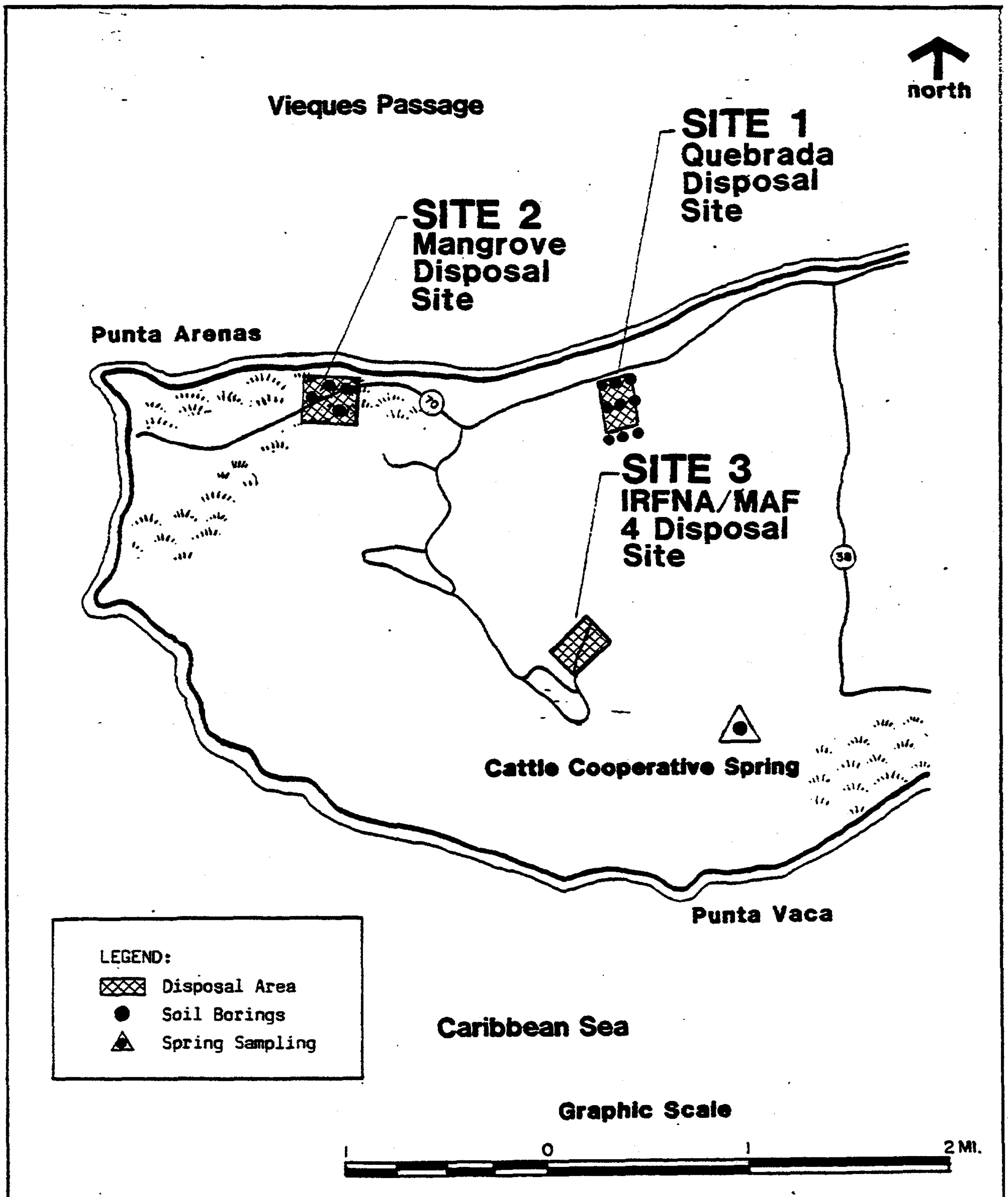

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FIGURE 3-1
SAMPLING MAP
SITES 1, 2, & 3

Table 3-2

ANALYTICAL METHODS
(By Method Number)

Parameter	Sample Type: Soil	Fresh-Water	Saline Water	Drum Liquid	Drum Solid
TOC	9060°	415.1†	415.1†	9060°	9060°
TOX	NA	9020°	9020°	9020°	NA
Chlorides	325.3†	325.3†	325.3†	325.3†	325.3†
Pesticides	8080°	608*	608*	8080°	8080°
PCB	8080°	608*	608*	8080°	8080°
Purgeable Halocarbons	NA	601*	601*	NA	NA
Oil and Grease	413.2†	413.2†	413.2†	NA	413.2†
Cadmium	7131°	213.2†	213.2†	7131°	7131°
Chromium	7191°	218.2†	218.2†	7191°	7191°
Mercury	7471°	245.1†	245.1†	7470°	7471°
Total Lead	7421°	239.2†	NA	7421°	7421°
Nickel	7521°	249.2†	249.2†	7521°	7521°
Copper	7210°	220.1†	220.1†	7210°	7210°
Selenium	7741°	270.3†	270.3†	7741°	7741°
Zinc	7950°	289.1†	289.1†	7950°	7950°

Methods

°"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 2nd Edition, USEPA, 1982.

†"Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, USEPA, March 1983.

*"Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA-600/4-82-057, USEPA, July 1982.

Remarks: The soil borings will be spaced in the site on both sides of North Shore Road (Route 70) where surface evidence of disposal (burned debris, etc.) can be seen. The borings will be used to determine distance to the water table and the depth to which disposed material can be found. The samples will be taken from zero to six inches, and from the deepest six inches of disposed material, and composited. The samples will be visually inspected for debris when taken.

3.2.3 Site 3, IRFNA/MAF-4 Disposal Site, Vieques. The purpose of this sampling effort is to establish if contaminants from fuel disposal have persisted and are present in the livestock water source. See Figure 3-1.

Type of Samples:	Surface water grab sample; soil borings if positives are found during the first sampling.
Frequency of Sampling:	Twice.
Testing Parameters:	Unsymmetrical dimethylhydrazine (Udmh), diethylenetriamine.

Remarks: The samples should be taken at high flow and low flow conditions.

3.2.4 Site 5, Army Cremator Disposal Area. See Figure 3-2

Type of Samples:	Ground water, soil, and container samples.
Ground Water Monitoring Wells:	Five; three on-site and two off-site.
Frequency:	Quarterly, for one year.
Testing Parameters:	TOC, TOX, purgeable organics (water only), pH, chlorides; copper, chromium, lead, and zinc (see Table 3-2).

Remarks: Ground Water and Soil: If screening of the composite soil samples taken while boring or of the ground water identifies any contamination, additional samples and analyses will be required.

Containers: Each intact container (55-gallon drums, pails, etc.) should be opened and sampled, using extreme caution. Sample analysis parameters will be decided based on the best professional judgment of the sampling team (only skilled, experienced personnel should undertake this operation) combined with an in-field ambient characterization by flame- and photoionizing detectors. Table 3-3 contains a generalized procedure for container opening, sampling, and analysis. Parameters analyzed for should include, but not be limited to, the following:

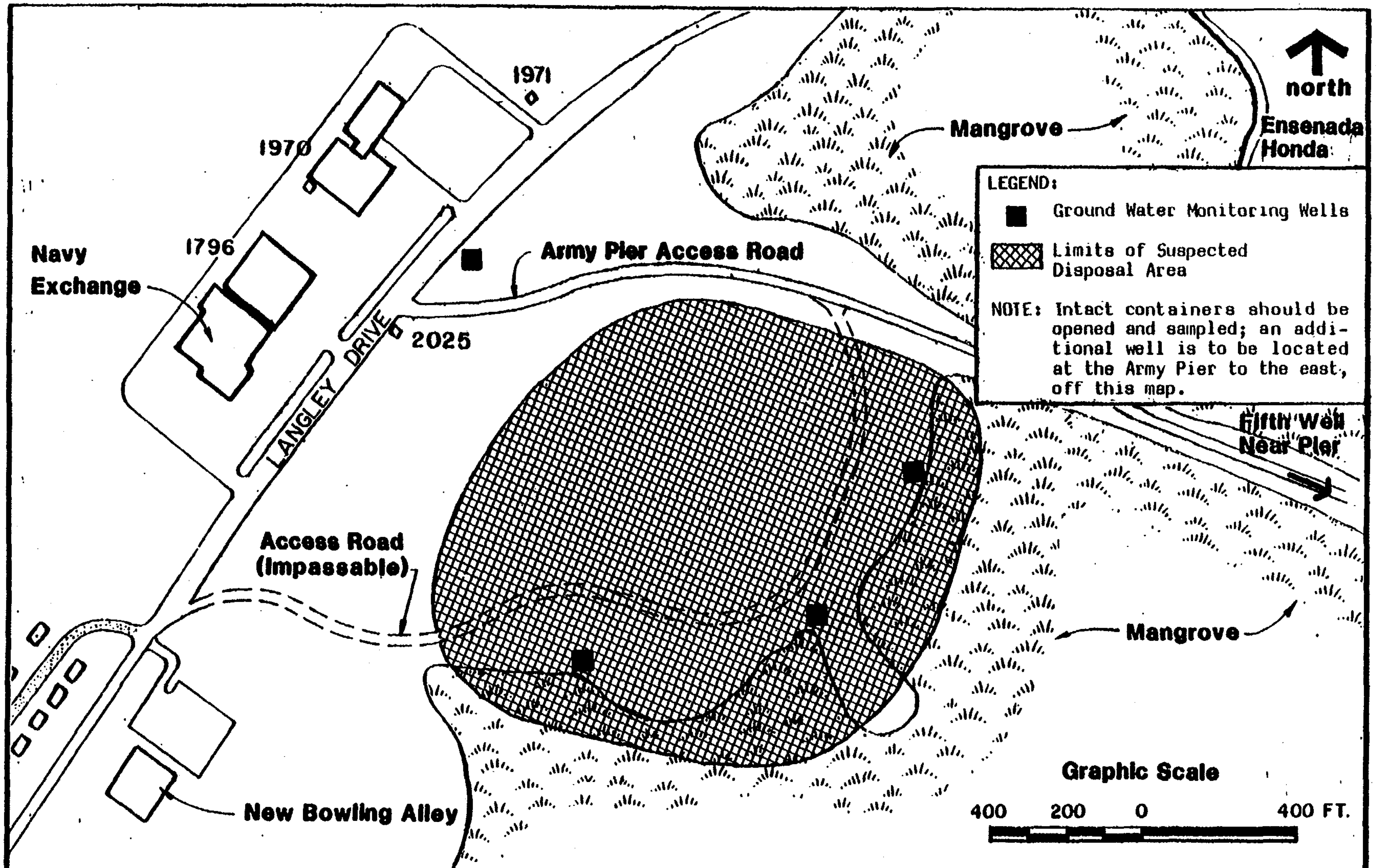

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FIGURE 3-2
SITE 5, ARMY CREMATOR DISPOSAL AREA

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Table 3-3

CONTAINER OPENING AND SAMPLING PROCEDURES

The opening and sampling of containers used for the disposal of hazardous material is rated as one of the most potentially dangerous operations undertaken by hazardous waste investigators. The possibility of major releases of material by container rupture, fire, or explosion is a real one, and threatens not only the field workers but also the surrounding populace and environment. The procedures discussed below have been used successfully many times in the field by experienced trained personnel; under no circumstances should they be considered for use by inexperienced personnel.

Operation	Discussion
1. Establish Operational Boundaries	A. Define exclusion area, segregation area, disposal staging area, contamination reduction area, personnel and equipment decontamination area, command post, safety observer post, laboratory and analysis area, dress-out area, and parking/visitors area. Establish downwind vapor hazard area, and secure perimeter. Establish first-aid station.
2. Establish Operational Procedures	Designate operations manager (OM); site safety officer (SSO); ambient monitoring team, documentation team, sampling team, decon team, chain-of-custody team, work party, equipment coordinator, and communications/log-book coordinator. Determine communications means (at least two of each network), procedures, and emergency evacuation notification. Determine and publish evacuation procedures (on-site, immediate surrounding area, and general evacuation). Establish air-monitoring stations and action levels. Coordinate with fire department, hospital, ambulance and emergency rescue teams, and police. Determine need for creation of restricted air zone. Establish media coordination. Establish vehicle maintenance and fueling area.
3. Undertake Operations	A. OM/SSO determine level of protection, work regime, decontamination procedures, and other safety measures.
	B. Remove and segregate containers for sampling. Unstack or unpile containers, using drum grappler, drum slings, grabbers, all-terrain forklifts, etc. Overpack all containers that leak or rupture. Neutralize spills; evaluate need for evacuation at the time of each spill. Stage empty containers for disposal. Segregate containers by size or type, being particularly cautious of drums containing acids/caustics. Immediately notify the OM/SSO of any containers that are corrugated, made of stainless steel or other exotic metals, are distended or burned, or have reinforcing bands. DO NOT MOVE THESE DRUMS. Notify the OM/SSO of any reactions.
	C. Documentation. Label each container with a unique number. Photograph each container. Record all markings and labels.

Table 3-3 (Cont.)

Operation	Discussion
3. Undertake Operations (Cont.)	D. Open and sample. Opening will be done by remote means, such as a three-foot copper-beryllium spike on a backhoe bucket, with the operator protected by a 1/4-inch Plexiglass splash shield and a 3/4-inch Lexan blast shield. Inform OM/SSO of any reactions. Overpack any leaking drums or containers; evaluate need for evacuation. Using glass thief, scoopula or other appropriate method, take two eight-ounce samples in wide-mouth EPA-prepared glass jars with Teflon-lined lids, labeled with the drum number. Note appearance of contents on sample record. Note any reactions (strong acids or oxidizers). Give one sample to laboratory for analysis; hold second sample in secure storage area.
	E. Analyze. Each drum will be monitored with a radiation indicator, explosive vapor indicator, and flame or photoionization device. Record all readings. Evacuate work party immediately if radiation readings are above 10 millREMS per hour, or an explosive atmosphere exists. Determine need for additional evacuation. Analyze samples for parameters necessary for acceptance at permitted disposal site; these may include, but will not necessarily be restricted to, the following categories: pH, sulfides (pH 7 or higher), cyanide (pH 4 or higher), hydrogen cyanide, flammability, reactivity (air, which is usually evident, and water), reduction and oxidation potential (redox), chlorinated hydrocarbons, PCBs (less than 50 ppm, 50 to 500 ppm, greater than 500 ppm), organics with flashpoints greater or less than 60°C, and neutral aqueous. Mark analysis on sample record and on each container.
	F. Segregate for disposal. Reseal containers (overpack, new bungs, or absorbent pads with bentonite sealer). Segregate for disposal, taking care to have adequate spacing between incompatible materials. Insure the containers meet Department of Transportation standards for transport to disposal area. If containers are to be held for any length of time, secure the area, store off the ground, and protect from elements.
	G. Decontaminate and dispose. Arrange for disposal with permitted facility. Note: The individual signing the transportation manifests should have sufficient authority to match the liability he is incurring. Decontaminate (on a daily basis) all personal equipment; keep as many tools and equipment as possible down range to minimize daily decon. Decontaminate using hydroblasters, steam jennys, detergents, decon solutions, scrubbing, soaking, or scraping. Contain all decontamination solutions and wash waters; dispose of properly. Throw away, rather than decontaminate as much as economically feasible; dispose of properly. Test soils and determine need for disposal of contaminated material. Dispose of oil, oil filters, hydraulic fluid, and air filters on vehicles and machinery used downrange. OM/SSO will certify all tools, equipment, and vehicles as clean and ready for use by unprotected personnel.
4. Site Safety Considerations	All on-site workers will probably require Level B protection (appropriate dermal protection and self-contained breathing apparatus). The appropriate sections of 29 CFR 1910.34 must be adhered to as well as other applicable OSHA regulations.

Source: Ecology and Environment, Inc. 1984.

pH; radiation; sulfides; cyanide; flammability; reactivity (air and water); redox potential; chlorinated hydrocarbons; PCBs; organics; and neutral aqueous solutions.

3.2.5 Site 6, Langley Drive Disposal Site. See Figure 3-3.

Type of Samples:	Ten to 15 samples of container contents; soil, as necessary (not to exceed 15 samples).
Number of Samples:	Sample each drum and other containers, particularly the glass containers of pellets (see Table 3-3 for procedures). If drum contents are determined to be hazardous, soil samples should be taken in and around their locations and analyzed.
Frequency of Sampling:	One time.
Testing Parameters:	TOC, TOX, purgeable organics (water only), pH, and chloride; copper, chromium, lead, and zinc (see Table 3-2).

Remarks: The area should be thoroughly traversed to determine location of all drums and other disposal areas. Samples taken from the 10 to 15 rusted-out drums should include portions of the greenish crust and white, plaster-like inner material. Any containers that are closed should be opened only by experienced personnel. If the drum contents are not hazardous, consideration should be given to mitigative actions such as removing the drums and other debris.

3.2.6 Site 7, Station Landfill. See Figure 3-4.

Type of Sample:	Ground water, "drum ditch" grab samples, and container contents, as appropriate.
Ground Water Monitoring Wells:	Eight new wells and up to six existing wells, if they can be developed.
Frequency:	Quarterly, for one year.
Testing Parameters:	Ground water: Pesticides, PCBs, pH, and specific conductance; purgeable organics and copper, chromium, lead, and zinc (see Table 3-2).
	Containers: See Section 3.2.4.

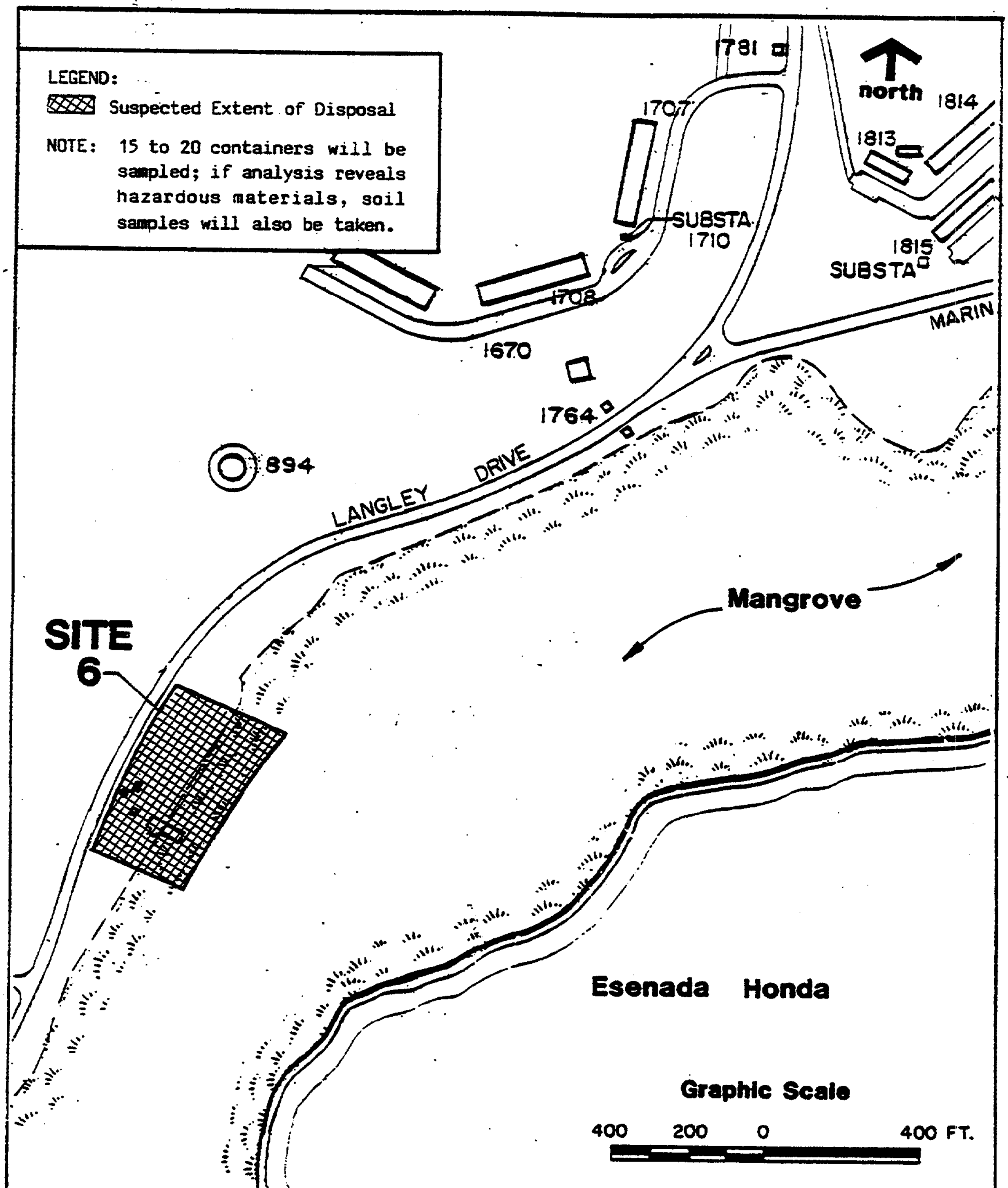

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FIGURE 3-3
SITE 6, LANGLEY DRIVE SITE

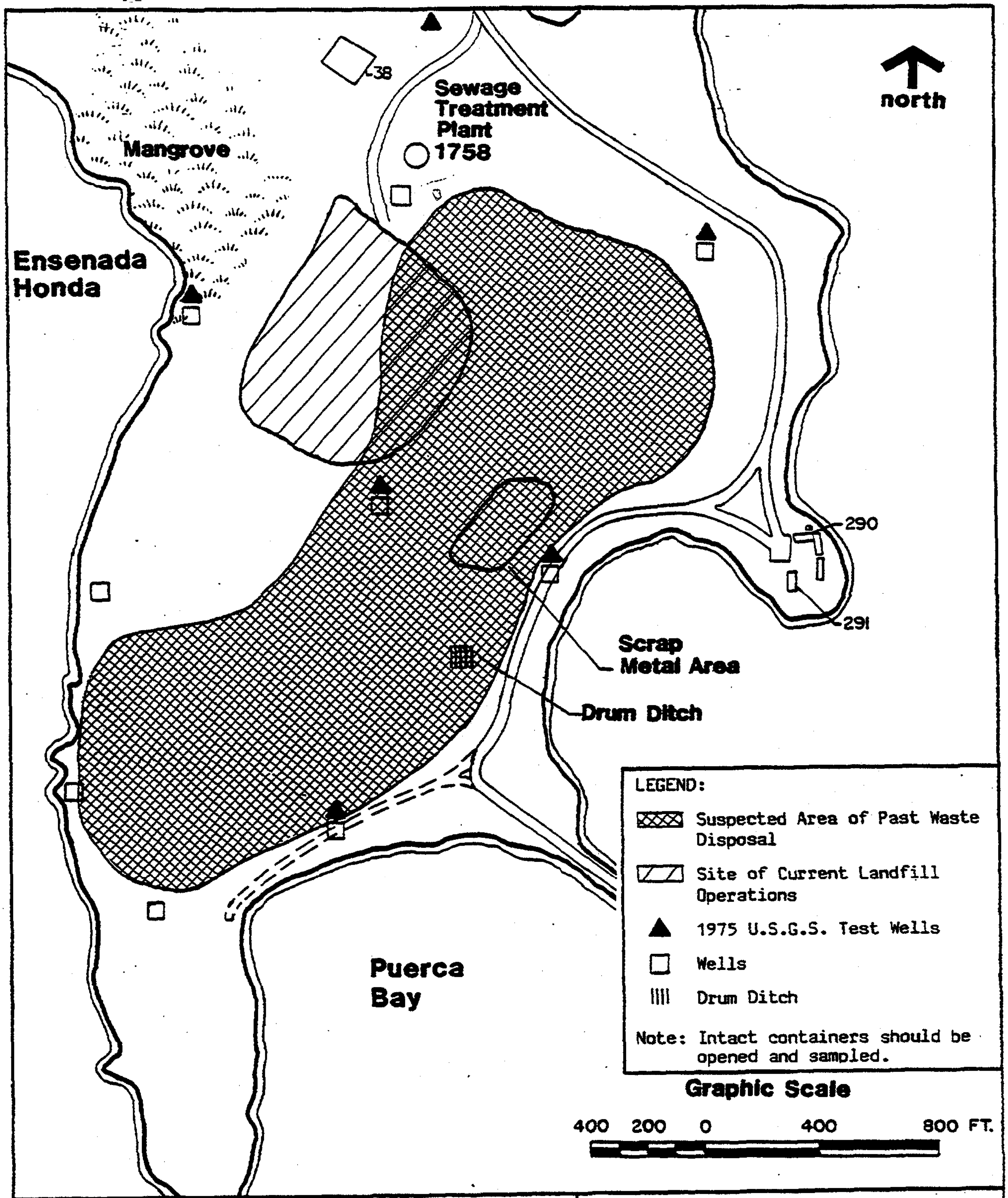

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FIGURE 3-4
SITE 7, STATION LANDFILL

	Drum Ditch: Oil and grease, TOC, TOX (see Table 3-2).

Remarks: If ground water screening identifies any contamination, additional samples and analyses will be required. The monitoring wells that were previously installed by the U.S. Geological Survey at the landfill and the sampling conducted were intended solely for drinking water analysis and may not have adequately defined the nature and extent of contamination by hazardous material. The sampling was only conducted on a one-time basis. It is probable that all of the U.S. Geological Survey monitoring wells have since been destroyed by landfill operations. Those still intact should be developed, if possible, and sampled. The ground water monitoring wells suggested above will detect contaminant migration from the drum ditch.

The piles of material inaccessible to the IAS team from the ground should be examined for intact containers, which should be opened and sampled <u>only</u> by skilled, experienced personnel. Samples analysis parameters will be decided based on the recommendations of the team leader. See Table 3-3.

3.2.7 <u>Site 8, Drone Washdown</u>. See Figure 3-5.

Type of Samples:	Soil borings.
Number of Soil Samples:	Five composite samples from the drainage ditch; one near Building 229 for background; and one from the spill area at Building 860.
Frequency of Soil Sampling:	One time, for verification.
Testing Parameters:	TOC, oil and grease (See Table 3-2).

Remarks: Samples to be taken upstream and downstream of the probable entry point of the drone washdown fluids into the drainage ditches north, south, and southeast of the site. Three samples to be taken from each point in ditch bottom, at zero-to six-inch depth, and composited. If contamination is found, the ditches should be sampled to their eventual termination point in the mangroves. Sampling of the ground around Building 860 also will be necessary to determine the extent of contamination. Sampling at Building 229 will establish background levels existing from normal airfield operations.

3.2.8 <u>Site 9, PCB Disposal, Dry Dock Area</u>. See Figure 3-6

Recommendation 1: It is recommended that an underwater visual inspection and magnetometer or metal detector survey be conducted by the Explosive Ordnance Team first. If intact cans

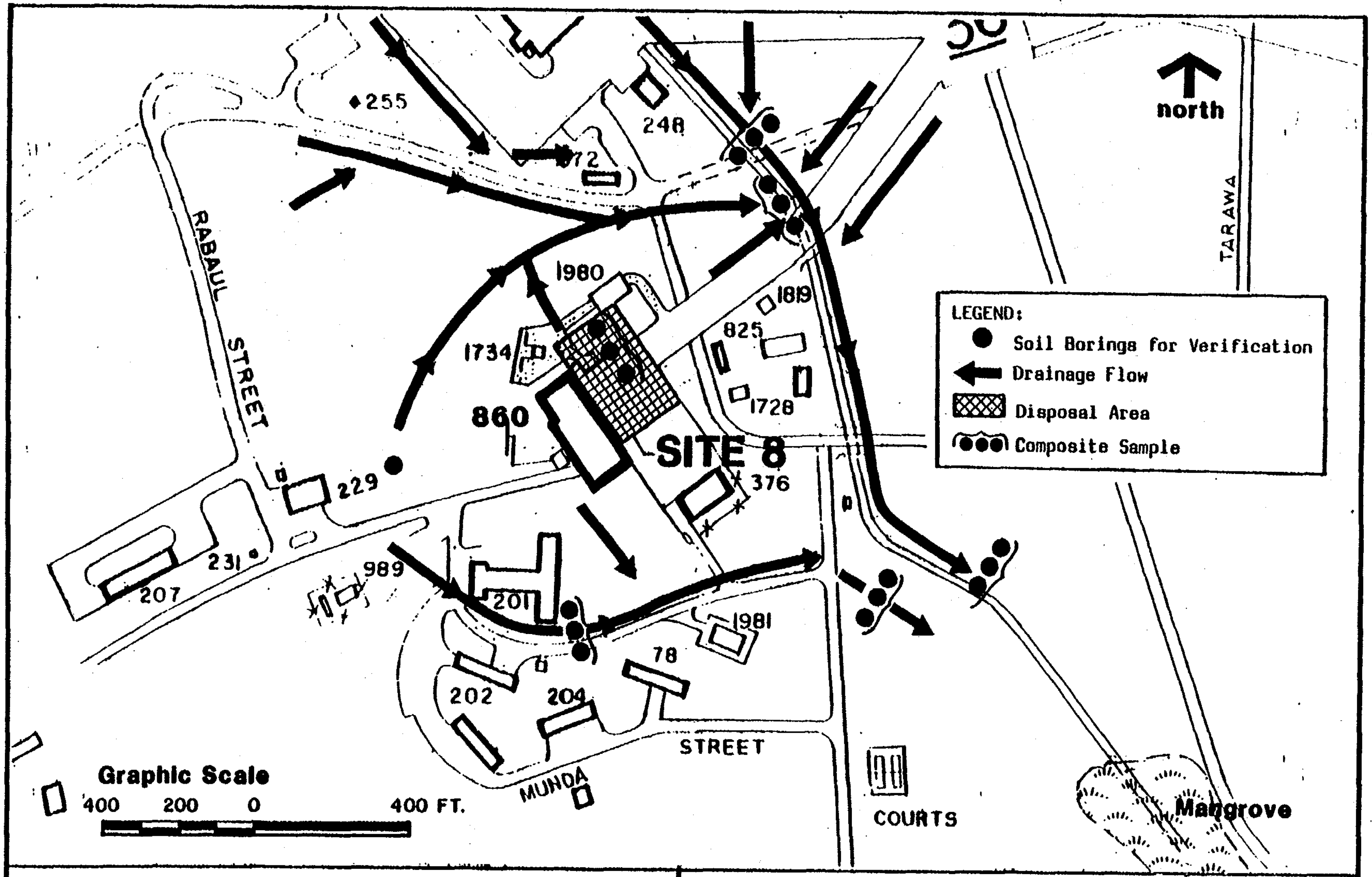

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FIGURE 3-5
SITE 8, DRONE WASHDOWN

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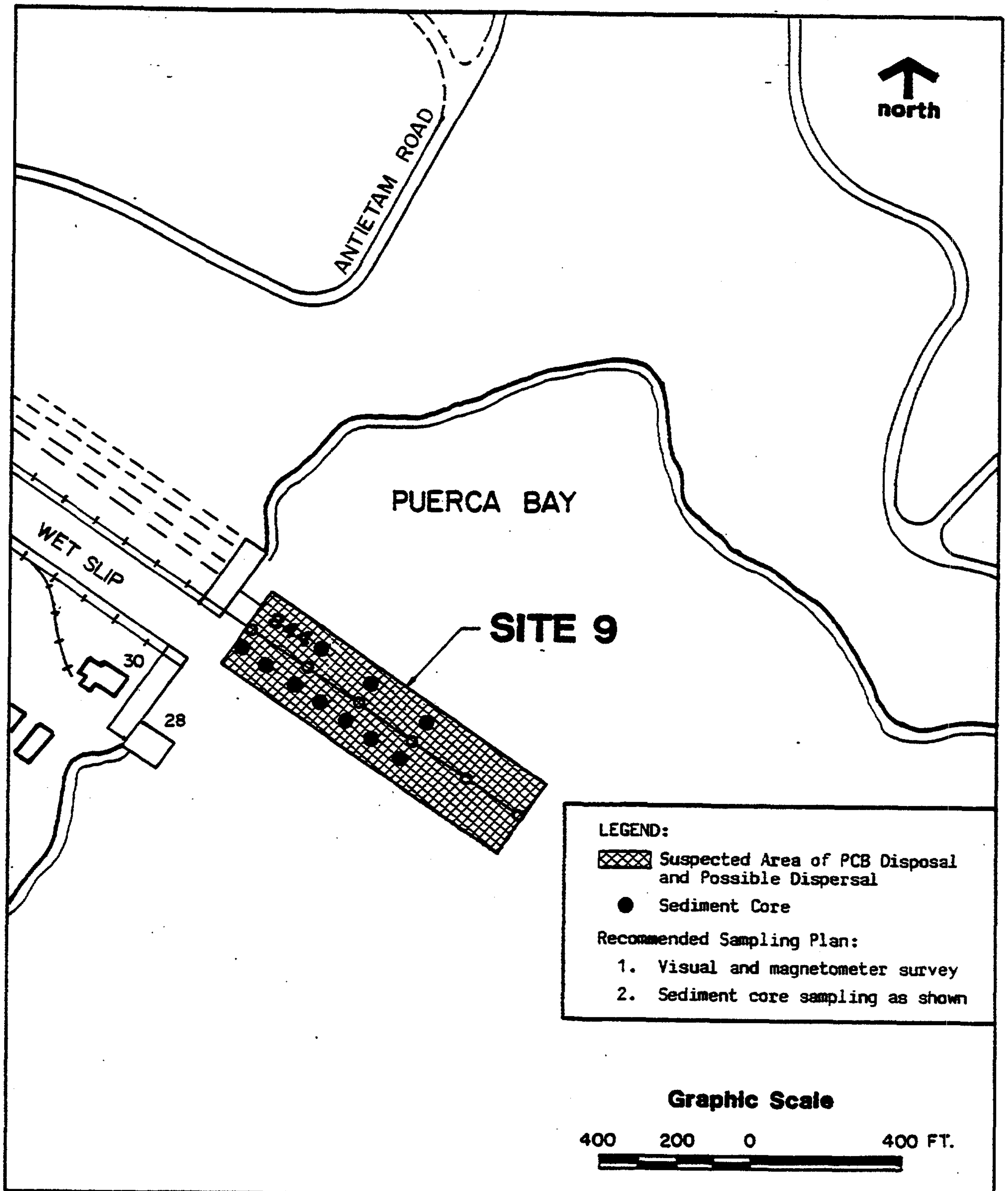

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FIGURE 3-6
SITE 9, PCB DISPOSAL
DRY DOCK AREA

(or magnetometer readings) indicating concentrations of ferrous metal are found, a biased grab sampling should be conducted in the immediate vicinity of the items. See Figure 3-6.

Type of Samples: Sediment (grab).

Number of Samples: One sample per each area of magnetic anomally or cans.

Testing Parameter: PCBs.

Recommendation 2: If the visual and magnetometer survey does not reveal heavy concentrations of metal or the presence of five-gallon cans, the following sediment sampling program is recommended.

Type of Samples: Ten sediment cores taken with a piston coring device.

Number of Samples: Thirty; three from each core taken from the depth intervals 0 to 12 inches, 24 to 36 inches, and 48 to 60 inches.

Testing Parameters: PCBs.

Remarks: Ten sediment cores, each 60 inches long, to be taken with a piston coring device at the locations indicated on Figure 3-6.

3.2.9 Site 10, Building 25 Storage Area. See Figure 3-7.

Type of Samples: Container contents and soil.

Number of Samples: Containers: One sample from each drum or other container in the area around Building 25 and the transportation lot of Building 31. One sample from the leaking transformer.

Soil: One sample from the stained area where the transformer has leaked. Up to 19 additional soil samples (zero to six inches) taken throughout the disposal area, particularly in areas of spills, stains, or stressed vegetation.

Testing Parameters: Containers: See Section 3.2.4.

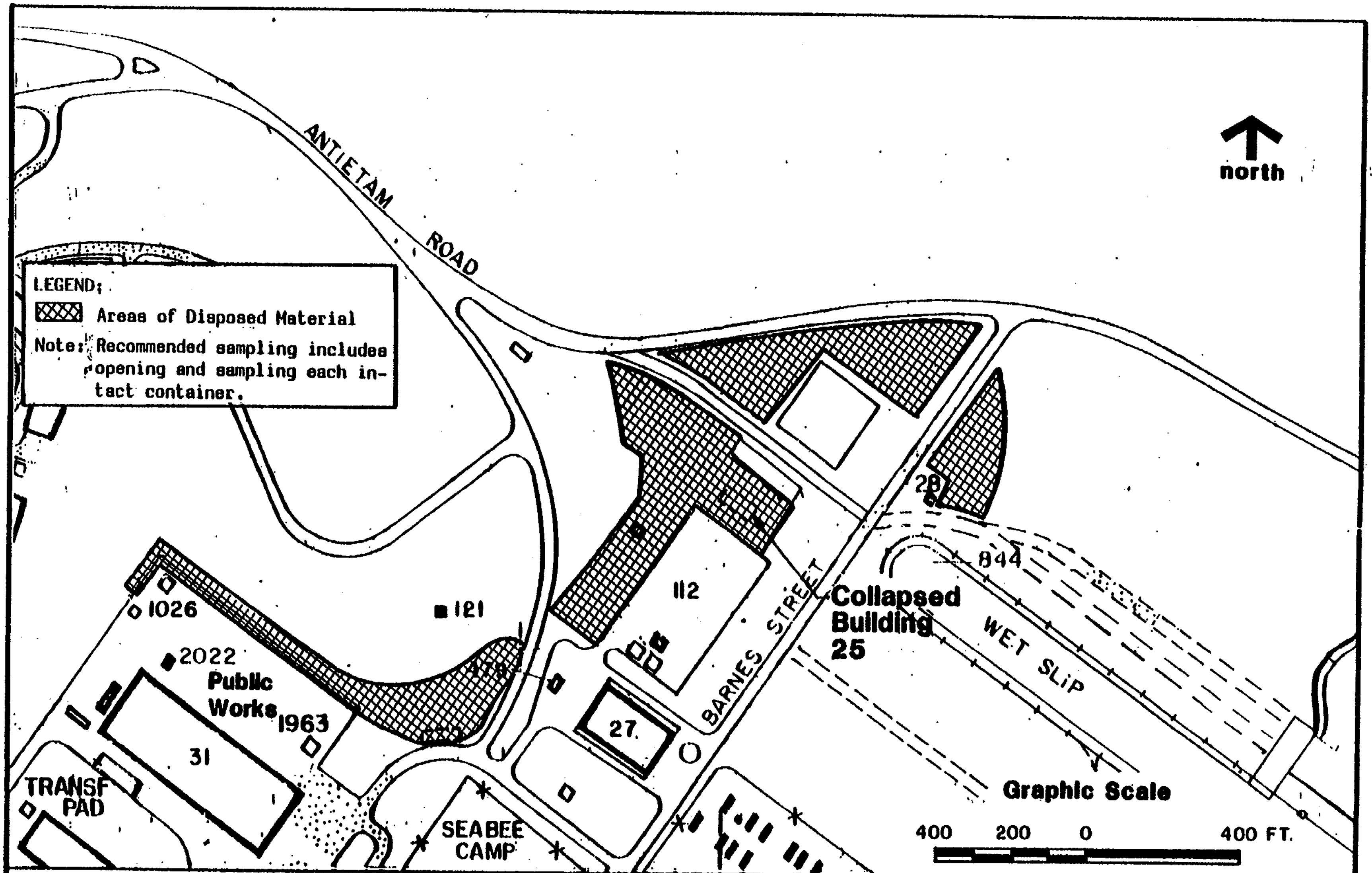

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FIGURE 3-7
SITE 10, BUILDING 25 STORAGE AREA

Transformer: PCBs.

Soils: Stained soil near transformer should be tested for PCBs. Analysis of other soil samples to be conducted after analysis of container contents; analyze soils for positives shown by container analysis.

Remarks: It is recommended that the disposal area be restricted to preclude possible exposure of base personnel. Based on the site inspection, some drums show severe corrosion about the seals. Extreme caution must be taken so as not to release drum contents. Only trained, experienced personnel should open, sample, and move the drums and other containers (see Table 3-3).

3.2.10 Site 11, Building 145. See Figure 3-8.

Type of Samples: Sample from each container; grab sample of standing water in the building.

Frequency of Sampling: Once.

Remarks: Those containers previously sampled by the IAS team should be disposed of in an appropriate manner based on the results of the analysis conducted by LANTNAVFACENGCOM. Results of these analyses indicate the majority of the material is extremely flammable. The remaining containers (about 100 five-gallon pails and 25 55-gallon drums) should be sampled in accordance with the procedures outlined in Table 3-3, and properly disposed of. Prior to this sampling, the standing water in the building should be sampled; testing parameters should be based on the positives obtained by LANTNAVFACENGCOM mentioned above.

3.2.11 Site 12, Two Way Road Fuels Farm. See Figure 3-9.

Type of Samples: Soil and leaching pit liquid.

Number of Samples: Nine soil; one liquid grab sample from leaching pit.

Frequency of Sampling: One time.

Testing Parameters: Oil and grease, lead (see Table 3-2).

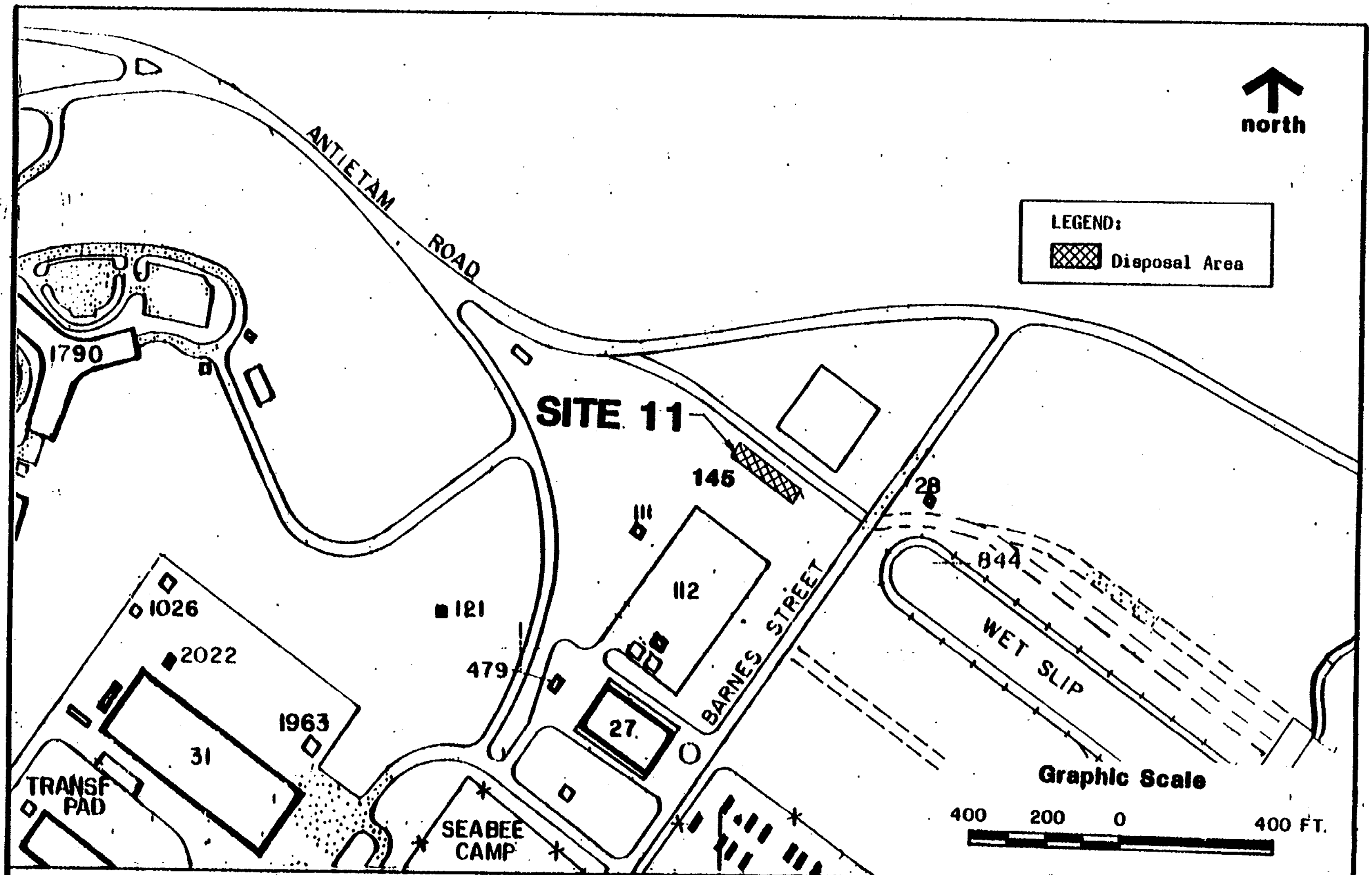

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FIGURE 3-8
SITE 11, BUILDING 145

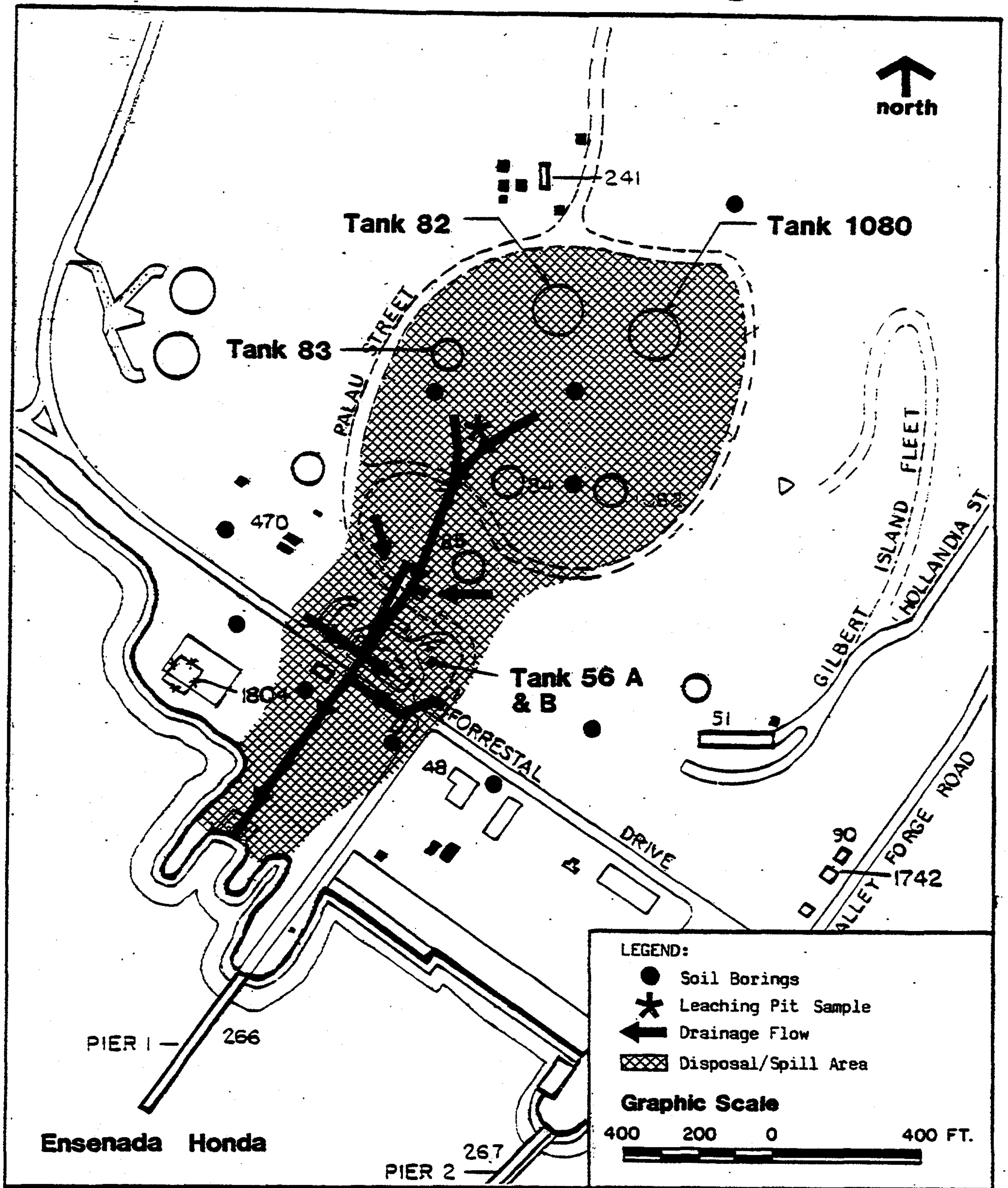

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FIGURE 3-9
SAMPLING MAP
SITE 12, TWO WAY ROAD
FUELS FARM

Remarks: Nine soil samples, as shown on Figure 3-9, and a grab sample from the leaching trench downgradient of the tanks should be taken. Samples will be taken at zero to six inches, 24 to 30 inches, and the last six inches before ground water. Soils will be visually examined at the time the samples are taken. Augering south of Tank 83 should be deep enough (perhaps as much as 10 feet) to sample the sludge buried there.

3.2.12 Site 13, Tanks 210 to 217. See Figure 3-10.

Type of Samples:	Soil; sludge if found; ground water (see remarks).
Number of Samples:	50 each.
Frequency of Sampling:	One time.
Testing Parameters:	Total lead, purgeable organics, TOC (see Table 3-2).

Remarks: Prior to any soil boring being conducted, an attempt should be made to obtain infrared photography of the tank sites, preferably historical, to determine the actual disposal areas. The IAS team did not find any infrared photos during its records search; it is probable that classified photos or information from other remote sensing devices can be made available. A terrain conductivity survey of the sites can also be made. This would necessitate removal of some portion of the vegetation (this is also necessary to conduct boring activities). The soil borings will be as much as eight to 12 feet deep in areas indicated by the infrared photos or terrain conductivity survey. Samples will be taken on a grid basis to define the extent of contamination. Soil borings will be examined, and those samples showing stains or containing sludge will be analyzed. Only ground water encountered will be sampled. If bedrock is encountered without any sludge or discolored soil being found, a sample of the six inches of soil in contact with the bedrock will be analyzed.

3.2.13 Site 14, Ensenada Honda Shoreline and Mangroves. See Figure 3-11.

Type of Samples:	Visual inspection; grab samples not to exceed 10.
Testing Parameters:	Oil and grease; see Table 3-2

Remarks: A light inflatable raft (e.g., Avon, Zodiac) should be used to conduct a waterside survey of the mangroves, as shown on Figure 3-11. The mangroves will be inspected for tar balls, oil stains on vegetation, and discolored soil. Grab samples will be taken as appropriate. The impact of the material and need for mitigative action will be determined following analysis.

3.2.14 Site 15, Substation 2. See Figure 3-12.

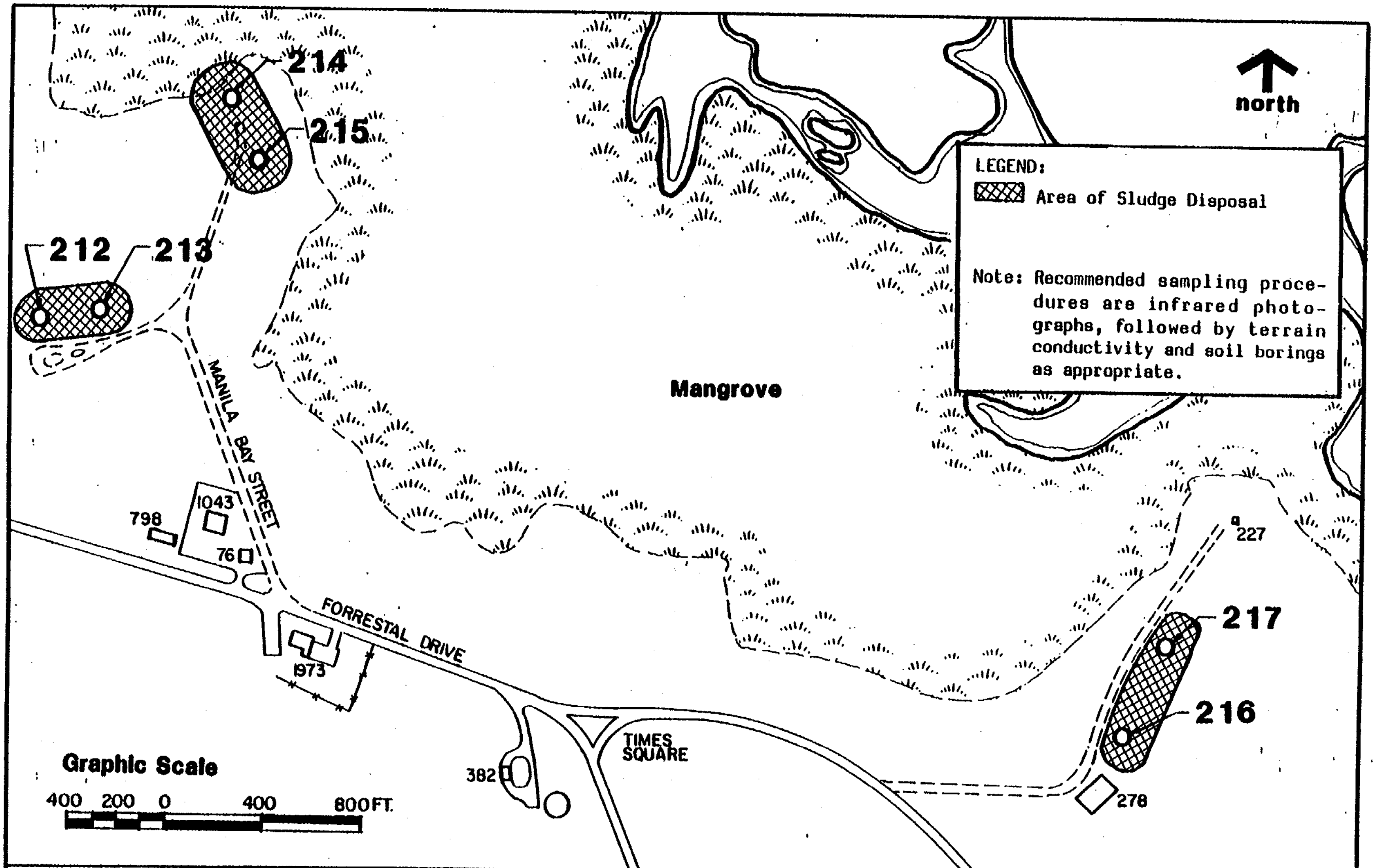

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FIGURE 3-10
SITE 13, TANKS 212-217

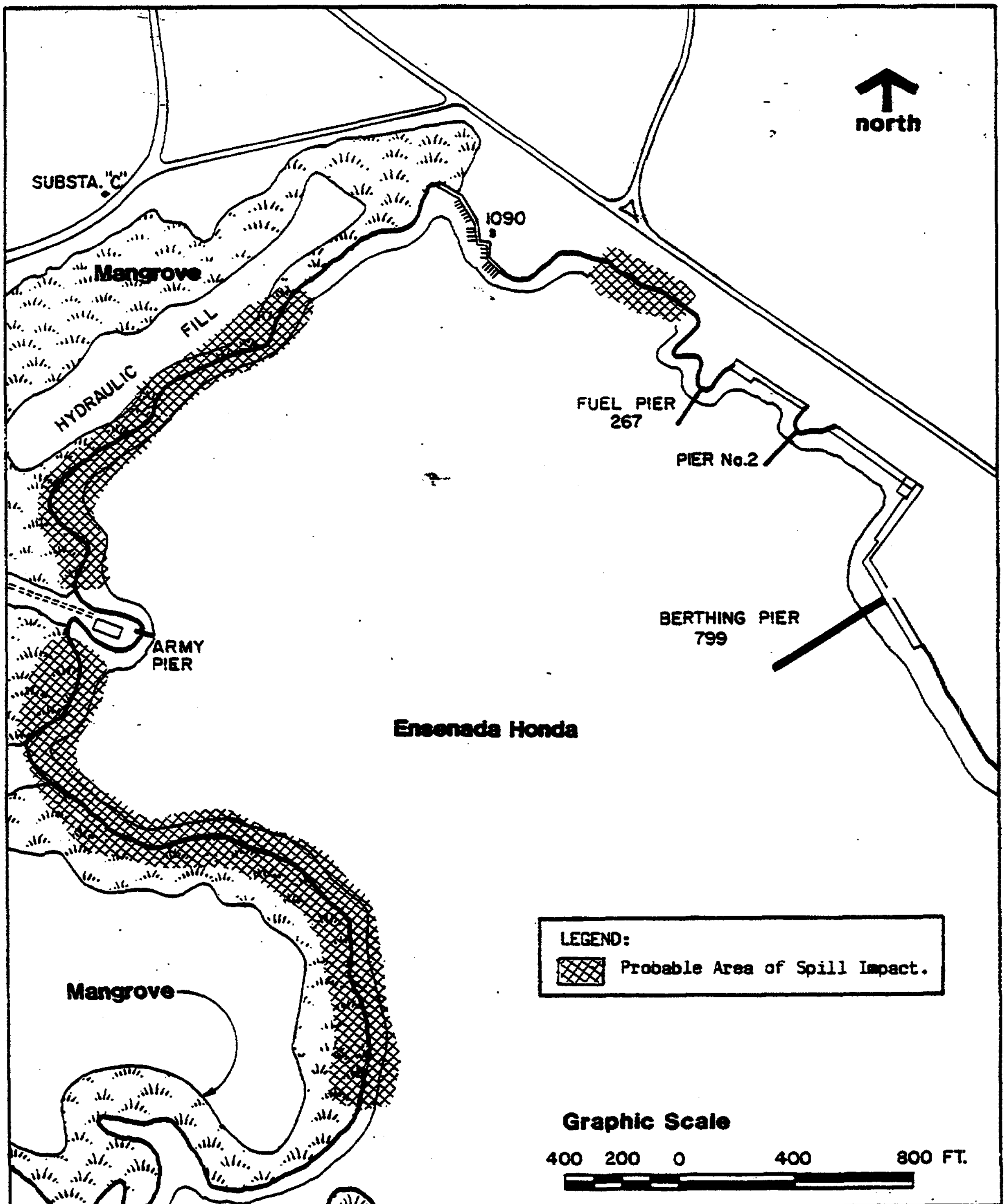

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FIGURE 3-11
SITE 14, ENSEÑADA HONDA
SHORELINE AND MANGROVES

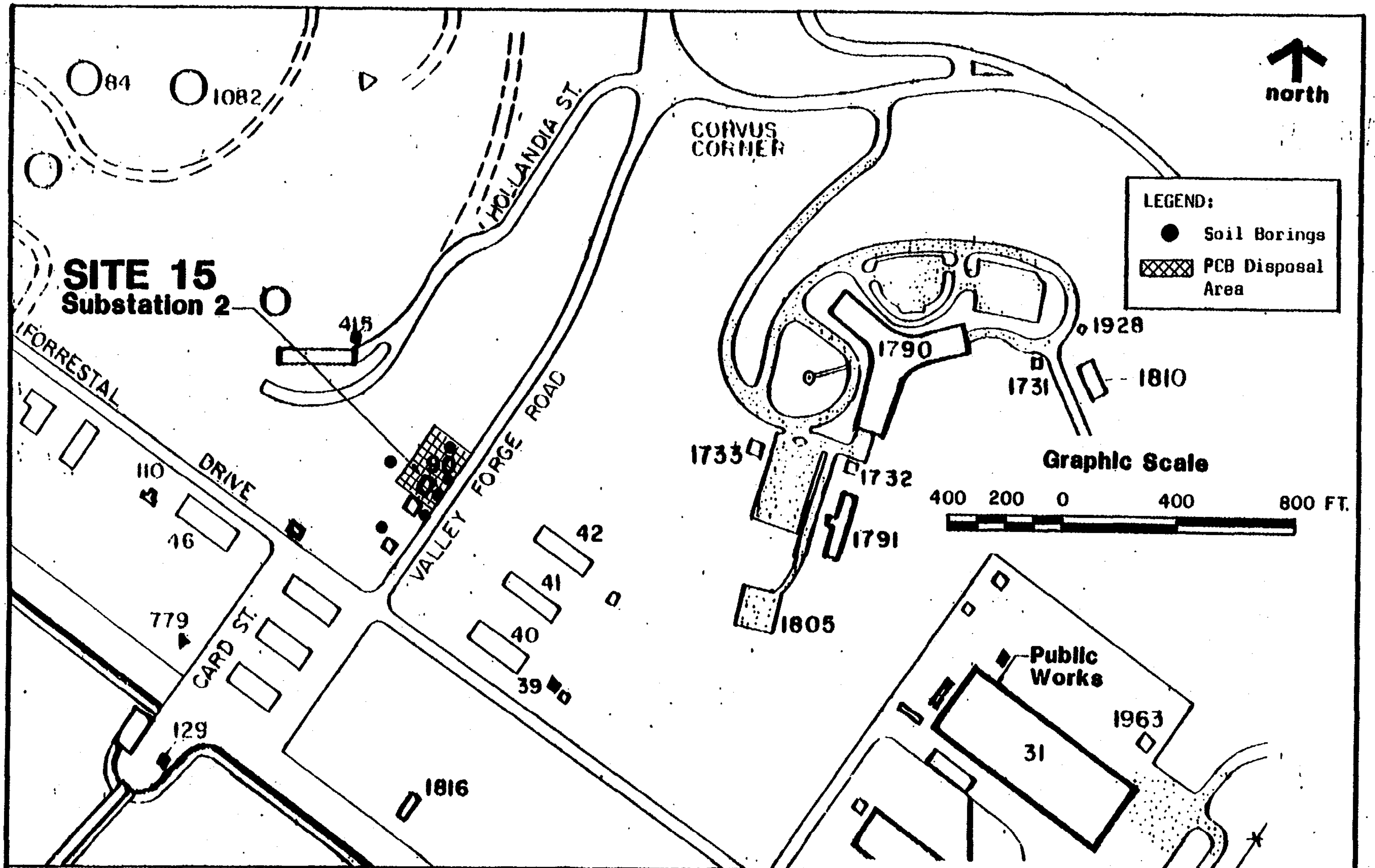

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FIGURE 3-12
SITE 15, SUBSTATION 2

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Type of Samples:	Soil (hand augered).
Number of Samples:	Six; one per each boring taken over the zero to 12-inch depth interval. One sample each taken to the north, west, and south of the building; three samples taken equally spaced east of the building.
Frequency:	Initial sampling effort at this time.
Testing Parameter:	PCBs (see Table 3-2).

Remarks: Care should be taken to clean auger between samples to prevent cross contamination.

3.2.15 <u>Site 16, Old Power Plant, Building 38</u>. See Figure 3-13.

Type of Samples:	Soil (hand augered).
Number of Soil Samples:	Six, each over the zero to 12-inch depth interval.
Frequency of Soil Samples:	Initial sampling effort at this time.
Testing Parameters:	PCBs, oil and grease (see Table 3-2).

Remarks: Two samples to be taken from the oil-stained ground northwest of the building; four samples to be taken on a grid basis in the area to the north and northeast of the building. Care should be taken to clean auger between samples to prevent cross contamination.

3.2.16 <u>Site 18, Pest Control Shop</u>. See Figure 3-14.

Hand-Auger Soil Borings:	Twenty-two.
Number of Samples:	Twenty-two; one composite taken upgradient in the drainage ditch; one composite downgradient; one sample near the road for background; and 19 samples in a grid pattern.
Testing Parameter:	Pesticides (see Table 3-2).

Remarks: Care should be taken to clean the auger between samples to prevent cross contamination. If contamination is detected in the drainage ditch, additional sampling will be necessary to determine the extent and degree of contamination further upgradient.

3.3 GENERAL RECOMMENDATIONS. All sites recommended for Confirmation Studies or for mitigative action should be designated on the base maps. The sites

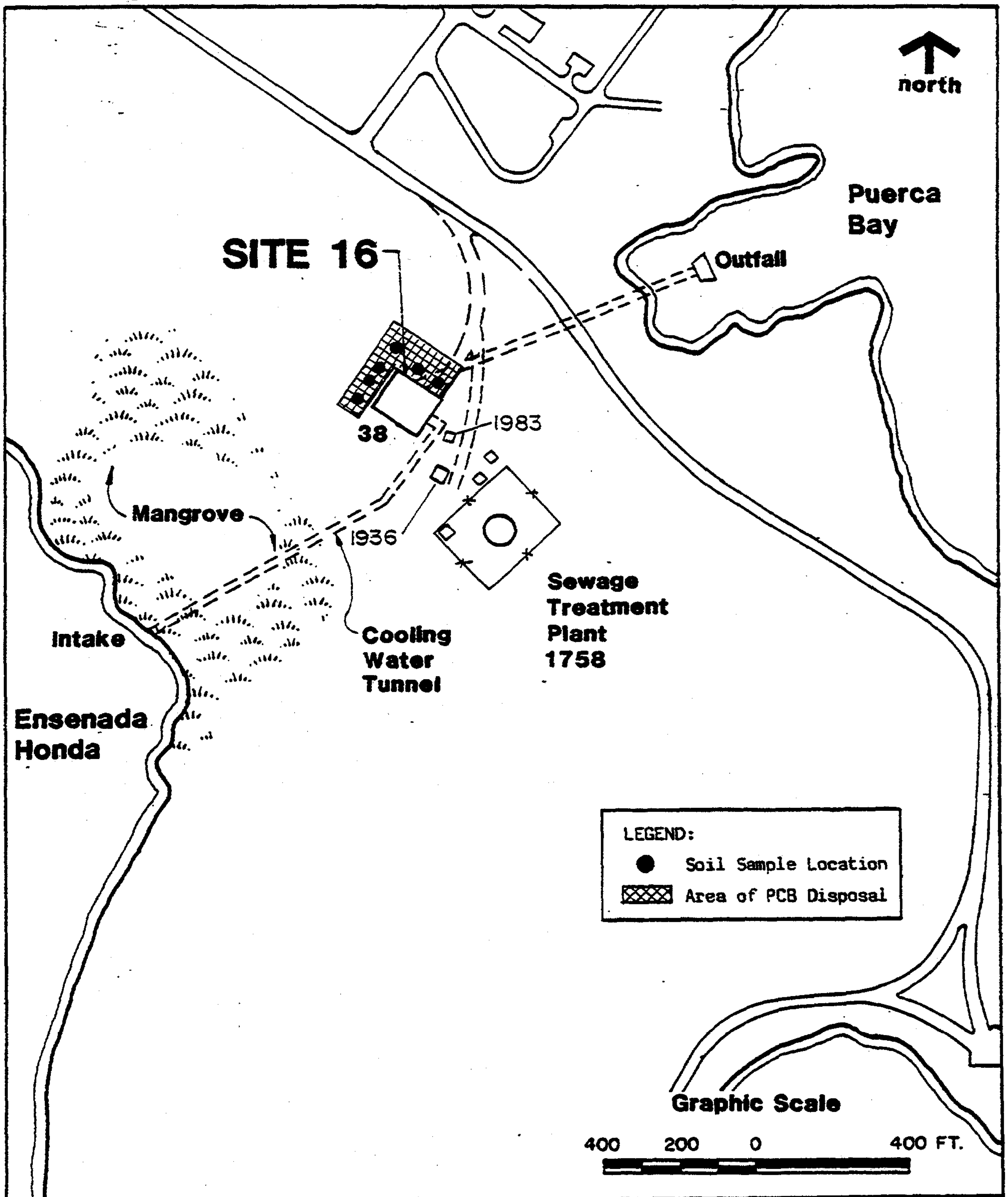

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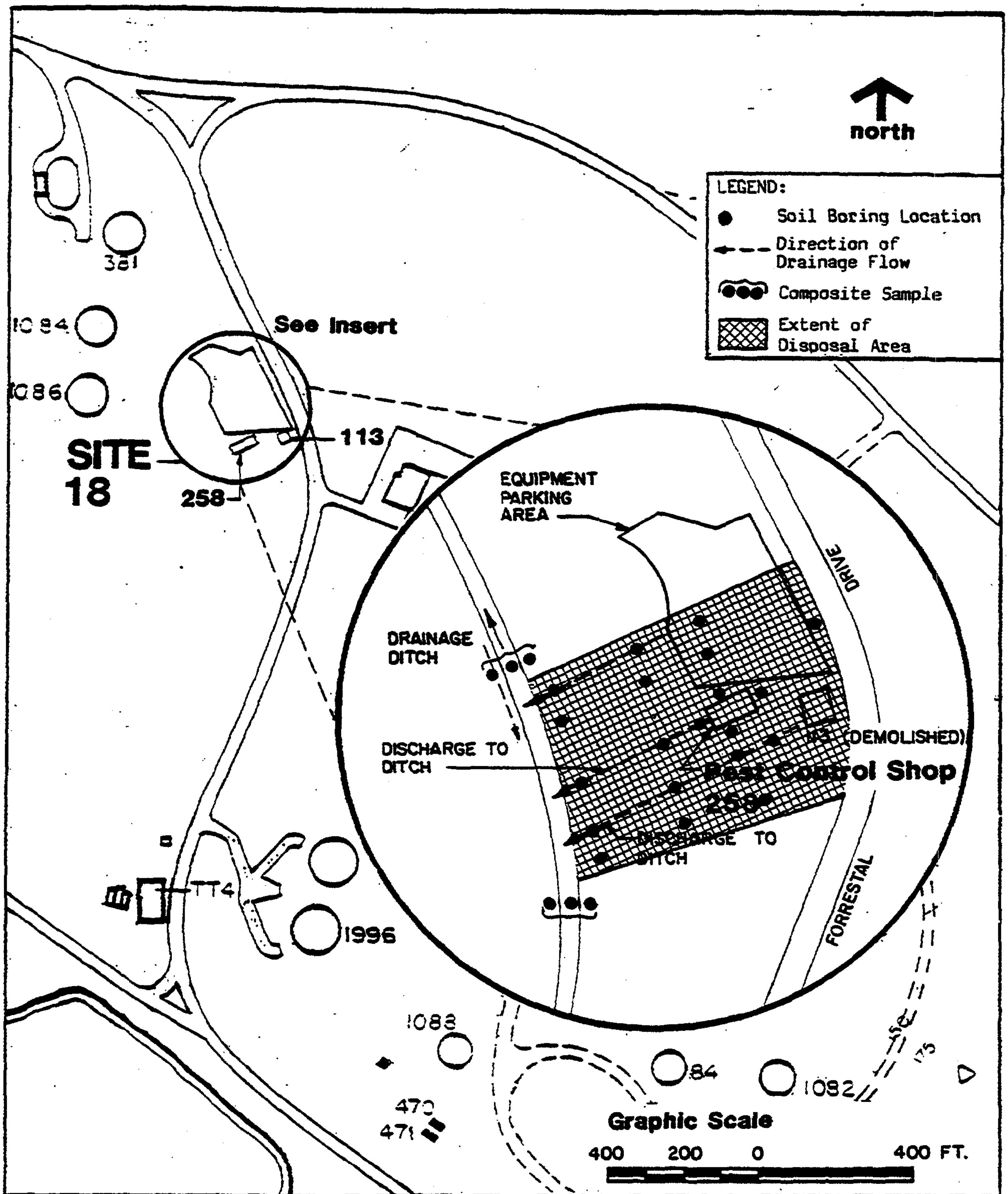
FIGURE 3-13
SITE 16, OLD POWER PLANT, BUILDING 38



INITIAL ASSESSMENT STUDY
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FIGURE 3-14
SITE 18, PEST CONTROL SHOP

should be entered into the facility Master Plan with a description of the proposed Confirmation Studies or mitigative actions. Any planned activities in these areas should be reexamined in light of the potential hazards that might be present on the site.

A separate series of recommendations for immediate mitigative actions to be undertaken at specific sites and to limit certain planned activities has been forwarded by NAVENENVSA to LANTNAVFACENGCOM.

CHAPTER 4. BACKGROUND

4.1 NAVSTA ROOSEVELT ROADS.

4.1.1 General. NAVSTA Roosevelt Roads is located on the east coast of Puerto Rico in the municipality of Ceiba, approximately 33 miles southeast of the capital City of San Juan (see Figure 2-1). The nearest major town is Fajardo, which is 10 miles north of the station. Immediately to the west of the station and adjacent to its western boundary is the town of Ceiba.

NAVSTA Roosevelt Roads encompasses over 33,500 acres of land, consisting of seven land holdings (see Table 4-1). A portion of the Navy's real estate assets in Puerto Rico are currently in the process of being excessed, with the potential recipient being the Commonwealth of Puerto Rico. Major facilities and land areas having this status are:

- NAVSTA San Juan and other facilities in Metropolitan San Juan;
- Naval Communication Station (NAVCOMSTA) Fort Allen; and
- Roosevelt Roads West Annex.

The primary mission of the Roosevelt Roads Naval Complex is to provide full support for Atlantic Fleet weapons training and development activities.

4.1.1.1 Adjacent Land Use. NAVSTA Roosevelt Roads is bordered on all sides but the west by the Caribbean Sea. Located to the southwest is agricultural land use and Bosque Estatal de Ceiba, which is a mangrove forest adjacent to the station's western border from south to north are several settlements, including Esperanza, Daguao, Quebrada Seca, Aguas Claras, and the town of Ceiba. The town of Ceiba has the largest population in the vicinity of the station, with 15,000 people in an area of approximately 27.5 square miles. Land use in these adjacent settlements is primarily residential, with some commercial uses interspersed. There are no industrial uses adjacent to the station.

There have been no instances in the past of contamination of station properties by adjacent land uses.

4.1.2 History. The present site of NAVSTA Roosevelt Roads, Puerto Rico, was first considered as a possible location for a Naval base as early as 1919. A report by LT Robert L. Pettigrew (CEC) USN in that year discussed the possibility, availability, and comparative advantages of several locations in the Vieques area, where no Naval activities existed at the time. Nothing further developed until U.S. involvement in World War II appeared inevitable. In letters to the Chief of Naval Operations (CNO) dated 13 and 15 May 1940, Captain R.A. Spruance, USN, Commandant of the Tenth Naval District, stated the need for a Fleet Base in the Puerto Rico area, and referred to LT Pettigrew's 1919 report.

The advantage of the Roosevelt Roads site, in addition to its location midway between Guantánamo Bay and Trinidad and its remoteness from the San Juan metropolitan area, included a strategic position; the availability of various supporting bases on San Juan and St. Thomas; the excellent land for positioning

Table 4-1

NAVAL STATION ROOSEVELT ROADS
LAND HOLDINGS

Land Holding	Acres
• Naval Station Roosevelt Roads	8,055
• Vieques East (Atlantic Fleet Weapons Training Facility Ranges, Camp García, and East Maneuver Area)	14,516
• Vieques West (Ordnance Storage Area)	8,081
• Culebra (Flamingo Point)	87
• St. Thomas (Crown Mountain)	7
• St. Croix (Underwater Tracking Range and St. Georges Hill)	7
	76
Total	30,829

Source: LANTNAVFACENGCOM, 1981.

coast artillery guns surrounding the area; the large size and available protection of the anchorage; the availability of sites for aircraft landing fields; the availability of three entrances; the short distance to water too deep for enemy mining; and the availability of a well sheltered bay on the mainland of Puerto Rico for piers to be used in connection with a shore establishment built on the adjoining land.

Roosevelt Roads was envisioned as a major operating base, the keystone of the Caribbean Defense System, with a thoroughly protected anchorage, a major air station, and an industrial establishment capable of supporting a large portion of the fleet under war conditions. It was intended that this base should furnish logistic support to the outlying secondary air bases at Antigua, St. Thomas, and Culebra, and that it would have facilities to provide the necessary support services for 60% of the Atlantic Fleet. The project was expected to cost $108,000,000. It is frequently stated in various references that "in the event Great Britain was overwhelmed by the Axis Powers, Roosevelt Roads was to become the new operating port for the British Fleet." This is a popular belief today, and while nothing in official military documents concerning the Caribbean area can be found to substantiate this, it is quite possible that such an agreement did exist at high planning levels.

When the United States Naval Operating Base, Roosevelt Roads, was commissioned in 1943, it was far from being the finished product of the 1940 plan. The essential operations and industrial portion of the projected base were completed in three years. By now, however, it was clear to the Allied leaders that due to the location of most Allied operations, a base of the intended size would not be necessary in the Caribbean.

On 1 September 1944 it was redesignated United States Naval Station Roosevelt Roads by the CNO, and in November of the same year it was placed in caretaker status under the supervision of a Public Works Officer, assisted by a small detachment of Seabees and a large labor force of local civilians. Placed in a maintenance status in the spring of 1945 it was again established as Naval Operating Base, Roosevelt Roads, Puerto Rico, on 1 April 1947. During these changes of status, the base was utilized primarily as a training site for portions of the Atlantic Fleet, and acted as an important refueling station.

In 1957 Roosevelt Roads was once more designated a Naval Station and given an entirely new mission. Because of its location, and the facilities already in existence on the base, Roosevelt Roads was chosen for development as the primary center for Fleet Guided-Missile Training Operations in the Atlantic.

When the base's original buildup was curtailed in 1943, many of the important facilities had been completed, including a dry dock 1,088 feet by 145 feet which is still among the world's largest, capable of receiving any ship; a machine shop to repair and service such ships as might arrive; a water supply system; a power plant; and fuel storage facilities. Dredging of the harbor, completion of the airfield, and completion of ammunition storage facilities were accomplished soon thereafter. With these completed there was no further expansion until 1957.

One of the first steps in the 1957 expansion of Roosevelt Roads was the acquisition of the U.S. Army's old Fort Bundy, an area which now comprises the southern portion of the station. Fort Bundy was established in 1940 as the headquarters for all coast artillery emplacements in the area; its mission was to provide defenses against enemy attack while the Naval base was under construction. Training and maintenance became the garrison's primary tasks. In 1947 the post was placed on standby status, and reopened within a year as headquarters for the 504th Field Artillery Battalion. When the 504th departed for the Canal Zone in 1950, Fort Bundy became inactive and was acquired by the Navy.

At dedication ceremonies for Roosevelt Roads on 21 May 1959, the airfield was named Ofstie Field in honor of the late Vice Admiral Ralph A. Ofstie, a distinguished leader in Naval aviation. The primary runway was extended to 11,000 feet and is capable of handling any existing jet aircraft. Numerous buildings and facilities were also erected to support the guided-missile mission.

Roosevelt Roads has provided support for various special and joint exercises that are held annually in the Caribbean waters (Operation Springboard, CARIBEX, etc.) for the Atlantic Fleet as well as for foreign navies.

Roosevelt Roads also provides support to tenant activities. The history of the Atlantic Fleet Weapons Training Facility (AFWTF) began with the Guided-Missile Operations Control Unit (GMOCU). In July 1963 AFWTF was commissioned as a separate activity. In July 1967 AFWTF activated its computerized Central Command and Control System (CCCS). The new CCCS is oriented around the Naval Tactical Data System (NTDS), allowing a rapid exchange of data between ships and aircraft exercising many miles apart at sea. The inauguration of the CCCS marked another milestone in the evolution of the Roosevelt Roads Complex as one of the largest, most technologically advanced training complexes in the world. A Remote Data and Drone Control System (RDDCS) was added to the CCCS in September 1968. This system provides for the control of drones from the Range Operations Center (ROC) instead of the three separate drone control sites located at the Naval Station and on St. Thomas and St. Croix.

During the early 1970s the closure of Naval Station San Juan brought four major commands to Roosevelt Roads: Commander, Tenth Naval District; Commander, Caribbean Sea Frontier Command; Antilles Defense Command; and Commander, Southern Atlantic.

4.1.2.1 Historical Sites. To date no systematic archaeological survey has been conducted at NAVSTA Roosevelt Roads. However, various sitings of aboriginal rock carvings (petroglyphs) on clusters of rocks located at the waters edge of Ensenada Honda were documented as early as 1893. The petroglyphs are in good condition and can be viewed by boat from Ensenada Honda. Past surveys have also identified various primitive campsites and village sites within the area of the station.

4.1.3 <u>Legal Actions</u>. The only environmental litigation which has been brought against NAVSTA Roosevelt Roads is the Romero vs. Brown case concerning Vieques. This litigation is discussed in Section 4.2.3.

4.1.4 <u>Biological Features</u>.

4.1.4.1 Ecosystems. Within NAVSTA Roosevelt Roads property there are four distinct ecosystems, the upland forest, mangrove, marine, and freshwater ecosystems, which are discussed in the following subsections.

4.1.4.1.1 Upland Forest Ecosystem. Upland forest areas include coastal dry-wood forests, beach strand association, and grassland areas. The upland forest is typified by trees with compound or simple leaves that are succulent or leathery, with broad expansive crowns. These trees rarely exceed 45 feet in height. Coppicing is common at the Naval Station, and results in the production of dense stands of relatively small trees. The most common tree species of the upland forest are listed in Table 4-2. Beach strand vegetational indicators are also listed in Table 4-2.

The upland forest ecosystem functions as an inhibitor of erosion, while it concurrently aides in ground water recharge. This type of habitat is principally utilized by avian species.

4.1.4.1.2 Mangrove Ecosystems. Mangrove ecosystems are self-maintaining coastal landscape units which couple upland terrestrial and coastal estuarine ecosystems; as such, they are perhaps the most important habitat type encompassed by Naval Station Roosevelt Roads. The three main species of mangroves are the red mangrove (Rhizophora mangle), black mangrove (Avicennia nitida), and white mangrove (Laguncularia racemosa). The red mangrove is capable of withstanding high salinities, and is generally found growing in pure stands on the seaward edge of a mangrove forest, becoming mixed with other species farther inland. The black mangrove is also tolerant of high salinities. It is not morphologically adapted to withstand prolonged submersion, although it is reportedly much more tolerant of shallow stagnant water than either the red or white mangrove. Thus it is generally found just landward of the red mangrove. White mangroves are the third species of importance at Roosevelt Roads; they are generally found on upland areas which are rarely subject to inundation by the sea.

Variations in structure and composition of mangrove forests are dependent upon such limiting factors as elevation, drainage patterns, tidal fluctuations, salinity, size, and geomorphology of their respective watersheds.

Three recognized mangrove associations occur at Roosevelt Roads: riverine, fringe, and basin forests. The basin forest is typified by a predominance of black and white mangroves, with a few red mangroves interspersed. This association is generally found in shallow depressions landward of the beach ridge or a fringing mangrove.

Fringe forests, dominated by red mangroves, are found in direct contact with the sea along the shoreline as well as inland along the banks of tidal channels.

Riverine mangrove forests are situated along the banks of freshwater drainages. They are characterized by a dominant fringe of red mangroves along the shoreline, which gives way to a mixture of red and black mangroves to landward. Table 4-3 gives the acreages of the major mangrove areas and their associated lagoon systems on the station.

Table 4-2

SPECIES INDICATORS OF COASTAL DRYWOOD FOREST
AND BEACH STRAND ASSOCIATION

Scientific Name	Common Name (Spanish, English)
Coastal Drywood Forest	
Bursera simaruba (L.) Sarg.	Almacigo, turpentine tree
Prosopis juliflora (Sw.) DC	Mesquite
Pictetia aculeata (Vahl) Urban	Tachuelo
Bucida buceras L.	Ucar
Guaiacum officinale L.	Guayacan
Guaiacum sanctum L.	Guayacan blanco
Leucaena glauca (L.) Benth.	Zarcilla, leadtree
Tamarindus indica L.	Tamarindo
Acacia macracantha Humb. & Bonpl.	Tamarindo silvestre
Acacia farnesiana (L.) Willd.	Sweet acacia
Melicoccus bijugatus Jacq.	Quenepa
Beach Strand Association	
Suriana maritima	Bay cedar
Cocolobo uvitera	Seagrape
Cocos nucifera	Coconut
Conocarpus erectus	Buttonbush
Hippomare mancinella	Manzanillo

Sources: Ewel and Whitmore, 1973; and
Little and Wadsworth, 1964.

Table 4-3

MANGROVES AT NAVAL STATION ROOSEVELT ROADS

Site	Area in Acres*				Shoreline (miles)
	Mangrove	Lagoon	Deforested	%	
Machos	855	140	170	16	13.0
Ensenada Honda	470	35	230	33	6.5
Río Daguao	460	11	15	3	3.4
Punta Figueras	160	6	0	0	2.0
Isla Piñeros	65	13	0	0	1.2
Punta Puerca	35	2	10	28	0.5
Total	2,045	207	425	17	26.6

*Lagoon areas do not include Cascajo Bay or Punta Blanca Bay. The term deforested refers to total acres of mangrove lost due to construction, dredge filling, or other modification. The estimates are based on March 1936 aerial photographs, as well as coastline topographic contours from U.S. Geological Survey quadrangles.

Source: U.S. Department of Agriculture, National Forest Service, 1976.

Recent scientific investigations have shown that mangrove forests are very important to fish and wildlife. They function as shoreline stabilizers by inhibiting erosive forces, such as wind and waves. They also act as "settling filters" for upland runoff, which results in relatively clean water return to the ocean after heavy rains. More importantly, mangroves provide food for primary consumer organisms through detrital leaf and twig fall. These organisms are fed upon in turn by successively larger species. Thus mangroves fix sunlight energy, which is then passed on through detrital fall to become a primary energy source upon which a large portion of the marine "food web" is dependent.

Mangrove forests (especially riverine and fringe association), then, provide food, cover, and nursery areas for the wide variety of marine sport and commercial fish species found at Roosevelt Roads (see Table 4-4).

The root systems of red mangroves also provide a large amount of submerged surface area which serves as substrate for a diversity of sessile (non-motile) marine organisms such as tunicates, sponges, and mangrove oysters.

The canopy of a mangrove forest provides nesting and roosting area for a variety of birds. Large egrets and pelicans will commonly roost in the top and outer areas of canopy, while smaller passerine (perching) birds utilize the lower and interior sections.

Certain avians are indigenous to mangroves, i.e., they are restricted to mangrove habitat alone--other habitat types cannot provide for their needs in terms of suitable food or cover.

4.1.4.1.3 Marine Ecosystems. The station also contains various marine ecosystems which can be generally characterized as coral reef associations and seagrass associations. While these areas remain unquantified (in terms of acreage) and are generally unmapped, they are nonetheless important habitat areas.

Coral reefs at Naval Station Roosevelt Roads are made up of stony and soft corals. They are utilized as habitat by a large variety of marine fish. Many of the coral reefs are pristine in more remote areas of the station. Coral reefs develop slowly and are highly sensitive to such factors as substrate and water quality. Once killed, they may be lost forever.

Seagrass beds consisting of turtlegrass (Thalassia testudinum) and manatee grass (Syringodium filiforme) are common in the clear shallow embayments of the station. The U.S. Army Corps of Engineers has estimated their areal extent in Ensenada Honda alone at approximately 600 acres.

While seagrasses grow rapidly, they are extremely slow in reproducing; thus once a bed has been damaged, it may be several years before it revegetates in the area affected. These communities tend to dissipate wave energy, which allows sediments to settle out of the water column. Further, they provide the majority of dissolved oxygen present in their associated waters. Finally, the plants serve as food and cover for myriads of marine vertebrates and invertebrates.

Table 4-4

FISHES IN THE MANGROVES OF
NAVAL STATION ROOSEVELT ROADS

Scientific Name	Common Name
Dasyatidae	Stingrays
Dasyatis americana	Southern stingray
Aetobatis narinari	Spotted eagle ray
Elopidae	Tarpons
Megalops atlanticus	Tarpon
Clupeidae	Herrings
Opisthonema ogliun	Thread herring
Herengula humeralis	Red ear sardine
Synodontidae	Lizardfishes
Synodus intermedius	Sand diver
Belonidae	Needlefishes
Stongylura timucu	Timucu
Mugilidae	Mullets
Mugil curema	White mullet
Sphyraenidae	Great barracuda
Sphyraena barracuda	Great barracuda
Polynemidae	Threadfins
Polydactilus virginicus	Barbu
Surranidae	Groupers
Epinephelus striatus	Nassau grouper
Grammidae	Fairy basslets
Gramma loreto	Fairy basslet
Centropomidae	Snook
Centorpomus undecimalis	Snook

Table 4-4 (Cont.)

Scientific Name	Common Name
Hemiramphidae	Halfbeaks
Hemirampus balao	Balao
Carangidae	Jacks
Carans fusus	Blue runner
Carans latus	Horse-eye jack
Oligoplites saurus	Leatherjacket
Lutjanidae	Snappers
Lutjanus apodus	Schoolmaster
Lutjanus jocu	Dog snapper
Lutjanus mahogoni	Mahogany snapper
Ocyurus chysurus	Yellowtail snapper
Pomadasydae	Grunts
Haemulon sciurus	Bluestriped grunt
Haemulon flavolineatun	French grunt
Haemulon macrostomum	Spanish grunt
Anisotremus virginicus	Porkfish
Sparidae	Porgies
Archosargus rhomboidalis	Sea bream
Gerreidae	Mojarras
Gerres cinereus	Yellowfin mojarra
Eucinostomus lefroyi	Mottled mojarra
Ephippidae	Spadefish
Chaetodlipterus faber	Spadefish
Scorpaenidae	Scorpionfishes
Scorpaena plumeri	Spotted scorpionfish
Dactylopteridae	Flying gunards
Dactylopterus volitans	Flying gunard
Chaetodontidae	Butterflyfishes
Chaetoclon capistratus	Foureye butterflyfish

Table 4-4 (Cont.)

Scientific Name	Common Name
Pomacentridae	Damselfishes
Eupomacentrus fuscus	Dusky damselfish
Eupomacentrus leucostictus	Beau gregory
Abuclefcluf saxatillis	Sergeant major
Labridae	Wrasses
Lachnolaimus maximus	Hogfish
Halichoeres burittatus	Slippery dick
Halichoeres poeyi	Black-ear wrasse
Thallasoma bifasciatum	Bluehead
Scaridae	Parrotfishes
Sparisoma rubrippine	Yellowtail parrotfish
Sparisoma aurofrenatum	Redband parrotfish
Scarus guacamaia	Rainbow parrotfish

Source: Puerto Rico Department of Natural Resources.

Each of these ecosystems (mangrove, upland forest, coral reef, and grassbeds) are highly complementary and interdependent. For example, the mangrove and upland forest function of filtering or inhibiting upland runoff is vital to the well-being of nearby coral reefs, which are extremely sensitive to turbid water. Coral reefs and grassflats are a "first defense" against wave energy, and thus complement the erosion-inhibiting function of the shore zone mangroves. Coral reefs and grassflats are mutually beneficial as cover and feeding areas for fishes, which may be fed upon by birds such as the pelican, which uses mangroves for roosting and nesting habitat.

4.1.4.1.4 Freshwater Ecosystems. Although freshwater bodies (with the exception of rivers) are not common in Puerto Rico, Naval Station Roosevelt Roads encompasses two small ponds located near the airport and the Officer's Club. These ponds are intermittent, i.e., they dry up at times due to weather conditions. The pond areas support birds including the white-crowned pigeon, osprey, white-cheeked pintail, and the blue and green-wing teal. The areas are utilized as feeding, roosting, and nesting habitat by these species.

4.1.4.2 Endangered, Threatened, and Rare Species. The abundance of relatively undisturbed shoreline, mangrove, and upland forest areas supports a unique and diverse number of bird species at Roosevelt Roads, including waterfowl, shorebirds, seabirds, birds of prey, and passerine birds. In fact, more than one-half of all the bird species found on the entire island can be found at the Naval Station either as residents, migrants, or vagrants. This abundance of avifauna may be partially attributable to the fact that the station has been declared a sanctuary where no hunting is permitted. Destruction of wetland and shore zone habitats on the east coast of Puerto Rico is increasing, which is also a factor contributing to the high diversity of bird populations found on the station.

Table 4-5 presents a species list of bird life at Roosevelt Roads. Included in this table are codes for each species' use of habitat at the station (e.g., breeding) where known, as well as a code relating to the species' status (e.g., endangered) developed by the Puerto Rico Department of Natural Resources.

The station supports a variety of federally protected biota (see Table 4-6 and Figure 4-1) which have been listed pursuant to the Rare and Endangered Species Act of 1973. The entire station "exclusive of those existing man-made structures or settlements which are not necessary to the normal needs or survival of the species" (U.S. Fish and Wildlife Service, 1983) has been designated as "critical habitat" for the yellow-shouldered blackbird (Agelaius xanthomus). Critical habitat consists of those areas that are vital to the continued existence and well-being of a given species. Yellow-shouldered blackbirds are endangered due to several factors, including contagious disease, lack of mangrove nesting areas free from rodent predation, and nest parasitation by glossy cowbirds.

The Eastern brown pelican (Pelecanus occidentalis carolinensis), while rare in the continental United States, is common throughout Puerto Rico and the Virgin Islands, although breeding rookeries are small as well as few in number.

The major concentration of West Indian manatees (Trichechus manatus manatus) in Puerto Rico is found within the protected waters of the station. This aggrega-

Table 4-5

BIRDS OF NAVAL STATION ROOSEVELT ROADS

Common Name	Scientific Name	Code
Pied-billed grebe	Podilymbus podiceps	
Red-billed tropic bird	Phaethon aethereus	(2)
Brown pelican	Pelecanus occidentalis	(4)
Brown booby	Sula leucogaster	
Magnificent frigatebird	Fregata magnificens	
Great blue heron	Ardea herodias	(3)
Louisiana heron	Hydranassa tricolor	B
Snowy egret	Egretta thula	B (3)
Great egret	Egretta alba	B (3)
Green heron	Butorides virescens	B
Little blue heron	Florida caerulea	B
Cattle egret	Bubulcus ibis	
Least bittern	Ixobrychus exilis	B
Yellow-crowned night heron	Nyctanassa violacea	B
Black-crowned night heron	Nycticorax nycticorax	(2)
Bahama pintail	Anas Bahamensis	B (1)
Blue-winged teal	Anas discors	
American widgeon	Anas americana	
Red-tailed hawk	Buteo jamaicensis	B
Osprey	Pandion haliaetus	B (3)
Merlin	Falco columbarius	
Clapper rail	Rallus longirostris	B
American coot	Fulica americana	
Caribbean coot	Fulica caribaea	B (3)
Common gallinule	Gallinula chloropus	B
Piping plover	Charadrius melodus	
Semipalmated plover	Charadrius semipalmatus	
Black-bellied plover	Squatarola squatarola	
Wilson's plover	Charadrius wilsonia	B
Killdeer	Charadrius vociferus	B
Ruddy turnstone	Arenaria interpres	
Black-necked stilt	Himantopus himantopus	B
Whimbrel	Numenius phaeopus	(2)
Spotted sandpiper	Actitis macularia	
Semipalmated sandpiper	Calidris pusilla	
Short-billed dowitcher	Limnodromus griseus	(3)
Greater yellowlegs	Tringa melanoleuca	
Lesser yellowlegs	Tringa flavipes	
Willet	Catoptrophorus semipalmatus	(3)
Stilt sandpiper	Micropalama himantopus	
Pectoral sandpiper	Calidris melanotos	
Laughing gull	Larus atricilla	
Royal tern	Thalasseus maximus	(2)

Table 4-5 (Cont.)

Common Name	Scientific Name	Code
Least tern	Sterna albifrons	B (2)
Sandwich tern	Thalasseus sandvicensis	(2)
Bridled tern	Sterna anaethetus	
Brown noddy	Anous stolidus	(5)
White-winged dove	Zenaida asiatica	B
Zenaida dove	Zenaida aurita	B
White-crowned pigeon	Columba leucocephala	B (4)
Mourning dove	Zenaida macroura	B
Red-necked pigeon	Columba squamosa	
Common ground dove	Columbina passerina	B
Bridled quail dove	Geotrygon mystacea	
Ruddy quail dove	Geotrygon montana	
Caribbean parakeet	Aratinga pertinax	
Smooth-billed ani	Crotophaga ani	B
Yellow-billed cuckoo	Coccyzus americanus	B
Mangrove cuckoo	Coccyzus minor	B
Short-eared owl	Asio flammeus	B (2)
Chuck-will's widow	Caprimulgus carolinensis	
Common nighthawk	Chordeiles minor	(5)
Antillean crested hummingbird	Orthorhyncus cristatus	B
Green-throated carib	Sericotes holosericeus	B
Antillean mango	Anthracothorax dominicus	B
Belted kingfisher	Ceryle alcyon	
Gray kingbird	Tyrannus dominicensis	B
Loggerhead kingbird	Tyrannus caudifasciatus	
Stolid flycatcher	Myiarchus stolidus	
Caribbean elaenia	Elaenia martinica	
Purple martin	Progne subis	
Cave swallow	Petrochelidon fulva	B
Barn swallow	Hirundo rustica	
Northern mockingbird	Mimus polyglottos	B
Pearly-eyed thrasher	Margarops fuscatus	B
Red-legged thrush	Mimocichla plumbea	B
Black-whiskered vireo	Vireo altiloquus	B
Prairie warbler	Dendroica discolor	
American redstart	Setophaga ruticilla	
Yellow warbler	Dendroica petechia	B
Parula warbler	Parula americana	
Magnolia warbler	Dendroica magnolia	
Black and white warbler	Mniotilta varia	
Cape May warbler	Dendroica tigrina	
Black-throated blue warbler	Dendroica caerulescens	
Adelaide's warbler	Dendroica adelaidae	
Palm warbler	Dendroica palmarum	
Ovenbird	Seiurus aurocapillus	

Table 4-5 (Cont.)

Common Name	Scientific Name	Code
Northern water thrush	Seirus noveboracensis	
Bananaquit	Coereba flaveola	B
Stripe-headed tanager	Spindalis zena	B
Shiny cowbird	Molothrus bonariensis	B
Black-cowled oriole	Jeterus dominicensis	B (4)
Greater antillean grackle	Quiscalus niger	B
Yellow-shouldered blackbird	Agelaius xanthomus	B (4)
Hooded mannikin	Lonchura cucullata	B
Yellow-faced grassquit	Tiaris olivacea	B
Black-faced grassquit	Tiaris bicolor	
Ruddy duck	Oxyura jamaicensis	(3)
Peregrine falcon	Falco peregrinus	(2)
Marbled godwit	Limosa fedoa	(2)
Puerto Rican lizard cuckoo	Saurothera vieilloti	
Prothonotary Warbler	Protonotaria citrea	(1)
Green-winged teal	Anas carolinensis	

Code*:

B = breeding;
(1) very endangered,
(2) endangered,
(3) on the verge of being endangered,
(4) status undetermined, and
(5) peripheral

*According to Rare and Endangered Animal Species of Puerto Rico list.

Source: Data compiled by James W. Wiley, U.S. Department of Agriculture Forest Service, Institute of Tropical Forestry, Rio Piedras, Puerto Rico, 1976.

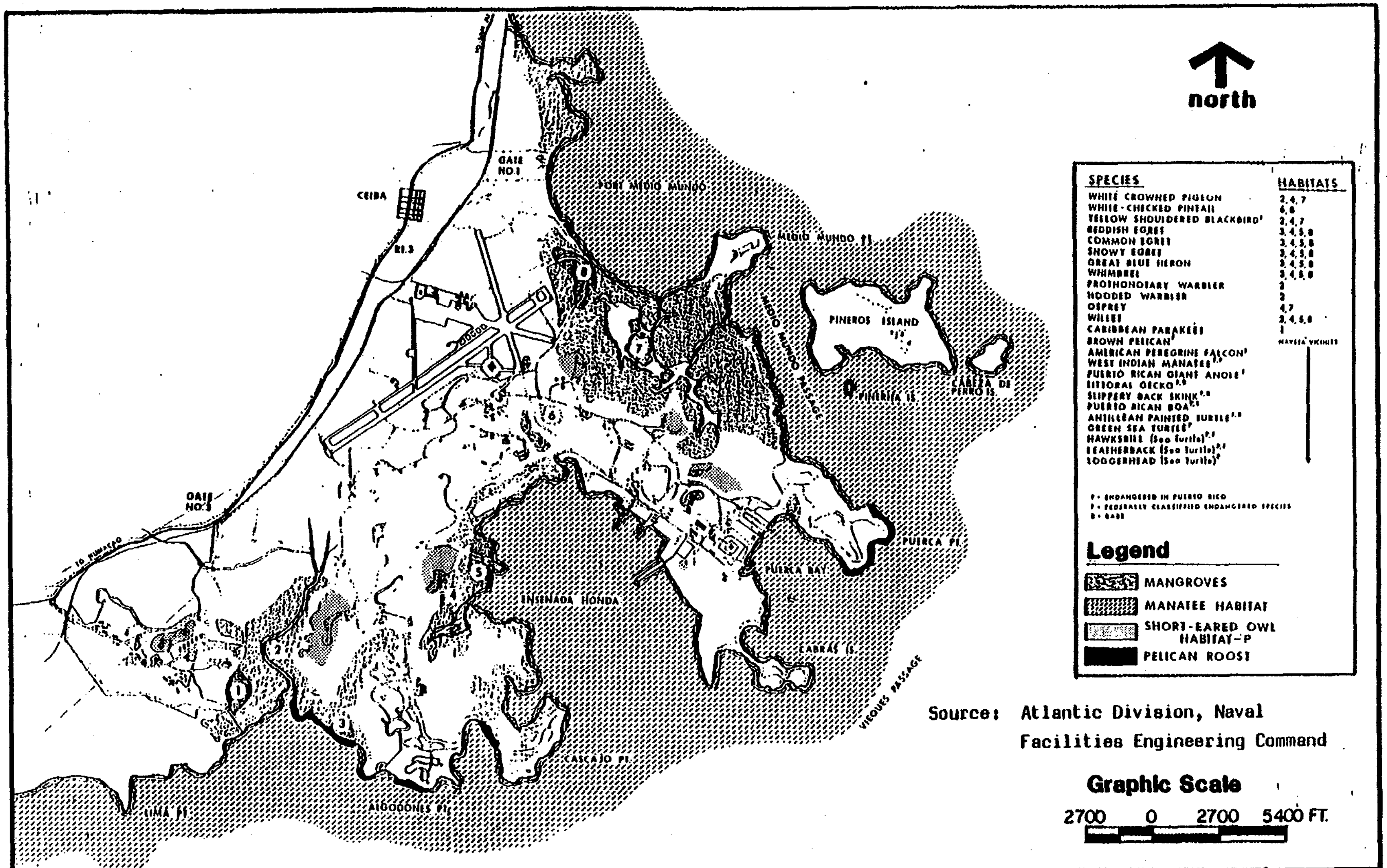
Table 4-6

FEDERALLY LISTED RARE AND ENDANGERED FAUNA
AT NAVAL STATION ROOSEVELT ROADS

Scientific Name	Common Name
Eretmochelys imbricata	Hawksbill turtle
Dermochelys coriacea	Leatherback turtle
Epicrates inornatus	Puerto Rican boa
Pelecanus occidentalis	Eastern brown pelican
Falco peregrinus anatum	American peregrine falcon
Columba inornata wetmori	Puerto Rican plain pigeon
Agelaius xanthomus*	Yellow-shouldered blackbird
Trichechus manatus	West Indian manatee

*Entire station, except for built-up areas, has been designated as critical habitat for this species.

Source: U.S. Fish and Wildlife Service.



INITIAL ASSESSMENT STUDY
NAVAL STATION
ROOSEVELT ROADS, PUERTO RICO

FIGURE 4-1

AREAS OF VARIOUS SPECIES, NAVSTA ROOSEVELT ROADS tion undoubtedly exists here due to the extensive seagrass beds which are utilized as a feeding area and the ready availability of freshwater from station wastewater outfalls. The manatee population utilizes the Vieques Passage between the station and Vieques for feeding and breeding.

Sea turtles have been sighted near coral reefs and grassbeds in protected, remote bays. There is a possibility that they nest on some of the more tranquil beaches. All sea turtles except the green sea turtle have been listed, and their survival depends on preservation of their feeding and nesting habitat.

The Puerto Rican boa (Epicrates inornatus) is also under federal protection and is considered endangered throughout its range. Currently, it appears that the species is recovering from severe habitat destruction and mongoose predation. Due to the undisturbed nature of large areas of the station, it may be a major refuge for this species. No collection of the species has been made on the station; however, collections have been made in ecologically similar areas adjacent to the station.

The Commonwealth government has compiled a list of rare and endangered species of Puerto Rico which is more extensive than that of the federal government (see Table 4-5).

At present, there are no freshwater sport fisheries on the station. Station personnel do, however, enjoy saltwater fishing for such species as snook (Centropomus undecimalis), great barracuda (Sphyraen barracuda), bonefish (Albula vulpes), snapper (Lutjanidae), and grouper (Serranidae).

4.1.5 Physical Features.

4.1.5.1 Climatology. The climate of the Roosevelt Roads area is characterized as warm and humid, with frequent showers occurring throughout the year. A major factor affecting the weather is the trade winds associated with the Bermuda High, the center of which is in the vicinity of 30° north, 30° west. The prevailing wind direction reflects the easterly trade winds. The area receives a surface flow from the northeast to the southeast about 75% of the time annually, and as much as 95% of the time in July when the easterly winds are strongest. The differential heating of the land and sea during the day tends to give a more northerly component to the flow on the northern side of the island and a more southerly component on the southern side. During the night, a land breeze causes a prevailing southeasterly flow in the north and a prevailing northeasterly flow over the southern coast. The mean annual wind velocity is 5.5 knots, with a minimum in November and a maximum in August. Gales associated with westward moving disturbances in the trade winds or hurricanes passing either north or south of the area have the highest probability of occurrence from June through October.

Uniform temperatures prevail, with small diurnal ranges as a result of insular exposure and the relatively small land areas. The warmest months are August and September, while the coolest are January and February. Mean annual maximum temperatures range from 82.0° in January to 88.2°F in August. The mean annual minimum temperatures vary from 64.0° in January to 73.2°F in June. The highest maximum temperature recorded was 95°F, while the lowest minimum was 59°F. Rain usually occurs at least nine days in every month, with an average of 60 inches per year. A dry winter season occurs from December through April. About 22 thunderstorm days occur per year, with maximum frequencies of three days per month from May through October.

In late summer the mean sky cover begins a steady decrease from a monthly maximum average of 6.5 tenths coverage in September to a minimum monthly average of 4.4 tenths coverage in February. From March through August the monthly average cloud cover increases steadily from 4.5 to 6.0 tenths coverage during the period. Over the open sea, a maximum of clouds (usually broken stratocumulus) occurs during early morning, with the skies clearing or becoming scattered with cumulus by afternoon. Completely clear or overcast skies are rare during daylight hours, while clear skies frequently occur at night.

The hurricane season is from mid-June through mid-September; maximum winds exceed 95 knots during severe hurricanes. An average of two tropical storms per year occur in the study area, one of which usually reaches hurricane intensity.

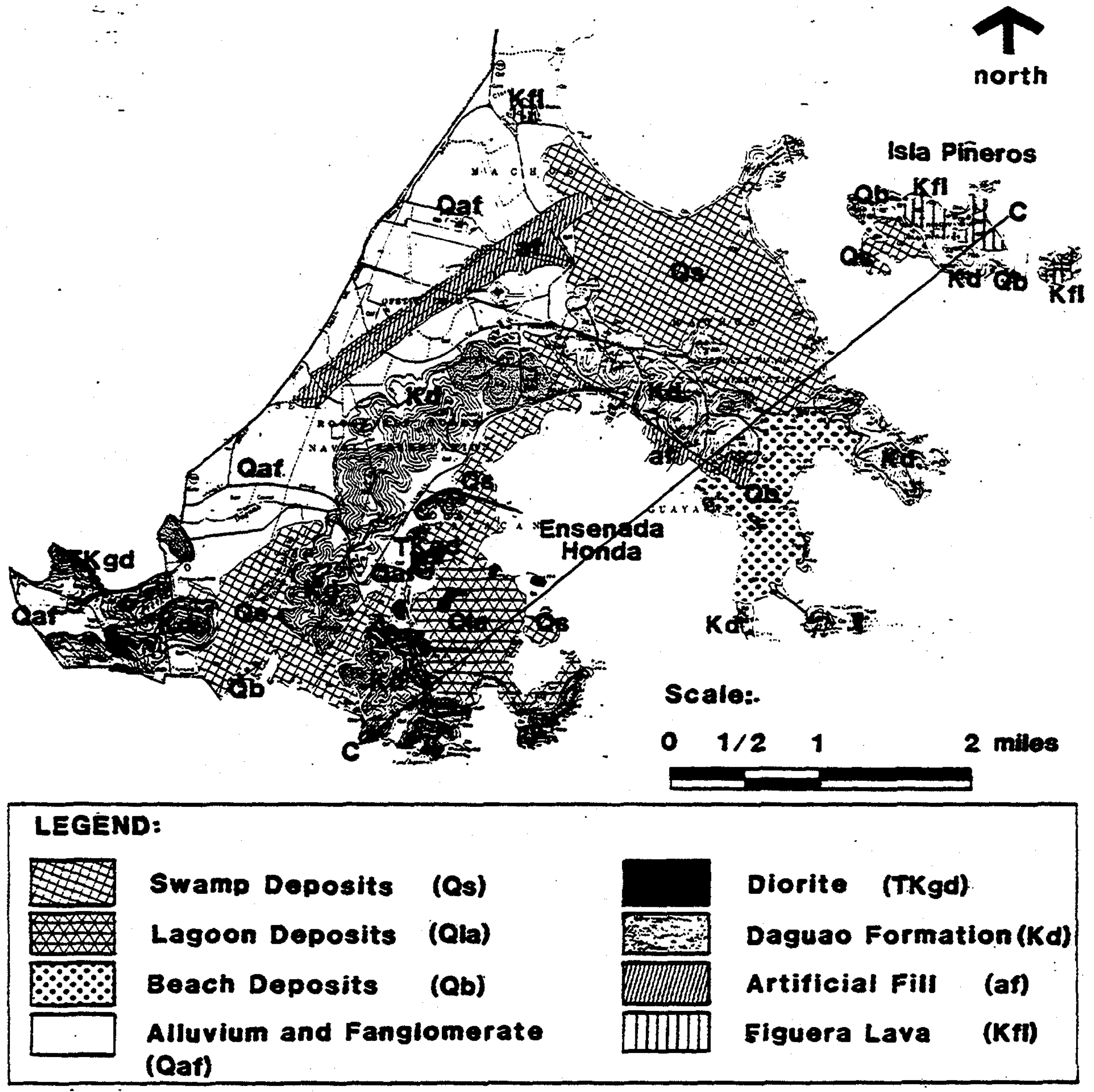
4.1.5.2 Topography. The regional area of the Naval Station consists of an interrupted narrow coastal plain with small valleys extending from the Sierra de Luquillo range, which has been deeply eroded by streams into valleys several hundreds of feet deep. Slopes of 30° to 45° are not uncommon.

In the immediate area of the station elevations range from sea level to approximately 295 feet. Immediately to the north of the station boundary, the hills rise abruptly to heights of 800 to 1,050 feet above sea level, with the tallest peak located within two kilometers of the station boundary. There is a series of three hilly areas on the station, two of which separate the southern airfield area from the Port/Industrial, Housing, and Personnel Support areas. The third set of hills is in the Bundy area. These ridge lines not only separate sections of the station, but dictate the degree of allowable development. The ridge line south of the airfield provides an excellent barrier which effectively decreases the aircraft-generated noise which reaches the Unaccompanied Enlisted Personnel Housing areas to an acceptable level. Relief is low along the shoreline. Lagoons and mangrove swamps are common.

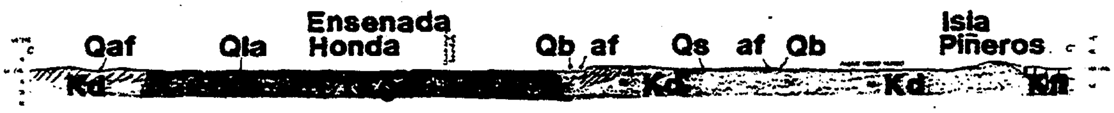
4.1.5.3 Geology. The underlying geology of the station area is predominantly volcanic composed of lava and tuff, as well as sedimentary rocks derived from discontinuous beds of limestone. These rocks range in age from early Cretaceous to middle Eocene. The volcanic rocks and interbedded limestones have been complexly faulted, folded, metamorphosed, and intruded by dioritic rocks. This complex geological restructuring occurred sometime after the deposition of the limestone during the middle Tertiary age, when Puerto Rico was separated from the other major Antillean Islands by block faulting and was arched, uplifted, and tilted to the northeast. Culebra, Vieques, and the Virgin Islands are part of the Puerto Rican block; they are separated from the main island simply because of the drowning that resulted from the tilting.

In addition to the predominate volcanic and sedimentary rock, the northwestern and western sectors of the base are underlain by unconsolidated alluvial and old alluvial deposits from the Quaternary period. See Figure 4-2.

The primary geologic formations on and near NAVSTA Roosevelt Roads are various beach deposits, alluvium, quartz diorite and granodiorite, quartz keratophyre,



Source: United States Geological Survey



Section C-C

INITIAL ASSESSMENT STUDY
NAVAL STATION
ROOSEVELT ROADS, PUERTO RICO

Figure 4-2
Geological Formation of Roosevelt Roads Property

the Daguao formation, and Figuera lava (see Table 4-7). The station is traversed by the Peña Pobre fault zone.

4.1.5.4 Soils. The soil associations found at the Naval Station are predominately of two types typical of humid areas, namely the Swamps-Marshes Association and the Mabi-Rio-Arriba-Cayagua Association, as well as the Descalabrado-Guayama Association, which is typical of dry areas. In addition, isolated areas of the Caguabo-Mucara-Naranjito Association, the Coloso-Toa-Bajura Association, and the Jacana-Amelia-Fraternidad Association are found at the station (see Figure 4-2).

The Swamps-Marshes and Mabi-Rio-Arriba-Cayagua associations cover over one half of the station's surface area and are equally distributed. The remaining area is covered primarily by the Descalabrado-Guayama and Caguabo-Mucara-Naranjito associations.

The Swamps-Marshes Association consists of deep, very poorly drained soils. This association is found in level or nearly level areas that are slightly above sea level but are wet, and when the tide is high, are covered or affected by saltwater or brackish water. The soils are sandy or clayey, and contain organic material from decaying mangrove trees. They are underlain by coral, shells, and marl at varying depths. The high concentration of salt inhibits the growth of all vegetation except mangrove trees, and in small scattered patches, other salt-tolerant plants (U.S. Department of Agriculture, 1977).

The Mabi-Rio-Arriba-Cayagua Association consists generally of deep, somewhat poorly drained and moderately well-drained, nearly level to moderately steep soils found on foot and side slopes, terraces, and alluvial fans. Soils of this association at the Naval Station are basically clayey, and are located predominantly in the areas surrounding Ofstie Field (U.S. Department of Agriculture, 1977).

The Descalabrado-Guayama Association generally consists of shallow, well-drained, strongly sloping to very steep soils on volcanic uplands. Soils of this association are found primarily in the hilly areas located directly inland and adjacent to the soils of the Swamps-Marshes Association (U.S. Department of Agriculture, 1977).

The Caguabo-Mucara-Naranjito Association consists generally of shallow and moderately deep, well-drained, sloping to very steep soils on volcanic uplands. This association consists of soils which formed in residual material that weathered from volcanic rocks. This association is represented at the Naval Station by soils of the Sabana series, which are found on the side slopes and the hilly terrain west of Langley Drive in the Fort Bundy area. These soils are suited for pasture and woodland. Steep slopes, susceptibility to erosion, and depth to bedrock are the main limitations for farming and for recreation and urban uses (U.S. Department of Agriculture, 1977).

The Coloso-Toa-Bajura Association consists of deep, moderately well drained to poorly drained, nearly level soils found on floodplains. This soil association extends along the western boundary of the station and around the airfield. The

Table 4-7

GEOLOGIC FORMATIONS AT NAVAL STATION ROOSEVELT ROADS

Designation	Description
Qbp	**BEACH DEPOSITS OF PEBBLES AND COBBLES (HOLOCENE)** - Moderately sorted, generally well-rounded local pebble and cobble deposits. Composed mainly of volcanic rock fragments from lavas and dikes, coral fragments, and calcareous sand. Gradational into sandy beach deposits. Thickness ranges from two to four meters or more.
Qla	**LAGOON DEPOSITS (HOLOCENE)** - Mud and calcareous sand deposits periodically inundated by very shallow marine waters. Gradational into swamp deposits. Found on western side of Ensenada Honda. Thickness uncertain.
Qs	**SWAMP DEPOSITS (HOLOCENE)** - Black to dark brown organics-rich soil and muck in poorly drained part of alluvial plains. In large part covered with mangroves. Thickness probably as much as five meters locally.
Qb	**BEACH DEPOSITS (HOLOCENE AND PLEISTOCENE?)** - Unconsolidated fine- to coarse-grained sand and pebble deposits. South of Ensenada Honda composed of quartz and feldspar grains and plutonic and volcanic rock fragments, with considerable amounts of sand (shell, algal, and coral fragments) locally. From Ensenada Honda northward, quartz grains are rare and plutonic rock fragments uncommon; deposits are principally of calcium carbonate grains with local admixtures of volcanic rock fragments and pebble clasts. Gradational into, and partly overlain by, alluvial and swamp deposits. Thickness probably more than 10 meters locally.
Qaf	**ALLUVIUM AND FANGLOMERATE (HOLOCENE AND PLEISTOCENE)** - Unconsolidated to weakly consolidated, poorly to well-sorted, clay to boulder-sized material in fans and in stratified alluvial valley fill deposits. Locally terraced; includes slope wash, small landslides, and channel fill deposits. Gradational into units mapped as predominantly alluvium, alluvial plain, and terraced deposits. Thickness locally more then 25 meters.
TKgd	**QUARTZ DIORITE AND GRANO DIORITE (TERTIARY?) AND UPPER CRETACEOUS?** - Light gray to light olive gray stocks of medium- to fine-grained unfoliated rock with hypodiomorphic-granular texture. Composition ranges from quartz diorite to granodiorite. Hornblende is the predominant mafic mineral; only minor amounts of biotite are present. Rounded metavolcanic xenoliths are locally present. A sample from the stock at the head of the Rio Daguao exhibits a peculiar fine-grained allotrimorphic-granular quartz and feldspar groundmass for the otherwise normally developed medium-grained minerals in the quartz diorite.
TKgdf	**FINE-GRAINED GRANO DIORITE FACIES.**
TKk	**QUARTZ KERATOPHYRE (TERTIARY? AND UPPER CRETACEOUS?)** - Stocks of medium-dark-gray to medium-bluish-gray porphyritic rock with an aphanitic matrix in north-central part of mapped area. Contains oligoclase and bipyramidal quartz phenocrysts. Weathers to grayish yellow, dusky yellow, and light brown. The quartz phenocrysts and the light colors are distinctive. Interior parts of the intrusive are massive in aspect, although the rock is commonly much jointed and locally shattered. Borders of the intrusive are often irregular, with numerous apophyses and dikes extending into the county rock. Groundmass is an intricate intergrowth of quartz albite and oligoclase. X-ray diffraction indicates that somewhat more than 10% of the rock is potassium feldspar, but this could not be confirmed optically. Phenocrysts of plagioiclase are albite and aligoclase in crystals about one to four millimeters in length. The three-millimeter-long quartz phenocrysts appear to be resorbed and rounded, although a bipyramidal shape is plainly evident in many of them. Epidote is common as patches and stringers throughout the rock.

Table 4-7 (Cont.)

Designation	Description
Kfl	**FIGUERA LAVA (LOWER CRETACEOUS)** - Andesitic lava sequence with intercalations of volcaniclastic breccia and tuff. Exposures generally confined to artificial cuts; most slopes show only float of lava fragments in soil. Medium-dark-gray to dark-gray, reddish-brown weathering lavas are generally fine-grained, medium-bedded to massive, and locally autobrecciated. The lava contains small, scattered andesine phenocrysts and sparse pyroxene phenocrysts. Quartz is fairly common in inlets, stringers, and blebs ranging from three to nine centimeters in length. The original composition of the groundmass appears to have been largely andesine and clinopyroxene with minor magnetite, but in most places the groundmass is altered to epidote, chlorite, tremolite-actinolite, quartz, and clay. Local amygdaloidal lavas have quartz, epidote, and calcite as vesicle fillings. Some lenticular zones of pillow lava are scattered through the section; the pillows range from one to two meters in diameter, and generally a light-colored, aphanitic, silicified(?) material occupies the interstices between the pillows. One thin light gray tuff bed (Kfla) crossed by Highway 975 along the ridge crest west of Ceiba appears in thin section to contain devitrified pumice fragments and glass shards in a brown cryptocrystalline groundmass containing scattered broken plagioclase and pyroxene crystals. A planar texture (flowage?) is readily discernible in the rock, and it is interpreted as a nonwelded andesitic ash flow tuff, relatively rich in crystal fragments. Volcaniclastic rocks occur in units a few meters thick as interbeds within the main lava sequence. These rocks include some graded tuffs in layers two to eight centimeters thick, but are mainly medium- to thick-bedded coarse tuff to lapilli tuff and tuff breccia. Clasts include some cherty-looking material (silicified tuff?) as well as minor pumaceous fragments, but are generally fine-grained lava and amygdaloidal lava, like that of the main part of the Figuera. An especially thick massive breccia (Kflb) underlying pillow lavas can be found along Route 972 on the ridge in the northwest part of the Naguabo quadrangle. The breccia is made up of angular to rounded pebble-sized clasts of pumice, amygdaloidal fine-grained lavas, and locally, silicified tuff in calcareous clinopyroxene-bearing tuff matrix. As much as 2,000 meters of Figuera Lava may be exposed in the area.
Kfld	**MIXED ZONE (LOWER CRETACEOUS)** - Interstratified Figuera Lava and Daguao Formation.
Kd	**DAGUAO FORMATION (LOWER CRETACEOUS)** - Interbedded volcanic breccia, lava, and subordinate volcanic sandstone and crystal tuff. The volcanic breccia is medium gray, massive, and is composed of clasts of dark-gray irregularly shaped subangular to subrounded granule- to cobble-size porphyritic andesite lava in a medium gray coarse-grained plagioclase and clinopyroxene crystal tuff matrix. The breccia units are commonly cut by fine-grained and prophyritic lava dikes. Breccia beds are generally exposed only in artificial excavations, and float on natural slopes consists largely of lava clasts. Lavas are principally medium-dark gray andesites with a pilotaxitic texture and andesine and clinopyroxene phenocrysts; they are locally amygdaloidal. Some of these lavas are flow breccias, with porphyritic andesite clasts commonly more than five centimeters in diameter, either welded together or in a matrix of sheared andesite. Some dark-greenish-gray, very fine-grained flows are also autobrecciated. Typical massive tuff breccia can be seen in housing excavations just northwest of Daguao; good breccia and lava exposures can be found along the coast southeast of Hucares. Coarse autoclastic lavas may be found throughout the section in the ridge directly west of Ensenada Honda and Langley Drive, on the Roosevelt Roads Naval Reservation. Dark- to medium-gray volcanic sandstones and tuffs are usually laminated to thin-bedded and graded, and are locally crossbedded. A few crystals tuffs are hornblende-rich; most sand stones and tuffs are composed of plagioclase and clinopyroxene grains like

Table 4-7 (Cont.)

Designation	Description
Kd (Cont.)	the matrix of the massive volcanic breccias, and calcareous are fairly common. The sandstones and tuffs generally form units only a few meters thick in the western part of the mapped area. Notably thicker sequences in the east are shown by diagonal lines. Thick sequences of thin-bedded to laminated tuff are well exposed along the coast from Punta Algodones to Punta Cascajo, on the Roosevelt Roads Naval Reservation. Rocks of the Daguao Formation are commonly epidotized and chloritized in varying degrees. Volcaniclastic hornfels (Kdh) occurs in a few places near the diorite and granodiorite stocks, and small exposures of phyllitic to schistose rocks (s) occur in one area north of Daguao, south of the keratophyre stocks (TKk). The formation interfingers with the overlying Figuera Lava in a few places (see text); its base is not exposed. The thickness of the Daguao is estimated to be on the order of 1,000 to 1,500 meters.
Kdi	**DAGUAO INTRUSIVE BRECCIA (LOWER CRETACEOUS)** - Hypabyssal intrusive rock medium-dark-gray brecciated andesite. Contains subangular clasts of dark-gray andesite with large plagioclase and clinopyroxene phenocrysts in a brecciated matrix of the same composition. The clasts seem to be lithologically identical to andesite clasts in the tuff breccias and autoclastic lavas of the Daguao Formation. The clasts of the two intrusive bodies in the Naguabo quadrangle east of Daguao range from three to 15 centimeters in length; on Isla Pineros in the Punta Puerca quadrangle blocks as large as 90 centimeters in length are found in an intrusive(?) body making up a small hill on the northwest corner of the island. The intrusive rocks are locally much epidotized and silicified; the epidote and quartz occur in veins and in irregular patches. In a quarry in the intrusive body that is south of the Roosevelt Roads airfield some podshaped zones several meters long have been largely replaced by epidote and quartz, yet the original texture of the porphyritic andesite breccia is discernible. An exposure of massive andesite lava about 100 meters wide and 200 meters long on the crest of the ridge to the northwest of Naguabo may also be an intrusive body. The lava is lithologically similar to the other intrusive breccias; although it is only partly brecciated, it does show some near vertical banding (flow lines).

Source: U.S. Geological Survey, 1977.

soils of this association formed in fine textured and moderately fine textured sediment of mixed origin on floodplains. The Coloso soils are deep and somewhat poorly drained; the Toa soils are deep and moderately well drained; and the Bajura soils and Maunabo soils are deep and poorly drained. The Reilly soils, also part of this association, are shallow to sand and gravel and are excessively drained; they lie adjacent to streams. The minor soils are Talante, Vivi, Fortuna, Vega Alta, and Vega Baja soils. The Talante, Vivi, Fortuna, and Vega Baja soils are found on floodplains, while the Vega Alta soils occupy slightly higher positions on terraces.

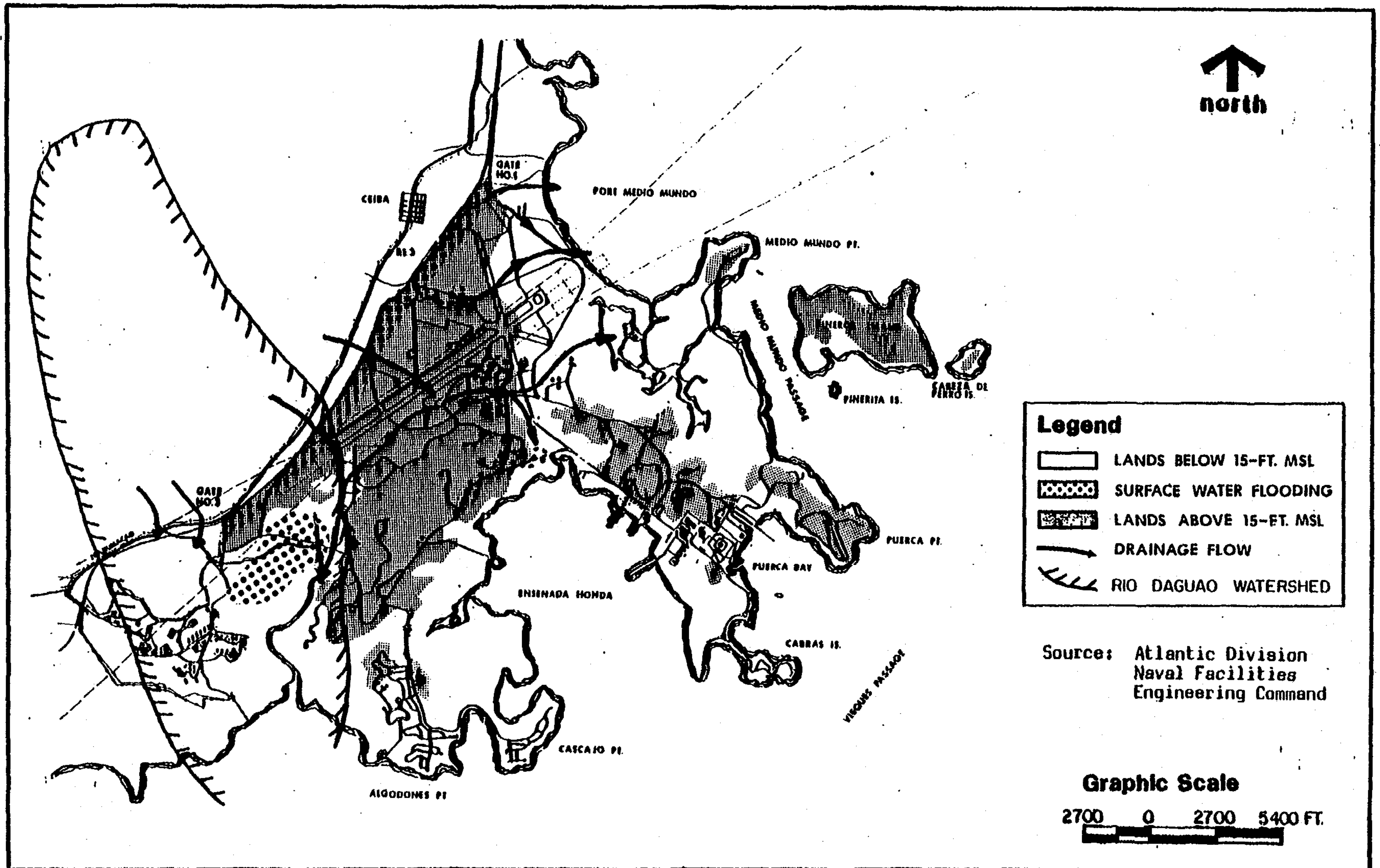
The Jacana-Amelia-Fraternidad Association consists generally of moderately deep and deep, well-drained and moderately well-drained, nearly level to strongly sloping soils on terraces, alluvial fans, and foot slopes. This association is represented at the Naval Station by soils of the Jacana series, which consist of moderately deep, well-drained soils found on the foot slopes and low rolling hills along Langley Drive and just east of the airfield. These soils formed in fine textured sediment and residium derived from basic volcanic rocks (U.S. Department of Agriculture, 1977).

4.1.5.5 Hydrology. Surface Water: The surface waters that flow across the northeastern plain of Puerto Rico, where the Naval Station is located, originate on the eastern slopes of the Sierra de Luquillo mountains. Surface runoff is channeled into various rivers and streams which eventually flow into the Caribbean Sea. The Daguao River and Quebrada Seca Stream (a tributary to Rio Daguao) collect surface waters from the hills immediately north of the station, and in periods of heavy rain, on-station flooding occurs. The Daguao-Quebrada Seca watershed comprises an area of approximately 7.6 square miles (4,864 acres), and the river falls some 700 feet from its source to sea level. Increased development in the Town of Ceiba, especially in areas adjacent to the station's northern boundary, has significantly increased the surface runoff reaching the station, causing ponding and erosion in the Boxer Drive area. Boxer Drive for a major portion of its length is subject to surface water flooding as are Hangar 200 and AIMD Hangar 379 and adjacent apron areas. See Figure 4-3.

In the low-lying shore areas, seawater flooding results from storms, wind, and abnormally high tides. The tidal ranges in the Roosevelt Roads area are rather small, with a maximum spring range of less than three feet.

Ground Water: Little information exists concerning the geohydrology of NAVSTA Roosevelt Roads. The only known possible sources of ground water are lenticular beds of clay, sand gravel, and rock fragments which occur at a depth of less than 30 meters. No wells have been developed on base from these formations. Some wells were developed upgradient of the station in Ceiba, some three kilometers from base headquarters, but were abandoned due to high levels of salinity.

4.1.5.5.1 Water Quality. The quality of surface waters is variable, reflecting the drainage area through which the water flows. Generally, surface waters have high turbidities and organics (naturally-occurring organics) due to the periodic heavy rains which can easily erode soils from steep slopes, exposed areas, and disturbed stream beds.



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ROOSEVELT ROADS, PUERTO RICO

FIGURE 4-3
SURFACE HYDROLOGY AND DRAINAGE PATTERNS,
NAVSTA ROOSEVELT ROADS

Water from alluvial aquifers along the coast of the Naval Station is of a calcium bicarbonate type, and has high concentrations of iron and manganese. The source of these minerals is unknown, but they may be derived from buried swamp or lagoon deposits.

A seawater-freshwater interface is present in the aquifers throughout the coastal areas of Puerto Rico, usually within a short distance inland of the coastline.

4.1.5.5.2 Water Supply. The Naval Station water treatment plant receives its raw water from the Rio Blanco through a 27-inch reinforced concrete pipe that replaced the old, open channel. The intake is located at the foot of the El Yunque rain forest. This buried raw water line traverses a distance of 14 miles from the intake to the station boundary. A raw water reservoir is located at the water treatment plant and has a 45-million gallon capacity. Additionally, there are two fire protection storage reservoirs with a total storage capacity of 520,000 gallons.

4.1.5.5.3 Potable Water. The base has been served for over 30 years by the present treatment facility. The plant (Building 88) has a capacity of 4.0 million gallons per day (mgd). Water flows by gravity into a 45 million gallon raw water storage basin from which the plant draws its supply at a rate of 1.3 mgd on the average. Treatment consists of pre-chlorination, coagulation sedimentation, filtration, and post-chlorination.

4.1.5.5.4 Industrial Water. The single potable water supply system also provides water to all industrial operations at the facility. The water supply is low in hardness, and therefore is an excellent source for industrial uses, particularly in boiler operation and maintenance.

4.1.5.5.5 Agricultural Water. Three hundred acres are used for pasture near Gate 1, and are irrigated as needed. Extensive sprinkling of lawns and green areas is evident throughout the base.

4.1.6 Migration Potential. Contaminants at NAVSTA Roosevelt Roads can migrate by surface runoff through the drainage ditches, by ground water movement, and by tidal action in the mangrove swamps.

Surface runoff would occur throughout the series of drainage ditches, which empty either into the Rio Daguao watershed and from there into Vieques Passage, or into the mangroves that fringe Ensenada Honda and Puerca Bay.

Ground water at Roosevelt Roads flows generally southeast, except in the areas of high ground on the peninsulas which constitute the Industrial Area, where sites 7, 10, 11, 12, 13, 15, 16, and 17 are located. In these areas, due to the steep slopes (as much as 40%), relatively shallow well-drained soils, and proximity of bedrock to the surface, subsurface contaminant migration will be in the direction dictated by local topography. This will generally be to the north and northeast into the mangrove swamps and Puerca Bay, or to the south and southeast into Ensenada Honda.

The various mangrove swamps are subject to tidal influence daily. In addition, high tides or increased flow from the streams and drainage ditches that terminate in the swamps would increase the migration of the contaminants.

4.2 VIEQUES.

4.2.1 General. Vieques is a long narrow island approximately 52 square miles in area. It is located in the Caribbean Sea approximately seven miles east of the southeast coast of Puerto Rico, between 65°35'W to 65°16'W longitude and 18°05'N to 18°10'N latitude.

The U.S. Navy began using Vieques, in conjunction with Naval Station Roosevelt Roads, in the early years of World War II as a base for Allied fleets. Land was acquired in the eastern and western sectors of the island between 1941 and 1943. Construction of Mosquito Pier and the building of facilities and magazines for an ammunition storage depot were generally completed by 1943. The Naval Ammunition Facility (NAF) on Vieques operated until 1948, when ammunition was removed and the facility closed. The facility was reactivated in 1962 in response to the Cuban missile crisis.

Although the acquisition of more land and the building of other facilities had been considered in the early 1940s, these plans were abandoned when an Allied victory seemed more promising. In 1947, however, the need to conduct amphibious training exercises and maneuvers resulted in the acquisition of additional land in the eastern portion of Vieques. Throughout the 1950s, Vieques was utilized primarily for Fleet Marine Force, Atlantic (FMFLANT), maneuvers and training. In 1960, the U.S. Navy established naval gunfire support (NGFS) and air-to-ground (ATG) targets on Vieques and began holding training exercises on the island.

The land area of Vieques is approximately 33,000 acres, about three-quarters of which is owned by the Navy. The Navy leases about 10,200 acres for use as a cattle range. The rest of the land is held by individuals or by the government of Puerto Rico, and the bulk of it is devoted to grazing or other undeveloped uses. The Cooperativa de los Ganaderos de Vieques holds leases to the 10,200 acres used for cattle grazing, of which 3,900 acres are part of the NAF and 6,300 acres are in the maneuver area on the eastern end of the island. The Cooperativa uses the land within the leaseholds for grazing cattle and horses.

As in the past, the U.S. Navy, Atlantic Fleet, continues to use the Island of Vieques for naval training exercises and ammunition storage. Naval training activities on Vieques are conducted within an area known as the Inner Range, extending to three miles from the eastern shores. Naval Station Roosevelt Roads, Puerto Rico, is the main support base for Naval activities within the Inner Range.

Within the Inner Range, the Atlantic Fleet's surface ships, aircraft and marine forces carry out training in all aspects of naval gunfire support (NGFS); air-to-ground (ATG) ordnance delivery; air-to-surface mine delivery; amphibious landings; small arms, artillery, and tank fire; and combat engineering. The Inner Range comprises two facilities: the Atlantic Fleet Weapons Training Facility (AFWTF) on Vieques, and the Eastern Maneuver Area (EMA).

The AFWTF on Vieques occupies roughly 3,500 acres on the eastern tip of the island and is tasked with providing facilities for scheduling and conducting NGFS and ATG ordnance delivery training for 96 Atlantic Fleet ships, 30 North Atlantic Treaty Organization ships, eight air wings (an air wing consists of approximately 50 to 70 aircraft), and smaller air units from Great Britain and the Puerto Rico National Guard. In addition, AFWTF tests and evaluates weapons systems to enhance fleet readiness.

FMFLANT also uses the Inner Range to train shore fire control parties (spotters). Training entails live firing by the ships described above, with fall of shot observed and adjusted (in accordance with the standard bracketing and halving procedures) by Marine spotters.

Facilities utilized in NGFS training are the observation post at Cerro Matías, six point targets, and two area targets. The NGFS range officer directs the exercises from Cerro Matías, and he is in voice contact with the ship or ships. During the exercise, AFWTF personnel record the accuracy and the elapsed time of naval gunfire, so that AFWTF can score the performance of each ship.

The EMA occupies approximately 11,000 acres adjacent and to the west of AFWTF's Vieques lands. FMFLANT, the Puerto Rico National Guard, and foreign marine forces use the EMA for training for amphibious landings, maneuvers, small arms and artillery practice, and battalion landing teams combat engineering. Red, Blue, Yellow, and Purple beaches are used for amphibious landings. Red and Blue beaches are most frequently used. These beaches are located within a restricted area which prevents conflicts with non-participating craft during training.

The NAF on Vieques occupies approximately 8,000 acres on the western tip of the island. Operated by the Weapons Department of Naval Station Roosevelt Roads, its mission is to receive, store, and issue all ordnance authorized by Roosevelt Roads for support of Atlantic Fleet units. At present, training exercises are not carried out at the NAF, though in the past, marine landing operations have been conducted along the south and west beach areas. On the northwest coast of Vieques, the facility operates a 625-foot ammunition handling pier (Mosquito Pier). NAF also maintains magazines. In a 12-month period in 1978 it received over 4,100 tons of explosives and ammunition. During this same period, more than 3,500 tons of ammunition and explosives were issued. Transshipments amounted to about 1,200 tons.

The activities at AFWTF, EMA, and NAF function under the consolidated command of Commander Fleet Air Caribbean, Naval Forces Caribbean, and Antilles Defense Command, whose headquarters are at Naval Station Roosevelt Roads. The commanding officer of AFWTF has jurisdiction over the scheduling of all Naval exercises in the Inner Range.

Both the NAF and Camp García purchase their major power requirements from local sources but supplement these sources with emergency generators. AFWTF uses two 150-KW diesel generators and one 100-KV diesel generator as standby power sources and a 90-KW unit supplies Monte Pirata during operations. Training units at Camp García use tactical mobile electrical power equipment.

4.2.1.1 Adjacent Land Use. The land adjacent to the NAF is privately owned or is owned by the Commonwealth of Puerto Rico. This land is primarily used for pasture or private homes, or has reverted to secondary forest growth. The land adjacent to the EMA is privately owned, or owned by the municipality of Vieques or the Commonwealth. The land along the northwest boundary of the EMA is used for cattle grazing and private residences. The remainder along the southwestern boundary of the EMA consists of pasture land, secondary forest growth, mangrove swamp, and a public beach (Sun Bay Beach).

4.2.2 History. The Caribbean Islands were settled by South American aborigines over 6,000 years ago. Vieques' prehistoric development occurred over a 3,000- to 4,000-year period. During this time the culture evolved from a preceramic and chipped stone tool technology, to permanent agricultural villages with a ceramic technology.

The first historical reference to Vieques occurs in 1493, when Columbus noted the island on his second trip to the New World. The next record of the island is in 1514, when Don Cristóbal de Mendoza led an expedition against a Carib tribe on Vieques in retaliation for an attack on a Spanish settlement.

Throughout the 17th century, Vieques was virtually uninhabited. The English occupied the island at the end of the 17th century; a 1718 map shows an English colony, and possibly a fort, on the south side of the island. During the same period France was establishing a foothold in the Caribbean and may have led an invasion on the island. Throughout this time both England and Spain claimed ownership to Vieques.

In the early 19th century, the first Spanish settlement was established on Vieques. This led to a series of confrontations and near confrontations between the English and Spanish, and eventually also involved the Danes, who were then established in the Caribbean. By the mid-19th century, Vieques was firmly established as a Spanish colony. Its first governor, Don Teófilo Jaime José Marie Lequillou who served from 1832 to 1843, established a hacienda near Santa María, where his tomb is located. In 1845 a small Spanish fort was constructed on a hill overlooking Isabel Segunda. The fort was established after the cessation of hostilities between England and Spain, and was never used in military combat. This fort is being restored by the Institute of Culture, and is currently listed on the National Register of Historic Places (NRHP).

By the latter part of the 19th century the sugarcane industry had become the major economic base of Vieques. Four principal sugarcane factories and haciendas operated in the early 20th century. These were:

- La Patience or La Central Santa María, located in the Village of Santa María;
- Esperanza or La Central Puerto Real, located on the southwest coast on Puerto Real;
- Arcadia on the northwest coast near the present barracks on NAF property; and

- La Playa Grande, the largest, located on the southwest coast on NAF property; this was in operation until 1952.

The remains of La Playa Grande are scattered over a 25-hectare area, and portions of its former railroad beds extend to Punta Arenas, which was the major shipping point for La Central.

In addition to these larger haciendas and factories, a series of smaller haciendas were scattered throughout the island. Among these was Campana, located on the northeast coast. It was an early sugar hacienda, but later served as a cotton warehouse which fell to ruin when the land was turned to pasture animals. There was a hacienda at Puerto Ferro, where Camp García is currently located. Resolución was a small hacienda on NAF property which later consolidated with Playa Grande. Another hacienda, Santa Elena, was located near Resolución, also on NAF property. In addition, four smaller haciendas were also located on Vieques: Resignación, Perseverencia, Pistole, and Marquesado.

4.2.2.1 Historic Sites. Archaeological surveys have been conducted on the Vieques Naval Reservation from 1978 to the present. During these surveys, 227 prehistoric and historic sites were located on the EMA and NAF. Of these sites, 34 were submitted for eligibility for inclusion to the NRHP, and it is estimated that an additional 10 will be nominated after completion of the final phase now in progress.

4.2.3 Legal Actions. In March 1978 the governor of Puerto Rico instituted a court suit (Romero-Barceló vs. Brown) against the U.S. Navy concerning alleged violation of environmental laws, contending that Naval activities had been illegally transferred to Vieques (from Culebra and its cays). The objective of the suit was to enjoin the Navy from using any portion of its land on Vieques or surrounding waters for Naval training operations. The Court decision stated that the continued use of Vieques by the Navy was essential to National defense and injunction of training activities was not appropriate relief for violations the Navy might be found responsible for.

The Court found the Navy in violation of the Federal Water Pollution Control Act, Executive Order 11593, and the National Environmental Policy Act. All other claims were dismissed. To correct these violations, the Navy is attempting to acquire a National Pollutant Discharge Elimination System (NPDES) permit for the release or firing of ordnance into the waters of Vieques, has conducted cultural resources surveys to locate sites eligible for the NRHP, and has filed an Environmental Impact Statement (EIS) in connection with its activities in and around Vieques.

4.2.4 Biological Features.

4.2.4.1 Ecosystems.

4.2.4.1.1 Vegetation. The vegetation on Vieques is mostly characteristic of subtropical dry zones. The island is divided into subtropical moist and subtropical dry forest regions, with the western part being the most humid. Prior to Navy acquisition of the island, all but the steepest parts of the western one-half of the island were used for agriculture, primarily sugarcane, while the eastern end was used for pasture. Many of the beach areas were developed as coconut plantations. Forests and scrub forests were restricted to higher hills, steep slopes, limestone areas, tidal swamps and associated wet lowlands, and a few quebradas (drainages). The present distribution of forest is not considerably different, though forest is now even more restricted in some areas. In contrast, the extent of scrub increased significantly with abandonment of agricultural practices and grazing, and today much of the island is covered by scrub types in various stages of succession. Currently, little or no land is in crop production.

Although major parts of Vieques are covered by a mix of scrub types, discrete types of habitat also occur, for example, beach scrub, evergreen scrub on limestone, mangroves, upland forest, and lowland forest.

On the western part of the island, at the NAF, the major activity of the Navy consists of ammunition storage in grass-covered storage areas. Most of this region was originally used for sugarcane production, but the former agriculture fields are now covered by mixed thorn scrub. The characteristic species are Zizyphus mauritiana, Randiaculeata, and Acacia spp. Rauvolfia viridis is common, but it is not a thorn scrub. The thorn scrub areas are wild pastures that are used for grazing livestock. In restricted areas, particularly near the NAF base camp and in the southeastern part near the civilian zone, the brush has been cleared for grazing and the grass mat is relatively complete. Large trees such as Albizzia lebbeck, Pithecellobium saman, and Ficus laevigata occur scattered in parts of the NAF rangeland area, usually on lowland.

The NAF area includes two special features: Monte Pirata, which is the highest point on the island, and a vast expanse of mangrove forest and associated lagoons. A microwave station is located on top of Monte Pirata, but much of the higher elevations of the mountain are covered with forest. This forest resembles a humid climax forest and is characterized by tall palms (Coccothrinax alta) and trees such as Bursera simaruba, Trichilia hirta, Zanthoxylum monophyllum, Citharexylum fruticosum, and other species.

Mangrove forests and lagoons are found on the northwestern part of Vieques. This complex is the largest of its kind on the island and is fringed on the coastal side by the largest continuous area of cocopalms on Vieques. The mangrove complex includes a large area of dead mangroves near the Laguna Boca quebrada.

The NAF is bordered by narrow beach on the north and northwest coasts. Beach scrub sites are mostly covered by cocopalms. The southwest and south coasts consist of cliffs, and lack substantial sandy beach as far east as Laguna Playa Grande, which is surrounded by mangroves.

The EMA is an area of low hills covered for the most part with microphyllous thorn scrub. Microphyllous thorn scrub consists of legume trees such as Prosopis juliflora and Acacia ssp., and has been named after the compound leaves with numerous small leaflets characteristic of these species. The shrubby trees are shade trees transmitting enough light for the development of a good grass cover, and the area is used for grazing. A part of the area in the south of the maneuver area was at one time used for sugarcane production, but the fields now support dense stands of microphyllous thorn scrub.

The more special vegetation of the maneuver area tends to occur along the southern coast. This area is relatively diverse and includes several limestone peninsulas covered by evergreen scrub and bays lined with mangroves. One of these bays, Puerto Mosquito, is noted for its bioluminescence.

The mangroves generally do not extend far inland, but in a number of lowland areas they are bordered by a broadleaf forest of ucar trees (Bucida bucerus). This forest has a limited distribution on the island and gives way to the microphyllous thorn scrub.

Upland forest is restricted to a number of hilltops and generally consists of a forest scrub. Bursera simaruba is the common tree, and the large pipe organ cactus (Cephalocerus royenni) is a frequent associate. Other important elements are Capparis ssp., Picteti , Pithecellobium, and Randia.

Stands of Lonochocarpus domingensis have been reported in some quebradas, but gallery forest is not well developed along the drainages of the eastern half of the island. Generally, the microphyllous thorn scrub occurs in a more solid stand where moisture conditions are favorable, and thins out on the hills.

The beaches are small in size and alternate with cliffs, particularly along the northeast. A number of these beaches, identified as Blue, Red, and Purple, are used for amphibious landing operations. Much of the area is used as a maneuver zone, and in the northeastern part, there are a number of small arms practice ranges run by AFWTF.

The vegetation in the AFWTF weapons training area displays some similarity with the previous description. However, this region appears to be drier and is more rocky. Microphyllous thorn scrub is a common vegetation type at lower elevations. On the higher hillsides, the common type has been classed as mixed low scrub, which consists of Lantana involucrata, Turnera diffus , Croton spp., Randia aculeata, Mimosa ssp., and others. Although the area is grazed by cattle, it is not an officially leased rangeland area. It is rocky, and the groundcover is generally sparse and open.

Upland forest is less extensive than in the regions previously described, since it appears to have been displaced mostly by mixed low scrub. While generally limited to a few small isolated sites, forest scrub is relatively extensive on the slopes of Cerro Matías and on the peninsula extending into Ensenada Honda. The composition of the forest scrub is similar to that described above for the EMA.

On hillsides, which are used by the Navy for artillery and practice bombing involving inert ordnance, the low mixed scrub or microphyllous scrub are widely dispersed and interspersed by a mixture of species characteristic of recently disturbed land, such as the giant milkweed (Calotropis procerus) and the low creeper (Stachytarpheta jamaicensis).

The most intensively used areas are the established target sites in the ATG impact zone. These sites require periodic rehabilitation (see Section 7.2.2), which consists of grading, and they are largely barren of vegetation or at best covered with a scattering of Calotropis, Stachytarpheta, and Prosopis.

Lowland forest in the surface impact area and ATG impact area has a very limited extent. Lowland sites are mostly covered with dense stands of microphyllous thorn scrub. Mangrove forest is restricted to the margins of a few lagoons.

The ATG impact area extends east to the eastern "friendly front line." East of this line, the area known as Punta Este consists of a flat limestone plateau that is covered with evergreen scrub. This evergreen scrub includes a palmetto (Thrinax morrisii) and the area is habitat for a rare orchid (Epidendrum bifidum).

4.2.4.1.2 Wildlife. On Vieques, birds are the dominant and most conspicuous wildlife, followed by herptiles (reptiles and amphibians), and mammals. Three distinct assemblages of birds, totaling 114 species, are known to occur on Vieques. The number of bird species fluctuates during the year because of spring and fall migrations, which affect primarily land birds and lagoon birds. Seabirds maintain a fairly constant population throughout the year.

Land birds are represented by the greatest diversity of species and the largest number of individuals. There are 36 species of lagoon birds, including herons, waterfowl, marshbirds and shorebirds, principally associated with the mangrove-lagoon complexes bordering the Vieques coast. An exception is the cattle egret, which is associated with cattle in all habitats. Seabirds are represented by only 12 species including pelicans, frigatebirds, boobies, tropic birds, gulls, and terns. These birds utilize the rocky shores, cliffs, small islands, sandy beaches, and to some degree, lagoons near the coast. The brown pelican, a federally designated endangered species, nests in a rookery on a small island, Cayo Conejo, in Bahía Salina del Sur, just off the southeast coast of Vieques.

Herptiles are represented by 20 species and constitute the second most diverse group of wildlife on Vieques (see Table 4-8). There are 17 species of reptiles and three amphibian species which, with the exception of the Southern woodslave, are all endemic to Puerto Rico. There are four species of oceanic turtles, all of which are federally designated as endangered species.

Mammals are poorly represented on Vieques. The geographical isolation of Puerto Rico at an early geologic period prevented mammals from becoming established as a dominant wildlife form (Briggs, 1964). One species, the manatee, is an oceanic mammal and is federally designated as an endangered species.

Bats constitute the largest group of mammals on Vieques. The only surviving endemic mammal is the red fruit bat, which is now considered an endangered species in Puerto Rico. All other mammals, including the house mouse, the rat, the mongoose, and domestic animals, have been introduced by man.

The coastal waters of the Caribbean are inhabited by an extremely diverse fish fauna that can be generally divided into three associations according to their preferred habitat. These associations include the grassbeds and sandflats, reef fishes, and open water or pelagic fish associations. There is a great deal of overlap among these associations since many of the fishes exploit the resources in the grassbeds, and the pelagic fishes feed in the reefs and grassbeds. The mangroves, swamps, and lagoons are highly valuable nursery areas for both juve-

Table 4-8

RELATIVE ABUNDANCE OF HERPTILES ON VIEQUES

Scientific Name	Common Name	Status
Leptodactylus albilabris	White-lipped frog	Abundant
Eleutherodactylus antillensis	Antillean frog	Common
Bufo marinus	Giant toad	Common
Hemidactylus mabouia	Southern woodslave (gecko)	Uncommon
Sphaerodactylus nicholsi	Pigmy gecko	Uncommon
Sphaerodactylus macrolepis	Common dwarf gecko	Common
*Sphaerodactylus roosevelti**°	Littoral gecko	Rare
Anolis cristatellus	Man lizard	Abundant
Anolis stratulus	Salmon lizard	Common
Anolis pulchellus	Sharp-mouthed lizard	Abundant
*Anolis cuvieri**°	Puerto Rican giant anole	Rare or extinct
Ameiva exsul	Common ground lizard	Abundant
*Mabuya sloanii**°	Slippery back skink	Rare or extinct
Typhlops°	Worm snake	Rare
Alsophis antillensis°	Ground snake	Rare or extinct
*Pseyudemys rtejnegeri**°	Antillean painted turtle	Rare
Chelonia mydas†°	Green sea turtle	Endangered
Dermochelys coriacea†°	Leatherback (sea turtle)	Endangered
Caretta caretta†°	Loggerhead (sea turtle)	Endangered
Eretmochelys imbricata†°	Hawksbill (sea turtle)	Endangered
Trimeresurus	Fer-de-lance	Rare or endangered

* = Endangered in Puerto Rico
† = Federally classified endangered species
° = Not observed during study

Source: Ecology and Environment, Inc., 1978.

nile reef and pelagic fishes which characterize the fish life found in these areas. Snook, mullet, needlefish, and mojarras are reportedly the most abundant forms in Puerto Rican mangroves. Spiny lobster, shrimp, and other crustaceans also use the mangroves as nursery areas. Table 4-9 lists fish species found around Vieques.

The submerged prop roots of the mangroves also support an extremely diverse association of epiphytic organisms, including oysters, sponges, flatworms, hydroids, bryozoans, annelides, barnacles, shrimp, amphipods, crabs, snails, clams, mussels, sea urchins, tunicates, and a large variety of algae.

Bioluminescent bays are occasionally found in protected tropical bays with very particular physical, chemical, and biological characteristics. In Puerto Rico these bays are found on the south coast near Parguera, Bahía Fosforescente, and Bahía Monsio José, and on the south coast of Vieques at Puerto Mosquito and Bahía Tapón. The bioluminescence is caused by the permanent bloom of the dinoflagellate Pyrodinium bahamense. Pyrodinium emits light only when it is disturbed. Propellers of boats and actions of swimmers and frightened fish result in flashing displays of thousands of disturbed dinoflagellates. All of the bioluminescent bays in Puerto Rico and Vieques are fringed with mangroves. The organic matter produced by the mangroves is believed to be a requirement for the growth and maintenance of the Pyrodinium populations.

Because of the delicate balance of physical, chemical, and biological characteristics in these bays, they represent a rare resource and are especially susceptible to even minor disturbances.

4.2.4.2 Endangered, Threatened, and Rare Species.

4.2.4.2.1 Vegetation. The federal endangered and threatened species list does not include plants from Puerto Rico. However, the Commonwealth of Puerto Rico has published a committee report on rare and endangered flora (Department of Natural Resources, 1977). A comparison between the committee report, the identified plant specimens gathered during the survey conducted by E & E on the island in 1978, and previous papers on Puerto Rican flora yielded 26 species as potential inhabitants of Vieques. These 26 species are listed in Table 4-10.

The majority of the 26 endangered and rare plants occur in two broad habitat categories: (1) moist upland forest and wooded ravines, and (2) coastal thickets and woods. These habitats are found in the NAF area. Lumbering in the past and agriculture have generally destroyed suitable habitat for the 26 species.

4.2.4.2.2 Wildlife. There are 34 wildlife endangered species on land and in the waters adjacent to Vieques. Of these, 24 species are birds, four are terrestrial herptiles, four are oceanic turtles, one is a bat, and one is an ocean mammal. Six species, the brown pelican, hawksbill turtle, leatherback turtle, green turtle, loggerhead turtle, and Caribbean manatee, are on the federal list of endangered species; these six species are discussed below. The remainder are considered endangered by the Commonwealth.

Brown pelicans are the largest, most conspicuous, and most abundant seabird on Vieques. It is endangered because of pesticide poisoning, human interference,

Table 4-9

REEF FISH SURVEY ON VIEQUES
FISH SPECIES

Scientific Name	Common Name	Reported in Commercial Fisheries Catch
Ginglymostoma cirratum	Nurse shark	
Gymnothorax moringa	Spotted moray	
Synodus intermedius	Sand diver	
Holocentrus ascensionis	Squirrelfish	X
H. coruscus	Reef squirrelfish	X
H. rufus	Longspine squirrelfish	X
H. vexillarius	Dusky squirrelfish	X
H. marianus	Longjaw squirrelfish	X
Myripristis jacobus	Black bar soldier	
Aulostomus maculatus	Trumpetfish	
Cephalopholis fulva	Coney	X
Epinephelus adscensionis	Rock hind	X
E. guttatus	Red hind	X
E. morio	Red grouper	
E. striatus	Nassau grouper	X
Hypoplectrus indigo	Indigo hamlet	
H. nigricans	Black hamlet	
H. puella	Barred hamlet	
H. unicolor	Butter hamlet	
Petrometopon cruentatum	Graysby	
Serranus tigrinus	Harlequin bass	
Gramma loreto	Fairy basslet	
Priacanthus arenatus	Bigeye	
P. cruentatus	Glasseye snapper	
Apogon maculatus	Flamefish	
A. townsendi	Belted cardinal	
Malacanthus plumieri	Sand tilefish	
Caranx crysos	Blue runner	X
C. ruber	Bar jack	
Elagatis bipinnulata	Rainbow runner	
Seriola dumerili	Greater amberjack	
Scomberomorus regalis	Cero	X
Lutianus analis	Mutton snapper	X
L. apodus	Schoolmaster	
L. mahogoni	Mahogany snapper	
Ocyurus chrysurus	Yellowtail snapper	X
Gerres cinereus	Yellowfin mojarra	X
Haemulon album	Margate	
H. aurolineatum	Tomgate	X

Table 4-9 (Cont.)

Scientific Name	Common Name	Reported in Commercial Fisheries Catch
H. chrysargyreum	Smallmouth grunt	X
H. flavolineatum	French grunt	X
H. melanurum	Cotton-wick	
H. plumieri	White grunt	X
H. sciurus	Bluestriped grunt	X
H. macrostomum	Spanish grunt	X
Calamus bajonado	Jolthead porgy	
Equetus acuminatus	High hat	
Mulloidichthys martinicus	Yellow goatfish	X
Pseudupeneus maculatus	Spotted goatfish	X
Pempheris schomburgki	Glassy (copper) sweeper	
Kyphosus sectatrix	Bermuda chub	
Holacanthus ciliaris	Queen angel	
H. tricolor	Rock beauty	
Pomacanthus arcuatus	Gray angel	
P. paru	French angel	
Chactodon capistratus	Foureye butterfly fish	
C. striatus	Banded butterfly fish	
Abudefduf saxatilis	Sergeant major	
A. taurus	Night sergeant	
Chromis cyaneus	Blue chromis	
C. multilneatus	Brown chromis	
Eupomacentrus mellis	Honey damsel	
Microspathodon chrysurus	Yellowtail damsel fish	
Pomacentrus fuscus	Dusky damsel	
P. leucostictus	Beaugregory	
P. partitus	Bicolor damsel	
P. planifrons	Threespot damsel	
P. variabilis	Cocoa damsel	
Bodianus rufus	Spanish hogfish	
Halichoeres bivittatus	Slippery dick	
H. garnoti	Yellowhead wrasse	
H. maculipinna	Clown wrasse	
H. caudalis	Painted wrasse	
H. poeyi	Blackear wrasse	
H. radiatus	Puddingwife	
Hemipteronotus novacula	Pearly razor fish	
Lachnolaimus maximus	Hogfish	
Thalassoma bifasciatum	Bluehead wrasse	
Scarus coelestinus	Midnight parrotfish	X
S. coeruleus	Blue parrotfish	X
S. croicensis	Striped parrotfish	X

Table 4-9 (Cont.)

Scientific Name	Common Name	Reported in Commercial Fisheries Catch
S. guacamaia	Rainbow parrotfish	X
S. taeniopterus	Princess parrotfish	X
S. vetula	Queen parrotfish	X
Sparisoma aurofrenatum	Redband parrotfish	X
S. chrysopterum	Redtail parrotfish	X
S. radians	Bucktooth parrotfish	X
S. rubripinne	Yellowfin parrotfish	X
S. viride	Stoplight parrotfish	X
Sphyraena barracuda	Barracuda	X
Ophioblennius atlanticus	Red lip blenny	
Coryphopterus glaucofraenum	Bridled goby	
C. personatus	Masked goby	
Gnatholepis thomsoni	Goldspot goby	
Gobiosoma genie	Cleaning goby	
Acanthurus bahianus	Ocean surgeon	
A. chirurgus	Doctor fish	
A. coeruleus	Blue tang	
Bothus lunatus	Peacock flounder	
Balistes veluta	Queen trigger fish	X
Cantherhines pullus	Orange-spotted file fish	
Melichthys niger	Black durgon	
Lactophrys triqueter	Smooth trunkfish	X
Canthigaster rostrata	Sharpnose puffer	
Diodon hystrix	Porcupine fish	

Source: Survey conducted by Ecology and Environment, Inc., 1978.

Table 4-10

PROBABLE RARE AND ENDANGERED PLANT SPECIES OF VIEQUES

Name	Growth Form	Habitat
Amaranthaceae		
Celosia virgata	Herb	Upland forest
Bignoniaceae		
Enallagma latifolia	Tree	Lowland forest
Bromeliaceae		
Tillandsia lineatispica	Epiphyte	Lowland forest
Witmackia lingulata	Epiphyte	Lowland forest
Caesalpiniaceae		
Caesalpinia bunduc	Woody vine	Beach scrub
Stahlia monosperma	Tree	Lowland forest
Capparidaceae		
Morisonia americana	Tree	Upland forest
Celastraceae		
Maytenus cymosa	Tree	Lowland forest
Compositae		
Baccharis dioica	Shrub	Evergreen scrub
Cyperaceae		
Bulbostylis pauciflora	Sedge	Pastures
Cyperus urbani	Sedge	Pastures
Flacourtiaceae		
Prockia cruis	Tree	Upland forest
Malpighiaceae		
Malpighia fucata	Tree	Beach scrub
M. infestissima	Tree	Beach scrub
M. linearis	Tree	Beach scrub
M. shaferi	Tree	Lowland forest
Tetrapteris inaequalis	Woody vine	Beach scrub
Myrtaceae		
Calyptranthes thomasiana	Tree	Upland forest
Olacaceae		
Schoepfia schreberi	Tree	Upland forest
Orchidaceae		
Epidendrum bifidum	Epiphyte	Evergreen scrub
Papilionaceae		
Sophora tomentosa	Shrub	Beach scrub

Table 4-10 (Cont.)

Name	Growth Form	Habitat
Piperaceae		
Peperomia myrtifolia	Herb	Upland forest
Polypodiaceae		
Adiantum villosum	Fern	Gallery forest
Solanaceae		
Brunfelsia americana	Tree	Upland forest
Urticaceae		
Pouzolzia occidentalis	Shrub	Upland forest
Zygophyllaceae		
Guaiacum officinale	Tree	Beach Scrub

Sources:
- Woodbury, Roy, *et al.*, 1975, Rare and Endangered Plants of Puerto Rico, a Committee Report, U.S. Department of Agriculture, Soil Conservation Service.
- Ecology and Environment, Inc., in 1978.

and low total numbers. The largest nesting colony of brown pelicans in the Commonwealth is located on Cayo Conejo, just off the southeast coast of Vieques, and the species is common on rock outcrops along the north coast east of the civilian sector, along all of the south coast except at Esperanza, and along the west coast. Traditional roosting sites are rock outcrops near Punta Vaca and Punta Boca Quebrada on the southwest coast, and on the pilings near Mosquito Pier. The pelican catches fish in the quiet waters of many coves and inlets surrounding Vieques, and also in some of the larger lagoons such as the Laguna Kiani complex at the NAF and Laguna Monte Largo.

Rare and endangered marine species whose range extends into the seas around Puerto Rico include the Caribbean manatee; the green, hawksbill, loggerhead, leatherback, and olive ridley sea turtles; and the blue, finback, humpback, sei, and sperm whales (U.S. Department of the Interior, 1978). Whales are infrequent visitors to the waters around Vieques. However, both the manatee and several species of sea turtles are found in shallow waters off the island.

The endangered Caribbean manatee, Trechechus manatus L., once ranged from Florida to Brazil. At present, it is virtually extinct in the Virgin Islands and Lesser Antilles, and relict populations are found in Puerto Rico, Hispaniola, Cuba, and Jamaica. Its decline is due to hunting, habitat degradation, and more recently, boating accidents. The manatee is a herbivore, and feeds on seagrass. While it is usually found in or near fresh or brackish water, it is not known whether the animal requires access to freshwater.

Aerial surveys were conducted on Vieques as part of the E & E 1978 survey. Forty manatee sightings were made, 38 of which were in the lee of Mosquito Pier, and 21 of which were off the west shore. A possible sighting was made by the survey team near the eastern end of Ensenada Honda, and four sightings were reported by others near Cayo Conejo, Bahía de la Chiva, and two in the lee of Mosquito Pier. The estimated population of manatees observed around Vieques in 1978 was 15 to 25. Manatees were observed feeding only in the large Thalassi meadow off the northwestern end of Vieques. There was some indication that the manatees on Vieques may be a part of the population found at Roosevelt Roads, and that they move back and forth across the Vieques Passage.

The green turtle, Chelonia mydas; hawksbill, Eretmochelys imbricata; loggerhead, Caretta caretta; and leatherback, Dermochelys coriacea, may be found in the waters around Vieques as residents or seasonal visitors. The olive ridley, Lepidochelys olivacea, in Puerto Rican waters is probably a rare vagrant. The hawksbill and leatherback are listed as endangered, and the green, olive ridley, and loggerhead are listed as threatened, on the Federal Endangered Species list.

The decline of these species has resulted from overhunting of these species for food and for their shells, which are used for ornaments. Habitat alienation and destruction are also believed to have significantly contributed to their decline in recent years. The turtles are most vulnerable when they return to their breeding beaches to lay their eggs at night. The leatherback nests mainly in March and April, and the other species nest mostly between June and October. The female turtles lay their eggs in nests dug in the sandy beaches during the night. Nesting requires about two hours, during which about 100 eggs are deposited in the nest. The turtles breed on the average every two to three years.

Most turtles nest several times during a breeding season, at about two-week intervals. Incubation of eggs takes between 45 to 72 days, after which the baby turtles emerge from the nest at night or early morning and return to the sea. Mating of sea turtles usually occurs in the coastal waters off the breeding beaches and can require several hours. Turtles are generally omniverous, feeding on seagrasses, molluscs, crustaceans, tunicates, fish and jellyfish, although adult green turtles prefer seagrasses and the leatherback prefers jellyfish.

Fifteen sea turtles were sighted during aerial and beach surveys conducted on Vieques during the summer of 1978. The highest numbers of sightings per hour occurred along the northeast shoreline. Sea turtle nesting activity, primarily by leatherbacks, was also concentrated along the northeastern coast. A second nesting area was noted on Yellow Beach.

4.2.5 Physical Features

4.2.5.1 Climatology. The climate of the Island of Vieques is of the tropical wet and dry class. Easterly trade winds blow directly across the island year-round. These winds moderate the tropical heat considerably. Showers occur frequently throughout the year, but they are usually of short duration, and there are considerable periods of sunshine.

The mean temperature in Vieques is approximately 80°F, with little variation in mean monthly temperatures. Based on the 28-year period of record up to 1975, the mean annual temperature at the village of Esperanza is 79.3°F; August is the warmest month, at 81.8°F, and February the coldest, at 76.0°F. The small temperature range is attributed to two factors: first, the island is surrounded by water, the temperature of which changes little from the warmest to the coolest season; and second, the island is near the equator, which accounts for the relatively small differences in energy received from the sun from season to season. Monthly extreme temperatures at Esperanza range from 98°F to 60°F for the 14-year period of record. The mean daily temperature range, that is, the difference between the daytime maximum and the nighttime minimum, is estimated to be between 15° and 25°.

There is little data on rainfall patterns on Vieques. The available data indicate that approximately 45 inches of rainfall occur annually.

The outstanding feature with regard to wind patterns around Vieques is the steadiness of the trade winds, which are from an easterly direction, almost without exception, varying from north-northeast to south-southeast. Two wind regimes affect the Island of Vieques, with the trade winds dominating.

4.2.5.2 Topography. The topography of Vieques is characterized by a series of low hills and small valleys. The hills on the western side of the island differ considerably in form and character from those on the eastern end. The hills in the west (except on high ledges) are gentler and more rolling, and have a deeper soil profile than those on the east end, which are angular and rugged in appearance and have a large amount of exposed rock surface. The highest point on the western end is Monte Pirata (elevation 301 meters). The highest point on the eastern end is Cerro Matías (elevation 138 meters). The areas of highest elevation are generally found along the longitudinal axis of the island. These areas exhibit a more angular, blocky appearance than the lower lying hills.

There are several low-lying coastal zones of sedimentary deposits that are generally level and contain lagoons and swamps. The largest of these are located in the northwest corner of the island; on the east end, north of Bahía Salina del Sur; and in the southern valley between Esperanza and Bahía Tapón.

4.2.5.3 Geology. Vieques is composed of three major rock types, in terms of age and general lithology. In addition, there are unconsolidated sedimentary deposits on the island. The three main rock types are Upper Cretaceous volcanic rocks, Upper Cretaceous or Lower Tertiary intrusive rocks, and Upper Tertiary and Quaternary sedimentary rocks. The unconsolidated sedimentary deposits are of Quaternary age and consist of alluvial deposits, beach and dune deposits, and swamp and marsh deposits (see Figure 4-4).

The oldest rocks exposed on Vieques are presumed to be of Upper Cretaceous age and are mostly andesites, tuffs, and conglomerates. It is generally thought that these rocks were deposited in a marine environment, and are similar to rocks of the same age found in Puerto Rico and the Virgin Islands. The thickness of these deposits is believed to vary across the island. Alteration of the rocks varies according to proximity to the various intrusive contacts. The least degree of alteration occurs in the eastern end of the island.

During the Upper Cretaceous or Lower Tertiary period, the emplacement of a quartz diorite complex pluton resulted in the deformation and metamorphosis of the Cretaceous volcanic rocks. The quartz diorite plutonic rocks appear as outcrops over a large percentage of the island, but particularly in the western and central portions. The pluton is divided into two major bodies by a narrow belt of metamorphosed andesites and andesite tuffs running from Isabel Segunda to Bahía de la Chiva. The western pluton is generally coarse-grained and equiangular in texture, while the eastern pluton is generally finer-grained with a microgranitic texture.

Mafic intrusives are also well distributed throughout the island. Dark, fine-grained dike rock outcrops occur at various locations throughout the island, while coarse-grained outcrops of varying color and texture occur at the western end of the island in the quartz diorite complex.

Limestone outcrops of Upper Tertiary age occur at three major areas on the island. Several peninsulas along the south coast constitute the largest concentration, with other deposits located on the extreme eastern end of the island, and at Desembarcadero Mosquito on the north coast. The limestone is soft, yellowish, and contains an abundance of fossils. On exposure, the limestone forms a hard crust which resists weathering.

4.2.5.4 Soils. The majority of the soils on Vieques are residual. Because of the tropical wet and dry climate type and the relatively impermeable intact volcanic rock, soil development has been severely limited on the eastern portion of the island, resulting in a very shallow soil profile. Generally, soils on the eastern end of the island are fine-grained, with a high clay content. Soils on the western end of the island are somewhat better developed. These have been formed by the weathering of the underlying granite diorite intrusive. They are primarily coarse-grained and contain primarily arkosic material, with subordinate amounts of clay (see Figure 4-5).

The larger valleys of Vieques are filled and blanketed by alluvial deposits of Quaternary age. These deposits, which are stream-laid, consist of clay, silt, sand, and gravel derived from either the parent volcanic rock or intrusive rock. The largest of these valleys are Valle de Resolución on the northwest side of the island, and the large valley stretching from Esperanza to Camp García on the south coast. Although the alluvial deposits vary in thickness, they are generally more than 40 feet thick. In addition to the major soil areas mentioned above, the areas along the shoreline are covered with deposits of beach, alluvial, and wind-blown sand, and lagoon and salt marsh muds.

4.2.5.5 Hydrology. The topography of Vieques consists of a series of low hills and shallow valleys, with an average elevation of about 75 meters above sea level. From the high points of the island, small, normally dry waterways (quebradas) flow in both north and south directions to the sea. This division of the drainage results in many small drainage basins, the great majority of which are less than a mile in length and only a fraction of a square mile in drainage area. Such small basins have no significance for water resource development and only function as drainage ditches to carry flood runoff in periods of intense rainfall.

The largest drainage area is that of Quebrada La Mina, which extends in a southeast-northwest direction from the village of Esperanza, on the southwest coast of the island. The total drainage area of that basin is 2.3 square miles. There are four other basins with drainage areas of one to two square miles.

4.2.5.5.1 Water Quality. The surface waters of Vieques were surveyed for explosive products and by-products in May 1978 by the Naval Surface Weapons Center, White Oak, Silver Spring, Maryland. Samples were collected from crater runoff water, lagoon water, and seawater near large bomb craters and compared to samples from waters outside of the impact zone for TNT, RDX, and tetryl. Results from thin-layer chromatography and vapor chase chromatography analysis indicated that there was no essential difference between the water samples taken outside the impact area and within the impact zone.

Additional analyses were performed for ammonia, cyanide, nitrate/nitrite, perchlorate, and white phosphorus. Results of the study show that cyanide and ammonia were found in most of the bomb craters and swamps inside the impact area. However, both parameters were below the maximum permissible concentration (MPC) of 0.5 ppm for ammonia and 0.2 ppm for cyanide. Nitrate/nitrite was found in every sample taken in the bomb craters and swamps, with values comparable to average seawater (0.05 ppm) and below the MPC of 10 ppm. No detectable concentrations of perchlorate or white phosphorus were found in any of the water samples, including the samples collected in target areas where ammunition containing white phosphorus was used.

The ground water on the island varies from salty to relatively fresh. The relatively high chloride values of the water have resulted from the accumulation of salts from sea spray in the ground water, a condition which is typical of islands with low rainfall, and from saltwater encroachment as a result of ground water withdrawals. The ground water is quite hard. Nitrates were low, ranging from 0.0 to 59 milligrams per liter (mg/l), with a median value of 2.3

mg/l. Iron concentrations were also low, with values below 0.3 mg/l. Sodium concentrations ranged from 7 to 1,670 mg/l, with a median value of 157 mg/l.

The two main sources of ground water on Vieques are the Valle de Resolución, located on the western portion of Vieques within the confines of the NAF, and the Valle de Esperanza, located on the south coast near Esperanza.

The quality of the ground water from the Valle de Resolución was good, with low chloride levels. Increased pumping from the Valle de Esperanza resulted in an increase in the chlorides from saltwater encroachment prior to the completion of the pipeline from Puerto Rico.

4.2.5.5.2 Water Supply. The population of Vieques was dependent on ground water for water supply until 1979; since then water has been piped from Puerto Rico. At present, there is a limited dependence on ground water in homes and installations outside the distribution systems.

An eight-inch freshwater pipeline from Puerto Rico supplies the NAF, Isabel Segunda, and Esperanza with potable water. Camp García and the EMA received potable water from two wells located north of Puerto Mosquito near the main gate of Camp García. These wells were in operation 24 hours a day. Four tanks, with a 15,000-gallon capacity, are present at the site for water storage.

The backup potable water source for the Vieques Naval Reservation and the civilian sector of Vieques are two aquifers in the Valle de Esperanza and the Valle de Resolución. These aquifers were the principal source of potable water for the island before the construction of the freshwater pipeline from Puerto Rico in 1979.

4.2.5.5.3 Industrial Water. The Navy currently operates several sanitary waste treatment facilities on Vieques. These include septic tanks with tile fields at the NAF, Cerro Matías, and Camp García; a secondary treatment stabilization lagoon with post-chlorination and an evaporation pond at Camp García; and a secondary treatment activated sludge plant at the NAF. None of the septic tanks discharge to surface waters. The sewage treatment plant at Camp García used to discharge to the sea near Bahía Tapón; however, this discharge was eliminated and replaced by a land application system. The sewage treatment plant at the NAF currently discharges to a swale that contains surface waters only during heavy rains. The Navy plans to provide a land application system for this facility very soon.

4.2.5.5.4 Agricultural Water. The U.S. Navy has leased land on the EMA and NAF to the local cattlemen's cooperative for pastureland. Water sources utilized for cattle production include rainwater and natural runoff (quebradas), pipeline water from Puerto Rico, and natural springs. A permanent spring located on the NAF property in the area south of Building 422 is used as a year-round source of water for cattle. During the dryer months of the year, this permanent water source attracts large numbers of cattle from the range and the area is used as a central location to herd cattle for range management.

4.2.6 Migration Potential. Contaminants at NAF on Vieques can migrate by surface runoff, subsurface movement, and tidal action.

Surface runoff would occur in the quebradas, which carry surface runoff two or three times a year, depending on rainfall patterns. At these times, the flow may be as much as 10 cubic feet per second, although it is of short duration. The quebrada on the north side of NAF Vieques discharges to the Vieques Passage.

Ground water movement occurs in the quebradas and in the Valle de Resolución, where alluvial deposits of clay, silt, sand, and gravel measure up to 40 feet thick. The ground water moves in a northwesterly and southeasterly direction from the subsurface water divide, which runs in a southwest to northeast direction across the Valle de Resolución just south of Building 422.

Tidal movements in the mangroves would also influence migration of contaminants.

4.3 CULEBRA.

4.3.1 General. The island of Culebra is part of the Commonwealth of Puerto Rico and is located at latitude 18°19' north and longitude 65°17' west, approximately 17 miles east of Puerto Rico. It is 12 miles west of St. Thomas, and nine miles north of Vieques. The AFWTF maintains an observation post on Culebra for the maintenance of the microwave communications system.

Culebra is 7,000 acres in area. This includes the main island and outlying cays, the three largest of which are Cayo Norte, Isla Culebrita, and Cayo de Luis Peña. The distance from Punta Resaca on the north to Punta del Soldado on the south is about four miles. From the cape of Punta de Mounos on the northwest, the Cabeza de Perro cape on the east is about seven miles. The coastline is irregular, and the topography is hilly. There are several summits between 100 and 650 feet. The island has a number of sheltered inlets and sounds on its south coast, and several fine beaches. Exceptional benthic reef structures are found off its Northwest Peninsula, in the waters between Culebra and Culebrita, and southwest of Puerto del Manglar. Exceptional fish and wildlife populations inhabit the island and water in the immediate vicinity. These include several rare and endangered species. The benthic environment includes extensive mangrove communities, Thalassia meadows, reef ecosystem zones, and a small bioluminescent inlet on the south coast of the island.

4.3.1.1 Adjacent Land Use. Adjacent to the Observation Post (OP) and lying generally east of the OP boundary, is a rare form of forest, the boulder forest, under the jurisdiction of the U.S. Fish and Wildlife Service. Directly south of the OP, the National Aeronautics and Space Administration (NASA) has leased land from the Navy for a windmill demonstration project. To the southwest, a spectacular beach shelters the brackish Laguna del Flamenco, which has a considerable population of the endangered Bahama pintail. Some private residences are being built there. Due west of the OP is the excessed Northwest Peninsula, the site of the Impact Area and targets for the old Navy range. The Caribbean Sea is to the north.

4.3.2 History. The original name of Culebra was "Pasaje," meaning passage. Later on, during Spanish rule, the island was renamed "San Ildefonso de la Culebra," after the Spanish monarch don Alfonso XII. Culebra was discovered on November 19, 1493, during the second voyage of Christopher Columbus. Unlike many of the other islands in the Caribbean chain, Culebra possessed neither important resources nor a strategic position, and as a result, settlement on the island was slow.

The first recorded inhabitants of Culebra were transient groups of aborigines who fled the Spanish colonization of Puerto Rico in the 16th century. The island later became an occasional base of operations for pirates raiding Spanish commercial ships traveling between Panama and the Old World.

European development of Culebra began in the late 1870s, when the Spanish Crown formulated a system of land grants. Under this system, 83 parcels of land were provided for settlement, each parcel consisting of 25 hectares. The parcels were located on the main island and did not include the surrounding cays. The site of the present AFWTF complex in 1887 was in the northwest corner of parcel number 90, which totaled about 500 acres. At that time it was designated a forest zone. In the following years, the town of San Ildefonso was settled. In 1899 the town had about 206 persons. That same year, Culebra's population was recorded as 704 residents.

After the Spanish-American War, Culebra and its adjacent cays were transferred to the United States under terms of the Treaty of Paris. In 1901, by Presidential Executive Order, all public lands on Culebra were set aside for government use under the jurisdiction of the Navy. A further Executive Order in 1909 designated the adjacent cays of the Culebra group as a wildlife preserve, subject to their use for Naval and lighthouse purposes.

Throughout the first quarter of the 20th century, Naval facilities such as coaling stations have operated on Culebra, although at times the operation was minimal. In 1936 an exercise training target range was established, primarily at Peninsula Flamenco, including ship-to-shore, aircraft gunnery, and bombing facilities. A further Presidential Executive Order prior to World War II established a Naval defense area around Culebra. Up to the middle 1970s, the agency primarily responsible for federally owned areas on Culebra was the Navy.

On 5 July 1972 and 26 May 1976, the U.S. Navy declared excess (Excess Notices 2-N-PR-472 and 2-N-PR-472A, respectively) a total of 2,591.8 acres of land on the islands of Culebra, Culebrita, Luis Peña, Ladrones, and Pela (Water Cay) to be under control of the General Services Agency (GSA). The jurisdictional responsibility for all of these islands except Culebra reverted to the U.S. Fish and Wildlife Service as part of the National Wildlife Refuge System. This jurisdictional reversion was in accordance with President Theodore Roosevelt's Executive Order Number 1042, dated 27 February 1909, "which established the islands of the Culebra group, except Culebra, as a preserve and breeding ground for native birds, subject to their use for Naval and lighthouse purposes." Excess lands on these four islands totaled 611 acres. An additional 236.4 acres on Culebra, commonly referred to as the "airport property," has been transferred to the Commonwealth of Puerto Rico through other federal agencies. Two-thousand six-hundred and sixty-two acres were excessed to GSA, which gave

111.72 acres to the Commonwealth of Puerto Rico and the rest to the Department of Interior (DOI), which in turn gave 1,091 acres to the Commonwealth of Puerto Rico.

Currently, all land excessions have been effected and the Navy retains jurisdiction for only the 87-acre AFWTF site at Punta Flamenco.

4.3.2.1 Historical Sites. There are no known historical sites on currently owned Navy land; several cultural resource sites have been identified on land formerly owned by the Navy, now controlled by the U.S. Fish and Wildlife Service.

4.3.3 Legal Actions. The use of Culebra was the issue in the case of Romero-Barceló vs. Brown, explained in Section 4.2.3

4.3.4 Biological Features.

4.3.4.1 Ecosystems. In general, the plant life of Culebra can be divided into three major groups: those associated with man's activities, slope associations, and coastal associations.

Most of the original vegetation on Culebra has been altered by cultivation and grazing. Grasses, such as guinea grass and Angleton grass, Andropogan annulatus, are common on the lower slopes. When pastures are abandoned, thorn scrub of mesquite and mimosa and various species of cactus, including the barrel cactus, prickly pear, and the rare snow cactus, Mamillaria nivosa, take over.

Slope associations consist of evergreen and deciduous forest with figs, cupey, black manpoo, and others. Thorn scrub, acacia, and mesquite are found in the drier areas. The coastal varieties begin at the upper end of sandy beaches, and extend onto the low sand dunes. They consist of coastal hedge, scrub, beach forest, mangrove swamp, and marine meadows. The beach forest is restricted to the lowlands behind the north shore of Bahía Flamenco.

Mangrove stands are usually composed of three species, the red mangrove Rhizophora mangle, the black mangrove Avicennia nitida, and the less common white mangrove Laguncularia racemosa.

Offshore, the Thalassia grass meadows are major underwater plant communities. These are known locally as turtle grass beds and named for the primary plant species, Thalassia testudinum. Thalassia beds grow in the sand and mud bottom, often between coral reefs, and in clear waters to depths of 30 feet or less. The Thalassia meadows provide an important habitat for a variety of marine life.

The most prominent form of wildlife on Culebra is birds. Culebra is one of the most important nesting areas in the Caribbean for sooty terns (an estimated 150,000 mating pairs). The island of Culebrita has a high land bird density, but is less important than the smaller offshore keys (in terms of nesting density) for seabirds. The white-cheeked (Bahama) pintail, which is rare in Puerto Rico, has been observed on both islands. Red-billed tropic birds have been reported to be nesting on Culebrita, the first documented breeding record for this species for Puerto Rico.

The native mammalian fauna consists of three species of bats. In addition, the Norway rat and the house mouse have reached Culebra and are probably present on Culebrita. White-tailed deer have been introduced on Culebra and appear to be established.

Four species of marine turtles, all federally listed as endangered or threatened species, are found on Culebra and Culebrita, or in adjacent waters (see Section 4.3.4.2).

The richness of the marine environment around Culebra and Culebrita is manifested not only by the spectacular shallow water coral reefs, but also by mobile forms of life. The bays of Ensenada Honda and Puerto del Manglar are the most outstanding breeding grounds in Puerto Rican waters for spiny lobsters and many species of fish. As a result, fishing is excellent off these bays and between Luis Peña and Alcarraza. Mullet, snappers, flounders, bonefish, and anchovies are commonly found in these waters.

4.3.4.2 Endangered, Threatened, and Rare Species. The brown pelican is listed as endangered throughout its range, which includes Culebra and Culebrita. This species utilizes the mangrove areas for roosting and loafing, and the adjacent waters for feeding.

The endangered giant Culebra anole (Anolis roosevelti) is believed to exist only in the Mount Resaca area of Culebra, which has been designated as critical habitat for this species (Federal Register, July 21, 1977). The reptile was last recorded in 1932; however, local people on Culebra maintain that it still survives in the area and claim to still see it. The U.S. Fish and Wildlife Service is currently conducting studies to determine the status of the giant anole.

Four species of marine turtles either nest on Culebra and Culebrita or are found in adjacent waters. Loggerhead and green turtles are listed as threatened, but no critical habitat has been designated for these turtles on the Culebra islands. Leatherback turtles are listed as endangered, though designated critical habitat does not include Culebra or Culebrita. The hawksbill turtle is listed as endangered throughout its range, and critical habitat has been proposed for Culebra, Culebrita, Cayo Norte, and Mona Island. These areas include the beaches of Resaca, Brava, and Larga, on the north shore of Culebra near the OP, and all beachfront areas on the southwest shore, east shore, and northwest shore of Culebrita.

Flora of both Culebra and Culebrita includes a mixture of xeric plants on the lowlands and more mesic species in the valleys and upper slopes. Culebra is characterized by dense, dry, scrub forest on the leeward slopes, merging into a "well preserved" coastal forest on the isthmus.

There are 372 known species of native and introduced plants, representing 76 families and 156 genera. Thirty-three species are considered rare or unique by the Commonwealth, being found only on Culebra or on a few of the other smaller islands.

Smooth yellow nicker (Caesalpini culebrae) and Culebra Island water willow (Justicia culebritae) are both localized endemics found on Culebrita. Culebra Island water willow, a very rare species, is found along a narrow trail leading from the southwestern side of the island across to the southernmost part of the bay on the north coast.

Wheeler's peperomia (Peperomia wheelerii) is found in the boulder forest on the slopes of Mount Resaca as well as on the east-facing slopes near the OP helicopter pad at Punta Flamenco. In the area by the OP helicopter pad this rare endemic is being threatened with habitat destruction by chickens. These birds scratch the rocks bare and destroy the mold and humus accumulations on which Wheeler's peperomia depends. This species is found on the north slopes of the Mount Resaca area all the way down to the coast.

The boulder forest is found in only one other location, on Tortola. The fan leaved palms found on Culebra make up a unique plant community.

4.3.5 Physical Features.

4.3.5.1 Climatology. The climate of Culebra is the principal factor in its character and ecosystem quality. Mean annual rainfall is only 36 inches, ranging from a low of 16 inches in 1967, to the 59 inches recorded in 1942. Almost half of the annual precipitation occurs in a four-month period, August to November. Temperatures are relatively constant throughout the year, ranging between 62 and 93°F, with an annual average temperature of 80°F. Evaporation factors at Culebra total 70 annual inches, and humidity varies from about 65% in daytime to approximately 80% at night.

Cloud cover, storm, and wind factors at Culebra are typical of the West Indies. Prevailing winds blow from the northeast in winter and shift to easterly in the summer months. Wind velocity becomes stronger then, although average winds measure approximately 10 miles per hour. Some storms have generated wind velocities as high as 85 miles per hour at the Punta Flamenco center. Hurricane season, as on Puerto Rico, lasts from June through November, with most storms occurring in July, August, and September. Local storms sometimes form waterspouts at Culebra and Vieques, causing some coastal damage before dying out on the island terrain. Mean annual cloud cover is 0.5%, which reflects the low precipitation record.

4.3.5.2 Topography. The AFWTF site is located on Culebra's north shore at Punta Flamenco. Relief along the area of the AFWTF site is extreme, with elevations ranging from sea level along the rocky shores to the west, north, and east, to nearly 120 meters above sea level at the mountain peak. Because annual rainfall is slight, averaging only 42 inches, there are no freshwater drainage systems located here or elsewhere on the island.

4.3.5.3 Geology. Culebra and its adjacent islands are underlain by volcanic and intrusive rocks of probable Upper Cretaceous age. Andesite lava underlies most of the island, and on many seacliff exposures the lava exhibits pillow structures characteristic of lavas erupted under the sea. This structure is remarkably well-preserved at Punta Seria on Cayo Norte. The andesite lava contains many veins and interpillow fillings of quartz. Andesite lava breccia lies along the straight southwest coast of the island and on Luis Peña (see Figure 4-6).

Andesite tuff overlies the lava along the north coast of Culebra. It is characterized by a prominent layering, with beds ranging from a few inches to many feet thick. This layering may be seen along the seacliffs between Playa Brava and Playa Larga.

The tuff and underlying lava have been intruded by diorite in north-central Culebra and by diorite porphyry on Luis Peña. The diorite weathers to rounded boulders several feet in diameter which cover much of the steep north-central slope of Culebra. The sandy soil washed down the slope from between these boulders has accumulated to form the small sand deposit behind Playa Brava.

Other alluvial deposits include fine coral sand and coarse gravel in beach deposits, and fine sand and clay underlying mangrove swamps and lagoon basins.

4.3.5.4 Soils. Culebra has a relatively limited variety of soils types, owing to its volcanic origin, small size, rugged terrain, and moderately uniform climate. Its total acreages consist of 75 to 80% soils of the Descalabrado and Rockland series, formed in slopes of 20 to 40%. Such topography is so limited in capability and so subject to erosive forces that it should be utilized only for grazing, wildlife habitat, or forest cover.

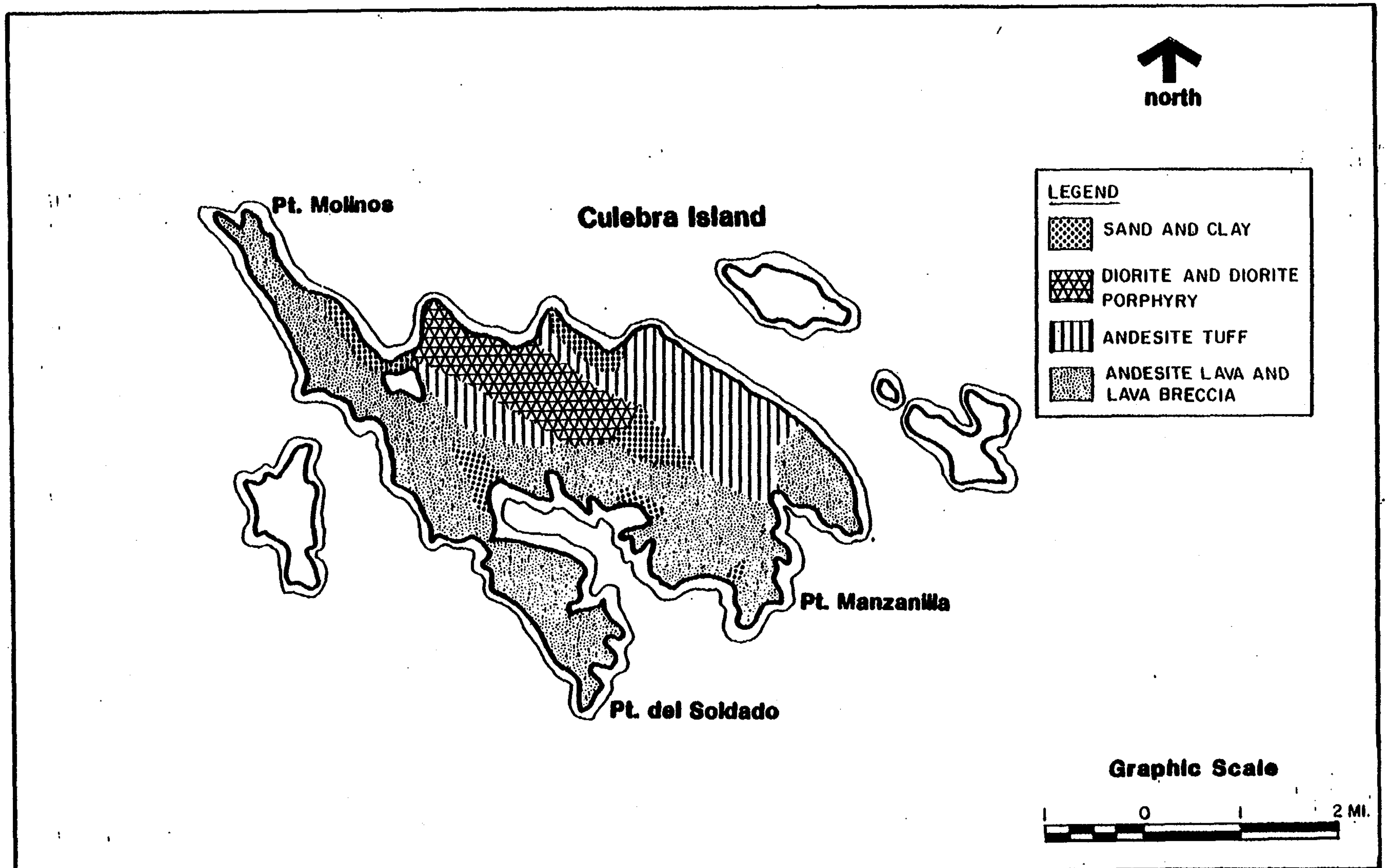
Soils within the area of the AFWTF site consist entirely of Rockland soils. These soils are found in areas where rock outcrops are present over 50 to 70% of the ground surface. Loose diorite boulders and rocks are also common on the ground surface. Very shallow soil material is found lying between the outcrops and the rocks. Slopes for Rockland soils are generally very steep, ranging from 60 to 70%. This land type is found in mountainous areas, and is characterized by scattered low brush vegetation. Areas of Rockland soils have little value for agricultural or engineering uses, and mainly provide wildlife habitat.

In the coastal areas directly to the southwest (Playa Flamenco) and southeast (Playa Resaca) of the AFWTF site, narrow areas of nearly level coastal beaches and Cataño loamy sand are present. Similar to the Rockland soils, these areas also are not suited for agricultural use.

4.3.5.5 Hydrology. Ensenada Honda, Bahía Flamenco, and Puerto del Manglar are drowned valleys whose waters receive intermittent drainage from higher terrain. No permanent watercourses exist, but some saline springheads are present. Shallow wells are used to provide water for livestock, and eight drilled wells supply non-potable water demand. However, such wells are high in chloride concentrations, and most potable water is supplied by cisterns (the OP has one) and the new desalination plant.

Comparatively, the geology and hydrology of Culebra have parallels on St. Thomas and Vieques. Their igneous geology is largely structured of volcanic andesite and intrusive diorite. Therefore, available ground water is stored in fissures and fractures in the rock, and considerable saline intrusion occurs.

Catchment installations were formerly the principal source of potable water on Culebra. However, as a result of the unusually arid years from 1961 through 1969, the catchment system has become a secondary backup source of water.



INITIAL ASSESSMENT STUDY
NAVAL STATION
ROOSEVELT ROADS, PUERTO RICO

FIGURE 4-6
GEOLOGIC FORMATION OF CULEBRA ISLAND

Catchment storage at three sites totals about 400,000 gallons, a two-week supply for the population at Dewey. Primary supply for Dewey was sought in a field of drilled wells east of the town. Four wells are operative, but only two have acceptably low levels of salinity. Well yield measures about 20 gallons per minute. However, salinity of the best wells has regularly exceeded 400 ppm, while the U.S. Public Health Service maximum is only 250 ppm.

4.3.6 Migration Potential. Contaminants at the OP would migrate by surface runoff due to the steep topography and shallow soils with rocky outcroppings. However, due to the distance (about one kilometer) to the ocean, it is doubtful that surface runoff would have much impact.

4.4 ST. THOMAS.

4.4.1 General. The AFWTF maintains a communications and target tracking and control facility on top of Crown Mountain. The Crown Mountain facility is located about 42 nautical miles east of NAVSTA Roosevelt Roads and provides drone and aircraft tracking capability. The collected data are relayed back to Range Operations Center (ROC) at NAVSTA Roosevelt Roads in real time for evaluation and correction of flight paths if required. Although drone control is exercised by the ROC, the Crown Mountain facility has command control capability in the event the ROC is unable to exercise control.

The Crown Mountain facility is operated and maintained by a civilian contractor and is under the direct control of the ROC. The majority of the facilities at Crown Mountain are relatively new; its tracking capability was greatly improved by the recent addition of the wide area search CAPRI radar. Crown Mountain can also duplicate various enemy ship and aircraft signatures with its highly sophisticated Threat Platform Simulators (TPS) on the displays of vessels and planes utilizing the range.

4.4.1.1 Adjacent Land Use. Land use adjacent to the Crown Mountain facility is limited to a broadcasting tower which belongs to the Virgin Island Broadcasting Service (due east), the old site (see discussion below), private residences (which belong to contract personnel), and undeveloped areas. The Crown Mountain site is relatively isolated, with little activity around the site.

4.4.2 History. The present facility was occupied in 1975, when operations were moved from the old site about 100 yards to the east. The present site was built by NMCB personnel, with additional construction in 1976, 1977, 1978, and 1983. Plans for 1984 include the installation of electronic items to augment the ITCS system at Pico del Este. The Crown Mountain site, as part of the AFWTF ranges, tracks and controls drones, and tracks surface vessels and aircraft.

4.4.2.1 Historical Sites. There are no historical sites on or near the Crown Mountain facility.

4.4.1 Legal Action. The Crown Mountain site has not been involved in any legal proceedings to date.

4.4.4 Biological Features. Vegetation now growing on the island differs from the original vegetation and differs somewhat in different parts. Uncleared mountainous areas support a fairly dense growth of tropical forest, including a few large trees and a dense undergrowth of brush and vines, but the cleared mountainous areas are covered with thorny brush, which is of little or no value.

Much of the cultivated acreage on the coastal plain has been converted to rangeland. The vegetation is mainly cactus and small thorny brush. There is very little pasture grass. Hurricanegrass, which is considered to be an inferior pasture grass, has spread rapidly over the southern part of the coastal plain and into adjacent mountainous areas.

Hilly areas between the coastal plain and the mountains are covered with thorny brush and poor quality pasture grass. There are only a few trees. The eastern end of the island, which is usually drier than other parts, is covered with a dense growth of cactus and thorny brush.

The ecosystems and biology of St. Thomas are quite similar to St. Croix, the primary difference being species distribution (see Table 4-14 in Section 4.5.4.2). The endangered black-crowned night heron and peregrine falcon found on St. Croix are not present on St. Thomas. Table 4-11 lists those species found on St. Thomas that are not present on St. Croix, and indicates which of these species are rare and endangered. The rare and endangered species are otherwise identical on the two islands.

4.4.5 Physical Features.

4.4.5.1 Climatology. The Virgin Islands extend eastward from Puerto Rico, along the path of the Lesser Antilles, directly in the belt of subtropical, easterly trade winds. The climate is maritime tropical, one of the most equable in the world. It is characterized by generally fair weather, steady winds, and slight but regular annual, seasonal, and diurnal ranges of temperature. A significant feature of the rainfall pattern is the marked variation within short distances with change in terrain and elevation.

Minor seasonal contrasts are generated by outbreaks of cold air from the higher latitudes in winter and by tropical disturbances late in summer and fall. Of greater significance is the diurnal tempering effect of the islands on the surrounding ocean climate. Since the land area is small, the Virgin Islands exert less modification on the surrounding ocean climate than do the islands of the Greater Antilles, which lie to the west.

Lifting of moist air over hilly terrain is the most common cause of rainfall on the islands. The amount of rainfall increases with increasing elevation. The average annual total at the higher elevations is between 50 and 60 inches, and at the lower elevations, between 20 and 30 inches. Whether an exposure is on the windward or the leeward side of a slope is a significant factor in the amount of rainfall received. In general, there is a much higher occurrence of rainfall by day than by night.

There is no sharply defined wet season or dry season on the islands. Records indicate seasons much like those along the southern coast of Puerto Rico. On

Table 4-11

SPECIES FOUND ON ST. THOMAS NOT PRESENT ON ST. CROIX

Common Name	Scientific Name
Man lizard	A. cristatellus
Sharp mouthed lizard	A. pulchellus
Salmon lizard	A. stratulus
Common ground lizard	A. exsul
Virgin Islands blind snake	A. fenestrata
Tree boa*	E. monensis
Ground snake*	Alsophis portoricensis
Garden snake*	Arrhyton exiguum
Red-billed tropic bird*	Phaeton aethereus
Stolid flycatcher*	M. stolidus
Red fruit bat*	Stenoderma rufun

*Indicates rare, endangered, or threatened species.

St. Thomas, the rainfall is generally lightest in February and March, and heaviest in September and October. The number of days with rainfall equal to or more than one-tenth of an inch ranges from about 75 to 110, depending on location.

Variations in temperature between the coolest and the warmest months are 5° to 7°F at the most. The highest temperatures are in August, and the lowest in January or February. During the warmest months, the highest average daytime temperature is about 87°F. During hot spells, which occur nearly every year, the temperature exceeds 88° or 90°F for several days in succession. The average lowest nighttime temperature during the warmest months is between 74° and 78°F. Nighttime temperatures are somewhat lower at the higher elevations, such as Crown Mountain. During the coldest months, the highest temperature is generally in the low 80s, and the lowest in the high 60s or low 70s. At the higher elevations, outbreaks of cold air into the Caribbean bring nighttime temperatures down to the low 60s or high 50s.

Regularity in direction of the trade winds is one of the most dependable weather phenomena on the islands. Almost without exception the trade winds blow from an easterly direction. The velocity varies daily. A velocity of more than 15 miles per hour occurs more frequently in winter than in other seasons. Leeward slopes are protected against the full force of the trade winds, but the flow is strong enough to pass over the higher terrain without diminishing in velocity. Most locations have a good flow of air movement most of the day.

The islands are affected occasionally by tropical storms and hurricanes. They lie outside the main paths of severe tropical disturbances, except those that occur from August through the first half of October. The storms that develop over the South Atlantic east of the Antilles chain usually move toward the north or northwest and pass north or south of the islands; rarely do they pass directly over them. There is risk of hurricane force winds about once every nine or 10 years.

4.4.5.2 Topography. The topography of St. Thomas in the vicinity of Crown Mountain consists of man-made level ground atop slopes of steep as 60°.

4.4.5.3 Geology. St. Thomas is underlain by indurated volcanic rock and sedimentary rock derived primarily from material eroded from the volcanic core; all of these rocks are of Cretaceous age. The only nonvolcanic rock is a thin bed of limestone of Cretaceous age. Alluvial deposits are present in the major stream valleys and interfinger with beach sand in the coastal embayments.

4.4.5.4 Soils. The following soil associations are found on St. Thomas: the Cramer-Isaac Association and the Dorothea-Victory-Magens Association.

The Cramer-Isaac Association consists of very steep to strongly sloping, well-drained soils, with a clayey subsoil. These soils are shallow and moderately deep over volcanic rock, and are found on mountainsides and foot slopes.

This association is characterized by steep and very steep mountainsides, strongly sloping foot slopes, and narrow alluvial fans and floodplains. The soils are reddish in color. The surface layer is gravelly or stony; between 50 and 70% of the surface is covered with rock outcrops, and boulders and stones are common.

Cramer soils are found on mountainsides. They are steep and very steep, shallow, red or reddish brown soils which are well drained and moderately permeable. Their surface layer is gravelly or stony. They formed in material weathered in place from volcanic rock.

Isaac soils are found on foot slopes. They are strongly sloping, moderately deep, and well drained. They have many angular volcanic rock fragments on the surface. These soils also formed in material weathered in place from volcanic rock.

Minor soils of this association are San Antón, Glynn, and Aguilita soils and Cobbly alluvial land. San Antón and Glynn soils occupy narrow alluvial fans and floodplains below Cramer and Isaac soils. Aguilita soils are found on low hills and foot slopes. Cobbly alluvial land is found on narrow floodplains.

Cramer and Isaac soils have severe limitations, chiefly shallowness over rock and steep slopes, that make them unsuitable for cultivation and for most nonfarm uses. They are limited largely to use for pasture and range, woodland, wildlife habitat, and recreation.

The Dorothea-Victory-Magens Association consists of steep and very steep, well-drained, deep soils, having a clay to clay loam subsoil. These soils are primarily found on mountainsides.

This association is characterized by steep and very steep, rugged, forested or pastured mountains that are slightly rounded at the top. The soils on the highest peaks of the island of St. Thomas--Hawk Hill, Crown Mountain, and Signal Hill--are in this association.

All of the major soils of this association are on mountainsides. Victory and Magens soils are steep; Dorothea soils are steep to very steep. All are deep, well drained, and moderately permeable, and all formed in material derived in place from highly weathered volcanic rock. Dorothea and Victory soils are yellowish brown, and Magens soils are red in the subsoil.

4.4.5.5 Hydrology. The Crown Mountain site obtains water by a catchment system, and on occasion, by trucking in water obtained from the VIWPA.

Periods of deficient rainfall occur almost every year in some parts of the Virgin Islands. Although some of these periods are of short duration, they have a serious impact on farming and dairying activities, on the urban water supply, and on the general economy. The islands have no large rivers and no large storage reservoirs. Consequently, even a few months of drought can be damaging. Droughts are most prevalent in late fall, winter, and early spring.

The severity of drought on the islands has been computed by the Palmer Index, developed by the Environmental Data Service. This computation is based on the difference between the amount of rainfall received and the amount needed to maintain an average for the area. It indicates that mild to extreme droughts can be expected about half the time, severe to extreme droughts about 15% of the time, and mild to moderate droughts about a third of the time. Since 1931 there have been 14 droughts indexed by the Palmer system. The longest was for 48 months, from February 1945 to February 1949. The drought of 1964-65 was the most recent and the most severe.

Drought is more serious now than ever before in the islands' history. Many springs and wells have gone dry. Subterranean reservoirs have become more and more depleted, even though, according to records, the islands receive about the same amount of rainfall as at any time in the past.

4.4.6 Migration Potential. The shallow stony nature of the soil at the Crown Mountain site, combined with the steep slopes (60°), lead to a high potential for the surface migration of contaminants.

4.5 ST. CROIX.

4.5.1 General. The island of St. Croix has two facilities associated with the Atlantic Fleet Weapons Training Facility (AFWTF), the mission of which is to operate, maintain, and develop weapons training facilities and services. As part of those services, AFWTF has located on St. Croix the Underwater Tracking Range (UTR) Control Complex at Sprat Hall, and the St. Georges Hill complex on top of 864-foot-high St. Georges Hill.

The facilities of the UTR provide approximately 69 square miles of instrumented deep water for three-dimensional tracking of ships, submarines, and underwater weapons. Normal activities include Weapons Systems Accuracy Trials (WSAT); air, surface, and subsurface torpedo exercises (TORPEX); Fleet Operational Readiness Checks (FORAC); research, development, testing, and evaluation projects; and any other trials for which precise in-water spatial measurements are required.

The UTR is located on and in deep water off the western shore of St. Croix and consists of two superimposed ranges. The older Short Baseline (SBL) synchronous range utilizes a 75 KHz MK-72 Pinger and consists of 21 square nautical miles of tracking area. The new Long Baseline (LBL) asynchronous range utilizes a 13 KHz MK-84 Pinger and consists of approximately 69 square nautical miles. The LBL range is normally utilized for all operations; however, the SBL range is available if desired. The boundaries of the SBL range are latitudes 17°47' and 17°41' north and longitudes 64°54' and 65°00' west. The boundaries of the LBL range are latitudes 17°46' and 17°39' north and longitudes 64°54' and 65°02' west. Water depth varies from 200 to 600 fathoms.

The data gathering and processing system at the UTR consists of both state-of-the-art hardware and real-time software, plus a full color integrated real-time display system. This system is made up of four MODCOMP IV-35B computers, a complex network of signal processors and other electronics, three RAMTEX Interactive Display Devices, and additional repeater display devices.

Operations on the UTR are man- and machine-controlled from a shore complex located immediately north of Sprat Hole on northwestern St. Croix. The complex, which consists of a number of large interconnected office-type industrial trailers, is operated and maintained by a civilian contractor. There are no Naval personnel permanently stationed at the range, although during periods of operation, a liaison/range control officer from AFWTF is present. Shops for instrumentation, maintenance, and torpedo preparation are located at Roosevelt Roads, as are the administrative offices for the UTR.

The UTR has several tracking modes:

a. Short Baseline (SBL) underwater acoustic instrumentation provides precise spatial relationships between in-water objects via a hydroacoustic interface and the data gathering and processing system (DGPS). Synchronous, spherical, SBL tracking principles are employed to obtain precision three-dimensional positions. The range is able to track over 20 objects in the total range areas or up to eight objects in an individual array area. The tracking is accomplished by 13 bottom-mounted hydrophone arrays which receive signals from a special acoustic device mounted on each object being tracked. The hydroplane array transmits these signals via submarine cables to the computers ashore which provide real-time course and speed, and torpedo firing control solutions. The accuracy of the system over the entire tracking area is approximately 25 feet or less. The accuracy within any particular array is approximately 10 feet or less.

b. Long Baseline (LBL) underwater acoustic instrumentation provides not only additional underwater track area but also another option for track. The system is designed to accept acoustic energy bursts from the phase-coded pingers MK-84 and MK-72-2. These energy bursts can occur at 1/2, 1, 2, and 4 second ping intervals, depending on the type and speed of the object being tracked. Once the system acquires an object or range, the computer and real-time software select automatically the "best" array for track and the best of several algorithms for given conditions. Three-dimensional computations are normally performed.

c. The Optical Tracking System is used primarily when positional information cannot be obtained by the acoustic three-dimensional systems. Precise positions can be determined by triangulation using readings from three theodolites. Under optimum conditions, triangulation closures of less than two feet are possible.

d. The UTR computers can utilize real-time radar track information provided by four radar systems: CAPRI on St. George Hill, St. Croix; NIKE-HERCULES on St. Thomas; CAPRI on St. Thomas; and NIKE-HERCULES on Vieques.

As part of the AFWTF, the Electronic Warfare Range (EWR) St. Georges Hill, provides both a realistic simulated hostile electromagnetic environment for the training of ship and aircrew electronic warfare teams, and a tactical electronic order-of-battle in support of exercises conducted on other AFWTF ranges. The EWR can support either single-ship or multi-ship exercises using its Threat Platform Simulators (TPS) situated throughout the AFWTF complex to provide overlapping coverage to portions of the Outer Range and all Inner and Underwater Ranges. The capabilities of the various electronic devices are shown in Table 4-12. A civilian contractor runs the facility, which is located atop 864-foot-high St. Georges Hill.

Table 4-12

CAPABILITIES OF RADARS AT ST. GEORGES HILL, ST. CROIX

AN/MSQ-51. Target Tracking and Control, Aircraft Tracking

Location	• St. Georges Hill, St. Croix, U.S. Virgin Islands North Delicias Hill, U.S. Naval Station Roosevelt Roads
Frequency	• ACQ: S-Band 3100 - 3500 MHz Track: X-Band 8.5 - 9.6 GHz
PW	• ACQ: 1.3 microsec Track: 0.25 microsec
PRF	• ACQ: 300 or 1,000 PPS Track: 380/1,000 PPS
Power	• ACQ: 1 MW Track: 250 KW
Antenna	• ACQ: 5, 10, or 15 RPM Track: Conical Both: 200 nautical miles

AN/FPS-105 "CAPRI": Missile, Aircraft, and Surface Tracking

Location	• St. Georges Hill, St. Croix, U.S. Virgin Islands
Frequency	• 5.45 - 5.825 GHz
PW	• 0.25, 0.5, 1 microsec
Power	• 1 MW
Antenna	• Cassegranian/Monopulse Feed
Maximum Range	• 16,000 nautical miles

4.5.1.1 Adjacent Land Use. Sprat Hall is an old sugar estate, now used as a guest house and restaurant. Other land uses adjacent to the UTR include recreational beaches and diving areas. Local fishermen and recreational boaters use the waters offshore. Land use adjacent to the St. George's Hill complex includes individual residences and a quarry.

4.5.2 History. For the island of St. Croix, as well as the rest of the Caribbean, the arrival of Columbus at the close of the 15th century marks the beginning of the historic period.

St. Croix was sought after by the Europeans not only for its economic potential as a locality suitable for the production of sugarcane, but also for its strategic position in the Caribbean as a port of trade.

A brief summary of the highlights in the historic chronology of St. Croix are presented in Table 4-13.

4.5.2.1 Historical Sites. Sprat Hall near the UTR has been proposed for listing on the NRHP. Various cultural resources (tools, campsites, middens, and other artifacts) have been found on land immediately adjacent to the UTR, and there is some evidence that the UTR was built on top of a significant archaeological site, which is, of course, now destroyed. There are no historical sites associated with the St. Georges Hill facility.

4.5.3 Legal Actions. In 1971, as a result of a legal action, St. Croix was evaluated as an alternative to the Naval gunnery activities at Culebra. Navy activities on the island, however, have not been involved in any legal actions of note.

4.5.4 Biological Features. St. Croix includes a large number of the major terrestrial ecosystems typical of the tropics. Although relatively dry, small, and isolated, the island has a climate which permits the growth of vegetation ranging from near rain forest to near desert. Along the shoreline is a group of specialized ecosystems strongly affected by saltwater and composed of relatively few species. Another group of ecosystems owes its origin and continued existence to the activities of man. These ecosystems, ranging from very low to very high species diversity, are the least stable.

The fauna and flora of the island are distinctive for the high proportion of exotic (non-native) species which have been introduced by man. Plants native to all tropical parts of the world are present. Livestock and mongoose dominate the fauna and are seen in virtually all of the island's ecosystems. In addition to the native avifauna, large numbers of migratory birds use the island twice a year as a stopover in their migrations.

St. Croix was more lush when Europeans first settled on the island. Crop agriculture, especially sugarcane, developed slowly and remained extensive as late as the early 20th century. The availability of water has decreased and the frequency of fire has increased throughout much of the island.

4.5.4.1 Ecosystems. St. Croix has 10 major terrestrial ecosystem types:

- Semi-evergreen forest (St. Croix rain forest),

Table 4-13

HISTORIC CHRONOLOGY OF ST. CROIX*

1493	SPAIN. On his second voyage to the New World, Columbus discovers St. Croix, which he names "Santa Cruz," claiming it for Spain.
1587	ENGLAND. John White, sent by Sir Walter Raleigh as Governor of Virginia, stays on St. Croix for three days; finds evidence of Indian habitation.
1625	HOLLAND AND ENGLAND. Small settlements begun by Dutch at Bassin (Christiansted) and by English on the southwest shore area (near Frederiksted).
1642	Holland increases settlement, causing unrest between themselves, the French, and the English.
1646	ENGLAND. British hold island after Dutch and French are driven out.
1650	SPAIN. English settlement overtaken by Spainards from Puerto Rico. Dutch try to recapture the settlement the same year, but are defeated by the Spanish.
1650	FRANCE. Governor de Poincy of the French West Indies takes possession of St. Croix for the French crown; plans to make it his capital.
1651	DE POINCY. St. Croix and other islands are purchased privately by de Poincy from the French King. As a leading Knight of Malta, he sends other knights and Frenchmen to colonize St. Croix.
1653	KNIGHTS OF MALTA. All of de Poincy's private possessions in the West Indies are granted to this Order of St. John.
1657	French settle St. Croix and, with some difficulty, run sugar, indigo, and tobacco plantations.
1665	FRENCH WEST INDIA COMPANY. All island possessions held by the Knights of Malta, including St. Croix, are purchased by the French West India Company.
1674	FRANCE. King of France pays off company debts and takes possession of the island.
1695	ABANDONED. Maintaining his country's claim over the island, the French King orders all inhabitants removed to Santo Domingo.
1733	DANISH WEST INDIA AND GUINEA COMPANY. St. Croix is purchased from the French crown by the Danish West India and Guinea Company, and shortly thereafter, is divided into 150- and 300-acre plantations to encourage settlement.
1755	DENMARK. Denmark takes possession of St. Croix as a Crown Colony. During the ensuing half century, St. Croix's economy, based on sugar, rum, and the slave trade, rises steadily.
1792	Danish government is the first country in the world to declare slave trade unlawful. (The abolition of the slave trade, however, does not come into force until 1803, and is not completely abolished until 1848).
1795 - 1800	Years of peak prosperity of sugar and rum economy; planters, however, foresee the beginning of the end.

Table 4-13 (Cont.)

1801	St. Croix captured by British; restored to Denmark in a few months.
1803	Denmark abolishes the slave trade completely.
1807 - 1815	St. Croix is held by British during Napoleonic Wars, but is eventually returned to Denmark. Economy worsens over the next 30 years with periods of drought, political upheaval, and war in Europe, and the general depression.
1848	Slaves on St. Croix are freed by Governor Von Scholton, after rioting began.
1866	A disastrous fire occurs in Christiansted.
1867	Earthquake and tidal wave bring further trouble to a declining economy.
1871	Capital moved from St. Croix to St. Thomas.
1872	Severe hurricane destroys crops and buildings.
1875	Danish government provides funds for construction of a Central Sugar Factory, which is begun in 1876.
1876	Severe hurricane and depression years until about 1888.
1878 - 1892	Serious labor riots take place; Frederiksted is partially burned. Financial difficulties result in further rioting in 1892.
1917	UNITED STATES. The United States purchases St. Croix, along with St. Thomas and St. John.

*After Lewisohn (1964).

- Deciduous forest,
- Thorn woodland,
- Thorn scrub,
- Mangrove swamp,
- Littoral woodland,
- Beach ecosystem,
- Savanna,
- Man's monoculture ecosystem, and
- Man's diverse ecosystem

The first four ecosystems are primarily climate-controlled, the following three are controlled by the effects of the sea, and the final three are primarily controlled by the activities of man. These ecosystems, or ecological systems, are combinations of plants, animals, microbes, soil, and atmosphere and their continual interaction. As such, the readily observable differences among the 10 types are the dominant plant species, height of vegetation, type of animals, total species diversity, litter accumulation on the soil, soil moisture, inundation by seawater, water input from the air, salt concentration, fire frequency, livestock density, and cultivation by man. The four climatically controlled ecosystem types represent four fairly distinct stages along a wider moisture gradient from rain forest to desert.

Three major background factors determine the range and nature of ecosystems present on St. Croix. Most important is the highest elevation of approximately 350 meters (1,165 feet), over which the warm, moist, eastern trade winds pass with little cooling and precipitation, therefore making it possible for several dry ecosystem types to succeed in the absence of a well-developed rain forest. Second, the island is 500 miles from South America, 1,100 miles from Florida, 60 miles from Puerto Rico, and 20 miles from the nearest other Virgin Island at the northern end of the Lesser Antilles; this relative isolation makes it difficult for new species to reach the island naturally. Third, the island is small, approximately 20 miles by eight miles (84 square miles), further contributing to low species diversity.

By way of comparison, St. Croix appears to have more kinds of ecosystems and more species diversity within them than nearby St. Martin to the east, which is lower in elevation, smaller, and farther away from species sources. Yet St. Croix exhibits less diversity than the nearby island of St. John to the north, which is smaller, 70 meters higher (and therefore moister), and was once connected to Puerto Rico during the Pleistocene ice age.

More recently, the history of land use by man has dramatically altered the landscape. In 1651 the French reported three rivers and 16 brooks on the island. Near the beginning of this century, sugarcane cultivation covered as much as 35% of the island, and as late as 1914, several streams and rivers were reported to flow year-round. At present, active sugarcane plantations have essentially disappeared, and all streams dry out during part of the year, generally leaving only a few trickles at higher elevations.

Before the cultivation of the island by European colonizers, deciduous and semi-evergreen forests probably covered most of the island, with drier vegetation in the east and southwest. Almost all of the island has been utilized by man at some time; currently the major uses are building and road construction, limited cultivation, and cattle, goat, horse, and sheep grazing. As in all dry tropical regions, much of the land area catches fire and burns repeatedly.

Mongoose are common in essentially all ecosystems. Deer are infrequently observed in the forests, woodlands, and savannas. Other mammals include rats, mice, fruit and insectivorous bats, livestock, and dogs. Seabirds and a relatively few land birds are resident species, but numerous migratory species are seen in season. Local herptile populations include dense small lizards, one rare large lizard species, a few frogs, and an introduced toad. Insects are relatively few in kinds and number. A listing of flora and fauna found on St. Croix is included in Appendix B.

4.5.4.2 Endangered, Threatened, and Rare Species. Endangered, threatened, or rare species found on St. Croix are listed in Table 4-14.

4.5.5 <u>Physical Features</u>.

4.5.5.1 Climatology. The climate of St. Croix is dry tropical, with daily temperature fluctuations exceeding the seasonal variation. Average monthly temperatures range from 24 to 28°C (75 to 83°F). Long-term average annual precipitation, which has remained constant over the last 112 years, ranges from about 140 centimeters in the northwest to about 60 centimeters in the eastern end and the southwestern area of the island. Differences in precipitation from year to year are greatest in the rain shadow areas of hilly sections and local ridges from Frederiksted across to Fountain Valley Road, Christiansted, and above Solitude Bay, and are least in the flat central region around the airport and eastward. Average monthly precipitation is fairly even throughout the year, with the driest month, March, receiving about four centimeters of rain (lower in dry regions) and the wettest month, between September and November, about four times as much. Seasonal variability from year to year is least in March and greatest from May to December. Evapotranspiration produces an annual soil-water deficit throughout the island almost every year; for short periods during most years, most of the areas of the island have positive soil-water balances. Hurricanes generally occur in pairs within a 12-year period separated by an average 38-year span. The last hurricane occurred in 1928. In summary, the temperature is warm and constant throughout the year, the driest season is January through April, and the wettest season September through November, though extended dry periods may occur any year at any season.

Throughout much of the year, the wind blows steadily out of the northeast at 10 to 20 miles per hour. Wave action is fairly heavy on exposed sections of the coast during most of the year, and the seas are steep and of short period. Water temperature varies from about 23° to 26°C in the winter months and averages about 28°C in the summer, with higher temperatures in areas of quiet water. The tides average about one foot and are diurnal in character. Low tides usually occur in the night during the winter and during the day in summer. Neap and spring tide periods are about a week in extent and closely follow the phases of the moon.

4.5.5.2 Topography. St. Croix is the largest and southernmost of the U.S. Virgin Islands, located about 40 miles to the south of St. Thomas and St. John. It is about 22 miles long and five miles wide. The island is surrounded by

Table 4-14

ENDANGERED, THREATENED, OR RARE SPECIES OF ST. CROIX

Common Name	Scientific Name
Reptiles	
Scaly sea turtles	Cheloniidae
Green turtle	*Chelonia mydas*
Hawksbill	*Eretmochelys imbricata*
Leathery sea turtles	Der mochelidae
Leatherback	*Dermochelys coriacea*
Iguandids	Iguanidae
Camman iguana	*Iguana Iguana*
Whiptails	Teiidae
St. Croix ground lizard	*Ameiva polops*
Skinks	Scincidae
Slippery back skink	*Mabuya mobouin (sloanei)*
Colubirds	Colubridae
Ground snake	*Alsophis portoricensis*
Birds	
Grebes	Podicipedidae
Least grebe	*Podiceps dominicus*
Tropic birds	Phaethontidae
White tailed tropic bird	*Phaethon lepturus*
Pelicans	Peleconidae
Brown pelican, Alcatraz	*P. occidentalis*
Boobies and gannets	Sulidae
Blue-faced booby	*Sula dactylatra*
Red-footed booby, boba blanca	*S. sula*
Herons and bitterns	Ardeidae
Great blue heron	*Ardea herodias*
Great (common) egret, garza real	*Casmerodius (egretta) albus*
Snowy egret	*Egretta (leucophoyx) thula*
Black-crowned night heron	*Nycticorax nycticorax*
Least bittern	*Ixobrychus exilis*
Ibises and spoonbills	Threskiornithidae
Glossy ibis	*Plegadis falcinellus*
Flamingos	Phoenicopteridae
American flamingo	*Phoenicopterus ruber*

Table 4-14 (Cont.)

Common Name	Scientific Name
Birds (Cont.)	
Swans, geese, and ducks	Anatidae
West Indian whistling duck	Dendrocygna arborea
Bahama duck	Anas bahamensis
Ruddy duck	Oxyura jamaicensis
Masked duck	O. dominica
Caracaras and falcons	Falconidae
Peregrine falcon	Falco peregrinus
Rails, gallinules, and coots	Raillidae
Clapper rail	Rallus longirostris
Purple gallinule	Porphyrula martinica
Caribbean coot	Fulica caribea
Plovers, turnstones, and surfbirds	Charadriidae
Snowy plover	C. alexandrinus
Woodcock, snipe, and sandpipers	Scolopacidae
Willet	Catoptrophorus semipalmatus
Gulls and terns	Laridae
Gull-billed tern	Gelochelidon nilotica
Common tern, gaviota	Sterna hirundo
Roseate tern	S. dougallii
Least tern	S. albifrons
Royal tern	S. (Thalasseus) maxima
Sandwich tern	S. (T.) sandvicensis
Pigeons and doves	Columbidae
White-crowned pigeon	Columba leucocephala
Plain pigeon	C. inornata
Bridled quail dove	Geotrygon mystacea
Typical owls	Strigidae
Puerto Rican screech owl	Otus nudipes
Mammals	
Fisherman bats	Noctilionidae
Fisherman bat	Noctilio leporinus
Sperm whales	Physeteridae
Sperm whale	Physeter catadon
Rorquals	Balaenopteridae
	Balaenoptera spp. (probably 4 species)
Humpback whale	Megaptera novaengliae

Source: Philbosian R. and, John A. Yatema, 1977.

deep water on all sides and has a relatively small shelf. The highest point on the island is in the northwest section, which has an elevation of 1,165 feet.

The coastline of St. Croix is regular, with only three deep indentations at Christiansted Harbor, Salt River, and on the south shore at Krause lagoon, now completely taken over by a large refinery and alumina plant. There are only two offshore islands--Green Cay and Buck Island.

4.5.5.3 Geology. The island of St. Croix consists of largely Upper Cretaceous, Oligocene, Miocene, and recent sedimentary rocks at the surface. There is a small surface area of intrusive diorite near the east end of the island and an area of gabbro in the northwestern mountains; these areas are of Tertiary age. The eastern and western parts of the island are separated by a graben filled with altered volcanic ash that is overlain by marl and limestone. The island remained isolated from its nearest neighboring islands during the Pleistocene age due to a deep sea trough to the north. Most of the stream valleys that head in the volcanic uplands were incised during the Pleistocene age, and the coastal reaches of the overdeepened valleys are filled with fine-grained alluvium.

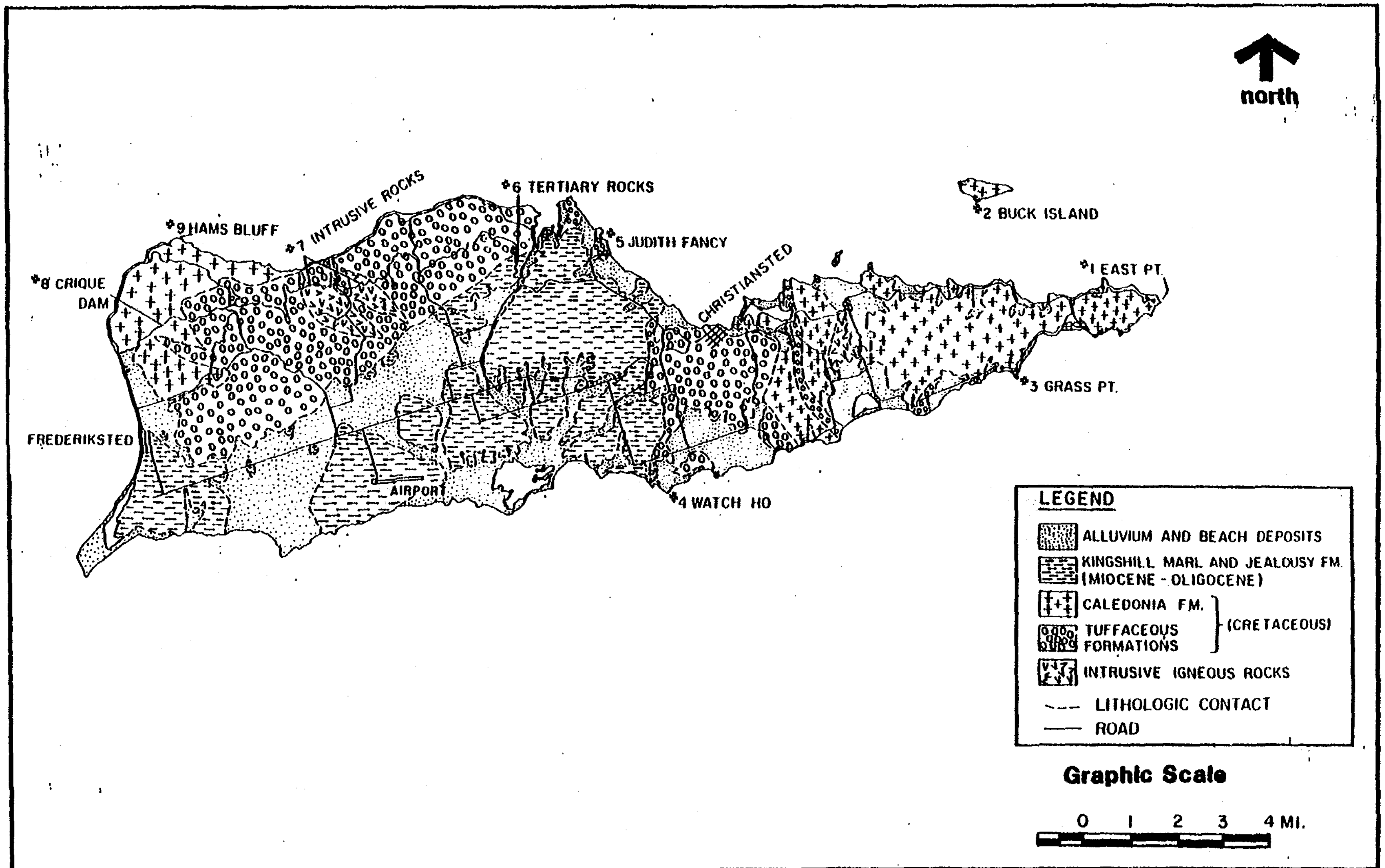
A popular misconception is that St. Croix was formerly a volcano. Although volcanoes are present on many nearby islands, there are none on St. Croix, and there probably have not been for tens of millions of years, if ever. Yet, most of the rocks are originally of volcanic origin.

The rocks underlying the mountain ranges on St. Croix (and probably those deep beneath the Central Valley) are sedimentary rocks derived from the erosion of older volcanic rocks and from volcanic ash spewed out from an erupting volcano. The sediments were deposited on the deep ocean floor in the late Cretaceous age (Campanian--Maestrichtian), and are approximately 80 million years old. The limestone (or marl) exposed at the surface of the Central Valley of St. Croix is considerably younger (lower Miocene, 20 million years), and is probably the remains of a coral reef that formed as the island was uplifted (see Figure 4-7).

4.5.5.4 Soils. The soils of St. Croix are primarily of the Cramer-Issac Association (see Section 4.4.5.4). Historically, the soil has been the most important natural resource of the island. At the height of the sugar plantation era approximately 40% of the island's 84 square miles was under cultivation. At present only a few hundred acres are in crops, although there are still approximately 17,000 acres used for pastureage and range.

Any past abuses of the soil such as overgrazing by goats, sheep, and cattle probably are insignificant compared to the effects of the bulldozer in the past decade. The Virgin Islands Government has acted within the last year to meet the mounting problems of construction-related erosion by requiring "earth change" permits to be approved before the land is altered. Over the past few decades earth dams have been placed on virtually every stream channel on the island to check erosion and to help recharge ground water supplies.

4.5.5.5 Hydrology. Annual rainfall on St. Croix ranges from up to 60 inches on the northwest coast to 25 to 30 inches on the east end of the island. Although there is generally a rainy season from August through November, the



INITIAL ASSESSMENT STUDY
NAVAL STATION
ROOSEVELT ROADS, PUERTO RICO

FIGURE 4-7
GEOLOGIC FORMATION OF ST. CROIX ISLAND

amount of precipitation is highly variable from year to year. Agriculture on the island has been plagued by occasional droughts since the first settlers arrived. A roof-catchment and cistern are required for all houses, although municipal well water and desalted water have largely supplanted these systems. The central lowland province, underlain by the Kingshill Marl, contains the principal ground water reserves. In 1970, this area was estimated to contain 130 billion gallons, of which only about one third has a sufficiently low content of dissolved solids (less than 6,000 mg/l) for watering plants or improvement by electrodialysis. Potable water is obtained only from shallow wells, as the chloride concentration increases rapidly near sea level. Much of the water for the public system in Christiansted is obtained from wells at Concordia (Salt River). However, this water is mixed with distilled water from the desalting unit at the power plant to improve its quality. Most of the shallow, sweet-water wells elsewhere on the island have been overpumped, resulting in reduced yields (or dry wells) and intrusion of seawater or brackish connate water.

Only about 3% of the total rainfall reaches the water table, owing to the high losses by evaporation and transpiration. Evaporation is enhanced by the typical pattern of brief intermittent showers. Transpiration by the abundant scrub thorn vegetation is particularly effective in blocking recharge of ground water because these plants have root systems that may extend 20 or more feet below the surface. In recent years many acres of shallow-rooted sugarcane and other grasses (roots two to three feet deep) have given way to the scrub thorn. Lowering of the water table by pumping, and the reduction of recharge by changes in vegetation, may account in large part for the virtual disappearance of running streams in the last 40 years.

Recharge of the main Kingshill Marl aquifer by rainfall was estimated to be at an average rate of 1.75 million gallons per day (mgd). Pumpage in 1970 was estimated at 700,000 gallons per day for the municipal supply and 300,000 gallons per day for private use, a total of 1,000,000 gallons per day. Since 1970 pumpage almost certainly has increased substantially in response to the increased population, and to new industrial demands. Figures for current pumpage are not available.

There are two ground water wells near the UTR. One lies on Navy property, but not within the fence line, south of the entrance gate to UTR. The well is 50 to 60 feet deep, and at one time was used for drinking water. Within the last five years the water has become too brackish for any other use than in the sanitary system. Wells along the south shore of St. Croix are also experiencing saltwater intrusion.

Except as noted above, all water for all uses at both the UTR and St. Georges Hill complex is rainwater caught in cisterns or, primarily, water trucked in by the VIWPA.

4.5.6 Migration Potential. The potential for surface migration of contaminants at the UTR on St. Croix is excellent due mainly to location. Perched on a small bluff directly on the Caribbean Sea, any contamination from past polluting practices would have rapidly entered the ocean, or infiltrated the sandy soil to the ground water. Currently, oil spills at the generator building can be seen to migrate off Navy property and enter the sea almost immediately. The situation is compounded by continuing erosion of the shoreline.

At St. Georges Hill, any contamination would enter the soil and travel only a short distance before meeting bedrock. With a heavy vegetative cover to detain surface runoff, no surface water, and a considerable distance to the sea, it is unlikely that any contaminants have migrated from the St. Georges Hill complex.

4.6 PICO DEL ESTE. The AFWTF site at Pico del Este is located in the Luquillo National Forest at an elevation of 3,450 feet and is approximately 10 air miles northwest of the station. The primary function of the Pico del Este site is to provide air and surface search radar coverage for the AFWTF operating areas. Systems located at the site include the Integrated Target Control System (ITCS), the Wide Area Active Surveillance System (WAAS), the Noise Jammer System (NJS), and the Electronic Warfare Range (EWR) Threat Platform Simulator (TPS). One of the facilities is shared with the Federal Aviation Administration (FAA), which provides aerial traffic control for the San Juan area.

4.7 NAVSTA ROOSEVELT ROADS, WEST ANNEX, AGUADILLA. NAVSTA Roosevelt Roads currently owns 11 buildings at the former Ramey Air Force Base in Punta Borinquen. The Navy acquired the buildings in 1973 when the U.S. Air Force excessed Ramey. The majority of the buildings are leased to the Commonwealth of Puerto Rico, which in turn leases the buildings for commercial use.

Buildings 504, 505, 506, 509, and 531 are leased to the Puerto Rico National Guard. Building 506 is currently the headquarters of the 20th Battalion, 65th National Guard, and was formerly the station commissary. Building 504 was the station bakery and is currently used as a storage compound by the National Guard. Building 531, which has been partially demolished by the National Guard, was formerly part of the Air Force civil engineering office and the carpentry material storage. Building 505 was also used by the Air Force civil engineering office.

Buildings 528 and 530 were the Air Force exchange gas station and vehicle maintenance shop prior to Navy acquisition. Building 528 was the gas station office and store, while Building 530 served as the garage for vehicle maintenance and repair. The station was operated by Texaco until 1973, and has been closed since then. The property is currently leased to an oil company which is in the process of renovating the facility. There has never been any occupation of these buildings by the Navy.

Building 571 is used by the Department of Education for band exercises and folkloric dances. The Air Force previously used this building for servicing the fuel tanks of B-52 Bombers. The fuel was drained from the aircraft prior to entering the hangar. The Navy has never utilized this building.

Buildings 706 and 703 (Building 703 is leased to the Commonwealth) were formerly the Air Force, and then the Navy, Exchange. A theatre was located in Building 706, which has been abandoned. A cafeteria, airline ticket office, beauty shop, and post office were part of the exchange located in Building 706. The building is currently a small shopping plaza which is subleased to commercial uses, including a restaurant, bakery, pharmacy, and legal office.

Building 561 is leased to the Commonwealth, which subleases it to MASCO Industry, a manufacturer of communications equipment. This building has never been occupied by the Navy.

All of the buildings owned by the Navy at Ramey have been declared excess and are awaiting disposal through GSA.

hospital includes oral surgery and some routine dental services. Wastes associated with these operations include X-ray fixing solution, developing solution, and scrap amalgam. Spent fixing solution and scrap amalgam are sent to DPDO for metals recovery at a rate of about one gallon per week and eight ounces per year, respectively. Developing solution is poured down the drain at the rate of one gallon per week.

Routine dental services for the entire base are provided at the Naval Regional Dental Center. Similar types of wastes are produced at the center as at the hospital. X-ray fixing solutions are sent to DPDO for silver recovery at a rate of about two gallons per month. Scrap amalgam containing mercury and silver is sent to DPDO at a rate of about one pound per month for metals recovery.

5.2.17 Water Treatment Plants. The base has been served for over 30 years by the present treatment facility. The plant (Building 88) has a capacity of four million gallons per day (mgd). The flow is by gravity into a 45-million gallon raw water storage basin, from which the plant draws its supply at a rate of 1.3 mgd on the average.

Treatment consists of pre-chlorination, coagulation sedimentation, filtration, and post-chlorination. The water is naturally soft with low turbidity requiring a small dosage of chemicals, namely aluminum sulfate for clarification and lime for pH control. Treated water is stored in two clear wells, from which it is pumped into the various storage tanks and the distribution system.

The plant has been in service for over 30 years producing approximately the same amount and type of waste as at present. Water from filter backwash and sludge from the sedimentation tanks comprise the bulk of the waste generated by this operation. One of the four filters is backwashed daily, discharging approximately 20,000 gallons per day into the adjacent lagoon constructed for this purpose and for receiving sludge from the sedimentation basins. The design provides for returning the decanted backwash water to the front of the plant. This feature enables the recovery of approximately one-half of the wash water, for a net waste of some 10,000 gallons per day. Sludge is also discharged into the sludge lagoon at a rate of 150 tons per year of dry sludge. This sludge consists of aluminum sulphate and calcium oxide.

Chlorine gas is delivered in cylinders from an off-base source and used in its entirety.

5.2.18 Specialized Installation Operations.

5.2.18.1 Veterinary Services, U.S. Naval Hospital, Roosevelt Roads. The Veterinary Services Section, commanded by a U.S. Army officer, conducts meat and food inspections at the Navy Exchange and the commissary. The unit offers small and large animal treatment.

For the last three years, approximately 25 dogs or other small animals per month have passed through Veterinary Services prior to disposal in the station landfill. Interviewees at the facility stated that this was a fairly consistent average. The interviewees also estimated that two horses a year die at the stables. These animals are disposed of by the Public Works Department

CHAPTER 5. WASTE GENERATION

5.1 GENERAL. The following sections describe waste generation processes associated with industrial, ordnance, and radiological operations at NAVSTA Roosevelt Roads.

5.2 INDUSTRIAL OPERATIONS.

5.2.1 Machine Shop. The Public Works Machine Shop in Building 31 performs all sheet metal and welding operations, including toolmaking work. Shop activities include repair and maintenance of pumps and other dynamic equipment. Wastes generated by this operation consist of metal pieces, welding material, small grease and oil containers, and small equipment parts. All waste materials are discarded at the base landfill. It is estimated that during the period 1960 to the present this shop has generated approximately 23 tons of waste per year.

5.2.2 Degreasing and Solvent Cleaning. Degreasing and solvent cleaning operations are located at many locations, including the AFWTF Drum Shop at Building 860, the Naval Exchange Repair Shop at Building 519, the Hobby Shop, Camp Moscrip, the Torpedo Shop in Building 395, and Surface Operations in Building 44. However, the most extensive operations are located at the Public Works Department, Aircraft Intermediate Maintenance Department (AIMD), and Fleet Composite Squadron Eight (VC-8). Cleaning operations are a result of maintenance and corrosion control requirements to remove grease and grime accumulations which occur during use.

5.2.2.1 Public Works Department. The Transportation Division of the Public Works Department performs routine maintenance of equipment and corrosion control of machinery. During 1960 to 1973, solvent and cleaning solutions were mixed with waste oil, brake fluids, and other oil derivatives and discarded at the landfill at an estimated rate of 2,500 gallons per year. From 1973 to the present, solvents were reclaimed through a filtration system.

5.2.2.2 Aircraft Intermediate Maintenance Department (AIMD). Cleaning operations occur in all AIMD shops, and vary from minor use of electrical contact solvent sprays in the Avionics Shop to parts dipping at the Power Plant Shop, Ordnance Shop, and Tire Shop, and at Aircraft Washdown and Ground Support Facilities. These shops are located in Buildings 379 and 826.

At the Power Plant Shop two small baths (10 cubic feet each) containing the degreasing chemical PD-680 are used for dipping engine parts. Small cleaning tanks, containing PD-680, are also used at the Tire Shop to degrease wheel housings, bearings, and associated hydraulic mechanisms. Solvents used by the Ordnance Shop include methyl ethyl ketone (MEK), PD-680, Freon, and corrosion inhibiting compounds, which are applied to tow wheels, racks, holders, and release mechanisms. At the Ground Support Facility, large equipment is cleaned over a wash rack which drains into an oil-water separator. Smaller parts are cleaned in small shop tanks. For aircraft washdown, a large wash rack located adjacent to the Building 379 hangar is used. This wash area has a special drain system which discharges to the sanitary sewer. Dry cleaning solvents (PD-680) and alkaline cleaning compounds are used at this facility.

Since the early 1970s, most of the spent solvents have been disposed of in bowsers for ultimate disposal (reclamation or sale) off-base by a contractor. However, some materials, both diluted and non-diluted, are released to the sewer system to adjacent drainage ditches via floor and hangar drains. This was common practice before the 1970s. A listing of the degreasing and solvent cleaning materials and associated quantities used at AIMD is found in Table 5-1.

5.2.2.3 Fleet Composite Squadron Eight (VC-8). The degreasing and solvent cleaning activities conducted at VC-8, located in Building 1625, are similar to AIMD but on a smaller scale, since VC-8 performs only routine and minor maintenance. Disposal practices are similar to those used by AIMD. Since the 1970s, the majority of recoverable solvents are placed in a bowser for ultimate disposal (reclamation or sale) off-base. Some material is eventually released to the sewer system or to surface drainage ditches via floor, hangar, and washdown drains. The types and amounts of cleaning materials disposed of by VC-8 are presented in Table 5-2.

5.2.2.4 Torpedo Shop. The Torpedo Shop assembles MK 30, MK 46, and MK 48 torpedoes for AFWTF and the Weapons Department. The shop has been run by contractors for 20 years.

If a torpedo fails to function, or immediately following a "run" by one of the target or practice torpedoes, the torpedo is recovered, the fuel removed, and the torpedo washed with Agentine, a dry cleaning solvent.

This operation generates the following types of waste: OTTO Fuel II, clothing contaminated in assembly and maintenance of the torpedoes (boots, booties, trousers, shirts, aprons, gloves), detergent, Agentine, alcohol (Neosol), sodium sulfide, denatured ethyl alcohol, acetone, oil, and silver cell batteries (MK 30 Torpedo Shop only). OTTO Fuel II consists of propylene-glycol dinitrate (76%), dibutyl sebacate (22.5%), and nitrodiphenylamine (1.5%). The by-products created from combustion of this fuel are carbon monoxide, carbon dioxide, hydrogen cyanide, methane, and hydrogen. MK 46 and MK 48 torpedoes are propelled by OTTO Fuel II, while the MK 30 torpedo is battery operated.

Between 1967 and 1970 the MK 46 and MK 48 Torpedo Shop burned water-contaminated OTTO Fuel II and contaminated clothing at various locations throughout the base landfill. It was estimated by shop personnel that a maximum of three barrels of OTTO Fuel II and contaminated clothing were burned each month during this period, totaling a maximum of 108 drums. Of this waste, OTTO Fuel II made up approximately eight to 10 55-gallon drums a year, totaling between 24 and 30 drums. During this period, a small but undetermined amount of liquid waste was disposed of in Ensenada Honda by ships conducting torpedo operations.

Beginning in 1968, all contaminated OTTO Fuel II, Agentine, and associated liquid and solid waste generated by the activity have been placed in 55-gallon drums in a permitted storage area behind the Torpedo Shop and shipped off-base for disposal. Shop personnel estimated that the activity generates approximately 10 55-gallon drums of waste per month. The waste was originally shipped to Naval Weapons Station Earle; since 1980 Naval Weapons Station Keyport has directed disposal which is handled by shipping to Cape Canaveral, Florida, with final disposition at Lenoir, North Carolina.

Table 5-1

AIMD DEGREASING AND SOLVENT CLEANING MATERIALS

Material	Monthly Quantity Used (gallons)
Isopropyl alcohol	33
Naphtha aliphatic	1
Freon	40 to 46
Aircraft surface cleaning compound	60
Ethyl alcohol	1
Xylene technical	1.25
Methanol technical	Seldom used
Dry cleaning solvent (PD-680)	36 to 40
Naphtha	4
Methyl ethyl ketone (MEK)	4
Propanol ACS	Seldom used
Trichlorothane	11 to 11.5
Freon 22	15
Aircraft cleaning compound with water	30

Sources: Inventory of hazardous materials held in AIMD, submitted to Public Works Department, Environmental Director, 22 June 1982.

AIMD Quality Assurance Memorandum, Submitted to Naval Station Safety Officer, 9 January 1984.

Table 5-2

VC-8 DEGREASING AND SOLVENT CLEANING MATERIALS

Material	Monthly Quantity Used (gallons)
Dry cleaning solvent	5
Alcohol	0.25
Aliphatic naphtha	1
Technical xylene	1
Methyl ethyl ketone (MEK)	2

Source: Hazardous Waste Annual Report, 1982, prepared by Fleet Composite Squadron Eight (VC-8), submitted to Public Works Department, Environmental Director.

A drum of liquid waste weighs approximately 394 pounds, while a drum of solid waste weighs about 180 pounds. The majority of liquid waste consists of OTTO Fuel II and Agentine. Five gallons of Agentine are used per torpedo run. Based on 300 runs annually, the activity generates about 1,500 gallons of used Agentine per year.

In total, approximately 120 55-gallon drums of solvent and fuel waste are generated yearly by the Torpedo Shop.

The contaminated OTTO Fuel II and other waste is stored temporarily in Building 248, which has been recently approved for storage by Naval Sea Systems Command. Waste that has been palletized and banded for shipment to Cape Canaveral is temporarily stored in Building 832. The frequency of shipment to the Cape is governed by the scheduled launching of the space shuttle and other rockets.

In 1983, the Hazardous Waste Manifest report stated that the Torpedo Shop generated 3,420 pounds of hazardous liquid waste and 5,776 pounds of hazardous solid waste. The Hazardous Waste Annual Report, for calendar year 1982, presents a breakdown of liquid waste for the activity as follows (quantities approximate):

OTTO Fuel II	450 gallons
Super Agentine	795 gallons
Sulfuric acid	3 gallons (added to batteries)
Engine degreaser	100 gallons
Corrosion preventative	800 gallons
Cleaning fluid	550 gallons

The silver cell batteries used in the operation of the MK 30 torpedo are shipped to Keyport, Washington, for silver reclamation.

Disposal of inoperable explosives generated by the Torpedo Shop is carried out by Explosive Ordnance Detachment (EOD) personnel. These materials are shipped to the Eastern Maneuver Area (EMA) on Vieques Island and properly disposed of there. In the last three years, three ignition separator assemblies (ISAs) and 20 propellant charges were transported and disposed of on Vieques (see Section 5.3.1).

5.2.3 <u>Paint Shops</u>. Paint shops are located at the Public Works Department, AIMD, and VC-8. Painting activities range from general interior and exterior painting of base structures, to vehicle and equipment repair, to aircraft maintenance and corrosion control by AMID and VC-8.

5.2.3.1 Public Works Department. The Carpentry Shop and Housing Maintenance Shop handle the painting activities within the Public Works Department.

The Carpentry Shop performs wood building and masonry work for all buildings and structures and all interior and exterior painting, other than housing. This shop generates a total of approximately 20 tons of waste per year, consisting of scrap wood pieces, sawdust, and empty paint cans (200 per year), mostly five gallons in size. About 40% of all paint used is water-based, with lead-based paints estimated at 1% and the remainder oil-based. A small amount of paint thinners, mostly mineral spirits and others (xylene), are also included. All wastes have been disposed of at the landfill since 1962. Usable paints are turned over to DPDO for resale. However, in 1982, approximately 40 gallons of unsellable oil-based paint were discarded at the landfill.

The Housing Maintenance Shop, located in Building 1755, performs house renovation, electrical repair work, plumbing and structural repair work in the housing area, and all interior painting. Wastes generated consist of screens, scrap wood, pipe pieces, etc., plus empty cans of paint, mostly water-based. Small amounts of paint thinner are disposed of at the work place or at the base landfill. It is estimated that over the last 15 years (1969 to the present), waste generation has been fairly consistent at 15 tons per year. In addition, it is estimated that some 1,800 empty paint cans were generated during this same time period.

5.2.3.2 Aircraft Intermediate Maintenance Department (AIMD). Painting activities conducted by AIMD, located in Buildings 379 and 826, primarily consist of painting aircraft components. Full-scale painting of aircraft is not routinely performed. Depending on the size of the component, painting may be conducted within a shop area or in an open area such as a hangar.

The majority of paints are applied from spray cans, which are used until the contents have been depleted. Other paints come in two-component kits which require mixing of both components prior to use. Application of two-component paints is by either a "Spray Tool" or paint gun provided by the paint manufacturer. Whatever is mixed, is applied. The unmixed portions of paint are stored for further use. Overaged paints and thinners are returned to the Supply Department, which turns them over to DPDO. Table 5-3 presents the types of paints and thinners used by AIMD, as well as the amounts of waste generated as established during a 1982 survey.

5.2.3.3 Fleet Composite Squadron Eight (VC-8). Paint activities conducted at VC-8, located in Building 1625, are limited to touch-up painting. Large component and full aircraft painting are not routinely performed. In a manner similar to operations at AIMD, all paints are consumed and overaged paints are returned to the Supply Department, which turns them over to DPDO. Table 5-4 lists the types of paints and thinners used at VC-8, as well as the amounts on-hand in a 1982 survey.

5.2.4 Paint Stripping. Paint stripping shops are located at the Public Works Department, AIMD, and VC-8. Paint stripping operations are a result of the maintenance requirements to prolong the life expectancy of equipment and aircraft.

5.2.4.1 Public Works Department. Paint stripping at the Public Works Department involves scraping paints from pumps, motors, vehicle parts, and other mechanical equipment by hand or with the use of machinery. Small amounts of paint scrapings are mixed with the rest of the trash for final disposal.

5.2.4.2 Aircraft Intermediate Maintenance Department (AIMD). Paint stripping operations conducted by AIMD, located in Buildings 379 and 826, primarily consist of stripping the paint from aircraft components. Full-scale paint stripping of aircraft is not routinely performed. Depending on the size of the com-

Table 5-3

AIMD PAINTS AND THINNERS

Item	Amount of Waste Generated
Enamel	550 gallons/year
Lacquer	200 gallons/year
Pigmented epoxy resin	12 gallons/year
Acryllic nitrocellulose	12 gallons/year
Primer	225 gallons/year
Toluene/methyl	12 gallons/year
Advanced C &.C hardener compound	200 gallons/year
Xylene/toluene lacquer thinner	250 gallons/year

Source: Inventory of hazardous materials held in AIMD, submitted to Public Works Department, Environmental Director, 22 June 1982.

Table 5-4

VC-8 PAINTS AND THINNERS

Item	Amount On-Hand
Lacquer	12 gallons
Epoxy paint	60 gallons
Enamel	36 gallons
Dope/lacquer thinner	24 gallons
Enamel thinner	24 gallons
Toluene	12 gallons

Source: Hazardous Waste Annual Report, 1982, prepared by Fleet Composite Squadron Eight (VC-8), submitted to Public Works Department, Environmental Director.

ponent, paint stripping is conducted either within a shop area or in an open area such as a hangar. Stripping operations consist of hand scraping or the use of several compounds which are applied by either brush or spray. When using removing compounds, the raised and semi-dissolved paint skin is rinsed from the component with water. Depending on the location of the stripping operation, rinse water containing paint skins and excess stripping compound is flushed to the sewer system or to a surface drainage ditch via floor drains and hangar or pad grates.

In addition to paint removal, the application of corrosion prevention and metal conversion coatings is also performed as an intermediate step between stripping and painting operations. These compounds are applied in a similar manner as paints and are used until consumed. If overaged, they are turned over to DPDO. A list of the paint stripping and corrosion/conversion coating compounds used at AIMD is presented in Table 5-5.

5.2.4.3 Fleet Composite Squadron Eight (VC-8). Paint stripping activities conducted at VC-8, located in Building 1625, are limited touch-up painting or corrosion/metal conditioning, as required, on a small scale. Large component and full-scale aircraft stripping is not routinely performed.

In a manner similar to such activities at AIMD, all paint stripping and coating compounds are consumed or turned over to DPDO when overaged. Paint stripping and coating compounds used at VC-8 include paint epoxy remover and polyurethane paint coating (1982 Hazardous Waste Annual Report prepared by VC-8).

5.2.5 Navy Publications and Printing Service Office, Southeastern Division. The publications and printing service provides publications, printing, and reproduction services to all Naval activities in accordance with the Navy Industrial Fund. The shop began operations in 1967 at its present location in Building 583, later expanding to Building 584 in 1972, when the Naval Air Station San Juan Publications and Print Shop was consolidated with the Roosevelt Roads shop. Building 584, currently used for office space and storage of supplies, was previously used by the Navy Hospital for office space. Prior to 1957, both buildings were used for office space by the U.S. Army (Fort Bundy).

The main operations of the printing service are located in Building 583, which houses four presses (two of which are operational), a cutter, and a Xerox machine. Prior to the early 1970s, oil-based ink was used in the printing process, which necessitated cleaning the presses every night with Blankrola solvent containing perchloroethylene and petroleum naphtha. The rags used to wipe down the presses were thrown in the dumpster and disposed of at the station landfill. Approximately one quarter pound per week of ink sludges produced during the printing process was also disposed of in this manner.

Since the early 1970s the shop has been using rubber-based ink and the presses are wiped down once a week, sometimes more often if colored ink is used. Approximately 62 gallons of roller wash is consumed every six months in cleaning the presses. The wipes which are used to clean the presses are disposed of in the station landfill. The electrostatic solution and developer and process gum are consumed in the printing process. Approximately 10 quarts of lubricating oil are used every four months for the maintenance of the machines and presses. Incidental spillage of oil on the floor is wiped up with rags. Two hydraulic

Table 5-5

AIMD PAINT STRIPPING AND COATING COMPOUNDS

Item	Amount of Waste Generated
Epoxy paint remover	15 gallons/year
Alodine	5 gallons/year
Corrosion prevention compound	50 gallons/year
Corrosion prevention; water displacing	50 gallons/year
Coating solution (epoxy polymide)	5 gallons/year
Polyurethane coating	None
Corrosion removing and metal conditioning compound	5 gallons/year
Urethane aliphatic isocyanate coating	None
Aledyne metal conversion solution	60 gallons/year
Phosphoric acid metal conversion solution	60 gallons/year

Sources: Inventory of hazardous materials held in AIMD, submitted to Public Works Department, Environmental Director, 22 June 1982.

AIMD Quality Assurance Memorandum, submitted to Naval Station Safety Officer, 9 January 1984.

fluid spills have occurred due to a hose breaking on the cutter machine. The first spill involved approximately three gallons, and the second, one gallon, both of which were wiped up with rags which were then disposed of in the dumpster.

The roller wash solvent comes in 55-gallon drums, which are stored outside of Building 583, and in one-gallon cans, which are stored in a flammable locker located between Buildings 583 and 584. There is no record of any spills or accidents involving these solvents.

5.2.6 Photo Shops: Fleet Audio Visual Center, Caribbean (FLTAUDVISCEN). The mission of the Fleet Audio Visual Center, Caribbean (FLTAUDVISCEN), is to provide official photography and coordination of photographic activities for the Naval establishment in the Caribbean area. Support is supplied to Navy Security Group Activity (NAVSECGRUACT) at Sabana Seca, AFWTF facilities throughout the Caribbean, and Naval Communications Station (NAVCOMSTA) facilities both on and off the island of Puerto Rico. The FLTAUDVISCEN also provides photographic services to other elements of the U.S. Armed Forces, and other governmental agencies as directed.

Housed in Building 790 since 1959, the center developed 1,275 36-shot rolls of black and white film, 650 36-shot rolls of color film, and 650 36-shot rolls of color slides in 1983. This represents the heaviest production schedule within the last 10 years. For the last six years, since 1977-78, the FLTAUDVISCEN has recycled all film for silver recovery through DPDO.

Prior to 1977-78, all wastes were disposed of in the base landfill. While no records of waste disposal were kept, personnel interviewed at the facility stated that, based on their experience at other Naval photographic facilities both stateside and overseas, it would not be unusual for some processing and developing solutions to have been "dumped out the back door." Such solutions would have included Kodak "EKTAFLO" fixer, Hunt Graph-O-Lith developer, and aluminum hydroxide, ammonium thiosulfate, formaldehyde, potassium bichromate, potassium permanganate, and sodium hydroxide. Fixer and developer wastes were most likely combined, then diluted and discharged to the sewer system connecting to the industrial area sewage treatment plant.

5.2.7 Calibration Shops. Electronic and gauge calibration shops are located at the Aircraft Intermediate Maintenance Department (AIMD), Fleet Composite Squadron Eight (VC-8), and Naval Electronics Engineering Office. Activities conducted at each calibration shop simulate field use by fine tuning electronic components against signal generators and frequency standards, or by testing the accuracy of various pressure and vacuum gauges. No major repair work is performed.

5.2.7.1 Aircraft Intermediate Maintenance Department (AIMD). AIMD electronic and gauge calibration shops are located in Building 379. Calibration of avionic components does not generate wastes. Penetrating liquids or contact cleaners are occasionally used on components in small quantities. These compounds are applied from spray cans and excess amounts are wiped off.

For testing gauges and hydraulic components, several instruments are used which contain small quantities of oil. As an example, one generator test instrument contains an oil-flow gauge which has a one-quart volume of oil. The oil is changed every six months. Waste oil is placed in a bowser and sold to a private contractor for recycling. This practice has been carried out since the early 1970s. Other instruments used to test large hydraulic components contain larger volumes of fluids. Although not a routine occurrence, components have failed on the test units (the exact number of failures or rates of failures are not known). When this has occurred, hydraulic fluid (less than 100 gallons total over the years) flowed freely from the test unit into a catch basin and floor drain and was released into the surface storm drainage.

5.2.7.2 Fleet Composite Squadron Eight (VC-8). VC-8 calibration shops are located in Building 1625. Activities performed are similar to AIMD, but on a smaller scale. Wastes generated from calibration of avionics and from hydraulic testing are negligible in quantity.

5.2.7.3 Naval Electronics Engineering Office. The Naval Electronics Engineering Office has been located in Building 377 since 1975, when it was moved from San Juan. The primary function of this office is to calibrate equipment for the entire Caribbean fleet. In addition, the office calibrates equipment for the local U.S. Coast Guard and U.S. Army units on a non-priority basis. The office has facilities for 44 electrical engineers and technicians. Currently, seven electronic experts are used on a full-time basis.

Equipment is calibrated against signal generators and frequency standards. These procedures do not generate any appreciable amounts of waste. Some penetration and contact cleaning compounds are used in small quantities. These compounds are applied from spray cans and any excess is wiped off.

Twice a year, usually in June and December, radiological instruments are calibrated. A radiological source in a closed trailer, located separate from the building along the northern boundary line of the facility, is maintained and checked by the Department of Energy. Interviewees stated that calibration sources are low-level isotopes, possibly of cesium and plutonium.

5.2.8 Electrical and Electronics Shops. Electrical and electronics shops are located in the Public Works Department; AIMD; VC-8; and Air Operations Department, Ground Electronics Division. Activities conducted at these shops include repair and maintenance of electrical motors, generators, switching units, etc., by the Public Works Department as well as repair and maintenance of navigational, communications, avionics equipment, etc., by the Air and Ground Support Facilities.

5.2.8.1 Public Works Department. The Electric Shop of the Public Works Department maintains and repairs intercommunication cables, electrical motors, and appliances. It repairs, installs, and replaces electrical systems up to 600 volts. Electric transformers are handled separately by the Power Distribution Shop. Wastes generated by this activity consist of cables, wires, conduits, receptacles, ballast, bulbs, a small amount of grease and oil containers, etc., all of which are disposed of at the station landfill. Waste generation, which has not changed significantly during the last 15 years, has produced a total of approximately 10 tons of waste material per year.

The Power Distribution Shop maintains and repairs the electrical distribution system, including servicing of transformers of over 600 volt rating, and as such, maintains 13 main transformers in eight substations located at the Airfield, Industrial Area, Bundy Area, and the Capehart Housing Area.

Maintenance of transformers was conducted by the Power Distribution Shop at the Power Plant, Building 38, from 1956 through 1964, and then at Substation 2, Building 90, up to the present. As part of the maintenance of the transformers, the transformer oil was drained to facilitate repair of the inner cores and coils. It was routine practice to drain the transformer oil on the ground at the work area until 1978, when the dangerous properties of PCB were recognized.

Shop personnel interviewed stated that Askarel transformers were the only exception to this practice. Employees stated that the reason for this was that employees developed skin rashes from direct contact with the Askarel, and sometimes required medical attention. Transformer oil drained from these transformers was placed in 55-gallon drums, which were then disposed of at the station landfill.

Since 1978, any transformer fluid which is drained from a transformer is placed in 55-gallon drums and disposed of through DPDO. Approximately 200 gallons per year of transformer oil is used by the Power Distribution Shop in the servicing of transformers.

5.2.8.2 Aircraft Intermediate Maintenance Department (AIMD). The AIMD Electronic/Avionics Shop is located in Building 379. The primary function of this shop is to provide avionics maintenance and repair services to all military aircraft as required. Services range from minor calibration to the complete overhaul of avionic components. However, AIMD does not service luminescent dials. These units are sent statewide for servicing.

Most of the materials used during these activities are consumed in the process. These materials include solder, lead, flux, and wire. Minor amounts of solder and lead are recovered and discarded each day.

Other activities include cleaning and repair of gauges. Cleaning fluids such as Freon are used at a rate of one quart per month. Replaced hydraulic fluid is disposed of at a rate of five gallons per month. Waste fluids are placed in a bowser for collection and sold to a private contractor for recycling.

5.2.8.3 Fleet Composite Squadron Eight (VC-8). The VC-8 Electronic/Avionics Shop is located in Building 1625. The VC-8 shop has the capability to provide similar type services as AIMD but is responsible only for squadron aircraft. Waste types and disposal methods are similar to AIMD but on a smaller scale.

5.2.8.4 Air Operations Department, Ground Electronics Division. The Ground Electronics Division's primary function is to maintain airfield electronics and ground communications for base operations and security. Ground electronic shops are located in Buildings 377 and 426. These shops generate wastes similar to those found at AIMD and VC-8, consisting of minor amounts of solder, lead, and spent cleaning fluids. In addition, small electronic transformers (no PCBs), low voltage batteries, and power tubes containing beryllium insulators, a total of 12 per month, are placed in the dumpster and ultimately disposed of in the base landfill. Approximately 10 to 15 years ago mercury switches were also disposed of in the landfill as well as vacuum tubes possibly containing radium, which may have emitted low levels of radioactivity. Larger pieces of equipment such as transceivers are returned to the Supply Department, which turns them over to DPDO.

5.2.9 Pest Control Shop. The Pest Control Shop, under the cognizance of the Public Works Department, is responsible for insect and rodent control in station buildings and on station property, as well as weed control along streets, sidewalks, and buildings. Prior to 1983 the Pest Control Shop was located in Buildings 258 and 113. Building 113 was used for office space and was recently demolished. The main work area was located in Building 258, where pesticides were stored and mixed. Table 5-6 contains a list of pesticides which were stored and used in the past in Building 258. Other pesticides which were used but discontinued include DDT and Paris Green.

Herbicides were mixed outside of Building 258, where there is still evidence of stressed vegetation. In general, Building 258 did not have adequate facilities, as evidenced by the 1977 Environmental Engineering Survey. This report cited problems of pesticide application equipment being washed out over a storm drain that emptied into a drainage ditch behind the shop. The survey stated that numerous aquatic kills had occurred due to pesticides entering the ditch, and recommended a pollution abatement project to construct a concrete wash pad with a connection to the sanitary sewer for washing pesticide application equipment.

In 1979 Building 258 was cited as being structurally inadequate. A request for pollution abatement funding for construction of a more suitable facility was submitted. Construction of the new Pest Control Shop was completed in the summer of 1983. When the shop moved out of Building 258, the Naval Hospital used the building for storage of metal beds and miscellaneous large objects. Before moving the hospital property into Building 258, the Public Works Department conducted a washdown of the interior of the building.

A small (four-foot by two-foot) in-ground concrete-lined trench known as the Chemical Dog Bath, was located between Building 258. The ditch was used in the past as a flea and tick dip tank for dogs. The dip tank also drained to the ditch behind Building 258. It was also used for housing infested animals used in various experiments by the hospital staff.

In the past, empty pesticide containers were rinsed and then disposed of at the station landfill. The rinse water went into the ditch behind Building 258. In 1978 Pest Control Shop personnel began collecting the rinse water that was generated from cleaning the equipment for use as dilute pesticide in the next application, or applied the rinsates to the application area.

A strong pesticide odor was noted outside and around the building during the IAS site visit.

The new Pest Control Shop, which opened in the summer of 1983, is equipped with modern facilities. There are separate storage areas for pesticides, herbicides, equipment, and pesticide mixing. A concrete-bermed equipment wash pad connected

Table 5-6

PESTICIDE INVENTORY/REQUIREMENTS, NAVAL STATION ROOSEVELT ROADS (1980)

Common Chemical Name	Percent Active Ingredient	Estimated Annual Requirements (lb/gal)	On-Hand (lb/gal)	On-Order (lb/gal)	Used Against
Insecticides					
Malathion	95.0	220 gal	155 gal	110 gal	Adult mosquitos
Diazinon	48.0	10 gal	5 gal	None	Roaches
Dursban	41.0	10 gal	10 gal	None	Roaches
Chlordane	72.0	120 gal	105 gal	None	Termites
Pentachlorophenol	5.0	20 gal	15 gal	None	Wood treatment
Malathion	57.0	15 gal	104 gal	None	Fleas, pests (stored products)
Baygon	1.0	50 gal	8 gal	12 gal	Roaches (food handling building
Altosid SR-10	100.0	100 gal	75 gal	25 gal	Mosquito larvae
Carbaryl	80.0	1,000 lb	600 lb	None	White grub
Diazinon	47.5	100 gal	300 gal	None	Household pests
Dursban 10CR	10.6	100 lb	150 lb	50 lb	Mosquito larvae
FLIT MLO	100.0	1,000 gal	2,000 gal	None	Mosquito larvae
Malathion	57.0	25 gal	55 gal	None	Flies

Table 5-6 (Cont.)

Common Chemical Name	Percent Active Ingredient	Estimated Annual Requirements (lb/gal)	On-Hand (lb/gal)	On-Order (lb/gal)	Used Against
Insecticides (Cont.)					
Malathion	95.0	50 gal	110 gal	None	Adult mosquitos
Propoxur (Baygon)	13.9	40 gal	10 gal	30 gal	Household pests
Herbicides					
Bromacil	80.0	150 lb	200 lb	50 lb	Weeds and brush
Diquat	35.1	50 gal	20 gal	30 gal	Aquatic weeds
Bromacil	80.0	800 lb	225 lb	None	Weeds, all vegetation
Prometone	25.0	100 gal	50 gal	None	Weeds, all vegetation
Glyphosate	41.0	35 gal	35 gal	None	Weeds, annual and perennial
Rodenticides					
Anticoagulant	0.025	20 lb	20 lb	20 lb	Rats
Anticoag	0.025	400 lb	120 lb	None	Rodents
Other					
Paradichlorobenzene	100.0	100 lb	200 lb	None	Bats

Source: NAVSTA Roosevelt Roads Public Works Department, Pest Management Plan, 1900.

to the sanitary sewer system is located adjacent to the building in the parking lot.

A new pest control facility was recently completed by NMCB at Camp Moscrip. The new facility is a small (20-foot by 24-foot) concrete block building with separate facilities for mixing and storage of pesticides. The old facility was demolished because it failed to meet safety and environmental requirements which require separate storage and mixing areas for pesticides. Both the old and new pest control shops were connected to the sanitary sewer system.

The Pest Control Shop at Camp Moscrip is operated by two certified operators from the Bravo Company. Management and technical assistance is provided to the NMCB by Public Works Pest Control Shop personnel in the area of pesticide application and equipment utilization. Registered pesticides utilized at the camp include diuron, malathion, baygon, and warfarin.

A Pest Control Shop is also located at the golf course. In the past Special Services conducted the pest control operations at the golf course. Since no golf course personnel are certified, Public Works Pest Control Shop personnel have taken over the function of procurement and usage of pesticides at the golf course. Moderate amounts of Dursban 5% mole cricket bait and various herbicides for crabgrass control are applied on the nine golf greens.

Household pest control is primarily provided by private pest control companies hired by the housing residents on an individual basis.

5.2.10 Boiler Plants. Boiler plant (power heating) operation and maintenance is a function of the Utility Shop. There are 16 boilers located around the base in several buildings, varying in design pressures from 15 pounds per square inch (psi) at the hospital vegetable cooker (Building 1790) to 150 psi in the laundry at the Navy Exchange (Building 1683). Boilers are used for making steam and hot water. The boilers are fueled, for the most part, by diesel No. 2 fuel, except for the hospital boiler and the boiler located at the laundry in the Bundy area, which use JP-5 fuel. Fuel is stored in underground tanks adjacent to the boilers.

Waste generated by this operation is rather small, amounting to 500 pounds per year, and consists of soft boiler sludge and soot from the heating tubes from regular maintenance. No acid cleaning is required to remove scale due to the excellent soft characteristics of the water supply. As part of routine maintenance, during the period 1962 to 1972, loose asbestos chipping from pipe insulation was removed; the material was disposed of at the landfill. About two barrels a year of loose asbestos chipping were discarded at the landfill.

5.2.11 Power Plants. Electric power has been supplied to the Naval Station for the last 30 years by the Puerto Rico Water Resources Authority. However, for emergency use, 42 fixed standby generators are located throughout the base in strategic areas. Some generators in key areas are provided with automatic start-up and transfer of load. These units vary in size from six kilowatts (KW) at each entrance gate to 850 KW at the Ship Refuel Station (Building 1940). In addition, there are 18 portable generating units ranging from 3.5 to 100 KW ready for use in an emergency.

All units operate on Navy diesel fuel. The 11 larger units (150 KW and up) are supplied from underground tanks, which vary in size from 250 to 2,500 gallons. Other units obtain fuel from day tanks.

Maintenance of the engines results in about 1,300 gallons of waste oil a year, which is turned over to the Transportation Division of the Public Works Department for final disposition to a private contractor for recycling. It is estimated that during 1960 to 1972, about 1,000 gallons per year of waste oil were discarded at the landfill. Other wastes, consisting of wires, meters, gauges, windings, etc., amounting to one ton per year, are also disposed of at the landfill. It is suspected that the non-electric temperature gauges have a small amount of mercury.

During the period 1940 to 1949, electric power was provided by a steam turbine plant with a generating capacity of 60 megawatts located at Building 38. The water intake was located at Puerca Bay in the vicinity of the present site of the Enlisted Beach; the outfall for the discharge was located at Ensenada Honda.

The plant used Bunker "C" fuel, which was stored in two 50,000-gallon underground tanks located directly northeast of the building.

In the 1970s there were several incidents of Bunker C fuel entering the manholes and discharging to the Enlisted Beach during heavy rainfalls. A contractor was hired twice to drain the Bunker C fuel from the inground tanks and to clean up the area of the spill.

The Power Plant was used by the Power Distribution Shop for the maintenance of transformers from 1956 through 1964; these activities are discussed further in Chapter 8.

From 1964 through 1978 the Power Plant was used for storage of canned goods by the base exchange and commissary. In 1978 the building was closed off at the direction of the Public Works Environmental Coordinator due to the asbestos and PCB hazard. In June 1982 a contractor was hired to drain the two transformers located inside the building. The transformer fluid was placed in 18 55-gallon drums. Before the fluid was drained, it was tested for PCB contamination. One transformer had a concentration of 394 ppm PCB and the other 413 ppm PCB. There are also two 55-gallon drums of PCB-contaminated solid material generated by the cleanup contractor located in the building.

The 55-gallon drums of PCB-contaminated material were still in storage at Building 38 when the IAS team conducted the on-site survey. The building is not a permitted hazardous waste storage facility. Approximately eight gas cylinders ranging in length from two feet to six feet were also observed by the IAS team in the vicinity of the building. The contents of the cylinders could not be identified. Areas of stressed vegetation were noted on the northwest and southwest perimeters of the site.

5.2.12 Air Conditioning and Refrigeration. The Refrigeration and Air Conditioning Shop, located in Building 1788, is responsible for the preventive maintenance and repair of air conditioning units as well as household, commercial, and industrial refrigeration equipment. Small compressor parts, tubing, air filters, wire pieces, window air conditioners, and empty cans of cleaning solution make up most of the waste generated by this activity. Larger compressor and mechanical equipment is turned over to DPDO for disposition.

The landfill receives the bulk of the waste material generated by this activity, including an average of 36 window air conditioners per year, 48 empty five-gallon cans of cleaning solution, most of which is commercially known as Power Bright Cleaner, and 2.5 tons per year of small parts, tubing, filters, and wire. Operation during the past 20 years is estimated to have generated waste at approximately the same rate.

5.2.13 Battery Shops. Battery shops are located at the Public Works Department, AIMD, and the Weapons Department. Primary operations in the battery shops are disassembly, reassembly, drainage, rinsing, recharging, and cleaning of batteries.

5.2.13.1 Public Works Department. The Transportation Division of the Public Works Department is responsible for battery replacement and maintenance of all station vehicles. All discarded batteries (approximately 20 per month) are drained free of acid and delivered to DPDO for disposition. Acids are neutralized at the shop in special acid-resistant containers. Containers and batteries not accepted by DPDO are picked up by private contractor. During past operations, from 1960 to 1973, batteries were discarded at the landfill. It is estimated that an average of 180 batteries per year were disposed of in the base landfill during this period, for a total of approximately 2,300 batteries.

5.2.13.2 Aircraft Intermediate Maintenance Department (AIMD). Two battery shops are operated by AIMD in Building 379. One battery shop services small nickel-cadmium (NICAD) rechargeable-type batteries, while the other handles lead/acid batteries. Operations at the battery shop consist primarily of cleaning and charging. No acids are handled in this shop. Batteries which will no longer hold an adequate charge are returned to the manufacturer. No batteries are disposed of by the shop.

At the lead/acid battery shop, operations consist of cleaning, draining, rinsing, and recharging. Wastes generated by this shop include concentrated sulfuric acid, acid-contaminated rinse water, and potassium hydroxide electrolyte. Common practice has been to neutralize acids with baking soda, and along with acid-contaminated rinse waters, discharge them through the shop drain to the sewer system. About 30 batteries a week are serviced. Old batteries having no further use are drained and sent to DPDO. The battery shop does not remove plates for metal recovery.

5.2.13.3 Weapons Department. The mission of the Weapons Department is to provide logistical support to the tenant activities and those units assigned to Roosevelt Roads for training. The Weapons Department has been located in Building 378 for 20 years. According to interviewees, no wastes associated with the silver cell batteries used in the MK 30, 37, 44, or 45 torpedoes were disposed of on Roosevelt Roads. The silver cell batteries were returned to Kingsport, Washington (since about 1980), or to Naval Weapons Station Earle (prior to 1980). The batteries were either reworked at these facilities, or scrapped and the silver recovered. Interviewees also stated there were no battery wastes generated or disposed of by any operations associated with the Advanced Underwater Weapons (AUW) Division.

5.2.13.4 Underwater Weapons Support, Atlantic Fleet Weapons Training Facility (AFWTF). The Underwater Weapons Support Facilities at Roosevelt Roads prepare and maintain most of the weapons and ancillary electronic assemblies that are used in the AFWTF ranges. These include MK 46-1/2/5 torpedoes, MK 42-1/2/5 exercise torpedoes, MK 48 torpedoes, MK 84 and MK 72-2 phase coded non-synchronous pingers, and the MK 30-MA and MK 30-Mod 1 Mobile Anti-Submarine Warfare Target (MASWT). Interviewees stated that a small number of nickel-cadmium and alkaline batteries have been disposed of in the station landfill, but that no significant wastes have been associated with these items.

5.2.14 <u>Vehicle Maintenance Shops</u>.

5.2.14.1 Public Works Department. The Transportation Division of the Public Works Department provides maintenance of all vehicles, trucks, bulldozers, and tractors. Operation has been contracted to a civilian contractor for the last year; previously, the Maintenance Division of the Public Works Department had been responsible for all vehicle maintenance.

The Transportation Division is responsible for the maintenance of 850 vehicles. Considerable amounts of waste products are generated by this operation, principally waste oil at the rate of 150 gallons per month. Waste oils are stored in drums and picked up by the Fuels Division to be sold to a private contractor. Cleaning and solvent solutions are reclaimed at the operation site through a filtration system. Filters are cleaned every six months and the residue, about 10 gallons, is mixed with the waste oil for disposal.

In addition to liquid wastes, approximately 20 sets of brake shoes and clutches are replaced monthly. These contain asbestos lining and are sprayed with water prior to removal. The old sets are reclaimed by a private contractor.

The current operation does not include painting of vehicles, which is done off-base. Used tires are generally recapped; others are delivered to DPDO for disposition at the rate of approximately 100 tires per month.

Small equipment and parts make up the balance of waste generation, together with some rags, wire, metal pieces, etc. This material is discarded at the landfill at the rate of 500 pounds per week, or 13 tons per year.

From 1960 to 1973, over 1,000 vehicles were handled by this activity on the average. Waste oil generated for that period was 25% higher than at present, since oil was changed more often than the 6,000-mile interval in practice now. During this period, all waste oil, solvents and brake fluids, and other currently segregated material were taken to the landfill in barrels, where the containers were emptied and returned for future use. Over 2,500 gallons per year of oil and oil derivatives were disposed of at the landfill, plus the balance of material not acceptable to DPDO. This material included 80 asbestos-lined brake shoes a month. Empty cans of paints and solvents were discarded also during this period at the rate of 500 one-gallon cans per year.

5.2.14.2 Naval Mobile Construction Battalion (NMCB). The NMCB is located adjacent to the Public Works Department shops and the dry dock area. Construction of Camp Moscrip was started in 1968 and completed in 1969. Every six months a new battalion arrives at Camp Moscrip to perform operational readiness training to meet contingency commitments; this battalion is also the Atlantic Fleet Alert Battalion. The Alpha Company provides support to Roosevelt Roads through its heavy construction capability. There are approximately 370 pieces of heavy construction equipment maintained by the Alpha Company.

Waste oil generated from the maintenance of construction equipment is temporarily stored in a 500-gallon underground tank, which was installed in the beginning of 1983. When the tank becomes full, usually once every two months, the Fuels Division of the Supply Department is contacted and a commercial waste oil contractor comes and drains the tank. The original design of the waste oil tank was deficient in that the inlet port to the tank was set at too low an elevation, so that when it rained, rain water would enter the tank causing an overflow. There were two incidents in the past where rain water entered the tank, causing it to overflow. On both occasions, the Public Works Department was contacted and the spills were cleaned up using sorbent material. The inlet port has since been modified to prevent any further overflowing of the tank.

Prior to the installation of the 500-gallon tank, waste oil was stored in 55-gallon drums, which were also picked up by a private contractor for disposal. Today, waste oil is occasionally stored in 55-gallon drums when the contractor does not empty the tank in time. When this happens, the drums are used until the tank can be emptied, and are stored in the equipment yard.

The majority of solid wastes generated by the Alpha Company are disposed of through DPDO. Old batteries are collected on pallets in the equipment yard. When the pallet is full (usually 30 to 40 batteries every six months), it is taken to DPDO for disposal. Approximately 50 to 60 old tires and 5,000 pounds of scrap metal are sent to DPDO every six months. Construction debris which is generated at the various sites where the NMCB is working is disposed of at the station landfill.

5.2.15 <u>Fire Fighting Training</u>. The Fire Division of the Air Operations Department provides fire protection and crash rescue response at Roosevelt Roads. The structural fire station, Building 798, was built in the early 1960s and is located on Forrestal Drive. The aircraft crash rescue station, Building 827, is located on the north side of Runway 6 between the 3,000- and 4,000-foot runway markers. This area has been used for fire fighting training since the early 1960s.

Section 8.17 gives the location of the fire fighting area. The old fire fighting training pit was an unlined gravel pit approximately 40 feet in diameter which was used for fire training once per month by two fire crews from the early 1960s through the beginning of 1983. Approximately 250 gallons of waste fuel, oil, and solvents including JP-5, JP-4, and diesel fuel obtained from Hangar 200, VC-8, AIMD, NMCB, Surface Operations, and the Fuels Division were used for each session. The various departments supplying the waste would call beforehand to see if the Fire Division needed the fuel. Wastes received in bowsers were drained directly to the fire training pit, and 55-gallon drums of waste fuel were dumped in 3,000- to 4,000-gallon aboveground storage tanks.

Over the useful life of the old fire training pit, estimated to be about 20 years, approximately 120,000 gallons of contaminated fuels and solvents were burned in the area. Also burned were wood, trash, fuel filter elements, plastic, oily rags, and other debris. The fires were extinguished with water; aqueous fire-fighting foam (AFFF) was used when the fire got out of control. Purple K (potassium bicarbonate) was used in the past but is currently used only once every six months as a maintenance check on the Twin Agent Unit.

The old fire fighting training pit was closed in the beginning of 1983 due to oil washing into the drainage ditch near the airfield. The new fire training pit was built in the same location as the old pit. During construction of the new pit, fire fighters used a temporary, unlined gravel pit for practice. It is estimated that this pit was used five or six times. A total of 3,000 gallons of contaminated fuel, oil, and solvents were burned in this area. When the new facility was finished in late 1983, minor structural deficiencies needed to be corrected before the pit could be used properly. At the time of the IAS visit in January 1984, the new facility was ready for use and the fire training staff had been instructed to discontinue using the temporary pit.

The new fire training pit is concrete lined and is connected to an oil-water separator. A concrete bermed area has been built for the storage of the 3,000-gallon waste fuel tank which will be connected directly to the pit. Before the new pit was constructed a soil sample was taken from the curbed barren soil area where contaminated fuels and spent solvents were burned during past fire fighting exercises. The laboratory report showed no detectable levels of PCB at the site. No other contaminants (e.g., dibenzofurans, TCDD) were tested for, since EPA required the base to test only for PCBs.

5.2.16 Medical and Dental Facilities. Medical and dental facilities are located in Buildings 1790 and 593. These units provide full health care services to all base and Caribbean military personnel.

5.2.16.1 U.S. Naval Hospital. The Naval Hospital opened in November 1973 in Building 1790. The hospital provides general clinical and hospitalization services for active duty Navy and Marine Corps personnel as well as eligible dependents. Acute and long-term cases are sent off base to larger, better equipped hospitals. Solid wastes produced at the hospital are disposed of in plastic bags and sent to the station landfill. Pathological and biohazardous wastes are burned at the permitted hospital incinerator. Laboratory wastes are disposed of through DPDO, with the exception of small amounts which are washed down the drain to the sanitary sewer system. X-ray solutions are processed for silver recovery and then disposed of down the drain to the sanitary sewer system.

The hospital was previously located in "Barracks C," Building 204, from the early 1950s through 1958. It was next located at the present site of the COMNAVFOR, Caribbean, Headquarters Building 598, until the new facility was built. Services offered at these past locations were much more limited; therefore, the types of wastes produced were limited and small in volume. Wastes produced then were disposed of at the station landfill.

5.2.16.2 Dental Facilities. Dental facilities are located at both the hospital and at the U.S. Naval Regional Dental Center. Dental care provided at the hospital includes oral surgery and some routine dental services. Wastes associated with these operations include X-ray fixing solution, developing solution, and scrap amalgam. Spent fixing solution and scrap amalgam are sent to DPDO for metals recovery at a rate of about one gallon per week and eight ounces per year, respectively. Developing solution is poured down the drain at the rate of one gallon per week.

Routine dental services for the entire base are provided at the Naval Regional Dental Center. Similar types of wastes are produced at the center as at the hospital. X-ray fixing solutions are sent to DPDO for silver recovery at a rate of about two gallons per month. Scrap amalgam containing mercury and silver is sent to DPDO at a rate of about one pound per month for metals recovery.

5.2.17 Water Treatment Plants. The base has been served for over 30 years by the present treatment facility. The plant (Building 88) has a capacity of four million gallons per day (mgd). The flow is by gravity into a 45-million gallon raw water storage basin, from which the plant draws its supply at a rate of 1.3 mgd on the average.

Treatment consists of pre-chlorination, coagulation sedimentation, filtration, and post-chlorination. The water is naturally soft with low turbidity requiring a small dosage of chemicals, namely aluminum sulfate for clarification and lime for pH control. Treated water is stored in two clear wells, from which it is pumped into the various storage tanks and the distribution system.

The plant has been in service for over 30 years producing approximately the same amount and type of waste as at present. Water from filter backwash and sludge from the sedimentation tanks comprise the bulk of the waste generated by this operation. One of the four filters is backwashed daily, discharging approximately 20,000 gallons per day into the adjacent lagoon constructed for this purpose and for receiving sludge from the sedimentation basins. The design provides for returning the decanted backwash water to the front of the plant. This feature enables the recovery of approximately one-half of the wash water, for a net waste of some 10,000 gallons per day. Sludge is also discharged into the sludge lagoon at a rate of 150 tons per year of dry sludge. This sludge consists of aluminum sulphate and calcium oxide.

Chlorine gas is delivered in cylinders from an off-base source and used in its entirety.

5.2.18 Specialized Installation Operations.

5.2.18.1 Veterinary Services, U.S. Naval Hospital, Roosevelt Roads. The Veterinary Services Section, commanded by a U.S. Army officer, conducts meat and food inspections at the Navy Exchange and the commissary. The unit offers small and large animal treatment.

For the last three years, approximately 25 dogs or other small animals per month have passed through Veterinary Services prior to disposal in the station landfill. Interviewees at the facility stated that this was a fairly consistent average. The interviewees also estimated that two horses a year die at the stables. These animals are disposed of by the Public Works Department which buries them on stable property in trenches approximately eight feet deep.

5.2.18.2 Special Warfare Group, Detachment 2, Caribbean. The mission of the Special Warfare Group, Detachment 2, Caribbean (SPECWARGRUTWO) is to provide training scenarios for the neutralization of objects and acquisition of intelligence, performing singly or in small groups. SPECWARGRUTWO has air, sea, and land operating capabilities.

SPECWARGRUTWO was formed in 1976, when all special underwater operations, such as the SEALS, the Naval Inshore Warfare Group, and the Underwater Demolition Teams, were combined under one command. The training activities of the SPECWARGRUTWO include use of diving equipment, which takes place in and around the unit's compound, and the use of small arms, explosive devices, and demolition charges, which takes place on Pineros Island and Dogs Head Island. Some training has occurred on Vieques, Culebra, and St. Thomas in the past, but has been conducted almost exclusively on Pineros and Dogs Head islands for the last 25 years.

Pineros Island was originally intended for use by the British Royal Family if the evacuation of the Royal Fleet and family was necessitated by German advances in World War II. The extensive bunker system built for the evacuees is still present, and is used primarily by bats.

Training activities on Pineros Island include boat-to-shore engagements using 50-caliber machine guns and 40-millimeter cannon, small arms practice on shore (M-79 grenade launchers, light antitank weapon (LAW) rockets, hand grenades, M-16 rifles, and 45-caliber pistols), and the use of various demolition devices and explosive charges (bangalore torpedoes, C-4 plastique explosive, detonation cord, TNT, and shaped charges).

The average use of Pineros Island for the past 22 years has been once weekly, with approximately 10 uses of Dogs Head Island in the last four years.

SPECWARGRUTWO personnel blew up the existing buildings on the island for practice, then constructed dummy buildings, which were removed by persons unknown. Until 1980, the majority of demolition work was conducted in the northwest corner of the beach. Following complaints received by the Public Works Department, the blows were reduced from the previous limits of 400 pounds of TNT equivalent for underwater blows and 200 pounds of TNT equivalent on land to 300 and 100 pounds, respectively.

There are no fuels or other materials stored on the island. There are a number of unexploded ordnance items dating back 25 years; since the island is still active, and will remain in use for the forseeable furture, no plans exist for cleaning up these items. While the island is off limits to all but personnel who have obtained approval from AFWTF, which controls use of the area, locals have been seen boating and swimming in the area of Pineros Island.

5.2.18.3 Public Affairs Office. This office publishes a monthly base newspaper, El Navigante. The paper provides base personnel with internal information, command policy, achievements, Navy-wide news, stories and featured articles. Depending on the importance of an issue, the office also acts as liaison in civilian-Navy matters.

Production activity consists of news gathering, page lay-out, and product distribution. No printing is done on-site; an off-base printer is used. As a historical information center, the office resources are limited to the past two years. Material dating prior to this (i.e., copies of "Mira Que Pasa," the predecessor to El Navigante) is discarded if no orders are given to retain it.

5.2.18.4 Navy Exchange Garage and Gas Station Facilities. The Navy Exchange operates two service areas: a garage and gas station facility in the Bundy Area, and a gas station near the base fire department, north of the Industrial Area.

At the Bundy facility, fuel for the station is held in two 12,000-gallon tanks and one 10,000-gallon tank, all of which are underground. The tanks are about 20 years old and have never shown problems of leakage. Routine measurements of tank volumes are conducted each month. The same procedure is performed at the industrial area station, which has three 10,000-gallon underground tanks.

Servicing of private vehicles is performed solely at the Bundy facility, although the industrial area station does have a 600-gallon underground waste-oil tank similar to that at the Bundy facility. These tanks were installed a few years ago. Two hundred vehicles per month are serviced at the Bundy garage. Service activities range from oil changing to complete engine overhaul. Waste oil, including lube oil and transmission oil, is generated at a rate of 75 gallon per month. A private contractor removes the oil for reclaiming. Until recently, waste oil was placed in four to five 55-gallon drums located on a concrete catch basin with six-inch sides. Oil was removed by the Public Works Department for transport to the base disposal area (landfill or waste oil burner). During periods of heavy rain, these drums would overfill and stain the immediate area. Similarly, oil spilled when drums were being filled or removed.

Other material presently discarded from the garage included about 50 batteries (with acid) per month, 50 to 60 tires per week, cardboard, and approximately 200 empty quart oil cans per month. A private contractor removes the batteries and about 10 tires. The remaining tires are disposed of at the base landfill. Radiator fluid is allowed to drain onto the ground. Machinery or resellable parts are turned over to the DPDO.

5.2.18.5 Water Security Patrol (WASP). The Water Security Patrol is under the command of Surface Operations and is responsible for waterfront security. The WASP operation was established in April 1983. Currently, two patrol boats are used. No fuel storage is present on-site. Fueling is done at the fuel pier loading facility. Waste generated from routine maintenance of boats and outboard motors is minimal, consisting of small amounts of oil, solvents, soaps, etc., all of which is disposed of at the base landfill.

5.2.18.6 U.S. Army Reserves - 390 Terminal Transfer Company. The mission of the 390 Terminal Transfer Company is to train reserves on weekends in material handling and transport, and for qualification for various motor vehicle class licenses. Although training in cargo handling is conducted, no cargo is actually handled. However, about one 55-gallon drum of waste oil from vehicle maintenance is turned over to DPDO every three months.

5.2.18.7 U.S. Army Reserves - 699 Engineering Company. The mission of the 699 Reserves Engineering Company is to provide port construction training. Four landing craft-type units as well as land vehicles are available to the reserves. Maintenance of the watercraft is handled by Surface Operations. Land vehicle maintenance generates about five gallons of waste oil per month, which is turned over to DPDO.

5.2.18.8 U.S. Navy Courier Service Detachment. The mission of the detachment is to provide transportation and handling of special classified documents in a manner similar to a private service such as Federal Express. Wastes generated from this service are minimal, consisting of general office waste and shredded paper.

5.3 ORDNANCE OPERATIONS.

5.3.1 Torpedo Shop. The Torpedo Shop, operated by AFWTF, is located in Building 395, in which MK 46 and MK 48 torpedoes are prepared and serviced, and in Building 378, in which MK 30 torpedoes are prepared and serviced. The activity prepares two types of MK 46 torpedoes: the dummy configured MK 46-1/2/5 and the MK 46-1/2/5 exercise torpedoes. The MK 46-1/5 torpedo can also be configurated for launching from aircraft.

All ordnance for disposal from the Torpedo Shop is taken by EOD to the Vieques Naval Reservation for proper disposal. Ordnance items include propellants, igniters, carbon dioxide bottles with squibs, explosive bolts, rocket motors, ignition separator assemblies (ISAs), and piston motors. About 20 propellant charges and three ISAs have been disposed of in the last three years by EOD on Vieques. Formerly, ISAs were burned off in the office ashtrays. Before 1968, explosives from this activity were disposed of in the landfill or in the ocean. None of the torpedoes prepared by this activity are armed with warheads.

5.3.2 Weapons Department, Naval Station Roosevelt Roads. The Weapons Department has the following functions: (1) to receive, store, maintain, assemble, checkout, inspect, modify, protect, and issue conventional ammunition, torpedoes, and other underwater munitions, specified weapons systems, missiles, technical items, and components; (2) to operate a facility to tranship ordnance materials; (3) to provide support for the on- and off-loading of ammunition and miscellaneous services for foreign and domestic ships; (4) to provide logistic and administrative support regarding ordnance materials for tenant activities and temporary duty units; and (5) to assist in the disposal of munitions and other ordnance items. (See also Section 4.2.1 for a description of Weapons Department activities on Vieques NAS).

The Magazine Field Office (Building 4041 and various storage bunkers) handles the receipt, storage, inspection, maintenance, and issue of munitions used by tenant activities, and the temporary receipt and storage of munitions off-loaded by units engaging in exercises at the various AFWTF facilities. Any ordnance items that are excessed, that have an elapsed shelf-life, or that fail quality control checks, are turned over to EOD for disposal. Other material, such as pallets, shipping containers, and dunnage, is turned over to DPDO for demilitarization as required, and ultimate disposal.

The Missile Assembly Building (Building 4086) assembles missiles for use on the AFWTF ranges. The missiles are shipped to Roosevelt Roads in reusable metal containers; only "nut-and-bolt" (no first-line) assembly is accomplished. The missiles themselves are expended during range operations, or very occasionally following a failure, turned over to EOD for disposal. The containers are sent back to the munitions plants for reuse. No leaks or spills of fuels have been noted in the past 22 years. The Advanced Underwater Weapons (AUW) Shop receives torpedoes in reusable metal containers. No spills or wastes associated with the OTTO Fuel II used in the weapons was ever noted by interviewees. No other waste has been associated by the interviewees with the AUW operations.

5.4 RADIOLOGICAL OPERATIONS. Radiological operations are limited to the Naval Electronics Engineering Center and the base medical and laboratory facilities.

5.4.1 Naval Electronics Engineering Center. Small radiological sources are located in a closed trailer at the electronics center. The trailer is separated from Building 377, along the northern boundary line of the facility. These sources are used twice a year for calibration of fleet electronic instruments, and are maintained and checked by the Department of Energy. The calibration sources are low-level isotopes.

5.4.2 Medical and Laboratory Services. The X-ray machines used at the Naval Hospital and Naval Regional Dental Center are of the electron-generator type, and therefore no radiological wastes are produced. The hospital laboratory uses small amounts of low-level radioisotopes such as iodine, which has a short half-life. The laboratory is certified to use these materials.

CHAPTER 6. MATERIAL HANDLING: STORAGE AND TRANSPORTATION

6.1 INDUSTRIAL. Material storage is generally a function of the Public Works Department. Since segregation of certain materials classified as hazardous was started in 1973 and fully implemented in 1976, materials such as PCBs, chemicals, oil products, pesticides, etc., have been isolated and monitored for compliance with standing regulations. Public Works as well as the other departments assigned with the responsibility of material storage are discussed in this chapter.

6.1.1 Materials Storage: Defense Property Disposal Office (DPDO). The DPDO located at Roosevelt Roads handles material from all base operations, other DOD facilities throughout the island, and Puerto Rico National Guard units. Materials are transported to DPDO on Navy and Army vehicles, or barged from the outlying islands. DPDO ensures that the materials are correctly packaged against damage or leakage during transport and handling. DPDO storage includes a warehouse facility, fenced lot, and a hazardous and flammable storage locker (Building 2009). Material is placed in the appropriate storage area depending on the material characteristics. All materials are numbered, and movement is controlled by a manifest system.

Material received by DPDO has been designated by the activities turning it in as "excess" or no longer of use, and ranges from office furniture and drained vehicle batteries, to PCB-filled transformers and demilitarized weapons. Materials most commonly received include approximately 1,000 gallons per month of acid, bases, paints, thinners, and sealing compounds, and 10 to 15 55-gallon drums of waste oils. Since DPDO's philosophy is that a hazardous material is not a hazardous waste until a use for it cannot be found, every attempt is made to find uses for such substances (i.e., they are offered to every possible government agency at no charge). If no agency wants the material, DPDO will either sell the material via an auction system, or send the material to private contractors for recovery of precious metals, etc., or for disposal of hazardous materials such as PCB-contaminated oil or non-usable pesticides (e.g., DDT). Generally, all materials are sellable items, and DPDO has not had much difficulty marketing them, including transformers which have less than 50 ppm PCBs. Transformers containing PCBs greater than 50 ppm are handled by an outside contractor.

6.1.2 Supply Storage. Storage of supplies occurs at all levels of base operations, from large warehouses to small shop lockers. The Supply Department has primary responsibility for storing supplies as well as for receiving and distributing materials used and needed by the base.

The Supply Department uses two large warehouses (Buildings 1207 and 27) as well as the storage yards adjacent to both buildings. These areas are used for storage primarily of Public Works Department material. The Public Works Department maintains and operates the cold storage facility at Building 53 and aviation storage at the airfield (Building 20) for the Supply Department. Scattered about the base are many smaller operational storage units containing material needed by the particular industrial operation at that location. These storage facilities usually contain a one-month supply. Storage lockers are also found in various shops in which small quantities of materials are readily available for immediate use.

In addition to the storage of Public Works and industrial-type material, the Navy Exchange operates three warehouses: Buildings 40, 41, and 42. These warehouses contain wholesale products, consumables, household furnishings, etc., which can be easily distributed to the various commissaries and exchange services.

6.1.3 Chemical and Hazardous Materials Storage. According to Supply Department personnel, chemical and hazardous materials are not stored in large quantities in any one single area, but are moved quickly when received from the Supply Department to the small out-building storages of the industrial operations area. These out-building structures are generally kept separate from industrial operations as a safety precaution. The materials stored at each structure include flammable liquids, solids, acids and bases, paints, solvents, industrial gases, or whatever is required by a particular operation. The arrangement of how materials are placed within each storage unit varies from well segregated storage practices to avoid reactions, as at DPDO, to a general assemblage of potentially non-compatible materials, as found at AIMD.

The storage structures themselves also vary, ranging from concrete bunker-type structures, to metal sheds with no flooring, to converted Quonset huts such as those found at Gun Storage Area 112.

6.1.4 Petroleum, Oil, Lubricants (POL). The Naval Station Fuels Division provides facilities necessary for the receipt, storage, and issue of aviation fuels, lubricants, gasoline, and diesel fuel marine (DFM).

The Fuels Division maintains 22 POL storage tanks located throughout Naval Station Roosevelt Roads. Of these storage tanks, seven contain DFM fuel, two contain MOGAS (regular), one contains MOGAS (unleaded), eight contain JP-5 fuel, and six contain AVGAS. Table 6-1 lists for each storage tank its number, fuel type, capacity, type of construction, and the direction and eventual location of the fuel if a spill were to occur.

Two bladder-type storage tanks containing approximately 50,000 gallons total of JP-5 fuel are currently in use near the airfield. These tanks are bermed and are not subject to periodic flooding or washout. Plans for anticipated long-range use are as yet unclear.

The fuel storage facilities have major connecting supply lines from Pier 1 and Pier 3. At Pier 1 there are fuel line outlets for AVGAS, JP-5, and DFM; and at Pier 3, for diesel fuel, JP-5 fuel, MOGAS, and AVGAS. Pier 1 is the primary fuel receiving point for the station, while fueling of vessels is accomplished at Pier 3. AVGAS and JP fuels are pumped directly into their respective storage tanks. The JP fuel is pumped from Tank 429 to the high-speed refueling hydrants on the north side of the flight line, where aircraft are refueled. AVGAS is supplied to aircraft by refueler vehicles.

All buried metallic storage tanks and transfer lines are cathodically protected. Public Works personnel monitor cathodic readings monthly. Fuels Division personnel are responsible for routine pressure checks, tank soundings, and

Table 6-1

FUEL STORAGE TANKS AT
NAVAL STATION ROOSEVELT ROADS

Facility	Type of Fuel*	Exact Volume (Bbls)	Type of Construction	Probable Direction of Flow of Spill
Tank 56A	DFM	227	Underground, steel-welded, horizontal	Southwest to harbor via storm drainage
Tank 56B	DFM	227	Underground, steel-welded, horizontal	Southwest to harbor via storm drainage
Tank 82	DFM	50,364	Pre-stressed concrete	South/southwest to retaining wall and controlled drainage
Tank 83	DFM	27,552	Pre-stressed concrete	South/southwest to retaining wall and controlled drainage
Tank 84	JP-5	13,920	Underground, steel-welded, vertical	Southwest to retaining wall and controlled drainage
Tank 85	JP-5	27,433	Underground, steel-welded, vertical	Southwest to retaining wall and controlled drainage
Tank 105	Unleaded MOGAS	121	Underground, steel-welded, horizontal	Southwest to retaining wall and controlled drainage
Tank 210	MOGAS	---	No longer in service	
Tank 211	MOGAS	---	No longer in service	
Tank 212	AVGAS	1,127	Concrete, latex-lined, vertical	Northeast to mangrove swamps
Tank 213	AVGAS	1,127	Concrete, latex-lined, vertical	Northeast to mangrove swamps
Tank 214	AVGAS	5,783	Concrete, latex-lined, vertical	Northeast to mangrove swamps
Tank 215	AVGAS	5,783	Concrete, latex-lined, vertical	Northeast to mangrove swamps
Tank 216	AVGAS	5,775	Concrete, latex-lined, vertical	Northeast to mangrove swamps

Table 6-1 (Cont.)

Facility	Type of Fuel*	Exact Volume (Bbls)	Type of Construction	Probable Direction of Flow of Spill
Tank 217	AVGAS	5,807	Concrete, latex-lined, vertical	Northeast to mangrove swamps
Tank 381	JP-5	27,373	Underground, steel-welded, vertical	Northeast to mangrove swamps via drainage system
Tank 429	JP-5	4,743	Underground, steel-welded, vertical	To mangroves via drainage ditches
Tank 470	MOGAS, regular	595	Underground, steel-welded, horizontal	Southwest to retaining wall and controlled drainage
Tank 471	MOGAS, regular	595	Underground, steel-welded, horizontal	Southwest to retaining wall and controlled drainage
Tank 1080	DFM	27,078	Underground, steel-welded, vertical	South/southwest to retaining wall and controlled drainage
Tank 1082	DFM	27,067	Underground, steel-welded, vertical	South/southwest to retaining wall and controlled drainage
Tank 1084	JP-5	27,404	Underground, steel-welded, vertical	Northeast to mangrove swamps via drainage system
Tank 1086	JP-5	27,404	Underground, steel-welded, vertical	Northeast to mangrove swamps via drainage system
Tank 1088	JP-5	9,751	Underground, steel-welded, vertical	Southwest to harbor
Tank 1995	JP-5	100,000	Aboveground, steel-welded	Northeast to mangrove swamps via drainage system
Tank 1996	DFM	100,000	Aboveground, steel-welded	Northeast to mangrove swamps via drainage system

*Key:

DFM = Diesel fuel marine
JP-5 = Jet propulsion aviation fuel
MOGAS = Motor gasoline, both regular and unleaded
AVGAS = Leaded aviation gasoline

system preventive maintenance. A Facilities Control Inspection of all fuel storage and transfer systems is conducted by Public Works personnel annually.

Bilge and ballast wastewater in vessels nested or anchored at Roosevelt Roads is collected and treated by the oil waste collection and treatment system. This system consists of a waste oil raft (donut); two Ships Waste Offload Barges (SWOBs), 75,000-gallon capacity each; and a special skid-mounted oily waste, waste oil, and water handling unit, known as the Donut Servicing Subsystem (DSS) on-shore.

The oil spill removal system is used for cleaning oil spills in the harbor. This system comprises floating oil containment booms, oil skimmers, and support equipment to contain and remove an oil spill. The oil and water mixture removed by the skimmer may be temporarily stored or treated before final disposal.

The majority of oil spills which have occurred at the station are transportation related. However, non-transportation spills occur. In 1976 three spills occurred at Pier 3 as the result of leaks in fuel lines and transfer lines. It is estimated that 4,000 gallons of diesel fuel and an unknown amount of JP-5 fuel escaped into the harbor.

Tanks 84 and 381 overflowed in 1977. Approximately 200 gallons of JP-5 fuel were lost at Tank 84 and over 5,000 gallons of JP-5 fuel at Tank 381. In both instances it was reported that the vast majority of the fuel either evaporated or was cleaned up, and that no long-term damage has resulted to the environment.

6.1.5 <u>Pesticide Storage</u>. Pesticides are stored in two locations at Roosevelt Roads. Table 6-2 lists the pesticides, herbicides, and rat poisons currently stored in the new Pest Control Shop. The facility provides separate storage space for pesticides and herbicides. Building 121 is an EPA-permitted hazardous waste storage facility which is used for the storage of outdated pesticides. Table 6-3 contains an inventory of pesticides which were in storage in Building 121 when the 1980 Pest Management Plan was prepared. In 1981 the DDT listed in Table 6-3 was overpacked in 74 85-gallon drums which included DDT from Fort Buchanan and San Juan, and shipped to Fort Gillem, Georgia, for proper disposal. Pest Control personnel interviewed were unaware of the exact quantities and types of pesticides currently stored in Building 121; from the appearance of the building it is possible that pesticides remain there undisturbed since 1981.

Prior to the opening of the new Pest Control Shop in 1983, pesticides were stored in Building 258, a 1,150-square foot Quonset hut. The building did not provide adequate storage space, and pesticide containers were often stored outside the building. The 1977 Environmental Engineering Survey prepared by Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM), stated that drums of waste and unidentified pesticides were being stored on the parking apron at the Pest Control Shop. It further stated that most of the drums had rusted to the point where they were ready to collapse. These drums were later moved to Building 121, and are awaiting disposal by DPDO. Former Pest Control Shop employees remember incidental spillage of pesticides in and around Building 258. An incident occurred in 1976 when a 55-gallon drum of malathion, which was stored outside the building, ruptured and the contents

Table 6-2

PESTICIDES INVENTORY FOR ROOSEVELT ROADS

Common Chemical Name	Percent Active Ingredient
Pesticides	
Baygon	7.0
Baygon	2.0
Baygon	1.0
Baygon 1.5	1.5
Chlordane	72.0
Diazinon 4E	47.0
Diazinon	48.0
Malathion	95.0
Pyrethrum	1.4
Pyrethrum 10-8	1.4
Pyrethrum Buto Bip	1.0
Pyrethrum ULD BP-300	3.0
Wasp and Hornet	
10.0 Prex	
20.0 PB	
0.5 Bay	
Vapona	20.0
ULV Flushing Solution 5.1	NA
Pentachlorphenol	5.0
Dursban 4E	92.0
Bird Repellent	48.0
Paradichlorobenzene	100.0
Wasp-B-Gone	85.0
Snail and Slug	2.75
Herbicides	
Bromacil	80.0
Diuron	80.0
Diquat	35.3
Karmex	80.0
Hyvar X	80.0
Spreader sticker	NA
Glyphosate (Round-up)	41.0
Pramitol	25.0
Rat Poisons	
Warfarin	0.025
Diphacinoe	0.005
Stiktite Rodent Glue	NA

Source: Pest Control Shop, Naval Station Roosevelt Roads, 5 January 1984.

Table 6-3

PESTICIDES IN STORAGE AT BUILDING 121*

Common Chemical Name	Date Declared Excess	Quantity (lb or gal)	Container Condition
Paris Green	20 June 78	25 lb	Good
Malathion	20 June 78	300 lb	Good
DMAG	20 June 78	45 lb	Good
DDT	20 June 78	600 lb	Good
DDT	20 June 78	380 gal	Good
Maldane	20 June 78	15 gal	Good

*Prior to disposal at Fort Gillem, Georgia, the DDT had been stored in Building 121. All other pesticides are still in storage awaiting disposal.

Source: Table is taken directly from the 1980 Pest Management Plan, Naval Station Roosevelt Roads.

spilled on the ground, eventually washing into the drainage ditch in back of the shop.

6.1.6 PCB Storage. PCB-contaminated transformer fluids and transformers have been stored at the pole yard storage area, located approximately 150 feet north of Building 42, since 1975. The yard is an EPA-permitted hazardous waste storage facility. Some of the transformers and 55-gallon drums of PCB-contaminated material are stored on concrete pads, while the majority are stored on the ground in a fenced yard.

In the past, five-gallon cans of PCB transformer fluid by the trade name Askarel were stored at Substation 2 (Building 90) and the Public Works storage yard (Building 31). In 1968, the Public Works Power Distribution Shop disposed of approximately 65 five-gallon cans of Askarel, 40 of which were disposed of at the station landfill and 25 at the dry dock wharf. The cans had been stored at Building 31 and were in a rusted condition at the time of the disposal.

PCB-contaminated material is also stored at the old Power Plant, Building 38. A contractor was hired in June 1982 to drain the two transformers located in the building. This resulted in 18 55-gallon drums of PCB-contaminated transformer fluid and two 55-gallon drums of PCB-contaminated solids.

6.1.7 Storage Lots and Scrap Yards. Large storage lots and scrap yards are found around the Public Works Transportation Division, Supply Department, Camp Moscrip, the DPDO facility, and the dry dock area. For the most part the storage lots at the Public Works Transportation Division and Supply Department contain vehicles and construction-type equipment. The same is true at the Naval Mobile Construction Battalion (NMCB), which also stores other types of materials including fuels, oils, and construction chemicals.

Other Public Works storage yards include open storage area 112 and the pole yard storage area located adjacent to Navy Exchange Warehouse 42. Materials stored at open storage area 112 in Quonset huts 249 and 250 include unused and spent construction chemicals, lubricants, industrial gases, and flammable/hazardous materials. Around the yard and along the fence perimeter, there is evidence of old and recent spillage. At the pole yard, electrical distribution equipment is stored, including telephone poles, transformers, and condensors. There is evidence of periodic spillage of transformer oil, some of which contains PCB.

At the DPDO facility, the storage yard is used for the display of marketable material. This material includes vehicles, large equipment of various uses, scrap metal, etc. The paint and flammable storage building is located within the yard boundary. This storage unit is well organized and maintained.

In the vicinity of the dry dock, materials have been scrapped in and around Building 145 (Site 11) and Building 25 (Site 10), now collapsed. Materials found include office furniture, 55-gallon drums with varying contents, asbestos, and construction rubble.

There is one fenced storage yard located around Building 28. Across the road from Building 28 another larger fenced yard is located. These yards are operated by Base Security and primarily contain confiscated vehicles. However, at the larger yard, other materials such as tires and drummed waste oils are also stored. The waste oil is used by local fire departments for training.

6.1.8 Materials and Waste Transportation. Both military operations and private contractors handle station material and transport wastes within and from station property. Incoming materials are received by the Supply Department and then distributed to the proper recipients by military vehicles. The majority of station wastes are collected and transported by private contractors. Private contractors are selected by a bidding system.

All garbage and domestic wastes as well as commercial and industrial refuse, up to a certain size, are collected by a private firm. For the most part, these wastes are disposed of at the base landfill, which is also operated by a private contractor. Wastes which are recoverable or resalable and oversized waste are collected by the Transportation Division and by various Public Works shops. Recoverable wastes such as waste oil, dirtied fuels, batteries, tires, and scrap metals are all handled by private contractors. Resalable wastes are transported by military vehicle to DPDO. The DPDO at Roosevelt Roads receives designated waste from all Puerto Rico Naval activities.

6.1.9 Nuclear Biological Chemical (NBC) Decontamination Agents Storage. NBC decontamination agents stored at Roosevelt Roads have included Super Tropical Bleach (STB) and Decontaminating Solution Two (DS-2). STB is used for decontamination of equipment and material contaminated with "mustard gas" (Lewisite, H, HD, HN, or HT), and for decontamination of certain types of contact or liquid nerve agents. STB is comprised of chlorinated lime and calcium oxide, yielding 30% available chlorine, and is commonly mixed with water to form a solution or slurry, depending on its intended use. STB can also be used in a dry form in a shuffle pit, or to create a path through a contaminated area. STB is commonly stored and shipped in eight-gallon steel cans containing 50 pounds of agent.

DS-2 is a liquid used for decontaminating materials contaminated with nerve agents (GA, GB, GD, or V, or their equivalents) and mustard gas. It consists of 70% active agent (diethylene tri-amine), 20% solvent (ethylene glycol monoethyl ether), and 2% booster (sodium hydroxide). DS-2 is shipped and stored in 1-1/3 quart and five-gallon cans. It is used by spraying DS-2 over the contaminated object, usually using a special hand-held sprayer charged with a carbon dioxide cylinder. DS-2 is flammable. A third less commonly used decontaminate, DANC, is comprised of a classified material (RH195) dissolved in acetylene tetrachloride. RH195 is shipped in small cans that attach to the three-gallon can of solvent for use against mustard gas and persistent nerve agents.

At Roosevelt Roads, the Public Works Department was given primary responsibility for storing decontamination agents. In 1976, the Public Works Department was directed to dispose of, by shipping to the United States, several thousand pounds each of DS-2 and STB which had elapsed shelf life, were improperly stored, and were rusting through, creating the strong possibility of a violent reaction by mixing. The materials remained stored in Building 1788 until 1980, when NAVSEA personnel determined the items were too badly decomposed to ship stateside. Accordingly, the DS-2 was trucked and barged to Vieques, where a day-long, EOD-supervised burn destroyed an estimated 1,500 gallons of DS-2.

Three hundred 55-gallon cans (1,750 gallons) had been stored in Warehouse 1788; the 250-gallon discrepancy in stored versus burned DS-2 is not considered significant.

No records exist of the disposal of the 3,550 pounds of STB. Interviewees stated that it was generally assumed the material had been disposed of in the station landfill.

No records exist of the presence or disposal of any DANC decontaminating agent.

6.2 ORDNANCE. Ordnance storage and transportation is handled by the Weapons Department on Roosevelt Roads. Many of the munitions used are shipped in re-useable metal containers, which are returned to the production center. Dunnage and pallets used in munitions shipping are turned over to DPDO, while any ordnance items or waste for disposal have always been turned over to EOD (see Sections 4.3.1 and 5.3.2) and stored in magazines at NAF.

6.3 RADIOLOGICAL. The handling, storage, and transportation of radiological materials are limited to medical and electronic calibration facilities. The X-ray units at the hospital and dental clinic are of the electron-generator type, and therefore no radioactive wastes are produced. The X-ray machines are maintained by trained and certified technicians. Low-level radioisotopes such as iodine, which has a short half-life, are used in the Naval Hospital laboratory, which is certified to use and dispose of these materials. The radiological calibration source stored at the Naval Electronics Engineering Center is checked and maintained by representatives of the Department of Energy. Only trained personnel have the authority to use the radiological standards during calibration operations, which occur twice a year.

6.4 CHLORINE STORAGE AND DISPOSAL. Twenty-one compressed gas cylinders (J type) containing chlorine were stored in Building 87 until 1982, when EPA Region 2 granted a one-time deep ocean disposal permit. The cylinders were jettisoned into a 1,200-foot deep area of the Atlantic Ocean.

CHAPTER 7. WASTE PROCESSING

7.1 INDUSTRIAL. The Public Works Department generates and processes most of the wastes classified as industrial. Some military operations also produce wastes which are processed prior to disposal. All processing operations pertinent to this study are discussed in the following subsections.

7.1.1 Wastewater System. The present wastewater system provides for separate storm and sanitary sewage systems. The storm sewer system consists of catch basins, a piping network, and natural and man-made open canals and ditches which discharge to the coastal waters. The sanitary sewer system comprises a network of gravity sewers and 17 pump stations. The entire flow of wastewater from the base, including ship-generated sewage, is processed through three treatment plants which provide secondary treatment prior to discharge to the ocean through short submarine outfalls.

Until 1973 there were some 40 septic tanks in service, varying in size from 500 to 4,000 gallons. Since that time an active septic tank elimination program has reduced the number to 10, most of which are too distant for connection to the sanitary system. As an example, the old Pest Control Shop (Building 258) was serviced until recently by a 500-gallon septic tank, which is suspected of having received pesticide waste while the old Pest Control Shop was active.

7.1.1.1 Capehart Area Wastewater Plant. The wastewater plant (Building 1691) serving the Capehart housing area has a total capacity of 0.46 million gallons per day (mgd) divided into two parallel units, one having a 0.30-mgd capacity, the other a 0.16-mgd capacity. Both units are similar extended aeration plants. Chlorinated effluent is discharged to the adjacent coastal waters through a submarine outfall.

The plant provides secondary treatment generally meeting EPA National Pollutant Discharge Elimination System (NPDES) standards. Digested sludge is dewatered in two drying beds and hauled periodically to the landfill. Sludge generation is estimated at 70 tons per year (10% moisture).

7.1.1.2 Bundy Area Wastewater Plant. With a capacity of 0.655 mgd, this plant (Building 1757) uses the trickling filter process with anaerobic digestion of sludge.

The plant provides secondary treatment consistently meeting NPDES standards. Plant effluent is chlorinated prior to final discharge to the ocean through an underwater outfall line.

Sludge production is estimated at 6.5 tons per year of anaerobically digested sludge (90% solids), which is dewatered in sludge drying beds and occasionally disposed of at the site, with most sludge going to the sanitary landfill (Site 7).

7.1.0 Industrial Area Wastewater Plant. This plant (Building 1758) has a capacity of 0.937 mgd using the trickling filter system with anaerobic digestion. It serves the southeastern section of the base, including the

Public Works Complex, and has received all ship-generated sewage since 1980. Little, if any, wastewater other than domestic sewage is processed here.

Sludge dewatering is accomplished in the sludge drying beds, and is delivered to the adjacent landfill at a rate of 60 tons per year (dry sludge).

Chlorinated secondary treated sewage meeting local water quality standards is discharged to the adjacent coastal waters through a 14-inch submarine outfall line.

7.1.3 Waste Fuel and Solvent Processing. This function was accomplished by the so-called "thermo-digester" located adjacent to the landfill entrance, near the Transportation Division of the Public Works Department. The present unit, installed in 1982, is a Vent-O-Matic incinerator which has not yet been placed in service as it is pending confirmation of stack emission tests meeting local air pollution regulations. The previous plant, installed in 1973 and dismantled in 1982, was used to burn classified material, contaminated diesel oil, JP-5 fuel usually mixed with some lube oil, solvents, and sludge residue. Contaminated fuel was brought two to three times a week to a fixed tank truck adjacent to the incinerator. During this period, it is estimated that 600 gallons of oil per week were processed through this plant.

Cleaning and solvent solutions used by the Transportation Division are reclaimed through a filtering system. Filters are reusable after periodic cleaning. Residue from filters is mixed with waste oil for disposal off-base.

7.1.4 Incinerators. Currently there is one incinerator at the station. Located at the hospital (Building 1790) it is a package incinerator with burners located in the main chamber at the base of the stack. The unit operates in compliance with all Commonwealth of Puerto Rico air pollution regulations. It is used exclusively to burn pathological waste generated by the hospital.

7.1.5 Garbage Cooker. This plant (Building 1936) boils foreign garbage from incoming ships prior to disposal into the adjacent landfill. A York-Shipley boiler generates steam at 90 pounds per square inch (psi) pressure and boils the water for a minimum of two hours in the specially constructed garbage containers.

Operation is intermittent in that garbage is cooked as it is received, but averages 1,200 pounds of wet garbage per day. A 1,000-gallon underground storage tank supplies DFM to the boiler, which burns 500 gallons of fuel per month.

This operation was started in 1972. An interview with the former caretaker (1972-1982) indicated that the present operation is at the same level as previously, when five containers (four cubic yards) of garbage per day were processed.

7.2 ORDNANCE.

7.2.1 Ordnance Incinerations: OTTO Fuel II. From 1966 to 1968, the Weapons Support Department of AFWTF disposed of OTTO Fuel II and Agentine solvent by burning in the station landfill. The OTTO Fuel II burned was left over from a torpedo run, and was usually contaminated with saltwater. Table 7-1 presents the components of OTTO Fuel II. Agentine, a dry cleaning solvent, was used to wash down the torpedoes after a practice run. In addition to the OTTO Fuel II and Agentine, various rags and items of protective clothing (shirts, coveralls, booties, pants, aprons) contaminated with OTTO Fuel II were also disposed of by burning at the dump. An estimated maximum of three barrels per month of fuel, Agentine, and contaminated materials were poured into holes in the landfill and burned. Wood was used to maintain the combustion.

Typically, the waste consisted of very small amounts of OTTO Fuel II, and larger amounts of solid waste and Agentine. Since cleanup of a torpedo after a run would generate approximately one cup of OTTO Fuel II and five gallons of Agentine wash, it can be concluded that the greatest amount of material was Agentine. Estimates of the total amount of material burned vary. Interviewees stated that fuel burning was conducted from 1966 to 1968, for a total of 72 drums; other interviewees stated that the first year's burning was very low (no more than four drums per quarter), and that only eight to 10 drums of waste were ever burned at the landfill. The IAS team assumed that a reasonable estimate would be approximately 50 drums of OTTO Fuel II and Agentine burned at the landfill.

All explosives (propellants, carbon dioxide bottles with squibs, explosive bolts, ignition separator assemblies (ISAs), rocket motors, and piston motors) were either burned off in ashtrays (ISAs), or more commonly, sent to EOD for disposal.

7.2.2 <u>Explosive Ordnance Disposal (EOD) Operations</u>. The disposal of ordnance related wastes is handled by the EOD detachment, which is responsible for the disposal of all malfunctioning ordnance from AFWTF-related activities, the disposal of any ordnance discovered below the high-tide mark, and the disposal of ordnance and ordnance wastes generated by the operations of the Weapons Department.

There are no known EOD ranges on Roosevelt Roads proper. Various EOD and other demolition activities have been carried out on, and in the waters around, the islands of Piñeros, St. Thomas, and Culebra. The property upon which these activities occurred has been excessed and lies outside the scope of this IAS, or is still in active use (Pineros) and is regulated.

The majority of EOD operations have occurred on Vieques. Several ranges have been used. Extensive retrograde disposal operations (blows) were conducted in the Eastern Maneuver Area (EMA). This area is still in active use as a target area. EPA has granted an interim status RCRA permit for thermal treatment of ordnance waste in this area.

The primary disposal area was located on the west end of Vieques, on NAF property, generally within one-half mile of the bridge (now gone) at Punta Boca Quebrada. The range had a 40,000-pound explosive limit. In 1976 three youngsters entered the area without authorization, and unknowingly used a photoflash cartridge as a windbreak for the fire they started. The resulting detonation injured all three. The range was swept by EOD shortly after, cleaning up an area in a one-half-mile radius around the site. Use of the range was stopped.

Table 7-1

OTTO FUEL II COMPONENTS

Composition

76% propylene-glycal dinitrate

22.5% dibutyl sebacate

1.5% nitrodiphenylamine

By-Products

Carbon monoxide

Carbon dioxide

Hydrogen cyanide

Methane

Hydrogen

The range was swept again, at least twice until 1979, when it was abandoned. The old range had been in use since at least 1969, and it probably had been in use since the 1940s.

Material disposed of at the site included eight-inch rounds which were fired from the peninsula where the lighthouse was located into the Surface Impact Area (SIA) in the EMA over Cerro Matías, the location of the Observation Post. 175-millimeter munition was fired from Punta Cerejo into the SIA, and duds were disposed of by EOD; 105 and 106-millimeter munitions were also fired into the area and disposed of by EOD (see also Section 4.2.1).

Currently, the EOD range on Vieques has a 3,000-pound explosive limit (7,000 pounds of bombs, with a 0.4 explosive equivalent multiplier). "Off-spec" and old munitions are disposed of here. Such munitions are generated when the munitions on base are subjected to and fail the three-year quality assurance field testing at Roosevelt Roads, or when entire manufactured lots of ammunition are declared excess or determined to have exceeded the useful shelf life. Excess munitions from ship off-loadings or the return of units are also disposed of. Munitions from Roosevelt Roads are trucked to the LST loading ramp, barged to Vieques, stored awaiting disposal, and then trucked to the range for thermal treatment.

AFWTF monitors operations on the range, and grants approval for blows.

Munition wastes are also generated on Vieques. Twice yearly (usually December/January and June/July), the AFWTF ranges are closed for target refurbishing. Before work crews enter the area, EOD teams sweep the range roads, the landing beaches, the transit and target access roads, and a 100-foot circle around each target. The sweep is a surface visual sweep only; bore hole magnetometers or mine detectors are not used. Each ordnance item found is uncovered to the point that a positive identification can be made. The area around the item is cleared for a counter charge, and the object blown in place. Very few "render safe" procedures are used. Some special effects explosives are employed to cut munitions in a limited "render safe" procedure. Following the clearing of the targets, EOD personnel will enter the outlying areas and practice "render safe" procedures on the munitions found as part of their training.

Underwater detonations were commonplace at one time when waterborne targets were used by AFWTF. However, in 1979, an agreement was reached with the Commonwealth in which water targets were no longer used; no "water shots" were initiated by EOD after this. If munitions are found in shallow water at the landing beaches where they might endanger the Marines practicing landings, EOD personnel will blow the item in place.

Items primarily found during the target refurbish sweeps are flares and cartridge-activated devices. Three shots occurred in January 1984 during the sweeps; none occurred in June and July 1983. Other disposal operations result from Naval Air Reserve Unit (NARU) visits and activities. In January 1983, 5,000 pounds of smokeless powder were burned on a pad at the NAF. The powder came from semi-fixed rounds stored on Vieques that were reworked by NARU in July, August, and September 1982.

The EOD was responsible for the burning of 1,500 gallons of DS-2 decontaminating agent. Material was stored in rusted containers on top of STB containers, creating a fire hazard. The material was ordered disposed in 1976 by returning it stateside. In 1980 the material had not been moved, and was determined to be too unsafe to move stateside. The DS-2 was barged to Vieques and burned at the new range in a day-long burn supervised by EOD and the Roosevelt Roads Fire Chief.

EOD personnel also assisted in clearing the demolition range, pistol range, machine gun range, combat range, and hand grenade range. These ranges were severely overgrown; to refurbish them, 10,000 gallons of diesel fuel were applied and the areas burned.

7.3 OUTLYING FACILITIES.

7.3.1 Crown Mountain, St. Thomas. The Crown Mountain site has been in its present location since 1975. Prior to that date, the functions of the complex were performed at a site roughly 100 yards to the east, but one-half mile by road, of the present site, on a slightly higher portion of Crown Mountain, now occupied by the Virgin Islands television station. The Crown Mountain complex retains a tower, trailer, and standby generator for communication services. A septic tank has been in use at the "old site" since 1978; no problems have been noticed with either the septic system or the fuel storage for the generator, other than very slight leaks during filling.

The new site was first occupied in 1975. Various structures on the site were erected in 1976, 1977, 1978, and 1983, with the microwave tower erected in August of 1983. (The ITCS tracker for the towers is focused on Pico del Este, and is part of the AFWTF surface vessel and aircraft tracking system.)

Waste generating activities at both the old and new sites have been extremely limited. Both areas have generators for ancillary power in the event of a malfunction of the VIWPA; such occurrences, while not common, would have a disastrous effect on the operations of the facility. The old site shows evidence of some spills from refueling the 1,000-gallon diesel tank, but no major events had been noticed by the interviewees in over 21 years.

At the present site, the 5,000-gallon underground diesel tank is checked on a fairly continual basis. Only one leak has been noted, when a six-inch fuel line was crushed by the construction of soundproof walls in the exhaust room attached to the generator building. Approximately 100 gallons of fuel leaked to the ground; no cleanup was attempted. Some very small areas of stressed vegetation remain in the immediate vicinity of the building.

Oil for the generators is changed on an irregular basis. Samples of the oil are sent out for spectrum analysis, and the oil is changed according to the results. This has happened two or three times since 1979; approximately 50 gallons of oil were changed, with the VIWPA claiming the used oil. VIWPA also reclaims oil from the two on-site vehicles through the civilian dealer that conducts all vehicular maintenance.

Water is trucked to the site to supplement water catchments, cisterns, and individually procured water supplies. All sanitary wastes are handled through a septic system, or the new minimum energy self-digesting "Cyclette" system, which suffers from lack of load. With a capacity of 240 flushes per day, the "Cyclette" system is underused.

Solid waste is transported to the VIWPA landfill at Bahonney, a one- to one and one-half hour drive away. Trash is stored in the exhaust room, which serves to keep pests down, then hauled by facility vehicle to the landfill. The vast majority of the load is paper trash and brown bag lunch remnants; no significant wastes are generated.

7.3.2 St. Georges Hill, St. Croix. Wastes generated at the St. Georges Hill facility in the past include oil from the on-site generator. The oil is changed after every 350 hours of operation of the generator. Ten gallons of oil are changed every two or three months, depending on the number of hours the generator is run to provide electricity to the EWR TPS and communication devices. The oil was formerly burned or dumped; it is now reclaimed by the VIWPA. The generator has a 500-gallon day tank and a 4,000-gallon underground diesel storage tank. A spill from the day tank occurred in 1980 or 1981 as the result of overfilling; the diesel soaked into the ground and was never cleaned up. A stain can be seen today.

Other chemicals used at the facility include alcohol, Agentine, and trichloroethylene. These solvents are used for cleaning electronics. Only small amounts (five-gallon cans and spray cans) are used; the empty cans are disposed of in trash cans on the facility.

The St. Georges Hill facility burned all solid waste in open cans from at least 1968 to 1980, when the practice was halted. Some carbonless paper, possibly the PCB containing type, was burned in these drums. Currently, the solid trash is handled by the VIWPA. Facility workers carry the approximately seven cans a month to the island's solid waste facility. More solid waste may be generated during construction activities; VIWPA also disposes of this material.

One "dry" transformer, owned by the Navy, is located at the facility. The VIWPA has three "wet" transformers; it is not known if these transformers contain PCBs. Any batteries that require servicing are sent to the Underwater Tracking Range (UTR).

Water is trucked in or brought in by individual workers; a cistern is present at the facility. Sanitary wastes are handled by a septic tank, which has not been cleaned in the 12 years it has been in operation. There has never been an overflow or backfill problem associated with the system.

All vegetation control is accomplished by hand cutting; pesticide usage is limited to spray cans.

The activities at St. Georges Hill generate little if any waste; no potential pollution problems exist.

7.3.3 Underwater Tracking Range (UTR), St. Croix. At the UTR, the mission is such that little hazardous waste, if any, has been generated at the site. There are no transformers on site; no ordnance materials; no torpedo storage, refitting, or refueling; and only two 200-KW generators. Some sonar buoy refurnishing occurred in the past, in which small amounts of paints and solvent were used. There are two (a 5,000-gallon and 2,500-gallon) diesel tanks, and some 55-gallon drums of POL. Leaks from the diesel tanks and drums have stained the soil in places and have migrated off the fenced portion of the site down a small bluff and possibly into the sea. No adverse impacts have been noted, and plans have been drawn up to mitigate this situation by berming.

The photographic laboratory processes, on the average, less than 1,000 black and white photos per year, and fewer than 200 36-shot rolls of color slides. The processing chemicals total about 30 gallons for each of the 15 to 25 tracking exercises per year. The bleach used in processing is neutralized and allowed to sit for one hour; then it and the other processing chemicals are dumped down the sink. A five-foot hose runs from the sink to the ground below the photographic laboratory trailer, where it is allowed to splash on the ground. The only noticeable effect is a three-foot circle devoid of vegetation at the splash point. The vegetation appears to have been killed by the puddling of the neutralized chemicals.

All used oil is given to the VIWPA.

In the past, pesticides provided by Naval Station Roosevelt Roads were used for weed control around the fence line. The material was locally known as "Weed 1," and was used from 1966 to 1970. After that, the vegetation was controlled by hand cutting or by spraying with diesel fuel.

For some years, from about 1966 to 1972, a small pit (10 feet by five feet) was used for the disposal of trash and garbage generated by the facility. The material was primarily paper, the remains of brown bag lunches, and other garbage. The material was also disposed of by dropping it into the sea. The pit was near Building 201; no evidence of it remains today and no effects are apparent. Since 1972 all such material is picked up by the VIWPA and disposed of. Until 1974 solid wastes were pushed into the sea by VIWPA at the St. Croix dump, just east of the Alexander Hamilton Airport. Wave action on the dump polluted the coastal waters with dissolved and floating materials. Partial burning on the dump led to periods of intense air pollution over the airport. In early 1974 the Virgin Islands Government closed the old dump and began a sanitary landfill operation on nearby land. Meanwhile, the old dump remains a source of water pollution from leaching of the exposed trash. There also exists a danger that the old dump deposits might be dispersed by waves from a tropical storm. The amount of material contributed by Navy activities is minimal.

7.3.4 Observation Post (OP), Culebra. The contractor-operated facility has one person manning the three generators, whose primary responsibility is changing over the generators and refueling them as necessary. There is a 3,500-gallon and a 1,300-gallon diesel fuel tank, with a 1,100-gallon gasoline-filled "water buffalo." Some small spills have occurred, the most recent a 25-gallon spill. No cleanup was attempted. Oil from the generators is collected as it is changed and then trucked and barged to Roosevelt Roads when a sufficient quantity has been collected. The refueling of the diesel tanks is by a 1,500-gallon tank, once monthly, as needed, from Roosevelt Roads; no one could remember the last waste oil shipment.

Some rags, paper, and other waste is open-air burned in 55-gallon drums; usually a burn takes 10 minutes once a week.

7.3.5 Pico del Este. Solid waste generated at the site is placed in a dumpster which is picked up by a private contractor and disposed of at the Roosevelt Roads station landfill. Sewage treatment is provided by two 1,000-gallon septic tanks which are cleaned and maintained on a regular basis by the Public Works Department. Electric power is provided commercially by the Puerto Rico Electric Power Authority (PREPA), with backup power provided by four emergency generators. Diesel fuel for the generators is stored in an aboveground 1,000-gallon tank, an inground 3,000-gallon tank, and a 500-gallon day tank. The aboveground 1,000-gallon diesel fuel tank, which is located behind the generator building and adjacent to the NJS, has leaked in the past, resulting in stressed vegetation and black oil stains in the vicinity of the tank. The exterior surface of the tank is blistered, and for this reason, has been scheduled for replacement.

An incinerator is used for the destruction of classified material.

7.3.6 NAVSTA Roosevelt Roads, West Annex, Aguadilla. NAVSTA Roosevelt Roads currently owns 11 buildings at the former Ramey Air Force Base in Punta Borinquen. The Navy acquired the buildings in 1973 when the U.S. Air Force excessed Ramey. Two of the buildings (Buildings 561 and 703) are leased to the Commonwealth of Puerto Rico, which in turn leases the buildings for commercial use.

All of the buildings owned by the Navy at Ramey have been declared excess and are awaiting disposal through GSA. An on-site survey was conducted in 1982 to determine PCB compliance. NAVSTA Roosevelt Roads, West Annex, Aquadilla, is in compliance with the PCB regulations as set forth in 40 CFR Part 761.

CHAPTER 8. DISPOSAL SITES AND POTENTIALLY CONTAMINATED AREAS

8.1 SITE 1, QUEBRADA DISPOSAL SITE, VIEQUES. This disposal site is located in a quebrada (an intermittent drainage area) south of North Shore Road in the north-central portion of the Naval Ammunition Facility (NAF), Vieques. A dirt road, present along the east side of the quebrada, facilitated easy access to the site. The site was in use from the early 1960s to the late 1970s by both civilian and U.S. Navy personnel (see Figure 8-1).

No records of the disposal site were found at the archives or in the base files; none of the base personnel were aware the site existed. The site had not been previously noted during the various environmental surveys done on the islands. This is not surprising, since the site is impossible to see from Route 70, and nearly invisible even from a helicopter. The U.S. Fish and Wildlife Service representative at NAF Vieques found the site solely by accident.

Site boundaries extend approximately 500 feet along the quebrada in a southerly direction from North Shore Road. The quebrada varies from 20 to 30 feet wide and 10 to 20 feet deep. It is estimated that there are over 1,500 cubic yards (500 feet x 20 feet x 4 feet) of material present at the site, including buried and exposed apparently empty 55-gallon drums, ordnance carriers (2.75-inch rocket launchers), POL, solvent and paint cans, rubble, fluorescent light fixtures, and cars as well as all types of base trash including glass, metal, tires, wood, etc. The material had been tumbled over the side of the quebrada, apparently beginning at the southern end of the quebrada and moving northward along the east side of the quebrada. Attempts had been made to shore up the sides of the quebrada where the material had been deposited. Several steel posts, usually used by combat engineers to string barbed wire or other fencing material, had been driven into the sides of the quebrada apparently to stabilize the mass of disposed material. Some of the material, especially solvent containers, have become detached from the main pile and were lying in the silt and sand at the bottom of the quebrada, where they had apparently been washed to when water was flowing in the quebrada.

Estimating the amount of potentially hazardous material that may have been disposed of at this site is difficult. The assumption will be made that no more than one percent of the material is hazardous, based on the low level of industrial-type activity at NAF, Vieques. One percent of 1,500 cubic yards is 15 cubic yards; using the figure of roughly 800 pounds per cubic yard for municipal garbage (Tchobanoglous et al., 1977), approximately 12,000 pounds or six tons of hazardous material may have been disposed of at this site.

8.2 SITE 2, MANGROVE DISPOSAL SITE, VIEQUES. The mangrove disposal site (see Figure 8-1) is located in an 18-acre oceanside mangrove swamp in Laguna Arenas along North Shore Road (Route 70) on the NAF, Vieques. This site was used as a base disposal area during the 1960s and 1970s. Materials present at the site include all types of base trash (glass, metal, wood, etc.), POL, solvent and paint cans, and rubble. These materials extend northeast from the Laguna Kiani Bridge approximately 300 feet, and into the mangrove swamp for about 100 to 120 feet in a northerly direction and about 10 feet in a southerly direction from North Shore Road. The IAS team estimated that there are 800 cubic yards

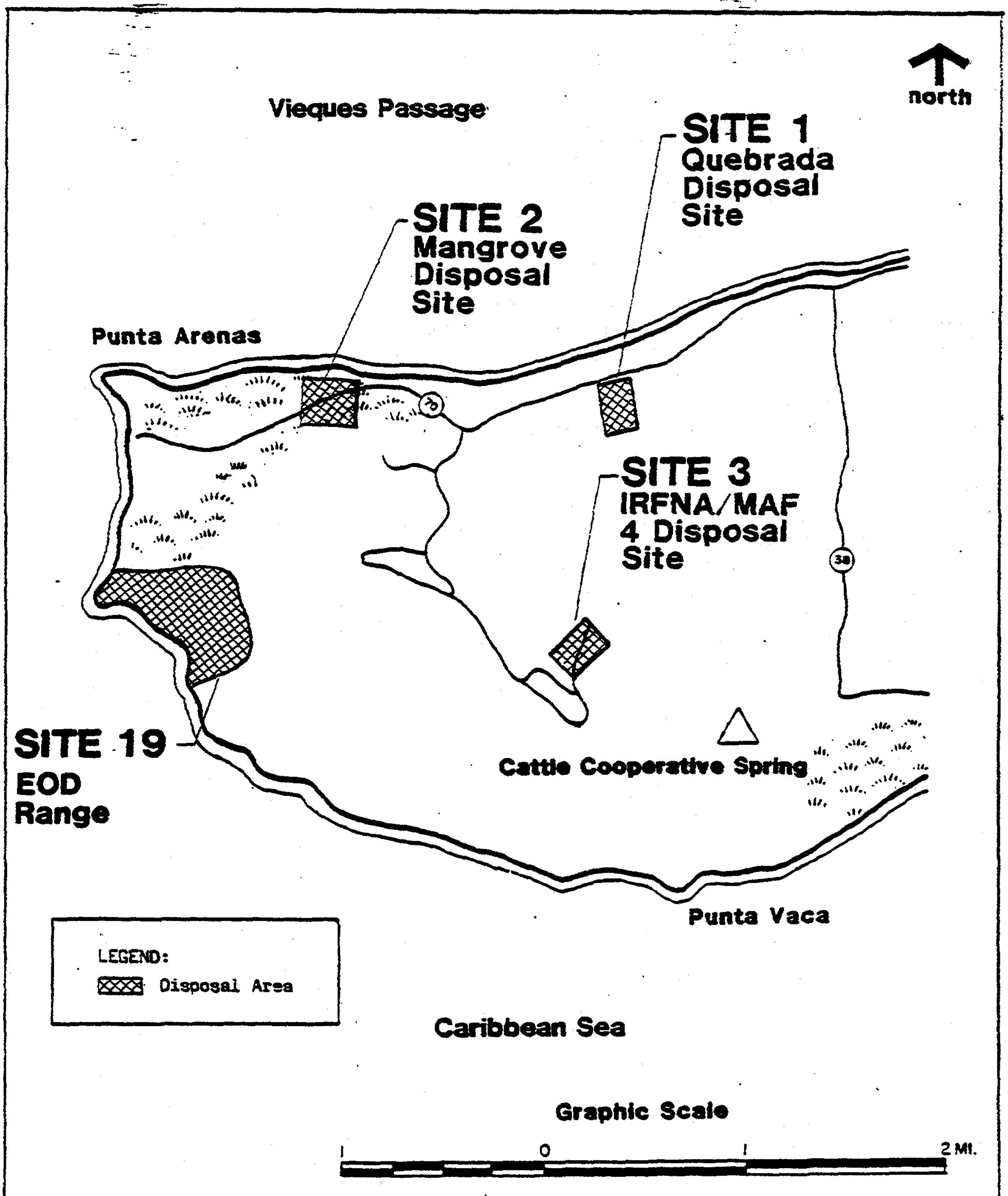


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FIGURE 8-1
SITE MAP-
SITES 1, 2, 3, & 19

(100 feet x 75 feet x 3 feet) of materials at the site. The material was apparently piled up, burned, and then bulldozed into the mangrove area. This practice continued to 1978.

Using the parameters mentioned above, as much as eight cubic yards of material weighing 6,400 pounds could be considered potentially hazardous. The fact that the material was burned increases the likelihood of contaminant migration.

These materials are in an existing mangrove. Two previous environmental studies (TAMS/E & E, 1979 and Lewis et al., 1981) recommended that the material be removed from the site to eliminate it as a source of contamination.

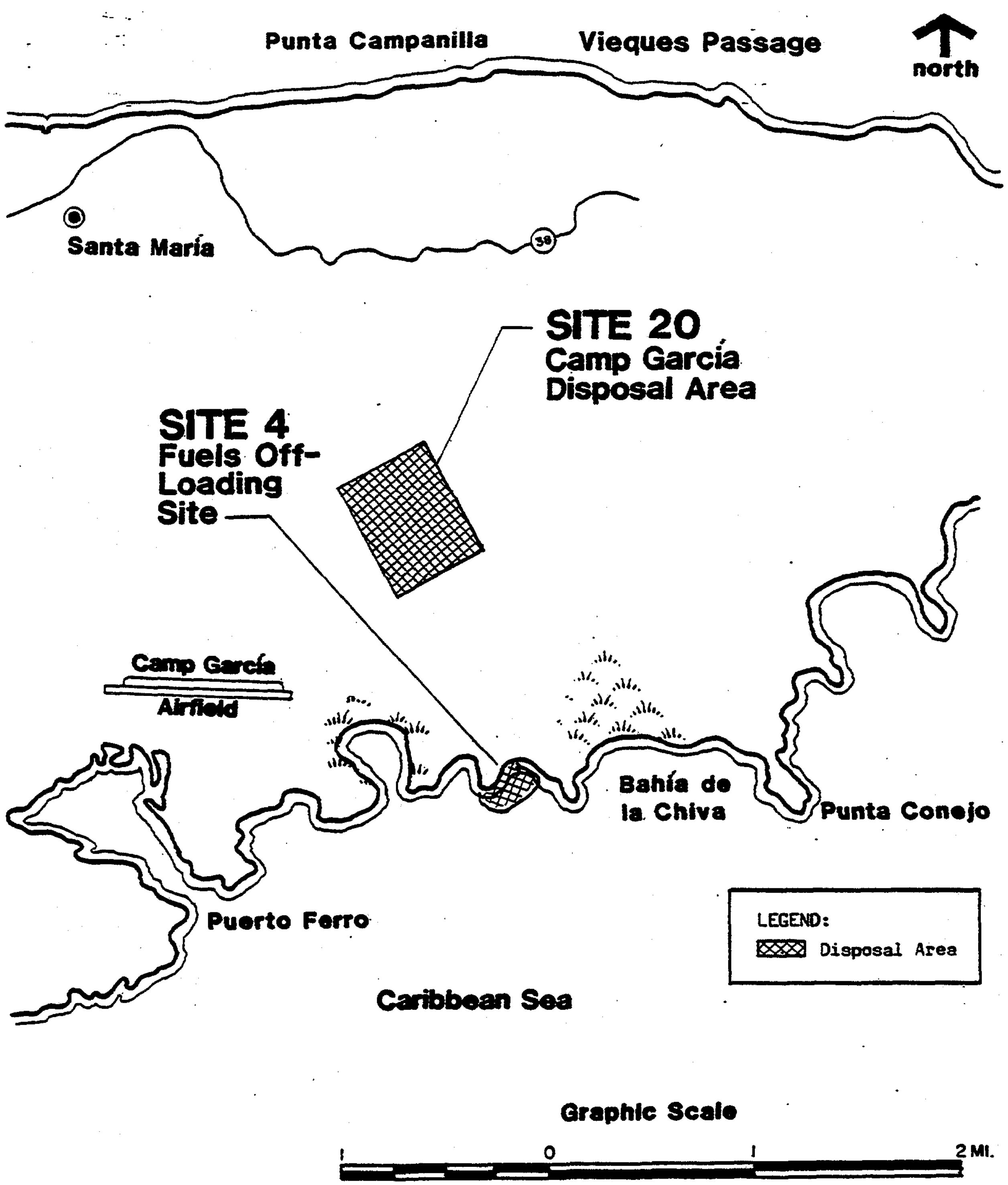
8.3 SITE 3, IRFNA/MAF-4 DISPOSAL SITE, VIEQUES. In 1975 Weapons Department personnel at NAVSTA Roosevelt Roads disposed of 25 AQM-37As on and near the island of Vieques (see Figure 8-1). The AQM-37A is a target drone capable of supersonic speeds. The 25 drones were found to be leaking. The fuel, consisting of 71 pounds of mixed amine fuel (MAF-4) and 211 pounds of inhibited red fuming nitric acid (IRFNA) per drone, was drained into a quebrada at the low spot in the road near Building 422 on the NAF, Vieques. A maximum total of 1,775 pounds of MAF-4 and 5,275 pounds of IRFNA were emptied into the quebrada, and the drone bodies were disposed of by dropping them into the ocean off a deep water ledge, where other ordnance items had been disposed of in the past.

The quebrada where the disposal took place is in the probable surface recharge area for one of the few naturally occurring springs on Vieques that runs year-round. The spring is currently used by the Cooperativa de los Ganaderos, a livestock raising cooperative, and is supplemented by water obtained from the pipeline from Vieques. The spring is frequently used by cattle, horses, and various birds and other wildlife. When the cooperative wants to count or brand the livestock, all supplemental water sources are withdrawn so that the livestock are attracted to the spring and can be easily captured. At these times, which correspond to the dry season, the spring is used extensively by livestock and wildlife.

Examination of the area where the fuel releases occurred disclosed no extensive areas of vegetation damage or any other indications of the incident. Indeed, interviewees stated that livestock were seen drinking from the puddles of fuel immediately after the release. The IRFNA most likely dispersed rapidly; however, the amines in the MAF could, given proper conditions, be somewhat persistent in the sandy soil present at the site.

8.4 SITE 4, FUELS OFF-LOADING SITE, VIEQUES. The fuel off-loading site (see Figure 8-2) is located off the south coast of Vieques at Camp García east of Bahía de la Chiva (Blue Beach). Four aboveground fuel tanks were constructed on a hill to the west overlooking the cove. The tanks were in use from 1953 to the late 1970s. They were removed between 1978 and 1979, and sold for scrap metal on the commercial market. A small amount of rubble is present at the former fuel tank site on the hilltop overlooking the off-loading site.

While in use, the tanks were filled with diesel fuel, unleaded gasoline (MOGAS), AVGAS, and JP-5 fuel. Two tanks had a capacity of 20,000 gallons; the other two tanks had a capacity of 30,000 gallons. Each tank was filled from an offshore barge every three months for approximately 25 years (to 1974). Fuel was pumped from the barge through an eight-inch submarine line to the tanks.



LEGEND:
Disposal Area

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FIGURE 8-2
SITE 4, FUELS OFF-LOADING SITE
SITE 20, CAMP GARCIA DISPOSAL
AREA, VIEQUES ISLAND

The line ran from the tanks to a buoy about 1,500 feet from the shoreline. During each refueling period it was necessary to flush the seawater from the hoses. This resulted in the discharge of approximately 1,000 gallons of fuel to the land and sea per refueling period. The tanks were filled a maximum of four times a year for about 25 years, resulting in a maximum of approximately 100,000 gallons (4 refueling periods x 25 years x gallons spilled per refueling operation) of fuel discharged to the ocean. While the total amount of fuel spilled seems significant, several factors contributed to the mitigation of the spills. The timing of the refueling operations (once every three months), combined with the relatively small amounts (estimated at 250 gallons) of each spill, allowed sea and wind currents to disperse and dilute the fuel. No accumulative effects were noticed, even during the intensive and extensive environmental assessment of the area conducted in 1978.

8.5 SITE 5, ARMY CREMATOR DISPOSAL AREA. This site was used as the primary station landfill from the early 1940s, when the Naval Station was first established, to the early 1960s (see Figure 8-3). The site was also used by the U.S. Army from the early 1940s through 1957 for the disposal of wastes from Fort Bundy. Early base maps labeled this area the "Army Cremator." The landfill was operated by the Public Works Transportation Division, with an individual stationed at the landfill on a full-time basis. Access to the landfill was made via a dirt road which began at Langley Drive just north of the location of the new bowling alley and looped to the Army Pier access road. Disposal activities occurred on both sides of the access road right up to the perimeter of the Ensenada Honda mangrove area.

All wastes generated at the station were disposed of at this landfill. Some segregation of metals and ordinary refuse was attempted, although no one interviewed could remember the exact locations of the specific disposal areas. The trash was dumped in mounds and burned every afternoon, and the remains were compacted with a bulldozer. No trenches were used and no daily cover was applied.

It is estimated that 10 to 20 tons per day of refuse were disposed of in this area. Material disposed of at the site included scrap metal, inert ordnance, old batteries, tires, appliances, cars, cables, dry cleaning solvent cans, paint cans, gas cylinders, construction debris, dead animals, and residential wastes. No records of the quantities of hazardous waste that may have been disposed of at the site were kept. However, using a factor of 1% for hazardous waste, a range can be estimated thus: (10 to 20 tons/day) x (200 working days/year) x (20 years) x (1% hazardous waste) = 400 to 800 tons of hazardous material in this area.

Also, during the IAS team's overflight, several large mounds of drums were detected from the air. The drums were in a rusted condition; some appeared to be intact. The mounds were located near the mangroves. An on-ground visual inspection of the drum areas was attempted by the IAS team, but vegetation in the area was too dense and the drums could not be located. Based on the types of material found in other discarded containers throughout the base, the intact drums probably contain solvents, paints, and other material that could be considered flammable or otherwise hazardous.

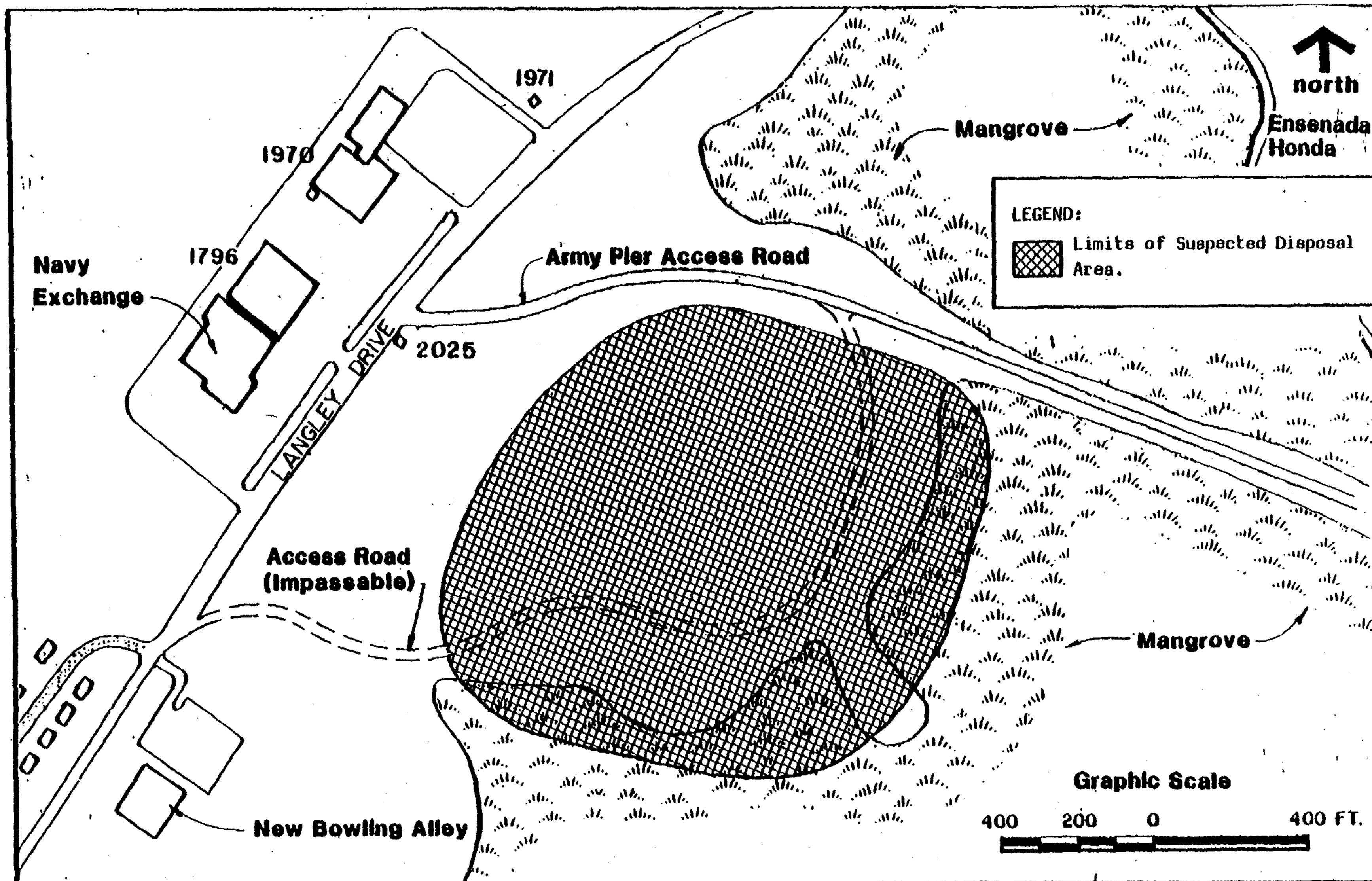

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FIGURE 8-3
SITE 5, ARMY CREMATOR DISPOSAL AREA

RR-00032-01.05-09/01/84

8.6 SITE 6. LANGLEY DRIVE DISPOSAL SITE. The Langley Drive disposal site (see Figure 8-4) is located approximately 2,000 feet north along Langley Drive from the Navy Exchange Complex and 300 feet east of the drive towards Ensenada Honda. The site is within the perimeter of the Ensenada Honda mangrove area, with heavy to moderate vegetation cover. Sparse ground cover exists within the immediate area of the disposed material. The site is inhabited by a population of rather large land crabs. The site allegedly had been used between 1939 and 1959. No record exists of its use; the IAS team was led to the site by a Public Works person who knew of the site.

Review of historical aerial photographs and general development maps show that the area along Langley Drive had once been clear of brush vegetation from the road to the mangrove perimeter. On an aerial photograph dated 8 January 1951, an unmarked dirt road is evident from Langley Drive to the mangrove area. Areas of surface disturbance indicative of a landfill operation extend from this dirt road. The total area of disturbance is estimated at 15,000 square feet. Other smaller areas of disturbance were also identified north along the Langley Drive corridor on the bayside.

A 15 January 1964 aerial photograph of the area shows an established vegetative cover. However, in the previous area of disturbance, the developing vegetation is limited to light ground cover. By 1972 brush type vegetation was established, except at a small location which was shown to be also disturbed in 1951.

Materials found during the site inspection included approximately 10 to 15 full 55-gallon drums, large metal and concrete objects, various sized sample containers (one containing pellets), old fuel lines, flexible metal hoses, steel cables, hardened tar, and rubble. Most of the materials were partially buried, with only a few items lying free on the surface. Most of the drums and other metallic objects showed deterioration and corrosion. The solid contents of some of the drums had become exposed. This exposed material had a discolored green crust about 1/2-inch thick, encasing a whitish compound with the consistency of semi-dry plaster.

With the exception of the 55-gallon drums, little if any of the other material could be classified as hazardous. The majority of the material seems to be construction debris or demolition rubble; the other items share the characteristics of being rather large and unwieldy objects (hoses, fuel lines, cable). The rubble debris and larger items seem to have been disposed of in a manner consistent with filling in the mangrove swamps to create new land. The drums, on the other hand, rest on the surface of the made land for the most part, and seem to have been disposed of at a later date.

The volume of material in the immediate area of investigation was estimated to be 300 cubic yards. However, within the 300-foot distance between this area and the Langley Drive corridor, smaller disposal piles (approximately two to five cubic yards in volume) are scattered. At these sites similar types of materials were found, consisting of metal and concrete objects, piping, and rubble. Much of this material was also partially buried. The IAS team found it impossible to fully investigate this area. It is likely that other material is present in the area. The IAS team considers the contents of the drums to

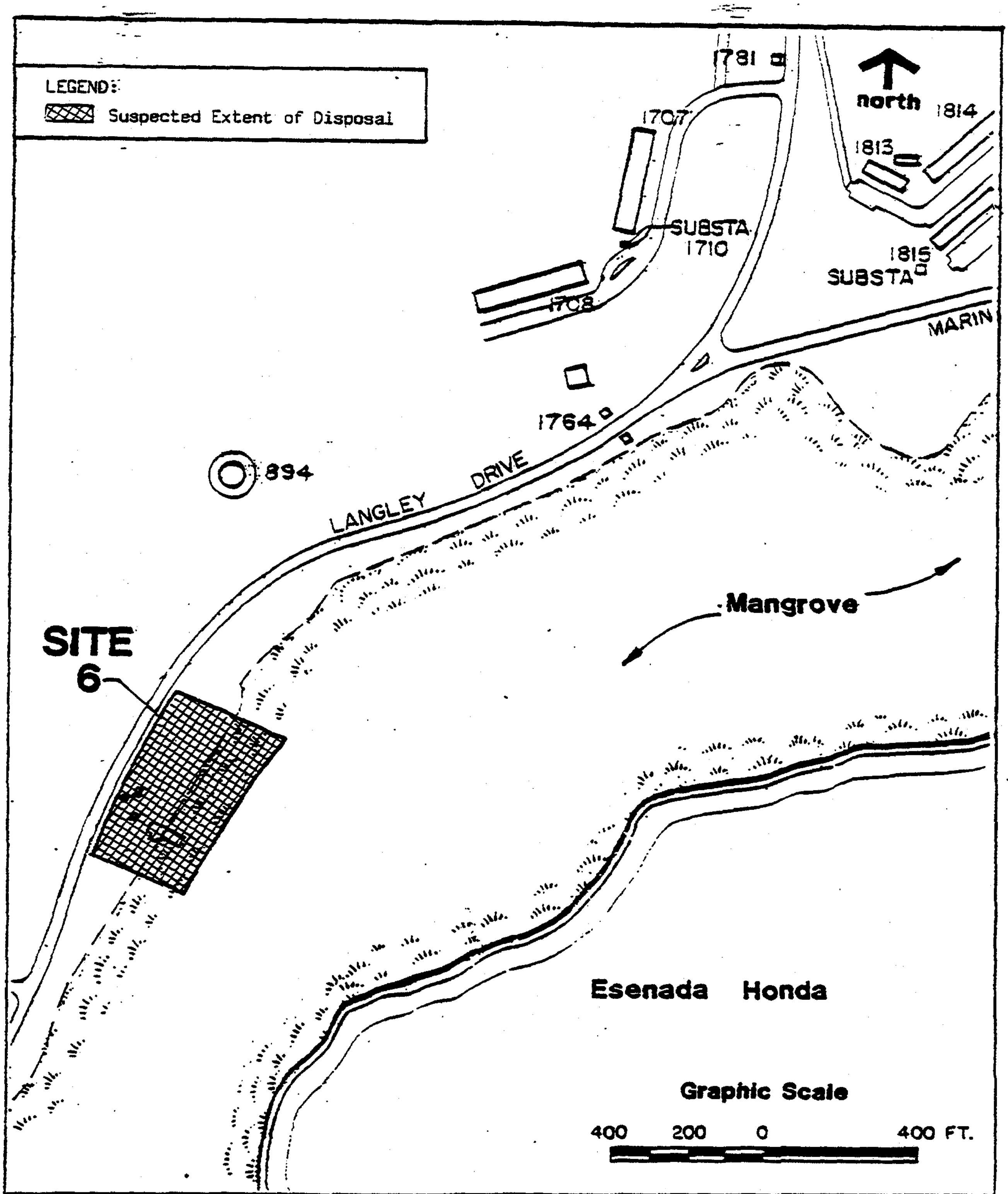

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FIGURE 8-4
SITE 6, LANGLEY DRIVE SITE

be potentially hazardous, so that as much as 800 pounds (20 drums x 50 gallons x 8 pounds/gallon) of hazardous material may be present.

8.7 SITE 7, STATION LANDFILL. This site has been used as the activity landfill since the early 1960s, when the Army Cremator disposal site (Site 5) was abandoned. The disposal of hazardous material at this site was halted in 1978. A map of the area is shown on Figure 3-5. The landfill site encompasses 85 acres of land, most of which has been used for waste disposal (see Figure 8-5). Prior to 1970 the Public Works Transportation Division was responsible for the collection of refuse and operation of the landfill. From 1970 through the present a private contractor has been contracted for refuse collection. From 1980 to the present a private contractor has operated the landfill.

Disposal methods used at the site consisted of excavating a trench to the water table, filling the trench in with waste materials, spreading and compacting this material with a bulldozer, and then covering the area with soil. Estimates of quantities of waste disposed of in the past range from 40 to 60 tons per day. Materials known to have been disposed of at the site include residential wastes, foreign cooked garbage, scrap metal, cables, paint waste, solvents, PCBs, OTTO Fuel II, Agentine, pesticides, lubricating oil, dead animals, digested sludge, construction debris, and possibly Super Tropical Bleach (STB), a decontaminating agent.

From the early 1960s through the mid-1970s, the Weapons Support Detachment of AFWTF disposed of contaminated OTTO Fuel II and Agentine at the landfill at the maximum rate of 10 55-gallon drums per month. The Power Distribution Shop disposed of 55-gallon drums of Askarel, a PCB fluid, which had been drained from transformers, as well as a one-time (1968) disposal of approximately 40 five-gallon cans of Askarel. The five-gallon cans of Askarel, which had been stored in Building 31, were never opened, and were in a rusted condition at the time of disposal. Old pole-mounted transformers, possibly containing 30 to 75 gallons of contaminated PCB oils each, were disposed of at a rate of eight per year for approximately 12 years.

There are several disposal areas within the landfill. The "scrap metal area" was originally designed as a storage area for scrap metal recycling. It covers an acre, and in addition to hundreds of car bodies and other scrap metal objects, contains solvents, lubricants, and aqueous film-forming foam (AFFF) containers which have leaked to the soil. South of the metals area in the landfill, a ditch containing approximately 10 leaking 55-gallon drums of what appears to be an oily substance has been recently discovered. The ditch was dug to the water level, and the oil is mixed with the ground water. Just to the north of the drum ditch is an area that has been used for asbestos disposal. The area is approximately 10 yards in diameter, as estimated from the presence of stressed vegetation. This area lies next to a main access road and is marked with only one faded sign. The asbestos disposal area is not segregated from the rest of the landfill, nor is direct human contact precluded. The cover over the area is disturbed, and totally lacking in vegetation.

To the south of the drum ditch, and generally lying between the active portion of the landfill and Ensenda Honda, are a number of disposal areas overgrown with vegetation which are undetectable from the ground. These areas appear to contain primarily metal items that have been placed on the ground, rather than

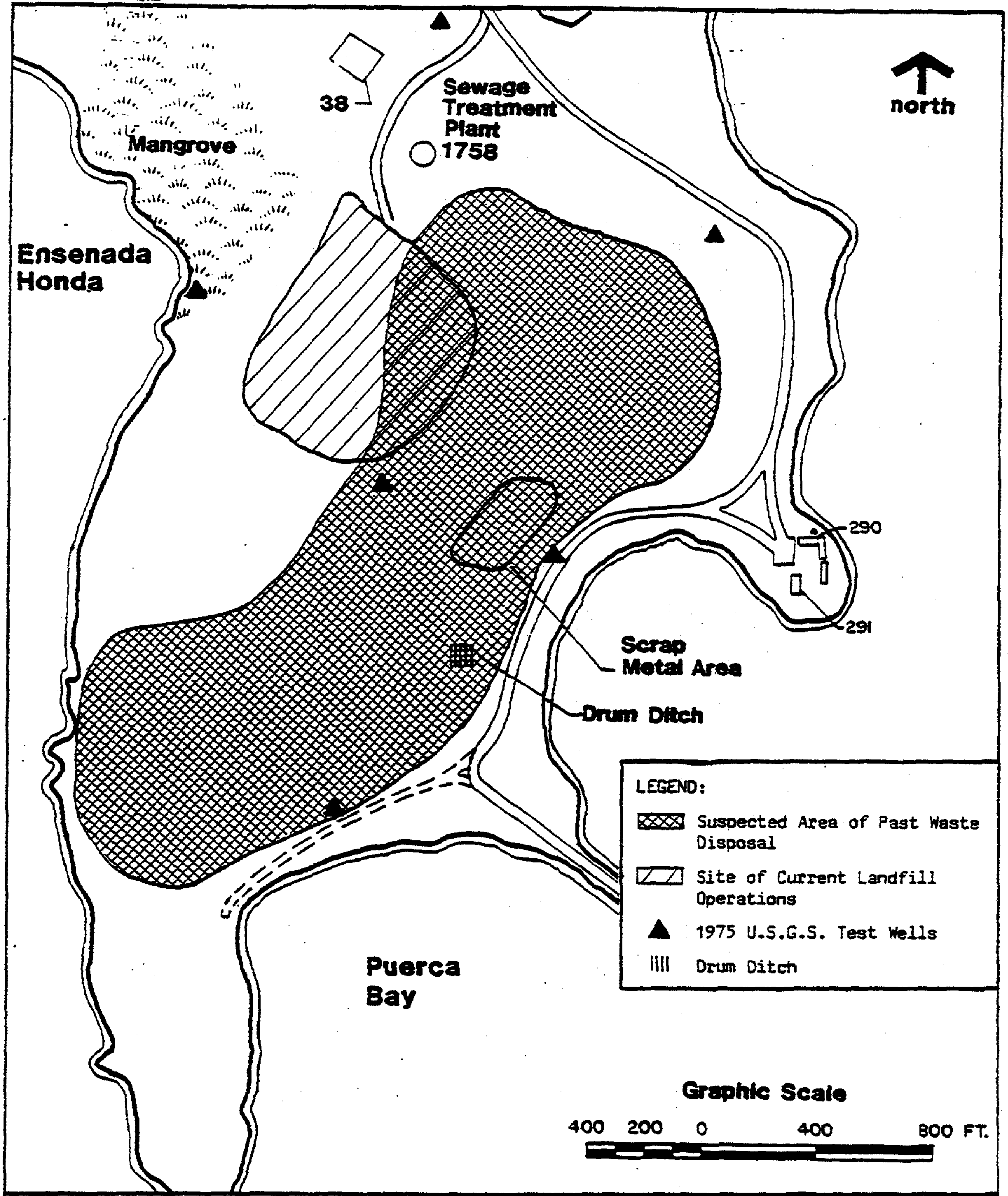

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FIGURE 8-5
SITE 7, STATION LANDFILL

buried. These materials vary from isolated metal items to piles of drums, approximately five yards in diameter and six to eight feet in height. There are an estimated 50 intact 55-gallon drums. Based on material found in drums elsewhere on the base, it is probable that the drums contain hazardous material.

One area of the landfill, south of the scrap metal area and east of the drum ditch, has been used for sand borrowing. This has uncovered old garbage, and has resulted in the water table appearing at the land surface. Inert ordnance items have been found in this area.

Areas of stressed vegetation are apparent throughout the landfill. In some areas it is probable that the vegetation is stressed due to the nature of the fill originally used to create the landfill; other areas are probably stressed due to the nature of the materials disposed of there.

8.8 SITE 8, DRONE WASHDOWN. The drone washdown area (see Figure 8-6) is located at Building 860 (Aerial Target Systems Department). The drones are launched from Cabras Island at the eastern entrance to Roosevelt Roads Harbor. Drones that are not destroyed during the presentation are recovered by helicopter in the Pasaje de Vieques for reuse and returned to Building 860. This operation has been active there since about 1961. Between 1961 and 1969 the Aerial Target Systems Activity averaged 125 presentations per year, totaling about 1,000 presentations. Since Radio Corporation of America, Inc., (RCA) received the contract in 1969, approximately 4,000 presentations have been conducted, bringing the total to approximately 5,000 presentations over a 20-year period.

After each presentation the outside of the drone is washed with freshwater to remove the saltwater and marker dye, and any remaining fuel is removed from the fuel tank. In the past this was done outside Building 860, where the fuel and wastewater were disposed of in a drainage ditch which flows into a mangrove swamp and eventually into the harbor. From about 1960 to the mid-1970s all contaminated fuels (JP-4 and JP-5) and oil were disposed of in this ditch. During this estimated 15-year period, about 2,500 presentations occurred. Estimating one to two gallons of unused fuel per drone, about 2,500 to 5,000 gallons of JP-4 and JP-5 fuel were disposed of in the unlined earthen drainage ditch. An undetermined amount of oil was also routinely disposed of in this ditch.

In the mid-1970s an underground oil separator was constructed outside Building 860 to prevent any oil or fuel from the drone washdown procedure from entering the drainage ditch and storm sewer system. A tank truck (1,500-gallon capacity) is used to siphon the fuel from the oil separator. Any oil or fuel removed from the drones is also disposed of in this tank truck. Until about 1982 the tank truck was emptied by the Public Works Department and disposed of by DPDO on a monthly basis; since this time it has normally been emptied every three or four months.

Until about 1983, the oil separator would overflow into the adjacent storm sewer system during periods of heavy rainfall. This problem was corrected by the installation of a valve on the pipe between the separator and storm sewer which, if closed, can stop the flow of oil into the storm sewer.

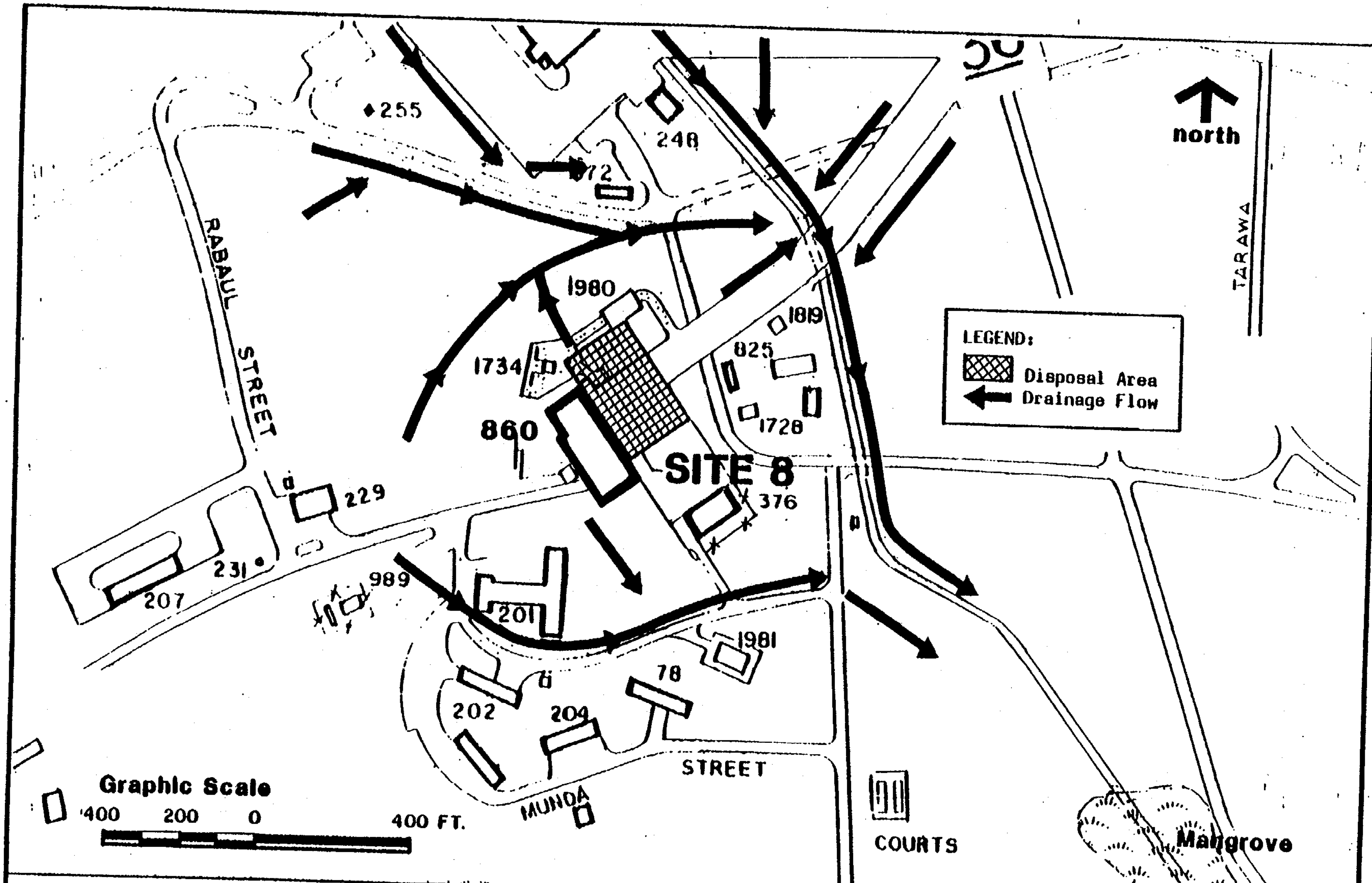

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FIGURE 8-6
SITE 8, DRONE WASHDOWN

8.9 SITE 9, PCB DISPOSAL, DRY DOCK AREA. In approximately 1968 the Power Distribution Shop made a one-time dumping of excess PCB fluid into the ocean at the dry dock wharf (see Figure 8-7). Twenty-five five-gallon cans of Askarel were disposed of into the ocean on the southern side of the wharf between the second and third berths. Some of the cans, which had been stored in Building 31 (Public Works) for some time, were in a rusted condition at the time of the dumping.

8.10 SITE 10, BUILDING 25 STORAGE AREA. Building 25 was used from 1951 until the structure collapsed in 1979 by the Public Works-Supply Department for temporary storage of materials to be turned over to DPDO (see Figure 8-8). The entire area around the building was used for open storage of drummed material from at least 1957, according to aerial photographs.

The entire area in and around the collapsed building is overgrown with vegetation, although historical aerial photographs show the area to be relatively free of vegetation other than ground cover through 1977.

Materials found in and around Building 25 include 20 to 25 apparently empty to partially filled 55-gallon drums; 10 to 15 five-gallon pails; office furniture; mechanical devices; construction rubble; industrial gas cylinders; asbestos sheeting; fiberglass buoys; and transformers.

Of particular interest are the five-gallon pails, the drums, and a large transformer found at the collapsed building. The five-gallon pails have become corroded, exposing a substance similar to that found at the Langley Drive site (Site 6, see Section 8.6). The compound has a green-colored crust about 1/2-inch thick, encasing a white material with the consistency of semi-dry plaster. A large transformer is lying on its side at the east corner of the building. No evidence of oil leakage was apparent.

Material was also found along the various access roads and consisted of drums, office furniture, asbestos, rubber, and a pole-mounted transformer from which oil has leaked. Some of these areas exhibited stressed vegetation. There are several other areas of disposed material (about five acres) between the access routes. A 1957 photograph taken by a tenant activity shows that the area around Building 145 was used as a general storage area for several hundred drums. During the IAS team's overflight, CONEX containers were also found in a clearing in this area.

Near Building 31 evidence of a similar type of storage operation was found. Approximately 50 drums were found within the vegetation bordering the north side of the Building 31 transportation lot. Most of the drums are full to partially full of unknown contents. The Public Works Department attempted to remove some of these drums; however, the condition of the drums resulted in massive leakage. The spill contaminated a flatbed truck before running onto the ground, staining an approximately 10-foot-diameter circle of soil. An extremely strong creosote or solvent odor was present. These drums and the spill can be easily accessed by base personnel. The spilled material was identified by the Navy as asphalt, and will be sent to DPDO for sale or reuse. Three drums were not identified and are being held.

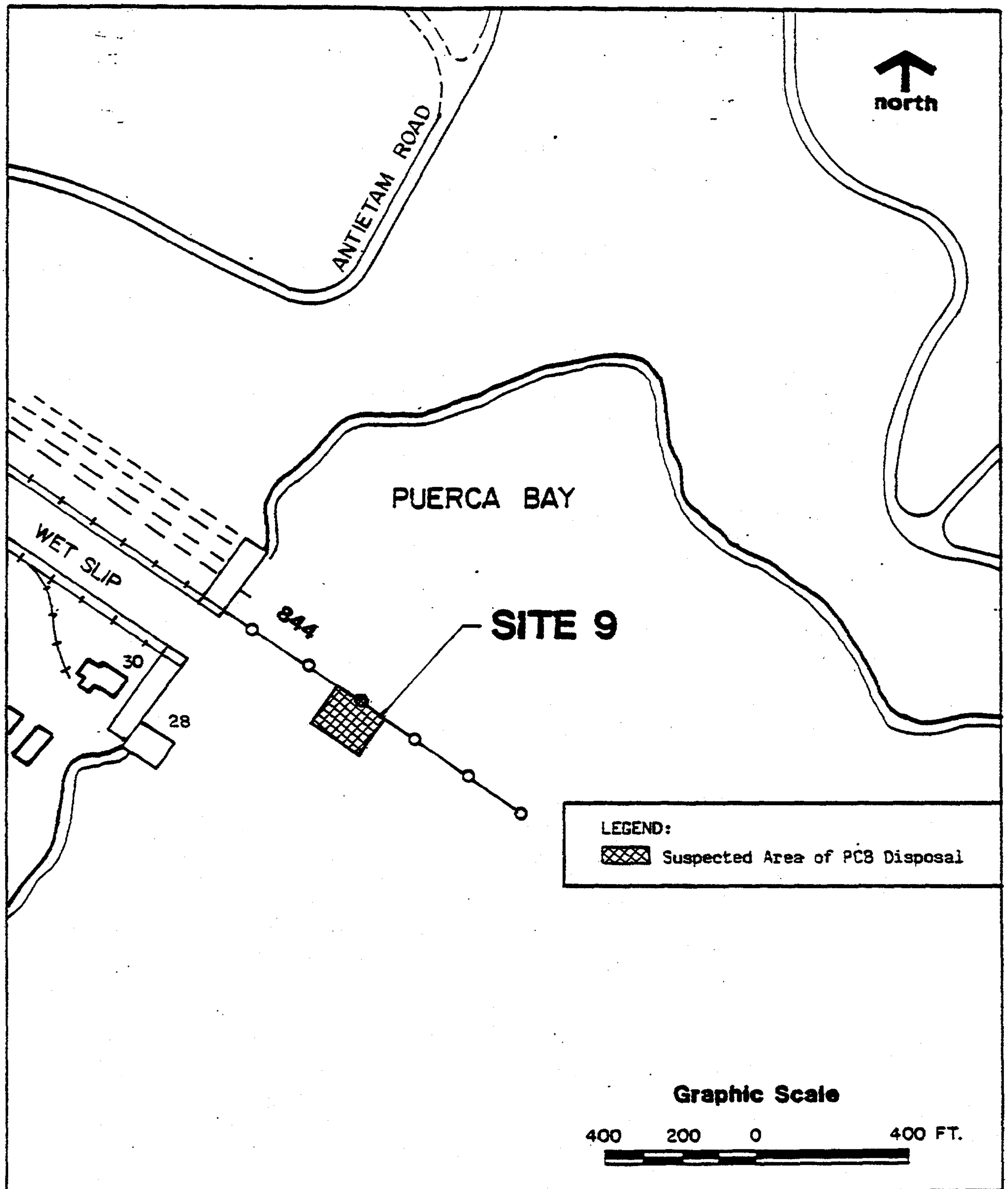

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FIGURE 8-7
SITE 9, PCB DISPOSAL
DRY DOCK AREA

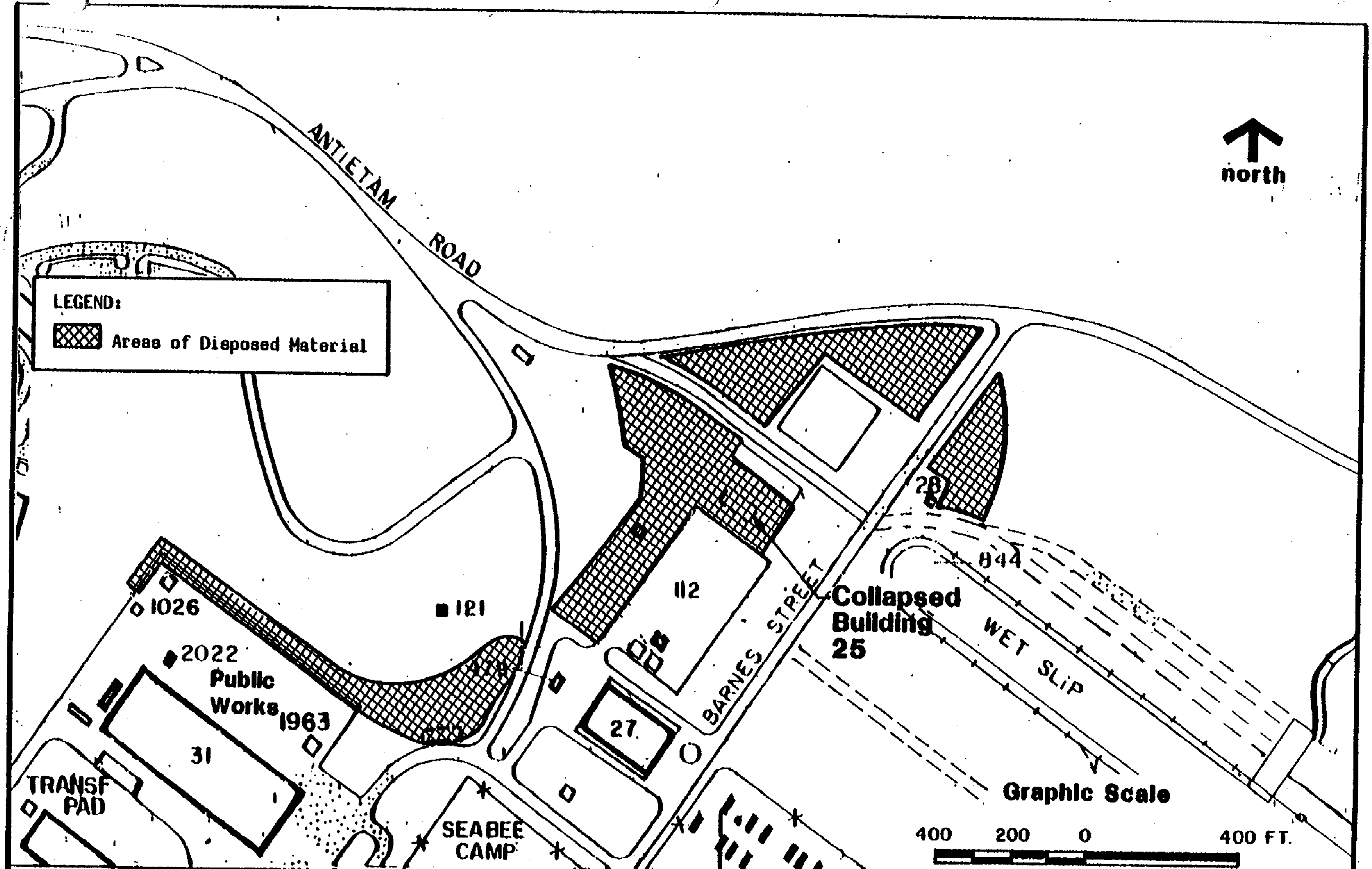

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FIGURE 8-8
SITE 10, Building 25 Storage Area

The IAS team estimates that about 50 to 75 drums of hazardous material are present at the site, along with some small (less than 25 gallons) amounts of fluids possibly containing PCBs in the transformers.

8.11 SITE 11, BUILDING 145. Building 145 (see Figure 8-9) contains an estimated 60 55-gallon drums, about 100 five-gallon pails, and a number of other small containers. The building is a concrete bunker about 60 yards long, about seven feet high, and eight feet wide. There are three openings to the surface through the roof that are covered with dilapidated wood structures, and one entrance at ground level. The walls and roof are made of reinforced concrete over a foot thick.

Various suggestions have been made as to the probable intended use of the structure. The building is not shown or listed on the earlier maps of the station. The first reference found to the building by the IAS team is on a map dated 1959; no function for the building is ever listed. The only other structures that are not shown on early (1939-1959) maps are those associated with the alleged planned evacuation of the British Royal Fleet, such as the Pineros Island bunker system. It is most probable that the structure was to be used in conjunction with the dry dock.

The building has been used for the storage of materials for at least 25 years based on interviews with base personnel. This is supported by the shipping dates found on the containers.

The containers are in three distinct areas within the tunnel. At the very rear, about 20 or 25 drums have been randomly placed (not dropped through the roof opening directly above, however). The drums are rusted; some have the bungs removed, and some have obviously leaked. Most seem empty or only partially full. Just past the midpoint of the tunnel, toward the rear, are approximately 100 five-gallon pails. The pails are tumbled about and prevent access to the rear of the tunnel. The pails seem to be filled.

Some old office furniture and other metal objects are in the center of the tunnel, which is a low point caused by the floor sloping in both directions toward the center. One of the three roof openings occurs here, and water has collected in a pool about 10 yards long, up to six inches deep, stretching between the walls. Roots from trees at ground level, about eight feet above the tunnel floor, have entered the roof opening and have grown into the pool of water.

Between the pool and the entrance are a number of 55-gallon drums, several five-gallon pails, and some smaller containers. All of these containers are neatly organized and stacked, and some are stored on metal pallets. Most of the containers were full. Some spills of material are also present.

Samples were taken by the IAS team from 21 55-gallon drums, eight five-gallon pails, and three other areas of spills or other materials. The containers sampled by the IAS team ranged from drums with fairly discernible markings and intact bung seals, to drums and pails that had obviously been opened, emptied of the original contents, and used for disposal of waste material. Material identified by sight by the IAS team included Navy gray paint, olive drab paint, black boot polish, and some adhesives. The materials sampled underwent anal-

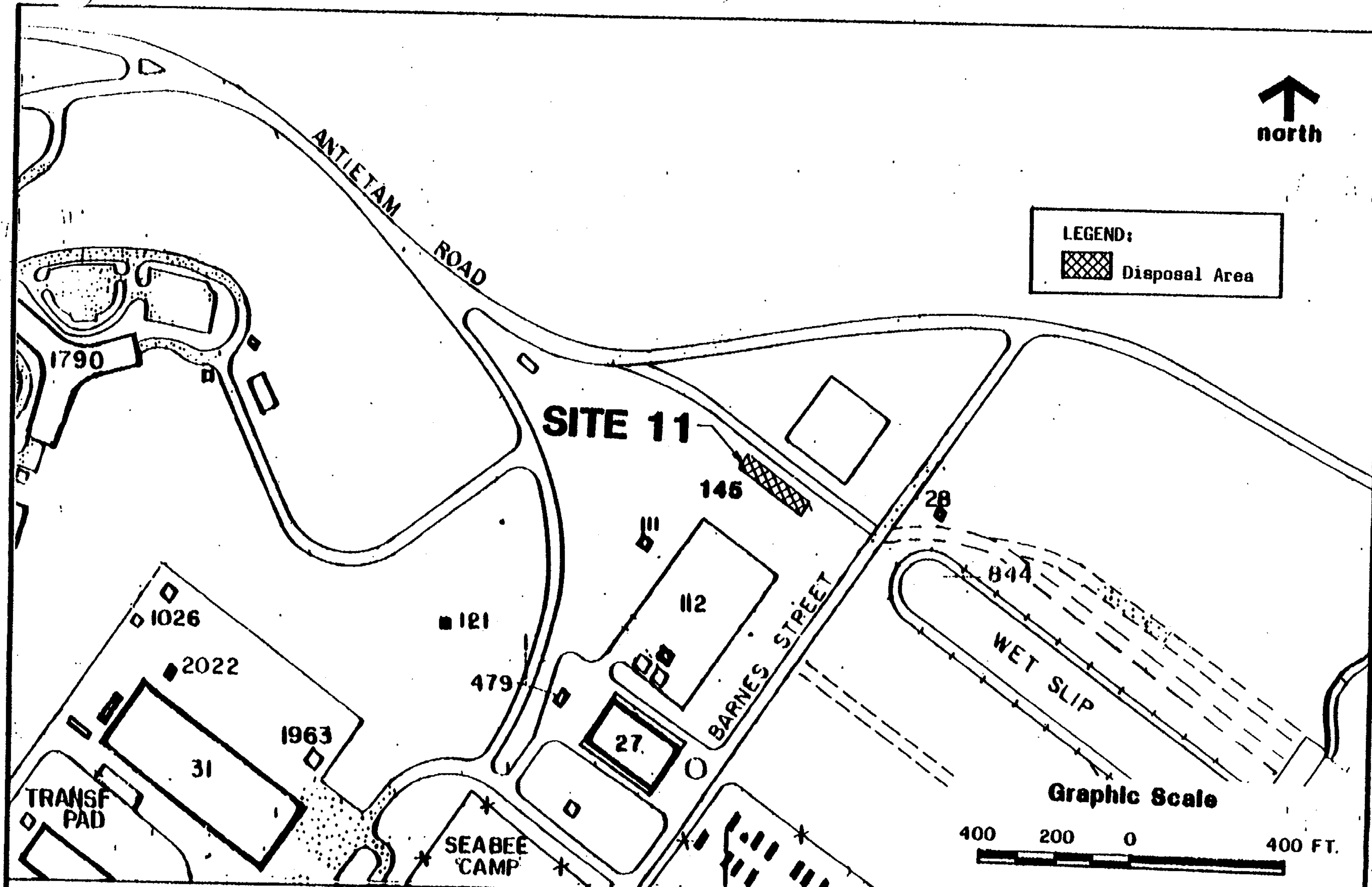

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FIGURE 8-9
SITE 11, BUILDING 145

ysis by contract laboratories under hire to Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM).

Markings on the containers included such items as "C-610/Corrosion Preventative, Aircraft"; "From Supply Officer, Newport News Ship Yard, Portsmouth, Virginia to Supply Officer, Roosevelt Roads"; "Paint, semi-gloss, rapid drying, olive drab, March 1959"; "Dupont-GRX Methanol"; "195_, Cheatam Annex"; and "Sherwin Williams Boot Topping."

All of the containers can be assumed to contain hazardous materials. Other material in and around the building includes ships tackle and various bolts, nuts, and other fastening devices.

8.12 SITE 12, TWO WAY ROAD FUELS FARM. The fuels farm (see Figure 8-10) is located northeast of Two Way Road on a hill overlooking Ensenada Honda and consists of a number of different tanks. Tank 1080 has a capacity of 1,134,000 gallons and was used to store diesel fuel. In 1978 a leak occurred at Tank 1080, resulting in the release of approximately 65,000 gallons of diesel fuel from the tank. The fuel flowed downhill, south of Tanks 82 and 83 and north of Tanks 1083 and 84, into the storm drain at the base of the hill and across Two Way Road into Ensenada Honda (north of the fuel pier). The fuel entered the harbor, reaching the Ensenada Honda mangrove area on the southwest side of the harbor, due in part to very windy weather conditions that day.

Cleanup procedures included the use of cloth absorbent diapers to remove the fuel, digging a leaching trench with a backhoe, placing booms across the harbor, and using an oil skimmer with an oil-water separator to recover the fuel. It is estimated that about 10,000 gallons were recovered during cleanup operations. The reclaimed fuel and absorbent pads were taken to the Public Works Department for disposal. A private contractor also assisted in the disposal effort. This included the disposal of several 55-gallon drums of absorbent pads in the Fajardo Landfill, as well as the delivery of approximately 60 drums of pads to the Crash Crew for burning during training operations.

Along the path of the fuel spill (approximately 1,000 feet long and 200 feet wide) vegetation remains stressed in several locations, and absent in others. A permanent leaching trench has been dug at the base of the hill to contain the fuel that still leaches from the hillside. After every heavy rainfall at least two barrels of cloth absorbent pads are collected from the area. A dense oil film was present in the trench at the time of the IAS team visit. To minimize fuel from entering the harbor, three booms have been placed northwest of the Fuel Pier.

In 1957 or 1958 a fuel line to Tank 82 (2,100,000-gallon capacity) burst when a hydraulic jack was removed, resulting in a major spill of Bunker C fuel. The oil spill (termed "a river" by interviewees) followed a path downhill toward the harbor in a southwesterly direction across Two Way Road to Ensenada Honda, extending to the shoreline and the Ensenada Honda mangrove swamp across the harbor. The spill occurred during the night and lasted several hours before it was stopped. It is estimated by base personnel in the Fuels Division and Surface Operations Department that at least 420,000 gallons of Bunker C fuel leaked from the storage tank.

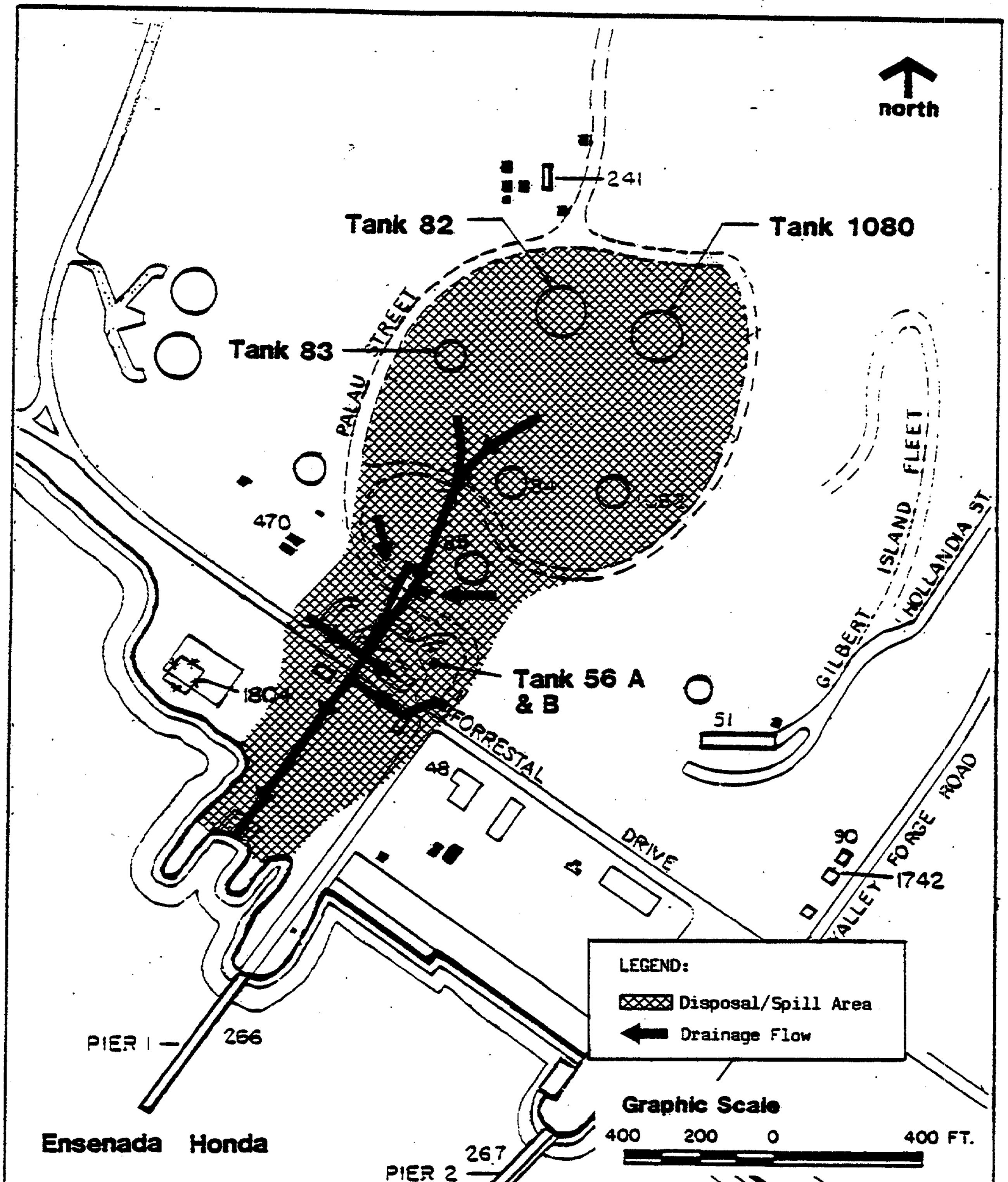

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FIGURE 8-10
SITE MAP
SITE 12, TWO WAY ROAD
FUELS FARM

Between 1971 and 1972 Tanks 83 (2,100,000-gallon capacity) and 1080 (1,34,000-gallon capacity) were cleaned in order to change over from Bunker C fuel to diesel fuel storage. The Bunker C fuel and sludge from the tanks were disposed of in pits dug within 100 feet of each tank. A pit approximately 100 feet in circumference and 10 to 20 feet deep was dug 50 to 75 feet west of Tank 83 (about 25 to 50 feet from the tunnel) for the disposal of the fuel and sludge from the tank. It is estimated that about 3,000 to 6,000 cubic yards of materials were disposed of at this site, which remained open for seven years.

A smaller pit, with a 50-foot circumference and 10- to 20-foot depth, was dug in proximity to Tank 1080. Oil and sludge from Tank 1080 were disposed of in this pit, which remained open for six or seven years. It is estimated that 900 to 1,500 cubic yards of oil and sludge were disposed of at this site. After the materials solidified in both pits (a process estimated to take six to seven years) a two- to three-foot layer of soil was placed over the pits.

Two underground diesel storage tanks (56A and 56B) have a capacity of 10,500 gallons each and were used to store diesel fuel, just north of Building 54. The tanks were used for 20 to 25 years.

In the late 1960s leaks began in these tanks. It is estimated by interviewees that 420,000 gallons spilled over a 15- to 20-year period onto the surrounding soil. In February 1984 the tanks were removed and replaced. A dark black fuel-stained soil was present around the old tanks, as well as isolated pools of oil. The spilled fuel was floating on top of the groundwater.

8.13 SITE 13, TANKS 210 TO 217. Tanks 212 to 215 are located along Manila Bay Road, north of Forrestal Drive. Tanks 216 and 217 are on a hilltop about 4,000 feet southeast of Tanks 212 to 215, north of Forrestal Drive. Tanks 210 and 211 have not been used since 1950 (see Figure 8-11).

The capacity of Tanks 212 and 213 is 50,000 gallons, while the capacity of Tanks 214 through 217 is 252,000 gallons each. Tanks 212 to 217 are located on hilltops which are surrounded by mangrove swamps to the northwest, north, and northeast. The tanks, which were installed in 1940, were used for the storage of AVGAS and were cleaned every five years thereafter until 1978. The tank cleaning procedure consisted of mucking out 20 to 30 drums (800 to 1,250 gallons) of leaded fuel sludge from the tanks into a pit in the vicinity of each tank. These pits, or trenches, were dug by a backhoe within 300 feet of each tank. On the average, the pits were dug to a depth of eight feet with a length and width of eight feet. The sludge and fuel were disposed of in the pit and remained uncovered until solidified. Three to four feet of soil were then placed over the sludge to fill in the hole.

Six of the tanks were cleaned at least seven times each during a 40-year period. An estimated 32,400 to 50,500 gallons of leaded sludge were discharged and buried in the vicinity of Tanks 212 to 217. An additional 1,600 to 2,500 gallons were buried at Tanks 210 and 211, totaling approximately 34,000 to 53,000 gallons of highly leaded sludge for the entire site.

8.14 SITE 14, ENSENADA HONDA SHORELINE AND MANGROVES. In August 1981, the <u>Arco Prestige</u>, a civilian tanker ship chartered by the U.S. Navy, developed a

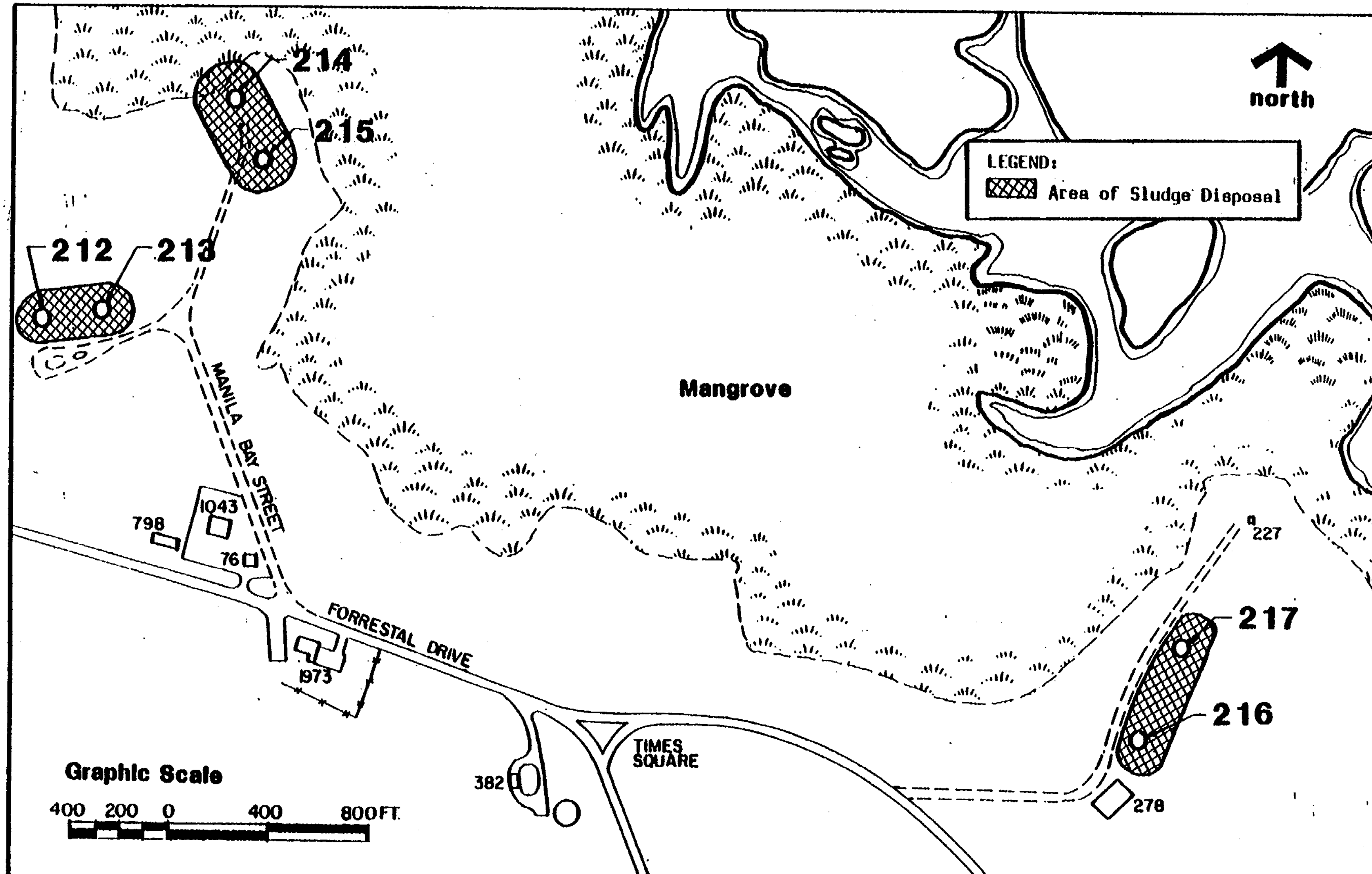

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FIGURE 8-11
SITE 13, TANKS 212-217

problem with the piping system while anchored in the vicinity of Berthing Pier No. 3 and leaked an estimated 210,000 gallons of diesel fuel into Ensenada Honda (see Figure 8-12). The fuel spread in a northwesterly direction across the harbor to Community Beach, the Ensenada Honda mangrove swamp north of Community Beach, and the area south to about Punta Cascajo.

Crowely Environmental Company was contracted to assist the Navy in cleanup operations. A boom was placed in the harbor and a skimmer on a flat bottom boat was used to remove the fuel floating on the surface of the water. The fuel was pumped into a Ships Waste Offload Barge (SWOB) with an oil-water separator. A large percentage of the spilled fuel was recovered from the harbor by this method. About 50 Navy personnel assisted Crowely Environmental Company in conducting cleanup operations along the shoreline using absorbent pads to remove fuel from Community Beach and the mangrove swamp. A total of 60 to 100 55-gallon drums of oil-soaked pads were collected and given to the Crash Crew for use in training. Approximately two to three five-ton truckloads of oil-stained sand also were removed from the beach front area. The remainder of the fuel (estimated at 100,000 gallons) was blown into the Ensenada Honda mangroves, or sank to the bottom.

8.15 SITE 15, SUBSTATION 2. Substation 2, Building 90 (see Figure 8-13) has been used by the Public Works Department-Power Distribution Shop as a transformer repair shop since 1964. As part of the maintenance of pole-mounted distribution transformers, the transformer oil was drained to facilitate repair of the inner core and coils. From 1964 to 1979 used oil drained from the transformers was poured onto the ground in the vicinity of Building 90. Personnel interviewed remembered using PCB-based dielectric fluids (by the trade names of Askarel, Inerteen, and Pyranol) for servicing the transformers. Approximately 200 gallons of replacement transformer fluid were ordered per year by the Power Distribution Shop.

Assuming that the total 200 gallons of transformer fluid were used per year, it is possible that over the 15 years of this practice, a maximum of 3,000 gallons of transformer oil were drained to the soil in the vicinity of the building. This oil could have been either "pure" PCBs or oil containing PCBs in the 300-ppm range, as was common at the time.

The only exception to this standard operating procedure was with Askarel transformers. Due to incidents in the past whereby Power Distribution Shop personnel developed skin rashes from direct contact with Askarel, the transformers containing this fluid were drained directly to 55-gallon drums, which were then disposed of at the station landfill. The exact quantity of Askarel disposed of in this manner is unknown. Replacement five-gallon cans of Askarel were disposed of in the station landfill (Site 7) or the ocean (Site 9).

There is visible evidence of past oil spills around Building 90 today.

8.16 SITE 16, OLD POWER PLANT, BUILDING 38. Building 38 was a 60-megawatt steam turbine facility that generated power from the early 1940s through 1949 (see Figure 8-14). The plant used Bunker "C" fuel, which was stored in two 50,000-gallon reinforced concrete tanks located directly northwest of the building. During heavy rainfalls in the 1970s, Bunker C fuel was observed in the manholes near the building and was also discharged to the Enlisted Beach

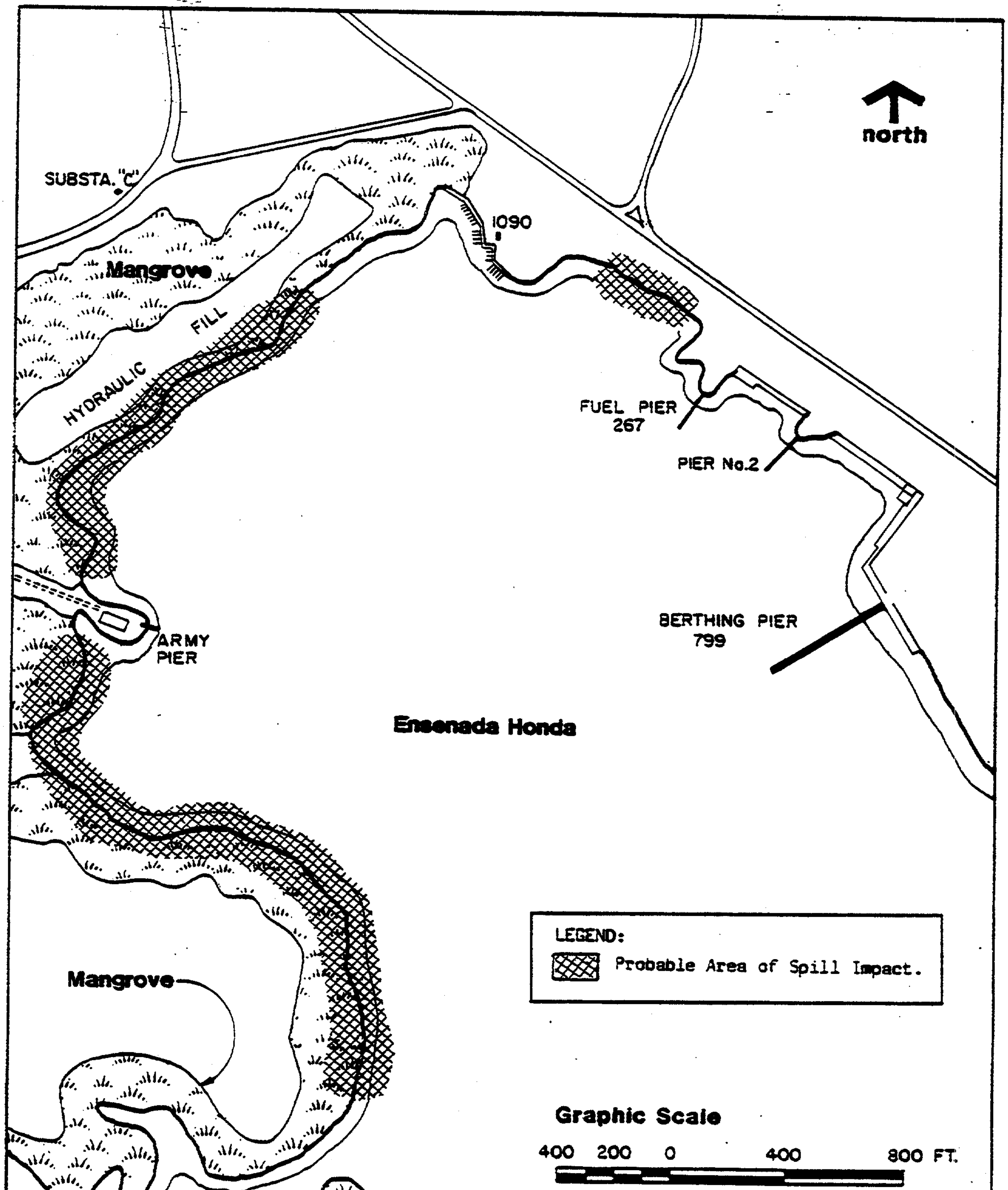

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FIGURE 8-12
SITE 14, ENSENADA HONDA
SHORELINE AND MANGROVES

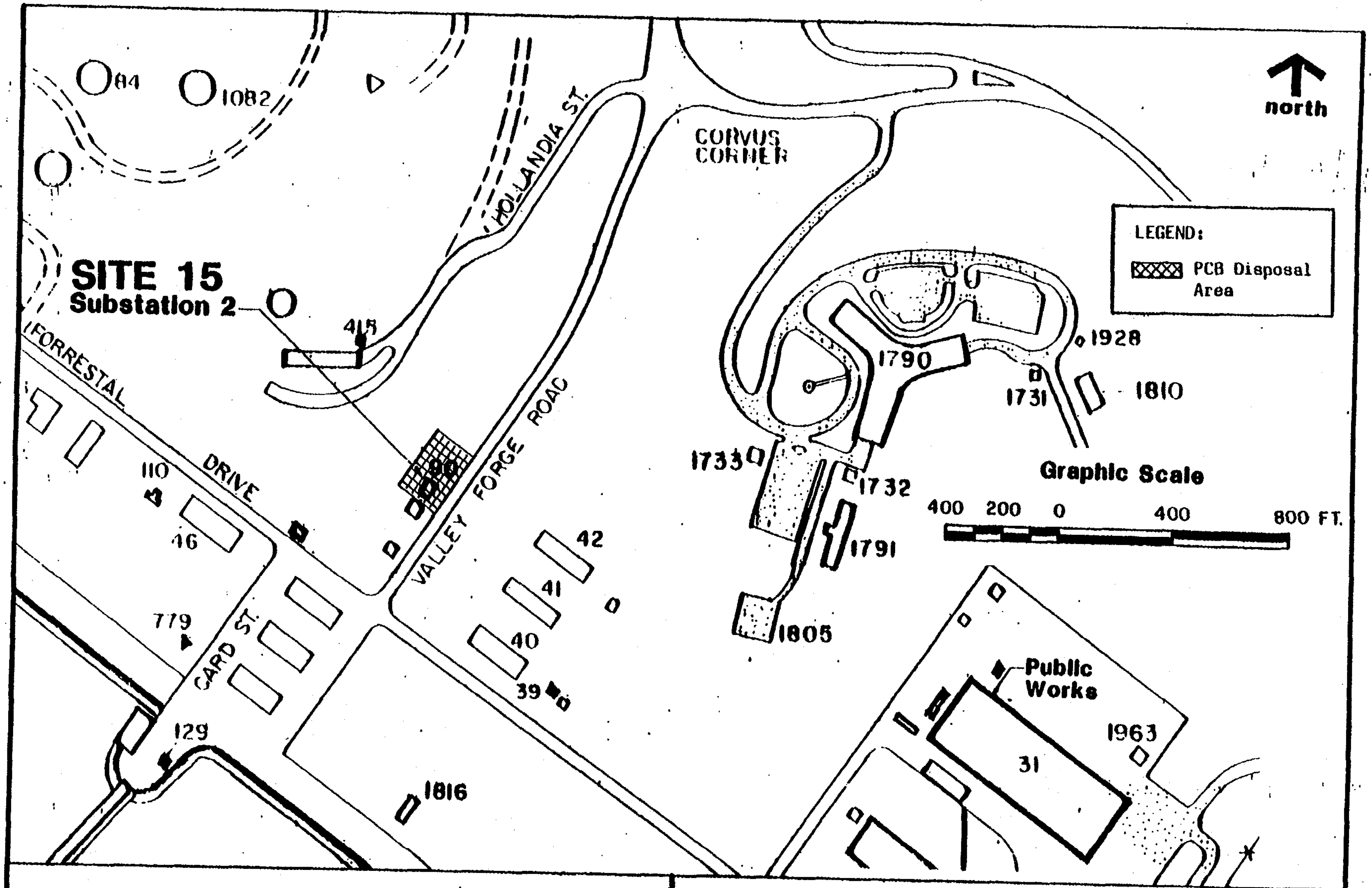

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FIGURE 8-13
SITE 15, SUBSTATION 2

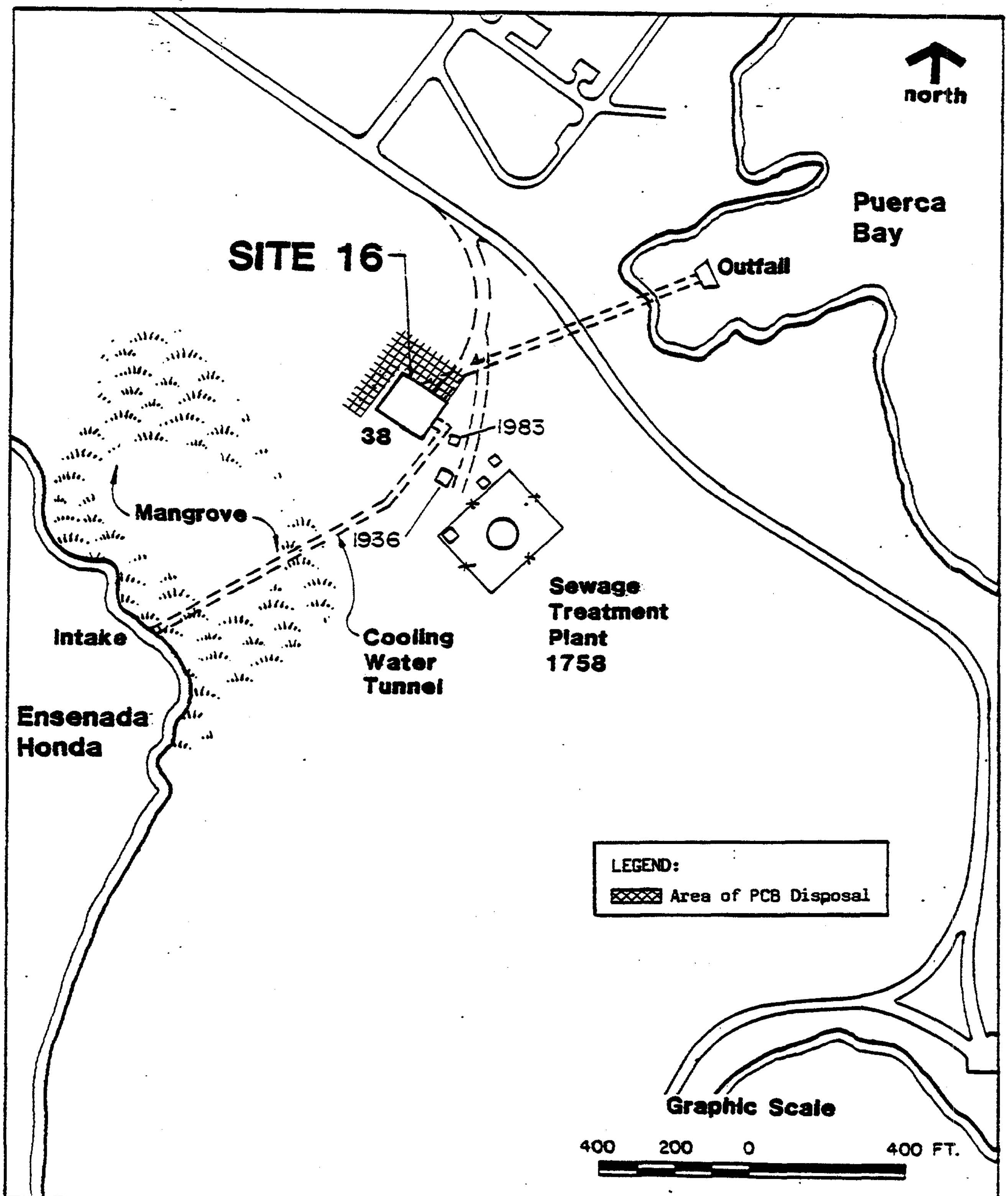

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FIGURE 8-14
SITE 16, OLD POWER PLANT,
BUILDING 38

via the old cooling water outlet for the Power Plant. A cleanup contractor was hired twice to drain the underground fuel tanks and cleanup the spill.

From 1956 to 1964 transformer maintenance was performed at Building 38 by the Public Works Power Distribution Shop. The majority of transformer repair work was conducted just outside of the building at its northeast corner. As part of the maintenance of the transformers, the transformer oil was drained to facilitate repair of the inner cores and coils. Interviewees reported draining the transformers to the soil in the immediate vicinity of the building. The only exception to this practice was with Askarel (a type of PCB) transformers. Power Distribution Shop employees drained transformers containing Askarel directly to 55-gallon drums which were disposed of at the station landfill. The exact quantity of Askarel disposed of in this manner is unknown. The Power Distribution Shop ordered 200 gallons of replacement transformer fluid per year. Assuming the total 200 gallons were used each year, it is possible that over the eight years during which Building 38 was used, approximately 1,600 gallons of transformer oil were drained to the soil in the vicinity of the building, with some portion going to the landfill. The transformer oil commonly used in this time frame was either "pure" PCBs or oil containing PCBs at a 300-ppm concentration.

Vegetation once located at the northeast corner of the building has since died. Interviewees suggested that the cause of this may have been the disposal of transformer fluids in this area, or the leakage of Bunker C fuel from the two 50,000-gallon underground storage tanks. The vegetation to the northwest and southwest of the building was also stressed.

8.17 SITE 17, CRASH CREW TRAINING AREA. The Crash Crew training area (see Figure 8-15) was operated by the Air Operations Department from the early 1960s through 1983.

Two unlined pits were used in the past for fire fighting training. The first pit, which was approximately 40 feet in diameter, was used from the early 1960s through the beginning of 1983 (20 years). Assuming 20 years of operation, about 120,000 gallons of waste solvents, fuels, and oils were placed in the pits and set on fire for fire fighting training. Also burned were wood, trash, plastic, fuel filter elements, oily rags, and other debris. The fires were extinguished using aqueous film-forming foam (AFFF) and potassium bicarbonate (Purple K). Past aerial photographs show drainage from this pit to the ditch along the runway shoulder. The new fire training pit was built at the same location as the old pit. When the new pit was built, all of the oil-stained, contaminated soil was excavated and most likely disposed of in the base landfill.

The second pit was used temporarily during the construction of the new fire training pit in 1983. This unlined gravel pit has a diameter of 200 feet and was used approximately six times. Approximately 3,000 gallons of waste fuel, oil, and solvents were burned in this area. Only small amounts of fuel were allowed to soak into the ground.

8.18 SITE 18, PEST CONTROL SHOP. The Pest Control Shop (see Figure 8-16) was located at Building 258 from the late 1950s through 1983. Pesticides were stored in Building 258 and also on the parking apron. Former Pest Control Shop

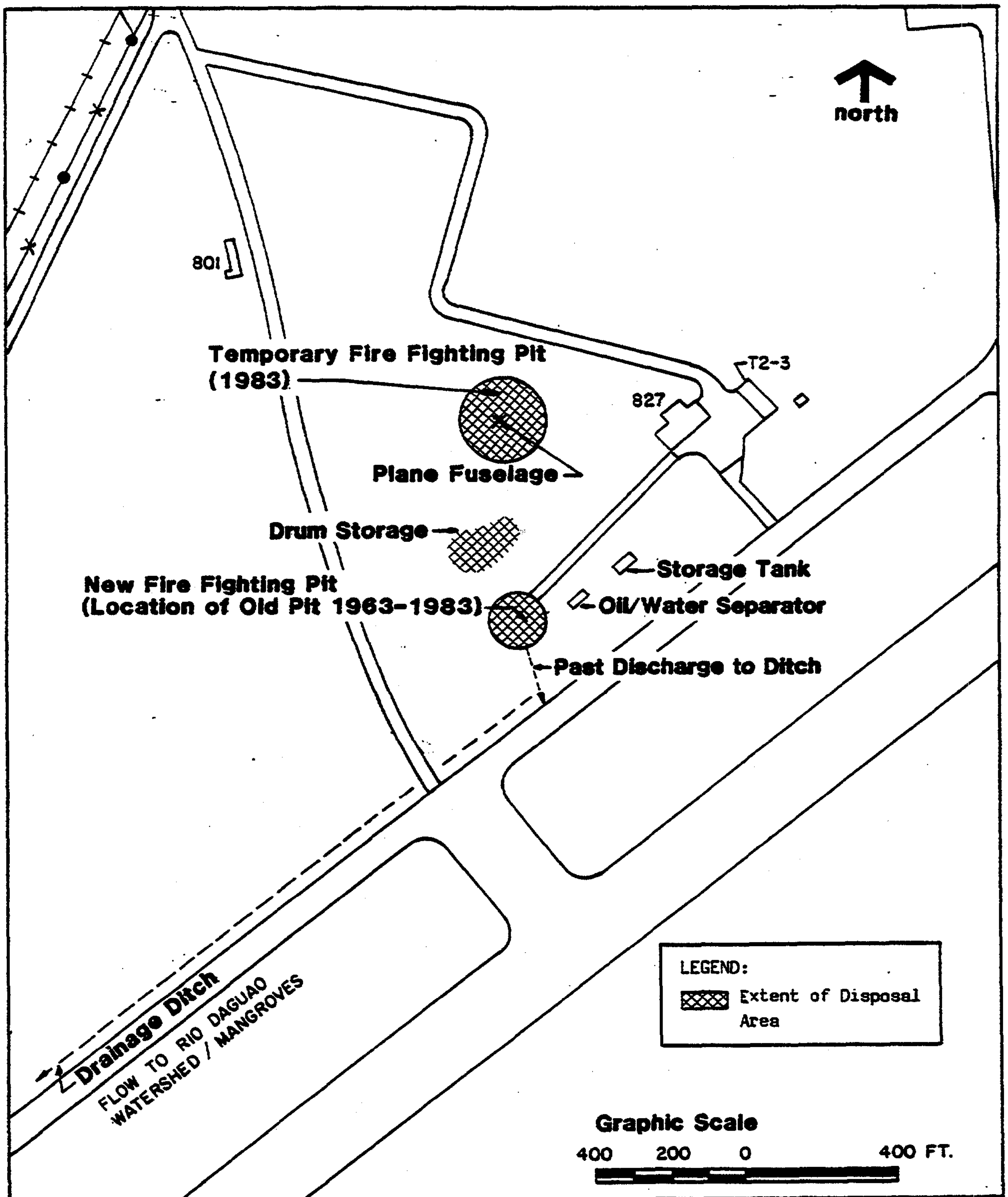

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FIGURE 8-15
SITE 17, CRASH CREW TRAINING AREA

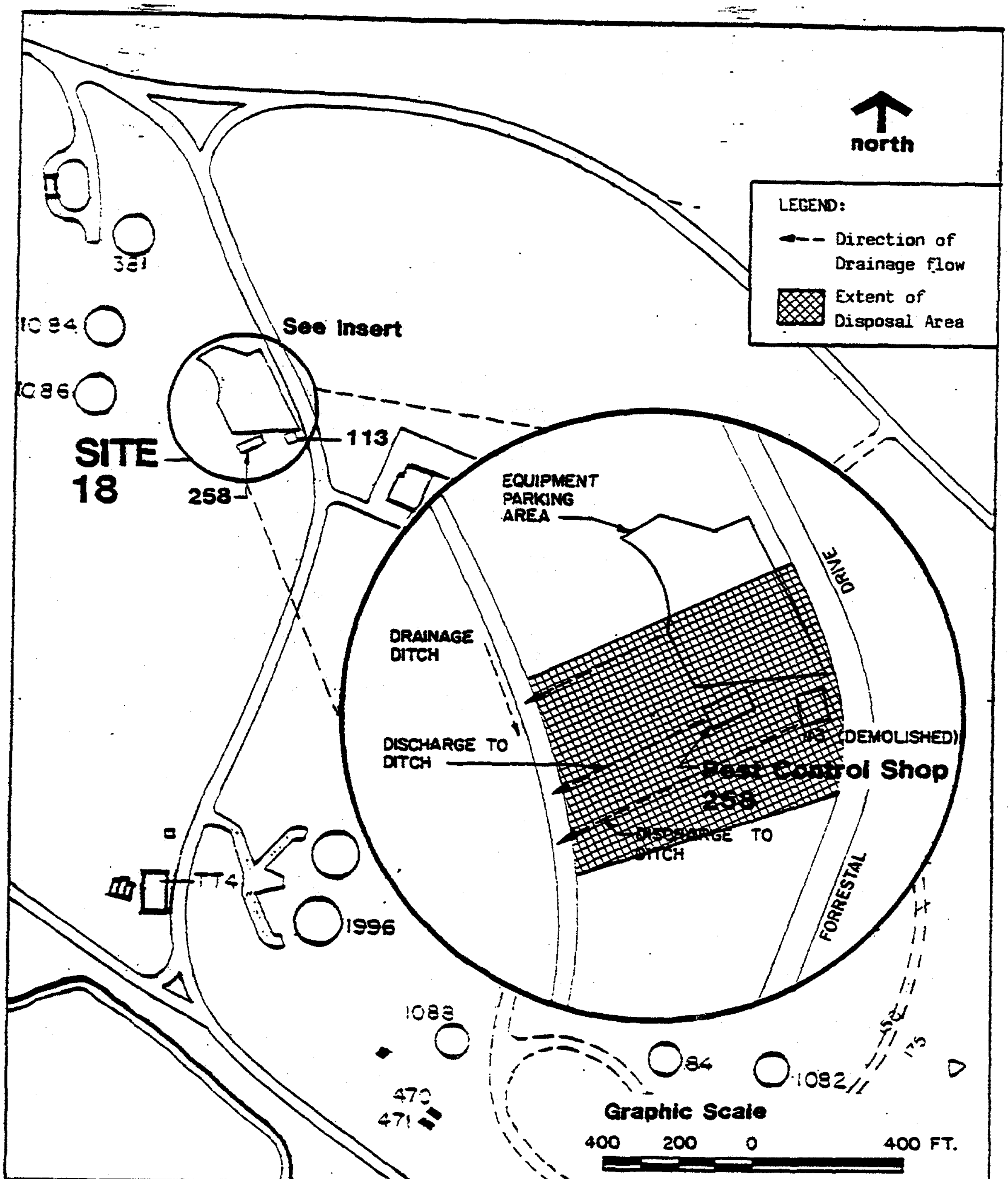

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FIGURE 8-16
SITE 18, PEST CONTROL SHOP

employees remember incidental spillage of pesticides in and around the building. In 1976 a 55-gallon drum of malathion, which was stored outside the building, ruptured and the contents spilled onto the ground, eventually washing into the drainage ditch in back of the building. This same ditch received rinse waters from the cleaning of pesticide equipment over a storm drain which discharged to the ditch. Excess pesticides were also poured into this ditch. Past environmental engineering surveys cite numerous aquatic kills due to pesticides entering the ditch. The area surrounding the building is devoid of vegetation, although the drainage ditch does not show any signs of stressed vegetation.

Pesticides used in the past include DDT, Paris Green, maldane, malathion, and chlordane. Table 8-1 gives toxicological information for each of these pesticides. There is no information available, either from records or interviewees, regarding the amounts or concentrations of the pesticides used. Table 8-1 contains information on amounts gathered from the 1980 Pest Management Plan.

8.19 SITE 19, WEST EXPLOSIVE ORDNANCE DISPOSAL (EOD) RANGE, VIEQUES. The West EOD Range, located within a one-half-mile radius of the old bridge at Punta Boca Quebrada (see Figure 8-1), was used from 1969 to about 1979. Interviewees stated the range may have been used since the 1940s. This is supported by the fact that no EOD blows have ever occurred on Roosevelt Roads itself, but no records exist. The range was closed after an accident in 1976 involving an undetonated photoflash cartridge. Between 1976 and 1979, the range was swept at least three times by EOD personnel. Inert items can still be seen scattered throughout the area, and unexploded munitions may still be present underground or in areas of extremely dense thorn shrub.

8.20 SITE 20, CAMP GARCIA DISPOSAL SITE, VIEQUES. The Camp García disposal site (see Figure 8-2) is located on high ground approximately 3,000 to 4,000 feet north-northwest of Bahía de la Chiva (Blue Beach) and 1.5 to 2 miles east of Camp García. The landfill was in operation from approximately 1954 to 1978, and serviced an average population of 150 individuals. This number was significantly increased during maneuvers and other military exercises. A five-ton dump truck was used to dispose of waste at the site. At least one trip per day was made to the site five days a week. The Camp García maintenance staff estimated that, on the average, 2.5 tons of waste were disposed of per week at the site over a 24-year period. Navy personnel estimated that 75 tons per year were deposited per week. It is estimated that between 1,800 and 3,120 tons of materials total have been disposed over the 100- to 200-acre area. This includes waste from the activity at Camp García over the 24-year period, as well as the EM Club, Staff Club, and Officers Club between 1965 and 1978.

Only Type I waste including paper, corrugated containers, rags, wood, scrap metal, cans and food packaging materials, and yard waste generated from the activities were taken to this site. Food garbage from Camp García and NAF, Vieques, was collected by civilians and used as livestock feed by the local farmers. Bulky wastes and junk vehicles were transported to Roosevelt Roads for disposal or to recheck survey yards or scrap steel stock sites. Junk vehicles were occasionally used on the range as targets; when destroyed, they were transported to Roosevelt Roads for disposal. Waste oil was also

Table 8-1

TOXICITY OF PESTICIDES HISTORICALLY USED AT ROOSEVELT ROADS

Pesticide	LD_{50} - Rat (mg/kg)*	Toxicity Rating	Annual Usage, 1980
Chlordane	283	High via oral and intraperitoneal routes	120 gallons, 72%**
DDT	113	High via oral and dermal routes	N/A
Diazinon	76	High via oral and dermal routes	10 gallons, 48%
Malathion	1,401	Moderate via oral and dermal routes	22 gallons, 95%
Paris Green (copper acetate)	710	Moderate via oral and inhalation routes	N/A
Dursban	145	High via oral and dermal routes	10 gallons, 41%

*The LD_{50} is the statistical estimate of dosage necessary to kill 50% of an infinite population of test animals.
**Percent active ingredient.

Source: Pesticide information taken from Dangerous Properties of Industrial Materials, Fifth Edition, N. Irving Sax, ed.; 1980 Pest Management Plan, NAVSTA Roosevelt Roads.

transported to Roosevelt Roads for disposal. Since 1978, all waste from the Vieques Naval Reservation has been disposed of in the municipal landfill.

The trench method of disposal was employed and land clearing was kept to a minimum to avoid erosion problems at the site. With the use of a bulldozer a trench was dug into which materials were disposed. The trench was then covered with six inches of soil to control blowing of litter. A final soil cover of two feet was placed over the trench.

No hazardous materials were ever disposed of at this landfill.

Other disposal areas on Camp García include a construction rubble disposal area, a scrap metal disposal area, and an aboveground disposal area for general trash. These areas do not constitute a potential pollution threat.

APPENDIX A

List of Offices Visited and Records Reviewed

APPENDIX A
LIST OF OFFICES VISITED AND RECORDS REVIEWED

APPENDIX B
FLORA AND FAUNA OF ST. CROIX

APPENDIX C
GLOSSARY

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APPENDIX B

FLORA AND FAUNA OF ST. CROIX

APPENDIX B. FLORA AND FAUNA OF ST. CROIX

B.1 FLORA OF ST. CROIX. Most island floras have at least some species of plants that are found nowhere else. These species, called "endemics," make up as much as 97% of the indigenous floras of some very high, very isolated islands, such as the Hawaiian group. Islands closer to other large islands or continents usually have a much lower percentage of endemics. The Virgin Islands have only a few endemic vascular plant species. Out of a total indigenous flora recorded by N. L Britton in 1918 for the U.S. Virgin Islands (the last list published) of 890 native seed plant species, 27 were considered endemic to the island group, and only four of the 27 were restricted to St. Croix. These figures have changed slightly since then, but not significantly.

Due to the activities of the Navy, extensive habitats have developed for xerophytic (dry-tolerant) species, and plants once confined to small dry rain shadow areas and steep, over-drained, rocky slopes have prospered and greatly extended their ranges, and now dominate much of the island. Thorny acacias, rigid spiny Randia, and several cacti are among the most obvious members of the flora.

The widespread strand and mangrove floras have been more successful than most other components of the total flora. Although their habitats have been much reduced, there are still many parts of the coastline where salt-tolerant species can find a home and where they may be seen to advantage. Inhospitable wind and spray-swept bluffs have not been much modified, and plants evolved for these conditions, such as Suriana, Lithophila, Sporobolus argutus, and Jacquemontia cumanensis, grow here. Likewise, on sand ridges and beach flats, Tournefortia gnaphalodes, Scaevola plumieri, Ipomoes pes-caprae, Sporobolus virginicus, Ernodea littoralis, and many other species still form a rather diverse shrubby or low vegetation, liberally parasitized by orange-colored stringy Cassytha. Here also the poisonous Hippomane, with Pisonia, Thespesia, Coccoloba, and other trees, form patches of beach forest. In saline swamps the several diverse trees termed mangroves, each with its own peculiar pneumatophores or "breathing" apparatus--Rhizophora, Laguncularia, Conocarpus, and Avicennia--form a characteristic vegetation. In open saline places Batis maritima and Sesuvium portulacastrum form conspicuous succulent mats.

Likewise, the Caribbean dry lowland flora shows considerable diversity. As noted above, its habitat on St. Croix was expanded as a result of human influence. Such widespread Caribbean genera as Acacia, Bursera, Bromelia, Cordia, Bourreria, Cephalocereus, Croton, Tabebuia, Piscidia, Melicoccus, Opuntia, Melocactus, Crescentia, and Pithecellobium are frequently seen. In slightly moister sites further upland other Caribbean genera such as Ficus, Eugenia (represented by a diversity of species), Clusia, Coccoloba, Amyris, Zanthoxylum, Lasiacis, the handsome but poisonous Comocladia, Andira, Enallagma, and Bucida (which also occurs at lower elevations) are found. Piper and Peperomia are common beneath the trees. Ferns are present in these higher, slightly moister areas, but are few, both in species and in numbers of individuals. This slightly more mesophytic flora is well represented in the higher mountains and in deep shaded gulches. Psychotria, an enoromous pantropical genus, is present in several species, prominent in the undergrowth. The epiphytic flora, even in the wettest areas, is very limited. Most of the few ferns and even some of the even fewer orchids are terrestrial.

The vast tropical American rain forest flora is almost totally unrepresented in St. Croix, as might be expected from the dryness of its climate.

While the native flora has been diminishing, the exotic flora has increased enormously. Economic plants, ornamentals, and weeds continue to be brought in, either intentionally or accidentally, and many of them have now become established.

Sugarcane and a number of forage grasses, such as Guinea grass (Panicum maximum), came in early. Sugar was the dominant crop for many years under Danish rule. The picturesque ruins of old windmills dot the landscape, indicating the sites of old sugarcane plantations. Although there are no plantations now, sugarcane (Saccharum officinarum) persists here and there, a tall coarse grass with pale silvery-lavender tassels.

Fruit trees such as mango (Mangifera indica), sour sop (Annona muricata), and sugar apple (Annona squamosa) are both cultivated and freely naturalized in the more moist areas. The papaya (Carica papaya) and the banana (Musa sapientum), which appear to be trees but are really gigantic herbs, are frequent, both planted around dwellings and, especially the papaya, naturalized.

Cotton (Gossphium barbadense and G. hirsutum) persists around settled areas as a reminder of former cultivation. Sisal (Agave sisalana) forms small stands, relicts of earlier attempts to establish a fiber industry on the island.

Coconut palms (Cocos nucifera) provide both food and drink, as well as characterize the tropical landscape.

Among the widespread tropical weeds to be seen in St. Croix gardens, fields, and along roadsides, are nut-grass (Cyperus rotundus), goose-grass (Eleusine indica), finger-grass (Chloris barbata), spurges (several species of Euphorbia), sand-bur (Cenchrus echinatus), false mallow (Malvastrum coromandelianum and a number of species of Sida and Abutilon), purslane (Portulaca oleracea), beggar's ticks (Bidens pilosa), beggar's lice (various species of Desmodium), and others. At least one native plant, Boerhavia coccinea, is a very successful weed.

The plants that give the tropics their reputation for floral magnificence are almost all exotics on St. Croix. Splashy, gaudy Bougainvillea, flamboyant (Delonix regia), golden shower (Cassia fistula), coral tree (several species of Erythrina), Mexican creeper (Antigonon leptopus), Ixora, African tulip (Spathodea campanulata), and ginger Thomas (Tecoma stans, possibly native), are present.

Foliage plants contribute greatly to this pantropical ornamental flora. Crotons (Codiaeum variegatum) and panax (several species of Polyscias), Rhaphidophora aurea, Buttonwood (Conocarpus erecta, probably native), bowstring hemp (several species of Sansevieria), asparagus fern (Asparagus sprengeri), and many others are seen. Breadfruit trees (Artocarpus altilis) from the South Seas provide excellent food.

The Tamarind (Tamarindus indicus) is, next to mahogany, perhaps the most common tree on the island. It comes from Asia, where the acid pulp of the pods is used to form the base of a pleasant soft drink. The mango (Mangifera indica), a tall tree with a full, seasonally varicolored crown, is present thoroughout the island.

Ornamental trees that yield valuable woods are the monkey pod (Samanea saman), mahogany, woman's tongue (Albizia lebbeck), the wood of which is widely used for charcoal, and many others.

The tropical almond (Terminalia catappa) has an elegant pagoda-like, horizontal branching pattern, a scattering of large bright red leaves, and a fruit containing an edible nut.

Palmettoes (Sabal), California fan plams (Washingtonia), native fan palms (Coccothrinax), date palms and Canary Island palms (Phoenix), and a few fis-tail palms (Caryota), as well as ornamental Pritchardia, are to be seen in many places.

Aroids (Araceae) are present locally on St. Croix in the wetter parts of the island and in gardens that are watered. Elephant ear (Alocasia), Monstera deliciosa, Rhaphidophora aurea, Anthurium, and various philodendrons are examples.

The mulberry family (Moraceae), though named for a temperate tree, is an enormously developed tropical family. Figs (Ficus) including various banyans and stranglers, breadfruit (Artocarpus), and the Cecropia, uncommon on St. Croix, but present, are members of this family.

Perhaps the most ubiquitous of all tropical families is the pea or bean family (Leguminosae). It is represented literally everywhere, and includes trees, lianas, shrubs, creepers, and herbs (smooth, fuzzy, or spiny). The spiny acacias which dominate the thorn forests also are legumes, as are the tamarine, the gorgeous pride-of-Barbados (Caesalpinia pulcherrima), chick peas (Cicer arietinus) and beans (Phaseolus vulgaris) which are items in the local diet, and the local fish-poison tree (Piscidia piscipula).

The orchid family (Orchidaceae), the largest of plant families and one of the most typical, is poorly represented on St. Croix. A number of species of Epidendrum are found in the mountain forests, but are rare and localized. Another grows in the scrub on the sand flats of Sandy Point.

The spurge family (Euphorbiaceae) is well represented. Its most notable local member, the deadly manchineel (Hippomane mancinella), with caustic sap and poisonous fleshy fruit, is commonly seen on beaches and the edges of mangrove swamps. A number of species of Croton, gray fuzzy-leafed shrubs, dominate large areas of scrub on dry slopes. An interesting shrubby Euphorbia is common in coastal scrub. A number of small weedy spurges (Euphorbia species) are abundant in cultivated and disturbed ground. The fleshy-stemmed shrub, Pedilanthus padifolius, is found on one or two high ridges, such as Lang Peak or Jakobsberg. Several cactus-like African species of Euphorbia, such as Euphorbia antiquorum and E. milii, are cultivated, as is rarely the Otaheite gooseberry, Phyllanthus acidus. The castor oil bean (Ricinus communis) and several similar species of Jatropha grow as weeds and are occasionally planted. Of these, Jatropha gossypifolia may be native.

The dogbane family (Apocynacear) is not well represented on St. Croix, but contains several fine ornaméntals, such as the grangipani (Plumeria rubra), Allamanda hendersonii, the oleander (Nerium oleander), the false gardenia (Tabernaemontana divaricata), and the curious Adenium with showy pink flowers and a swollen stem base.

The trumpet-vine family (Bignoniaceae) provides some of the finest flowering trees, shrubs, and vines, such as the famed Ginger Thomas (Tecoma stans), official island flower of St. Croix; the African tulip (Spathodea); the jacaranda (Jacaranda mimosifolia); several handsome Tabebuia species; the red Tecomaria capensis; and the curious sausage-tree. In addition, the calabash tree has long leafy wand-like branches and cannonball-like fruits from which utensils are made.

Finally, the coffee family (Rubiaceae) is frequently seen. The most ornamental in St. Croix are several kinds of Ixora, with scarlet flowers. Coffee itself (Coffea arabica and another species) persists in a few places from former cultivation. Psychotria, a green-stemmed shrub which bears red fruit, is common in undergrowth in all moist forests. The pain-killer Morinda citrifolia is a commonly seen shrub or small tree with a reputation in folk medicine. Several inconspicuous tree species of Guettarda are found in the forests. Portlandia grandiflora has been brought from Jamaica to be planted in gardens. The littoral shrubs Ernodea littoralis, Strumpfia maritima, and Erithalis fruticosa, are common enough locally in their proper habitats.

B.2 AVIFAUNA OF ST. CROIX. Off the northeast coast of St. Croix lies Buck Island National Monument. Birds recorded here are typical of the arid scrub, and include the brown pelican, magnificent frigatebird, red-tailled hawk, laughing gull, Zenaida dove, ground dove, green-throated carib, gray kingbird, Caribbean elaenia, yellow warbler, and the bananaquit.

Recorded on St. Croix itself are the brown pelican, magnificent frigatebird, great blue heron, American egret, snowy egret, little blue heron, cattle egret, red-tailed hawk, sparrow hawk, spotted sandpiper, least tern, royal tern, Zenaida dove, ground dove, mangrove cuckoo, smooth-billed ani, green-throated carib, Antillean crested hummingbird, gray kingbird, Caribbean elaenia, northern mockingbird, black-whiskered vireo, yellow warbler, bananaquit, and the black-faced grassquit.

Birds found at ponds on the island include the pied-billed grebe, green heron, common gallinule, pectoral sandpiper, and the Louisiana waterthrush.

Salt ponds or lagoons are found on the southern coast of the island, with Great Pond in the east and Westend Saltpond on the far side of the southern coast. Birds recorded at the salt ponds include the great blue heron, American egret, snowy egret, little blue heron, green heron, Bahama duck, osprey, semi-palmated plover, Wilson's plover, black-bellied plover, black-necked stilt, greater yellowlegs, lesser yellowlegs, solitary sandpiper, spotted sandpiper, willet, short-billed dowitcher, semi-palmated sandpiper, western sandpiper, white-rumped sandpiper, least sandpiper, stilt sandpiper, laughing gull, gull-billed tern, royal tern, and the sandwich tern.

Forested areas are found in the northwest, between Frederiksted and Mt. Eagle. Here can be found the red-tailed hawk, red-necked pigeon, green-throated carib, pearly-eyed thrasher, bananaquit, and the black-faced grassquit.

Brown boobies, bobwhite, guinea fowl, cattle egrets, and smooth-billed ani are also found on St. Croix.

B.3 MAMMALS, REPTILES, AND AMPHIBIANS. The mammalian fauna of St. Croix is depauperate in native species because of the difficulties inherent in colonizing an island so far removed from centers of species origin in North and South America. The species listed in Table B-1 are known to have occurred on St. Croix in recent times.

B.4 OTHER FAUNA. Invertebrates are diverse. The molluscan fauna of St. Croix is excellent in diversity and ecological types. Many coelenterate species, echinoderms, crustaceans, foraminifera, and sponges are present. In deep water, sclerosponges are common, and two species of crinoids have been collected.

The fish population, especially at Buck Island, is varied. West Indian fish traps have seriously cut fish populations in many other shallow water areas. Large gamefish are well-known from the shelf edges; sharks can be observed. Porpoises, turtles, and whales are frequently sighted.

Table B-1

MAMMALS, REPTILES, AND AMPHIBIANS OF ST. CROIX

Mammals

Order Chiroptera (bats)

Family Phyllostomatidae

- Brachyphylla cavernarum - West Indian fruit-eating bat
- Artibeus jamaicensis - Jamaican fruit-eating bat

Family Noctilionidae

- Noctilio leporinus - Fish-eating bat

Family Molossidae

- Molossus major - Velvety free-tailed bat

Reptiles

Order Squamata (lizards and snakes)

Family Amphisbaenidae

- Amphisbaena fenestrata - Ground worm

Family Gekkonidae

- Hemidactylus mabouia - Small wood slave
- Thecadactylus rapicaudus - Large wood slave
- Sphaerodactylus macrolepis - Tiny gecko "cotton ginner"
- Sphaerodactylus beattyi - Tiny gecko

Family Iguanidae

- Iguana iguana - Iguana
- Anolis acutus - Tree lizard
- Anolis cristatellus - Doctor lizard
- Anolis pulchellus - Snake lizard

Family Teidae

- Ameiva exul - Ground lizard
- Ameiva polops - Ground lizard

Family Typhlopidae

- Typhlops richardii - Blind snake

Family Scincidae*

- Mabuya sloanii - Slippery back

Family Colubridae*

- Alsophis santi-crusis- Snake

Table B-1 (Cont.)

<u>Amphibians</u>

Order Anura (toads and frogs)
Family Bufonidae
<u>Bufo</u> <u>turpis</u> - Crapaud toad
<u>Bufo</u> <u>marinus</u> - Marine toad

Family Leptodactylidae
<u>Leptodactylus</u> <u>albilabrus</u> - Water frog
<u>Eleutherodactylus</u> <u>lentus</u> - Tree frog
<u>Eleutherodactylus</u> <u>portoricensis</u> - Tree frog
<u>Eleutherodactylus</u> <u>antillenis</u> - Tree frog

*Of doubtful occurrence on St. Croix.

APPENDIX C

GLOSSARY

APPENDIX C. GLOSSARY

AFFF	aqueous film-forming foam, used to extinguish fires
AFWTF	Atlantic Fleet Weapons Training Facility
Agentine	dry cleaning solvent
AIMD	Aircraft Intermediate Maintenance Division
alluvium	clay, silt, sand, or gravel deposited by running water
amphipods	any of large group of small crustaceans such as the sand flea
andesite	extrusive usually dark grayish rock consisting essentially of oligoclase or feldspar
annelides	any of a phylum of coelomate and usually elongated segmented invertebrates such as marine worms
aquifer	water-bearing stratum of permeable rock, sand, or gravel
ATG	air to ground
AUW	Advanced Underwater Weapons
AVGAS	leaded aviation gasoline
breccia	rock consisting of sharp fragments embedded in fine-grained sand or clay
bryozoans	any of a phylum or class of aquatic mostly marine invertebrate animals that reproduce by budding and usually form permanently attached branched or mossy colonies
calcareous	consisting of or containing calcium carbonate
CCCS	Central Command and Control System
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CNO	Chief of Naval Operations
COMNAVFACENGOM	Commander, Naval Facilities Engineering Command
CSRS	Confirmation Study Ranking System
DFM	diesel fuel marine

DGPS	data gathering and processing system
dinoflagellate	any of an order of chiefly marine plankton usually solitary plantlike flagellates that include luminescent forms
diorite	granular crystalline igneous rock
DOD	Department of Defense
DPDO	Defense Property Disposal Office
DSS	Donut Servicing System
DS-2	Decontaminating Solution Two
drone	pilotless airplane controlled by radio signals
EFD	Engineering Field Division
EIS	Environmental Impact Statement
EMA	Eastern Maneuver Area
EOD	Explosive Ordnance Detachment
EPA	United States Environmental Protection Agency
epiphyte	plant that derives its moisture and nutrients from the air and rain and usually grows on another plant
evapotranspiration	loss of water from the soil by evaporation and by transpiration from plants
EWR	Electronic Warfare Range
FAA	Federal Aviation Administration
floodplain	level land that may be submerged by floodwaters
FLTAUDVISCEN	Fleet Audio Visual Center, Caribbean
FMFLANT	Fleet Marine Force, Atlantic
FORAC	Fleet Operational Readiness Check
gabbro	granular igneous rock
GMOCU	Guided-Missile Operations Control Unit
graben	depression of the earth's crust bounded on at least two sides by faults

granodiorite	granular intrusive quartzose igneous rock intermediate between granite and quartz diorite
GSA	General Services Agency
herptiles	reptiles and amphibians
IAS	Initial Assessment Study
indurated	hardened
IRFNA	inhibited red fuming nitric acid
ISA	ignition separator assembly
ITCS	Integrated Target Control System
JP fuel	jet propulsion fuel
KW	kilowatt
LANTNAVFACENGCOM	Atlantic Division, Naval Facilities Engineering Command
LAW	light antitank weapon
LBL	Long Baseline
limestone	rock formed chiefly by accumulation of organic remains (shells, corals) consisting mainly of calcium carbonate
littoral	of, relating to, or situated or growing on or near a shore, especially of the sea
mafic	of or relating to a group of usually dark-colored minerals rich in magnesium and iron
MAF-4	mixed amine fuel
marl	loose or crumbling earthy deposit containing a substantial amount of calcium carbonate
MASWT	Mobile Anti-Submarine Warfare Target
MEK	methyl ethyl ketone
mesic	characterized by, relating to, or requiring a moderate amount of water
MG	megawatt
mgd	million gallons per day

mg/l	milligrams per liter
microphyllous	characterized by a leaf that has single unbranched veins and no demonstratable leaf gap
MOGAS	motor gasoline, regular or unleaded
MPC	maximum permissible concentration
NACIP	Navy Assessment and Control of Installation Pollutants
NAF	Naval Ammunition Facility
NARU	Naval Air Reserve Unit
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAVCOMSTA	Naval Communication Station
NAVENENVSA	Naval Energy and Environmental Support Activity
NAVSECGRUACT	Navy Security Group Activity
NBC	nuclear, biological, chemical
NEPSS	Naval Environmental Protection Support Service
NGFS	Naval gunfire support
NJS	Noise Jammer System
NMCB	Navy Marine Construction Battalion
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NTDS	Naval Tactical Data System
OP	Observation Post
PCB	polychlorinated biphenyl
petroglyph	aboriginal rock carving
plutonic	formed by solidification of molten magma within the earth
POL	petroleum, oil, lubricants

ppm	parts per million
PREPA	Puerto Rico Electric Power Authority
psi	pounds per square inch
Purple K	potassium bicarbonate, used to extinguish fires
quebrada	intermittent drainage area
RCA	Radio Corporation of America, Inc.
RDDCS	Remote Data and Drone Control System
ROC	Range Operations Center
SAM	surface-to-air missile
saprolite	disintegrated rock lying in its original place
SBL	Short Baseline
sedimentary rock	rock formed by deposits of sediment through biological, mechanical, and organic processes
SHPO	State Historic Preservation Office
SIA	Surface Impact Area
SPECWARGRUTWO	Special Warfare Group, Detachment 2, Caribbean
STB	Super Tropical Bleach (decontamination agent)
SWOB	Ships Waste Offload Barge
TOC	total organic carbon
TORPEX	torpedo exercises
TOX	total organic halogens
TPS	Threat Platform Simulator
tuff	rock composed of the finer kinds of volcanic detritus, usually fused together by heat
UEPH	Unaccompanied Personnel Housing
UTR	Underwater Tracking Range
VC-8	Fleet Composite Squadron Eight
VIWPA	Virgin Islands Water and Power Authority

WAAS	Wide Area Active Surveillance System
WASP	Water Security Patrol
WSAT	Weapons Systems Accuracy Trials
xeria	characterized by, relating to, or requiring only a small amount of moisture