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**RCRA FACILITY INVESTIGATION
FINAL WORK PLAN**

**Naval Air Station, Oceana
Virginia Beach, Virginia**

Prepared for:

**Naval Facilities Engineering Command
Atlantic Division
Norfolk, Virginia
Contract N62 470-90-C-7638**

Prepared by:

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June 1992

WDCR301/082.51

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Glossary

APEG	alkaline metal hydroxide/polyethylene glycol
ATEG	alkaline metal hydroxide/tetraethylene glycol
BDAT	best demonstrated available technology
BNs	base-neutral extractable organics
BNAs	base-neutral/acid extractable organics
BOD	biological oxygen demand
BTU	British thermal unit
CMA	corrective measure study
cm/s	centimeters per second
COD	chemical oxygen demand
CRP	community relations plan
DCQAP	data collection quality assurance plan
DMSO	dimethyl sulfoxide
EDB	ethylene dibromide
EPA	U.S. Environmental Protection Agency
HEA	health and environmental assessment
IAS	initial assessment study
ICMs	interim corrective measures
IRP	Installation Restoration Program
LDR	land disposal restrictions
MCL	maximum contaminant level

MCLG	maximum contaminant level goal
MEK	2-butanone
MIBK	4-methyl-2-pentanone
MSL	mean sea level
NAS	naval air station
NCP	National Contingency Plan
PAHs	polyaromatic hydrocarbons
PNA	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
POTW	publicly owned treatment works
ppb	parts per billion
ppm	parts per million
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RFI	RCRA facility investigation
Semivolatiles	Acid and base-neutral extractable organics
SSO	site safety officer
SVE	soil vapor extraction
SWMU	solid waste management unit
TCDD	2,3,7,8-dioxin
TCE	trichloroethylene
TDS	total dissolved solids

TIC	tentatively identified compound
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSS	total suspended solids
VC	vinyl chloride
VOCs	volatile organic compounds
VSI	visual site inspection

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Chapter 1 Introduction

This work plan describes activities associated with a Resource Conservation and Recovery Act (RCRA) Facility Investigation of the Naval Air Station (NAS), Oceana, in Virginia Beach, Virginia. Figure 1-1 shows the location of the NAS in the southeastern corner of Virginia. The work plan will focus on 19 solid waste management units (SWMUs). Due to the proximity of some SWMUs to one another, some have been combined for the purposes of this RFI, resulting in a total of 17 areas to be investigated.

The 17 sites to be investigated during the RFI are:

- Site 1—West Woods Oil Disposal Pit
- Site 2B—Line Shack 130-131 Disposal Area
- Site 2C—Line Shack 400 Disposal Area
- Site 2D—Line Shack 125 Disposal Area
- Site 2E—Line Shack 109 Disposal Area
- Site 11—Firefighting Training Area
- Site 15—Abandoned Tank Farm
- Site 16—Pesticide Storage Area
- Site 18—Hazardous Waste Storage
- Site 19—Waste Oil Storage Area, Building 541
- Site 20—Waste Oil Storage Area, Building 543
- Site 21—Transformer Storage Yard
- Site 22—Construction Debris Landfill
- Site 23—Bowser, Building 830
- Site 24—Bowser, Building 840
- Site 25—Inert Landfill
- Site 26—Firefighting Training Area, Building 220

Environmental investigations at NAS, Oceana, were initiated under the Navy's Installation Restoration Program (IRP), which was designed to identify and correct problems of environmental contamination caused by operations at naval facilities. The first stage of the investigation at NAS, Oceana, was the completion of an initial assessment study (IAS) in 1984 (RGH, 1984). Sixteen sites were evaluated during this investigation; the IAS recommended that field investigations be conducted at five sites at NAS, Oceana, to confirm whether hazardous constituents were being released to the environment. In response to the IAS, the round 1 verification step study was performed in 1986 (CH2M HILL, 1986). A third IRP investigation at NAS, Oceana, followed in 1988 (CH2M HILL, 1989). That investigation focused on the areas around line shacks 130 and 400.

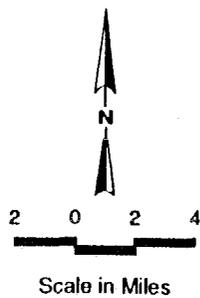
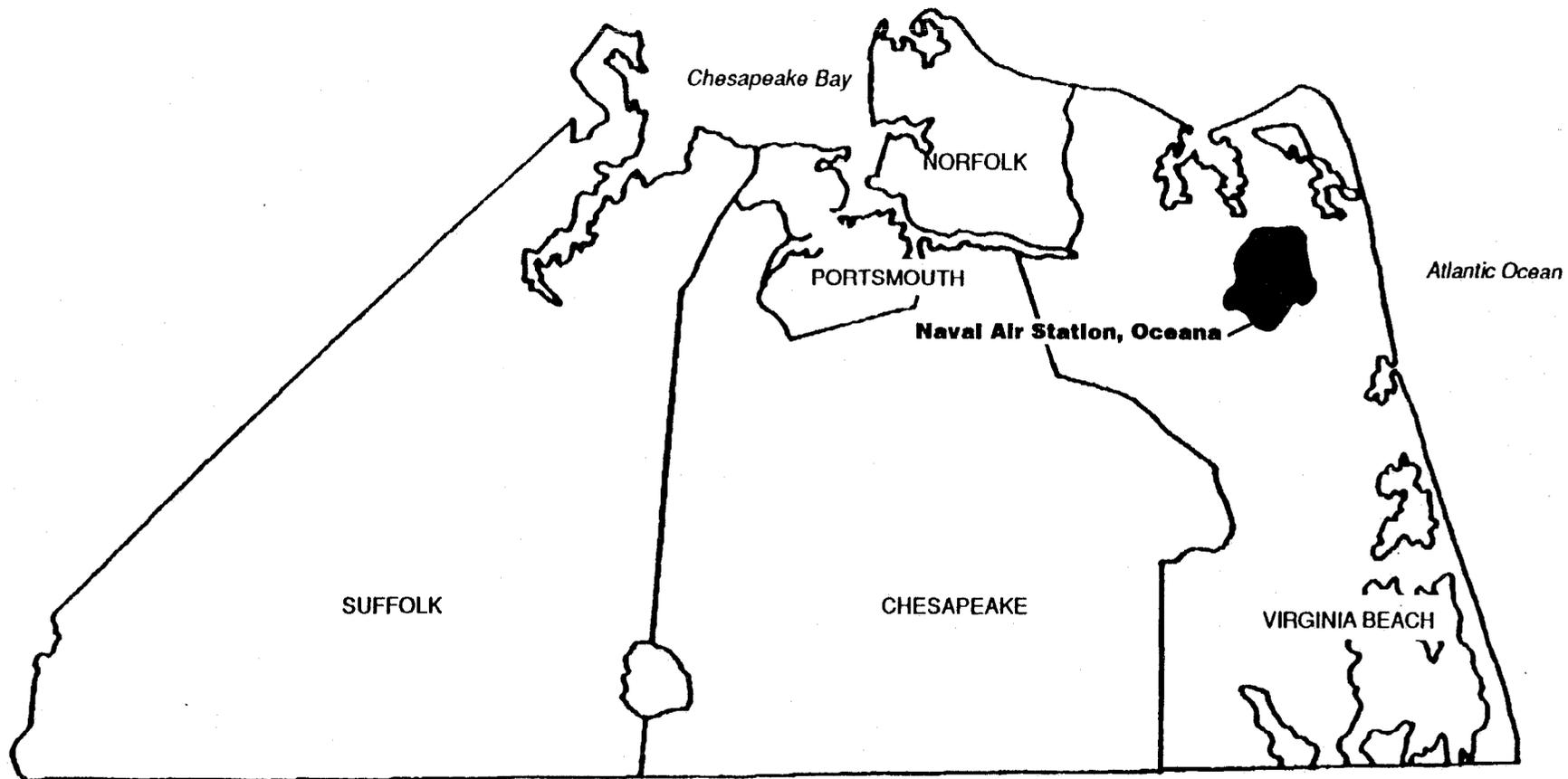


Figure 1-1
LOCATION OF THE
NAVAL AIR STATION, OCEANA



RCRA corrective action began at Oceana in June 1988, when U.S. Environmental Protection Agency (EPA) contractors conducted a RCRA Facility Assessment (RFA) of the base. The RFA identified 99 SWMUs, including all of the sites previously studied under the IRP. The RFA also identified several additional SWMUs and areas of concern (AOC) that had not been previously identified. The EPA followed by issuing a 3008(h) of RCRA. The draft Consent Order contained 60 SWMUs.

In 1990, an interim RFI was conducted to continue the investigation of six sites at Oceana that had begun under the IRP. The interim RFI also served to initiate work at four additional sites and to guide the RFI's scope of work (CH2M HILL, 1991). Field activities at each of the 10 sites were geared toward obtaining sufficient information to determine whether a given site should remain within the scope of the RFI.

Through negotiations between EPA and the Navy, 41 of the SWMUs were removed from the Consent Order. The reason for the removal of each SWMU is briefly outlined in Table 1-1. The final Consent Order, signed in May 1991, specified that 19 SWMUs be included in the RFI work plan. Two of the 19 RFA SWMUs named in the Consent Order have been combined with nearby SWMUs and renumbered as single RFI SWMUs (RFA 1 and 54 to RFI 2E, RFA 23 and 24 to RFI 11); therefore 17 SWMUs will be investigated during the RFI.

The objectives of this RFI are:

- To define the nature and extent of potential releases of hazardous waste or constituents from the SWMUs
- To determine whether a corrective measure study (CMS) is necessary and to establish potential preliminary media protection standards
- To gather the data necessary to support a CMS, if one is needed. The CMS will evaluate the effectiveness of potential remedial actions, including ease of implementation, safety, and potential adverse effects of implementing remedies, to assist in developing a corrective action plan.

An RFI consists of the following tasks (EPA, 1986):

- Task 1--Preliminary Report: Description of Current Conditions
- Task 2--Pre-investigation Evaluation of Corrective Measures Technologies
- Task 3--RFI Work Plan
- Task 4--Facility Investigation
- Task 5--Investigation Analysis
- Task 6--Laboratory and Bench-Scale Studies
- Task 7--RFI Reports

**Table 1-1
STATUS OF SOLID WASTE MANAGEMENT UNITS
IDENTIFIED IN THE RCRA FACILITY ASSESSMENT
NAVAL AIR STATION, OCEANA**

Page 1 of 4

RFA SWMU No.	RFI SWMU No.	Description	Status of SWMU	Included in RFI?
1	2e	Hazardous Waste Storage Area, Bldg. 23	Included in RFI work plan.	Yes
3	18	Hazardous Waste Storage Area, Bldg. 204	Included in RFI work plan.	Yes
8		Hazardous Waste Storage Area, Bldg. 1102	Dropped from the Consent Order since the unit has a hazardous waste closure plan and since the unit is inspected on a regular basis.	No
10		Hazardous Waste Storage Area, Fentress	Not contiguous--dropped from inclusion in RFI work plan by EPA.	No
11		Hazardous Waste Storage Area, Permitted	This unit will be closed per the closure plan in the Part B permit application of 1988. Not included in this RFI work plan.	No
22	22	Construction Debris Landfill	Included in this RFI work plan.	Yes
23	14	Fentress Landfill	Not contiguous--dropped from inclusion in RFI work plan by EPA.	No
24	7	Fifth Green Landfill	Results from interim RFI do not indicate evidence of release. Not included in RFI work plan.	No
25	25	Inert Landfill	Included in RFI work plan.	Yes
26	8	North Station Landfill	Results from interim RFI do not indicate evidence of release. Not included in RFI work plan.	No

*EPA Region III agreed to drop this unit from the RFI during negotiations with the Navy and its consultant on May 17, 1990 and June 13, 1990.

**Table 1-1
STATUS OF SOLID WASTE MANAGEMENT UNITS
IDENTIFIED IN THE RCRA FACILITY ASSESSMENT
NAVAL AIR STATION, OCEANA**

Page 2 of 4

RFA SWMU No.	RFI SWMU No.	Description	Status of SWMU	Included in RFI?
27*		Old CPO Club Landfill	Not included in RFI work plan. A.T. Kearney's RFA indicated that there was no indication of a release.	No
28		Sanitary Landfill (Old CPO Landfill)	Active landfill monitoring wells show no evidence of a release. An MW is chosen by VDWM for annual monitoring for Cl, pH, Fe, TOX, and pesticides. A closure plan is to be submitted to VDWM by December 1990. Not included in RFI work plan since this unit is being addressed under similar clean-up program administered by different regulatory agency.	No
29*	3	West Side Landfill	Not recommended for additional study. (RGH, 1984) Given no evidence of contamination, the SWMU was deleted from further study.	No
30-44* 45* 46*		Oil/Water Separators Oil/Water Separator, Bldg. 1102 Oil/Water Separator	Discharges go to a POTW. A maintenance program is in place to monitor for and remediate any releases from these units. Not included in RFI work plan.	No
48*		Washrack--Golf Course	Electric golf carts stored. No evidence of release nor any chemicals or oils of any significance used in the area. Not included in RFI work plan.	No

*EPA Region III agreed to drop this unit from the RFI during negotiations with the Navy and its consultant on May 17, 1990 and June 13, 1990.

**Table 1-1
STATUS OF SOLID WASTE MANAGEMENT UNITS
IDENTIFIED IN THE RCRA FACILITY ASSESSMENT
NAVAL AIR STATION, OCEANA**

Page 3 of 4

RFA SWMU No.	RFI SWMU No.	Description	Status of SWMU	Included in RFI?
51-54	2b, 2c, 2d, 2e	Line Shack Disposal Areas	Included in RFI work plan.	Yes
55	2a	Line Shack Disposal Area	Results from interim RFI do not indicate evidence of release. Not included in RFI work plan.	No
56	4	Bougainville Mercury Spill Area	No contamination found--not recommended for additional study (RGH, 1984). Not included in RFI work plan.	No
57	1	West Woods Oil Disposal Pit	Included in RFI work plan.	Yes
58	15	Abandoned Tank Farm, Old CPO Club	Included in RFI work plan.	Yes
59	6	Navy Exchange Maintenance Building Waste Oil Disposal Area, Bldg. 518	Not recommended for additional study (RGH, 1984). Not included in RFI work plan. Results from interim RFI do not indicate evidence of release.	No
60, 61*		Mercury Spill Areas, Bldgs. 305 and 1102	Spill material was stored here. Buildings were later demolished. Soil sampling showed no contamination. Not included in RFI work plan.	No
62,63,65	11, 26	Fire Fighter Burn Pits	Included in RFI work plan.	Yes
64		Fire Fighter Burn Pits	Located at Fentress which is not contiguous to main Oceana facility. Not included in RFI work plan.	No

*EPA Region III agreed to drop this unit from the RFI during negotiations with the Navy and its consultant on May 17, 1990 and June 13, 1990.

**Table 1-1
STATUS OF SOLID WASTE MANAGEMENT UNITS
IDENTIFIED IN THE RCRA FACILITY ASSESSMENT
NAVAL AIR STATION, OCEANA**

Page 4 of 4

RFA SWMU No.	RFI SWMU No.	Description	Status of SWMU	Included in RFI?
66*		Old Tank	This unit, which has been removed, used to be located at the fire training pit which is being investigated separately. Not included in RFI work plan.	No
67-70*		Underground Waste Oil Storage Tanks	Subject to Virginia UST regulations and therefore subject to similar regularly clean-up program. Not included in RFI work plan.	No
71	19	Waste Oil Storage Areas, Bldg. 541	Included in RFI work plan.	Yes
72	20	Waste Oil Storage Areas, Bldg. 543	Included in RFI work plan.	Yes
75-77*		Waste Fuel Storage Tanks	Subject to Virginia UST regulations and therefore subject to similar regularly clean-up program. Not included in RFI work plan.	No
78	23	Bowser, Bldg. 830	Included in RFI work plan.	Yes
79	24	Bowser, Bldg. 840	Included in RFI work plan.	Yes
87*		Corrosion Control Shop, Degreaser Pit, Bldg. 513	Pit emptied and inspected quarterly. Discharges to Hampton Roads Sanitary District. No signs of any releases. Not included in RFI work plan.	No
95	16	Pesticide Storage Area, Bldg. 821	Included in RFI work plan.	Yes
97	21	Transformer Storage Yard, Bldg. 830	Included in RFI work plan.	Yes

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*EPA Region III agreed to drop this unit from the RFI during negotiations with the Navy and its consultant on May 17, 1990 and June 13, 1990.

Typically, the RFI work plan addresses only the first three tasks. These three tasks encompass investigations necessary for evaluating potential releases from the 19 SWMUs identified in the Consent Order signed in May 1991.

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Chapter 2 Summary of Existing Conditions

Facility Location

NAS, Oceana is located in the Tidewater region of Virginia as shown in Figure 1-1. The base lies southeast of Norfolk, immediately west of the Atlantic Ocean, and just south of the Chesapeake Bay in Virginia Beach.

According to the *New HRS Deficiency Information Collection Efforts* (Baker Environmental, 1991) there are 65 known public consumption and private water supply wells within a 4-mile radius of the sites at NAS, Oceana. Of these, 25 wells are private and 40 wells are public consumption wells. Public water, within a 4-mile radius of NAS, Oceana, is supplied by the City of Virginia Beach Department of Public Utilities (Virginia Beach DPU). The Virginia Beach DPU receives all of its water from the City of Norfolk Department of Utilities (Norfolk DU) and reportedly has no supply wells. The Norfolk DU obtains its raw water from a number of surface-water sources, except when reservoir levels drop below 70 percent capacity. Then, a series of four deep wells (total capacity 16 mgd) can be activated. Three of the four wells discharge to Lake Prince, the other discharges to Lake Burnt Mills. Use of these wells is avoided when possible because the groundwater has a high phosphorus content. However, all four of these deep wells are outside the 4-mile radii of the sites.

Surface waters at the base includes West Neck Creek, London Bridge Creek, and Great Neck Creek. These creeks flow into Lynnhaven River to Lynnhaven Bay and Broad Bay. The bays are used primarily as ports for sport and the fishing industry. The bays are occasionally used for contact recreation (water skiing and swimming). There are no water bodies within 15 miles of NAS, Oceana which are designated as potable water supply by the Virginia State Water Control Board in accordance with Section 305(a) of the Clean Water Act (Baker Environmental, 1991).

Facility Description

On November 25, 1940, the U.S. Government purchased 328 acres of remote, swampy land for constructing a small auxiliary airfield to accommodate 32 officers and 172 enlisted personnel. Asphalt runways 2,500 feet long were constructed from 1940 to 1941. In 1943, at the height of World War II, Congress approved plans to expand the station to accommodate up to 160 officers and 800 enlisted personnel. By the fifties, the Navy Auxiliary Air Station had become too large to work as a subordinate to other stations in the area, hence it was designated a Naval Air Station. Oceana then became an all-weather air station, and was eventually officially designated a master jet base.

By 1976, five of the six Atlantic Fleet Carrier Air Groups were based at Oceana. The latter part of the 1970s also involved installation of numerous training devices at NAS, Oceana. These included an A6A Cockpit Procedures Trainer, an A4 Operational Flight Trainer, and an F14A Weapons Trainer.

Over the years, Oceana has grown to more than 16 times its original size. The base now encompasses 5,916 acres of land and supports a naval community of more than 10,200 Navy personnel and some 11,500 dependents. The annual payroll exceeds \$286 million.

The 12 F-14 Tomcat jet-fighter squadrons and 7 A-6 Intruder medium-attack squadrons assigned to the Atlantic Fleet are based at Oceana. In addition, the station also supports a Search and Rescue unit that flies the SH-3 Seal King helicopter and provides rescue service to both military and civilian communities. Three squadrons for training aircrews and maintenance personnel are also permanently stationed at the base. In all, 74 squadrons, tenants, and non-naval units are currently assigned to Oceana.

The primary mission of NAS, Oceana is to provide virtually every element of supply, material, maintenance, personnel, training facilities, and dependent personnel support required to ensure that the 12 F-14 Tomcat fighter squadrons and 7 A-6 Intruder medium attack squadrons based at Oceana achieve the requisite level of readiness necessary to deploy on Commander Naval Air Force, U.S. Atlantic Fleet aircraft carriers as fully combat-capable fighter and attack squadrons.

Substantial sections of the Oceana site boundary are secured with fences. However, parts of the NAS boundary along London Bridge Road on the west and south, and Potters Road on the north are not fenced. All roads have gates and all areas of the NAS are patrolled, including the area west of the runways.

Environmental Setting

Topography

The elevation of the base ranges from approximately 5 feet above mean sea level (MSL) in the drainage ditches to approximately 25 feet above MSL in the open fields. Elevations in the main area of the base range from 10 to 25 feet. In general, there is an easterly slope to the land surface in the Virginia Beach area, with local relief caused by natural and artificial drainage. Surface runoff from the base is aided by a system of drainage ditches and surface canals, especially west and south of the base.

Geology, Soils, and Hydrogeology

NAS, Oceana is on the outer edge of the Atlantic Coastal Plain physiographic province. The Atlantic Coastal Plain is a broad wedge of unconsolidated sediments that dip and thicken to the east. In the vicinity of NAS, Oceana, these sediments consist of several thousand feet of unconsolidated sand, clay, silt, and gravels, and are underlain by granitic basement rock. The sediments range in age from late Cretaceous to Recent. The five principal geologic units are (from oldest to youngest) the Potomac Formation, the unnamed Upper Cretaceous deposits, the Pamunkey Group, the Chesapeake Group, and the Columbia Group (Meng and Harsh, 1984). The Chesapeake Group has been differentiated into five subformations, which are, from oldest to youngest, the Calvert, Choptank, St. Marys, Eastover, and Yorktown Formations. The Columbia Group sediments overlying the Yorktown Formation have also been differentiated locally into several units (Oaks and Coch, 1973).

The geologic units of concern in the environmental investigations at NAS, Oceana are the Yorktown Formation and the Columbia Group sediments. The upper Yorktown Formation consists of interbedded layers of shelly, very fine to coarse sands, clayey sands and sandy clay of Tertiary age. Shell layers are common in the Yorktown Formation (Meng and Harsh, 1984). Sidulya et al. (1981) divided the Yorktown Formation into three sand units, each overlain by a confining layer of silt and clay.

Regionally, the uppermost of these silt and clay beds separates the Yorktown Formation from the sediments of the Columbia Group that overlie it. This uppermost bed consists of massive, well-bedded yellow-gray to greenish-gray clays and silty clays, commonly containing shells, fine sand, and mica. Although the clay layers within the confining bed are generally extensive, they are composed of a series of coalescing clay beds rather than a single deposited unit (Meng and Harsh, 1984). The sediments of the Columbia Group consist of interbedded gravels, sands, silts, and clays of Pleistocene and Holocene age (Oaks and Coch, 1973).

The geology of the near surface sediments at NAS, Oceana is quite variable laterally, even within individual study sites. However, in order of increasing depth, the sediments generally consist of:

- Approximately 5 feet of fine material, primarily sandy silts
- A 5- to 15-foot-thick layer of sand
- A second layer of fine material, primarily silty sands
- The shelly sands and silty sands of the Yorktown Formation

The clay layer reported to overlie the upper Yorktown sands regionally has not been encountered in the borehole drilling conducted to date at NAS, Oceana. The specific geology of individual sites is described later in this section.

The depth to water within the surficial Columbia Group aquifer is approximately 5 to 10 feet below land surface. Aquifer conditions are unconfined within the Columbia Group and unconfined to semi-confined within the upper Yorktown Formation (Siudyla et. al, 1981). Where the clay confining unit overlying the Yorktown is absent the upper Yorktown aquifer is generally unconfined. The direction of groundwater flow is controlled by topography and artificial drainage structures. The direction of groundwater flow in the Virginia Beach area is therefore highly variable due to the complexity of drainage patterns. In the absence of nearby drainages, the direction of groundwater flow in the surficial aquifer is generally southward in the areas of the NAS east of the runways.

Since most of NAS, Oceana has been graded, filled, paved, or otherwise disturbed, the native soil types are divided on the basis of drainage and water-table characteristics rather than by classical soil profiles and weathering of the parent rock materials (RGH, 1984). The soil types at NAS, Oceana are as follows:

- Well-drained
- Imperfectly drained
- Light-colored poorly drained
- Dark-colored poorly drained
- Miscellaneous

Surface runoff from the base drains through a series of drainage ditches, which discharge to West Neck Creek, Great Neck Creek, and London Bridge Creek. The northeast part of the facility drains into Great Neck Creek, which empties into the Broad Bay, then flows into the Lynnhaven Bay and eventually drains to the Chesapeake Bay. Drainage from the northwest part of the facility enters London Bridge Creek and the Eastern Branch of the Lynnhaven River, which flows into the Lynnhaven Bay and the Chesapeake Bay. Runoff from the southwest section of NAS, Oceana drains into West Neck Creek, which flows into the North Landing River and onto the Currituck Sound (Baker Environmental, 1991).

Ecology

Prior to acquisition of the Oceana NAS by the Navy in the early 1940s, the land was used for agricultural purposes and contained scattered tracts of forested land. In 1949 large tracts of forest existed both west and south of the aircraft runways, but by 1954 most of the forest south of the runways and approximately half of the forest west of the runways had been cleared. Since 1954 most of the forest west of the runways has been reestablished, but many of these areas are relatively young and represent shrub or immature woodlands in early stages of forest succession. Of a total of approximately 800 acres of forest and open land at Oceana NAS, forests currently comprise about 600 acres.

Most of the forests on NAS Oceana contain a mixture of loblolly pine and deciduous trees. This mixed forest community is a common cover on moderately drained soils and is among the most mature and stable of the plant communities on Oceana NAS. The topography in these forests is nearly level, often with many isolated water-filled swales. Loblolly pine usually dominates the higher ground, and red maple generally replaces it in the depressions. Other common trees of this forest cover include sweetgum, water oak, and blackgum (RGH, 1984).

Much of the land on the NAS is former swampy land that has been drained or filled. The current NAS area east of the runways where most disposal has occurred consists of urban built-up areas such as buildings, roads, and lawns. In addition, large areas adjacent to the runways have been planted in grass. Although these periodically mowed grassy areas provide little value as wildlife habitat, they are important foraging areas for animals such as white-tailed deer, eastern cottontail, and cattle egret (RGH, 1984).

In addition, successional developing plant communities are present in a number of these drained and filled areas. Because these areas have been drained and filled, the present cover contains species characteristic of upland situations. These areas typically contain a variety of grasses, shrubs, and tree seedlings and saplings. These successional developing plant communities provide habitat for game species such as eastern cottontail, American woodcock, bobwhite, mourning dove, and white-tailed deer (RGH, 1984).

An isolated forested area west of the runways is designated as wetlands on the USGS topo map. This area can be expected to contain vegetation characteristic of forested wetlands or swamp. This plant community owes its existence to periodic flooding or a high water table. Typically, red maple and bald cypress would be expected to dominate this plant community, while other species may include black willows, blackgum, and cottonwood. Because the forested wetland is within a larger mixed forest, wildlife inhabiting these two forest covers are probably similar. Typical mammals of these forests include gray squirrel, white-tailed deer, raccoon, red fox, white-footed mouse and beaver (RGH, 1984).

Some limited areas of stressed vegetation have been observed near individual SWMUs on the station. These stressed areas are described in the site descriptions in Chapter 2.

There are no ponds within the boundary of NAS Oceana. Areas north and northeast of the station that were formerly used as borrow pits have filled in with water since the end of excavation activities.

Climate

The climate of the Tidewater area is characterized as oceanic, with the nearby Atlantic Ocean and Chesapeake Bay providing a profound moderating effect. Winters are relatively mild and summers are cool. Average daily temperatures in July range from 75°F to 87°F. Winter temperatures seldom reach the freezing mark and daily highs are near 50°F. The maximum temperature recorded over a 40-year period (1939 to 1978) was 103°F; the minimum, 5°F.

The average number of frost-free days per year is 245. The first killing frost occurs around November 21, and the last around March 21. On the basis of the 40-year data record at the Naval Oceanography Command Detachment at NAS, Oceana, annual precipitation averages 45 inches, with the heaviest precipitation in the summer. Snowfall averages 7.3 inches per year.

Prevailing winds from the southwest average 12.2 miles per hour. Summer winds are "sea breezes," coming in off the ocean during the day, with land breezes returning more slowly at night. Neither northern nor tropical storms usually affect the area, but hurricanes are experienced about once every 7 years (RGH, 1984).

Regulatory and Permit Status

Resource Conservation and Recovery Act (RCRA)

NAS, Oceana currently has interim status for operation of a treatment/storage/disposal (TSD) hazardous waste facility (VA 2170024606). A RCRA Part A Permit Application for the TSD facility was submitted on November 19, 1980. Interim status was granted on January 22, 1982. The storage capacity of the facility is 8,250 gallons. A revised Part A permit application was submitted in December 1991. A Part B permit application is currently being prepared for this facility.

National Pollution Discharge Elimination System (NPDES)

NPDES Permit No. VA 0005266 was issued to NAS, Oceana in December 1986 and expired December 1991. A new permit application was submitted in December 1991. Continued discharge has been approved on an interim basis pending review of the application. This permit requires that specific discharge points be monitored and that chemical samples be collected periodically from these compliance points.

State Air Pollution Control Board

In March 1988, the State Air Pollution Control Board issued a permit (No. 60294) to NAS, Oceana, to construct and operate three oil-fired boilers.

Other Permits

NAS, Oceana also has a sewage discharge permit (0100) with Hampton Roads Sanitation District, which was issued on March 1, 1992, and expires on March 1, 1995, and a Safe Drinking Water Act, potable water requirements permit (3810430) with Virginia, which was issued on June 15, 1979, and has no expiration date.

Waste Generation and Management

Waste Generation

Oceana had its beginnings in Princess Anne County in the early 1940s as an auxiliary landing field for the Naval Air Station, Norfolk, Virginia. It expanded during World War II, and in 1952 was designated a Naval Air Station (NAS). This designation resulted in a construction program for a major runway and aircraft support facility between 1952 and 1956. Since then, most of its operational functions have remained the same. However, waste generation at Oceana generally increased over the years in response to its expanded capabilities to service carrier-based jet aircraft in the mid-1950s and the increase of the Air Intermediate Maintenance Department during the 1960s and 1970s.

Past and present operations generating hazardous waste are discussed in this section by department, division, branch, and shop. Oceana's auxiliary landing field at Fentress is also discussed here. Because of personnel changes, particularly in the squadrons, only a limited amount of information on past operations was available for presentation in this section.

Much of the petroleum, oil, and lubricant (POL) wastes generated at Oceana result from the operation and maintenance of aircraft squadrons rotated between aircraft carriers and NAS, Oceana. This presentation reports waste generation by a typical fighter and fleet squadron, taking into account the average proportion of time they are using Oceana facilities.

Typical management practices for hazardous waste and POL in the immediate past are fairly clear. In late 1981, the Public Works Department initiated a comprehensive hazardous waste pickup program, working very closely with the various shops at NAS, Oceana, to assure that wastes are properly contained, segregated, labeled, and collected. Currently, waste jet fuel (JP-5) from the squadron is managed as a segregated waste stream by placement into designated bowers. The majority of this is recycled. A portion is also burned by the Fire and Rescue Division during fire fighting training exercises. The waste fuel may contain small quantities of thinners and other solvents.

Before 1977, hazardous waste disposal practices can only be stated in very general terms because of a lack of base personnel with specific knowledge of them. Waste POLs and other nonaqueous hazardous substances were collected for use by the Fire and Rescue Division (early 1960s to 1977), for disposal in the West Woods oil disposal pit (mid-1950s to late 1960s), for application to roads for dust control, or for storage and pickup by private waste-oil dealers. Before 1977, waste POL and other hazardous wastes, both aqueous and nonaqueous, were also disposed of into storm and sanitary sewers and on the ground near aircraft maintenance shops, particularly behind the line shacks.

A summary of wastes generated at NAS, Oceana during 1989 and 1990 is presented in Table 2-1.

Waste Management

Hazardous waste generated at NAS, Oceana has been picked up by Public Works since September 1981. A shop or activity that generates industrial wastes is responsible for placing wastes in marked, properly segregated containers and sealing the containers for pickup. When a pickup is needed, the shop or activity fills out Form 1348 and calls the Public Works Trouble Call desk to request a hazardous waste pickup. Wastes are picked up from the shop or activity and taken to the hazardous waste storage facility, a fenced area located near the entrance of the Avenue D Landfill behind the Public Works Building. Typical waste pickups include paint, thinners, xylene, methyl ethyl ketone, toluene, methyl isobutyl ketone, strippers, PD-680 (solvent and gun cleaner), lacquers, and enamel. The hazardous wastes storage facility serves as a pickup point for final disposal.

Public Works is also responsible for cleaning and maintaining oil booms in stormwater drainage ditches on the station. The booms intercept floating fuel and oil from spills that have been washed off runways and maintenance pads in the hangar area. Each boom is visually inspected twice per day.

Nonhazardous solid waste on the base is placed in dumpsters by the generating unit. These are picked up on a regular basis and are carried to the Avenue D Landfill for disposal. Before 1961, wastes were carried to the Fifth Green Landfill (1954 to 1961), the North Station Landfill (1945 to 1954), and the West Side Landfill (1941 to 1945). Hazardous waste were also placed in the base landfills, however, this practice was stopped in 1981 with the implementation of the Public Works hazardous waste pickup program.

**Table 2-1
SUMMARY OF HAZARDOUS WASTE GENERATED AT NAS, OCEANA**

Waste Description	Hazardous Waste Code(s)	Amount Generated in 1989 (lbs)	Amount Generated in 1990 (lbs)
Waste Corrosives, Solids	D002	0	106
Waste Corrosives, Liquids	D002 D007	1,800	2,740
Hazardous Waste Liquid, ORM-E	F002 D003 D007 D008	10,035	8,122
Poisonous and Infectious (Poison B)	P021 P122	0	520
Hazardous Waste Substances, ORM-A	D007 F001 F002	1,145	1,954
Waste Paint and Related Material	D001 F002 F003 F005	5,505	5,312
Waste Combustible Liquids	D001	4,320	6,292
Waste Flammable Liquids	D001 F003 F005	3,175	767
Waste Compressed Gas	D001	1,681	1,555
Hazardous Waste Substances, ORM-E	D003	164	116
Oxidizers	D002 D003	33	24

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Summary of Past Investigations

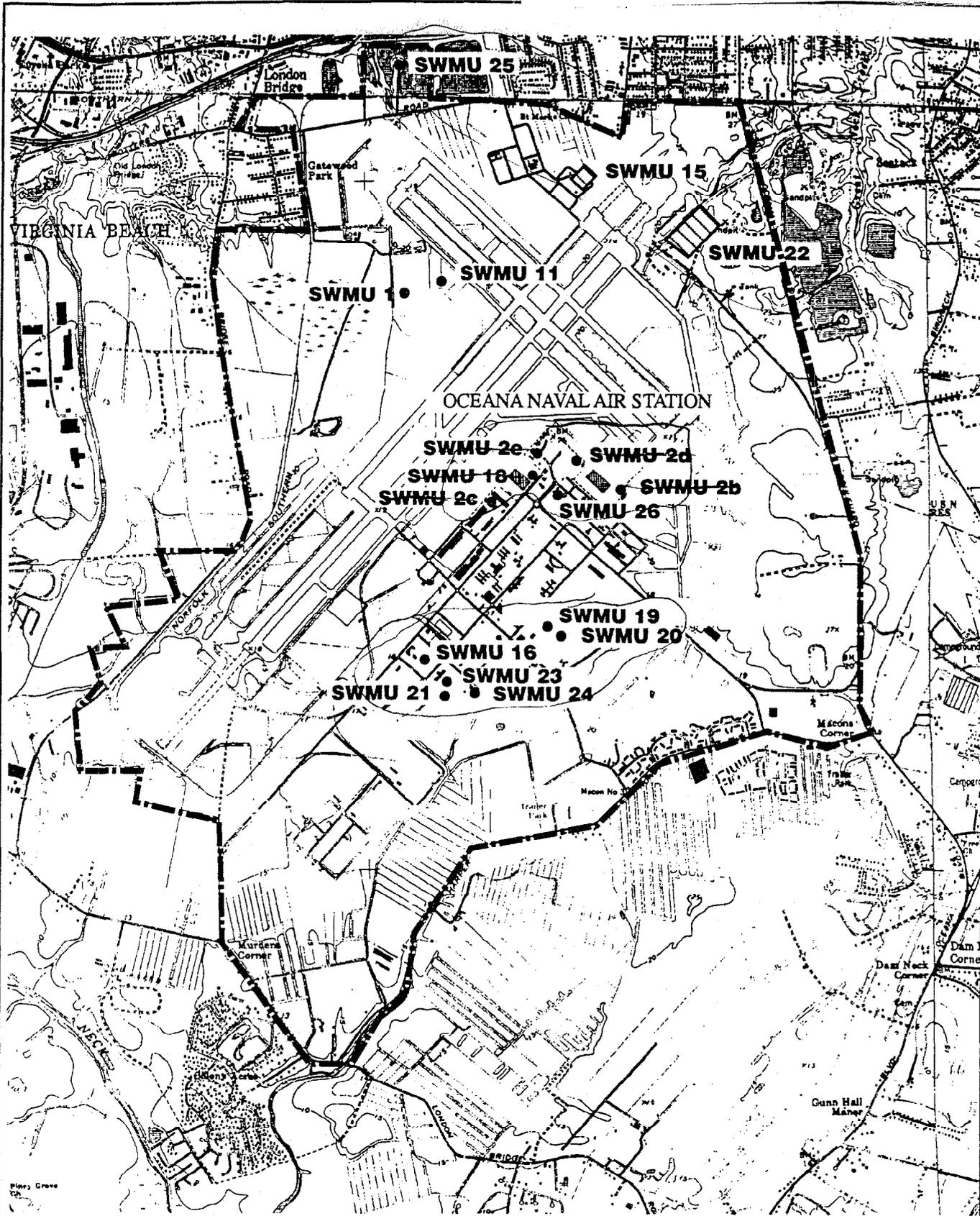
The history, environmental setting, and investigation results at each of the 19 SWMUs to be investigated as part of the RFI are described in this section. Because of their proximity, RFA SWMUs 1 and 54 have been combined into RFI SWMU 2E and RFA SWMUs 62 and 63 have been combined into RFI SWMU 11. As a result, only 17 areas will be investigated. The locations of the 17 areas are shown in Figure 2-1. The chemical data obtained during previous investigations are presented to support the technical scope of work outlined for each SWMU. Where available, maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), and proposed MCLs are presented with the chemical data. Virginia water quality criteria and standards will be evaluated along with federal standards in determining whether a Corrective Measures Study (CMS) is necessary and in establishing media cleanup standards.

✓ SWMU 1 (RFA SWMU 57)—West Woods Oil Disposal Pit

Site History

The oil disposal pit at West Woods is in the northwest part of NAS, Oceana, approximately 1,000 feet west of abandoned Runway 9 and the fire fighting training area (see Figure 2-1). According to the IAS, the site was originally an open pit in which an estimated 70,000 gallons of waste oil, fuel, aircraft-maintenance chemicals, and other liquid wastes were disposed of from the mid-1950s to the late 1960s (RGH, 1984). On the basis of a 1958 aerial photograph of the site, the pit appears to have been tens of feet in diameter. In the late 1960s, after flooding caused the pit to overflow and washed its contents toward properties off base, disposal was stopped and the pit was filled with soil (RGH, 1984). Based on the northward flow in the drainage ditch and the general westerly or northwesterly slope of the land surface near Site 1, it is likely that contaminated flood waters flowed west or northwest from Site 1 during the late-1960s flood. The boundary of the station is approximately 1,000 to 2,000 feet from the oil pit in that direction. There is no mention in the IAS of the remedial response to the offsite flow of oil (RGH, 1984).

A 1,000-foot long ditch connecting Runway 9 to the oil disposal pit was described in the IAS; however, this ditch was not visible in 1971 air photos and no evidence of it was found in a 1984 field check. This ditch was used to dispose of waste fuel and oil when the ground was too wet to allow access to the pit by disposal trucks. Subsequent investigations have failed to define the location of this ditch and no contamination associated with it has been identified.



NOT TO SCALE

Figure 2-1
LOCATIONS OF SWMUs
 RCRA Facility Investigation—Naval Air Station, Oceana

Environmental Setting

The site is relatively flat and currently wooded with mature trees and shrubs. There is no visible evidence at the ground surface of previous disposal activity. Surface drainage is directed toward a north-south-oriented drainage ditch in which there is a permanent flow of water to the north. There is a low area approximately 550 feet west of Site 1, defined as a swampy area in the USGS topographic map of NAS Oceana (USGS, 1989). However, the grassy central part of this area alongside the main western access road does not appear to be swampy. Site 1 is separated from the low areas by the 4- to 5-foot-deep drainage ditch. Shallow boreholes drilled at the site during the interim RFI and during previous investigations indicated that the near-surface geology consists of a 5- to 7-foot-thick layer of silts, clays, and fine silty sands that is underlain by an 11- to 13-foot-thick layer of clean, fine-to-coarse sand. Monitoring wells at this site are screened in this sand layer. Locally, the depth to groundwater ranges from approximately 8 to 11 feet below grade.

Investigation Results

Field investigations have been conducted at this site on two occasions: the Phase I Verification Study (CH2M HILL, 1986) and the Interim RFI (CH2M HILL, 1991). In the Phase I Verification Study, monitoring wells 01-MW1, 01-MW2, and 01-MW3 were installed. They were inadvertently located upgradient of the former pit because the pit's location was not correctly identified. Samples of groundwater collected from these wells were analyzed for VOCs, EDB, PCBs, 2,3,7,8-dioxin, and oil and grease. With the exception of oil and grease (6,000 to 15,000 $\mu\text{g/l}$), all parameters were below minimum detection limits. The wells are shown in Figure 2-2.

During the interim RFI, two shallow monitoring wells (01-MW4 and 01-MW5) were installed between the drainage ditch and the approximate location of the original pit. The three previously installed wells, along with the two new wells, were sampled during the RFI and were analyzed for VOCs, EDB, PCBs, TPH, and dioxin. The location of the two monitoring wells installed during the interim RFI are also shown in Figure 2-2.

Approximately 6 weeks after the monitoring wells were sampled for the interim RFI, surface water and sediment samples were collected from three locations in the adjacent drainage ditch. The sampling locations for these media are also shown in Figure 2-2. On the basis of results obtained from groundwater analyses, only analyses for VOC, TPH, and PCBs were performed on the surface water and sediment samples.

Water-Level Data. Water-level data were collected in August 1990 for the interim RFI, and a map of the local water-table surface was constructed (see Figure 2-3). The data are consistent with water-level data collected in 1986, and indicate that groundwater flow in the shallow, unconfined aquifer at this site is generally toward the west and most likely discharges locally into the drainage ditch.

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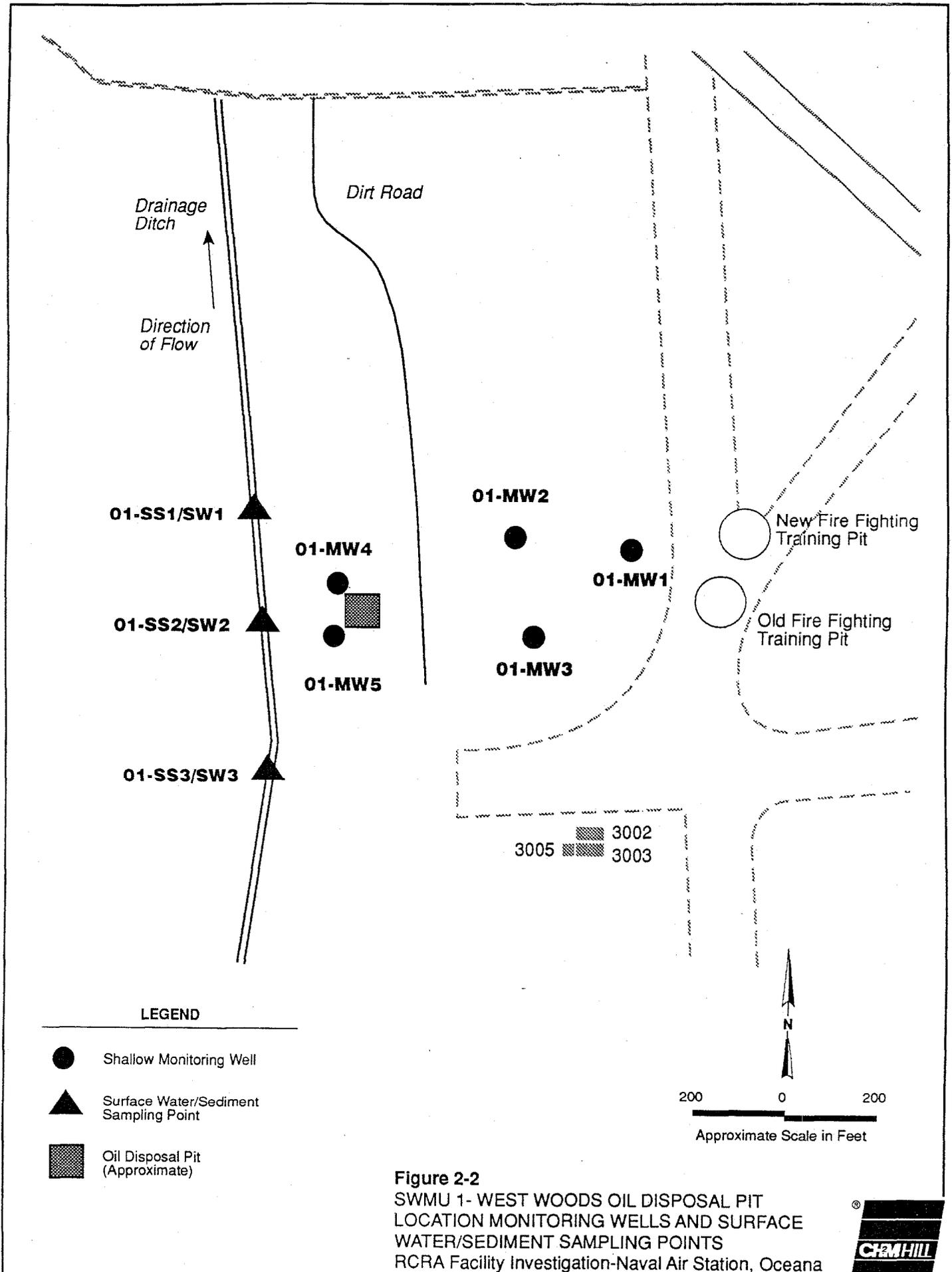
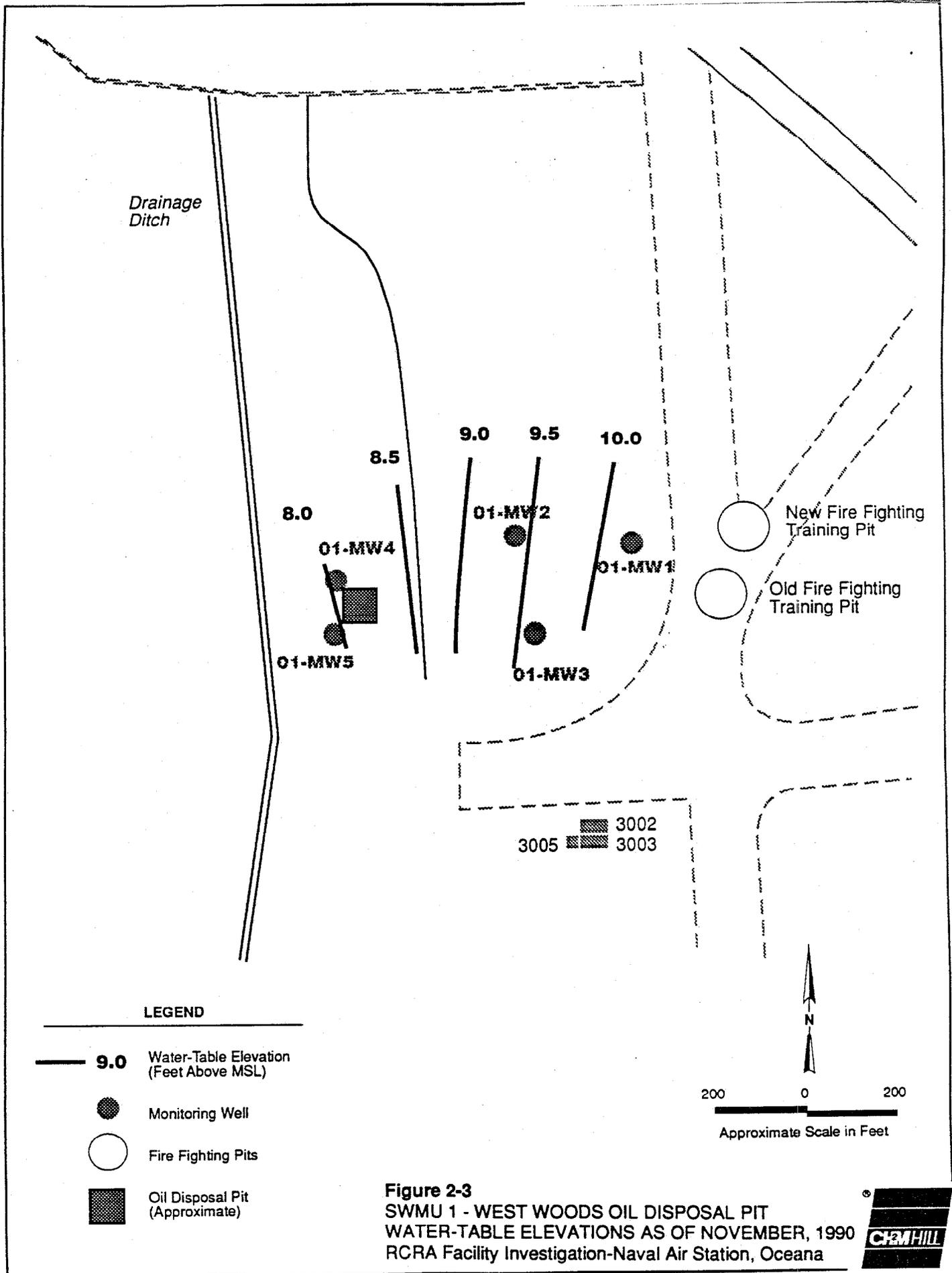


Figure 2-2
 SWMU 1- WEST WOODS OIL DISPOSAL PIT
 LOCATION MONITORING WELLS AND SURFACE
 WATER/SEDIMENT SAMPLING POINTS
 RCRA Facility Investigation-Naval Air Station, Oceana



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LEGEND

- 9.0 Water-Table Elevation (Feet Above MSL)
- Monitoring Well
- Fire Fighting Pits
- Oil Disposal Pit (Approximate)

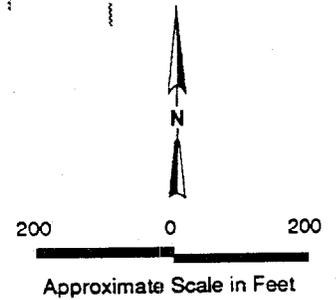


Figure 2-3
 SWMU 1 - WEST WOODS OIL DISPOSAL PIT
 WATER-TABLE ELEVATIONS AS OF NOVEMBER, 1990
 RCRA Facility Investigation-Naval Air Station, Oceana



Chemical Data. During the installation and sampling of 01-MW4 and 01-MW5, there was evidence such as strong hydrocarbon odors, oil-stained soil, detection of volatiles in cuttings by the HNu photoionization detector. During the sampling of these wells, free-product hydrocarbons were observed in distinctly immiscible liquid phases in the first gallon of purge water. Floating product was observed, as were globules of liquid at the bottom of the container of purge water. Both free product phases were black. Based on these observations, nonaqueous phase liquids with specific gravities less than and greater than water may be present in the shallow aquifer at this site.

A summary of the chemical data from the monitoring wells at this SWMU is presented in Table 2-2. Only compounds detected in the laboratory are included in the table, which also includes data obtained during the previous investigation at this site (CH2M HILL, 1986).

The groundwater data from 01-MW1 through 01-MW3 indicate that the resulting concentrations of the parameters analyzed in these wells were:

- Not detected
- Below the accurately quantifiable detection limit
- Detected at levels not significantly different than the concentration in the laboratory blank (i.e., a difference of less than a factor of ten)
- Detected at concentrations that fell below potentially applicable regulatory standards (as discussed below)

The data from 01-MW4 and 01-MW5, however, indicate the presence of TPH (254,000 and 6,770) micrograms per liter $\mu\text{g/l}$, respectively) and VOCs. PCBs also were detected in 01-MW4 (0.2 to 0.4 $\mu\text{g/l}$).

The chemical data from the surface water and sediment samples obtained during the interim RFI are presented in Table 2-3. One sample taken downstream from the former pit (01-SW1) had TPH identified above the detection limit.

Sediment samples obtained during the interim RFI contained TPH at concentrations that progressively increased from upstream to downstream locations. An order-of-magnitude increase in the concentration was observed between the upstream sample and those collected adjacent to and downstream of the former pit. The highest value (1,260 milligrams per kilogram) was reported at the downstream location (01-SD1).

Of the parameters analyzed and detected at this SWMU, none exceed the federal standards typically used by the EPA to determine whether a CMS should be implemented under RCRA corrective action (i.e, MCLs, carcinogens, toxicants, other criteria;

Table 2-2
ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 1 (WEST WOODS OIL DISPOSAL PIT)
 (All Concentrations in µg/l)

Analyte	Detection Limit	01-MW1		01-MW2		01-MW3		01-MW4		01-MW5
		5/86	8/90	5/86	8/90	5/86	8/90	8/90	8/90 Duplicate	8/90
EDB	0.02	--	--	--	--	--	--	--	--	--
PCBs:										
Aroclor-1254	0.2	--	--	--	--	--	--	0.4	0.3	--
Aroclor-1260	0.2	--	--	--	--	--	--	0.2	--	--
TCDD		<0.0002	<0.0006	<0.00017	<0.0008	<0.00021	<0.0007	<0.0038	<0.0017	<0.0008
Oil and Grease	3,000	6,000	NA	--	NA	15,000	NA	NA	NA	NA
TPH	60-8,060 ^a	NA	--	NA	140	NA	140	254,000	307,000	6,770
Volatile Organic Compounds:										
Acetone	10	--	6 ^{bj}	--	24 ^b	--	6 ^{bj}	16 ^b	15 ^b	55 ^b
Benzene	5	--	--	--	--	--	--	4 ^j	--	1 ^j
Carbon Disulfide	5	--	--	--	--	--	--	--	7	1 ^j
Ethylbenzene	5	--	--	--	--	--	--	9	42	3 ^j
Methylene Chloride	5	--	3 ^{bj}	--	8 ^b	--	6 ^{bj}	25 ^b	5 ^b	3 ^{bj}
4-Methyl-2-pentanone	10	--	--	--	--	--	--	--	--	3 ^c
Xylenes (Total)	5	--	--	--	--	--	--	26	120	14

Notes:

All volatile compounds not reported were below detection limits in all samples.

EDB = Ethylene Dibromide

TCDD = 2,3,7,8-dioxin

TPH = Total Petroleum Hydrocarbons

NA = Not analyzed

^aDetection limit range for TPH samples is particular to this site

^bCompound found in laboratory blank as well as sample; sample concentration is less than 10 times blank concentration.

^jEstimated value--measured value is less than the accurately quantitative detection limit.

(--) = Concentration below detection limit

Table 2-3 ORGANIC COMPOUNDS IN SEDIMENT/SURFACE WATER AT SWMU 1 (WEST WOODS OIL PIT) NOVEMBER 1990					
Surface Water ($\mu\text{g/l}$)					
Parameter	Detection Limit	01-SW1	01-SW2	01-SW3	01-SW3 Duplicate
PCBs	0.20-2.0 ^a	--	--	--	--
TPH	50	540	--	--	--
Volatile Organic Compounds:					
Methylene Chloride	5	9 ^b	5 ^b	11 ^b	NA
Acetone	10	9 ^{bj}	7 ^{bj}	10 ^b	NA
Carbon Disulfide	5	3 ^j	--	--	NA
Chloroform	5	2 ^j	--	--	NA
Xylenes (Total)	5	2 ^j	--	--	NA
Bromodichloromethane	5	--	--	1 ^j	NA
Sediment ($\mu\text{g/kg}$)					
Parameter	Detection Limit	01-SD1	01-SD2	01-SD3	01-SD3 Duplicate
PCBs	41-210	--	--	--	--
TPH	12,900-44,100 ^d	1,260,000	1,180,000	153,000	85,300
Volatile Organic Compounds:					
Methylene Chloride	28	--	24 ^e	90 ^e	330 ^e
Acetone	28	--	410 ^e	31 ^b	24 ^b
MEK	14	44	110	14 ^j	--
Ethylbenzene	14	95	--	--	--
Xylenes (Total)	14	110	--	--	--
Toluene	14	--	--	23	--
Notes:					
All volatile compounds not reported were below detection limits in all samples.					
TPH = Total Petroleum Hydrocarbons					
NA = Not analyzed; VOC duplicate not collected at this site.					
^a Detection limit range in water for AROCLOR-1016, 1221, 1232, 1242, 1248, 1254, and 1260					
^b Compound was found in laboratory blank as well as in sample; sample concentration was less than 10 times the blank concentration.					
^d Detection limit range in soil for TPH samples was particular to this site.					
^e Compound was found in laboratory blank as well as in sample; sample concentration was more than 10 times the blank concentration.					
^j Estimated value; measured value is less than the accurately quantitative limit.					

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Section 8.4, EPA, 1989). However, on the basis of the concentrations of TPH in the groundwater and sediment, the EPA did require further study of the SWMU to determine the specific contaminants that make up the TPH values. EPA will base its decision to require a CMS, on the results of the further SWMU study. This decision will be based on the preliminary health and environmental assessment (HEA) prepared by the Navy as part of the RFI.

✓ ***SWMU 2b (RFA SWMU 53)—Line Shack 130-131 Disposal Area*** *Matwing Side*

Site History

SWMU 2b is made up of the area in the vicinity of Line Shacks 130 and 131 (see Figure 2-1). SWMU 2b includes aircraft maintenance areas and five aircraft cleaning stations. The line shacks were constructed in 1963. According to the IAS, up until the early 1980s, waste oils and aircraft maintenance chemicals were dumped onto the ground in unknown amounts adjacent to these line shacks (RGH, 1984).

Environmental Setting

Much of the site is on the flight line. As a result, much of the ground surface is flat and covered with concrete or asphalt. Cores bored through the concrete reveal that it is approximately 18 inches thick and reinforced with large aggregate up to 4 inches in diameter. Off the flight line, the site encompasses an open grassy field and wooded areas with mature trees. The grassy area is mowed periodically. Runoff from the flight line is directed to drains that discharge to ditches which direct flow offsite. Drains in the vicinity of aircraft cleaning stations direct runoff to oil-water separators prior to discharge to local drainage ditches. Off the flight line, there are two drainage ditches that direct surface water off the site. Only one of these ditches carries perennial flow. The other ditch carries storm runoff and only flows intermittently.

On the basis of boreholes drilled during previous investigations, the shallow (approximately 20 feet deep) subsurface geology generally consists of three stratigraphic layers. The first is a 7- to 10-foot-thick unit of fine sediments, mainly silty clay and sandy silt. This unit is underlain by a 5- to 10-foot-thick layer of fine-to-medium sand, which in turn is underlain by a layer of silty sand. All monitoring wells at this site are screened over parts of the middle sand and lower silty sand units. Locally, the average depth to groundwater ranges from approximately 5 to 8 feet below the ground surface.

Investigation Results

Field investigations have been conducted at this site on three occasions: The Phase I Verification Study (CH2M HILL, 1986), the Line Shack Inspection Study (CH2M HILL, 1988), and the interim RFI (CH2M HILL, 1991). Work performed during the Phase I Verification Study involved the installation and sampling of three monitoring wells (2B-MW1, 2B-MW2, and 2B-MW3). The chemical analyses included EDB,

VOCs, and oil and grease. Concentrations of VOCs were detected in all three wells, and in two of the wells (2B-MW1 and 2B-MW3); the concentrations of both vinyl chloride (VC) and trichloroethylene (TCE) exceeded their respective federal maximum contaminant levels (MCLs).

A line-shack inspection investigation was conducted in 1988 for reasons related to the contamination detected in 1986. Three monitoring wells (2B-MW4, 2B-MW5, and 2B-MW6) were installed for that study. These wells were located in a separate potential source area cross-gradient from the three previously installed wells. All six wells were sampled, however. VOCs were detected in the three original wells, thus reconfirming previously collected VOC data. VOCs were also detected in one of the newly installed wells (2B-MW5).

During the interim RFI, sampling was conducted in 11 shallow monitoring wells (2B-MW1 through 2B-MW11) and at two surface water locations (2B-SW1, 2B-SW2). In situ hydraulic conductivity tests were conducted in six monitoring wells (2B-MW5, 2B-MW7, and 2B-MW8 through 2B-MW11). All water samples were analyzed for VOCs, EDB, and TPH. The locations of these wells are shown in Figure 2-4.

Water-Level Data. Water-level data for all wells at SWMU 2b were collected in August 1990 during the interim RFI, and a water-table contour map was constructed (see Figure 2-5). The 1990 data are consistent with the water-level measurements of 1986 and 1988 and indicate that shallow, unconfined groundwater at this site generally flows in a direction ranging from the southwest to the southeast.

Hydraulic Conductivity Data. During the interim RFI, in situ hydraulic conductivity tests were performed at 6 of the 11 monitoring wells within this area. Results from these tests are summarized in Table 2-4. The values calculated at this site range from 1×10^{-3} centimeters per second (cm/s) to 4×10^{-3} cm/s. This range is typical of the hydraulic conductivity in clean to silty sands (Freeze and Cherry, 1979) and is also consistent with the stratigraphy encountered at this site.

The interim RFI calculated a range of average linear groundwater velocities in the northeastern part of the site and estimated that the average linear groundwater velocity in this area is between approximately 14 and 84 feet per year.

Chemical Data. The organic chemical data obtained to date from all monitoring wells are shown in Table 2-5. Data on dissolved metals concentrations collected in 1988 from the six previously installed wells are summarized in Table 2-6 (CH2M HILL, 1989). The analytical data on the two surface water samples are presented in Table 2-7. Finally, VOC data on soil samples collected from 14 shallow boreholes in 1988 (CH2M HILL, 1989) are presented in Table 2-8. The locations of these boreholes are shown in Figure 2-6.

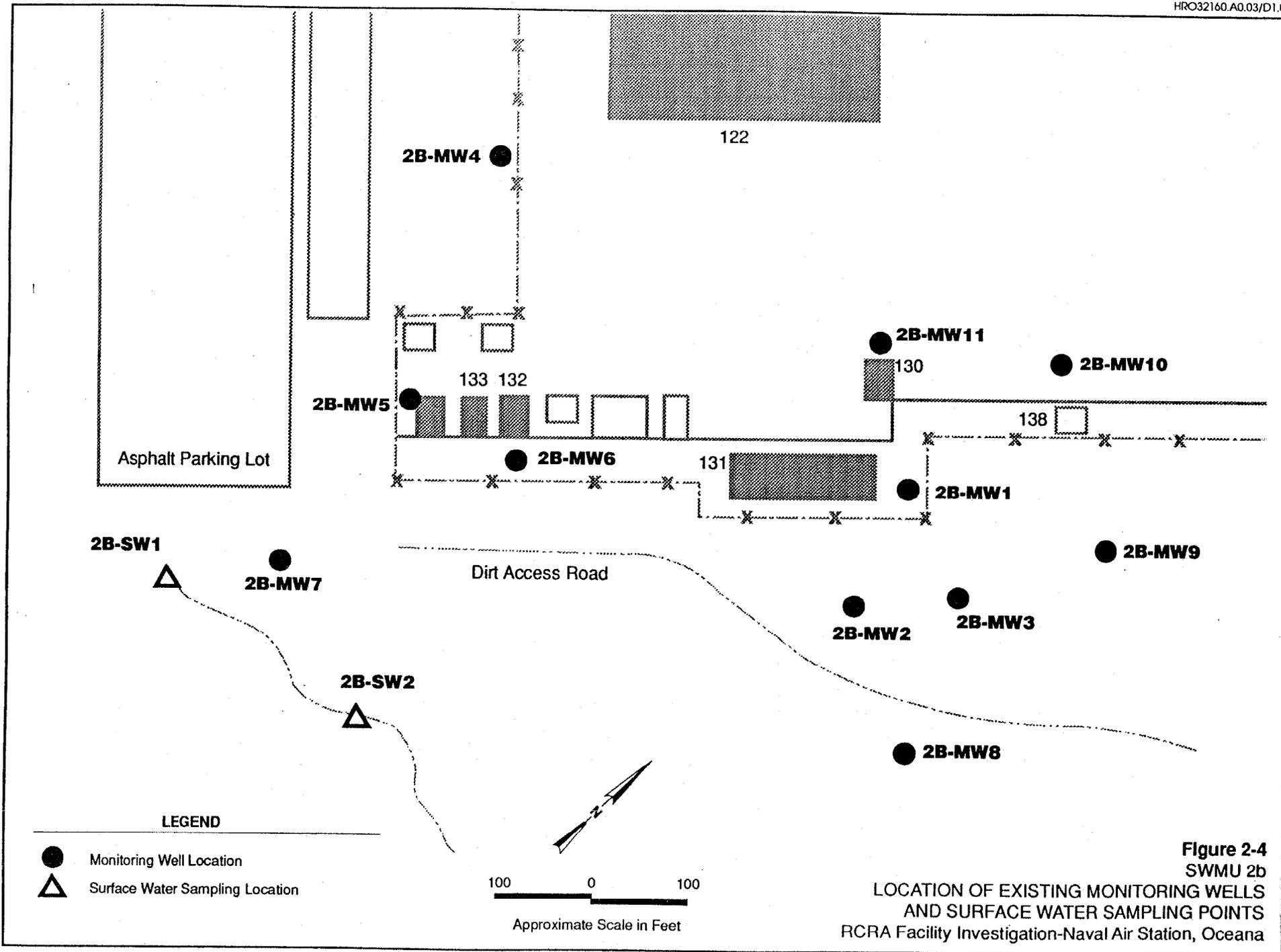
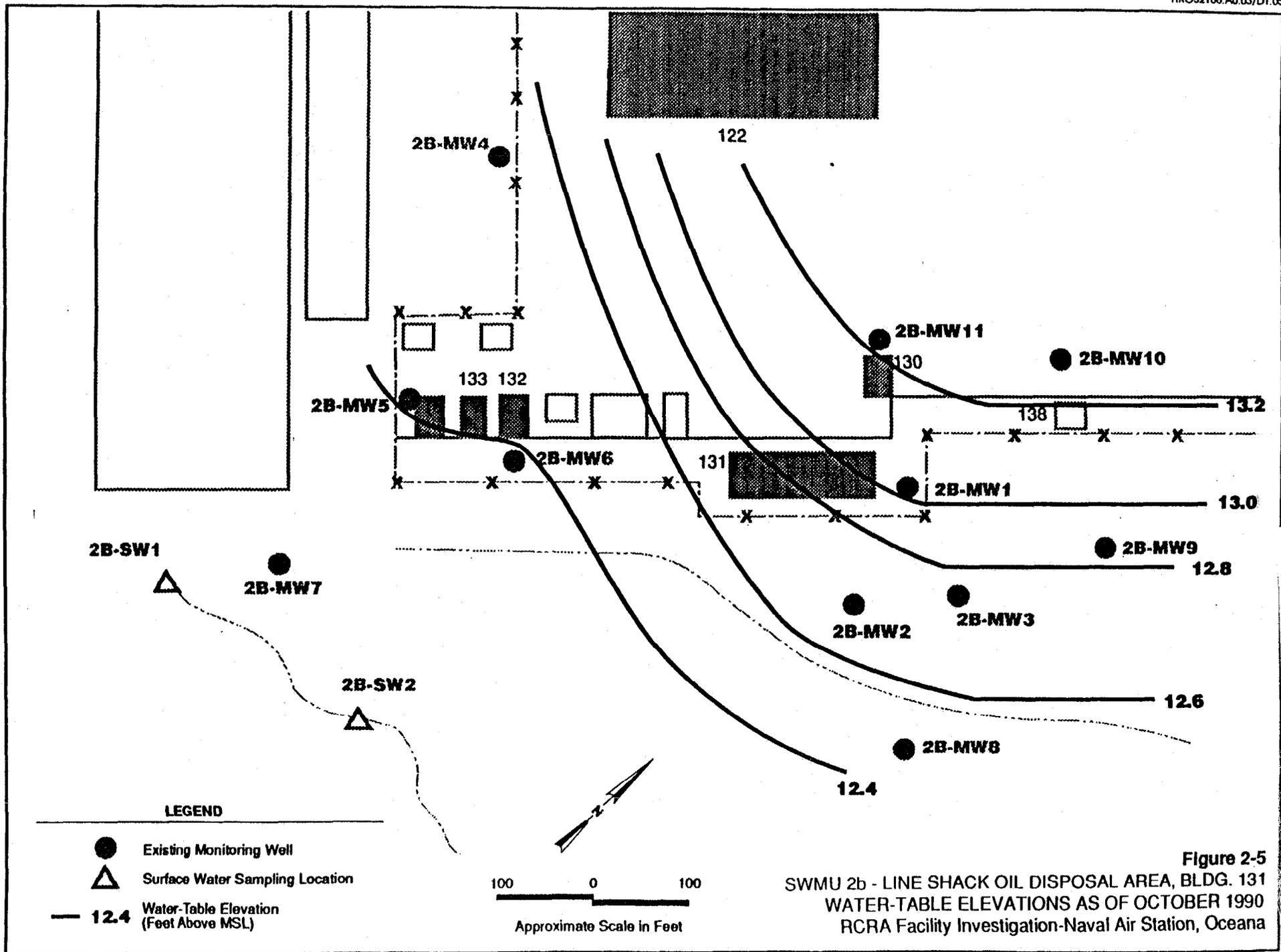


Figure 2-4
SWMU 2b
LOCATION OF EXISTING MONITORING WELLS
AND SURFACE WATER SAMPLING POINTS
RCRA Facility Investigation-Naval Air Station, Oceana

OC-00011-03.08-06/01/92



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Table 2-4
SWMU 2b IN SITU HYDRAULIC CONDUCTIVITY
TEST RESULTS AT LINE SHACK OIL DISPOSAL AREA
(BUILDING 131)

Well	Hydraulic Conductivity (cm/sec)
2B-MW5	2×10^{-3}
2B-MW7	4×10^{-3}
2B-MW8	3×10^{-3}
2B-MW9	3×10^{-3}
2B-MW10	3×10^{-3}
2B-MW11	1×10^{-3}

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Table 2-5
ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 2b, LINE SHACK 130-131 DISPOSAL AREA
 (All concentrations in µg/l)

ANALYTE	Detection limit	2B-MW1					2B-MW2			2B-MW3		
		5/86	9/88	Duplicate 9/88	8/90	Duplicate 8/90	5/86	9/88	8/90	5/86	9/88	8/90
EDB	0.02	--	NA	NA	--	--	--	NA	--	--	NA	--
Oil and Grease	3,000	3,000	NA	NA	NA	NA	5,000	NA	NA	5,000	NA	NA
TPH	60	NA	NA	NA	220	210	NA	NA	110	NA	NA	70
Volatle Organic Compounds:												
Acetone	10	--	--	--	22 ^{bj}	24 ^{bj}	--	--	5 ^{bj}	--	--	35 ^b
Benzene	5	--	--	--	--	--	--	--	--	--	--	--
2-Butanone (MEK)	10	--	--	--	--	--	--	--	--	21	--	--
Carbon disulfide	5	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	10	2.0	--	--	--	--	--	--	--	--	--	--
Chloroform	5	--	--	--	--	--	2.8	--	--	--	--	--
1,1-Dichloroethane	5	170	82	52	50	49	--	--	--	3.2	44	18
1,2-Dichloroethane	5	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethylene	5	25	13	6	10 ^j	11 ^j	--	--	--	--	420	--
1,2-Dichloroethylene (total)	5	NA	340	290	400	400	NA	--	5	NA	--	140
Trans-1,2-dichloroethylene	5	800	NA	NA	NA	NA	--	NA	NA	29	NA	NA
2-Hexanone	10	--	--	--	--	--	--	--	--	9.1	--	--
4-Methyl-2-pentanone (MIBK)	10	--	--	--	--	--	--	--	--	6.6	--	--
Methylene chloride	5	--	--	--	6 ^{bj}	7 ^{bj}	--	--	5 ^b	--	--	10 ^b
1,1,2,2-Tetrachloroethane	5	--	--	--	--	--	--	--	--	2.4	--	--
Toluene	5	--	--	--	--	--	--	--	--	3.4	--	--
Trichloroethylene	5	1,300	330	340	230	280	3.7	5	7	58	820	230
Vinyl chloride	10	99	31	27	30	37	--	--	--	3.0	--	--

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Table 2-5
ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 2b, LINE SHACK 130-131 DISPOSAL AREA
(All concentrations in µg/l)

ANALYTE	Detection limit	2B-MW4		2B-MW5		2B-MW6		2B-MW7	2B-MW8	2B-MW9	2B-MW10	2B-MW11
		9/88	8/90	9/88	8/90	9/88	8/90	8/90	8/90	8/90	8/90	8/90
EDB	0.02	NA	--	NA	--	NA	--	--	--	--	--	--
Oil and Grease	3,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH	60	NA	390	NA	200	NA	290		130	300	140	240
Volatile Organic Compounds:												
Acetone	10	--	6 ^{bj}	--	6 ^{bj}	--	8 ^{bj}	14 ^b	26 ^b	5 ^{bj}	5 ^{bj}	6 ^{bj}
Benzene	5	--	--	--	1 ^j	--	--	2 ^j	--	--	1 ^j	--
2-Butanone (MEK)	10	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	5	--	3 ^j	--	--	--	--	--	--	--	--	--
Chloroethane	10	--	--	--	--	--	--	4 ^j	--	--	--	--
Chloroform	5	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	5	--	--	7	12	--	--	110	--	--	16	--
1,2-Dichloroethane	5	--	--	--	--	--	--	3 ^j	--	--	--	--
1,1-Dichloroethylene	5	--	--	49	4 ^j	--	--	4 ^j	--	--	2 ^j	--
1,2-Dichloroethylene (total)	5	--	--	--	6	--	3	40	--	--	24	--
Trans-1,2-dichloroethylene	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone (MBK)	10	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-pentanone (MIBK)	10	--	--	--	--	--	--	27	--	--	--	--
Methylene chloride	5	--	5 ^b	--	5 ^b	--	5 ^b	4 ^{bj}	8 ^{bj}	5 ^{bj}	3 ^{bj}	4 ^{bj}
1,1,2,2-Tetrachloroethane	5	--	--	--	--	--	--	--	--	--	--	--

Table 2-5
ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 2b, LINE SHACK 130-131 DISPOSAL AREA
 (All concentrations in $\mu\text{g/l}$)

ANALYTE	Detection limit	2B-MW4		2B-MW5		2B-MW6		2B-MW7	2B-MW8	2B-MW9	2B-MW10	2B-MW11
		9/88	8/90	9/88	8/90	9/88	8/90	8/90	8/90	8/90	8/90	8/90
Toluene	5	--	--	--	--	--	--	1 ^j	--	--	--	--
Trichlorethylene	5	--	--	22	3 ^j	--	--	18	--	2 ^j	--	--
Vinyl chloride	10	--	--	55	--	--	22	58	--	--	--	--

Notes:

EDB = Ethylene Dibromide

NA = Not analyzed

TPH = Total Petroleum Hydrocarbons

^bCompound found in laboratory blank as well as sample. Sample concentration is less than 10 times blank concentration.

^jEstimated value. Measured value is less than the accurately quantitative detection limit.

(--) = Concentration below detection limit

Table 2-6
RESULTS OF METALS ANALYSIS OF GROUNDWATER AT SITE 2B, LINE SHACK 130-131 DISPOSAL AREA
LINE SHACK SITE INSPECTION, SEPTEMBER 1988
 (All concentrations in µg/l)

Parameter	2B-MW1	2B-MW1 Duplicate	2B-MW2	2B-MW3	2B-MW4	2B-MW5	2B-MW6
Silver	<3	<3	<3	<3	<3	<3	<3
Aluminum	<200	<200	<200	<200	<200	<200	<200
Arsenic	<5	<5	<5	<5	<5	13	17
Barium	<200	<200	<200	<200	<200	<200	<200
Beryllium	<5	<5	<5	<5	<5	<5	<5
Calcium	14,500	13,500	42,200	104,000	47,500	37,600	16,800
Cobalt	<50	<50	<50	<50	<50	<50	<50
Chromium	<10	<10	<10	<10	<10	<10	<10
Copper	<25	<25	<25	<25	<25	70	<25
Iron	5,840	5,670	1,340	7,470	12,100	23,400	13,700
Mercury	0.4	<0.2	<0.2	1.0	<0.2	<0.2	0.5
Potassium	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000
Magnesium	15,700	14,800	5,600	10,000	16,300	26,300	8,200
Manganese	190	190	310	640	420	1,000	390
Sodium	42,800	40,300	24,000	62,900	25,600	23,300	14,000
Nickel	<40	<40	<40	<40	<40	<40	<40
Lead	<5	<5	<5	<5	<5	<5	<5
Antimony	<5	<5	<5	<5	<5	<5	<5
Selenium	<5	<5	<5	<5	<5	<5	<5
Thallium	<5	<5	<5	<5	<5	<5	<5
Vanadium	<50	<50	<50	<50	<50	<50	<50
Zinc	170	160	50	160	220	170	130

Table 2-7
ORGANIC COMPOUNDS IN SURFACE WATER AT SITE 2B,
LINE SHACK 130-131 DISPOSAL AREA, AUGUST 1990
 (All Concentrations in $\mu\text{g/l}$)

Analyte	Detection Limit	2B-SW1	2B-SW2
EDB	0.02	--	--
TPH	60	1,770	2,610
Volatile Organic Compounds:			
Acetone	10	19 ^b	12 ^b
2-Hexanone	10	1 ^j	--
Methylene Chloride	5	4 ^{bj}	4 ^{bj}
Xylenes (Total)	5	2 ^{bj}	--
<p>Notes: EDB = Ethylene Dibromide TPH = Total Petroleum Hydrocarbons (--) = Concentration below detection limit ^bCompound found in laboratory blank as well as sample; concentration is less than 10 times blank concentration. ^jEstimated value; measured value is less than the accurately quantitative detection limit. Compounds from the TCL-VOA scan not listed in this table were below detection limits in all samples.</p>			

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Table 2-8
 VOLATILE ORGANIC COMPOUNDS IN SOIL SAMPLES AT SITES 2B, LINE SHACK 130-131 DISPOSAL AREA
 September 1988
 (Concentrations in µg/kg)

Soil Boring No.	Acetone	Methylene Chloride	Benzene	Ethylbenzene	Toluene	Xylenes (Total)	2-Butanone (MEK)	4-Methyl-2-pentanone	Carbon Disulfide	Trichloroethylene
B1 - S1	--	64	--	--	--	--	--	--	--	--
B1 - S2	--	580	--	--	--	--	--	--	--	--
B1 - S3	--	15	--	--	--	--	--	--	--	--
B2 - S1	--	--	--	--	--	--	--	--	--	--
B2 - S2	--	--	--	--	--	--	--	--	--	--
B2 - S3	140	840	--	--	--	--	--	--	--	--
B3 - S1	--	130	--	85	--	480	--	--	--	--
B3 - S2	--	--	--	--	--	--	--	--	10	--
B3 - S3	180	660	--	--	--	--	--	--	--	32
B4 - S1	65	390	--	11	10	18	--	--	--	--
B4 - S2	26	30	--	--	--	--	--	--	13	--
B4 - S3	--	78	--	--	--	--	--	--	--	54
B5 - S1	--	--	--	--	--	--	--	--	--	--
B5 - S2	--	--	--	--	--	--	--	--	--	--
B5 - S3	--	--	--	--	--	--	--	--	--	--
B6 - S1	--	220	--	--	6	--	--	--	--	--
B6 - S2	--	300	--	--	--	--	--	--	--	--
B6 - S3	--	260	--	--	--	--	--	--	--	--
B7 - S1	--	160	--	--	--	--	--	--	--	--
B7 - S2	--	180	--	--	--	--	--	--	--	--
B7 - S3	--	26	--	--	--	--	--	30	--	--
B8 - S1	38	12 ^a	--	7	--	7	--	--	--	--
B8 - S2	63	17 ^a	12	32	110	7	--	--	10	--
B8 - S3	--	160	--	--	--	--	--	--	--	--

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Table 2-8
VOLATILE ORGANIC COMPOUNDS IN SOIL SAMPLES AT SITES 2B, LINE SHACK 130-131 DISPOSAL AREA
 September 1988
 (Concentrations in $\mu\text{g}/\text{kg}$)

Page 2 of 3

Soil Boring No.	Acetone	Methylene Chloride	Benzene	Ethylbenzene	Toluene	Xylenes (Total)	2-Butanone (MEK)	4-Methyl-2-pentanone	Carbon Disulfide	Trichloroethylene
B9 - S1	82	12 ^a	--	--	--	--	--	--	--	--
S2	--	13 ^a	--	--	--	--	--	--	--	--
S3	57	31 ^a	--	--	--	--	--	--	--	--
B10 - S1	92	41 ^a	--	--	--	--	--	--	--	--
S2	240	--	--	--	--	--	27	--	--	--
S3	--	--	--	--	--	--	--	--	--	--
B11 - S1	--	14 ^a	--	--	--	--	--	--	--	--
S2	--	460 ^e /140 ^b	--	--	17 ^b /6 ^a	--	--	--	--	--
S3	--	150 ^b	--	--	--	--	--	--	--	--
B12 - S1	--	17 ^a	--	--	--	--	--	--	--	--
S2	47 ^a	16 ^a	--	--	--	--	17	--	18	--
S3	28 ^a	--	--	--	--	--	--	--	--	--
B13 - S1	--	24	--	--	--	--	--	--	--	--
S2	--	69	--	--	--	--	--	--	--	--
S3	--	--	--	--	--	--	--	--	--	--
B14 - S1	--	55 ^a	--	--	--	--	--	--	--	--
S2	57	--	--	--	--	--	--	--	--	--
S3	--	15 ^a	--	--	--	--	--	--	--	--
B15 - S1	14	17 ^a	--	--	--	--	--	--	--	--
S2	--	17 ^a	--	--	--	--	--	--	--	--
S3	--	12 ^d /21 ^a	--	--	--	--	--	--	--	--

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Table 2-8
VOLATILE ORGANIC COMPOUNDS IN SOIL SAMPLES AT SITES 2B, LINE SHACK 130-131 DISPOSAL AREA
September 1988
(Concentrations in $\mu\text{g}/\text{kg}$)

Page 3 of 3

Soil Boring No.	Acetone	Methylene Chloride	Benzene	Ethylbenzene	Toluene	Xylenes (Total)	2-Butanone (MEK)	4-Methyl-2-pentanone	Carbon Disulfide	Trichloroethylene
MW4 - S1	34 ^a	36 ^a	--	--	--	--	--	--	--	--
S2	49 ^a	19 ^a	--	--	--	--	--	--	--	--
S3	39 ^a	32 ^a	--	--	--	--	--	--	--	--
MW5 - S1	47 ^a	--	--	--	--	--	--	--	--	--
S2	120 ^a	120 ^b	--	--	--	--	--	--	--	--
S3	--	--	--	--	--	--	--	--	--	--
MW6 - S1	--	--/20 ^a	--	--	--	--	--	--	--	--
S2	41 ^a	--	--	--	--	--	--	--	--	--
S3	--	490 ^b	--	--	--	--	--	--	--	--
Surface Soil No.										
SS1	--	430	--	--	--	--	--	--	--	--
SS2	--	--	--	--	--	--	--	--	--	--
SS3	--	--	--	--	--	--	--	--	--	--
SS4	57	42 ^a	--	--	--	--	--	--	--	--
SS5	--	21 ^a	--	--	--	--	--	--	--	--

Notes:

12/12 Indicates sample result and duplicate sample result.
 All values not reported were below detection limits.

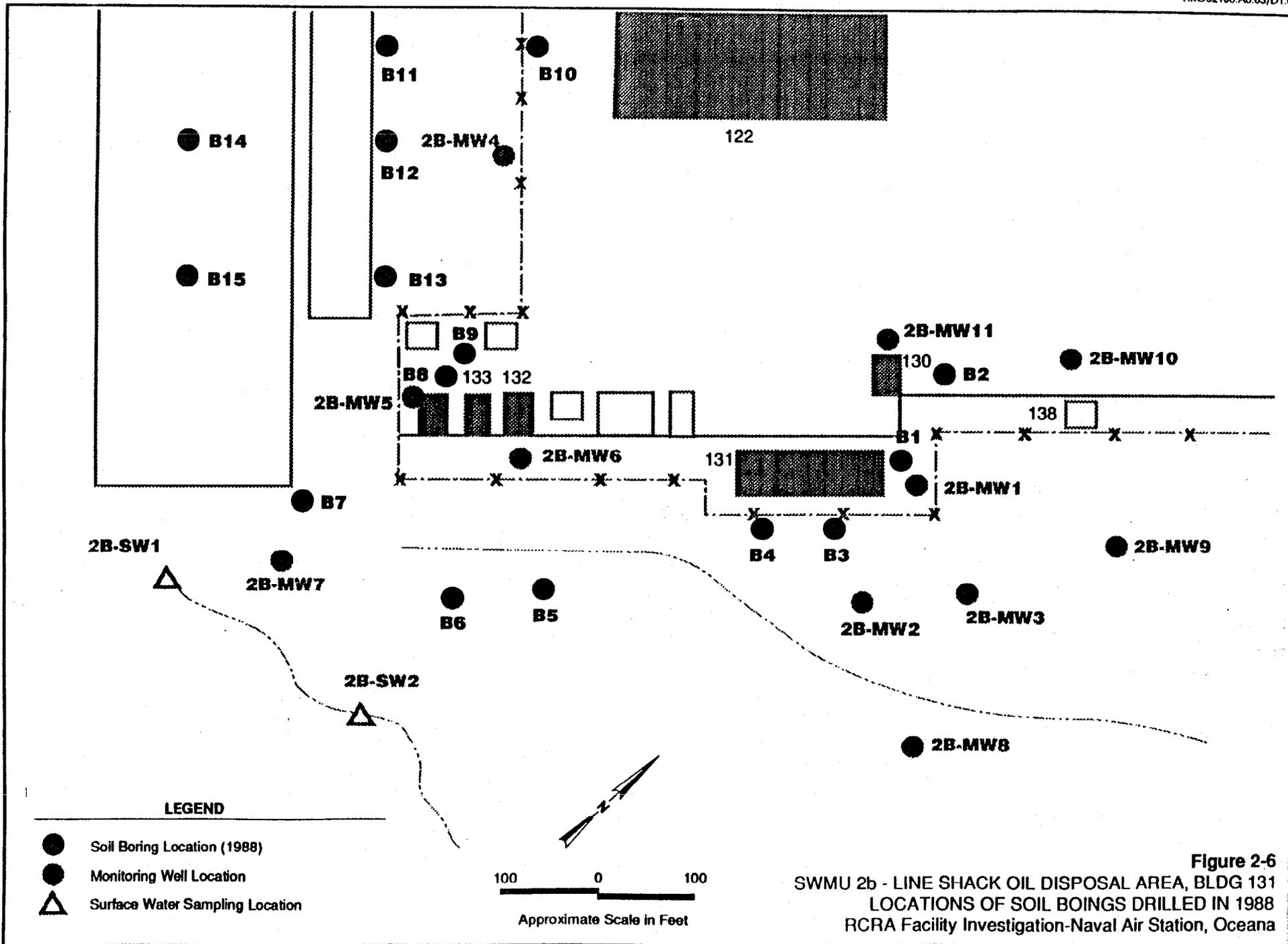
Sample Depths:
 S1--0 to 2 feet
 S2--3 to 5 Feet
 S3--8 to 10 feet

^aCompound found in blank as well as in sample. Sample concentration less than 10 times blank concentration.

^bCompound found in blank as well as in sample. Sample concentration greater than 10 times blank concentration.

(--)= not detected

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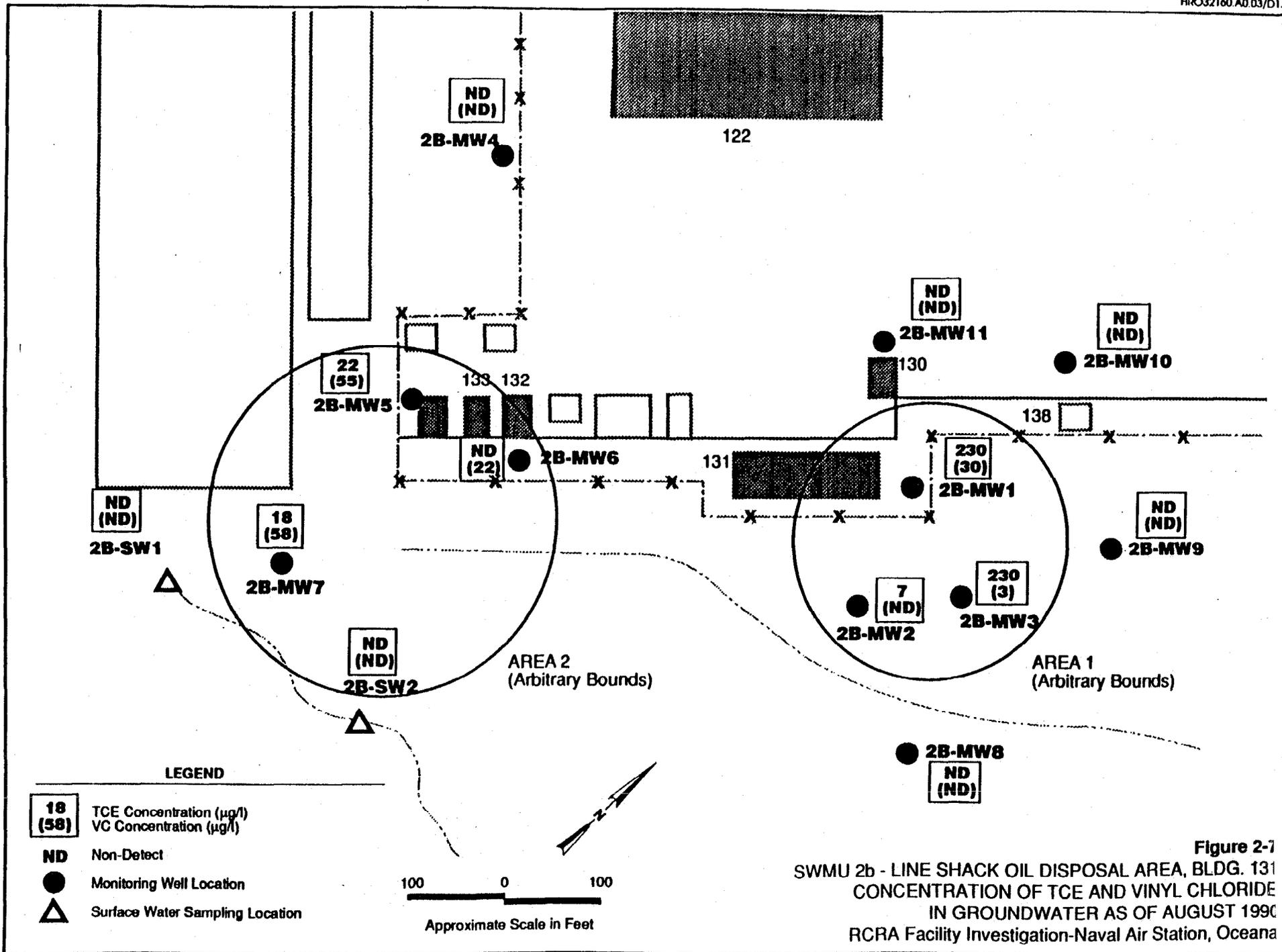
The chemical data indicate that various VOCs, particularly chlorinated hydrocarbons, are present in the groundwater at this SWMU. The most commonly detected contaminants include VC, TCE, 1,2-dichloroethylene (1,2-DCE), and 1,1-dichloroethane (1,1-DCA).

Figure 2-7 shows the concentrations of TCE and VC at each sampling point as of August 1990. The data shown in the figure indicate that the distribution of these two contaminants appears concentrated into two separate areas of the site. One area (Area 1) is located immediately east of Line Shack 131 and is identified by the contaminants in wells 2B-MW1 through 2B-MW3. The other area (Area 2) is south of Buildings 132 and 133, where wells 2B-MW5 through 2B-MW7 are located. Given the general pattern of shallow groundwater flow across the site, the two localized areas of contamination suggest the presence of at least two separate sources for the chemicals detected in the groundwater.

The contamination in Area 1 was first identified in 1986 (CH2M HILL, 1986). Since then, the VOC concentrations in this area have changed over time, but the relative difference in concentrations among the three affected wells has changed little. Well 2B-MW1 has typically contained the highest level of VOC contamination at this site, suggesting that it is located relatively close to a contaminant source. However, the total concentration of VOCs detected in 2B-MW1 declined by more than half (from roughly 2,400 $\mu\text{g/l}$ to approximately 750 $\mu\text{g/l}$) between 1986 and 1988, and between 1988 and 1990; there has been essentially no change in the total VOC concentration in 2B-MW1. The general trend with time suggests that the source may be inactive or at least less active than at previous times.

The nearest wells downgradient of 2B-MW1 (2B-MW2 and 2B-MW3) have very different records of contamination from each other. Concentrations of total VOCs in 2B-MW2 have consistently remained at least two orders of magnitude less than in 2B-MW1, despite the apparent direction of groundwater flow from 2B-MW1 toward 2B-MW2 and the relatively short distance (less than 150 feet) between these wells. According to the interim RFI, one possible explanation may be that 2B-MW2 is screened over a slightly (5 feet) deeper interval than 2B-MW1, and this difference may be enough to reduce the level of contamination detected in 2B-MW2.

Another possible explanation discussed in the interim RFI may be that the contaminants have not had sufficient time to reach 2B-MW2 from 2B-MW1. Using the values of average linear groundwater velocity determined for this site, one can generate a range of estimated travel times for groundwater to migrate from 2B-MW1 to 2B-MW2, a distance of approximately 120 feet. The resulting travel times range from 1.5 to 8.5 years. As described above, these values correspond to values of average linear groundwater velocities, and do not take into account various physical and chemical mechanisms such as sorption that are likely to occur and would act to increase the travel time figures. Also not taken into account is the presence of more permeable



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geologic zones that would decrease the travel time. The absence of significant VOC contamination in 2B-MW2 may indicate only that the contaminant plume has not yet arrived.

The total concentration of VOCs in 2B-MW3 has generally increased over the last 4 years. The VOC concentrations were higher in 1988 when the concentrations of 1,1-DCE and TCE were particularly high (420 and 820 $\mu\text{g/l}$, respectively). Well 2B-MW3 is not along a downgradient streamline from 2B-MW1, but the source of contamination to both wells could be the same. The elevated TCE concentration in 1988 could be the result of a discontinuous source that caused a "pulse" of contamination to pass by the well at that time. This pulse would also be consistent with the chemical data in 2B-MW1. It is not obvious what caused the one-time occurrence of high levels of 1,1-DCE in 2B-MW3 in 1988.

The contamination in Area 1 is generally bounded laterally to the north and east by wells 2B-MW8 through 2B-MW11. The chemical data from each of these wells do not indicate the presence of VOC contamination, with the exception of 2B-MW10. Although 2B-MW10 is the farthest upgradient in the area, the compounds detected in this well--1,1-DCA (16 $\mu\text{g/l}$) and 1,2 DCE (24 $\mu\text{g/l}$)--do not suggest that the source of the principal VOC contamination in Area 1 (i.e., TCE and VC) is located this far upgradient.

The interim RFI describes contamination in Area 2 as less well defined because Area 2 lacks the concentration of monitoring wells found in Area 1. Initial evidence of VOC contamination in this area was discovered in 1988 with the Line Shack Investigation (CH2M HILL, 1989). At that time, however, VC was not detected in 2B-MW6.

Concentrations of contaminants detected in groundwater are compared to relevant federal standards in Table 2-9. The standards presented in this table are based on the criteria used by the EPA in its determination of whether interim corrective measures (ICMs) or a CMS would be appropriate at this site (EPA, 1989). If available, the Safe Drinking Water Act maximum contaminant level (MCL) is used as the principal criterion in the EPA's health and environmental assessment under RCRA. Should a particular contaminant not have an MCL, then the evaluation process uses other criteria such as specific health-based standards for carcinogens and systemic toxicants, or Clean Water Act water quality criteria. Because all of the detected contaminants have either an associated MCL, proposed MCL, or an MCL goal (MCLG), the analytical data were compared only against these standards. The concentrations of four VOCs exceed at least one standard at this location. TCE concentrations exceed the MCL (i.e., 5 $\mu\text{g/l}$) in four wells. Two of these wells (2B-MW1 and 2B-MW3) exceed the MCL by two orders of magnitude. VC concentrations exceed the MCL (i.e., 2 $\mu\text{g/l}$) in three wells (2B-MW1, 2B-MW6, and 2B-MW7).

Table 2-9
CONTAMINANTS PRESENT AT SWMU 2b IN CONCENTRATIONS GREATER THAN
POTENTIALLY APPLICABLE FEDERAL STANDARDS
AT LINE SHACK OIL DISPOSAL AREA (BLDG 131)
August 1990
(Concentrations in $\mu\text{g/l}$)

Chemical	Location Detected	Concentration	MCL	MCLG	Proposed MCL
1,1-Dichloroethylene	2B-MW1	10 ^j	7	7	--
1,2-Dichloroethylene (total)	2B-MW1	400	-- ^a	--	70/100 ^a
	2B-MW3	140			
Trichloroethylene	2B-MW1	230	5	Zero	--
	2B-MW2	7			
	2B-MW3	230			
	2B-MW7	18			
Vinyl chloride	2B-MW1	30	2	Zero	--
	2B-MW6	22			
	2B-MW7	58			

Notes:

MCL = Safe Drinking Water Act Maximum Contaminant Level is the maximum permissible level of a contaminant in water, which is delivered to any user of a public water system. Standards current as of April 1990.

MCLG = Safe Drinking Water Act Maximum Contaminant Level Goal is a nonenforceable concentration of a drinking water contaminant that is protective of adverse human health effects and allows an adequate margin of safety. Standard given is current as of April 1990.

(-) = Concentration below detection limit

^a70 $\mu\text{g/l}$ and 100 $\mu\text{g/l}$ were standards for cis- and trans-isomers, respectively. "Total" includes both isomers. As of April 1991, these proposed MCLs have been approved as MCLs.

^jEstimated value. Measured value was less than the quantitative detection limit.

The analytical results from the two samples of surface water obtained during the interim RFI from the perennially flowing ditch indicate that the VOC contamination detected in the local groundwater has not been detected in the ditch. Concentrations of TPH were detected in both surface-water locations (1,770 $\mu\text{g/l}$, and 2,610 $\mu\text{g/l}$). On the basis of the location of the samples and the direction of flow in the ditch (toward the east), the source of this TPH contamination may be other than at this SWMU.

SWMU 2c (RFA SWMU 54)—Line Shack 400 Disposal Area *Fitting*

Site History

SWMU 2c consists of the area adjacent to Line Shack 400, bounded by Buildings 301, 401, and 404 (see Figure 2-1). The principal activities at the site have involved aircraft maintenance and cleaning. The IAS reported that various maintenance and cleaning chemicals were dumped onto uncovered surface from the time of Line Shack 400's construction in 1963 until the early 1980s, when the surface immediately around the building was covered with concrete (RGH, 1984).

Environmental Setting

Most of the site is on the flight line. As a result, much of the site is flat and covered with either concrete or asphalt. Cores bored through the concrete reveal that it is approximately 18 inches thick with large aggregate up to 4 inches in diameter. Off the flight line north of B Avenue, most of the ground surface is covered with grass. The exception is the fenced area around Building 401, which is covered with asphalt. Currently, the paved part of the flight line is drained by flush-mounted grates that direct runoff to an oil-water separator by underground pipes. The grassy area of the site drains to an unlined ditch that cuts across a lawn, directing water toward B Avenue and entering a culvert there. This unlined ditch also receives runoff from storm drains originating at Buildings 404 and 400. The area south of B Avenue is characterized by mature woods with brushy ground cover.

On the basis of boreholes drilled during the interim RFI and during previous investigations, the shallow subsurface geology at this site consists of two general units. The uppermost unit is a fine-textured layer composed primarily of silty clay and clayey silt, which is 4 to 11 feet thick. This unit is underlain by a layer of sands and silty sands. All monitoring wells at this site are screened in this lower unit. Locally, the average depth to groundwater ranges from approximately 7 to 9 feet below grade.

Investigation Results

Field investigations have been conducted at this site on two occasions: the Line Shack Inspection Study (CH2M HILL, 1989) and the interim RFI (CH2M HILL, 1991). In the line shack inspection investigation, four monitoring wells were installed (2C-MW1, 2C-MW2, 2C-MW3, and 2C-MW4). Samples were collected and analyzed for VOCs

and metals. In addition, six soil borings were drilled and seven surface soil samples were collected. The chemical analyses performed on the soil samples included VOCs and EP TOX metals.

During the interim RFI, five shallow monitoring wells (2C-MW5 through 2C-MW9) were installed and sampled. In addition, the four existing monitoring wells (2C-MW1 through 2C-MW4) were sampled. In situ hydraulic conductivity tests were conducted in six of the nine wells (2C-MW1 through 2C-MW3, 2C-MW6, 2C-MW7, and 2C-MW9). The locations of all of the monitoring wells are shown in Figure 2-8. All water samples were analyzed for VOCs, EDB, and TPH.

Water-Level Data. Water-level data were collected in August 1990 and were contoured to create a map of the water-table surface throughout this SWMU (see Figure 2-9). The 1990 data are consistent with the water-level measurements made in 1988 and indicate that the principal direction of flow of shallow, unconfined groundwater at this site is generally toward the south.

Hydraulic Conductivity Data. As part of the interim RFI, in situ hydraulic tests were performed at six of the nine monitoring wells at SWMU 2c. The results of these tests are presented in Table 2-10. The values calculated ranged between 1 by 10^{-3} and 9 by 10^{-3} cm/s. This range is typical for relatively permeable silty sands (Freeze and Cherry, 1979) and is consistent with the stratigraphy encountered at this site.

Chemical Data. Organic chemical data obtained to date for all monitoring wells at this SWMU are shown in Table 2-11. Data on dissolved metals concentrations collected in 1988 from the four previously installed wells are summarized in Table 2-12 (CH2M HILL, 1989). Also presented are VOC data (CH2M HILL, 1989) on soil samples collected from six shallow boreholes in 1988 (Table 2-13). The locations of these boreholes are shown in Figure 2-10.

The chemical data indicate that a variety of VOCs are present in the groundwater at this site. Most of the dissolved metals were not detected. The compounds most prevalently detected include DCE, VC, and TCE. Also detected in groundwater at this site were chloroethane, DCA, and 2-butanone.

Figure 2-11 shows the concentrations of TCE, DCE, and VC in monitoring wells at SWMU 2c as of August 1990. The interim RFI notes that the spatial distribution of the concentration of these compounds, together with the water-level information presented in Figure 2-9, suggest that there may be more than one source of the groundwater contamination. The data in these two figures also indicate that 2C-MW5 and 2C-MW6, which are relatively free of the contaminants analyzed, are in upgradient locations. This suggests the contaminant sources are or were primarily within the current bounds of the SWMU 2c study area.

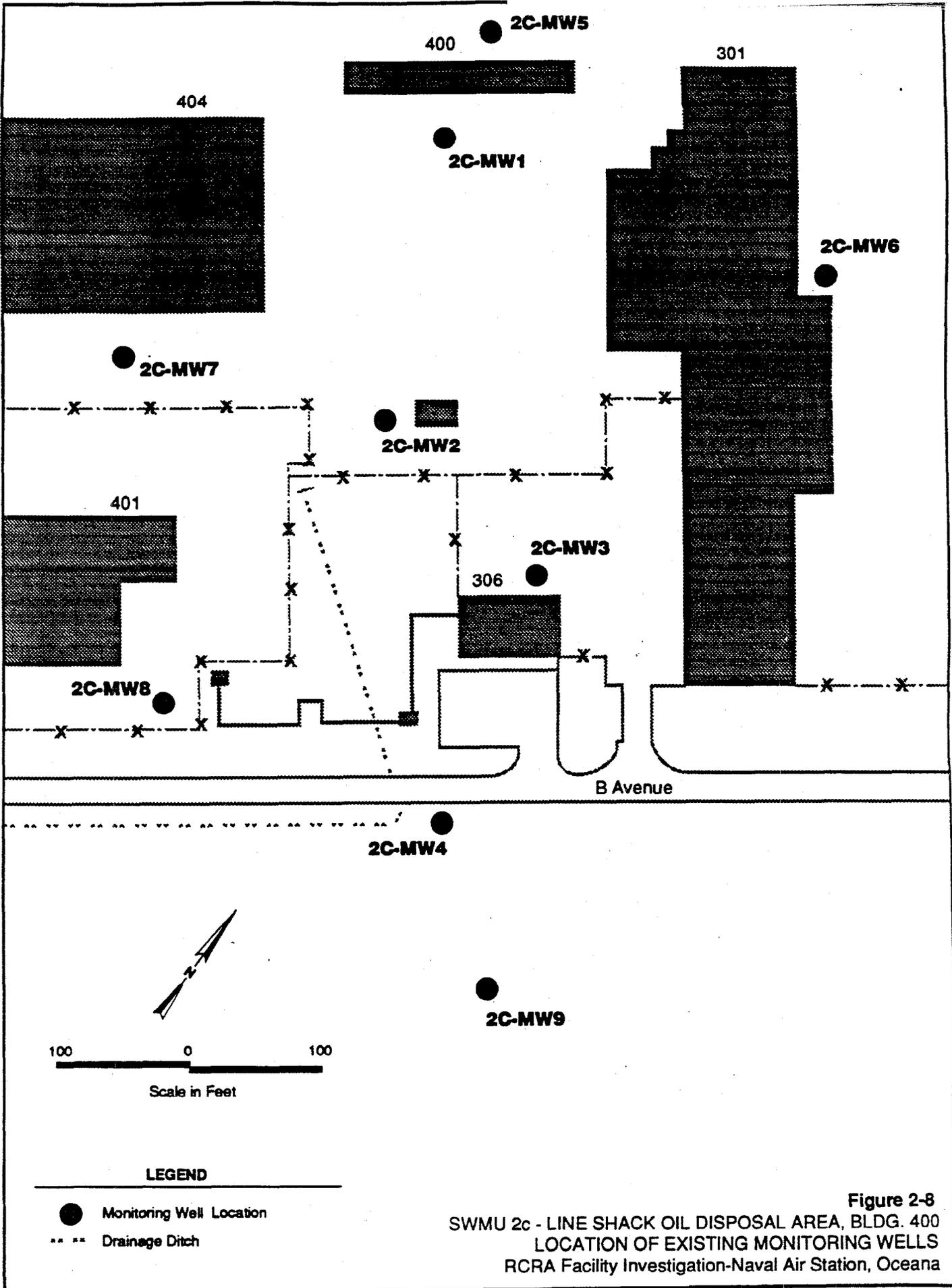


Figure 2-8
 SWMU 2c - LINE SHACK OIL DISPOSAL AREA, BLDG. 400
 LOCATION OF EXISTING MONITORING WELLS
 RCRA Facility Investigation-Naval Air Station, Oceana

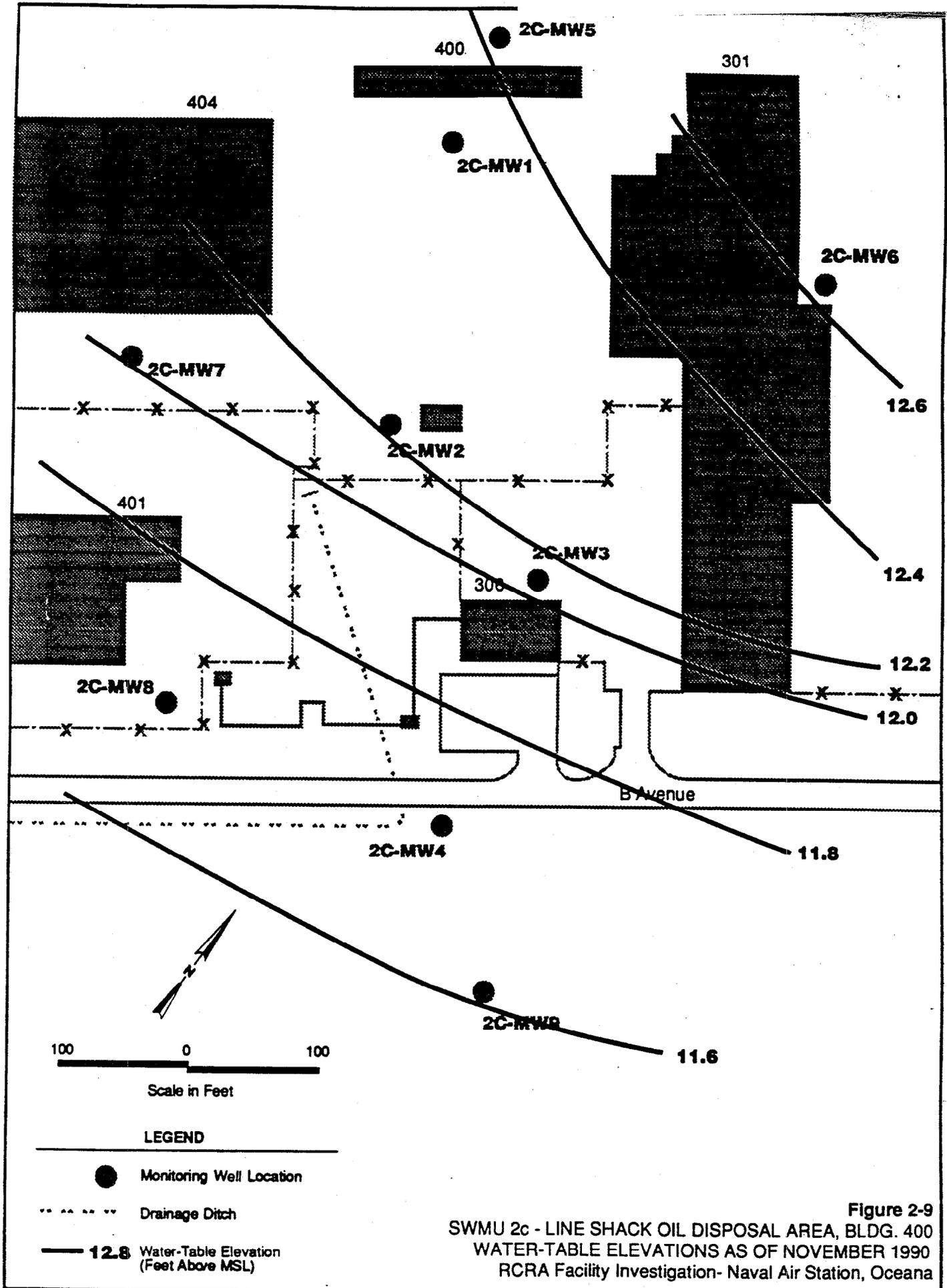


Table 2-10 SWMU 2c, LINE SHACK OIL DISPOSAL AREA (BLDG 400) IN SITU HYDRAULIC CONDUCTIVITY RESULTS	
Well	Hydraulic Conductivity (cm/sec)
2C-MW1	1×10^{-3}
2C-MW2	4×10^{-3}
2C-MW3	3×10^{-3}
2C-MW6	5×10^{-3}
2C-MW7	6×10^{-3}
2C-MW9	9×10^{-3}

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Table 2-11
ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 2c, LINE SHACK OIL DISPOSAL AREA (BLDG 400)
 (Concentrations in µg/l)

Analyte	Detection Limit	2C-MW1			2C-MW2		2C-MW3		2C-MW4		Production Well	2C-MW5	2C-MW6	2C-MW7	2C-MW8	2C-MW9
		Sept. 88	Aug. 90	Duplicate Aug. 90	Sept. 88	Aug. 90	Sept. 88	Aug. 90	Sept. 88	Aug. 90	Sept. 88	Aug. 90				
EDB	0.02	NA	--	--	NA	--	NA	--	NA	--	NA	NA	--	--	--	--
TPH	60	NA	260	360	NA	280	NA	290	NA	380	NA	160	--	140	150	170
Volatile Organic Compounds:																
Acetone	10	13	7 ^{bj}	210 ^b	30	22 ^b	--	9 ^{bj}	--	5 ^{bj}	18	10 ^b	9 ^{bj}	10 ^b	8 ^{bj}	86 ^{bj}
Benzene	5	7	2 ^j	--	--	2 ^j	5	4 ^j	--	1 ^j	--	--	2 ^j	--	3 ^j	--
2-Butanone (MEK)	10	--	--	--	--	13	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	5	--	1 ^j	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	10	--	--	--	--	--	--	--	78	31	--	--	--	--	--	--
1,1-Dichloroethane	5	--	--	--	--	--	--	3 ^j	25	11	--	--	--	4 ^j	78	--
1,2-Dichloroethane	5	--	--	--	--	--	--	--	--	2 ^j	--	--	--	--	--	--
1,1-Dichloroethylene	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethylene (total)	5	2,400	140	130	--	3 ^j	--	--	12	11	--	9	--	34	66	1,300
Ethylbenzene	5	15	1 ^j	--	--	--	--	1 ^j	--	--	--	--	2 ^j	--	--	--
Methylene chloride	5	--	4 ^{bj}	170 ^b	--	5 ^b	--	4 ^{bj}	--	6 ^b	--	5 ^b	8 ^b	5 ^b	5 ^b	21 ^{bj}
Toluene	5	34	14	20 ^j	--	--	--	--	--	1 ^j	--	--	--	--	--	--
Trichloroethylene	5	--	--	--	--	--	--	--	--	2 ^j	--	--	--	--	12	63
Vinyl chloride	10	2,500	2,000	1,900	37	22	--	11	210	81	--	--	--	13	320	380
Xylenes (total)	5	--	15	47 ^{bj}	--	2 ^{bj}	5	3 ^{bj}	--	2 ^j	--	2 ^{bj}	5 ^b	2 ^{bj}	2 ^{bj}	--

Notes:

EDB = Ethylene Dibromide
 TPH = Total Petroleum Hydrocarbons
 NA = Not analyzed

^bCompound found in laboratory blank as well as sample; sample concentrations is less than 10 times blank concentration
^jEstimated value; measured value is less than the accurately quantitative detection limit
 (--) Concentration below detection limit

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Table 2-12
RESULTS OF METALS ANALYSIS OF GROUNDWATER SITE 2C,
LINE SHACK 400 DISPOSAL AREA
September 1988
(Concentrations in $\mu\text{g/l}$)

Parameter	2C-MW1	2C-MW2	2C-MW3	2C-MW4	Production Well
Silver	<3	<3	<3	<3	<3
Aluminum	<200	<200	<200	<200	<200
Arsenic	<5	<5	<5	6	<5
Barium	<200	<200	<200	<200	<200
Beryllium	<5	<5	<5	<5	<5
Calcium	60,800	52,300	39,000	33,000	59,200
Cadmium	<3	5	<3	<3	<3
Cobalt	<50	<50	<50	<50	<50
Chromium	<10	<10	<10	<10	<10
Copper	<25	<25	<25	<25	<25
Iron	13,500	8,300	7,100	4,500	3,680
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2
Potassium	40,000	11,500	<5,000	<5,000	<5,000
Magnesium	6,900	8,200	15,900	10,600	14,600
Manganese	610	430	690	350	370
Sodium	37,000	31,000	50,600	44,200	52,700
Nickel	<40	<40	50	<40	<40
Lead	<5	<5	<5	<5	<5
Antimony	<5	<5	<5	<5	<5
Selenium	<5	<5	<5	<5	<5
Thallium	<5	<5	<5	<5	<5
Vanadium	<50	<50	<50	<50	<50
Zinc	170	120	160	120	50

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Table 2-13
VOLATILE ORGANIC COMPOUNDS IN SOILS AT SITE 2C LINE SHACK 400 DISPOSAL AREA
September 1988
(Concentrations in µg/kg)

	Acetone	Methylene Chloride	Toluene	Xylenes (Total)	Carbon Disulfide	Vinyl Chloride	1,1-Dichloroethane	Chloroform
Soil Boring No.								
B1-S1	--	170 ^a	--	--	--	--	--	6 ^a
B1-S2	17 ^a	--	--	--	--	--	--	7 ^a
B2-S1	--	130 ^a	--	--	--	--	--	--
B2-S2	--	--	--	--	--	--	--	--
B3-S1	--	--	--	--	--	--	--	8 ^a
B3-S2	--	--	--	--	--	--	--	--
B4-S1	16 ^a	29 ^a	--	--	--	--	--	8 ^a
B4-S2	--	--	--	--	--	--	--	--
B5-S1	--	--	--	--	--	--	--	8 ^a
B5-S2	110 ^a /62	160 ^a /10 ^a	--	--	--/45	--	--	--
B6-S1	--	--	--	--	--	--	--	--
B6-S2	--	110 ^a	--	--	17	--	--	--
Monitoring Well No.								
MW2-S1	--	36 ^a	--	--	--	--	--	--
MW2-S2	--	140 ^b	--	--	--	--	--	--
MW2-S3	--	--	--	--	--	--	--	--
MW3-S1	--	22 ^a	--	--	--	--	--	6 ^a
MW3-S2	--	19 ^a	12	--	--	30	--	--
MW3-S3	--	83 ^a	--	--	--	--	9	--

Table 2-13
VOLATILE ORGANIC COMPOUNDS IN SOILS AT SITE 2C LINE SHACK 400 DISPOSAL AREA
September 1988
(Concentrations in µg/kg)

	Acetone	Methylene Chloride	Toluene	Xylenes (Total)	Carbon Disulfide	Vinyl Chloride	1,1-Dichloroethane	Chloroform
Surface Soil No.								
SS1	--	52	--	--	--	--	--	--
SS2	--	--	--	--	--	--	--	--
SS3	--	89 ^a	--	--	--	--	--	--
SS4	--	--	--	--	--	--	--	--
SS5	58 ^a	160 ^a	6	16	--	--	--	--
SS6	--	18 ^a	--	--	--	--	--	--
SS7	--	68 ^a	--	--	--	--	--	--

Notes:

All Values not reported were below detection limits.
 (--) Concentration below detection limit

Sample Depths:
 S1--3 to 5 feet
 S2--8 to 10 feet
 S3--14 to 16 feet.

^aCompound found in blank as well as sample. Sample concentration less than 10 times blank concentration.
^bCompound found in blank as well as sample. Sample concentration greater than 10 times blank concentration.

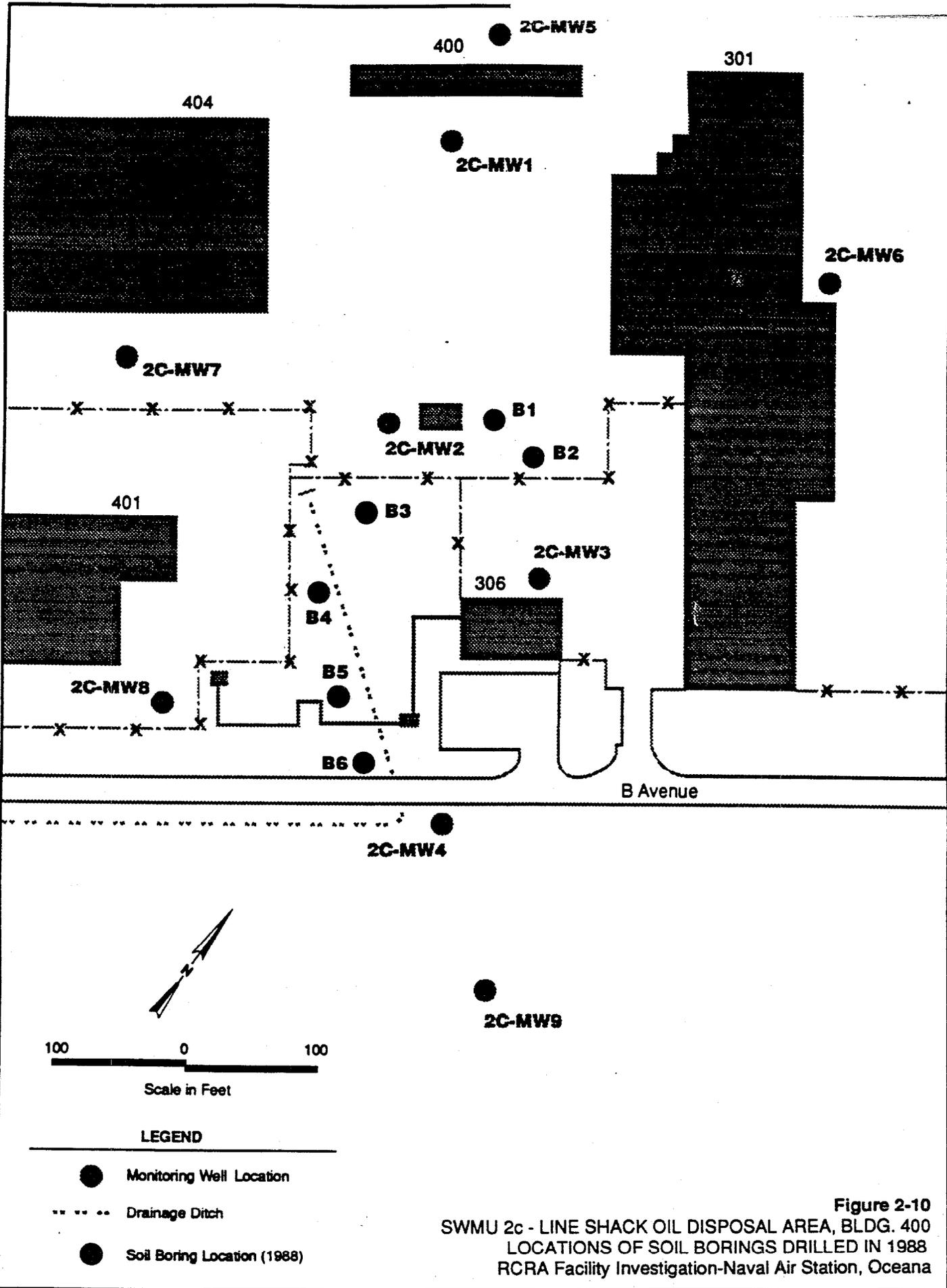
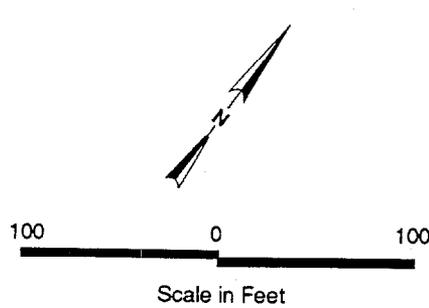
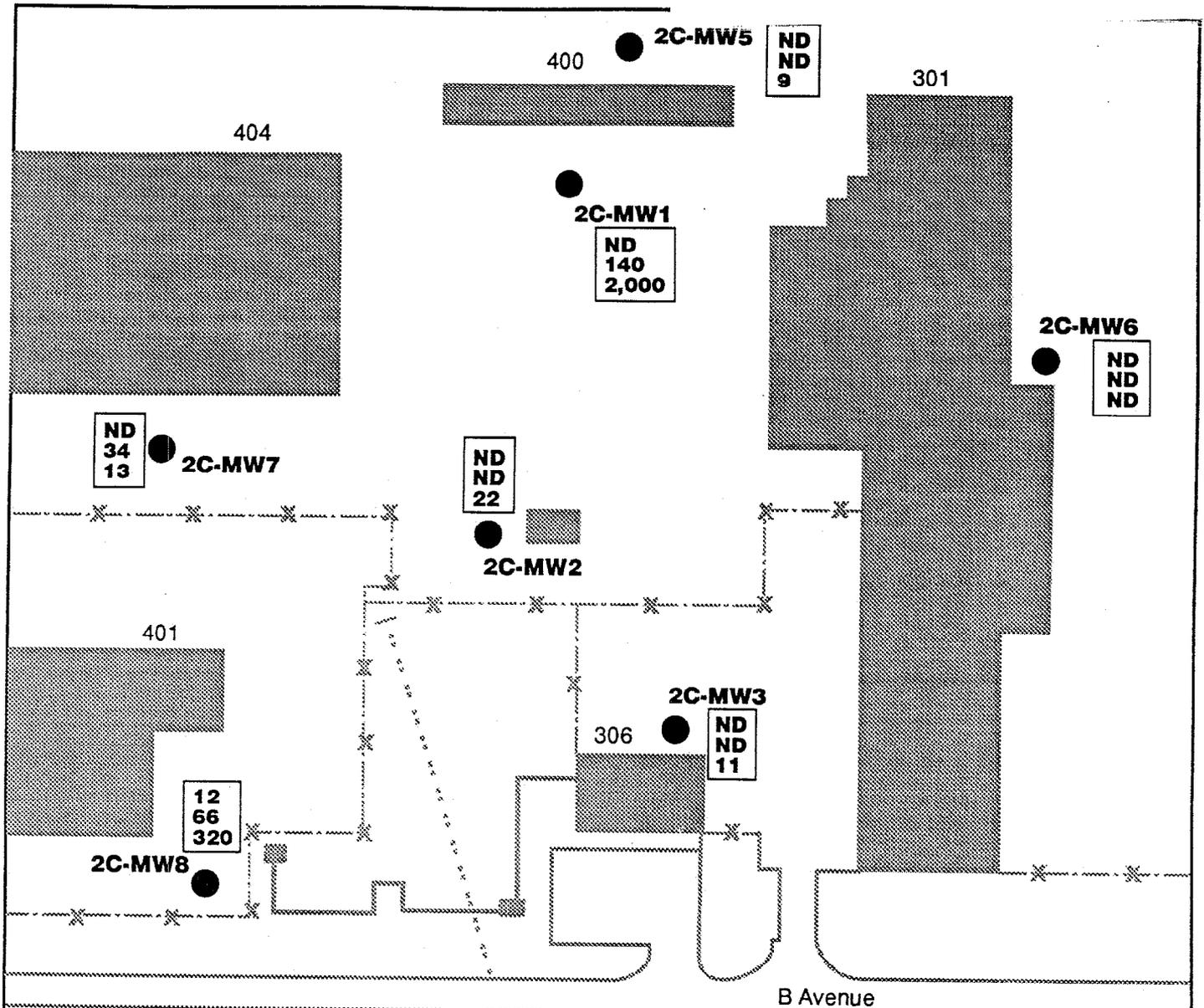


Figure 2-10
 SWMU 2c - LINE SHACK OIL DISPOSAL AREA, BLDG. 400
 LOCATIONS OF SOIL BORINGS DRILLED IN 1988
 RCRA Facility Investigation-Naval Air Station, Oceana



LEGEND

- Monitoring Well Location
- Drainage Ditch
- Concentrations (µg/l) of:
 - 12 TCE
 - 66 DCE
 - 320 VC
- ND Non-Detect

Figure 2-11
 SWMU 2c
 CONCENTRATION OF TCE, DCE, AND VINYL CHLORIDE
 IN GROUNDWATER AS OF AUGUST 1990
 RCRA Facility Investigation—Naval Air Station, Oceana

The interim RFI also noted that the high concentrations of VC and DCE in 2C-MW1 and low concentrations of these compounds in 2C-MW5 suggest that the source of contamination in 2C-MW1 is likely to be close to this well. The detection of the same contaminants at lower concentrations in 2C-MW7, which is downgradient from 2C-MW1, suggests that the contamination in these two wells may originate at the same place.

The contaminant signature in 2C-MW2 and 2C-MW3 is different from that of 2C-MW1 and 2C-MW7 in that the former wells contain only VC. Moreover, 2C-MW2 and 2C-MW3 are not directly downgradient from 2C-MW1. The interim RFI noted that, depending on the degree of anisotropy (i.e., the directional dependence of hydraulic conductivity), a streamline could flow from 2C-MW1 to either 2C-MW2 or 2C-MW3, but this was unlikely.

Wells 2C-MW2 and 2C-MW3 themselves are not along a common streamline. Consequently, contamination of these wells from a common source implies that the source is either of a relatively large lateral extent or occurs as a linear feature parallel to a line connecting the two wells. The principal contaminant detected in both of these wells is VC, which is a commonly used chemical in this form and is also a natural daughter product of TCE and DCE degradation.

Well 2C-MW8 contains significant concentrations of VC, TCE, 1,2-DCE, and 1,1-DCA (78 $\mu\text{g/l}$). This well is hydraulically downgradient from the general area of 2C-MW2 and 2C-MW3, but is more contaminated.

Table 2-14 presents a comparison of the detected values against applicable federal standards. As was the case with the data from SWMU 2b, the contaminants present at SWMU 2c generally have either an associated MCL, proposed MCL, or non-zero MCLG. Inasmuch as the EPA will most likely have these criteria take precedent over other standards for contaminants in groundwater (EPA, 1989), no other standards are included in Table 2-14.

The results from the interim RFI indicate that the most widespread contaminant at SWMU 2c is VC, which is present above its MCL of 2 $\mu\text{g/l}$ in all but the two wells farthest upgradient. In 2C-MW1, the level of VC (2,000 $\mu\text{g/l}$) is 1,000 times greater than the MCL. TCE concentrations were detected above their MCL of 5 $\mu\text{g/l}$ in two wells (2C-MW8 and 2C-MW9), and 1,2-DCE (total) was detected at levels that exceed its proposed MCL in two other wells (2C-MW1 and 2C-MW9). With 1,2-DCE, the proposed MCL differentiates between the cis- and trans-isomers of this compound, but the laboratory only reported values that combined all isomers.

Table 2-14
CONTAMINANTS PRESENT AT SWMU 2c IN CONCENTRATIONS GREATER THAN
POTENTIALLY APPLICABLE FEDERAL STANDARDS
August 1990
(Concentrations in $\mu\text{g/l}$)

Chemical	Location Detected	Concentration	MCL	MCLG	Proposed MCL
1,2-Dichloroethylene (total)	2C-MW1	140	--	--	70/100*
	2C-MW9	1,300			
Trichloroethylene	2C-MW8	12	5	Zero	--
	2C-MW9	63			
Vinyl Chloride	2C-MW1	2,000	2	Zero	--
	2C-MW2	22			
	2C-MW3	11			
	2C-MW4	81			
	2C-MW7	13			
	2C-MW8	320			
	2C-MW9	380			

Notes:

MCL = Safe Drinking Water Act Maximum Contaminant Level. Standards given are current as of April 1990.

MCLG = Safe Drinking Water Act Maximum Contaminant Level Goal. Standards given are current as of April 1990.

(--) Concentration below detection limit

*70 $\mu\text{g/l}$ and 100 $\mu\text{g/l}$ are standards for cis- and trans-isomers, respectively. "Total" includes both "Total" includes both isomers.

SWMU 2d (RFA SWMU 52)—Line Shack 125 Disposal Area *Matwing****Site History***

SWMU 2d consists of the area in the immediate vicinity of Line Shack 125 and south of Hangar 111 (see Figure 2-1). The IAS reported that soil excavated near Line Shack 125 in the early 1980s was found to be saturated with oily substances down to a depth of approximately 6 feet (RGH, 1984). Like the other line shacks at Oceana, Line Shack 125 was constructed in 1963 and has been a location for aircraft cleaning and maintenance, and equipment and material storage. The IAS identified this area as a place where waste chemicals used for aircraft cleaning and maintenance were dumped onto the ground.

Environmental Setting

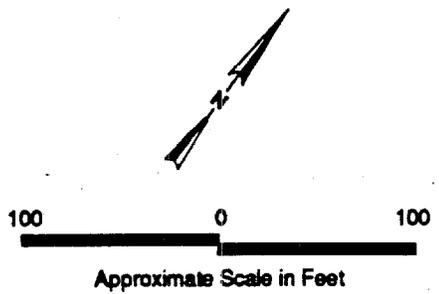
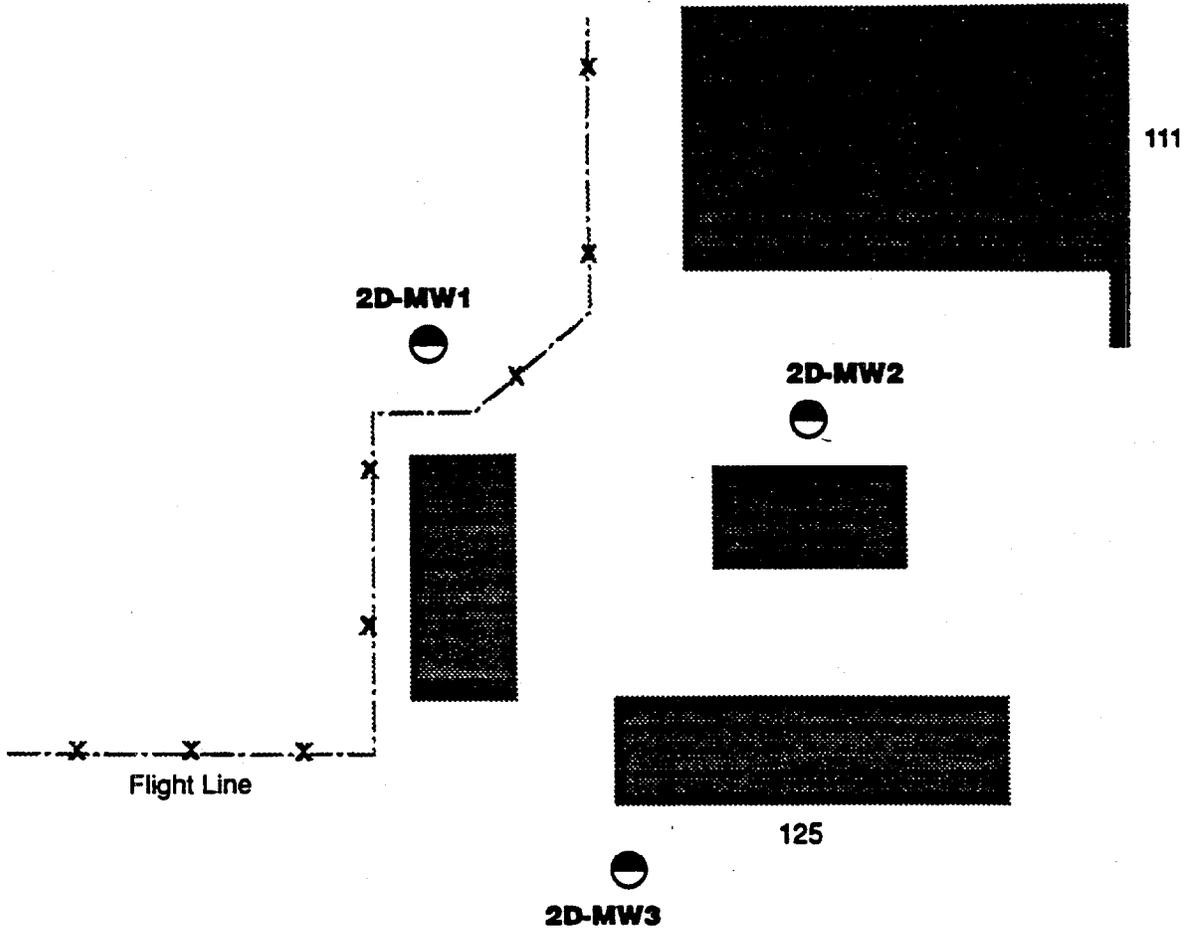
Most of this site is on the flight line; consequently, most of the site is covered by a generally flat asphalt pavement. Off the flight line, the ground surface slopes down toward a mature wooded area northwest of the flight line. Runoff at the site is directed southwest and off the flight line by storm drains. The area within 20 feet of the flight line fence is covered with short grass that is mowed frequently.

Shallow boreholes (less than 20 feet deep) drilled for monitoring well installation at this site revealed that the local subsurface sediments consist of clay, sandy silt, and silty sand. The clean sand layer observed at other Oceana sites was absent here. Locally, the depth to groundwater in August 1990 was approximately 7 feet below grade.

Investigation Results

Three shallow monitoring wells (2D-MW1 through 2D-MW3) were installed and sampled during the interim RFI (see Figure 2-12). Groundwater samples obtained during the interim RFI were analyzed for VOC, EDB, and TPH concentrations. The results of water-level measurements of all three wells made in August 1990 were contoured to create a map of the water-table surface over this site (see Figure 2-13). The data suggest that the general direction of flow of shallow, unconfined groundwater at this site is toward the west.

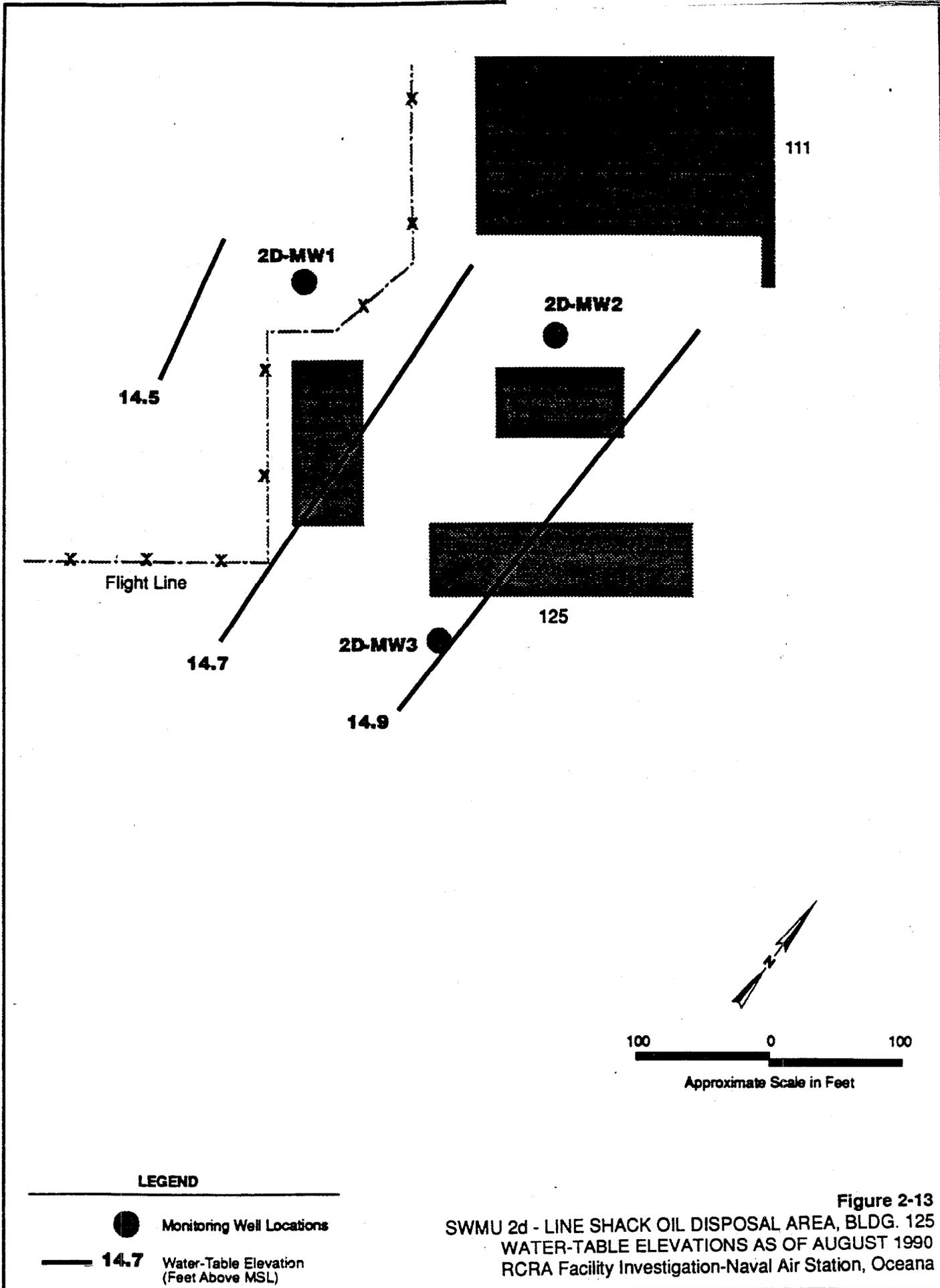
The organic chemical data gathered from the three wells at this site during the interim RFI are presented in Table 2-15. The analytical results indicate that only 2D-MW2 contains detectable concentrations of the parameters analyzed for. Specifically, the compounds detected at accurately quantifiable levels include 1,1-DCA (64 $\mu\text{g/l}$), 1,1-DCE (9 $\mu\text{g/l}$) and total xylenes (6 $\mu\text{g/l}$). Of these compounds, only 1,1-DCE has a relevant federal standard to compare the resulting chemical data against. The MCL and MCLG for 1,1-DCE is 7 $\mu\text{g/l}$; consequently, the concentration of 1,1-DCE in 2D-MW2 is above its MCL.



LEGEND

 Monitoring Well Locations

Figure 2-12
 SWMU 2d - LINE SHACK OIL DISPOSAL AREA, BLDG. 125
 LOCATION OF EXISTING MONITORING WELLS
 RCRA Facility Investigation-Naval Air Station, Oceana



LEGEND

- Monitoring Well Locations
- 14.7** Water-Table Elevation (Feet Above MSL)

Figure 2-13
 SWMU 2d - LINE SHACK OIL DISPOSAL AREA, BLDG. 125
 WATER-TABLE ELEVATIONS AS OF AUGUST 1990
 RCRA Facility Investigation-Naval Air Station, Oceana

Table 2-15 ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 2d, LINE SHACK 125 DISPOSAL AREA August 1990 (Concentrations in $\mu\text{g/l}$)				
	Detection Limit	2D-MW1	2D-MW2	2D-MW3
EDB	0.02	--	--	--
TPH	60	360	220	--
Volatile Organic Compounds:				
Acetone	10	5 ^{bj}	5 ^{bj}	20 ^b
Benzene	5	--	3 ^j	-
Carbon disulfide	5	--	--	1 ^j
1,1-Dichloroethane	5	--	64	--
1,1-Dichloroethylene	5	--	9	--
1,2-Dichloroethylene (total)	5	--	2 ^j	--
Ethylbenzene	5	--	2 ^j	--
Methylene chloride	5	4 ^{bj}	3 ^{bj}	4 ^{bj}
Xylenes (total)	5	--	6	--
Notes: EDB = Ethylene Dibromide TPH = Total Petroleum Hydrocarbons (--) = Concentration below detection limit ^b Compound found in laboratory blank as well as sample; sample concentration is less than 10 times blank concentration. ^j Estimated value. Measured value is less than the accurately quantitative detection limit.				

WDCR570/036.51

SWMU 2e (RFA SWMUs 51 and 1)—Line Shack 109 Disposal Area, and Hazardous Waste Storage Area, Bldg 23 FLYING

SWMU 2e is composed principally of the area behind Line Shack 109 and Hangar 23 (see Figure 2-1). These two sites were combined as one area of investigation because of their close proximity. This RFI work plan will address only one area of investigation for the two sites.

SWMU 2e (RFA SWMU 51)—Line Shack 109 Disposal Area***Site History***

Like the other line shacks at Oceana, Building 109 was constructed in 1963 and has been a location for aircraft cleaning and maintenance, and equipment and material storage. The IAS identified this area as a place where waste chemicals used for aircraft cleaning and maintenance had been dumped onto the ground (RGH, 1984).

Environmental Setting

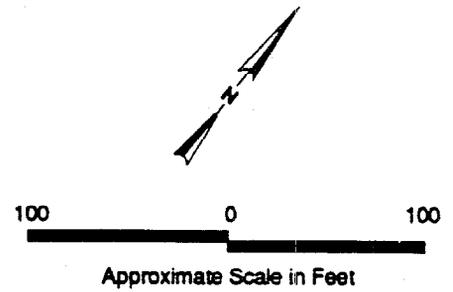
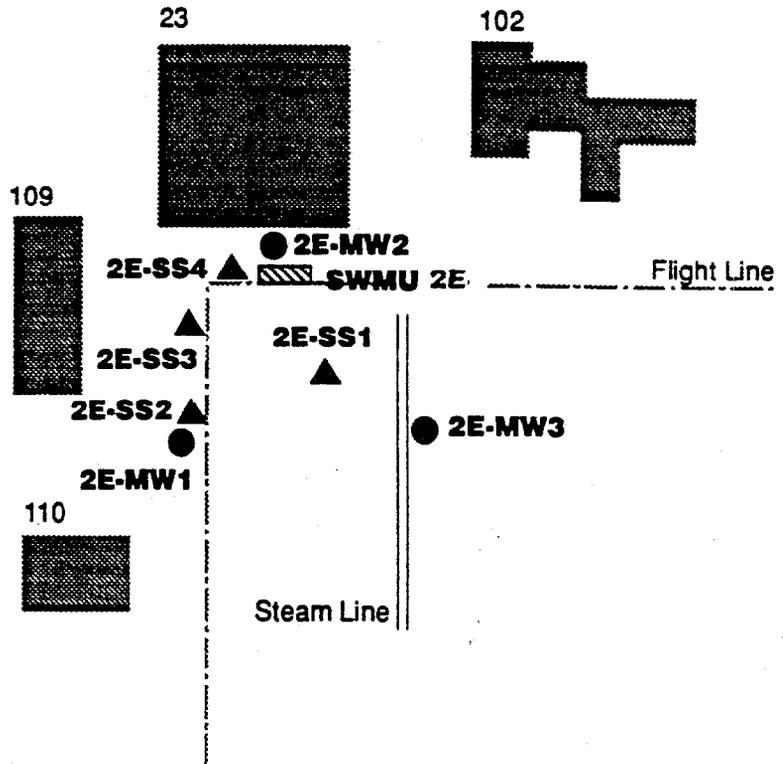
Much of the site is on the flight line and covered with a flat asphalt surface. Off the flight line, the site is covered by short grass which is mowed frequently. There is no specifically designed runoff collection or storm drain system at this site. In general, there is a slight slope to the overall topography that directs runoff toward the southeast.

Shallow boreholes (less than 20 feet deep) drilled for monitoring well installation at this site during the interim RFI revealed that the subsurface stratigraphy generally consists of two sedimentary units. At the surface is a unit of fine silts and clays that is approximately 7 to 8 feet thick, and beneath this unit is a layer of clean and silty sand that extends to a depth of at least 20 feet. Locally, the depth to groundwater in August 1990 at this site was approximately 7 feet below grade.

Investigation Results

Interim RFI field activities conducted at this site consisted of installing and sampling three shallow monitoring wells (2E-MW1 through 2E-MW3) and collecting samples of surface soils at four locations (2E-SS1 through 2E-SS4), as shown by Figure 2-14. All groundwater samples and three of the soil samples were analyzed for VOC, EDB, and TPH. The fourth soil sample (2E-SS4) was analyzed for VOCs only.

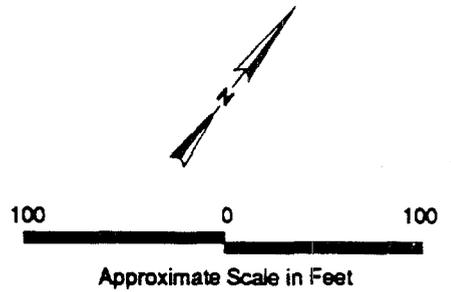
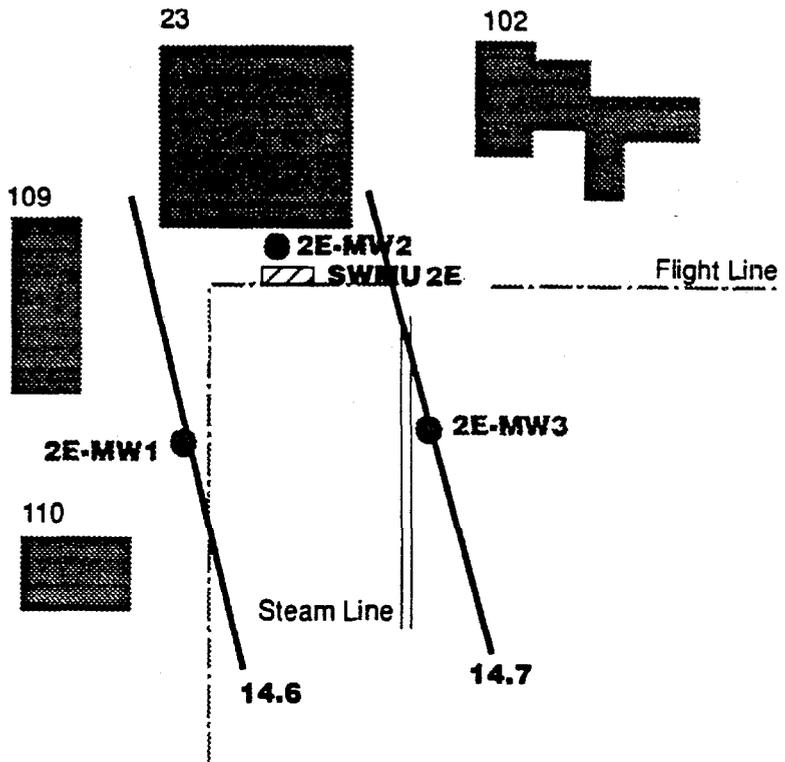
Water-level measurements of all three wells were made in August 1990 and were contoured to create a map of the water-table surface over this site (see Figure 2-15). The differences in water-level elevations among the three wells are too small (0.1 foot) to be conclusive for defining the direction of shallow groundwater flow. However, the



LEGEND

- ▲ Soil Sampling Location
- Monitoring Well Location
- ▨ SWMU 2E

Figure 2-14
SWMU 2e - HAZARDOUS WASTE STORAGE AREA AND BLDG. 23
LOCATION OF EXISTING MONITORING WELLS AND SOIL
SAMPLING POINTS
 RCRA Facility Investigation-Naval Air Station, Oceana



LEGEND

- Monitoring Well Location
- 14.6 Water-Table Elevation (Feet Above MSL)
- ▨ SWMU 2E

Figure 2-15
SWMU 2e - HAZARDOUS WASTE STORAGE AREA AND BLDG. 23
WATER-TABLE ELEVATIONS AS OF AUGUST 1990
RCRA Facility Investigation-Naval Air Station, Oceana

data suggest that local groundwater may be flowing to the south. This direction of flow is consistent with the hydrogeological data from SWMU 2c, located west of this SWMU.

The organic chemical data obtained from the three wells at this site are presented in Table 2-16, and the soil analytical data are presented in Table 2-17. The results indicate that the parameters analyzed for in groundwater were either not detected or were detected at levels below the accurately quantifiable level. The same result occurred for the soil analytical data, with the exception of TPH, and in one soil sample (2E-SS4) methylene chloride was detected, but at a relatively low level, considering it was also detected in the laboratory blank for that sample. TPH was detected in two soil samples (2E-SS2 and 2E-SS3) at concentrations of 513 and 242 mg/kg, respectively.

✓ *SWMU 2e (RFA SWMU 1)—Hazardous Waste Storage Area, Bldg 23*

Site History

According to the RFA, this SWMU consists of a short-term storage area that stores hazardous waste drums on pallets outside, near Building 23. No means of release control was evident during the visual site inspection (VSI). Space is provided for a maximum of 5 to 10 drums of waste. The location of this SWMU is shown in Figure 2-14.

The SWMU is currently active, but no information on the SWMU's startup date is included in the RFA. There is also no information included in the RFA regarding releases from this SWMU. However, visible evidence of soil staining at the SWMU was noted during the VSI. The hazardous waste storage areas at NAS, Oceana, typically store some or all of the following items: double-bagged empty oil and paint cans, double-bagged oily rags, drums of oil, paint thinner, paint remover, jet fuel, solvents, asbestos, PD 680, hydraulic fluid, freon, neutralized battery acid, and electric coolant oil.

Environmental Setting

The SWMU is on the flight line and consists of a gravel-surfaced area approximately 10 feet by 10 feet surrounded by a chain-link fence.

Shallow boreholes (less than 20 feet deep) drilled for monitoring well installation at SWMU 2e, adjacent to this SWMU during the interim RFI, revealed that the sub-surface stratigraphy generally consists of two sedimentary units. At the surface is a unit of fine silts and clays that is approximately 7 to 8 feet thick, and beneath this unit is a layer of clean and silty sand that extends to a depth of at least 20 feet. Locally, the groundwater in August 1990 at this site was approximately 7 feet below grade.

Investigation Results

There has been no previous environmental sampling done at this SWMU.

The chemical data obtained during the interim RFI from monitoring well 2E-MW2 and soil boring 2E-SS4 may be the most representative of SWMU 1 (see Tables 2-16 and 2-17). The results indicate that the parameters that were analyzed in groundwater samples were either not detected or were detected at levels below the accurately quantifiable level. Methylene chloride was detected in the soil sample.

SWMU 11 (RFA SWMUs 62 and 63)—Fire Fighting Training Areas

Site History

This SWMU constitutes the old and new fire fighting training rings and their immediate surroundings. It is located on the west side of the base at the intersection of two abandoned runways (see Figure 2-1). The IAS reported that the old ring was constructed in the early 1960s. Up until the mid-1970s, fire fighters were trained by extinguishing 7,500 gallons per year of jet fuel mixed with various liquid hazardous wastes such as paints, thinners, naphtha, and trichlorotrifluoroethane. In the mid-1970s, an earthen berm was constructed, and the volume of liquid burned wastes increased to approximately 50,000 gallons annually (RGH, 1984). In recent years, this practice has been stopped. The new fire pit has been constructed adjacent to the old one, and jet fuel without hazardous additives is burned to train personnel.

Environmental Setting

The fire rings are situated directly on abandoned concrete runways. As a result, the area is very flat with the exception of the 2-foot-high earthen berm, which outlines each ring. The site is covered with weathered concrete except just east of the fire rings. There, the ground has a cover of untended tall grass, and is slightly lower than the rings. The grass area, consequently, appears to collect surface runoff from the immediate area, including the fire rings.

Investigation Results

Interim RFI field activities were conducted only at the old firing training area. One monitoring well (11-MW1) was installed and four samples (11-SS1 through 11-SS4) of near-surface soil (i.e., from approximately 12 to 18 inches below grade) were collected. The locations of all sampling points are shown in Figure 2-16. The groundwater sample was analyzed for VOC, BN, TPH, and lead. The soil samples were analyzed for these same parameters and also for ignitability.

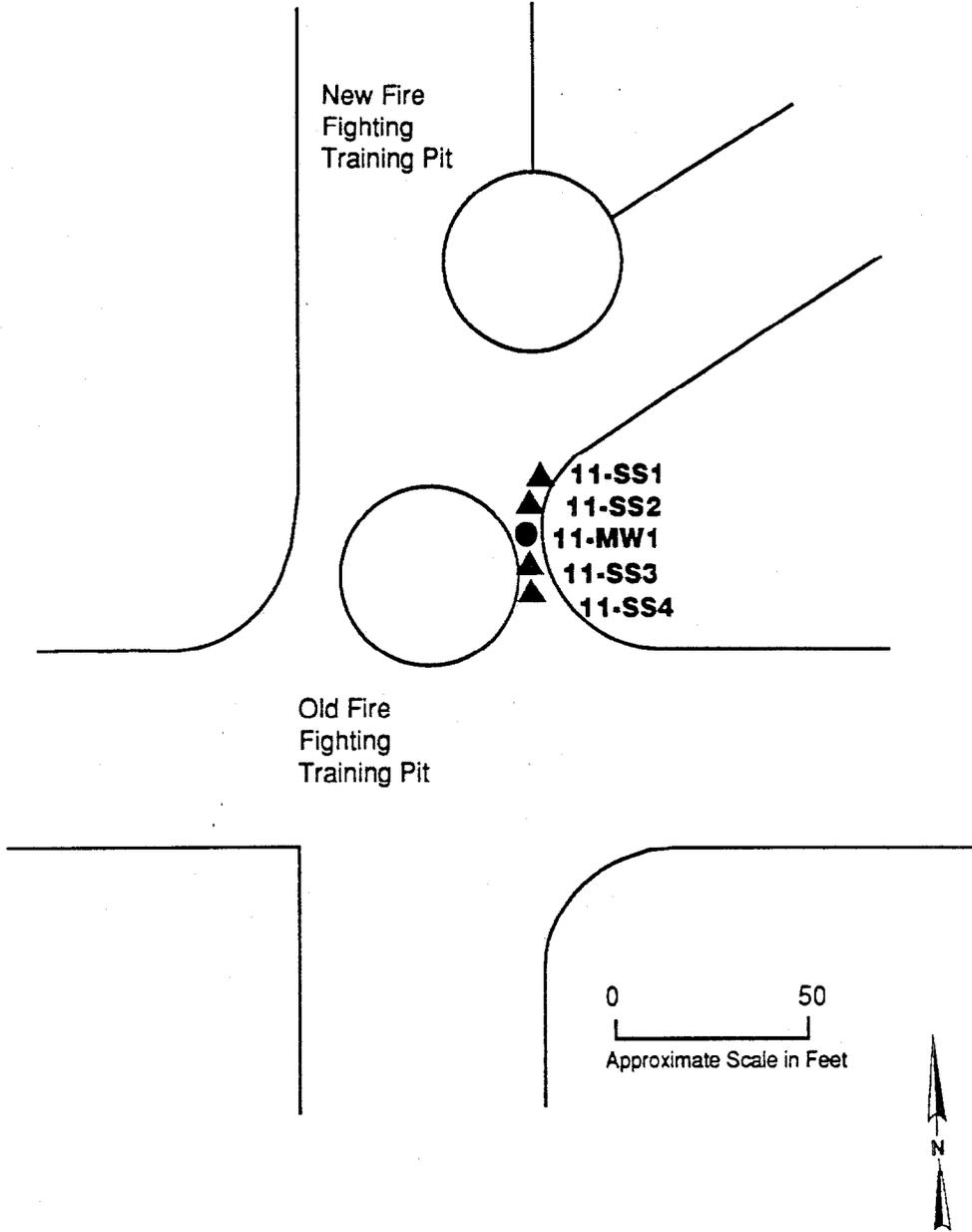
Table 2-16 ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 2e LINE SHACK 109 DISPOSAL AREA (BLDG 23) (Concentrations in $\mu\text{g/l}$)				
Analyte	Detection Limit	2E-MW1	2E-MW2	2E-MW3
TPH	60	200	--	210
EDB	0.02	--	--	--
Volatile Organic Compounds:				
Acetone	10 ^{bj}	6 ^{bj}	6 ^{bj}	4 ^{bj}
Benzene	5	2 ^j	--	--
Carbon disulfide	5	--	--	2 ^j
Ethylbenzene	5	2 ^j	--	--
Methylene chloride	5	5 ^b	7 ^b	5 ^b
Xylenes (total)	5	3 ^j	--	--
Notes: EDB = Ethylene Dibromide TPH = Total Petroleum Hydrocarbons (--) = Concentration below detection limit ^b Compound found in laboratory blank as well as in sample. Sample concentration was less than 10 times blank concentration. ^j Estimated value. Measured value is less than the quantitative detection limit.				

WDCR570/037.51/1

<p align="center">Table 2-17 ORGANIC COMPOUNDS IN SOIL AT SWMU 2e LINE SHACK 109 DISPOSAL AREA (Concentrations in µg/kg)</p>					
	Detection Limit	2E-SS1	2E-SS2	2E-SS3	2E-SS4
TPH	1,900-18,900 ^a	99,400	513,000	242,000	NA
EDB	0.2	--	--	--	NA
Volatile Organic Compounds:					
Acetone	10	11 ^{bj}	21 ^b	13 ^b	14 ^b
Methylene chloride	10	24 ^b	13 ^b	61 ^b	120 ^e
Toluene	6	--	--	--	2 ^j
<p>Notes:</p> <p>NA = Not analyzed EDB = Ethylene Dibromide TPH = Total Petroleum Hydrocarbons (--) = Concentration below detection limit</p> <p>^aDetection limit range in soil for TPH samples particular to this site. ^bCompound found in laboratory blank as well as sample. Sample concentration is less than 10 times blank concentration. ^eCompound found in laboratory blank as well as sample. Sample concentration is greater than 10 times blank concentration. ^jEstimated value. Measured value is less than the quantitative detection limit.</p>					

WDCR570/037.51/2

HRC032160.AO.03/08/05



LEGEND

-  Fire Fighting Training Pit
-  Shallow Monitoring Well
-  Soil Sampling Locations

Figure 2-16
SWMU 11 - FIRE FIGHTING TRAINING AREA
LOCATION OF EXISTING MONITORING WELL AND
SOIL SAMPLING POINTS
 RCRA Facility Investigation-Naval Air Station, Oceana



The interim RFI obtained water-level information from 11-MW1 and combined it with water-level data from SWMU 1; the groundwater elevation in 11-MW1 indicates that it is upgradient of the old fire training ring. In other words, in August 1990, the principal direction of shallow groundwater flow at this site was generally to the west.

The organic chemical data obtained from 11-MW1 is presented in Table 2-18, and the soil analytical data are presented in Table 2-19. These results indicate that the parameters that were analyzed for in groundwater were either not detected at a significant level (e.g., TPH) or were not detected at levels significantly different than the laboratory blank. The same result occurred for the soil analytical data, with the exception of TPH in 11-SS4 (289 mg/kg).

SWMU 15 (RFA SWMU 58)—Abandoned Tank Farm VACAPES

Site History

On the basis of the information contained in the IAS, SWMU 15 is located approximately 800 feet north of Runway 23R and 300 yards east of the old CPO Club at North Station (see Figure 2-1).

The site is the former location of two concrete 50,000-gallon tanks (G5 and G6) and one 500,000-gallon tank (G9) that were used to store aviation gas and a number of smaller above-ground tanks that were used to store kerosene and lubrication oils (RGH, 1984). All of these tanks have been removed since the mid 1980s. At least two buried lines that were used for draining wash fluids from the tanks may still exist. After North Station was decommissioned, Tanks G5 and G6 were emptied of fuel and filled with water. Tank G-5 was later used to store waste oil and fuel that may have included PD 680, naphtha, and chlorinated and aromatic hydrocarbons such as dichlorodifluoromethane, toluene, benzene, and their derivatives. The IAS reports that small amounts of fuel were observed to have leaked from the tanks or from their connecting pipelines.

Environmental Setting

The oil tanks were dismantled approximately 7 years ago and natural grasses have returned, making it difficult to find the exact location of the former tanks.

Investigation Results

Three backhoe pits were excavated and four monitoring wells were installed in 1982 in an attempt to determine whether fuel leaks were occurring for the tanks and/or buried pipelines.

Table 2-18 ORGANIC COMPOUNDS IN GROUNDWATER AT SWMU 11 FIRE FIGHTING TRAINING AREA (Concentrations in $\mu\text{g/l}$)		
Parameter	Detection Limit	11-MW1
Pb	3	--
TPH	60	120
Base Neutral Extractable Organics:		
bis (2-ethylhexyl) phthalate	10	20 ^b
Volatile Organic Compounds:		
Acetone	10	5 ^{bj}
Methylene Chloride	5	4 ^{bj}
Notes: (--) Concentration below detection limit ^b Compound found in laboratory blank as well as sample. Sample concentration is less than 10 times blank concentration. ^j Estimated value. Measured value is less than the accurately quantitative detection limit.		

WDCR570/038.51

<p align="center">Table 2-19 ORGANIC COMPOUNDS IN SOIL AT SWMU 11 FIRE FIGHTING TRAINING AREA (Concentrations in $\mu\text{g}/\text{kg}$)</p>					
Parameter	11-SS1	11-SS1 (Duplicate)	11-SS2	11-SS3	11-SS4
Pb (mg/kg)	9	9.6	11.4	10.9	10.4
TPH (mg/kg)	9.3	6.3	22.9	18.8	289
Ignitability	NI	NI	NI	NI	NI
Base Neutral Extractable Organics:					
bis (2-ethylhexyl) phthalate	640	310 ^j	110 ^j	98 ^j	54 ^j
Volatile Organic Compounds:					
Acetone	27 ^b	17 ^b	60 ^b	26 ^b	19 ^b
Methylene Chloride	57 ^e	45 ^e	76 ^e	65 ^e	27 ^b
<p>Notes:</p> <p>^bCompound found in laboratory blank as well as in sample. Sample concentration is less than 10 times blank concentration.</p> <p>^eCompound found in laboratory blank as well as in sample. Sample concentration is greater than 10 times blank concentration.</p> <p>^jEstimated value. Measured value is less than the accurately quantitative detection limit.</p> <p>NI = Non-ignitable</p>					

WDCR570/039.51

Results indicated that traces of degraded fuel were present in two of the backhoe pits. No free-floating product was observed in any well; however, emulsified fuel was observed on the groundwater surface of one of the wells installed. It was concluded that Tank G-5 may have been the source of the leakage (Wright, 1983).

SWMU 16 (RFA SWMU 95)—Pesticide Storage Area, Bldg 821 ✓

Site History

This SWMU is located adjacent to the pesticide shop (see Figure 2-17). The IAS states that rinsewater from the pesticide mixing tank was discharged directly onto the ground around this location between 1968 and 1982 (RGH, 1984). The pesticides used at this location include 2,4-D, 2,4,5-T, baygon heptachlor, malathion, dustban, nibaryl, aldrin, chlordane, bromacil, warfarin, and DDT. About 2,000 pounds of active ingredients of these pesticides were mixed each year at this site. Although a total of less than 30 pounds of all the pesticides was discharged to the ground, contamination may have resulted from the washout of pesticide containers and equipment over the 15-year life of the pesticide shop.

Environmental Setting

The pesticide storage area is located on the southeast side of the pesticide shop building. The site is flat with a dirt ground cover. The area southwest of the storage area is wooded, with a ground cover of shrubs.

Investigation Results

There has been no environmental sampling at this SWMU.

SWMU 18 (RFA SWMU 3)—Hazardous Waste Storage Area, Bldg 204

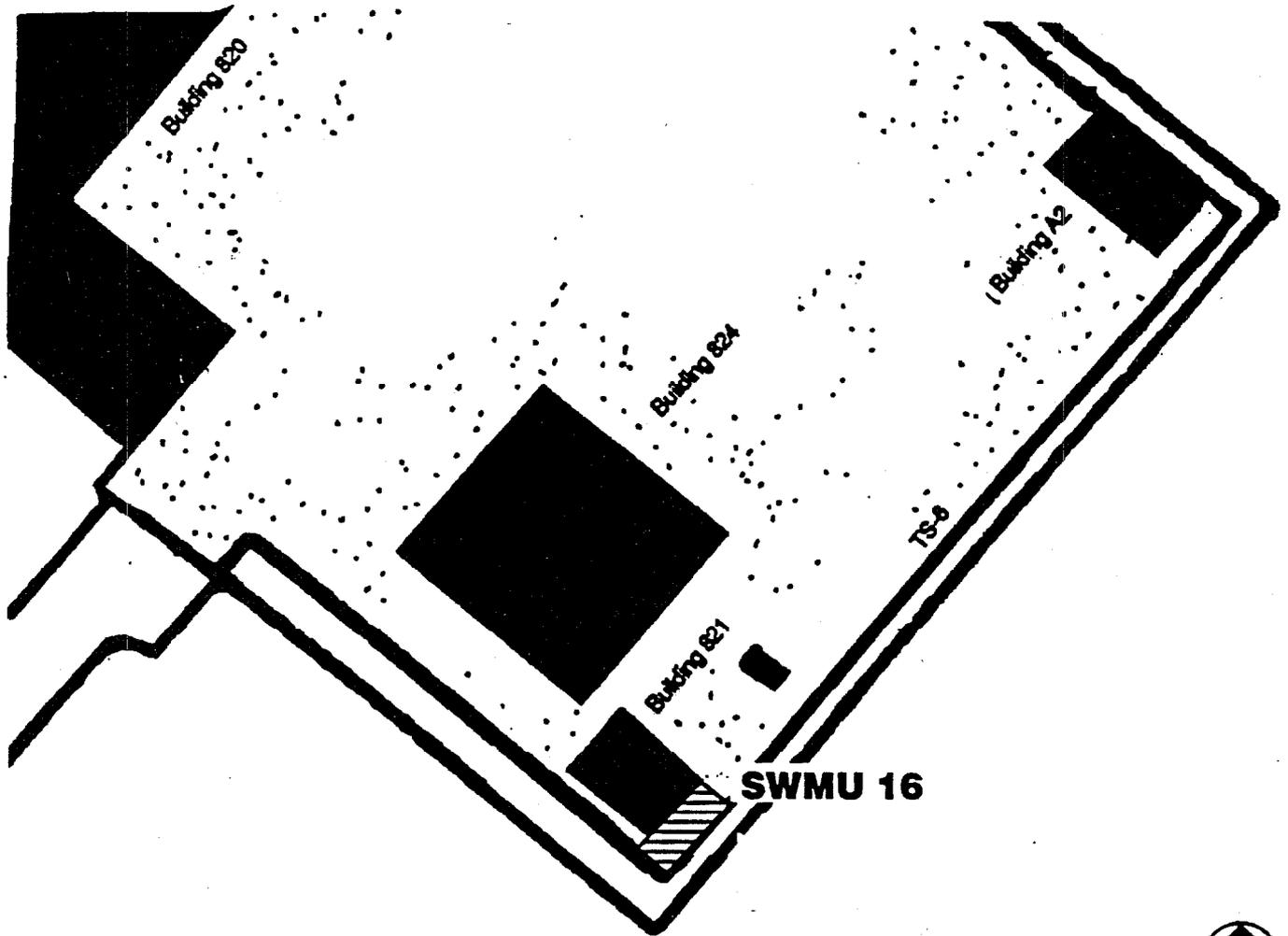
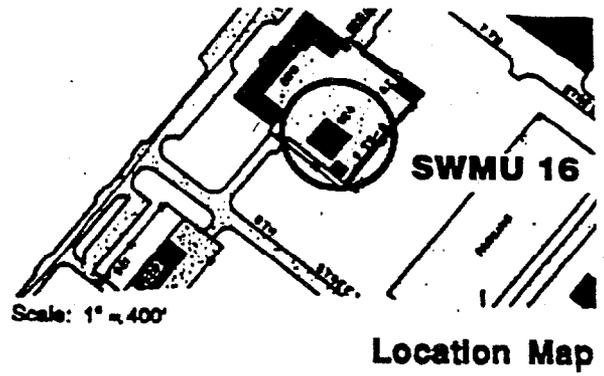
Site History

FITWING Behind 201 ?

This SWMU is located near Building 201. The approximate location is shown in Figure 2-18. According to the RFA, this SWMU stores drums directly on the ground in a fenced-in area for periods of less than 90 days. The unit is small, about 12 feet by 25 feet, and stores less than 10 drums. No release control methods were observed, but soil staining was observed during the VSI for the RFA. The hazardous waste storage area has existed for at least 10 years and was in use at the time of the VSI.

The RFA noted that materials typically stored in this SWMU may include any of the following: double-bagged empty oil and paint cans, double-bagged oily rags, drums of oil, paint thinner, paint remover, jet fuel, solvents, asbestos, PD 680, hydraulic fluid, freon, neutralized battery acid, and electric coolant oil.

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana



Scale: 1" = 50'

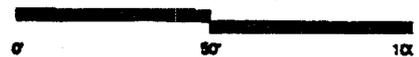
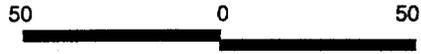
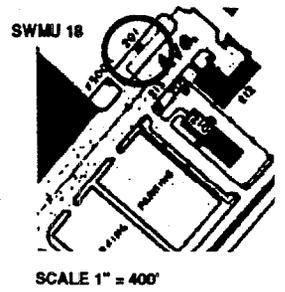


Figure 2-17
APPROXIMATE LOCATION OF SWMU 16
PESTICIDE STORAGE AREA, BUILDING 821
RCRA Facility Investigation—Naval Air Station, Oceana

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana



Approximate Scale in Feet



NOT TO SCALE

SWMU 18

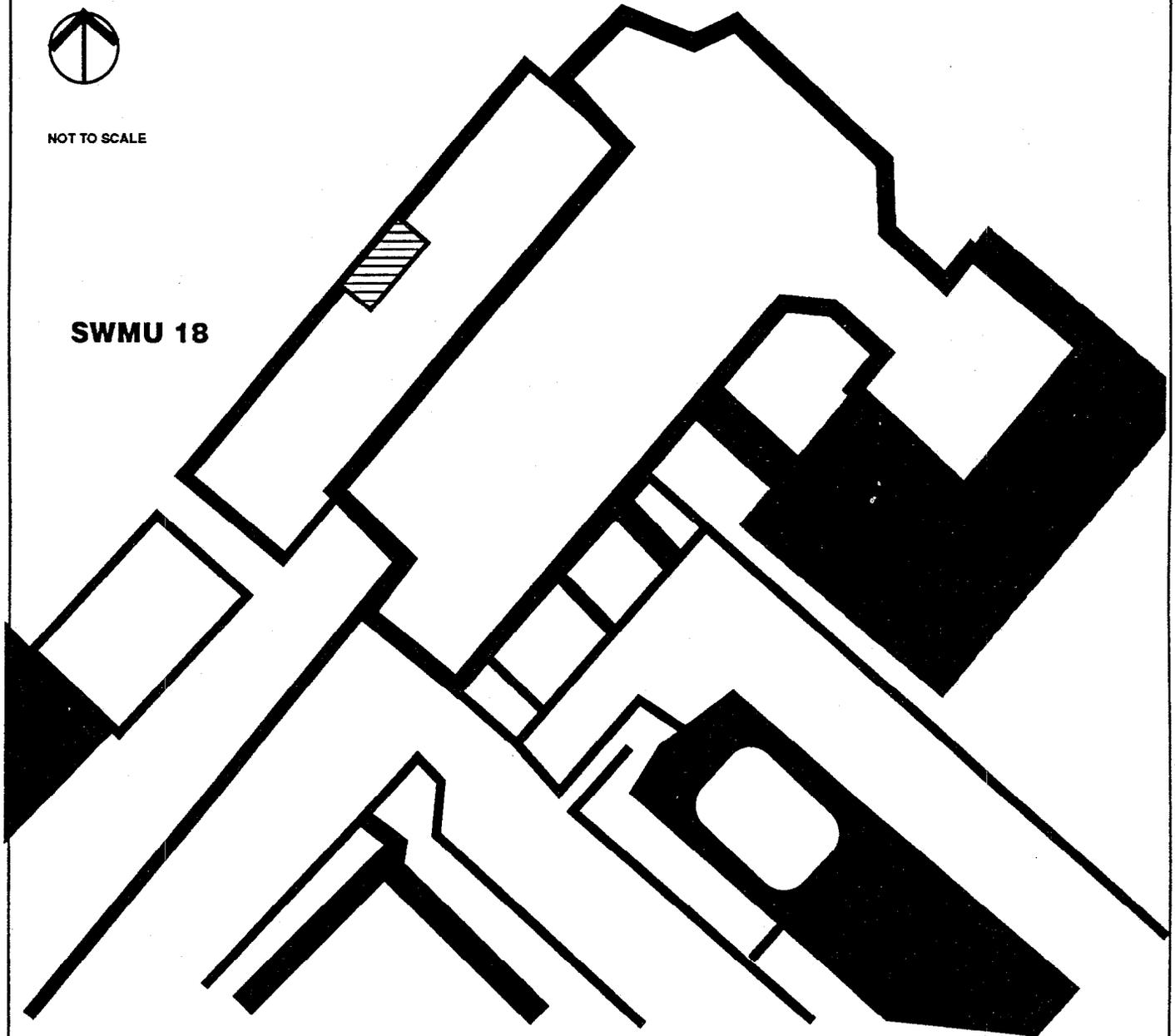


Figure 2-18
APPROXIMATE LOCATION OF SWMU 18
HAZARDOUS WASTE STORAGE AREA, BUILDING 204
RCRA Facility Investigation-Naval Air Station, Oceana

Environmental Setting

This site is located on the flight line and consists of a small shed and an adjacent area of flat bare ground where drums are stored.

Investigation Results

There has been no environmental sampling at this SWMU.

**SWMU 19 (RFA SWMU 71)—Waste Oil Storage Area, Bldg 541, and
SWMU 20 (RFA SWMU 72)—Waste Oil Storage Area, Bldg 543**

Site History

These SWMUs are located near Buildings 541 (see Figure 2-19) and 543 (Figure 2-20), where waste oil was observed to be stored in 55-gallon drums directly on the ground. At the time of the VSI, SWMU 19 stored one drum in good condition and SWMU 20 stored two drums that were also in good condition. The area northeast of SWMU 19 is covered with grasses that are mowed periodically. The shaded area shown in the site figure is a strip of grass approximately 150 feet long by 3 feet wide. Soil staining and dead grass were observed near each unit. No release-control methods were in place during the VSI. The waste oil is generated by repair of automobile engines and may include waste motor oil, hydraulic fluid, automatic transmission fluid, and solvents (RFA, 1988).

Environmental Setting

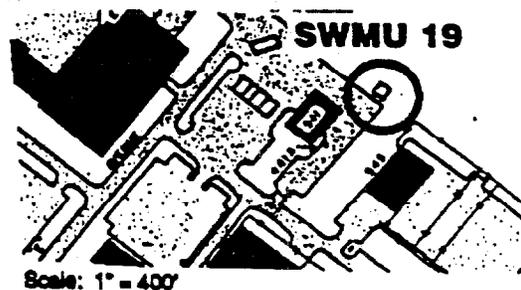
✓ SWMU 19 is located behind the Citgo gasoline station adjacent to an area where used tires are now stored. The area is flat and covered with lawn. No drums are currently present. The area of this SWMU is 50 to 100 square feet.

✓ SWMU 20 is located behind the self-help automotive garage for base personnel. This SWMU consists of a strip of bare ground between Building 543 and an asphalt area where cars in disrepair are parked. The area is flat, and no drums are currently present.

Investigation Results

There has been no previous environmental sampling at either of these SWMUs.

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana



Location Map

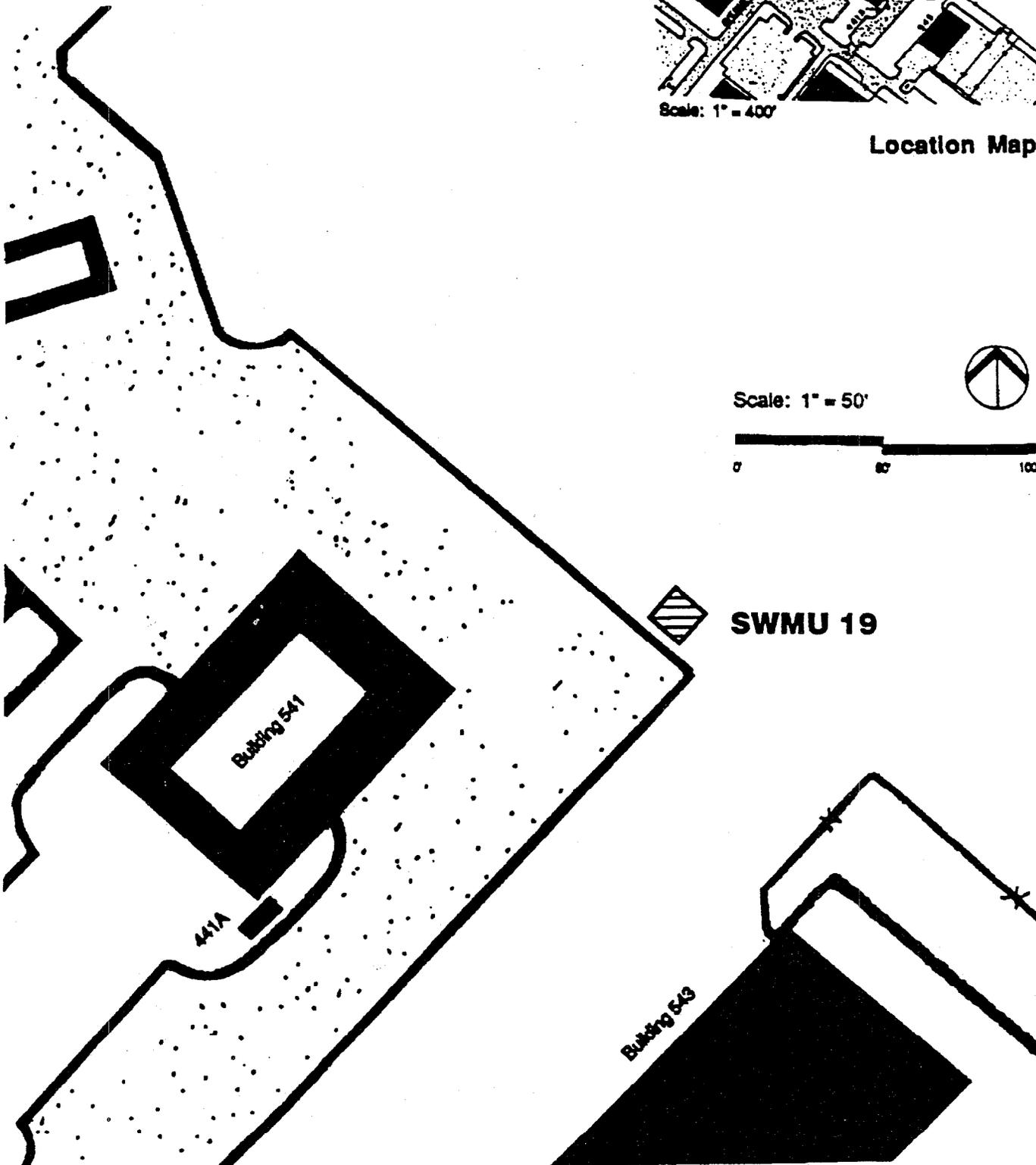
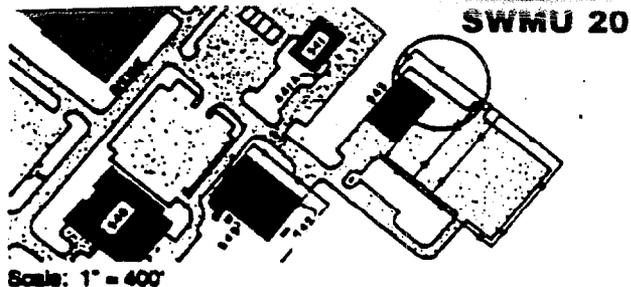


Figure 2-19
APPROXIMATE LOCATION OF SWMU 19
WASTE OIL STORAGE AREAS, BUILDING 541
RCRA Facility Investigation-Naval Air Station, Oceana

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana



Location Map

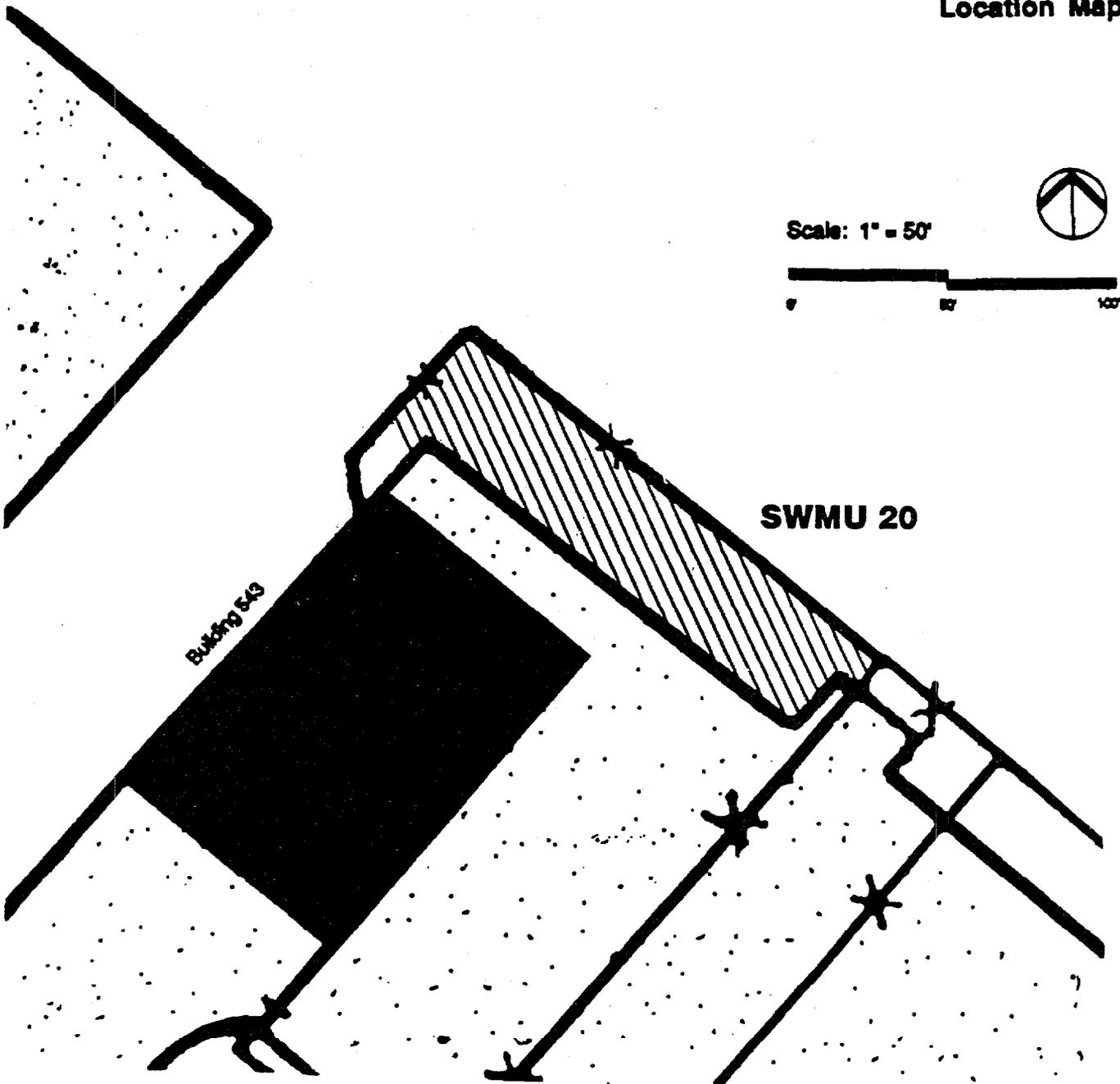


Figure 2-20
APPROXIMATE LOCATION OF SWMU 20
WASTE OIL STORAGE AREAS, BUILDING 543
RCRA Facility Investigation-Naval Air Station, Oceana

✓ **SWMU 21 (RFA SWMU 97)—Transformer Storage Yard, Bldg 830**

Site History

This SWMU is located behind Building 830, as shown in Figure 2-21. It is an open yard used to store several old electrical transformers (3.75 kw) on pallets; no release controls were observed during the VSI, and two of the transformers were leaking electrical oil onto the ground (RFA, 1988). Vegetation downslope of the transformers appeared to be dead.

Environmental Setting

This area consists of a flat, unpaved, earth and gravel parking lot.

Investigation Results

There has been no environmental sampling at this SWMU.

SWMU 22 (RFA SWMU 22)—Construction Debris Landfill *Not Known*

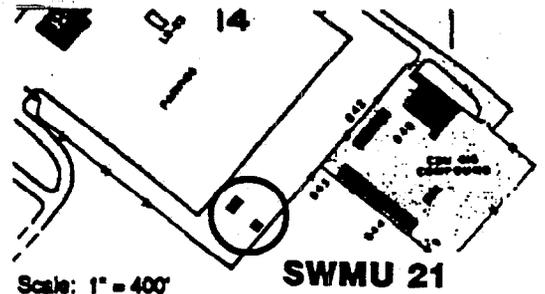
Site History

The construction debris landfill is located approximately 2,500 feet west of the intersection of South First Colonial Road and Oceana Boulevard (see Figure 2-22). The landfill is an approximately 0.5-acre unlined facility and was in use at the time of the VSI; no release controls were observed (RFA, 1988). The age of the landfill is unknown, but it was first discovered in 1986 (RFA, 1988). Wastes disposed of at this SWMU consist of, but are not limited to, construction debris, furniture, empty paint and paint thinner cans, tires, and scrap metal.

Environmental Setting

This SWMU is located in a low-lying area immediately east of Oceana Boulevard. Approximately 1,000 feet east and southeast of SWMU 22 are borrow areas that have filled in with water. There are also wetlands along the banks of Great Neck Creek, approximately 3,000 feet east of this unit.

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana



Location Map

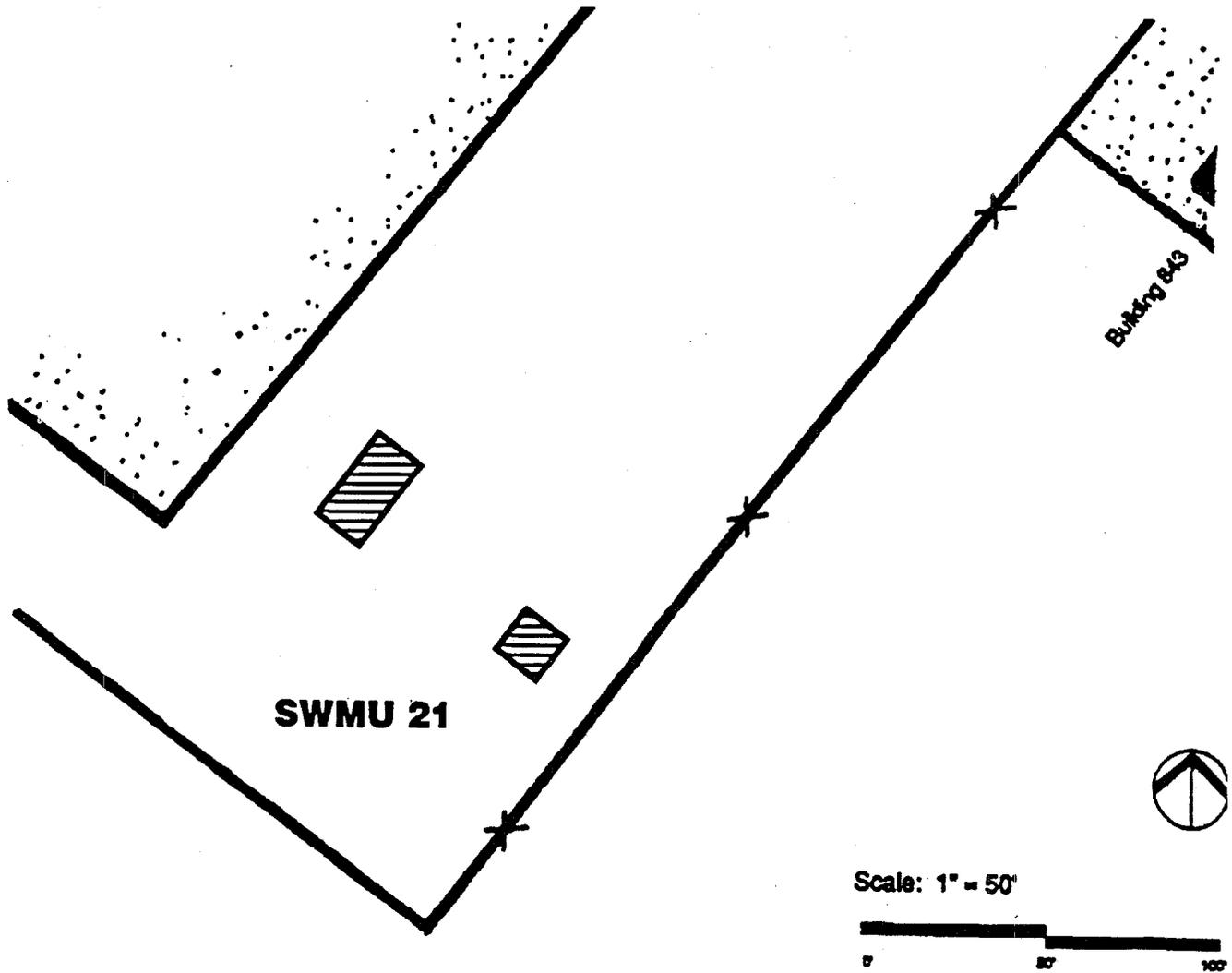
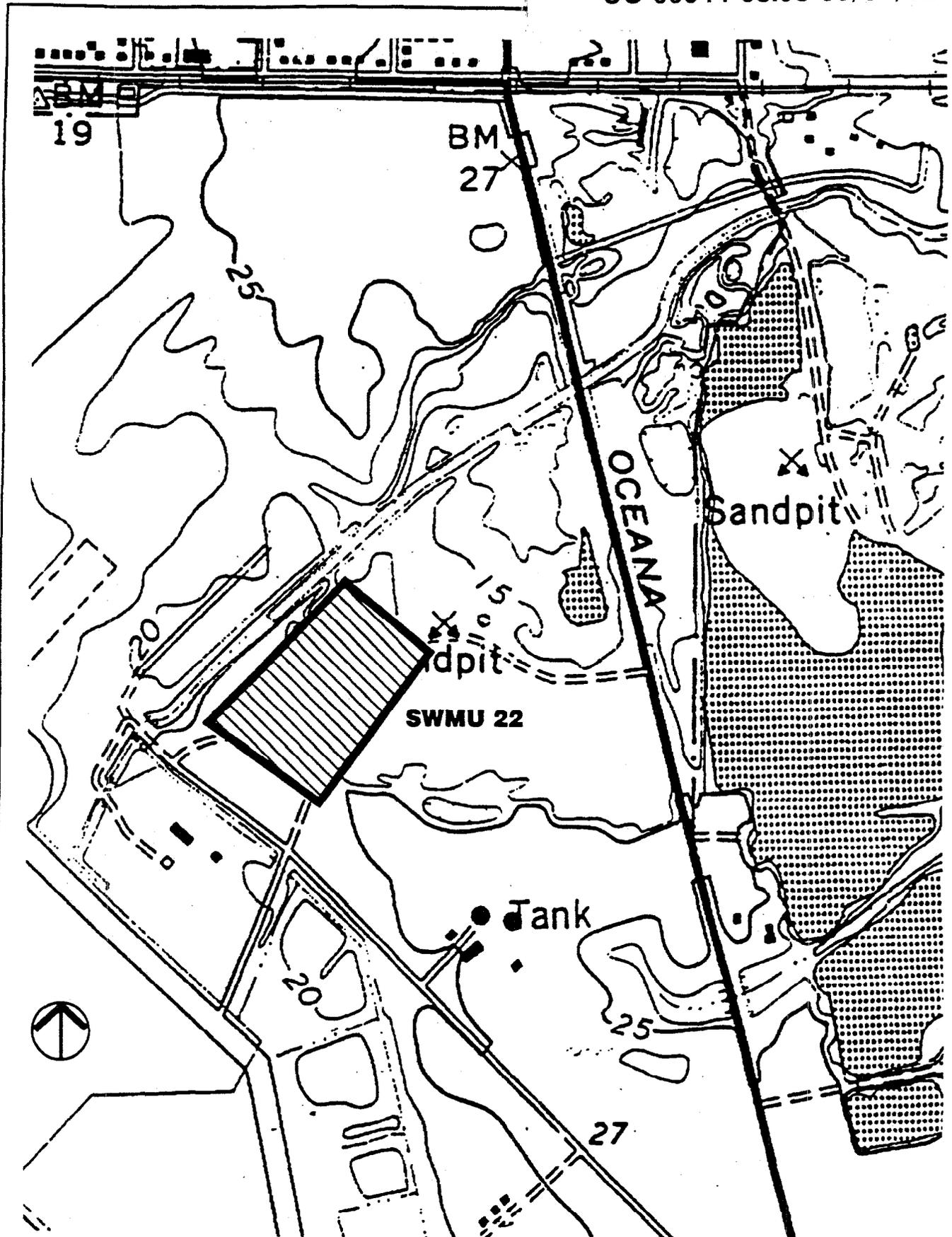


Figure 2-21
APPROXIMATE LOCATION OF SWMU 21
TRANSFORMER STORAGE YARD, BLDG. 830
RCRA Facility Investigation-Naval Air Station, Oceana



SCALE 1" = 600 Feet

Figure 2-22
APPROXIMATE LOCATION OF SWMU 22
CONSTRUCTION DEBRIS LANDFILL
RCRA Facility Investigation—Naval Air Station, Oceana

SWMU 23 (RFA SWMU 78)—Bowser, Bldg 830, and SWMU 24 (RFA SWMU 79)—Bowser, Bldg 840***Site History***

These two SWMUs are located near Buildings 830 and 840 (see Figure 2-23 and Figure 2-24) and consist of 500-gallon mobile bowser used to collect wastes generated at these two locations. According to the RFA, SWMU 23 collects waste motor oil drained from engine parts; approximately 1,500 to 2,000 gallons of waste oil is generated each year. Building 830 has been used since 1954 and waste may have been generated and disposed of since this date. When full, the bowser is transported to the Fuel Division Storage Yard for transfer to storage tanks.

SWMU 24 collects waste motor oil and solvents generated from equipment maintenance; the bowser is hauled to the tank farm for disposal of the waste (RFA, 1988). Building 840 may have been generating these wastes since 1972.

Environmental Setting

SWMU 23 consists of the principal area where a bowser was parked adjacent to Building 830. The setting is a small (10 feet by 10 feet) rectangular section of a flat asphalt parking lot. SWMU 24 consists of the principal area where a bowser was parked in the vicinity of Building 840. The setting is a small (10 feet by 10 feet) area on a gravel parking lot.

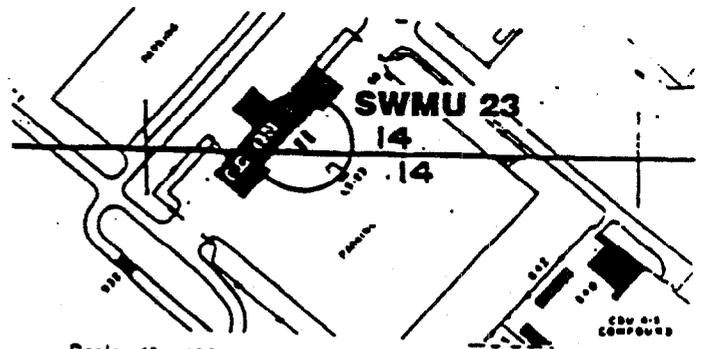
Investigation Results

There has been no environmental sampling at this SWMU.

SWMU 25 (RFA SWMU 25)—Inert Landfill***Site History and Environmental Setting***

The inert landfill is located north of Potters Road (see Figure 2-25) on 26 acres of land. According to the RFA, the facility is unlined and was used as a borrow pit that supplied soil used in the construction of state Route 44. The pit was developed in a fine, sandy loam soil that has a moderately high hydraulic conductivity. Eventually, the pit filled with water and was used as a local dump. Burrow areas east of the inert landfill have also filled with water. NAS, Oceana, purchased the land in 1979 and received a permit from the Virginia Department of Health on May 24, 1979, permitting the disposal of inert solid waste. Waste disposal, however, may have begun as early as 1978 (RFA, 1988). NAS, Oceana, currently disposes of inert construction debris at this SWMU; however, uncontrolled community waste disposal of unknown materials was taking place before NAS, Oceana's purchase of the site.

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



Location Map

Scale: 1" = 50'

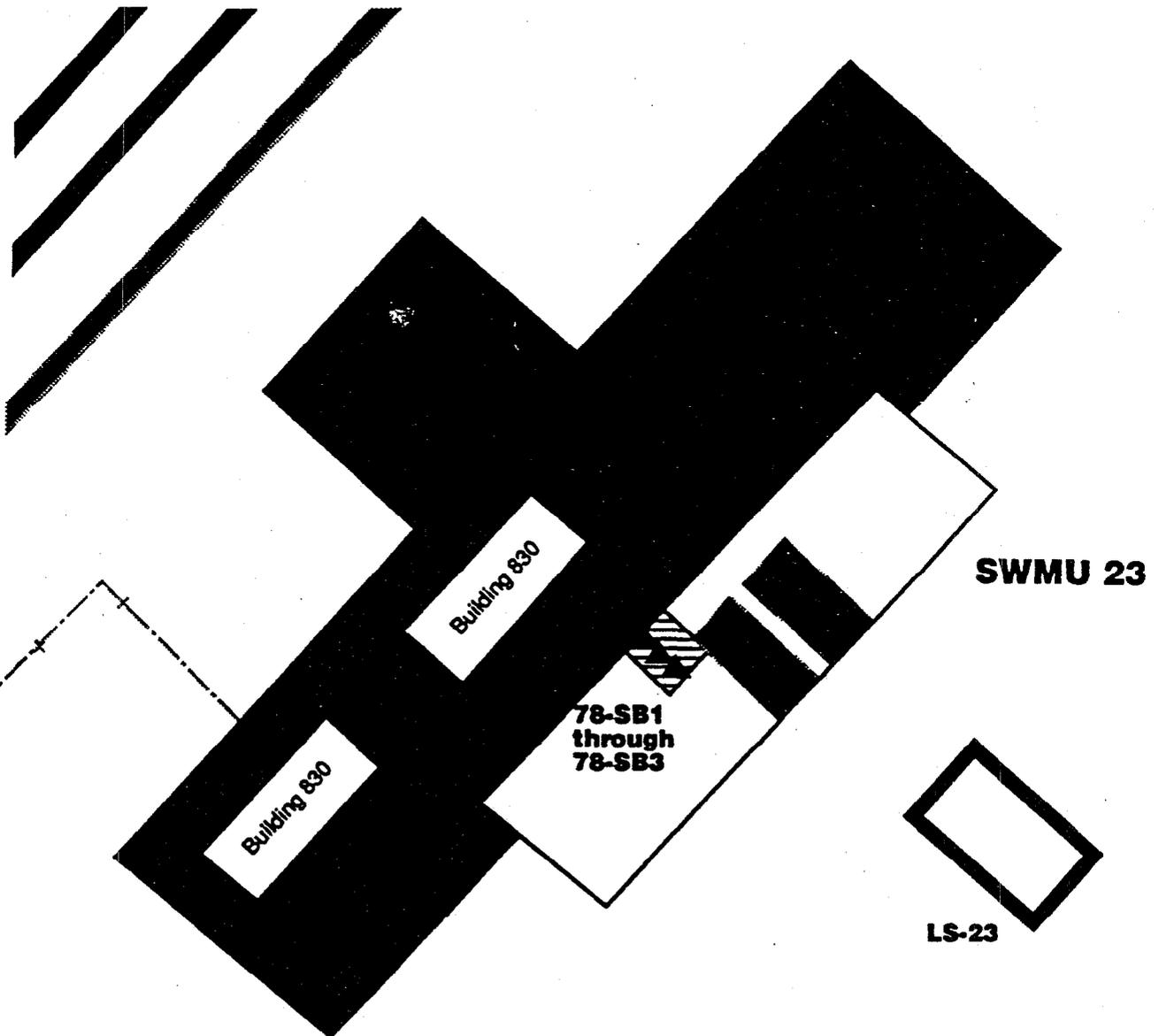


Figure 2-23 APPROXIMATE LOCATION OF SWMU 23 BOWSER, BUILDING 830 RCRA Facility Investigation—Naval Air Station, Oceana

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana

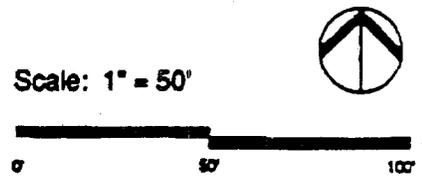
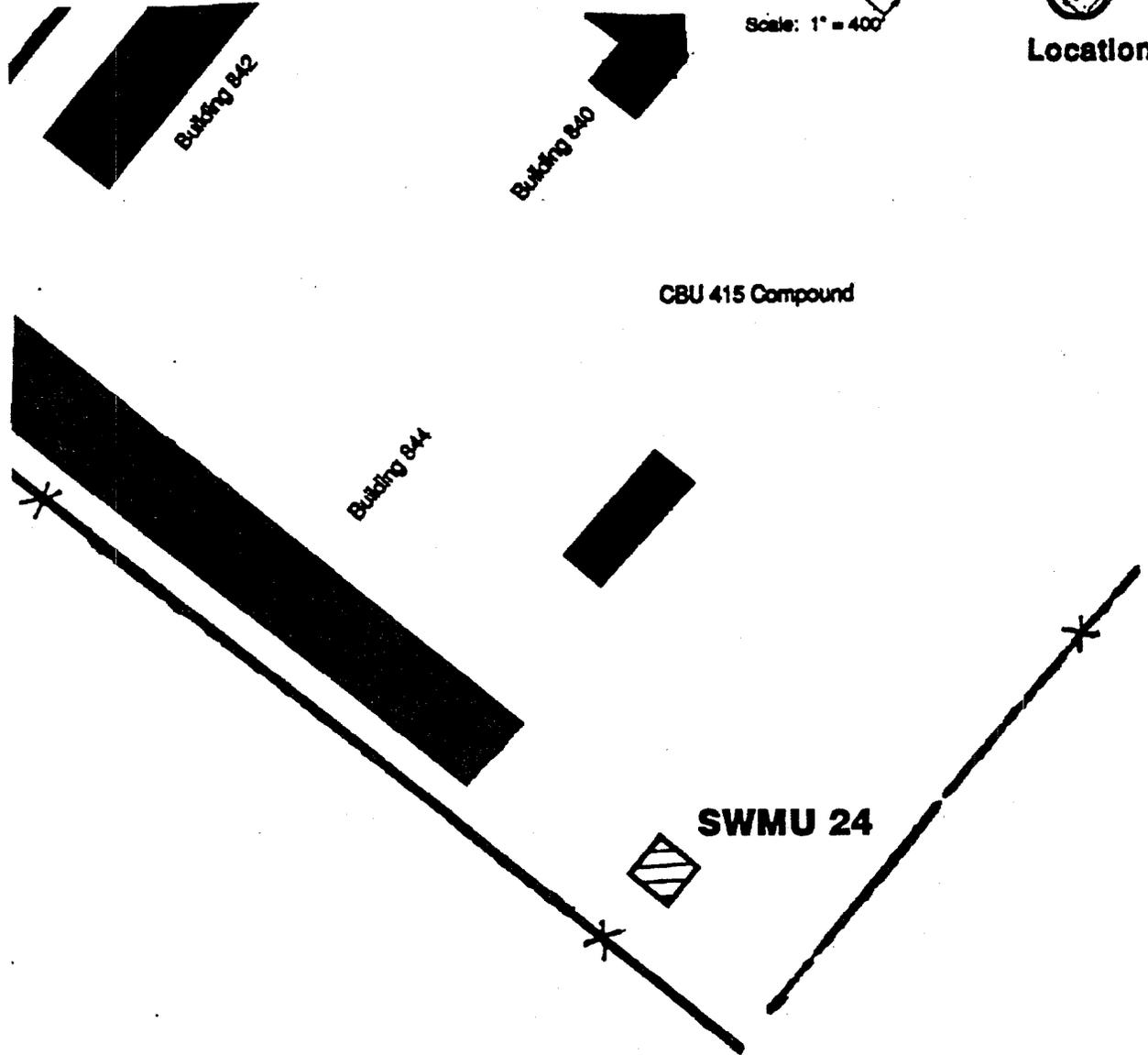
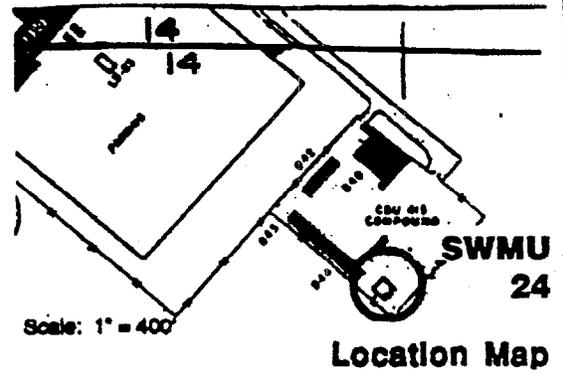
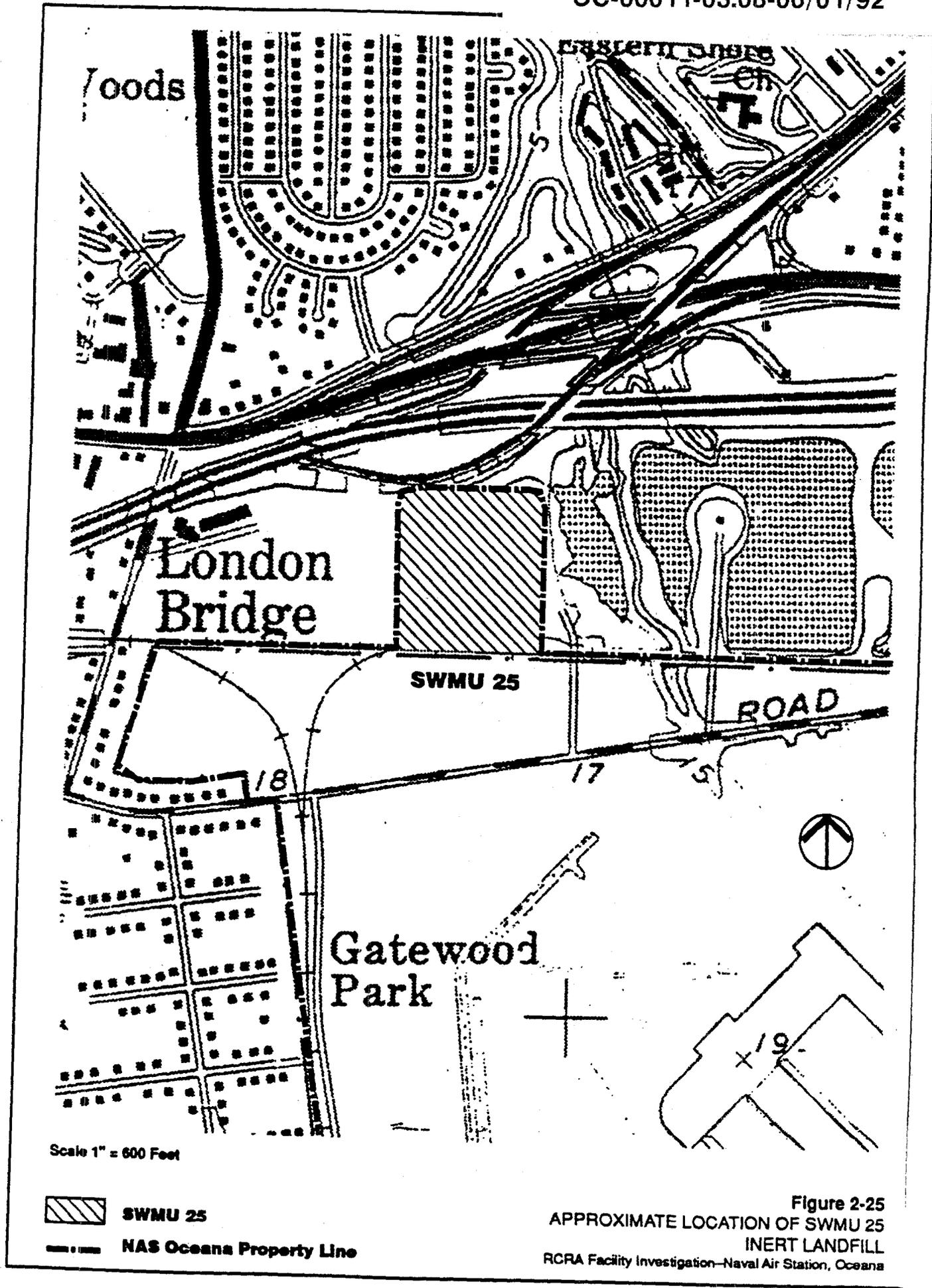


Figure 2-24
APPROXIMATE LOCATION OF SWMU 24
BOWSER, BUILDING 840
RCRA Facility Investigation-Naval Air Station, Oceana



Scale 1" = 600 Feet

-  SWMU 25
-  NAS Oceana Property Line

Figure 2-25
 APPROXIMATE LOCATION OF SWMU 25
 INERT LANDFILL
 RCRA Facility Investigation—Naval Air Station, Oceana

Investigation Results

There has been no environmental sampling at this SWMU.

SWMU 26 (RFA SWMU 65)—Fire Fighting Training Area ✓***Site History***

SWMU 26 is a training burn pit located behind Building 220 (see Figure 2-26). It is a gravel-covered depression used for portable fire extinguisher training. Waste POL and fuel-contaminated objects are placed in the burn pit and ignited. Visible staining of the ground was observed during the VSI; the staining extended to a nearby drainage ditch. No release controls were noted at this SWMU during the VSI.

Environmental Setting

The burn pit is a small, flat, rectangular structure approximately 5 feet by 3 feet surrounded by short grass. Overflow from the pit has resulted in an area of oil-stained soil approximately 5 feet by 15 feet. Immediately adjacent to the pit is a linear depression in the ground surface that directs surface runoff away from the site to a drainage ditch to the southeast. The ditch is broad and shallow, and flows to the northeast.

Investigation Results

There has been no previous environmental sampling at this SWMU.

WDCR547/045.51

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana

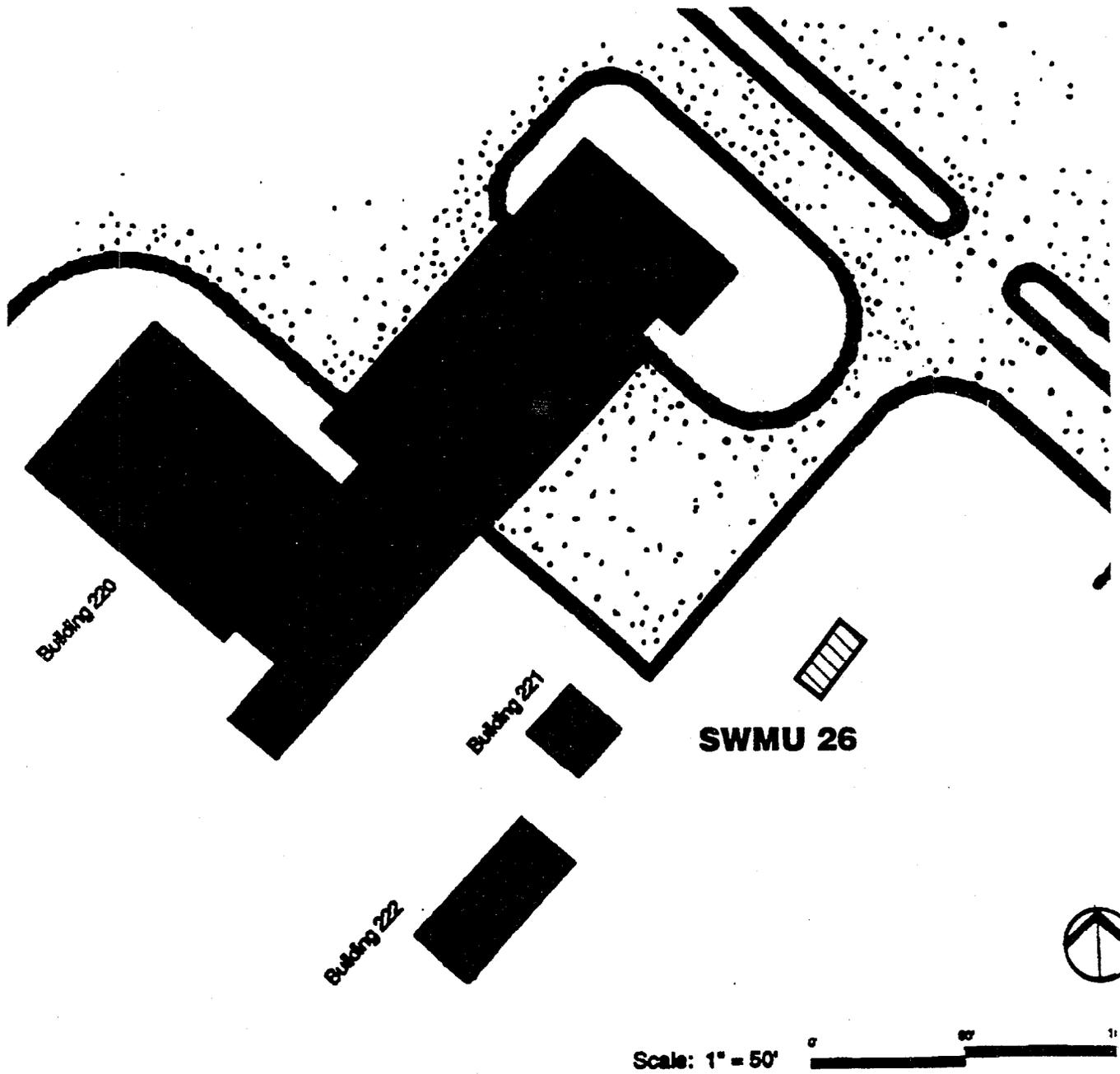
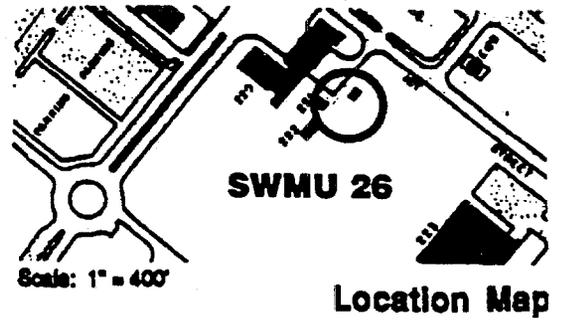


Figure 2-26
APPROXIMATE LOCATION OF SWMU 26
FIRE FIGHTING TRAINING AREA
RCRA Facility Investigation—Naval Air Station, Oceana

Chapter 3 Project Management Plan

The project management plan documents the overall management approach to the RFI and ensures that field data collection and the RFI report satisfy project objectives. The technical approach is designed to yield the data and information needed to determine the applicability of, or need for, corrective action that will mitigate releases of hazardous constituents to the environment from the SWMUs at NAS, Oceana. In the broadest sense, the RFI work plan has been prepared to help determine whether hazardous constituents have been released and, if so, the extent of the release from the SWMUs under scrutiny. The work plan will also guide the gathering of data to support selection of corrective measures, if needed. This section discusses corrective measure technologies identified before the investigation that may be appropriate for implementation at the SWMUs and presents the technical approach to management of the project.

Pre-Investigation Evaluation of Corrective Measure Technologies

A preliminary evaluation of corrective measure technologies has been conducted to maximize the extent to which data collected during the RFI support the corrective measure selection process. A pre-investigation evaluation is useful in defining a technical approach and identifying probable data gaps. This evaluation helps focus the RFI planning effort. Although several environmental studies have been performed at NAS, Oceana, no environmental analytical data has been gathered for 11 of the 19 SWMUs of concern. Subsequently, data gaps have been identified, and data collection has been designed to address a number of different corrective action measures.

Methods

The purpose of the pre-investigation evaluation of corrective measures technologies is to identify corrective measure technologies that could be used to remediate areas of concern and then to define the data needed for the accurate evaluation and selection of final measures, if required. The process consists of five steps as follows:

1. Review existing chemical data for each SWMU.
2. Identify compounds of interest at each SWMU.
3. Identify potential pathways associated with each SWMU.

4. Identify all corrective measures technologies applicable to the different environmental media of concern.
5. Identify the data needed to further evaluate the applicability of the technologies.

Current Knowledge

The current understanding of environmental conditions at NAS, Oceana, is described in Section 2. EPA Region III has designated 19 SWMUs for the RFI investigation (see Table 3-1). Due to the proximity of several of the SWMUs, some have been combined, resulting in 17 areas to be investigated.

Compounds of Interest

Table 3-2 presents the contaminants detected in the soil samples collected from the SWMUs at NAS, Oceana. The compounds were encountered at varying concentrations throughout the air station. All compounds that were detected in concentrations above the analytical detection limits and that were not determined to be laboratory contaminants are included in Table 3-2. Sample constituents found in concentrations less than 10 times the concentration in the laboratory method blank were considered laboratory contaminants for the purposes of Table 3-2. Their appearance in the table does not necessarily indicate that the compounds were found in high concentrations. Table 3-3 presents potential soil contaminants for which there are no quantitative data but which, on the basis of historical information, may exist at the SWMUs. Table 3-4 presents the contaminants detected in groundwater and surface water samples, and Table 3-5 presents the additional contaminants suspected to be in the water, on the basis of historical information.

Exposure Pathways

An exposure pathway is the course that a chemical of concern follows from its source to an exposed organism or individual called a *receptor*. A completed pathway has five elements:

- Contaminant source
- Mechanism for contaminant release
- Environmental transport medium
- Exposure point (receptor location)
- Feasible route of exposure (the means by which contamination could move from the source to the receptor)

**Table 3-1
 NAS, OCEANA SOLID WASTE MANAGEMENT UNITS (SWMU)
 REQUIRING FURTHER ACTION**

SWMU No.	RFA SWMU No.	SWMU Name
1	57	West Woods Oil Disposal Pit
2b	53	Line Shack Oil Disposal Area, Bldg. 131
2c	54	Line Shack Oil Disposal Area, Bldg. 400
2d	52	Line Shack Oil Disposal Area, Bldg. 125
2e	51, 1	Line Shack Oil Disposal Area, Bldg. 23
		Hazardous Waste Storage Area, Bldg. 23
11	62, 63	Fire Fighting Training Area
15	58	Abandoned Tank Farm
16	95	Pesticide Storage Area, Bldg. 821
18	3	Hazardous Waste Storage Area, Bldg. 204
19	71	Waste Oil Storage Areas, Bldg. 541
20	72	Waste Oil Storage Areas, Bldg. 543
21	97	Transformer Storage Yard, Bldg. 830
22	22	Construction Debris Landfill
23	78	Bowser, Bldg. 830
24	79	Bowser, Bldg. 840
25	25	Inert Landfill
26	65	Fire Fighting Training Area

WDCR388/090.51

Table 3-2 CONTAMINANTS DETECTED IN SOIL AND SEDIMENT SAMPLES AT NAS, OCEANA	
SWMU	Compounds
1 (West Woods Oil Disposal Pit)	TPH Volatile Organics -- Ethylbenzene -- MEK -- Toluene -- Xylenes
2b (Line Shack Disposal Area, Bldg. 131)	Volatile Organics -- Benzene -- Carbon Disulfide -- Ethylbenzene -- MEK -- MIBK -- Toluene -- Trichloroethene -- Xylenes
2c (Line Shack Disposal Area, Bldg. 400)	Volatile Organics -- Carbon Disulfide -- 1,1-Dichloroethane -- Toluene -- Vinyl Chloride -- Xylenes
2e (Line Shack Disposal Area, Bldg. 23)	TPH
11 (Fire Fighting Training Area)	TPH
Constituents with concentrations less than 10 times the concentration of the laboratory method blank are not listed. See Chapter 2.	

WDCR388/091.51

Table 3-3 SOIL AND SEDIMENT CONTAMINANTS SUSPECTED AT NAS, OCEANA, BASED ON HISTORICAL INFORMATION	
SWMU	Compounds
1 (West Woods Oil Disposal Pit)	PCBs Dioxins Semi-volatile Organics
15 (Abandoned Tank Farm)	PAHs Chlorinated Volatiles Aromatic Volatiles Volatile Organics
16 (Pesticide Storage Area)	Pesticides
18 (Hazardous Waste Storage Area, Bldg. 204)	Semi-volatile Organics Metals
19 (Waste Oil Storage Area, Bldg 541)	PAHs Chlorinated Volatiles Aromatic Volatiles
20 (Waste Oil Storage Area, Bldg 543)	PAHs Chlorinated Volatiles Aromatic Volatiles
21 (Transformer Storage Yard, Bldg. 830)	PCBs
22 (Construction Debris Landfill)	Volatile Organics Semi-volatile Organics Pesticides/PCBs Metals
23 (Bowser, Bldg. 830)	Volatile Organics PAHs Chlorinated Volatiles Aromatic Volatiles
24 (Bowser, Bldg. 840)	Volatile Organics PAHs Chlorinated Volatiles Aromatic Volatiles
25 (Inert Landfill)	Volatile Organics Semi-volatile Organics Pesticides/PCBs Metals
26 (Fire Fighting Training Area)	PAHs Chlorinated Volatiles Aromatic Volatiles Volatile Organics Lead Ignitable Compounds

Table 3-4 CONTAMINANTS DETECTED IN GROUNDWATER AND SURFACE WATER SAMPLES AT NAS, OCEANA	
SWMU	Compounds
1 (West Woods Oil Disposal Pit)	TPH Volatile Organics -- Ethylbenzene -- Xylenes
2b (Line Shack Disposal Area, Bldg. 131)	Volatile Organics -- 1,1-Dichloroethane -- 1,1-Dichloroethene -- 1,2-Dichloroethene -- Trichloroethene -- Vinyl Chloride
2c (Line Shack Disposal Area, Bldg. 400)	Volatile Organics -- Benzene -- Chloroethane -- 1,1-Dichloroethane -- 1,2-Dichloroethene -- Toluene -- Vinyl Chloride -- Xylenes
2d (Line Shack Disposal Area, Bldg. 125)	Volatile Organics -- 1,1-Dichloroethane -- 1,1-Dichloroethene -- Xylenes

WDCR388/093.51

Table 3-5 GROUNDWATER/SURFACE WATER CONTAMINANTS SUSPECTED AT NAS, OCEANA, BASED ON HISTORICAL INFORMATION	
SWMU	Compounds
1 (West Woods Oil Disposal Pit)	PCBs Dioxins Semi-volatile Organics
15 (Abandoned Tank Farm)	PAHs Chlorinated Volatiles Aromatic Volatiles Volatile Organics
22 (Construction Debris Landfill)	Volatile Organics Semi-volatile Organics Pesticides/PCBs Metals
25 (Inert Landfill)	Volatile Organics Semi-volatile Organics Pesticides/PCBs Metals

WDCR388/094.51

Based on a review of data from past investigations presented in Chapter 2, it is anticipated that the two main sources of potential contaminant release at NAS Oceana, are surface soil and subsurface soil. Several possible release mechanisms associated with each source are presented graphically in Figures 3-1 and 3-2. The figures represent the potential exposure pathways for surface and subsurface soil and include pathways that can be discounted because they do not apply to conditions at Oceana. For example, no trespassers are expected at the site due to the restricted access to NAS property resulting from security patrols, gates, and fences, so pathways that include trespassers as receptors can be eliminated. Figure 3-1 shows that runoff from contaminated soil can be transported to surface waters. At NAS, Oceana, several drainage ditches that can potentially be affected by the SWMUs under study, discharge to West Neck Creek, Great Neck Creek, London Bridge Creek, and Wolfsnare Creek. Figure 3-2 includes the exposure pathway of greatest concern at NAS, Oceana--release of contaminants from subsurface soil to groundwater. Pathways for surface water and groundwater contamination at NAS Oceana can be traced by following the pathways from these media as shown in Figures 3-1 and 3-2.

Identification of Available Corrective Measure Technologies

Groundwater and Surface Water

The corrective measure technologies for groundwater and surface water presented in this section were selected on the basis of limited data. Chemical analyses to date have included only limited analytes. More comprehensive analyses are recommended to determine if other contaminants are present that would require treatment. In addition, water chemistry information is needed to better assess treatment technologies.

After contaminants are quantified, treatment goals need to be established. Treatment involves removing contaminants from the water and either concentrating the contaminants so they can be safely disposed of or destroying them. The objective is to produce the largest fraction of treated water that can be discharged. The destination of this treated water usually determines the required level of treatment. Four discharge options for treated water at NAS, Oceana, are:

- Discharge to a publicly owned treatment works (POTW)
- Discharge to a local body of surface water
- Recharge or reinjection into the groundwater
- Recirculation of treated water back to the station for non-potable use

Discharge requirements typically vary for each of these options. Therefore, these discharge options need to be carefully evaluated in the context of applicability and effectiveness of the treatment technologies presented.

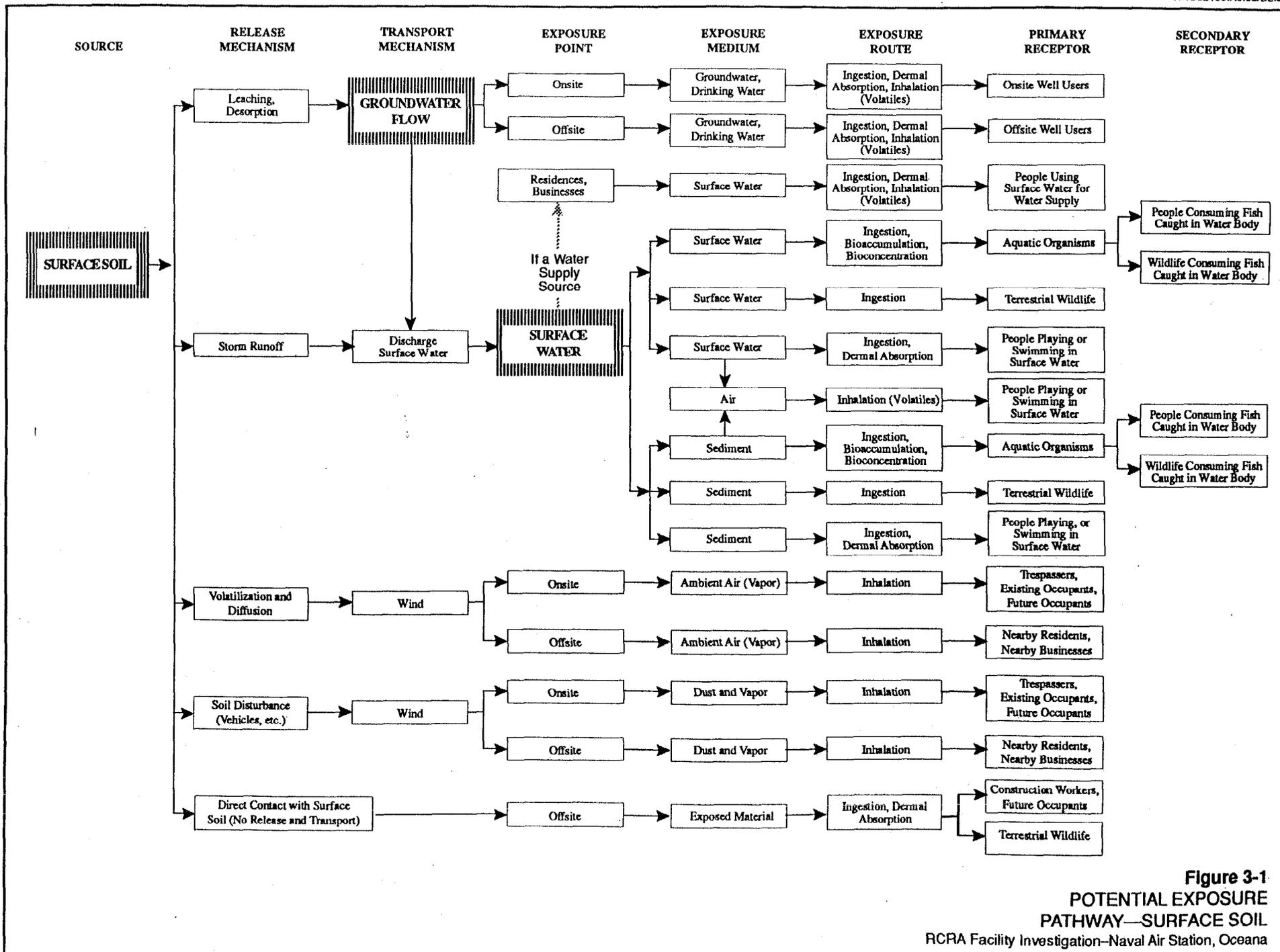


Figure 3-1
POTENTIAL EXPOSURE
PATHWAY—SURFACE SOIL
 RCRA Facility Investigation—Naval Air Station, Oceana

OC-0001-03.08-06/01/92

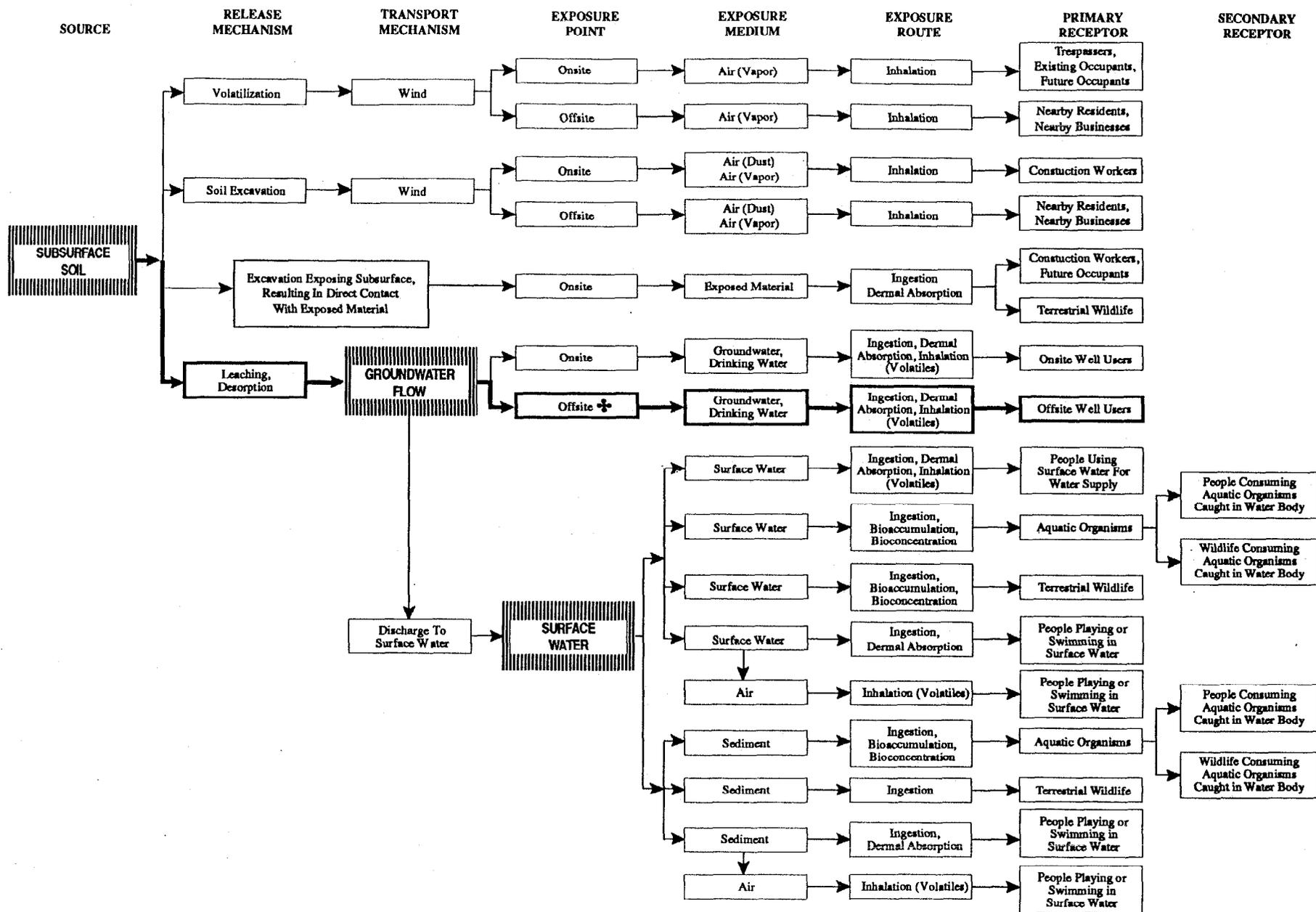


Figure 3-2
 POTENTIAL EXPOSURE PATHWAY—SUBSURFACE SOIL
 RCRA Facility Investigation—Naval Air Station, Oceana

OC-0001-1-03.08-06/01/92

Treatment technologies are described in the following subsections. Due to the variety of contaminants detected, multiple treatment technologies in series may be required to treat the groundwater and surface water prior to discharge. Table 3-6 summarizes the advantages and disadvantages of potentially applicable technologies and also indicates the SWMUs at which these technologies may be applied.

Oil/Water Separation. Oil/water separation is often used to remove oil and grease from wastewater streams. Gravity separation vessels, such as skim tanks or API separators, may be used on free oils, which readily form a separate phase from the water. In these vessels, the floating oils rise and are removed from the surface while the water continuously flows out under partitions.

Emulsified oils require treatment to break the oil-water emulsion prior to separation. Emulsions may be broken by chemical or treatment methods, usually by lowering the pH to two or three or by increasing the temperature to 160 degrees F or above. Emulsion-breaking polymers or other chemicals may also be used prior to the oil/water separator.

Flotation. Flotation is used to remove suspended materials such as oil and grease from wastewaters. In the process, air is bubbled into the wastewater. The air bubbles attach to the solids or oil particles, increasing their buoyancy and causing them to float. A surface layer or froth forms and is continuously skimmed off for disposal. Flotation is a fully developed process and is commonly used to remove emulsified oils and grease from wastewaters.

Discharge to POTW. If contaminant concentrations are below pretreatment levels, the contaminated groundwater could be discharged directly to a POTW. The accepting POTW could impose monitoring restrictions or additional fee to accept the wastewater.

Precipitation. Precipitation is often used in waste treatment to remove soluble heavy metals and inorganics from wastewater as insoluble hydroxides, sulfides, or carbonates. Lead is removable by precipitation.

Chemical precipitation involves alteration of the ionic equilibrium to convert soluble metal ions to insoluble precipitates. These precipitates are then removed by solids separation processes such as coagulation, flocculation, sedimentation, and filtration.

Most precipitation reactions are carried out by adding appropriate chemicals and mixing. Some common additives to treat lead include lime, caustic, and ferric sulfate. Adjustment of the liquid stream pH may be required after the removal of the solid precipitates.

**Table 3-6
GROUNDWATER CANDIDATE TREATMENT TECHNOLOGIES**

Technologies	Applicable Contaminants	State of Development	Advantages	Disadvantages	SWMUs for Potential Use																	
					1	2b	2c	2d	2e	11	15	16	18	19	20	21	22	23	24	25	26	
Chemical Oxidation	Volatiles, Semi-Volatiles, Pesticides	Commercial	1. Detoxification of certain organics 2. No process residuals requiring additional treatment or disposal	1. If ozone and/or ultraviolet radiation are used relatively high capital and operating costs 2. Oxidation may introduce additional pollutants into effluent 3. Products of incomplete oxidation may be toxic 4. Oxidants are nonselective so easily oxidizable material in the waste stream may limit the use of the oxidizing agent on the contaminant(s) of concern	●	●	●	●			●							●			●	
Air Stripping	Volatiles	Commercial	1. High removal efficiencies of volatile organics 2. Simple, reliable operation	1. Exhaust gases may require additional treatment 2. Intermittent disinfection may be required to prevent fouling of the pecking	●	●	●	●			●							●			●	
Discharge to POTW	Low Concentrations	--	1. Low cost, easy to implement	1. Applicable only to low contaminant concentrations 2. May involve additional monitoring	●	●	●	●			●							●			●	

Precipitation was the technology used in setting the concentration-based BDAT treatment standard for D008 wastewaters (Note: D008 is the hazardous waste code for lead toxicity characteristic). Several precipitants were evaluated in setting the standard, including those mentioned above; however, one was not promulgated by EPA.

Ion Exchange. Ion exchange involves the removal of ionic species, principally inorganic, from an aqueous phase into a concentrated waste stream. Metals in general are suitable for removal by ion exchange.

Liquid streams are brought into contact with solid ion exchange resins, which preferentially give up specific ions on the resins' active surface sites to adsorb ions dissolved in the liquid stream.

There are four operations carried out in a complete ion exchange cycle: service, backwash, regeneration, and rinse. In the service step, the ion exchanger is contacted with the solution containing the ion to be removed until the active sites in the exchanger are partially or completely used up. The backwash step is then operated in the reverse direction to the service cycle to expand the bed and to remove fines that may be clogging the bed. The exchanger is then contacted with a sufficiently concentrated solution of the ion originally associated with it to regenerate it back to its original form. The rinse step removes excess regeneration solution prior to the next service step. The process yields a large volume of purified product stream and a small volume of used regenerant solution containing a high concentration of the extracted species.

Ion exchange has been demonstrated on many aqueous streams, and systems are available commercially. Cation-exchange resins are readily available to treat lead waste streams.

An emerging technology currently being evaluated by EPA in the SITE program is the AlgaSORB® process developed by Bio-Recovery Systems, Inc. AlgaSORB® is an algal based material that is immobilized into a polymeric matrix. During the immobilization process, the algae are killed, which allows the algal matrix to be exposed to heavy metals under conditions that would be toxic to living cells. The AlgaSORB® process functions like a commercial ion exchange resin. According to an EPA document addressing this technology, lead can be removed with the algal biomass; however, only data on mercury removal were presented.

Activated Carbon Adsorption. This technology is a separation process in which organic and inorganic contaminants are removed from wastewater by the attraction and accumulation of the contaminants on the surface and in the pore volumes of the carbon particles. Activated carbon has widespread application in the treatment of industrial wastewater treatment systems. It is used for the removal of several organics and some inorganics from aqueous waste. PCBs, many pesticides, and volatile and semi-volatile organic compounds such as phenolics and chlorinated organics are adsorbed onto the

surface of activated carbon to various degrees. In addition, certain heavy metals, including lead, may be removed by activated carbon.

In the carbon process, wastewater is passed through the carbon, usually in packed beds. Contacting methods for granular activated carbon include adsorbers in parallel, series, moving bed, and up-flow expanded beds. When the carbon reaches its maximum capacity for adsorption, or when effluent concentrations are unacceptable, the spent carbon is replaced by fresh carbon. The spent carbon is then disposed of or regenerated.

Activated granular carbon systems are available commercially and are in widespread use for the removal of organic contaminants. This technology is not as widely used or understood for metals removal.

Carbon adsorption and incineration were selected by EPA as BDAT treatment technologies for D013 wastewaters (Note: D013 is the hazardous waste code for lindane toxicity characteristic.). One of these technologies must be used when treating D013 wastewaters unless a variance is obtained from EPA for another technology demonstrated to be equally effective.

Chemical Oxidation. Chemical oxidation usually is considered only for dilute aqueous wastes. Oxidizable substances include inorganics and some volatile and semi-volatile organics and pesticides.

Oxidation-reduction, or *redox* reactions, are those in which the oxidation state of at least one reactant is raised while that of another is lowered. This is accomplished by the electron transfer from one ion to another. Hazardous constituents can be converted by this process to less toxic oxidation states. Oxidation of some organics can proceed readily to CO₂ and water. However, the reaction is dependent on oxidant dosage, pH, oxidation potential of the oxidant, and formation of stable intermediates.

There are many oxidizing agents; however, only a few are convenient to use for organics treatment. Some common agents include ozone, permanganate, and hydrogen peroxide. Ultraviolet radiation has also been used in conjunction with other oxidants to increase the reaction efficiency.

EPA's SITE program has evaluated an oxidation system developed by Ultrox International. The system consisted of three processes used in combination: hydrogen peroxide, ozone, and ultraviolet radiation. The site at which this system was evaluated has groundwater contaminated with volatile organic compounds. Removal efficiencies as high as 90 percent were achieved for the total volatiles present. EPA concluded that Ultrox International's system is effective in removing chlorinated and nonchlorinated organics.

Air Stripping. Air stripping may be used to remove volatile compounds from groundwater. In air stripping, extracted groundwater is pumped to the top of an air stripping column that contains a packing medium. An air stream is introduced into the bottom of the column and leaves through the top of the column with the volatile compounds. If concentrations of volatiles in the groundwater are low, the air may be discharged to the atmosphere. Otherwise, air pollution control devices such as activated carbon may be needed.

Air stripping is a common remediation technology for groundwater contaminated by volatile organics, and equipment is readily available.

Soil Treatment Technologies

Summary of Soil Contamination

The soils at NAS, Oceana, have been found to contain elevated levels of TPH and volatile organics. Historical information indicates that other contaminants may exist at the site in elevated levels below the soil surface. There are insufficient data to determine the actual areal extent and depth of the contamination, so the volume of contaminated soil cannot be determined. Treatment technologies should be assessed continually as this information and the data needs presented in the next subsection are obtained.

Potentially Applicable Treatment Technologies

On the basis of the limited soil data, potentially applicable treatment methods for the soils at the site have been identified. These methods outlined in Table 3-7 include physical, thermal, and chemical treatment processes. Table 3-7 also summarizes the advantages and disadvantages of these methods and lists the SWMUs at which these technologies may be applied. Many of the technologies identified would require a bench-scale and/or pilot-scale treatability study to determine their site-specific applicability. Other applicable technologies that would not require treatability testing are presented below (e.g., incineration and capping).

Soil Washing. In soil washing, excavated soils are mixed in a reaction vessel with a washing solution. This solution is usually water that has various contaminant-specific compounds dissolved in it. For example, a surfactant may be used for hydrophobic contaminants, or a chelating agent may be used for metals. The pH of the washing solution may also be adjusted to enhance the movement of the contaminants into the water phase. Once the solution has moved the contaminants from the soils into the water phase, the solids are dewatered, and the wastewater is treated in a wastewater treatment process.

**Table 3-7
POTENTIALLY APPLICABLE SOIL/SEDIMENT TREATMENT TECHNOLOGIES**

Treatment Technologies	Applicable Contaminants	State of Development	Advantages	Disadvantages	SWMUs for Potential Use																	
					1	2b	2c	2d	2e	11	15	16	18	19	20	21	22	23	24	25	26	
Soil Washing	PCBs Metals Pesticides Volatiles Semi-Volatiles	Demonstrated	1. The soil washing solution can be chosen to target the contaminants specific to the site. 2. The process is permanent and irreversible	1. Soil must be excavated before treatment 2. Generates a wastewater that requires treatment	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Solidification/ Stabilization	Metals/ Inorganics	Demonstrated	1. The processes are widely used and use simple, readily available processing equipment 2. Inexpensive 3. May be performed in situ 4. Processes applicable to a wide variety of contaminants	1. Processes may cause an increase in volume 2. Heterogeneity in soil may cause incomplete stabilization 3. It may be difficult to verify sufficient mixing and process completion for in situ processes									●					●			●	●
Low Temperature Thermal Treatment	Volatiles (Boil Point <500°F)	Experimental	1. Process is permanent and irreversible 2. Less energy-intensive than other thermal treatment processes 3. Reduces volume of contaminated material requiring final treatment 4. Process applicable to a wide variety of contaminants	1. Soils must be excavated before treatment 2. May generate a contaminated activated carbon by-product that requires treatment 3. Contaminants removed in the process require final treatment 4. Volatilized arsenic could pose a problem for off-gas treatment	●	●	●	●			●				●	●		●	●	●	●	●

**Table 3-7
POTENTIALLY APPLICABLE SOIL/SEDIMENT TREATMENT TECHNOLOGIES**

Treatment Technologies	Applicable Contaminants	State of Development	Advantages	Disadvantages	SWMUs for Potential Use																	
					1	2b	2c	2d	2e	11	15	16	18	19	20	21	22	23	24	25	26	
Incineration	Volatiles, Semi-Volatiles, Pesticides, PCBs, Dioxins	Demonstrated	<ol style="list-style-type: none"> Proven technology Process applicable to a wide variety of contaminants Process is permanent and irreversible 	<ol style="list-style-type: none"> Expensive (high energy requirements) Soils must be excavated before treatment May generate contaminated air stream Ash must be disposed of Incomplete combustion may generate hazardous by-products 	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Asphalt Batching	TPH	Demonstrated	<ol style="list-style-type: none"> Inexpensive Applicable to range of soil volumes 	<ol style="list-style-type: none"> Only TPH-contaminated soils accepted End market of final product fluctuates greatly, often resulting in a lot of material being stored at the batching facility 					●	●												
Capping	Volatiles, Semi-Volatiles, Pesticides, PCBs, Dioxins, Metals	Demonstrated	<ol style="list-style-type: none"> Flexibility of design Potential use of on-site materials Wide range of costs 	<ol style="list-style-type: none"> May require maintenance May require solids dewatering/processing May have short service life 	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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**Table 3-7
POTENTIALLY APPLICABLE SOIL/SEDIMENT TREATMENT TECHNOLOGIES**

Treatment Technologies	Applicable Contaminants	State of Development	Advantages	Disadvantages	SWMUs for Potential Use																
					1	2b	2c	2d	2e	11	15	16	18	19	20	21	22	23	24	25	26
Aeration	Volatiles	Demonstrated	1. Process uses simple, readily available equipment 2. Cost effective	1. Volatiles may contaminate surrounding air 2. Only viable for soils with low levels of volatiles	●	●	●	●			●			●	●		●	●	●	●	●
Soil Vapor Extraction	Volatiles	Demonstrated	1. Process is in situ 2. Process is permanent and irreversible	1. May generate contaminated activated carbon stream 2. Only effective for volatile contaminants 3. Site geology must be fully understood	●	●	●	●			●			●	●		●	●	●	●	●
Offsite Disposal	Volatiles, Semi-Volatiles, Pesticides, PCBs, Dioxins	Demonstrated	1. May be cost effective for small volumes of soil	1. May incur liability for improper disposal 2. Soil must be excavated	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Bioremediation	Semi-Volatiles, Volatiles, Pesticides	Demonstrated	1. Process is permanent and irreversible 2. Process may be performed in situ 3. Cost effective	1. Process is intolerant of some toxins, including heavy metals 2. Process effected by temperature, pH, soil moisture, etc.	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●

Soil washing is a well-developed technology that has been used extensively in Europe and at a number of Superfund sites in the United States. Soil washing is an appropriate technology for water-soluble and water-mobile contaminants, possibly including metals, pesticides, PCBs, and volatile and semi-volatile organics. It is not appropriate for soils with a high clay content. Soils with a wide range of particle sizes may need to be screened to separate the soil by particle size prior to washing. EPA has indicated that soil washing has good-to-excellent applicability for treating metals and inorganics (such as lead) in sandy/gravelly soils. Soil washing was also one of two technologies investigated that achieved the recommended effluent concentrations for metals for obtaining a soil and debris treatability variance for the land disposal restrictions (LDRs). EPA also indicated that soil washing may have only moderate-to-marginal applicability for soils contaminated with halogenated pesticides. Bench and/or pilot-scale treatability studies, using contaminated soils from a site, are usually required to determine the proper chemistry of the washing solution.

Soil Flushing. Soil flushing uses the same principles as soil washing, but instead of excavating the soils, soil flushing removes the contaminants in situ. In soil flushing, the washing solution is applied to the soil and allowed to percolate through the contaminated area. The solution is then recovered by down-gradient extraction wells and treated in a wastewater treatment process to remove the contaminants. The treated water may then be recycled and reused as the washing solution.

The effectiveness and rate of cleanup by soil flushing depend on the specific contaminant and site. Soil flushing may be appropriate for water soluble or water-mobile contaminants. It is inappropriate for soils with low or variable permeability. The groundwater hydrology of the site must be fully characterized to successfully design a soil flushing system. This may involve computer modeling of the groundwater flow at the site. Column studies using contaminated soils from a site are usually required to determine the optimum application and pumping rates and the proper chemistry of the washing solution.

Solidification/Stabilization. Stabilization technologies convert contaminants in soils to a less soluble, mobile, or nontoxic form by mixing the contaminated soil with a stabilizing agent. The processes may involve physical and/or chemical reactions. Some examples of stabilizing agents include cement, pozzolanic materials (fly ash, kiln dust), and clays. Solidification technologies encapsulate the contaminants in a solid with a high structural integrity and involve only physical processes. Thermoplastic micro-encapsulation using asphalt is one example of a solidification process.

Solidification/stabilization processes may be carried out on excavated soils or in situ, depending on site characteristics such as volume and depth of contamination and homogeneity of the soil. The processes are well established and proven for a wide range of contaminants, although in situ applications are more recent. The processes have been used most often for inorganic contaminants such as metals (including lead) and organics of high molecular weight such as plastics and tars. Immobilization

technologies such as solidification/stabilization were listed by EPA as technologies that can attain the required treatment levels to receive an LDR treatability variance for metals-contaminated soil and debris. The processes have not been proven for halogenated compounds of low molecular weight such as volatile organics and chlorinated pesticides. Solvents and other organics may reduce the effectiveness of the processes.

Bench and/or pilot-scale treatability tests on the contaminated soil would be required to determine the proper stabilizing agents and other process variables such as waste-to-agent ratios and mixing times. Other data requirements would include soil parameters such as percentage of moisture, organic content, particle size distribution, and cationic exchange capacity.

Chemical Dehalogenation. The organic contaminants initially detected at NAS, Oceana, include PCBs. Dioxins and chlorinated pesticides may also be present in the soils. One method of treating these compounds is by chemical dehalogenation. There are several different reagents that may be used in the process, including alkaline metal hydroxide/polyethylene glycol (APEG) and alkaline metal hydroxide/tetraethylene glycol (ATEG). The alkaline metal hydroxides currently used include sodium and potassium hydroxides. The APEG process is applicable to aromatic compounds but can dehalogenate aliphatics if reaction times and temperatures are significantly increased. The ATEG process is applicable to aliphatics.

In the APEG and ATEG processes, the excavated soil is added to a heated ($>100^{\circ}\text{C}$) reactor with the chemical reagents. The reactor is then mixed for approximately 1 to 5 hours to allow the reaction to occur. The reagent is then decanted, and the soil is washed to remove any reagent residuals.

Various catalysts have been studied to speed up the dehalogenation reactions. Dimethyl sulfoxide (DMSO) has been used to increase the extraction rates of aromatic compounds in the APEG process, and a solution of nickel chloride in alcohol has been used to dehalogenate organic pesticides.

The processes have been used on a commercial scale for treating soils contaminated by PCBs, and laboratory tests have been completed on chlorinated pesticides.

Solvent Extraction. Solvent extraction processes mix organic-contaminated soils with an organic solvent. Once the mixture has reached equilibrium, the solvent and the dissolved contaminants are separated from the soil. The solvent stream is then separated from the contaminants and reused to treat the next batch of soil.

Solvent extraction works best on soils with a large particle size, such as sands, and with a naturally low organic content. The process works only for contaminants that are more soluble in organics than in an aqueous phase (i.e., high octanol-water coefficient). Solvent extraction is a relatively new process, and it has not been used extensively on a full-scale application although it has been used to treat PCBs and dioxins.

Low Temperature Thermal Treatment. In low temperature thermal treatment, excavated solids are fed to a heat transfer unit along with an induced air stream. As the soils are heated to greater than 500°F, the soil moisture and any volatile contaminants are volatilized and carried by the air stream to an off-gas handling system. The contaminants are then either condensed or adsorbed onto activated carbon. The condensed contaminants must then be incinerated.

Low temperature thermal treatment is an appropriate technology for volatile contaminants that have boiling points of less than approximately 500 to 800°F. This technology may be inappropriate for soils with a high clay or water content or a pH less than 5 or greater than 11. Bench and/or pilot-scale tests using contaminated soils from a site would be required to determine process applicability and operating parameters.

Incineration. Incineration is a proven treatment technology for soils contaminated by a wide range of organic contaminants. In the process, the soils are fed to a rotary kiln or other type of incinerator. The incinerator heats the soils to greatly elevated temperatures so that the contaminants are broken down to nonhazardous products. However, if the combustion process is incomplete, hazardous by-products may be generated.

Asphalt Batching. Soils contaminated only by with TPHs may be sent to an asphalt batching plant for processing. This is an inexpensive solution for soils that are not contaminated with other compounds. The soils would need to be sampled and analyzed for other contaminants before the batching facility would accept them.

Capping. Caps are used to reduce or eliminate precipitation infiltration, prevent contaminated soil erosion, and isolate contaminated soils from human contact. A variety of impermeable cover materials is available for capping contaminated soils. The choice of materials is dictated by site-specific factors such as local availability and cost of materials, compatibility with wastes being covered, local climate and hydrology, and projected use of the site.

Aeration. Aeration may be used to remove low levels of volatile organics from soils. In the process, the soils are excavated and spread out above ground. The soils are then periodically turned over or mixed. This allows the volatile compounds in the soil to come into contact with the air and to volatilize. This process works best on soils with low concentrations of contaminants in warm, dry climates. Aerating soils with high concentrations of volatiles could violate air quality regulations.

Soil Vapor Extraction. Soil vapor extraction (SVE) may be used to remove volatile contaminants from soils in situ. In the process, a vacuum is drawn on one or more extraction points in the soil. This vacuum draws the soil gases and any volatile contaminants out of the soil and to the surface. If there are high concentrations of volatiles in the extracted gases, then an activated carbon collection vessel may be used to adsorb the contaminants from the extracted gases before they are discharged to the atmosphere.

Bioremediation. Bioremediation uses naturally occurring microorganisms such as bacteria, fungi, or yeast to degrade harmful chemicals into less toxic or non-toxic compounds. Contaminants can be either a primary food source or a secondary food source that is consumed along with other food sources. The residues of biological treatment are usually harmless products such as carbon dioxide, water, or fatty acids. Bioremediation actually destroys contaminants rather than merely transferring them from one environmental medium to another.

In general, the bioremediation process involves collecting samples at the site and analyzing them to determine what types of microorganisms are present, and what climatic conditions such as pH, moisture, temperature, and oxygen levels can enhance microbial degradation. Once the ideal environmental conditions have been defined, measures can be taken to improve the environment such as adding nutrients or oxygen, or reducing the toxicity of the soil by adding other chemicals.

Bioremediation techniques currently in use can be grouped into two general categories: in-situ techniques, which treat wastes without removing the contaminated soil, and above-ground ex-situ techniques, which treat soil in a vessel, reactor, or compost pile.

Bioremediation can often be accomplished on site, therefore, eliminating risks associated with transportation, and may cost less. However, bioremediation may not be appropriate for sites with complex mixtures of contaminants. In addition, the bioremediation process must be carefully monitored to ensure the effectiveness of degradation and to ensure that the by-products are not toxic.

Offsite Disposal. Contaminated soils may be excavated and transported to an offsite treatment facility.

Data Requirements

Table 3-8 is a list of general data needs for various groundwater and surface water corrective measure technologies. Table 3-9 lists the data needs for the soils and sediments corrective measure technologies. Certain technologies require favorable water and soil properties to function effectively. Soil and water parameters necessary for the selection of likely corrective measure technologies at SWMUs where CMSs may

**Table 3-8
GROUNDWATER AND SURFACE WATER TECHNOLOGIES DATA NEEDS**

Technology	Data Need	Comments
Precipitation	Alkalinity Hardness (Ca, Mg, Sr, Fe, Mn) TDS Sulfate Cation/Anion Balance Metals pH	All of the information requested will aid in determining reagent requirements and reaction success. The data will also be used to evaluate the applicability and cost effectiveness of this technology.
Ion Exchange	Hardness (Ca, Mg, Sr, Fe, Mn) TDS Cation/Anion Balance Metals pH	Data will help in assessing resin interferences. Information will also be used to determine resin type.
Carbon Adsorption	Volatiles and Semi-Volatiles TOC PCBs COD Pesticides	The data will be used to evaluate the total adsorptive demand placed on the carbon.

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**Table 3-8
GROUNDWATER AND SURFACE WATER TECHNOLOGIES DATA NEEDS**

Technology	Data Need	Comments
Chemical Oxidation	Volatiles and Semi-Volatiles TOC Pesticides COD Cation/Anion Balance Alkalinity Sulfides Nitrites	The amount of oxidizable material will be determined based on the data. Species that consume oxidants (scavengers) will also be determined.
Oil/Water Separation	TPH Oil and Grease Viscosity Settleable Solids	Data will be used to evaluate applicability.
Flotation	TPH Oil and Grease TSS	Data will be used to evaluate applicability.

**Table 3-8
GROUNDWATER AND SURFACE WATER TECHNOLOGIES DATA NEEDS**

Technology	Data Need	Comments
Air Stripping	Volatiles BOD	Data will be used in computer modeling to determine feasibility and to determine fouling potential.
Discharge to POTW	Volatiles Semi-Volatiles Pesticides Metals	The data will be used to determine if pretreatment would be required before discharge to a POTW.

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**Table 3-9
SOIL/SEDIMENT TECHNOLOGIES DATA NEEDS**

Technology	Data Need*	Comments
Soil Washing	Particle size distribution Soil classification	Technology inappropriate for soils with a high clay or fines content
Solidification/ Stabilization	Soil moisture content Particle size distribution Organic content (TOC) Oil and grease Cationic exchange capacity	Processes are less effective on soils with a high organic content
Low Temperature Thermal Treatment	Particle size distribution Soil moisture content	Technology may be inappropriate for soils with a high clay or fines content or more than 50 percent moisture
Chemical Dehalogenation	Soil moisture content Organic content (TOC) Particle size distribution	Organics in soil may exert a reagent demand Moisture may dilute the reagents
Solvent Extraction	Soil moisture content Organic content (TOC) Particle size distribution	Organics in soil may exert a solvent demand Moisture may dilute the solvent Process may be inappropriate for soils with high clay content or small particle size

**Table 3-9
SOIL/SEDIMENT TECHNOLOGIES DATA NEEDS**

Technology	Data Need*	Comments
Soil Flushing	Particle size distribution Depth to groundwater Hydraulic conductivity Organic content (TOC)	Technology is inappropriate for soils with low hydraulic conductivities such as clays
Incineration	Soil Moisture Content Btu	Soils with high moisture content may require dewatering.
Capping	Organic content (TOC) Soil moisture content Particle size distribution	Soils with high moisture content may require dewatering.
Aeration	Organic content (TOC) Particle size distribution	Process may be more difficult to implement with soils with a high clay content.
Soil Vapor Extraction	Particle size distribution Soil moisture content Depth to groundwater Hydraulic conductivity	Technology is more difficult for soils with low hydraulic conductivities such as clays.
Bioremediation	Particle size distribution Soil moisture content Hydraulic conductivity Depth to groundwater Organic content (TOC)	Technology is more difficult for soils with low hydraulic conductivities such as clays.
*Nature and extent of soil contamination is needed for each technology.		

be needed, based on past results, will be collected during the first phase of the RFI. Further assessment of corrective technologies based on Phase 1 data will determine what, if any, additional data need to be collected. Because the need for a CMS at each of the SWMUs cannot be determined before the HEA is complete, and because the technology to be chosen during the CMS would not be known *apriori*, phasing the data collection is necessary to avoid superfluous data collection during the first phase of the RFI.

Technical Approach

The work plan is based on a phased approach to the investigation of SWMUs studied during the RFI. If the detection of contaminant releases from any of the SWMUs reveals that data gaps or additional investigation is required, suggestions for further investigation will be detailed in the RFI report. The following are objectives of the sampling investigation:

- To assess the potential for containment releases to onsite subsurface/ sediments and groundwater
- To provide a characterization of site-specific hydrogeologic conditions
- To identify the type and extent of contamination that may exist at the facility

On the basis of information collected to date on each of the SWMUs, no formal air sampling program is proposed for the field investigation. However, during the course of field investigations, ambient air will be evaluated during soil boring, well installation, and sampling activities, and the results will be included in the RFI report. Should ambient air sampling indicate a potential problem, an expanded air program will be detailed for later implementation.

Upon the completion of field activities and evaluation of preliminary data, additional field tasks will be proposed if further site characterization is necessary. Additional requirements that may be included in a second phase of investigation would focus on addressing data gaps in the present sampling/monitoring network and characterizing the nature and extent of contaminant releases in support of the development of a corrective action plan.

Characterization of SWMUs

Characterization of the SWMUs studied during the RFI will be accomplished in two phases. The first phase will be the RFI work described in this plan. The second phase will be based on the actions recommended in the RFI report and specified by the EPA during its review. The first phase will require collection of samples from the medium

or media of concern at each SWMU, as indicated in Chapter 4. These samples will be analyzed for contaminants previously detected or assumed to be present based on information provided in the RFA. Analysis of Appendix IX parameters will also be included at some SWMUs, as indicated in Chapter 4. Appendix IX parameters will henceforth in this work plan refer to the analysis of volatiles (VOC), chlorinated and aromatic hydrocarbons, polyaromatic hydrocarbons (PAH), base/neutral/acid extractables (BNA), organochlorine pesticides and PCBs, and metals. Details on the parameters to be analyzed are presented in Chapter 4.

The ecology of the base and of individual SWMUs will also be studied during the RFI. This work will involve:

- The collection of available ecological data and the development of ecosystem maps for the larger, more ecologically complex SWMUs.
- The study of the ecological setting of each SWMU.
- The analysis of the risk to the nearby ecosystem from contamination at the SWMUs.

The creation of SWMU-specific ecosystem maps will rely on existing data, potentially including: ecosystem and wetlands maps prepared for all or part of the base, National Wetlands Inventory Maps, recent aerial photographs, topographic maps, information on threatened and endangered species, and soil maps available from the Soil Conservation Service. These sources of data will be used to create general ecosystem maps of the SWMUs, which will be ground-truthed by a qualified ecologist during a field visit to NAS Oceana. The results of this effort will be described in the general description of NAS Oceana in the RFI report.

The ecology of individual SWMUs will be studied and described by a qualified ecologist during the RFI. This effort will include descriptions of:

- Topography
- Area surface water bodies
- Wetlands
- Vegetation types and species
- Biotic stress
- Sensitive habitats
- Wildlife observed during the field study

The results of this study will be presented in the individual site descriptions in the RFI report.

Results of the first phase sampling will be used to determine if RCRA action levels have been exceeded. A preliminary health and environmental assessment (HEA) will

be prepared based on the results of the RFI, previous sampling results, and data collected during the ecological study. The RFI report will present the results of the RFI and make recommendations for future action. A second phase of field investigation may then be conducted at SWMUs where action levels have been exceeded if site data from the first phase are not sufficient to proceed with the CMS decision analysis. Some data to support the CMS decision will be collected during the RFI. During the second phase, any additional parameters necessary for evaluating corrective measures will be analyzed, as needed, in addition to the RCRA parameters (TC and reactivity) for evaluating disposal options.

Project Personnel

Project management of the RFI includes selecting, coordinating, and scheduling staff members, contractors, and subcontractors. Figure 3-3 presents a schematic diagram of the project organization.

The project will proceed under the overall management of LANTNAVFACENCOM remedial project manager, Mr. Jesse Waltz.

The prime contractor project manager will have a least 5 years of professional experience and will be a registered professional in his or her area of expertise. The project manager will be responsible for the successful execution of the RFI work plan and will manage the RFI, taking responsibility for staffing, coordination, cost and schedule control, and technical quality.

The senior review team will review the technical and management activities of the project, including all project deliverables. This team will be composed of senior-level personnel or discipline specialists from the prime contractor's resource pool. The senior review team will be involved with the project during all phases and will function independently of the project staff, reporting directly to the project manager.

The field team leader will have at least 5 years of professional experience and will be a registered professional in his/her area of expertise. The field team leader will be responsible for the coordination of field efforts, will assure the availability and maintenance of sampling equipment and materials, and will be responsible for shipping and packing materials. The field team leader will supervise the field work and sampling operations of the field technicians and will be responsible for completion of the field notebook. The field team leader will maintain close coordination with the project manager.

The site safety officer (SSO) will finalize a health and safety plan (Chapter 6) and ensure that the plan is implemented during field activities. The SSO will oversee all field activities involving contractor and subcontractor personnel. This individual has the

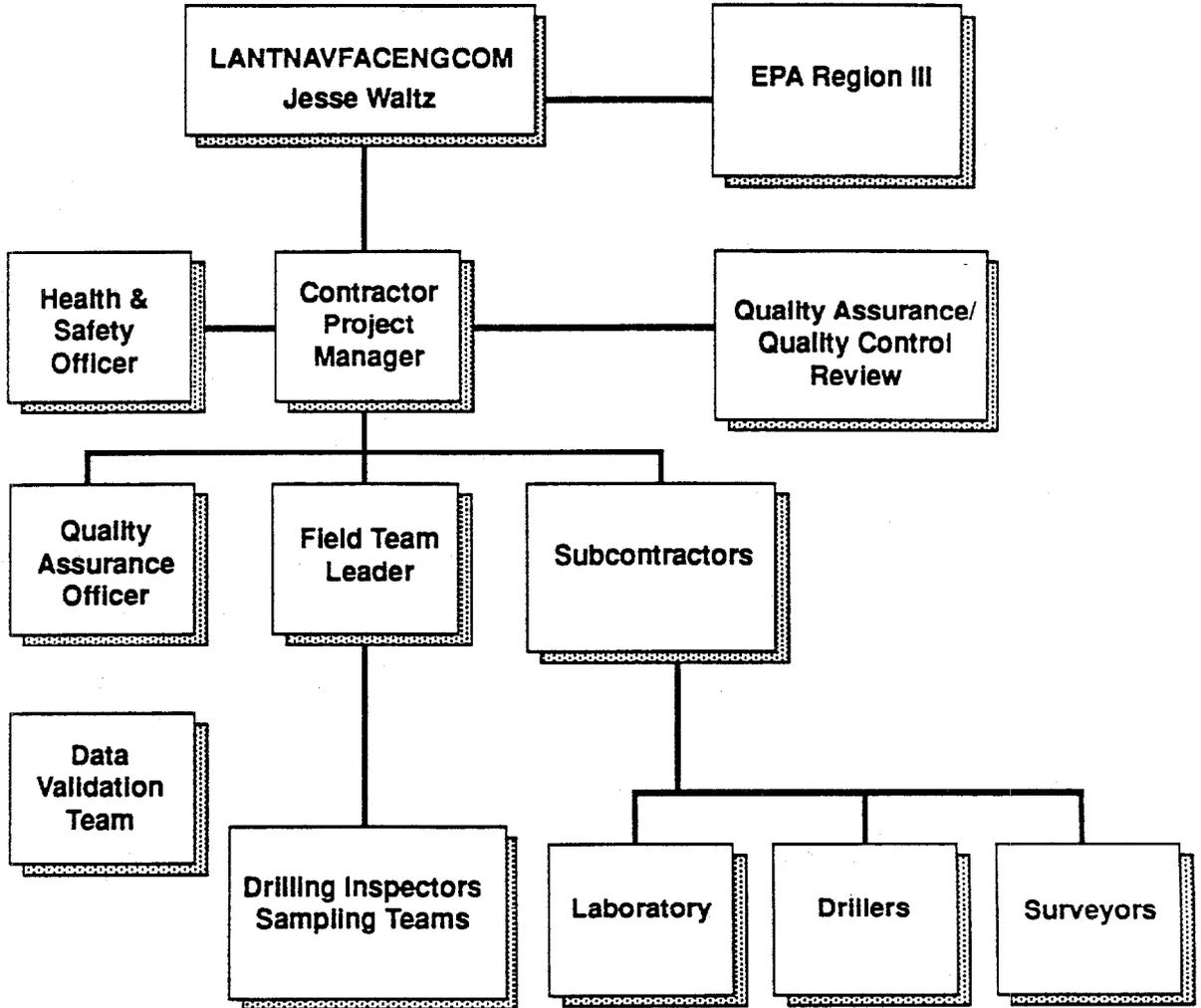


Figure 3-3
PROJECT ORGANIZATION CHART
RCRA Facility Investigation—Naval Air Station, Oceana

authority to terminate field activities if health-threatening situations arise or if the site safety plan is not being executed properly. The SSO will coordinate field activities with the field team leader and report directly to the contractor's project manager.

A quality assurance team was involved in preparation of the data collection quality assurance plan (DCQAP) (Appendix A) for field and laboratory tasks. The Quality Assurance Officers will ensure the requirements of the DCQAP are met during the field investigation, laboratory analysis, and data validation tasks. Periodic site and laboratory audits may be conducted to observe activities and to ensure that data quality objectives are satisfied. The data quality assurance officers will report periodically to the contractor's project manager for debriefing of data quality.

Prior to initiation of field activities, the plans discussed below will be finalized.

Sampling and Analysis Plan

To maintain project quality control and assurance, a sampling and analysis plan specific to the project personnel and contractors is prepared before starting field activities. Requirements of the sampling and analysis plan are described in Chapter 4 and in Appendix A of this work plan. The plan includes a site-specific sampling and analysis plan for each SWMU.

Field measurements and sampling and analysis will be conducted on the basis of compliance with the Part B permit, the *Interim Final RCRA Facility Investigation Guidance Document* (RFI Guidance) (EPA, 1989), the *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (TEGD) (EPA, 1986).

Data Management Plan

The data management plan presented in Chapter 5 of this work plan will be implemented during the RFI to document and track investigation results. Data documentation materials and procedures, project file requirements, and project-related progress reporting procedures and documents are identified.

Health and Safety Plan

A health and safety plan specific to the sampling activities has been developed as part of this work plan (Chapter 6). Upon approval of the work plan, the health and safety plan will be finalized to meet project- and personnel-specific requirements.

Community Relations Plan

A community relations plan, described in Chapter 7, has been prepared under separate cover for corrective action activities at NAS, Oceana.

Health and Environmental Assessment

A preliminary health and environmental assessment (HEA) will be prepared during the RFI to assess the potential for each of the SWMUs to threaten human health and the environment. The HEA is the responsibility of the regulating agency, as stated in the most recent RFI guidance (EPA, 1989); however, the Navy will collect data during the RFI to support a preliminary HEA to be done as part of the RFI.

The data to support the HEA that will be collected during the RFI will include:

- An evaluation of historical use and disposal of hazardous chemicals
- Characterization of the extent of contamination
- Identification of receptors and contaminants of concern for both the human and environmental evaluation
- An assessment of potential exposure routes, quantifiable intake rates, and the bioavailability of contaminants

The assessment of risk will be based on qualitative and quantitative comparison of exposure point concentrations to human and ecological criteria. Only the risk due to direct exposure will be addressed. Risk attributable to indirect pathways, such as bioconcentration and bioaccumulation, will not be addressed due to the limited nature of the available data. Current state criteria and federal health and environmental criteria listed in the RFI guidance will be used for quantitative comparison. Separate toxicity-based ecological criteria may be developed, if warranted. The potential for existing concentration to threaten humans and the site-specific biota and general environment will be analyzed qualitatively in addition to the comparisons to quantitative criteria. The potential for soil contamination to raise groundwater concentrations above quantitative criteria because of downward leaching will be calculated at SWMUs where groundwater concentrations are below groundwater criteria but substantial soil contamination is measured.

The assessment of ecological impacts will be based on the ecological study of each SWMU site in addition to quantitative criteria. Visible stress and a differentiation in flora and fauna compared to unaffected sites will be emphasized in this analysis. Lithologic and air monitoring data collected during drilling and sampling will be reported and analyzed. Site conditions will also be compared to ecoregional reference area data in the EPA database, as described and suggested in the guidance (EPA, 1992), if available and appropriate. The HEA for each site will be presented in the individual site sections of the RFI report.

Report

After the initial results have been interpreted, a summary of the data will be submitted to EPA. At the completion of the initial investigation an RFI report summarizing the results of the data collection activities and meeting the requirements of the RFI guidance and the Consent Order will be prepared. This report will include but not be limited to the following sections:

- Environmental setting
- Source characterization
- Type and extent of contamination at the facility
- Contamination characterization, including migration pathways
- Qualitative and quantitative contamination assessments relative to background levels for the area and current federal standards
- Potential receptors
- Recommendations for further action at each SWMU

Schedule

Figure 3-4 is the schedule of RFI activities. Quarterly progress reports describing the status of the technical work and the schedule will be sent to EPA Region III and to LANTNAVFACENGCOM. These reports will include the following information:

- Description of tasks and percentage of completion of the RFI
- Results of all sampling and analysis activities conducted during the quarter
- Summary of findings
- Summary of changes made in the RFI
- Summary of contacts with the local community, public interest groups, and state government
- Summary of problems, potential problems, and corrective actions taken
- Changes in personnel
- Work projected for the next reporting period

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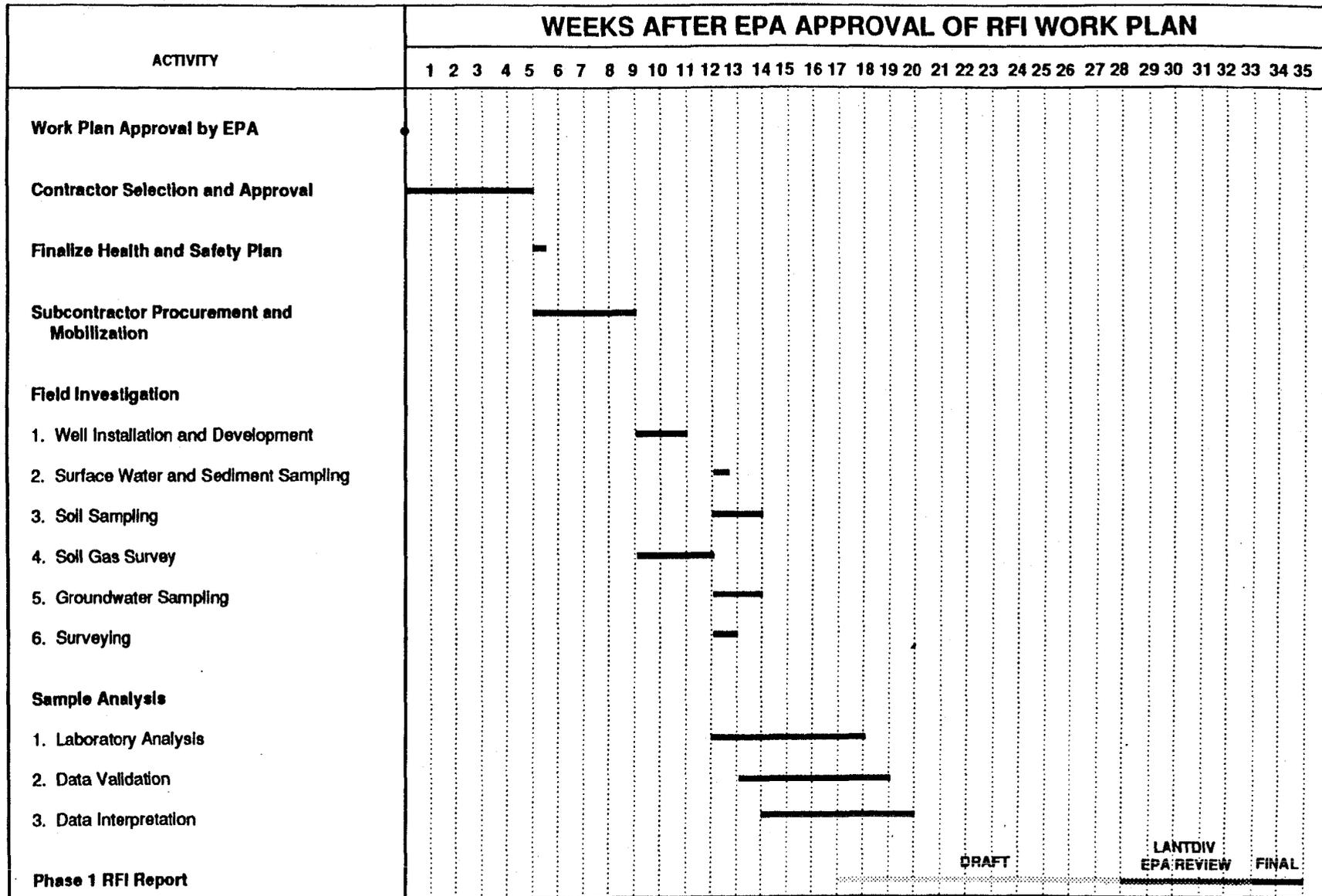


Figure 3-4
PROJECT SCHEDULE
RCRA Facility Investigation
NAS, Oceana

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Chapter 4

Sampling and Analysis Plan

This chapter defines field investigation techniques and the sampling and analysis procedures that will be performed during the NAS, Oceana RFI. The Data Collection Quality Assurance for the RFI field activities is comprised of the Sampling and Analysis Plan (SAP) in this chapter, the Data Management Plan in Chapter 5, and the Data Collection Quality Assurance Plan (DCQAP) in Appendix A.

Due to the close proximity of some of the 19 SWMUs listed in the Consent Order, some of these SWMUs were combined for purposes of the RFI. The SAP has been designed to address 17 areas of investigation.

Sample Collection Goals and Objectives

The principal goals of the RFI are to: (1) examine potential contaminant releases to surrounding soils, surface water, sediment, and groundwater from each SWMU listed in the Consent Order, (2) collect data to determine the lateral and vertical extent of contamination, (3) determine the rate and direction of contaminant migration, (4) study the ecosystem of the SWMUs and identify stressed vegetation or other signs of ecological stress, and (5) collect data necessary to develop potential corrective measures.

Ecological data will be collected at each individual site to supplement data from the IAS and any previous investigations. These data will include descriptions of surface water, topographic features, wetlands, vegetation, visual signs of biotic stress, and any sensitive habitats. Site disturbances during RFI field activities will be minimized to avoid ecological impacts. Specific objectives developed to satisfy the goals of the RFI for each SWMU are detailed in the "Technical Approach" subsection of Chapter 3 and are summarized below.

SWMU 1—West Woods Oil Disposal Pit

- Determine vertical and lateral extent of groundwater contamination
- Determine the hydraulic characteristics and flow regime of the shallow aquifer materials
- Characterize the soils in the vicinity of the pit
- Determine extent of soil contamination
- Confirm previously obtained data on chemicals, surface water, and sediment

- Determine whether sediment and surface water contamination extends 1,000 feet downstream from the site, near the radar station

SWMU 2b—Line Shack Oil Disposal Area (Bldg. 131)

- Determine the vertical extent of groundwater contamination in Area 1
- Determine the lateral and vertical extent of groundwater contamination in Area 2
- Obtain a second round of groundwater data for previously sampled wells
- Determine the extent of soil contamination in Area 1
- Characterize soil in the vicinity of the source at Area 2
- Determine the relationship between the shallow groundwater and the water in the perennially flowing drainage ditch
- Confirm that contaminated groundwater at this SWMU is not entering the perennially flowing surface water in the ditch
- Determine whether TPH contamination in the surface water of the perennially flowing ditch is from sources other than this SWMU

SWMU 2c—Line Shack Oil Disposal Area (Bldg. 400)

- Determine vertical extent of groundwater contamination
- Determine if there are offsite sources of contamination
- Determine the nature and extent of soil contamination in the suspected source area adjacent to Building 400
- Characterize the nature of soil contamination in the ditch flowing through the central portion of this SWMU
- Determine the lateral extent of contaminant migration in the groundwater south of B Avenue

SWMU 2d—Line Shack Oil Disposal Area (Bldg. 125)

- Obtain a second round of groundwater data from previously sampled wells to determine if further investigation is required

SWMU 2e—Line Shack Oil Disposal Area (Bldg. 23) and Hazardous Waste Storage Area (Bldg 23)

- Obtain a second round of groundwater data from previously sampled wells to determine if further investigation is required
- Determine extent of TPH contamination in the soils in the vicinity of this SWMU

SWMU 11—Fire Fighting Training Areas

- Obtain a second round of groundwater data from previously sampled wells
- Determine the extent of soil contamination in the vicinity of the SWMU

SWMU 15—Abandoned Tank Farm

- Characterize the shallow groundwater at this unit

SWMU 16—Pesticide Storage Areas (Bldg. 821)

- Characterize the soils in the area used for pesticide storage

SWMU 18—Hazardous Waste Storage Area (Bldg. 204)

- Characterize the soil at this SWMU

SWMU 19—Waste Oil Storage Area (Bldg. 541)

- Characterize the soils at the old tire storage area

SWMU 20—Waste Oil Storage Area (Bldg. 543)

- Characterize the soils in the oil storage area north of Building 504

SWMU 21—Transformer Storage Yard (Bldg. 530)

- Characterize the soils at the two areas behind Building 830 that were used for storage of old transformers

SWMU 22—Construction Debris Landfill

- Characterize the groundwater at this SWMU
- Determine if there is any impact to the nearby wetlands

SWMU 23—Bowser, Building 830

- Characterize the soils at the area where the bowser was parked

SWMU 24—Bowser, Building 840

- Characterize the soils at the area where the bowser was parked

SWMU 25—Inert Landfill

- Characterize the surface water and sediment at the pond that was used for the disposal of various solid wastes
- Determine the relationship between the water level in the pond and the groundwater

SWMU 26—Fire Fighting Training Area

- Characterize the soils in the vicinity of this SWMU

Sampling Locations and Media

Characterization of the SWMUs addressed by this RFI work plan will be accomplished in two phases. The first phase will require the collection of samples from the medium or media of concern at each SWMU, as indicated in Chapter 2. These samples will be analyzed for contaminants previously detected or assumed to be present, based on information provided in the RFA. Analysis of the RCRA Appendix IX parameters will also be included for a subset of samples at some of the SWMUs to confirm that no additional parameters from the Appendix IX list are evident at the site.

The number of samples to be collected from medium or media of concern at each SWMU is summarized in Tables 4-1 through 4-3. Table 4-4 provides a summary of the categories of the chemical parameters to be analyzed. A complete list of the Appendix IX parameters is given in Appendix A. Detailed discussion of these samples is provided in the following subsections. While the proposed locations for additional environmental sampling are indicated for each SWMU, actual locations will be determined by field personnel based on conditions existing at the time of the investigations.

**Table 4-1
SUMMARY OF GROUNDWATER SAMPLING AND ANALYSIS PROGRAM
NAVAL AIR STATION, OCEANA
RCRA FACILITY INVESTIGATION**

Parameters	Analytical Method ^a	Number of Samples to Be Collected							
		SWMU 1*	SWMU 2b ^d	SWMU 2c ^d	SWMU 2d	SWMU 2e	SWMU 11	SWMU 15 ^d	SWMU 22
Volatiles ^c	SW-8240	10			3	3	4		3
Semi-Volatiles	SW-8270		1	1	1	1			3
Base-Neutral Extractable Organics	SW-8270						1		
Pesticides and PCBs	SW-8080								3
Chlorinated Volatiles ^c	SW-8010		20	17					
Aromatic Volatiles	SW-8020							1	
Total Metals	SW-6010/7000	9				3	4		3
Dissolved Metals	SW-6010/7000	8				3	4		3
Appendix IX ^b w/Total Metals		1							1
Appendix IX Dissolved Metals		1							1
Polynuclear Aromatics	SW-8100	10			2	2	3	1	
PCBs	SW-8080	9							
Dioxin	SW-8280	1							
Total Lead	SW-7421							1	
Dissolved Lead	SW-7421							1	

Notes:

^aAnalytical methods as per *Test Methods for Evaluating Solid Waste*, 3rd Edition, Dec. 1986.

^bAnalytical methods for Appendix IX parameters are given in Appendix A.

^cA detection limit of 2 µg/l or less will be required for vinyl chloride.

^dSee description of soil gas and in-situ groundwater sampling at Site 15 in Chapter 4. In-situ groundwater samples will also be collected at Site 2B and 2C. This table includes fixed laboratory analyses only, not mobile lab analyses.

*Site 1 totals include 9 wells and 2 free product samples. The floating free product sample will not be analyzed for dissolved metals. The dense free product will be analyzed for VOCs and PAHs.

Table 4-2
SUMMARY OF SURFACE WATER AND SEDIMENT SAMPLING AND ANALYSIS PROGRAM
NAVAL AIR STATION, OCEANA
RCRA FACILITY INVESTIGATION

Parameters	Analytical Method ^a	Number of Samples to Be Collected					
		SWMU 1		SWMU 2b		SWMU 25	
		Surface Water	Sediment	Surface Water	Sediment	Surface Water	Sediment
Volatiles ^c	SW-8240	4	4			1	2
Semi-Volatiles	SW-8270					1	2
Pesticides and PCBs	SW-8080					1	2
Total Metals	SW-6010/7000	4	4			1	2
Dioxin	SW-8280	1	1				
Appendix IX ^b						1	1
Polynuclear Aromatics	SW-8100	4	4	4	4		
PCBs	SW-8080	4	4				
Chlorinated VOCs ^c	SW-8010			4	4		

Notes:
^aAnalytical methods as per *Test Methods for Evaluating Solid Waste*, 3rd Edition, Dec. 1986.
^bAnalytical methods for Appendix IX parameters are given in Appendix A.
^cA detection limit of 2 ug/l or less will be required for vinyl chloride in water.

4-6

Table 4-3
SUMMARY OF SOIL SAMPLING AND ANALYSIS PROGRAM
NAVAL AIR STATION, OCEANA
RCRA FACILITY INVESTIGATION

Parameters	Analytical Method ^a	Number of Samples to Be Collected												
		SWMU 1	SWMU 2b	SWMU 2c	SWMU 2e	SWMU 11	SWMU 26	SWMU 16 ^d	SWMU 18	SWMU 19	SWMU 20	SWMU 21	SWMU 23	SWMU 24
Volatiles	SW-8240	9			6	5	5			1	4		2	2
TPH	SM-418.1 ^c				6	5	5			1	4	2	2	2
Appendix IX Chlorinated Pesticides, Organo. Pesticides	SW-8080 SW-8140							8						
Appendix IX Herbicides	SW-8150							8						
Lead	SW-7421							4		1	4			
Metals	SW-6010/7000	9			6	5	5						2	2
Ignitability							5							
Appendix IX ^b		2							2					
Polynuclear Aromatics	SW-8100	9			5	5	5			1	4		2	2
PCBs	SW-8080	9										10		
Chlorinated VOCs	SW-8010		14	8										
Arsenic	SW-7060							4						
Copper	SW-7211							4						
Semivolatiles	SW-8270				1									

Notes:
^aAnalytical methods as per *Test Methods for Evaluating Solid Waste*, 3rd Edition, Dec. 1986.
^bAnalytical methods for Appendix IX parameters are given in Appendix A.
^cAnalytical method as per *Standard Method for Analysis of Water and Wastewater*.
^dNumbers include samples from golf course pesticide shop.

Table 4-4
CHEMICAL PARAMETERS FOR LABORATORY
ANALYSIS

Volatile Organic Compounds (SW-8240)

Acetone
Acrolein
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethyl vinyl ether
Chloroform
Chloromethane
Dibromochloromethane
Dibromomethane
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
1,4-Dichloro-2-butene
Ethanol
Ethyl methacrylate
Ethylbenzene
2-Hexanone
Idomethane
Methyl ethyl ketone (2-Butanone)
4-Methyl-2-pentanone
Methylene chloride
Styrene
1,1,2,2-Tetrachloroethane
Tetrachloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
Toluene
Vinyl acetate
Vinyl chloride
Xylene (total)

Table 4-4
CHEMICAL PARAMETERS FOR LABORATORY
ANALYSIS

Semi-Volatile Organic Compounds (SW-8270)

Benzoic Acid
4-Chloro-3 methyl phenol
2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2-Methyl-4,6-dinitrophenol
2,4-Dinitrophenol
2-Methyl phenol
4-Methyl phenol
2-Nitrophenol
4-Nitrophenol
Pentachlorophenol
Phenol
2,4,5-Trichlorophenol
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Benzyl alcohol
bis(2-Chloroethyl) ether
bis(2-Chloroethoxy) methane
bis(2-Chloroisopropyl) ether
bis(2-Ethylhexyl)phthalate
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
4-Chloroaniline
2-Chloronaphthalene
4-Chlorophenyl phenyl ether
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran
Dibutyl phthalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
Diethyl phthalate
Dimethyl phthalate
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octyl phthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone

Table 4-4
CHEMICAL PARAMETERS FOR LABORATORY
ANALYSIS

Semi-Volatile Organic Compounds (SW-8270)
Continued

4-Nitroaniline
Nitrobenzene
N-Nitrosodi-n-propylamine
N-Nitrosodiphenylamine
Phenanthrene
Pyrene
1,2,4-Trichlorobenzene
2,4,6-Trichlorophenol
1,2,4,5-Tetrachlorobenzene
1,2-Diphenylhydrazine
1-Chloronaphthalene
1-Naphthylamine
2,3,4,6-Tetrachlorophenol
2,6-Dichlorophenol
2-Naphthylamine
2-Picoline
3-Methyl cholanthrene
4-Aminobiphenyl
7,12-Dimethyl(a)anthracene
a,a-Dimethylphenethylamine
Acetophenone
Aniline
Benzidine
Dibenz(a,j)acridine
Diphenylamine
Ethylmethane sulfonate
Methylmethane sulfonate
n-Nitrosodimethylamine
n-Nitrosopiperidine
n-Nitroso-di-n-butylamine
Pentachlorobenzene
Pentachloronitrobenzene
Phenacetin
Pronamide
p-Dimethylamino(azo)benzene

Table 4-4
 CHEMICAL PARAMETERS FOR LABORATORY
 ANALYSIS

Chlorinated Pesticides and PCBs (SW-8080)

Alpha-BHC
 Beta-BHC
 Delta-BHC
 Gamma-BHC (lindane)
 Heptachlor
 Aldrin
 Heptachlor epoxide
 Endosulfan I
 Dieldrin
 4,4'-DDE
 Endrin
 Endosulfan II
 4,4'-DDD
 Endosulfan sulfate
 4,4-DDT
 Methoxychlor
 Endrin ketone
 Chlordane
 Toxaphene
 PCB-1016
 PCB-1221
 PCB-1232
 PCB-1242
 PCB-1248
 PCB-1254
 PCB-1260

Metals

Antimony
 Arsenic
 Barium
 Beryllium
 Cadmium
 Chromium
 Cobalt
 Copper
 Iron
 Lead
 Manganese
 Mercury
 Nickel
 Selenium
 Silver
 Thallium
 Tin
 Vanadium
 Zinc

Chlorinated Volatiles (SW-8010)

1,1,1,2-Tetrachloroethane
 1,1,1-Trichloroethane
 1,1,2,2-Tetrachloroethane
 1,1,2-Trichloroethane
 1,1-Dichloroethane
 1,1-Dichloroethene
 1,2,3-Trichloropropane
 1,2-Dichlorobenzene
 1,2-Dichloroethane
 1,2-Dichloropropane
 1,3-Dichlorobenzene
 1,4-Dichlorobenzene
 1-Chlorohexane
 2-Chloroethylvinyl ether
 2-Chlorotoluene
 2-Chlorotoluene
 4-Chlorotoluene
 Benzyl chloride
 Bis(2-chloroethoxy)methane
 bis-2-Chloroisopropyl ethyr
 Bromobenzene

Bromodichloromethane
 Bromoform
 Bromomethane
 Carbon tetrachloride
 Chloroacetaldehyde
 Chlorobenzene
 Chloroethane
 Chloroform
 Chloromethane
 Chloromethylmethyl ether
 Dibromochloromethane
 Dibromomethane
 Dichlorodifluoromethane
 Methylene chloride
 Tetrachloroethene
 trans-1,2-Dichloroethene
 trans-1,3-Dichloropropene
 Trichloroethene
 Trichlorofluoromethane
 Vinyl chloride

Table 4-4
CHEMICAL PARAMETERS FOR LABORATORY
ANALYSIS

Aromatic Volatiles (SW-8020)

Ethylbenzene	1,2-Dichlorobenzene
m-Xylene	1,3-Dichlorobenzene
o-Xylene	1,4-Dichlorobenzene
p-Xylene	Benzene
Toluene	Chlorobenzene

Polynuclear Aromatic Hydrocarbons (SW-8100)

3-Methylcholanthrene	Dibenz (a,h) acridine
7H-Dibenzo (c,g) carbazole	Dibenz (a,j) acridine
Acenaphthene	Dibenzo (a,e) pyrene
Acenaphthylene	Dibenzo (a,h) anthracene
Anthracene	Dibenzo (a,h) pyrene
Benzo (a) anthracene	Dibenzo (a,i) pyrene
Benzo (a) pyrene	Fluoranthene
Benzo (b) fluoranthene	Fluorene
Benzo (ghi) perylene	Indeno (1,2,3-cd) pyrene
Benzo (j) fluoranthene	Naphthalene
Benzo (k) fluoranthene	Phenanthrene
Chrysene	Pyrene

The study of the RFI SWMUs at Oceana will be done in two phases: (1) the RFI study described in this plan, and (2) additional studies to be done in preparation for the CMS. Results of the first phase sampling will be used to determine if RCRA action levels have been exceeded. In anticipation of the likelihood that corrective measure studies may be required at certain SWMUs, soil and water parameters necessary to evaluate the most likely technologies will be collected at selected sites during Phase 1. The results of Phase 1 will be described in the RFI report.

A second phase of field investigations may be conducted at SWMUs where action levels have been exceeded and additional data is needed after the RFI but prior to the CMS. During the second phase, additional parameters necessary for evaluating groundwater corrective measures such as alkalinity, hardness, TDS, TOC, or sulfate will be analyzed. Parameters necessary for evaluating soil corrective measures such as particle size distribution, percent organic carbon, bulk density, and moisture content will also be analyzed during the second phase, as appropriate. Soil leachate tests may also be conducted, if appropriate. In addition, the samples may be analyzed to determine if the waste is hazardous for evaluation of disposal options in the corrective measures study.

SWMU 1—West Woods Oil Disposal Pit

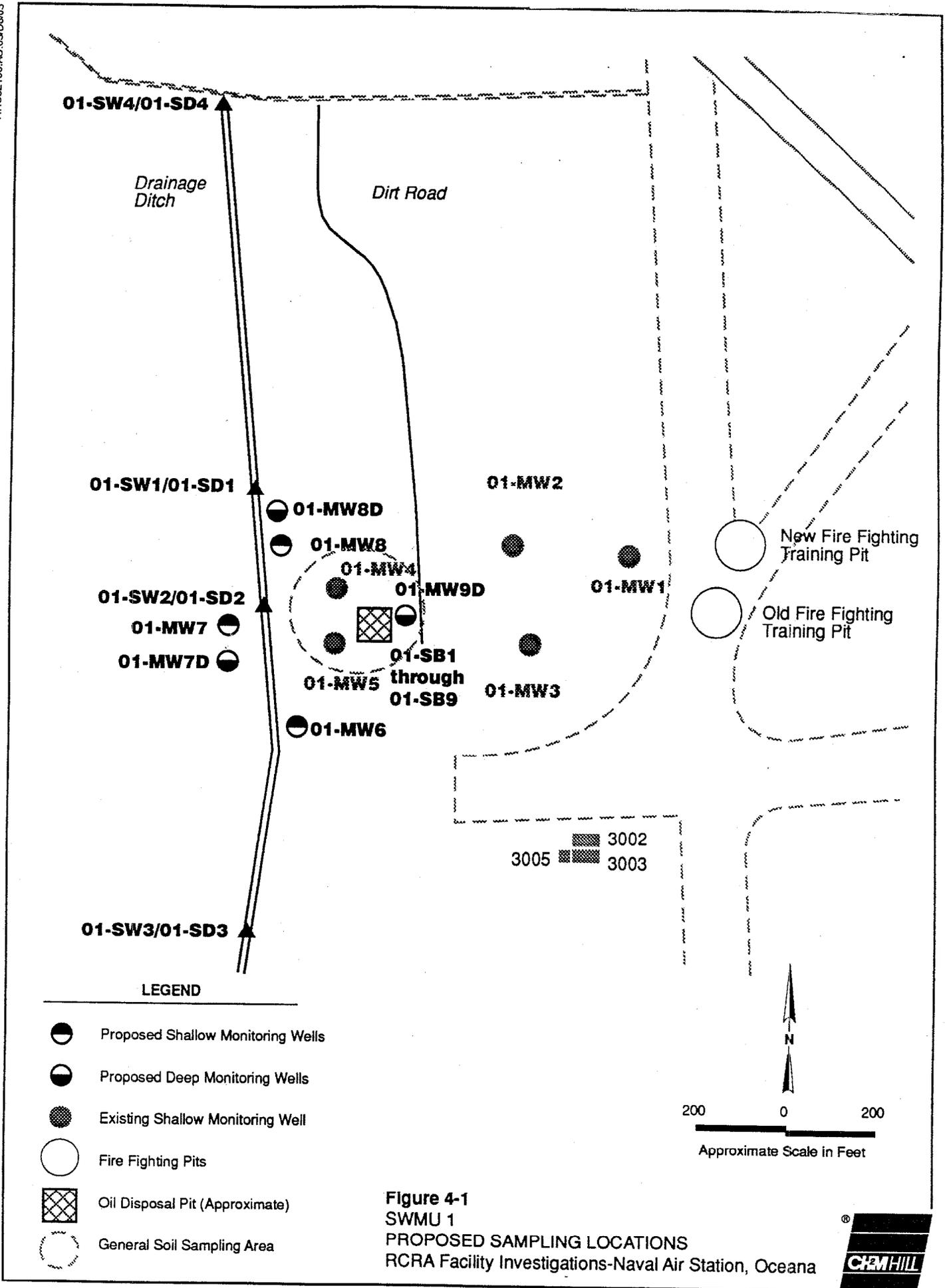
Soil

Chemicals in the soil at this SWMU represent a continuing source of contamination to the local shallow aquifer. Groundwater flow, in turn, is potentially a major pathway for the offsite migration of dissolved contaminants. Eliminating the soil contamination will, therefore, assist groundwater remediation. Consequently, characterizing the nature and extent of soil contamination at this site is of primary importance during this RFI.

Defining the extent of soil contamination will require a systematic approach of soil sample collection and analysis. Nine soil samples will be collected at 20-foot intervals near the approximate location of the former pit, that is, in the area of the dashed circle shown in Figure 4-1. The nine samples will be sent to the laboratory for analysis. The corners of the grid will be surveyed for horizontal control in order to have a relatively permanent frame of reference within the heavily wooded area in which this SWMU is located. The 20-foot spacing was chosen to minimize the number of sample points.

The samples will be collected by augers or a Geoprobe® sampler, and will be advanced to a depth of approximately 10 feet, or to obvious contamination, whichever is shallower. A soil sample will be collected every 2 feet and will be screened in the field for contamination by direct observation (i.e., color and odor) and by head-space analysis using an HNu photoionization detector. If field screening indicates that the lateral extent of the soil contamination has not been defined, then an additional seven locations will be sampled. In addition to screening in the field, a maximum of nine samples with the highest observed contamination will be shipped to the laboratory for chemical

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analyses. Parameters to be analyzed in each sample include the VOCs, PAHs, and PCBs. Two of the most visibly contaminated samples of soil will also be analyzed for the complete Appendix IX list.

Soil samples will also be collected in the area between the pit and the ditch potentially contaminated by the overflow of the oil disposal pit in the late-1960s flooding. Two samples will be collected and analyzed for VOCs, PAHs, and PCBs. Locations will be chosen based on topography and assumed patterns of flood-stage surface water flow.

Groundwater

Groundwater investigations at this site will focus on determining the extent of contamination, both laterally and vertically, and on identifying the hydraulic conductivity of the shallow aquifer materials. This will require the installation of additional monitoring wells both shallow (approximately 25 feet) and deep (approximately 70 feet) and conducting in-situ hydraulic conductivity tests on selected wells.

Three shallow and three deep wells will be installed. The need for additional wells will depend on the chemical data obtained from these six new wells. The approximate locations of the wells to be installed are shown in Figure 4-1. The rationale for the well locations is outlined as follows:

- Wells 01-MW6 and 01-MW8 will be located laterally away from the former pit and hydraulically downgradient in order to define the lateral extent of shallow groundwater contamination. These wells will be screened across the water table to capture free product should it exist at their respective locations.
- Well 01-MW7 is a shallow well to be located on the other side of the drainage ditch from the former pit. This location will help determine whether the ditch affects local groundwater hydrodynamics, and hence contaminant migration.
- Wells 01-MW7D and 01-MW8D are deep wells to be located adjacent to the shallow wells just described in order to determine whether contamination exists at greater depths locally. These deep wells are expected to monitor the Upper Yorktown Formation.
- Well 01-MW9D is deep. It will be located close to the former pit in a direction that is hydraulically upgradient. Chemical data from this well will be used to determine background conditions which, in turn, can be compared with deep wells located downgradient of the pit.

Groundwater samples collected from these six new wells will be analyzed for VOCs, PAHs, total metals, dissolved metals, and PCBs. In addition, wells 01-MW4, 01-MW5,

and 01-MW3 installed during previous investigations, will be resampled and analyzed for the same parameters, for a total of 9 wells. The groundwater sample from well 01-MW4 will be analyzed for the complete Appendix IX list. This sample will provide confirmation of the absence of dioxin in groundwater observed during the interim RFI. Both total and dissolved Appendix IX metals will be analyzed in 01-MW4. Well 01-MW3 is the upgradient shallow groundwater monitoring location.

Floating and dense free product found in any monitoring well will be measured for thickness using an interface probe. Both floating free product (LNAPL) and dense free product (DNAPL) will be sampled in well 01-MW4, if present. Floating free product from well 01-MW4 will be analyzed for PAHs, PCBs, metals, dioxin, and VOCs; dense free produce will be analyzed for VOCs and PAHs. Metals, PCBs, and dioxin from the DNAPL sample will not be analyzed because these contaminants are commonly associated with oils, which are LNAPLs. Modified SW 8100, 8080, 6010/7000, 8280, and 8240 methods will be used to analyze the free product concentrations of PAHs, PCBs, metals, dioxin, and VOCs, respectively. Detection limits of the constituents are expected to be high because of dilution.

In-situ hydraulic-conductivity tests will be performed on the three shallow wells, 01-MW3, 01-MW6, and 01-MW8, and on the three deep wells, 01-MW6D, 01-MW8D, and 01-MW9D. The information gained will be used to estimate the average linear velocity of the shallow groundwater.

All new monitoring wells will be surveyed for vertical and horizontal control.

Surface Water and Sediments

The surface water in the drainage ditch will be resampled at the intermediate (01-SW2) and downstream (01-SW1) locations used in the Interim RFI. The upstream sample location (01-SW3) will be sampled 200 feet upstream of the Interim RFI location. A fourth location, downstream near the radar station, will also be sampled. The four samples will be analyzed for total metals, VOCs, PAHs, and PCBs. Sediment samples will also be collected at these same locations and analyzed for the same parameters. One of the downgradient samples of surface water and sediment (01-SD1 and 01-SW1) will also be analyzed for dioxin. If Appendix IX constituents are found in groundwater, then 01-SW1 will also be analyzed for Appendix IX parameters after the completion of the RFI.

The water level in the ditch will be measured at a benchmark adjacent to the former pit to correlate the relationship between shallow groundwater flow and surface water in the ditch. Water quality data from the NPDES compliance point approximately 3,000 feet downstream of Site 1 will be included in the RFI report.

SWMU 2b—Line Shack Oil Disposal Areas (Bldg. 131)

RFI activities at this site will address the two different areas of groundwater contamination separately. The existing data are sufficient to begin a systematic investigation to identify the source of groundwater contamination. Although the existing data suggest a general location for the groundwater contamination in this area, a more detailed identification is important to guide remediation. The source may no longer exist at a scale that can be positively identified, but that conclusion can only be made after initiating a program that combines in-situ groundwater sampling with chemical analysis in the field and confirmatory soil sampling in the laboratory.

In-Situ Groundwater Sampling

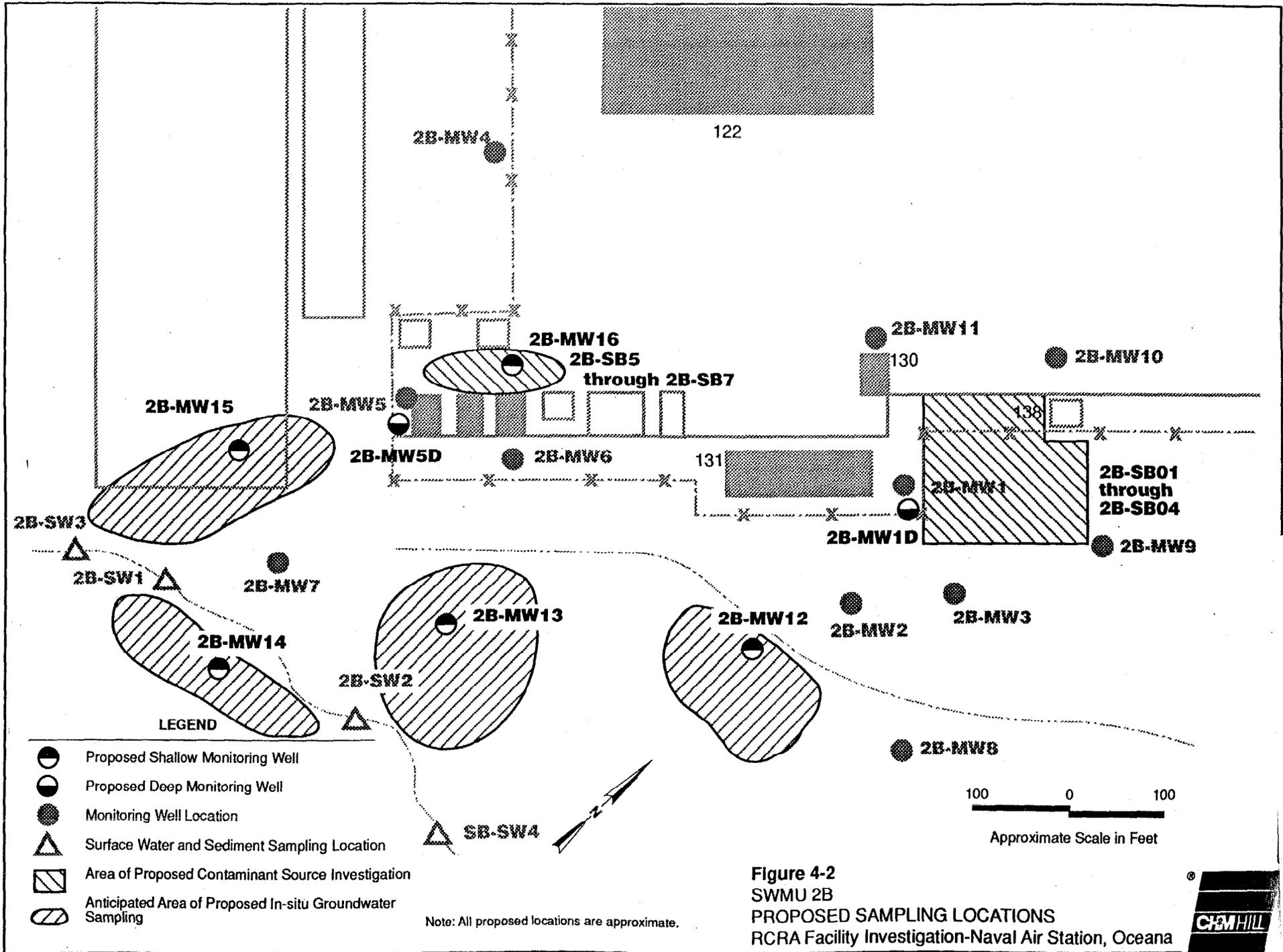
An in-situ grab sampling technique for collecting groundwater samples will be used as a screening tool at the site. This work will be done using a Geoprobe® sampler and a mobile laboratory equipped with a gas chromatograph capable of onsite analysis of the groundwater samples, using EPA-approved mobile laboratory procedures. This in-situ groundwater sampling will be used for two purposes. The first purpose will be to help define the extent and sources of contamination. The second purpose will be to help locate shallow downgradient monitoring wells.

In the two potential groundwater contamination source areas identified in Figure 4-2, it is anticipated that a total of eight in-situ groundwater samples will be collected. A field laboratory will analyze each of the samples for selected VOCs, using modified EPA method SW 8010 with headspace analysis. Five volatile organic compounds detected during previous sampling will be quantified during analysis by the mobile lab. Samples will be collected and analyzed in a sequence that will facilitate mapping of the highest groundwater concentrations in each area. One duplicate groundwater sample will be sent to the CH2M HILL laboratory for confirmatory analysis of chlorinated VOCs. A detection limit of 2 ppb or less will be required for vinyl chloride in this analysis.

A total of 12 in-situ groundwater samples is anticipated to be collected and analyzed by the field laboratory to help locate four proposed downgradient monitoring wells. The approximate areas where these in-situ groundwater samples will be collected are identified in Figure 4-2. The field laboratory will analyze the samples for the same selected VOCs. One duplicate groundwater sample will be sent to the CH2M HILL laboratory for confirmatory analysis of chlorinated VOCs. A detection limit of 2 ppb or less will be required for vinyl chloride in this analysis.

Soil

At the completion of the in-situ groundwater sampling investigation, soil samples will be collected from the areas of highest concentration to determine the extent of contamination within the soil. It is anticipated that a total of seven soil borings will be advanced



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to the water table using an auger or the Geoprobe® sampler. Soil samples will be collected at 2-foot intervals within each boring. Soil samples from each boring will be screened with an HNu. Two samples from each boring with the highest observed concentration will be sent to the CH2M HILL laboratory for chemical analysis of chlorinated VOCs; therefore, a total of 14 soil samples will be analyzed by the CH2M HILL laboratory.

Groundwater

Two deep wells, approximately 70 feet deep (2B-MW1D and 2B-MW5D) will be installed, adjacent to 2B-MW1 and 2B-MW5 (see Figure 4-2) to determine the vertical extent of contamination in the areas where the highest concentrations were observed in shallow groundwater. The deep wells will be screened in a permeable zone of the Upper Yorktown Formation. Five shallow monitoring wells, approximately 25 feet deep, will be installed at the site. One of these wells, 2B-MW16, will be at the area of the highest source concentration determined from the in-situ groundwater sampling. Four wells will be located downgradient to help define the southerly extent of shallow groundwater contamination. The exact location of these four wells will be determined by the results of the in-situ groundwater sampling.

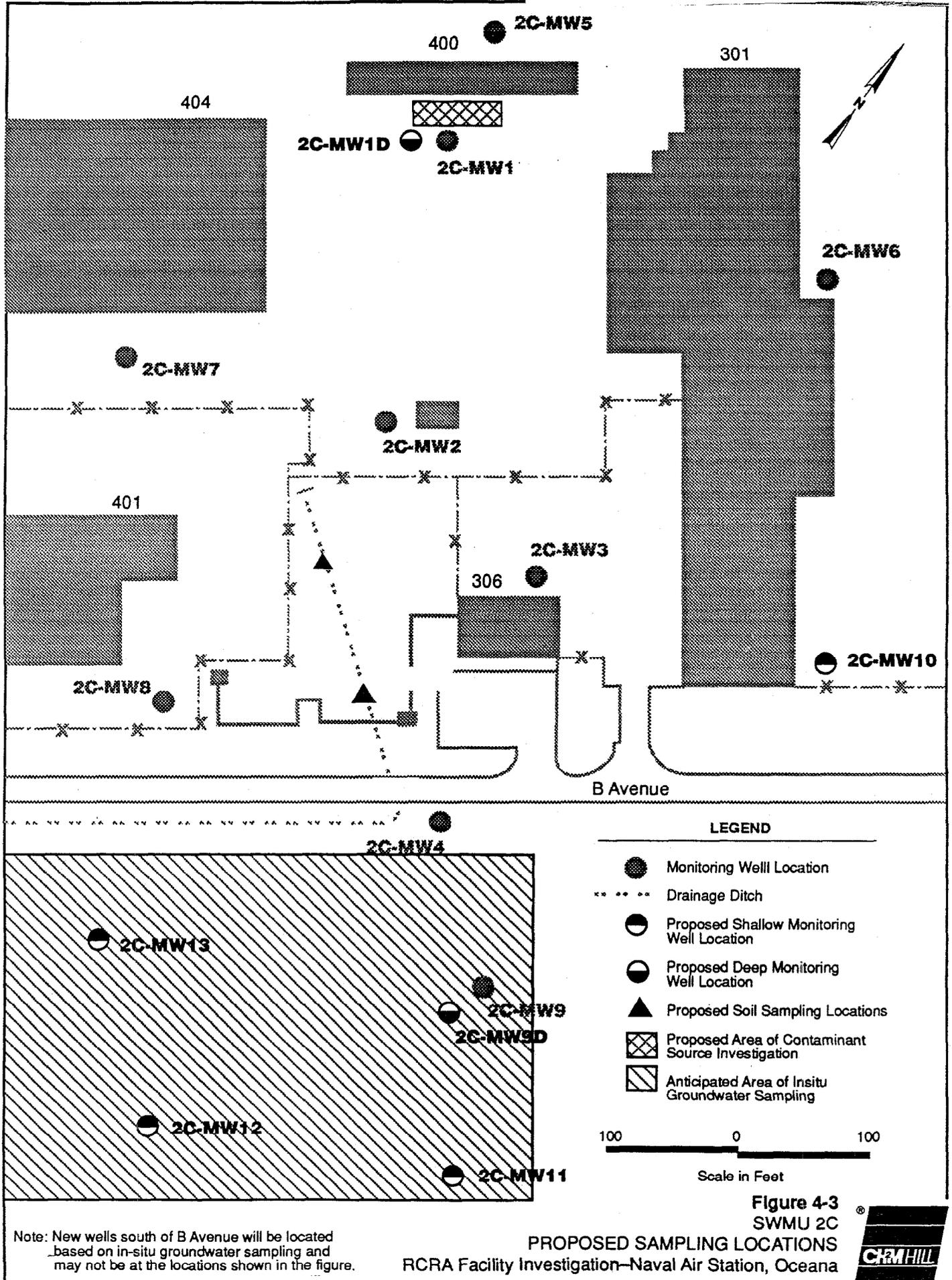
Groundwater samples will be collected from all new and existing monitoring wells. A total of 18 groundwater samples will be collected and analyzed in the CH2M HILL laboratory for chlorinated VOCs in addition to the two duplicates of the in-situ samples. A detection limit of 2 ppb or less for vinyl chloride will be required for all volatile analyses. Well 2B-MW1 will also be analyzed for semivolatiles. Chlorinated volatiles will be analyzed because three previous scans for all volatiles showed that only chlorinated volatiles are present (see Chapter 2).

Surface Water and Sediment

The elevation of a benchmark in the perennially flowing drainage ditch will be surveyed near the 2B-SW2 sampling location to determine the relationship between the surface water in the ditch and shallow groundwater flow. Surface water and sediment samples will be collected from the two locations previously sampled and from additional upstream and downstream locations. Approximate sample locations are shown in Figure 4-3. The four samples will be analyzed for chlorinated VOCs and PAHs. A detection limit of 2 ppb or less will be required for vinyl chloride analysis. PAHs will be analyzed because TPH concentrations in surface water exceeded 1,000 ppb during Interim RFI sampling.

SWMU 2c—Line Shack Oil Disposal Area (Building 400)

As discussed in Chapter 2, the pattern of groundwater flow coupled with the resulting spatial distribution of contamination, suggests that there are multiple sources and



Note: New wells south of B Avenue will be located based on in-situ groundwater sampling and may not be at the locations shown in the figure.

Figure 4-3
SWMU 2C
PROPOSED SAMPLING LOCATIONS
RCRA Facility Investigation-Naval Air Station, Oceana



destinations for the chemicals detected in groundwater at this SWMU. In order to determine as accurately as possible where the contamination in a particular well is coming from and where it may be going, a systematic approach to implementing further fieldwork at this site will be followed.

The first step in this approach will be to develop an expanded and more detailed site plan. This will involve developing a map from a survey of the locations of monitoring wells, buildings, and other major permanent features. Superimposing the available water-level and chemical data on a more accurate and expanded base map will enhance the picture of existing conditions, and, in turn, enable better siting of additional monitoring wells and/or soil sampling points which most likely will be required to define the source(s) and extent of contamination.

The current level of information describing conditions at this SWMU, however, does enable scoping of the RFI activities for this SWMU. Additional investigations to be conducted at this SWMU are presented below.

In-Situ Groundwater Sampling

An in-situ grab sampling technique for collecting groundwater samples will be used as a screening tool at the site. This in-situ groundwater sampling will be used for two purposes. The first purpose will be to help define the source of contamination. The second purpose will be to help locate shallow downgradient monitoring wells.

In the potential groundwater contamination source area identified in Figure 4-3, it is anticipated that a total of three in-situ groundwater samples will be collected. A field laboratory will analyze each of the samples for five VOCs detected at the site during previous investigations. Samples will be collected and analyzed in a sequence that will facilitate mapping of the highest groundwater concentrations in each area. One duplicate groundwater sample will be sent to the CH2M HILL laboratory for confirmatory analysis of chlorinated VOCs.

A total of 10 in-situ groundwater samples is anticipated to be collected and analyzed by the field laboratory to help locate three proposed downgradient monitoring wells. The approximate area where these in-situ groundwater samples will be collected is identified in Figure 4-3. The field laboratory will analyze these samples for the same VOCs as the source characterization samples. One duplicate groundwater sample will be sent to the CH2M HILL laboratory for confirmatory analysis of chlorinated VOCs.

Soil

At the completion of the in-situ groundwater sampling investigation, soil samples will be collected from the areas of highest concentration at the source to determine the extent of contamination within the soil. It is anticipated that a total of three soil borings will

be advanced to the water table using an auger or Geoprobe® sampler. Soil samples will be collected at 2-foot intervals within each boring. Soil samples from each boring will be screened with an HNu. Two samples from each boring with the highest observed contamination will be sent to the CH2M HILL laboratory for chemical analysis of chlorinated VOCs.

Two soil samples will be collected from the drainage ditch which extends through the central portion of the site (see Figure 4-3). Samples will be collected with an auger at a depth of 1 to 2 feet below grade. Samples will be analyzed for chlorinated VOCs.

Groundwater

Two deep wells (2C-MW1D and 2C-MW9D), approximately 70 feet deep, will be installed at the site. They will be adjacent to 2C-MW1 and 2C-MW9 (see Figure 4-3) to determine the potential vertical extent of contamination at the highest concentrations observed in shallow groundwater. Four shallow monitoring wells, approximately 25 feet deep, will be installed at the site. One well, 2C-MW10 will be located near Building 301 at an area potentially upgradient from 2C-MW9. The other three wells will be located downgradient to help define the southerly extent of shallow groundwater contamination. The exact location of these three new shallow wells will be determined by the results of the in-situ groundwater sampling.

Groundwater samples will be collected from all new and existing monitoring wells. A total of 15 groundwater samples in addition to the two in-situ confirmation samples will be collected and analyzed in the laboratory for chlorinated VOCs. Well 2C-MW1 will also be sampled for semivolatiles.

SWMU NO. 2d—Line Shack Oil Disposal Area (Bldg. 125)

Chemical data from three monitoring wells, installed and sampled during the Interim RFI, indicated that the parameters that were analyzed were detected in only one (2D-MW2) of the three wells. The data are insufficient to support installation of additional wells or to initiate soil sampling in an effort to identify the potential source of the contaminant in the one well. Therefore, the three existing wells (see Figure 2-11) will be resampled to confirm the results obtained during the Interim RFI, and to determine if additional environmental sampling is appropriate at this SWMU. 2D-MW1 and 2D-MW3 groundwater samples will be analyzed for VOCs and PAHs; 2D-MW2 will be analyzed for VOCs and semivolatiles. Full VOCs will be analyzed at Site 2D to confirm the Interim RFI results for the first time; the results of Sites 2B and 2C have been confirmed with full VOC scans on two previous occasions.

SWMU 2e—Line Shack Oil Disposal Area (Bldg. 23) and Hazardous Waste Storage Area (Bldg. 23)

Both of these areas are adjacent to Building 23 (see Figure 2-13); consequently, the results of environmental sampling will be relevant to both SWMU sites.

Groundwater

Chemical data from the three shallow monitoring wells installed and sampled during the Interim RFI indicated that the analyzed parameters were either not detected or were detected at levels below the accurately quantifiable level.

The chemical data are insufficient to support installation of additional wells at this SWMU. 2E-MW2 and 2E-MW3 will be resampled and analyzed for VOCs, total metals, dissolved metals, and PAHs. Well 2E-MW1 will be analyzed for VOCs, total metals, dissolved metals, and semivolatiles, to confirm the results of the Interim RFI. The locations of the existing wells are shown in Figure 4-4.

Soil

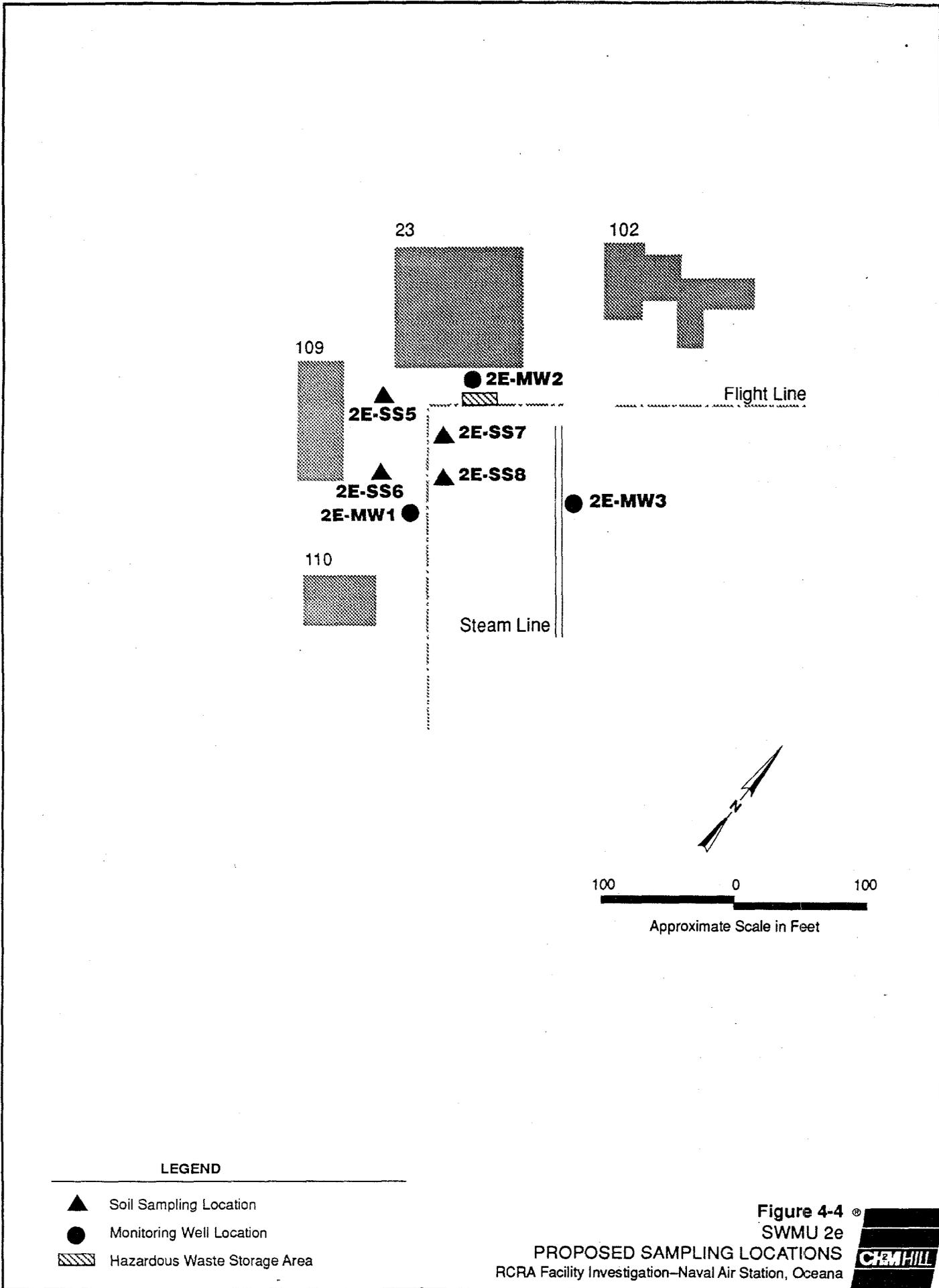
Chemical analysis of soil samples collected during the Interim RFI indicated that VOCs were not present. TPH was detected in two samples. Therefore, four additional locations will be sampled in the vicinity of the locations where the samples with detectable levels of TPH were collected to define the extent of contamination in the soil. Figure 4-4 shows the proposed location of the four soil sample locations. At these four locations, samples will be collected from a 0.5-foot to a 1-foot depth. At two locations, those that appear most contaminated, additional samples will be collected from 2 to 3 feet. Five of the six samples will be analyzed for TPH, metals, PAHs, and VOCs. The sixth sample, the one with the highest apparent concentration, will be analyzed for TPH, metals, VOCs, and semivolatiles.

SWMU 11—Fire Fighting Training Areas

As mentioned in Section 2, these two SWMU sites are adjacent to each other (see Figure 2-15); consequently, results of environmental sampling will be relevant to both areas.

Groundwater

Chemical data from a shallow monitoring wells 1-MW1 and 11-MW1 installed during the previous investigations indicated that parameters analyzed were not detected (see Figure 4-5).



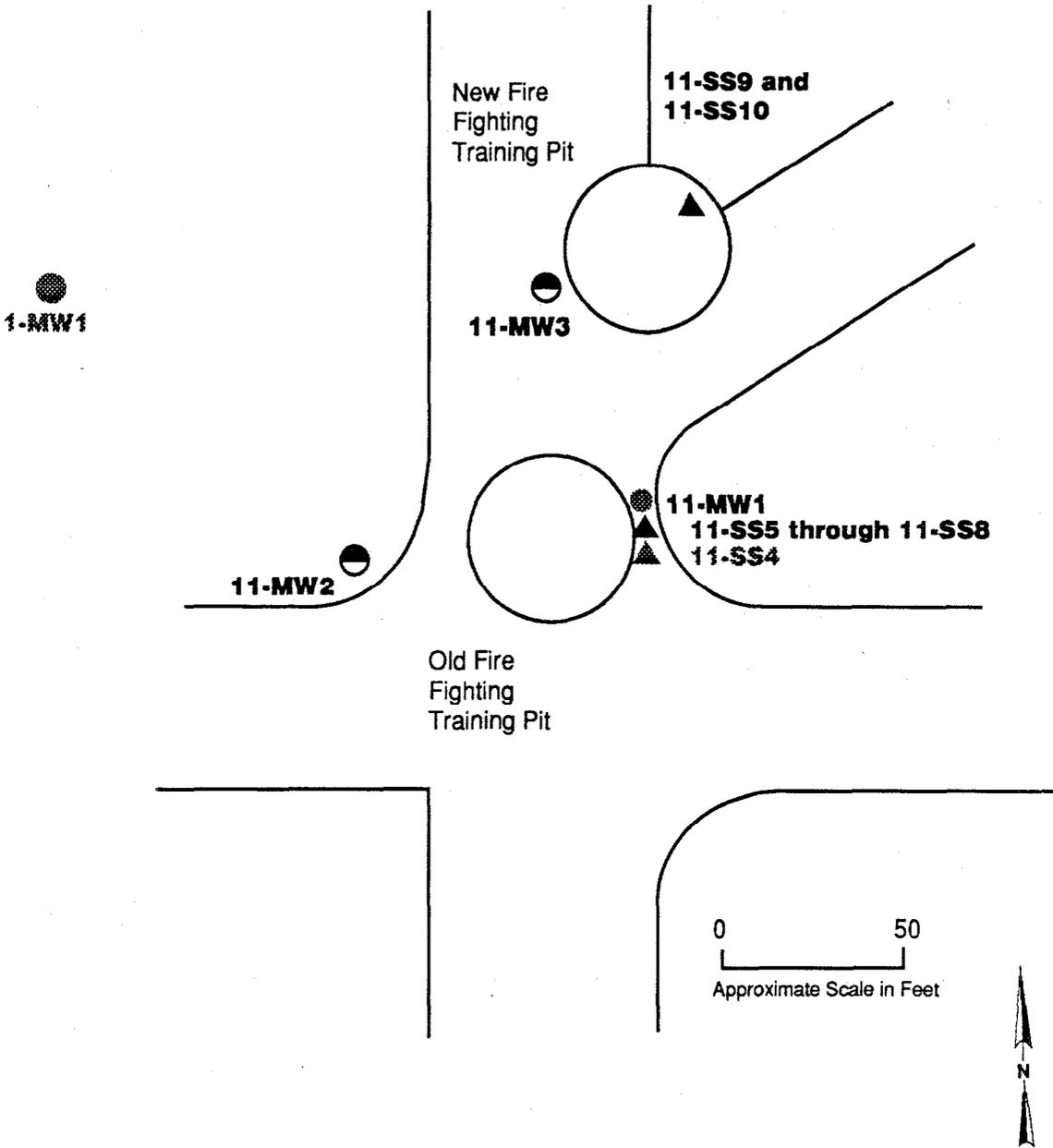
LEGEND

- ▲ Soil Sampling Location
- Monitoring Well Location
- ▨ Hazardous Waste Storage Area

Figure 4-4 [®]
SWMU 2e
PROPOSED SAMPLING LOCATIONS
 RCRA Facility Investigation—Naval Air Station, Oceana



HRO32160.AC.03/D8/06



LEGEND

- Fire Fighting Training Pit
- Existing Shallow Monitoring Well
- ◐ Proposed Shallow Monitoring Well
- ◑ Previous High TPH Soil Sampling Location
- ▲ Soil Sampling Locations

Figure 4-5
SWMU 11
PROPOSED SAMPLING LOCATIONS
RCRA Facility Investigation-Naval Air Station, Oceana



Two additional shallow monitoring wells, 11-MW2 and 11-MW3, both approximately 25 feet deep, will be installed downgradient of the site to determine if there has been a contaminant release from these SWMUs to the groundwater. Samples will be collected from 11-MW2 and 11-MW3 and the two existing wells, 1-MW1 and 11-MW1. 11-MW3, 1-MW1, and 11-MW1 will be analyzed for VOCs, PAHs, total metals, and dissolved metals. At 11-MW2, base-neutral extractable organics, VOCs, total metals, and dissolved metals will be analyzed.

Soil

Chemical data from four soil samples collected during the Interim RFI indicated VOCs and BNs were not present in the soil and that the soil was not ignitable. Lead, however, was detected in all four samples and TPH was detected in one.

Four locations (11-SS5 through 11-SS8) will be sampled in the vicinity of the sample where TPH was detected at the old fire training area during the RFI (11-SS4). Two locations (11-SS9 and 11-SS10) will also be sampled at the new fire training area. Samples will be collected from 0.5 to 1 foot and 2 to 3 feet at all locations with a hand auger. Soil samples will be screened using an HNu photoionization detector. Five samples with the highest apparent concentrations, based on HNu readings, visible contamination, or odors, will be submitted to the CH2M HILL laboratory for analysis of PAHs, TPH, VOCs, and metals.

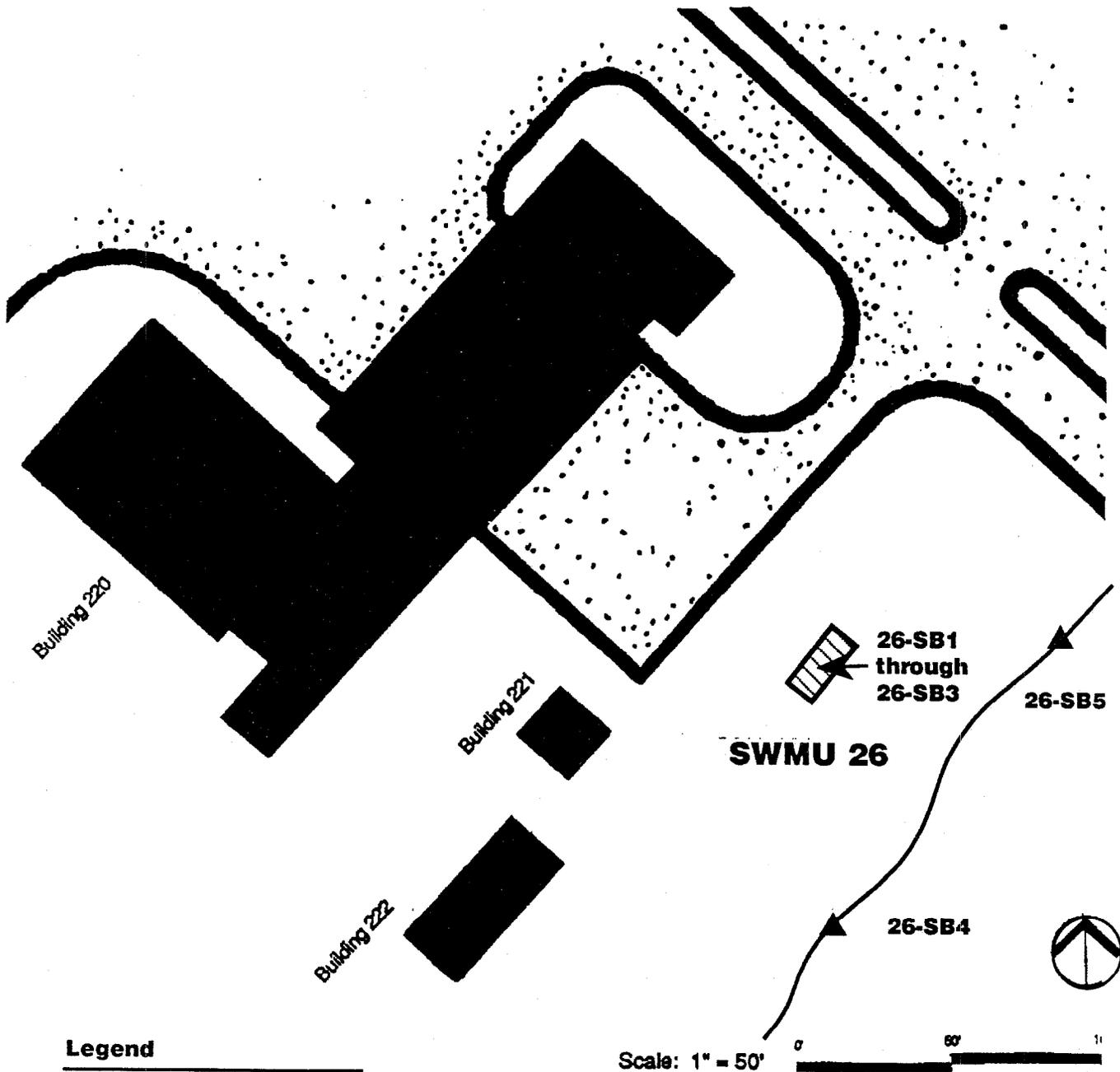
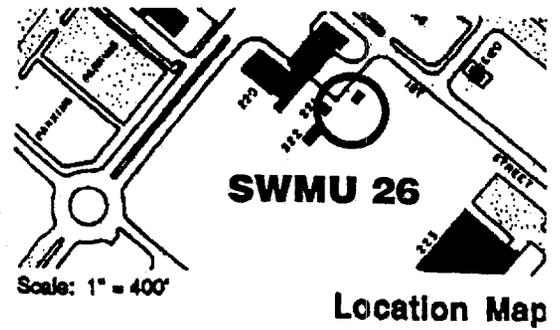
In the event that all of the samples screened indicated elevated HNu readings, then additional soil samples will be screened to determine the extent of contamination. Irrespective of the number of additional boreholes screened, a maximum of five samples will be submitted for confirmatory analysis. Proposed soil sampling locations are shown on Figure 4-5.

SWMU 26—Fire Fighting Training Area (Bldg. 220)

The RFA reports that the soil was stained with oil at this SWMU (Kearney, 1989). No environmental sampling has been performed at this SWMU. Soils from three locations in and near the pit will be sampled to determine if there has been a release of hazardous constituents. One sampling location will be within the pit. A fourth and fifth soil sampling location will be in the ditch, one upstream and one downstream of the pit area. Soil samples will be collected from 0.5 to 1 foot and 2 to 3 feet at each of the locations with a hand auger. Soil samples will be screened using an HNu photoionization detector as well as odor and visual signs of contamination.

The five most contaminated samples will be submitted to the CH2M HILL laboratory for confirmatory analysis of VOCs, PAHs, TPH, metals, and ignitability. The proposed soil sampling locations are shown in Figure 4-6.

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



Legend

-  Approximate SWMU Location
-  Soil Sampling Location

Figure 4-6
SWMU 26
PROPOSED SOIL SAMPLING LOCATIONS
 RCRA Facility Investigation—Naval Air Station, Oceana

SWMU 15—Abandoned Tank Farm

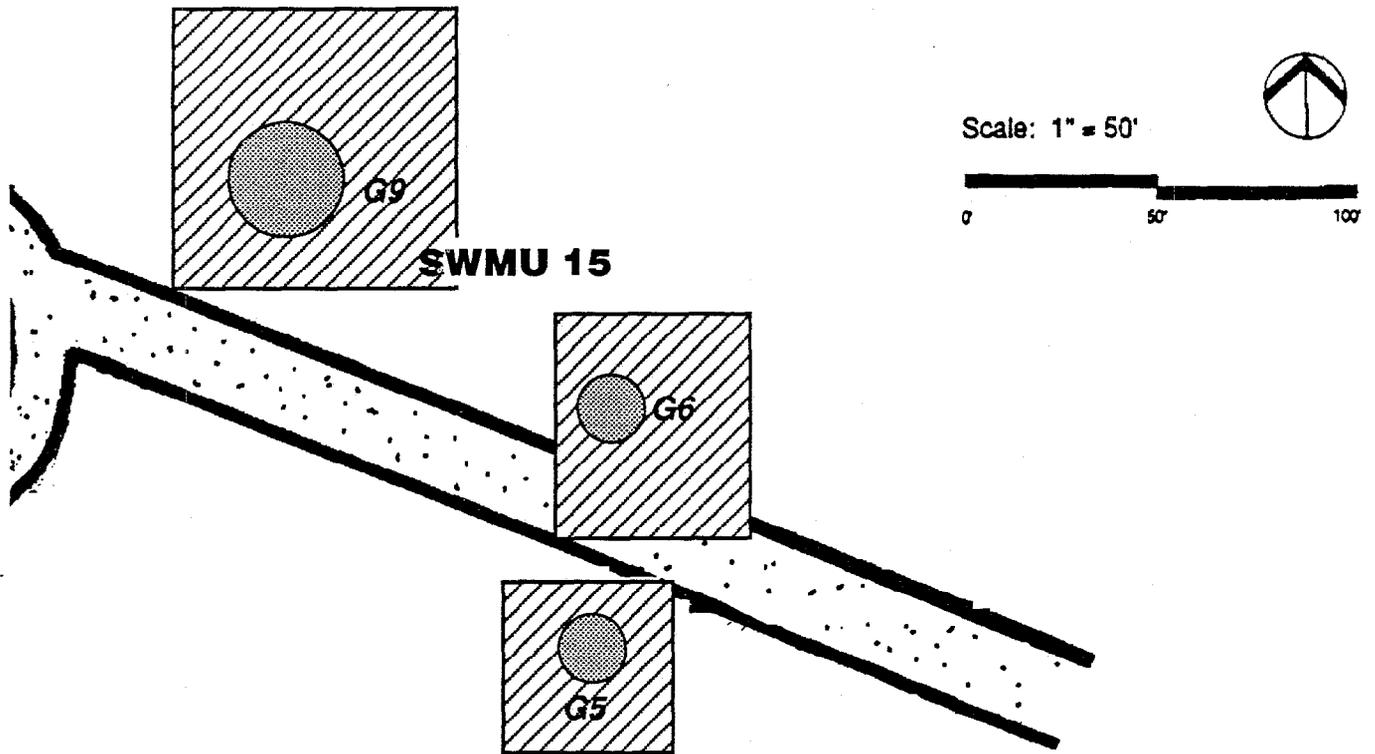
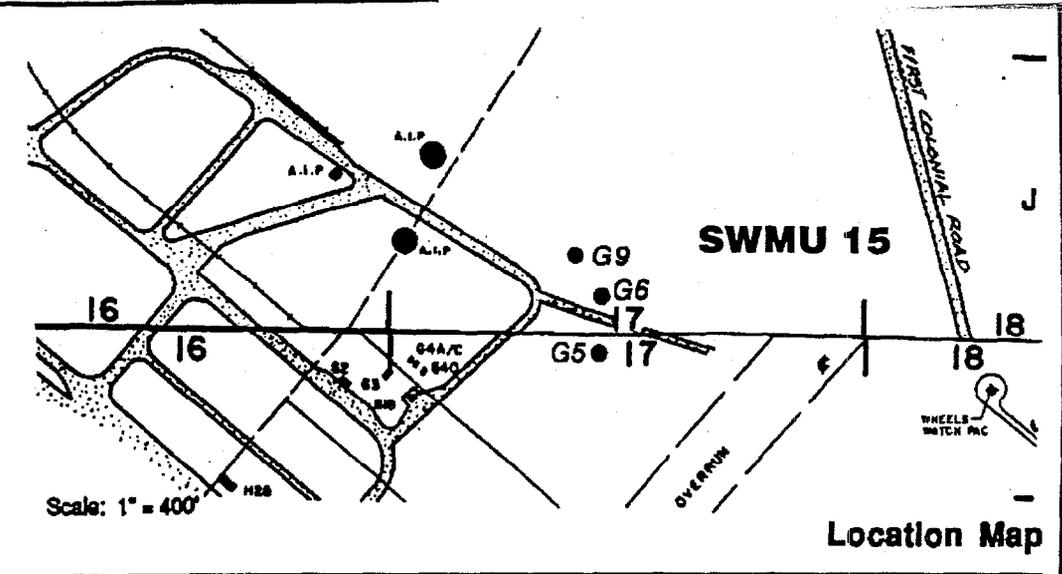
The extent of contamination at this SWMU is unknown. The oil tanks were dismantled approximately 7 years ago and the natural vegetation of the area has returned, making it difficult to determine the specific locations of the former tanks and associated piping. The location of the former tanks will be verified using aerial photographs, if possible.

The investigation of this SWMU will be done by in-situ sampling of soil gas and groundwater using a Geoprobe® sampler with on-site analysis of the samples using a mobile laboratory. The investigation will begin with a series of 10 soil gas samples distributed around the three former tanks. The samples will be collected at a depth of 6 feet and will be analyzed for benzene, xylene, ethylbenzene, and toluene (BTEX) compounds. If the soil gas samples do not show contamination, one in-situ groundwater sample will be collected at the water table near the tanks and analyzed using the mobile laboratory. If the soil gas is contaminated, a series of five in-situ groundwater samples will be collected. The approximate areas where the in-situ samples will be collected are indicated in Figure 4-7.

The soil gas and groundwater samples will be analyzed for BTEX compounds in the field using the mobile laboratory. One of the in-situ groundwater samples will be split and analyzed for aromatic VOCs, PAHs, and total and dissolved lead at the CH2M HILL lab. The in-situ screening results will be reported in the RFI report, which will include recommendations for future activities.

SWMU 16—Pesticide Storage Area (Bldg. 821)

No environmental sampling has been performed at this SWMU. The RFA reports that rinsewater from the pesticide mixing tank was discharged to the ground in this area (Kearney, 1989). Four soil samples from a depth of 1 to 2 feet will be collected adjacent to the pesticide shop (Bldg. 821). Samples will be collected based on visual signs of contamination; however, lacking such signs, sampling locations will be distributed evenly over the 300 square foot storage area. The soil samples will be analyzed for the Appendix IX chlorinated pesticides, organophosphate pesticides, and herbicides. Copper, lead, and arsenic will also be analyzed in two of the samples. Recent reviews of site history and RFA data by NAS Oceana personnel have revealed that pesticides have also been used at a pesticide storage area near the golf course. The sampling program at the Building 821 area will be repeated at the golf course pesticide area once the storage area has been identified more precisely. The proposed soil sampling locations near Building 821 are shown by Figure 4-8. Results from both areas will be reported in the RFI report under SWMU 16.



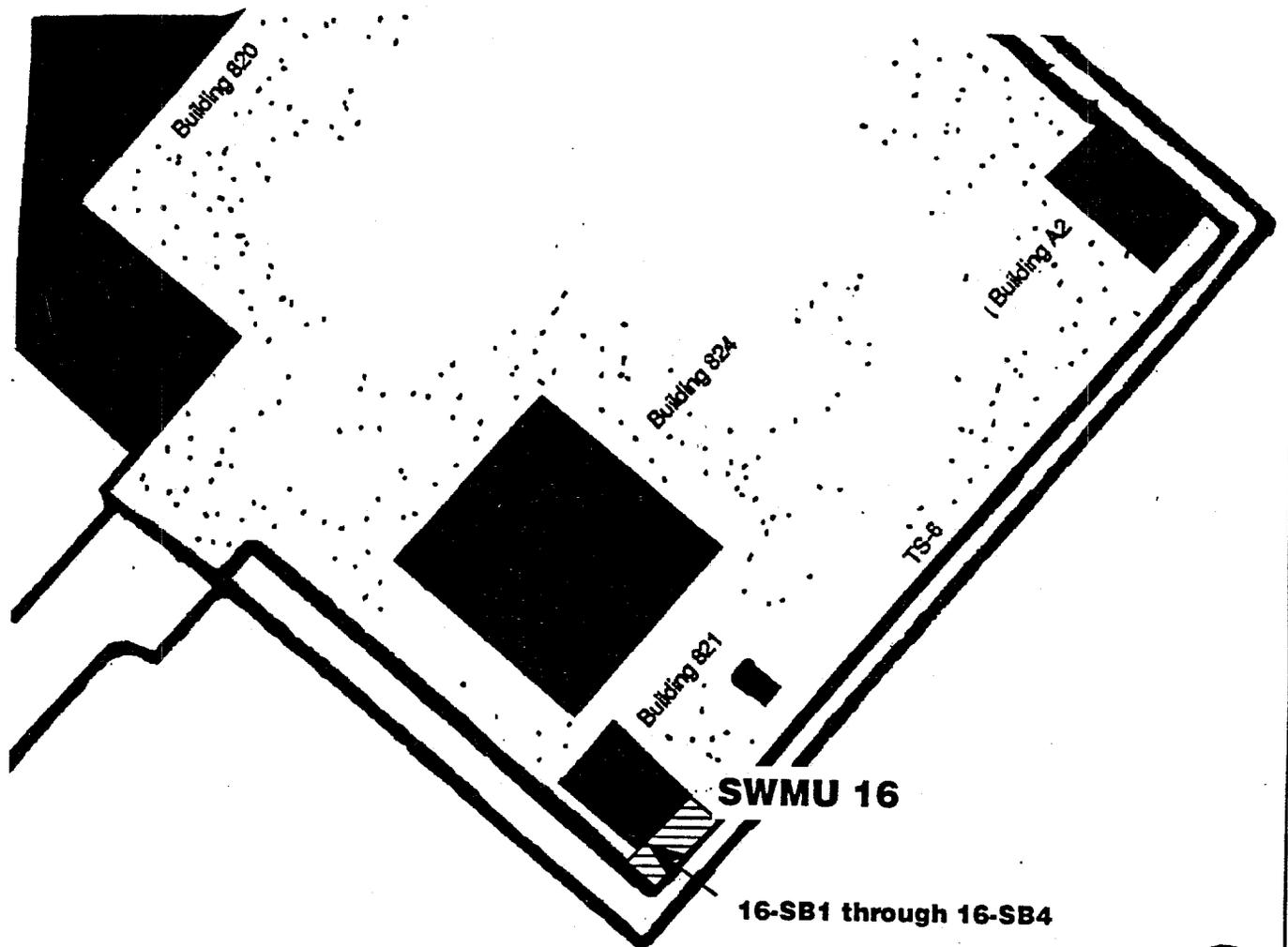
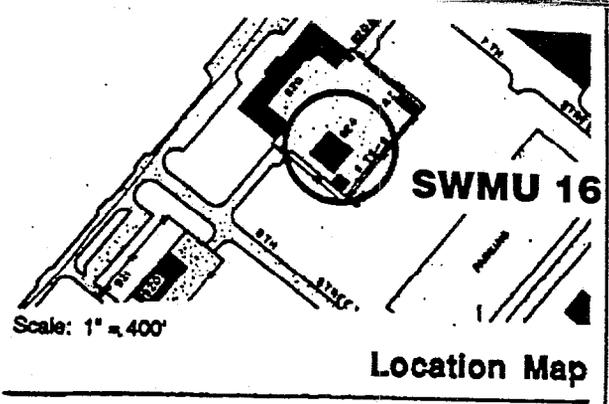
Legend

-  Former Tank Location
-  Areas of Proposed In-situ Soil Gas and Groundwater Sampling.

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana

Figure 4-7
SWMU 15
PROPOSED SAMPLING LOCATIONS
RCRA Facility Investigation—Naval Air Station, Oceana

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



Legend

 Approximate SWMU Location

Scale: 1" = 50'



Figure 4-8
SWMU 16 - PESTICIDES STORAGE AREA, BLDG. 821
PROPOSED SOIL SAMPLING LOCATIONS
RCRA Facility Investigation-Naval Air Station, Oceana

SWMU 18—Hazardous Waste Storage Area (Bldg. 204)

No environmental sampling has been performed at this SWMU, which has an area of 50 to 100 square feet. The assumed location of this SWMU is the hazardous waste storage area at Building 201. Two locations will be sampled at this area. One sample will be collected from 0.5 feet to 1 foot at each location with a hand auger. The two samples will be submitted for analysis of Appendix IX parameters. The proposed sample locations are shown in Figure 4-9.

SWMU 19—Waste Oil Storage Area (Bldg. 541)

No environmental sampling has been performed at this SWMU which is located behind the Citco Gas Station. The area was formerly used for waste-oil storage in the area adjacent to the area used for old tire storage. One location will be sampled at this site. The proposed sample location is shown in Figure 4-10. The samples will be collected from 0.5 feet to 1 foot and 2 to 3 feet and screened using an HNu photoionization detector as well as odor and visual signs of contamination. Samples will be collected with a hand auger. The sample with the highest observed contamination will be submitted for analysis of VOCs, PAHs, TPH, and lead.

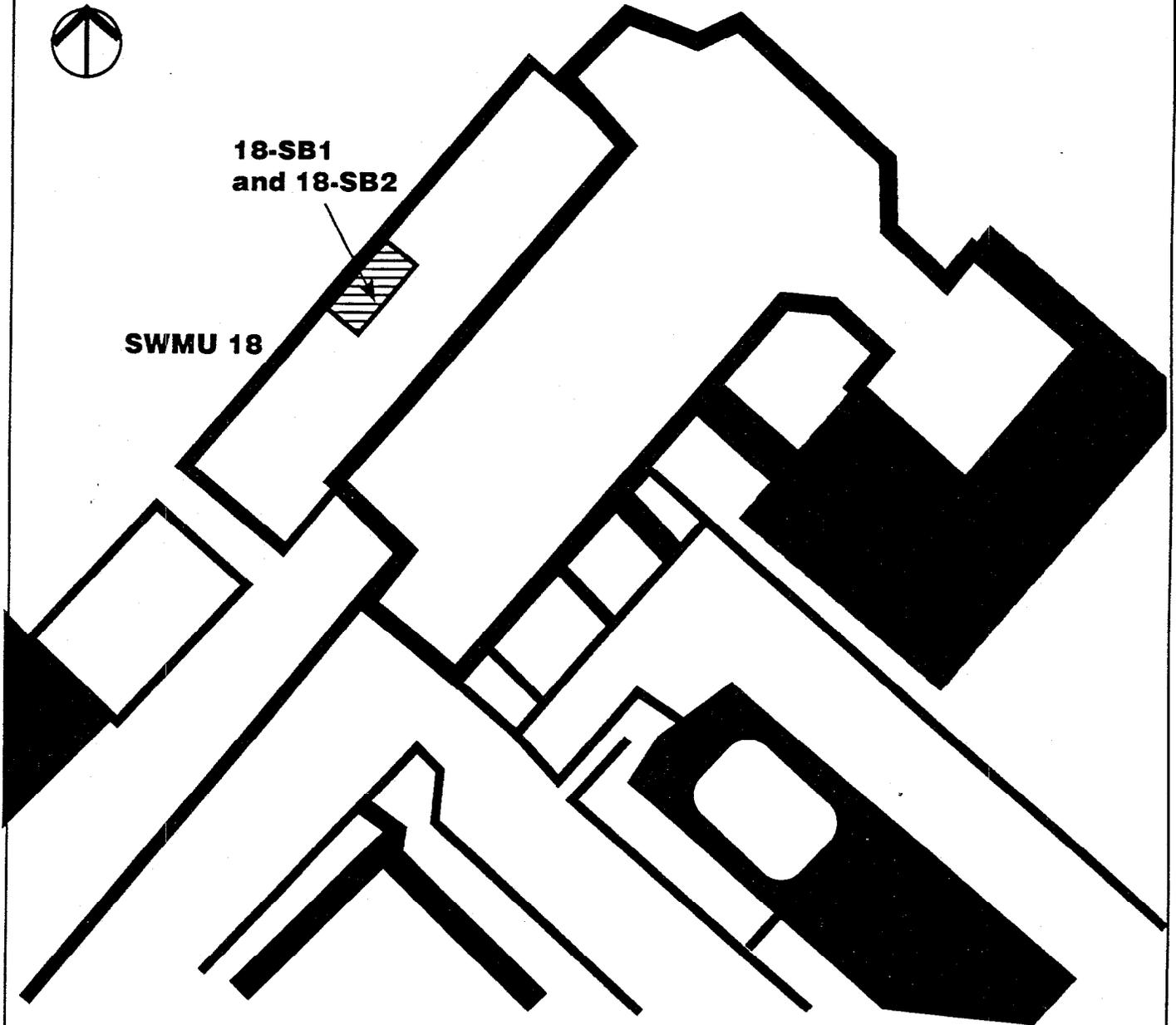
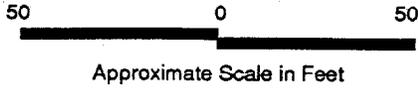
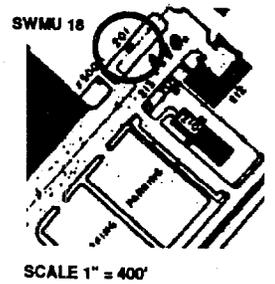
SWMU 20—Waste Motor Oil Storage Area (Bldg. 543)

No environmental sampling has been performed at this SWMU which is located at the Auto Repair Hobby Shop. The area used for waste-oil storage is the area to the north of Building 543 and the asphalt paving. Four locations will be sampled at this area. The proposed locations of the soil samples are shown in Figure 4-11. Samples will be collected at depths of 0.5 feet to 1 foot and 2 to 3 feet with a hand auger at each location and screened using an HNu photoionization detector as well as odor and visual signs of contamination. The sample with the highest observed concentration at each location will be submitted for analysis of PAHs, VOCs, TPH, and lead.

SWMU 21—Transformer Storage Yard (Bldg. 830)

No environmental sampling has been performed at this SWMU. This unit consists of two separate areas behind Building 830. Building 830 is used for storing old electrical transformers. One area is 30 feet by 15 feet and the other area is 80 feet by 10 feet. At the time of the RFA, two transformers were leaking electrical oil onto the ground (Kearney, 1989). Soil samples will be collected at six locations in the larger area and four locations in the smaller area. Sampling will focus on areas with staining and stressed vegetation. Proposed locations are shown in Figure 4-12. Soil samples will be collected at each location from depths of 0.5 feet to 1 foot. Ten samples will be submitted for analysis of PCBs. One TPH sample will also be collected from each of the two areas.

Source: General Development Map - Existing
Sectors 1-12, revised 1985.
U. S. NAS Oceana

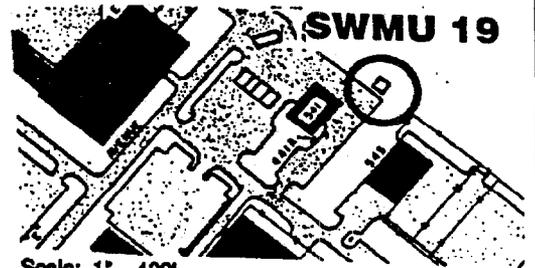


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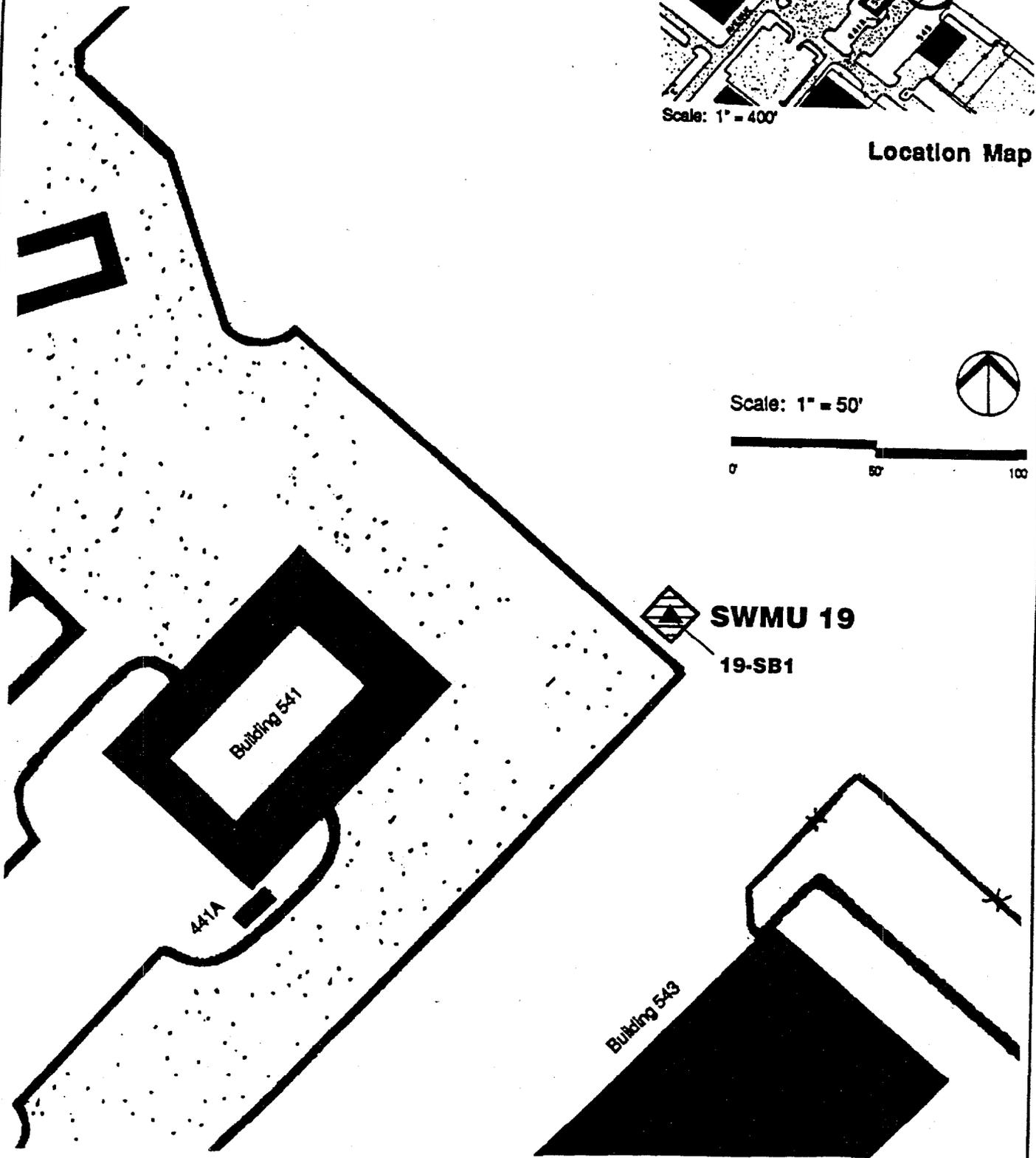
-  Approximate SWMU Location

Figure 4-9
SWMU 18
PROPOSED SOIL SAMPLING LOCATIONS
RCRA Facility Investigation—Naval Air Station, Oceana

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



Location Map

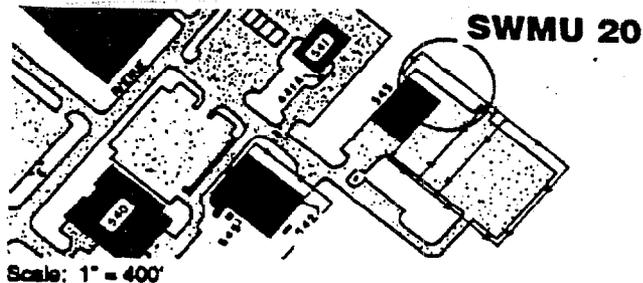


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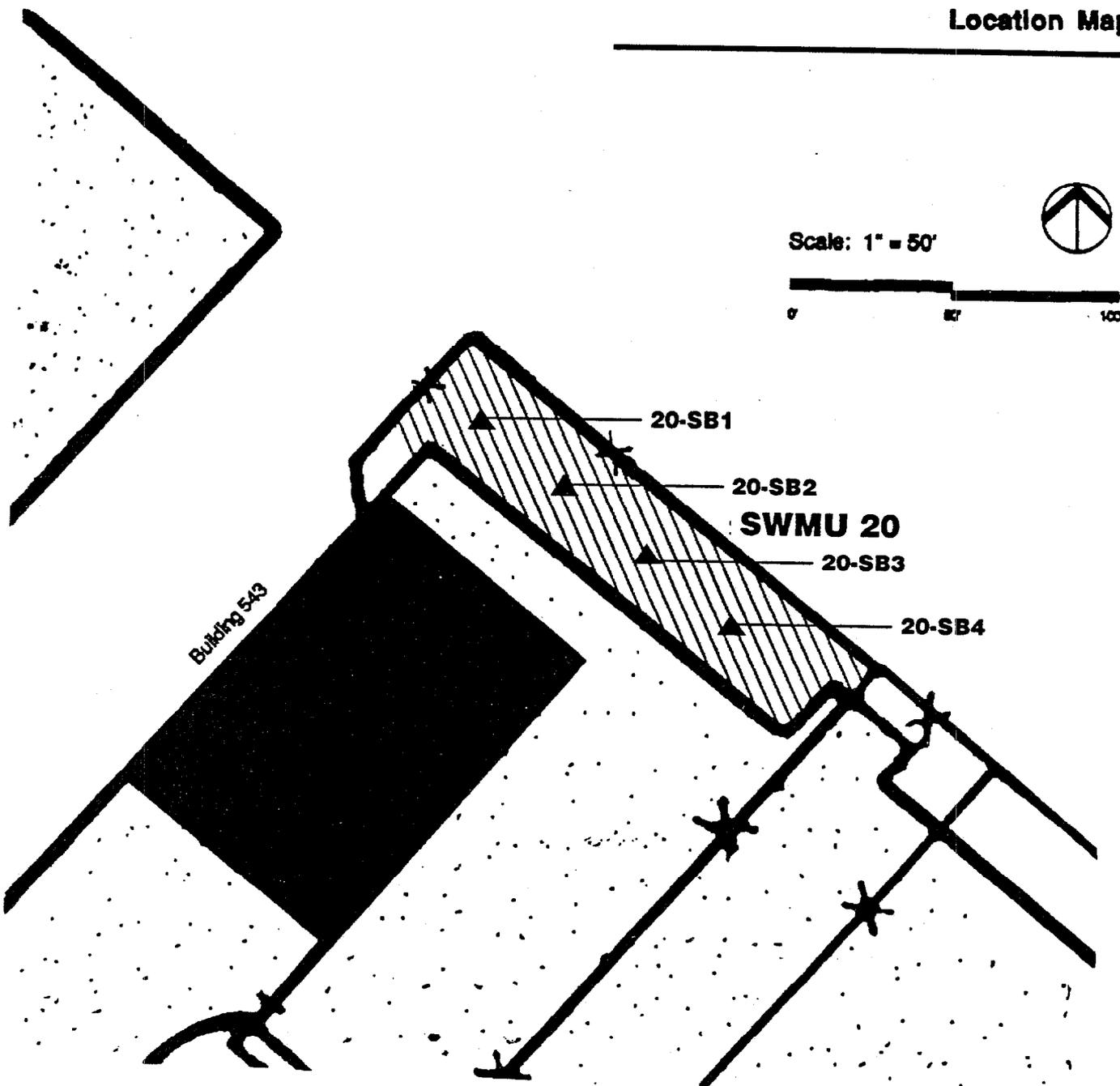
-  Approximate SWMU Location
-  Proposed Soil Sampling Location

Figure 4-10 SWMU 19 - WASTE OIL STORAGE AREAS, BLDG. 541 PROPOSED SOIL SAMPLING LOCATIONS -RCRA Facility Investigation-Naval Air Station, Oceana

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



Location Map

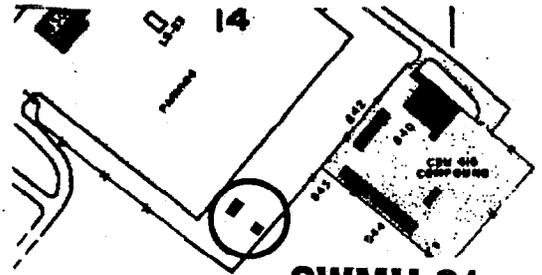


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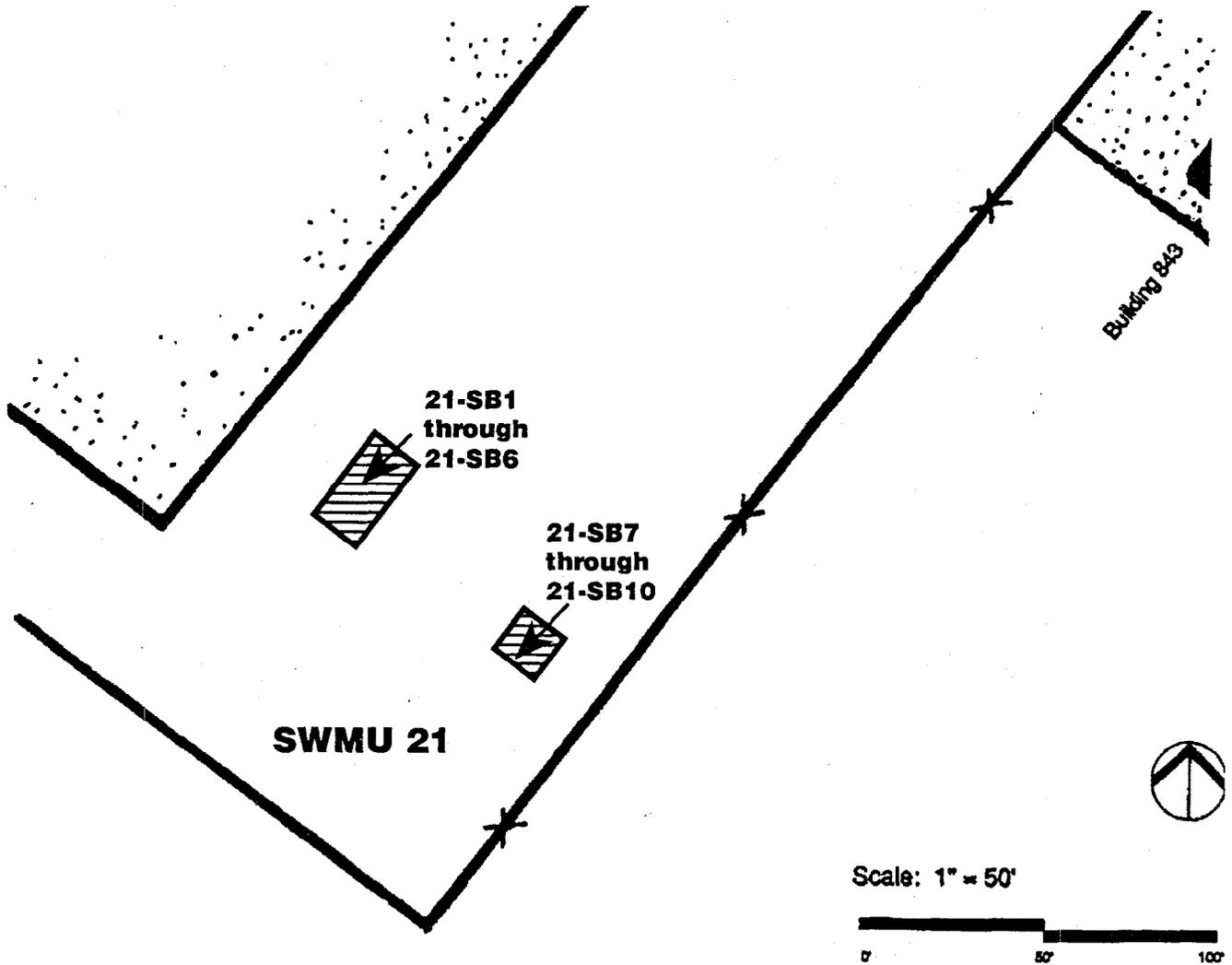
-  Approximate SWMU Location
-  Proposed Soil Sampling Location

Figure 4-11
SWMU 20 - WASTE OIL STORAGE AREAS, BLDG. 543
PROPOSED SOIL SAMPLING LOCATIONS
RCRA Facility Investigation-Naval Air Station, Oceana

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



SWMU 21
Location Map



Legend

 Approximate SWMU Location

Figure 4-12
SWMU 21
PROPOSED SOIL SAMPLING LOCATIONS
RCRA Facility Investigation—Naval Air Station, Oceana

SWMU 22—Construction Debris Landfill

No environmental sampling has been performed at this SWMU. Three shallow monitoring wells, approximately 25 feet deep, will be installed along the edge of the landfill nearest the wetlands. A fourth monitoring well will be installed at a location that is believed to be upgradient on the other side of the landfill. Groundwater samples from three of the wells will be collected and analyzed for VOCs, semi-volatiles, total metals, dissolved metals, and pesticides and PCBs. One downgradient sample (22-MW2) will be analyzed for Appendix IX parameters. The proposed locations of the wells are shown in Figure 4-13.

SWMU 23—Bowser, Building 830

There has been no environmental sampling at this SWMU. Waste oil generated by equipment maintenance activities was accumulated in a mobile 500-gallon bowser located next to Building 830.

Two soil samples will be collected from under the asphalt in the area where the bowser was parked. Proposed locations of the soil samples are shown by Figure 4-14. Samples will be collected from a depth of 0.5 feet to 1 foot below the bottom of the asphalt with a pick and a hand auger. Samples will be analyzed for VOCs, PAHs, metals, and TPH. After the samples have been collected, the hole will be repaired with an asphalt patch.

SWMU 24—Bowser, Building 840

No environmental sampling has been performed at this SWMU. Waste solvents and oils generated at the equipment maintenance garage in Building 840 were hand-carried and poured into the bowser located next to the building. Two soil samples will be collected from the area where the bowser was parked. Proposed locations of the soil samples are shown in Figure 4-15. Samples will be collected from a depth of 0.5 feet to 1 foot below ground surface with a hand auger. Samples will be analyzed for VOCs, metals, PAHs, and TPH.

SWMU 25—Inert Landfill

The Inert landfill is an unlined borrow pit used as a source of grading materials during the construction of State Route 44. The pit was allowed to fill with water, and before its access was restricted, the local community used the pit as a dump. NAS, Oceana, has since used the pit for disposal of inert solid waste, principally concrete and other construction material. The depth of the pit is unknown.

Two surface water samples and three sediment samples will be collected. One surface water and two sediment samples will be analyzed for VOCs, semi-volatiles, total metals,

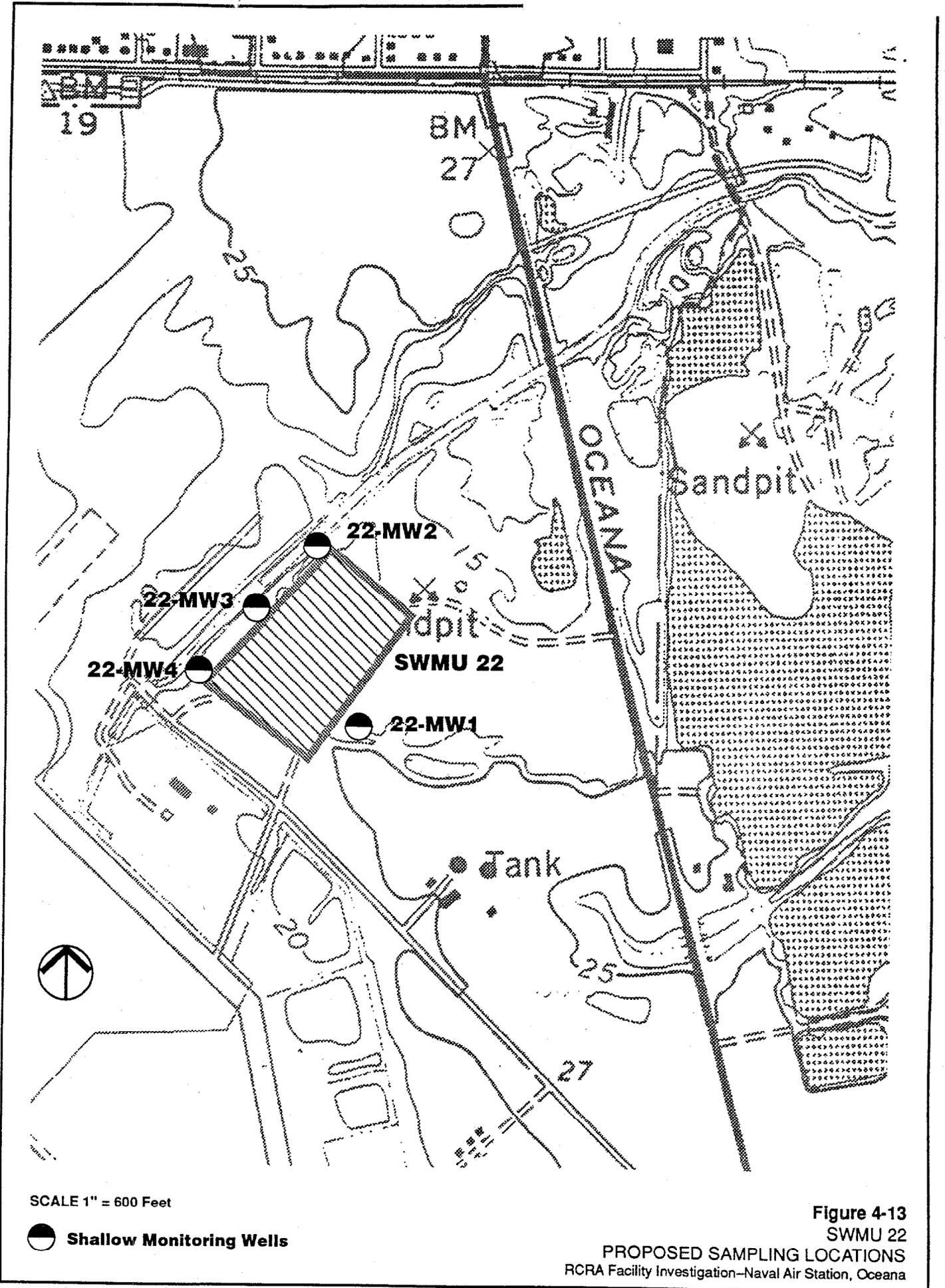
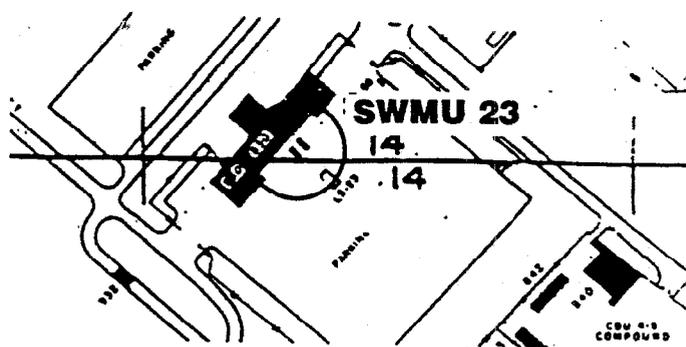


Figure 4-13
SWMU 22

PROPOSED SAMPLING LOCATIONS
RCRA Facility Investigation—Naval Air Station, Oceana

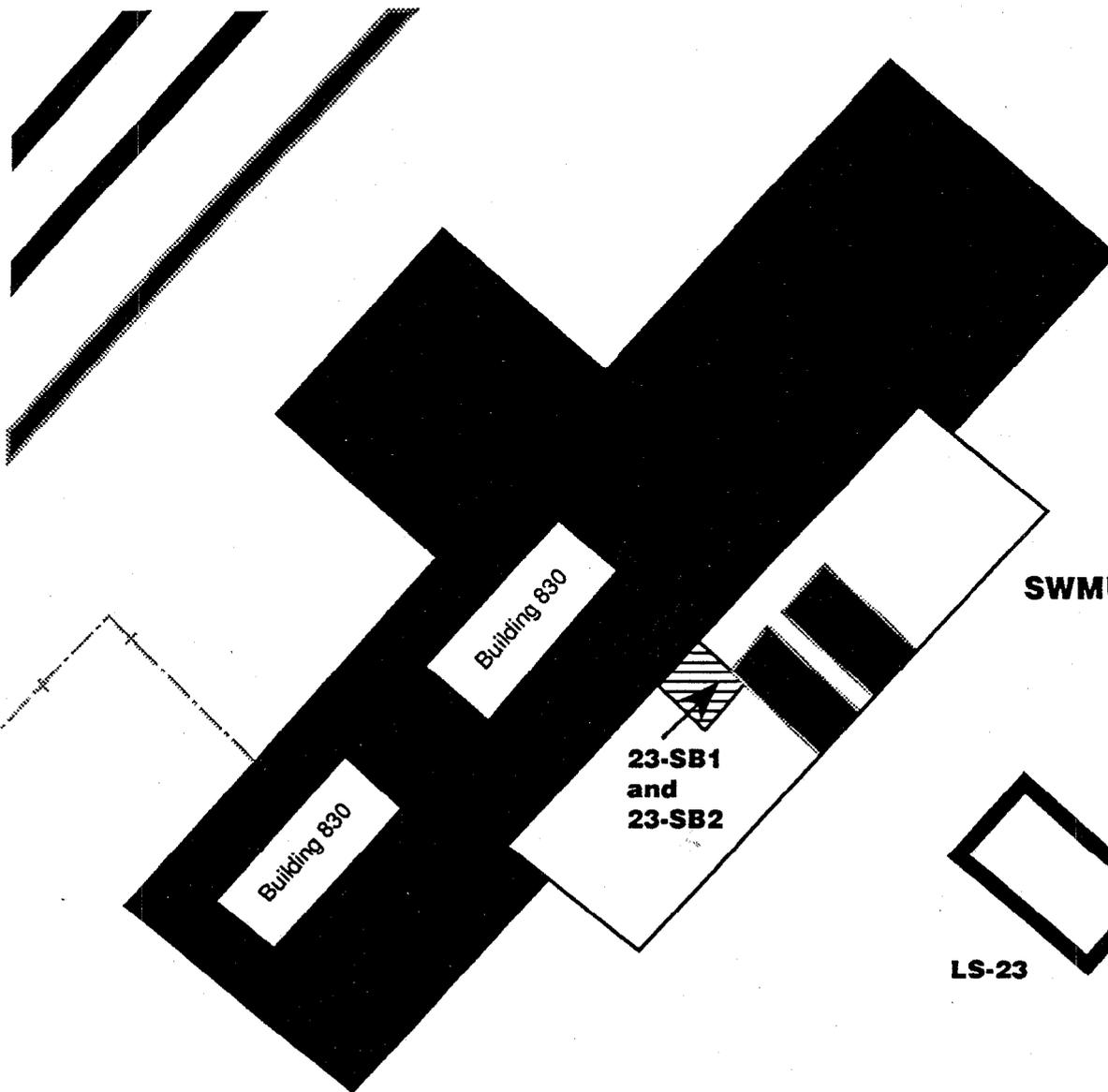
Source: General Development Map - Existing Sectors 1-12, revised 1985, U. S. NAS Oceana



Scale: 1" = 400'

Location Map

Scale: 1" = 50'



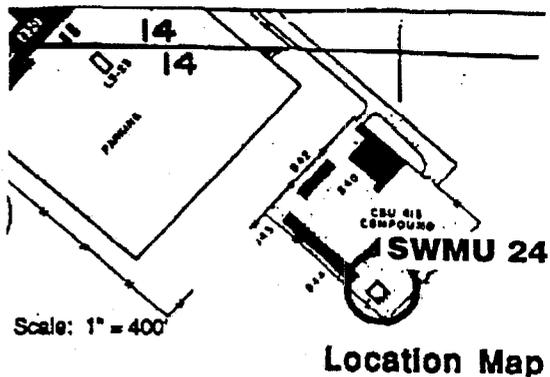
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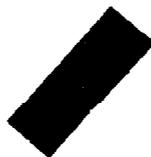
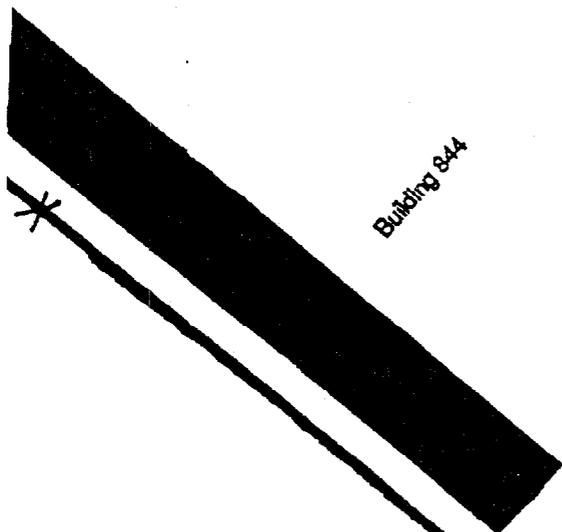
Approximate SWMU Location

Figure 4-14
 SWMU 23
 PROPOSED SOIL SAMPLING LOCATIONS
 RCRA Facility Investigation—Naval Air Station, Oceana

Source: General Development Map - Existing Sectors 1-12, revised 1985. U. S. NAS Oceana



CBU 415 Compound



SWMU 24
24-SB1
and 24-SB2



Scale: 1" = 50'



Legend

 Approximate SWMU Location

Figure 4-15
SWMU 24 - BOWSER, BLDG. 840
PROPOSED SOIL SAMPLING LOCATION
RCRA Facility Investigation-Naval Air Station, Oceana

pesticides, and PCBs. The remaining surface water and sediment sample will be analyzed for Appendix IX parameters. This information, together with the depth measurements of the pond, will provide information on shallow groundwater. A map of the pond was shown in Chapter 2 (see Figure 2-25).

Sample Collection Procedures

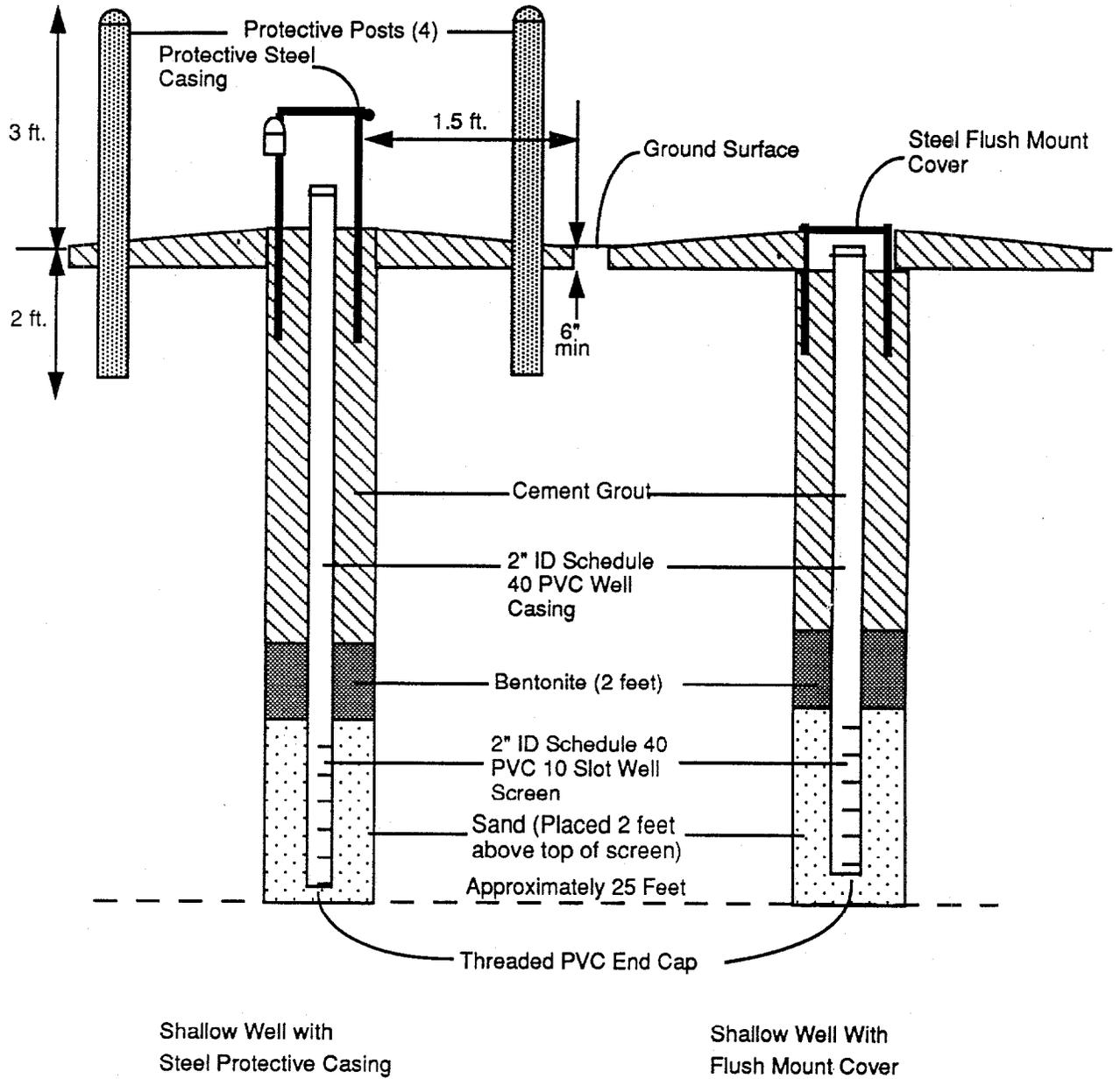
Monitoring Well Installation

Groundwater samples will be collected from monitoring wells installed in previous investigations and from those installed during the RFI. The discussion below focuses on the drilling methods, construction materials, and well development procedures for the monitoring wells.

Drilling Methods

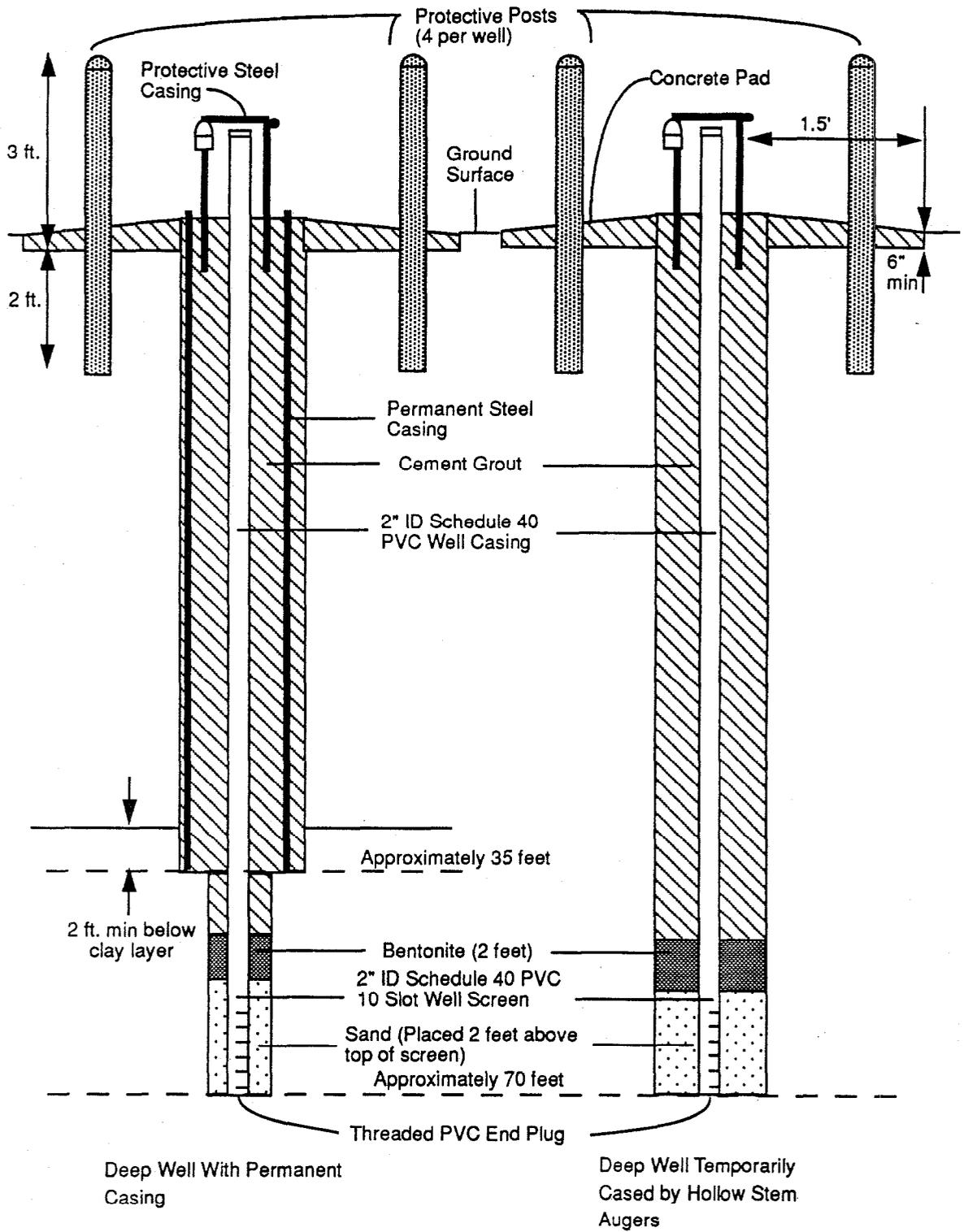
Boreholes for the shallow monitoring wells will be drilled using a minimum 6-inch-inside-diameter (ID) hollow-stem augers. The drilling will be performed by either a truck or trailer-mounted drilling rig, except possibly at SWMU 1 and SWMU 15 where an ATV-mounted rig will likely be required. During drilling, 18-inch split spoon samples will be collected on 5-foot intervals. The sediment lithology and geotechnical characteristics will be recorded, as will other observations such as apparent depth to water, moisture content, and drilling resistance. The boreholes will be advanced to approximately 25 feet below the ground surface, or approximately 15 feet below the water table. Ten-foot segments of screen will be installed from approximately 5 to 15 feet below the apparent water table, using 2-inch 0.010-slot threaded PVC casing and screen. The monitoring wells will be constructed inside the augers which will be raised progressively as soil, bentonite, and grout are added to the borehole. Drill cuttings will be placed in metal drums, which will be sealed and labelled.

Boreholes for the deep monitoring wells will be drilled in two stages. Hollow-stem augers will be used to drill to the top of the Yorktown Aquifer at a depth of approximately 35 feet. The Yorktown is described locally as a silty sand rich in shell fragments and overlain by a distinct layer of blue-green marine clay. If a confining layer (as determined by lithology, e.g., clay or silty clay of relatively low permeability) is encountered above the Yorktown, the permanent casing will be installed through the overlying shallow aquifer. If a confining layer is not encountered, then drilling will continue until the borehole is advanced a minimum of 20 feet into the Yorktown, using either hollow-stem augers or air rotary drilling technique. Typical construction diagrams for the shallow and deep monitoring wells are shown in Figures 4-16 and 4-17.



NOT TO SCALE

Figure 4-16
SCHEMATIC DIAGRAM OF SHALLOW
MONITORING WELL CONSTRUCTION
RCRA Facility Investigation—Naval Air Station, Oceana



NOT TO SCALE

Figure 4-17
SCHEMATIC DIAGRAM OF DEEP
MONITORING WELL CONSTRUCTION
RCRA Facility Investigation-Naval Air Station, Oceana

Construction Materials

The monitoring wells will be constructed of 2-inch ID Schedule 40 PVC well pipe and screen. The screen length will be 10 feet with 0.01-inch slots. At most of the SWMUs, the top of the screen will be placed approximately 5 feet below the apparent water table in the shallow wells and a minimum of 10 feet into the Yorktown in the deep wells. Screen placement is designed to determine whether dissolved contamination is migrating away from the SWMU. Concentrations from wells screened near the water table can also be used to judge whether floating free product is present above the water table. At SWMU 1, where fuels were disposed, the screens will be placed across the water table to intercept possible floating free product hydrocarbons and, therefore, will be 15 feet in length. All well piping and screen will be joined by threaded, flush-joint connections; no glues or solvents will be used in well construction. The annular space between the well and the borehole will be backfilled with No. 1 clean sand throughout the screened interval; this sand pack will extend to approximately 2 feet above the screen. Past lithologic analysis of sediments within the screened zone suggests that the combination of No. 1 sand and 0.01-inch slots will filter out the sediments effectively. A bentonite seal with a thickness of two feet will be placed above the sand pack. The remaining annular space will be grouted to the surface with a cement/bentonite mix with approximately 4 lbs of powdered bentonite per bag of cement. The grout will be added to the annulus using a tremie pipe with a side-flow outlet if the depth to bentonite is greater than 4 feet. A steel protective casing will be set into the grout. The casing will have a locking cap to restrict access to the monitoring well.

The wells will be completed above grade with a 3- to 3.5-foot diameter concrete pad and four guard posts except those wells installed in high vehicle traffic areas. In these areas, the wells will be completed below grade with flush-mounted steel covers for protection.

Well Development

Following construction, each well will be developed to remove residual fine-grained material from around the sand pack. All development equipment will be decontaminated prior to use in each well. Well development will be accomplished by first surging water into and out of the screened portion of the well with a surge block. Following this step, the wells will be pumped to remove sediment that has entered the well during surging. The discharge will be monitored to detect a reduction in the turbidity of the purge water with successive surge and pump cycles. The wells will be pumped until the discharge water is determined to be relatively free of suspended solids. The wells will be pumped using either a submersible pump, a vacuum pump, or a positive displacement pump. Development water will be contained in cases that pose an unacceptable risk to human health and the environment.

Groundwater Sampling

The following paragraphs describe the groundwater sampling procedures for sampling from monitoring wells that will be implemented.

Measurement of Static Water Level Elevation

Measurements of static water level elevations are used to calculate water volumes in the well. They are also used to determine groundwater hydraulic gradients, which in turn can be used to predict groundwater flow directions and velocities. Water-level measurements will be recorded to the nearest 0.01 foot using electronic probes.

Purging

Standing water will be purged from the well, to allow sampling of groundwater directly from the aquifer. The deep wells will be purged using an internal air displacement pump; a positive displacement bladder pump will be used to purge the shallow monitoring wells. The pump will be decontaminated between each well in accordance with EPA-approved procedures outlined in this chapter and Section 5 of the DCQAP in Appendix A. The purge pump intake will be placed in the monitoring well approximately at the top of the screened interval. The purging procedure will be as follows:

- Calculate the volume of water in the well.
- If free product, either DNAPL or LNAPL, is present, its thickness will be measured using an electronic interface probe. This probe is based on an audible signal and includes a precisely-ruled measurement tape. Free product, if present, will be sampled using a disposable bailer.
- Start the pump and collect the discharge in a graduated container for volume measurements. Measure the following field parameters after each well volume of purged water or after the well has recharged from being pumped dry: pH, specific conductivity, and temperature. Calibrated electronic meters will be used to measure parameters. An in-line parameter measurement box will be used. Sampling will occur after the parameters have been stable to within 10 percent for at least three well volumes, or until the well has been purged dry. If the water level falls below the pump intake, the pump will be lowered 2 or 3 feet. Parameter measurements and well volumes will be recorded in the log book. If the well goes dry before three volumes are obtained, sampling will occur when the well has recovered sufficiently to collect the volume needed.

- In shallow wells, purging and sampling will be performed with the same positive displacement bladder pump. The effective flow rate of this pump is approximately 1 liter per minute or less. In deep wells, purging with the internal air displacement pump will continue until parameters are stable for three well volumes. The effective rate of this pump is approximately 1 gpm or less. Because most deep screens will be 20 to 40 feet below the water surface, cascading down the screen is not expected. Deep sampling will be done with the positive displacement pump after the parameters have restabilized to the values recorded during purging.
- Purge water will be contained in cases that pose an unacceptable risk to human health or the environment.

Sample Collection

Groundwater samples will be collected from all of the monitoring wells using a submersible bladder pump, except free products wells, which will be sampled with a disposable bailer. Sampling will generally proceed from lowest to highest contamination zones within each SWMU area. Sampling will be from the top of the screened zone. The pump rate will be adjusted according to the sample being collected. When VOC samples are being collected, the pump discharge will be adjusted using valves on the control box to achieve a flow rate low enough to fill the VOC bottles without aerating the sample (approximate flow rate of 100 ml/min). The VOC bottles will be checked for air bubbles, and refilled if any bubbles are present. Samples collected for the analysis of other parameters will not require flow rate adjustments. Samples collected for metal analysis will be field-filtered prior to preservation. Metal samples will be filtered through a disposable 0.45-micron filter. An unfiltered total metals sample will also be collected. Sample collection details not specified here will generally conform to descriptions set forth in Section 5 of the DCQAP. At the Site 1 well sampled for free product, the bailer will be lowered to the bottom of the well to sample possible DNAPL contamination.

Surface Water Sampling

Surface water samples will be collected by dipping clean sampling containers directly into the surface water to be sampled. Samples will be collected from 5 cm below the water surface. The VOC samples will be collected first so that the sampled water is as undisturbed as possible. The VOC samples will be collected with as little agitation as possible. Other samples will then be collected in the appropriate containers supplied by the laboratory. If the water is too shallow for the larger bottles, samples will be collected by repeated filling of a smaller sampling container and transferring to the larger sample bottle. Sampling will proceed downstream to upstream locations.

Sediment Sampling

Sediment samples will be collected directly below the point where surface water samples were obtained. Selection of sampling instruments will depend on the depth of the sediment surface. At locations where the surface water is less than 5 feet deep, a decontaminated stainless steel hand auger will be used to obtain sample material. The auger head type (sand, clay, peat) will be selected according to the type of sediment encountered. At locations where the sediment surface is more than 5 feet deep, a Ponar dredge will be used to trap and retrieve sediments to the surface. The Ponar dredge consists of two stainless steel, spring-loaded jaws that re-set against a retracting pin. The impact of the dredge on the sediment surface releases the pin allowing the jaws to close, trapping up to 30 ounces of soft sediment. The dredge and sample material are retrieved to the surface on a rope. Sediment sampling will proceed from downstream to upstream locations.

VOC samples will be collected immediately upon retrieval from the hand auger or dredge. Remaining sample material will be homogenized in a decontaminated stainless steel tray. Sample bottles will then be filled with homogenized sediment.

Soil Sampling

Most soil samples will be collected from a depth of 1 to 2 feet using a stainless steel hand bucket auger. Actual sampling depths are specified in the individual site sections in this chapter. The samples will be transferred from the auger to the sample containers with as little disturbance as possible, using stainless steel implements. In areas where soil samples are to be collected from locations below concrete or asphalt, the latter will be cored or hammered prior to collecting the sample. At Site 1, deep borings will be collected by split spoon sampling inside small diameter hollow stem augers or by using the Geoprobe® sampler as described in the drilling methods section.

In-Situ Groundwater Sampling

In-situ grab samples of groundwater will be collected by driving an approximate 1-inch-diameter drive point to 10 feet below the water table. A slotted drive point tip will allow groundwater to migrate into the drive point shaft. The groundwater will then be extracted and analyzed by the field laboratory. The small hole will be backfilled, if appropriate, upon removal of the drive point.

Sample Preservation and Handling

In the time between sample collection and laboratory analysis, the concentration and distribution of constituents in the sample could be altered by contamination, reaction, degradation, volatilization, sorption, and other processes. Sampling and handling procedures specify the type of container to use for specific analyses, proper temperature control, pH control, any chemical addition to minimize changes in the concentration or

distribution of constituents, and maximum acceptable sample holding times between collection and analysis. The sample handling and analytical methods will conform to EPA document SW-846, *Test Methods for Evaluating Solid Wastes (EPA, 1986b)*. All field samples will be shipped within 24 hours of collection by overnight Priority 1 air express so they will reach the laboratory within their respective holding times. Further details of these processes are presented in the DCQAP (Appendix A).

Hydraulic Conductivity Tests

In-situ hydraulic conductivity tests will be performed at six wells at Site 1. In general, each well tested is subjected to a rapid (in theory, instantaneous) drop or rise in water level. The subsequent change in the water level is then recorded on a datalogger until the water level has recovered to near the original static elevation. The water-level data are then input to formulas, the solutions of which are approximate values of hydraulic conductivity. The results will be analyzed according to the method of Bouwer and Rice (1976), or Cooper et. al. (1967).

Decontamination Procedures

Sampling Equipment

To prevent cross-contamination between samples, sampling equipment (pumps, bailers, spatulas, split spoons) will be cleaned using the following method:

1. Wash and scrub with non-phosphate detergent.
2. Rinse with 10 percent methanol solution.
3. Rinse with a 10 percent hexane solution
4. Rinse with tap water.
5. Rinse with distilled/deionized water.
6. Air dry thoroughly.
7. Wrap in aluminum foil, shiny side out, for transport.

To prevent cross-contamination between wells, all drilling equipment introduced into the boreholes, well screens, and casing materials will be thoroughly cleaned with high-pressure hot water after use at that site. Thick accumulations of drill cuttings will be removed from the equipment before decontamination; this soil will be contained. Wastes derived from the drilling boreholes will include drill cuttings, drilling fluid, protective clothing, and other contaminated materials.

During decontamination, drilling equipment and tools will be placed on plastic sheeting on the ground after the main thickness of soil has been removed and placed in containers at the borehole. Soil residues on the equipment will be washed off with the jetted hot water and will settle onto the sheeting. A cloth will be placed downslope

from the equipment to trap suspended solids. Rinse water will be allowed to run through the cloth and off the sheeting and will not be contained. All sheeting, cloth, and soil residues from the decontamination at each well site will be contained and sealed in labelled drums. The decontamination of drilling equipment from each well will be done within a 50-foot radius of each well or, in the case of Site 1, in the area west of the unpaved access road, so as to be upgradient from the disposal pit area. The decontamination area will be different for each well, the intention being to avoid concentrating the estimated 30-50 gallons of rinse water per well in one location. This rinse water is assumed not to be a RCRA hazardous waste.

No drilling, sampling, or excavation wastes will be removed from the site. Drill cuttings, cloth, decontamination sheeting, and protective clothing will be drummed. These wastes will be stored temporarily at each site and will be handled as part of the final remedy at each site.

Drums will be labeled according to contents and assembled at a central secure area adjacent to each SWMU following drilling. Drum lids will be secured with lug bolts. To determine the hazardous nature of drum contents, several representative samples may be collected from each group of drums and submitted for analysis.

Personnel

Onsite personnel will follow the procedures outlined below at the designated decontamination area prior to leaving the work site: (1) drop equipment; (2) remove and dispose of boot covers; (3) wash boots; (4) wash and remove outer gloves; (5) remove and dispose of inner gloves; (6) remove boots; (7) remove SCBA or APR; (8) wash and rinse facepieces; (9) remove and dispose of inner gloves; (10) wash hands and faced. Cleaning liquid will be 0.5 pounds of trisodium phosphate and sodium carbonate (1:1) mixed with 1 gallon of water, followed by a fresh water rinse. SCBAs or APRs will be washed in MSA sanitizer, rinsed in water, or cleaned with MSA wipes.

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Chapter 5 Data Management Plan

The data management plan details the procedures for inventory, control, storage, validation, evaluation, and presentation of data during the RFI at NAS, Oceana.

A large variety of technical data will be generated during the course of the RFI. A data management program will be designed so that the integrity of the data is maintained and can be used in any future related or nonrelated study. Project tracking data, schedules, progress reports, and field notes will be maintained to monitor, manage, and document the progress of the RFI.

Data Record

Data from past investigations and from the RFI will be compiled and summarized in tables.

The following information will be included in the tables:

- Sample location number
- Date of each sample
- Parameters measured
- Results of analyses or measurements
- Reporting units
- Explanatory footnotes

All incoming data and reports will be logged and dated. All information generated from field activities will be documented on appropriate forms, including the following:

- Boring logs
- Chain-of-custody record
- Field books
- Location sketch
- Photograph log
- Sample container inventory
- Telephone conversation log

Incoming documents will be filed. If distribution is required, the appropriate number of copies will be made and distributed to project personnel. In addition, all notes from project meetings and telephone conversations will be filed along with other project documents.

Data Validation

Data validation entails a review of the quality control (QC) data and the raw sample data to verify that the analytical laboratory has operated within the required control limits, the analytical results are correctly transcribed from the instrument readouts, and which, if any, natural samples are related to any out-of-control laboratory QC samples. The objective of the data validation is to identify any qualitative, unreliable, or invalid laboratory measurements. If anomalies are discovered while reviewing laboratory data, the validation contractor will require additional written documentation from the laboratory as necessary.

The data validation process consists of a review of the following: laboratory holding times, instrument tuning and calibration, blanks, field duplicates, surrogate recovery, matrix spike/matrix spike duplicates, internal standards performance, system performance, and reported detection limits.

The laboratory responsible for analyzing the samples will send the analytical data to the validation contractor who will validate the analytical data using EPA protocols, (*Laboratory Data Validation Functional Guidelines for Evaluating Organics and Inorganics Analyses* and *U.S. EPA Region III Functional Guideline Modifications*), and data validation procedures reported in *Sampling and Analysis Quality Assurance Requirements for the Navy Installation and Restoration Program*. Region III will be contacted to verify that the most current version is being used before conducting the data validation.

Facility Maps

A number of sitewide and SWMU-specific facility maps will be generated from the RFI. The following maps will be included in the RFI reports, as appropriate:

- Topographic map of entire facility
- General base map describing important facilities and potential receptors
- Study area maps
- Site-specific ecosystem maps
- Sampling and field measurement location maps
- Cross section maps
- Structure contour map of several important hydrogeologic units
- Spyder maps of spatial distribution of contaminant concentrations
- Isopach maps

Tabular Displays

Tables will be used to display a wide variety of data including the following:

- Analytical data summaries
- Well construction information
- Well development information
- Survey information
- Hydraulic conductivity data

Graphical Displays

Data that can be analyzed spatially or with time will be displayed in graphic form. Some of the figures anticipated for the RFI include:

- Cross sections
- Hydrographs of tidal data
- Hydrographs of monthly water level data
- Contaminant concentrations versus depth
- Flownets

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Chapter 6 HEALTH AND SAFETY PLAN

This plan will be kept onsite during field activities and will be reviewed and updated as necessary. This plan adopts, by reference, the standards of practice (SOP) contained in the CH2M HILL *Waste Management and Industrial Processes Discipline Health and Safety Manual, Volumes 1 and 2*, and other applicable CH2M HILL SOPs as appropriate. The Site Safety Coordinator (SSC) is to be familiar with these SOPs. In addition, this plan adopts procedures contained in the work plan for the project.

1.0 PROJECT INFORMATION AND DESCRIPTION

CLIENT: <u>Atlantic Division, NAVFACENGCOM</u>	PROJECT NO: <u>WDC32160.A0.01</u>
PROJECT MANAGER: <u>Doug Dronfield</u>	OFFICE: <u>Reston, Virginia</u>
SITE NAME: <u>Naval Air Station, Oceana</u>	
SITE ADDRESS: <u>Oceana, Virginia</u>	
DATE HEALTH AND SAFETY PLAN PREPARED: June, 1992	
DATE(S) OF INITIAL VISIT: 1986	
DATE(S) OF SITE WORK: Summer 1992	
SITE ACCESS: Controlled by gates, security patrols	
SITE SIZE: 5,000 acres	
SITE TOPOGRAPHY: Flat	

1.1 Facility Description

The NAS Oceana is a 5,000-acre complex in Virginia Beach, Virginia (see Site Map, Attachment A). The base employs 11,000 people and primarily maintains and operates facilities to support Naval aviation. Altitudes range from about 5 to 25 feet above mean sea level. Windy conditions are common. Drainage from the NAS is aided by a system of canals which direct surface runoff off base to nearby lakes or streams.

The water table aquifer (Columbia Group) occurs near ground surface in the area and extends to a depth of 20 to 25 feet. Some limited use of the shallow aquifer for water supply may occur. Near Oceana the underlying Yorktown Formation is used for potable supply. The Yorktown Formation extends from approximately 20 to 150 feet below land surface.

Nineteen Solid Waste Management Units (SWMUs) have been identified as having known or potential environmental releases and will be investigated in this study. Some SWMUs have been combined for the RFI due to their proximity to

each other, leaving the number of areas to be investigated at 17. Each site is described briefly below:

- **SMWU 1, West Woods Oil Disposal Area** is located near abandoned Runway 9 on the west side of the NAS. Waste oil, fuel, and other aircraft maintenance chemicals were disposed here from the mid 1950s to the late 1960s. An estimated 100,000 gallons of these liquid wastes were disposed in the 25-foot diameter pit. Oil displaced by flood waters in the late 1960s contaminated properties off base; therefore, the pit was filled in with soil. Possible wastes deposited in the pit include fuels (JP-5, JP-3, and AVGAS), oils, PD 680, paints, and various stripping and degreasing agents, including trichlorofluoromethane, benzene, toluene, and naphtha. A drainage ditch is located 250 feet away, downgradient. Chemicals found in the groundwater during previous investigations include PCBs, TPH, oil and grease, and total xylenes. Chemicals found in the sediment/surface water include TPH, Methylene Chloride, and methylethyl ketone (MEK).
- **SWMU 2b, Line Shack Oil Disposal Area** is located near Buildings 130 and 131. The buildings, constructed in 1963, were used as aircraft maintenance and cleaning stations. According to the IAS, until the early 1980's, waste oils and cleaning chemicals were deposited onto the ground adjacent to the buildings. Chemical data from previous investigations indicated that chlorinated hydrocarbons such as vinyl chloride (VC) and trichloroethylene (TCE), among others, were present in the groundwater. Surface water from a nearby drainage ditch showed elevated concentrations of total petroleum hydrocarbons (TPH) and volatile organic compounds. Soils sampled at this SWMU revealed the consistent presence methylene chloride and acetone, as well as the presence of other compounds such as MEK (2-butanone), carbon disulfide, and trichloroethylene. Other wastes of concern include oil, hydraulic fluid, PD 680, and aromatic hydrocarbons (naphtha, benzene, toluene, phenol, and derivatives) which are or have been commonly used in aircraft maintenance for lubrication, paint stripping, and grease removal.
- **SWMU 2c, Line Shack Oil Disposal Area** is adjacent to building 400 and bounded by buildings 301, 401, and 404. These structures, built in 1963, were used for aircraft maintenance and cleaning. Various chemicals were poured directly onto the ground surface until the early 1980's when the area was covered with concrete, (RGH, 1984). Contaminants found in the groundwater at this site include 1,2-DCE, TCE, VC and TPH. Other wastes of concern include oil, hydraulic fluid, PD 680, and aromatic hydrocarbons (naphtha, benzene, toluene, phenol, and derivatives) which are or have been commonly used in aircraft maintenance for lubrication, paint stripping, and grease removal.

- **SWMU 2d, Line Shack Oil Disposal Area** consists of the area in the immediate vicinity of building 125. The building was also used for aircraft maintenance and cleaning and was constructed in 1963. The soil surrounding the building was found to be saturated to a depth of approximately six feet (RGH,1984). Previous investigations showed that DCE, DCA, TPH and total xylenes were present in the groundwater.
- **SWMU 2e, Line Shack Oil Disposal Area** located between Line Shack 109 and Hangar 23, and the **Hazardous Waste Storage Area** at Hangar 23 have been grouped together as an area of concern in the May 1991 Consent Order from the EPA due to their close proximity and will be considered as such.

Line Shack 109, built in 1963, was used for aircraft maintenance and cleaning, and has been identified as an area where waste chemicals have been discarded onto the ground surface. During previous investigations, TPH was found in soil and groundwater samples taken in this area. Other wastes of concern are oil, hydraulic fluid, PD 680, and aromatic hydrocarbons (naphtha, benzene, toluene, phenol, and derivatives) that are or have been commonly used in aircraft maintenance for lubrication, paint stripping, and grease removal.

The area adjacent to Hangar 23 is currently used as a less than 90 day hazardous waste storage area for approximately five to ten drums. The storage area is fenced in and is locked. Hazardous waste at NAS Oceana includes double bagged oil cans, paint cans, and oily rags; and drums of oil, paint thinner and paint remover. In addition, jet fuel, solvents, asbestos, PD 680, hydraulic fluid, freon, neutralized battery acid, and electric coolant oil were also stored at this SWMU.

- **SWMU 11, Fire Fighter Training Area.** This site is an area on abandoned Runway 18-36 on the west side of the base, where waste fuels are burned to train fire fighters. The general area has been used since the early 1960s. Until the mid 1970s, fires were set by pouring waste petroleum, oils, and lubricants (POLs) and other hazardous wastes (paints, thinners, strippers, PD 680, naphtha, trichlorotrifluoroethane) amounting to 7,500 gallons per year directly on the runway. More recently, fires of about 50,000 gallons per year were set in an earth-bermed circle constructed to contain the fires and prevent loss of unburned POLs. The Fire Prevention Branch monitors the level of liquid in the pit and pumps out the water phase when the unburned fuel floating on the water threatens to overtop the berm. In 1986, a new fire fighting ring was constructed. It is connected directly to an oil/water separator which, if properly maintained, should further safeguard against loss of POL and contamination of the groundwater. Chemicals detected in the soil at this

SWMU include lead, TPH, methylene chloride. TPH was also detected in the groundwater.

SWMU 15, Abandoned Tank Farm is located north of Runway 23R and east of the old CPO club at North Station. Two concrete 50,000 gallon tanks (G-5,G-6), numerous smaller above ground tanks (RGH, 1984), one 500,000 gallon above ground storage tank (G-9) and at least two buried lines exist at the Abandoned Tank Farm. Tank G-5, and G-6, originally were used to store aviation gas. They were emptied when the North Station was decommissioned. G-5 was later used to store waste oil and fuel which may have included PD 680, naphtha, and chlorinated and aromatic hydrocarbons, such as dichlorodifluoromethane, toluene, benzene, and their derivatives. According to IAS G-5 is no longer used to store waste oils but may contain approximately 5,000 gallons of oil. Leakage from the tanks and underground lines have also be reported at the abandoned tank farm.

SWMU 16, Pesticide Storage Area is located at building 821, the pesticide storage building. Rinse water from the pesticide mixing tank was discharge directly to the ground around the building 821 between 1968 and 1982. About 2,000 pounds of active ingredients of various pesticides were mixed at this site each year, though less than thirty pounds were discharged directly to the ground not including equipment rinsing. Pesticides used at this location include 2,4-D; 2,4,5-T; baygon heptachlor, malathion, dursban, nibaryl, aldrin, chlordane, bromacil, warfarin, and DDT (RGH, 1984).

SWMU 18, Hazardous Waste Storage Area, located near building 204, is a small drum storage area. This hazardous waste storage area has existed for at least ten years, and was in active use at time of the VSI and soil staining was observed during the inspection. Materials typically stored at this SWMU may include double bagged empty oil cans, paint cans and oily rags; drums of oil, paint thinner, paint remover, jet fuel, solvents, asbestos, PD 680, hydraulic fluid, freon, neutralized battery acid, and electric coolant oil. The storage area is fenced and locked.

SWMU 19 and SWMU 20, Waste Oil Storage Areas, are located near buildings 541 and 543, respectively. Waste oil stored in 55-gallon drums were found at these SWMUs. Heavy soil staining and dead grass were observed at both SWMUs during the VSI. The waste oil, generated from automotive and engine repair, may include waste motor oil, hydraulic fluid, automatic transmission fluid, and solvents (RFA, 1988).

SWMU 21, Transformer Storage Yard, located behind building 830, is an open yard used to store six used transformers (3.75 kw) on pallets. Two

of the transformers were leaking electrical oil during visual inspection, and dead vegetation was found downslope of the yard. Polychlorinated biphenols (PCBs) may be present in the oil.

SWMU 22, Construction Debris Landfill, is located west of the intersection of South First Colonial Road and Oceana Boulevard. The unlined landfill is approximately 0.5 acres and was in active use at the time of the VSI. The age of the landfill is unknown, but was first discovered in 1986 (RFA, 1988). The landfill may contain, but is not limited to, construction debris, furniture, empty paint and paint thinner cans, tires and scrap metal. Compounds associated with leachate derived from this SWMU may be numerous and varied.

SWMU 23 and SWMU 24, Bowers, are located near buildings 830 and 840, respectively. The 500 gallon bowzers are used to collect wastes generated at each location. According to the RFA, SWMU 23 collects waste motor oil. Approximately 1,500 to 2,000 gallons of waste oil are generated each year, and are then transported to the Fuel Division Storage Yard for transfer to storage tanks. Building 830 has been in use since 1954, and may have generated wastes since that date. SWMU 24 collects waste motor oil and solvents generated during equipment maintenance. The bowser is taken to the tank farm for disposal of the waste (RFA, 1988). The building has been in use since 1972, and may have generated wastes since then.

SWMU 25, Inert Landfill, located north of Potters Road, is approximately 26 acres in size. The unlined landfill was originally a borrow pit for the construction of Interstate 44. After filling with water, the pit became the local dump, and the property was purchased by NAS Oceana in 1979. NAS Oceana then obtained a permit from the Virginia Department of Health to use the borrow pit as a disposal for inert solid waste. The contents of the debris deposited before 1979 is unknown.

SWMU 26, Fire Fighting Area, is a fire fighter training burn pit located behind building 220, the fire station. It is a gravel covered depression used for portable fire extinguisher training. Waste POL and fuel contaminated booms are placed in the pit and ignited. Visible staining was observed in the pit area and extended to a nearby drainage ditch. The ditch is broad and shallow and is not a confined space.

Features and Unusual Features (water supply, telephone, radio, power lines, gas lines, watermains, terrain, etc.):

Locations of buried utilities (electrical, telephone, steam lines, and jet fuel lines) will be determined by the base prior to the beginning of drilling. These locations will be verified by CH2M HILL personnel using a metal detector. Avoid overhead wires when erecting the drill rig mast. Ensure that base personnel are aware of mast height and location to avoid conflict with low level take-off and landing patterns. Drilling operations near the Line Shacks at Oceana may be dependent on aircraft operations. Be aware of exhaust and noise from engine static tests, engine runups, or taxiing aircraft. The crossing of active runways is not anticipated. Air Operations (AirOps) can be reached at 433-2841.

Status (active, inactive, unknown):

Active military base.

History (worker or non-worker injury; complaints from public; previous agency action):

NAS Oceana was commissioned in 1943. The NAS Oceana is a master jet base intended to maintain and operate facilities to support Naval aviation. An Initial Assessment Study (IAS) of the base was completed in December 1984 by Rogers, Golden, and Halpern (RGH). The Round 1 Verification Step of the Confirmation Study, completed in 1986, was conducted by CH2M HILL to examine sites recommended by the IAS as needing further study. Other than offsite migration of oil in flood waters at Oceana (West Woods Disposal Pit), there have been no complaints or agency actions against the bases from disposal operations.

No worker injuries or complaints from the public are known.

2.0 TASKS TO BE PERFORMED UNDER THIS PLAN

The purpose of the field work at Oceana NAS is to obtain the data identified in the RFI workplan. The tasks to be performed under this task include: drilling and installation of monitoring wells, groundwater sampling at new and existing monitoring wells, soil sampling, sediment sampling, and surface water sampling.

Soil borings will be hand augered at each sample location. The depth of each boring will range from 6 to 18 inches. Sediment sample will be shallow samples, except for SWMU 25 where a Ponar dredge will be used. No specific hazards are associated with this dredge.

Groundwater samples will be collected with a bladder pump and surface waters will be collected by dipping clean sampling containers directly into the surface water.

3.0 HAZARD EVALUATION AND CONTROL

3.1 Known Chemicals of Concern

Table 1 lists the known site contaminants and their symptoms and effects of acute exposure.

3.2 Heat and Cold Stress

Site personnel may be required to work in temperature extremes. Please refer to Table 2 for guidelines for working in temperature extremes.

3.3 Physical (Safety) Hazards

Site personnel may be exposed to a variety of physical (safety) hazards. Refer to Table 3 for a listing of these hazards, and engineering controls to abate them.

3.4 Hazards Posed by Chemical Substances Provided by CH2M HILL

In accordance with Virginia Hazard Communication regulations, Material Safety Data Sheets are provided for the following chemicals brought to the work site by CH2M HILL (Attachment B): Isobutylene (HNU calibration gas), pentane (explosimeter calibration gas), isopropyl alcohol, TSP, methanol MSA sanitizer/cleanser, nitric acid. The existence and location of these MSDSs must be disclosed to the client and any contractors or subcontractors in CH2M HILL's work area.

4.0 SITE PERSONNEL

4.1 Team Organization

<u>Team Member^a</u>	<u>Responsibility</u>
Steve Brown/WDC	Field Team Leader
April Lloyd/WDC	Site Safety Coordinator, Level D
April Lloyd/WDC	Site Safety Coordinator, Level C
Don Martinson/WCC	Team Member
Mike Showalter/WDC	Team Member
	Team Member

^aTeam members will be identified prior to RFI field activities.

**Table 1
KNOWN SITE CONTAMINANTS**

Known Contaminant	Highest Observed Concentration in Groundwater	PEL/TLV ^a	IDLH	Symptoms/Effects of Acute Exposure	Photo Ionization Potential
Vinyl chloride	2,000 ug/l	1 ppm	NL	Weak, abdom pain, GI bleeding, hepatomegaly; pallor or cyan of extremities; [carc]	9.99
1,2-Dichloroethane	47 ug/l	1 ppm	1,000 ppm	CNS depres; nau, vomit; derm; irrit eyes, corneal opacity; [carc]	11.05
Benzene	5 ug/l	1 ppm	3,000 ppm	Irrit eyes, nose, resp sys; gidd; head, nau, staggered gait, ftg, anor, lass; derm; bone marrow depres; [carc]	9.24
Toluene	3 ug/l	100 ppm	2,000 ppm	Ftg, weak; conf, euph, dizz, head; dilated pupils, lac; ner, musc ftg, insom; pares; derm	8.82
Ethyl benzene	8 ug/l	100 ppm	2,000 ppm	Irrit eyes, muc memb; head; derm; narco, coma	8.76
Pentachlorophenol	10 ug/l	0.5 mg/m ³	150 mg/m ³	Irrit eyes, nose, throat; sneezing, cough; weak, anor, low-wgt, sweat; head, dizz; nau, vomit; dysp, chest pain; high fever; derm	NL
Napthalene	3 ug/l	10 ppm	500 ppm	Eye irrit; head; conf, excitement, mal; nau, vomit, abdom pain; irrit bladder, profuse sweat; jaun; hema, hemog, renal shutdown; derm	8.12
m-Xylene	84 ug/l	100 ppm	1,000 ppm	Dizz, excitement, dron, inco, staggering gait; irrit eyes, nose, throat; corneal vacuolization, anor, nau, vomit, abdom pain; derm	8.56
(o-,p-)Xylenes	84 ug/l	100 ppm	1,000 ppm	Dizz, excitement, dron, inco, staggering gait; irrit eyes, nose, throat; corneal vacuolization, anor, nau, vomit, abdom pain; derm	8.56/8.44
Acetone	27 ug/l	750 ppm	20,000 ppm	Irrit eyes, nose, throat; head, dizz; derm	9.69
4-Methyl-2-pentanone	71 mg/kg	200 ppm	3,000 ppm	Narc, irrit eyes, skin, resp.	9.30
1,1,2,2-Tetrachloroethane	100 mg/kg	1 ppm skin	150 ppm	Nau, vomit, abdom pain; tremor fingers, jaun, enlarged tend liver; derm; monoc; kidney damage	11.10
bis(2-Ethylhexyl) phthalate	240 ug/l	5 ppm	NL	Irr-skin	NL
Chlorobenzene	7 ug/l	10 ppm	2,400 ppm	Irrit skin, eye, nose; drow, inco, in animal; liver, lung, kidney damage	9.07
Chloroform	4 ug/l	2 ppm	1,000 ppm	Dizz, mental dullness, nau, disorientation; head, ftg; anes; hepatomegaly; irrit eyes, skin; [carc]	11.42

8-8

^aLower value of PEL or TLV listed.

**Table 1
KNOWN SITE CONTAMINANTS**

Known Contaminant	Highest Observed Concentration in Groundwater	PEL/TLV ^a	IDLH	Symptoms/Effects of Acute Exposure	Photo Ionization Potential
1,2-Dichloropropane	47 ug/l	75 ppm	2,000 ppm	Eye irrit; drow, li-head; irrit skin; [carc]; in animals: liver, kidney disease; skin irrit	10.87
1,2,3-Trichloropropane	24 ug/l	10 ppm	1,000 ppm	Irrit eyes, throat; CNS depres, liver inj; skin irrit; [carc]	NL
2-Methylnaphthalene	7 ug/l	NL	NL	Irrit eye; head; conf; naus; vomit; abdom. pain; sweat; dermatitis	8.0
Lindane (BHC)	28 ug/l	0.5 mg/m ³ -skin	1,000 mg/m ³	Irrit eyes, nose, throat; head; nau; clonic convuls; resp difficulty; cyan, aplastic anemia; skin irrit; musc spasm; in animals; liver, kidney damage	NL
2-Chloroaniline	99 ug/l	NL	NL	Head; weak; dizz; cyan; irrit eye	7.9
2,4,6-Trichlorophenol	1,900 ug/l	NL	NL	Irrit eyes, nose, throat; weak; mus. aches; tremors	-8.5
Dinitrotoluene	700 ug/l	1.5 mg/m ³ -skin	200 mg/m ³	Anoxia; cyan; anemia; jaun; [carc.]	NL
2,4-Dinitrophenol	71 u/l	NL	NL	Head; fever; lass; sweat; thirst; cough; breath. diffic.	-9.0
Lead	1,000 mg/kg	.05 mg/m ³	700 mg/m ³	Weak, lass, insom; facial pallor, pal eye, anor, low-wgt, malnut; constip, abdom pain, colic; anemia; gingival lead line; tremor; para wrist, ankles; encephalopathy, nephropathy; irrit eyes; hypo-tension	NL
4,4-DDT	24 mg/kg	1 mg/m ³	Ca	Pares tongue, lips, face; tremor; appre, dizz, conf, mal, head, ftg; convuls; paresis hands; vomit; irrit eyes, skin; [carc]	NL
4,4-DDD	4.0 mg/kg		NL		NL
4,4-DDE	3.8 mg/kg		NL		NL
Chlordane	4.9 mg/kg	0.5 mg/m ³	500 mg/m ³	Blurred vision; conf; ataxia, delirium; cough; abdom pain, nau, vomit, diarr; irrity, tremor, convuls; anuria; in animals: lung, liver, kidney damage	NL
Heptachlor	0.8 mg/kg	0.5 mg/m ³	700 mg/m ³	In animals: tremors, convul, liver damage; [carc]	NL
Dieldrin	3.6 mg/kg	0.25 mg/m ³	450 mg/m ³	Head, dizz; nau, vomit, mal, sweat; myoclonic limb jerks; clonic, tonic convuls; coma; [carc]; in animals: liver, kidney damage	NL
Lindane (BHC)	1.0 mg/kg	0.5 mg/m ³ -Skin	1,000 mg/m ³	Irrit eyes, nose, throat; head; nau; clonic convuls; resp difficulty; cyan; aplastic anemia; skin irrit; musc spasm; in animals: liver, kidney damage	NL

6-9

^aLower value of PEL or TLV listed.

**Table 1
KNOWN SITE CONTAMINANTS**

Known Contaminant	Highest Observed Concentration in Groundwater	PEL/TLV ^a	IDLH	Symptoms/Effects of Acute Exposure	Photo Ionization Potential
Toxaphene	120 mg/kg	0.5 mg/m ³	200 mg/m ³	Nau, conf, agitation, tremors, convuls, unconscious; dry, red skin; [carc]	NL
Gasoline		890 mg/m ³	NL	Cough, conjunctiva irrit, conf, dermat, blistering of skin, CNS depres, pulm. edema	
Kerosene		100 mg/m ³	NL	Cough, nau, conf, drow, fever	
Arsenic	2,000 mg/kg	.01 mg/m ³	100 mg/m ³	Ulceration of nasal septum, dermat, GI disturbances; peri neur, resp irrit, hyper pig of skin, [carc]	NL

Notes:

NL = No limit found in reference materials.
 IDLH = Immediately dangerous to life or health
 TLV = Threshold limit value
 Ca = Potential human carcinogen
 PEL = Permissible exposure limit

abdom = Abdominal	depres = Depressant/depression	head = Headache	lass = Lassitude	opac = Opacity
anes = Anesthesia	derm = Dermatitis	hemato = Hematopoietic	li-head = Lightheadedness	para = Paralysis
anor = Anorexia	diarr = Diarrhea	hemog = Hemoglobinuria	low-wgt = Weight loss	pares = Paresthesia
appre = Apprehension	dizz = Dizziness	inco = Incoordination	mal = Malaise	peri neur = Peripheral neuropathy
[carc] = Carcinogen	drow = Drowsiness	inj = Injury	malnut = Malnutrition	pig = Pigmentation
CNS = Central nervous system	dysp = Dyspnea	insom = Insomnia	monocy = Monocytosis	resp = Respiratory
conf = Confusion	euph = Euphoria	irrit = Irritation	musc = Muscle	sweat = Sweating
constip = Constipation	ftg = Fatigue	irrity = Irritability	narco = Narcosis	sys = System
convuls = Convulsions	GI = Gastrointestinal	jaun = Jaundice	nau = Nausea	tend = Tenderness
cyan = Cyanosis	gidd = Giddiness	lac = Lacrimation	ner = Nervousness	vomit = Vomiting
				weak = Weakness

Source:

Guide to Occupational Exposure. American Conference of Governmental Industrial Hygienists (ACGIH). 1991. Cincinnati, Ohio.

Pocket Guide to Chemical Hazards. National Institute for Occupational Safety and Health (NIOSH). 1990. Department of Health and Human Services.

POTENTIAL ROUTES OF EXPOSURE

Dermal: Drilling, sampling

Inhalation: Drilling, sampling

Other:

6-10

^aLower value of PEL or TLV listed.

**Table 2
HEAT AND COLD STRESS
GUIDELINES FOR WORKING IN TEMPERATURE EXTREMES
WHILE WEARING PERSONAL PROTECTIVE EQUIPMENT (PPE)**

Temperature	Work Cycle	Rest Cycle	Control Measures
<32° F or <55° F & raining	2 hrs	15 min	Review cold stress in safety meeting. Rest in a warm area. Drink at least 8 ounces of warm non-caffeinated, non-alcoholic beverage at each rest break. Schedule a mid-day lunch break of at least 30 minutes in a warm area to begin not later than 5 hours after startup.
72° to 77° F	2 hrs	5 min	Review heat stress in safety meeting. Take resting pulse rate before beginning work. Drink 8 ounces of cool water before beginning work, and 4 ounces at rest break. Have ice available.
77° to 82° F	2 hrs	5 min	As above, but seated rest break. Monitor pulse rate. (See below.)
82° to 87° F	60 min	15 min	As above, but rest area to be shaded.
87° to 90° F	60 min	15 min	As above. Try to provide a shaded work area.
>90° F	30 min	15 min	As above. Provide a shaded area with seats in the work area for team members to use as needed. Try to reschedule work to avoid mid-day heat.

Above guidelines apply to unacclimated workers who wear PPE. Guidelines may vary for workers who do not wear PPE, or who have become acclimated.

PULSE CRITERIA. Take resting radial (wrist) pulse at start of work day; record it. Measure radial pulse for 30 seconds as rest period begins. Pulse not to exceed 110 beats per minute (bpm), or 20 bpm above resting pulse. If pulse exceeds this criteria, reduce work load and/or shorten the work cycle by one third, and observe for signs of heat stress. No team member is to return to work until his/her pulse has returned to <110 bpm, or resting pulse +20 bpm.

SYMPTOMS AND TREATMENT OF HEAT AND COLD STRESS

Heat Stroke	Heat Exhaustion	Frostbite	Hypothermia
Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high body temperature.	Pale, clammy, moist skin; profuse sweating; weakness; normal temperature; headache; dizzy; vomiting.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Cool victim rapidly by soaking in cool (not cold) water. Get medical attention immediately!!	Remove victim to a cool, air conditioned place. Loosen clothing, place head in low position. Have victim drink cool (not cold) water.	Remove victim to a warm place. Rewarm area quickly in warm (not hot) water. Have victim drink warm fluids--not coffee or alcohol. Do not break any blisters. Elevate the injured area and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids--not coffee or alcohol. Get medical attention.

Table 3
PHYSICAL (SAFETY) HAZARDS AND CONTROLS

Page 1 of 2

Hazard	Engineering or Administrative Controls
Flying debris/objects	Provide shielding and PPE.
Noise > 85 dBA	Noise protection and monitoring required.
Steep terrain/unstable surface	Brace and shore equipment.
Build-up of explosive gases	Provide 20 lb A,B,C fire extinguisher and ventilation.
Build-up of static electricity	No spark sources within 50 feet of an excavation, heavy equipment, or UST removal. Ground as appropriate.
Gas cylinders	Make certain gas cylinders are properly anchored and chained. Keep cylinders away from ignition sources.
High pressure hose rupture	Check to see that fitting and pressurized lines are in good repair before using.
Electrical shock	Make certain third wire is properly grounded. Do not tamper with electrical wiring unless qualified to do so.
Suspended loads	Work not permitted under suspended loads.
Moving vehicles	Back-up alarm required for heavy equipment. Observer remains in contact with operator and signals safe back-up. Personnel to remain outside of turning radius.
Overhead electrical wires	Heavy equipment (e.g. drill rig) to remain at least 15 feet from overhead powerline for powerlines of 50 kV or less. For each kV > 50 increase distance 1/2 foot.
Buried utilities, drums, tanks, and so forth.	Locate buried utilities, drums, tanks, etc. prior to digging or drilling and mark location.
Slip, trip, fall hazards due to muddy work areas	Use narrow-gapped wood pallets or similar devices in muddy work areas.
Back injury	Use proper lifting techniques, or provide mechanical lifting aids.

Table 3
PHYSICAL (SAFETY) HAZARDS AND CONTROLS

Page 2 of 2

Hazard	Engineering or Administrative Controls
Confined space entry	Permit and safety plan required (reference CH2M HILL SOP HS-17).
Trenches/excavations	Make certain trench meets OSHA standard before entering. All excavations > 5 feet deep must be sloped or shored. Excavations > 4 feet deep must have a ladder every 25 feet. If not entering trench, remain 2 feet from edge of trench at all times.
Protruding objects	Flag visible objects.

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Note: The SSC is to complete Form 533 (Attachment C) and return it to Liz Veach/WDC at the end of the field work.

Employees listed above are enrolled in the CH2M HILL chemical protection program (CPP) and meet the medical surveillance, 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training requirements of OSHA 29CFR 1910.120. Employees designated "SSC" have received 8 hours of supervisor and 8 hours of instrument training and can serve as site safety coordinator (SSC) for the level of protection indicated. There must be one SSC present during any task performed in exclusion or decontamination zones with the potential for exposure to safety and health hazards. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. There must be one FA-CPR designated employee present during any task performed in exclusion or decontamination zones with the potential for exposure to safety and health hazards. The "buddy system" requirements of OSHA 29CFR1910.120 are to be met at all times.

The field team leader will lead all field efforts, including logistics and enforcement of procedures described in the work plan. The site safety coordinator will enforce the requirements of the health and safety plan, both in Levels C and D. Drillers must present the Site Safety Coordinator with certification that workers onsite have, by name, (1) been examined by a licensed physician within the past 12 months and determined to be medically capable of wearing a respirator and performing the work and (2) been fit tested and trained in the use of the respiratory equipment to be used onsite. Physician's name and phone number must be provided. Drillers must attend a site safety briefing led by the SSC prior to work startup. Drillers must complete training required by 29 CFR 1910.120 and must have a health and safety program.

4.2 Personal Protective Equipment Specification

Refer to Table 4 for the personal protective equipment (PPE) specification.

4.3 Monitoring Equipment

Please refer to Tables 5 and 6 for the monitoring equipment and calibration specifications. Operation and calibration will follow manufacturer's procedures. Detection data will be recorded during all phases of work.

5.0 WORK PROCEDURES

5.1 Site Entry Procedures

Sign in at base command and review applicable base procedures, including communications and emergencies. Post emergency telephone numbers. Locate

Table 4 PERSONAL PROTECTIVE EQUIPMENT (PPE) SPECIFICATION								
Task	Level	Body	Foot	Head	Eye	Hand	Respiratory	Other
Drilling, soil boring, soil sediment sampling, groundwater sampling operations no respiratory hazard ³	D	Long-sleeve cotton coveralls (polycoated Tyvek for operations with splash hazards)	Steel Toe, Shank Safety Boot	Hardhat available ¹	Safety glasses, goggles, and face shield available	Nitrile outer gloves, latex inner gloves	N/A	Boot covers available
Drilling, soil boring, soil sediment sampling, groundwater sampling operations respiratory hazard ³	C	As above	As above	As above	Face shield available	As above	APR, full face, GMC-H cartridges	Boot covers available
Notes: ¹ The SSC shall specify hardhat areas ² A selection of rubber gloves shall be available as determined by SSC. ³ <ul style="list-style-type: none"> Level D to be worn during all drilling, soil boring, soil/sediment sampling, and groundwater sampling tasks. Level C to be worn when action-levels specified in Section 6.0 are exceeded. 								
REASONS TO UPGRADE OR DOWNGRADE LEVEL OF PROTECTION								
Upgrade					Downgrade			
<ul style="list-style-type: none"> Request of individual performing task. Change in work task that will increase contact or potential contact with hazardous materials. Occurrence or likely occurrence of gas or vapor emission. Known or suspected presence of dermal hazards. Instrument action levels (Section 6.0) exceeded. 					<ul style="list-style-type: none"> New information indicating that situation is less hazardous than originally thought. Change in site conditions that decreases the hazard. Change in work task that will reduce contact with hazardous materials. 			

**Table 5
MONITORING EQUIPMENT SPECIFICATION**

Instrument	Task	Action Levels	Monitoring Frequency	Calibration Frequency
CGI: MS Model 260	Drilling and soil boring	0-10% LEL No explosion hazard 10-25% LEL Potential for hazard >25% LEL Explosion hazard; evacuate	Continuous	Daily
O ₂ Meter: MSA Model 260	Drilling and soil boring	20.8% Normal oxygen content <19.5% Oxygen deficient; evacuate	Continuous	Daily
Photoionization Detector (pid): HNU PI-101, 11.7EV	Drilling, soil boring, soil, sediment, surface water, and groundwater sampling	0-1 ppm ^{ab} Level D 1-5 ppm ^{ab} Level C >5 ppm Stop work; re-evaluate	Every 15 min. in breathing zone	Daily
Benzene and Vinyl Chloride Drager Tube	Drilling, soil boring, soil, sediment, surface water, and groundwater sampling	Use Drager tube when HNU or OVA readings exceed 1 ppm in breathing zone. >1 ppm Stop work; re-evaluate	Every 15 min. in breathing zone	N/A
Flame Ionization Detector (FID): OVA-128	Drilling, soil boring, soil, sediment, surface water, and groundwater sampling	0-1 ppm ^{ab} Level D 1-5 ppm ^{ab} Level C >5 ppm Stop work; re-evaluate	Every 15 min. in breathing zone	Daily
Dust Monitor; Mini-ram	Drilling, soil boring, soil sampling	0-1 mg/m ^{3ab} Level D >1 mg/m ^{3ab} Level C	Continuous	Zero meter daily
Notes: 1. ab = above background 2. Use either PID (HNU) or FID (OVA). Both not needed.				

Table 6 CALIBRATION SPECIFICATION				
Instrument	Gas	Span	Reading	Method
PID: HNU, 10.2 ev probe	100 ppm isobutylene	9.8 ± 2.0	55 ppm	1.5 l/m reg T-tubing 0.25 l/m reg direct tubing
PID: HNU, 11.7 ev probe	100 ppm isobutylene	5.0 ± 2.0	68 ppm	1.5 l/m reg T-tubing 0.25 l/m reg direct tubing
FID: OVA-128	100 ppm methane	3.0 ± 1.5	100 ppm	1.5 l/m reg T-tubing
CGI: MSA 260, 261, 360, or 361	0.75% pentane	N/A	50% LEL $\pm 5\%$ LEL	1.5 l/m reg direct tubing

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nearest available telephone. Set up decon. Hold initial site safety briefing on first day and daily site meetings prior to work startup. Identify exclusion zones, contaminant reduction zones, support zones. Designate at least one vehicle for emergency use and keep a copy of the Health and Safety Plan in that vehicle. Special permission will be needed to enter the Line Shack area at Oceana; FITWING, Lt. Baker 433-5611; MATWING, Master Chief Collins 433-9129 should be contacted.

5.2 Work Practices

- No spark sources within exclusion or decontamination zones.
- Avoid visibly contaminated areas.
- No eating, drinking, or smoking in contaminated areas, or exclusion or decontamination zones.
- SSC to establish areas for eating, drinking, smoking.
- No contact lenses in exclusion or decontamination zones.
- No facial hair that would interfere with respirator fit if Level C or B is anticipated.
- Site work will be performed during daylight hours whenever possible. Any work conducted during hours of darkness will require enough illumination intensity "to read a newspaper without difficulty."

5.3 Site Control Measures

- Site safety coordinator (SSC) to conduct site safety briefing (see below) before starting field activities, or as tasks and site conditions change.
- SSC records safety briefing attendance in logbook, and documents topics discussed.
- Post OSHA job site poster in a central and conspicuous location at the site.
- Determine wind direction.
- Establish work zones: support, decontamination, and exclusion zones, and delineate work zones with flagging or cones as appropriate. Support zone upwind of site.

- Establish decontamination procedures, including respirator decontamination procedures, and test.
- Utilize access control at the entry and exit from each work zone.
- Chemicals to be stored in proper containers.
- MSDSs are available for onsite chemicals employees exposed to.
- Establish onsite communications. These will consist of:
 - Line of sight/hand signals
 - Air horn
 - Two-way radio or cellular phone if available
- Communicate emergency signals to all personnel. These will be:
 - Grasping throat with hand--EMERGENCY--HELP ME
 - Grasping buddy wrist--LEAVE AREA NOW
 - Thumbs up--OK, UNDERSTOOD
 - Two short blasts on air horn--ALL CLEAR
 - Continuous air horn--EMERGENCY--EVACUATE
- Establish offsite communications. These will be:
 - NAS problems: Call Will Bullard or Rick Hylton at (804) 433-2229 from offbase pay phones or go to Building 820 to communicate in person. Nearby convenience stores are good places to call; these are northwest and southeast of Oceana.
 - Overall project problems: Call Jesse Waltz at (804) 445-6911 in Norfolk. Use base phones at Building 820 or call from pay phones off base.
- Establish "buddy" system.
- Establish procedures for disposal of material generated onsite.
- Initial air monitoring conducted by SSC i appropriate level of protection.
- SSC to conduct periodic inspections of work practices to determine effectiveness of this plan. Deficiencies to be noted, reported to DHSM or RHSM, and corrected.

- Site safety briefing topics: general discussion of health and safety plan; site specific hazards; location of work zones; PPE requirements; equipment; special procedures; emergencies.

5.4 Decontamination Procedures

Personnel:

1. Remove boot covers
2. Thoroughly scrub boots and outer gloves with detergent in water
3. Thoroughly rinse boots and gloves
4. Remove outer gloves
5. Remove disposable Tyvek, if used, and dispose in garbage bag, or remove cotton coveralls
6. Remove inner gloves
7. Wash hands and face
8. Dispose of rinse water and personal protective equipment in drums.

If level C work, prior to 6., remove APR and then remove inner gloves and discard. Discard APR cartridges after each day's use and sanitize respirator. Wash all clothing worn on site prior to re-wearing. Isolate worn clothing in plastic bags to prevent cross contamination prior to laundering. Shower and shampoo as soon as possible at the end of the work day. Follow client instructions for disposal of used personal protective equipment (PPE).

Equipment:

All drilling equipment will be cleaned between boreholes with a high-pressure steam rinse using a potable water supply. After drilling operations have been completed at the site, the drill rig will be cleaned with a high-pressure hot water rinse including tires and undercarriage. The drilling equipment will be thoroughly inspected by the Site Safety Coordinator to ensure that no visible residual material is transported between boreholes or off the site, and that these procedures have been followed. Split spoon samplers will be cleaned with a detergent solution and then, a methanol in water rinse after each sample.

All groundwater sampling equipment will be cleaned prior to contact with each groundwater sample. Equipment will be cleaned first with a trisodium phosphate (TSP) detergent solution, then a 10 percent methanol rinse, then with a rinse of 10 percent hexane in water, then a tap water rinse, and then a deionized or distilled water rinse. The submersible pump and discharge tubing will be purged with all solutions between each well, prior to moving to the new well.

All reusable soil sampling equipment, such as stainless steel trowels, bowls, spoons, and augers, will be decontaminated between sampling stations, prior to

moving to the new station, by wiping with a clean, disposable towel, rinsing with a 20 percent solution of methanol in clean water then rinsing with deionized water.

Please Note: It is the responsibility of the Site Safety Coordinator to make sure that all pieces of equipment coming offsite are properly decontaminated according to the procedures outlined above. Documentation of decontamination must be made in the field log notebook that will become part of the permanent project file. A suitable tag is to be placed on each piece of decontaminated CH2M HILL equipment (or group of equipment, such as a bag of hand tools), stating the date of decontamination and initialed by the SSC.

5.5 Disposal of Materials Generated On Site

Bag all disposables in plastic garbage bags and place in drums along with rinse waters, muds, etc.

6.0 EMERGENCY RESPONSE PLAN (REFERENCE CH2M HILL SOP HS-12)

6.1 Pre-Emergency Planning

The SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with the facility and local emergency service providers as appropriate.

- Locate nearest telephone to the site and inspect onsite communications.
- Locate chemical, safety, radiological, biological hazards.
- Confirm and post emergency telephone numbers and route to hospital.
- Post site map marked with location of emergency equipment and supplies.
- Review emergency response plan for applicability to any changed site conditions, alterations in onsite operations, or personnel availability.
- Evaluate capabilities of local response teams.
- Where appropriate and acceptable to the client, inform emergency room/ambulance service and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.

- Inventory and check site emergency equipment and supplies.
- Review emergency procedures for personnel injury, exposures, fires, explosions, chemical and vapor releases with field personnel.
- Locate onsite emergency equipment and supplies of clean water.
- Verify local emergency contacts, hospital routes, evacuation routes, and assembly points.
- Drive route to hospital.
- Review names of onsite personnel trained in first aid and CPR.
- Review notification procedures for contacting CH2M HILL's medical consultant and team member's occupational physician.
- Rehearse the emergency response plan once prior to site activities.
- Brief new workers on the emergency response plan.

6.2 Emergency Equipment and Supplies

The SSC marks the locations of emergency equipment on the site map and posts the map in the support zone.

- 20 lb ABC fire extinguisher
- Industrial first aid kit
- Facility emergency equipment:
- Additional emergency equipment:

6.3 Emergency Medical Treatment

- The SSC will assume charge during a medical emergency until the ambulance arrives, or the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR.
- Call the ambulance and hospital.

- Determine if decontamination will make injury worse. Yes--seek medical treatment immediately.
- Make certain that injured person is accompanied to emergency room.
- Notify the Project Manager of the injury.
- Notify the District or Regional Health and Safety Manager.
- Notify the injured person's human resources department.
- Prepare an incident report. Submit this to the Corporate Director Health and Safety (WDC) and Corporate Human Resources Department (DEN) within 48 hours.

6.4 Evacuation

- Evacuation routes will be designated by SSC prior to beginning of work.
- Onsite and offsite assembly points will be designated prior to beginning of work.
- Personnel will exit the exclusion zone and assemble at the onsite assembly point upon hearing the emergency signal for evacuation of the exclusion zone.
- Personnel will assemble at the offsite point upon hearing the emergency signal for a site evacuation.
- The SSC and a "buddy" will remain onsite after the site has been evacuated (if possible) to assist local responders and advise them of the nature and location of the incident.
- SSC accounts for all personnel in the onsite assembly zone.
- A person designated by the SSC (prior to work) will account for personnel at the offsite assembly area.
- The SSC is to write up the incident as soon as possible after it occurs, and submit a report to the Corporate Director Health and Safety.

6.5 Emergency Response Telephone Numbers**SITE ADDRESS****PHONE**

Police: NAS Oceana Police
Address:

Phone: 433-2224

Fire: NAS Oceana Fire
Address:

Phone: 433-3333 (Emergency)
 433-2841 (Chief's Office)

Ambulance: NAS Oceana Clinic/Ambulance
Address:

Phone: 433-2222

Water: NAS Oceana Utilities

Phone: 433-3105

Gas: NAS Oceana Utilities

Phone: 433-3105

Electric: NAS Oceana Utilities

Phone: 433-3105

Hospital: Virginia Beach General Hospital
Address:

Phone: 481-8262

Route To Hospital:

From Oceana, leave base at main entrance, turn left onto Oceana Boulevard (Route 615). Travel about 3 miles, turn left on Virginia Beach Boulevard (Route 58), then right on First Colonial Road (Route 615). Travel about 1.5 miles, Virginia Beach Hospital is on the right. Drive route prior to work startup.

6.6 Emergency Contacts**CH2M HILL Medical Consultant**

Dr. Kenneth Chase

Washington Occupational Health Associates

202/463-6698 (8 AM to 5 PM EST)

202/463-6440 (after hours answering service; physician will return call within 30 minutes)

Occupational Physician (Regional or Local)

Dr. Kenneth Chase

Washington Occupational Health Associates

202/463-6698 (8 AM to 5 PM EST)

202/463-6440 (after hours answering service; physician will return call within 30 minutes)

Corporate Director Health and Safety

Name: Marty Mathamel/WDC

Phone: 703/471-1441, Extension 4646

Site Safety Coordinator (SSC)

Name: April Lloyd/WDC

Phone: 703/471-6405, Extension 4321

District Health and Safety Manager (DHSM)

Name: Marty Mathamel/WDC

Phone: 703/471-1441, Extension 4646

Regional Manager

Name: George Gunn

Phone: 703/471-1441, Extension 4200

Regional Health and Safety Manager (RHSM)

Name: Marty Mathamel/WDC

Phone: 703/471-1441, Extension 4646

Project Manager

Name: Doug Dronfield/WDC

Phone: 703/471-6405, Extension 4339

Radiation Health Manager (RHM)

Name: George Stephens/ORO

Phone: 615/483-9032

Regional Human Resources Department

Name: Beth Sexton/WDC
Phone: 703/471-6405, Extension 4241

Client Contact

Name: Jesse Waltz
Phone: 804/445-6643

Corporate Human Resources Department

Name: Beth Brown/DEN
Phone: 303/771-0952

If an injury occurs, notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured. Notification MUST be made within 24 hours of the injury.

7.0 PLAN APPROVAL

This site safety plan has been written for the use of CH2M HILL employees. CH2M HILL claims no responsibility for its use by others. The plan is written for the specific site conditions, purposes, dates and personnel specified and must be amended if these conditions change.

PLAN
PREPARED BY: _____ Date: _____

APPROVED BY: _____ Date: _____

Distribution of approved plan:

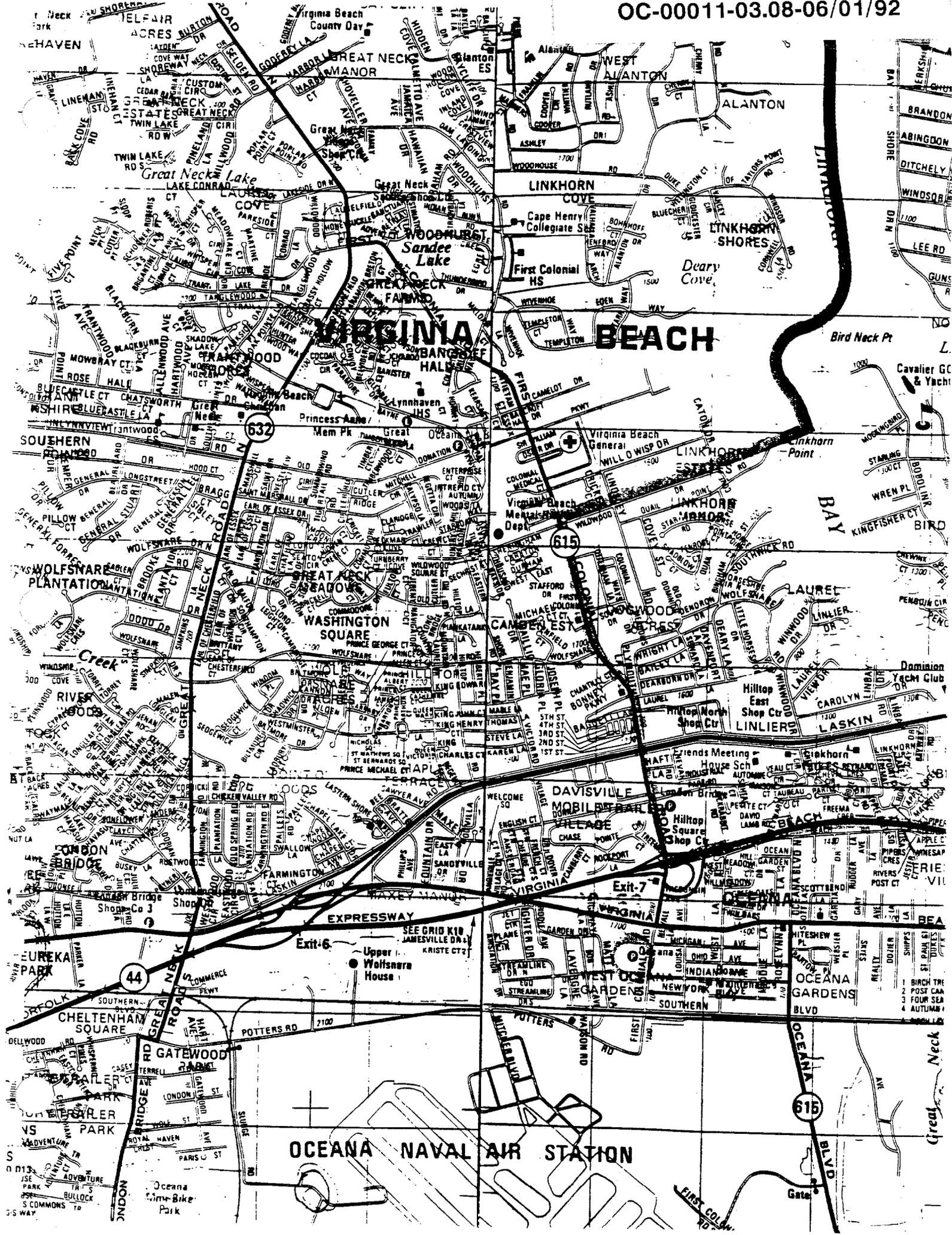
Site manager (responsible for distribution to team members and client)
Marty Mathamel/WDC

Employees who have read this health and safety plan and agree to abide by its provisions must sign the Employee Signoff (Attachment D)

Attachments:

- A. Site Map
- B. MSDS for
 - isobutylene
 - pentane
 - isopropanol
 - methanol
 - TSP
 - MSA sanitizer/cleanser
 - Nitric Acid
- C. Form 533, Record of Hazardous Waste Field Activity
- D. Employee Signoff

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OCEANA NAVAL AIR STATION

Exit-7

Exit-6

Upper Wolfsware House

615

44

Great Neck

1 BIRCH TR
2 POST CA
3 FOUR SE
4 AUTUMN

ADVENTURE TR
BULLOCK
COMMONS

ATTACHMENT C

FORM 533

RECORD OF HAZARDOUS WASTE FIELD ACTIVITY

SITE NAME:
SITE SAFETY COORDINATOR:
PROJECT NUMBER:
RECORD OF ACTIVITIES FOR (DATES):

EMPLOYEE NAME / NUMBER	TOTAL DAYS ONSITE	DAYS IN LEVEL B	DAYS IN LEVEL C	DAYS IN LEVEL D	DAYS AS SSC LEVEL B	DAYS AS SSC LEVEL C	DAYS AS SSC LEVEL D	ACTIVITIES PERFORMED

Chapter 7 Community Relations Plan

A final community relations plan (CRP) has been completed. It was designed to meet the needs of the community in and around NAS Oceana during the RCRA facility investigation (RFI). The CRP described the history of community activity in the area and potential community concerns regarding the RFI. It also outlined community relations activities to be conducted during the RFI. The draft CRP was produced in July, 1991. The plan was finalized in December 1991.

The CRP was developed in accordance with all public participation and community relations requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980/Superfund Amendments and Reauthorization Act of 1986 (CERCLA/SARA) and the National Contingency Plan (NCP). In addition, the CRP follows guidance described in *Community Relations in Superfund; A Handbook* (EPA, 1988), *Region III RCRA Corrective Action Community Relations Guide* (EPA, 1990), and *Installation Restoration Public Affairs Plan* (Department of the Navy, 1989).

Community Relations Objectives

According to *Region III RCRA Corrective Action Community Relations Guide* (EPA, 1990), the objectives of the community relations program, under RCRA 3008(h) corrective action orders, are:

- To create communication channels that provide opportunities for public involvement
- To provide access to information
- To integrate community concerns, interests, and comments into all activities and decisions, as appropriate
- To create early and continuing opportunities for public participation in RCRA corrective actions
- To ensure Agency understanding of and responsiveness to public concerns
- To anticipate conflicts and provide early means of resolution
- To give the public the opportunity to comment on and provide input to technical decisions

- To inform the public of planned and ongoing actions.

The CRP will describe community relations activities to be implemented during the RFI to meet these objectives.

Preparing the Community Relations Plan

The final CRP was completed in December 1991. It was based primarily on the results of personal interviews with a cross-section of the NAS Oceana community. Approximately 15-20 people were interviewed in June, 1991. Interviews were conducted with a variety of people in the community, such as officers, enlisted personnel, civilians employed at NAS Oceana, local elected government officials, business leaders, environmental leaders or activists, and local residents. These interviews focused on learning more about community concerns, attitudes, and information needs related to the facility, and how and when the public would like to be involved in site activities.

Background information for preparing the CRP will also be collected from sources such as facility reports and files, and local newspaper articles.

Content of the Community Relations Plan

The CRP contains the following chapters:

- Overview of the CRP

The overview provides a general introduction to the document. It describes the purpose of the CRP, summarizes the information it contains and the general attitude of the community toward the facility, and highlights features of the planned community relations program. The overview also defines the roles and responsibilities of various commands and government agencies for implementing the community relations program.

- Facility Description

The facility description introduces the reader to NAS Oceana. It summarizes any historical, geographical, technical, or other information necessary for the reader to understand why the facility is undergoing an RFI. The facility description also includes site maps, a chronological list of activities related to potential site contamination, a listing of all known releases contributing to contamination, and a discussion of any potential threat to public health or the environment potentially posed by the facility.

- Community Background

The community background includes three major subsections: a community profile, a chronology of community involvement, and a description of key community concerns.

The community profile describes local economics and demographics, identifies the type of local government, and identifies general issues of local community concern. It also describes local geography, such as the proximity of sensitive receptors (i.e., schools, hospitals, etc.) to the sites.

The chronology of community involvement highlights the history of community reaction to the facility and level of interest in facility operations. It also describes actions taken by the facility in the past to inform or involve the local community in facility activities.

The description of key community concerns outlines how the community regards the potential risks posed by the facility, and the concerns that they identify regarding RFI activities.

- Highlights of the Community Relations Program

The highlights chapter states the purpose of conducting a community relations program and outlines the specific goals of the planned program for NAS Oceana. The highlights of the community relations program will follow directly from the discussion of key community concerns.

- Community Relations Activities

The community relations activities chapter describes in detail all community relations activities that are planned. In addition, any additional community relations activities that may be necessary contingent on specific technical activities (i.e., an unexpected finding of contamination) should be described. This chapter also includes a schedule showing when community relations activities will be implemented in relation to technical activities and milestones.

- Appendices

Several appendices are included in the CRP: A—Sample Interview Questions; B—Site Descriptions; C—Location of Information Repositories; D—Suggested Meeting Locations; E—Mailing List, including government officials, Technical Review Committee members, environmental organizations, civic associations, and several NAS officers.

Required Community Relations Activities

Certain community relations and public participation activities are required under CERCLA/SARA, RCRA, and the Navy's IR Program. These required activities provide the backbone of the community relations program. Depending on the complexity of the site and the level of community interest, additional community relations activities may be necessary. Any additional activities planned will be discussed thoroughly in the CRP.

The following eleven community relations activities are required by the Region III Corrective Action Basic Community Relations Program:

- Prepare a CRP
- Establish an information repository
- Issue an RFI work plan fact sheet
- Hold an RFI kick-off public meeting
- Issue a public notice for the proposed corrective measure alternative
- Issue a proposed corrective measure alternative fact sheet
- Hold a public comment period on the proposed corrective measure alternative
- Provide an opportunity to hold a public meeting on the proposed corrective measure alternative (dependent on public interest)
- Provide responses to comments
- Issue a public notice for the final corrective measure alternative
- Issue a fact sheet on corrective action design

A brochure describing corrective action efforts at Oceana NAS is currently being prepared. This brochure will serve as the RFI work plan fact sheet, and will include all information that is required in that fact sheet.

WDCR407/108.51

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Appendix A

**DATA COLLECTION QUALITY ASSURANCE PLAN
FOR THE RCRA FACILITY INVESTIGATION
AT THE NAVAL AIR STATION, OCEANA
VIRGINIA BEACH, VIRGINIA**

June 1992

Prepared by

**CH2M HILL, INC.
625 Herndon Parkway
Herndon, Virginia**

**DATA COLLECTION QUALITY ASSURANCE PLAN (QAPP)
 APPROVAL SHEET
 NAVAL AIR STATION, OCEANA
 RCRA FACILITY INVESTIGATION**

Prepared By: CH2M HILL
 Reviewed and Approved By:

- | | | | |
|----|-----------|--|------|
| 1. | Reviewed: | CH2M HILL's PM | Date |
| 2. | Reviewed: | CH2M HILL's Designated
QC Manager | Date |
| 3. | Reviewed: | Atlantic Division, Naval Facilities
Engineering Command RPM | Date |
| 4. | Approved: | EPA Region III
Hazardous Waste Management Division | Date |
| 5. | Reviewed: | EPA Region III Central
Regional Laboratory | Date |
| 6. | Reviewed: | Analytical Laboratory PM | Date |
| 7. | Reviewed: | Analytical Laboratory QC Manager | Date |

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Section 1 INTRODUCTION

The Naval Air Station (NAS), Oceana in Virginia Beach, Virginia, has reached an agreement with the U.S. Environmental Protection Agency (EPA) Region III under Section 3008(h) of the Resource Conservation and Recovery Act (RCRA) to continue the corrective action process begun under the Navy's Installation Restoration Program (IRP). The Navy and EPA have entered into a Consent Order to perform a RCRA Facility Investigation (RFI) and a Corrective Measures Study (CMS) to identify contaminant releases, characterize them, and select appropriate corrective measures to mitigate the releases at the facility.

The Consent Order stipulates that the RFI work plan shall include a Data Collection Quality Assurance Plan (DCQAP) to document the sample collection field measurement and sample analysis procedures to be performed during the RFI to characterize the environmental setting, source, and contamination so that the information and data gathered and resulting decisions are technically sound, and properly documented. The DCQAP for NAS, Oceana is comprised of this appendix and by reference the Sampling and Analysis Plan in Chapter 4 and the Data Management Plan in Chapter 5 of the RFI work plan.

This DCQAP is prepared to present in specific terms, the policies, objectives, organization, functional activities, and quality assurance and quality control (QA/QC) activities designed to achieve the data quality goals of the RFI. Where possible, existing QA/QC guidelines, policies, and programs will be incorporated into the DCQAP by reference.

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Section 2 PROJECT DESCRIPTIONS

The Atlantic Division, Naval Facilities Engineering Command (LANTNAVFACENGCOM) has retained CH2M HILL to provide assistance in complying with a Consent Order dated May, 1991, between the Navy and EPA. The Consent Order specified that 19 solid waste management units (SWMU) at NAS Oceana require an RFI. Two of these sites were grouped with nearby sites such that 17 RFI SWMUs are being investigated.

The project site, shown by Figure 2-1, is located in Virginia Beach, Virginia. It is bounded on the north, east, and west by residential and light industrial areas and on the south by farmland. Some of the 19 SWMUs to be investigated have been combined for the RFI due to their proximity to each other, leaving the number of areas to be investigated at 17. The SWMUs are described below:

- SWMU 1 - West Woods Oil Disposal Pit
- SWMU 2b - Line Shack Oil Disposal Area (Bldg. 131)
- SWMU 2c - Line Shack Oil Disposal Area (Bldg. 400)
- SWMU 2d - Line Shack Oil Disposal Area (Bldg. 125)
- SWMU 2e - Line Shack Oil Disposal Area (Bldg. 23) and
Hazardous Waste Storage Area, Bldg. 23
- SWMU 11 - Fire Fighting Training Areas
- SWMU 15 - Abandoned Tank Farm
- SWMU 16 - Pesticide Storage Area (Bldg. 821)
- SWMU 18 - Hazardous Waste Storage Area (Bldg. 204)
- SWMU 19 - Waste Oil Storage Areas (Bldg. 541)
- SWMU 20 - Waste Oil Storage Areas (Bldg. 543)
- SWMU 21 - Transformer Storage Yard (Bldg. 830)
- SWMU 22 - Construction Debris Landfill
- SWMU 23 - Bowser, Bldg. 830
- SWMU 24 - Bowser, Bldg. 840
- SWMU 25 - Inert Landfill
- SWMU 26 - Fire Fighting Training Area

PROJECT OBJECTIVES

The objectives of the RFI are as follows:

- Characterize the nature, extent, and rate of migration of releases to soil, groundwater, surface water, and sediments from the SWMUs.
- Determine the criteria for and scope of corrective measures.

- Provide a detailed geologic and hydrogeologic characterization of the area surrounding and underlying the SWMUs.
- Identify actual or potential receptors.

DCQAP OBJECTIVES

The objectives of the DCQAP are to specify procedures to obtain samples which are precise, accurate, complete, representative and comparable as well as to specify sampling and analytical procedures that will permit identification of the contaminants of concern.

SCOPE OF FIELD ACTIVITIES

The estimated total number of samples to be collected by medium and by investigation areas are provided in Tables 4-1 through 4-3 of the RFI work plan. The procedures for sample collection and documentation are detailed in Section 5 and those for sample custody in Section 6.

Field measurements will include those for pH, specific conductance, and temperature. Soil samples will be screened using the HNu.

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Section 3 PROJECT ORGANIZATION AND RESPONSIBILITY

PROJECT ORGANIZATION

This section outlines the authorities and responsibilities of key members of the project team. Figure 3-1 illustrates the project organization. Subcontract management personnel are also indicated in the figure. Please note that this DCQAP is premised on CH2M HILL being the RFI contractor. The actual RFI contractor will be named at a later date by LANTNAVFACENGCOM.

CH2M HILL provides general project management. Primary responsibility for project quality rests with the LANTNAVFACENGCOM and the CH2M HILL project manager (PM). Independent QA review is provided by the field QC manager and the laboratory QC manager.

PROJECT MANAGER (PM)

The project manager will be responsible for project execution. He or she will be responsible for all technical, administrative, and Agency-related aspects of the project. He or she will also be responsible for progress reporting, schedule, and budget control. The PM will also select properly trained and qualified personnel for field and laboratory activities. The project manager will be the primary contact between CH2M HILL and LANTNAVFACENGCOM.

FIELD QC MANAGER

The field QC manager will review and advise on all aspect of QA/QC related to sample collection, shipping, custody, and documentation. Responsibilities include:

- Conducting field audits during execution of the program
- Auditing sample custody to determine if procedures specified in the DCQAP are followed
- Issuing corrective action orders when necessary

ANALYTICAL QC MANAGER

The Analytical QC Manager will review and advise on all aspects of QA/QC related to samples analysis. Responsibilities include:

- Verifying that field analytical QA procedures are as specified in the QA/QC program

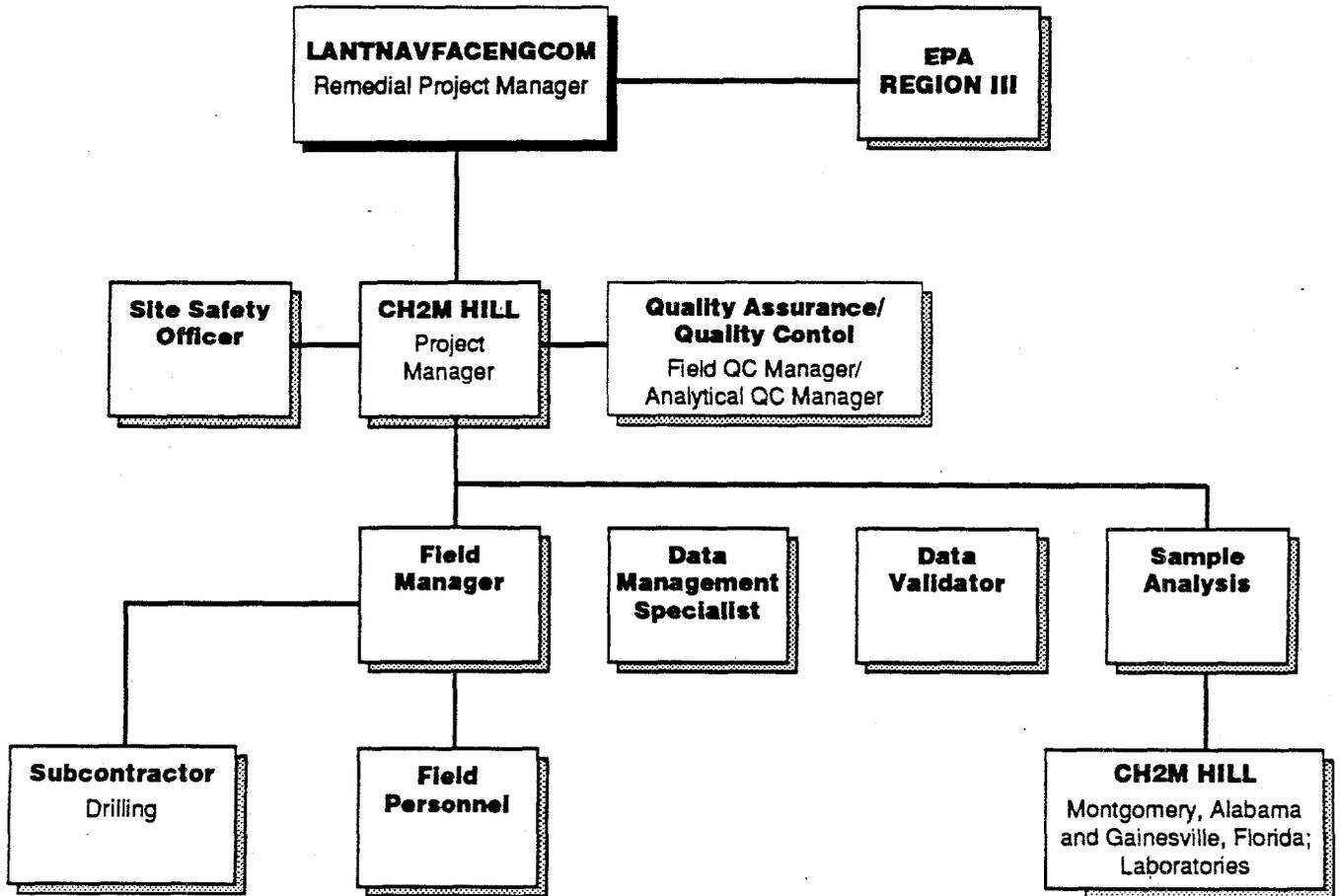


Figure 3-1
PROJECT QA ORGANIZATION CHART
RCRA Facility Investigation—Naval Air Station, Oceana



- Conducting laboratory audits during execution of the program
- Making QC evaluations and, if necessary, submitting audit samples to assist in reviewing QA/QC procedures; making recommendations to the PM concerning repeat samples and analysis if problems are detected
- Auditing sample custody to determine if procedures specified in the DCQAP are being followed

FIELD MANAGER (FM)

The FM, a hydrogeologist, will schedule and coordinate all CH2M HILL field activities and will be present whenever field activities are being conducted. The FM will be responsible for the coordination and implementation of all field activities associated with the sampling and for adherence to all QA/QC procedures outlined in the DCQAP. These responsibilities include:

- Verifying that field personnel are trained and qualified in sampling procedures and field analytical procedures prior to taking samples
- Verifying that field personnel are aware of the field sampling schedule and will be available when the activity is to occur
- Coordination of sample collection, documentation, and shipping activities
- Participating in the field sampling quality audits with the field QC manager

SITE SAFETY OFFICER

The site safety officer (SSO) will be responsible for auditing adherence of team members to the site safety requirements as described in the Site Safety Plan. Additional responsibilities of the SSO are as follows:

- Modifications of the levels of protection based on site conditions
- Locating and posting of routes to medical facilities including poison control centers, and arranging for emergency transportation of medical facilities
- Examination of work party members for symptoms of exposure or stress
- Provision of emergency medical care and first aid as necessary onsite

FIELD PERSONNEL

Field personnel will collect the samples described in Table 2-1. The field personnel will be under the direction of the FM. The field personnel will be responsible for the following:

- Collecting and labeling the samples following the procedures outlined in Section 6
- Taking photographs of the sampling locations and wells
- Completing all necessary documentation
- Packing and shipping the samples
- Verifying that samples are collected, labeled, preserved, stored, transported, and when necessary, filtered as specified in Section 6
- Checking that all sample documentation (labels, field notebooks, chain-of-custody (COC) records, packing lists) is correct and transmitting that information with the samples to the analytical laboratory

DATA MANAGEMENT SPECIALIST

Responsibilities of the data management specialist will include:

- Scheduling of the analytical laboratory for delivery of sample containers and for sample analysis
- Coordinating appropriate paperwork for sample collection, custody and shipping
- Organization of analytical results into a computerized data base to be used for data validation, data evaluation and for reporting
- Coordination with data validation

DATA VALIDATOR (DV)

The DV will be responsible for conducting a systematic review of the analytical data for compliance with the established QA/QC criteria defined in the *Laboratory Data Validation Functional Guidelines for Evaluating Organics and Inorganics Analyses*, EPA Region III Functional Guidelines Modifications, and *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, December 1986. The DV will also evaluate data accuracy,

precision, representativeness, comparability (if different laboratories are used) and completeness, and determine data usability. The data validator will be independent from field and project management personnel.

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Section 4

QUALITY ASSURANCE OBJECTIVES

The overall QA objectives are to develop and implement procedures for field sampling, chain of custody, laboratory analysis, and reporting that will provide analytical data of known defensible quality. This section addresses objectives for field quality control; accuracy and precision; completeness; representativeness; comparability; and detection limits.

FIELD QUALITY CONTROL

DUPLICATES AND BLANKS

Duplicate (replicate) samples and field and trip blanks will be collected in the field and submitted to the analytical laboratory to assess the quality of data from the media sampled. Duplicate samples will be used to provide a measure of the internal consistency of the sample and an estimate of variance and bias.

Duplicate (replicate) samples will be collected concurrently with actual samples in exactly equal volumes, at the same location, with the same sampling equipment, and in identical containers. These QC samples will be preserved and handled in the same manner as the regular samples. Each replicate will be evenly split into two samples—one with the sample location number; the second with a different number. This second sample will not be labelled as a duplicate; however, the chain-of-custody form will have "Do QC" marked next to the second (duplicate) sample number. The Navy QA/QC contractor will receive a letter from CH2M HILL field personnel designating the field duplicates after they have been sent to the lab. The purpose of this approach is to satisfy both the Navy QC requirement that lab personnel know which samples to run MS/MSDs on, and the EPA practice of taking blind field duplicates. Duplicates will be collected at a rate of 1 duplicate for every 10 or fewer samples per medium.

Blanks will be analyzed to provide a measure of cross-contamination sources (field blanks), decontamination efficiency (equipment blanks), and other potential errors that can be introduced from sources other than the sample. Trip blanks will accompany the shipment of samples to be analyzed for volatile organic compounds each day volatiles are shipped. Trip blanks will indicate if there is any contamination during shipment and storage. The frequency of field QC samples is indicated in Table 4-1 and are described in detail in Section 10.

FIELD MEASUREMENTS

Field measurements, including pH, dissolved oxygen, specific conductance, and temperature, involve measurements where QA concerns are appropriate but sample collection

Table 4-1 Collection Frequencies of Field QC Samples					
Analysis	Trip Blank	Field Blank	Equipment Blank	Replicate	Additional Volume Needed for MS/MSD
Volatiles	1/day	1/event	1/day average	1/10 samples or fewer	Triple volume per 20 samples or fewer
Semi-Volatiles		1/event	1/day average	1/10 samples or fewer	Triple volume per 20 samples or fewer
Metals		1/event	1/day average	1/10 samples or fewer	Double volume per 20 samples or fewer

is not required. Procedures for field measurements, equipment calibration (where appropriate), and maintenance are documented in Sections 5, 7, and 12, respectively. The primary QA objective for field measurements are to obtain reproducible measurements with a degree of accuracy consistent with limitations of the analytical techniques used and with the intended use of the data.

DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) development process involves three stages, including (1) definition of the question or decision to be made, (2) clarification and precise identification of the information required, and (3) data collection program design.

The following parameters are indicators of the data quality: accuracy, precision, completeness, representativeness, and comparability. Frequencies of QC measures are shown in Table 4-1 and are described in detail in Section 10. Table 4-2 summarizes the quantitative goals for the data quality indicator parameters described below for the three main categories of analysis. These parameters will be determined by QC measures taken in the field and in the laboratory.

ACCURACY AND PRECISION

Accuracy is a measure of the agreement between an experimental result and the true value of the parameter. Sample preparation and analytical accuracy can be determined using known reference materials or matrix spikes. Reference materials are spiked into the actual sample matrix or the laboratory's distilled and/or deionized water. By plotting the results of the method blank spike on control charts, a true picture of the actual process of sample analysis is obtained with fewer problems from matrix effects and sample non-homogeneity. This information, used in conjunction with matrix spike recoveries, aids in determining whether out-of-control conditions are due to laboratory problems or matrix problems. Laboratory performance is also measured by the spiking of surrogate compounds prior to sample preparation.

Accuracy can be expressed as the percent recovery (P) as determined by the following equation:

$$P = \frac{SSR - SR}{SA} \times 100$$

where: SSS = spiked sample result
 SR = sample result (native)
 SA = spike added

Table 4-2
Analytical Precision, Accuracy, and Completeness Objectives

Parameter	Method	Precision^(a) (Relative Percent Dif- ference)	Accuracy^(a) % Spike Recovery	% Completeness
Volatiles	SW-846-8240	See Table 7 of SW-846	See Table 7 of SW-846	85
Semi-Volatiles	SW-846-8270	See Table 7 of SW-846	See Table 7 of SW-846	85
Metals	SW-846- 6010/7000	See Volume 1A of SW-846	See Volume 1A of SW-846	85
	SW-846-8010	See Table 4 of SW-846	See Table 4 of SW-846	85
	SW-846-8020	See Table 4 of SW-846	See Table 4 of SW-846	85
	SW-846-8100	See Table 3 of SW-846	See Table 3 of SW-846	85
	SW-846-8140	See Table 3 of SW-846	See Table 3 of SW-846	85
	SW-846-8080	See Table 4 of SW-846	See Table 4 of SW-846	85
<p>^(a)The laboratory accuracy and precision (spike recoveries and duplicate precision) vary for different parameters. Consult SW-846 for the specific acceptance criteria. SW-846 refers to <i>Test Methods for Evaluating Solid Waste</i>, Third edition, December 1986.</p>				

Precision is the measure of the agreement or repeatability of a set of replicate results obtained from repeat determinations made under the same conditions. The precision of a duplicate determination can be expressed as the relative percent difference (RPD) which is determined by the following equation:

$$RPD = \frac{X1 - X2}{X1 + X2} \times 200$$

where: X1 = first duplicate value
X2 = second duplicate value

For a given laboratory analysis, the replicate RPD values are tabulated, and the mean and standard deviation of the RPD are calculated. Control limits for precision are usually plus or minus two standard deviations from the mean. Laboratory precision limits for the analytical work will be those established by EPA, as indicated in Table 4-2.

Accuracy and precision will be monitored by using field replicate, matrix spike, and matrix spike duplicate samples. These data alone cannot be used to evaluate accuracy and precision of individual samples but will be used to assess the long-term accuracy and precision of the analytical method.

COMPLETENESS

Completeness is defined as the percentage of analytical measurements made that are judged to be valid with validity being defined by the DQOs. Percent completeness is calculated as the number of valid analyses divided by the total number of analyses performed multiplied by 100. The QA objective for this RFI is to obtain valid analytical results for a minimum of 85 percent of the samples collected.

REPRESENTATIVENESS

Representativeness expresses the degree to which sample data accurately and precisely represent parameter variations at a sampling point. Representativeness is a measure of how closely the measured results reflect the actual distribution and concentration of certain chemical compounds in the medium sampled. Section 5 describes the procedures to be used to collect samples. These procedures will generate samples that are as representative as possible. Documentation of field and laboratory procedures, as described in Section 5 and Section 8, will be used to establish that protocols have been followed and that sample identification and integrity have been maintained.

COMPARABILITY

Comparability is the term that describes the confidence with which one data set can be compared to another. Comparability refers to such issues as using standard field and

analytical techniques and reporting data in the same units. This criterion becomes important if more than one field team is collecting samples or more than one laboratory is analyzing the samples.

DETECTION LIMITS

The detection limits for the analytical methods listed in Tables 4-1 through 4-3 of the work plan are as defined by *Test Methods for Evaluating Solid Waste*, SW-846, Third edition, December 1986 and *Standard Methods for the Examination of Water and Wastewater*, 16th Edition, 1985.

Practical Quantification Limits (PQLs) for the Appendix IX constituent are shown in Attachment B.

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Section 5 SAMPLE COLLECTION AND HANDLING PROCEDURES

SAMPLE COLLECTION

Sample collection goals and objectives, sampling locations and media, field measurements, and sample collection procedures are detailed in Section 4 of this RFI work plan. Samples will be collected from soil, groundwater, and surface water and sediments.

SAMPLE HANDLING

SAMPLE CONTAINERS

The sample containers used to collect samples will be compatible with the analyses of interest. Water samples to be tested for organics analysis will be collected in glass bottles with Teflon-lined caps. Water samples for metals analysis will be collected in plastic (polyethylene) bottles. Soil samples will be collected in wide-mouth glass bottles with Teflon-lined caps. The sample containers will be cleaned by the laboratory using standard procedures and protocol for RCRA investigations before shipment to the site. The specific bottle requirements are listed in Table 5-1.

SAMPLE SHIPPING

Samples will be placed in metal coolers packed with an inert material, e.g., vermiculite, in order to avoid bottle breakage. Ice will be packed in ziplocked bags and placed in the coolers to keep the samples cooled to 4°C during shipment. A chain-of-custody form and return label will be sealed in a ziplock bag and taped to the inside lid of the cooler. The cooler will be secured with strapping tape, custody seals, and appropriate carrier's air bill for shipment to the laboratory. All samples will be shipped within 24 hours of sampling by Priority, overnight air express, or hand delivered to the laboratory so that they will reach the laboratory well within their respective holding times.

SAMPLE PRESERVATION

All field and QA samples will be preserved according to the procedures outlined in Table 5-1. The preservatives used on the samples will be HPLC quality, in concentrated form so that only small volumes of preservative will be needed to adjust the pH of the samples. To adjust pH, a disposable eye dropper will be used to add the preservative while the pH is measured simultaneously, with noncontaminating calorimetric tape. Calorimetric tape will not be placed directly in the sample jar. A small

**Table 5-1
Sample Container Preservation and Holding Times Requirments**

Analyte	Container	Preservation	Maximum Holding Time
Water			
Volatile Organic Compounds	Three 40 ml glass vials with Teflon septa	4°C, pH <2 with HCL	14 days
Semi-Volatiles	Two 1 liter amber glass with Teflon lined lid	4°C	7 days until extraction, 40 days after extraction
Metals	One liter polyethylene bottle	4°C, pH <2 with HNO ₃	28 days for Hg, 6 months for others
Pesticides	Two 1-liter amber glass with Teflon-lined lid	4°C	7 days until extraction, 40 days after extraction
PCBs	Two 1-liter amber glass with Teflon-lined lids	4°C	7 days until extraction, 40 days after extraction
Soil/Sediments			
Volatile Organic Compounds	Two 4-oz wide-mouth glass jar with Teflon lined lid	4°C	14 days
Semi-Volatiles	One 8-oz ml wide-mouth glass jar with Teflon lined lid	4°C	14 days until extraction, 40 days after extraction
Metals	One 8-oz ml wide-mouth glass jar with Teflon lined lid	4°C	28 days for Hg, 6 months for others
Dioxin	One 8-oz ml wide-mouth glass jar with Teflon lined lid	4°C	30 days after extraction, 45 days after sample collection
PCB	One 8-oz ml wide-mouth glass jar with Teflon lined lid	4°C	14 days until extraction, 40 days after extraction
Pesticides	One 8-oz ml wide-mouth glass jar with Teflon lined lid	4°C	14 days until extraction, 40 days after extraction
Ignitability	One 16-oz widemouth glass jar		

5-2

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amount aliquot of sample will be spilled over the tape. All appropriate samples will be preserved immediately following sampling. Preservatives will be recorded on the chain-of-custody form.

Since early 1988, EPA sampling protocol has required VOA samples to be acidified to a pH <2. The pH of the samples will be adjusted to <2 by carefully adding 1:1 HCL drop by drop to the required 2 (40 ml) VOA sample vials. The number of drops of 1:1 HCL required will be determined on a third portion of sample water of equal volume. If acidification of the sample causes effervescence, the sample will be submitted without preservation except for cooling to 4°C.

DECONTAMINATION PROCEDURES

The following field equipment decontamination procedures will be used for all Teflon, stainless steel, or metal equipment used to collect samples for organic compounds or trace metals analyses:

1. Wash and scrub with phosphate-free detergent.
2. Rinse with 10 percent methanol solution.
3. Rinse with a 10 percent hexane solution.
4. Rinse with tap water.
5. Rinse with distilled/deionized water.
6. Air dry thoroughly.
7. Wrap with aluminum foil, shiny side out, to prevent contamination during storage and transport.

In cleaning the interior of the sampling pump, 1 gallon of each of the 5 detergents or rinses will be pumped through the pump and Teflon hose. The interior of the purge pump and purge hoses will be cleaned by pouring these liquids through the interior.

All auger flights, auger bits, drilling rods, drill bits, hollow stem augers, split-spoon samplers, shelby tubes, and other parts of the drilling equipment that will contact the soil, and groundwater, will be high-pressure hot water. A decontamination pad will be designated near each well site for all steam cleaning activities. Residual soil from decontamination of drilling equipment will be retained on plastic sheeting and disposed, along with the sheeting into DOT-approved 55-gallon drums. These containerized

solids will be stored temporarily on site pending the final remedy, as outlined in Chapter 4 of the RFI work plan. Decontamination fluids will not be contained; however, cloth laid down to trap suspended sediments will be contained.

The following cleaning procedure will be used to clean field equipment, i.e., water level indicator, bladder pumps, and any hoses used to purge groundwater wells:

1. Wash with phosphate-free detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Place equipment in a polyethylene bag or wrap with polyethylene film to prevent contamination during storage or transport as appropriate.

All personnel wash and rinse water will be placed in the decontamination pad sump and handled with those liquids. Disposable clothing and gloves will be placed in garbage bags and disposed of as outlined in the RFI work plan.

FIELD NOTEBOOKS

Field notebooks will be used to record general data collection activities performed by field personnel during the RFI. Entries will be in waterproof ink and written in sufficient detail so that a history of the sampling event can be reconstructed with minimum reliance on memory.

Field notebooks to be used will be bound field survey books. Notebooks will be assigned to all field personnel.

After project completion these documents will be in the custody of the Field Manager. Each notebook will be identified by the project-specific number. Pages will be numbered.

The cover of the notebook will indicate:

- Person or organization to whom book is assigned
- Book number
- Project name
- Start date
- End date

Notebook entries will contain a variety of information. At the beginning of each daily entry field personnel will record the date, start time, and current weather. Names of field personnel present, the level of personal protection being used onsite, the names of visitors to the site, and the purpose of their visit will be recorded. Difficulties, accidents, incidents, or deviations from the work plan will also be recorded and explained in the notebook. The bottom of each page will be signed by the person making entries. Each line on a page should be used or, if not used, should be crossed out, signed, and dated.

The person making entries will initial the entries. Corrections will be made by drawing a single line through the error and initialing and dating the correction. Information may not be erased or rendered unreadable. Wherever sample/data collection is recorded in the field notebook, a detailed description of the location of the station will be recorded.

Equipment used by field personnel to make measurements will be identified along with the data of last calibration. Any equipment used by field personnel to collect samples will also be noted, along with the time of sampling and all field parameters measured.

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Section 6

SAMPLE CUSTODY

During the RFI, samples will be collected for the purposes of defining the presence or absence of contamination. For this reason, the possession of samples must be traceable from the time the samples are collected until they are analyzed. Chain-of-custody procedures are used to maintain and document sample possession during collection and analysis. The principal documents used to identify samples and to document possession are:

- Sample labels
- Chain-of-custody record forms
- Air bills (e.g., Federal Express, Purolator, etc.)
- Field notebooks

SAMPLE LABELS

Samples will be identified by a unique number as soon as the sample is obtained. Labels will be attached to each sample container. The label will contain at a minimum the following information:

- Project name
- Boring designation
- Medium, e.g., soil
- Identification number
- Date and time of sample collection
- Name of sample collector

CHAIN OF CUSTODY

Before a sample is removed from the sample location and transferred to the laboratory for analysis, it will be preserved if required in accordance with prescribed procedures, and each will be identified with a separate chain of custody form shown by Figure 6-1.

DEFINITION OF CUSTODY

A sample is under custody if one or more of the following criteria is met:

- It is in the sample collector's possession.
- It is in the sample collector's view, after being in the person's possession.

- It was in the sample collector's possession and then safeguarded to prevent gross contamination.
- It is in a designated secure area.

FIELD CUSTODY PROCEDURES

The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly under chain-of-custody procedures. Field custody procedures include:

- Collect only enough sample volume to provide a good representation of the media being sampled. The quantity and types of samples and sample locations are outlined in Section 5. As few people as possible should handle samples.
- Record the following information on the chain- of- custody form:
 - Project name
 - Identification number
 - Time, date, location, and depth of sample
 - Type of analysis requested
 - Sample preservation if used
 - Signature of person relinquishing/receiving sample
 - Designation of samples for which QC, including MS and MSDs, is to be done

TRANSFER OF CUSTODY AND SHIPMENT

All shipments are accompanied by the chain of custody record identifying its contents. The original record accompanies the shipment; the pink copy is retained by the FM. When transferring samples, the individuals relinquishing and receiving sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the offsite laboratory.

Shipping containers are sealed for shipment to the laboratory. The method of shipment, courier name(s), and other pertinent information are entered in the "Remarks" section of the chain of custody record.

LABORATORY CUSTODY PROCEDURES

A designated sample custodian will accept custody of the shipped samples and will verify that the identification numbers on the container labels match that on the chain of

custody record form. The custodian will also verify that custody seals on the sample shipment containers are intact. The custodian will then enter the identification numbers into a bound logbook.

The laboratory custodian will then use either the identification number or will assign a unique laboratory number to each sample and will ensure that all samples are transferred to the proper analyst or stored in the appropriate secure area.

The custodian will distribute the samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian.

When sample analyses and necessary QA checks have been completed, the unused portion of the sample must be disposed of properly. All identifying stickers, data sheets, and laboratory records will be retained as part of the permanent documentation.

SAMPLE DISPOSAL

Unless otherwise instructed, the analytical laboratory will dispose of unused sample portions, according to Resource Conservation and Recovery Act (RCRA) regulations, after the analyses have been completed and any outstanding issues between the contractor and the laboratory have been resolved.

WDCR544/012.51

Section 7 EQUIPMENT CALIBRATION

During the RFI, field measurements will be taken with the following equipment: pH meter, an HNu, a conductivity meter, and a dissolved oxygen meter.

FIELD EQUIPMENT CALIBRATION

Calibration procedures for the equipment to be used in the field (described above) are reported in Attachment A of this DCQAP. A copy of the calibration procedures will be kept on file by the field manager.

If an individual suspects an equipment malfunction, the device shall be removed from service, tagged so that it is not inadvertently used, and the CH2M HILL equipment manager notified so that a substitute piece of equipment can be used. Back-up equipment will be available in the field for use in the event of a malfunction.

Equipment that fails calibration or becomes inoperable during use shall be removed from service and either segregated to prevent inadvertent use or tagged to indicate it is out of calibration. Such equipment shall be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

Results of activities performed using equipment that has failed recalibration shall be evaluated. If the results are adversely affected, the outcome of the evaluation will be documented and the PM notified.

LABORATORY CALIBRATION

Laboratory calibration procedures and frequency of calibration are specified in the Standard Operating Procedures (SOP) of CH2M HILL's laboratory described in the *Quality Assurance Manual*, CH2M HILL SOUTHEAST, INC., Environmental Laboratory, June 1990.

WDCR544/013.51

Section 8

ANALYTICAL PROCEDURES

Samples will be analyzed for compounds listed in Tables 4-1 through 4-3 of the RFI work plan. Specific analytical methods reported in *Test Methods for Evaluating Solid Wastes*, U.S. EPA SW846, Third Edition, December 1986 are also listed in Tables 4-1 through 4-3.

In order to achieve the data quality objectives identified in Section 4, the Navy's Installation Restoration Program analytical Level C will be used. The laboratory method requirement and required deliverables are included as Attachment C of this DCQAP.

WDCR544/014.51

Section 9

DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting are steps in the overall management and use of both field and laboratory data. Figure 9-1 shows the flow of information and sample tracking forms. The Data Management Plan is detailed in Chapter 5 of the RFI work plan.

DATA REDUCTION

DEFINITION

Data reduction frequently includes computation of summary statistics and their standard errors. Data reduction will be done manually using existing data tables. All quantitative field and analytical data collected will be tabulated.

Units for sediment sample results will be reported in ug/kg and for water samples, ug/l.

DATA COLLECTION

The data collected at the site includes pH, temperature, conductivity, dissolved oxygen, etc. These data will be recorded in log books.

BACKGROUND DATA

Background data produced for internal records and not reported as part of the analytical data include the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standards records, maintenance records, calibration records, and associated quality control. These sources will be available for inspection during audits and to determine the validity of data.

DATA VALIDATION

CH2M HILL will conduct the validation of the analytical data in accordance with the most current versions of the EPA documents, *Laboratory Data Validation, Functional Guidelines for Evaluating Organics and Inorganics Analyses*, EPA Region III Functional Guidelines Modifications, and data validation procedures reported in *Sampling and Chemical Analysis Quality Assurance Requirements of the Navy Installation and Restoration Program* (Attachment C).

Region III will be contacted to verify that the most current version is being used before conducting the data validation. The data validation personnel are familiar with the NAS Oceana RFI, its objectives, and the intended use of the data. A data validation report using the format specified by the Region will be prepared.

REPORTING

CONTENTS OF REPORT

The laboratory report will contain such information for samples as:

- Title and location of the project
- Project identification number
- Name of the report
- Date report was prepared
- Name, address, and telephone number of the Subcontractor
- Sample identification number
- Name and location of sample
- Type of sample (water, soil, waste, air)
- Date on which analysis was performed
- Any special observations, circumstances, or comments that may be relevant for interpretation of the data
- The laboratory manager's signature

Each parameter tested will include: name of parameter, testing procedure references, results of analysis, and the units of the reported results.

RECORDS

The following describes procedures for maintaining the project's records:

- The PM shall maintain records in accordance with the requirements of this section until those records are turned over to NAS Oceana.

- Records of field activities that support the integrity of samples shall be entered on bound and numbered pages. Such records shall be dated and signed or otherwise authenticated on the day of entry.
- Records retained on file shall be indexed. The indexing system shall include the location of records within the indexing system. (The indexing system shall be in alphabetical, chronological or numerical order, or as otherwise indicated in written procedures).
- There shall be sufficient information in records to permit identification between the record and the item(s) or activity to which it applies. Identification of records will be by means that permit traceability.
- The records storage system shall provide for accurate retrieval of records without undue delay.

WDCR544/018.51

Section 10 QUALITY CONTROL CHECKS

A number of QA/QC samples will be collected to check the adequacy of sample collection and analysis and to monitor laboratory performance.

Duplicates, blanks, and spiked samples are used to test the sampling technique to determine if the technique affects the analytical results, to measure the internal consistency of the samples, and to estimate any variance or bias in the analytical process. The field and laboratory QA/QC sampling procedures are described below.

FIELD SAMPLING QUALITY CONTROL PROCEDURES

Several QA samples will be collected to confirm the reliability and validity of the field data gathered during the RFI. Replicate (duplicate) samples are used to provide a measure of the internal consistency of the samples and an estimate of variance and bias. Blanks provide a measure of cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. Table 4-2 shows the collection frequencies of the field QC samples.

REPLICATE/DUPLICATE SAMPLES

One field replicate (duplicate) sample will be obtained for every 10 field samples collected, per medium. The sampling station from which the duplicate is taken will be randomly selected for each event. Each replicate sample will be split evenly into two sample containers and submitted for analysis as two independent samples with different numbers, such that the duplicate is blind.

FIELD BLANKS

Field blank samples will consist of source water and used for decontamination and steam cleaning and be handled in the same manner as the regular samples. One such blank will be collected for each sampling event (sampling event is defined as duration of a specific set of field tasks, such as a one-week period of monitor well drilling and installation).

TRIP BLANKS

A trip blank is a 40-ml glass vial filled with Type II reagent grade water. The trip blanks will be supplied by the laboratory and accompany the analytical samples back to the laboratory and are handled like a sample. One trip blank will be submitted with each day's analytical samples that are shipped offsite for analysis of volatile organic compounds.

EQUIPMENT BLANK

One equipment (rinsate) blank will be included, on average, with each daily shipment of samples for each media sampled. These blanks will be collected in the field to identify errors, such as contamination resulting from poor sampling techniques. After sample collection equipment is decontaminated, it will be rinsed with distilled, deionized water and the rinsate will be collected, packed, and shipped with the other samples.

LABORATORY ANALYTICAL QUALITY CONTROL PROCEDURES

The analytical laboratory will use all of the quality control elements as specified by the EPA Contract Laboratory Program, including matrix spikes, duplicates, and laboratory blanks.

MATRIX SPIKES AND DUPLICATES

Matrix Spike will be spiked with the analyte being analyzed for two separate aliquots of a sample selected for a batch of 18 field samples. The MS/MSD and 18 field samples will consist of a batch of 20 samples. The MS/MSD results will be used to assess accuracy and precision. The MSD is not required for inorganic analysis.

The MSD is a sample identical to the MS which is analyzed to determine reproducibility of results.

Laboratory Blanks

For each extraction batch, a method blank will be analyzed to check on any background contamination for the laboratory.

Method blanks will be analyzed for background contamination from the laboratory as specified by the manual.

WDCR544/019.51

Section 11

PERFORMANCE AND SYSTEMS AUDITS

The audits will cover, in general, verification that approved procedures are used, personal responsibilities are clearly defined, a COC program and records retention program are in place, and corrective action of variances taken by personnel is responsive and timely.

LABORATORY PERFORMANCE AND SYSTEMS AUDITS

The analytical laboratory will conduct both internal and external quality control checks. External quality control checks include participation in EPA's certification programs in which laboratories analyze QC samples of known concentrations received from EPA. CH2M HILL's laboratory schedule for conducting audits is outlined in the *Quality Assurance Manual*, June 1990.

FIELD TEAM PERFORMANCE AND SYSTEMS AUDITS

A performance audit will be conducted by the PM and FM during the first week of sampling to verify that proper procedures are followed and that subsequent sample data will be valid. The audit will focus on the details of the QA program. The audit checklist, which will serve as the guide for the performance audit for field procedures, is shown in Figure 11-1. The audit will evaluate the organization of responsibilities to determine whether the QA organization is operational, as well as verify whether or not the following is taking place:

- The quality assurance organization is operational
- Collection of samples followed the available written procedures
- COC procedures are followed for traceability of sample origin
- Specified equipment was available, calibrated, and in proper working order
- Sampling crews were adequately trained
- Recordkeeping procedures were followed; field notebooks, logsheets, bench sheets, and tracking forms are properly prepared and maintained
- Corrective action procedures are followed

Figure 11-1
FIELD PERFORMANCE AND AUDIT CHECKLIST

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members: _____

Yes ___ No ___ 1) Was a DCQAP prepared?
Comments _____

Yes ___ No ___ 2) Was a briefing held for project participants?
Comments _____

Yes ___ No ___ 3) Were additional instructions given to project participants?
Comments _____

Sample Collection

Yes ___ No ___ 1) Is there a written list of sampling locations and descriptions?
Comments _____

Yes ___ No ___ 2) Were samples collected as stated in the DCQAP?
Comments _____

Yes ___ No ___ 3) Were samples collected in the types of containers specified in the DCQAP?
Comments _____

Yes ___ No ___ 4) Was sample equipment available, calibrated, and in proper working order?
Comments _____

Yes ___ No ___ 5) Were samples preserved as specified in the DCQAP?
Comments _____

Yes ___ No ___ 6) Were the numbers, frequency, and types of samples collected as specified in the DCQAP?
Comments _____

Yes ___ No ___ 7) Were quality assurance checks performed as specified in the DCQAP?
Comments _____

Yes ___ No ___ 8) Were photographs taken and documented as specified in the DCQAP?
Comments _____

Document Control

Yes ___ No ___ 1) Have any accountable documents been lost?
Comments _____

Yes ___ No ___ 2) Have any accountable documents been voided?
Comments _____

Yes ___ No ___ 3) Have any accountable documents been disposed of?
Comments _____

Yes ___ No ___ 4) Are the samples identified with sample tags?
Comments _____

Yes ___ No ___ 5) Are blank and duplicate samples properly identified?
Comments _____

Yes ___ No ___ 6) Are samples listed on a chain-of-custody record?
Comments _____

Yes ___ No ___ 7)

Is chain-of-custody documented and maintained?

Comments _____

An audit report summarizing any results and corrections will be prepared and filed in the project files. Significant variances from established procedures will be reported to NAS, Oceana. Adherence to the general QA procedures, as specified above, will be checked continuously by the designated FM during the remainder of sampling. Significant variances will be reported to NAS Oceana.

WDCR544/020.51

Section 12
PREVENTIVE MAINTENANCE

Routine maintenance procedures and schedules for sampling equipment are described in the manufacturers' instruction manuals. All records of inspection and maintenance will be dated and documented in the field notebook.

Maintenance procedures and schedules for all field and laboratory analytical instruments will be in strict accordance with the recommendations of the equipment manufacturers. Routine maintenance will be performed by laboratory personnel as needed. All records of inspection and maintenance will be dated and documented in laboratory record books.

Critical spare parts for the pH and conductivity meters include batteries and electrodes; they will be included in the sampling kits to minimize downtime.

WDCR544/022.51

Section 13 DATA ASSESSMENT PROCEDURES

The precision and accuracy of data will be routinely assessed to ensure that they meet the requirements of the DQOs presented in Table 4-1. If enough data are generated, the precision, accuracy, and completeness may be assessed using statistical procedures.

Precision is commonly determined from duplicate samples; thus, precision is usually expressed as RPD or relative standard deviation (RSD). These quantities are defined as follows.

$$RPD = 100 \times 2 \frac{X_1 - X_2}{(X_1 + X_2)}$$

$$RSD = (100/\sqrt{2}) \times [2 (X_1 - X_2) / (X_1 + X_2)]$$

where X_1 and X_2 are the reported concentrations for each duplicate sample

Accuracy is commonly presented as percent bias or percent recovery. Percent bias is a standardized average error; that is, the average error divided by the actual or spiked concentration and converted to a percentage. Percent bias is unitless, so it allows the accuracy of analytical procedures to be compared easily.

Percent recovery provides the same information as percent bias. Accuracy is often determined from spiked samples. Percent recovery is defined as:

$$\% \text{ Recovery} = \frac{R}{S} \times 100$$

where S = spiked concentration
 R = reported concentration

Given this definition it can be shown that

$$\% \text{ bias} = \% \text{ recovery} - 100$$

WDCR544/023.51

Section 14 QA/QC CORRECTIVE ACTIONS

The PM is responsible for initiating project corrective actions. Corrective action steps will include problem identification, investigation responsibility assignment, investigation, action to eliminate the problem, increased monitoring of the effectiveness of the corrective action, and verification that the problem has been eliminated.

Documentation of the problem is important to the overall management of the study. A Corrective Action Request Form for problems associated with sample collection, shown in Figure 14-1, will be completed by the person discovering the QA problem. This form identifies the problem, establishes possible causes, and designates the person responsible for action. The responsible person will be either the FM or CH2M HILL's designated field QC officer.

The Corrective Action Request Form includes a description of the corrective action planned and has space for follow-up. The field QC officer will verify that initial action has been taken and appears to be effective and, at an appropriate later date, check to see if the problem has been fully resolved. The field QC officer receives a copy of all Corrective Action Request Forms and enters them into the Corrective Action Log. This permanent record will aid the field QC officer in follow-up and will assist in resolving quality assurance problems with the PM.

For the CH2M HILL laboratory, corrective action procedures are required as the result of nonconformance with QA/QC criteria or audit results. The first level of responsibility lies with the staff. The analysts will monitor performance and take actions as necessary. Documentation of nonconformance will be achieved by recording the circumstances in the daily logbook; successes and failures in corrective actions will be recorded as well. The laboratory operations manager will be notified in all cases. The second level of responsibility lies with the data reviewer as described in Section 9.0.

Examples of corrective actions include, but are not limited to, correcting COC forms, analysis reruns (if holding time criteria permit), recalibration with fresh standards, replacement of sources of blank contamination, examination of calculation procedures, reassignment of analytical responsibilities using a different batch of containers, or recommending an audit of laboratory procedures. An additional approach may be to accept the data and acknowledge the level of uncertainty or inaccuracy by flagging the data and providing an explanation for the qualification.

WDCR544/024.51

Figure 14-1
CORRECTIVE ACTION REQUEST FORM
(Sample Collection)

Originator: _____ Date _____

Person responsible for replying: _____

Description of problem and when identified: _____

State cause of problem, if known or suspected: _____

Sequence of Corrective Action (CA): (If no responsible person is identified, submit this form directly to the field QC officer.)

State date, person, and action planned:

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approval by: _____ Date: _____

Information copies to:

RESPONSIBLE PERSON: _____

Field QC Officer: _____

PM: _____

Section 15
QUALITY ASSURANCE REPORTS

A QA report will be completed at the end of the field activity to summarize the QA/QC status of the project and any problems. The report will be an assessment of the measured QA parameters; for example, precision, accuracy, and results of performance audits; any reported non-conformance; and any significant QA problems and the recommended solutions. Any change in the DCQAP will be summarized in a report or letter and sent to LANTNAVFACENCOM and distributed to the CH2M HILL project team.

Navy requirements for monthly reports for laboratory quality control are included in Attachment C.

For this project, no separate report is anticipated to describe the QA/QC achieved. The final project report will contain separate QA sections that summarize QA/QC information generated during the course of the project.

WDCR544/026.51

STANDARD OPERATING PROCEDURES

1. Field Measurement of pH
2. Field Measurement of Specific Conductance and Temperature
3. Dissolved Oxygen Meter Monitoring
4. HNu Monitoring

SOP NO. 1: FIELD MEASUREMENT OF pH**I. PURPOSE**

To provide a general guideline for field measurement of pH.

II. SCOPE

Standard field pH determination techniques for use on groundwater samples.

III. EQUIPMENT AND MATERIALS

- o pH buffer solution for pH 4, 7, and 10
- o Deionized water in squirt bottle
- o pH meter
- o Combination electrodes
- o Beakers
- o Glassware that has been washed with soap and water, rinsed twice with hot water, and rinsed twice with deionized water

IV. PROCEDURES AND GUIDELINES**A. CALIBRATION**

Calibrate unit prior to initial daily use and at least once every 4 hours or every five samples, whichever is less. Calibrate with at least two solutions. Clean probe according to manufacturer's recommendations. Duplicate samples should be run once every 10 samples or every 4 hours.

1. Place electrode in pH 7 buffer solution.
2. Allow meter to stabilize and then turn calibration dial until a reading of 7.0 is obtained.
3. Rinse electrode with deionized water and place it in a pH 4 or pH 10 buffer solution.
4. Allow meter to stabilize again and then turn slope adjustment dial until a reading of 4.0 is obtained for the pH 4 buffer solution or 10.0 for the pH 10 buffer solution.

SOP. NO. 1

5. Rinse electrode with deionized water and place in pH 7 buffer. If meter reading is not 7.0, repeat sequence.

B. PROCEDURE

1. Before going out into the field:
 - a) Check batteries.
 - b) Do a quick calibration at pH 7 and 4 to check electrode.
 - c) Obtain fresh solutions.
2. Calibrate meter using calibration procedure.
3. Pour the sample into a clean beaker.
4. Rinse electrode with deionized water between samples.
5. Immerse electrode in solution. Make sure the white KCl junction on the side of the electrode is in the solution. The level of electrode solution should be one inch above sample to be measured.
6. Recheck calibration with pH 7 buffer solution after every five samples.

C. GENERAL

1. When calibrating the meter, use pH buffers 4 and 7 for samples with pH <8, and buffers 7 and 10 for samples with pH >8. If meter will not read pH 4 or 10, something may be wrong with the electrode.
2. Measurement of pH is temperature dependent. Therefore, buffers temperatures should be within about 2 degrees C of sample temperatures. For refrigerated or cool samples, use refrigerated buffers to calibrate the pH meter.
3. Weak organic and inorganic salts and oil and grease interfere with pH measurements. If oil and grease are visible, note it on the data sheet. Clean electrode with soap and water and rinse with distilled water. Then recalibrate meter.

4. Following field measurements:
 - a) Report any problems.
 - b) Compare with previous data.
 - c) Clean all dirt off meter and inside case.
 - d) Store electrode in pH 4 buffer.
5. Accuracy and precision are dependent on the instrument used; refer to manufacturer's manual. Expected accuracy and precision are +/- 0.1 pH unit.

V. ATTACHMENTS

pH meter calibration sheet

VI. KEY CHECKS AND ITEMS

- o Check batteries
- o Calibrate

VII. PREVENTIVE MAINTENANCE

- o Refer to operation manual for recommended maintenance.
- o Check batteries, have a replacement set on hand.

pH METER CALIBRATION SHEET

<u>Date</u>	<u>Time</u>	<u>Analyst Initials</u>	<u>Instrument Readings</u>				<u>Comments</u>	
			<u>Uncalibrated</u>		<u>Calibrated</u>			
			<u>(Two Required)</u>		<u>(Two Required)</u>			
			<u>@pH4</u>	<u>@pH7</u>	<u>@pH4</u>	<u>@pH7</u>		

SOP NO. 2: FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE AND TEMPERATURE**I. PURPOSE**

To provide a general guideline for field measurement of specific conductivity and temperature.

II. SCOPE

Standard field conductivity and temperature techniques for use on groundwater samples.

III. EQUIPMENT AND MATERIALS

- o Conductivity meter and electrode
- o Distilled water in squirt bottle
- o Standard potassium chloride (KCl) solution (0.01 N)

IV. PROCEDURES AND GUIDELINES

TECHNICAL: Detection limit = 1 umho/cm @ 25°C; range = 0.1 to 100,000 umho/cm

CALIBRATION

Calibrate prior to initial daily use and at least once every 4 hours or every five samples, whichever is less. Calibrate with standard solution. The standards should have different orders of conductance. Clean probe according to manufacturer's recommendations. Duplicates should be run once every 10 samples or every 4 hours.

1. With mode switch in OFF position, check meter zero. If not zeroed, set with zero adjust.
2. Plug probe into jack on side of meter.
3. Turn mode switch to red line and turn red line knob until needle aligns with red line on dial. If they cannot be aligned, change the batteries.
4. Immerse probe in 0.01 N standard KCl solution. Do not allow the probe to touch the sample container.
5. Set the mode control to **TEMPERATURE**. Record the temperature on the bottom scale of the meter in degrees C.

SOP NO. 2

6. Turn the mode switch to appropriate conductivity scale (i.e., x100, x10, or x1). Use a scale that will give a midrange output on the meter.
7. Wait for the needle to stabilize. Multiply reading by scale setting and record the conductivity. The conductivity must then be corrected for temperature.
8. Calculate conductivity using the formula:

$$G_{25} = G_T / [1 + 0.02 (T - 25)]$$

Where:

G_{25} = conductivity at 25°C, umho/cm

T = temperature of sample, degrees C

G_T = conductivity of sample at temperature T , umho/cm

The table below lists the values of conductivity the calibration solution would have if the distilled water were totally nonconductive, however, even water of very high purity will still possess a small amount of conductivity.

<u>Temperature °C</u>	<u>Conductivity (umho/cm)</u>
15	1,141.5
16	1,167.5
17	1,193.6
18	1,219.9
19	1,246.4
20	1,273.0
21	1,299.7
22	1,326.6
23	1,353.6
24	1,380.8
25	1,408.1
26	1,436.5
27	1,463.2
28	1,490.9
29	1,518.7
30	1,546.7

9. Rinse the probe with deionized water.
10. Run sample and rinse with deionized water when done.

V. ATTACHMENTS

Conductivity meter calibration sheet

VI. KEY CHECKS AND ITEMS

- o Check battery.
- o Calibrate.
- o Clean probe with deionized water when done.
- o When reading results, note sensitivity settings.

VII. PREVENTIVE MAINTENANCE

- o Refer to operations manual for recommended maintenance.
- o Check batteries, and have a replacement set on hand.

CONDUCTIVITY METER CALIBRATION SHEET

<u>Date</u>	<u>Time</u>	<u>Analyst</u> <u>Initials</u>	<u>Instrument Readings</u>		<u>Comments</u>
			<u>Uncalibrated</u> <u>@EC=225</u>	<u>Calibrated</u> <u>@EC=225</u>	

SOP. NO. 3

SOP NO. 3: DISSOLVED OXYGEN METER MONITORING**I. PURPOSE**

To provide general guidelines for the calibration and use of the Dissolved Oxygen (DO) meter.

II. SCOPE

This is a general guideline for the field use of a DO meter. For specific instructions, refer to the operations manual.

III. EQUIPMENT AND MATERIALS

- o Operations manual
- o A DO probe and readout/control unit with batteries
- o Electrolyte solution (KCl dissolved in deionized water) and probe membrane

IV. PROCEDURES AND GUIDELINES**A. CALIBRATION**

Calibrate prior to initial daily use before any readings are taken. Clean probe according to manufacturer's recommendations.

1. Prepare DO probe according to manufacturer's recommended procedures using electrolyte solution.
2. In the off position, set the pointer to zero using the screw in the center of the meter panel.
3. Turn function switch to red line and adjust using red line knob until the meter needle aligns with red mark at the 31 degrees C position.
4. Turn function switch to zero and adjust to zero using the zero control knob.
5. Attach prepared probe and adjust retaining ring finger tight.

SOP. NO. 3

6. Allow 15 minutes for optimum probe stabilization (when meter is off or during disconnection of the probe).
7. Place probe in hollow stopper that is supplied for use with the YSI Calibration Chamber.
8. Place approximately 1/2 inch of deionized water into a 4-ounce, wide mouth screw cap bottle. Keep this bottle capped and with the DO meter.
9. Just before use, shake the bottle to saturate the water with air.
10. Remove cap, place probe in bottle keeping an air-tight seal around the rubber stopper. Swirl water around in the bottle while waiting for conditions to reach equilibrium.
11. Shield chamber from sun and wind to avoid temperature fluctuations during calibration.
12. Turn function switch to temperature and record temperature reading. Determine calibration factor for that temperature and altitude correction factor from tables supplied by manufacturer.
13. Multiply the calibration factor by the correction factor to get a corrected calibration value.
14. Turn function switch to appropriate ppm range and adjust the calibrate knob until the meter reads the corrected calibration value. Wait two minutes to verify calibration value. Readjust as necessary.

B. PROCEDURE

1. Before going out into the field:
 - a) Check batteries
 - b) Obtain fresh electrolyte solution
 - c) Prepare DO probe
2. Calibrate meter using calibration procedure.

SOP. NO. 3

3. Place probe in water to be measured. In a stream (1 ft/sec or greater), the probe should be placed at mid depth in the main thread of flow. If the stream is not flowing at 1 ft/sec, the probe should be moved through the water at this velocity or use a probe with a built-in stirrer.
4. Allow sufficient time for probe to stabilize to water temperature and DO. Record DO meter reading.

V. ATTACHMENTS

DO meter calibration sheet

VI. KEY CHECKS AND ITEMS

- o Battery check
- o Calibration

VII. PREVENTIVE MAINTENANCE

- o Refer to operation manual for recommended maintenance.
- o Check batteries, have replacement set on hand.

**DO METER
CALIBRATION SHEET**

<u>Date</u>	<u>Time</u>	<u>Analyst's Signature</u>	<u>Temp (C)</u>	<u>Alt (ft)</u>	<u>Predict (ppm O₂)</u>	<u>Actual (ppm O₂)</u>	<u>Comment</u>
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RAYMK2/015.50

SOP NO. 4: HNu MONITORING**I. PURPOSE**

To provide general guidelines for the calibration and use of the HNu photoionization detector.

II. SCOPE

This is a broad guideline for the field use of an HNu. For specific instructions, refer to the operations manual.

III. EQUIPMENT AND MATERIALS

- o Operations manual
- o An HNu readout/control unit and photoionization probe (either 10.2 or 11.7 eV depending on requirements) with fully charged battery pack
- o Charging unit
- o A cylinder of calibration gas, typically 100 ppm isobutylene in air
- o A regulator for the calibration gas cylinder
- o A short length of 1/8th-inch tube to transfer calibration gas from the cylinder to the HNu probe (as short as possible)

IV. PROCEDURES AND GUIDELINES

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL

A. CALIBRATE THE HNu

1. Identify the probe by lamp model.
2. Connect the sensor/probe to the readout/control unit.
3. Perform a battery check by turning the function switch to "Batt."
4. Turn function switch to "Standby" and set the readout to zero by turning the zero knob.

SOP NO. 4

5. Hold the sensor/probe to your ear to verify that it is powered. A faint humming sound will be heard.
6. Set the range to the appropriate setting.
7. Connect the tube from the calibration gas cylinder to the end of the probe and open the valve on the calibration gas cylinder.
8. Sample the calibration gas and adjust to the proper reading with the span control knob.
9. If calibration cannot be achieved, disassemble the sensor/probe assembly and clean lamp. If the span knob setting is at the end of the span range, unit must be serviced by qualified personnel.

B. SAMPLING WITH THE HNu

1. Once calibration is complete, unit is ready for sampling. When not in use, set function knob to "Standby."
2. When done for the day, turn unit off and disconnect the sensor/probe.
3. Charge the battery overnight (complete recharge takes 14 hours).
4. For preventive maintenance, refer to instruction manual.

V. ATTACHMENTS

HNu calibration sheet

VI. KEY CHECKS AND ITEMS

- o Check battery.
- o Zero and calibrate.
- o Verify sensor probe is working.
- o Recharge unit after use.

VII. PREVENTIVE MAINTENANCE

A complete preventive maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual.

- o A complete spare HNu should be available on site whenever field operations require this instrument.
- o A spare lamp should be on hand so a defective unit can be changed without returning the unit.
- o Occasional cleaning of the lamp should be performed as needed.
- o Charge batteries daily.
- o Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

HNu CALIBRATION SHEET

<u>Date</u>	<u>Time</u>	<u>Analyst Initials</u>	<u>Uncalibrated @10 ppm</u>	<u>Calibrated @10 ppm</u>	<u>Comments</u>
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Attachment B
PRACTICAL QUANTITATION LIMITS

INORGANICS

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	IX	HBM		POL		SUGGESTED METHOD
					SOIL mg/kg	WATER mg/l	SOIL mg/kg	WATER mg/l	
Aluminum phosphide (as Al)	20859-73-8				3E+1	1E-2	2E+1	5E-1	6010
Antimony	7440-36-0	X	X	X	3E+1	5E-3	2E+1	3E-2	6010(s) 7041(w)
Arsenic	7440-38-2	X	X	X	4E-1	5E-2	3E+1	1E-2	6010(s) 7060(w)
Barium	7440-39-3	X		X	1E+3	5E 0	1E 0	2E-2	6010
Beryllium	7440-41-7	X	X	X	2E-1	1E-3	2E-1	3E-3	6010
Cadmium	7440-43-9	X	X	X	2E 0	5E-3	2E 0	1E-3	6010(s) 7131(w)
Chromium	7440-47-3	X	X	X	3E-1	1E-1	4E 0	1E-2	6010(s) 7191(w)
Lead	7439-92-1	X	X	X	1.5E+2	5E-2	2E+1	1E-2	6010(s) 7421(w)
Mercury	7439-97-6	X	X	X	2E+1	2E-3	1E-1	2E-3	7470
Nickel	7440-02-0	X	X	X	1E+3	1E-1	8E 0	2E-1	6010
Selenium	7782-49-2	X	X	X	2E+2	5E-2	4E+1	2E-2	6010(s) 7740(w)
Silver	7440-22-4	X	X	X	2E+2	5E-2	4E 0	2E-3	6010(s) 7761(w)
Thallium	7440-28-0	X	X	X	6E 0	1E-3	2E+1	1E-2	6010(s) 7870(w)
Vanadium	7440-62-2	X		X	1E+3	3E-1	4E 0	8E-2	6010
Zinc	7440-66-6	X	X	X	1E+3	7E 0	1E 0	2E-2	6010
vanide (amenable)	57-12-5				1E+3	2E-1	4E-2	4E-2	9010

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DIOXINS & DIBENZOFURANS

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	IX	HM	HM	PQL	PQL	SUGGESTED METHOD
					SOIL	WATER	SOIL	WATER	
					mg/kg	mg/l	mg/kg	mg/l	
2,3,7,8-TCDDioxin	1746-01-6			X	4E-6	5E-8	2E-3	1E-5	8280
2,3,7,8-PeCDDioxins				X	8E-6	1E-7	2E-3	1E-5	8280
2,3,7,8-HxCDDioxins				X	4E-5	5E-7	2E-3	1E-5	8280
1,3,7,8-HpCDDioxins					4E-4	5E-6	2E-3	1E-5	8280
CDDioxins	3268-87-9				4E-3	5E-5	2E-3	1E-5	8280
1,3,7,8-TCDFuran	51207-31-9			X	4E-5	2E-9	2E-3	1E-5	8280
1,2,3,7,8-PeCDFuran				X	8E-5	4E-9	2E-3	1E-5	8280
1,3,4,7,8-PeCDFuran	57117-31-4			X	8E-6	4E-10	2E-3	1E-5	8280
1,3,7,8-HxCDFurans				X	4E-5	2E-9	2E-3	1E-5	8280
1,3,7,8-HpCDFurans					4E-4	2E-8	2E-3	1E-5	8280
CDFurans					4E-3	2E-7	2E-3	1E-5	8280

PESTICIDES & PCB'S

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HEM	HEM	PGL	PGL	SUGGESTED METHOD
					SOIL mg/kg	WATER mg/l	SOIL mg/kg	WATER mg/l	
Aldrin	309-00-2	X	X	X	4E-2	2E-6	3E-3	4E-5	8080
Aramite	140-57-8			X	3E+1	1E-3	7E-1	2E-2	8270
alpha-BHC *syn.* alpha-Hexachlorocyclohexane	319-84-6	X	X	X	1E-1	6E-6	2E-3	3E-5	8080
meta-BHC *syn.* beta-Hexachlorocyclohexane	319-85-7	X	X	X	4E-1	2E-5	4E-3	6E-5	8080
gamma-BHC *syn.* Lindane	58-89-9	X	X	X	2E+1	2E-6	3E-3	4E-5	8080
Chlordane	57-74-9	X	X	X	5E-1	2E-3	2E-3	5E-5	8080
Chlorobenzilate *syn.* Ethyl-4,4'-dichlorobenzilate	510-15-6			X	1E+3	7E-1	3E-1	1E-2	8270
DDE	72-54-8	X	X	X	3E 0	1E-4	3E-3	1E-4	8080
DDE	72-55-9	X	X	X	2E 0	1E-4	3E-3	4E-5	8080
DDT	50-29-3	X	X	X	2E 0	1E-4	3E-3	1E-4	8080
Diallate	2303-16-4			X	1E+1	6E-4	3E-1	1E-2	8270
1,2-Dibromo-3-chloropropane *syn.* DBCP	96-12-8			X	3E-2	2E-4	5E-3	3E-5	8260(s) 8011(w)
2,4-Dichlorophenoxyacetic acid *syn.* 2,4-D	94-75-7			X	8E+2	7E-2	1E 0	2E-3	8150
Dieldrin	60-57-1	X	X	X	4E-2	2E-6	1E-3	2E-5	8080
Dimethoate	60-51-5			X	2E+1	7E-3	3E-1	1E-2	8270
Dinoseb *syn.* 2-(sec-Butyl)-4,6-dinitrophenol or DNBP	88-85-7			X	8E+1	7E-3	7E-1	2E-2	8270
Disulfoton	298-04-4			X	3E 0	1E-3	3E-1	2E-3	8270(s) 8140(w)
Eridosulfan	115-29-7	X	X	X	4E 0	2E-3	9E-3	1E-4	8080
Endosulfan	145-73-3				1E+3	1E-1	/2	9E-2	8045 /2
Endrin	72-20-8	X	X	X	2E+1	2E-3	3E-3	6E-5	8080
Ethylene dibromide *syn.* EDB	106-93-4				8E-3	5E-5	5E-3	3E-4	8260(s) 8011(w)
Famphur *syn.* Famophos	52-85-7			X	2E+2	7E-2	7E-1	2E-2	8270
Heptachlor	76-44-8	X	X	X	1E-1	4E-4	2E-3	3E-5	8080
Heptachlor epoxide (alpha,beta,gamma isomers)	1024-57-3	X	X	X	8E-2	2E-4	2E-3	5E-5	8080
Heptoxychlor	72-43-5	X		X	1E+3	4E-1	1E-1	2E-3	8080
Methyl parathion	298-00-0			X	2E+1	9E-3	3E-1	1E-2	8270
Octamethyl pyrophosphoramide *syn.* Schraden or OMPA	152-16-9				2E+2	7E-2	7E 0	2E-1	8270
Parathion	56-38-2			X	5E+2	2E-1	3E-1	1E-2	8270
Pentachloronitrobenzene *syn.* PCNB	82-68-8			X	2E+2	1E-1	1E 0	2E-2	8270
Pentachlorophenol *syn.* PCP	87-86-5	X	X	X	1E+3	2E-1	2E 0	5E-2	8270
Phorate	298-02-2			X	4E+1	2E-2	3E-1	1E-2	8270
Polychlorinated biphenyls (PCB's)	12767-79-2	X	X	X	9E-2	5E-4	4E-2	7E-4	8080
Pronamide	23950-58-5			X	1E+3	3E 0	3E-1	1E-2	8270
Strychnine & salts	57-24-9				2E+1	1E-2	1E 0	4E-2	8270
2,3,4,6-Tetrachlorophenol	58-90-2			X	1E+3	1E 0	3E-1	1E-2	8270
Tetraethyl dithiopyrophosphate *syn.* Sulfotepp or TEDP	3689-24-5			X	4E+1	2E-2	3E-1	1E-2	8270
Toxaphene	8001-35-2	X	X	X	7E-1	5E-3	2E-1	2E-3	8080
2,4,5-Trichlorophenoxyacetic acid *syn.* 2,4,5-T	93-76-5			X	8E+2	4E-1	2E 0	2E-3	8150
2,4,5-Trichlorophenoxypropionic acid *syn.* 2,4,5 TP	93-72-1			X	6E+2	5E-2	2E 0	2E-3	8150

VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBM	HBM	PQL	PQL	SUGGESTED METHOD
					SOIL mg/kg	WATER mg/l	SOIL mg/kg	WATER mg/l	
Acenaphthene	83-32-9	X	X	X	1E+3	2E 0	3E-1	1E-2	8270
Acetaldehyde *syn.* Ethanal	75-07-0				9E+1	5E-3	1E-1	1E-1	8240
Acetone *syn.* 2-Propanone	67-64-1	X		X	1E+3	4E 0	1E-1	1E-1	8240
Acetonitrile *syn.* Methyl cyanide	75-05-8			X	5E+2	2E-1	1E-1	1E-1	8240 *
Acetophenone	98-86-2			X	8E+1	4E 0	3E-1	1E-2	8270
Acrolein	107-02-8		X	X	3E+2	5E-1	5E-3	5E-3	8240 *
Acrylamide	79-06-1				2E-1	8E-6	1E-1	1E-1	8260 *
Acrylonitrile	107-13-1		X	X	1E 0	6E-5	5E-3	5E-3	8240 *
Allyl chloride *syn.* 3-Chloropropene	107-05-1			X	7E 0	3E-4	5E-3	5E-3	8240
Aniline *syn.* Benzeneamine	62-53-3			X	1E+2	6E-3	7E-1	1E-2	8270
Benz[a]anthracene	56-55-3	X	X	X	2E-1	1E-5	3E-1	1E-2	8270
Benz[a]anthracene	56-55-3	X	X	X	2E-1	1E-5	9E-3	1E-4	8310
Benzene	71-43-2	X	X	X	2E+1	5E-3	5E-3	5E-3	8260 (8240)
Benzidine	92-87-5			X	3E-3	2E-7	2E 0	3E-2	8270
Benzo[b]fluoranthene	205-99-2	X	X	X	4E-1	2E-5	3E-1	1E-2	8270
Benzo[b]fluoranthene	205-99-2	X	X	X	4E-1	2E-5	1E-2	2E-4	8310
Benzo[k]fluoranthene	207-08-9	X	X	X	8E+1	4E-3	3E-1	1E-2	8270
Benzo[k]fluoranthene	207-08-9	X	X	X	8E+1	4E-3	1E-2	2E-4	8310
Benzo[a]pyrene	50-32-8	X	X	X	6E-2	2E-4	3E-1	1E-2	8270
Benzo[a]pyrene	50-32-8	X	X	X	6E-2	2E-4	2E-2	2E-4	8310
Benzotrichloride	98-07-7				2E-4	1E-8	3E 0	5E-2	8120 /1
Benzyl alcohol	100-51-6	X		X	1E+3	1E+1	3E-1	2E-2	8270
Benzyl chloride	100-44-7				4E-1	2E-4	1E-1	1E-1	8260 (8240)
Bis(2-chloroethyl) ether *syn.* Dichloroethyl ether	111-44-4	X	X	X	6E-1	3E-5	3E-1	1E-2	8270
Bis(2-chloroethyl) ether *syn.* Dichloroethyl ether	111-44-4	X	X	X	6E-1	3E-5	3E-1	3E-3	8270(s) 8110(w)
Bis(2-chloroisopropyl) ether *syn.* Dichloroisopropyl ether	108-60-1	X	X	X	1E+3	1E 0	3E-1	1E-2	8270
Bis(2-ethylhexyl) phthalate *syn.* Diethylhexyl phthalate	117-81-7	X	X	X	5E+1	3E-3	3E-1	1E-2	8270
Bromodichloromethane	75-27-4	X	X	X	1E+3	7E-1	5E-3	5E-3	8260 (8240)
Bromoform *syn.* Tribromomethane	75-25-2	X	X	X	9E+1	4E-3	5E-3	5E-3	8260 (8240)
Butanol *syn.* n-Butyl alcohol	71-36-3				1E+3	4E 0	1E-1	1E-1	8240
Butyl benzyl phthalate	85-68-7	X	X	X	1E+3	7E 0	3E-1	1E-2	8270
Carbon disulfide	75-15-0	X		X	1E+3	4E 0	1E-1	1E-1	8240 *
Carbon tetrachloride *syn.* Tetrachloromethane	56-23-5	X	X	X	7E 0	5E-3	5E-3	5E-3	8260 (8240)
p-Chloroaniline	106-47-8	X		X	3E+2	1E-1	7E-1	2E-2	8270
Chlorobenzene	108-90-7	X	X	X	1E+3	1E-1	5E-3	5E-3	8260 (8240)
p-Chloro-m-cresol	59-50-7	X	X	X	1E+3	2E-1	3E-1	1E-2	8270
Chlorodibromomethane	124-48-1	X	X		1E+3	7E-1	5E-3	5E-3	8260 (8240)
Chloroform	67-66-3	X	X	X	1E+2	6E-3	5E-3	5E-3	8260
o-Chlorophenol	95-57-8	X	X	X	4E+2	2E-1	3E-1	1E-2	8270
Chloroprene *syn.* 2-Chloro-1,3-butadiene	126-99-8			X	1E+3	7E-1	5E-3	5E-3	8260

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VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBM	HBM	PQL	PQL	SUGGESTED METHOD
					SOIL mg/kg	WATER mg/l	SOIL mg/kg	WATER mg/l	
Chrysene	218-01-9	X	X	X	4E 0	2E-4	3E-1	1E-2	8270
Chrysene	218-01-9	X	X	X	4E 0	2E-4	1E-1	2E-3	8310
Cresols	1319-77-3	X		X	1E+3	2E 0	3E-1	1E-2	8270
Toluene *syn.* Isopropyl benzene	98-82-8				1E+3	1E 0	5E-3	5E-3	8240
Dibenz[a,h]anthracene	53-70-3	X	X	X	1E-2	7E-7	3E-1	1E-2	8270
Dibenz[a,h]anthracene	53-70-3	X	X	X	1E-2	7E-7	2E-2	3E-4	8310
Di-n-butyl phthalate	84-74-2	X	X	X	1E+3	4E 0	3E-1	1E-2	8270
o-Dichlorobenzene	95-50-1	X	X	X	1E+3	6E-1	1E-2	1E-2	8260 (8270)
o-Dichlorobenzene	106-46-7	X	X	X	3E+1	7.5E-2	5E-3	5E-3	8260 (8270)
3,3'-Dichlorobenzidine	91-94-1	X	X	X	2E 0	8E-5	3E-1	1E-2	8270
Dichlorodifluoromethane	75-71-8			X	1E+3	7E 0	5E-3	5E-3	8260 (8240)
1,1-Dichloroethane	75-34-3	X	X	X	8E 0	4E-4	5E-3	5E-3	8260 (8240)
1,1-Dichloroethane	75-34-3	X	X	X	8E 0	4E-4	7E-4	7E-4	8021
1,2-Dichloroethane	107-06-2	X	X	X	8E 0	5E-3	5E-3	5E-3	8260 (8240)
1,1-Dichloroethylene	75-35-4	X	X	X	1E 0	7E-3	5E-3	5E-3	8260 (8240)
trans-1,2-Dichloroethylene	156-59-2				8E+2	7E-2	5E-3	5E-3	8260 (8240)
cis-1,2-Dichloroethylene	156-60-5		X	X	1E+3	1E-1	5E-3	5E-3	8260 (8240)
2,4-Dichlorophenol	120-83-2	X	X	X	2E+1	1E-1	3E-1	1E-2	8270
1,2-Dichloropropene	78-87-5	X	X	X	1E+1	5E-3	5E-3	5E-3	8260 (8240)
1,3-Dichloropropene	542-75-6	X	X	X	2E+1	1E-2	1E-2	1E-2	8240
Diethyl phthalate	84-66-2	X	X	X	1E+3	3E+1	3E-1	1E-2	8270
Diethylstilbesterol	56-53-1				1E-3	7E-8	3E-1	1E-2	8270
3,3'-Dimethoxybenzidine *syn.* Dianisidine	119-90-4				5E+1	3E-3	3E 0	1E-1	8270
Dimethylamine *syn.* DMA	124-40-3				2E+2	7E-2	1E-1	1E-1	8240
7,12-Dimethylbenz[a]anthracene	57-97-6			X	3E-2	1E-6	3E-1	1E-2	8270
3,3'-Dimethylbenzidine *syn.* o-Tolidine	119-93-7			X	8E-2	4E-6	3E-1	1E-2	8270
2,4-Dimethylphenol	105-67-9	X	X	X	4E+2	2E-2	3E-1	1E-2	8270
Dimethyl phthalate	131-11-3	X	X	X	1E+3	4E+2	3E-1	1E-2	8270
1,3-Dinitrobenzene *syn.* m-Dinitrobenzene	99-65-0			X	8E 0	4E-3	3E-1	2E-2	8270
2,4-Dinitrophenol	51-28-5	X	X	X	2E+2	7E-2	2E 0	5E-2	8270
2,4-Dinitrotoluene	121-14-2	X	X	X	1E 0	5E-5	3E-1	1E-2	8270
2,6-Dinitrotoluene	606-20-2	X	X	X	1E 0	5E-5	3E-1	1E-2	8270
Di-n-octyl phthalate	117-84-0	X	X	X	1E+3	6E-1	3E-1	1E-2	8270
1,4-Dioxane	123-91-1			X	6E+1	3E-3	1E-1	1E-1	8260 *
Diphenylamine	122-39-4			X	1E+3	9E-1	7E-1	1E-2	8270
1,2-Diphenylhydrazine	122-66-7		X		9E-1	4E-5	3E-1	1E-2	8270
Dichlorhydrin	106-89-8				7E+1	4E-3	1E-1	1E-1	8010 *
1,2-Dichloroethoxyethanol *syn.* Ethylene glycol monoethyl ether	110-80-5				1E+3	1E+1	1E 0	1E 0	8260 *
Ethyl acetate	141-78-6				1E+3	3E+1	1E-1	1E-1	8240
Ethylbenzene	100-41-4	X	X	X	1E+3	7E-1	5E-3	5E-3	8260 (8240)

VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	IX	APP	HBM	HBM	PQL	PQL	SUGGESTED METHOD
					SOIL	WATER	SOIL	WATER		
						mg/kg	mg/l	mg/kg	mg/l	
Ethyl ether *syn.* Diethyl ether	60-29-7					1E+3	2E+1	1E-1	1E-1	8240
Ethyl methacrylate	97-63-2			X		1E+3	3E 0	5E-3	5E-3	8240
Ethylene dibromide *syn.* EDB	106-93-4					8E-3	5E-5	5E-3	3E-4	8011
Fluoranthene	206-44-0	X	X	X		1E+3	1E 0	3E-1	1E-2	8270
Fluorene	86-73-7	X	X	X		4E+1	2E-3	3E-1	1E-2	8270
Fluorene	86-73-7	X	X	X		4E+1	2E-3	1E-1	2E-3	8310
Formaldehyde	50-00-0					1E+3	1E-3	/2	1E-2	8315(w) *
Formic acid	64-18-6					1E+3	7E+1	2E-1	2E-1	8015 *
Furan	110-00-9					8E-1	4E-2	1E-1	1E-1	8240
Hexachlorobenzene	118-74-1	X	X	X		6E+1	1E-3	3E-1	1E-2	8270
Hexachlorobenzene	118-74-1	X	X	X		6E+1	1E-3	3E-2	5E-4	8120
Hexachlorobutadiene	87-68-3	X	X	X		9E 0	4E-4	5E-3	5E-3	8260 (8120)
Hexachlorocyclopentadiene	77-47-4	X	X	X		3E+2	5E-2	3E-1	1E-2	8270
Hexachloroethane	67-72-1	X	X	X		5E+1	3E-3	3E-1	1E-2	8270
Hexachlorophene	70-30-4			X		2E+1	1E-2	4E-1	5E-2	8270
Indeno[1,2,3-cd]pyrene	193-39-5	X	X	X		4E 0	2E-4	3E-1	1E-2	8270
Indeno[1,2,3-cd]pyrene	193-39-5	X	X	X		4E 0	2E-4	3E-2	4E-4	8310
Isobutyl alcohol	78-83-1			X		1E+3	1E+1	1E-1	1E-1	8240 *
Isophorone	78-59-1	X	X	X		2E+2	9E-3	3E-1	1E-2	8270
Methacrylonitrile	126-98-7			X		8E 0	4E-3	3E-2	3E-2	8240 *
Methanol	67-56-1					1E+3	2E+1	1E-1	1E-1	8240
Methyl bromide *syn.* Bromomethane	74-83-9	X	X	X		1E+2	5E-2	1E-2	1E-2	8260 (8240)
Methyl chloride *syn.* Chloromethane	74-87-3	X	X	X		5E+1	3E-3	1E-2	1E-2	8260 (8240)
Methylene bromide *syn.* Dibromomethane	74-95-3			X		8E+2	4E-1	5E-3	5E-3	8260 (8240)
Methylene chloride *syn.* Dichloromethane	75-09-2	X	X	X		9E+1	5E-3	5E-3	5E-3	8240
3-Methylchloanthrene	56-49-5			X		7E-2	4E-6	7E-1	1E-2	8270
Methyl ethyl ketone *syn.* 2-Butanone	78-93-3	X	X			1E+3	2E 0	1E-1	1E-1	8240 *
Methyl isobutyl ketone *syn.* 4-Methyl-2-pentanone	108-10-1	X	X			1E+3	2E 0	1E-1	1E-1	8240 *
Methyl methacrylate	80-62-6			X		1E+3	3E 0	3E-2	3E-2	8240
Naphthalene	91-20-3	X	X	X		3E+2	1E-1	3E-1	1E-2	8270
Naphthalene	91-20-3	X	X	X		3E+2	1E-1	5E-3	5E-3	8260
Nitrobenzene	98-95-3	X	X	X		4E+1	2E-2	3E-1	1E-2	8270
2-Nitropropene	79-46-9					7E-2	4E-6	1E-1	7E-1	8260
N-Nitrosodi-n-butylamine	924-16-3			X		1E-1	6E-6	3E-1	1E-2	8270
N-Nitrosodiethylamine	55-18-5			X		5E-3	2E-7	7E-1	2E-2	8270
N-Nitrosodimethylamine	62-75-9		X	X		1E-2	7E-7	7E-1	1E-2	8270
N-Nitrosodiphenylamine	86-30-6	X	X	X		1E+2	7E-3	3E-1	1E-2	8270
N-Nitrosodi-n-propylamine	621-64-7	X	X	X		1E-1	5E-6	3E-1	1E-2	8270
Nitrosomethylethylamine	10595-95-6			X		3E-2	2E-6	7E-1	1E-2	8270
N-Nitrosopyrrolidine	930-55-2			X		3E-1	2E-5	1E 0	4E-2	8270

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VOLATILES & SEMIVOLATILES

HAZARDOUS CONSTITUENT	CAS NO.	TCL	PPL	APP IX	HBM	HBM	PQL	PQL	SUGGESTED METHOD
					SOIL mg/kg	WATER mg/l	SOIL mg/kg	WATER mg/l	
Pentachlorobenzene	608-93-5			X	6E+1	3E-2	3E-1	1E-2	8270
Pentachlorophenol *syn.* PCP	87-86-5	X	X	X	1E+3	2E-1	2E 0	5E-2	8270
Phenanthrene	85-01-8	X	X	X	4E+1	2E-3	3E-1	1E-2	8270
Phenanthrene	85-01-8	X	X	X	4E+1	2E-3	5E-1	6E-3	8310
Phenol	108-95-2	X	X	X	1E+3	2E+1	3E-1	1E-2	8270
p-Phenylenediamine	106-50-3			X	5E+2	2E-1	3E-1	1E-2	8270
Phthalic anhydride	88-44-0				1E+3	7E+1	3E 0	1E-1	8270 /3
2-Picoline	109-06-8			X	1E+3	2E 0	5E-3	5E-3	8240
Pyrene	129-00-0	X	X	X	1E+3	1E 0	3E-1	1E-2	8270
Pyridine	110-86-1			X	8E+1	4E-2	5E-3	5E-3	8240
Styrene	100-42-5	X		X	1E+3	5E-3	5E-3	5E-3	8240
Styrene	100-42-5	X		X	1E+3	5E-3	1E-4	1E-4	8021
1,2,4,5-Tetrachlorobenzene	95-94-3			X	2E+1	1E-2	3E-1	1E-2	8270
1,1,1,2-Tetrachloroethane	630-20-6			X	3E+1	1E-3	5E-3	5E-3	8260 (8240)
1,1,2,2-Tetrachloroethane	79-34-5	X	X	X	4E 0	2E-4	5E-3	5E-3	8260 (8240)
1,1,2,2 Tetrachloroethane trichloroethylene *syn.* Perchloroethylene	79-34-5	X	X	X	4E 0	2E-4	1E-4	1E-4	8310
1,1,2,2 Tetrachloroethane trichloroethylene *syn.* Perchloroethylene	127-18-4	X	X	X	8E+2	5E-3	5E-3	5E-3	8260 (8240)
1,3,4,6-Tetrachlorophenol	58-90-2			X	1E+3	1E 0	3E-1	1E-2	8270
Toluene	108-88-3	X	X	X	1E+3	2E+0	5E-3	5E-3	8260 (8240)
2,4-Toluenediamine	95-80-7				2E 0	9E-5	3E-1	1E-2	8270
2,6-Toluenediamine	823-40-5				1E+3	6E 0	7E-1	2E-2	8270
Toluene diisocyanate	26471-62-5				1E+3	7E-1	3E-1	1E-2	8270 /4
o-Toluidine	95-53-4			X	3E 0	1E-4	3E-1	1E-2	8270
p-Toluidine	106-49-0				4E 0	2E-4	3E-1	1E-2	8270
1,2,4-Trichlorobenzene	120-82-1	X		X	1E+3	9E-3	3E-1	1E-2	8260 (8270)
1,1,1-Trichloroethane	71-55-6	X	X	X	1E+3	2E-1	5E-3	5E-3	8260 (8240)
1,1,2-Trichloroethane	79-00-5	X	X	X	1E+1	5E-3	5E-3	5E-3	8260 (8240)
Trichloroethylene	79-01-6	X	X	X	7E+1	5E-3	5E-3	5E-3	8260 (8240)
Trichlorofluoromethane	75-69-4			X	1E+3	1E+1	5E-3	5E-3	8260 (8240)
2,4,5-Trichlorophenol	95-95-4	X		X	1E+3	4E 0	2E 0	5E-2	8270
2,4,6-Trichlorophenol	88-06-2	X	X	X	4E+1	3E-3	6E-1	1E-2	8270
1,2,3-Trichloropropene	96-18-4			X	5E+2	2E-1	5E-3	5E-3	8260 (8240)
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1				1E+3	1E+3	5E-3	5E-3	8260
sym-Trinitrobenzene *syn* 1,3,5-Trinitrobenzene	99-35-4			X	4E 0	2E-3	7E-1	1E-2	8270
Vinyl chloride	75-01-4	X	X	X	5E 0	2E-3	1E-2	1E-2	8240
Vinyl chloride	75-01-4	X	X	X	5E 0	2E-3	2E-4	2E-4	8021
Xylene (total)	1330-20-7	X		X	1E+3	1E+1	5E-3	5E-3	8260 (8240)

FOOTNOTES

HSN - Health-based number.

PQL - Practical quantitation limit.

1 - Benzotrichloride is hydrolytically unstable. Analyze for benzoic acid.

2 - Method not currently available for soil analysis.

3 - Phthalic anhydride is hydrolytically unstable. Analyze for phthalic acid.

4 - Toluene diisocyanate is hydrolytically unstable. Analyze for toluene diamine.

* - Indicates constituent should be analyzed by direct injection for analysis of water sample.

Attachment C

**NAVY'S REQUIREMENTS FOR ANALYTICAL
METHOD DELIVERABLES**

SAMPLING AND CHEMICAL ANALYSIS QUALITY ASSURANCE
REQUIREMENTS FOR THE NAVY
INSTALLATION RESTORATION PROGRAM

NEESA 20.2-047B
Project Manager: Anthony R. Sturtzer

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NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY
Port Hueneme, California 93043-5014

7. ANALYTICAL METHODS

An analytical method is a series of steps or procedures that must be performed to determine the identity and quantity of analyte in a sample. The methods to be employed by the Navy-approved laboratory fall mainly into two categories--those which have been approved by the EPA and those which have been developed by the Army. The former refer primarily to the methods presented in the *Federal Register* of October 26, 1984 (49 FR 43234), where the EPA has listed ~250 pollutants (pp. 43251-43258) or pollutant categories and the method(s) by which each must (by virtue of final or final interim ruling status of the methods) be tested. The acceptance of methods not under either status will be handled on a case-by-case basis among the concerned parties. Non-standard methods shall be submitted to the NCR who will discuss the method with Navy and EPA personnel prior to use on Navy projects. Other applicable EPA methods include the *SW-846* methods which are applicable to Resource Conservation and Recovery Act sites and the Superfund CLPs which are applicable to the CERCLA sites.

Many of the EPA methods are found in the documentation of other organizations (e.g., U.S. Geological Services, ASTM) and are incorporated by reference into the regulations. Such incorporation involves listing the organization, the specific document and its date, the method number assigned by the other organization, and perhaps a page number in the document of the other organization. Technically speaking, to maintain the applicability of the regulation, no deviations from the given citations are allowed by the EPA, even in cases where an organization (ASTM, for example) may have an updated version of the method. However, there are instances where EPA regional offices have granted exceptions to different laboratories for the testing of various substances. If a laboratory has such a variance, in writing, from the EPA (either to use a different ASTM method, for example, than the one cited in the October 26, 1984 *Federal Register* or to use a somewhat modified method, for example, than the one cited in the October 26, 1984 *Federal Register*), a copy of the variance (sent to the NCR) may be used to seek Navy approval of the different or modified method. It must also be shown that the conditions for which the variance was issued by the EPA are similar to the expected conditions (sampling and handling techniques, environmental matrix, concentration range, interferences, etc.) in the IRP.

It is also recognized that the analyst may have some leeway resulting from the regulations themselves. For instance, in the October 26, 1984 *Federal Register*, several methods are listed involving GC. Typically, in paragraph 8.1.2, these methods allow the analyst "certain options," provided various subsequent QC requirements are met. For example, the EPA allows some flexibility in the procedures (and no written permission is needed from the EPA) once a sample has been extracted and placed into the instrument. On the other hand, changes in operations prior to this instrumental analysis (e.g., preparation, storage) would probably require written documentation.

The *Federal Register* of October 26, 1984 (49 FR 43437) also contains a proposed ruling where additional substances and methods are listed: specifically, some proposed modifications to Tables IC and ID (Tables 7.1 through 7.5 of this guide) of the previously mentioned final rule. In those cases where a substance/method does not appear on one of the earlier tables but does occur on one of the proposed listings, the method in the proposed listing is recommended by the EPA (Medz, 1985) but without any regulatory force.

For the analytical method to be used in the case of munition-related substances, the laboratory should consult the NCR who will forward a copy(s) of the appropriate method developed by the Army Toxic and Hazardous Materials Agency.

For biota and air samples, the methods must be evaluated individually by the NCR to determine whether they may be used for the work in question.

A list of references containing methods, statistics, and sampling information is supplied in the Bibliography of this document.

For Level D QC sites, the current CLP methods and documentation must be followed. For methods not covered by CLP and for sites requiring Level D, the latest edition of *SW-846* or other methods listed in Tables 7.1 through 7.5, may be used. For the Levels C and E sites, CLP methods, *SW-846* methods, or other methods listed in Tables 7.1 through 7.5 shall be used. The exception to the Levels C and E method requirement occurs in the volatile and semivolatile area. In any level of QC and for any site where volatiles and semivolatiles are analyzed by GC/MS, the current CLP methods shall be used.

7.1 QC REQUIREMENTS FOR THE LABORATORY

The following are the minimum QC requirements for the laboratory analyses. For Level D QC, the current CLP QC requirements are specified. For methods not defined in the CLP, the blank, blank/spike, matrix spike, and matrix spike duplicate shall be performed for every 20 samples of similar matrix. The batch size for Level D QC is 20 samples.

In Levels C and E, the optimum batch size is determined by the number of samples of similar matrix which can be processed simultaneously through the entire preparation and analysis process. For example, if 5 samples can be extracted and 20 analyzed by the instrument, the batch size is 5. Once this is determined, it is used with the blank/spike control program in the following manner.

In Levels C and E, a blank/spike control shall be analyzed with each batch and shall be plotted on control charts as described in Sect. 4.4. For metals, anions, and other wet chemical analysis, a method blank shall also be processed with each batch and shall contain less than the method detection limit for compounds of interest. In any method using surrogates spiked into the blank, the blank shall serve as both the method blank

Table 7.1. List of approved biological test procedures
(40 CFR, Part 136, July 1, 1987)

Parameter and units	Method ¹	EPA ²	Reference (Method Number or Page)		
			Standard Methods 15th Ed.	ASTM	USGS
Bacteria:					
1 Coliform (fecal) number per 100 ml	MPN, 5 tube, 3 dilution; or, membrane filter (MF) ⁴ , single step	p. 132	980C		
2 Coliform (fecal) in presence of chlorine number per 100 ml	MPN, 5 tube, 3 dilution	p. 124	909C		B-0050-77
3 Coliform (total) number per 100 ml	MPN, 5 tube, 3 dilution; or, MF ⁴ single step or two step	p.132	908C		
4 Coliform (total) in presence of chlorine, number per 100 ml	MPN, 5 tube, dilution; or MF ⁴ with enrichment	p. 114	908A		B-0025-77
		p. 108	908A		
5 Fecal streptococci, number per 100 ml	MPN, 5 tube, 3 dilution; MF ⁴ , or, plate count	p. 114	908A		
		p. 111	909 (A - A.5c)		
		p. 139	910A		
	p. 136	910B		B0055-77 ⁵	
	p. 143	910C			

Table 1A Notes

¹ The method must be specified when results are reported

² "Microbiological Methods for Monitoring the Environment, Water and Wastes, 1978", EPA-600/8-78-017, U.S. Environmental Protection Agency.

³ Greeson, P.E., et al., Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples, "U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 5, Chapter A4, Laboratory Analysis, 1977

⁴ 0.45 um membrane filter or other pore size certified by the manufacturer to fully retain organisms to be cultivated, and free of extractables which could interfere with their growth and development.

⁵ Approved only if dissolution of the KF Streptococcus Agar (Section 5.1, USGS Method 8-0055-77) is made in a boiling water bath to avoid scorching of the medium

Table 7.2. List of approved inorganic test procedures
(40 CFR, Part 136, July 1, 1987)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 16th Ed.	ASTM	USGS ¹	Other
1. Acidity, as CaCO ₃ mg/L	Electrometric end point or phenolphthalein end point.	305.1	402(4.a)	D1067-82(E)	—	
2. Alkalinity, as CaCO ₃ mg/L	Electrometric or colorimetric titration to pH 4.5, manual, or Automated.	310.1 310.2	403 —	D1067-82(B) —	I-1030-84 I-2030-84	33.014 ²
3. Aluminum—Total ³ mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, Inductively coupled plasma, or Colorimetric (Erichrome cyanine R).	202.1 202.2 — —	303C 304 — 306B	— — — —	I-3051-84 — — —	200.7 ⁴
4. Ammonia (as N), mg/L	Manual distillation (at pH 9.5) ⁵ , followed by Nesslerization, Titration, Electrode, Automated phenate or Automated electrode.	350.2 350.2 350.2 350.3 350.1 —	417A 417B 417D 417E or F 417G —	— D1426-79(A) — D1426-79(D) D1426-79(C) —	— I-3520-84 — — I-4523-84 —	33.057 ² 33.057 ² — — — Note 6
5. Antimony—Total ³ , mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, or Inductively coupled plasma	204.1 204.2 —	303A 304 —	— — —	— — —	200.7 ⁴
6. Arsenic—Total ³ , mg/L	Digestion ³ followed by AA gaseous hydride, AA furnace, Inductively coupled plasma, or Colorimetric (SDDC)	206.5 206.3 206.2 — 206.4	— 303E 304 — 307B	— D2972-84(B) — — D2972-84(A)	— I-3062-84 — — I-3060-84	200.7 ⁴
7. Barium—Total ³ , mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, or Inductively coupled plasma	208.1 208.2 —	303C 304 —	— — —	I-3084-84 — —	200.7 ⁴
8. Beryllium—Total ³ , mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, Inductively coupled plasma, or Colorimetric (aluminon).	210.1 210.2 — —	303C 304 — 309B	D3654-84(A) — — —	I-3095-84 — — —	200.7 ⁴
9. Biochemical oxygen demand (BOD ₅), mg/L	Dissolved Oxygen Depletion.	405.1	507	—	I-1578-78 ⁷	33.019 ² , p.17 ⁸
10. Boron—Total, mg/L	Colorimetric (curcumin), or Inductively Coupled plasma.	212.3 —	404A —	— —	I-3112-84 —	200.7 ⁴
11. Bromide, mg/L	Titrimetric.	320.1	—	D1246-82(C)	I-1125-84	p.544 ⁹

Table 7.2. (continued)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 16th Ed.	ASTM	USGS ¹	Other
12. Cadmium—Total ² , mg/L	Digestion ³ followed by AA direct aspiration,	213.1	303A or B	D3557-84(A or B)	I-3135-84 or I-3136-84	33.089 ² , p.37 ⁶
	AA furnace,	213.2	304	—	—	
	Inductively coupled plasma,	—	—	—	—	200.7 ⁴
	Voltametry ¹⁰ , or Colorimetric (Dithizone).	—	310B	D3557-84(C)	—	
13. Calcium—Total ² , mg/L	Digestion ³ followed by AA direct aspiration,	215.1	303A	D511-84(B)	I-3152-84	
	Inductively coupled plasma, or Titrimetric (EDTA).	215.2	311C	D511-84(A)	—	200.7 ⁴
14. Carbonaceous biochemical oxygen demand (CBOD ₅), mg/L ¹¹	Dissolved Oxygen Depletion with nitrification inhibitor.	—	507(5.e.6)	—	—	
15. Chemical oxygen demand (COD), mg/L	Titrimetric, or,	410.1, 410.2, or 410.3	508A	D1252-83	I-3560-84-or I-3562-84	33.034 ¹ , p.17 ⁶
	Spectrophotometric, manual or automated.	410.4	—	—	I-3561-84	Notes 12 or 13
16. Chloride, mg/L	Titrimetric (silver nitrate) or (Mercuric nitrate), or	325.3	407A 407B	D512-81(B) D512-81(A)	I-1183-84 I-1184-84	33.067 ²
	Colorimetric, manual or Automated (ferricyanide).	325.1, or 325.2	407D	D512-81(C)	I-1187-84 I-2187-84	
17. Chlorine—Total residual, mg/L	Titrimetric					
	Amperometric direct,	330.1	408C	D1253-76(A)	—	
	Starch end point direct,	330.3	408A	D1253-76(B) Part 18.3	—	
	Back titration either end point ¹⁶ , or	330.2	408B	—	—	
	DPD-FAS;	330.4	408D	—	—	
Spectrophotometric, DPD, or Electrode.	330.5	408E	—	—	Notes 15	
18. Chromium VI dissolved, mg/L	0.45 micron filtration followed by					
	AA chelation-extraction, or Colorimetric (Diphenylcarbazide).	218.4	303B	—	I-1232-84 I-1230-84	307B ¹⁴
19. Chromium—Total ² , mg/L	Digestion ³ followed by AA direct aspiration,	218.1	303A	D1687-84(D)	I-3236-84	33.089 ²
	AA chelation-extraction,	218.3	303B	—	—	
	AA furnace,	218.2	304	—	—	
	Inductively coupled plasma, or	—	—	—	—	200.7 ⁴
	Colorimetric (Diphenylcarbazide).	—	312B	D1687-84(A)	—	
20. Cobalt—Total ² , mg/L	Digestion ³ followed by AA direct aspiration,	219.1	303A or B	D3558-84(A or B)	I-3239-84 or I-3240-84	p.37 ⁶
	AA furnace, or Inductively coupled plasma	219.2	304	—	—	200.7 ⁴

Table 7.2. (continued)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 16th Ed.	ASTM	USGS ¹	Other
21. Color, platinum cobalt units or dominant wavelength, hue, luminance, purity.	Colorimetric (ADMI), or (Platinum cobalt), or Spectrophotometric.	110.1	204D	—	—	Note 17
		110.2	204A	—	1-1250-84	
		110.3	204B	—	—	
22. Copper—Total ² , mg/L	Digestion ² followed by AA direct aspiration, AA furnace, Inductively coupled plasma, Colorimetric (Neocuproine), or (Bicinchoninate).	220.1	303A or B	D1688-84(D or E)	1-3270-84 or 1-3271-84	33.089 ² , p.37 ³
		220.2	304	—	—	
		—	—	—	—	200.7 ⁴
		—	313B	D1688-84(A)	—	Note 18
23. Cyanide—Total, mg/L	Manual distillation with MgCl ₂ followed by Titrimetric, or Spectrophotometric, manual or Automated. ¹⁹	—	412B	—	—	p.22 ⁵
		—	412C	—	—	
		335.2 335.3	412D —	D2036-82(A) D2036-82(A)	1-3300-84 —	
24. Cyanide amenable to chlorination, mg/L	Manual distillation with MgCl ₂ followed by titrimetric or spectrophotometric	335.1	412F	D2036-82(B)	—	
25. Fluoride—Total, mg/L	Manual distillation ⁴ followed by Electrode, manual or Automated, Colorimetric (SPADNS), or Automated complexone.	—	413A	—	—	
		340.2	413B	D1179-80(B)	—	
		340.1	413C	D1179-80(A)	1-4327-84	
		340.3	413E	—	—	
26. Gold—Total ² , mg/L	Digestion ² followed by AA direct aspiration, or AA furnace.	231.1	303A	—	—	
		231.2	304	—	—	
27. Hardness—Total, as CaCO ₃ , mg/L	Automated colorimetric, Titrimetric (EDTA), or Ca plus Mg as their carbonates, by inductively coupled plasma or AA direct aspiration. (See Parameters 13 and 33.)	130.1	—	—	—	
		130.2	314B	D1126-80	1-1338-84	33.082 ²
28. Hydrogen ion (pH), pH units	Electrometric, measurement, or Automated electrode.	150.1	423	D1293-84(A or B)	1-1586-84	33.006 ²
		—	—	—	—	Note 20
29. Iridium—Total ² , mg/L	Digestion ² followed by AA direct aspiration, or AA furnace.	235.1	303A	—	—	
		235.2	304	—	—	
30. Iron—Total ² , mg/L	Digestion ² followed by AA direct aspiration, AA furnace, Inductively coupled plasma, or Colorimetric (Phenanthroline).	236.1	303A or B	D1068-84(C or D)	1-3381-84	33.089 ²
		236.2	304	—	—	
		—	—	—	—	200.7 ⁴
		—	315B	D1068-84(A)	—	Note 21

Table 7.2. (continued)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 18th Ed.	ASTM	USGS ¹	Other
31. Kjeldahl nitrogen— Total (as N), mg/L	Digestion and distillation followed by	351.3	420A or B	D3590-84(A)	—	
	Titration.	351.3	417D	D3590-84(A)	—	33.051 ²
	Nesslerization.	351.3	417B	D3590-84(A)	—	
	Electrode.	351.3	417E or F	—	—	
	Automated phenate.	351.1	—	—	1-4551-78 ⁷	
	Semi-automated block digester, or Potentiometric.	351.2 351.4	— —	D3590-84(A) D3590-84(A)	— —	
32. Lead—Total ³ , mg/L	Digestion ³ followed by					
	AA direct aspiration.	239.1	303A or B	D3559-85(A or B)	1-3399-84	33.089 ²
	AA furnace.	239.2	304	—	—	
	Inductively coupled plasma.	—	—	—	—	200.7 ⁴
	Voltametry ¹⁰ , or Colorimetric (Dithizone).	—	318B	D3559-85(C)	—	
33. Magnesium—Total ³ , mg/L	Digestion ³ followed by					
	AA direct aspiration.	242.1	303A	D511-84(B)	1-3447-84	33.089 ²
	Inductively coupled plasma, or Gravimetric	— —	— 318B	— D511-77(A)	— —	200.7 ⁴
34. Manganese—Total ³ , mg/L	Digestion ³ followed by					
	AA direct aspiration.	243.1	303A or B	D858-84(B or C)	1-3454-84	33.089 ²
	AA furnace.	243.2	304	—	—	
	Inductively coupled plasma, or Colorimetric (Persulfate), or (Periodate)	— — —	— — 319B	— — D858-84(A)	— — —	200.7 ⁴ 33.126 ² Note 22
		—	—	—	—	
35. Mercury—Total ³ , mg/L	Cold vapor, manual or Automated.	245.1 245.2	303F —	D3223-80 —	1-3462-84 —	33.095 ²
36. Molybdenum— Total ³ , mg/L	Digestion ³ followed by					
	AA direct aspiration.	246.1	303C	—	1-3490-84	
	AA furnace, or Inductively coupled plasma.	246.2 —	304 —	— —	— —	200.7 ⁴
37. Nickel—Total ³ , mg/L	Digestion ³ followed by					
	AA direct aspiration.	249.1	303A or B	D1886-84(C or D)	1-3499-84	
	AA furnace.	249.2	304	—	—	
	Inductively coupled plasma, or Colorimetric (Heptoxime).	— —	— 321B	— —	— —	200.7 ⁴
38. Nitrate (as N), mg/L	Colorimetric (Brucine sulfate), or Nitrate-nitrite N minus Nitrite N (See parameters 39 and 40).	352.1	—	D992-71	—	33.063 ² , 419D ¹⁰ , p.28 ⁶
39. Nitrate-nitrite (as N), mg/L	Cadmium reduction.					
	Manual or Automated, or Automated hydrazine.	353.3 353.2 353.1	418C 418F —	D3867-85(B) D3867-85(A) —	— 1-4545-84 —	

Table 7.2. (continued)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 16th Ed.	ASTM	USGS ¹	Other
40. Nitrite (as N), mg/L	Spectrophotometric, Manual or Automated (Diazotization).	354.1	418	D1254-67	—	Note 24
		—	—	—	I-4540-84	
41. Oil and grease— Total recoverable, mg/L	Gravimetric (extraction).	413.1	503A	—	—	
42. Organic carbon— Total (TOC), mg/L	Combustion or oxidation.	415.1	505	O2579-85(A or B)	—	33.044 ² , p.4 ²²
43. Organic nitrogen (as N) mg/L	Total Kjeldahl N (Parameter 31) minus ammonia N (Parameter 4.)					
44. Orthophosphate (as P), mg/L	Ascorbic acid method, Automated or Manual single reagent, or Manual two reagent.	365.1	424G	—	I-4601-84	33.116 ²
		365.2	424F	D515-82(A)	—	33.111 ²
		365.3	—	—	—	
45. Osmium—Total ² , mg/L	Digestion ² followed by AA direct aspiration, or AA furnace.	252.1	303C	—	—	
		252.2	304	—	—	
46. Oxygen, dissolved, mg/L	Winkler (Azide modification), or Electrode.	360.2	421B	D888-81(C)	I-1575-78 ⁷	33.028 ²
		360.1	421F	—	I-1576-78 ⁷	
47. Palladium—Total ² , mg/L	Digestion ² followed by AA direct aspiration, or AA furnace.	253.1	—	—	—	p.S27 ⁹
		253.2	—	—	—	p.S28 ⁹
48. Phenols, mg/L	Manual distillation ²⁸ followed by Colorimetric (4AAP) manual, or Automated ¹⁹ .	420.1	—	D1783-80(A or B)	—	Note 26
		420.1	—	—	—	Note 26
		420.2	—	—	—	
49. Phosphorus (elemental) mg/L	Gas-liquid chromatography.	—	—	—	—	Note 27
50. Phosphorus—Total, mg/L	Persulfate digestion followed by Manual or Automated ascorbic acid reduction, or Semi-automated block digestor.	365.2	424C(III)	—	—	33.111 ²
		365.2 or 365.3	424F	D515-82(A)	—	
		365.1	424G	—	I-4600-84.	33.116 ²
		365.4	—	—	—	
51. Platinum—Total ² , mg/L	Digestion ² followed by AA direct aspiration, or AA furnace.	255.1	303A	—	—	
		255.2	304	—	—	
52. Potassium—total ² , mg/L	Digestion followed by AA direct aspiration, Inductively coupled plasma Flame photometric, or Colorimetric (Cobaltinrate).	258.1	303A	—	I-3630-84	33.103 ²
		—	—	—	—	200.7 ⁶
		—	322B	D1428-82(A)	—	
		—	—	—	—	3178 ¹⁰

Table 7.2. (continued)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 16th Ed.	ASTM	USGS ¹	Other
53. Residue—Total. mg/L	Gravimetric, 103-105°C.	160.3	209A	—	1-3750-84	
54. Residue—filterable. mg/L	Gravimetric, 180°C.	160.1	209B	—	1-1750-84	
55. Residue—nonfilterable. (TSS), mg/L	Gravimetric, 103-105°C post washing of residue.	160.2	209C	—	1-3765-84	
56. Residue—settleable. mg/L	Volumetric (Imhoff cone) or gravimetric.	160.5	209E	—	—	
57. Residue—volatile. mg/L	Gravimetric, 550°C.	160.4	209D	—	1-3753-84	
58. Rhodium—Total ² . mg/L	Digestion ³ followed by AA direct aspiration, or AA furnace.	265.1	303A	—	—	
		265.2	304	—	—	
59. Ruthenium—Total ² . mg/L	Digestion ³ followed by AA direct aspiration, or AA furnace.	267.1	303A	—	—	
		267.2	304	—	—	
60. Selenium—Total ² . mg/L	Digestion ³ followed by AA furnace, Inductively coupled plasma, or AA gaseous hydride.	270.2	304	—	—	
		—	—	—	—	200.7 ⁴
		270.3	303E	D3859-84(A)	1-3667-84	
61. Silica—Dissolved. mg/L	0.45 micron filtration followed by Colorimetric, Manual or Automated (Molybdo- silicate), or Inductively coupled plasma.	370.1	425C	D859-80(B)	1-1700-84	
		—	—	—	1-2700-84	
		—	—	—	—	200.7 ⁴
62. Silver—Total ² . mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, Colorimetric (Dithizone), or Inductively coupled plasma.	272.1	303A or B	—	1-3720-84	33.089 ² , p.37 ⁴
		272.2	304	—	—	
		—	—	—	—	3198 ^{1*}
		—	—	—	—	200.7 ⁴
63. Sodium—Total ² . mg/L	Digestion ³ followed by AA direct aspiration, Inductively coupled plasma, or Flame photometric.	273.1	303A	—	1-3735-84	33.107 ²
		—	—	—	—	200.7 ⁴
		—	325B	D1428-82(A)	—	
64. Specific conductance, micromhos/cm at 25°C	Wheatstone bridge.	120.1	205	D1125-82(A)	1-1780-84	33.002 ²
65. Sulfate (as SO ₄). mg/L	Automated colorimetric (barium chloranilate), Gravimetric, or Turbidimetric.	375.1	—	—	—	
		375.3	426A or B	D516-82(A)	—	33.124 ²
		375.4	—	D516-82(B)	—	426C ^{1*}

Table 7.2. (continued)

Parameter and Units	Method	Reference (Method No. or Page)				
		EPA 1979	Std. Methods 18th Ed.	ASTM	USGS ¹	Other
66. Sulfide (as S), mg/L	Titrimetric (iodine) or Colorimetric (methylene blue).	376.1	427D	—	1-3840-84	228A ²⁰
		376.2	427C	—	—	
67. Sulfite (as SO ₃), mg/L	Titrimetric (iodine- iodate).	377.1	428A	D1339-84(C)	—	
68. Surfactants, mg/L	Colorimetric (methylene blue).	425.1	512B	D2330-82(A)	—	
69. Temperature, °C.	Thermometric.	170.1	212	—	—	Note 31
70. Thallium—Total ² , mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, or Inductively coupled plasma.	279.1	303A	—	—	
		279.2	304	—	—	
		—	—	—	—	200.7 ⁴
71. Tin—Total ² , mg/L	Digestion ³ followed by AA direct aspiration, or AA furnace.	282.1	303A	—	1-3850-78 ⁷	
		282.2	304	—	—	
72. Titanium—Total ² , mg/L	Digestion ³ followed by AA direct aspiration, or AA furnace.	283.1	303C	—	—	
		283.2	304	—	—	
73. Turbidity, NTU	Nephelometric.	180.1	214A	D1889-81	1-3860-84	
74. Vanadium, Total ² , mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, Inductively coupled plasma, or Colorimetric (Gallic acid).	286.1	303C	—	—	
		286.2	304	—	—	
		—	—	—	—	200.7 ⁴
		—	327B	D3373-84(A)	—	
75. Zinc—Total ² , mg/L	Digestion ³ followed by AA direct aspiration, AA furnace, Inductively coupled plasma, or Colorimetric (Dithizone) or (Zincon).	289.1	303A or B	D1691-84(C or D)	1-3900-84	33.089 ² , p.37 ⁸
		289.2	304	—	—	
		—	—	—	—	200.7 ⁴
		—	328C	—	—	
		—	—	—	—	Note 32

¹"Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 85-495, 1986, unless otherwise stated.

²"Official Methods of Analysis of the Association of Official Analytical Chemists," methods manual, 14th ed. (1985).

³For the determination of total metals the sample is not filtered before processing. A digestion procedure is required to solubilize suspended material and to destroy possible organic-metal complexes. Two digestion procedures are given in "Methods for Chemical Analysis of Water and Wastes, 1979." One (Section 4.1.3), is a vigorous digestion using nitric acid. A less vigorous digestion using nitric and hydrochloric acids (Section 4.1.4) is preferred; however, the analyst should be cautioned that this mild digestion may not suffice for all sample types. Particularly, if a colorimetric procedure is to be employed, it is necessary to ensure that all organo-metallic bonds be broken so that the metal is in a reactive state. In those situations, the vigorous digestion is to be preferred making certain that at no time does the sample go to dryness. Samples containing large amounts of organic materials would also benefit by this vigorous digestion. Use of the graphite furnace technique, inductively coupled plasma, as well as determinations for certain elements such as arsenic, the noble metals, mercury, selenium, and titanium require a modified digestion and in all cases the method write-up should be consulted for specific instruction and/or cautions.

NOTE: If the digestion included in one of the other approved references is different than the above, the EPA procedure must be used.

Dissolved metals are defined as those constituents which will pass through a 0.45 micron membrane filter. Following filtration of the sample, the referenced procedure for total metals must be followed. Sample digestion for dissolved metals may be omitted for AA (direct aspiration or graphite furnace) and ICP analyses provided the sample solution to be analyzed meets the following criteria:

Table 7.2. (continued)

- a. has a low COD (<20)
 b. is visibly transparent with a turbidity measurement of 1 NTU or less.
 c. is colorless with no perceptible odor, and
 d. is of one liquid phase and free of particulate or suspended matter following acidification.
- ¹⁴The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given at Appendix C of this Part 136.
- ¹⁵Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary, however, manual distillation will be required to resolve any controversies.
- ¹⁶Ammonia, Automated Electrode Method, Industrial Method Number 379-75 WE, dated February 19, 1976, Technicon AutoAnalyzer II, Technicon Industrial Systems, Tarrytown, NY, 10591
- ¹⁷The approved method is that cited in "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments," USGS TWRI, Book 5, Chapter A1 (1979).
- ¹⁸American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 1430 Broadway, New York, NY 10018.
- ¹⁹"Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater* (1981).
- ²⁰The use of normal and differential pulse voltage ramps to increase sensitivity and resolution is acceptable.
- ²¹Carbonaceous biochemical oxygen demand (CBOD₅) must not be confused with the traditional BOD₅ test which measures "total BOD." The addition of the nitrification inhibitor is not a procedural option, but must be included to report the CBOD₅ parameter. A discharger whose permit requires reporting the traditional BOD₅ may not use a nitrification inhibitor in the procedure for reporting the results. Only when a discharger's permit specifically states CBOD₅ is required, can the permittee report data using the nitrification inhibitor.
- ²²OIC Chemical Oxygen Demand Method, Oceanography International Corporation, 512 West Loop, P.O. Box 2960, College Station, TX 77840.
- ²³Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537
- ²⁴The back titration method will be used to resolve controversy.
- ²⁵Orion Research Instruction Manual, Residual Chlorine Electrode Model 97-70, 1977, Orion Research Incorporated, 840 Memorial Drive, Cambridge, MA 02138.
- ²⁶The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 14th Edition, 1976.
- ²⁷National Council of the Paper Industry for Air and Stream Improvement, (Inc.) Technical Bulletin 253, December 1971.
- ²⁸Copper, Biocinchonate Method, Method 8506, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.
- ²⁹After the manual distillation is completed, the autoanalyzer manifolds in EPA Methods 335.3 (cyanide) or 420.2 (phenols) are simplified by connecting the re-sample line directly to the sampler. When using the manifold setup shown in Method 335.3, the buffer 6.2 should be replaced with the buffer 7.6 found in Method 335.2.
- ³⁰Hydrogen Ion (pH) Automated Electrode Method, Industrial Method Number 378-75WA, October 1976, Technicon Auto-Analyzer II, Technicon Industrial Systems, Tarrytown, NY 10591.
- ³¹Iron, 1,10-Phenanthroline Method, Method 8008, 1980, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.
- ³²Manganese, Periodate Oxidation Method, Method 8034, Hach Handbook of Wastewater Analysis, 1979, pages 2-113 and 2-117, Hach Chemical Company, Loveland, CO 80537.
- ³³Goerlitz, D., Brown, E., "Methods for Analysis of Organic Substances in Water," U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A3, page 4 (1972).
- ³⁴Nitrogen, Nitrite, Method 8507, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.
- ³⁵Just prior to distillation, adjust the sulfuric acid-preserved sample to pH 4 with 1 + 9 NaOH.
- ³⁶The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 14th Edition. The colorimetric reaction is conducted at a pH of 10.0 ± 0.2. The approved methods are given on pp. 578-81 of the 14th Edition: Method 510A for distillation, Method 510B for the manual colorimetric procedure, or Method 510C for the manual spectrophotometric procedure.
- ³⁷R. F. Addison and R. G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," *Journal of Chromatography*, vol. 47, No. 3, pp. 421-426, 1970.
- ³⁸Approved methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/L and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to a pH of 12. Therefore, for levels of silver above 1 mg/L, 20 mL of sample should be diluted to 100 mL by adding 40 mL each of 2 M Na₂S₂O₃ and 2M NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/L the approved method is satisfactory.
- ³⁹The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 15th Edition.
- ⁴⁰The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 13th Edition.
- ⁴¹Stevens, H. H., Ficke, J. F., and Smoot, G. F., "Water Temperature—Influential Factors, Field Measurement and Data Presentation," U.S. Geological Survey, Techniques of Water Resources Investigations, Book 1, Chapter D1, 1975.
- ⁴²Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2-231 and 2-333, Hach Chemical Company, Loveland, CO 80537.

Table 7.3. List of approved test procedures for nonpesticide organic compounds (40 CFR, Part 136, July 1, 1987)

Parameter	EPA Method Number			Other
	GC	GC/MS	HPLC	
1 Acenaphthene	610	625, 1625	610	
2 Acenaphthylene	610	625, 1625	610	
3 Acrolein	603	*624, 1624		
4 Acrylonitrile	603	*624, 1624		
5 Anthracene	610	625, 1625	610	
6 Benzene	602	624, 1624		
7 Benzidine		*625, 1625	605	Note 3, p. 1;
8 Benzo(a)anthracene	610	625, 1625	610	
9 Benzo(a)pyrene	610	625, 1625	610	
10 Benzo(b)fluoranthene	610	625, 1625	610	
11 Benzo(ghi)perylene	610	625, 1625	610	
12 Benzo(k)fluoranthene	610	625, 1625	610	
13 Benzyl Chloride				Note 3, p. 130; Note 6, p. S102.
14 Benzyl Butyl Phthalate	606	625, 1625		
15 Bis(2-chloroethoxy) methane	611	625, 1625		
16 Bis(2-chloroethyl) ether	611	625, 1625		
17 Bis(2-ethoxyethyl) phthalate	606	625, 1625		
18 Bromodichloromethane	601	624, 1624		
19 Bromoform	601	624, 1624		
20 Bromomethane	601	624, 1624		
21 4-Bromophenylphenyl ether	611	625, 1625		
22 Carbon tetrachloride	601	624, 1624		Note 3, p. 130;
23 4-Chloro-3-methylphenol	604	625, 1625		
24 Chlorobenzene	601, 602	624, 1624		Note 3, p. 130;
25 Chloroethane	601	624, 1624		
26 2-Chloroethylvinyl ether	601	624, 1624		
27 Chloroform	601	624, 1624		Note 3, p. 130;
28 Chloromethane	601	624, 1624		
29 2-Chloronaphthalene	612	625, 1625		
30 2-Chlorophenol	604	625, 1625		
31 4-Chlorophenylphenyl ether	611	625, 1625		
32 Chrysene	610	625, 1625	610	
33 Dibenzo(a,h)anthracene	610	625, 1625	610	
34 Dibromochloromethane	601	624, 1624		
35 1,2-Dichlorobenzene	601, 602, 612	624, 625, 1625		
36 1,3-Dichlorobenzene	601, 602, 612	624, 625, 1625		
37 1,4-Dichlorobenzene	601, 602, 612	625, 1624, 1625		
38 3,3-Dichlorobenzene		625, 1625	605	
39 Dichlorodifluoromethane	601			
40 1,1-Dichloroethane	601	624, 1624		
41 1,2-Dichloroethane	601	624, 1624		
42 1,1-Dichloroethene	601	624, 1624		
43 trans-1,2-Dichloroethane	601	624, 1624		
44 2,4-Dichlorophenol	604	625, 1625		
45 1,2-Dichloropropane	601	624, 1624		
46 cis-1,3-Dichloropropane	601	624, 1624		
47 trans-1,3-Dichloropropane	601	624, 1624		
48 Diethyl phthalate	606	625, 1625		
49 2,4-Dimethylphenol	604	625, 1625		
50 Dimethyl phthalate	606	625, 1625		
51 Di-n-butyl phthalate	606	625, 1625		
52 Di-n-octyl phthalate	606	625, 1625		
53 2,4-Dinitrophenol	604	625, 1625		
54 2,4-Dinitrotoluene	606	625, 1625		
55 2,6-Dinitrotoluene	606	625, 1625		
56 Epichlorohydrin				Note 3, p. 130; Note 6, p. S102.
57 Ethylbenzene	602	624, 1624		
58 Fluoranthene	610	625, 1625	610	
59 Fluorene	610	625, 1625	610	
60 Hexachlorobenzene	612	625, 1625		
61 Hexachlorobutadiene	612	625, 1625		
62 Hexachlorocyclopentadiene	612	*625, 1625		
63 Hexachloroethane	612	625, 1625		
64 Iseno(1,2,3-cd)pyrene	610	625, 1625	610	
65 Isophorone	606	625, 1625		
66 Methylene Chloride	601	624, 1624		
67 2-Methyl-4,6-Dinitrophenol	604	625, 1625		Note 3, p. 130;
68 Naphthalene	610	625, 1625		
69 Nitrobenzene	606	625, 1625		
70 2-Nitrophenol	604	625, 1625		
71 4-Nitrophenol	604	625, 1625		
72 N-Nitrosodimethylamine	607	625, 1625		
73 N-Nitrosod-n-propylamine	607	625, 1625		
74 N-Nitrosodphenylamine	607	*625, 1625		
75 2,2-oxylbis(1-chloropropane)	607	*625, 1625		
76 PCB-1016	606		625	Note 3, p. 43;
77 PCB-1221	606		625	Note 3, p. 43;
78 PCB-1232	606		625	Note 3, p. 43;
79 PCB-1242	606		625	Note 3, p. 43;
80 PCB-1248	606		625	Note 3, p. 43;
81 PCB-1254	606		625	Note 3, p. 43;
82 PCB-1260	606		625	Note 3, p. 43;
83 Pentachlorophenol	604	625, 1625		Note 3, p. 140;

Table 7.3. (continued)

Parameter ¹	EPA Method Number ²			Other
	GC	GC/MS	HPLC	
84. Phenanthrene.....	610	625, 1625	610	
85. Phenol.....	604	625, 1625		
86. Pyrene.....	610	625, 1625	610	
87. 2,3,7,8-Tetrachlorodibenzo-p-dioxin.....		^a 613		
88. 1,1,2,2-Tetrachloroethane.....	601	624, 1624		Note 3, p. 130;
89. Tetrachloroethene.....	601	624, 1624		Note 3, p. 130;
90. Toluene.....	602	624, 1624		
91. 1,2,4-Trichlorobenzene.....	612	625, 1625		Note 3, p. 130;
92. 1,1,1-Trichloroethane.....	601	624, 1624		
93. 1,1,2-Trichloroethane.....	601	624, 1624		Note 3, p. 130;
94. Trichloroethene.....	601	624, 1624		
95. Trichlorofluoromethane.....	601	624,		
96. 2,4,6-Trichlorophenol.....	604	625, 1625		
97. Vinyl Chloride.....	601	624, 1624		

Table IC Notes

¹ All parameters are expressed in micrograms per liter (µg/L).

² The full text of Methods 601-613, 624, 625, 1624, and 1625, are given at Appendix A, "Test Procedures for Analysis of Organic Pollutants," of this Part 136. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit," of this Part 136.

³ Methods for Benzene; Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978.

⁴ Method 624 may be extended to screen samples for Acrolein and Acrylonitrile. However, when they are known to be present, the preferred method for these two compounds is Method 603 or Method 1624.

⁵ Method 625 may be extended to include benzidine, hexachlorocyclopentadiene, N-nitrosodimethylamine, and N-nitrosodiphenylamine. However, when they are known to be present, Methods 605, 607, and 612, or Method 1625, are preferred methods for these compounds.

^a 625, Screening only.

⁶ "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater* (1981).

⁷ Each analyst must make an initial, one-time, demonstration of their ability to generate acceptable precision and accuracy with Methods 601-613, 624, 625, 1624, and 1625 (See Appendix A of this Part 136) in accordance with procedures each in section 8.2 of each of these Methods. Additionally, each laboratory, on an on-going basis must spike and analyze 10% (5% for Methods 624 and 625 and 100% for methods 1624, and 1625) of all samples to monitor and evaluate laboratory data quality in accordance with sections 8.3 and 8.4 of these Methods. When the recovery of any parameter falls outside the warning limits, the analytical results for that parameter in the unspiked sample are suspect and cannot be reported to demonstrate regulatory compliance.

Note.—These warning limits are promulgated as an "interim final action with a request for comments."

Table 7.4. List of approved test procedures for pesticides¹
(40 CFR, Part 136, July 1, 1987)

Parameter µg/L	Method	EPA ^{1,2}	Standard Methods 15th Ed	ASTM	Other
1 Aldrin	GC GC/MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
2 Amethrin	GC				Note 3, p. 83; Note 6, p. S68.
3 Aminocarb	TLC				Note 3, p. 94; Note 6, p. S16.
4 Atrazin	GC				Note 3, p. 83; Note 6, p. S68.
5 Atrazine	GC				Note 3, p. 83; Note 6, p. S68.
6 Azinphos methyl	GC				Note 3, p. 25; Note 6, p. S51.
7 Barban	TLC				Note 3, p. 104; Note 6, p. S64.
8 α-BHC	GC GC/MS	608 625	509A	D3086	Note 3, p. 7.
9 β-BHC	GC GC/MS	608 625		D3086	
10 δ-BHC	GC GC/MS	608 625		D3086	
11 γ-BHC (Lindane)	GC GC/MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
12 Captan	GC		509A		Note 3, p. 7.
13 Carbaryl	TLC				Note 3, p. 94; Note 6, p. S60.
14 Carbofenthothion	GC				Note 4, p. 30; Note 6, p. S73.
15 Chlordane	GC GC-MS	608 625	509A	D3086	Note 3, p. 7.
16 Chloroprotham	TLC				Note 3, p. 104; Note 6, p. S64.
17 2,4-D	GC		509B 509A		Note 3, p. 115; Note 4, p. 35.
18 4,4'-DDD	GC GC-MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
19 4,4'-DDE	GC GC/MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
20 4,4'-DDT	GC GC/MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
21 Demeton-O	GC				Note 3, p. 25; Note 6, p. S51.
22 Demeton-S	GC				Note 3, p. 25; Note 6, p. S51.
23 Diazinon	GC				Note 3, p. 25; Note 4, p. 30; Note 6, p. S51.
24 Dicamba	GC				Note 3, p. 115.
25 Dichlofenthothion	GC				Note 4, p. 30; Note 6, p. S73.
26 Dichloran	GC		509A		Note 3, p. 7.
27 Dicolof	GC			D3086	
28 Dieldrin	GC GC/MS	608 625	509A		Note 3, p. 7; Note 4, p. 30.
Dioxathion	GC				Note 4, p. 30; Note 6, p. S73.
29 Disulfoton	GC				Note 3, p. 25; Note 6, p. S51.
31 Diuron	TLC				Note 3, p. 104; Note 6, p. S64.
32 Endosulfan I	GC GC/MS	608 625	509A	D3086	Note 3, p. 7.
33 Endosulfan II	GC GC/MS	608 625	509A	D3086	Note 3, p. 7.
34 Endosulfan sulfate	GC GC/MS	608 625			
35 Endrin	GC GC/MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
36 Endrin aldehyde	GC GC/MS	608 625			
37 Ethion	GC				Note 4, p. 30; Note 6, p. S73.
38 Fenuron	TLC				Note 3, p. 104; Note 6, p. S64.
39 Fenuron-TCA	TLC				Note 3, p. 104; Note 6, p. S64.
40 Heptachlor	GC GC/MS	608 625	509A	D3086	Note 3, p. 7; Note 4, p. 30.
41 Heptachlor epoxide	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30; Note 6, p. S73.
42 Isodrin	GC/MS	625			Note 4, p. 30; Note 6, p. S73.
43 Linuron	GC				Note 3, p. 104; Note 6, p. S64.
44 Malathion	GC		509A		Note 3, p. 25; Note 4, p. 30; Note 6, p. S51.
45 Methiocarb	TLC				Note 3, p. 94; Note 6, p. S60.
46 Methoxychlor	GC		509A	D3086	Note 3, p. 7; Note 4, p. 30.
47 Mexacarbale	TLC				Note 3, p. 94; Note 6, p. S60.
48 Mirex	GC		509A		Note 3, p. 7.
49 Monuron	TLC				Note 3, p. 104; Note 6, p. S64.
50 Monuron-TCA	TLC				Note 3, p. 104; Note 6, p. S64.
51 Neburon	TLC				Note 3, p. 104; Note 6, p. S64.
52 Parathion methyl	GC		509A		Note 3, p. 25; Note 4, p. 30.
3 Parathion ethyl	GC		509A		Note 3, p. 25.
4 PCNB	GC		509A		Note 3, p. 7.
5 Perthane	GC			D3086	
56 Prometon	GC				Note 3, p. 83; Note 6, p. S68.
57 Prometryn	GC				Note 3, p. 83; Note 6, p. S68.
58 Propazine	GC				Note 3, p. 83; Note 6, p. S68.
9 Propham	TLC				Note 3, p. 104; Note 6, p. S64.
0 Propoxur	TLC				Note 3, p. 94; Note 6, p. S60.
1 Secbumeton	TLC				Note 3, p. 83; Note 6, p. S68.
2 Siouron	TLC				Note 3, p. 104; Note 6, p. S64.
3 Simazine	GC				Note 3, p. 83; Note 6, p. S68.
4 Trobane	GC		509A		Note 3, p. 7.

Table 7.4. (continued)

Parameter µg/L	Method	EPA ^{1,2}	Standard Methods 15th Ed	ASTM	Other
65. Weed	TLC				Note 3, p. 104, Note 6, p. S64
66. 2,4,5-T	GC		509B		Note 3, p. 115, Note 4, p. 35
67. 2,4,5-TP (Silvex)	GC		509B		Note 3, p. 115
68. Terbutylazine	GC				Note 3, p. 83, Note 6, p. S68
69. Toxaphene	GC	608	509A	D3086	Note 3, p. 7, Note 4, p. 30
	GC/MS	625			
70. Trifluralin	GC		509A		Note 3, p. 7

Table 1D Notes

- ¹ Pesticides are listed in this table by common name for the convenience of the reader. Additional pesticides may be found under Table 1C, where entries are listed by chemical name.
 - ² The full text of methods 608 and 625 are given at Appendix A, "Test Procedures for Analysis of Organic Pollutants," of this Part 136. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit," of this Part 136.
 - ³ "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978. This EPA publication includes thin-layer chromatography (TLC) methods.
 - ⁴ "Methods for Analysis of Organic Substances in Water," U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 5, Chapter A3 (1972).
 - ⁵ The method may be extended to include α-BHC, δ-BHC, endosulfan I, endosulfan II, and endrin. However, when they are known to exist, Method 608 is the preferred method.
 - ⁶ "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater* (1981).
 - ⁷ Each analyst must make an initial, one-time, demonstration of their ability to generate acceptable precision and accuracy with Methods 608 and 625 (See Appendix A of this Part 136) in accordance with procedures given in Section 8.2 of each of these methods. Additionally, each laboratory, on an on-going basis, must spike and analyze 10% of all samples analyzed with Method 608 or 5% of all samples analyzed with Method 625 to monitor and evaluate laboratory data quality in accordance with Sections 8.3 and 8.4 of these methods. When the recovery of any parameter falls outside the warning limits, the analytical results for that parameter in the unspiked sample are suspect and cannot be reported to demonstrate regulatory compliance.
- Note.—These warning limits are promulgated as an "interim final action with a request for comments."

Table 7.5. List of approved radiological test procedures
(40 CFR, Part 136, July 1, 1987)

Parameter and units	Methods	EPA ¹	Reference (method No. or page)		
			Standard Methods, 15th Ed.	ASTM	USGS ²
1 Alpha-Total, pCi per liter	Proportional or scintillation counter	900.0	703	D1943-66	pp. 75 and 78 ³
2 Alpha-Counting error, pCi per liter	Proportional or scintillation counter	Appendix B	703	D1943-66	p. 79
3 Alpha-Counting error, pCi per liter	Proportional counter	900.0	703	D1890-66	pp. 75 and 78 ³
4 Beta-Counting error, pCi per liter	Proportional counter	Appendix B	703	D1890-66	p. 79
5 (a) Radium-Total, pCi per liter	Proportional counter	903.0	705	D2460-70	
(b) ²²⁶ Ra, pCi per liter	Scintillation counter	903.1	706	D3454-79	p. 81

Table 7E Notes

¹ "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032 (1980 update), U.S. Environmental Protection Agency, August 1980.
² Fishman, M.J. and Brown, Eugene, "Selected Methods of the U.S. Geological Survey of Analysis of Wastewaters," U.S. Geological Survey, Open-File Report 76-177 (1976).
³ The method found on p. 75 measures only the dissolved portion while the method on p. 78 measures only the suspended portion. Therefore, the two results must be added to obtain the "total."

and blank/spike control. In methods not using surrogates such as metals, anions, and wet chemical analysis, a blank and a blank/spike (laboratory control sample) shall be analyzed. For pesticide/PCB methods, surrogates are often used. However, problems have been noted in surrogate recovery for the dibutyl chlorinate typically used. For pesticide/PCB analysis, a blank and a blank/spike shall be analyzed with each batch as separate samples. A pesticide or a PCB shall be used as the spiking compound.

In Level C, when performing analyses for petroleum hydrocarbons; oil and grease; anions such as nitrates, sulfates and chloride; and other wet chemical methods, a matrix spike and matrix spike duplicate are required for every 20 samples of similar matrix. Similar matrix is defined as either soil or water from the same military base.

All methods specified require calibration. In keeping with the method calibration requirements, the following requirements are presented. For all semivolatile and volatile analysis by GC/MS, the current CLP calibration method shall be used. The current CLP criteria shall be used for frequency of calibration, for the system performance check compounds (SPCCs), and for the calibration check compounds (CCCs).

For other methods, a minimum of three different concentration standards for each analyte shall be analyzed for initial calibration. Calibration shall be checked every 12 h of operation and prior to sample analysis. The laboratory shall use the calibration check acceptance criteria specified by the method. The daily calibration acceptance criteria to be used for each method shall be documented in the laboratory QA plan or in the site-specific QA plan. The initial calibration curve shall be plotted and the correlation coefficient and response factors evaluated. The laboratory shall indicate in the laboratory QA plan or in the site-specific QA plan the acceptance criteria to be used for the initial calibration curve. The calibration shall include one standard at a concentration at the method detection limits. The calibration curve shall bracket all samples in the concentration range. If the samples are not within the calibration range, appropriate dilution shall be performed to bring the samples into the calibration range. The aforementioned calibration requirements shall be used for Levels C and E.

In Level C, a matrix spike and matrix spike duplicate are required for volatiles, semivolatiles, and all GC analysis for every 20 samples of similar matrix. For metals analysis, a duplicate and a matrix spike are required for every 20 samples of similar matrix.

For all GC methods used in level C QC, second column confirmation shall be used for all positive responses for the analytes of interest. In Level E, second column confirmation is not required.

In Level E, no matrix spikes or duplicates are required; only the initial and continuing calibration, method blank, and blank/spike are required.

7.2 DELIVERABLES

For Level D QC, a CLP data package shall be delivered. This shall include the summary package and the remainder of the package, which includes initial and continuing calibration, matrix spikes, matrix spike duplicates, blanks, duplicates, surrogate recoveries, chromatograms, mass spectra, and absorbance data. For methods which are not defined by CLP, the calibration information, method blanks, blank/spikes, the chromatograms, absorbance, matrix spikes, and matrix spike duplicates shall be reported. The control charts plotted per Sect. 4 associated with the blank/spikes shall be presented with the data.

For Level C QC, the method blanks, blank/spike, surrogates, matrix spikes, matrix spike duplicates, duplicates, and initial and continuing calibration data shall be reported. Table 7.6 lists the required deliverables. The forms referred to in Table 7.6 are from the current CLP for organics and metals/cyanide. The form numbers will be upgraded as new revisions occur in the CLP, which require changes in form content or numbering.

In Level E, the only information to be submitted is the sample data, method blank data, and the control chart from the blank/spike.

The deliverables shall be presented to the NCR. The forms shall be used when reporting any data in the MPR and in submitting the final data package prior to its inclusion in the appendix and summary tables of the final report. The final data deliverables shall be presented to the NCR at least three weeks prior to issuing the draft of the final report.

7.3 DATA VALIDATION

7.3.1 Level D Validation

At a minimum, the data generated from Level D will be validated per the CLP criteria as outlined in the following documents.

EPA, Hazardous Site Control Division, *Laboratory Data Validation Functional Guidelines for Evaluating Pesticides/PCB's Analyses*, R-582-5-5-01, May 28, 1985.

EPA, Hazardous Site Control Division, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*, R-582-5-5-01, May 28, 1985.

EPA, Office of Emergency and Remedial Response, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*, 1985.

Table 7.6. Data set deliverables for Level C QA

Method requirements	Deliverables
Organics - Method blank spikes with results and control charts. Run with each batch of samples processed.	Control chart
- Results to be reported on CLP Form 1 or spreadsheet per Sect. 9. Sample results using CLP data flags.	Form 1 or Sect. 9 1/Sample chromatograms/and mass spectra
- Surrogate recovery from samples reported on CLP Form 2. Surrogates to be used in volatiles, semivolatiles, pesticides/PCB. For volatiles by GC, the names of surrogates should be changed to reflect the surrogate used.	Form 2
- Matrix spike/spike duplicate 1 spike and spike duplicate per 20 samples of similar matrix reported on Form 3.	Form 3
- Method blank reported on CLP Form 4. For volatiles by GC, a similar format will be used as CLP Form 4 for blanks.	Form 4 or Sect. 9
- GC/MS tuning for volatiles/semi-volatiles. Report results on Form 5.	Form 5
- Initial calibration data reported on Form 6. For volatiles by GC, the initial calibration data with response factors must be reported.	Form 6 No Form
For pesticide/PCB data Form 9 must be used for calibration data.	Form 9
- Continuing calibration GC/MS data reported on Form 7. For volatiles, GC data, the response factors and their percent differences from the initial must be reported.	Form 7 No Form
Internal Standard Area for Volatiles and Semivolatiles.	Form 8

Table 7.6. (continued)

Method requirements	Deliverables
Organics - For pesticides/PCB data, the CLP Form 9 (cont'd) must be presented.	Form 9
<p>No chromatograms or mass spectra are presented for calibration. These data should be filed in the laboratory and available if problems arise in reviewing/validating the data. The calibration information should be available for checking during on-site audits.</p>	
- Internal standard area for GC/MS analyses CLP Form VIII shall be supplied.	
- Second column confirmation shall be done for all GC work when compounds are detected above reporting limits. Chromatograms of confirmation must be provided.	Chromatograms
Metals - Level C, requirements	Deliverables
- Sample results with CLP flagging system	CLP Form 1 or Sect. 9
- Initial and continuing calibration	CLP Form 2, Part 1 only
- Blanks 10% frequency	Form 3
- Method blank taken through digestion (1/20 samples of same matrix)	Form 3 or Sect. 9
- ICP interference check sample	Form 4
- Matrix spike recovery (1 per 20 samples of similar matrix)	Form 5, Part 1
- Postdigestion spike sample recovery for ICP metals. Only done if predigest spike recovery exceed CLP limits.	Form 5, Part 2 (never used for GFAA work)
- Postdigest spike for GFAA	Recovery will be noted on raw data
- Duplicates (1 per 20 samples will be split and digested as separate	Form 6 samples

Table 7.6. (continued)

Method requirements	Deliverables
Metals (cont'd) - Method blank spike information will be plotted on control chart, one per batch of samples processed.	Control chart
- Standard addition. The decision process outlined in CLP page E-3 will be used to determine when standard additions are required.	Form 8
Holding times	Form 10
Wet Chemistry Level C	
- Blank spike 1/batch	Control chart
- Method Blank 1/batch	Report result No format
- Sample results	Report result No format
- Matrix spike/spike duplicate or calibration information	Report result if applicable
- Calibration check report percent RSD or percent difference from initial calibration	Report percent or percent difference
	No format

7.3.2 Level C Data Validation Guidelines

Listed below are the validation criteria which will be utilized in evaluating the analytical data for a Level C QC site. For methods not listed here, a similar procedure will be submitted by the prime contractor and the laboratory which outlines validation of the holding times, initial calibration, continuing calibration, and blank-vs-sample results. The validation procedure will be approved by the NCR.

1. For Petroleum Hydrocarbons (418.1/SW-3540, EPA 418.1)

Holding Times - Holding times are 28 days for water samples which are preserved and refrigerated. No holding times are cited for soils.

Calibration - Ensure that a three-to-five point curve bracketing the sample concentration is performed daily.

Blanks - A blank should be run with each batch. If the blank concentration exceeds the reporting limit, the reporting limit shall be raised and the data flagged as estimated (UJ).

2. Target Compound List (TCL) for VOAs (CLP Methods)

Holding Times - Samples must be analyzed within the holding times specified in Sect. 3 or the data should be marked as estimated (J).

GC/MS Tuning - Check that bromofluorobenzene tune is completed each 12-h shift of operation. Check that it meets the CLP criteria. Assure that each sample is associated with a tune.

Initial Calibration - The maximum relative standard deviation [(RSD) percent RSD] shall not be >30% for indicted CLP CCC. The maximum mean relative response factor (RRF) for SPCC shall be >0.300 (0.250 for bromoform). The SPCCs are chloromethane, 1,1-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and chlorobenzene. The CCC compounds are vinyl chloride, 1,1-dichloroethene, chloroform, 1,2-dichloropropane, toluene, and ethylbenzene.

Continuing Calibration - The minimum response factor for the SPCC components for VOAs analyses shall not be <0.300 (0.250 for bromoform). The maximum response factor percent deviation for indicated CLP CCC components from the mean initial calibration response factor shall not exceed 25%. If these criteria are exceeded, a new calibration for the compound shall be employed.

Blank/Spike Control Samples - Any control sample which exceeds the internal QC limits set by the laboratory for a given sample matrix shall require all data from the associated batch of samples to be closely inspected. If no analytical problems are found, the data analyzed with the out-of-control point shall be discussed in the QC section of the MPR and final report. If problems are found in the analytical data, the samples associated with the batch shall be reanalyzed and the data from reanalysis reported. If holding times are exceeded in the reanalysis, both sets of data shall be presented.

If the blank/spike results are outside the internal laboratory limits and if the matrix spike results are outside the CLP limits, the laboratory will either reanalyze the samples within the holding times or the data will be flagged with an "R," and the data are not usable.

Surrogates - If surrogates exceed the CLP limits, the data shall be flagged that the surrogates exceeded limits.

Method Blanks - A method blank should be run each day following the Continuing Calibration Standard. Common laboratory solvents should not be found in the blank at levels over five times the detection

limits. Other compounds should not be found in the blank at levels exceeding the detection limits. If common contaminant compounds are detected in samples at a concentration of <10 times the concentration found in the blank, or other compounds at <5 times the concentration in the blank, report those compounds as not detected. Adjust the sample quantitation limit to the value reported in the samples and flag the limit as estimated (UJ).

Matrix Spike/Spike Duplicate - Ensure that 1 out of 20 samples has been spiked in duplicate. The recoveries shall meet the CLP criteria. If the recoveries do not meet the criteria, examine the blank spike data. If the blank spike data exceed the limits and the matrix spikes exceed limits, the data shall be flagged as unusable (R). If the blank spike data from the batch are satisfactory, the data is usable, and the low recovery is discussed in the final report QA/QC and in the QC report sent to the NCR.

Field Trip and Equipment Blanks - If contaminant analytes are detected in samples at concentrations of <5 times the concentration found in the highest associated blank, the results are considered suspect and are reported as estimated.

3. TCL Semivolatile Organics (CLP Methods)

Holding Times - Samples must be extracted within 7 days of collection and analyzed within 40 days of extraction. Any samples which do not meet these requirements must be flagged as estimated.

GC/MS Tune - Make certain that a decafluorotriphenylphosphine tune is completed every 12 h of sample analysis, that each sample is associated with a tune, and that each tune meets CLP requirements. Data are not reported if the instrument does not meet tune.

Initial Calibration - Ensure that a 5-point curve has been completed. The RRF of the BNA compounds shall be a minimum of 0.050 for the SPCC listed in the current revision of the CLP. The maximum RSD for the CCC listed in the CLP procedure is 30.0%. The minimum RRF for the SPCC is 0.050, and the maximum percent difference for the CCC is 25%. If these limits are exceeded, a new calibration curve shall be generated.

Continuing Calibration - The continuing calibration check will be performed once every 12 h during operation. The minimum RRF for the SPCC is 0.05, and the maximum percent difference from the initial calibration shall not exceed 25% for the CCC. If these limits are exceeded, a new calibration curve shall be generated.

Blank/Spike Control Samples - Any control sample which exceeds the internal QC limits set by the laboratory for a given sample matrix shall require all data from the associated batch of samples to be closely inspected. If no analytical problems are found, the data and the out-of-control point shall be discussed in the QC section of

the report. If problems are found in the analytical data, the samples associated with the batch shall be reanalyzed and the data from reanalysis reported. If holding times are exceeded in the reanalysis, both sets of data shall be presented.

If the blank/spike results are outside the internal laboratory limits and if the matrix spike results are outside the CLP limits, the laboratory will either reanalyze the samples or the data will be flagged with an "R," and the data is not usable.

Surrogates - If surrogates exceed the CLP limits, the data shall be flagged that the surrogates exceeded limits.

Blanks - A method blank should be run each day following the Continuing Calibration Standard. Phthalate should not be found in the blank at levels over five times the detection limits. Other compounds should not be found in the blank at levels exceeding the detection limits. If common contaminant compounds are detected in samples at a concentration of <10 times the concentration found in the blank, or other compounds at <5 times the concentration in the blank, report those compounds as not detected. Adjust the sample quantitation limit to the value reported in the samples and flag the limit as estimated (UJ).

Matrix Spike/Spike Duplicate - Ensure that 1 out of 20 samples has been spiked in duplicate. The recoveries should meet the CLP criteria. If the recoveries do not meet the criteria, examine the blank spike data. If the blank spike data exceed the limits and the matrix spikes exceed limits, the data shall be flagged as unusable (R). If the blanks spike data from the batch is satisfactory, the data are usable, and the low recovery is discussed in the final QC report sent to the Analytical Environmental Support Section.

4. Metals

Holding Times - Samples must be analyzed within six months, except mercury shall be analyzed in 28 days from sample collection.

ICP Initial Calibration - A calibration blank and at least one standard must be analyzed daily. An initial calibration verification standard must be within 90 to 110% recovery or the samples should be reanalyzed. If it is not possible to perform reanalysis, the data are rejected and flagged with an "R."

AA Calibration - Calibration blank and at least three standards shall be used in establishing the curve prior to sample analysis. A curve shall be analyzed each day prior to sample analysis.

Calibration Verification - Verification using a standard obtained from a source other than that of the initial calibration shall be used and the result shall be within 90 to 110% of the true value for

both ICP and AA work. Calibration verification shall be done at a minimum frequency of 10% or every 2 h, whichever is more frequent, and shall be done at the end of the analytical run.

Method Blanks - At least one preparation blank shall be prepared with each batch of samples. The blanks shall contain less than the detection limit for all analytes. If the concentration of the associated blanks is above the detection limit and if the lowest analyte concentration is <10 times the blank, reanalysis of the sample must occur. If reanalysis is not done, the data shall be reported and flagged as estimated. The blank shall never be subtracted from the sample.

Field and Equipment Blanks - If contaminant analytes are detected in samples at concentrations of <5 times the concentration found in the highest associated blank, the results are considered suspect and are reported as estimated.

Blank/Spike Laboratory Control Samples - Any laboratory control sample which exceeds the internal QC limits set by the laboratory for a given sample matrix shall require all data from the associated batch of samples to be closely inspected. If no analytical problems are found, the data and out-of-control point shall be discussed in the QC section of the report. If problems are found in the analytical data, the samples associated with the batch shall be reanalyzed and the data from reanalysis reported. If holding times are exceeded in the reanalysis, both sets of data shall be presented. A discussion of data reported when the blank/spike laboratory control sample is out of control shall be presented in the QC section of both the final report and the MPR.

If the blank/spike results are outside the internal laboratory limits and if the matrix spike results are outside the CLP limits, the laboratory will either reanalyze the samples or the data will be flagged with an "R," and the data are not usable.

8. MAINTAINING LABORATORY APPROVAL

Once a laboratory has received Navy approval to begin analysis of samples, maintaining that approval requires adherence to the QA plan and reporting of QA-related information. The performance and reporting requirements outlined below are essential to ensuring that data of known and defensible quality are being generated throughout the course of a site investigation. Topics covered include control samples, control charts, out-of-control events, corrective action reports, significant changes in the QA plan, and other reporting requirements.

8.1 MONTHLY PROGRESS REPORT

The primary means of communication from the laboratories to the NCR will be the MPR to be submitted by the laboratories to the NCR on the 15th of each month in which work for the Navy is performed. The following information is to be included in the MPR.

1. Site name and contract number.
2. Numbers, types and locations of samples collected and analyzed for Navy project only.
3. Data for blanks, spikes, laboratory duplicates and controls related to Navy samples.
4. New methods used for analysis and changes in old methods.
5. Copies of all control charts pertinent to Navy samples and to which results have been added over the reporting period.
6. Summaries of out-of-control incidents during the reporting period, including references to documentation and corrective action reports.
7. Descriptions of and justifications for significant changes in the QA.
8. Changes in LQAC personnel and other key technical personnel; resumes of new personnel must be submitted.
9. Completed sample data.

Much of the information presented in an MPR is incremental in nature and relates to changes and findings since the previous MPR.

1. Control charts from the minimizing control charts program and any additional control charts from monitoring matrix spikes, duplicates, or other QC parameters.
2. Personnel changes relating to QA responsibilities.

3. Method changes (e.g., a minor modification with an attached EPA variance).
4. Procedural changes in establishing control limits and/or the preparation and use of control charts.

Since the first such report for each laboratory has no precedent, more explanation and detail may be necessary; subsequent MPRs will likely not require as much detail in some areas.

8.2 FINAL REPORT

A draft of the final report shall be reviewed by the NCR prior to its release. This report is the final deliverable from the engineering subcontractor. An outline for a typical report is as follows.

1. Site name and Navy contract number.
2. Foreword--signed by those with major responsibilities for the QA program and by project management.
3. Executive Summary--brief review of the report.
4. Table of Contents--with specificity at approximately the same level as the Table of Contents in this Navy document.
5. Introduction--summarize the Navy field sites of interest, when the study occurred (dates of sampling, dates of analysis) and the objectives of the QA plan as they relate to the study.
6. Data Summary--summarize the results on a site-by-site basis.
7. Other Information--present any other information requested in the statement of work such as risk assessment, recommendation to perform more site characterization, or recommend site closure. This information was specified prior to beginning work and is directed by the Navy EIC.
8. The final report shall present the findings from the analytical, geological, and hydrogeological studies. The summary of analytical data will exclude non-detected compounds. No subtraction of blanks is allowed. Data will be flagged if blank contamination occurs. All data flags will follow the result in the summary.
9. QC Summary--the QC summary section will include a discussion of are data which flagged. Flagged data defined as data for which trip, field, or laboratory blanks were contaminated, matrix spike/spike duplicates exceed limits, calibration criteria are not met, and laboratory controls exceed limits. The QC summary will also discuss the results of laboratory blanks, matrix spikes/spike duplicates,