April 1983

INITIAL ASSESSMENT STUDY OF NAVAL AIR STATION, ALAMEDA, CALIFORNIA

NEESA 13-014

NAVAL ENERGY AND ENVIRONMENTAL
SUPPORT ACTIVITY
Port Hueneme, California 93043

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INITIAL ASSESSMENT STUDY
NAVAL AIR STATION, ALAMEDA, CALIFORNIA

UIC:
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Prepared for:

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

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John Accardi NEESA

April 1983

NEPSS

Naval
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FOREWORD

The Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program in OPNAVNOTE 6240 ser 45/733503 of 11 September 1980 and Marine Corps Order 6280.1 of 30 January 1981. The purpose of the program is to systematically identify, assess, and control contamination of the environment resulting from past hazardous materials management operations.

An Initial Assessment Study (IAS) was performed at the Naval Air Station, Alameda, California, by a team of specialists from Ecology and Environment, Inc., (E & E). Further confirmation studies under the NACIP program were recommended at several areas at the activity. Sections dealing with significant findings, conclusions, and recommendations are presented in the earlier sections of the report. The later technical sections provide more in-depth discussion on important aspects of the study.

Questions regarding the NACIP program should be referred to the NACIP Program Director, NEESA 112N, Port Hueneme, CA 93043, AUTOVON 360-3351, FTS 799-3351, or commercial (805) 982-3351.

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- Joe Shandling, Bill Faulhaber, and Stan Ristrem, NAS Alameda.
- Jeff Heath and John Accardi, Naval Energy and Environmental Support Activity.
- Bob Julian, Western Division, Naval Facilities Engineering Command.
- Pam Clements, Hiroshi Dodohara, and Linda Lay, Ordnance Environmental Support Office.
- Dr. Allard, Navy Historical Center, Operational Archives.
- Dr. Everly, National Archives.

EXECUTIVE SUMMARY

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

Based on information from historical records, aerial photographs, field inspections, and personnel interviews, a total of 12 potentially contaminated sites were identified at NAS Alameda. Each of the sites was evaluated with regard to contamination characteristics, migration pathways, and pollutant receptors. No sampling or analysis was performed as part of this IAS.

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

Site 1: West Beach Landfill; used as a general disposal area from 1956 to 1960s/1970s.

Site 2: 1943-1956 Disposal Area; used as a general disposal area from 1943 to 1956.

Site 3: Seaplane Lagoon; received discharges of waste and wastewater for 30 years ending in 1972.

Site 4: Area 97; past leaks from abandoned fuel storage tanks.

Site 5: Buildings 301 and 389; PCBs were leaked and sprayed onto the ground.

Site 6: Cans C-2 Area; chemicals have leaked onto the ground; PCBs were used as weed killer.

Site 7: Building 360; spills from industrial processes have leaked through the floor onto the ground.

No potable groundwater supplies are threatened. The largest colony in northern California of the California least tern (Sterna albifrons browni), a state and federally designated endangered species, is located at NAS Alameda. San Francisco Bay supports recreational and limited commercial fishing. Crab Cove, a state-protected marine reserve, is located to the southeast. No adverse impacts to the endangered species, San Francisco Bay, or Crab Cove have been reported or noted.

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

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TABLES

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CHAPTER 1. INTRODUCTION

1.1 SCOPE.

1.1.1 Authority. As directed by the Chief of Naval Operations (CNO), the Naval Energy and Environmental Support Activity (NEESA), in conjunction with the Ordnance Environmental Support Office (OESO), conducts studies and evaluates evidence indicating the existence of pollutants from on-station sites which may have contaminated an area or which may pose a health hazard to people located on or off the naval installation under investigation. The Navy Assessment and Control of Installation Pollutants (NACIP) program was initiated by OPNAVNOTE 6240 ser 45/733503 of 11 September 1980 and Marine Corps Order 6280.1 of 30 January 1981.

1.1.2 NACIP Program. The Initial Assessment Study (IAS) is the first phase of the NACIP program, the objective of which is to identify, assess, and control environmental contamination from past hazardous materials storage, transfer, processing, and disposal operations.

1.2 SEQUENCE OF EVENTS.

1.2.1 Designation. Naval Air Station (NAS) Alameda and Naval Air Rework Facility (NARF) Alameda (see Figure 1-1) were designated for an IAS by CNO letter ser 451/397464 of 3 August 1981.

1.2.2 Contract. Ecology and Environment, Inc., (E & E) was awarded Navy Contract N62474-82-C-8272 for "Initial Assessment Studies at NAS Alameda, NSY Mare Island, and NWS Concord," effective 24 March 1982.

1.2.3 Correspondence. The Commanding Officer of Western Division, Naval Facilities Engineering Command, was notified of the impending study by NEESA by letter ser 587 dated 2 April 1982. The Commanding Officer, NAS Alameda, was notified of the impending study by NEESA by letter ser 626 dated 9 April 1982.

1.2.4 Initial Site Visit. An initial visit was made to NAS Alameda on 22 April 1982 by E & E team members and Mr. Jeff Heath, NEESA Engineer-in-Charge of Contract, and Mr. John Accardi, NEESA Study Manager for NAS Alameda. On 23 April 1982, Mr. John Accardi conducted the command briefing for NAS Alameda personnel.

1.2.5 Records Search. Various government agencies were contacted for documents pertinent to the IAS. Table 1-1 is a representative listing of the agencies contacted.

1.2.6 On-Site Survey. The on-site phase of the IAS was conducted from 7 through 11 June 1982, and from 28 through 30 June 1982. In addition to record reviews, IAS team members conducted interviews with long-term and former NAS Alameda employees. Ground and aerial tours of the installation were also made. Information presented in this report is not specifically referenced with a citation. Some information was received through interviews with knowledgeable individuals. Information received was generally verified by one or more additional

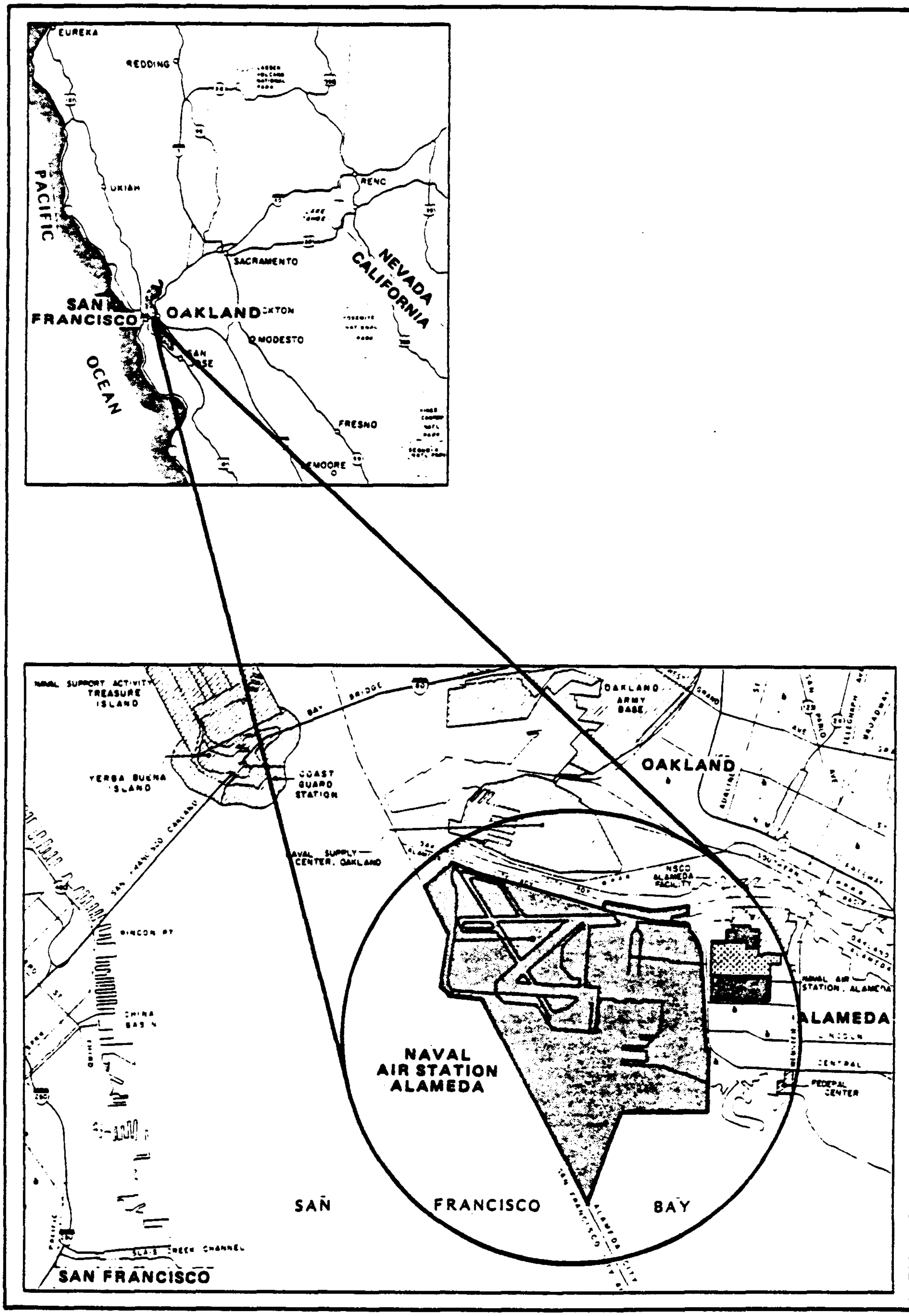


Figure 1—1 LOCATION OF NAVAL AIR STATION (NAS) ALAMEDA

Table 1-1

REPRESENTATIVE LISTING OF GOVERNMENT AGENCIES CONTACTED

- NEESA
- NAVFAC Command Historian, Naval Construction Battalion Center, Port Hueneme, California
- Naval Sea System Command, Alexandria, Virginia
- Naval Facilities Engineering Command, Western Division, San Bruno, California: Planning Branch, Geotechnical Branch, Maintenance Division, Facilities Planning Department, Real Estate Branch, Natural Resources Management Branch, Civil Branch, and Acquisition Department
- Ordnance Environmental Support Office, Naval Ordnance Station, Indian Head, Maryland
- Naval Surface Weapons Center, Dahlgren, Virginia
- National Cartographic Information Center, United States Geological Survey, Reston, Virginia
- Defense Mapping Agency, Washington, D.C.
- Department of Defense Explosive Safety Board, Alexandria, Virginia
- Navy Historical Center, Operations Archives, Navy Yard, Washington, D.C.
- Aerial Photography Field Office, Department of Agriculture, Salt Lake City, Utah
- EROS Data Center, Sioux Falls, South Dakota
- Environmental Protection Division, Chief of Naval Operations, Department of the Navy, Washington, D.C.
- National Archives: Navy and Old Army Branch and Cartographic Branch, Washington, D.C.; and National Archives at Suitland, Maryland
- California Department of Fish and Game, Yountville, California
- National Marine Fisheries Service, Tiburon, California
- United States Environmental Protection Agency, Region IX, San Francisco, California

interviews, or by comparison with documented data. In particular, substantiation was obtained for interview data affecting IAS conclusions and recommendations.

1.3 REPORT RECOMMENDATIONS. Recommendations for possible courses of action are provided for disposal sites and spill areas located during the IAS. For sites posing a potential danger to human health or to the environment, confirmation studies under the NACIP program are recommended.

1.3.1 Confirmation Study. The second phase of the NACIP program is the confirmation study. During confirmation studies, extensive sampling and monitoring is conducted to confirm or refute the existence of suspected contamination at sites identified during an IAS. If significant contamination exists, the confirmation study recommends the types of remedial actions to be implemented. The confirmation study is conducted in two steps: verification and characterization.

1.3.1.1. Verification Step. The purpose of the verification step is to verify the presence of migrating contamination and determine generalized site geohydrology. Efforts include short-term sampling of existing monitoring wells, sediment, soil, and surface water. The result of this phase is a general evaluation of contamination found, including geohydrological, health, safety, and regulatory aspects, and a recommendation as to whether or not to proceed with the characterization step.

1.3.1.2 Characterization Step. The characterization step, if required, is designed to determine specifics of groundwater movement, site geohydrology, and the levels and distribution of contamination, both vertical and horizontal, around contaminated sites. Efforts may include installation of monitoring wells, geophysical measurements, and quantitative analyses for selected contaminants. The result of this phase is a quantitative assessment of contamination sources and contaminant migration potential.

1.3.1.3 Criteria. A confirmation study is recommended only under the following circumstances:

1. Sufficient evidence exists to indicate the potential presence of contamination, and

2. Contamination poses a potential health or environmental threat on or off the naval facility.

If these criteria are not met, no further studies under the NACIP program are recommended in the IAS report.

1.3.1.4 Evidence. Evidence used in supporting recommendations for confirmation studies include written information from records, verbal reports from individuals knowledgeable of installation operations, or laboratory analysis.

1.3.1.5 Confirmation Study Ranking System. All known or suspected hazardous waste disposal sites identified by the IAS team were evaluated using a Confirmation Study Ranking System (CSRS) developed by NEESA for the NACIP program. The system is a two-step procedure for systematically evaluating a site's potential hazard to human health and the environment based on evidence collected during the IAS.

Step one of the system is a flowchart which eliminates innocuous sites from further consideration. Step two is a ranking model which assigns a numerical score, within a range of 0 to 100, to indicate the potential severity of a site. Scores are a reflection of the characteristics of the waste disposed of at a site, contaminant migration pathways, and potential contaminant receptors on and off the installation. CSRS scores and engineering judgment are then used to evaluate the need for a confirmation study based on the criteria stipulated in Section 1.3. CSRS scores assigned to sites recommended for confirmation studies also assist Navy managers in establishing priorities for accomplishing the recommended actions.

A more detailed description of the CSRS is contained in NEESA Report 20.2-042.

CHAPTER 2. SIGNIFICANT FINDINGS

2.1 INTRODUCTION. Significant findings are defined as any evidence of past contamination that might represent a threat to human health or the environment. At least two indicators of contamination, e.g., interviews, documentation, or physical evidence, were necessary for the determination of significant findings. No sampling or analysis was performed as part of this survey.

At NAS Alameda, 12 sites were identified during the IAS. Table 2-1 summarizes the NAS Alameda significant findings at these sites, while Figure 2-1 shows the locations of the sites.

2.2 WEST BEACH LANDFILL (SITE 1). The West Beach Landfill served as the NAS Alameda disposal area from approximately 1952 through March 1978, although most disposal of hazardous waste at the landfill had been eliminated by the late 1960s and early 1970s. In addition, other naval installations disposed of wastes at this site, including the Oak Noll Naval Hospital, Naval Supply Center-Oakland, and Treasure Island. Materials reportedly disposed of at the landfill included municipal garbage; solvents; oily waste and sludges; paint waste, strippers, thinners, and sludges; plating wastes; industrial strippers/cleaners; acids; mercury; polychlorinated biphenyl (PCB)-contaminated fluids and TAC rags; batteries; low-level radiological wastes; scrap metal; inert ordnance; spoiled food; asbestos; pesticides; tear gas agents (CS and CSC); infectious waste; creosote; and waste medicines and reagents.

Estimates of the total amount of waste and the amount of hazardous materials disposed of at the landfill vary. Since the landfill was used as a general disposal area, there were no truck scales, or any other means of quantifying the amounts or types of waste as it was disposed.

The estimates of amounts of waste in the landfill are based largely on individual recollection and judgement; however, some quantification of the amount of hazardous material was possible, based on industrial process information. It has been estimated that a maximum of 1.6 million tons of municipal garbage are present in the landfill. Estimates of the amount of hazardous waste vary from 30,000 tons to 500,000 tons.

NAS Alameda Project P-183 is designed to close the landfill as a Class II site in accordance with state and local regulations. The design parameters for the landfill closure were in part derived from groundwater sampling that was conducted in 1977 by contractors working for the Navy.

A series of 14 wells was installed. Based on the information available, sampling and analysis for oil and grease, sulfides, iron, nitrate nitrogen, lead, total phosphorus, total nitrogen, and methane derivatives was conducted. Only low concentrations of these materials were found; accordingly, the landfill closeout design was for a Class II (less than 1% by volume hazardous materials) landfill. Based on

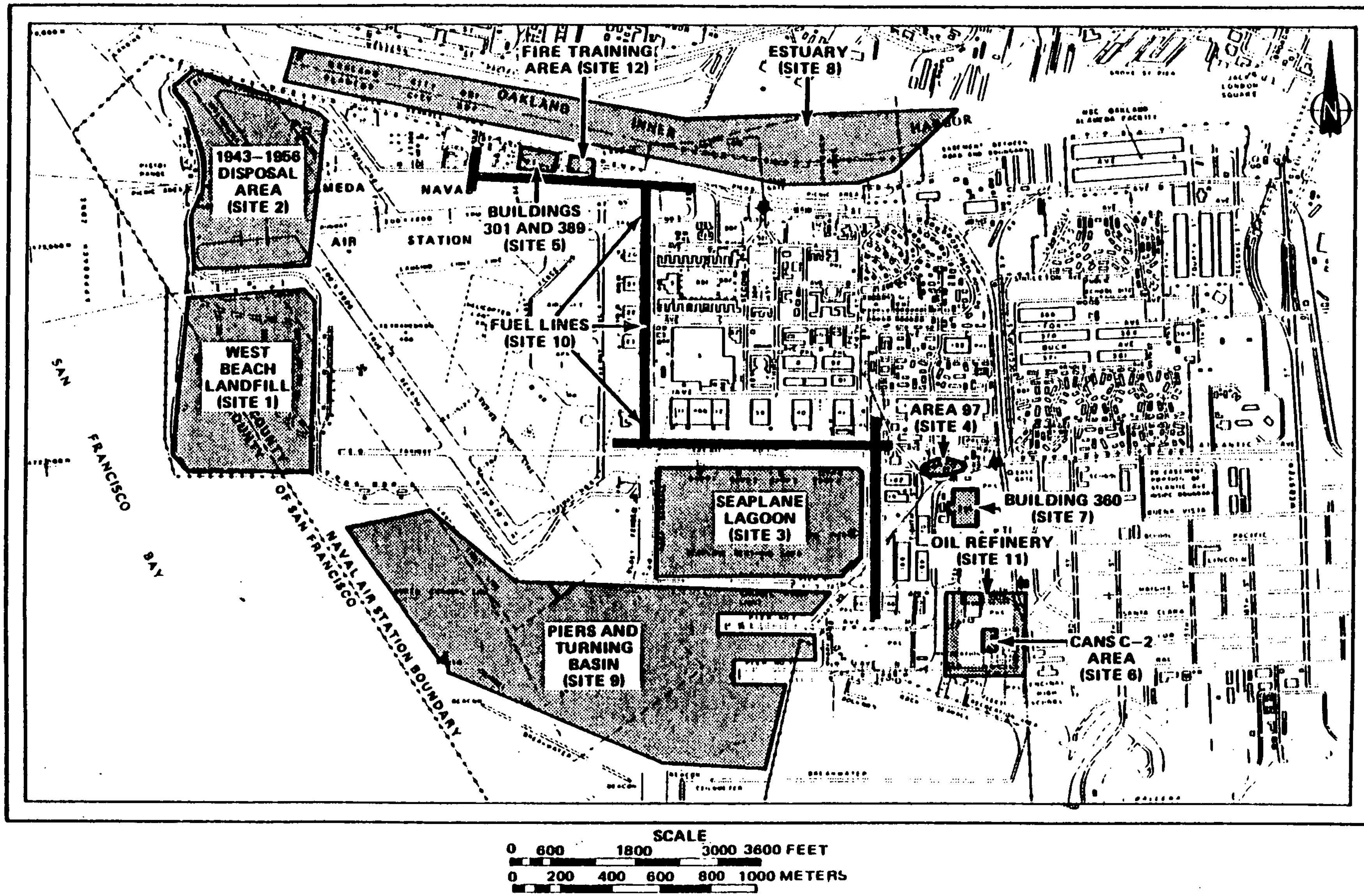
Table 2-1

AREAS OF CONTAMINATION,
NAS ALAMEDA

Area of Concern	Period of Operation	Types of Waste Disposed of or Spilled	Comments
West Beach Landfill (Site 1)	1952 to 1978	Industrial and non-industrial wastes	An estimated 1.6 million tons of garbage and between 30,000 and 500,000 tons of hazardous waste. Hazardous wastes included in this total amount were PCBs, solvents, plating wastes, metals, pesticides, inert ordnance, low-level radiological waste, infectious waste, and acids.
1943-1956 Disposal Area (Site 2)	1943 to 1956	Industrial and non-industrial wastes	An estimated 15,000 to 200,000 tons of waste, including old aircraft engines, low-level radiological wastes, scrap metal, waste oil, paint wastes, solvents, cleaning compounds, and construction debris.
Seaplane Lagoon (Site 3)	1943 to 1975	Industrial and non-industrial wastes	Over the approximately 30-year period, approximately 300,000,000 gallons of wastewater contaminated with heavy metals, solvents, paints, detergents, acids, alkyles, caustics, mercury, oil and grease, and probably pesticides and PCBs.
Area 97 (Site 4)	1960s to early 1970s	AVGAS	About 365,000 gallons of AVGAS may have been leaked to shallow groundwater in the area and been dispersed.
Buildings 301 and 389 (Site 5)	1950 (?) to 1974	PCBs	PCB oils have leaked from transformers; also, PCBs were allegedly used for weed control in the area.
Cans C-2 Area (Site 6)	1963 (?) to present	PCBs	PCBs have leaked from a transformer and allegedly were used for weed control.

Table 2-1 (Cont.)

Area of Concern	Period of Operation	Types of Waste Disposed of or Spilled	Comments
Building 360 (Site 7)	1954 to present	Alkaline permanganate, caustics, cleaning solvent, hydrochloric acid, nitric acid, paint remover, phosphoric acid, rust corrosion remover, and sodium hydroxide	Top four inches of soil removed from under the cleaning shop in 1979.
Estuary (Site 8)	1943 to 1975	Industrial and non-industrial wastes	Approximately 150,000,000 gallons of wastewater over a 20-year period, including organics, wastewaters, and detergents.
Piers and Turning Basin (Site 9)	1943 to 1974	Shipboard and industrial wastes	Sediments contaminated by lead, zinc, cadmium, copper, volatile solids, and oil and grease.
Fuel Lines (Site 10)	1943 to 1978	Fuel	Leakage since 1943.
Oil Refinery (Site 11)	1879 to 1903	Oil	Decommissioned 1903; some problems in the 1940s.
Fire Training Area (Site 12)	1950s (?) to present	Contaminated fuel oil	Aqueous fire-fighting foam, carbon dioxide, potassium chloride, and Purple K have been used to extinguish fires in this area.



1.8 MI LONG
.8 MI WIDE

Figure 2–1 AREAS OF SIGNIFICANT FINDINGS, NAS ALAMEDA the information gathered during the IAS, additional information on the landfill should be obtained before it is closed as a Class II site. The specific recommendations for additional data gathering are discussed in Chapter 4.

2.3 1943-1956 DISPOSAL AREA (SITE 2). The 1943-1956 Disposal Area was used for waste disposal from the early 1940s to 1956. Specific information concerning the materials disposed of at this site is limited. However, it is known that most solid waste generated on the base during this time was disposed of at this site. An estimated 15,000 to 200,000 tons of waste were buried here. The material disposed of at this site was similar to the material disposed of at the West Beach Landfill. Other items reported to have been disposed of at the 1943-1956 Disposal Area include low-level radiological wastes, old aircraft engines, cooked garbage from ships in port, and construction debris.

2.4 SEAPLANE LAGOON (SITE 3). The seaplane lagoon served as a receiving water for the disposal of millions of gallons of wastewaters (estimates are that at least 380,000 gallons a day were discharged) from industrial and storm sewer outfalls for over 30 years. At least 300,000,000 gallons of wastewater were deposited in the lagoon over this 30-year period. The lagoon was originally dredged (in the 1940s) to a depth of 15 feet; sludge and sediment have accumulated in the basin. A report put out by the Navy in 1976 on hydrographic conditions reported that the depth in a portion of the lagoon varied between 15 and 18 feet.

The seaplane lagoon has received wastewater contaminated with heavy metals, solvents, paints, detergents, acids, alkyles, caustics, mercury, oil and grease, and probably pesticides and PCBs. It has also received the concentrated hazardous material spills that were often washed into the station's industrial waste or storm sewer collection systems. Over the years, ships docked at the piers to the south of the lagoon have cumulatively discharged wastewater contaminated with chromium, waste oil and fuel, and assorted mixtures of paints, solvents, and trash, which were swept into the lagoon by tidal action.

Accounts by long-time employees at NAS Alameda emphasize the magnitude of toxic and hazardous wastes that have been disposed of in the seaplane lagoon. Several personnel remembered that fish caught in the lagoon during the early 1970s strongly smelled of solvents and were inedible. During the 1960s and 1970s, bottom paints from small boats anchored in the lagoon would occasionally dissolve. Examination of the bottom of the lagoon in 1971 revealed a significantly depressed macrobenthic community.

Wastewater discharges and waste disposed into the seaplane lagoon, particularly from NARF operations, continued until approximately 1975. Accidental spills of materials such as oil and other waste have occurred since 1975.

In summary:

1. Between the early 1940s and mid-1970s, the seaplane lagoon received over three million gallons of industrial wastewater containing toxic and hazardous wastes from industrial activities within NARF and from ship maintenance activities at the piers.

2. Some constituents of the wastes disposed of in the lagoon are heavy metals, PCBs, and other environmentally persistent toxic substances.

3. The seaplane lagoon is almost entirely enclosed by seawalls. Bay currents are such that pollutant flushing action from the lagoon is impaired, and a high shoaling rate exists.

4. Dredging of the lagoon has been limited. Base personnel stated that, in 1981, 21,000 cubic yards of material were removed from the southeast side of the lagoon in the vicinity of Pier 1, the seawall, and the Port Services Officer Building. The spoils from this dredging were disposed of at the West Beach Landfill. No evidence exists suggesting that most of the lagoon has ever been dredged; shoals are visible throughout the lagoon.

2.5 AREA 97 (SITE 4). Supply Fuels Branch personnel estimate that up to 365,000 gallons of AVGAS may have leaked to the shallow groundwater in Area 97 in the 1960s and early 1970s, based on the amount of AVGAS lost from the storage tanks. While the majority of the AVGAS undoubtedly evaporated, a study conducted by a contractor in 1979, four years after the leaks were discovered, revealed the existence of dangerous concentrations of gasoline vapors in sewers and utility ducts in the vicinity of Area 97. Interviews with NAS Alameda personnel indicate that this vapor problem persists, although funding has been requested to remedy the situation (MCON Project P-192). In addition, reevaluation of data from the contractor's report indicates that gasoline-contaminated groundwater is capable of greater velocities than those assumed by the contractor, and may have had the potential over the past 15 years to travel several thousand feet from Area 97. Based on this, it is possible that the contaminated groundwater from Area 97 has reached the seaplane lagoon as well as parts of the NAS Alameda industrial and residential areas.

2.6 BUILDINGS 301 AND 389 (SITE 5). Prior to 1974, electrical transformers taken out of commission at NAS Alameda were stored on bare ground north of the runways adjacent to the Oakland Inner Harbor channel, in the vicinity of Buildings 301 and 389. Personnel familiar with the operation estimate that 200 to 400 gallons of PCB oil may have been present at any one time. Occasional leakages were recalled (amount unknown, probably minor). More importantly, it was stated that some of the oil was routinely drained from the transformers and spread on the ground to control weed growth adjacent to the transformers.

2.7 CANS C-2 AREA (SITE 6). The Cans C-2 Area, located near Buildings 338-A through H, has been used as a storage area for hazardous material. Material stored in this area originates from NARF. Paints, solvents, acids, and bases were stored outside in containers that leaked, corroded, or were open, resulting in spills over the years. PCBs were used as needed for weed control in the area until 1963, and a PCB transformer leaked into the area. Base environmental personnel stated that 10 cubic yards of the PCB-contaminated soil from the transformer spill were removed in August 1982 (after the IAS survey was completed) by IT Corporation under contract to NARF. Tests indicate that the soil remaining on the spill site contains less than 1 ppm PCBs.

2.8 BUILDING 360 (SITE 7). The engine cleaning shop in Building 360 has been in operation since 1954. In early 1979 it was noticed that chemicals (see Table 2-1) were seeping through the shop floor and contaminating the soil in the crawl space beneath the building. Soil samples taken at the site in 1979 indicated that the contaminated soil was a hazardous material and should be removed to an approved disposal site. The contaminated area was estimated to be approximately 135 feet by 155 feet; depth of contamination was unknown. By June 1982, the top four inches of contaminated soil were removed and a layer of plastic installed under the shop to protect maintenance personnel who work in the crawl space. Some chemical leakage has occurred since the installation of the plastic. The soil has been sampled to determine residual contamination. Similar leaks into the crawl space have also occurred under the Building 360 plating shop. Tests for acids, cyanides, and metals will be conducted on the soil.

2.9 ESTUARY (SITE 8). The Oakland Inner Harbor, like the seaplane lagoon, served for several decades as a discharge point for industrial wastes disposed of in the sewer system. These wastes included organics, wastewaters, and detergents discharged at a rate of approximately 30,000 gallons per day, for a total of approximately 150,000,000 gallons of wastewater between the 1940s and the 1960/70s.

2.10 PIERS AND TURNING BASIN (SITE 9). In 1974, "Cold Iron" facilities to handle shipboard wastes were completed at NAS Alameda. Prior to that time, ships in port continued normal power generation and ship support functions. The waters of the piers and turning basin received shipboards wastes, bilgewater, and maintenance debris from as many as 17 ships (aerial photographs show four carriers and 13 other ships in port) at once. These wastes contaminated the sediments in the turning basin and pier area.

Analysis of the sediments in the pier area conducted by the Department of Navy in March 1976 prior to maintenance dredging in 1978 revealed that these sediments exceeded allowable United States Environmental Protection Agency (EPA) concentrations for lead, zinc, cadmium, copper, volatile solids, and oil and grease. The turning basin, which lies to the west toward the bay, had lesser concentrations of these pollutants.

2.11 FUEL LINES (SITE 10). When constructed, NAS Alameda contained numerous AVGAS distribution lines which were buried at depths of less than two feet. When the Area 37 AVGAS tanks were taken out of commission in 1968, and the Area 97 tanks in 1975 and 1978, the fuel lines leading from these tanks were abandoned. The abandonment procedure consisted of draining the fuel from the lines and then filling them with water.

Few of the abandoned lines had retained their structural integrity. Two lines failed the routine hydrostatic testings conducted prior to the general 1968, 1975, and 1978 decommissionings, and had to be abandoned earlier than scheduled. Unable to hold the water put into them as part of the abandonment procedure, these lines filled up with gasoline vapor from residual gasoline, thus creating a potentially hazardous explosive condition. When construction at Pier 1 necessitated the removal of abandoned lines in 1979, one pipe caught fire three times before being removed.

Breaks in the pipeline leading from the main JP-5 storage area (Area 374) to the aircraft fuel truck loading area (Area 373) have been observed. These breaks have resulted in some leakage of fuel into the surrounding area. This type of problem has been present since 1941, when one break, reported to be located "southwest of Hangar 23," required extensive soil excavation and the removal of gasoline by pumping before vapor levels could be brought to a safe level. These abandoned fuel lines do not normally represent a hazard, and any contamination of groundwater would be minimal. However, the lines do present problems to workers whenever excavation or removal of the lines occurs.

2.12 OIL REFINERY (SITE 11). From 1879 to 1903, the Pacific Coast Oil Company had a refinery located in the area that is now the southeast corner of the base. The refinery was removed upon completion of Standard Oil refining facilities at Point Richmond. Refinery waste and asphalt-type residue were dumped at the site, creating sufficient vapor pressure to cause disturbance of the Navy-constructed surfacing in the 1940s. The problem was eventually solved by excavating an area approximately 30 feet square down to the old material, pouring a concrete slab over the entire area, and backfilling and resurfacing. There has been no further trouble at this location; however, "black oil" has been found during drilling in the area.

2.13 FIRE TRAINING AREA (SITE 12). The fire training area, located on the perimeter road in the vicinity of Building 443, serves as a training facility, a fire extinguisher discharge point, and a drug contraband burning area. Burning has been conducted twice a month using approximately 100 gallons of contaminated fuels and oils obtained from NAS Alameda plane defueling operations or from bowsers (reconfigured aircraft engine shipping containers used to hold waste fluids; see Figure 6-12 in Section 6). Aqueous fire-fighting foam, carbon dioxide, potassium chloride, and Purple K are used to extinguish the fire. Approximately 60 to 70 thirty-pound potassium chloride extinguishers were discharged three to four times a year for at least 10 years. The use of bowser fluids contaminated with heavy metals could have left a toxic residue at this area.

2.14 GENERAL SIGNIFICANT FINDINGS. NAS Alameda receives its water from the East Bay Municipal Utility District (EBMUD). Shallow groundwater has never been considered as a water supply. Additionally, two early, fairly deep wells were closed due to natural mercury contamination.

The largest nesting and breeding grounds in Northern California for the California least tern are located on NAS Alameda (see Figure 5-2 in Section 5). The least tern is listed by the state and federal governments as an endangered species. Other endangered species located in the vicinity of NAS Alameda are listed in Appendix D.

In addition to the sensitive environment of the least tern's nesting grounds, NAS Alameda is near several other sensitive environments located in the San Francisco Bay Area. The seaplane lagoon has been designated by the California Fish and Game Commission as a striped bass sports fishing area (see Figure 5-2 in Section 5). The Commission has designated the estuary as a sports fishing area for perch, as well as a collecting area for littleneck and soft-shell clams. Southeast of NAS Alameda, in the bay, there is commercial fishing for herring and sports fishing for leopard sharks. There is also a public beach located southeast of NAS Alameda. Nearby, another endangered bird species, the California clapper rail, is found. NAS Alameda is also near a flatfish nesting area. Crab Cove, located at the west end of the Robert Crown Memorial State Beach, is a unique marine reserve protected by California law and administered by the East Bay Regional Park District.

A major part of the evaluation of the current effects of past waste disposal practices is a review of the toxicological, chemical, and physical properties of the contaminants. The chemicals historically present at NAS Alameda are of two categories: those that should not pose a problem to the surrounding environment or the health of base personnel, since they are neither particularly toxic nor persistent (see Table 2-2); and those that are potential problems, since they are corrosive, toxic, or persistent (see Table 2-3). These chemicals may adversely affect the environmental component they come in contact with, or persist for years, or bioaccumulate to levels of environmental concern. To facilitate an understanding of the potential problems present at NAS Alameda, Appendix A gives brief summaries of the toxicological characteristics of the chemicals in the second category.

Table 2-2

CHEMICAL WASTES GENERATED AT NAS ALAMEDA
WITH POTENTIAL FOR MINIMAL ENVIRONMENTAL IMPACT

Acetic acid
Acetone
Butyl alcohol
Ethyl acetate
Ethyl alcohol
Glycerine
Isopropyl alcohol
Methyl alcohol
Methyl ethyl ketone
Oleic acid
Sodium sulfate

Table 2-3

CHEMICAL WASTES GENERATED AT NAS ALAMEDA
WITH POTENTIAL FOR MODERATE TO HIGH
ENVIRONMENTAL IMPACT

Acrylic thinners	Methylene chloride
Ammonium nitrate	Methylchloroform (1,1,1-trichloroethane)
Antimony trioxide	Methyl ethyl ketone peroxide
Asbestos	Mercury
Aviation gasoline	Naphtha
Batteries (lead, mercury)	Naphthalene
Benzene	Nickel
Benzoyl peroxide	Nitric acid
Beryllium	Phenols
Cadmium	Phosphoric acid
Chromates	Polyaromatic hydrocarbons (PAHs)
Chlordane	Polychlorinated biphenyls (PCBs)
Chloroform	Potassium cyanide
Copper	Potassium permanganate
Copper cyanide	Plating and metal finishing (cadmium, chrome, copper, lead, nickel, silver)
Creosol	Silver cyanide
Creosote	Soaps
Cresylic acid (hydroxytoluene)	Sodium cyanide
2,4-D	Sodium hydroxide
Dichlorobenzene	Sodium hypochlorite
Dimethylaniline	Spent blasting grit
Dope thinner	Stoddard solvent
Ethylene glycol	Sulfuric acid
Fluorides	Tear gas agents (CS and CSC)
Fluorinated hydrocarbons	Tetrachloroethylene
Heptane	Toluene
Hexane	Trichloroethane
Hydrochloric acid	Trichloroethylene
Lacquer thinner	Xylene
Lead	
Lindane	
Kerosene	
Manganese carbonyl	

CHAPTER 3. CONCLUSIONS

3.1 INTRODUCTION. Professional judgment on the part of the IAS team was the prime determinant in concluding that a site represented a potential threat to human health or the environment and, as such, warrants further action under the NACIP program. The IAS team was assisted in reaching these conclusions by use of the NEESA-developed CSRS (see Section 1.3.1.3). Of the 12 sites identified, seven were judged to warrant further study. The following sections discuss the conclusions reached for each site.

3.2 WEST BEACH LANDFILL (SITE 1). The West Beach Landfill reportedly has received 1.6 million tons of garbage and between 30,000 and 500,000 tons of waste oils, solvents, chemicals, PCB-contaminated fluids, asbestos, pesticides, low-level radiological material, and other hazardous wastes. The soils at this site are possibly contaminated, and migration of contaminants to the San Francisco Bay is possible. The area of the bay near the West Beach Landfill serves as a feeding ground for the California least tern, an endangered species. Contamination from NAS Alameda could affect the food chain for this bird through bioaccumulation of contaminants contained in the small fishes and other marine life upon which the least tern feeds. It could also affect the sports fishing for striped bass and leopard sharks in the area, as well as nesting grounds for the flatfish. The IAS team has concluded that further investigation under the NACIP program is warranted.

3.3 1943-1956 DISPOSAL AREA (SITE 2). The 1943-1956 Disposal Area reportedly has received between 15,000 and 200,000 tons of waste, including waste oil, paint waste, solvents, cleaning compounds, scrap metal, cooked garbage, and radiological material. Currently, the area is covered with soil and is occupied by the west end of Runway 7-25, the north end of Runway 13-31, two ammunition storage facilities, and a recreation area consisting of a skeet and pistol range, picnic grounds, a baseball diamond, and recreation building. In addition, a jogging course runs the length of the site.

The contamination that exists in this area could affect the health of individuals using the recreation area if significant disturbance of the soil cover were to occur. Such a disturbance is possible as the result of such proposed projects as the expansion of recreational facilities and the construction of additional storage facilities. These projects would involve extensive earth moving or excavation. While none of the proposed projects have received full funding to date, the possibility of significant disturbance of the soil cover exists.

Migration of contaminants from the disposal area into the San Francisco Bay could also affect the California least tern, an endangered species, through bioaccumulation of contaminants contained in the small fishes and other marine life upon which the least tern feeds. Striped bass and leopard sharks, both of which are important to the sports fisheries in the bay, could also be affected by bioaccumulation of contaminants.

The 1943-1956 Disposal Area warrants further investigation under the NACIP program.

3.4 SEAPLANE LAGOON (SITE 3). The contaminants in the lagoon are such that the food chain for the California least tern could be affected. In addition, there has been a demonstrated effect on the sports fishing in the lagoon (in the past, fishermen have complained of a "solvent-like smell and taste" to the striped bass caught in the lagoon). Further investigation of this site under the NACIP program is warranted.

3.5 AREA 97 (SITE 4). Gasoline vapors continue to present a hazard in the vicinity of Area 97. MCON Project P-192 proposes to vent the utility lines, thus reducing the hazard of gasoline vapors. However, funding for this project has not yet been received. Gasoline has also been detected in the groundwater. It is probable (based on the analysis discussed on page 6-8 of this report) that contaminated groundwater has reached and continues to reach discharge points such as the seaplane lagoon. AVGAS could be affecting the food chains in the lagoon. Further study under the NACIP program is warranted.

3.6 BUILDINGS 301 and 389 (SITE 5). During the 1960s and early 1970s, PCB oils leaked and were sprayed onto the ground to control weeds at the old used-transformer storage area in the vicinity of Buildings 301 and 389. The amount of oils remaining in this area is unknown. However, PCBs are very persistent, with a half-life in soil of approximately eight years, and bioaccumulate. These PCBs could represent a threat to human health; however, their proximity to the Oakland Inner Harbor with its concentration of fish (see Figure 5-2 in Section 5) is of greater concern, and warrants further investigation under the NACIP program.

3.7 CANS C-2 AREA (SITE 6). The soils beneath the Cans C-2 Area have been contaminated by spills of solvents, paints, paint strippers, and organic chemicals, as well as by the deliberate spraying of PCBs for weed control. These chemical spills, which can still be seen, represent a potential threat to the health of the workers in the area. As such, further investigation of the extent of contamination is warranted under the NACIP program.

3.8 BUILDING 360 (SITE 7). Soils beneath the engine cleaning and plating shops in Building 360 have been contaminated with unknown quantities of various chemicals. Some measures have been taken to mitigate the contamination beneath the cleaning shop; however, no investigation or remedial measures have been undertaken regarding the potentially contaminated soils beneath the plating shop. The site warrants further investigation under the NACIP program.

3.9 ESTUARY (SITE 8). Materials discharged directly to the estuary totaled approximately 30,000 gallons of waste per day. However, three factors have helped to mitigate the effect of these chemicals. First, the wastes themselves were either quickly dispersed because of their volatility (organics), or were dilute to begin with (wash waters), or had only moderate potential for harming the environment (detergents).

Secondly, the Oakland Inner Harbor has a vigorous flushing action due to tidal influences, as well as a good mixing action and dilution capability. Finally, the Oakland Inner Harbor has a low shoaling rate and is dredged, thereby reducing the possibility of a buildup of contaminants in the estuary as the result of NAS Alameda activities. These factors culminate in no discernible environmental effect; further study under the NACIP program is not warranted.

3.10 PIERS AND TURNING BASIN (SITE 9). Analysis of samples of the sediment in the piers and turning basin indicate contamination according to EPA standards. However, the advent of Cold Iron at NAS Alameda has greatly reduced the possibility of continued pollution. The nearly annual dredging of the piers and turning basin reduces the amount of previously contaminated sediment in the area. Disposal practices are such that no new environmentally sensitive areas are threatened. Further investigation under the NACIP program is not warranted.

3.11 FUEL LINES (SITE 10). While the leaks from the fuel lines have been a continuing environmental problem at NAS Alameda, the impact of these leaks is minor. The IAS team has concluded that futher investigation under the NACIP program is not warranted.

3.12 OIL REFINERY (SITE 11). The mitigative actions undertaken at this site in the 1940s have apparently removed any threat to human health or the environment. No further study under the NACIP program is warranted.

3.13 FIRE TRAINING AREA (SITE 12). The use of contaminated oils for fuels and the discharge of fire-fighting chemicals may have resulted in the contamination of soils in the fire training area. However, the effects are localized and relatively minor. No further study under the NACIP program is warranted.

CHAPTER 4. RECOMMENDATIONS

4.1 INTRODUCTION. Recommendations for possible courses of action are provided for areas of potential contamination identified during the IAS. For sites posing a potential danger to human health or to the environment, confirmation studies under the NACIP program are recommended. For sites which warrant cleanup actions but do not warrant confirmation studies, mitigating actions are proposed. Seven sites have been recommended for further action (see Table 4-1).

4.2 WEST BEACH LANDFILL (SITE 1).

Groundwater Sample Borings: As a possible means of reducing costs during the verification phase of the confirmation study for the West Beach Landfill, the IAS team recommends using the 14 wells previously installed whenever possible. Not all of the old wells may be acceptable. However, no more than 14 groundwater sample borings will be necessary since the number of sample borings to be drilled will depend on the present condition of the old sampling wells. If an old well is no longer usable, a sample boring should be drilled at that location. If an old well is present but extends to a depth greater than 10 feet beneath the present water table (i.e., the length of the water column in the well exceeds 10 feet), a sample boring should be drilled adjacent to the old well. Appendix B details the specifications for conducting the sample boring program.

Type of Samples: Groundwater.

Number of Samples: One per well; no more than 14.

Testing Parameters: Inorganics: cadmium, chromium, lead, mercury, nickel, silver, selenium, and zinc. Organics: total organic carbon (TOC) and total organic halogens (TOX). Also, gross alpha and gross beta radiation measurement, pH and static water levels.

Frequency: Quarterly for one year. If screening identifies any contamination, additional samples and analyses will be required.

Remarks: This is only the verification phase of the confirmation study. If significant contamination is found, a more detailed characterization phase of the confirmation study would be necessary to determine its extent. Appendix C contains an outline of such a study.

4.3 1943-1956 DISPOSAL AREA (SITE 2).

Groundwater Sample Borings: Three, equally spaced along the seawater perimeter of the site.

Type of Samples: Groundwater.

Number of Samples: Three.

Testing Parameters: Same as for Section 4.2, above.

Remarks: Same as for Section 4.2, above.

Table 4-1

RECOMMENDATIONS, NAVAL AIR STATION (NAS) ALAMEDA

			Confirmation Study					
			Verification (One-Time Study)			Characterization (First-Year Effort)		
Report Number-Site Number	Site Name	CSRM Score	Number of Soil Samples	Number of Water Samples	Testing Parameters	Number of Wells	Number of Samples	Testing Parameters
014-1	West Beach Landfill	38	0	No more than 14	Inorganics: cadmium, chromium, lead, mercury, nickel, silver, selenium, and zinc. Organics: TOC and TOX; gross alpha and gross beta	20	20 groundwater	As detected during verification study
014-2	1943-1956 Disposal Area	36		3	Same as above	3	3 groundwater	As detected during verification study
014-3	Seaplane Lagoon	40	3 60-inch piston core sediment samples	3 near-bottom	Same as above			Mitigative action to follow verification
014-4	Area 97	17		12	Gasoline			If gasoline is found, additional borings should be installed to define extent of gasoline plume

Table 4-1 (Cont.)

Report Number-Site Number	Site Name	CSRM Score	Confirmation Study: Verification (One-Time Study): Number of Soil Samples	Number of Water Samples	Testing Parameters	Characterization (First-Year Effort): Number of Wells	Number of Samples	Testing Parameters
014-5	Buildings 301 and 389	14	9		PCBs		45 to 60	
014-6	Cans C-2 Area	20	30		PCBs, pesticides, heavy metals		90 to 150	If pesticides or heavy metals found, appropriate EPA toxicity tests should be run
014-7	Building 360	8	6		In the six equally spaced holes beneath the plating shop: pH, cyanide, chrome, lead, silver, and nickel			Mitigative action to follow verification phase if necessary

4.4 SEAPLANE LAGOON (SITE 3).

Sediment Cores: Three, each 60 inches long, to be taken with a piston coring device at the locations indicated on Figure 4-1. The sample locations were selected so that both dredged and undredged portions of the lagoon could be sampled.

Near-Bottom Water Samples: To be taken at the same locations as the sediment cores.

Type of Samples: Sediment and water.

Number of Samples: Three water and nine sediment. Three from each core taken from the depth intervals zero to 12 inches, 24 to 36 inches, and 48 to 60 inches.

Testing Parameters: The same as listed for the landfill study outlined in Section 4.2 above.

4.5 AREA 97 (SITE 4).

Groundwater Sample Borings: Twelve, initially (see Figure 4-2 for locations). The boring procedures to be followed are described in Appendix B.

Type of Samples: If multi-phase conditions are encountered, separate samples of the gas and groundwater should be obtained; i.e., separate samples from each phase. Samples may simply be dipped or thieved out of the holes.

Number of Samples: Twelve, initially.

Testing Parameter: Gasoline.

Remarks: This program comprises the verification phase of the confirmation study based on the analysis discussed on page 6-8 of this report. Should gasoline be found, additional borings should be installed in appropriate locations to define the extent of the gasoline plume in the characterization phase of the confirmation study.

4.6 BUILDINGS 301 AND 389 (SITE 5).

Hand-Auger Soil Borings: Three in verification phase; 15 to 20 in characterization phase of the confirmation study.

Type of Samples: Soil.

Number of Samples: Nine, in verification phase; three per boring taken at zero to six inches, 18 to 24 inches, and 30 to 36 inches. In characterization phase, 15 to 20 borings at appropriate depths.

Testing Parameter: PCBs.

Remarks: Initial three borings should be installed in areas most likely to be contaminated. Care should be taken to clean auger between samples to prevent cross contamination.

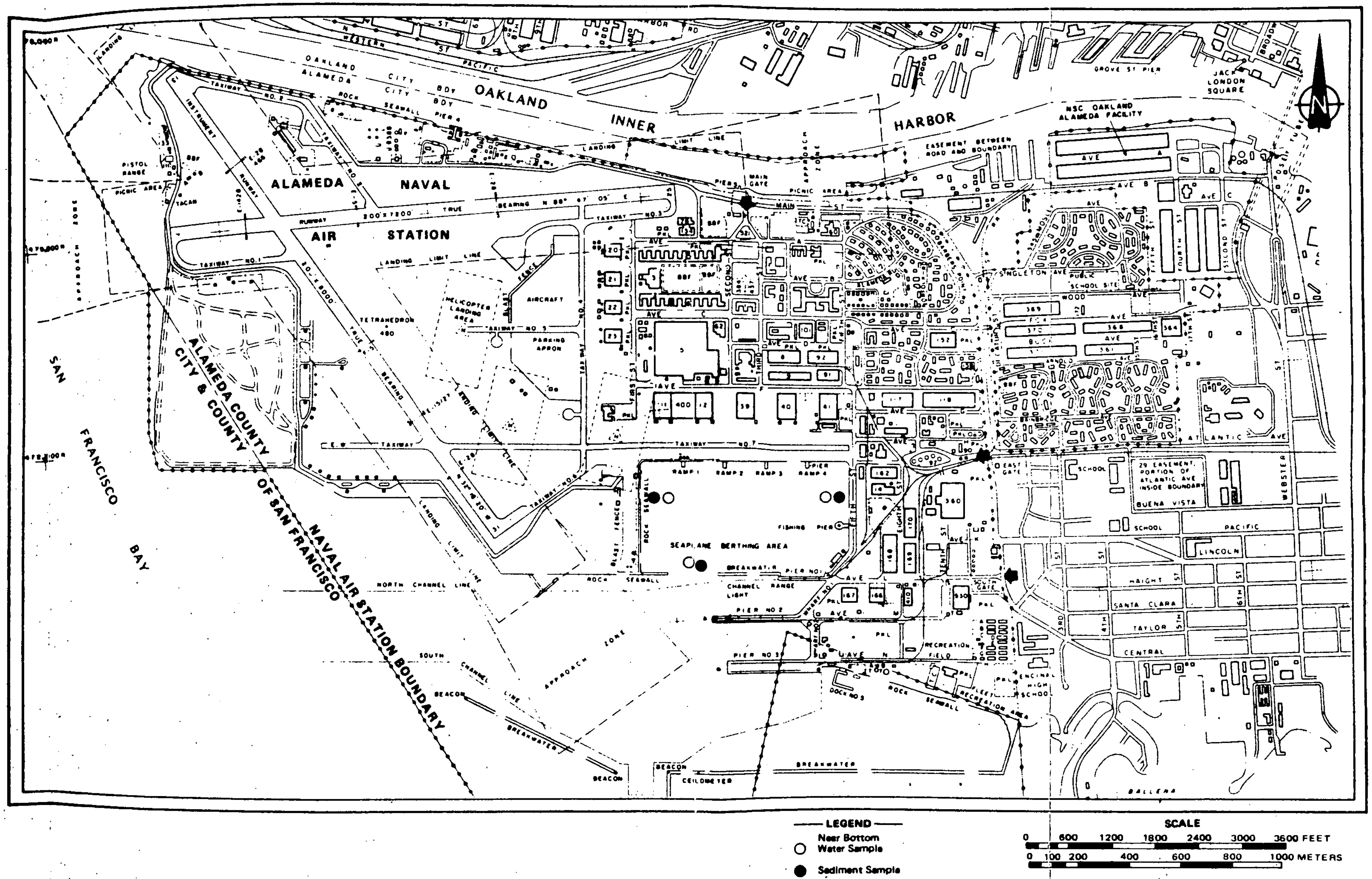


Figure 4–1 PROPOSED SAMPLING PLAN, SEAPLANE LAGOON (SITE 3), NAS ALAMEDA

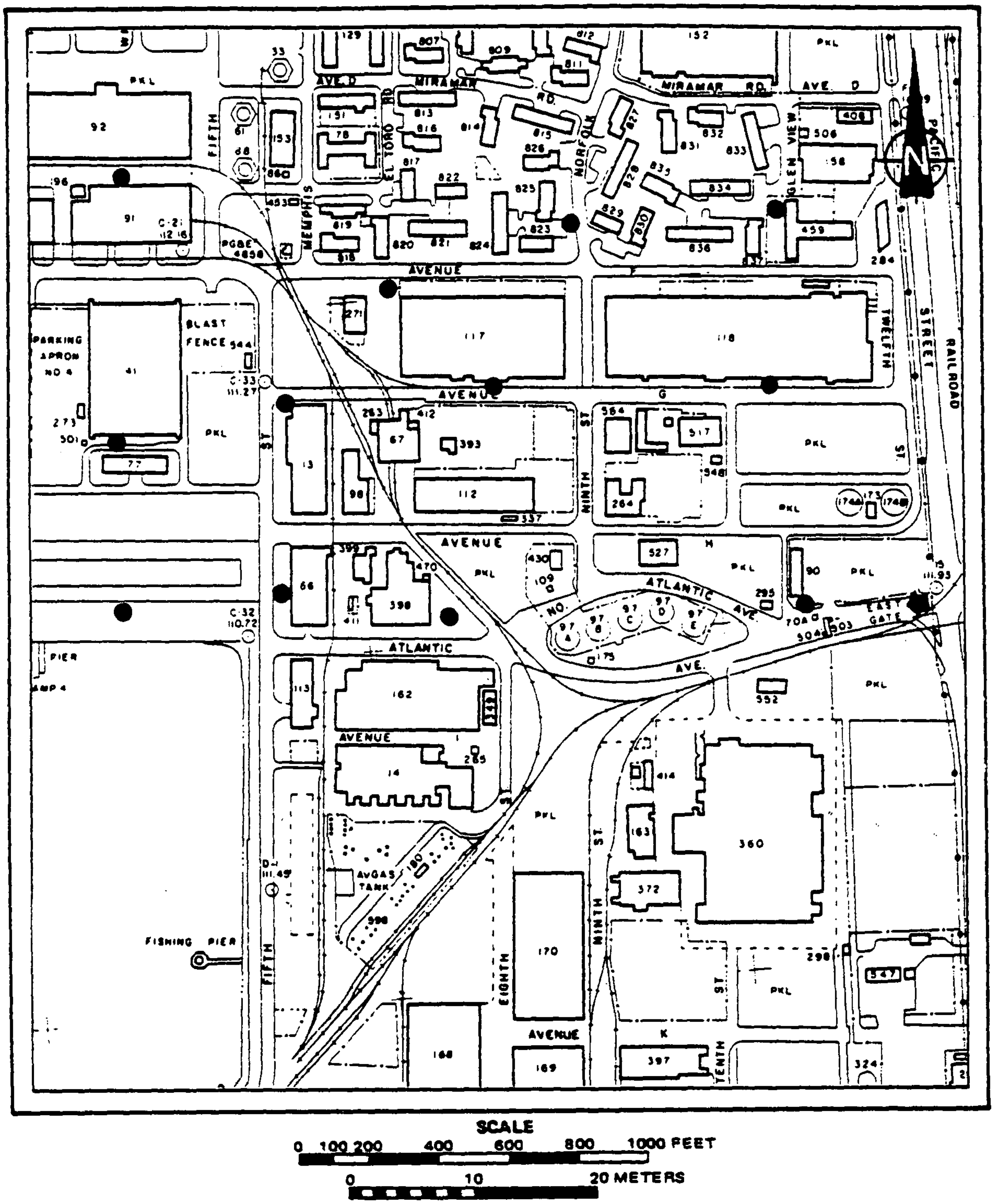


Figure 4–2 PROPOSED PHASE I SOIL BORING LOCATIONS (APPROXIMATE), AREA 97 (SITE 4), NAS ALAMEDA

4.7 CANS C-2 AREA (SITE 6).

Hand-Auger Soil Borings: Five to 10 for the verification phase in the more visible spill areas and on the steel grid roadway where PCBs were reported to have been sprayed for weed control. For characterization phase, 30 to 50 locations.

Type of Samples: Soil.

Number of Samples: Five to 10 for the verification phase; three per boring taken at zero to six inches, 18 to 24 inches, and 30 to 36 inches. In confirmation phase, 90 to 150 samples at appropriate depths.

Testing Parameters: PCBs, pesticides, cadmium, zinc, lead, silver, mercury, copper, chromium, and nickel. If pesticides or heavy metals are found to be present, the appropriate EPA toxicity tests should be conducted.

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

4.8 BUILDING 360 (Site 7).

Hand Augered Soil Borings: Six equally spaced in the ground beneath the plating shop.

Type of Samples: Soil.

Number of Samples: Six; one per each boring taken over the zero to 12-inch depth interval.

Testing Parameters: Beneath the plating shop: pH, cyanide, chrome, lead, silver, and nickel.

4.9 GENERAL RECOMMENDATIONS. All sites recommended for confirmation studies under the NACIP program, or for mitigative activity of any kind, should be designated on base maps as areas of interest. These sites should also be entered into the facility Master Plan with a description of the proposed confirmation studies or mitigative actions.

The IAS team concurs with the sampling and cleanup activities proposed or currently being undertaken by the facility, as discussed in Chapter 2. These activities include closure of the West Beach Landfill (Site 1) in accordance with state directives; the reduction of the hazard posed by vapors in manholes and vaults resulting from the leaks in Area 97 (Site 4); and the cleanup of PCB-contaminated soil from the Cans C-2 Area (Site 6). The IAS team recommends that these efforts be coordinated with the activities presented in Sections 4.2 through 4.8.

CHAPTER 5. BACKGROUND

5.1 GENERAL. NAS Alameda is located at the west end of the City of Alameda in Alameda County, California. Original development of the base was begun by the United States Army in 1930 and was transferred to the Navy in 1936. The population of NAS Alameda present at any one time averages 15,600. NAS Alameda serves as homeport to over 12,000 Navy personnel aboard ships and 2,000 reserve personnel. Civilians total approximately 7,400, nearly 5,000 of which are employed by NARF.

5.1.1 Socioeconomics. NAS Alameda is at the geographic center of the San Francisco-Oakland Metropolitan Area. This area is divided into two sectors. San Francisco and San Mateo counties make up the portion known as the West Bay, while Alameda and Contra Costa counties make up the portion known as the East Bay. NAS Alameda is located in the East Bay Area.

The San Francisco-Oakland Standard Metropolitan Statistical Area (SMSA),* consisting of Alameda, Contra Costa, Marin, San Francisco, and San Mateo counties, covers 2,480 square miles bordering San Francisco Bay. The City of San Francisco (the boundaries are coextensive with the county) is the largest city. Oakland, just across the bay in Alameda County, is the second largest city.

To the north lie Sonoma, Napa, and Solano counties, principally known for their vineyards and rural settings, although Sonoma County contains a sizeable trade and service center and Solano County is the site of a shipyard (NSY Mare Island) employing several thousand workers. To the east lies the San Joaquin Valley, California's agricultural heartland. Santa Clara County, which borders Alameda and San Mateo counties on the south, has rapidly become an important manufacturing and population center. The Bay Area's western boundary is the Pacific Ocean.

The bay region is made up of nine counties and cities linked together economically, socially, and politically. This area is overseen by a number of municipal, county, state, and federal agencies which administer programs and formulate policies addressing a variety of regional concerns. Executive Order 12088 of 13 October 1978 states that all federal facilities must comply with the "substantive, procedural, and other requirements" of all applicable pollution control standards. By its intention, the Navy and other federal agencies must abide by state and local regulations as well as federal requirements pursuant to environmental acts. These acts are identified as the Clean Air Act; Noise Control Act; Marine Protection, Research and Sanctuaries Act ("Ocean Dumping" Act); Safe Drinking Water Act; and radiation guidance from the Atomic Energy Act. Other regulations affecting NAS Alameda

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*The San Francisco-Oakland Standard Metropolitan Statistical Area will, for convenience, be referred to as the San Francisco-Oakland SMSA, the San Francisco-Oakland Metropolitan Area, or the Bay Area.

include the Resources Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation and Liability Act. NAS Alameda is therefore affected directly or indirectly by a number of governmental entities and regulatory agencies, the most important of which are discussed below, along with their corresponding jurisdictions.

Water Quality. The California Regional Water Quality Control Board (CRWQCB) for the San Francisco Bay Area implements local water quality standards. It administers those policies established by the state level authority of the California Water Resources Control Board. The CRWQCB sets water quality minimums for all waters, including groundwater in the bay region, and regulates discharges into these waters. The CRWQCB also regulates the quality standards of the water that can be decanted back into the bay from dredge spoil ponds.

Air Quality. Air quality standards are interpreted and enforced by the California Air Resources Board. The local implementing agency, the Bay Area Air Quality Management District (BAAQMD), maintains surveillance over industries in the area for compliance with regulations concerning air polluting emissions.

Bay Fill and Coastal Consistency Development. The agency currently most active in the review of projects and development concerning the bay and its coastline is the San Francisco Bay Conservation and Development Commission (BCDC). The BCDC has been given the responsibility for developing and enforcing the Coastal Zone Management Program for the San Francisco Bay. Its jurisdiction in the regulation of dredging, filling, and coastline development of the bay includes all waters and land subject to its tidal action, i.e., sloughs, tidelands and adjacent marshlands, salt ponds, submerged lands, and certain waterways. Authority also has been granted over a shoreline band that extends 100 feet inland from the water's edge at highest tide.

Though not legally subject to the jurisdiction of the BCDC (federal lands are exempt from a state coastal zone management plan), the Navy and other federal agencies are required by the legislation of the Coastal Zone Management Act (CZMA) to "be consistent to the maximum extent practicable" with the plans and policies of the initiating agency for the local coastal zone management program.

Dredging and Dredge Spoil Disposal. The United States Army Corps of Engineers is responsible for maintaining the deep water channels of the shipping lanes of the San Francisco Bay. They issue all dredging permits in the bay after hosting the necessary public review process.

Other agencies involved in the review of a proposed dredging project include the BCDC, the CRWQCB, and the California Department of Fish and Game (CDFG). Each agency has its own interests and concerns. The BCDC, as previously described, is primarily concerned with preserving the integrity of the bay and protecting the surrounding marshes and tidelands; CRWQCB regulates the quality of water that can be legally decanted back into the bay; and CDFG makes judgments as to the possible adverse impacts on fish and other wildlife caused by a proposed dredging project, especially dredging impacts on endangered species.

Intergovernmental coordination between the Navy and the United States Army Corps of Engineers occurs when NAS Alameda requests a dredging permit.

The Association of Bay Area Governments (ABAG). The ABAG is a voluntary organization primarily made up of elected officials from city and county governments who serve in an advisory capacity to solve regional problems. This organization acts under state enabling legislation as the areawide clearinghouse for the review of all federal grant applications for the bay region. While ABAG does not have any enforcement authority, the association does serve as a guardian of public interest and can use the media to achieve its aims.

The California Governor's Office of Planning and Research (OPR). The OPR is the comprehensive planning agency for the state and serves as the planning and research staff for the Governor, his cabinet, and the legislature. OPR is the state clearinghouse (A-95) for the review of environmental impact reports, federal grant applications, and planning action programs.

The California Department of Health Services. This agency is responsible for administering the California Hazardous Waste Program as well as the Resource Conservation and Recovery Act (RCRA) program in California.

The Alameda County Airport Land Use Commission (ALUC). The ALUC is an appointed body concerned with land use in the vicinity of public airports. The ALUC has adopted an airport area of concern for NAS Alameda and is reviewing development proposals in the vicinity of the air station within their area of influence.

United States Coast Guard. The United States Coast Guard is responsible for proper use of shipping lanes in the San Francisco Bay, as well as oil spill response.

5.1.2 Location and Description. NAS Alameda encompasses a total of 2,634 acres of land, water, and airspace easement. The 2,561 acres owned in fee include 958 acres of water. Of the 159 acres held under a one-dollar-per-year, long-term lease from the City of Alameda, only nine acres are land. In April 1969, an aviation easement for a 50-year term was acquired from the Port of Oakland. This allowed airspace rights over 122 acres of land in the glide approach to Runway 13. NAS Alameda's real property includes: two runways (one 200 feet by 8,000 feet and the other 200 feet by 7,200 feet), encompassing 337,800 square yards; taxiways, encompassing 183,235 square yards; and aircraft parking/access aprons, encompassing 469,700 square yards.

The northern portion of the island of Alameda was formerly tidelands, marshlands, and slough adjacent to the historical San Antonio Channel, now known as the estuary or the Oakland Inner Harbor. Much of NAS Alameda, which is on the west side of the island, originally was water. The station is rectangular in shape, a little over two miles in length, and one mile in width. To date, the base occupies 2,570 acres of dry land, most of which was created by filling. The terrain is flat, averaging 15 feet above sea level. (Sections 5.3 and 5.4 discuss the physical features of NAS Alameda in greater detail.)

5.1.3 Organization. The mission of NAS Alameda is to maintain and operate facilities and provide services and material support operations for aviation activities and units of the operating forces of the Navy, as well as for other activities and units as designated by the CNO.

Figure 5-1 shows the chain of command for NAS Alameda. The commanding officer represents an echelon five level of command. His principal responsibility is to see that assigned tasks and functions are performed to the successful accomplishment of the overall mission of the station. Higher echelon commands having authority over the operations and duties of the station are the Commander in Chief, U.S. Pacific Fleet (CINCPACFLT); Commander Naval Air Force, U.S. Pacific Fleet (COMNAVAIRPAC); and Commander Light Attack Wing, U.S. Pacific Fleet (COMLATWINGPAC). The major claimant from whom all Operation and Maintenance (O&MN) monies and military construction (MILCON) funding are provided is CINCPACFLT.

5.1.4 Tenants and Supported Units. An important function of NAS Alameda is to provide facilities and support to the many tenants and major supported units stationed at the base. At present, 30 separate and diverse activities provide their services to the Pacific Fleet from facilities at the station. The Naval Air Rework Facility (NARF) and the Naval Air Reserve Unit (NARU) are the station's largest tenant commands. Support of these two activities is one of the primary functions of NAS Alameda. The tenants presently on board at NAS Alameda are listed below:

Naval Air Rework Facility (NARF);

Naval Regional Data Automation Center (NARDAC);

Naval Oceanographic Command Detachment (NAVOCEANCOMDET);

Naval Regional Medical Center (NAVREGMEDCEN);

Navy Public Works Center (PWC);

Naval Air Reserve Unit (NARU);

Marine Air Group Forty-Two (MAG-42);

Navy Commissary Store (COMSYSTO);

Naval Regional Dental Center (NAVREGDENCEN);

Navy Disease Vector Ecology and Control Center (NAVDISVECTECOLCONCEN);

Naval Supply Center-Oakland (NSCO);

Naval Investigative Service Office (NAVINVSERVO);

Human Resource Management Detachment (HUMRESMANDET);

Telecommunications Center; and

PRESIDENT OF THE UNITED STATES

SECRETARY OF DEFENSE
(SECDEF)

SECRETARY OF THE NAVY
(SECNAV)

ECHELON 1: CHIEF OF NAVAL OPERATIONS
(CNO) (OPNAV)

ECHELON 2: COMMANDER IN CHIEF
U.S. PACIFIC FLEET
(CINCPACFLT)

ECHELON 3: COMMANDER NAVAL AIR FORCE
U.S. PACIFIC FLEET
(COMNAVAIRPAC)

ECHELON 4: COMMANDER LIGHT ATTACK WING
U.S. PACIFIC FLEET
(COMLATWINGPAC)

ECHELON 5: COMMANDING OFFICER
NAVAL AIR STATION, ALAMEDA
(NAS ALAMEDA)

Figure 5-1 CHAIN OF COMMAND, NAS ALAMEDA

Supervisor of Shipbuilding, Conversion and Repair, San Francisco (SUPSHIP).

Major supported units are:

Commander Carrier Group Three (COMCARGRU 3);

Commander Carrier Group Seven (COMCARGRU 7);

COMNAVAIRPAC Material Representative Office;

Naval Construction Battalion Unit-416 (CBU-416);

Explosive Ordnance Disposal (EOD) Group One;

Marine Barracks;

Naval Aviation Engineering Services Unit;

Navy Exchange;

Submarine Development Group One Detachment (COMSUBDEVGRUONE-DET);

Combined Services Support Program School (COMBINED SVCSUP-PSCOLSPAC);

Counseling and Assistance Center;

Naval Air Logistic Control Office Eastern Pacific (NALCOEAST-PAC);

Navy Alcohol Action Safety Program;

Personnel Support Activity Detachment; and

Pacific Fleet Audio-Visual Facility (PACFLTAVFAC).

5.2 HISTORY. Alameda Island, originally a peninsula covered with giant oaks and thick undergrowth, was first inhabited by the mussel- and clam-eating tribe of the Costanoan Indians. Old Alameda Point, now part of NAS Alameda, was the site of an Indian burial ground. In 1776, the 43,000-acre island was granted to Don Luis Maria Peralta, who had immigrated from Tabac in Sonora, for his 40 years of service as a soldier to His Majesty, the King of Spain. Before his death, Don Luis distributed his lands among his children. His son, Antonia Maria, received the portion that includes the City of Alameda, which he subdivided and sold to early settlers. The settlers chopped down the oak trees of West Alameda and raised vegetables and fruit on the cleared land. Originally, the area was called "Bolsa de Encinal" or "Encinal de San Antonio." In 1853, the name of the developing town was changed to Alameda, meaning "grove of poplar trees."

Chinese labor was later brought to Alameda to construct roads. The Chinese made Alameda the headquarters of their Tong, a secret political/religious society. In 1864, the San Francisco and Alameda Railroad was constructed, running from High Street, Oakland, to the west end of Alameda and terminating at a ferry landing at the present site of Pier 2. This became the western terminus of the Central Pacific transcontinental railroad. Old Alameda Point was the scene of early industrial activity. An oil refinery called the Pacific Coast Oil Company was constructed in 1879 and later purchased by the Standard Oil Company, which operated the plant until 1903.

In 1876, engineers cut a channel through the peninsula's tip which linked San Leandro Bay with the main bay, and Alameda became an island. Dredging was done to deepen the canal, and in 1902 the Tidal Canal was opened. At this time, 20-mule teams hauled raw borax out of Death Valley for transshipment to Alameda's Pacific Coast Borax Works. This four-story plant was located at the present site of the aircraft engine overhaul building.

In 1911, foreshadowing the future of the site, an adventurous young aviator named Weldon Cooke, as part of the entertainment for President William H. Taft on his Columbus Day visit to Oakland, took off from the sands of Alameda (the present site of the station) and flew three times around Lake Merritt before landing. In May 1927, shortly after the Atlantic flight of Charles Lindbergh, the City of Alameda established an airport on the site consisting of an administration building and three hangars, with Curtiss-Wright the major tenant. The airfield consisted of one narrow east-west runway. To the southwest of the airfield, the city established a yacht harbor. In 1935, Pan American Airways took over the yacht harbor as the eastern terminus of trans-Pacific flights.

On 2 December 1930, the United States Army acquired the site from the city. The Army named the 100-acre site Benton Field and, on 3 April 1931, Captain Leander Larson took charge of the construction work. The army drilled and tested a 12-inch well. Both the Army well and the Pan American well, which had been sunk in the vicinity of Buildings 26 and 52, were eventually shut down due to natural mercury contamination.

On 7 October 1936, the Navy acquired the title to the 1,075-acre site, together with the 929.34 acres (above and below water) which comprised the Alameda Airport. On 10 February 1938, Commander E.C. Seibert, (CEC) USN, arrived to assume his duties as Officer in Charge of Construction. More land was necessary and dredging was done, during which a dredge crew discovered the old trestle pier and ferry slip built about 75 years before. The wreckage, which included pile stubs, iron railings, locomotive wheels, coupling links, and a pile of sandstone cobbles (evidently discarded sailing-ship ballast), was removed.

On 15 March 1940, the first two permanent civil service employees arrived at the station and, on 1 November 1940, the station was officially commissioned. The ceremony was brief and informal. Rear

Admiral A.J. Hepburn, Commandant of the Twelfth Naval District; members of his staff; all officers attached to the station; officials of the cities of Alameda, Oakland, and San Francisco; and representatives of the newspapers of these cities gathered before the administration building. The Commandant read his orders as the ceremony began at 1015. He turned the station over to Captain McCrary, who read his orders, and then directed the Executive Officer to set the watch. There were approximately 390 marines and sailors on board. The first squadron of planes to arrive, which flew in from Seattle on 3 January 1941, was commanded by Lieutenant Commander W.L. Erdman.

On 7 December 1941, the Japanese struck at Pearl Harbor and the station immediately went on a war-time basis. To meet the needs of the fighting forces, additional land was acquired and larger buildings were added to the still unfinished original plant. The military and civilian population increased along with station expansion. NAS Alameda became the "aviation gateway to the Pacific," funneling men and supplies to overseas destinations. It was at NAS Alameda that General Jimmy Doolittle and his B-25 bombers were taken aboard the USS Hornet, later to make the first U.S. attack on the Japanese homeland.

Construction of station facilities continued at a rapid pace until the end of World War II. The immediate post-war period saw the major part of the outlying activities and target areas disposed of and a general retrenchment in the main station. The Korean action, however, brought about increased activity as well as extensive revisions to the runway system, additional overhaul shops, and supply storage facilities. Naval Air Reserve Unit (NARU) became a tenant activity at NAS Alameda when commissioned on 1 July 1961. On 1 April 1967, the former Overhaul and Repair (O&R) Department was commissioned as a new activity under the title, Naval Air Rework Facility (NARF) Alameda.

NAS Alameda continued in its tradition of service throughout the dramatically increased activities of Vietnam and stands today as a vital part of the Navy.

5.3 PHYSICAL FEATURES.

5.3.1 Climatology. The prevailing winds of the San Francisco Bay Area are from a westerly direction. Records show that winds of gale force or greater have occurred only rarely in the area. Heavy fogs occur on the average of 21 days per year. These fogs impair visibility for navigation at Oakland an average of less than 100 hours per year. Freezing temperatures rarely occur, and no snow or icing conditions are encountered. Rainfall averages approximately 20 inches annually, generally occurring from October to May.

5.3.2 Topography. The island of Alameda is characterized by a low topographic profile, with surface elevations varying from mean sea level to approximately 30 feet above mean sea level. The average land elevation is approximately 20 feet. Formerly, the northern portion of the island was tidelands, marshlands, and slough adjacent to the historical San Antonio Channel, now known as the estuary. Much of what is now NAS Alameda originally was water. The station, located on the west side of the island, is rectangular in shape, a little over two miles in length, and one mile in width. It presently occupies 2,570 acres of dry land, most of which was created by filling. The terrain is flat, averaging 15 feet above sea level.

5.3.3 Geology and Soils. Alameda Island was formed by the natural process of beachsand deposits. This type of deposit, identified by geologists as "the Merrit Sand Formation," is classified as a fine-grained, well-sorted sand interspersed with layers of clayey sand and clay. In contrast, the former tidal flats of the estuary and the bay bottom surrounding Alameda are made up of more recent geological deposits of very fine materials held in suspension in bay water and gently deposited. These soils, known as "bay mud," are now largely overlain with man-made fills dredged from the estuary, which are plastic, unstable, and relatively weak.

For the most part, NAS Alameda is built on land created by placing fill (mostly dredge fill) over marginal lands. The original swamp area consisted of deep deposits of bay mud interspersed with numerous drainage channels and sloughs. Additional land was obtained by filling in adjacent tidal areas of the bay. The fill came from many places, including material dredged from the estuary during construction of the Posey Tube in the 1920s. Most of the station area is overlaid with silty sand and sand fill six to eight feet thick which ranges from moderately to poorly compacted. Beneath the fill, soft silt clay (bay mud) extends to depths of 25 to 120 feet below the existing ground surface. The soil below the bay mud consists of loose to dense silty and clean sands and stiff to very stiff sandy clays. The fill soils range from low to moderate in compressibility, while the underlying bay mud is high in compressibility.

The soils on the station are predominantly coarse textured and have a low water holding capacity. Except for a small area on the west side next to the San Francisco Bay, the soils are well drained. In the poor drainage area, the soils are medium textured and are affected by moderate amounts of alkali and salts. The soil depth ranges from 20 to 60 inches. Over the coarse-textured sand and bay mud lies an imported four- to six-inch layer that is loam in texture.

Depth to bedrock at the site is not known. A map published by the United States Geological Survey (1957) indicates that exploration borings made in the vicinity penetrated to depths of up to 354 feet without encountering bedrock. A boring approximately one mile northwest of NAS Alameda encountered bedrock at an elevation of -433 feet (mean lower low water datum). Bedrock at this location was described as yellow shale. In borings that did not reach bedrock, the soils consisted primarily of clays with interbedded sandy and gravelly layers.

There is no evidence of any fault traversing the site. However, the site is located approximately six miles west of the Hayward Fault and about 12.5 miles east of the San Andreas Fault. These faults are known to be active and have been the cause of major earthquakes in the past. Destructive earthquakes have occurred in the San Francisco Bay

Area in 1836, 1838, 1861, 1865, 1868, and 1906. Other less severe but damaging earthquakes have also occurred in the area.

5.3.4 Hydrology. There are no natural surface streams or ponds on NAS Alameda. Precipitation that falls on the base either is evapotranspired back into the atmosphere, runs off in the storm drain network, or infiltrates to the water table. Soil investigations conducted at various locations on the base have shown that the groundwater table occurs generally at elevations of four to eight feet above the lower low tidal elevation. This elevation, greater than the average tidal elevation, is maintained only because some precipitation infiltrates to the water table.

No water budget studies have been conducted at NAS Alameda. However, of the approximately 20 inches of rainfall that occur typically, approximately four inches of the total could be expected to infiltrate into the soil and yield an average groundwater underflow rate to the San Francisco Bay and the Oakland Inner Harbor channel at an average rate of 15 gallons per day per foot of shoreline. However, for any significant segment of shoreline this rate may vary significantly depending on a variety of factors, including precipitation, drainage, grading, and soil permeability.

Tidal effects on water table fluctuation are probably not significant, except within 25 to 50 feet of the shoreline or other water surfaces connected to the bay, such as flooded or leaking sewers. This is demonstrated by the following procedure. The equation for computing groundwater flow is $V = Ki/n$, where "V" is velocity, "K" is permeability, "i" is hydraulic gradient, and "n" is porosity. Therefore, assuming a permeability for a good, clean sand of 10^{-1} centimeters per second, a relatively steep hydraulic gradient of 0.1, a typical sand porosity of 20%, and a time period of six hours (the approximate time interval between high and low tide), the computed flow distance of the tidal water is only 35 feet.

NAS Alameda is underlain by a thick aquitard sequence of the bay mud formation, which is a silty clay. The underlying formations contain some sand units that have served as aquifers in the past. Two wells into these lower units were shut down years ago because of water quality problems (high background levels of naturally occurring mercury). At the present time, the groundwater beneath Alameda Island is not used as a water supply, nor is it likely to be in the future. Furthermore, according to the East Bay Municipal Utility District (EBMUD), no groundwater is used for water supply on Alameda Island or in Oakland.

5.3.5 Migration Potential. Since NAS Alameda is part of an island, all potential surface water and groundwater migration pathways lead to essentially one place, the ocean, by way of the San Francisco Bay and the Oakland Inner Harbor channel. As discussed in Section 5.3.4, the average groundwater flow into the bay is on the order of 15 gallons per day per foot of shoreline. Contaminants in the groundwater could be expected to reach the bay waters at the same rate or less, depending on the attenuation capabilities of the soil. Surface waters on the base reach the bay waters either by way of the storm water runoff system or sheet runoff and small rivulet channels. Any contaminants dumped into these systems will eventually reach the bay.

5.4 BIOLOGICAL FEATURES.

5.4.1 Fauna. The western half of NAS Alameda, including the airfield and the landfill area, is the most undeveloped area of the base. The NAS Alameda landfill area is inhabited by rats, field mice, and other typical rodent fauna. Jackrabbits abound. Predatory control is exercised by a small feral cat population. A variety of waterfowl and shorebirds feed and rest in the seaplane lagoon seasonally. The shorebirds utilize the exposed rock and limited mud areas, feeding on worms, crustaceans, molluscs, and smaller fish. The tidal fluctuations expose the margin of the lagoon regularly, creating a diverse environment for the sedentary life of the shoreline and for the many shorebirds. Table D-1 in Appendix D provides a list of birds commonly found on NAS Alameda. Aquatic organisms are found in the bay waters adjacent to the station. Invertebrate and fish species that have been identified at the station are listed in Tables D-2 and D-3, respectively, in Appendix D.

The character of the important fisheries of San Francisco Bay (chinook salmon, striped bass, sturgeon, shad, Pacific herring, northern anchovy, starry flounder, surfperch, elasmobranches, bay shrimp, and bivalves) has changed dramatically over the past century. Many commercial fisheries that were once important to the Bay Area economy have disappeared (e.g., the river fishery for chinook salmon and the extensive clam and oyster industries), and although other commercial fisheries have been revived in recent years (e.g., herring, bay shrimp), there has been an overall change in emphasis from commercial to recreational fishing. This has been largely due to legislation restricting the commercial harvest of anadromous species such as salmon, striped bass, and sturgeon.

Man-induced changes in the environment are implicated in the decline of certain fishery resources. Water storage and diversion projects have affected the distribution and abundance of salmon and striped bass, and land reclamation and domestic sewage pollution essentially eliminated the clam and oyster industries. Fishing pressure has also been linked with the decline of the bay shrimp and sturgeon fisheries.

San Francisco Bay contains large numbers of shellfish species, some of which have known potential commercial and recreational value, such as the soft-shell clam, Japanese littleneck clam, mussels, and the native oyster. Although considerable progress has been made in improving water quality in the bay in recent years, shoreline waters are apparently not yet free enough of sewage contamination for the State Public Health Department to sanction harvesting of bay shellfish for consumption.

Commercial herring fishing occurs to the south of NAS Alameda in San Francisco Bay, with sports fishing for leopard shark and halibut occurring in the same vicinity, as shown on Figure 5-2. This area also contains a flatfish nursery and a localized concentration of striped bass. Recreational fishing for striped bass, perch, top smelt, jack smelt, and brown rockfish takes place in the seaplane lagoon at the public fishing dock. Sports fishing for striped bass

LEGEND

1 Soft-shell clam
2 Common little-neck clam
3 Striped bass – sports fishing
4 California least tern – nesting area (FE, SE)
5 California clapper rail – adult concentration, nesting area (FE, SE)
6 Flatfish – nursery
7 Rodents, Jackrabbits, and Feral cats
8 Perch – sports fishing, off piers
9 Halibut – sports fishing
10 Leopard shark – sports fishing, shallow waters
11 Herring – commercial fishing
12 Barrow's golden eye – adult concentration, overwintering area
13 Smelt – sports fishing
14 Brown rock fish – sports fishing

CODE DESIGNATIONS

SE = State-listed endangered species
SR = State-listed rare species
FE = Federally-listed endangered species

SOURCE: U.S. Fish and Wildlife Service, 1981, Pacific Coast Ecological Inventory.

Kato, Susumu, personal communication, National Marine Fisheries Service.

U.S. Fish and Wildlife Service, California Department of Fish and Game, 1979, Protection and Restoration of San Francisco Bay Fish and Wildlife Habitat.

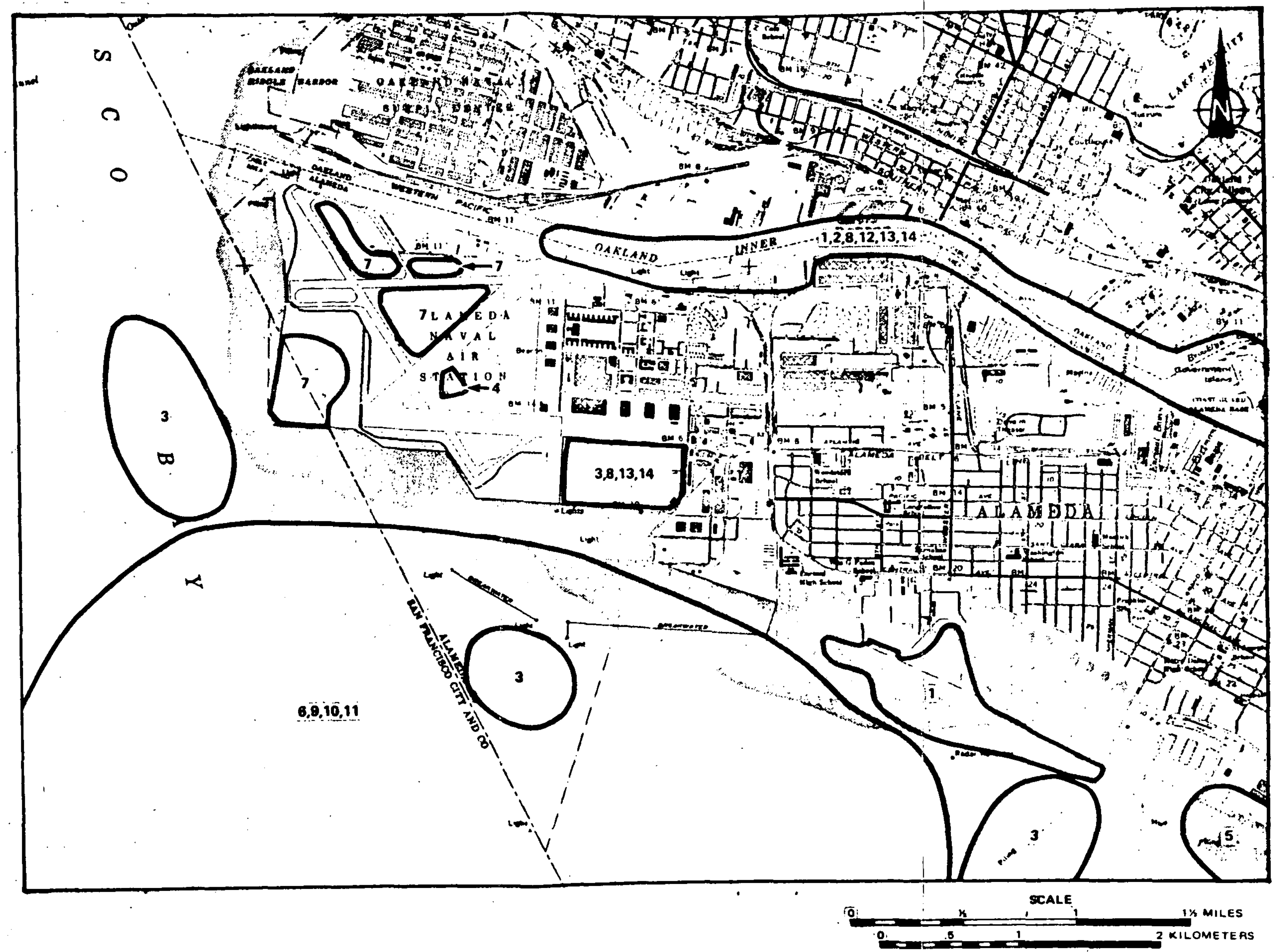

Figure 5–2 BIOTA IN THE VICINITY OF NAS ALAMEDA

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also occurs to the west of the landfill. Soft-shell clams and common littleneck clams are found in the Oakland Inner Harbor, but are not harvested for commercial purposes. Sports fishing for perch, top smelt, jack smelt, and brown rockfish occurs off the piers located along the harbor. An adult concentration of Barrow's golden eye is located in this area, which is also used as an overwintering area.

The habitat of endangered, threatened, and rare species takes on special significance because of federal and California state laws enacted to protect these species and their habitats. Both the United States (Endangered Species Act of 1973) and the State of California (California Endangered Species Act 1970) protect designated endangered fish and wildlife, publish lists of these species, and give notice of the status of each species.

San Francisco Bay and its immediate surroundings support certain rare and endangered wildlife species, but no rare or endangered fish species. The species are listed in Table 5-1.

A complete list of species or subspecies of California wildlife that have been declared endangered or rare by the California Fish and Game Commission, or endangered or threatened by the Secretary of the Interior, is included in Appendix D as Table D-4. The official state of California listing of endangered or rare wildlife is contained in the California Administrative Code, Title 14, Section 670.5. The official federal designations of endangered and rare species are published in the Federal Register.

The only known endangered species inhabiting NAS Alameda is the California least tern. Due to the destruction of suitable nesting habitats and the subsequent decrease in their population, the California least tern (Sterna albifrons browni) is considered endangered by both state and federal governments. It receives full protection under the Endangered Species Act of 1973. Each spring, the California least tern nests and raises its young on the coast of California.

Although least tern colonies were once abundant from Monterey County to Baja California, the only nesting sites north of San Luis Obispo County are now restricted to the San Francisco Bay Area. Since at least 1977, and perhaps for a decade, NAS Alameda has been the site of the largest least tern colony in the Bay Area and, thus, in northern California. Although least tern breeding populations may fluctuate at colony sites from year to year, NAS Alameda is the primary nesting site in terms of both the number of breeding pairs and the stability of the colony.

California least terns nest at NAS Alameda on a triangular patch of asphalt and dirt adjacent to an active aircraft taxiway (see Figure 5-2). Located in the middle of the south end of the airfield, the colony site has one active taxiway, Taxiway 7, off the south side and three access roads for north, east, and west borders. Runway 31 passes near the southwest corner behind the west road; continues northwest, crossing east and west of Runway 25/7; and ends at the mouth of the estuary. The substrate of the site is composed of intact

Table 5-1

RARE AND ENDANGERED WILDLIFE SPECIES OF
SAN FRANCISCO BAY AND VICINITY

Common Name	Scientific Name	Federal*	State*
Amphibians			
San Francisco garter snake	Thamnophis sirtalis tetrataenia	E	E
Birds			
California least tern	Sterna albifrons browni	E	E
California clapper rail	Rallus longirostris obsoletus	E	E
California black rail	Laterallus jamaicensis coturniculus		R
Southern bald eagle	Haliaeetus leucocephalus leucocephalus	E	E
American peregrine falcon	Falco peregrinus anatum	E	E
California brown pelican	Pelecanus occidentalis californicus	E	E
Mammals			
Salt marsh harvest mouse	Reithrodontomys raviventris	E	E

*E: Endangered
R: Rare

Source: United States Fish and Wildlife Service and California Department of Fish and Game, 1979, Protection and Restoration of San Francisco Bay Fish and Wildlife Habitat.

asphalt pavement or pebbles from decomposed asphalt pavement, sand, and some dirt. Vegetation is sparse, consisting of scattered clumps of ice plant and plantain.

A nesting area of California clapper rails, also a state and federally endangered species, is located to the southeast of NAS Alameda bordering the San Francisco Bay, as shown on Figure 5-2.

Located to the southeast of NAS Alameda at the west end of the Robert Crown Memorial State Beach is Crab Cove, a state-protected marine reserve. Crab Cove is one of 13 areas in the state of California which has marine protection. All invertebrates in this area are protected from commercial and sports fishing. The land is owned by the state and leased to the East Bay Regional Park District, which administers it. In 1980, Crab Cove was designated a marine reserve by the California State Department of Fish and Game at the request of the East Bay Regional Park District, which was concerned with the growing decline of estuarine species in the area due to illegal harvesting and sports fishing and wanted to create an educational program for the public as well. The Crab Cove visitor center provides an area where students and the general public can come and learn about the protected species.

5.4.2 Flora. NAS Alameda is almost entirely man-made land, the majority of which is either paved or planted in typical urban fashion with native and non-native lawns, trees, shrubs, etc. Those portions of the station allowed to grow in a wild state are basically limited to the landfill area. The modified marsh areas on the airfield and at the landfill, as shown on Figure 5-2, are designated as existing and potential wildlife habitat by the United States Fish and Wildlife Service and the California Department of Fish and Game. There are no known endangered, rare, or threatened plant species inhabiting NAS Alameda. A complete list of federally endangered and threatened and California state rare and endangered plant species of the Pacific Coast is included in Appendix D as Table D-5. A complete inventory of the various grasses, shrubs, and other ground cover has not been undertaken to date, and it was beyond the scope of this study to conduct such a survey.

5.5 ADJACENT LAND USE. Land use in the vicinity of NAS Alameda is primarily residential and military, as shown on Figure 5-3. The base is bordered to the north by the Oakland Inner Harbor, north of which is the main site of the Naval Supply Center-Oakland (NSCO), occupying 541 acres in Alameda County. Located to the west and south of the station is the San Francisco Bay. To the east is a mixture of industrial, residential, and public land uses. The Todd Shipyards are located immediately adjacent to the northeast corner of the base. The Naval Supply Center Oakland-Alameda Facility (NSCO-AF) occupies 107 acres immediately to the east of the Todd Shipyards. The Naval Supply Center Oakland-Alameda Annex (NSCO-AA) occupies 81 acres and is located to the east of NAS Alameda and the southern boundary of NSCO-AF. The College of Alameda Peralta Junior College District lies on the eastern boundary of NSCO-AF. The remaining land use to the east of

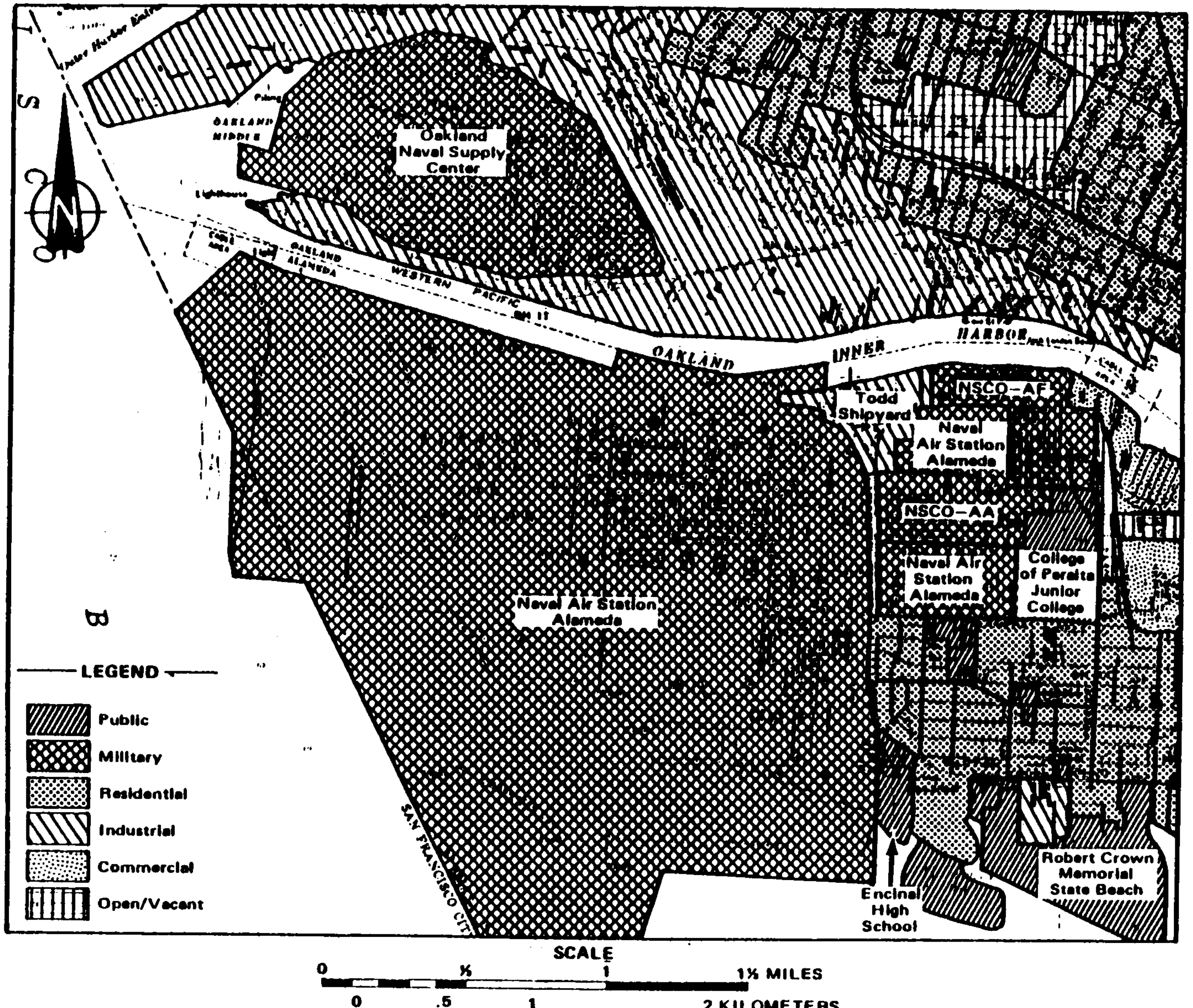

Figure 5–3 ADJACENT LAND USE, NAS ALAMEDA

NAS Alameda is residential, with scattered commercial establishments such as restaurants and retail stores. There are a number of schools located in this residential area, including Woodstock School, Chipman School, Longfellow School, William G. Paden School, and Encinal High School, which borders directly on the southeastern edge of the station. Located to the east of Encinal High School is the Robert Crown Memorial State Beach. The state-protected marine reserve, Crab Cove, is located at the west end of this beach.

Possible sources of external environmental contamination from adjacent areas would include the Todd Shipyards and the industries along the Oakland Inner Harbor. The Todd Shipyards provide total ship repair, including dry dock facilities. Hazardous wastes associated with a shipyard may be present on this site. There have been no known incidents of migration of contaminants from the shipyard to NAS Alameda. The Oakland Inner Harbor could contain a variety of hazardous wastes due to the industrial activities located along its shores.

5.6 LEGAL ACTIONS. A review of past environmental litigation brought against NAS Alameda indicates two major areas of concern: the proper treatment and discharge of industrial wastes, and compliance with air quality standards.

On 25 September 1972, NAS Alameda was served with a summons and complaint, Civil Action No. 427945, for violation of Section 13243 of the California Water Code, which prohibits the discharge of industrial wastes other than to a community sewer system. At that time, NAS Alameda was discharging approximately 380,000 gallons per day of industrial wastes from steam cleaning, degreasing, paint stripping, metal plating, and photographic processing operations. The wastes were discharged through eight storm drains to the San Francisco Bay by way of the seaplane lagoon and the estuary, following minor treatment by oil and sludge separators.

The United States Navy proposed a project at NAS Alameda for pretreatment and disposal of industrial waste into the EBMUD sewer system as a high priority item in July 1967. The project was submitted to Congress in the fiscal year 1970 military construction program and was advertised for construction in the fall of 1970. The bids received exceeded the funds authorized, and it was necessary for the United States Navy to resubmit the project for Congressional approval of funds in the fiscal year 1972 program. The contract was awarded in 1972 and termination of the industrial discharge was accomplished in 1975 in compliance with the requirements of CRWQCB, San Francisco Bay Region.

The second area of conflict concerns the violation of air quality standards. The jet engine test cells have been cited in the past on many occasions for exceeding air emissions criteria as set forth by the Bay Area Air Pollution Control Board. Modification in the structures and test procedures have been implemented.

CHAPTER 6. ACTIVITY FINDINGS

6.1 INTRODUCTION. The sections that follow describe the purpose and organization of each activity at the station, its relationship to the other activities, and its past hazardous materials management practices. Since most of the pollutants at NAS Alameda were disposed of either in the San Francisco Bay, the 1943-1956 Disposal Area, or the West Beach Landfill, Section 6.6 ties the activity findings to the final disposal operations.

6.2 NAVAL AIR STATION (NAS) ALAMEDA. Activities conducted by NAS Alameda which were of interest to the IAS team are discussed in the following subsections.

6.2.1 Aircraft Intermediate Maintenance Department (AIMD). The AIMD, located in Building 41, is responsible for the intermediate repair of aircraft components for transient and tenant aircraft. The department works primarily on components for the following aircraft: A-7B, A-4F, TA-4J, CH-53D, SH-3D, and KA-3B. AIMD handles approximately 1,300 specific and individual items per month. The calibration laboratory processes another 400 items a month. Specialties include the repair of components from all related aircraft subsystems, such as hydraulics, brakes, avionics (aviation electronics), engines, electrical wiring, instrumentation and calibration of test equipment, etc.

The estimated waste load quantities listed in Table 6-1 are representative according to AIMD personnel interviewed who have worked for the department since 1969. AIMD personnel indicated that, as far back as they could recall, wastes have been containerized and removed from Building 41 as hazardous waste.

AIMD personnel also told the IAS team that, as recently as 1981, more than 100 barrels containing wastes were "stored" on the asphalt pavement on the west side of Building 41. Most, though not all, of these wastes had been generated by AIMD. During the past year, the contents of all but 19 of the drums and one bowser had been identified and removed by Public Works personnel. Prior to 1982, the NAS Alameda Supply Department was responsible for hazardous waste disposal. Waste samples from the remaining drums and bowser are currently being analyzed by the NARF laboratory to determine chemical composition and, based on this, the appropriate disposal method. AIMD personnel were not aware of any spills that may have occurred there.

The AIMD paint stripping tank is located just outside Building 41. It is small (three feet by five feet by one foot) and is used only for stripping small parts. After soaking, the parts are rinsed off with water, which then flows into a sewer manhole. The manhole is linked to the sewage system, through which the rinse water would flow to the East Bay Municipal Utility District (EBMUD) system.

6.2.2 Air Operations. NAS Alameda is homeport to eight NARU and Marine Air Group (MAG) squadrons. The primary function of NAS Alameda is to provide support and facilities for the training of pilots and crew of assigned reserve units. Training maneuvers performed by the

Table 6-1

REPRESENTATIVE ESTIMATED WASTE LOAD QUANTITIES FOR AIMD ACTIVITIES

Waste Chemical	Approximate Annual Quantity (gallons)
PD 680 dry cleaner	1,100
Trichlorotrifluoroethane solvent	300
6083 oil from Magnaflux testing machine	300
Trichloroethane solvent (trichloroethylene prior to 1978)	10
Paint wastes (including methyl ethyl ketone thinner)	110
MIL-R-81294 caustic paint stripper	110
Used hydraulic fluid	550
Magnaflux Zyglo dye penetrant	55

Source: Interviews with AIMD personnel.

pilots include touch-and-go landings to economize fuel and time in developing takeoff and landing skills, as well as Field Carrier Landing Practice (FCLP) to simulate landing conditions on board aircraft carriers. As one of two deployment points on the West Coast for aircraft carriers and host for NARF, NAS Alameda accommodates a significant number of transient aircraft in addition to its own squadrons.

The air operations office manages a Navy Class "C" airfield at NAS Alameda. This is a complete airfield capable of handling any aircraft that the Navy operates under IFR or VFR conditions, with standard precision instrument approach conditions of 200-foot ceiling and one-half-mile visibility.

A number of types of aircraft are based at, or operate out of, NAS Alameda. These aircraft are designated as: A, attack; F, fighter; C, cargo; T, trainer; H, helicopter; P, patrol; S, search; U, utility; and O, observation. All have different flight characteristics and capabilities. The A-7 accounts for 22% of the operations of any aircraft type. The A-3 and A-4 represent 15% of the operations. The C-9 accounts for 9%, helicopter operations 16%, and the Aero Club 21%, leaving a balance of 17% for miscellaneous military aircraft operations. Just prior to an aircraft carrier deployment (approximately four times a year), there is a significant increase in air operations at NAS Alameda from arriving aircraft squadrons and FCLP training. In addition, the reserves have two periods of intensive FCLP training each year.

The air station has two bisecting airstrips which create four runway operational directions. Runway 13/31 (aligned northwest-southeast) is 8,000 feet long. Runway 7/25 (aligned east-west) is 7,200 feet long. Both runways are 200 feet wide. All runway operational directions, except for Runway 7, are served by Ground Control Approach (GCA) radar, and all four are equipped with arresting gear.

Air operations at NAS Alameda have generated varying amounts of contaminants. In the 1940s, as many as 1,500 planes, including seaplanes, were based at NAS Alameda. Then, as now, contaminants associated with air operations included fuel spills, fuel dumps prior to emergency landings, and occasional crashes.

6.2.3 Weapons Department. The Weapons Department, located in Building 102, is responsible for receiving, issuing, storing, and transshiping ammunition, ammunition components, and explosives authorized to the station for fleet commands and tenant activities. The department also operates the small arms firing range and saluting battery, and coordinates ordnance disposal with the Explosive Ordnance Disposal (EOD) Detachment. The department must comply with established criteria for the safe handling of ordnance. These criteria are delineated in the Naval Sea Systems Command OP-5 Manual, Volume I, Fourth Revision, "Ammunition and Explosives Ashore."

6.2.4 Navy Exchange: Service Stations. The Navy Exchange operates two service stations at NAS Alameda, one on the base located in Building 459, which is 20 years old, and an on-base annex station, accessible from off base, located in Building 547, which is eight years old.

In 1982 it was discovered that the fuel lines in Building 459 leading from the underground gasoline storage tanks to the gas pumps were leaking. The lines were dug up and replaced, thus eliminating the source of the problem. However, personnel present during excavation noted that the soil appeared to have been contaminated and that a visible oil sheen had accumulated on standing water in the trenches. Based on this, it is likely that the shallow groundwater beneath the Building 459 station is contaminated to some extent. No other leakage has been reported during the 20-year history of the station.

Three years ago an underground gasoline storage tank ruptured at the Building 547 station when a measuring dip stick was dropped onto the tank's unprotected fiberglass bottom. However, because the tank is located below the water table (as are all tanks at both stations), no gasoline was spilled. When a ruptured tank is located below the water table, water will leak in instead of gasoline leaking out of the tank. In fact, the problem at Building 547 first became apparent when customers discovered they were pumping water into their automobile fuel tanks instead of gasoline. No other problems have been reported during the eight-year history of the station.

Waste oils at both stations are stored in an underground tank and are pumped out on an as-needed basis by a local contractor. Oily rags are laundered and reused.

Prior to 1961, the Navy Exchange operated a service station on the site now occupied by Building 162. No one could be found who had any personal recollection of this service station or of any associated problems. However, even if leakage had occurred there in the past, it almost certainly would now be obscured by the more recent massive (365,000 gallons) AVGAS losses from the Area 97 storage facility located adjacent to Building 162.

6.2.5 Supply Department. The NAS Alameda Supply Department has a number of duties in addition to receiving, storing, and distributing the materials used and needed by the station. Its function and tasks include:

1. Providing logistic supply support to NAS Alameda; Fallon, Nevada; NARU Alameda; locally based fleet activities; assigned vessels; and other assigned tenants and commands.

2. Providing dockside services, including aircraft loading and offloading for ships assigned to the Commander Naval Air Force, U.S. Pacific Fleet (COMNAVAIRPAC), and other ships as required.

3. Providing a general mess for station departments, tenants, commands, and fleet units based or homeported at NAS Alameda.

4. Providing a service as the West Coast seaboard terminal for loading Air Force/Army aircraft on aircraft carriers on the

Military Sealift Command and commercial vessels under inter-service support agreement with those services.

5. Providing a service as a fueling support for station, tenant and transient aircraft, ships, and vehicles.

6. Providing a reporting stock for certain ordnance and ammunition and a consumer stock point for general use items.

The fueling support service has been a continual source of contamination since 1941, when AVGAS supply lines near the hangers ruptured and caused the evacuation of several buildings. Several days' pumping were required before the area was safe enough to resume operations.

Area 97 contains five below-ground fuel storage tanks, each 100,000 gallons in capacity (see Figure 6-1). Tanks A, B, C, and D, constructed in 1943, are concrete tanks lined with carboline. Tank E, constructed in 1962, is made of steel. All five tanks were used exclusively for the storage of 115/145 AVGAS. In 1975 it was discovered that Tanks A, C, and D were leaking and, in October of that year, they were drained, cleaned, and filled with water. In 1978, Tank B was determined to be leaking; this tank and Tank E (though not reported leaking) were drained and filled with water. Tanks B and E, however, were not cleaned, and one to two inches of AVGAS remained on their water surfaces. The MCON P-192 project proposes to remove the abandoned tanks and vent the utility lines subject to build-up of fuel vapor; however, the project has not been funded.

Based on tank inventories, Supply Fuels Branch personnel estimated that 365,000 gallons of AVGAS may have escaped from Area 97 in the 1960s and early 1970s. The leaking fuel has caused (and continues to cause) gasoline vapor problems in both sewer and electrical manholes in the vicinity of Area 97. In 1977, an electrical contractor working in a nearby electrical manhole generated a spark which resulted in an explosion and fire; the contractor was severely injured. More recently, high gasoline vapor readings have forced several evacuations of the credit union in Building 527, located immediately to the north of Area 97.

In 1979, the Navy retained the services of the consulting firm Kennedy Engineering to determine the extent of the problem and to develop alternative remedial measures. Kennedy Engineering installed 18 monitoring wells (see Figure 6-2) and collected continuous soil samples for gasoline analysis in each bore hole. The consultant did not find pooled fuel in any of the study areas. However, a pellicular fuel residue (adhering as a film to the surface of soil particles) was found above the water table. The consultant concluded that the bulk of the fuel spilled from Area 97 had drained away, probably through infiltration into storm sewers and sanitary sewers, particularly those sewers which run along Atlantic Avenue immediately south of Area 97. Pellicular fuel residues, as well as small residuals of fuel trapped in the sewers and electrical ducts, continue to cause fuel vapor problems. Based on the study results, the Navy has initiated a military construction project to vent the ducts and sewers and demolish the tanks. The project is presently programmed for 1985.

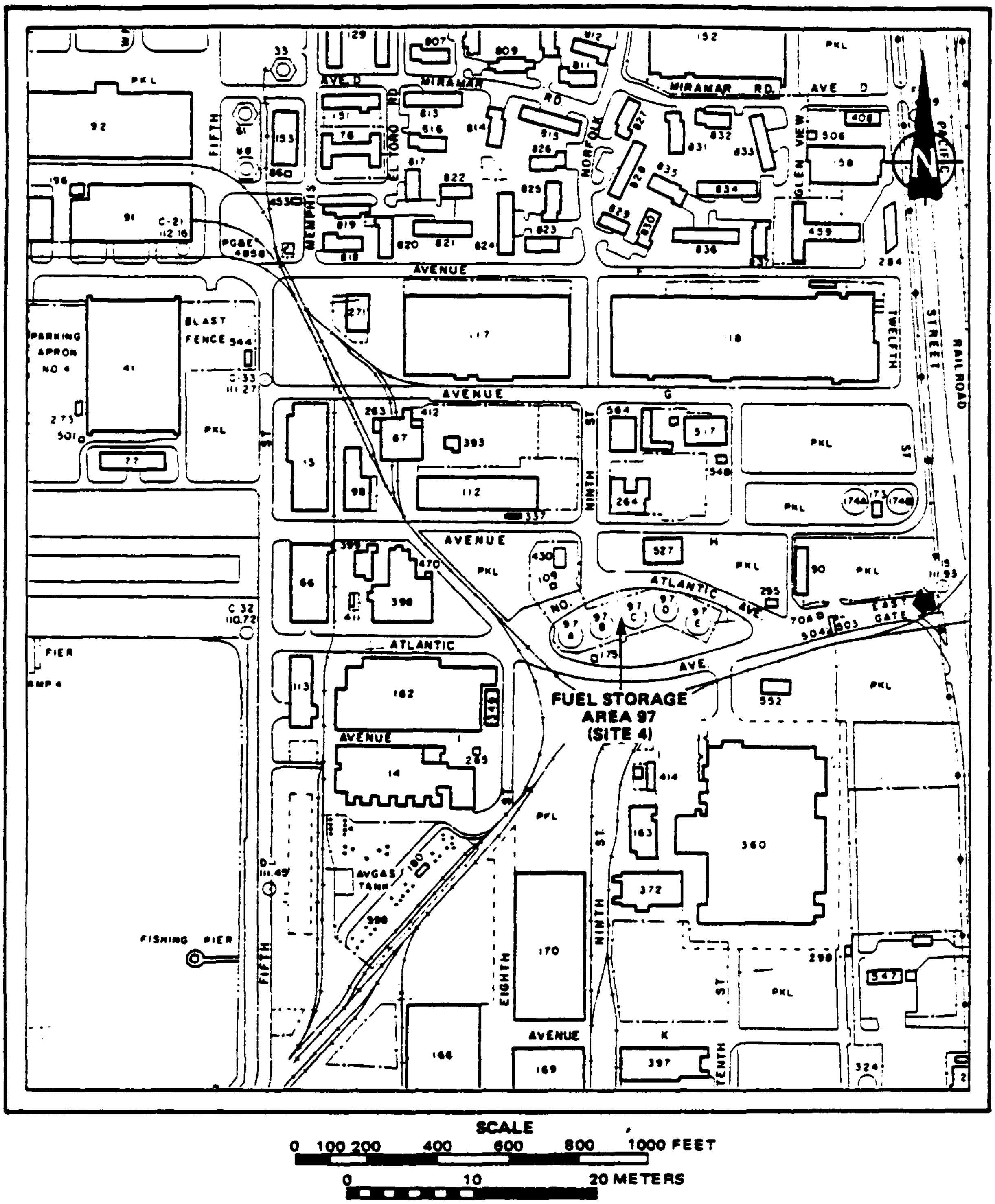

Figure 6—1 LOCATION OF FUEL STORAGE AREA 97, (SITE 4), NAS ALAMEDA

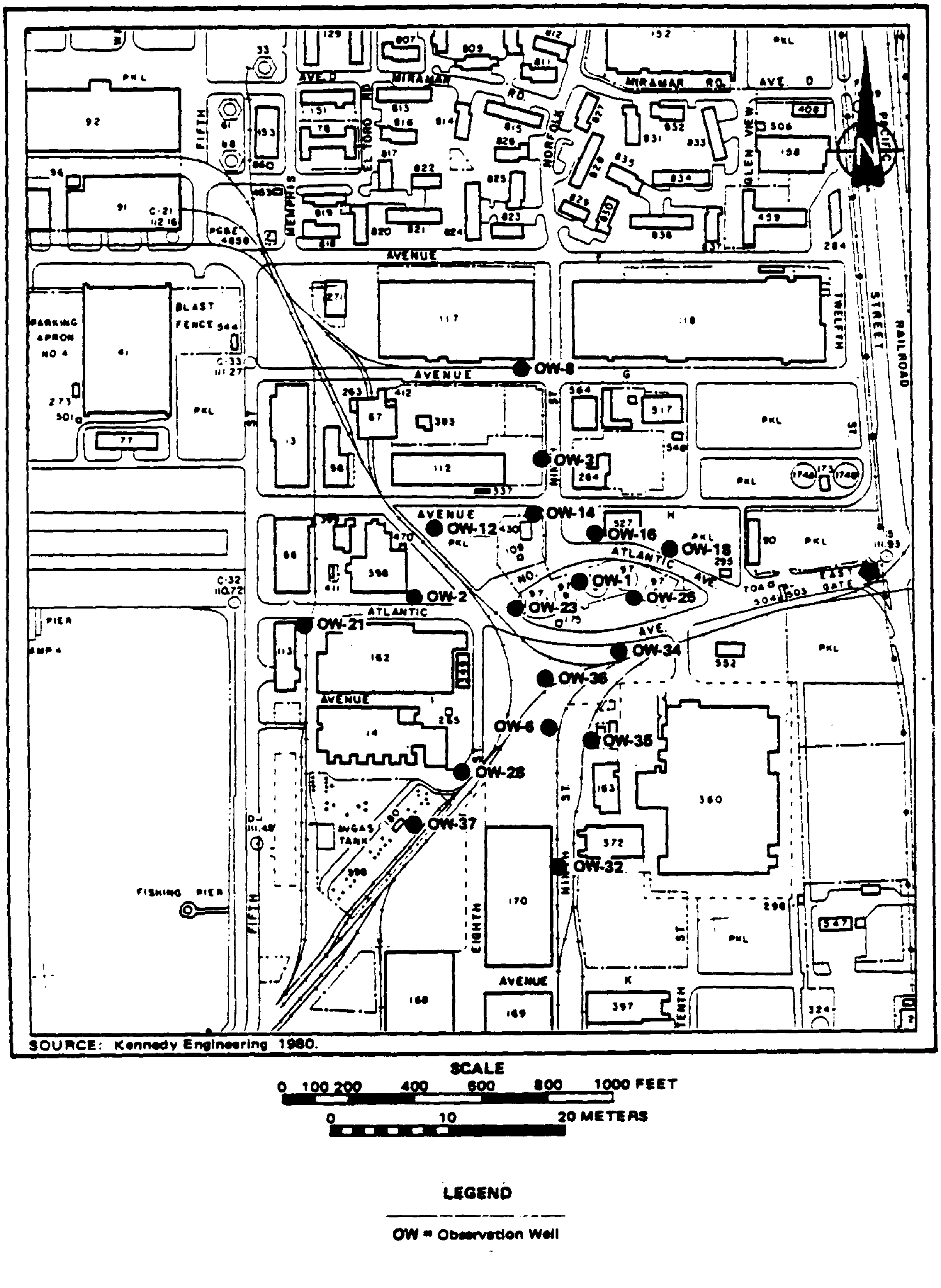

Figure 6–2 MONITORING WELL NETWORK INSTALLED AROUND FUEL STORAGE AREA 97 (SITE 4) IN 1979, NAS ALAMEDA

One unusual aspect of the situation not addressed by Kennedy Engineering relates to the distribution of the pellicular fuel residue. According to the consultant's data, this residue was found as far north as sampling location OW-3 (Figure 6-2), 500 feet from the tanks, suggesting that gasoline had moved to the north or northwest. It is important to note that, if gasoline has moved (as it apparently has) along a path contaminating soils and groundwater at OW-1, OW-16, OW-14, and OW-13, and that the groundwater flow path probably curves toward the San Francisco Bay and seaplane lagoon (to the west) as it moves farther from Area 97, it is possible that the contaminant pathway passes between sampling wells OW-12 and OW-8, which were reportedly gasoline-free.

The report also may have significantly underestimated groundwater movement velocity. A permeability of 10^{-3} centimeters per second was assigned as an average permeability and used to compute velocities. However, the report characterizes many of the sediments as "loose clean sands," and the geologic logs support this. Since most of the groundwater flow will occur through these more permeable materials, a higher permeability should be assigned. Assuming a porosity of 20% (typical for sands) and a permeability on the order of 10^{-2} centimeters per second (which is within the range of permeabilities for "loose clean sands"), the calculated velocity range may well be 0.2 to 1.0 feet per day, not 0.02 to 0.1 feet per day.

Clarification of this flow velocity is significant. Assuming that gasoline has been leaking from Area 97 for the past 15 years, groundwater contaminated with gasoline and moving at 1.0 feet per day would have the potential of moving more than a mile (see Figure 6-3). Therefore, under worst-case conditions it is possible that the entire flow path from Area 97 to the seaplane lagoon or even the Oakland Inner Harbor is contaminated with gasoline.

6.2.6 Pest Control Program. Prior to 1974, pest and weed control at NAS Alameda was a function of the station's Public Works Department. Application equipment (hand sprayers and a truck sprayer) and sufficient short-term chemical supplies were stored in Building 114. After use, equipment was rinsed off in the Building 114 yard with water which drained into the storm sewer system and ultimately into the seaplane lagoon. Drains presently connect with the industrial wastewater collection system. Empty pesticide containers were disposed of in the landfills until 1974, when the Public Works Department ceased operations. After 1974, all functions of the NAS Alameda Public Works Department were shifted to the Oakland Naval Supply Center's Public Works Center. However, this has had no important effect on pesticide operations, since essentially the same personnel are involved using the same equipment and the same facility (Building 114).

Current use of pesticides includes the herbicides Roundup, Princep, and Krovar I for weed control on streets, sidewalks, and around the runway and taxiway lights; the insecticides Malathion and Diazinon for fly control around dumpsters in food handling areas; and the rodenticide Warfarin for rat control at the landfills. In the past, the insecticides chlordane, lindane, and DDT, as well as the herbicides Telvar, Chlorvar, and 2,4-D, have also been used. Of these, DDT is the only one presently banned for use in the United States (banned on

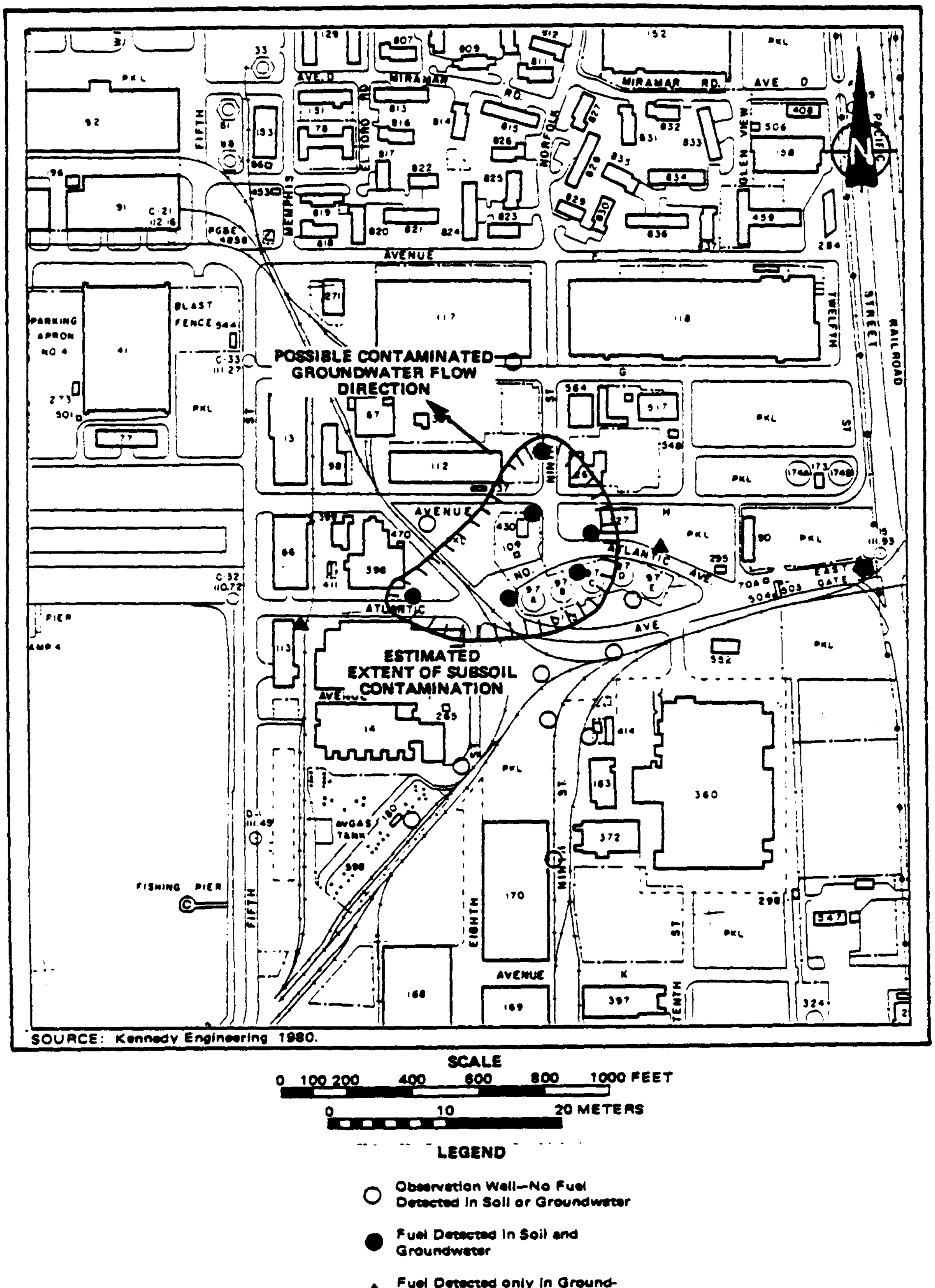

Figure 6–3 SOILS AND GROUNDWATER AREAS OF CONTAMINATION AT FUEL STORAGE AREA 97, (SITE 4), NAS ALAMEDA

January 1, 1973). Table 6-2 gives toxicological information for each of the pesticides listed above.

Personnel presently employed at NAS Alameda who worked on the pesticide control programs go back as far as 1961. No one recalls any significant spills or personnel health problems during that time. No one interviewed associated with the Public Works pesticide program would support the alleged use of PCBs for weed control.

6.3 NAVAL AIR REWORK FACILITY (NARF) ALAMEDA. NARF is the largest tenant at NAS Alameda, employing nearly 5,000 civilians and occupying all or part of 28 buildings (Figure 6-4). The primary function of NARF is the maintenance and reworking of aircraft under the command of the U.S. Pacific Fleet. Presently, the aircraft that receive maintenance at NARF Alameda are the S-3 Viking, the P-3 Orion, the A-6 Intruder, the A-3 Sky Warrior, anti-submarine warfare aircraft, and the C-118.

NARF Alameda was created in 1967 from similar aircraft maintenance operations that began at the station in 1941. Initially, under the authority of the Assembly and Repair Department, the first aircraft maintenance activities at the station were limited to the repair and rework of fabric and wood-frame aircraft. From 1948 to 1967, as aircraft maintenance operations at the station increased in scope and complexity, rework efforts were managed by the Overhaul and Repair (O&R) Department.

Presently, NARF Alameda activities are divided among the following seven administrative departments: Administrative Services, Management Controls, NAVAIR Engineering Support Office, Quality and Reliability Assurance, Flight Check, Production Planning and Control, Production Engineering, and Production.

The Production Department carries out all NARF industrial activities and is thus its major source of industrial wastes. Most of these wastes, both sewerable and non-sewerable, are generated from six common processes: electroplating, paint stripping, chroming, painting, cleaning, and engine testing. Although the NARF Production Department processes are housed in more than a dozen buildings at NAS Alameda, most of its industrial waste-generating processes are housed in Buildings 5, 360, and 410.

Also of interest to this survey were the industrial waste-generating practices employed by the Missile Rework Division while it occupied Building 400, prior to 1972. At that time, the Missile Rework Division shops were moved to the newly constructed Building 530. Finally, other industrial wastes were commonly generated throughout NARF Alameda production facilities as a result of routine operations, plant maintenance, spillage and breakage, and tool and instrument disposal.

From 1943 until 1972, and to some degree until 1975, all industrial wastewater generated by NARF activities was discharged untreated into the San Francisco Bay via the industrial waste collection system, which emptied into the seaplane lagoon and the estuary. The bulk of the discharge was into the seaplane lagoon. Four discharges with an

Table 6-2

PESTICIDES HISTORICALLY USED AT NAS ALAMEDA*

Pesticide	Action	LD_{50} (mg/kg)-Rat	Comments
Chlordane	Stomach and contact insecticide	367 to 515	
Chlorvar	Nonselective weed and grass killer	1,200	Highly corrosive and reactive; no longer manufactured
2,4-D	Selective herbicide	300 to 1,200	
DDT	Insecticide	113	Banned in United States since January 1, 1973
Diazinon**	Insecticide, nematicide	300 to 400	
Krovar I**	Broad spectrum of weed control	3,400	
Lindane	Insecticide	88 to 125	Somewhat volatile; strong central nervous system stimulant; can cause convulsions
Malathion**	Insecticide	1,000	
Princep**	Selective herbicide	>15,380	
Roundup**	Herbicide	4,300	
Warfarin**	Rodenticide (anticoagulant)	3	

*Pesticide information taken from Farm Chemicals Handbook 1981, published by Farm Chemicals magazine.
**Pesticides presently used at NAS Alameda.

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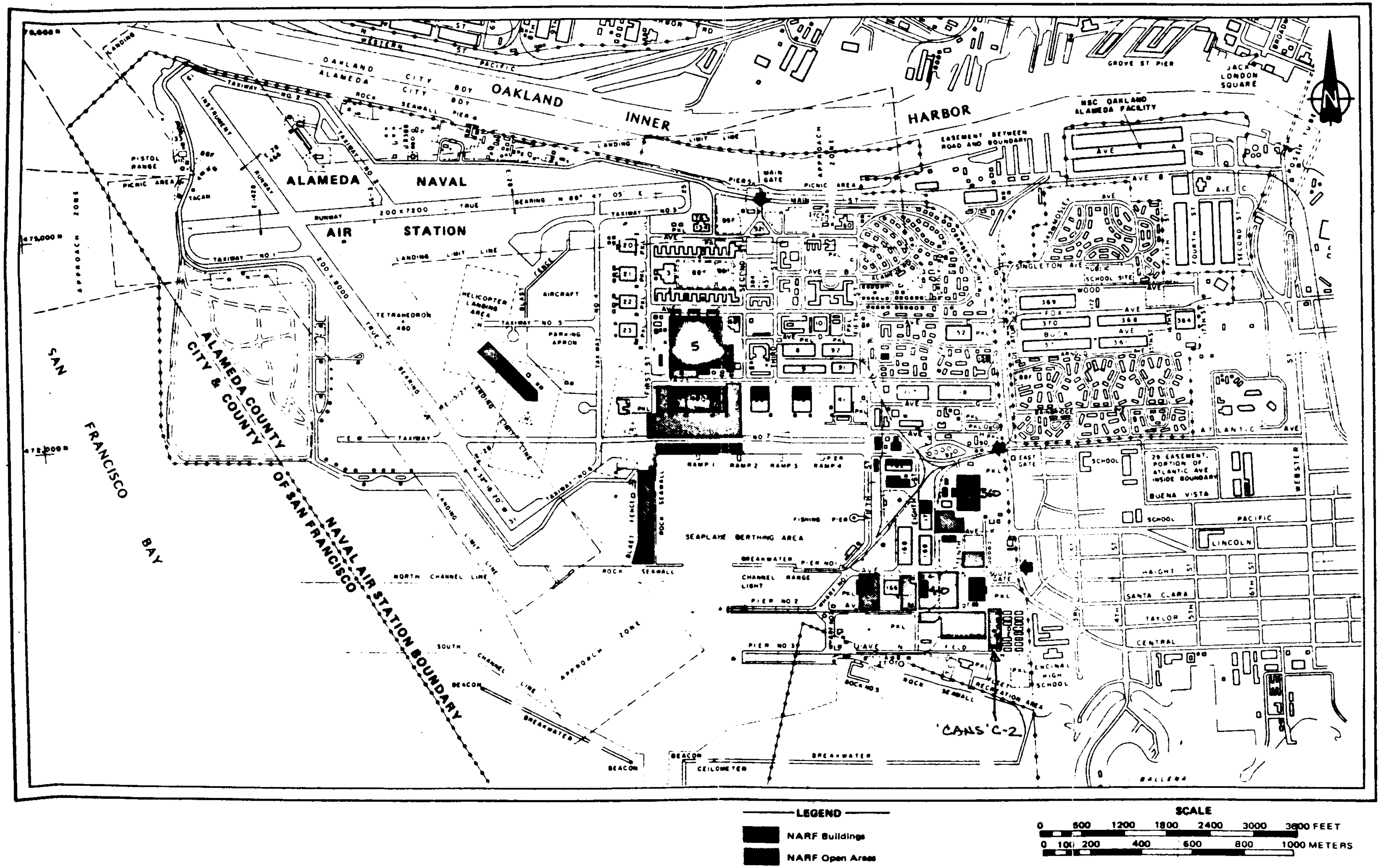

Figure 6-4 NAVAL AIR REWORK FACILITY (NARF) BUILDINGS AND OPEN AREAS, NAS ALAMEDA

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average flow of 150,000 gallons a day emptied the NARF wastes into the seaplane lagoon. Other NARF discharge points included the estuary and the pier area. Additionally, the storm sewers also carried wastewater from cross connections, direct dumpings, or spills.

6.3.1 Building 5. Shops operating in Building 5 (B-5), constructed in 1942, are primarily those of the Metal and Process Division. Operations include the cleaning, reworking, and manufacturing of metal parts; tool maintenance; welding; paint stripping and conversion coating; and plating and painting. In the B-5 Annex (B-5A), the Aircraft Rework Branch conducts component removal, structural rework, instrument testing, and aircraft painting for the P-3 and C-118 aircraft. Of these activities, major industrial waste generators in B-5 and B-5A are the plating, painting, paint stripping and conversion coating, and cleaning operations. Figure 6-5 identifies the major sewerable and non-sewerable wastes resulting from these operations.

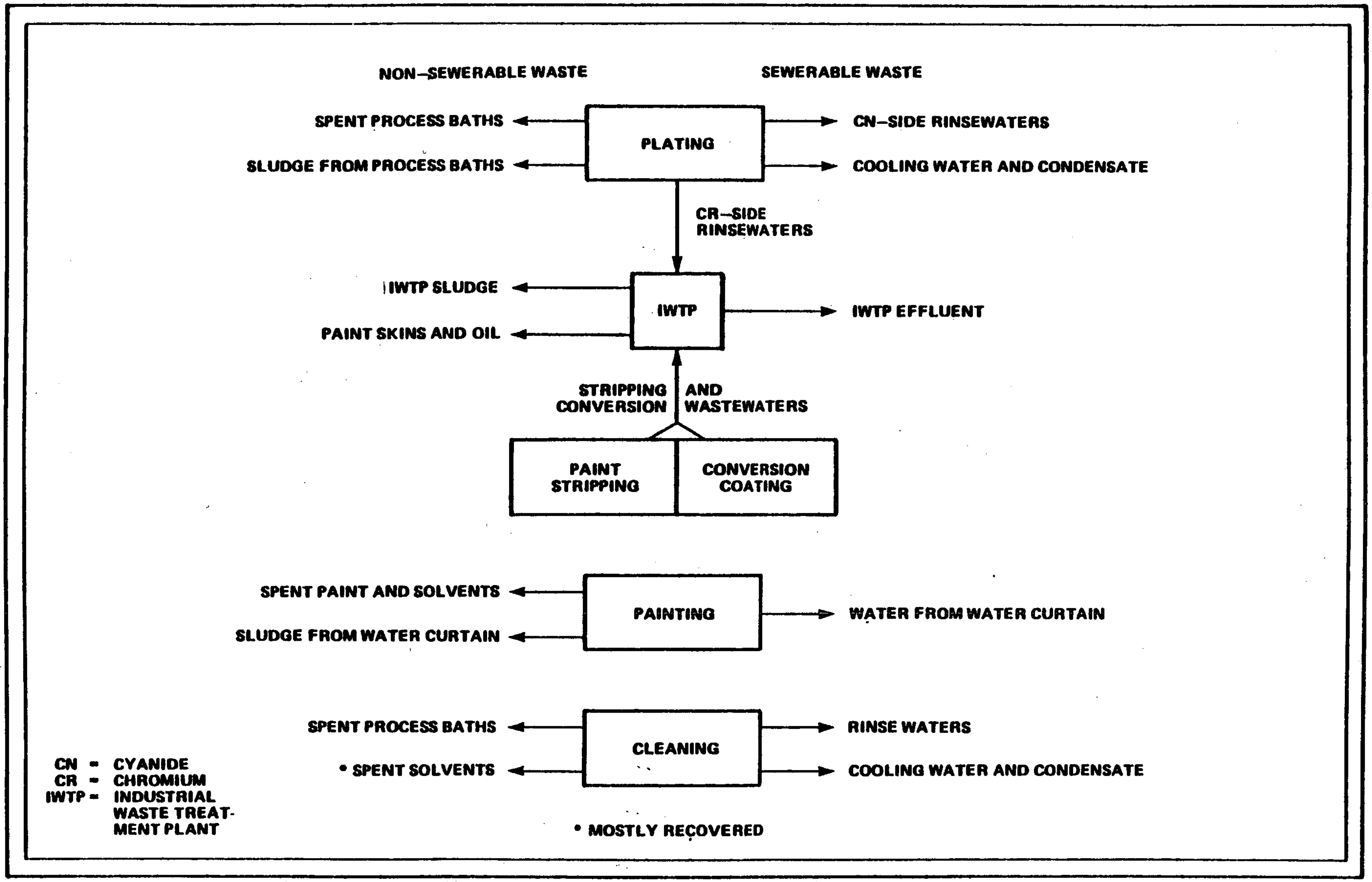
6.3.1.1 B-5 Plating Shop. Plating operations at B-5 include degreasing; caustic and acid etching; metal stripping and cleaning; and chrome, nickel, silver, cadmium, and copper plating. Wastes generated from these processes consist of rinse tank wastewater, concentrated plating bath dumps, plating tank sludges, caustic cleaners, and cyanide stripper bath dumps.

The shop is divided into two areas to separate the cyanide and chromium processes. Since 1975, wastewaters from the chromium process have been discharged at an average rate of 19,200 gallons per day to the B-5 industrial waste treatment facility (IWTF) prior to entering the main industrial sewer system. This generation rate is indicative of the waste amounts generated since 1942. Wastewaters from the cyanide process are directly discharged to the industrial sewer system at a rate of approximately 14,400 gallons per day. Table 6-3 presents B-5 plating wastewater characteristics as measured by a 1981 study.

Not all of the stripping, cleaning, and plating baths are dumped. In the past, during times of heavy production, some of the baths have been dumped between one and four times a year. Since 1970, baths at the B-5 plating shop have been pumped to containers for collection and off-base disposal by contractors. Before that time, bath dumps resulted in direct discharges to the industrial waste collection system. Until tighter controls were placed on their disposal in the 1970s, plating tank sludges were collected and disposed of at the West Beach Landfill. During the 33 years from 1942 to 1975, at least 18,000 tons of waste were generated by this shop.

Tank overflows, particularly from chrome plating tanks, occur regularly in the plating shop. Through the late 1970s, such spills entered drains in the work area and discharged to the industrial waste collection system untreated. Presently, the spills are diverted to a holding tank and either treated and discharged to the industrial wastewater system, or hauled off base.

6.3.1.2 B-5 Paint Stripping. Paint stripping and conversion coating of airframe parts is conducted in B-348, a cleaning shelter located adjacent to B-5. Whole aircraft that have already been totally or



SOURCE: Post, Buckley, Schuh and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

Figure 6–5 SOURCES OF WASTE IN BUILDING 5, NARF ALAMEDA

Table 6-3

BUILDING 5 PLATING SHOP WASTE CHARACTERISTICS

Parameter	Combined Chromium Rinse*	Combined Cyanide Rinse*
Cyanide	0.78	2.6
Silver	0.01	0.01
Cadmium	0.44	0.95
Chromium (total)	3.7	0.74
Chromium (VI)	3.5	0.38
Copper	0.22	0.32
Iron	0.16	0.15
Nickel	0.28	0.18
Lead	0.040	0.01
Zinc	0.074	0.30
pH (std. units)	7.5	8.4
Suspended solids	1.0	5.0
Total solids	80.0	110.0
Conductivity (umhos/cm)	86.0	220.0
COD	12.0	3.2
Surfactants (MBAS)	60.0	0.28
Flow (1,000 gpd)	19.2	14.6

*All concentrations mg/L, unless otherwise noted.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

partially stripped in B-410 are conversion coated in the adjacent hanger. Paint stripping operations use several phenolic stripping compounds primarily in a spray-on/rinse-off process that produces large quantities of wastewater. While actual figures vary depending on the size of the plane, each plane in general is painted with 35 gallons of paint (primer, base, and top coat) and requires 75 gallons of paint stripper to be stripped. Ethyl acetate is used to hasten the drying off process after the planes are washed with hot water following application of the paint stripper. The wastewaters, which are drained to the B-5 IWTF, are laden with stripper, paint skins, solvents, and detergents. These wastewaters usually contain high levels of phenol (4,000 ppm at times), methylene chloride, chromium, and oil and grease. Typical characteristics of the raw wastewater discharged from the paint stripping operations at B-5 are listed in Table 6-4.

Large paint skins do not wash down the drains. Those collected on the paint skin screen at the B-5 IWTF are presently collected and removed from the station by contractors for disposal off base. Prior to 1974, paint skins were disposed of in the West Beach Landfill.

The conversion coating process is an intermediate step between paint stripping and painting. The conversion coat is a surface primer containing chromate, activators, and some dissolved aluminum and iron. Conversion coating results in a high pH aluminum-, chromium-, and iron-laden wastewater that is discharged to the B-5 IWTF. Table 6-5 presents the results of analyses performed during a 1981 survey on conversion coat wastewater samples.

A frequent problem associated with the operations at the paint stripping and conversion coating shops, as well as at the aircraft washing shop, has been the spillage of wastewaters outside of industrial sewer drain pads, resulting in raw wastewater discharges to the storm sewer.

6.3.1.3 B-5 Cleaning Shop. The cleaning shop in B-5 engages in the cleaning and paint stripping of parts in spray booths, and in sandblasting aircraft parts. Presently, trichloroethane is used to degrease parts. From the 1940s to the late 1970s, solvents such as carbon tetrachloride and 1,1,1-trichloroethylene were commonly used. Cleaning solvents used in the cleaning shop are generally reused. However, accumulations of spent or aged solvents require special handling and disposal methods. Rinse water and paint stripping wastewaters discharge through a floor drain that connects to the industrial wastewater collection system. Wastewater flows measured in 1981 at the shop floor drain were 25,000 gallons per day and were considered to be slightly above normal, but much less than during peak operations. Table 6-6 represents the results of grab sample analyses for a 1981 study of cleaning shop discharges.

6.3.1.4 B-5 Paint Shops. There are two paint bays (east and west) in B-5 for aircraft as well as several spray paint booths for parts. The bays and booths are equipped with downdraft ventilation systems in which recirculating water is used to trap paint particles and solvents. Small amounts of this water are leaked to the industrial waste collection system. About four times a year, the paint bay recirculation sump is pumped to tank trucks for off-base disposal.

Table 6-4

BUILDING 5 PAINT STRIPPING WASTE CHARACTERISTICS

Parameter	Paint Stripping Water*
Cadmium	0.96
Chromium (total)	160.0
Chromium (VI)	0.72
Zinc	0.13
pH (std. units)	9.3
Suspended solids	160.0
Total solids	14,000.0
BOD	5,100.0
COD	9,100.0
Phenol	1,600.0
Surfactants (MBAS)	3.0
Methylene chloride	**
Oil and grease	**
Flow (1,000 gpd)	11.7

*All concentrations mg/L, unless otherwise noted.
**Present, but not quantified.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

Table 6-5

BUILDING 5 AIRCRAFT CONVERSION COAT
WASTE CHARACTERISTICS

Parameter	Conversion Coat Waste*
Chromium (total)	69.0
Chromium (VI)	0.5
Iron	2.0
pH (std. units)	9.2
Suspended solids	32.0
Total solids	2,000.0
COD	3,500.0
Surfactants	45.0
Flow (1,000 gpd)	11.7

*All concentrations mg/L, unless otherwise noted.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

Table 6-6

BUILDING 5 CLEANING SHOP WASTE CHARACTERISTICS

Parameter	Shop Floor Drain*
Chromium (total)	18.0
Iron	7.3
Suspended solids	62.0
Conductivity (umhos/cm)	7.8
COD	1,400.0
Phenol	250.0
Oil and grease	68.0
Surfactants (MBAS)	8.0
Flow (1,000 gpd)	25.9

*All concentrations mg/L, unless otherwise noted.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

Table 6-7

BUILDING 5 WEST PAINT BAY WASTE CHARACTERISTICS

Parameter	Recirculated Water*
Chromium (total)	11.0
Iron	1.3
Lead	0.4
Zinc	2.5
Suspended solids	98.0
COD	8,000.0
Phenol	290.0
Flow (1,000 gpd)	5.0

*All concentrations mg/L, unless otherwise noted.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

The wastewater from B-5 paint shops is contaminated with high levels of chromium, zinc, iron, COD, and phenol. Typical daily flows have been approximately 5,000 gallons per day. Table 6-7 presents the results of grab sample analyses performed in 1981 on wastewater from the west paint bay.

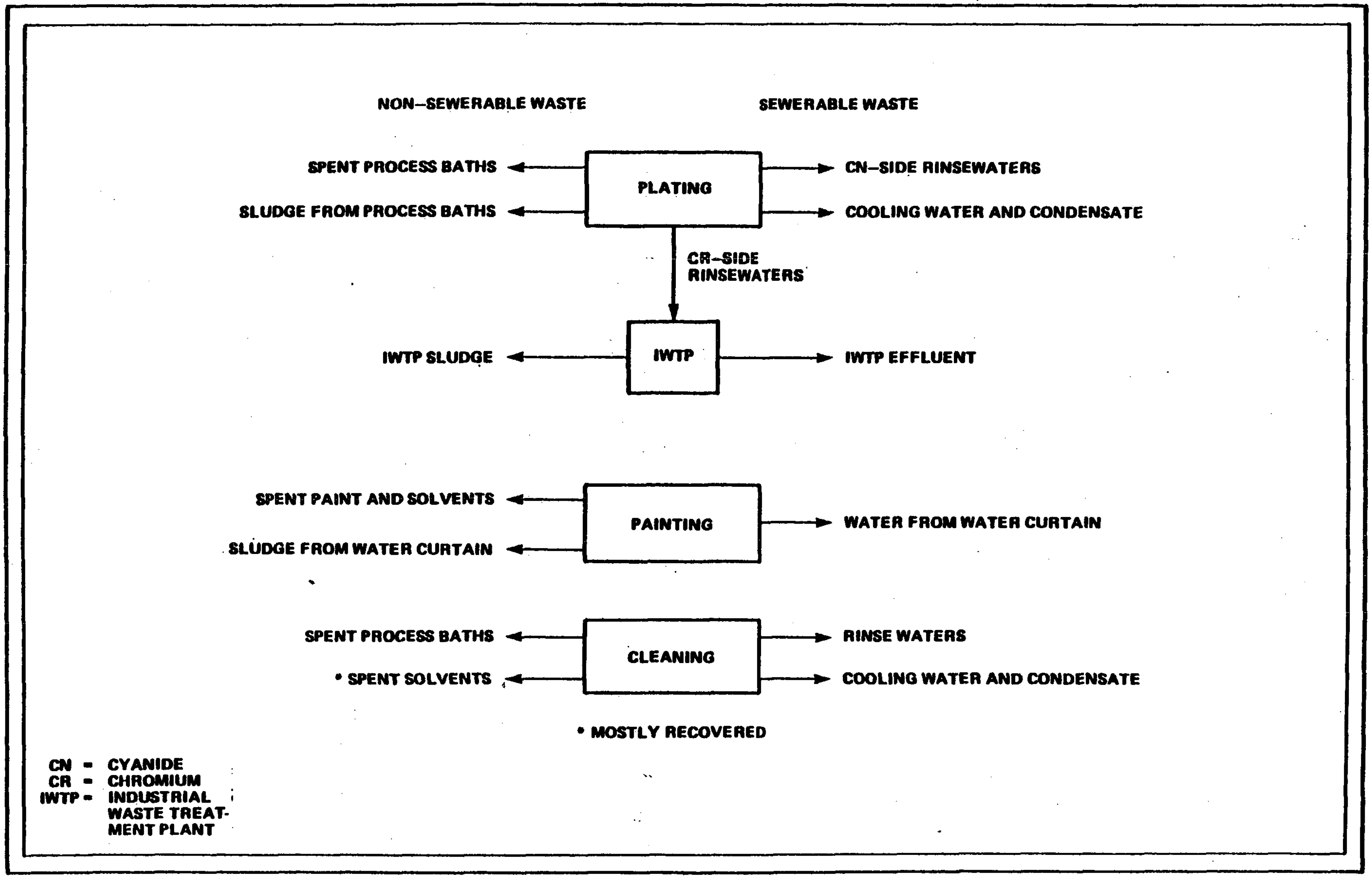
6.3.1.5 B-5 Miscellaneous Wastes. As with any industrial activity, B-5 operations generate various non-sewerable wastes, including oil, grease, spent solvents, old paints, paint sludges, detergents, and discarded stripping and cleaning agents. Until controls were placed on the disposal of hazardous industrial wastes at NAS Alameda in the late 1960s, these wastes were disposed of at the West Beach Landfill. Before that they were disposed of at the 1943-1956 Disposal Area. For the most part, quantities are unknown. Quantification of the wastes disposed of is difficult, since processes and the wastes generated have changed, the degree of control over non-sewerable wastes has fluctuated with the NARF work load, and the work load itself has varied dramatically in times of peace and war.

6.3.2 Building 360. Building 360 (B-360), constructed in 1954, houses most of the production shops within the NARF Alameda Power Plant Division. These shops conduct rework, maintenance, and testing of both jet turbine and propeller aircraft engines. Major waste sources in B-360 are the cleaning and blasting and plating and paint shops. Figure 6-6 shows the major types of wastes resulting from these operations.

6.3.2.1 B-360 Plating Shop. Plating processes in B-360 include paint stripping by blasting; chrome, lead, silver, and nickel stripping; etching; and chrome, nickel, lead, tin, silver, and copper plating. As in B-5, the plating operations in B-360 are divided into two areas to separate the cyanide and chromium processes. Wastewaters from the cyanide process are primarily cyanide-bearing rinse waters which enter the industrial waste collection system at a rate of about 5,400 gallons per day without treatment. Recent studies indicate that wastewaters from the cyanide process contain significant levels of cyanide (4 ppm), nickel (6 ppm), total solids (210 ppm), and COD (330 ppm) at pH levels near 8. Chromium-bearing wastewaters are discharged to the B-360 IWTF prior to entering the industrial waste collection system at a rate of about 2,700 gallons per day. From 1954 to 1975, such wastes were discharged directly to the lagoon. Chromium wastewaters are typically high in total chromium (40 ppm), total solids (300 ppm), and pH (about 9).

The B-360 plating shop acid area and cyanide area each has a separate sump. Some tanks are located over the wrong sump. Actions are underway to complete the separation of acid and cyanide tanks in the B-360 plating shop.

Another source of industrial waste at the B-360 plating shop is the fume scrubber, which handles ventilation from all plating baths. Scrubber water is not reused, but is presently collected in containers and disposed of by contractors off base. Sand and grit used in the removal of paint from aircraft parts at B-360 are also collected and disposed of off base by contractors. From 1954 to 1978, the



SOURCE: Post, Buckley, Schuh and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

Figure 6–6 SOURCES OF WASTE IN BUILDING 360, NARF ALAMEDA paint-laden grit was disposed of in the West Beach Landfill, or along the entire seawall of NAS Alameda. Some deposits are still visible.

Finally, tank overflows and leakages have been frequent problems in the plating shop. Discharges of raw wastewaters to the storm sewers have occurred numerous times prior to 1975; these storm sewers discharge to the seaplane lagoon.

6.3.2.2 B-360 Painting Shop. Small amounts of machine parts are painted in four paint spray booths in B-360. As at B-5, paint spray and solvent vapors in B-360 are controlled with a water curtain system that filters air exhausted from the booths. The water is collected in a tank underneath the booths and reused until contaminant levels become excessive. The water is then discharged to 55-gallon drums and disposed of off base. Paint skins are occasionally skimmed from the water tanks, put into containers, and disposed of off base. This material went into the landfill from 1954 to the 1970s.

The paint shop at B-360 also operates two degreasers; the second was added in 1974. The primary degreasing agent currently in use is 1,1,1-trichloroethane. However, from the 1950s to the late 1970s, more toxic trichloroethylene, and before it, highly toxic carbon tetrachloride, were regularly employed. Degreasing agents are generally reused; however, some enter the sewer system through spillage and parts rinsing.

Wastewater generation rates for the painting and degreasing areas of B-360 are highly variable. No recent wastewater flow measurements have been taken at these shops. The wastewater characteristics, except for flow, are generally the same as those presented in Table 6-4 for B-5. Whereas spent or aged degreasing agents and paints, paint sludges, and containers are presently disposed of off base, such materials were routinely hauled to the West Beach Landfill during its operation.

6.3.2.3 B-360 Cleaning and Blasting Shop. The B-360 cleaning and blasting shop uses baths of phenolic-base cleaners, alkyline-type cleaners, rust remover, descaling compounds, and caustics in the cleaning of metal parts. Wastewaters discharged to the industrial waste collection system originate from parts rinsing operations at a rate of approximately 13,000 gallons per day. Recent studies indicate that levels of metals, solvents, and grease in the cleaning shop wastewaters are low, probably due to the use of large amounts of rinse waters which dilute the contaminants. Table 6-8 presents the results of wastewater analyses performed in 1981.

Non-sewered wastes from B-360 cleaning operations include spent process baths and spent solvents. At present, baths are dumped into tanks and disposed of off base by contractors. Spent solvents are recovered to the greatest possible extent. From the 1950s to the late 1960s, however, baths were commonly dumped into the sewer system and solvents were put into drums for disposal at the West Beach Landfill, along with old containers.

Table 6-8

BUILDING 360 CLEANING SHOP WASTE CHARACTERISTICS

Parameter	Rinse Composite*
Cadmium	0.13
Chromium (total)	0.23
Copper	0.14
Iron	0.67
Lead	0.07
Zinc	1.10
pH (std. units)	10.60
Suspended solids	19.00
Total solids	180.00
BOD	10.00
COD	700.00
Phenol	21.00
Oil and grease	6.60
Surfactants (MBAS)	0.18
Methylene chloride	0.05
Chloroform	0.001
Trichloroethane	0.001
Chlorine demand	0.05
Flow (1,000 gpd)	13.10

*All concentrations mg/L, unless otherwise noted.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

The blasting of metal parts to remove paint is performed at B-360 in four small and four walk-in booths. These booths are used irregularly, and waste grit from their operations is containerized and hauled off base for disposal. Spent contaminated grit and sand were disposed of at the West Beach Landfill or along the station's seawall prior to the mid-1970s.

6.3.3 Building 410. The only major source of industrial waste generated at B-410 is the aircraft paint stripping operation. Essentially, all wastes generated as a result of B-410 stripping operations are in the form of wastewater laden with oil, paint, paint skins, detergents, and stripper. The wastewaters are discharged to the B-410 IWTF at a rate of about 16,000 gallons per day prior to discharge to the industrial wastewater collection system.

Before construction of the IWTF at B-410 in 1973, all wastewater from paint stripping operations was discharged to the industrial wastewater collection system without treatment. As discussed in Section 6.3.1 for Building 5, the predominant types of paint strippers used by NARF Alameda contain large amounts of phenol, as well as methylene chloride, chromium, and detergents. Although methylene chloride is toxic, its high volatility tends to preclude its presence in large quantities in wastewater discharges. Wipe-down solvents such as ethyl acetate are also used in the B-410 aircraft paint stripping operation. Table 6-9 presents the results of composite analyses performed on B-410 wastewater in 1981. These results indicate high total solids, BOD, COD, phenols, surfactants, and chromium in the paint stripping operations wastewater discharges.

6.3.4 Buildings 400 and 530. The Missile Rework Branch of NARF Alameda is housed in B-530 near the southern portion of the station. Its relatively small operations encompass the complete rework of missiles and their charges, including disassembly, parts cleaning, metal grinding, welding, fabrication, paint stripping, and painting. At present, the handling of sewerable and non-sewerable wastes is consistent with similar operations in Buildings 5, 360, and 410. Considering the waste disposal methods employed since 1972, as well as the small amounts of waste generated at the building, B-530 operations cannot be considered significant contributors to problems associated with past polluting practices on the base.

Prior to 1972, missile rework operations were performed in Building 400. The same waste disposal methods employed throughout NARF at that time were used. Although no accurate records of waste quantities are currently available, it can be assumed that the following types of solid wastes were disposed of at the West Beach Landfill: paint sludges; metal shavings; paint strippers; cleaning solvents (trichloroethylene and carbon tetrachloride); testing fluids; and miscellaneous waste oils and grease.

Industrial wastewaters generated by missile rework operations in Building 400 can be assumed to be similar in composition to the wastewaters discharged from similar operations in Buildings 5, 360, and 410. All such wastewaters were discharged to the industrial waste collection facility without treatment.

Table 6-9

BUILDING 410 PAINT STRIPPING WASTE CHARACTERISTICS

Parameter	Stripping Waste*
Cadmium	0.093
Chromium (total)	180.0
Chromium (VI)	0.81
Zinc	4.4
pH (std. units)	7.9
Suspended solids	190.0
Total solids	2,100.0
BOD	5,200.0
COD	74,000.0
Phenol	2,100.0
Oil and grease	**
Surfactants	53.0
Methylene chloride	4.5
Chloroform	0.025
Trichloroethane	0.080
Flow (1,000 gpd)	16.6

*All concentrations mg/L, unless otherwise noted.
**Present, but not quantified.

Source: Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

During the survey of long-time NARF employees, little information could be obtained regarding special problems at Building 400, such as major or regular spill events, or special disposal practices not discussed above.

6.3.5 Miscellaneous NARF Industrial Wastes. As with any large industrial operation, NARF generates various amounts of common wastes such as oil, grease, test solutions, and cleansers. However, certain hazardous wastes also are or were commonly generated by NARF operations. These include mercury, petroleum products, beryllium, TAC rags, and asbestos, which have been generated wherever NARF aircraft disassembly, rework, painting, and assembly activities have been conducted. Such wastes are described below in terms of their sources, as well as past and present disposal methods. A discussion of the total amount of wastes generated at NARF Alameda is presented in Section 6.3.6. These amounts are documented where available. The following sections include specific amounts based on information collected during interviews with NARF personnel.

6.3.5.1 Mercury Waste. Mercury waste has been generated for over 30 years at NARF Alameda. Its primary sources are discarded or broken manometers, fluorescent light bulbs, and thermometers. In the 1960s, NARF attempted to reuse as much of its mercury waste as possible through triple distillation. However, the cleanup of spills, particularly in the B-14 test shop, and the disposal of light bulbs continued to generate mercury waste. Until strict controls on the disposal of mercury were instituted at the base, many wastes were disposed of in the West Beach Landfill. It is assumed that occasional mercury spills were routinely washed into the industrial waste collection system or into the storm sewer system.

For four or five years, until 1973 or 1974, a "tube buster" was operated outside the southwest corner of Building 5. NARF personnel estimated that approximately 1,300 eight-foot-long fluorescent tubes were disposed of each week by shattering them into a 55-gallon drum using the "tube buster." Approximately one drum was filled every two weeks. Prior to 1968, the bulbs were disposed of in the West Beach Landfill. After 1968, fluorescent tubes were disposed of off base by contractors.

There are 27 manometers on base, containing from five to 20 pounds of mercury. The cleanup of spills from these and other mercury-containing devices has generated mercury-contaminated clothes, gloves, and respirators, as well as "flowers of sulphur" used to absorb the spilled mercury. On the average, approximately one 30-gallon drum of contaminated material was generated each month from 1943 to 1954. Prior to 1954, this material was disposed of in the West Beach Landfill or the 1943-1956 Disposal Area.

6.3.5.2 Waste Petroleum Products. Waste petroleum products have been segregated and reclaimed on a full-scale basis at NAS Alameda since 1972. Quantities estimated at 300,000 gallons of waste petroleum products are removed annually to storage tanks located throughout NARF and then sold to reclaimers. For 30 years prior to this, however, petroleum products were either discharged through drains to the storm sewers, or buried in containers at the West Beach Landfill. In addition, fuel spills from aircraft were routinely washed into the storm sewers.

6.3.5.3 TAC Rags. Rags containing PCBs (commonly called TAC rags) were routinely used in NARF paint stripping shops from the 1950s to 1972. The rags, along with PCB-contaminated gloves and clothing, were collected in barrels and disposed of at the West Beach Landfill for years. Although no estimates can be made of the total quantities of such wastes generated over the years, long-time employees have indicated that the amounts were "significant." The fact that 16 people developed chloracne from using TAC rags is an indication of the prevalent use of these rags. It has been estimated that 1,400 of the 36-inch by 36-inch rags containing four grams of PCBs each were disposed of per week in the West Beach Landfill for a period of at least 10 to 12 years.

6.3.5.4 Beryllium. Because of its tremendous cost, beryllium, a metal used as a heat sink for aircraft brakes, bomb bay door contact strips, electrical panel bonding straps, and other aircraft parts, has been routinely recycled in NARF shops. Long-time employees at NARF agree that beryllium wastes have been reused as much as possible. However, in 1981, 100 pounds of these wastes were disposed of off base, suggesting that some beryllium waste may once have been disposed of at the West Beach Landfill.

6.3.5.5 Asbestos. Long-time NARF employees reported that asbestos was used ubiquitously for many years, and until about 1980, tons of asbestos wastes were generated annually. Presently, asbestos wastes generated at NARF are bagged and disposed of off base by contract haulers. In the past, however, all asbestos wastes were disposed of at the West Beach Landfill. An estimate of the total amount of asbestos disposed of in the landfill is difficult to determine; one interviewee estimated the amount at not less than 100 tons. It should be noted that buried asbestos which remains covered and is not transported by groundwater is innocuous.

6.3.6 NARF Industrial Waste Quantities. Because of the broad range of industrial operations necessary to rework and maintain Navy aircraft, large quantities of hazardous wastes are generated by NARF facilities. Table 6-10 gives approximate amounts of hazardous wastes presently generated at NARF. The data presented are drawn from several reference sources documenting waste generation quantities for different time periods and compiled for different purposes; thus, these figures should be used only as an approximation of the actual quantities generated at present and to infer probable quantities of wastes generated in the past.

Accurate distinctions between the quantities of hazardous waste disposed of at the West Beach Landfill or the 1943-1956 Disposal Area as solids or contained liquid and those discharged into the industrial waste or storm sewer systems are not available. Several different reports dating from 1971 to 1981 give limited data on such amounts. A 1971 industrial waste disposal methods survey conducted by the Naval Air Development Center in Warminster, Pennsylvania, states that 50,000

Table 6-10

ESTIMATED ANNUAL HAZARDOUS WASTE GENERATION RATES AT NARF ALAMEDA

Hazardous Waste	Annual Quantity Generated
Asbestos	200 pounds
Beryllium	100 pounds
Used oil and fuel*	140,000 gallons
Water-contaminated petroleum products	80,000 gallons
Non-reclaimable solvents	2,000 gallons
Oily wastewaters and sludges	160,000 gallons
Plating wastes	1,500 gallons
Paint wastes/strippers/cleaners	16,000 gallons
Acids	100 gallons
Synthetic oils	1,500 gallons
Mercury	60 pounds
IWTF sludges	260,000 gallons
Caustic cleaning compounds	200 gallons

*Includes material generated by ships.

Sources: NAS Alameda, 1972 Environmental Protection Award Evaluation Report.

United States Navy Public Works Center, Oakland, 1982, Areawide Hazardous Waste Management Plan.

Post, Buckley, Schuh, and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

gallons per month of concentrated chemical wastes were hauled away for burial at the West Beach Landfill. This report was compiled at a period of high activity levels on base in support of the Vietnam conflict. According to the 1980 hazardous waste survey, approximately 30,000 gallons of concentrated chemical baths are hauled away each year. However, this figure represents only one source of the hazardous wastes, and was taken during a relatively inactive period following the implementation of strict controls. Activity on base probably fluctuated between these two levels during the time the landfill was used.

6.4 OTHER TENANTS AND SUPPORTED UNITS.

6.4.1 Port Operations. NAS Alameda has two major operations: air operations and port or waterfront operations. Since port operations are dependent on the presence of ships, and vary depending upon the type of ship, this section will discuss both the port operations and the tenant units, Carrier Groups 3 and 7. Throughout its history, NAS Alameda has served as the homeport for some of the proudest names in the Navy's long line of ships, including the USS Hornet, the USS Ranger, and the USS Enterprise. Once homeport to five carriers and their associated escort and support vessels, NAS Alameda currently is homeport to nine ships (see Table 6-11).

NAS Alameda is the only port in Northern California with a 40-foot plus project depth (mean lower low water) required for berthing CV/CVN class ships (aircraft carriers). It serves as one of only two deployment points for aircraft carriers on the West Coast. The three major piers total 6,120 feet of berth and offer the best pier facilities for Navy ships in the San Francisco Bay Area. NAS Alameda also has the only pier facilities in the Central Bay Area capable of handling a limited quantity of ordnance. For this reason, and because of the deep water capability, submarines use the station to offload and load their torpedoes before entering and leaving NSY Mare Island.

Pier 1 is the smallest of the three piers, having one 1,200-foot berth available. It is designed to be used for berthing one AQR, DD, or AFS type ship. However, the pier is not structurally sound, and thus is not used for berthing purposes. Pier 2 has four berthing spaces available totaling 2,420 feet. One of these spaces has been reserved for fleet operations and is left vacant. Transient vessels use this berth for loading and offloading small amounts of ordnance. The remaining three berthing spaces usually accommodate combinations of destroyers and service ships. Pier 3 is the largest berthing facility at NAS Alameda and can simultaneously accommodate two nuclear-powered attack carriers. Total feet of berth available at this pier is 2,500. Berthing of aircraft carriers and the deployment of aircraft on board is most often done at this pier. Cold Iron support is available at Piers 2 and 3.

Prior to the initiation of Cold Iron programs designed to eliminate discharges to the pier waters by a ship in port, the sediments and the waters at the piers received the discharges and wastes associated with normal shipboard operations. Over the last 40 years, this continual

Table 6-11

SHIPS HOMEPORTED AT NAS ALAMEDA

Ship Name	Standard Classification	Class Type
USS Coral Sea	CV	Attack Carrier
USS Enterprise	CVN	Nuclear Powered Attack Carrier
USS Kansas City	AOR	Replenishment Oiler
USS Niagara Falls	AFS	Combat Store Ship
USS Carl Vinson	CVN	Nuclear Powered Attack Carrier
USS Roanoke	AOR	Replenishment Oiler
USS Wabash	AOR	Replenishment Oiler
USS Witchita	AOR	Replenishment Oiler
USS California	CGN	Nuclear Guided Missile Cruiser

Sources:

- Navy, Department of, Naval Facilities Engineering Command, Western Division, October 1981, Master Plan for Naval Air Station, Alameda, California, San Bruno, California.
- Personal communications, NAS Alameda.

influx of material has led to the contamination of the bottom sediments.

6.4.2 Commander Naval Air Force U.S. Pacific Fleet Material Representative (COMNAVAIRPAC MAT REP). COMNAVAIRPAC MAT REP serves as liaison between the Commander of the Pacific Naval Air Fleet and the repair activities conducted at NARF and AIMD, NAS Alameda. The activity offers the Pacific Air Fleet ground support in avionics, standard depot level maintenance, and calibration of test equipment.

The office has done some minor hydroblasting and straight water blasting for corrosion control. This blasting was done in front of Building 116; all splash and drippings were caught in the IWTF. Other industrial operations conducted by COMNAVAIRPAC MAT REP included steam cleaning, a small enclosed blasting booth, and a paint booth. The paint booth has been used for touch-up painting only. Some storage of "yellow gear" and avionics occurs when the USS Coral Sea and other supported ships are out of port.

6.4.3 Construction Battalion Unit 416 (CBU 416). Construction Battalion Unit 416 (Seabees) occupies a complex of buildings on the northwest corner of the base. Included in the Seabees complex are a woodworking shop (Building 240), a construction and weight handling equipment shop (Building 230), an electrical shop (Building 290), utility system storage (Building 299), and the heavy equipment maintenance shop (Building 528). Historically, the Seabees have been largely self-sufficient; their impact on the pollution problems at NAS Alameda has been minimal. Reportedly, the Seabees have disposed of contaminated oils from their vehicles and heavy equipment by using the West Beach Landfill or by spraying the oil on the dirt roads in the area.

6.4.4 Defense Property Disposal Office (DPDO). Over the years NAS Alameda has been in operation, DPDO has been engaged in the sale of used hazardous materials having some recyclable value, particularly solvents, oils, and PCB-filled transformers. Solvents and oils have generally always been salable items, and DPDO has not had a great deal of difficulty marketing them.

In more recent years, as information has become available concerning the toxic and hazardous nature of some of these materials, DPDO has found it necessary to segregate many of the wastes. However, since DPDO's philosophy is that a hazardous material is not a hazardous waste until a use for it cannot be found, and since DPDO administratively finds it much easier to dispose of "materials" than "wastes," every attempt is made to find uses for even hazardous substances. At present, DPDO receives and stores hazardous material for recycling with the exception of acids and flammables. DPDO anticipates requiring storage capacity for acids and flammables sometime in 1984.

6.4.5 Navy Disease Vector Ecology Control Center (DVECC). The Navy DVECC Alameda is one of two offices of this kind in the country. Its jurisdiction includes all of the states west of the Mississippi River. Its major duties concern vector and pest management control. By definition, a vector is any agent which spreads disease and disease agents. While this office does not directly control these agents, it does identify, diagnose, and advise on vectors and their control and management. DVECC tasks include visits to bases, stations, and ships; training sessions; civilian liaison for coordinated control of pests; emergency and disaster relief; and research, testing, and development. Some spraying of ships for cockroaches using 12-ounce spray cans of Dephenefrino occurs on request.

The office of the DVECC is located in Building 130, which contains offices, laboratories, storage, and training classrooms. Another part of this function is located at Point Molate, where there is an equipment shed and yard for special sprayers and pest control equipment.

6.4.6 Alameda Detachment, Explosive Ordnance Disposal Group One. Explosive Ordnance Disposal (EOD) Group One, which occupies Building 43 (West), responds to accidents and incidents involving munitions. EOD Group One also responds to bomb threats on the base and assists the civilian community with the disposal of explosives and explosive devices. The group does not have a blasting range and, therefore, has only limited capabilities for disposal operations. In the past, the group has accepted picric acid from the Danville Fire Department (1970), red phosphorus from an undisclosed source, and old, unstable ether. The ether cans were disposed of on base by burying them in the sand in the bunker at the fire training area and then rupturing them with a blasting cap, thus venting the ether to the atmosphere. EOD Group One has also assisted in off-base emergency response, such as the 1973 Roseville train disaster involving the recovery and "safeing" of 1,238 Mark 81 Low Drag Bombs. The United States Army EOD was in charge of the operation.

6.4.7 Marine Air Group 42. Marine Air Group 42 has two squadrons at NAS Alameda consisting of 14 A-4Fs, two TA-4Js, and six CH-53A helicopters. Historically, any above-line maintenance has been handled by NAS Alameda. Waste generation has been comparatively minimal.

6.4.8 Marine Barracks. The Marine Barracks house the Marine detachment responsible for perimeter security and some limited internal security at the station. Although NAS Alameda has its own security department, the Marines supplement it by providing guards at the gates at the base perimeter. They also provide security surveillance for a storage area called the Alpha Area. The Marines use the base pistol range approximately six times yearly. All vehicular maintenance is handled by The Presidio; all "self-help" items, such as paints, are disposed of on base.

6.4.9 Naval Air Reserve Unit (NARU). NARU Alameda is the nation's largest single air reserve activity. Its purpose is to administer the Naval Reserve Program directed by the Chief of Naval Reserves (CNAVRES). More specifically, NARU provides the logistic support and administrative coordination for the training of pilots and crew belonging to the Naval Air Reserve and Marine Corps Air Reserve units in the area. The commanding officer of NARU reports to both the CNAVRES and Chief of Naval Air Reserve headquartered in New Orleans, Louisiana. Six squadrons are assigned to NARU Alameda (see Table

6-12). A listing of buildings occupied by NARU is given in Table 6-13.

The purpose of VA-304 is to train Naval Reserve personnel to conduct offensive air-to-surface attack operations with conventional and nuclear weapons. The VA-304 is currently flying A-7B aircraft to perform this mission. For training purposes, there is an A-7 simulator located in Building 101, which belongs to and is maintained and operated by NARU. The officers are responsible for the training. The enlisted men are trained to support the attack mission by maintaining the A-7B aircraft at operational level. This maintenance activity historically has been a generator of waste. The waste (generally fuels, paints, oils, some cleaning and stripping fluids, and hydraulic and lubricating fluids) was disposed of in the seaplane lagoon until 1974. Table 6-14 lists the NARU buildings and the waste streams associated with NARU activities.

6.4.10 Navy Public Works Center, San Francisco Bay (PWC SFRAN BAY). The PWC SFRAN BAY is a consolidated service organization commissioned in June 1974 to provide the full range of public works support to the operating forces, dependent activities, and other supported commands in the Bay Area. PWC SFRAN BAY is responsible for providing public works, public utilities, public housing, transportation support, engineering services, shore facilities planning support, and all other public works logistic support. At NAS Alameda, in addition to the management and control of 1,213 family housing units through a PWC branch office in Building 101, PWC SFRAN BAY is responsible for the operation and maintenance of more than 30 utility buildings and stations on base.

6.4.10.1 Building 114. Historically, Building 114 has housed the majority of public work shops, including a woodworking, steam cleaning, and paint shop; pesticides shop; and general maintenance shop. (The pest control program is discussed in Section 6.2.6.) Steam cleaning, paint stripping, and paint spray booth activities housed in Building 114 generated approximately 250 gallons of wastewater per day for approximately 12 years. Until the early 1970s, these wastes were discharged directly to the storm drains which emptied into the San Francisco Bay by way of the seaplane lagoon and the estuary. Current discharge is to the industrial waste collection system. A separator pit which was intended to separate sludges and floating scums from the wastewater was located in the western corner of the courtyard of Building 114. Examination and analyses of waste flows downstream of these separators indicated inadequate separation, particularly of oils and grease. Periodically, the separator pits were pumped out by the Public Works Department and disposed of at the West Beach Landfill.

6.4.10.2 Building 6. The transportation shop has always been located in Building 6 since the Navy Public Works Center, San Francisco Bay was established. This shop is used for the repair and overhaul of automotive and construction equipment. In the late 1960s, the steam cleaning operations and the car wash rack generated approximately 1,250 gallons per week of wastewaters containing soap, detergents, oil, and grit. These wastes were discharged directly to the San Francisco Bay following minor treatment by an oil and sludge separator

Table 6-12

AIRCRAFT ASSIGNED TO NARU ALAMEDA

Unit	Number	Type of Aircraft
VA-303	13	A-7B
VA-304	14	A-7B
VAK-208	5	KA-3B
VAK-308	5	KA-3B
HS-85	8	SH-3D
VR-55	3	C-9B

Source: Navy, Department of, Naval Facilities Engineering Command, Western Division, October 1981, Master Plan for Naval Air Station, Alameda, California, San Bruno, California.

Table 6-13

BUILDINGS OCCUPIED BY RESERVE UNITS

Building	Description	User
2	Administrative offices/training classrooms	NARU
13	Reserve intelligence programs spaces	NARU
20	Aircraft maintenance hangar	VA-303 VA-304 CVW-30
21	Aircraft maintenance hangar	VAK-208 VAK-308
22	Aircraft maintenance hangar	MAG-42
39	Aircraft maintenance hangar	HS-85
40	Aircraft maintenance hangar	VR-55
90	Recruiting offices	NARU
101	Training devices/simulators	NARU
114	Reserve intelligence program spaces	NARU
193	Administrative spaces	MAG-42
266	Line maintenance shelter	HGR 21
307	Inert storehouse	HGR 40
308	Inert storehouse	HGR 40
314	Ready service ammunition locker	HGR 21
315	Ready service ammunition locker	HGR 21
316	Ready service ammunition locker	HGR 20
319	Ready service ammunition locker	HGR 20
320	Ready service ammunition locker	HGR 21
321	Ready service ammunition locker	HGR 22
326	Dry storage tank	All
329	Line maintenance shelter	HGR 21
334	Paint locker	HGR 21
335	Lube storage	HGR 21
378	Lube storage	HGR 21
462	Warehouse	MAG-42
463	Radar control platform	MAG-42
464	General storage shed, open	MAG-42
465	Warehouse	MAG-42
526	Line maintenance shelter	HGR 20
536	Line maintenance shelter	HGR 20
537	Line maintenance shelter	HGR 20
538	Line maintenance shelter	HGR 22
539	Line maintenance shelter	HGR 22
541	Line maintenance shelter	HGR 22
549	Line maintenance shelter	HGR 20
582	Wash rack shelter	HGR 20

Source: Navy, Department of, Naval Facilities Engineering Command, Western Division, October 1981, Master Plan for Naval Air Station, Alameda, California, San Bruno, California.

Table 6-14

WASTE STREAMS GENERATED BY
NARU ACTIVITIES - 1960s

Building/Activity	Waste Streams
Hangars 20-21 Partial aircraft wash, seven per day; aircraft wash area between Hangars 20-21	Detergents, solvents, emulsified grease, oil, and grime; average 3,500 gallons per day
Hangar 22 Aircraft wash area, one aircraft per day	Soap, detergents, brighteners, carbon remover, emulsified grease, oil, and grime; 500 gallons per day
Hangar 39 Air operations; aircraft wash area along seawall; 21 washed weekly, one washed twice monthly	Detergents, spot remover, paint remover, brighteners, carbon remover; average 10,000 gallons per day
Hanger 40 Aircraft wash area along seawall; six to eight aircraft per month	Detergents, brighteners, paint remover, emulsified grease and grime; average 3,500 gallons per day

Source: Navy, Department of, Naval Facilities Engineering Command, Western Division, 1966, Report on Study of Water Pollution Generated in Industrial Wastewater at Naval Air Station, Alameda, California.

located at Building 6. Approximately 350 gallons per month of sludges from this separator pit were disposed of by the Public Works Department at the West Beach Landfill. The transportation shop also disposed of approximately 150 gallons per year of battery acids which were neutralized with baking soda before being discharged to the sewers.

6.4.10.3 Power Plant - Building 10. There are two power plants at NAS Alameda used for the generation of steam. The power plant located in Building 10 was built in the early 1940s, when the base was first commissioned. Seven boilers were in operation at the plant until the early 1970s, when five of the boilers were taken out and two new boilers were installed. The primary fuel used currently at Building 10 is natural gas; diesel fuel is used as a back-up fuel.

Bunker "C" fuel oil was used as fuel for the plant until the early 1970s. This fuel was stored in eight (one 24,000-gallon and seven 12,000-gallon capacity) underground tanks located on the north side of the building. Spills have occurred in the past, resulting in the accumulation of Bunker "C" fuel oil in the trenches for the steam pipes on the north side of the building. When a spill occurred, a suction truck was used to skim the oil off and dispose of it in the oil sump at the West Beach Landfill. When the power plant was converted to natural gas (with diesel fuel as an alternative) in the early 1970s, the Bunker "C" tanks were filled with water and abandoned. Eight new aboveground diesel tanks with a total capacity of 150,000 gallons were installed on the south side of the plant. The area where the tanks are located is bermed, and there have been no incidents of leakage or spills.

In the past, waste oils generated at the plant were put in a bowser which was periodically pumped out into an oil tanker and taken away for disposal at the West Beach Landfill.

Boiler blowdown containing caustic soda, phosphate, and sulfide was discharged to the sanitary sewage system. The chemicals for the internal boiler water treatment were, and still are, stored in the plant in an open area. There have been no incidents of chemical spills.

6.4.10.4 Power Plant - Building 584. The power plant located in Building 584 near the docks was built in 1976 solely to provide "Cold Iron" support for the ships which homeported at NAS Alameda. Before its construction, two mobile steam units borrowed for use from Port Hueneme were located at Pier 3. Boiler blowdown at the plant located in Building 584 drains to the industrial waste treatment system. Diesel fuel for the plant is stored in aboveground fiberglass tanks across the street towards the piers. The area is bermed, and there have been no incidents of leakage or spills.

6.4.11 Naval Regional Dental Center (NAVREGDENCEN) Branch Clinic. The Branch Clinic at NAS Alameda is one of several branch clinics of NAVREGDENCEN, San Francisco. The purpose of the clinic is to provide professional dental support to shore bases and fleet activities in the general area. Fleet-based personnel represent about 60% of the work load, while permanent personnel represents about 35%. Retired personnel and others represent about 5% of this office's work load.

The dental clinic was established in the early 1940s to provide general dental services to active duty Navy and Marine Corps personnel and retired military personnel and their dependents. The clinic is located in Building 16, which is also occupied by NAVREGMEDCEN. Currently, the building houses 12 operating chairs, nine offices, one cleaning room, one operating/diagnosis room, and a preventive dentistry room. There are also three X-ray rooms, a duty (emergency) room, a locker room, and a waiting room with clerical space. As an indication of their activity, approximately 1,600 dental records are on file.

Hazardous wastes generated at the clinic include scrap amalgam and waste X-ray solution. The scrap amalgam is routinely turned over to the DPDO for reclamation of silver and mercury, and spent X-ray solution is processed for silver recovery. According to personnel interviewed, the clinic has always turned their wastes over for proper disposal and reclamation.

6.4.12 Naval Regional Medical Center (NAVREGMEDCEN) Branch Clinic. Currently, the purpose of NAVREGMEDCEN Oakland is to provide outpatient consultation and general clinical services to active duty Navy and Marine Corps personnel, active duty members of other branches of the armed services, dependents of active duty personnel, and other persons as authorized in current directives.

The assigned specific tasks and functions as directed by the Commanding Officer, NAVREGMEDCEN Oakland, are to:

1. Provide general outpatient medical support to authorized military personnel;

2. Provide authorized general outpatient care to eligible dependents of active duty, retired, or deceased personnel as determined by the Officer-in-Charge and contingent on availability of personnel and funds;

3. Provide ambulance service as directed by higher authority; and

4. Provide or undertake other appropriate functions that may be authorized or directed by higher authority.

With a total staff of 83 (eight officers, 46 enlisted, and 29 civilians), the Medical Branch Clinic at NAS Alameda occupies and utilizes the following facilities:

1. All of Building 16 is occupied by the NAVREGMEDCEN and NAVREGDENCEN Branch Clinics.

2. A portion of Building 115 provides garage facilities for vehicles used to support the mission, office space for the Preventive Medicine Section, NAVREGMEDCEN Branch Clinic, and

storage space for both NAVREGMEDCEN and NAVREGDENCEN Branch Clinic facilities.

3. A portion of Building 5-A, located on the ground floor of Hangar 5, is occupied by the Industrial Medical Clinic, which provides occupational health services for the station and its tenants.

The medical clinic includes a small laboratory, as well as X-ray photography, pharmacy, and emergency care areas. There are no facilities for surgery or inpatient care.

Because of the limited nature of the clinic, the types of wastes generated are limited and are produced only in small volumes. These wastes include small amounts of laboratory reagents and solvents; developing and fixing solution for X-ray photography; and solid, possibly infectious, wastes such as swabs, wound dressings, and used, empty, or out-of-date pharmaceutical containers. Solid items are typically disposed of in plastic bags, which in turn are disposed of by the Public Works Center. Infectious wastes may be incinerated by the NAVREGMEDCEN Oakland. X-ray developing solutions are processed for silver recovery and then disposed of directly into the sewer system. Because the X-ray units are of the electron-generator type, no radioactive wastes are produced.

An adjunct to the Medical Branch Clinic at NAS Alameda is the Occupational Health Clinic located in Building 5-A. This clinic provides minor first-aid and industrial health services, such as employment physicals and occupational safety monitoring, and produces only small quantities of solid wastes. These wastes include swabs, dressings, and empty pharmaceutical containers typically discarded in plastic bags for pick-up by the Public Works Center.

6.4.13 Pacific Fleet Audio-Visual Facility (PACFLTAVFAC) Component. The PACFLTAVFAC Component, located in Building 19, provides photographic services to NAS Alameda, including film developing, motion picture support, and photodocumentation of official visits and special operations. The average monthly work load is given below:

Product	Quantity
Black and white negatives	2,779
Black and white prints	1,848
Color negatives	1,077
Color prints	589
Color slides	579

Silver and other precious metals have been recovered from processing fluids. Photographic paper is shredded and the silver recovered. The recovery process has been handled since 1974 by the DPDO. All other chemicals are disposed of down the drain, but only in small quantities.

6.4.14 Shore Intermediate Maintenance Activity (SIMA). SIMA has been aboard NAS Alameda less than one year. Prior to SIMA, the USS Hector provided maintenance assistance during 1978 and 1979. The Fleet Maintenance Assistance Group (FMAG) was assigned to NAS Alameda from Hunter's Point in 1975 and continued until 1978. All three activities had the same function: to provide maintenance assistance to the carriers homeported at NAS Alameda and to provide support for all Navy vessels in the Bay Area. The maintenance performed by these three activities varied from major ship overhaul work by FMAG to the relatively minor work done by SIMA. Wastes generated during maintenance work included metal turnings, oils, fuels, paint, blasting grit, and lubricating and hydraulic fluids. All wastes generated by the USS Hector, SIMA, or FMAG were disposed of by contractors off base.

6.4.15 Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP). Since 1978, SUPSHIP San Francisco has maintained two offices at NAS Alameda for the purpose of managing routine maintenance activities for homeported ships. The SUPSHIP-Enterprise office oversees the maintenance of the carrier USS Enterprise and is located in a trailer office near Pier 3. The main SUPSHIP office at NAS Alameda, located in Building 162, manages the maintenance operations for all other homeported ships. Prior to 1978, ship maintenance operations at NAS Alameda were managed directly from SUPSHIP San Francisco offices at Hunter's Point, California. SUPSHIP activities are limited to voyage repair, as opposed to the major repairs conducted at a shipyard such as NSY Mare Island. Only components or subsystems of the ships are totally replaced or repaired. From 1975 to 1978, Selected Restricted Availability (SRA) capability existed for SUPSHIP, and certain shipyard type repairs were done at the piers by the direction of SUPSHIP at Hunter's Point.

Wastes generated by SUPSHIP operations include asbestos, oil, bilgewater, and amounts of cleaning solvents, paints, and primers. Because civilian contractors have performed most of the maintenance work on ships at NAS Alameda for many years (long-time employees report that contractors have worked at the NAS Alameda piers since the 1940s), they have long had the responsibility for collecting, transporting, and disposing of these wastes. Thus, NAS Alameda has few records on the quantities of wastes generated in the past. With the exception of bilgewater, SUPSHIP has always required its contractors to collect all wastes, such as paint and solvent cans, spent solvents, old paint, and asbestos lagging, in dumpsters for periodic hauling to off-base disposal facilities. Because no restrictions on the disposal of liquid wastes were placed on NAS Alameda ship maintenance operations prior to 1972, it is likely that all such liquid wastes were routinely disposed of into the bay.

Ship maintenance operations at NAS Alameda have probably significantly contributed to past polluting practices only in two ways. In the past, the majority of drums, barrels, or other material left on the piers after a ship's departure was hauled to the West Beach Landfill (Site 1). At the West Beach Landfill, the containers of liquid were punctured and allowed to drain on the ground. The materials left by the ship varied considerably, and included items ranging from chemicals whose shelf life had expired, to excess materials for which storage space could not be found, to a ton of rancid pork on one occasion. Disposing of materials by leaving them on the dock the night before sailing was considered by shipboard personnel to be more desirable than turning them over to DPDO.

The disposal of asbestos in the West Beach Landfill is the second way in which ship maintenance operations at NAS Alameda have contributed to past polluting practices. Prior to 1973, almost all insulation in the ship, such as lagging, was asbestos. Any ship coming in for a five-year overhaul in the early 1970s had the asbestos ripped out. The asbestos was then disposed of in the West Beach Landfill.

6.5 RADIOLOGICAL OPERATIONS. Extensive use of radioactive materials at NAS Alameda began in the late 1940s in the dial painting section of the instrument shop located in Building 5-A. In this shop, aircraft instrumentation was refurbished by scraping old dials, cleaning them in solvent, and then repainting them with radioluminescent paint containing Radium 226. Scrapings from the old dials were deposited on the surfaces of shop benches and cleaned with TAC rags. According to recent correspondence with a former station industrial hygienist, radium wastes from Building 5-A, consisting of paper wipes and used paint brushes, were discarded at the 1943-1956 Disposal Area and the West Beach Landfill. Liquid wastes were discharged directly to the seaplane lagoon.

The radium dial painting shop was closed in the late 1950s/early 1960s (exact date unknown). A contractor was hired to decontaminate the facility. The drain pipe from the room was sealed at both ends, but reportedly still contains contaminated material. The Radiological Affairs Support Office (RASO) has been advised of this situation and will investigate it further. Waste materials, such as masking tape and detergent wash water, reportedly were put in containers and hauled away by the contractor to an unknown location. According to the former industrial hygienist and personnel interviewed, an unspecified number of metal and wooden workbenches from the instrument dial painting and stripping shop were buried at the 1943-1956 Disposal Area because neither station personnel, the contractor, nor Naval Radiological Defense Laboratory could decontaminate them. The radioactive material was disposed of in an unlined trench 50 feet long, eight feet deep, and approximately 11 feet wide north of the rifle range, approximately 50 feet north of the aboveground water outlet. The material was brought to the disposal area by NARF personnel, who wore protective white coveralls which were subsequently buried along with the radioactive material. Reportedly, much of the dial stripping sludge was also buried there.

Current activities associated with radium dials are restricted to their removal and replacement with non-radioluminescent materials. These operations are housed in a controlled area on the second deck of Building 400. In early 1979, radium contamination was detected in the work area. A contractor was called in to decontaminate and monitor rooms 203 and 204. Benches, ducting, and drains were removed and disposed of off base by the contractor. The bulk of the contamination, which was apparently confined to a relatively small floor area, was removed by stripping the paint from the floor. Subsequent monitoring by the contractor indicated no detectable Radium 226 or Radon 222 levels above normal background levels in ambient air. No significant radon breath test results were found when personnel were tested. Since work area decontamination in 1979, all work with suspect radium dials has been performed in a control booth equipped with a laminar flow ventilation system, a fixed alpha radiation room monitor, and a hand-held alpha and beta/gamma detector. Personnel performing the work wear disposable outer clothing.

The glass prisms from some celestial navigation devices represent another source of radiological material associated with the instrument shop. The glass prisms were found to contain thorium during routine maintenance of Baird atomic navigation devices from A-3 aircraft. In 1980 these prisms were found to emit 1.6 to 3.3 mR/hr from Thorium 232, but no activity was detected when a wipe test was made with alcohol-wetted filter paper. Station personnel reported that some instruments with thoriated prisms may have been disposed of in the landfill as early as the 1950s. These reports are not documented, and even if the disposals did occur, there would be minimal hazard. Instruments with thoriated prisms were replaced by the manufacturer.

Other events which could have resulted in environmental contamination from radiological materials have been limited. Records indicate that in 1951 the Overhaul and Repair (O&R) Department decontaminated two jet engines from a plane that had been flown through the cloud resulting from an atomic bomb blast. These activities were performed under the direction and supervision of the Naval Radiological Defense Laboratory, San Francisco. No further records or recollections of these operations were obtained. In the late 1960s, the P-3 aircraft was found to have instruction placards painted with uranium oxide located at the starboard, aft ditching stations. These placards were removed, placed in containers, and held at the low-level storage building at the West Beach Landfill for disposal by a licensed contractor at an unspecified off-base location.

6.6 WASTE DISPOSAL OPERATIONS.

6.6.1 West Beach Landfill (Site 1). The West Beach Landfill is located at the southwest corner of the base and occupies approximately 110 acres, as shown on Figure 6-7. The site is bordered to the west and south by San Francisco Bay and to the north and east by runways (see Figure 6-8). The site was used for general disposal purposes, with an estimated 1.6 million tons of garbage disposed of. Hazardous waste disposal operations first began at this site in the early 1950s with the disposal of waste chemical drums in an area known as the chemical dump, which is located at the northeast corner of the site. However, the majority of the disposal operations did not occur until 1954 or 1956. It was during this time period that disposal operations at the 1943-1956 Disposal Area ceased and the West Beach Landfill became the main disposal area for the base. During this time period, 50 to 100 tons or more per day of municipal type refuse were being disposed of at the site.

Although most of the liquid wastes generated at NAS Alameda were discharged directly to the storm drains prior to the early 1970s, an estimated 50,000 gallons per month of accumulated sludges, spent liquid, and solid process materials were disposed of at the landfill.

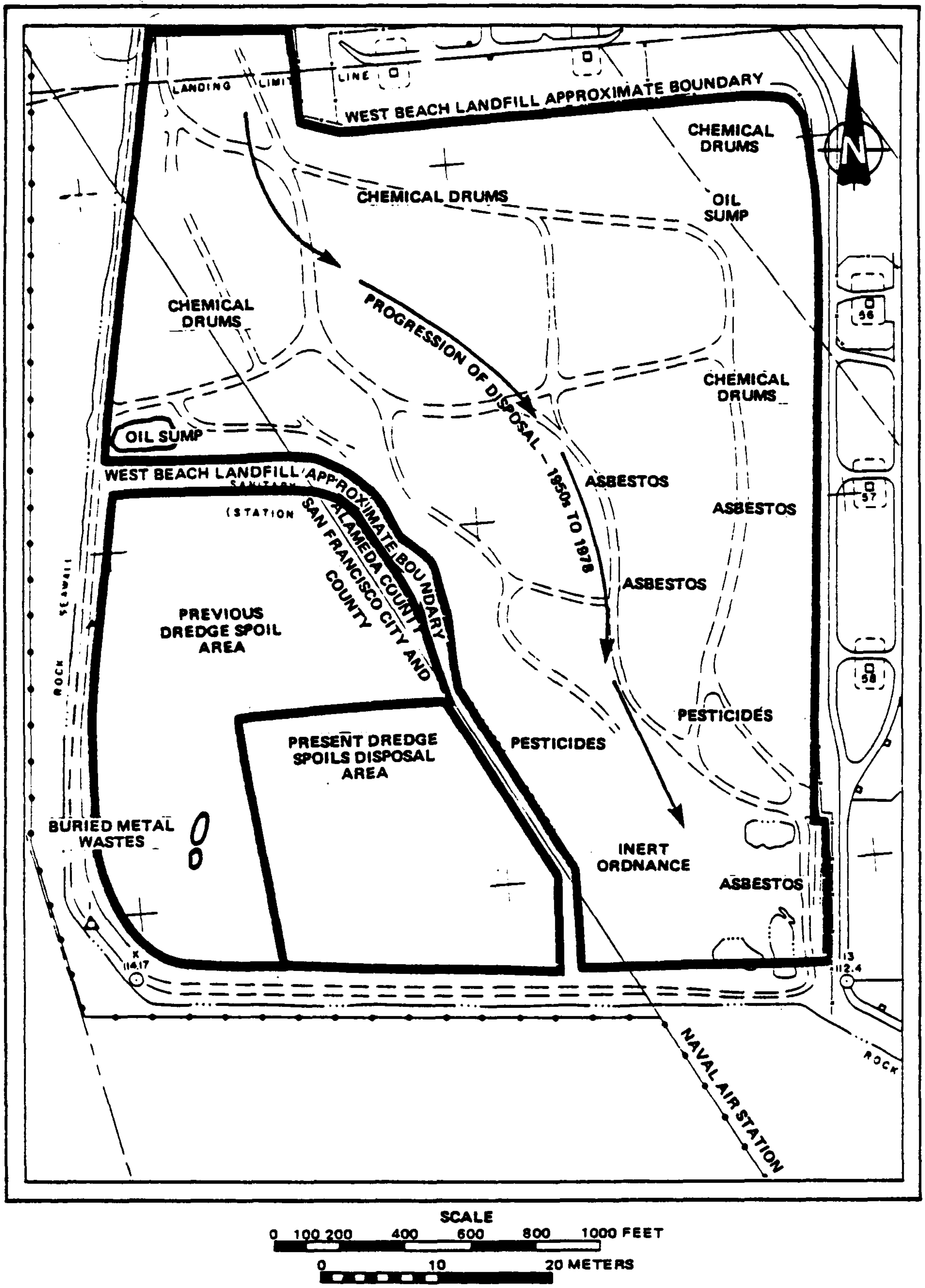


Figure 6–7 AREAS OF SUSPECTED HAZARDOUS WASTE DISPOSAL, WEST BEACH LANDFILL (SITE 1), NAS ALAMEDA

Figure 6–8 AERIAL VIEW, WEST BEACH LANDFILL (SITE 1), NORTHERN BOUNDARY.
The northern boundary of the West Beach Landfill lies to the right of the fence visible in the center of the photograph. Shortly after the bunkers were constructed at this site, an exudite appeared on the interior walls, caused by the landfill (June 1982).

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Waste solvents, metal cleaning compounds, spent electroplating and anodizing baths, paint, paint removers and thinners, and heat treating compounds were collected in bulk at various locations by plant maintenance personnel and buried at the landfill. Table 6-15 lists the wastes from overhauled aircraft which were disposed of at this site.

Sludges from 15 separator pits which intercepted wastewater flows were periodically pumped by Public Works personnel and buried at the landfill. Estimated volumes of materials disposed of by plant maintenance and Public Works personnel as indicated by operator records are given in Table 6-16.

Disposal methods used at the site by Public Works personnel consisted of excavating a trench to the water table, filling the trench in with materials, spreading and compacting the material with a bulldozer, and then covering the area with the excavated soil on an intermittent basis. In the early years of operation, whole drums were buried at the landfill (Figure 6-9). However, following three different fires caused by bulldozers running over full drums of apparently flammable material, all drums containing liquid waste were punctured and drained before being buried. The practice of using daily soil cover was not instituted until the early 1970s (Figure 6-10). The roads which traverse the landfill were made by clearing an area with a bulldozer and then placing spent blasting sand and abrasives (green garnet) down to form the road surface. From approximately 1957 to the early 1970s, it was common practice to open the valves on waste oil tankers and release the waste oils on the roads for dust control purposes (Figure 6-11). Waste oils from bowsers (Figure 6-12) were also disposed of in this manner.

This site also contained two unlined oil sumps (see Figure 6-7). Waste oils generated on the base which were not reclaimed or sold were disposed of in these sumps. It was standard practice for the tanker trucks to back up to the oil sump, open their outlet, and drain the oil into the sump. There was usually a visible sheen on the impounded water located in the midsection of the landfill (Figure 6-13), indicating that the oil in the sumps was contaminating the water. The water encountered during trench digging on the landfill usually had an oil sheen.

PCB-contaminated oil from base transformers was also disposed of at this site. The PCB fluids were brought to the landfill in 30-gallon garbage cans loaded on a trailer and then spread on the road in the northeast corner of the West Beach Landfill. The road was later covered with a layer of soil. Other PCB-contaminated material disposed of at this site included TAC rags from NARF operations. Approximately 1,400 36-inch by 36-inch TAC rags soaked with four grams of PCBs were disposed of each week, beginning in the early 1950s and continuing through the 1970s. These included rags possibly contaminated with radium from the instrument dial painting and stripping shop. Tons of carbonless paper containing PCBs used on the base were also disposed of at the landfill. Three other naval bases in the San Francisco Bay Area also disposed of waste at NAS Alameda. Large quantities of infectious waste (approximately 30 cubic yards per day) were received from the Oak Noll Naval Hospital. The Naval Supply Center-Oakland

Table 6-15

WASTE PRODUCTS FROM AIRCRAFT OVERHAUL AND REPAIR

Nomenclature	Quantity/Year
Acid, Hydrochloric[1]	1,000 gallons
Acid, Nitric[1]	700 gallons
Acid, Sulfuric[1]	350 gallons
Methyl Ethyl Ketone[3]	18,000 gallons
Ethyl Acetate[3]	50,000 gallons
Sodium Hydroxide[1]	4,400 pounds
Stoddard Solvent[2]	160,000 gallons
Paint Remover[2]	105,000 gallons
Cleaner Brightener[1]	2,400 gallons
Ortho Dichlorobenzene[1]	1,000 gallons
Methylene Chloride[1]	11,000 gallons
Methyl Chloroform[3]	4,900 gallons
Trichlorethylene[2]	24,000 gallons
Toluene[1]	2,600 gallons
Xylene[1]	4,500 gallons
Oil, 1010[2]	16,000 gallons
Naphtha, Aliphatic[3]	4,000 gallons
Naphtha, Aromatic[3]	1,800 gallons
Emulsion Cleaner[1] (MIL-C-22543)	80,000 gallons
Carbon Remover[2] (MIL-C-19853)	12,000 gallons
Acetone	9,100 gallons
Cleaning Compound[2]	
Turco 4228	15,000 pounds
Chromic Acid[1]	19,700 pounds
Sodium Cyanide[1]	2,400 pounds
Potassium Cyanide[1]	2,400 pounds
Copper Cyanide[1]	500 pounds
#396 Perliton	
Heat Treating Cyanide	500 pounds
Paint Thinners[2] (various kinds)	35,000 gallons
Steam Cleaner	21,000 gallons

1. To drains by leakage, direct discharge, or drag-out; to seaplane lagoon or estuary.
2. Buried at the dump.
3. To drains or buried at dump.

Source: Navy, Department of, Naval Facilities Engineering Command, Western Division, 1966, Report on Study of Water Pollution Generated in Industrial Wastewater at Naval Air Station, Alameda, California.

Note: Quantities were rounded to two significant figures.

Table 6-16

ESTIMATED VOLUMES OF SLUDGE DISPOSED OF AT THE WEST BEACH LANDFILL - 1960s

Building	Volume
	Plant Maintenance Disposals
5	21,000 gallons per month
360	14,000 gallons per month
	Public Works Disposals
6	350 gallons per month
10	100 gallons per month
14	2,000 gallons per month
67	100 gallons per month
162	4,000 gallons per month
166	175 gallons per month
360	1,000 gallons per month
372	2,200 gallons per month
397	3,000 gallons per month
410	4,000 gallons per month
459	60 gallons per month
460	200 gallons per month
Total	53,000 gallons per month

Source: Navy, Department of, Naval Facilities Engineering Command, Western Division, 1966, Report on Study of Water Pollution Generated in Industrial Wastewater at Naval Air Station, Alameda, California.

Note: Quantities have been rounded to two significant figures.

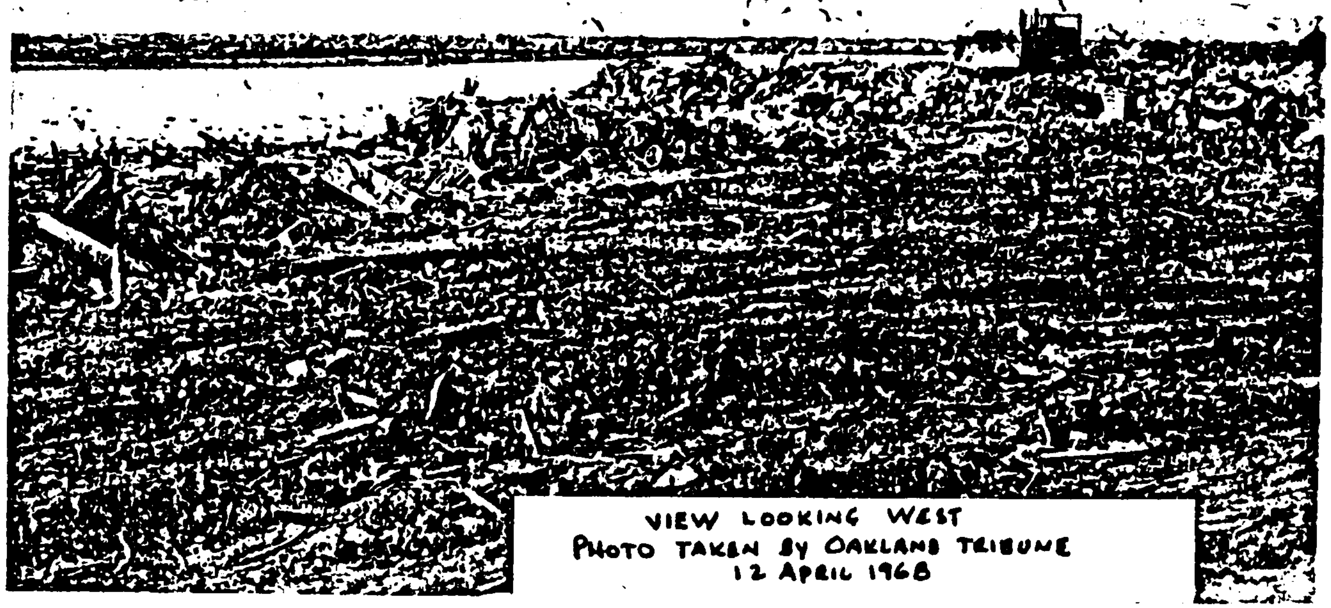

Figure 6–9 WEST BEACH LANDFILL (SITE 1), VIEW LOOKING SOUTHWEST, 1968.

This photograph shows the typical day-to-day operations of the West Beach Landfill (Site 1). Materials were pushed into the impounded water area (April 1968).

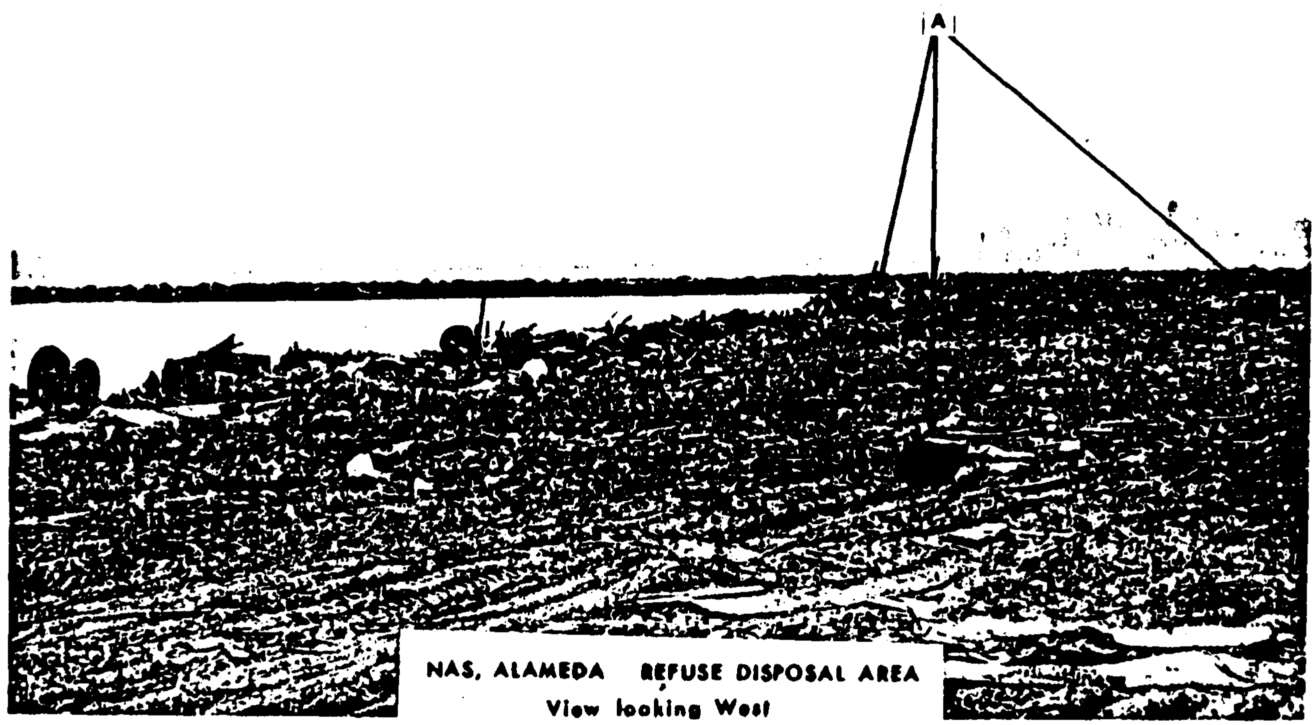

Figure 6–10 **WEST BEACH LANDFILL (SITE 1), LOOKING SOUTHWEST, 1968.**

This photograph shows the West Beach Landfill (Site 1) after the application of cover. Cover was not applied daily until after 1970. Note the intact barrels still on the surface (A) (April 1968).

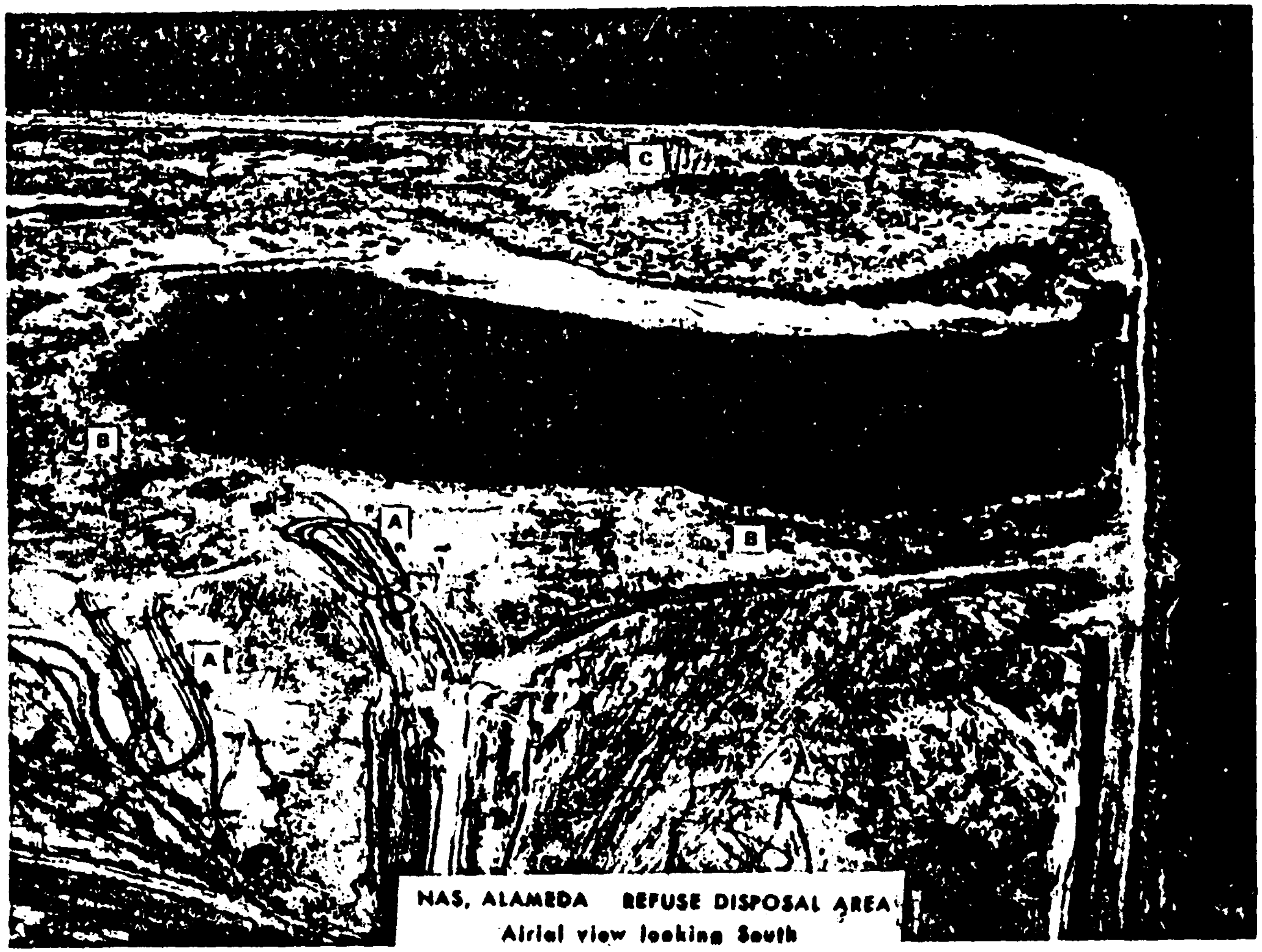

Figure 6–11 AERIAL VIEW, WEST BEACH LANDFILL (SITE 1), LOOKING SOUTH, 1968.

This photograph shows oil disposal from tank cars which opened their valves and drove until the tanks were empty (A). Uncovered waste material can be seen at (B). The bulldozed area at (C) is still visible today.

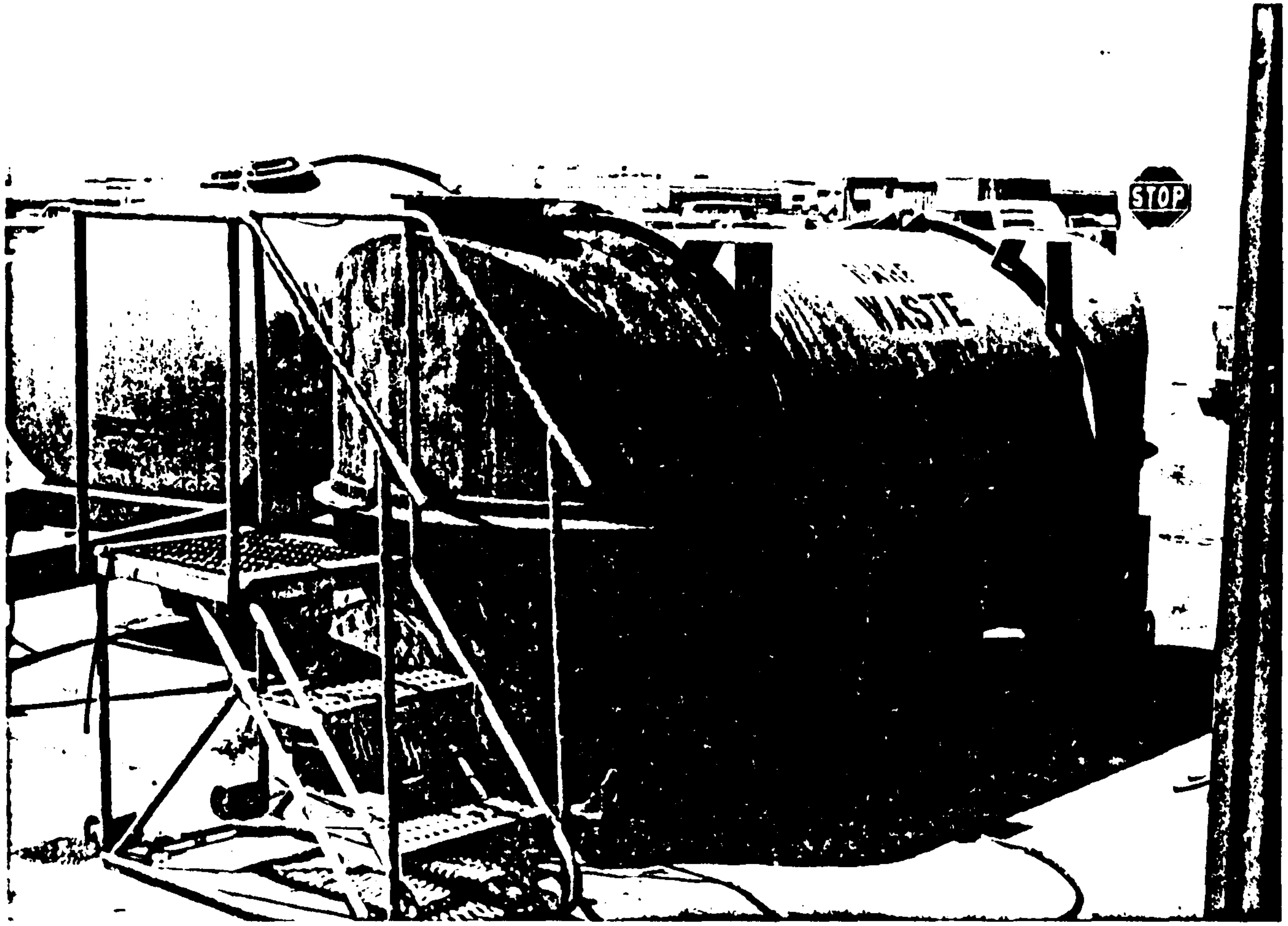

Figure 6–12 BOWSER.
Twenty-seven bowsers are scattered throughout the base and receive all kinds of waste liquids, primarily oils. Previously, the contents of these bowsers were spread on roads, burned for fire training, or disposed of into sumps at the 1943–1956 Disposal Area and West Beach Landfill (June 1982).

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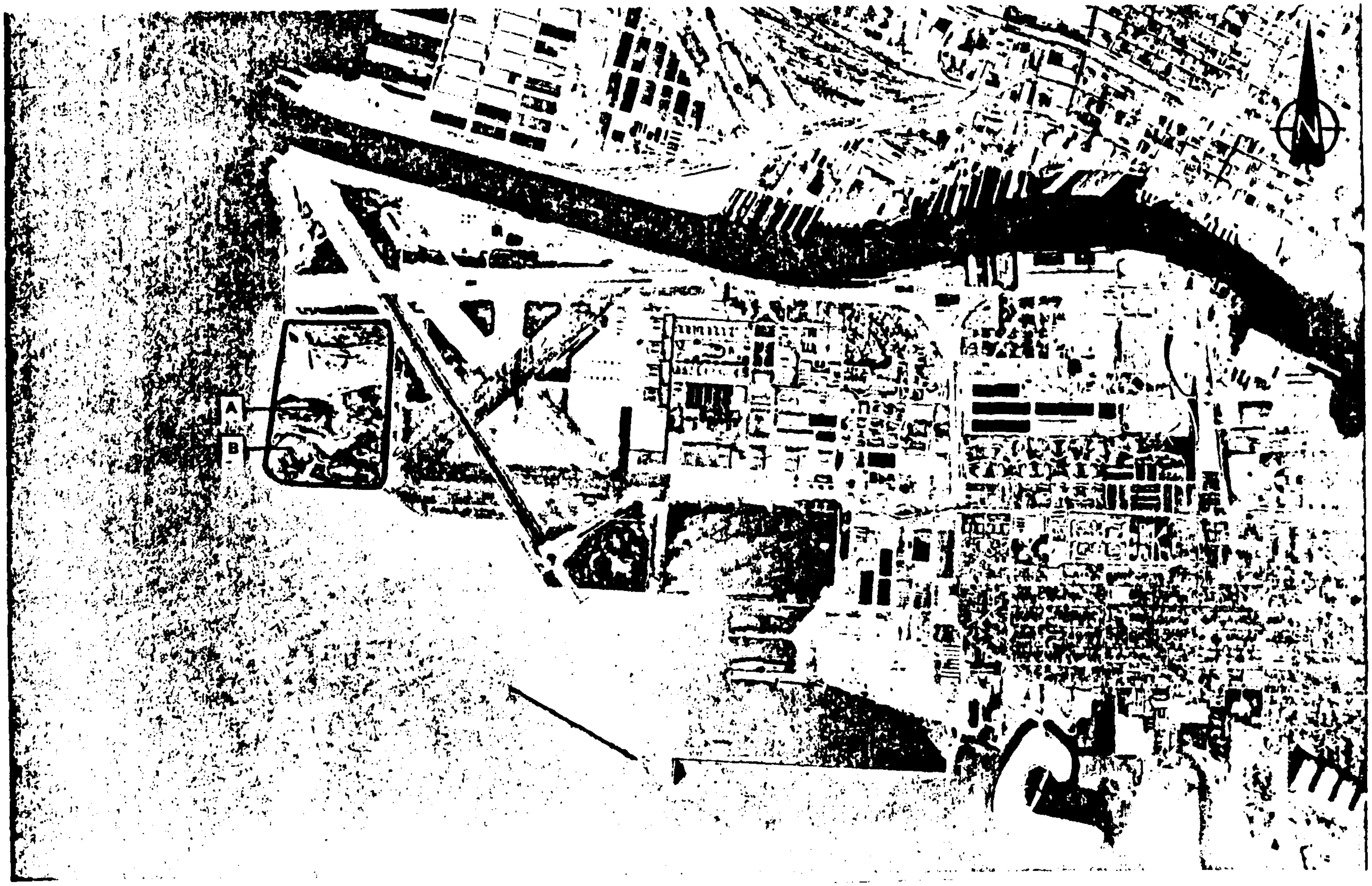

Figure 6–13 **AERIAL VIEW, WEST BEACH LANDFILL (SITE 1), 1968.**
The outlined area roughly delineates the boundaries of the West Beach Landfill (Site 1). Note the oil sheen (A) from the oil sumps at the northern edge of the impounded water area. Note also that the dredge spoils area (B) shows no indication of disposal at this time. Use of this area as a disposal area began in the 1970s (July 1968).

sent approximately four 30-cubic-yard trucks of waste per day, including laboratory wastes, to the landfill. Treasure Island sent approximately two 30-cubic-yard trucks per day of unknown wastes. In addition, all wastes generated by ships in port and aircraft carriers were disposed of at the landfill.

Asbestos pipe lagging ripped out and removed from ships was disposed of in the mid-eastern section of the landfill (see Figure 6-7). The asbestos was brought to the dump loose in dumpsters and was not contained until the early 1970s, when it was put into plastic bags for disposal. The area where the asbestos was buried is covered with soil. There was no visible evidence of exposed asbestos at the surface during the site visit in June 1982.

A one-time disposal of large quantities (several hundred pounds) of tear gas agents (CS and CSC) left over after use by the National Guard during the Berkeley student riots was made in 1968 or 1969. The tear gas was disposed of in containers as a loose powder; the exact location is not known.

From approximately 1952 to 1968, mercury wastes from broken manometers and fluorescent tubes were put in drums and disposed of at the landfill. The actual drumming of the mercury was done inside Building 5, where the "tube buster" was located. The "tube buster" would smash approximately 1,300 eight-foot-long fluorescent light bulbs per week. Each light bulb contained two to three drops of mercury.

Inert ordnance from the Defense Logistics Agency (DLA) in Alameda was also disposed of at this site. Approximately four truckloads of ordnance ranging in size from four feet long, 12 inches wide, to smaller ammunition were buried in 1976 (see Figure 6-7).

It is also reported that in the late 1970s the Public Works Pest Control Shop (Building 114) was cleaned out and all pesticides affected by the Toxic Substances Control Act (TSCA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) were disposed of in the landfill. The pesticide disposal area was approximately 30 to 50 feet on a side (900 to 2,500 square feet) (see Figure 6-7). The pesticides were disposed of in a ditch which was covered with three to four feet of soil. The IAS team was shown the location of the alleged pesticide disposal area and were told that the pesticides disposed of in this area were both liquid and solid; the majority of pesticides disposed of there was solids. The pesticides were contained in cardboard containers, glass bottles, and plastic containers. Personnel of the Public Works pesticide department maintain that all pesticides which were affected by TSCA were sent to the Oakland Naval Supply Center and then to a Class I disposal site for hazardous wastes.

As shown on Figure 6-7, waste disposal operations occurred in all but the southwestern corner of the landfill site. The only known material which was disposed of in this area was metal scrap from various Public Works sites which was buried in the late 1970s (Figure 6-14). This area was used for disposal of dredge spoils which, for the most part, came from the pier areas, turning basin, and the entrance channel. In 1981, 24,000 cubic yards of dredge spoils from the seaplane lagoon

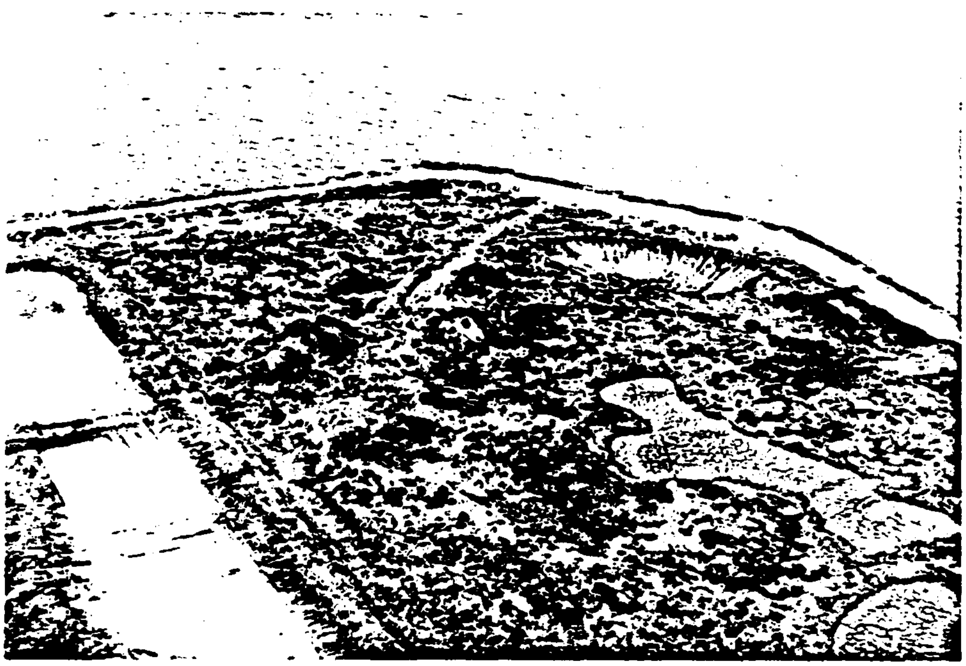

Figure 6—14 AERIAL VIEW, WEST BEACH LANDFILL (SITE 1), LOOKING SOUTHWEST.

Dredge spoil area. Note the mounds in the center of the photograph and the cleared, bulldozed area in the upper right-hand corner (June 1982).

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reportedly were disposed of at this site. As outlined in the 1981 Master Plan, plans for the area call for the establishment of an ordnance area, including the construction of ammunition bunkers. A study conducted in 1978 indicated that this area could be utilized for this purpose.

6.6.2 1943-1956 Disposal Area (Site 2). Waste disposal operations at the 1943-1956 Disposal Area first began with the opening of NAS Alameda in the early 1940s and continued through 1956. The site of the disposal area is in the northwest corner of the base (Figure 6-15). Although the exact quantities of wastes disposed of at this site are unknown, it was the general opinion of the long-term employees interviewed that the disposal area had received all wastes generated on base other than those which were simply drained to the storm sewers. Materials known to have been disposed of at this site include old aircraft engines, cooked garbage, cables, scrap metal, waste oil, paint waste, solvents, cleaning compounds, construction debris, and, reportedly, some radioactive material from NARF (Figure 6-16). Paper products were burned in the base incinerator, which was located in the vicinity of Building 459 and operated from approximately 1940 through 1945. Ashes from the incinerator were disposed of at the site.

The disposal method used by Public Works personnel consisted of digging trenches to the water table, filling them with waste, and compacting the material with a bulldozer. Cover material was applied on an irregular basis. Combustion of waste drums occurred often during bulldozing operations, suggesting that flammable materials were disposed of in this area. In the early 1950s, the Public Works Department changed the method of disposal to open burning, which was then continued until 1954. The burning pit was located at the northern end of Runway 13-31 in the northwest corner of the base, as shown on Figure 6-15. All materials received for disposal during this time were burned at night and the residue was pushed into the San Francisco Bay with a bulldozer in the morning.

In 1952, plans for the extension of Runway 12 (now Runway 13-31) and Runway 7-25 necessitated covering the northern corner of the disposal area. Spoils stockpiled at the end of the runway during the dredging operations of the late 1940s were used as fill for the 1952 runway development. The entire disposal area eventually was covered with soil to an unknown depth and disposal operations were moved to the West Beach Landfill located directly to the south (Figure 6-16).

In the mid-1950s, the western edge of the disposal area was developed as the West Beach Fleet Recreation Area. Activities in this area include a skeet and target range, baseball diamond, picnic area, and recreation building. In addition, a jogging course traverses the site. It should be noted that these activities are located directly on top of the disposal area (Figure 6-17).

6.6.3 Seaplane Lagoon (Site 3). The seaplane lagoon is located south and east of the major industrial facilities at NAS Alameda. The lagoon was originally bounded on the west by a seawall constructed in the 1940s to partially enclose the lagoon. The area west of the

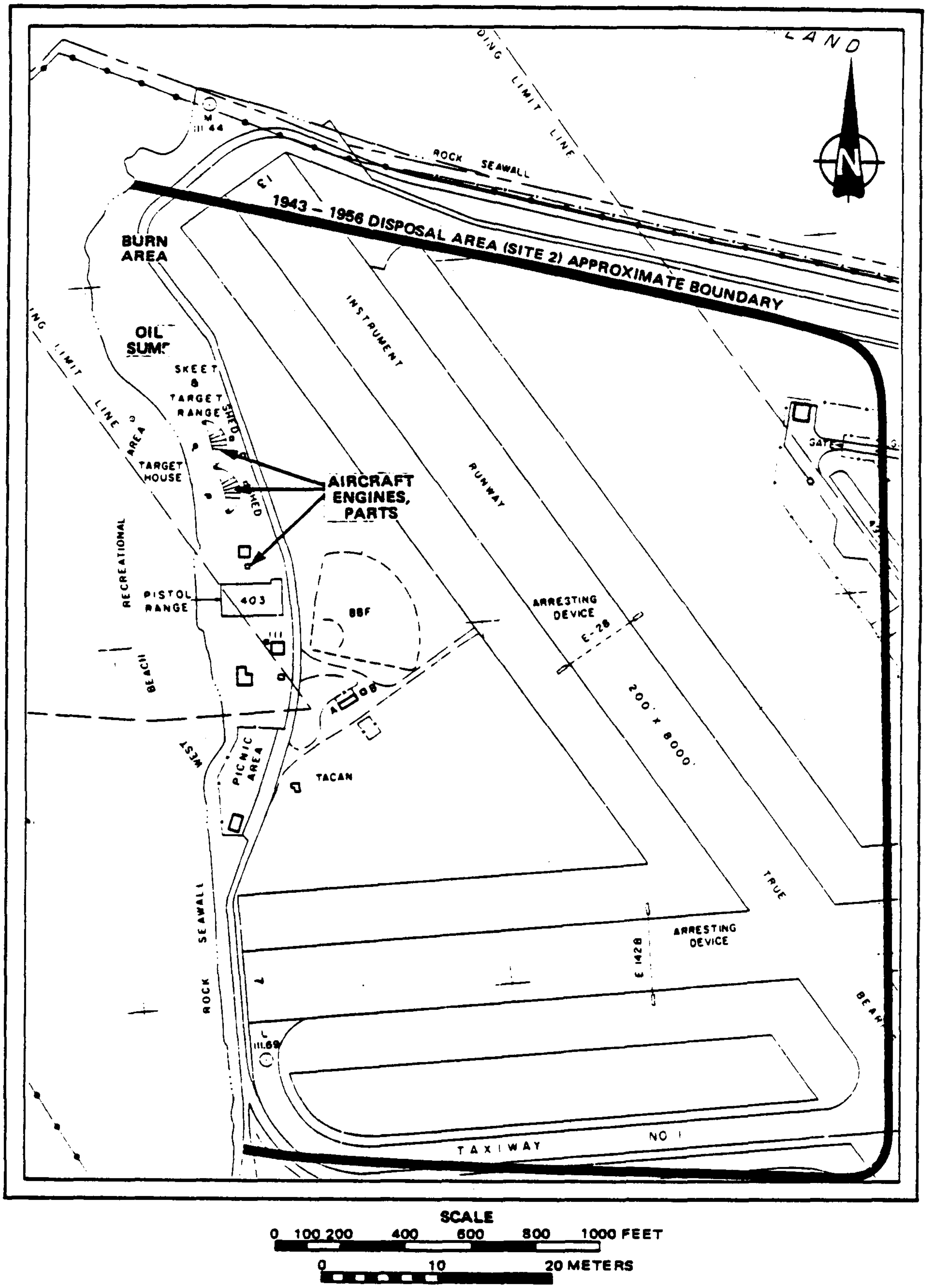

Figure 6–15 1943 – 1956 DISPOSAL AREA (SITE 2), NAS ALAMEDA

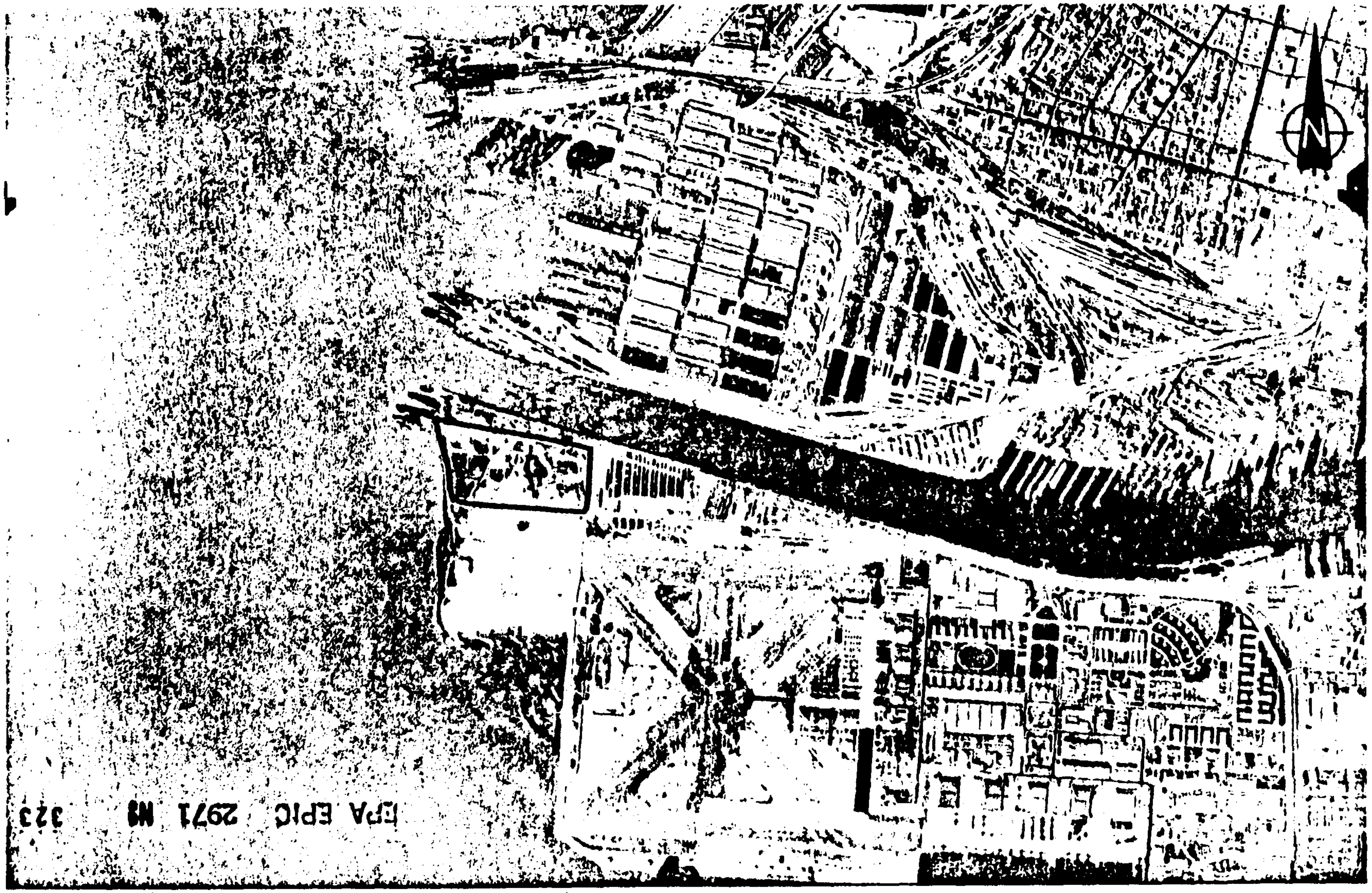

Figure 6–16 AERIAL VIEW, 1943–1956 DISPOSAL AREA (SITE 2), 1946.
The outlined area roughly delineates the boundaries of the 1943–1956 Disposal Area (Site 2). Note that disposal activity took place throughout the entire area (July 1946).

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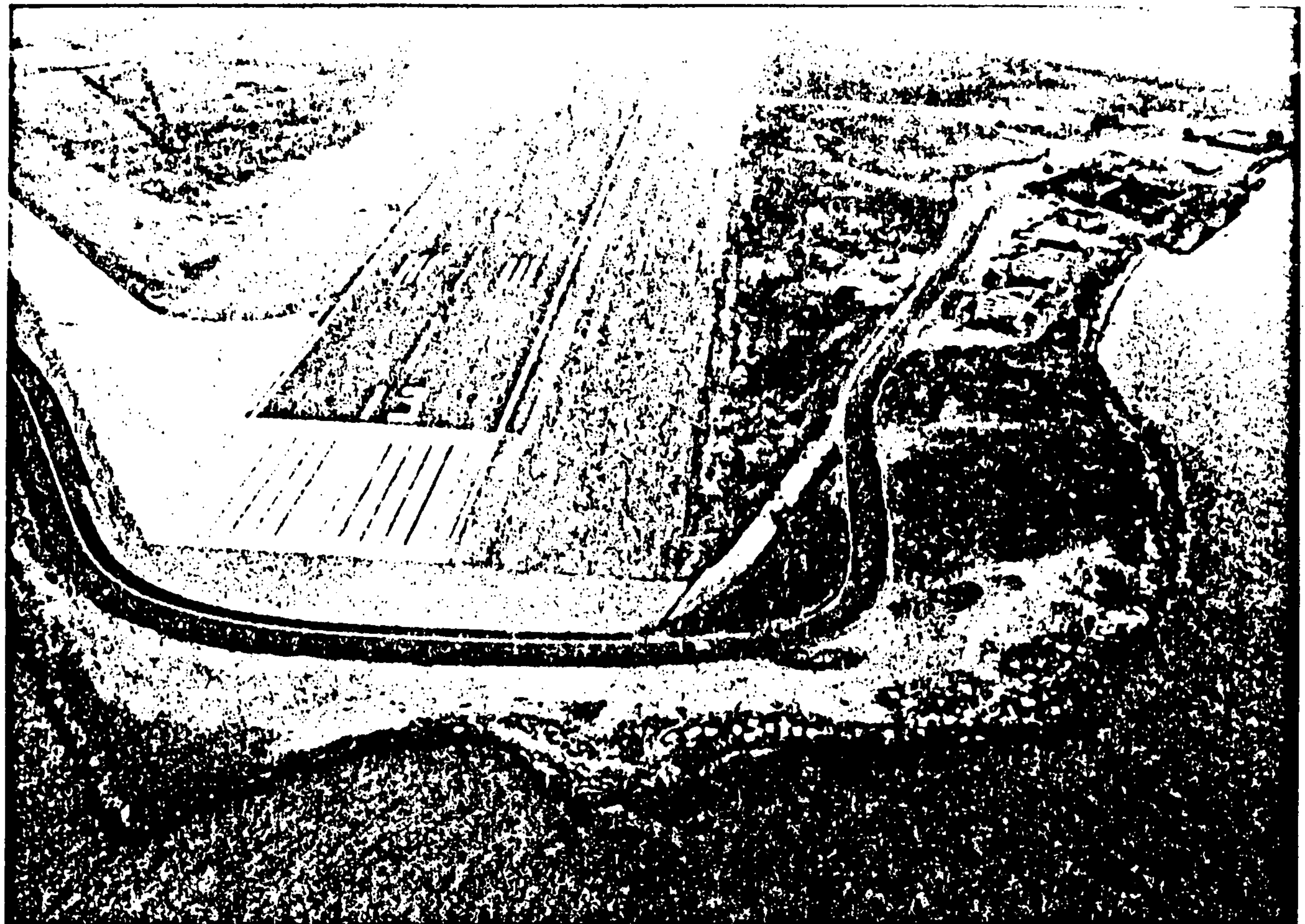

Figure 6–17 AERIAL VIEW, 1943-1956 DISPOSAL AREA (SITE 2), LOOKING SOUTHEAST.

This area, now the Fleet Recreation Area, was used for disposal of garbage and hazardous waste (June 1982).

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seawall is presently filled and supports portions of the NAS Alameda runways as well as the NARF engine run-up pads. To the south are the ship piers; Pier 1 forms the lagoon's southern border. Although it has not been used for over 25 years, the seaplane lagoon was originally enclosed to provide a landing and take-off area for seaplanes. For this reason, the lagoon has never been dredged.

The seaplane lagoon at NAS Alameda was the receiving water for four raw industrial wastewater discharges between the 1940s and 1975 (Figure 6-18). In addition, maintenance activities on ships docked at Pier 1 and other piers have resulted in the disposal of oil, bilgewater, and other ship wastes during the same time period. Examination of aerial photographs shows that bay currents would sweep such discharges into the lagoon.

Reportedly, raw wastewaters contaminated with heavy metals, acids, solvents, paints, paint strippers, radium, mercury, cleaners, caustics, phenols, and possibly PCBs have been discharged to the lagoon. Studies conducted just prior to the abatement of lagoon discharges in the mid-1970s show that average flows at the time were approximately 150,000 gallons per day.

Wastes dumped into the lagoon from ship maintenance activities at Pier 1 cannot be quantified. This is due to the extensive number of years of operation, combined with evidence that dumping was often done indiscriminantly by the contractors hired to perform maintenance work.

6.6.4 Wastewater Discharges. Prior to 1974, all industrial wastewaters generated at NAS Alameda were discharged directly to the storm drains, which discharged directly to the lagoon and estuary. Because the industrial waste collection system was not integrated, 10 separate discharge outfall locations were employed. In addition, due to cross connections, direct dumping, or occasional spills, the storm sewer system also received industrial wastewaters, discharging them to the bay at another 20 outfall points.

The present locations of the NAS Alameda industrial wastewater collection system and storm water collection system and discharge points are shown on Figures 6-19 and 6-20, respectively. Table 6-17 presents the flow rates, sources, and locations for the raw wastewater discharge outfalls employed at NAS Alameda prior to 1972. The table indicates that the bulk of industrial wastewaters was discharged to the seaplane lagoon. The three estuary discharges were limited to aircraft cleaning wastes, wash waters, paint spray booth overflow, and swimming pool overflow. Three additional discharges are located near the piers; these discharged cleaning, stripping, plating, defueling, and anodizing wastes into the bay.

Although no comprehensive sampling effort was undertaken to characterize the individual wastewater discharges to the bay, pretreatment studies were conducted on composite samples for the design of the new treatment system and the East Bay Municipal Utilities District (EBMUD) discharge. Table 6-18 presents the results of composite sample analyses for four dates between 1966 and 1969. The data in the table, particularly for color, indicate the high variability in the

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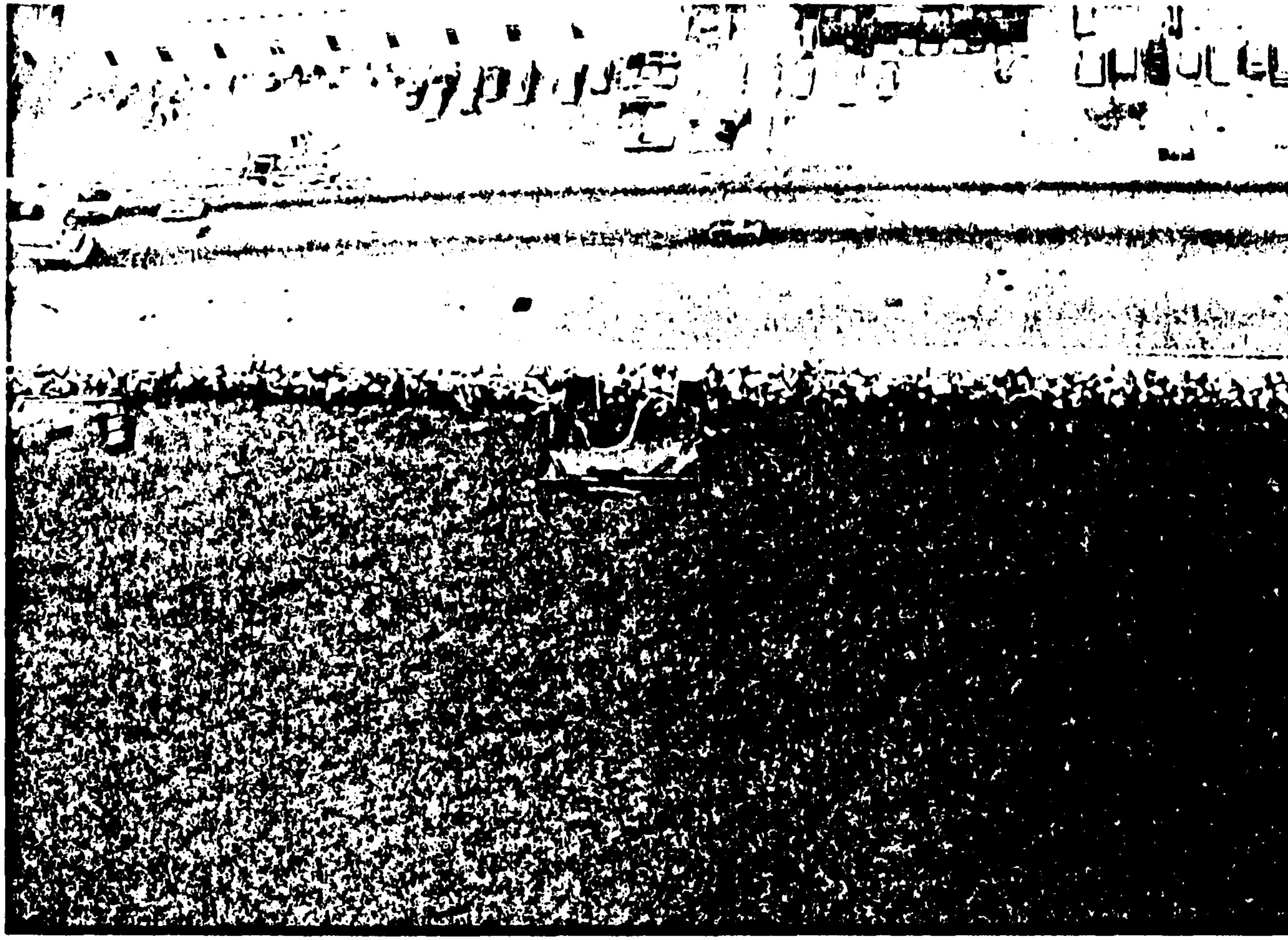

Figure 6–18 AERIAL VIEW OF SEAPLANE LAGOON (SITE 3), EASTERN EDGE, OUTFALLS.

The outfalls are now contained so that spills can be controlled and skimmed off. Untill the mid-1970s, waste from NARF and NAS operations flowed into the lagoon. The base fishing pier is located approximately 200 yards to the right (June 1982).

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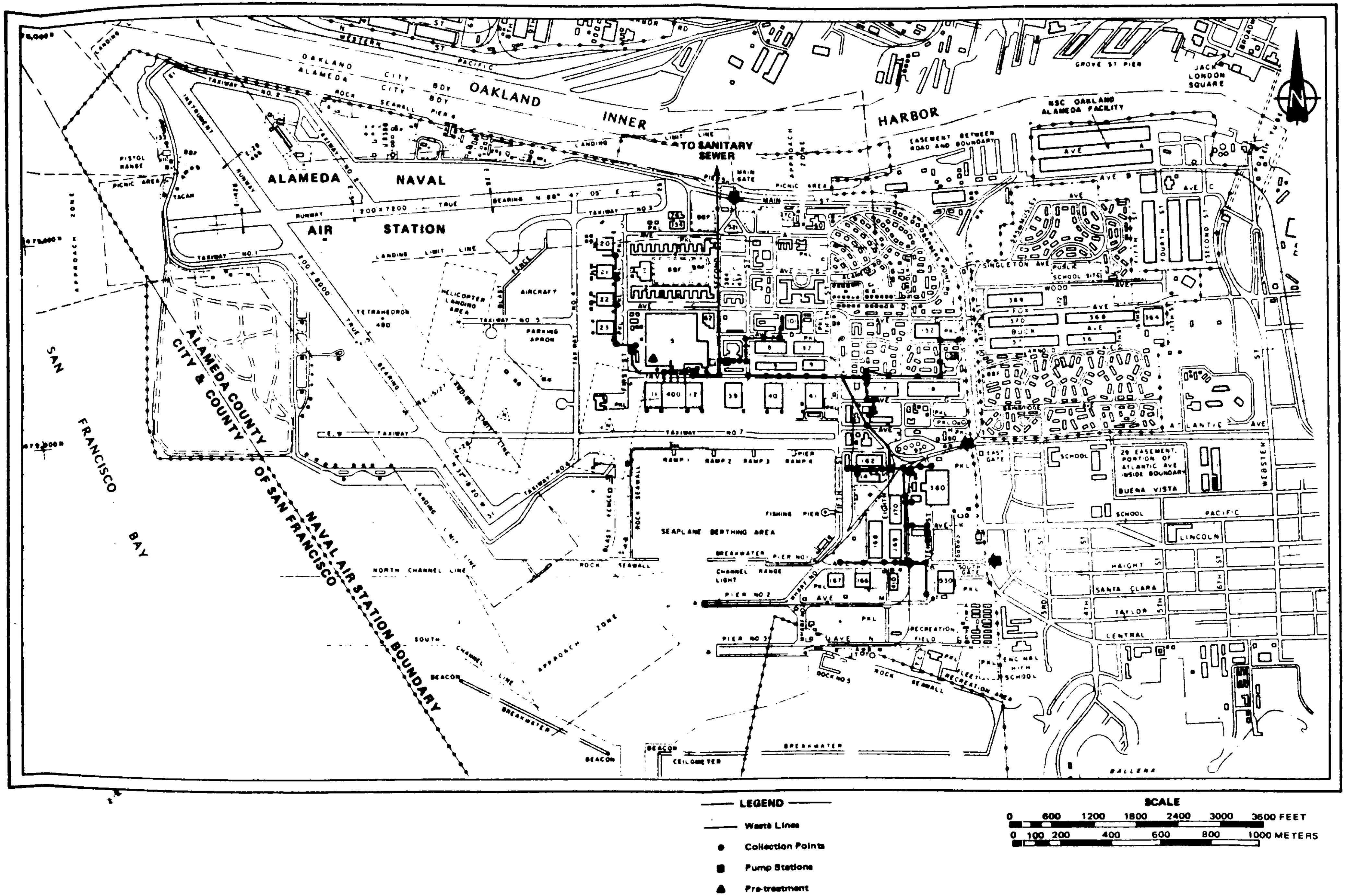

Figure 6–19 INDUSTRIAL WASTEWATER COLLECTION SYSTEM, NAS ALAMEDA

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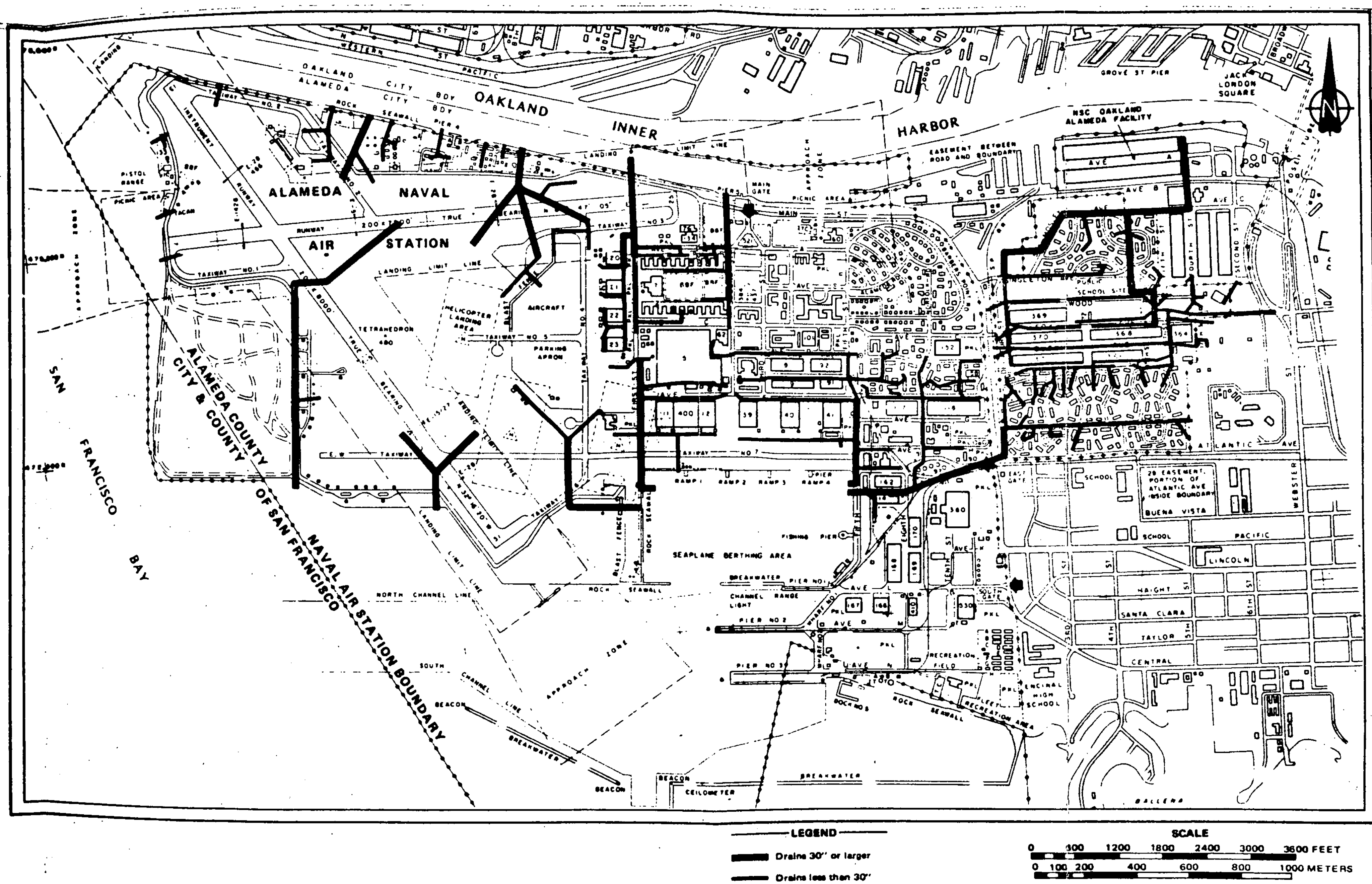

NOTE: Prepared in accordance with NAS Alameda Master Plan dated 23 September 1981.

Figure 6–20 STORM WATER COLLECTION AND DISCHARGE SYSTEM, NAS ALAMEDA

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Table 6-17

NAS ALAMEDA WASTEWATER DISCHARGES PRIOR TO 1975

Outfall No.	Estimated Flow Rate* (gpd)	Receiving Water	Source(s)
1	17,400	Estuary	Aircraft cleaning, paint spray booth
2	7,300	Estuary	Paint spray booth, swimming pool
3	7,200	Piers	Steam cleaning, swimming pool, spray painting, one restroom
4	60,000	Seaplane lagoon	Electroplating, heat treatment, cleaning, stripping, photo lab
5	1,800	Seaplane lagoon	Overhaul parts, plastics, photo lab
6	42,900	Seaplane lagoon	Cleaning, paint booth, boiler water, service aircraft, conditioning equipment backwash
7	29,150	Seaplane lagoon	Paint booths, equipment washing, cleaning and overhaul, cooking tower bleed-off
8	104,900	East of piers	Cleaning and stripping, painting, anodizing, electroplating
9*	450	East of piers	Aircraft defueling
10*	450	Estuary	Garbage equipment wash area

*Intermittent flows

Source: Navy, Department of, 1972, Environmental Protection Award Evaluation Report Alameda NAS, Alameda, California.

Table 6-18

COMPOSITE RAW WASTEWATER CHARACTERISTICS,
1966 to 1969, NAS ALAMEDA

Parameter	Sample Collection Date			
	3/66	8/66	5/69	6/69
Total solids	2,138	4,196	2,775	1,994
Suspended solids	127	295	67	92
Dissolved solids	--	--	2,707	--
Grease	2,065	378	37.9	376
BOD	348	297	299	677
COD	2,060	215	568	--
pH (units)	8.4	7.4	6.74	7.55
Color	Black	Turbid	Yellow	--
Alkalinity	154	112	129	86
Chlorides	794	1,091	1,150	--
Phosphates	10.9	3.8	7.65	3.91
Gross heavy metals	1.98	9.3	2.9	2.23
Lead	6	1.48	0	0.3
Nickel	0.3	--	0.15	--
Phenol	62.7	978	0.98	116.2
Cadmium	0.22	0.29	--	--

*All quantities expressed in mg/L, except as noted.

Source: Kurgmen Engineers, August 10, 1970, Alameda NAS Waste Flow Characteristics.

wastewater discharges during that period. For raw industrial wastewater, levels of heavy metals in the composite samples are unusually low. Notably omitted are analyses for cyanide and specific solvents (except as COD). It is likely that dilution from the large quantities of wash water from aircraft washing, storm water runoff, groundwater infiltration, or tidal back-up, may have diluted some portions of the sewer system.

Prior to 1956, NAS Alameda operated its own sanitary wastewater facility near Building 27. At its peak operation, the sanitary treatment facility provided secondary treatment of 660,000 gallons per day of raw sewage, discharging its treated effluent into the estuary. In 1956, NAS Alameda discontinued its own treatment of sanitary sewage and connected its sewer system to the EBMUD system.

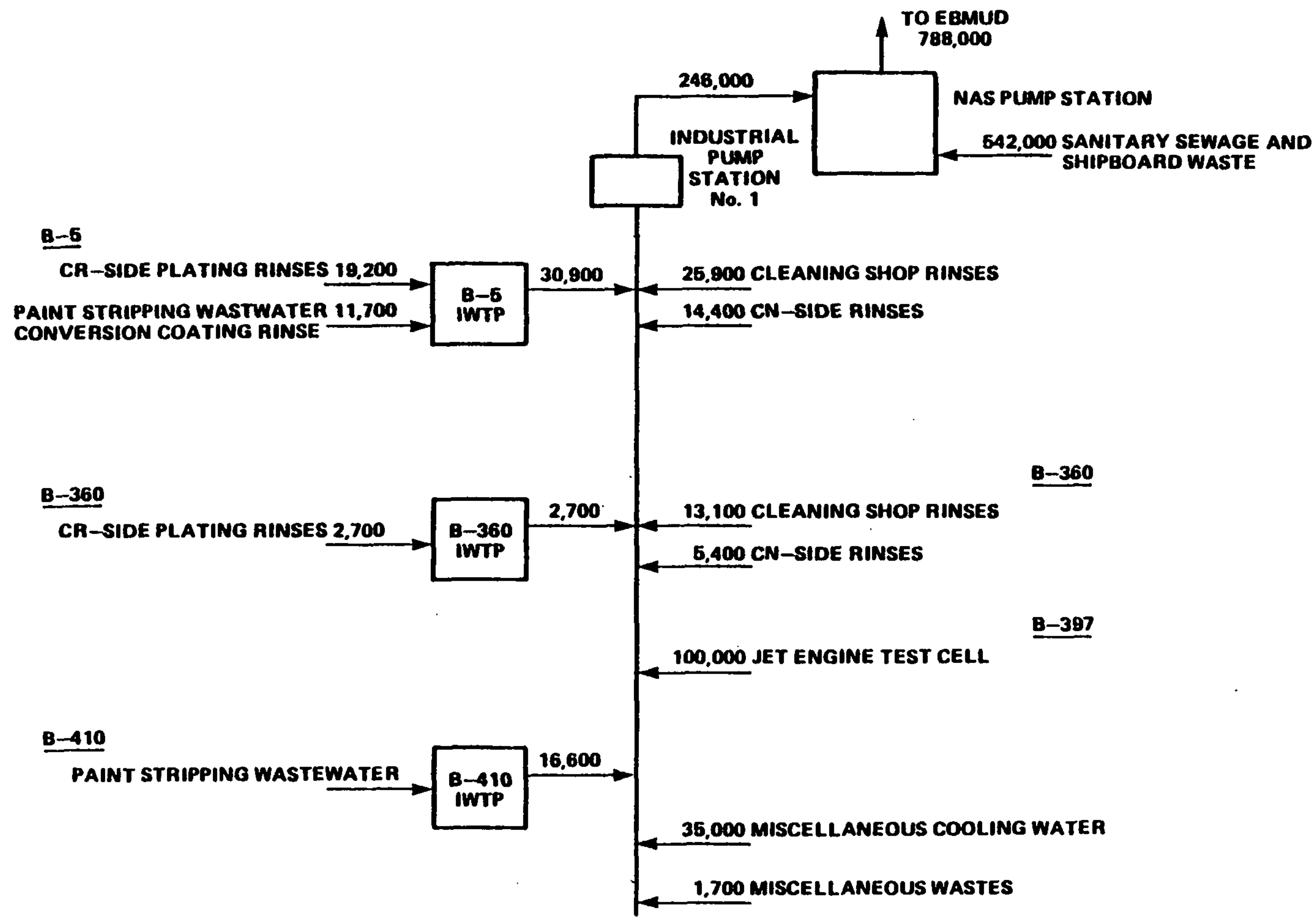
Between 1972 and 1975, the industrial waste collection system was rerouted to discharge to the EBMUD wastewater system. To meet EBMUD influent standards, three industrial pretreatment facilities were constructed at Buildings 5, 360, and 410.

The B-5 industrial waste pretreatment facility is designed to treat chromium-bearing rinse water and paint stripping waste. After the stripping waste is screened and the oil separated, these wastewaters join the chromium wastes for treatment by chromium reduction, coagulation, floculation, and clarification prior to discharge to the industrial waste collection system. The B-5 plant handles approximately 30,900 gallons per day.

The B-360 treatment plant treats chromium plating rinses with chromium reduction, coagulation, and clarification prior to discharge to the collection system. Typical flow rates through the B-360 plant are approximately 2,700 gallons per day.

Finally, the B-410 industrial waste treatment facility treats only paint stripping wastewaters, beginning with screening and oil separation. The treatment scheme is chromium reduction, coagulation, floculation, and clarification. The paint solids screened from both the B-410 and the B-5 treatment facilities are collected, containerized, and disposed of off base by contractors.

Figure 6-21 presents the sources of industrial wastewater flows to NAS Alameda industrial waste treatment facilities and waste collection system. Presently, flow rates in the system range from 200,000 to 350,000 gallons per day.



SOURCE: Post, Buckley, Schuh and Jernigan, Inc., 1981, NARF Industrial Waste Survey, Alameda, California.

Figure 6–21 SOURCES AND QUANTITIES OF SEWERABLE WASTE, NAS ALAMEDA (Gallons per day)

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APPENDIX A. TOXICOLOGICAL AND RISK ASSESSMENT, NAS ALAMEDA

A.1 DEFINITIONS OF RISK AND ECOLOGICAL ASSESSMENTS FOR HAZARDOUS CHEMICALS. A toxicant is a chemical agent that can produce an adverse effect in a biological system. Such an adverse effect may be an alteration of normal function or destruction of life. This definition is broad since all chemicals are toxic at some dose, i.e., all chemicals are capable of altering some function or producing death in some biological organism. While this statement may seem obvious, it serves to emphasize the basis of risk assessment, i.e., those circumstances and conditions under which an adverse effect can be produced.

Risk is defined as the probability that a substance will produce harm under specified conditions; i.e., it is a practical consideration to determine whether or not some harm will be elicited from a specific chemical exposure. Safety is the reciprocal of risk, or the probability that a substance will not produce harm under the specified conditions. Thus, when determining the risk or safety of a chemical, the critical factor is not necessarily the intrinsic toxicity of the chemical *per se*, but the likelihood that the level of exposure to the chemical *is* sufficient to express its intrinsic toxicity.

In general terms, then, the risk is approximated by the equation:

$$R = T \times E$$

where "R" is risk, "T" is toxicity, and "E" is exposure. More accurately, the equation for risk is equal to the toxicity as a function (f) of the exposure, or:

$$R = Tf(E)$$

This better defines the extrapolation, since under certain conditions the risk is not always linear over the entire dose-response curve; and since, depending on how one defines function (f), threshold or non-threshold dose-response curves may be fitted to this equation. However, regardless of how one chooses to express the risks to chemical exposure, it is clear that: (a) the actual risk is dependent upon both the toxicity (i.e., hazard) and the exposure (i.e., amount of chemical) and (b) to change either alters the risk.

Therefore, one may approximate an assessment of the risk or ecological impact of a waste site by estimating the inherent toxicities of the mixture based on the toxicities of the constituents, and then determine whether or not the site allows for unnecessary or unwarranted exposure to the environment.

A.2 ENVIRONMENTAL HAZARDS. At least 50 different chemicals or chemical wastes with the potential to cause adverse ecological or health impacts have been disposed of in either the landfills or the seaplane lagoon and the estuary. Any site could contain from one up to 15 different carcinogenic chemical wastes (see Table A-1). Similarly, there are over 10 different chlorinated compounds capable of inducing

Table A-1

CHEMICALS WITH CARCINOGENIC ACTIVITY

Asbestos
Benzene
Beryllium
Cadmium
Chlordane
Chloroform
Chromium
Lead
Lindane
Mercury*
Nickel
PAHs
PCBs
Tetrachloroethylene
Trichloroethane*
Trichloroethylene

*May have carcinogenic activity

liver/kidney damage, as well as many organics and several metals capable of causing injury to these organs. The number of toxic metal wastes further complicates all exposures because, in general, as broad, cytotoxic poisons, they should have some increased effect on the toxicities of the other chemicals present.

In short, the chemical wastes listed on the following pages are chemicals whose acute toxicities have the potential to adversely affect all human functions if excessive exposure occurs. Many of these chemicals produce teratogenic, mutagenic, and carcinogenic responses in animal test systems. Moreover, the magnitude of the toxic chemicals present and the large number of these chemicals which produce similar toxicities (e.g., birth defects, cancer, liver damage, central nervous system depression) is such that additive and even synergistic increases in toxicity may be expected and can be predicted for many exposure situations. For example, nickel is a metal carcinogen known to synergistically potentiate the lung cancer produced by asbestos, PAHs, and viral cancers. Another example is cyanide and ammonia; low levels of either potentiates the toxicity in fish of the other toxicant. Thus, the probability of increased toxicity for the mixed constituents at waste sites validates the need to lower those levels considered to be acceptable exposures for the chemicals individually.

A.3 CHEMICAL FATE AND SITE EXPOSURES. As can be seen in Table A-2, most of the chemicals of concern are inherently toxic and are also environmentally persistent. The heavy metals, as elements, can never be metabolized or biotransformed by organisms into a less toxic state. In fact, certain organisms methylate some of the metals, like mercury, to a much more hazardous and environmentally detrimental form.

The chlorinated chemicals also are quite persistent; lindane and chlordane have half-lives within the environment of several years and PCBs have environmental half-lives on the order of five to 10 years. Under ideal conditions, the half-lives for the chemicals of concern are very long. Site conditions, chemical concentrations, and the toxicity of the mixture are such that, in many instances, microbial degradation or photooxidation may be decreased or prevented; thus the half-lives of the chemicals present may be even longer.

In addition to the persistency of the chemicals present, some of the disposal methods employed allow for high transport within the environment, increasing the impacts of these chemicals. Both the lagoon and the landfills are in direct contact with the bay, and chemicals in the wastes disposed of there have direct access to the aquatic life in the bay via leachate and sediments.

The following sections discuss the various groups of hazardous materials.

A.4 METALS. An important toxicological feature of all metals is their ability to bind electron donating moieties (ligands) of cellular macromolecules. Biologically, the most important electron donors are oxygen, nitrogen, and sulfur. Thus, the number of ligands is very large in proteins because they contain many different electron

Table A-2

ENVIRONMENTALLY PERSISTENT CHEMICALS

Metals	Inorganics
Antimony trioxide	Asbestos
Beryllium	Fluoride (cadium and sodium salts)
Cadmium	
Chromium (chromates)	**Organics**
Copper	Many components of kerosene, diesel fuel, and gasoline
Manganese	Polyaromatic hydrocarbons (PAHs)
Mercury	Tear gas agents (CS and CSC)
Nickel	
Silver	
Chlorinated Organics	
Chlordane	
Chloroform	
2,4-D	
Dichlorobenzene	
Fluorinated hydrocarbons	
Lindane	
Methylene chloride	
Polychlorinated biphenyls (PCBs)	
Tear gas	
Trichloroethane (methyl chloroform)	
Tetrachloroethylene	
Trichloroethylene	

donating groups (i.e., -OH, -COOH, $-PO_3H_2$, -SH, $-NH_2$, imidazole) and because most proteins contain so many of these metal binding groups. Thus, metals are basic, and in a sense, nonspecific cellular poisons. Poisonous metals are toxic either by competing with the metal naturally present in the enzyme; by altering the charge on structures of the enzyme, thereby inactivating or even precipitating the protein; or by binding to and removing important functional groups (e.g., sulfhydryl groups).

Antimony. Animal studies indicate that inhalatory exposure to antimony trioxide leads to pneumonitis and fibrosis of the lungs as well as degenerative changes in the heart. Other routes of exposure have led to injury of the liver and kidneys. From human exposure studies, industrial inhalation has resulted in reports of irritation of the respiratory tract, fatal pulmonary edema, rhinitis, pneumonitis, nosebleeds, pneumoconiosis, emphysema, and obstructive lung disease. Other systemic effects have been reported. In one, a high rate of mortality and chronic heart disease was seen. Clinical application of antimony has resulted in sudden death as well as liver injury. Moreover, electrocardiographic changes were reported.

Beryllium. Beryllium is used in alloys for electrical equipment and is present in some fluorophors used in cathode-ray tubes and fluorescent lights. (Most manufacturers, however, have discontinued the use of these fluorophors in fluorescent lamps.)

Beryllium appears to inhibit certain magnesium-activated enzymes. The relation between this effect and the pathological changes induced by beryllium is not well understood. Soluble beryllium salts are directly irritating to the skin and mucous membranes, and induce acute pneumonitis with pulmonary edema. At least part of the changes present in acute pneumonitis and chronic pulmonary inflammation develop as a result of hypersensitivity to the beryllium in the tissues. Upon pathological examination, fibrous tissue growth is found at the site of beryllium localization.

Following traumatic skin contact, cuts from beryllium-contaminated objects form deep ulcerations which heal slowly. Acute dermatitis from contact with dust simulates first- and second-degree burns. Following eye contact, dust contamination causes acute conjunctivitis with corneal damage and diffuse irritation. Following inhalation, chronic pulmonary berylliosis may develop, marked by weight loss and difficult breathing beginning three months to 11 years after first exposure. In chronic pulmonary berylliosis, X-ray examination reveals a "snowstorm" appearance of the lungs. The disease may pursue a steady downhill course, or may be marked by exacerbations and remissions. Right heart failure may occur as a result of increased pulmonary resistance. Fever is variable. Following chronic skin contact, dermatitis and rash appear in a large percentage of exposed workers. In such persons, patch tests with dilute beryllium solutions show positive reactions.

Beryllium is carcinogenic in three experimental animal species. The epidemiological evidence that occupational exposure may increase cancer is limited. Thus, beryllium is only considered a suspect human carcinogen at present.

Cadmium. Regardless of the route of entry, cadmium is found principally in the liver and kidneys. Even though animal studies seem to indicate that cadmium is an essential trace element, its principal physiological effect of concern is still its toxicity. Excessive cadmium exposure is of particular concern because cadmium has a long half-life of elimination in humans and, therefore, readily bioaccumulates. With a half-life estimated at 20 to 40 years, each dose, for all practical purposes, should be considered cumulative with all preceding exposures. Blood levels of cadmium are usually less than one microgram per 100 milliliters, but smokers may have levels 50% higher. Excretion of cadmium is approximately one to two micrograms per day; persons exposed to abnormally high levels of cadmium may excrete much higher levels.

When administered orally, cadmium induces vomiting at concentrations of about 400 parts per million (23 milligrams per kilogram) in food, or a total dose of about 15 milligrams. The estimated lethal dose of cadmium for man is approximately 350 milligrams when ingested and about two to 20 milligrams when inhaled. Chronic inhalation exposure leads to lung and kidney damage, generally emphysema, while chronic oral ingestion causes kidney damage only. In addition, it is hypothesized that higher than normal cadmium exposure may be a factor in hypertension (high blood pressure). Other physiological dysfunctions that may be associated with overexposure to cadmium are abnormal liver function, anemia, bone marrow changes, and nonspecific nervous system symptoms.

A wide variety of substances can modify the toxicological properties of cadmium. Those chemicals affecting absorption (i.e., zinc, copper, iron, and vitamins C and D) all decrease cadmium toxicity. Selenium also decreases the toxicity of cadmium.

Besides the toxic effects most often seen in man (e.g., lung and kidney disease), animal studies reveal the potential for other serious and insidious effects. Low doses to rodents have caused damage to the ovaries and testicles. Cadmium also damages the placenta, and teratogenic effects have been observed. (Note that none of the above effects have been verified in man.) In vitro tests reveal that cadmium can cause chromosomal aberrations and decrease the fidelity of DNA synthesis. Numerous studies using oral or inhalation exposures have failed to demonstrate an increased cancer incidence in animals. However, a possible relationship between occupational exposure to cadmium oxide and prostate cancer in man has been proposed. Cadmium is considered to be a "suspect carcinogen."

Chromium (Chromates). The fatal dose of soluble chromate such as potassium chromate, potassium bichromate, or chromic acid is approximately five grams. The threshold limit value (TLV) in air for chromium (determined as chromic oxide) is 0.1 milligrams per cubic meter. Up to 20% of chromium workers develop dermatitis.

Chromium and chromates are irritating and destructive to all cells of the body. In fatalities from acute poisoning, kidney damage is found. The principal manifestation of chromium poisoning is irritation or corrosion. Following ingestion, dizziness, intense thirst, abdominal pain, vomiting, shock, and kidney damage may occur. Death results from uremia. Repeated skin contact leads to an incapacitating dermatitis, with edema and ulceration which heal slowly. Breathing chromium fumes over long periods causes painless ulceration, bleeding, and perforation of the nasal septum, accompanied by a foul nasal discharge. Conjunctivitis, lacrimation, and acute hepatitis with jaundice have also been observed. The incidence of lung cancer is increased up to 15 times higher than normal in persons exposed to dusty chromite, chromic oxide, and chromium ores.

There is little or no pertinent data concerning the teratogenic activity of chromium. However, mutagenicity tests have been positive. Hexavalent chromium is carcinogenic in rats, while tests with the trivalent form are inadequate. Chromium is considered a human carcinogen.

Copper. Copper is widely distributed in nature. While copper is an essential element in most organisms, the range between deficiency and toxicity is low. Those organisms that do not have an effective membrane barrier to control the absorption of copper are particularly sensitive. For example, algae, fish, and some invertebrates are sensitive to copper because they invariably absorb higher amounts of the metal. For this reason, water purification processing has included the use of copper to remove algae.

Copper is highly absorbed by the oral route, with more than 50% reaching the bloodstream. Industrial exposure to copper dust or fumes may cause irritation in the upper respiratory tract. Silicosis-like histologic changes have also been reported. Investigations have not revealed that this leads to chronic lung damage. The systemic effects are hemolytic anemia, kidney damage, and liver damage.

Lead. With chronic exposure, 90% of the lead is localized within the bone. Excretion of lead is slow and is largely via the kidneys. Lead affects several organ systems, but the most sensitive appears to be the blood. Lead impairs the formation of red blood cells largely by inhibiting hemsynthetase and delta-ALA-dehydratase; it also inhibits Corproporphyrinogen III oxidose and its decarboxylase. Heme is also utilized in cellular cytochromes and lead apparently decreases the cellular contents of these important molecules.

One of the manifestations of chronic lead poisoning is anemia, combined in some cases with "stippled" red blood cells. Lead encephalopathy (damage to the brain) is another major feature of lead poisoning. Symptoms include headache, giddiness, insomnia, amblyopia, deafness, depression, stupor, tremor, mania, delerium, convulsions, paralysis, ataxia, and coma. A neuromuscular syndrome called "lead palsy" may also be evident. This syndrome is characterized by weakness or paralysis of the extensor muscles and is manifested by the so-called "wrist drop" and "foot drop" features. Lead has also been shown to cause kidney damage.

Daily ingestion of more than one milligram will result in lead accumulation and chronic poisoning. The acute lethal dose to man is about 20 to 50 grams.

Lead is embryotoxic and teratogenic in animals, but apparently in man the embryo-fetotoxicity exceeds the teratogenic sensitivity. Some chromosomal aberrations have been seen, but lead is negative in many bacterial mutagenicity tests. There is evidence that lead is an animal carcinogen in rodent species, inducing tumors in the kidney. However, there is insufficient data to evaluate its human carcinogenic potential.

Mercury. Mercury is a liquid. Air saturated with mercury at 20°C contains about 15 milligrams per cubic meter. At 40°C, saturated air contains 68 milligrams per cubic meter. The fatal dose of mercuric salts such as mercuric chloride is one gram. Ingested metallic mercury is not as toxic, since it is not absorbed as well.

Mercury depresses cellular enzymatic mechanisms by combining with sulfhydral (-SH) groups; for this reason, soluble mercuric salts are toxic to all cells. The high concentration attained during kidney excretion can lead to specific kidney damage. In fatalities from mercury poisoning, the pathologic findings are acute kidney damage. The mucosa of the gastrointestinal tract shows inflammation, congestion, coagulation, and corrosion.

Alkyl mercury compounds are concentrated in the brain, resulting in ataxia, tremors, and convulsions. Damage tends to be permanent. Inhalation of mercury vapor, dusts, or organic vapors, or skin absorption of mercury or mercury compounds over a long period of time causes mercurialism. Findings are extremely variable and include tremors, salivation, stomach pain, loosening of the teeth, blue line on the gums, pain and numbness in the extremities, kidney damage, diarrhea, anxiety, headache, weight loss, loss of appetite, mental depression, hallucinations, and evidences of mental deterioration. The lowest concentrations of methyl mercury in blood associated with identifiable symptoms is 0.2 milligrams per liter.

Environmental contamination from industrial discharge of organic mercury compounds has resulted in organic mercurial poisoning from eating fish from the discharge area.

Mercury is a known teratogen and has demonstrated mutagenic activity in several tests; therefore, carcinogenic activity may be suspected.

Nickel. Inorganic nickel in animals has caused dysfunction of the thyroid, liver, and kidneys. In man, kidney damage has been observed after accidental industrial exposure to nickel carbonyl. Inhalation of nickel carbonyl has also resulted in lung and brain damage. Nickel is an allergen and, in many cases of contact, dermatitis and sensitization have been reported; females are more sensitive than males. Ingested nickel may also lead to dermatitis in sensitive individuals.

Nickel appears to have a synergistic effect on the carcinogenicity of polycylic aromatic hydrocarbons (PAHs), asbestos, and possibly some viral cancers. High doses of nickel affect normal spermatogenesis and fertility. Nickel is fetotoxic, but apparently not teratogenic. Inhalation of nickel subsulphide or nickel carbonyl has induced pulmonary carcinomas in rodents. Intravenous injections of nickel carbonyl leads to carcinomas of the liver and kidney as well. Epidemiological studies conclusively demonstrate an excess cancer risk of the lung and nose for workers in nickel refineries.

A.5 HALOGENATED ALKANES. The halogenated alkanes are widely used in industry because they are excellent solvents of low flammability. In general terms, these chemicals have several toxicologic properties. They cause liver and kidney damage and act as a central nervous system depressant. Halogenated alkane exposure may also sensitize the heart to adrenalin such that increased work or stress may lead to cardiac arrhythmia and cardiac arrest. In general terms, increasing the halogenation of the methyl or ethyl molecule increases the anesthetic properties, liver and renal injury, and chronic toxicity of the compounds. Unsaturated double bonds among the ethane congeners likewise increase these toxic effects. Brominated compounds tend to be more toxic and stronger skin irritants, while fluorinated compounds are less irritating and less toxic than the more commonly used chlorinated compounds.

The chlorinated alkanes in question always represent an environmental problem because they are water soluble and heavier than water; thus they collect fairly easily in water systems and elute through soils much faster than the larger chlorinated hydrocarbons, such as DDT or PCBs. The chlorinated ethanes form azeotropes with water, a characteristic which could influence and increase their persistence. The chlorinated alkanes are metabolized slowly by aquatic organisms; thus they are relatively persistent pollutants in an aquatic environment. There is concern for these chemicals as environmental waste pollutants because they have been shown to increase the incidence of liver tumors during cancer assay in rodents.

Chloroform. Chloroform is far more toxic than methylene chloride. While chloroform does not significantly bioconcentrate in aquatic species or biomagnify along the food chain into higher trophic levels, it is a relatively stable and persistent chemical within the environment. Chronic exposure can lead to liver and kidney damage in animals. The toxic effects attributable to chloroform in humans include local irritation of the skin, central nervous system depression, degeneration of the nervous system, gastrointestinal irritation, liver and kidney injury, and cardiac sensitization to adrenalin. The mean lethal dose is approximately 44 grams. Chloroform has not yet been shown to be a mutagen, but it is considered a suspect human carcinogen based on an increased tumorigenesis in animal studies.

Fluorinated Hydrocarbons. The fluorinated alkanes are more volatile and more environmentally persistent than the respective chlorinated analogs. The toxicities of the fluorinated analogs are qualitatively similar but quantitatively dissimilar. Acute cardio-nervous system depression is probably higher; cardiac sensitization is possibly greater, while liver and kidney injury is probably less.

Methylene Chloride. Methylene chloride is a volatile solvent with wide general applications as an aerosol propellant, paint stripper, and degreasing solvent. It is possibly the least toxic of the chlorinated methanes, causing a "drunken" state of inebriation only at high vapor concentrations. In addition, it is only mildly irritating to the skin. Eye contact, though painful, is not likely to cause serious injury. Animal studies indicate that methylene chloride is not likely to cause kidney or liver damage, even after chronic exposures.

1,1,1-Trichloroethane (Methyl Chloroform). The toxic effects induced in animals by trichloroethane are anesthesia, sensitization of the heart, and damage to the liver and kidneys. However, generally high concentrations of the solvent are needed to induce these effects. In humans, inebriation and irritation are the principally observed effects. There is no indication of chronic disabilities with chronic human exposure. Trichloroethane was negative in teratogenic studies, but is mutagenic in the Ames test. Its carcinogenic potential is in question and is being retested.

Trichloroethylene (TCE) and Tetrachloroethylene (Perchloroethylene or PERC). The acute and chronic systemic toxicities of these compounds are similar to those mentioned above. Neither TCE nor PERC were teratogenic when tested. Both appear to have some mutagenic activity in the Ames assay and both have carcinogenic potential in mice.

A.6 CHLORINATED ORGANICS. These highly stable compounds are environmentally persistent, tend to bioconcentrate and bioccumulate, and are chronically toxic. They generally are central nervous system poisons at lethal doses, but chronic exposure usually leads to liver damage. Several of these compounds are carcinogenic in animal tests. Thus, their persistence, bioaccumulative potential, and chronic toxicity (carcinogenic potential) make these chemicals among the worst as environmental pollutants.

Chlordane. Chlordane has caused death in man at doses as low as seven grams and is more dangerous than DDT. Chlordane has caused the following toxic effects in animals: convulsions, stomach ulcers, damage to the liver and kidneys, decreased fertility, and a lower offspring viability. It has mutagenic activity in cell cultures and yeast tests, but is negative in the Ames and dominant lethal test. Chlordane is carcinogenic in mice.

2,4-D. The compound 2,4-dichlorophenoxyacetic acid (2,4-D) is one of the most familiar chemicals used as a herbicide. It exerts its herbicidal action by acting as a growth hormone in plants. It is only moderately toxic in animal studies and its environmental residue is fairly well tolerated for short periods. The estimated lethal oral dose in man is three to four grams. The acute toxicity causing death in animals is believed to be ventricular fibrillation. Non-lethal doses cause profound muscular weakness and paralysis. Some liver and kidney injury is seen in animals exposed to high doses. This compound has caused contact dermatitis in man.

Lindane. Lindane is the gamma isomer of benzene hexachloride (hexachlorocyclohexane). It can induce convulsions in acute poisonings and liver injury in chronic poisonings. Lindane has disrupted the estrus cycle and, therefore, fertility in rodent tests and the viability of the subsequent offspring. No teratogenic effects were seen. Lindane was not mutagenic in bacterial, yeast, or fruit fly tests, but has been reported to cause chromosomal damage. Lindane is carcinogenic in mice.

Polychlorinated Biphenyls (PCBs). PCBs are highly persistent and bioaccumulative as pollutants. Their acute toxicity is low but their chronic toxicities are very similar to the chlorinated pesticides. They are liver toxins with long-term exposure, and at high doses have caused suppression of the immune system, reproductive dysfunction, birth defects, and liver tumors. PCBs are considered a suspect carcinogen.

A.7 ORGANIC COMPOUNDS AND SOLVENTS. In general, the "organic compounds" are water insoluble, nonpolar molecules. While various functional groups, such as amines, hydroxyls, halogens, carboxyls, etc., can be added to alter these two basic chemical properties, these properties result in two pharmacologic effects that provide the basis of their acute toxicities. Organic chemicals in general act as anesthetics (i.e., they depress the activity of the central nervous system) and are irritants to the eyes, respiratory system, and skin because they are good solvents for lipids (fat). Repeated and prolonged skin contact will dry and defat the skin, resulting in irritation, dermatitis, cell damage, and necrosis. Eye contact may cause irritation, tearing, and possibly permanent damage. Direct contact of liquid hydrocarbons with lung tissue (aspiration) can result in chemical pneumonitis, pulmonary edema, and hemorrhage. Both the anesthetic and irritant properties of organic alkane compounds are increased by halogenation and unsaturated double bonds. Most functional groups (e.g., amines, carboxylic acids, aldehydes, etc.) increase the ability of organic chemicals to cause tissue damage (corrosivity).

The chronic toxicity of organic chemicals varies widely with structure and the functional non-carbon groups that are attached. These chronic toxicities include kidney, liver, heart, and lung damage; methomoglobin formation in red blood cells and depression of blood cell formation; degenerative changes in the nervous system; sensitization and allergic reactions; and mutagenic, teratogenic, and carcinogenic effects.

Petroleum Distillates

The petroleum products discussed below represent different distillation fractions from petroleum refining and, as such, are actually complex mixtures of many different organic compounds. Gasoline alone contains over 400 different chemical constituents, some not yet positively identified by chemical structure. Kerosene and diesel fuel contain even more constituents and even less of these have been positively identified. Stoddard solvent is a mixture of aliphatic hydrocarbons, naphthenes, and benzene derivatives used extensively in degreasing operations and as a paint thinner.

The major components of the petroleum products discussed in this section are branched and straight chain alkanes and alkenes, cycloalkanes, and a variety of aromatics. To accurately identify the potential toxicities caused by such mixtures is an enormous and probably impossible task. The summaries below are provided to enable an appreciation of the potential problems and possible environmental impacts associated with such compounds.

Alkylbenzenes (Toluene, Ethylbenzene, Xylene, Cumene, etc.). These chemicals are liquids with relatively low boiling points. They are primarily used as solvents and as intermediates in the synthesis of other compounds. Because of their high affinity for lipids, these compounds are rapidly taken up by the central nervous system. With acute exposure, anesthesia is usually the primary problem, but high concentrations can lead to cardiac arrhythmia and are toxic to the kidneys. Still, because of the high exposures required, these compounds are relatively nontoxic.

With chronic exposure, the harmful effects on the blood system seen with benzene do not occur. Chronic toluene exposure stimulates the metabolising capacity of the liver and may increase the toxicity of other chemicals. Psychological tests of occupationally exposed workers have shown decreased performance in sensorimotor speed, psychomotor performance, and visual accuracy tests. Excessive chronic exposure to toluene, such as "glue sniffing," results in diffuse disorders of the cerebellar and cerebral functions of the brain, including a lack of coordination and emotional instability. The other compounds are similar in chemical structure and probably act similarly, but less data have been reported for them.

These chemicals do not appear to be highly mutagenic; they are negative in the Ames and yeast tests. However, some chromosomal damage has been reported in animals. These chemicals are embryotoxic and some skeletal anomalies have been reported. However, none of these solvents has been proven to be teratogenic. Likewise, they are not considered to be carcinogenic.

Although the alkybenzenes, such as toluene, xylene, cumene, and ethylbenzene, are major toxic water-soluble components of petroleum, only limited effort has been made to quantify their effects on aquatic environments. Aquatic toxicity tests reveal lethality in fish in the several ppm-range, but their volatility somewhat limits their expected impact on aquatic life. They do bioconcentrate, but are rapidly eliminated when the exposure ceases. At hundreds to thousands of ppm, these compounds are antibacterial.

Benzene. Benzene is a colorless, volatile liquid with a rather pleasant odor. It should be distinguished from benzine, a petroleum distillate containing mixed hydrocarbons (such as pentane and hexane) in uncertain proportions. Benzene is present to some extent in most gasolines, and is a common ingredient of paint and varnish removers. Notwithstanding its insidious toxicity, benzene continues to be extensively used in the petroleum, explosive, plastics, pesticide, and other industries.

Benzene is toxic when it gains access to the body by any route. Inhalation of a high concentration of benzene may cause exhilaration followed by drowsiness, fatigue, vertigo, nausea, and headache. With higher concentrations or longer exposure times, convulsions followed by paralysis and loss of consciousness may result. High concentrations of benzene are irritating to the mucous membranes of the eyes, nose, and respiratory tract. Liquid benzene is irritating to the skin, and direct contact of liquid benzene with the lung (aspiration) will cause severe pulmonary edema and hemorrhage which may be fatal, depending on the volume aspirated. Pathological findings from benzene inhalation include acute granular tracheitis, laryngitis, and bronchitis; massive hemmorhage of the lungs; congestive gastritis; acute congestion of the kidneys; and marked cerebral edema.

In cases of chronic poisoning from inhalation, the major toxic manifestations result from the action of the poison on the bone marrow. Significant chromosomal changes have also been reported after chronic benzene exposure. The toxic effects of chronic poisoning may not become apparent for months or even years after the initial contact with the chemical. Indeed, they may appear after all exposure has ceased. Symptoms of chronic exposure include anemia, petechiae, and abnormal bleeding. The anemia may progress to complete aplasia of the bone marrow.

Death from benzene-induced myeloid leukemia has been reported.

Hexane, Heptane, and Higher Alkanes. At moderate air concentrations, these simple straight chain organics cause dizziness, giddiness, hilarity, and uncoordination which may progress to complete respiratory depression and death. At higher concentrations, central nervous system depression may progress so rapidly that selective depression within the brain leads to convulsions and death. Hexane is metabolised to a specific toxicant that produces a degenerative nerve disease.

High acute or chronic exposure to the higher carbon alkanes and alkenes is considered hazardous since severe, acute hydrocarbon intoxication may cause central nervous system sequelae. There is little doubt that in most cases of acute hydrocarbon intoxication in man, recovery is complete. However, large amounts of hydrocarbons carried by the blood to nerve or brain tissue may cause chemical irritation. This is followed by the chain of events of the inflammatory reaction that may ultimately leave scarring in a small but delicate area of the brain. This may be the focal point for cerebral dysrhythmia, resulting in convulsions or seizures months after the initial severe acute exposure.

Lubricating Oil. While considered a relatively harmless product, motor oils contain PAHs and other mutagenic and carcinogenic substances at relatively low concentrations (ppm). However, with normal use, the amount of mutagenic activity (and thus the risk of carcinogenicity) dramatically increases such that disposal poses an ill-defined environmental problem.

Naphtha. Naphtha is another mixture of organic compounds for which narcosis (depression of central nervous system); irritation of eyes, throat, and skin; liver and kidney damage; and various lung problems may develop depending on the exposure.

Naphthalene. Inhalation of naphthalene vapors causes headache, confusion, nausea, and profuse perspiration. Severe exposures may cause optic neuritis and humaturia. Cataracts have been produced experimentally in rabbits and one case reported in humans. Naphthalene is an irritant and hypersensitivity has been reported.

Polynuclear Aromatic Hydrocarbons (PAHs). Absorption of PAHs via all routes of exposure is high because of their high lipid solubility. PAHs distribute largely to the fat and fatty tissues, such as the liver. At high doses, the acute toxicity of PAH compounds results in widespread and often severe tissue damage (e.g., adrenal necrosis, damage to the lymphatic and hematopoietic tissues, thymus degeneration, injury to intestinal epithelium, and testicular degeneration). Application of PAHs containing material such as coal tar, mineral oils, or petroleum waxes is known to cause dermatitis and other skin disorders. It has also been demonstrated that the PAHs with carcinogenic activity have immunosuppressive effects on animals. Several of the PAH compounds have demonstrated highly mutagenic characteristics in the Ames assay and in mammalian cell culture systems. The most serious adverse effect of PAHs is their carcinogenicity.

Some of the polycyclic aromatic hydrocarbons are unique among hydrocarbons in possessing the property for inducing new or abnormal growth in tissue. The discovery that the repeated application of certain chemicals to the skin of mice and rabbits causes tumors is of great practical importance since many industrial chemicals come in contact with the skin of workers. The repeated topical application to the skin of experimental animals simulates the manner of contact in industry. Furthermore, the fact that coal tar, shale oils, coal pitch, certain unrefined mineral oils, and other materials are known to cause skin cancer in man magnifies the significance of the finding that a chemical produces a tumor by repeated application to the skin.

In recent times, numerous PAHs have demonstrated carcinogenic potential in skin painting experiments. PAHs have also demonstrated in animal studies the ability to induce lung tumors if inhaled and to cause cancer in various parts of the body if ingested.

Special Considerations for Petroleum and Fuel Products.

- Variation of Constituents Between Fuel Samples. The variability of constituents in fuels, such as gasoline, kerosene, and diesel fuel, has already been stated. It should be emphasized here that different blends that make up a given fuel, each with different specifications, are used for different geographical areas and for different seasons or climatic conditions. Thus, great quantitative differences exist in the constituent makeup of different samples of fuels.

Additive composition can also vary between fuels. An obvious example is the difference between leaded and unleaded fuels. Not only can leaded fuels contain tetraethyl lead or tetramethyl lead, but dichloroethane and dibromoethane as well in order to prevent the lead from fouling the engine. In unleaded fuels, methylcyclopentadienyl manganese tricharbonyl is used as an antiknock additive and is required for use in all automobiles equipped with catalytic converters. In addition, alcohols are added as a fuel conservation measure.

- Effect of Complex Mixtures on the Toxicity of Individual Constituents. It must be remembered that toxicity expressed by an individual constituent in a complex mixture can be different than the toxicity expressed by the same individual constituent alone.

  In a given sample of fuel, such as diesel fuel, there are substances present which can alter the toxicity of individual constituents of the sample and may even alter an organism's response to toxic constituents from other sources. Thus, there can be an enhancement, inhibition, or introduction of a toxic property, such as chemical carcinogenicity by individual constituents not possessing the toxic property themselves but influencing the expression of toxicity of some other initiating constituent. This is only one of many types of possible interactions between constituents in altering expression of toxicity.

  For example, in one experiment, decane, undecane, tetradecane, and hexadecane were tested for cocarcinogenic properties. The carcinogen (initiator), benzo(a)pyrene, was applied to the skin of the mice concomitantly with the N-alkanes. The decane, undecane, and tetradecane enhanced the formation of skin tumors, but the hexadecane inhibited the formation of skin tumors. In a second study, it was demonstrated that dodecane can act as a cocarcinogen with certain chemical carcinogens and as an inhibitor of chemical carcinogenesis with other carcinogens.

- Minor Constituents in Fuels Causing Major Toxicity. In some instances, the minor constituents may be responsible for major toxicity in complex mixtures. First, minor quantitative constituents of a fuel may get incorporated into an environmental system under study more readily than major quantitative constituents of the fuel upon contamination of that environmental system. Thus, a minor quantitative constituent of a fuel may become a major persistent quantitative environmental contaminant.

For example, when diesel fuel is mixed with seawater, the principal persistent water soluble compounds are aniline-alkylanilines, alkylphenols, and indole-alkylindoles. These compounds are not considered the principal major constituents of diesel fuel. However, they are the principal constituents of the water soluble fraction of diesel fuel. Most edible fish will come into contact with only the water soluble fraction of diesel fuel upon a seawater spill.

The second factor is that minor quantitative constituents may be responsible for a major quantitative toxicity in a complex mixture, such as a fuel or a crude oil. It has been well established that some of the principal mutagenic and carcinogenic constituents in crude oils are not necessarily the principal quantitative constituents. In natural crude oil, one of the principal classes of compounds responsible for mutagenicity and carcinogenicity in experimental studies are the PAHs of four rings and greater. The PAHs thought primarily responsible for the experimental mutagenicity and carcinogenicity of natural crude oil and its higher boiler fractions are thought to consist of benzanthracenes, dibenzanthracenes, substituted anthracenes, benzopyrenes, benzofluorenes, pyrene, subtituted pyrenes, and chrysenes. For the fuels mentioned above, the relative magnitude of PAH content is as follows: diesel fuel > kerosene ~ gasoline.

- <u>Chemical Transformation of Constituents Due to Environmental or Other Action Enhancing or Modifying Toxicity</u>. Once a fuel or petroleum product contaminates the environment, a number of chemical transformations can occur which can enhance or otherwise modify toxicity. If a fuel ignites, the formation of mutagenic and carcinogenic PAHs will result. PAHs are formed by incomplete combustion of organic material. Therefore, PAHs are formed with fossil fuel combustion such as occurs in power plant operations, motor vehicle operation, and home heating. PAHs are produced naturally by the decomposition of organic matter in soil. Kerosene soot possesses potent mutagenic activity and has been demonstrated to contain known carcinogens.

  Photochemically-transformed products of oils have been demonstrated to have increased toxicity over the non-transformed parent oil. Photooxidation of diesel fuel, as from sunlight striking an oil sump or sheen on water, results in production of water soluble compounds more toxic to yeast, algae, fish, and shrimp than water soluble compounds from nonirradiated diesel fuel.

- <u>Conclusions and Summary</u>. The entire toxicity spectrum of all constituents of gasoline, kerosene, and diesel fuel is enormous. The constituents of gasoline and particularly kerosene and diesel fuel have not yet been completely elucidated; thus predictive toxicities and interactions to be made are not yet complete. Synergistic and antagonistic actions of the individual constituents of gasoline, kerosene, and diesel fuel on each other's respective toxicities may be significant. The toxicities of these complex hydrocarbon mixtures may in some cases bear little relationship to a simple additive toxicity of individual constituents. The toxicity of the whole fuel or a particular fraction of the fuel may be of greater importance than the toxicities of the "major" constituents because certain fractions are more likely to enter the environment. Upon entering a particular ecosystem, the constituents of a fuel may undergo dramatic changes in chemical composition due to environmental chemical actions that can drastically alter toxicity. In fact, the environmentally-altered chemical constituents may possess toxicities not originally present in the parent fuel. Lastly, the toxicity or impact of these mixtures may be altered by proprietary fuel additives.

A.8 MISCELLANEOUS.

Acids and Acid-Like Corrosives (Hydrochloric, Nitric, Phosphoric, and Sulfuric). Acids and acid-like corrosives are used for cleaning metals and other products, as well as in a variety of chemical reactions. Corrosive acids destroy tissues by direct chemical action. The tissue protein is precipitated and coagulated in concentrated acid. The intense stimulation by acid also causes loss of vascular tone by corrosion and irritation. The principal manifestation of acid poisoning is corrosion. Besides their corrosive nature and incompatibility with certain chemicals, the disposal of these substances represents the obvious environmental problem of creating pH changes that may be lethal to the affected organisms, e.g. fish.

Ammonium Nitrate. Ammonium nitrate is an oxidizing agent capable of undergoing detonation if heated within a confined space or subjected to shock. The nitrogen oxide gases emitted from decomposition are extremely toxic and are very corrosive to the lungs.

Asbestos. "Asbestos" is a common name for a large group of hydrated silicates that, when crushed or milled, separate into flexible fibers. When deposited in the lungs, asbestos fibers produce interstitial fibrosis, bronchogenic carcinoma, and mesothelial tumors. Tumor production generally has a long lag time of about 30 years. Lung cancer is greatly increased in smokers. The mechanism of cancer is not clear, but the physical form is vital and may result from chronic irritation and injury to tissues.

Blasting Grit. The blasting grit is probably composed of primarily inert compounds such as silicates. As such, these compounds probably (without exact identification of the exact chemical composition) represent only an inhalation hazard. Silicosis is an irreversible lung disease resulting from chronic exposure to silica- and silicate-containing dusts. Therefore, proper disposal and dust control measures should be applied to any piles of spent grit to prevent dust problems.

Chloroacetophenone (Tear Gas CS and CSC). A strong irritant to eyes, chloroacetophenone may cause blisters to skin. High concentrations may cause burns and loss of eyesight. Little is known concerning its chronic toxicity. It is quite stable, but can decompose (hydrolyze) to yield hydrochloric acid.

Creosote. Creosote is largely a mixture of aromatics and phenols obtained from distillates of either wood tar or coal tar. It is used to protect wood and as a disinfectant, insecticide, fungicide, and germicide. For a discussion of its toxicity, see the discussion on phenols below.

Cresylic Acid (Hydroxytoluene or Cresol) and Phenols. Phenols and closely related methyl or alkyl phenols are relatively toxic chemicals. Phenols presumably exert their germicidal action by denaturing protein. The protein-phenol complex is a loose one. Therefore, phenol is diffusible and penetrates into tissues. These compounds have a markedly toxic action, and because of their penetrability, affect even the unabraded skin.

Phenol stimulates and then depresses the central nervous system. In man, brief stimulation is observed, and the prominent effects are those of central nervous system depression. The circulation is also markedly depressed by phenol. The blood pressure falls, partly as a result of central vasomotor depression, but mainly due to a direct toxic action of phenol on the myocardium and the smaller blood vessels.

Phenol is a powerful antipyretic. The toxicity of phenol can be put into some perspective by noting that its TLV for workroom air is less than that of cyanide.

Cyanide Salts (Copper, Potassium, Silver, Sodium). Cyanide is commonly found in rat poisons, silver and metal polishes, photographic solutions, and fumigating products. Cyanide is readily absorbed through all routes, including the skin, although alkali salts of cyanide are generally toxic only when ingested. Salts exposed to acids or acidic conditions are particularly hazardous because cyanide gas is generated. Cyanide is freely soluble in water. Its adverse environmental impact stems largely from the fact that it is a potent poison.

Dichlorobenzene. Dichlorobenzene is a moderate irritant which can cause sensitization or allergic reactions and is absorbed via the skin. It leads to liver damage systemically. Toxic gases, such as hydrogen chloride, are emitted when burned.

Dimethylaniline (Xylidine). Amines are highly corrosive and tissue damaging agents. They are significantly absorbed through the intact skin, and their dermal toxicity is similar to their oral toxicity. Dimethylaniline, like many amine compounds, causes methemoglobin formation in red blood cells. Methemoglobin is an oxidized state hemoglobin that renders it incapable of carrying oxygen. Dimethyl-aniline also depresses the central nervous system.

Ethylene Glycol. Ethylene glycol appears to be considerably more toxic to humans than to other species. The lethal oral dose in man is about 100 milliliters. Ethylene glycol is metabolized in the body to oxalate, which precipitates in the kidneys and bladder as stones.

Fluorine and Fluorides. Both fluorine and hydrogen fluoride are gases at normal temperatures. Fluorine is used in organic synthesis. Hydrogen fluoride is used in the petroleum industry and in etching glass.

Skin or mucous membrane contact with hydrogen fluoride produces deeply penetrating skin burns. Neutral fluorides in 1 to 2% concentrations will cause inflammation and damage of mucous membranes, including brain edema, lung edema, and degeneration of liver and kidneys. The principal manifestation of fluorine and fluoride poisoning is corrosion. In chronic exposure, X-ray evidence of bone thickening and calcification of ligaments is indicative of fluorosis. In severe fluorosis, both red and white blood cell counts may be diminished.

Peroxides (Benzoyl and Methyl Ethyl Ketone). These compounds are highly flammable and explosive. They are unstable to heat and sensitive to impact and friction, and should not be mixed with organic material. Their reactive nature classifies their toxic reaction largely as irritants to mammalian species.

Potassium Permanganate. The acute and chronic toxicities of potassium permanganate have not been well studied. It is a relatively strong oxidizing agent and is thus potentially explosive when mixed with many of the above organic chemicals. Its general reactivity and oxidizing action on biological material should make it toxic and lethal to most tissues and organisms in sufficient concentrations.

Sodium Hydroxide, Alkalies, and Phosphates. Sodium hydroxide and other alkalies and phosphates are used in the manufacture of soaps and cleansers and in chemical synthesis. The alkalies combine with protein to form proteinates and with fats to form soaps, thus producing soft, deep destruction in tissue areas contacted. The solubility of these products allows further penetration, which may continue for several days. Besides their corrosive nature and incompatibility with certain chemicals, the disposal of these substances represents the obvious environmental problem of creating pH changes that may be lethal to the affected organisms, e.g. fish.

Sodium Hypochlorite. Sodium hypochlorite is the active ingredient in bleach. The solid form is unstable, and anhydrous hypochlorite is explosive and may cause ignition when it comes into contact with organic materials. It is a strong irritant and corrosive-like material, causing blistering and perforation of exposed surfaces if swallowed. Concentrated solutions should act as a sterilant and disinfectant to the exposed soil or water.

Table A-3 lists various product categories (e.g., cleaners, thinners, etc.) as well as the likely components of these products. All of the chemical constituents making up these products have been discussed, except those for soaps. The environmental and health impacts of these products can be estimated from the combined effects of their constituents.

Table A-3

CHEMICALS COMMONLY FOUND IN MOST BRANDS OF COMMERCIAL PRODUCTS

Product	Active Chemical Composition
Cleaning compounds	Ammonium, sodium, and potassium hydroxides; sodium hydrochlorite; trisodium phosphate; detergents and surfactants
Paint removers, acrylic and epoxy	Methylene chloride; toluene; benzene; acetone; alcohols; sodium phosphate; sodium silicate; sodium hydroxide
Shellac, varnish, lacquers, and their thinners	Methanol; acetone; toluene, xylenes; turpentine; petroleum distillates; ketones; butyl acetate
Penetrating oil	Benzene; toluene; light petroleum oils
Solvent	Hydrocarbon solvents consisting of paraffinic, naphthenic, and aromatic compounds
Mold release liquids	Silicone polymers
Rust and corrosives inhibitors*	Chelateing compounds such as EDTA
Descaling compounds*	Acids
Carbon removers*	Petroleum distillates
Detergents	Linear alkyl sulfonates; benzene alkyl sulfonates; and other wetting agents

*Additional investigation recommended.

Note: Lacquers are coatings that dry by solvent evaporation. Varnishes dry by polymerization. Shellac is a natural lacquer.

APPENDIX B. VERIFICATION PHASE SPECIFICATIONS

The groundwater sample borings may be dug with any suitable auger, such as a boring machine of the type used for installing telephone poles. If necessary, a temporary casing and screen can be installed to keep the sides of the hole from collapsing during the sampling operation. The borings should be dug to a depth of five feet beneath the water table or to a depth equivalent to the lower low tide elevation, whichever is less. In order to avoid cross contamination from boring to boring, the drilling equipment should be properly rinsed between holes.

With the exception of that portion of the sample taken for volatile organic analysis (VOA), the groundwater sample may be removed from the boring using any available sampling device, provided that the device can be adequately rinsed between samplings to avoid cross contamination. VOA samples should be taken with a bottom-filling bailer in a manner that minimizes sample disturbance.

The same procedures may be used to sample existing old wells, with the following exception. Immediately prior to sampling, a volume of water should be pumped from the well equivalent to at least five static well volumes. This pre-sampling volume may be computed by the following formula:

$$V = 0.204\ D^2(L_1 - L_2),$$

where

V = volume in gallons,

D = inside casing diameter in inches,

L_1 = total length of casing and screen in feet, and

L_2 = depth to static water level in feet, as measured from the top of the casing.

As an example, if the casing and screen length of a two-inch diameter well is 30.5 feet, and the depth to the static water level from top of casing is 24.63 feet, the volume of water to be purged from the well prior to sampling would be:

$$V = 0.204(2)^2(30.5 - 24.63) = 4.79 \text{ gallons.}$$

This procedure helps to insure that the water sampled is representative of the groundwater environment surrounding the well and not of the initial stagnant water in the well.

With the exception of the VOA portions of the samples, all samples should be filtered in the field using a 0.45-micron filter. Sample preservation procedures, container types, shipping procedures, and analytical procedures should be consistent with procedures presented in the most recent edition of the American Public Health Association's <u>Standard Methods for the Examination of Water and Wastewater</u>.

APPENDIX C. CHARACTERIZATION PHASE SPECIFICATIONS FOR WEST BEACH LANDFILL AND 1943-1956 DISPOSAL AREA

The purpose of the recommended sampling program is to identify the contaminants moving via groundwater from the sites and to quantify the loading rates for each contaminant identified. The contaminants should be identified by installing 20 sampling wells, equally spaced along the downgradient perimeter of the sites. Each well should be installed near the water's edge (within 50 feet) and screened from a depth of three feet beneath the ground surface to a depth equal to approximately five feet below the lower low tide level (total average well depth would be approximately 15 to 20 feet). Each well should be installed using hollow stem auger techniques.

Continuous split-spoon samples should be taken at each location. A geologist on-site should carefully log each sample, noting blow counts and percent recovery. Representative samples from each hole should be bagged and taken to a laboratory for particle size analysis. The monitoring well, installed through the hollow stem augers, should consist of 1.25-inch inside diameter. Schedule 40 or 80 polyvinyl chloride (PVC) casing and screen (threaded flush joint type for both casing and screen, no glue allowed) should be used. The screen slot size should not be larger than 80 and should be factory slotted.

The sandpack should consist of clean Ottawa-type silica sand and should extend for the full length of the screen. The last three feet of the hole should consist of a one-foot bentonite seal atop the sandpack and a two-foot concrete plug to the ground surface. A four-inch protective casing with a locking vented cap should be installed around the 1.25-inch casing and anchored in the cement. The earth surrounding this protective casing should be sloped up to the casing (and maintained in that configuration for the duration of the project) so that no rainwater can pond up in the immediate vicinity of the well.

After installing each monitoring well, the on-site geologist will determine where, in the three-foot to eight-foot depth beneath the water table, the most permeable stratum occurs. (This should be done by examination of the split-spoon samples.) Another 1.25-inch permeability test well, with a one-foot screen, should be installed to that depth, within five feet (laterally) of the monitoring well. A sandpack should be placed around the screen from the bottom of the hole to six inches above the screen. A three-foot bentonite seal should be placed over that, and the remainder of the annular space filled with cuttings. Casing specifications should be the same as for the sampling wells described above. A protective casing, locking cap, or concrete seal are not necessary. After use (described below), the casing should be removed and the hole filled with cuttings.

Both monitoring wells and permeability test wells should be fully developed before use. The purpose of this is to maximize the communication between the well and the surrounding aquifer. Generally, this is accomplished by pumping large quantities of water from the well until the water runs clear, indicating that no fine-grained materials are present that could clog the sandpack. A certain amount of judgment must be exercised in the field, since it is possible that the wells may be installed in fine-grained materials such as silts and clays. In any case, the purpose of development is to achieve aquifer communication. Any non-chemical technique that works would be satisfactory. Note that these wells should be sufficiently shallow to allow the use of vacuum-type devices such as pitcher pumps, peristalsic pumps, or centrifugal pumps.

Before sampling the monitoring wells, the static water level in the casing should be recorded, accurate to ±0.01 foot. The static volume of water in the well should then be computed and a volume of water withdrawn equal to 10 static volumes; in no case should more water than can be removed from the well in a one-hour period be withdrawn. This purging process can be accomplished by using a peristalsic pump. The pump should then be used to take the sample. The sample line should consist of Tygon tubing and should be changed from one well to the next.

Both a slug and a bail test should be run on each permeability test well. The procedure to be used is described on pages 339 to 342 of Groundwater, a textbook written by R. Allan Freeze and John A. Cherry, published in 1979 by Prentice-Hall, Inc., of Englewood Cliffs, New Jersey. Care should be taken to run the test for a sufficiently long time so that curve extrapolation is minimized. After the tests for each well are analyzed and the results found to be satisfactory, the wells should be removed according to the directions given above. If the results are unsatisfactory, another test attempt should be made before well removal.

Each monitoring well should be sampled on a monthly basis for a period of one year. Preferably, the one-year period should not begin during the months of December through May, the rainy season, since it is desirable to conduct the sampling through one contiguous rainy season. It would be preferable to begin the study in the fall, continuing through to the following summer.

Samples should be analyzed for contaminants identified during the verification phase of the confirmation study.

In order to determine groundwater recharge into the site during the sampling year, a four-inch inside diameter PVC well should be installed in a suitable location in the center of the site. This well should be slotted up to three-feet of the ground surface, should penetrate to a depth equal to the lower low tide level, and should be installed and sandpacked into an open hole drilled by an eight-inch outside diameter hollow stem or solid stem auger. A simple stage recorder (float type), along with a suitable instrument shelter, should be set up at this well to continuously record water table fluctuation. A continuously recording rain gauge (tipping bucket type or weighing type) should be installed adjacent to this recorder. For the duration of the study, the instruments should be checked on a weekly basis. The smallest time divisions on the chart paper (or equivalent) to be used should not exceed two hours.

All well top elevations should be surveyed relative to the base datum to an accuracy of ± 0.01 foot. During each of the monthly sampling runs, the static water level elevations of each of the existing wells should be recorded.

APPENDIX D

PLANT AND ANIMAL SPECIES IN THE NAS ALAMEDA AREA

Table D-1

BIRDS OF THE NAS ALAMEDA REGION

Common Name	Scientific Name
Eared grebe (W)	Podiceps caspicus
Red-throated loon (W)	Gavia stellata
Piebilled grebe (R)	Podilymbus podiceps
Western grebe (W)	Aechmophorus occidentalis
Doublecrested cormorant (R, W)	Phalacrocorax auritus
Great blue heron (R)	Ardea herodias
Common or American egret (W)	Casmerodius albus
Snowy egret (R, W)	Leucophoyx thula
Canvasback (W)	Aythya valisineria
Lesser scaup (W)	Authya affinis
Greater scaup (W)	Aythya marila
Common goldeneye (W)	Bucephala clangula
Bufflehead (W)	Bucephala albeola
White-winged scoter (W)	Melanitta deglandi
Surf scoter (W)	Melanitta perspicillata
Ruddy duck (R)	Oxyura jamaicensis
White pelican (M, W)	Pelecanus erythrorhynehos
American coot (R)	Fulica americana
Killdeer (R)	Charadrius vociferus
Semipalmated plover (M)	Charadrius semipalmatus
Snowy plover (R)	Charadrius alexandrinus
Common snipe (W)	Capella gallinago
Black-bellied plover (M, W)	Squatarola squaiarola
Long-billed curlew (M, W)	Numenius americanus
Hudsonian curlew (M)	Numenius phacopus
Willet (R, W)	Catoptrophorus semipalmatus
Least sandpiper (M, W)	Erolia minutilla
Dunlin (M, W)	Erolia alpina
Western sandpiper (M, W)	Ereunetes mauri
Short-billed dowitcher (M, W)	Limnodromus griseus
Marbled godwit (M, W)	Limosa fedoa
Black turnstone (M, W)	Arenaria melanocephala
Avocet (R)	Recurvirostra americana
Black-necked stilt (R)	Himantopus mexicanus
Northern phalarope (M)	Lobipes lobatus
Western gull (R)	Larus occidentalis
Herring gull (W)	Larus argentatus
California gull (W)	Larus californicus
Ring-Billed gull (W)	Larus delawarenis
Bonaparte's gull (W)	Larus philadelphia
Glaucous-Winged gull (W)	Larus glaucescens
Forster tern (M, W)	Sterna forsteri
Caspian tern (R, W)	Hydroprogne caspia

Key: (R) = Resident
(W) = Winter
(S) = Summer
(M) = Migrates through

Source: Environmental Assessment Engineering, June 1974, Preliminary Submission Candidate Environmental Impact Statement for Dredge Spoil Operations at the Naval Air Station, Alameda, California.

Table D-2

INVERTEBRATES IDENTIFIED IN WATERS ADJACENT TO NAS ALAMEDA

Nemeratea
- Anopla
  - Unidentified species

Annelida
- Polychaeta (segmented worms)
  - *Asychis amphiglypta*
  - *Cirriformia spirabrancha*
  - *Cirratulus cirratus*
  - *Dorvillea gracilis*
  - *Glycinde armigera*
  - *Haploscoloplos elongata*
  - *Nephtys caecoides*
  - *Streblospio benedicti*
  - Sabellidae

Mollusca
- Gastropoda
  - *Nassarius mendicus* (mud snail)
- Pelecypoda
  - *Mytilus edulis* (bay mussel)
  - *Mytilus californianus* (California mussel)
  - *Ostrea lurida* (native oyster)
  - *Portothaca staminea* (littleneck clam or rock cockle)
  - *Tapes semidecussata* (Japanese littleneck clam)
  - *Mya arenaria* (soft-shelled clam)
  - *Macoma nasuta* (bent-nosed clam)
  - *Macoma balthica*

Crustacea
- Cirripedia
  - *Balanus glandula* (white acorn barnacle)
- Amphipoda
  - Unidentified species
- Decopoda
  - *Hemigrapsus oregonensis* (mud crab)
  - *Rithropanopeus harrisi*
- Bryozoa
  - Unidentified colonies

Source: Environmental Assessment Engineering, June 1974, *Preliminary Submission Candidate Environmental Impact Statement for Dredge Spoil Disposal Operations at the Naval Air Station, Alameda, California.*

Table D-3

FISH OF THE NAS ALAMEDA WATERS

Common Name	Scientific Name
Seven gill shark	Notorynchus maculatus
Spiny dogfish	Squalus acanthias
Leopard shark	Triakis semifascinta
Gray smoothhound	Musielus californicus
Brown smoothhound	Musiclus heplei
Bat ray	Myliobatus californicus
Big skate	Raja binoculaia
Pacific herring	Clupea pallasi
American shad	Alosa sapidissima
Northern anchovy	Engraulis mordax
King salmon	Oncorhynchus tshawytscha
Surf smelt	Hypomcsus pretiosus
White perch	Phanerodon furcatus
Pile perch	Damalichthys vacca
Rubber lip perch	Rhacochilus toxotes
Shiner surfperch	Cymaiogaster aggregata
Black perch	Embiotoca jacksoni
Pacific tomcod	Microgadus proximus
Top smelt	Atherinops affinis
Jack smelt	Atherinopsis californiensis
Striped bass	Morone (Roccus) saxatilis
White croaker	Genyonemus lineatus
Staghorn sculpin	Leptocottus armatus
Bay goby	Lepidogobius lepidus
Yellowfin (Oriental) goby	Acanthogobius flavimanus
Long-jawed mudsucker	Gillichthys mirabilis
Rockfishes	Sebastes sp.
Northern midshipman	Porichthys notatus
Pacific sanddab	Citharichthys sordidus
Speckled sanddab	Citharichthys stigmaeus
Starry flounder	Platichthys stellatus
English sole	Parophrys vetulus
Diamond turbot	Hypsopsetta guttulata

Source: Environmental Assessment Engineering, June 1974, Preliminary Submission Candidate Environmental Impact Statement for Dredge Spoil Disposal Operations at the Naval Air Station, Alameda, California.

Table D-4

ENDANGERED, RARE, AND THREATENED ANIMALS OF CALIFORNIA[1]

Species Common Name	Scientific Name	Code Designation
Gastropods		
Trinity Bristle Snail	Monadenia setosa	SR
Crustaceans		
California Freshwater Shrimp	Syncaris pacifica	SE
Shasta Crayfish	Pacifastacus fortis	SR
Insects		
Mission Blue Butterfly	Icaricia[2] icarioides missionensis	FE
Lotis Blue Butterfly	Lycaeides argyrognomon lotis	FE
Palos Verdes Blue Butterfly	Glaucopsyche lygdamus palosverdesensis	FE
El Segundo Blue Butterfly	Euphilotes (=Shijimiaeoides) battoides allyni	FE
Smith's Blue Butterfly	Euphilotes (=Shijimiaeoides) enoptes smithi	FE
San Bruno Elfin Butterfly	Callophrys mossii bayensis	FE
Lange's Metalmark Butterfly	Apodemia mormo langei	FE
Kern Primrose Sphinx Moth	Euproserpinus euterpe	FT
Delta Green Ground Beetle	Elaphrus viridis	FT
Valley Elderberry Longhorn Beetle	Desmocerus californicus dimorphus	FT
Fishes		
Little Kern Golden Trout	Salmo aquabonita whitei	FT
Lahontan Cutthroat Trout	Salmo clarkii henshawi	FT
Paiute Cutthroat Trout	Salmo clarkii seleniris	FT
Bull Trout	Salvelinus confluentus	SE
Mohave Chub	Gila mohavensis[3]	SE, FE
Owens Tui Chub	Gila bicolor snyderi	SE
Bonytail Chub	Gila elegans	SE, FE
Colorado Squawfish[4]	Ptychocheilus lucius	SE, FE

1 Effective September 15, 1980
2 Same as Plebejus
3 Same as Gila bicolor mohavensis
4 Federal: Colorado River Squawfish

Table D-4 (Cont.)

Species Common Name	Scientific Name	Code Designation
Fishes (Cont.)		
Lost River Sucker	Catostomus luxatus	SE
Modoc Sucker	Catostomus microps	SE
Shortnose Sucker	Chasmistes brevirostris	SE
Humpback Sucker	Xyrauchen texanus	SE
Desert Pupfish	Cyprinodon macularius	SE
Cottonball Marsh Pupfish	Cyprinodon milleri	SR
Tecopa Pupfish	Cyprinodon nevadensis calidae	SE, FE[5]
Owens Pupfish[6]	Cyprinodon radiosus	SE, FE
Unarmored Threespine Stickleback	Gasterosteus aculeatus williamsoni	SE, FE
Rough Sculpin	Cottus asperrimus	SR
Amphibians		
Santa Cruz Long-toed Salamander	Ambystoma macrodactylum croceum	SE, FE
Siskiyou Mountain Salamander	Plethodon stormi	SR
Desert Slender Salamander	Batrachoseps aridus	SE, FE
Kern Canyon Slender Salamander	Batrachoseps simatus	SR
Tehachapi Slender Salamander	Batrachoseps stebbinsi	SR
Limestone Salamander	Hydromantes brunus	SR
Shasta Salamander	Hydromantes shastae	SR
Black Toad	Bufo exsul	SR
Reptiles		
Magic Gecko	Anarbylus switaki	SR
Coahella Fringed-Toed Lizard	Uma anornata	SE
Blunt-nosed Leopard Lizard	Crotaphytus wizlizenii silus[7]	SE, FE
Island Night Lizard	Klauberina riversiana	FT
Southern Rubber Boa	Charina bottae umbratica	SR
Alameda Striped Racer	Masticophis lateralis euryxanthus	SR
San Francisco Garter Snake	Thamnophis sirtalis tetrataenia	SE, FE
Giant Garter Snake	Thamnophis couchi gigas	SR

[5] Probably extinct
[6] Federal: Owens River Pupfish
[7] Federal: Crotaphytus silus. Also, scientific name widely accepted as Gambelia silus.

Table D-4 (Cont.)

Species Common Name	Scientific Name	Code Designation
Birds		
California Brown Pelican	Pelecanus occidentalis californicus	SE, FE
Aleutian Canada Goose	Branta canadensis leucopareia	FE
California Condor	Gymnogyps californianus	SE, FE
Bald Eagle	Haliaeetus leucocephalus	SE, FE
American Peregrine Falcon	Falco peregrinus anatum	SE, FE
California Clapper Rail	Rallus longirostris obsoletus	SE, FE
Light-footed Clapper Rail	Rallus longirostris levipes	SE, FE
Yuma Clapper Rail	Rallus longirostris yumanensis	SR, FE
California Black Rail	Laterallus jamaicensis coturniculus	SR
California Least Tern	Sterna albifrons browni	SE, FE
California Yellow-billed Cuckoo	Coccyzus americanus occidentalis	SR
Elf Owl	Micrathene witneyi	SE
Great Gray Owl	Strix nebulosa	SE
San Clemente Loggerhead Shrike	Lanius ludovicianus mearnsi	FE
Least Bell's Vireo	Vireo bellii pusillus	SE
Inyo Brown Towhee	Pipilo fuscus eremophilus	SE
Belding Savannah Sparrow	Passerculus sandwichensis beldingi	SE
San Clemente Sage Sparrow	Amphispiza belli clementeae	FT
Santa Barbara Song Sparrow	Melospiza melodia graminea	FE[8]
Mammals		
San Joaquin Antelope Squirrel	Ammospermophilus nelsoni	SR
Mohave Ground Squirrel	Citellus[9] mohavensis	SR
Morrow Bay Kangaroo Rat	Dipodomys heermanni morroensis	SE, FE
Giant Kangaroo Rat	Dipodomys ingens	SE
Stephens Kangaroo Rat	Dipodomys stephensi	SR
Fresno Kangaroo Rat	Dipodomys nitratoides exilis	SE
Salt Marsh Harvest Mouse	Reithrodontomys raviventris	SE, FE
Amargosa Vole	Microtus californicus scirpensis	SE

8 State: Considered to be extinct
9 Same as spermophilus

Table D-4 (Cont.)

Species Common Name	Scientific Name	Code Designation
Mammals (Cont.)		
Sperm Whale	Physeter catodon	FE
Gray Whale	Eschrichtius robustus	FE
Finback Whale[10]	Balaenoptera physalus	FE
Sei Whale	Balaenoptera borealis	FE
Blue Whale	Balaenoptera musculus	FE
Humpback Whale[11]	Megaptera novaeangliae	FE
Right Whale	Balaena glacialis	FE
Sierra Nevada Red Fox	Vulpes vulpes necator	SR
San Joaquin Kit Fox	Vulpes macrotis mutica	SR, FE
Island Fox	Urocyon littoralis	SR
Wolverine	Gulo gulo	SR
Southern Sea Otter	Enhydra lutris nereis	FT
Guadalupe Fur Seal	Arctocephalus townsendi	SR
California Bighorn Sheep	Ovis canadensis californiana	SR
Peninsular Bighorn Sheep	Ovis canadensis cremnobates	SR

[10] Also called Fin Whale
[11] Also called Humpbacked Whale

Code designations:

SE = State-listed endangered species
SR = State-listed rare species
FE = Federally listed endangered species
FT = Federally listed threatened species

Note: Common and scientific names are shown as designated on the state or federal lists. If the nomenclature differs for a species that is included on both lists, the nomenclature used on the state list is shown here with the federal nomenclature in a footnote. Other synonyms are footnoted.

Table D-5

ENDANGERED, RARE, AND THREATENED TERRESTRIAL PLANTS OF THE PACIFIC COAST

	Code Designation
Madder family	
Island bedstraw	SR
Carrot family	
San Diego coyote thistle	SE
Mason's lilaeopsis	SE
Adobe sanicle	SE
Aster family	
Point Teyes blennosperma	SR
Fountain thistle	SE
Otay tarweed	SE
Santa Susana tarweed	SR
Santa Cruz tarweed	SE
Barberry family	
Island barberry	SE
Borage family	
San Francisco allocarya	SE
Mustard family	
Contra Costa wallflower	FE, SE
Santa Cruz wallflower	SR
Stonecrop family	
Santa Monica Mountains dudleya	SR
Santa Cruz Island dudleya	SR
Laguna Beach dudleya	SR
Santa Barbara Island dudleya	FE
Cypress family	
Santa Cruze cypress	SE
Figwort family	
San Clemente Island paintbrush	FE
Salt marsh bird's beak	FE, SE
Soft bird's beak	SR
Pennell's bird's beak	SR
Monterey Dune monkey flower	SE
Dudley's lousewort	SR
Heath family	
Baker's manzanita	SR
Hearst's manzanita	SE
San Bruno Mountain manzanita	SE
Pacific manzanita	SE
Alameda manzanita	SE
Hanging gardens manzanita	SE
Presidio manzanita	FE
Pea family	
Trask's milk-vetch	SR
Trask's island lotus	FE
Santa Barbara false-lupine	SE
Pacific Grove clover	SR
Monterey clover	SE

Table D-5 (Cont.)

	Code Designation
Waterleaf family	
Indian Knob Mountain balm	SE
Lompoc yerba santa	SR
Mint family	
San Mateo thornmint	SE
San Diego County monardella	SE
San Diego mesa mint	FE, SE
Lily family	
Dwarf golden star	SR
Tiburon mariposa	SE
Roderick's fritillary	SE
False mermaid family	
Cunningham marsh meadow foam	SE
Mallow family	
San Clemente Island bush-mallow	FE
Santa Cruz Island bush-mallow	SE
Evening-primrose family	
Presidio clarkia	SE
Pismo clarkia	SR
Antioch Dumes evening-primrose	FE, SE
Grass family	
Marin bent-grass	SR
Leafy reed-grass	SR
California orcuttia	SE
Hoover's semaphore grass	SR
Buckwheat family	
Orcutt's chorizanthe	SE
Butterworth's buckwheat	SR
Conejo buckwheat	SR
Santa Barbara Island buckwheat	SR
San Nicolas Island buckwheat	SE
Crowfoot family	
Baker's larkspur	SR
San Clemente Island larkspur	FE, SR
Yellow larkspur	SR
Buckthorn family	
Hearst's ceanothus	SE
Maritime ceanothus	SR
Mason's ceanothus	SR
Rose family	
Hickman cinquefoil	SR

Source: United States Fish and Wildlife Service, 1981, Pacific Coast Ecological Inventory.