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Final 1996
Site Management Plan
Naval Base, Norfolk; Norfolk, Virginia



Prepared for
Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia

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Prepared by

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FINAL
1996 SITE MANAGEMENT PLAN
NAVAL BASE, NORFOLK
NORFOLK, VIRGINIA
CONTRACT TASK ORDER 0010
MARCH, 1997

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under:

LANTDIV CLEAN Program
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Contents

<u>Section</u>	<u>Page</u>
1. Introduction	1-1
1.1. Purpose of the Site Management Plan.....	1-1
1.2. Facility Description	1-1
1.2.1. Facility Location/Physical Description	1-1
1.2.2. Facility History/Mission.....	1-3
1.2.3. Operations/Process Descriptions	1-3
1.3. Environmental Setting	1-4
1.3.1. Topography and Surface Water Hydrology.....	1-4
1.3.2. Geology and Hydrogeology	1-4
1.4. Environmental History	1-6
1.4.1. Installation Restoration Program.....	1-6
1.4.2. Previous Base-Wide Investigations	1-6
1.5. Format of the Site Management Plan	1-9
2. Site Descriptions Site Histories	2-1
2.1. Installation Restoration Program (IRP) Sites.....	2-1
2.2. Solid Waste Management Units (SWMUs).....	2-8
3. Site Ranking	3-1
3.1. Quantitative Analysis	3-1
3.2. Qualitative Analysis.....	3-2
3.2.1. Contaminant Hazard Factors (CHF).....	3-7
3.2.2. Receptor Factor	3-7
3.2.3. Migration Pathway Factor	3-10
3.3. Relative Risk Designation	3-10
3.3.1. Significant CHF	3-13
3.3.2. Moderate CHF	3-13
3.3.3. Minimal CHF	3-13
3.4. Summary.....	3-14
4. CERCLA Process Activities	4-1
4.1. CERCLA RI/FS Process.....	4-1
4.2. Removal Action Process	4-3
4.3. Interim Remedial Action Process.....	4-3
4.4. Treatability Studies	4-4
5. Site Management Plan Schedules	5-1
5.1. Scheduling Assumptions.....	5-1
5.1.1. Field Investigation and Laboratory Analysis/Validation.....	5-1
5.1.2. Document Preparation and Document Review.....	5-2
5.1.3. Remedial Design/Remedial Action	5-5
5.2. IRP Site Project Schedules	5-5
5.3. Submittals List	5-6

Contents (continued)

<u>Table</u>	<u>Page</u>
1-1 Stratigraphic and Hydrogeologic Units of Southeast Virginia	1-5
1-2 Current Status Summary—IRP Sites	1-8
3-1 Contaminant Hazard Factors	3-3
3-2 Receptor Factor and Migration Pathway Factors	3-8
3-3 Site Relative Risk Designation	3-11
3-4 Relative Risk Designation for Significant CHF Sites	3-13
3-5 Relative Risk Designation for Moderate CHF Sites	3-13
3-6 Relative Risk Designation for Minimal CHF Sites	3-14
5-1 Active Projects for 1996/1997	5-3
5-2 Document Preparation Durations	5-4
5-3 Submittals List Summary	5-7
<u>Figure</u>	<u>Page</u>
1-1 Installation Location Map	1-2
1-2 Base Map with Original Site Locations	1-10
1-3 Base Map with Additional Site Locations	1-11
2-1 Camp Allen Landfill (Site 1) and Camp Allen Salvage Yard (Site 22)	2-17
2-1b Site Map Camp Allen Salvage Yard (Site 22)	2-18
2-2 NM Slag Pile (Site 2), Apollo Fuel Disposal Sites (Site 10), and Former NM Hazardous Waste Storage Area (Site 18)	2-19
2-3 Q Area Drum Storage Yard (Site 3)	2-20
2-4 P-71 Transformer Storage Area (Site 4)	2-21
2-5 Pesticide Disposal Site (Site 5), Instrument Repair Shop Drains (Site 11), Alleged Mercury Disposal Site (Site 12), Past Industrial Wastewater Outfalls (Site 13) and Buildings V60/V90 (Site 19)	2-22
2-6 CD Landfill (Site 6), Inert Chemical Landfill (Site 7), and Asbestos Landfill (Site 8)	2-23
2-7 Q Area Landfill (Site 9)	2-24
2-8 Chemical Fire, Building X-136 (Site 16)	2-25
2-9 Chemical Fire, Building SDA-215 (Site 17)	2-26
2-10 LP-20 Site (Site 20)	2-27
2-11 Building W-316 (Site 21)	2-28
2-12 SP-2B Accumulation Area (SWMU 1)	2-29
2-13 Building Z-309 Ash Hopper Storage (SWMU 2) and Building Z-309 Oil/ Lubricant Storage Area (SWMU 3)	2-30
2-14 PWC Sandblast Area (SWMU 4)	2-31
2-15 LF-61 Waste Tank Area (SWMU 5)	2-32
2-16 V-28 Waste Pit (SWMU 6)	2-33
2-17 LF-18 Aircraft Ramp (SWMU 7)	2-34
2-18 Fire Training School (SWMU 18)	2-35
2-19 LP-200 MAC Terminal (SWMU 9)	2-36

Contents (continued)

<u>Figure</u>	<u>Page</u>
2-20	LP-200 MAC Terminal East (SWMU 10) 2-37
2-21	Old Weapons Station Entrance (SWMU 11) 2-38
2-22	Disposal Area Near Building NM-37 (SWMU 12) 2-39
2-23	Disposal Area Behind Slag Pile/ PWC Operations Building (SWMU 13) 2-40
2-24	Q-50 Satellite Accumulation Area (SWMU 14) 2-41
2-25	W-130 Hazardous Waste Accumulation Area (SWMU 15) 2-42
2-26	NM-37 Accumulation Area (SWMU 16) 2-43
2-27	Old Mounds Northeast of NM-31 (SWMU 26) 2-44
2-28	Mason Creek Embankment (SWMU 27) 2-45
2-29	Probable Solid Waste Disposal South of CEP 201 (SWMU 28) 2-46
2-30	Solid Waste Disposal Area/ CD-3/CD-4 (SWMU 29) 2-47
2-31	Sludge Fill Disposal Area/ Marshy Area South of Runway (SWMU 30) 2-48
2-32	Solid Waste Disposal Area CEP-160/161 Embankment (SWMU 2-32) 2-49
2-33	Debris Piled at Seawall (SWMU 33) 2-50
2-34	Solid Waste Disposal CEP 200 (SWMU 34) and Solid Waste Disposal CEP-196 (SWMU35)..... 2-51
4-1	CERCLA RI/FS Process 4-2
5-1	Site 1—Camp Allen Landfill 5-10
5-2	Site 2—NM Slag Pile..... 5-11
5-3	Site 3—Q-Area Drum Storage 5-12
5-4	Site 5—Pesticide Disposal Site 5-13
5-5	Site 6—CD Landfill..... 5-14
5-6	Site 20—LP-20 Site 5-15
5-7	Site 21—Building W-316 5-16
5-8	Site 22—Camp Allen Salvage Yard 5-17
5-9	Model Schedule—Simple IRP Site..... 5-18
5-10	Model Schedule—Complex IRP Site..... 5-19
5-11	Model Schedule—Simple SWMU 5-20
5-12	Model Schedule—Complex SWMU..... 5-23
5-13	Model Schedule—Complex IRP Site 5-27

Appendix

- A Quantitative Site Data Used for The Final Relative Risk Ranking System Data Collection Sampling and Analysis Report

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Acronyms

Activity	Naval Base, Norfolk
AOC	area of concern
AST	Above-ground storage tank
CASY	Camp Allen Salvage Yard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund")
CHF's	contaminant hazard factors
CS	confirmation study
DEQ	Department of Environmental Quality
DoD	Department of Defense
DPVE	dual-phase vapor extraction
EE/CA	Engineering Evaluation/Cost Analysis
FEMA	Federal Emergency Management Agency
FS	feasibility study
FY	fiscal year
HWAA	Hazardous Waste Accumulation Area
HRSD	Hampton Roads Sanitation District
IAS	initial assessment study
IRP	Installation Restoration Program
IRPRI	IRP Remedial Investigation
IWTP	Industrial Wastewater Treatment Plant
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
MPF	migration pathway factors
NAS	Naval Air Station
NBN	Naval Base, Norfolk
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
PA	preliminary assessment
PRAP	proposes remedial action plan
QADSY	Q-Area Drum Storage Yard
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RF	receptor factor
RFA	RCRA Facility Assessment
RI	remedial investigation
ROD	record of decision or decision document

SAA	satellite accumulation areas
SI	site inspection
SMP	Site Management Plan
SWMU	solid waste management unit
TPH	total petroleum hydrocarbons
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	volatile organic compound

1. Introduction

This report presents the Site Management Plan (SMP) for fiscal year 1996 (FY-96) for the Naval Base, Norfolk (NBN) located in Norfolk, Virginia. This report has been prepared by CH2M HILL for use by Atlantic Division, Naval Facilities Engineering Command (LANTDIV) and Naval Base, Norfolk (Activity) personnel.

1.1. Purpose of the Site Management Plan

The purpose of the SMP is to provide a management tool for LANTDIV and Activity personnel to be used in planning, scheduling, and setting priorities for environmental remedial response activities to be conducted at NBN. This SMP focuses on upcoming activities that were planned in 1996. The SMP will be updated following the NBN's anticipated upcoming placement on the US Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) in 1997.

The SMP presents a relative risk designation for each site, which has been developed according to the Navy's Relative Risk Ranking System to rank sites such that the "high" risk sites are addressed first. The primary factors considered in developing the relative risk designation are human health and ecological risks presented by the site. Quantitative analysis including contaminant hazard factors (CHF) as well as qualitative factors including receptor factors (RF) and migration pathway factors (MPF) have been used to develop the risk designation.

The SMP presents the rationale for the sequence of environmental investigations and remedial response activities to be completed for each site and the estimated schedule for completion of these activities. Detailed activity schedules are provided for calendar year 1996, and model activity schedules are provided for 1997 and beyond.

1.2. Facility Description

1.2.1. Facility Location/Physical Description

NBN is the largest naval base in the United States. It is situated on 4,631 acres of land (ref: A.T. Kearny, 1991) in the northwest portion of the City of Norfolk, Virginia. The location of the NBN is shown in Figure 1-1. NBN is bounded on the north by Willoughby Bay, on the west by the confluence of the Elizabeth and James Rivers, and on the south and east by the City of Norfolk. A portion of the NBN eastern boundary is formed by Mason Creek.

NBN includes approximately 4,000 buildings, 20 piers, and an airfield. The western portion of NBN is a developed waterfront area containing the piers and facilities for loading, unloading and servicing naval vessels.

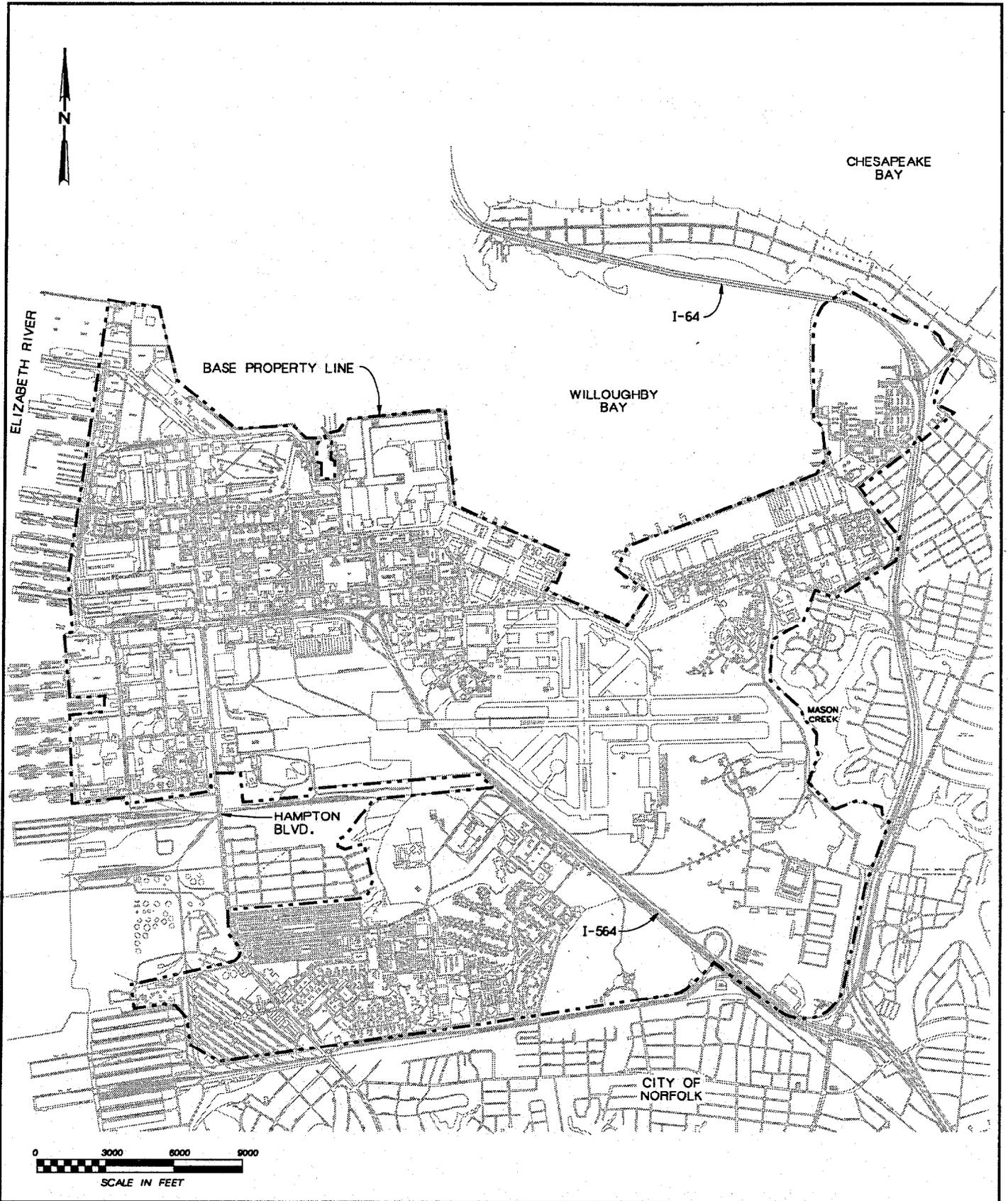


Figure 1-1
 LOCATION MAP
 Naval Base Norfolk



Land use in the surrounding area is commercial, industrial and residential. The waterfront area south of the NBN provides shipping facilities for several large industries. A network of rail lines is located in the area to service nearby industries. Residential areas surround the NBN to the south and east. Willoughby Spit, a low-density residential area located northeast of the NBN, is also used for recreational activities.

A number of other military installations are located within a 25-mile radius of the NBN. These include Fort Monroe and Langley Air Force Base to the north, Navy Amphibious Base—Little Creek and Fort Story to the east, Naval Air Station Oceana to the southeast, Norfolk Naval Shipyard and St. Juliens Creek Annex to the south, and Naval Supply Center-Craney Island Fuel Terminal to the southwest.

1.2.2. Facility History/Mission

NBN began operations in 1917, when the U.S. Navy acquired 474 acres of land to develop a naval base to support World War I activities. Bulkheads were built along the coast to extend available land. After dredge and fill operations, the total land under Navy control was 792 acres.

An additional 143 acres of land were acquired in 1918 and officially commissioned for the Naval Air Station (NAS). From 1936 until 1940, improvements to the piers and expansion of supplies/material handling facilities were completed.

During World War II (between 1940 and 1945), major construction projects were completed including a power plant, numerous runways and hangars, a tank farm, and several barracks/housing complexes. During this time, the area of the NBN expanded to over 2,100 acres. After World War II, the NBN continued to acquire land through various types of land transfers and dredge and fill operations conducted in areas of Mason Creek and Bousch Creek Basins and Willoughby Bay.

During its history, NBN has expanded to become the world's largest naval installation, with 105 ships home-ported in Norfolk. The Base currently has 20 piers handling approximately 3,100 ship movements annually.

The mission of NBN is to provide fleet support and readiness for the U.S. Atlantic Fleet.

1.2.3. Operations/Process Descriptions

NBN operates in various capacities to provide support to vessels, aircraft, and other activities. The NBN includes many tenants, each performing different operations. The majority of operations involve servicing and maintenance of vessels and aircraft.

Service and maintenance of ships include defueling, refueling, utilities hook-up, on-board maintenance and coordination of ship movements in the harbor. Other functions include loading, unloading, and handling of fuels and oils used aboard the vessels. Ship and aircraft repair operations reportedly include paint stripping, patching, parts cleaning, repainting, engine overhauls, sandblasting and metal plating processes.

1.3. Environmental Setting

1.3.1. Topography and Surface Water Hydrology

Topographically, NBN is nearly level. Elevations on the NBN range from sea level at the north and west boundaries to approximately 15 feet above sea level in central portions of the NBN.

Four major surface water features surround the greater Norfolk area including the James and Elizabeth Rivers and Willoughby and Chesapeake Bays, all of which are tidal in nature in this area.

The majority of surface water on the NBN flows to either Mason Creek or to the remnants of Bousch Creek. The main channel of Bousch Creek was filled during development of the NBN and replaced by a network of drainage ditches and culverts. Due to the proximity of tidal waters and the low relief of the land, both Mason Creek and the remnant tributaries of Bousch Creek are tidal throughout the NBN. Both creeks discharge to Willoughby Bay, and ultimately, to the Chesapeake Bay. Some surface water runoff from the NBN discharges directly to the Elizabeth River.

A Federal Emergency Management Agency (FEMA) flood insurance study established that the 100-year floodplain elevation at the NBN is 8.5 feet above sea level (ref: A.T. Kearny, 1991). Therefore, portions of the NBN adjacent to Willoughby Bay and the Elizabeth River are within the 100-year floodplain.

1.3.2. Geology and Hydrogeology

NBN is in the outer Atlantic Coastal Plain Physiographic Province, which is characterized by low elevations and gently sloping relief. The Base is underlain by more than 2,000 feet of gently dipping sandy sediment, ranging in age from Recent to Lower Cretaceous. Table 1-1 contains a stratigraphic column of hydrogeologic units of southeast Virginia.

The uppermost geologic unit is the Columbia Group, composed of the Sand Bridge Formation and the underlying Norfolk Formation. The Columbia Group is approximately 60 feet thick. The upper 20 to 40 feet consist of unconsolidated fine sands and silts of low to moderate permeability. The lower 20 to 40 feet consist of relatively impermeable silt, clay, and sandy clay. The Yorktown Formation underlies the Columbia Group. The Yorktown Formation is approximately 90 to 100 feet thick in the vicinity of the Base. It consists of moderately consolidated coarse sand and gravel with abundant shell fragments.

Two significant aquifer systems in the area are the water-table aquifer in the upper 20 to 40 feet of the Columbia Group and the underlying Yorktown Aquifer. The water-table aquifer reportedly is thin and consists of discontinuous heterogeneous sand and shell lenses. The depth to the water table is usually less than 8 feet. The Yorktown Aquifer is semiconfined beneath a clay layer in the upper Yorktown Formation. Water-bearing zones in the Yorktown Aquifer consist of fine to coarse sand, gravel, and shells.

Table 1-1
 Stratigraphic and Hydrogeologic Units
 of Southeast Virginia
 (From Harsh and Lacznik, 1990)

Geologic Age		Group	Stratigraphic Formation	Hydrogeologic Unit
Period	Epoch			
Quaternary	Holocene	Columbia	Holocene Deposits	Columbia Aquifer
	Pleistocene		Undifferentiated Deposits	
Tertiary	Pliocene	Chesapeake	Yorktown Formation	Yorktown Confining Unit
			Eastover Formation	Yorktown- Eastover Aquifer
	Miocene		St. Mary's Formation	St. Mary's Confining Unit
			Choptank Formation	St. Mary's- Choptank Aquifer
			Calvert Formation	Calvert Confining Unit
	Oligocene		Pamunkey	Old Church Formation
	Eocene	Chickahominy Formation		
		Piney Point Formation		
		Nanjemoy Formation		Nanjemoy-Marlboro Clay Confining Unit
	Marlboro Clay			
	Paleocene	Aquia Formation		Aquia Aquifer
		Brightseat Formation		Brightseat- Upper Potomac Confining Unit Brightseat- Upper Potomac Aquifer
	Cretaceous	Late Cretaceous	Potomac	Potomac Formation
Middle Potomac Aquifer				
Early Cretaceous		Lower Potomac Confining Unit		
	Lower Potomac Aquifer			

1.4. Environmental History

1.4.1. Installation Restoration Program

NBN was proposed for the United States Environmental Protection Agency (USEPA) National Priorities List (NPL) in June, 1996. The final listing is anticipated in March 1997. Once on the NPL, all investigations will require signed concurrence by the USEPA and the Virginia Department of Environmental Quality (DEQ), throughout the Installation Restoration Program (IRP) process.

In 1975, the Department of Defense (DoD) began a program to assess past hazardous and toxic materials storage and disposal activities at military installations. The goals of this program, now known as the IRP, were to identify environmental contamination resulting from past hazardous materials management practices, to assess the impacts of the contamination on public health and the environment, and to provide corrective measures as required to mitigate adverse impacts to public health and the environment.

The environmental condition of the NBN is being investigated through the Department of Defense's IRP. The IRP is being conducted in accordance with applicable federal and state environmental regulations and requirements.

In 1976, the Resource Conservation and Recovery Act (RCRA) was passed by Congress to address potentially adverse human health and environmental impacts of hazardous waste management and disposal practices. RCRA was legislated to manage the present and future disposal of hazardous wastes. In 1980, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or "Superfund", was passed to investigate and remediate areas resulting from past hazardous waste management practices. This program is administered by the USEPA or state agencies.

In 1981, the DoD's IRP was re-issued, with additional responsibilities and authorities specified in CERCLA delegated to the Secretary of Defense. The Navy subsequently restructured the IRP to match the terminology and structure of the USEPA CERCLA Program. The current IRP is consistent with CERCLA and applicable state environmental laws. The CERCLA process is further discussed in Section 4.0 of this SMP.

1.4.2. Previous Base-Wide Investigations

Previous base-wide investigations completed through the IRP include the Initial Assessment Study (IAS), dated February 1983, the IRP Remedial Investigation—Interim Report (IRPRI), dated March 1988, and a RCRA Facility Assessment (RFA), completed for the NBN in February 1991.

The purpose of the 1983 IAS was to identify and assess sites posing a potential threat to human health and/or the environment due to contamination from past hazardous materials handling and operations. A total of 18 potentially contaminated sites, designated Sites 1 through 18, were identified based on information obtained from historical records, photographs, site inspections, and personnel interviews. Each of the 18 sites was evaluated for the type of contamination, migration pathways, and pollutant receptors. The IAS concluded that 6 of the 18 sites posed sufficient threats to human health or the environment

to warrant further evaluation in a confirmation study. Sampling and analysis were not performed as part of the IAS.

A confirmation study was subsequently performed for the six sites which were recommended for further investigation in the IAS to confirm or refute the existence of the suspected contamination. This effort for five of the six sites was documented in the 1988 IRPRI Report. An independent confirmation study was performed by the Navy on Site 6—CD Landfill. The objectives of the confirmation study were to determine the extent of contamination, develop and evaluate economically feasible remedial alternatives, and recommend a remedial action at the following five sites:

- Site 1—Camp Allen Landfill
- Site 2—NM Area Slag Pile
- Site 3—Q-Area Drum Storage Yard
- Site 4—Transformer Storage Area P-71
- Site 5—Pesticide Disposal Site

Since the 1983 IAS, four additional IRP sites (Sites 19 through 22) have been identified and added to the IRP. The current status of the 22 IRP sites is summarized in Table 1-2. Sites 14 and 15 are being addressed under the underground storage tank (UST) program and are no longer IRP sites. This brings the total number of IRP sites to 20.

During the course of the on-going IRP at the NBN, several site-specific remedial investigations, feasibility studies, removal actions, and site remediations have been completed or are in progress. Remediations have been completed or are in progress at Sites 1, 3, 4, 11, 16, 17, and 19 as indicated in Table 1-2.

A Draft RCRA Facility Assessment (RFA) was completed for NBN, in February 1991. This study was a base-wide inventory of existing solid waste management units (SWMUs) and other Areas of Concern (AOCs). A total of 274 SWMUs and 10 AOCs was tentatively identified in this study. The Navy initially selected three of the SWMUs for investigation and evaluation under the IRP.

The three additional SWMUs that were selected for inclusion in the IRP and will be considered in this SMP are:

- SWMU 1—SP-2B Accumulation Area
- SWMU 2—Building Z-309 Ash Hopper Storage Area
- SWMU 3—Building Z-309 Oil/Lubricant Storage Area

In 1996, 22 additional SWMUs were added to the base-wide inventory for evaluation and possible investigation. These SWMUs will be further evaluated to determine whether cleanup is needed. The 22 additional SWMUs added in 1996 and included in this SMP are:

- SWMU 4—PWC Sandblast Area
- SWMU 5—LF-61 Waste Holding Tank
- SWMU 6—Bldg V-28 Waste Pit
- SWMU 7—LF-18 Aircraft Ramp
- SWMU 8—Firefighting Training School
- SWMU 9—LP-200/MAC Terminal
- SWMU 10—LP-200/MAC Terminal/East

TABLE 1-2
Current Status Summary IRP Sites
Norfolk Naval Base Site Management Plan

Site	PA or IAS	SI or CS	TBA	Work Plans	RI	FS	PRAP	ROD	RD	RA	Comments
1. Camp Allen Landfill	1983*	1988**		1991	1994	1994	1995	1995	√	√	Removal action (soil) completed. Long-term groundwater pump & treat being implemented. Ecological monitoring underway in sediments, surface water.
2. NM Slag Pile	1983*	1988**		1996	√	√	0	0			Limited sampling program revealed only minimal contamination.
3. Q-Area Drum Storage	1983*	1988**		1991	1996	1996	1996	1996	1996	√	VOC-contaminated groundwater.
4. P-71 Transformer Storage	1983*	1988**		1991	1991	1991	1991	1992	1991	1992	Cleanup completed. Groundwater monitoring completed in 1995.
5. Pesticide Disposal Site	1983*	1988**		1996	√	√	0	0			Pesticide-contaminated soil. No documented groundwater contamination. RI/FS underway.
6. CD Landfill	1983*	1991		1993	1995	1995	1996	1996	1996	0	Heavy metal- and pesticide-contaminated sediments.
7. Inert Chemical Landfill	1983*		0								State-approved, non-hazardous waste landfill. No further action recommended per IAS.
8. Asbestos Landfill	1983*		0								State-approved, non-hazardous waste landfill. No further action recommended per IAS.
9. Q-Area Landfill	1983*		0								Construction debris only landfill. No further action recommended per IAS.
10. Apollo Disposal Sites	1983*		0								Apollo fuel component has most likely biodegraded. No further action recommended per IAS.
11. Repair Shop Drains	1983*		0	1989	1989	1989	1989	1990	1989	1991	Cleanup completed.
12. Alleged Mercury Disposal Site	1983*		0								No evidence of mercury disposal found. No further action recommended per IAS.
13. Past Wastewater Outfalls	1983*		0								Industrial wastewater rerouted to treatment plant. No further action recommended per IAS.
14. Oil Spill - Piers 4, 5, 7	1983*										Site being addressed under the UST Program - no longer an IRP Site.
15. Oil Spill - Piers 20, 21, 22	1983*										Site being addressed under the UST Program - no longer an IRP Site.
16. Fire, Building X-136	1983*		0	0						X	Cleanup completed. No further action recommended per IAS.
17. Fire, Building SDA-215	1983*		0	0						X	Cleanup completed. No further action recommended per IAS.
18. Former NM Waste Storage	1983*		0								State landfill permit issued. No further action recommended per IAS.
19. Buildings V-60/V-90	1988	1988		1989	1989	1989	1989	1990	1989	1991	Cleanup completed. No further action recommended per IAS.
20. LP-20 Site	1991	1991		1994	1996	1996	1996	1996	√		TPH and chlorinated solvents in groundwater.
21. Building W-316	√	√		1996							PA/SI underway.
22. Camp Allen Salvage Yard	1994	1994		1996	√	√	0	0			PA/SI documented soil and groundwater contamination. RI/FS in progress.

LEGEND:
 1993 - Year Activity Completed
 X - Activity Completed (date unknown)
 √ - Activity In Progress
 0 - Activity Planned
 PA - Preliminary Assessment
 IAS - Initial Assessment Study
 SI - Site Inspection
 CS - Confirmation Study

RI - Remedial Investigation
 FS - Feasibility Study
 PRAP - Proposed Remedial Action Plan
 ROD - Record of Decision or Decision Document
 RD - Remedial Design
 RA - Remedial Action
 TBA - To Be Addressed

* Refers to "Initial Assessment Study of Sewells Point Naval Complex," dated February 1983.
 ** Refers to "Installation Restoration Program Remedial Investigation Interim Report," dated March 1988.

- SWMU 11—Old Weapons Station Entrance
- SWMU 12—Disposal Area Near NM-37
- SWMU 13—Disposal Area PWC Operations
- SWMU 14—Q-50 Satellite Accumulation Area
- SWMU 15—W-130 Accumulation Area
- SWMU 16—NM-37 Accumulation Area
- SWMU 26—Old Mounds Northeast of NM-31
- SWMU 27—Mason Creek Embankment
- SWMU 28—Probable Solid Waste Disposal South of CEP 201
- SWMU 29—Solid Waste Disposal Area/CD-3/CD-4
- SWMU 30—Sludge Fill Disposal Area/Marshy Area South of Runway
- SWMU 32—Solid Waste Disposal Area CEP-160/161 Embankment
- SWMU 33—Debris Piled at Seawall/Corner of Sustain Pier
- SWMU 34—Solid Waste Disposal Area CEP 200
- SWMU 35—Solid Waste Disposal Area CEP 196/Resolute Embankment

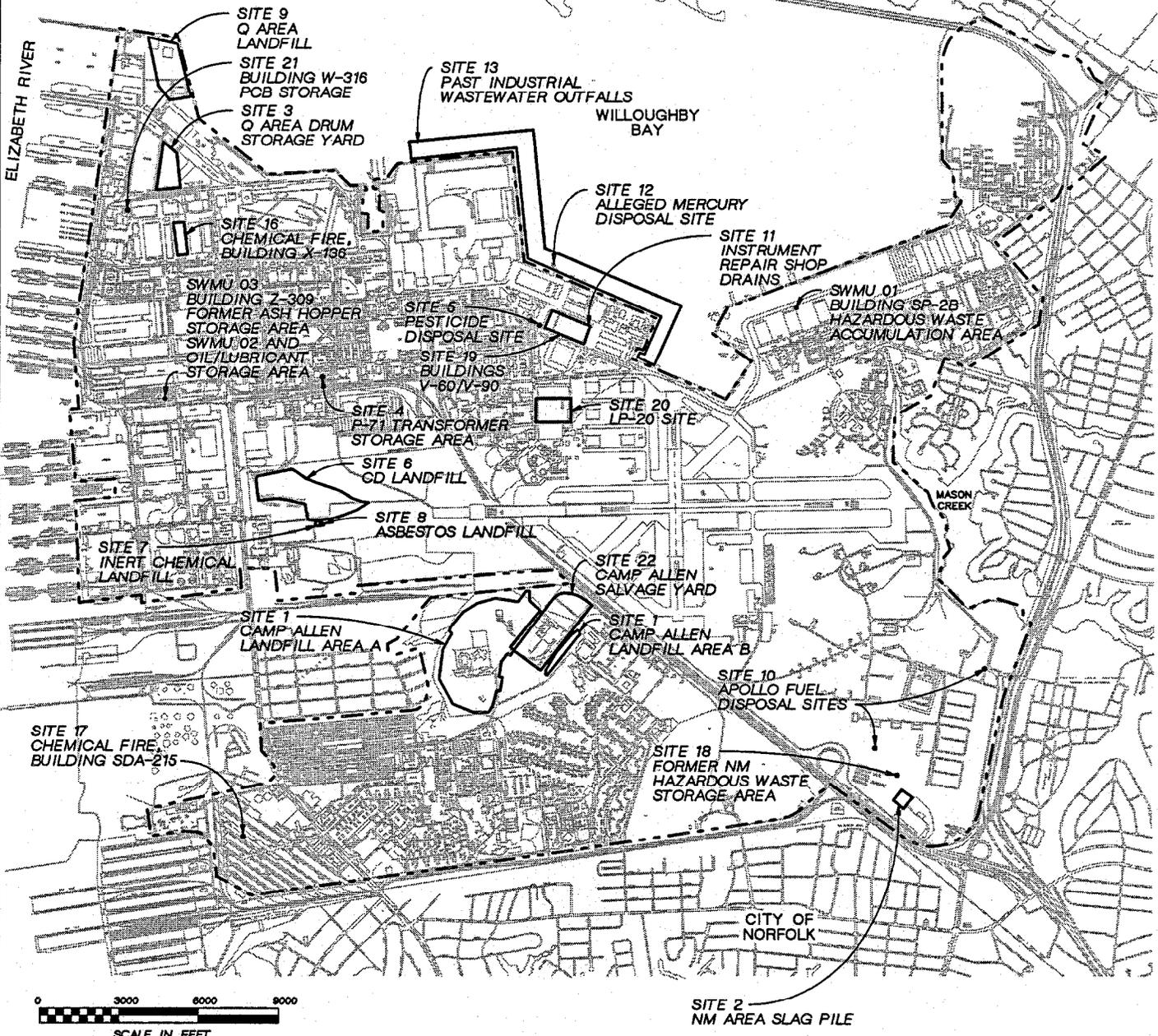
A base map of the NBN, showing the locations of the 20 IRP sites and the original three SWMU sites, is provided as Figure 1-2. The locations of the 22 additional SWMU sites are shown in Figure 1-3.

1.5. Format of the Site Management Plan

This SMP consists of five sections.

- Section 1.0, Introduction, describes the scope and purpose of the SMP, provides a description and history of NBN, and summarizes the environmental setting and previous environmental investigations conducted at NBN.
- Section 2, Site Descriptions/Site Histories, provides specific information regarding each of the 45 sites that are included in the SMP. Site-specific information includes site physical characteristics, a description of past activities conducted at the site, and known contaminants in each site media. A site map is provided for each site.
- Section 3, Site Ranking, presents a relative risk designation for each site, which has been developed to rank sites such that the "high" risk sites are addressed first. The primary factors considered in developing the relative risk designation are human health and ecological risks presented by the site.
- Section 4, CERCLA Process Activities, provides a summary of the processes of investigation, feasibility study, and remedial action for CERCLA (IRP) sites.
- Section 5, Site Management Plan Schedules, provides scheduling assumptions and SMP project schedules.

CHESAPEAKE BAY



LEGEND

--- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 1-2
BASE MAP WITH
ORIGINAL SITE LOCATIONS
Norfolk Naval Base



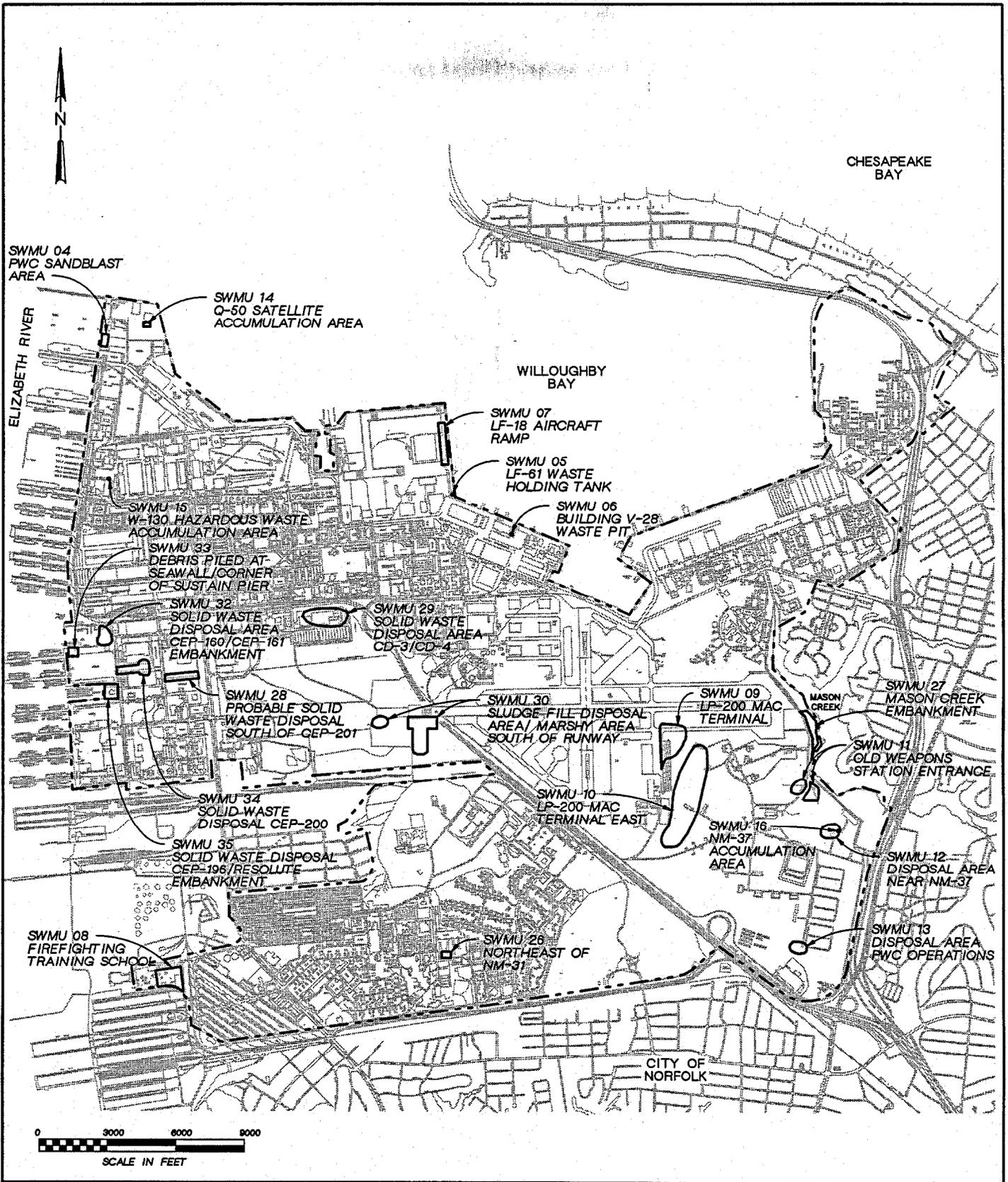


Figure 1-3
 BASE MAP WITH
 ADDITIONAL SITE LOCATIONS
 Norfolk Naval Base



2. Site Descriptions Site Histories

This section provides specific information regarding each of the 45 sites that are included in the SMP. Site-specific information includes site physical characteristics, a description of past activities conducted at the site, and known contaminants in each site media. In addition, the current status of each site in the IRP is briefly discussed. A site map is provided for each site at the end of this section.

2.1. Installation Restoration Program (IRP) Sites

The 20 IRP sites at NBN are described below. These descriptions include physical characteristics, past activities, and detected contaminants for each site.

Site 1—Camp Allen Landfill

The Camp Allen Landfill Site includes two distinct areas (Areas A and B), as shown in Figure 2-1. Area A is a 45-acre landfill that was used for disposal of metal plating and parts cleaning sludges, paint-stripping residue, various chlorinated organic solvents, overage chemicals, pesticides, asbestos, incinerator ash, fly and bottom ash from the Base power plant, and miscellaneous debris. The Area A landfill was operated from the 1940s until approximately 1974. Area B comprises approximately two acres and is located east of Area A. The Camp Allen Salvage Yard, which ceased operations in April 1995, is located between Areas A and B. Wastes from a 1971 salvage yard fire, including drums containing various chemicals, were buried via trench and fill operations in Area B.

Contamination from prior disposal practices at the Camp Allen Landfill Site has affected surface and subsurface soil, sediment, surface water, and groundwater. The primary contaminants found at the site in all media are volatile organic compounds (VOCs). Areas of inorganic contamination of surface water and sediments in the surrounding drainage ditches and in the on-site pond also were detected. Groundwater contamination was found in both the water table aquifer and the deeper Yorktown Aquifer in Area A and B. This is due to the lack of a confining layer between the two aquifers in the Camp Allen Landfill area.

Currently, the Base brig facility and a heliport are located over a portion of the Area A landfill. Area B is not currently used. Areas A and B are soil-covered and vegetated to minimize surface erosion. Both areas are adjacent to tidal drainage ditches that convey stormwater run-off to Willoughby Bay.

In 1994, a non-time-critical removal action was implemented in Area B. The primary source areas of contamination were removed. The Camp Allen Landfill Site RI/FS was completed in 1994. Proposed remediation of the site includes dual-phase vapor extraction (DPVE) for "hot spots" identified in the Area A landfill, and implementation of a groundwater extraction and treatment system in Areas A and B. The Decision Document was finalized in 1995. Groundwater treatment plant design is currently being completed, and the groundwater treatment system is expected to begin operations in early 1997.

Site 2—NM Slag Pile

The NM Slag Pile is an approximately one-acre disposal area for slag generated by an aluminum smelting operation. During the 1950s and 1960s, aluminum smelting was conducted by the Navy in the NM area of the Naval Air Station. Figure 2-2 illustrates the location of the NM Slag Pile Site.

During the smelting operation, the slag pile area was well-defined by a lack of vegetation around the site. The surface of the site has since been regraded and vegetated. Presently, a portion of the slag pile area is covered by a gravel parking lot.

The potential for site contamination from metals, including chromium, cadmium, and zinc, was identified in the 1983 IAS. Trace amounts of inorganics were detected in surface soil, surface water and sediment samples taken during the 1988 Interim RI. However, the samples were taken after site regrading and placement of gravel surfacing at the site. Since these activities disturbed the surface soil, these analytical results may not be representative of potential subsurface contamination at the site.

Additional investigation is required to adequately characterize the extent of contamination at the site. Initial sampling was completed in the fall of 1996. A RI/FS is currently in progress. A PRAP and ROD are planned for this site in 1997.

Site 3—Q-Area Drum Storage Yard

The Q-Area Drum Storage Yard (QADSY), shown on Figure 2-3, was previously a compound that occupies approximately five acres in the northwest corner of the NBN near the carrier piers. This area of the NBN was created by dredging operations in the early 1950s. The QADSY is an open earthen yard which was used from the 1950s until the late 1980s to store tens of thousands of drums. Most of the drums contained new petroleum products, various chlorinated organic solvents, paint thinners, and pesticides. Previous investigations showed dark stains on the soil and oil-saturated soil throughout the storage yard indicating past spills. The northern portion of the yard, which was used to store leaking or damaged drums and hazardous materials, is particularly stained. These drums have been removed, and the site is not currently used.

An RI, completed in 1996, revealed soil contaminated with total petroleum hydrocarbons (TPH), VOCs, and pesticides. In addition, VOCs were found in groundwater. This is due to the lack of a confining layer between the two aquifers in this area. The general extent of the groundwater plume, which impacts approximately 29 acres beneath the fleet parking area west of the site, has been defined.

The RI/FS for this site was completed in 1996. As part of the remedial design effort, a pilot treatability study for soil (soil vapor extraction) and groundwater (air sparging) have been completed. Review of the remedial design is scheduled to be complete in the fall of 1996. Remedial activities are also scheduled to begin at the end of 1996.

Site 4—P-71 Transformer Storage Area

The P-71 Transformer Storage Site is located south of Building P-71, as shown on Figure 2-4. This site is approximately 0.5 acre and was used to store new and out-of-service electrical transformers from the 1940s until 1978. Reportedly, transformer oil was drained from out-of-service transformers onto the ground surface in this area. During the 1983 IAS, much of

the area was covered with gravel, but exposed soil in open areas exhibited dark stains as evidence of past spillage.

An RI, performed in 1991, revealed PCB contamination in the top three feet of soil and in the shallow groundwater. The predominant contaminant was Aroclor 1260. An FS, PRAP, and remedial design were performed in 1991.

The site soil and groundwater remediation was completed in 1992. The PCB-contaminated soil was excavated and disposed of at a permitted off-site landfill, and groundwater was pumped from the site and transported off site for treatment. A post-cleanup groundwater monitoring program has been completed at this site. The site currently is used for utility vehicle parking.

Site 5—Pesticide Disposal Site

The Pesticide Disposal Site, located southeast of Building V-95, is shown on Figure 2-5. The site consists of a French drain, constructed from a 28-inch diameter culvert placed into a gravel-filled pit. This drain was used for disposal of waste pesticide materials from the 1960s until 1973. Approximately 100 gallons per week of pesticide rinse water, as well as intermittent discharges of overage concentrated pesticides, were disposed of using the French drain system.

The types of pesticides disposed of in the drain included chlordane, malathion, DDT, DDD, and dieldren. Currently, this area is fenced off and is used for storage of other materials.

A study performed in 1988 revealed pesticide contamination in the soil but no contamination of the shallow groundwater (one monitoring well was installed) in the vicinity of the site. The site soil analysis indicated elevated levels of all the pesticides noted above. Concentrations of DDT and DDD were highest in the surface soil and gradually decreased with depth. Some small fuel oil spills have occurred directly adjacent to the site. Additional investigation is required to adequately characterize the extent of contamination. An RI/FS is currently in progress for the site.

Site 6—CD Landfill

The CD Landfill Site occupies approximately 30 acres and is located just east of Hampton Boulevard and south of the Naval Exchange, as illustrated in Figure 2-6. This landfill was used primarily for the disposal of inert, non-hazardous waste from 1974 until 1987. Materials disposed of in the landfill included construction debris, sand blasting waste, salvage fuel boiler and power plant ash, and miscellaneous inert waste. Significant quantities of cadmium-contaminated dust and sandblasting grit containing lead were also disposed at this site from 1974 until 1981. EPA toxicity testing performed in 1981 found the dust hazardous for cadmium. After 1981, the cadmium-contaminated material was disposed offsite at a permitted hazardous waste disposal facility.

The landfill consists of two adjacent areas. The eastern half of the landfill was used from 1974 to 1979 before permit requirements were enacted. The western half of the landfill was permitted by the Commonwealth of Virginia in 1979, and operated from 1979 until 1987. In accordance with state regulations, a closure plan was submitted to the Commonwealth in October 1988, but closure was suspended in lieu of addressing the site through the IRP. The landfill area has an intermittent soil cover and is vegetated. Seabee Road, which separates the eastern and western portions of the landfill, was constructed over the landfill in 1993.

The RI, completed in December 1996, indicates that disposal/landfill activities at this site have affected only sediment. An FS was completed in 1995 for the CD Landfill Site. The ROD has been signed for OU1, sediment remediation, and remediation will begin in 1997. A decision document will be signed for OU2, groundwater (deep and shallow), soils (surface and subsurface), and surface water, in 1997.

Site 7—Inert Chemical Landfill

The Inert Chemical Landfill is located south of CD Landfill, as shown on Figure 2-6. It was used for a one-time disposal of inert chemicals, primarily unused ion exchange resins. Eighty-four pallets of materials were buried in this landfill in June 1979, with the approval of the Virginia State Department of Health, Solid and Hazardous Waste Management Division.

The landfill is approximately 2,000 square feet. The landfill was constructed with a one-foot clay base and six-foot clay side berms. The landfill cover consists of two feet of soil and one foot of clay.

No further action is recommended for this site because of the inert, non-hazardous nature of the disposed materials and the state approved the landfill construction and disposal methods.

Site 8—Asbestos Landfill

The Asbestos Landfill is located just east of the Inert Chemical Landfill, as shown on Figure 2-6. It was used for a one-time disposal of asbestos materials generated during a ship retrofitting operation. Approximately 6,500 bags (double-bagged) of asbestos materials were buried at this location in June 1979, with the approval of the Virginia State Department of Health, Solid and Hazardous Waste Management Division.

The landfill is approximately 600 square feet, and the landfill construction method was similar to the Inert Chemical Landfill (clay base and side berms, with soil/clay cover materials).

No further action is recommended for this site because the disposed materials were non-hazardous and the state approved the landfill construction and disposal methods.

Site 9—Q-Area Landfill

The Q-Area Landfill, shown on Figure 2-7, is located on the northwestern corner of the Base in the Q Area. This area was created by dredging operations in the early 1950s. This landfill was operated from 1974 until 1978 and was used for the disposal of construction debris.

No further action was recommended for this site in the 1983 IAS since the landfill reportedly was used for non-hazardous construction debris only and there was no evidence of hazardous waste disposal in the landfill.

Site 10—Apollo Fuel Disposal Sites

From 1967 until 1969, two or three Apollo spacecraft capsules were off-loaded from aircraft carriers at the Base. A remaining fuel component, monomethylhydrazine, was drained from the capsules into 55-gallon drums. Reportedly, three or four drums from each spacecraft capsule were disposed of by pouring the fuel component onto the ground surface and

allowing it to percolate through the soil at two locations. The two disposal sites are located in the NM Area, as shown in Figure 2-2. One site, consisting of a fenced area about 40 feet long and 20 feet wide, was located north of the Taussig Can Area. Three or four drums of the fuel component were disposed, and one or two disposal events were conducted at this site. The site was abandoned because of its proximity to a drainage ditch, and the fence was moved from the site to another site near Building NM-37, where the fence was re-constructed. The disposal procedure practiced at this site was the same as that used at the former site, with approximately the same quantity of material disposed.

Inspection of both Apollo Fuel Disposal Sites during the 1983 IAS indicated that the vegetation was not visibly stressed as a result of the past disposal operations. It is unlikely that the past disposal of the fuel component (monomethylhydrazine) has resulted in significant contamination. This fuel component most likely has degraded over the years to non-hazardous products. Therefore, no further action was recommended at this site.

Site 11—Instrument Repair Shop Drains

Unknown quantities of radium wastes from ship dials were poured down the sink drains in the instrument repair shop located in Building V-60 (see Figure 2-5), contaminating the drain pipes and sink traps. The instrument repair shop was operated from the late 1940s until 1956. As an interim measure to address the contamination, the drain traps were plugged with concrete to prevent flushing of the radium into the storm sewer system and, ultimately, into Willoughby Bay.

In 1982, Chem Nuclear was awarded a contract to remove the low-level radiological contamination in the Building V-60 plumbing, and the cleanup was completed. The subsequent remediation (decontamination, demolition, and disposal) of Site 19 (Buildings V60/V90) in 1991 also included this site. Therefore, no further action is recommended for this site.

Site 12—Alleged Mercury Disposal Site

Approximately 150 ten-pound glass bottles of elemental mercury were reportedly dumped off the seawall near Building V-88 (see Figure 2-5) into Willoughby Bay in the late 1960s (IAS, 1983). Subsequently, bottom sediment samples were collected from Willoughby Bay at the alleged dump site for mercury analysis, and divers probed the sediments for the glass containers in 1976. However, no evidence of mercury or the glass containers was found. Therefore, no further action is recommended for this site.

Site 13—Past Industrial Wastewater Outfalls

Historically, numerous industrial wastewater streams generated by Base operations were discharged to the storm sewer system and, ultimately, to Willoughby Bay (see Figure 2-5). These discharges included metal plating solutions and rinse water, parts cleaning solutions, and paint stripping waste. These multiple discharges were a source of water pollution, which included metals (primarily chromium, cadmium and zinc), cyanide, oil and grease, and phenols.

In the mid-1970s, the industrial waste streams were re-routed to the Industrial Wastewater Treatment Plant (IWTP), which serves as a centralized pretreatment facility with the effluent being discharged to the Hampton Roads Sanitation District (HRSD) sewage

treatment plant. Approximately 100,000 gallons per day have been routed to the IWTP since it began operation in 1976.

In addition, discharges from the storm sewer system from the Base have since been permitted under the National Pollutant Discharge Elimination System (NPDES). These permitted discharges consist primarily of storm water runoff, steam condensate, and non-contact cooling water.

In light of these corrective actions, the storm sewer outfalls are no longer considered a source of water pollution at the Base, and no further actions are recommended at this time.

Site 16—Chemical Fire, Building X-136

In July 1979, a chemical fire occurred in Building X-136 as a result of incompatible chemical storage, predominantly of calcium hypochlorite and acids. During the firefighting operation, approximately two tons of calcium hypochlorite were flushed down the storm drain with water, and ultimately discharged to the Elizabeth River. The Virginia State Water Control Board was notified of this flushing procedure, and no subsequent adverse water quality impacts to the Elizabeth River were observed. Figure 2-8 shows the location of Building X-136.

Inspection of the chemical fire site during the 1983 IAS indicated that the site had been adequately cleaned up. Therefore, no further action is recommended at this site.

Site 17—Chemical Fire, Building SDA-215

In August 1981, a chemical fire occurred in cell 6 of Building SDA-215 as a result of incompatible chemical storage, predominantly of calcium hypochlorite and acids. Considerable site contamination resulted from the fire and fire-fighting operation. However, the site was cleaned up by removing the remaining hazardous chemicals and residues, as well as the contaminated soil adjacent to Building SDA-215. The contaminated materials were hauled off site to a permitted hazardous waste disposal facility. Figure 2-9 shows the location of Building SDA-215.

Inspection of the site of the chemical fire during the 1983 IAS indicated that the site had been adequately decontaminated. Therefore, no further action is recommended at this site.

Site 18—Former NM Hazardous Waste Storage Area

The NM hazardous waste storage area was used from 1975 until 1979 to store drums of hazardous wastes, consisting mainly of waste oil, metal plating solutions and sludges, various chlorinated organic solvents, acids, and paint stripping solutions. The storage area was an open earthen yard located east of the large metal storage buildings, known as the Taussig Cans, in the NM Area. The approximate site location is shown in Figure 2-2.

Considerable leakage and spillage of waste oil and hazardous wastes onto the ground surface occurred in this area, and a significant intentional spill occurred in July 1979. Consequently, a pit was excavated, and an existing drainage ditch was widened and lengthened to convey waste oil and contaminated stormwater runoff to the unlined pit. Waste oil and contaminated runoff were periodically pumped from the pit into a tank truck, which transported it to the IWTP for treatment.

Sampling and analysis of the soil in the spill area indicated that it was contaminated with metals, primarily chromium and cadmium. However, a sample of the soil was subjected to EP toxicity testing and was found to be non-hazardous. The contaminated soil was then excavated and placed in piles near the spill area.

A landfill permit was obtained from the Virginia State Department of Health in October 1980 for the one-time disposal of the contaminated soil at this site by grading and seeding it to establish a vegetative cover. In addition, the permit required a continuing monitoring program to determine if contaminant migration is occurring.

In the IAS, no further action was recommended for this site since the disposal of the contaminated soil was permitted by the Virginia State Department of Health and because on-going monitoring was occurring. Monitoring of the former NM hazardous waste storage area is no longer conducted as part of the NPDES monitoring program for the Base because the former discharge point has been removed by regrading activities.

Site 19—Buildings V-60/V-90

Buildings V-60 and V-90, shown in Figure 2-5, were aircraft hangars used for maintenance and repair of F-14 and A-6 aircraft. The buildings, which have since been demolished and removed, housed an aircraft brake shop, instrument repair shop, engineering offices, and a cafeteria/kitchen.

In 1986, a fire occurred in an electrical switch gear in Building V-60. The electrical equipment at the source of the fire contained PCBs (Aroclor 1260). Following the fire, PCB-contaminated soot was visible on all horizontal surfaces in Building V-60 and the adjacent Building V-90.

An RI/FS was completed in 1989. The following chemicals were found in the buildings:

- beryllium (aircraft brake materials)
- Radium 226 (aircraft instrument paint)
- PCBs
- polychlorinated dibenzofuran (PCDF)
- polychlorinated dibenzodioxin (PCDD)
- asbestos
- acids
- solvents/degreasers
- pesticides
- miscellaneous chemicals

The extent of contamination led to the decision to decontaminate the salvageable materials contained in the buildings and demolish the buildings in 1989. Confirmatory sampling, completed in late 1991, verified that the cleanup was successfully completed.

Site 20—LP-20 Site

LP-20 Site is one of many large buildings located northwest of the NAS main runway, as shown in Figure 2-10. Currently, the building houses an aircraft engine overhaul and maintenance shop. In the past, a portion of the building was used for a metal plating operation. A large fuel storage area, known as LP fuel farm, is located south of the building.

Previous investigations of adjacent property, including the LP fuel farm, led to the installation of a product recovery system. Groundwater monitoring in the area was instituted to measure the effectiveness of the product recovery system.

A PA/SI completed in 1991 identified TPH and chlorinated solvents in the groundwater east and south of the site. An RI/FS has been completed at the LP-20 Site. Air sparging and soil vapor extraction tests have been performed. Final design has been completed.

Site 21—Building W-316

Building W-316 is located east of Pier H at the Naval Station, as shown in Figure 2-11. This building is a small storage facility used by the Navy Public Works Center (PWC) to store various electrical components. The building and small storage yard adjacent to the facility have been contaminated with PCBs from the electrical transformers stored in the storage yard area. The facility is still used for storage and has been posted with signs indicating PCB contamination. A PA/SI is in progress.

Site 22—Camp Allen Salvage Yard

The Camp Allen Salvage Yard (CASY), has been operating at the Base since the 1940s and was closed down in 1995. The CASY is located between Area A and Area B of the Camp Allen Landfill Site, as shown on Figure 2-1. Figure 2-1b illustrates the layout of the CASY. CASY activities have included storage and management of waste oils and chemicals, used chemicals, and scrap industrial/commercial equipment. Metal smelting and miscellaneous incineration also occurred at the CASY. Various recycling activities have been performed at the salvage yard. The facility was also used to store acids, paint thinners, solvents, pesticides and transformers. A PCB spill occurred at the CASY in 1989 when a transformer was damaged by a forklift. The PWC responded to the spill and conducted preliminary cleanup at that time.

A PA/SI was completed for the CASY in May 1994. The investigation results indicated that surface and subsurface soils were contaminated with PCBs, pesticides, and metals. The shallow and deep groundwater aquifers in the vicinity are known to be contaminated from the Camp Allen Landfill RI results. However, groundwater contamination in the area will be addressed by the Camp Allen Landfill cleanup action currently being implemented. The extent of other contamination at this site is being addressed through the RI/FS, which is in progress.

2.2. Solid Waste Management Units (SWMUs)

The 25 SWMUs being investigated at NBN are described below. Sampling was completed in 1995 and is described in the Final Relative Risk Ranking System Data Collection Sampling and Analysis Report dated January 9, 1996. These sites will be further evaluated to determine whether cleanup is needed. Additional investigations of SWMUs 1, 4, 6, and 8 were undertaken in late 1996.

SWMU 1—SP-2B Hazardous Waste Accumulation Area

This site is one of many accumulation areas at the NBN that is used for temporary storage of containers of hazardous waste. The accumulation areas manage various types of wastes

generated by operations and maintenance activities on the Base. The wastes are picked up periodically for off-site treatment, recycling, and/or disposal.

The SP-2B Accumulation Area is located outdoors, northeast of Building SP-2 next to a Coast Guard Trailer on A Street, as shown in Figure 2-12. This unit is approximately 6 feet by 6 feet and has a concrete base, is partially bermed, has a wooden roof, and is caged to prevent unauthorized access. This unit handled industrial wastes, which were stored in closed drums and were moved biweekly to a RCRA-regulated storage area. The unit is currently used to store equipment. The types of wastes that were previously managed in this unit are unknown.

In the RFA, a moderate potential for release to the soil/groundwater was determined due to the deterioration of the concrete base of the unit. It was recommended that soil sampling be performed at this unit to determine if a release of contaminants from the unit has occurred. It was recommended that soil samples be analyzed for metals and semi-volatiles. Preliminary sampling showed elevated concentrations of acetone and several semi-volatiles in one sample. Additional soil sampling was performed at the end of 1996 to determine the need for further investigations. Comprehensive recommendations regarding further actions will be made.

SWMU 2—Building Z-309 Former Ash Hopper Storage Area

This unit (designated SWMU M-14 in the RFA) is located adjacent to Building Z-309, in the western portion of the Base, as shown in Figure 2-13. This unit received ash from boiler operations in Building Z-309. Collected ash was sent to an off-site solid waste landfill. This unit is a steel hopper approximately 30 feet by 30 feet and elevated 12 to 15 feet off the ground. It is underlain by a concrete base sloped to a drain, and is surrounded on three sides by a 3-inch asphalt berm. Black stains were observed on the concrete base below this unit.

This unit managed ash from boiler operations and operated from 1967 until 1986 when the Building Z-309 salvage fuel boilers ceased burning municipal waste. While in operation, the unit was emptied daily.

In the RFA, a moderate potential for release to the soil/groundwater was determined due to the presence of soil surrounding the concrete pad. It was recommended that soil sampling be performed at this unit to determine if a release of contaminants from the unit has occurred. Analysis of soil samples for metals and semi-volatiles was recommended. Sampling was initiated in 1995 and will be completed as a part of the future investigations.

SWMU 3—Building Z-309 Oil/Lubricant Storage Area

This area is located adjacent to Building Z-309 (see Figure 2-13) in the northwest portion of the Base. The area was used for storage of oils and lubricants used in the Z-309 area. Drums were stored horizontally on racks approximately 18 inches above a soil and gravel base. The area has a 2-foot wide by 6-inch berm on one side. The base of the area directly underneath the drums was observed to be heavily stained and partially covered with absorbent. Drip pans were present beneath the drum racks.

In the RFA, a high potential for release to the soil and groundwater was determined due to the presence of heavily stained soil beneath the drum racks. Soil sampling was recommended at this unit to determine if a release of contaminants from the unit has

occurred. Analysis of soil samples for semi-volatiles was recommended. Soil and groundwater sampling was performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

Additional Sites

SWMU 4—PWC Sandblast Area

This area is located in the northwestern corner of the NBN adjacent to Building Q-72 and is shown in Figure 2-14. The site is adjacent to the Elizabeth River and is used to perform sandblasting of barges. Sandblasting grit was observed on the soils in the vicinity of the site. The AOC is approximately one-half acre and is underlain by soil. Storm water runoff and spray from operations at the site discharge to the Elizabeth River. This discharge is allowed by a NPDES permit for the site.

The site previously stored sandblasting grit generated from the sandblasting of barges. Indications are that this material migrates to the Elizabeth River during periods of precipitation. Sampling and analysis were performed in 1995 using a geoprobe. Additional sampling and analysis were performed in late 1996. After the recently collected data are evaluated, the comprehensive recommendations regarding further actions will be made.

SWMU 5—LF-61 Waste Holding Tank

This site consists of an aboveground storage tank (AST) with a holding capacity of approximately 5,000 gallons located approximately 25 feet south of Willoughby Bay (Figure 2-15). The AST serves as a holding tank for wastes generated at Buildings LF-53, LF-38, and LF-34. The AST is surrounded by a concrete wall approximately 3 feet high. The AST is situated on a concrete base, however, it appears that portions of the base are cracked.

In December 1989, the AST overflowed due to frozen pipes in Building LF-38. Approximately 100 to 500 gallons overflowed to surrounding soil and Willoughby Bay. Contaminants consisted of chromium, cadmium, nickel, and zinc. Sampling and analysis of the groundwater and soil were performed in 1994-1995. Surface soil and groundwater were analyzed for both organics and inorganics. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 6—Bldg V-28 Waste Pit

This site consists of a subsurface concrete pit used to hold wastes from a metal plating shop within Building V-28. Figure 2-16 illustrates the location of V-28 Waste Pit. The ground surface of the entire area is covered with approximately 6-inches of concrete. The area is located between Buildings V-28 and V-4. Access to the area can be restricted by gates located between Buildings V-4 and V-28. Willoughby Bay is located approximately 200 feet north of the site.

The concrete sump located outside of Building V-28 was used to collect metal plating wastes. The plating operations were discontinued in late 1987. No history of releases is associated with this unit. Sampling and analysis of the groundwater and subsurface soil were performed in 1994-1995. Additional soil and groundwater sampling were performed in late 1996. After the recently collected data are evaluated, comprehensive recommendations regarding further actions will be made.

SWMU 7—LF -18 Aircraft Ramp

This SWMU is located east of Building LF-18 in the northern portion of the NADEP area and is shown in Figure 2-17. It currently serves as a parking lot for civilian workers. The ground surface is covered with either asphalt or concrete, except for the rip/rap located along the water front. Willoughby Bay is located immediately east of the site. Several civilian workers were observed fishing in this area during the field program.

Aerial photographs from 1963 indicated potential petroleum staining of the ground surface. Interpretation of the photographs suggests that the staining resulted from seaplane activities. Sampling and analysis of the groundwater and subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 8—Fire Training School

The Fire Training School is located in the extreme southwest portion of the NBN, near the Norfolk International Terminal (Figure 2-18). The area is used by U.S. Navy personnel to train in extinguishing various types of fires under a variety of conditions. Three fire pits and two buildings are used to practice fire training techniques. The ground surface is entirely covered with asphalt and concrete. The fire training sites are surrounded by drainage basins to collect water runoff. Access to the site is restricted during non-working hours.

Aerial photographs from 1949 through 1990 indicate petroleum staining of the surface within the site. This staining is likely from fuel oil used in fire fighting training activities. Site sampling and analysis was done in 1994-1995. Additional soil and groundwater sampling were performed in late 1996. After the new data are evaluated, comprehensive recommendations regarding further actions will be made.

SWMU 9—LP -200 MAC Terminal

The 200 MAC Terminal area is located east of Building LP-167 and south of the taxiway for Runway 28 (Figure 2-19). The area immediately east of Building LP-167 has a concrete surface and is used as a tune-up area for Jet engine aircraft (F-14s). The land located east of the engine tune-up area is grass covered and is drained by a surface water drainage ditch that parallels the taxiway. From the vegetation present along the ditch, it appears that the ditch is wet year round. Access to this area is restricted to personnel performing aircraft maintenance activities.

Aerial photographs from 1949 through 1954 indicated a solid waste and fill disposal area consisting of coarse-textured materials with possible discarded objects visible. Sampling and analysis of the surface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 10—LP-200 MAC Terminal East

The LP-200 MAC Terminal East is shown in Figure 2-20. The site extends from the MAC Terminal parking area, northward to just south of the Runway 28 taxiway. The site includes a portion of the Weapons Station near Building NM-25. The site is entirely grass or shrub covered. Portions of the site are mowed periodically in the vicinity of the MAC Terminal and Building NM-25. A drainage ditch intercepts the southern portion of the site and then parallels the western boundary. The drainage ditch is tidally influenced.

Aerial photographs from 1954 through 1990 indicate small disturbed and graded areas with possible activities observed at various locations. Sampling and analysis of the surface soil and groundwater were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 11—Old Weapons Station Entrance

The Old Weapons Station Entrance, shown in Figure 2-21, is located west of Patrol Road within the boundary of the Weapons Station area. The SWMU contains two separate areas. Both areas are grass covered fields that slope southward to a tidally influenced tributary of Mason Creek. Drainage ditches that line the entrance road also eventually discharge to the tributary. Wooded areas outline the boundary of the fields to the north. A radio communication station is located east of the site on the opposite side of the Weapons Station security fence. Although the fields are visible from Patrol Road, access to the site is restricted by Weapons Station operations.

Aerial photographs from 1949 and 1954 indicate mounds of multi-toned materials and stacked objects. Sampling and analysis of the surface soil and groundwater were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 12—Disposal Area Near NM-37

Figure 2-22 illustrates the location of the disposal area near building NM-37. Building NM-37 is a vehicle maintenance building located within the Weapons Station area. The facility services trucks, forklifts, and other military vehicles within the Weapons Station. The ground surface in the immediate vicinity of Building NM-37 is covered with an asphalt surface. The surrounding area is well vegetated and heavily wooded. The facility operates two Hazardous Waste Accumulation Areas (HWAA's). One is a metal container that is apparently used to store fuel for mowers, oils, and hydraulic fluids. This HWAA is located directly north of the building. The second area is a hazardous waste storage area located on the northwest side of the building. This HWAA is used for the storage of solvents and paints. The HWAA has a concrete block wall approximately 2 feet high and is enclosed on three sides by a chain-link fence. It is covered by an aluminum roof and has a concrete floor for containment.

An aerial photograph from 1958 indicates a possible disposal area marked by ground surface scarring. Sampling and analysis of the surface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 13—Disposal Area Behind Slag Pile/PWC Operations

The disposal area PWC Operations site, shown in Figure 2-23, is located in a wooded area north of the Building NM-92 compound. This compound is used to store various storage units used for the transportation of equipment. Although located in the vicinity of the Weapons Station, this area is accessible by foot from Patrol Road. The site is divided by two manmade drainage ditches. Water has been observed in both ditches.

Aerial photographs from 1937 through 1949 indicate a possible disposal area based on the irregular area of disturbed ground surface. Sampling and analysis of the surface soil and

groundwater were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 14—Q-50 Satellite Accumulation Area

The Q-50 Satellite Accumulation Area is located in the northeast corner of the NBN, as shown in Figure 2-24. The site is a concrete containment area approximately 15 feet by 25 feet. It is used to store wastes generated from oil cleanup activities around the base such as absorbent booms, oil-contaminated soils, and trash picked up from oil spills. Petroleum staining at several areas were observed during previous site visits.

Sampling and analysis of the surface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 15—W-130 Hazardous Waste Accumulation Area

Figure 2-25 illustrates the location of the W-130 Hazardous Waste Accumulation Area. Building W-130 is used as a maintenance building for forklifts. The former HWAA is located on the northern side of the Building. This area has a gravel surface, and large paved parking areas are located in the vicinity of the site. This area is no longer used as a HWAA.

The HWAA formerly managed waste oils and wash rack sludge generated during the maintenance of forklifts. The facility generated one to two 55-gallon drums of each material per month. No releases were reported; however, areas of stained surface soils were observed during earlier site visits. Sampling and analysis of the surface soil was done in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 16—NM-37 Accumulation Area

The NM-37 Accumulation Area contains stressed vegetation and is located northeast of building NM-37 as shown in Figure 2-26. Building NM-37 is a vehicle maintenance building located within the Weapons Station area. The facility services trucks, forklifts, and other military vehicles within the Weapons Station. The ground surface in the immediate vicinity of Building NM-37 is covered with an asphalt surface. However, the surrounding area is well vegetated and heavily wooded.

The NM-37 Accumulation Area is designated to accumulate waste materials. Although there is no history of releases, areas of stressed vegetation were observed during earlier site visits. Sampling and analysis of the surface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 26—Old Mounds NE of NM-31

This SWMU, NE of NM-31, contains light-toned materials and is located in the south central portion of the NBN. It is at the intersection of Fleet Road and Blandy Road between the southern end of residential Buildings NH-140 and NH-141 (Figure 2-27). A 1937 aerial photograph indicated numerous mounds of light-toned materials. Sampling and analysis of the surface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 27—Mason Creek Embankment

The Mason Creek Embankment is in an area of disturbed surface soils located along the western bank of Mason Creek, near the eastern end of Runway 28. The location of the Mason Creek Embankment is shown in Figure 2-28. The site is wooded and separated from Base property by a chain-link fence. Access to the site is possible by walking along the fence line from a park located approximately 1,200 feet to the south. The park is only open during daylight hours.

Aerial photographs from 1987 indicate disturbed surface soils. This suggests that materials may be disposed of in the area. Sampling and analysis of the surface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 28—Probable Solid Waste Disposal South of CEP 201

This SWMU is defined by a solid waste and disposal area with dark-toned mounds of material, debris, and probable earthen materials intermixed with debris. The SWMU is located on an asphalt surface south of Building CEP-201 and is shown in Figure 2-29. This area is a storage facility for large objects or equipment awaiting shipment. Tractor trailers are also kept in the area until they are needed for material transportation.

The debris and material are visible on a 1982 aerial photograph. Sampling and analysis of the subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 29—Solid Waste Disposal Area/CD-3/CD-4

This SWMU consists of a mound of material within a solid waste disposal area located south of Admiral Taussig Boulevard (Figure 2-30). Dental offices and Navy Exchange outlets are located in the surrounding area. The site is unsecured and easily accessible from the boulevard.

Aerial photographs from 1958 and 1963 indicate that this area was used for solid waste disposal. At the time the photographs were taken, the disposal activities had ceased and the mound of material was vegetated. Sampling and analysis of the subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 30—Sludge Fill Disposal Area/Marshy Area South of Runway/North of Camp Allen

This sludge fill disposal area is located south of the west end of Runway 28 as shown in Figure 2-31. The site area is entirely grass covered. The ground around the site slopes away from the runway before leveling off approximately 200 feet away. It appears that during periods of heavy rain, surface water may accumulate in the disposal area. Bousch Creek and a manmade drainage ditch bound portions of the site. Bousch Creek enters a concrete culvert and passes beneath the west end of the runway area. In this area, Bousch Creek is influenced by the tides.

Aerial photographs from 1949, 1968, and 1991 indicate that this area was used for the disposal of sludges and fill material. Sampling and analysis of the subsurface soil were

performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 32—Solid Waste Disposal Area/CEP-160/161 Embankment

This SWMU is a gravel parking lot located in the pier area that was formerly used for waste and fill disposal (Figure 2-32). The site is situated in the southwest corner of the intersection of Admiral Taussig Boulevard and Second Street. The site is divided by a chain-link fence and an aboveground steam line. The western portion of the parking lot is currently being used by pier workers. The eastern side of the lot is presently being re-graded with additional soils. Surface waters drain to a drainage ditch located on the southern side of the site. These waters discharge directly to the Elizabeth River.

Aerial photographs from 1968 and 1982 verify that this area was used for waste and fill disposal. Sampling and analysis of the subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 33—Debris Piled at Seawall/Corner of Sustain Pier

This former debris pile, shown in Figure 2-33, is located at the floating dry dock USS Sustain. The western side of the site is adjacent to the Elizabeth River while the northern side of the site borders the dry-dock area. A gravel parking lot is located south of the dry-dock area. The site extends across both the dry-dock area and the parking lot. A portion of the site is covered with asphalt while the parking area has a gravel surface. A SAA is also located within the area. Access to the dry-dock portion of the site is restricted by U.S. Navy personnel.

An aerial photograph from 1963 indicates that debris was mounded and buried in this area. Sampling and analysis of the subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 34—Solid Waste Disposal Area CEP 200

This SWMU is a grass covered mounded disposal area located between Building CEP-156 to the north and Building CEP-200 to the south. Figure 2-34 illustrates the location of this site. The length of the site extends from Second Street eastward until nearly reaching Virginia Avenue. The crest of the mound is approximately 10 feet above the surrounding ground surface.

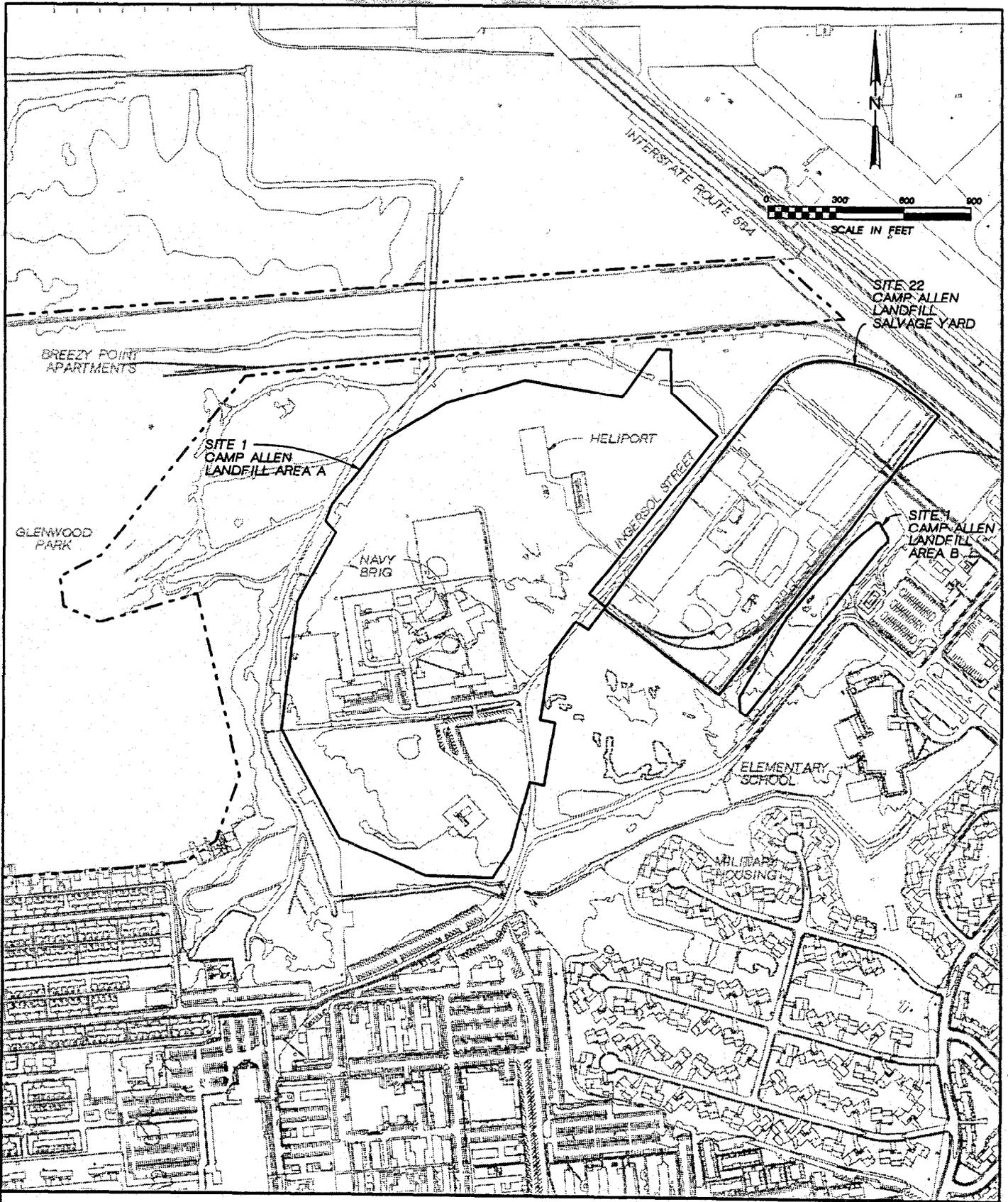
Aerial photographs from 1963 indicate that debris was stored in this area. Sampling and analysis of the subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

SWMU 35—Solid Waste Disposal Area CEP 196/Resolute Embankment

This solid waste disposal site is located in an area east of the floating dry-dock USS Resolute. Figure 2-34 illustrates the location of this site. A portion of the site forms a peninsula that extends into the Elizabeth River. The peninsula is grass covered while the northern portion of the site is situated within an asphalt parking lot. The areas of the site

that border the waterfront are lined with large rocks to prevent erosion. Second Street is located immediately east of the site area.

An aerial photograph from 1982 indicates that this area was used for waste and fill disposal. Sampling and analysis of the subsurface soil were performed in 1994-1995. After further analysis of the site, comprehensive recommendations regarding further actions will be made.

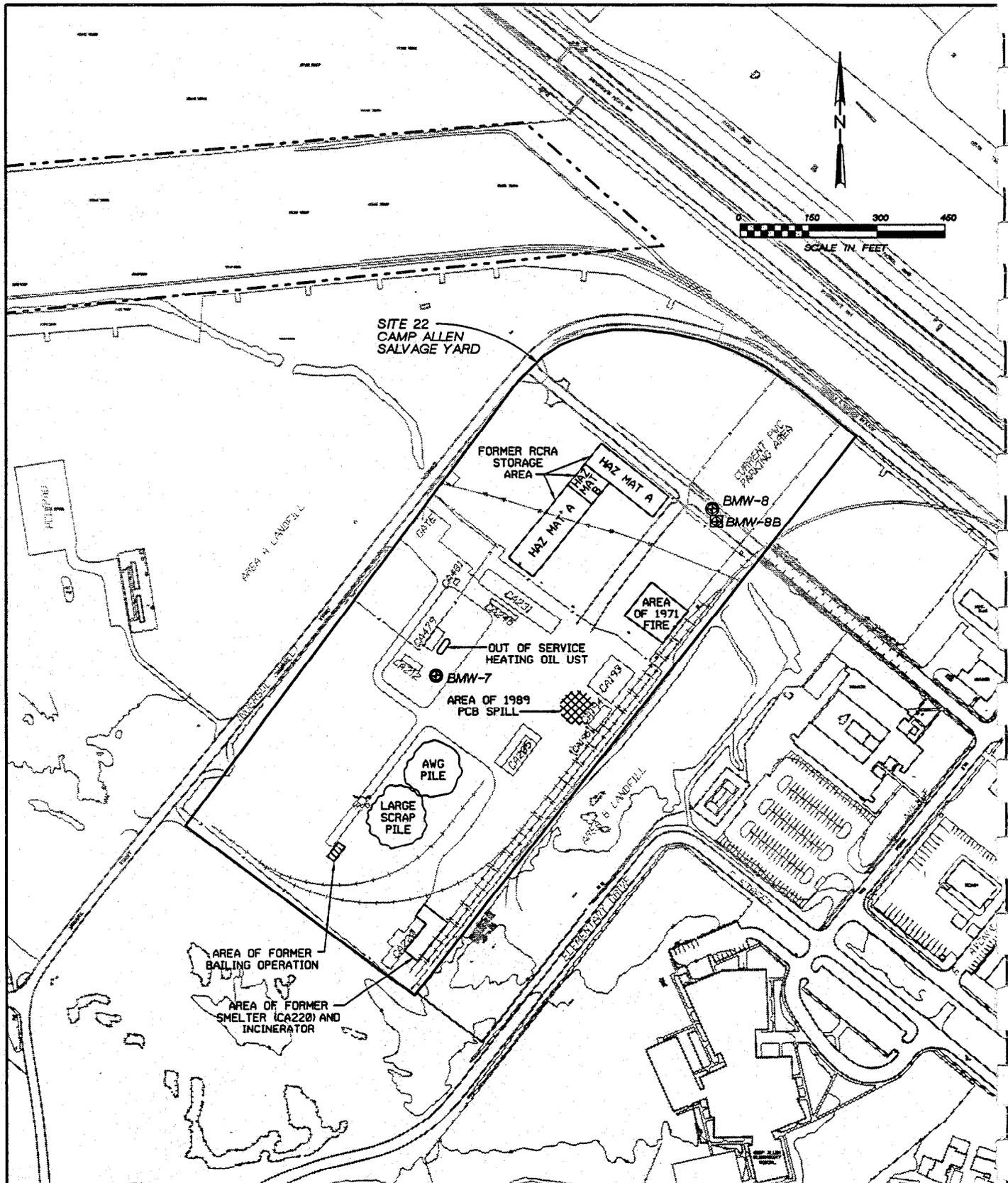


LEGEND

----- PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-1
 SITE 1 - CAMP ALLEN LANDFILL AND
 SITE 22 - CAMP ALLEN SALVAGE YARD
 Norfolk Naval Base





LEGEND

- BMW-7** EXISTING SURFICIAL AQUIFER
GROUNDWATER MONITORING WELL
(25 FEET DEEP)

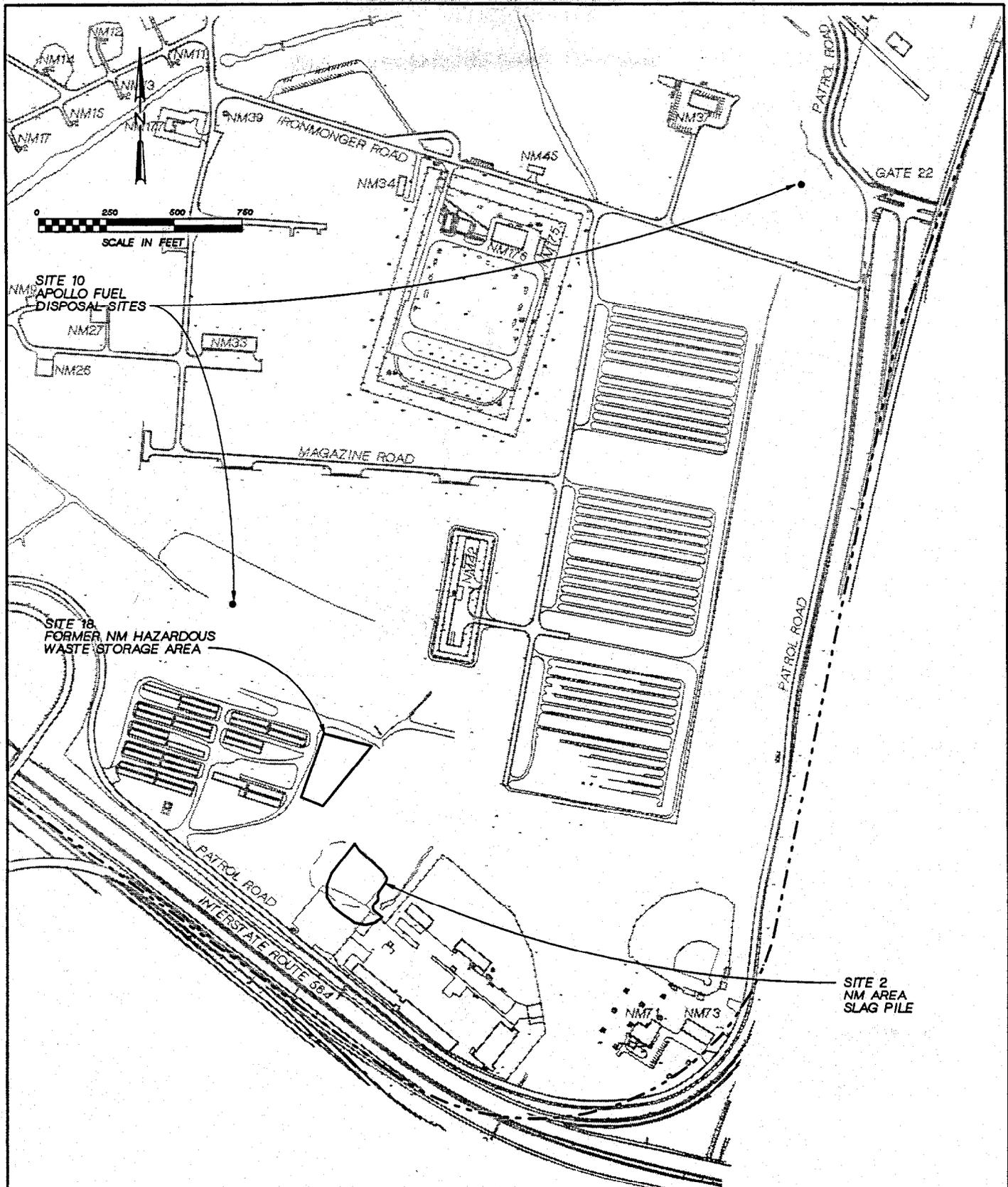
- BMW-8B** EXISTING YORKTOWN AQUIFER
GROUNDWATER MONITORING WELL
(65 FEET DEEP)

- AREA OF KNOWN PCB SPILL**

- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE**

Figure 2-1B
 SITE MAP
 SITE 22 - CAMP ALLEN
 SALVAGE YARD
 Norfolk Naval Base



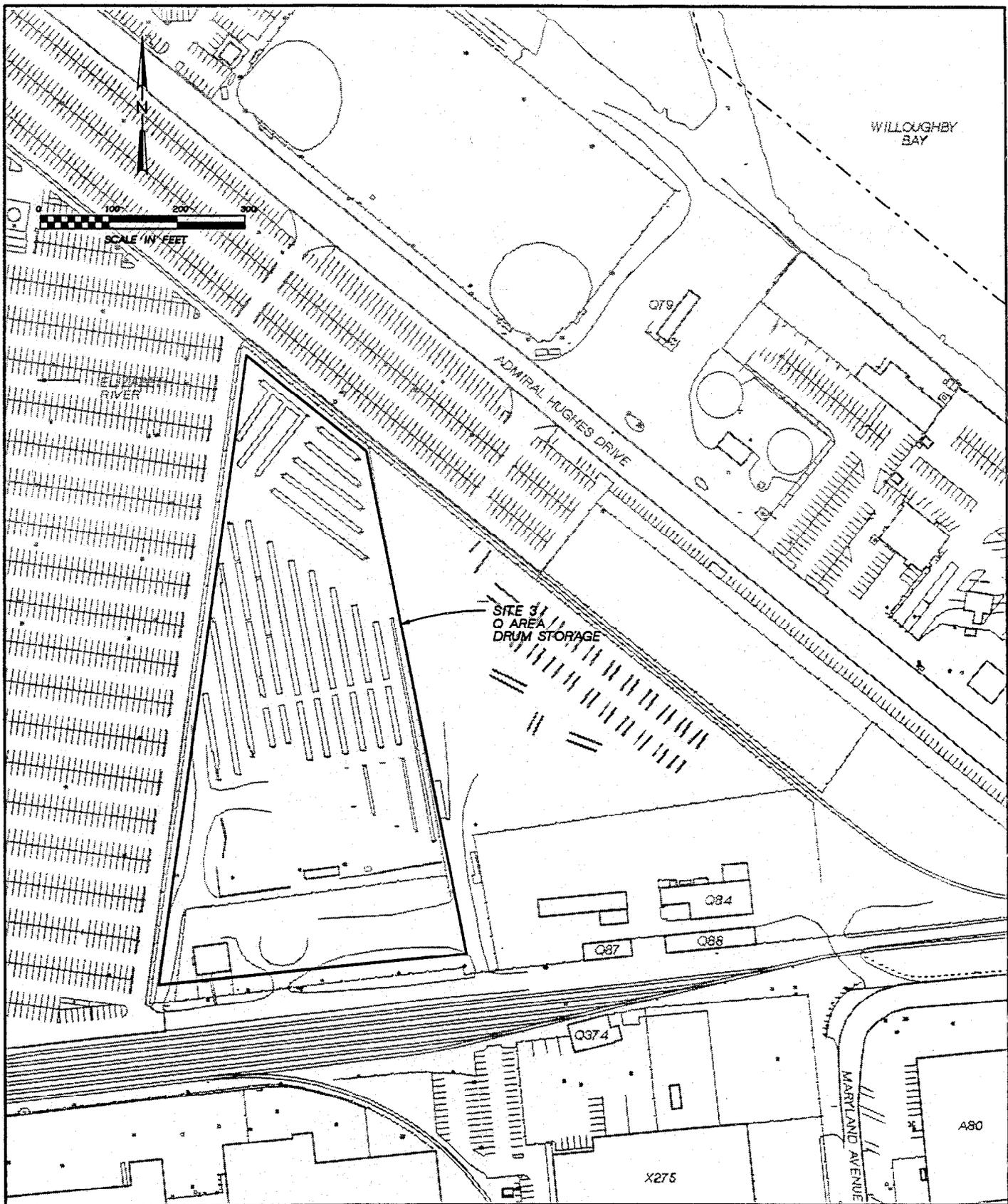


LEGEND

----- PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-2
 SITE 2 - NM AREA SLAG PILE,
 SITE 10 - APOLLO FUEL DISPOSAL
 SITE, AND SITE 18 - FORMER NM
 HAZARDOUS WASTE STORAGE AREA
 Norfolk Naval Base



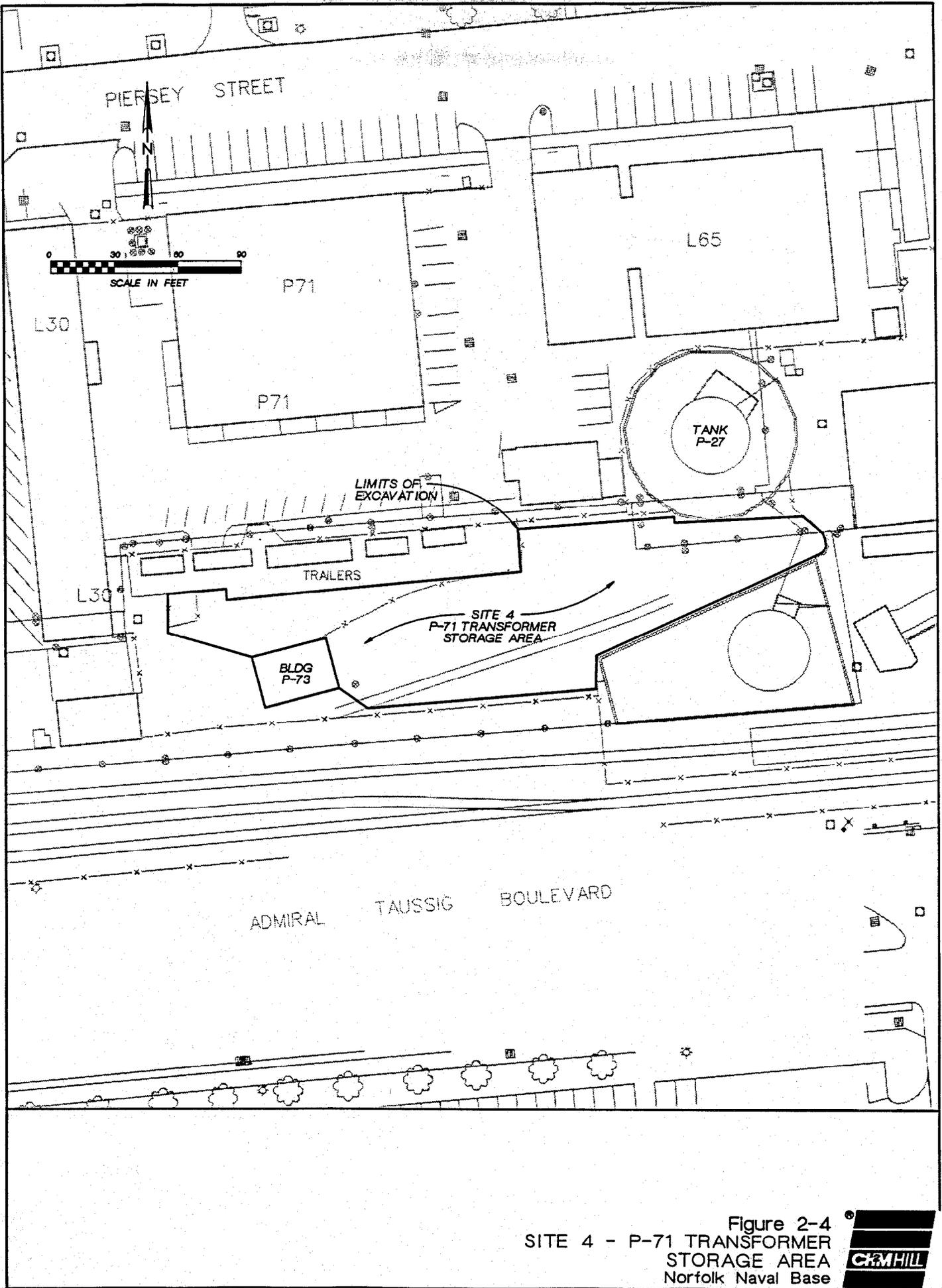


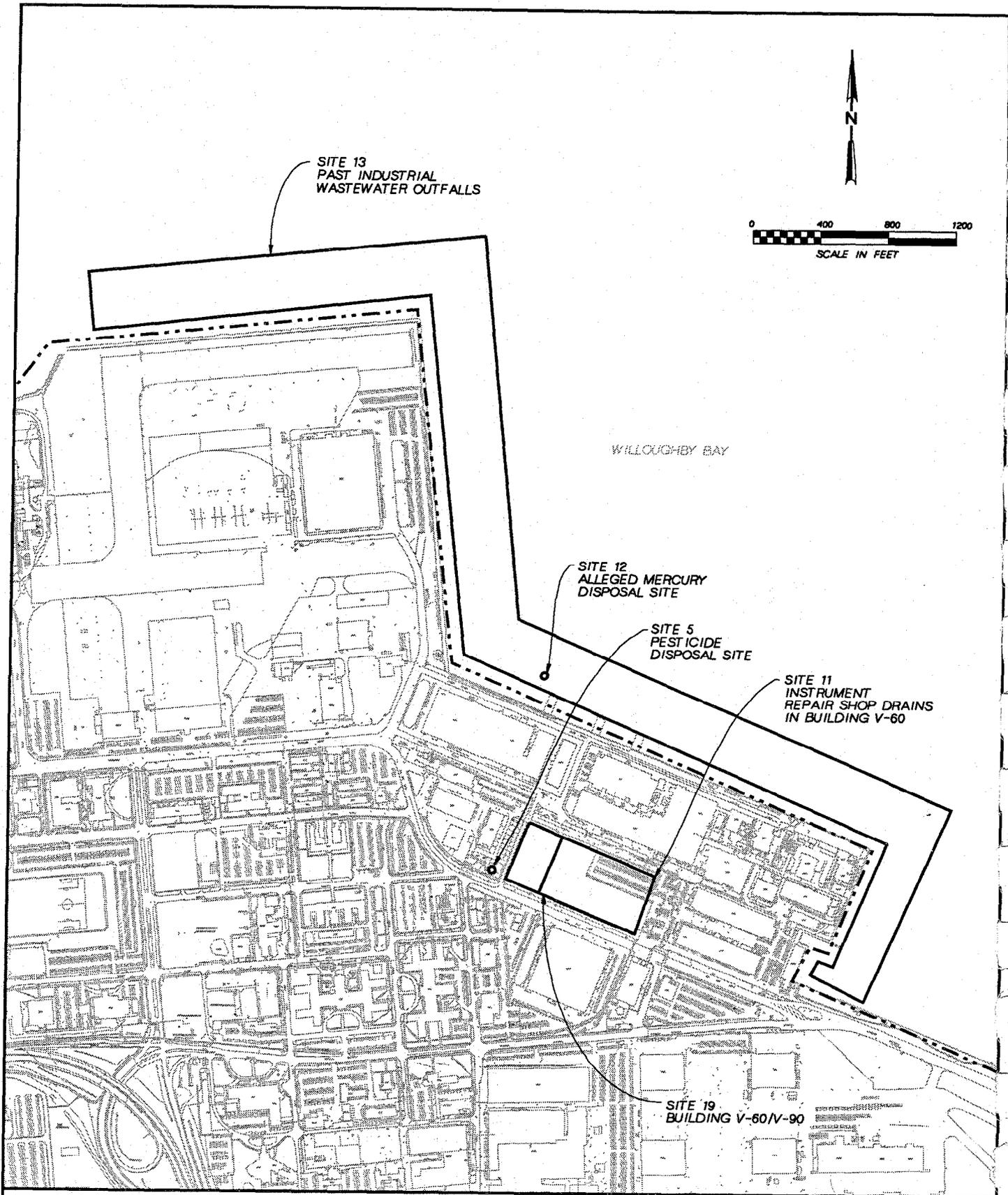
LEGEND

----- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-3
SITE 3 - Q AREA
DRUM STORAGE
Norfolk Naval Base





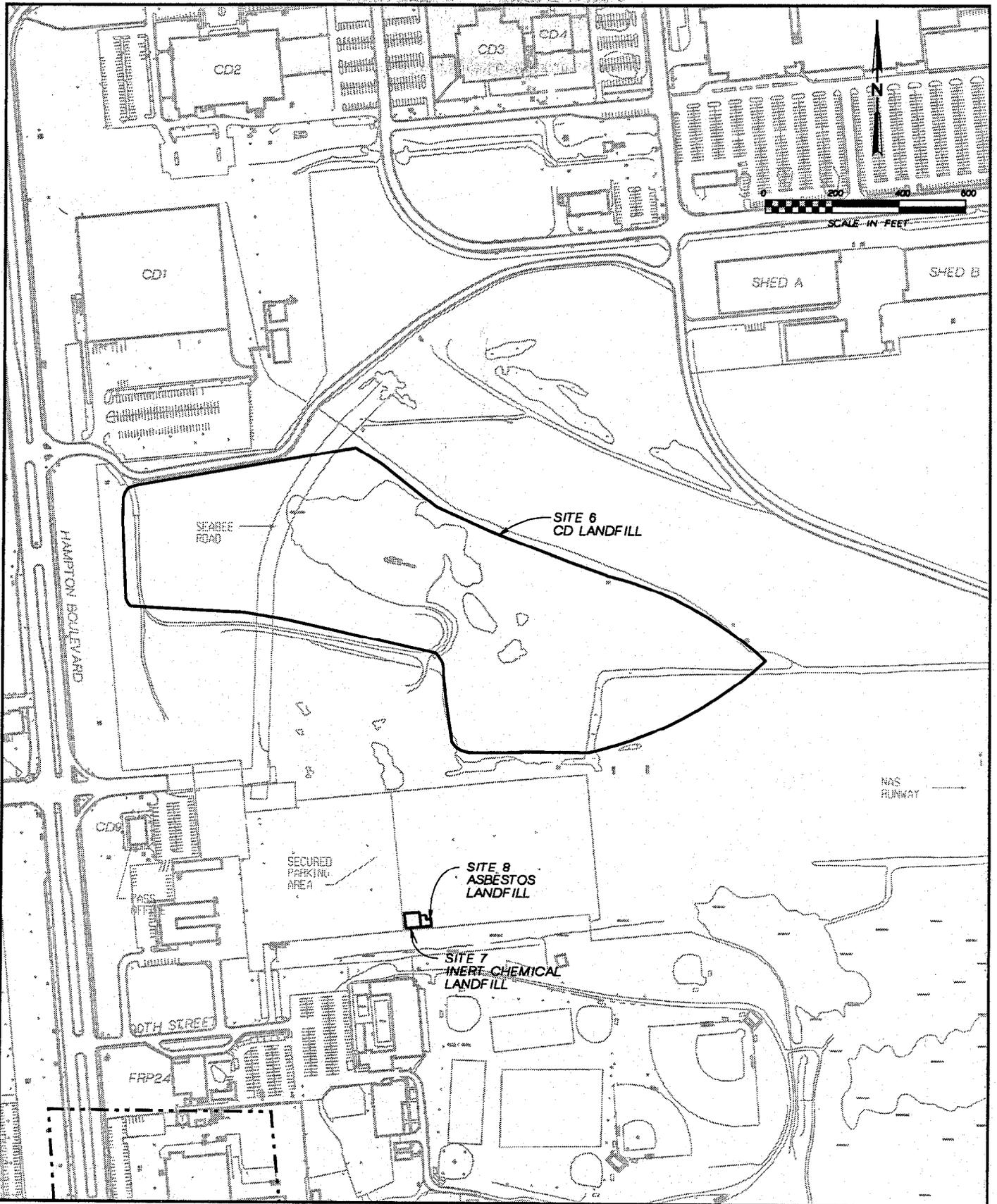


LEGEND

----- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-5
 SITE 5 - PESTICIDE DISPOSAL SITE,
 SITE 11 - INSTRUMENT REPAIR SHOP DRAINS,
 SITE 12 - ALLEGED MERCURY DISPOSAL SITE,
 SITE 13 - PAST INDUSTRIAL WASTEWATER
 OUTFALLS, AND SITE 19 - BUILDINGS V60/V90
 Naval Base Norfolk





LEGEND

----- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-6
 SITE 6 - CD LANDFILL,
 SITE 7 - INERT CHEMICAL LANDFILL,
 AND SITE 8 - ASBESTOS LANDFILL
 Naval Base Norfolk



JAMES RIVER

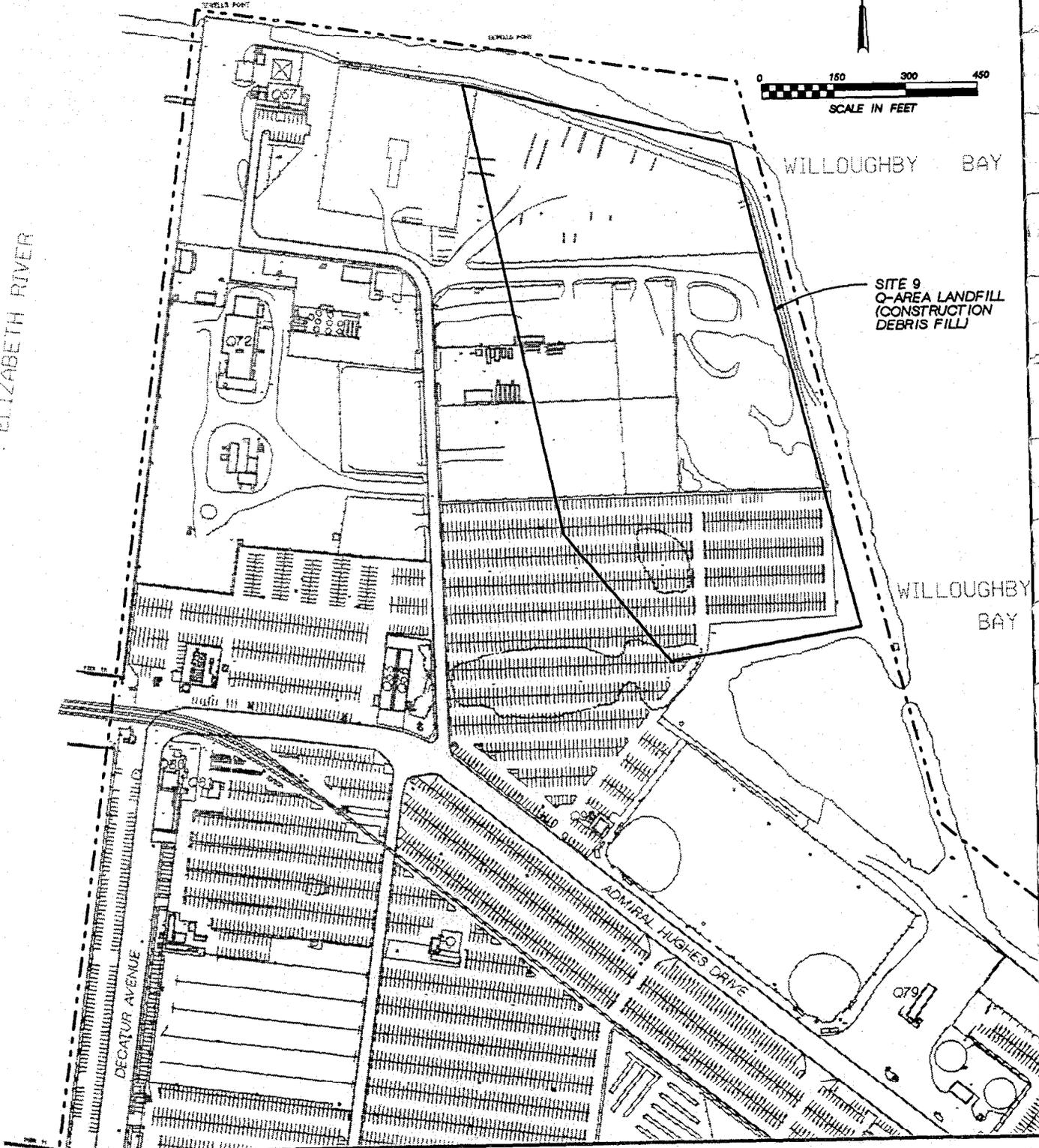
ELIZABETH RIVER



WILLOUGHBY BAY

SITE 9
Q-AREA LANDFILL
(CONSTRUCTION
DEBRIS FILL)

WILLOUGHBY BAY



LEGEND

----- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-7
SITE 9 - Q AREA LANDFILL
Norfolk Naval Base



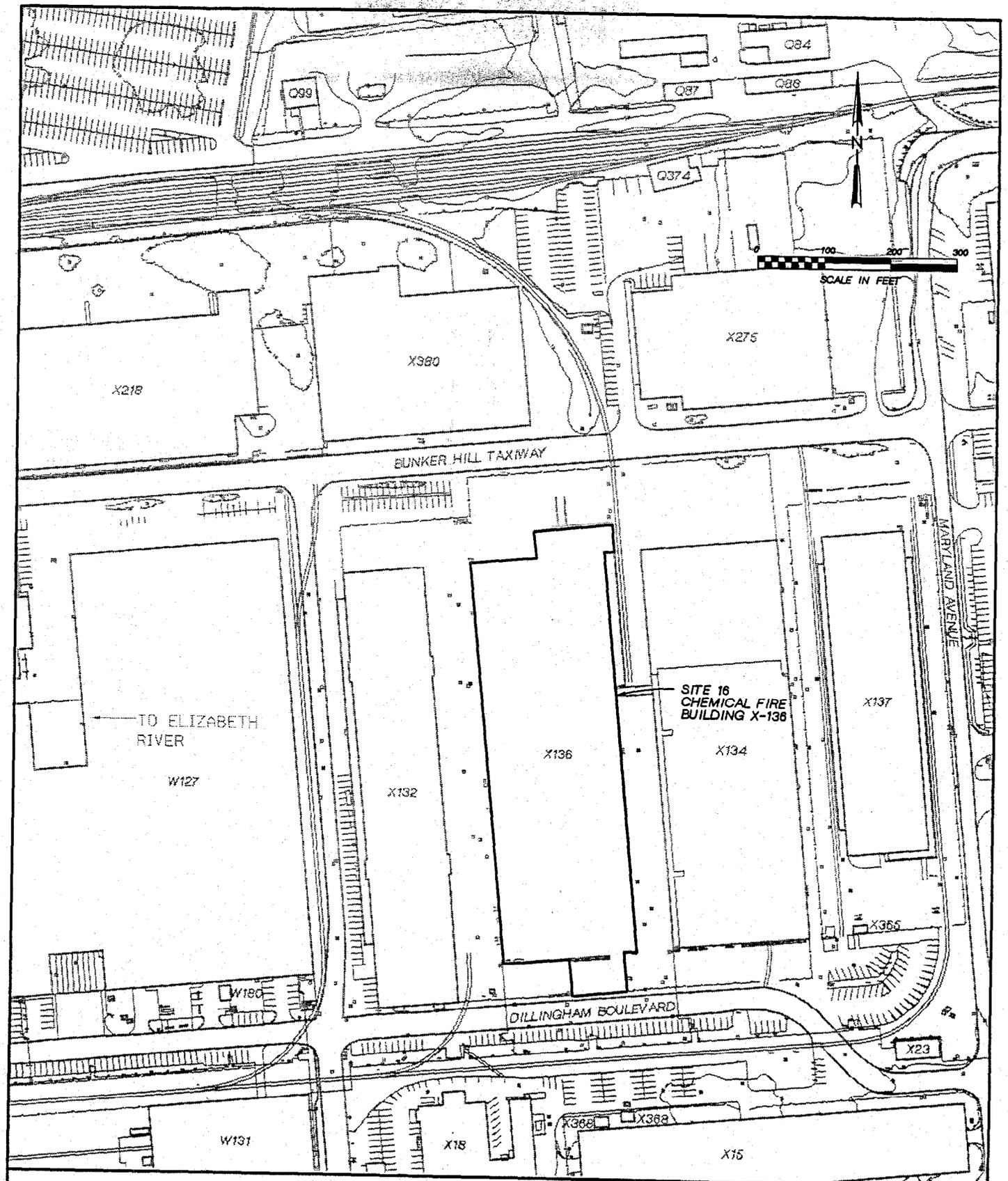
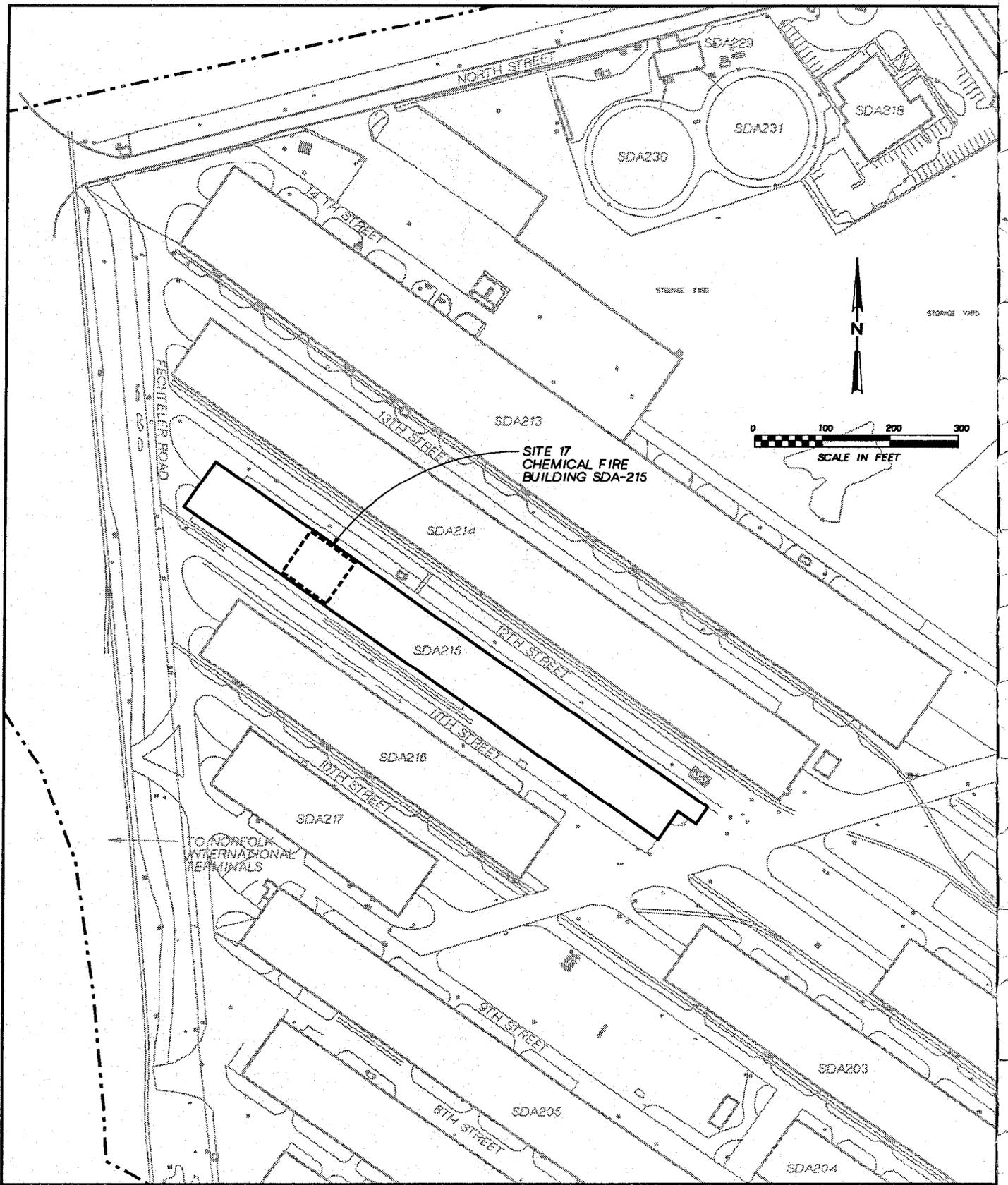


Figure 2-8
 SITE 16 - CHEMICAL
 FIRE, BUILDING X-136
 Norfolk Naval Base



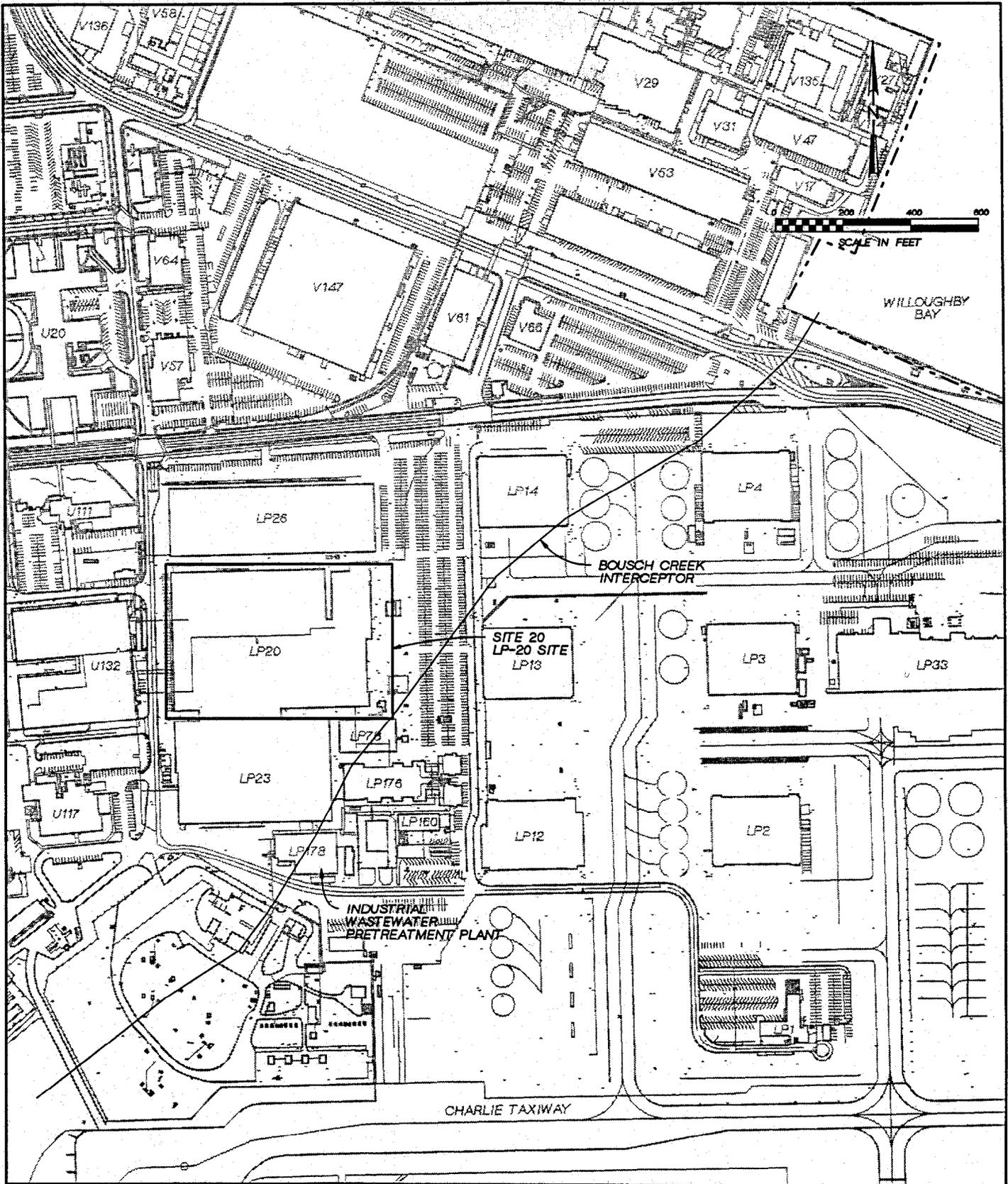


LEGEND

----- PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-9
 SITE 17 - CHEMICAL
 FIRE, BUILDING SDA-215
 Naval Base Norfolk





LEGEND

--- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-10
SITE 20 - LP-20 SITE
Norfolk Naval Base



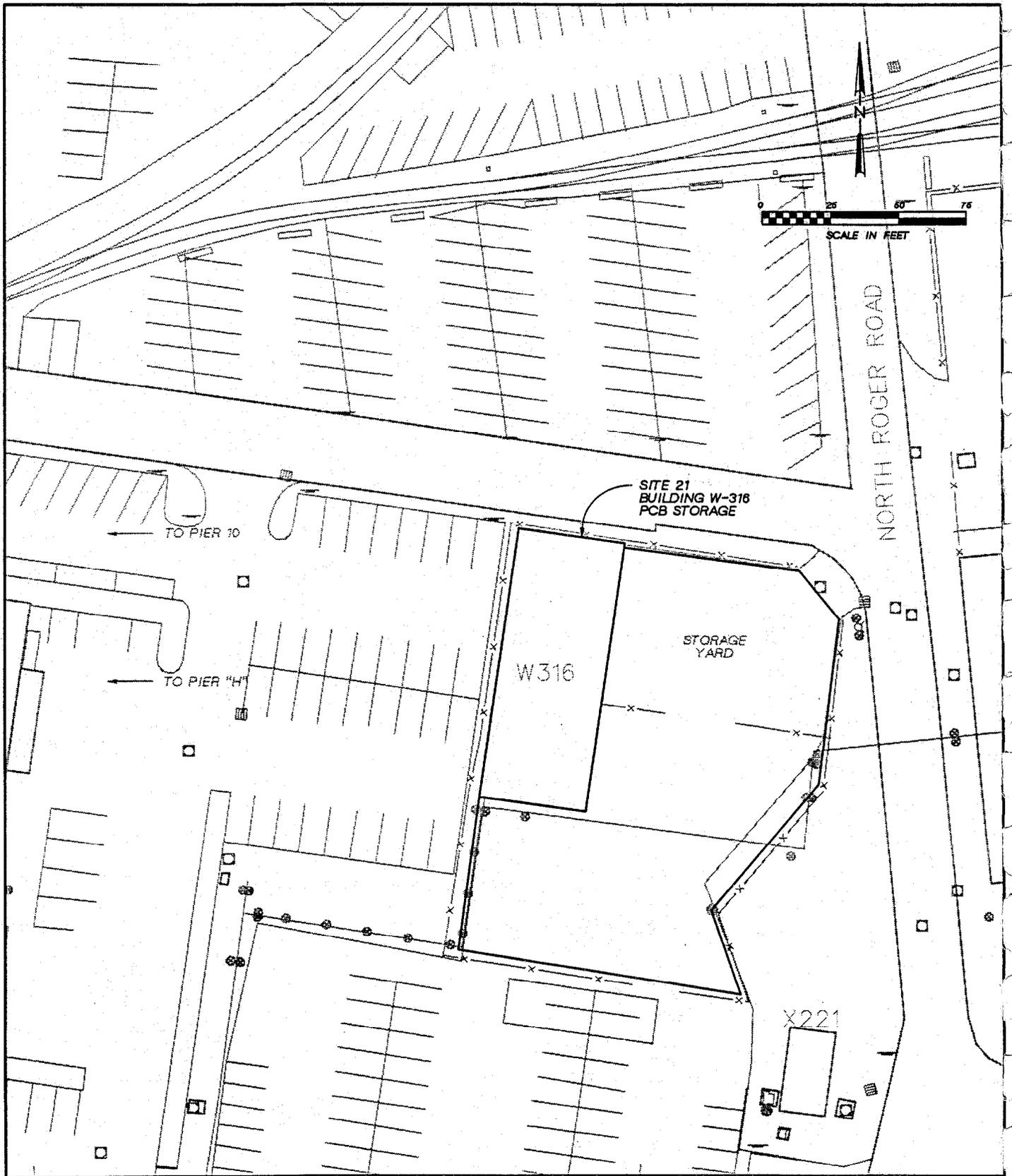
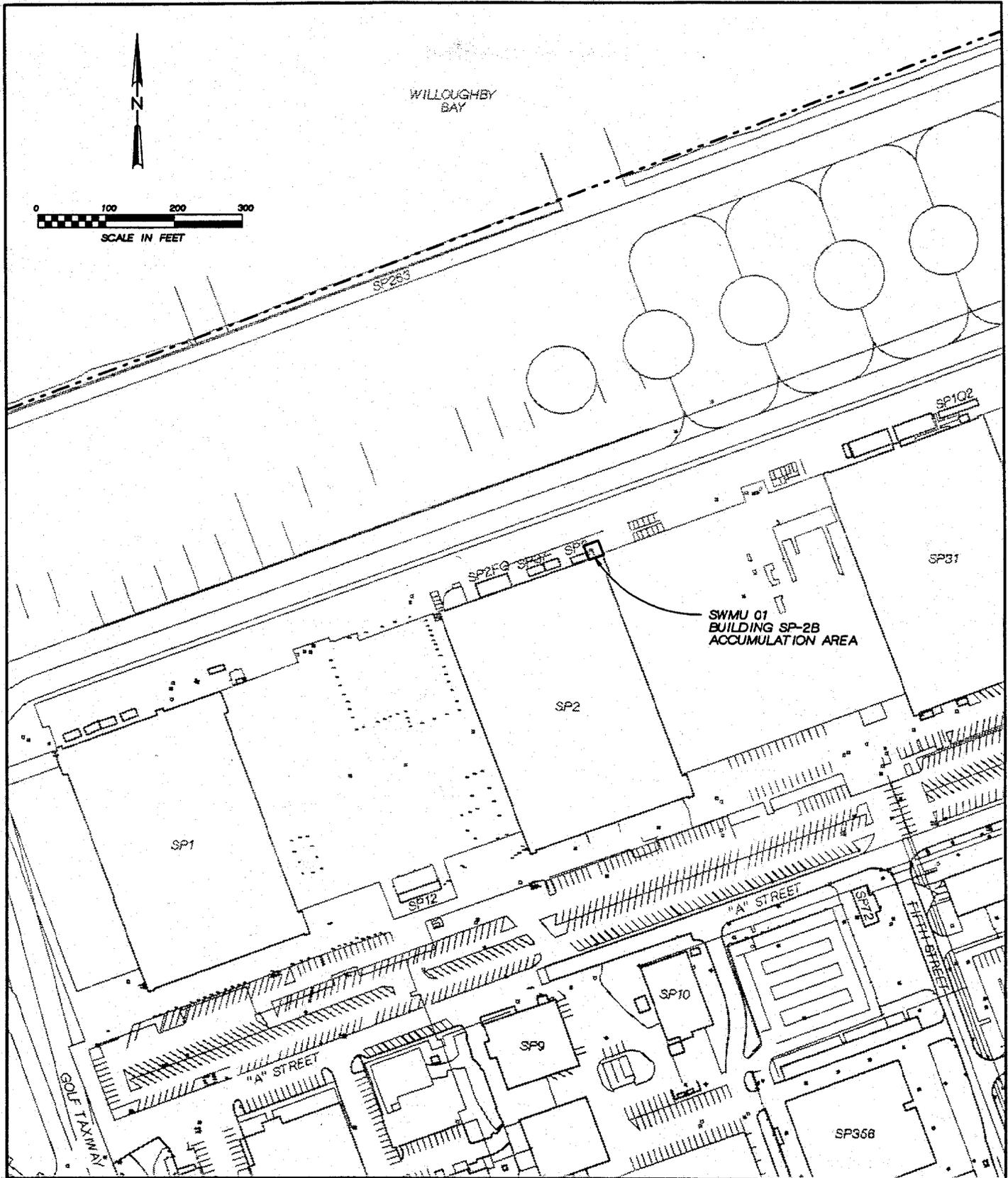


Figure 2-11
 SITE 21 - BUILDING W-316
 PCB STORAGE SITE
 Norfolk Naval Base





LEGEND

----- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-12
SWMU 01 - BUILDING SP-2B
ACCUMULATION AREA
Norfolk Naval Base



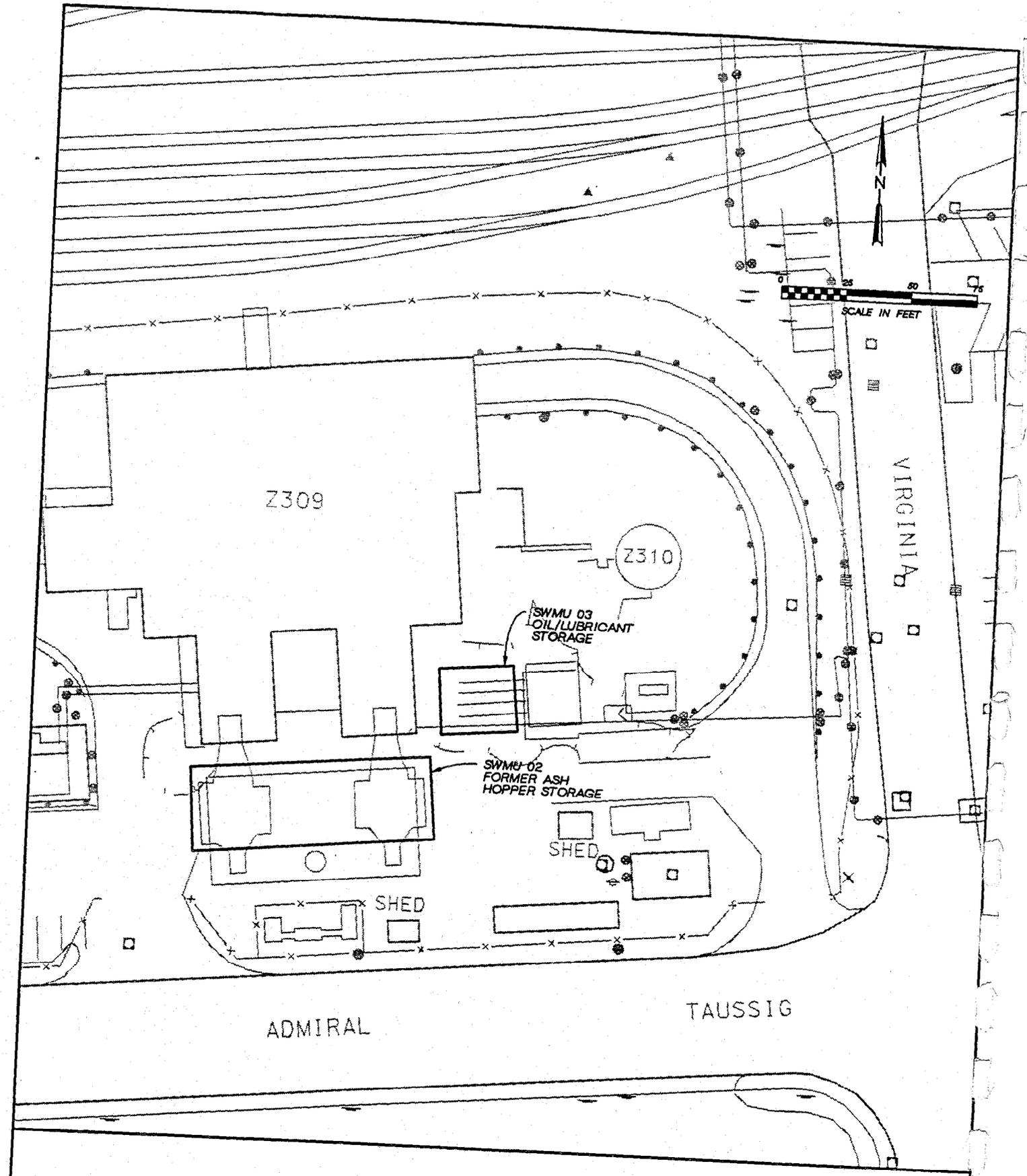
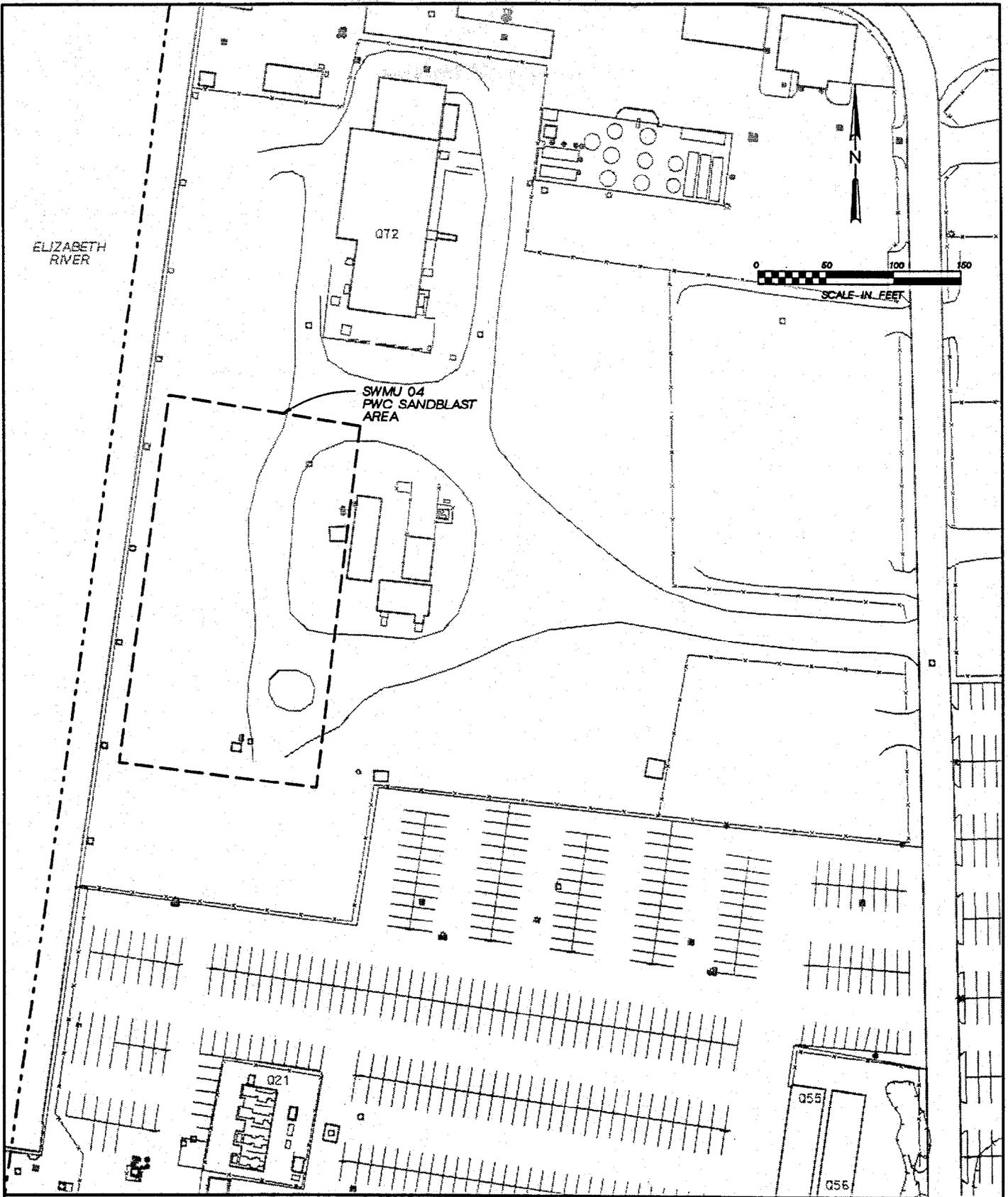


Figure 2-13
 SWMU 02 - BUILDING Z-309
 FORMER ASH HOPPER AND
 SWMU 03 - BUILDING Z-309
 OIL/LUBRICANT STORAGE
 Norfolk Naval Base

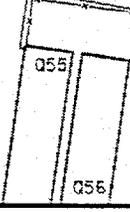
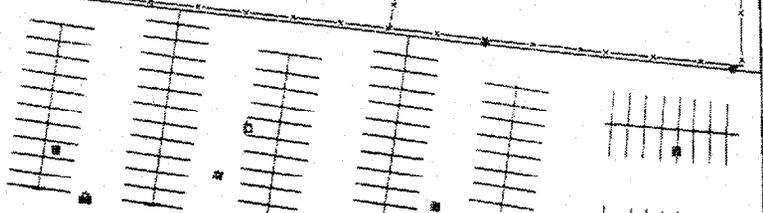
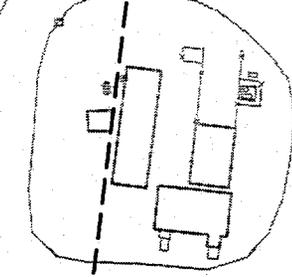




ELIZABETH RIVER

Q72

SWMU 04
PWC SANDBLAST
AREA

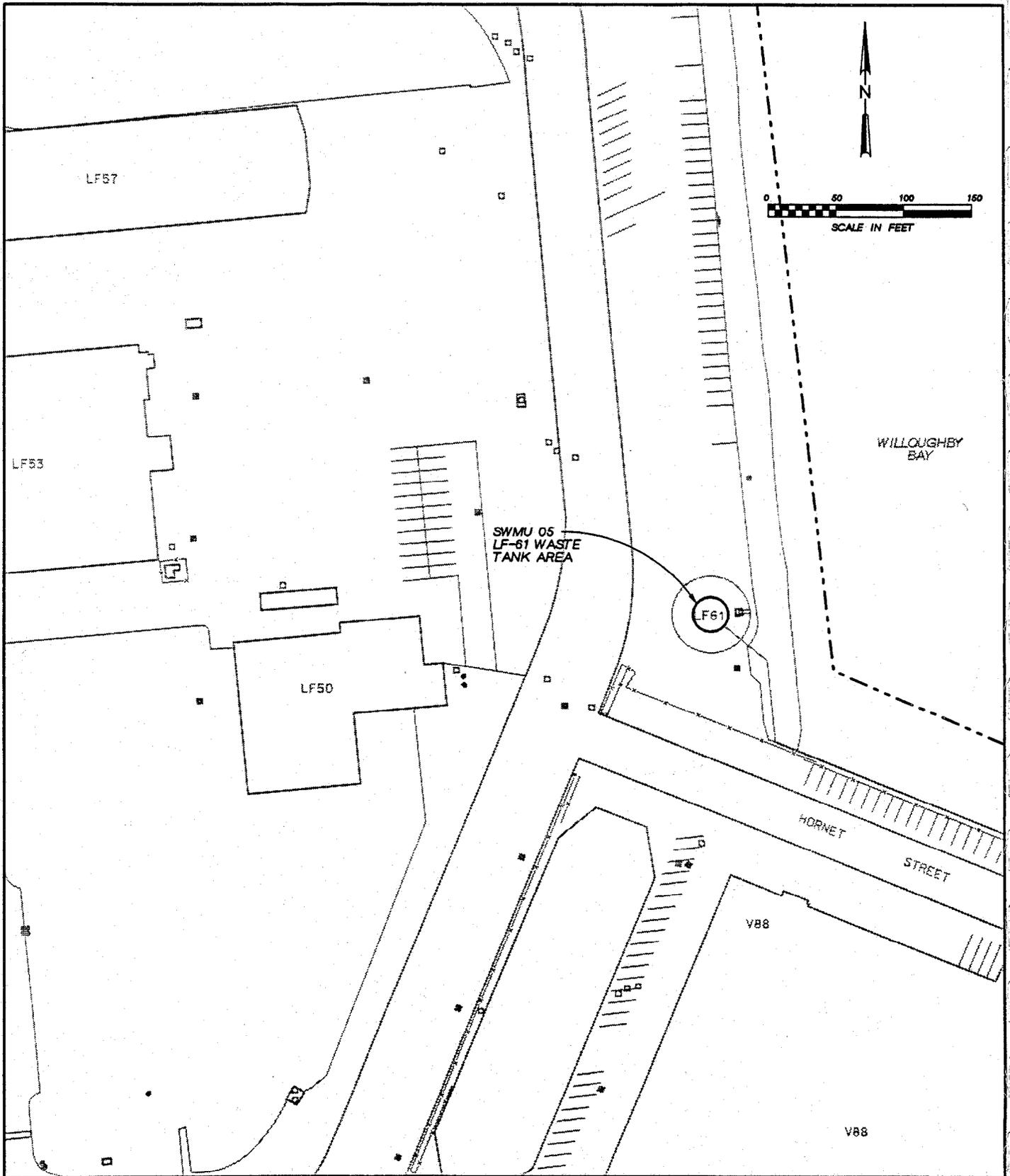


LEGEND

-  ESTIMATED EXTENT OF SOLID WASTE MANAGEMENT UNIT
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-14
SWMU 04 - PWC
SANDBLAST AREA
Norfolk Naval Base



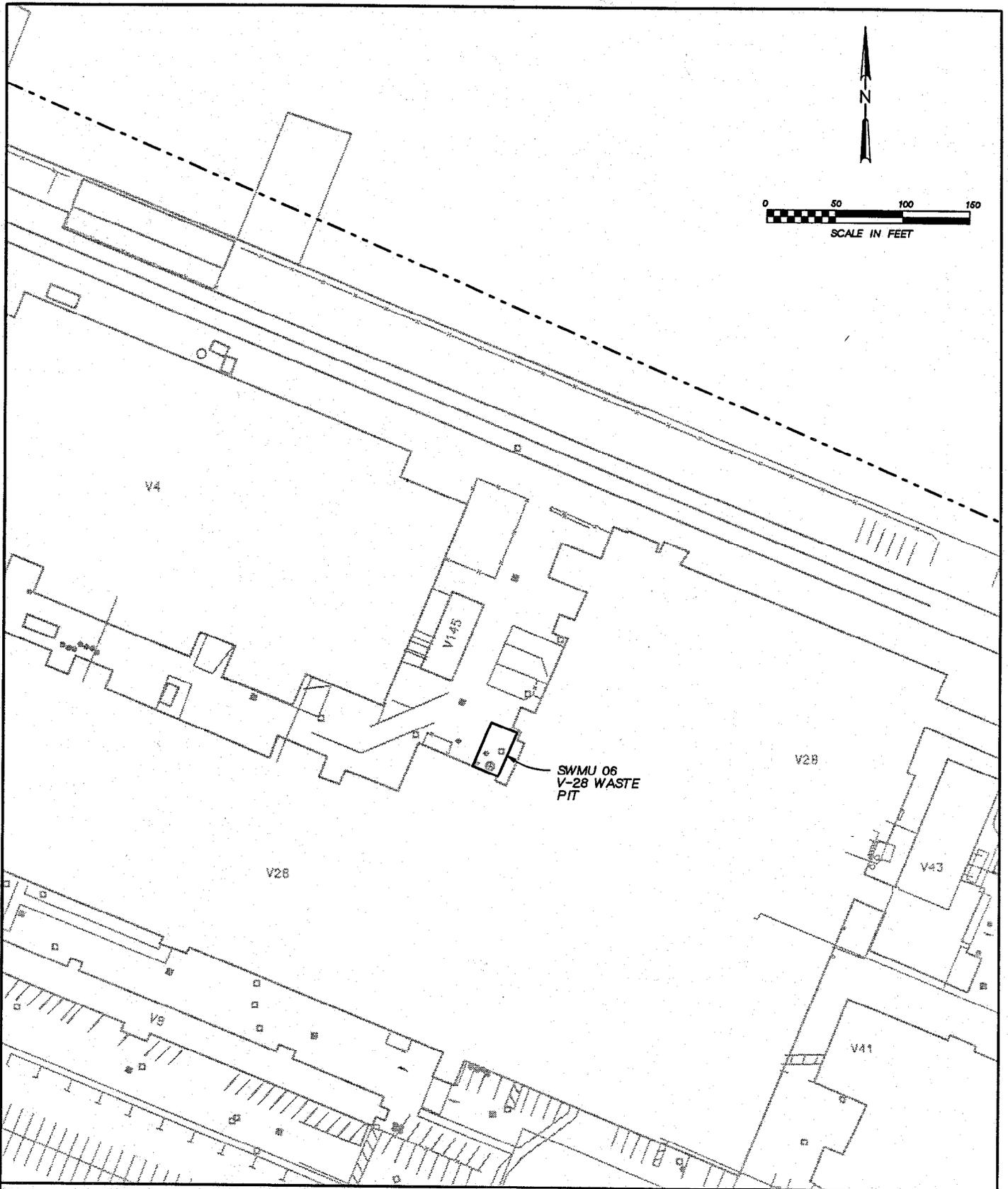


LEGEND

--- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-15
SWMU 05 - LF-61
WASTE TANK AREA
Norfolk Naval Base



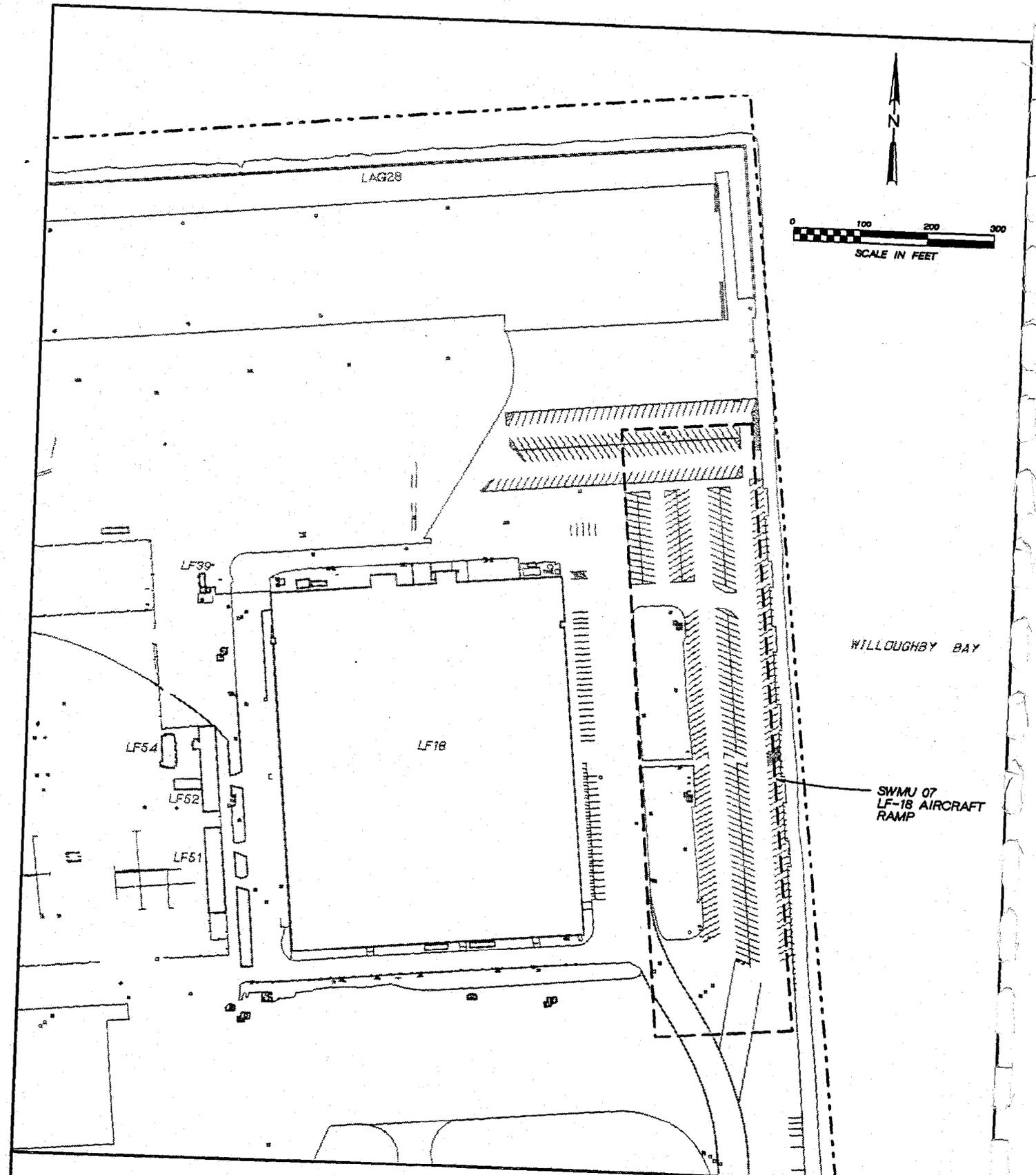


LEGEND

----- PROPERTY BOUNDARY -
NORFOLK NAVAL BASE

Figure 2-16
SWMU 06 - V-28 WASTE PIT
Norfolk Naval Base



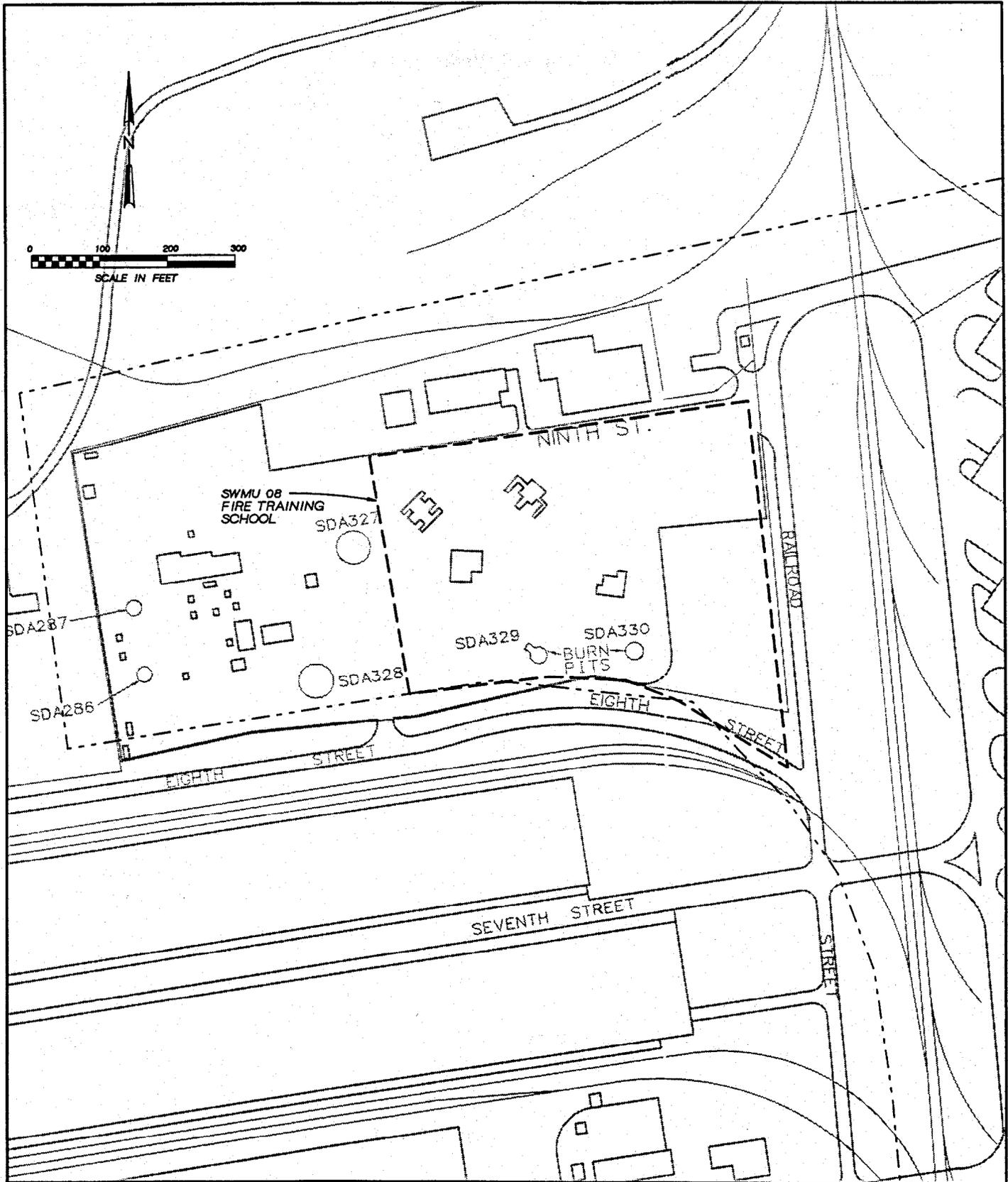


LEGEND

-  ESTIMATED EXTENT OF WASTE DISPOSAL AREA
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-17
 SWMU 07 - LF-18
 AIRCRAFT RAMP
 Norfolk Naval Base





LEGEND

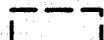
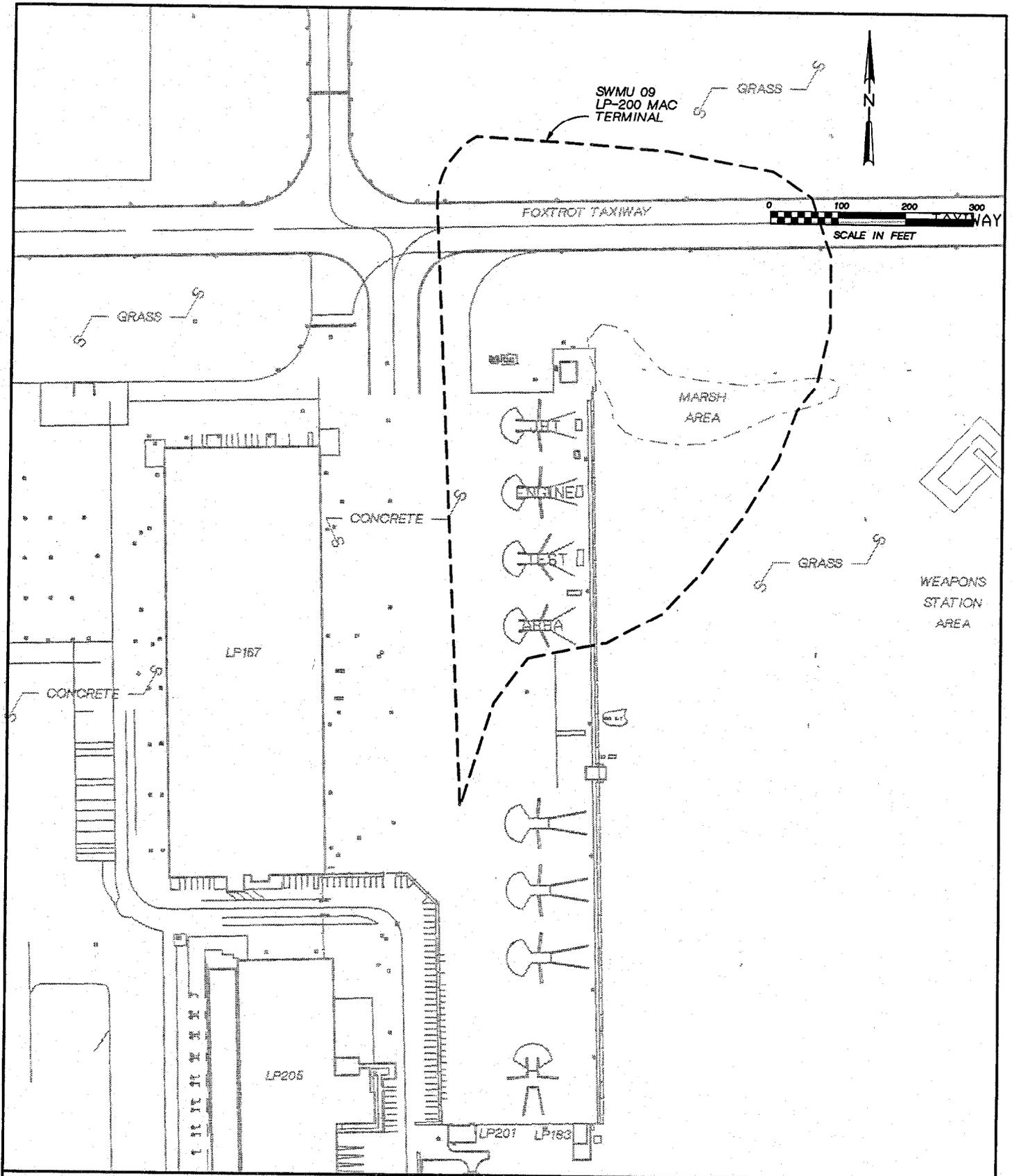
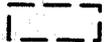
-  ESTIMATED EXTENT OF WASTE DISPOSAL AREA
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-18
 SWMU 08 - FIRE TRAINING SCHOOL
 Norfolk Naval Base





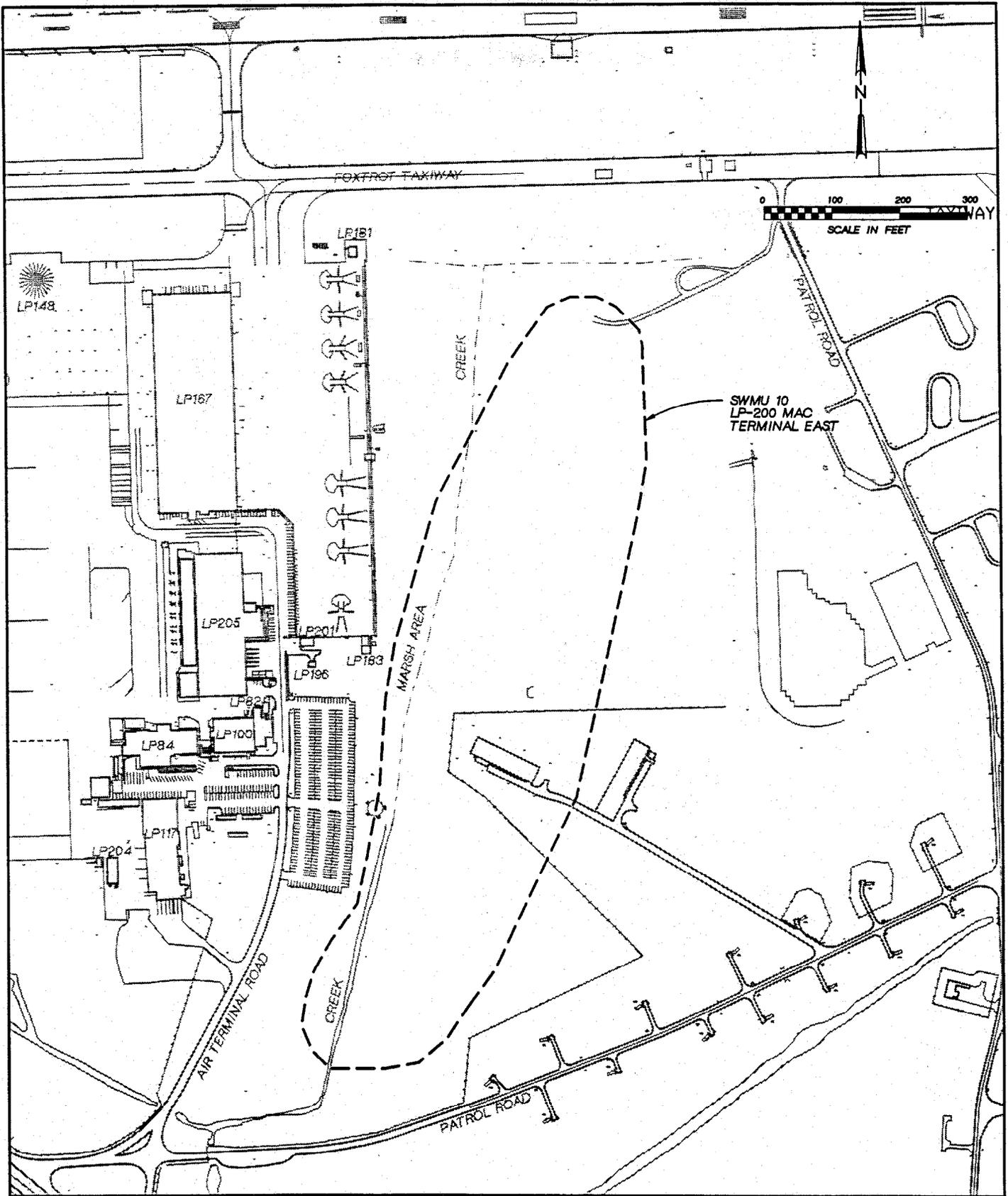
LEGEND



ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-19
 SWMU 09 - LP-200
 MAC TERMINAL
 Norfolk Naval Base





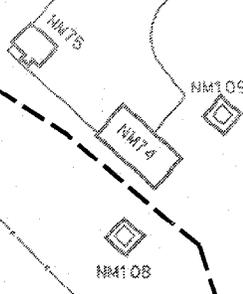
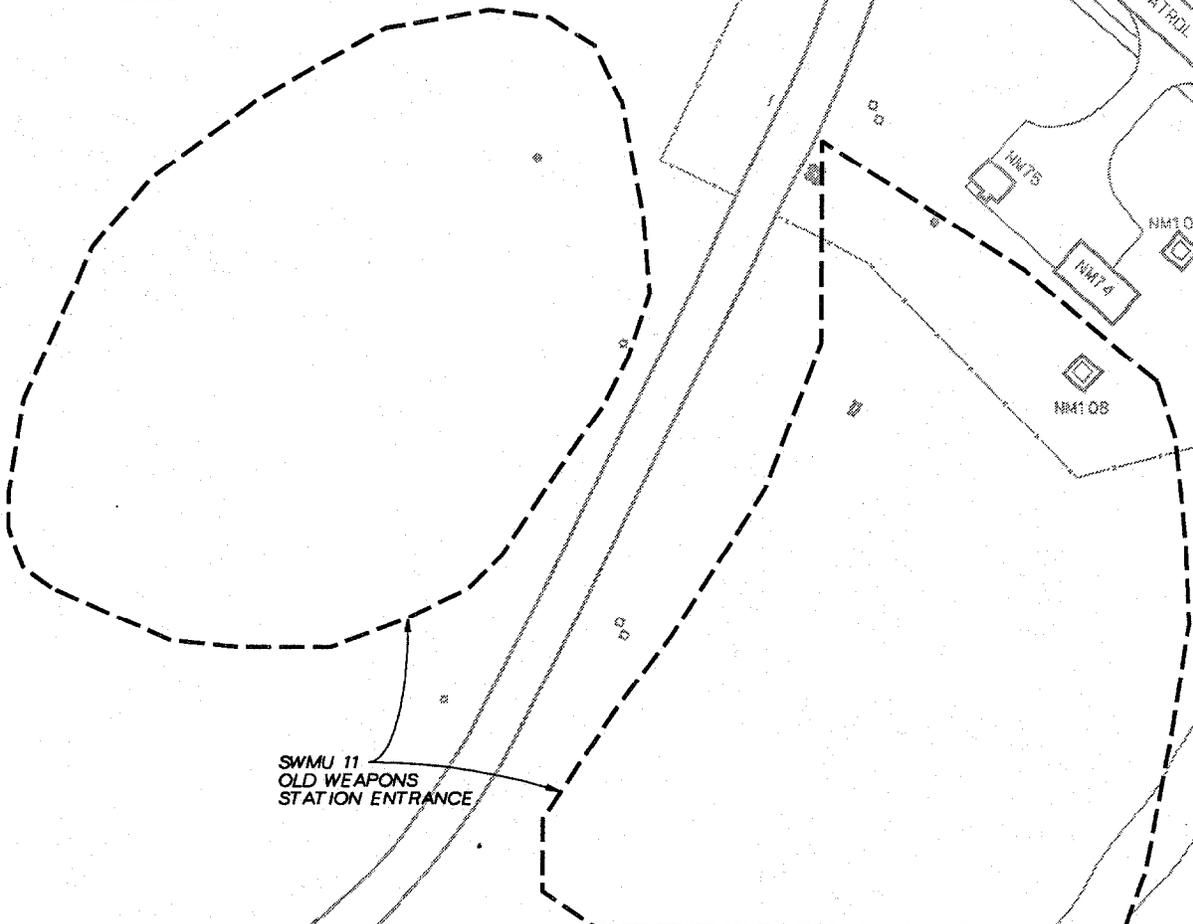
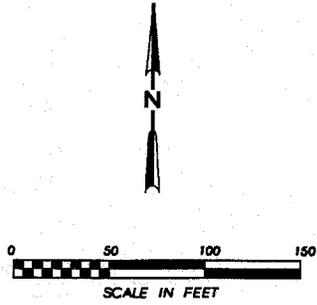
LEGEND



ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-20
 SWMU 10 - LP-200
 MAC TERMINAL EAST
 Norfolk Naval Base





LEGEND

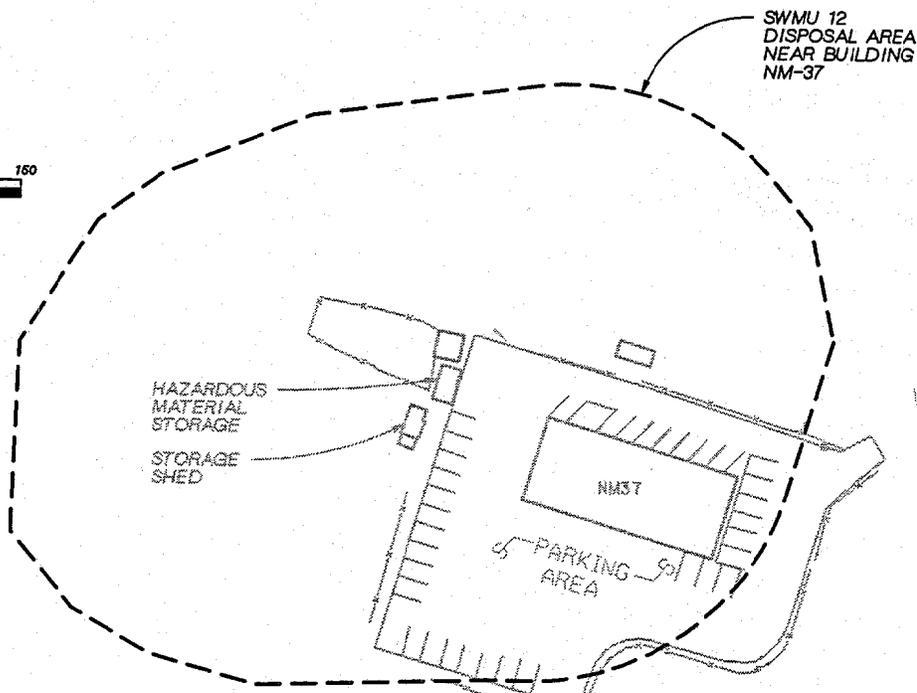
-  ESTIMATED EXTENT OF WASTE DISPOSAL AREA
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-21
SWMU 11 - OLD WEAPONS
STATION ENTRANCE
Naval Base Norfolk





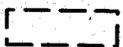
WOODED



WOODED

IRONMONGER ROAD

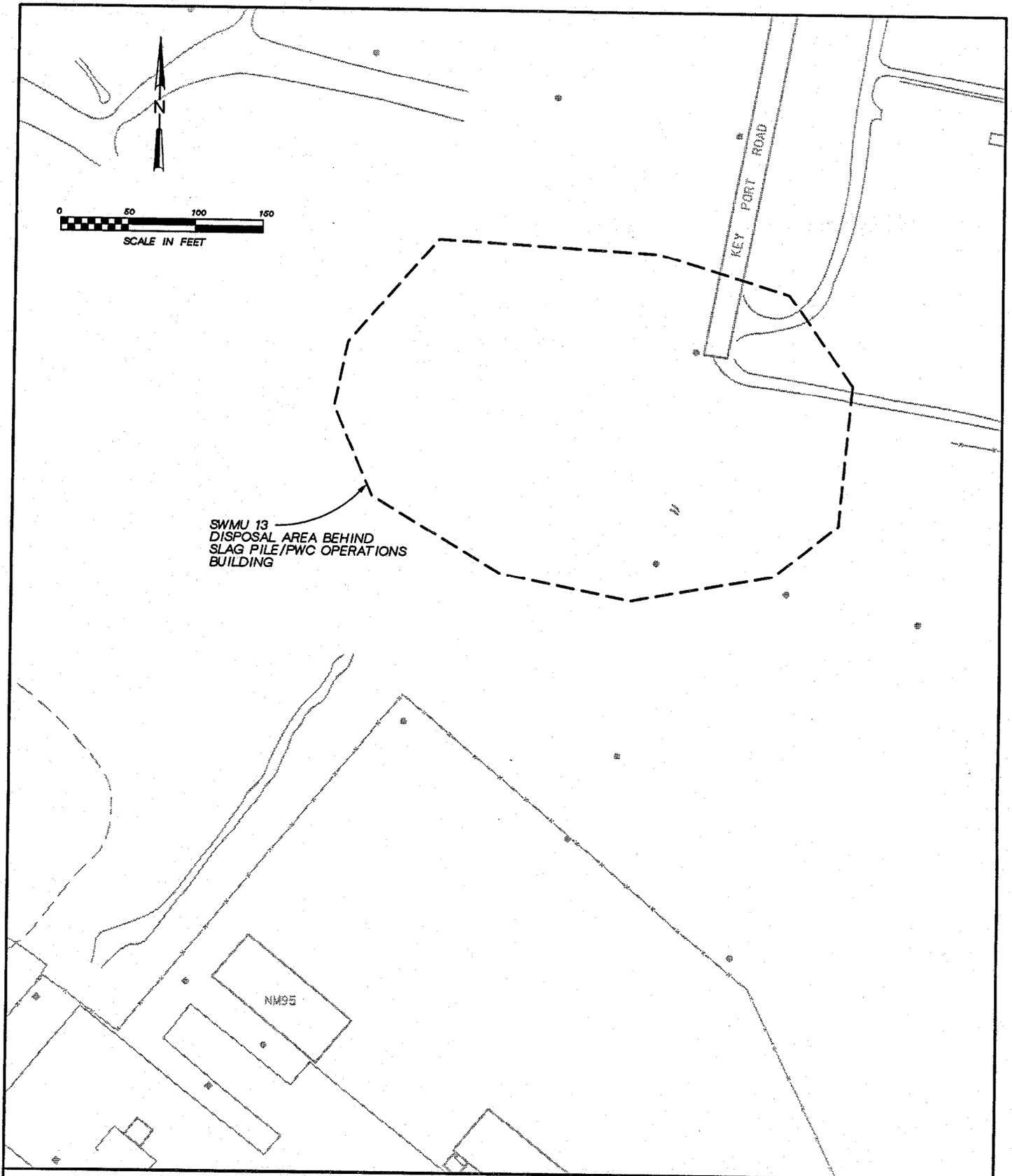
LEGEND



ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-22
SWMU 12 - DISPOSAL AREA
NEAR BUILDING NM-37
Naval Base, Norfolk





SWMU 13
DISPOSAL AREA BEHIND
SLAG PILE/PWC OPERATIONS
BUILDING

NM95

KEY PORT ROAD

0 50 100 150
SCALE IN FEET

LEGEND

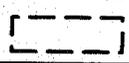
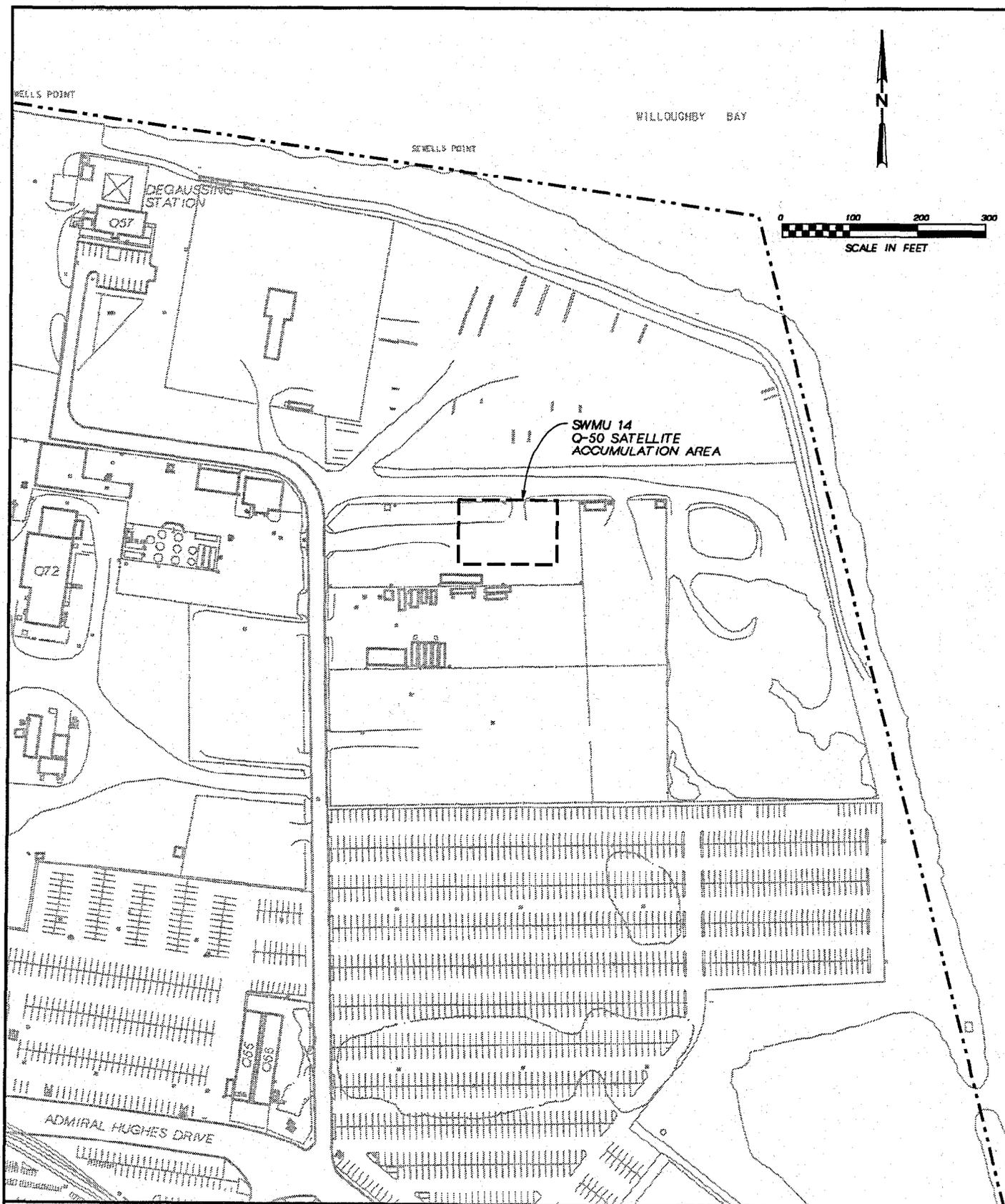
 ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-23
SWMU 13 - DISPOSAL AREA BEHIND
SLAG PILE/PWC OPERATIONS BUILDING
Norfolk Naval Base



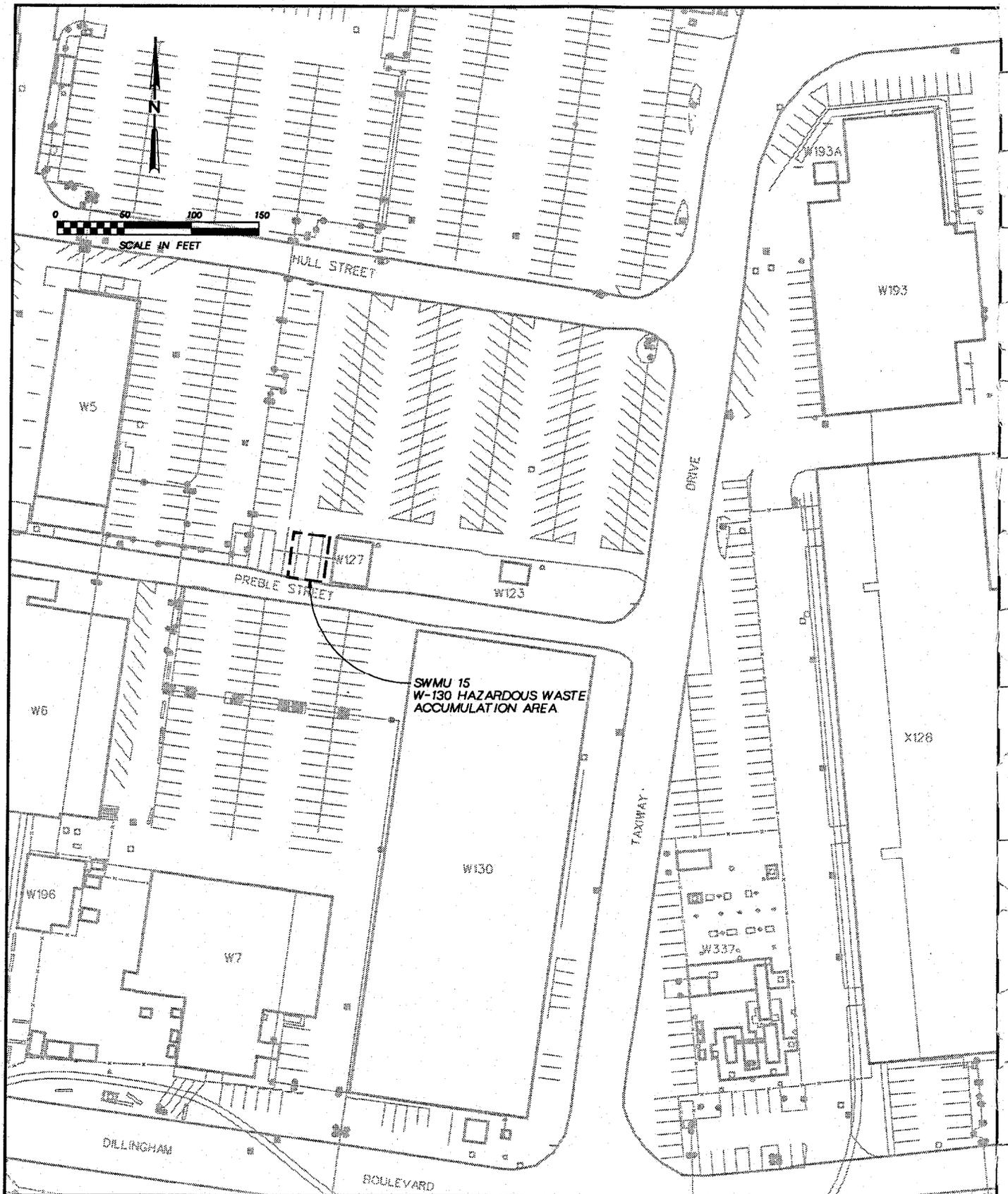


LEGEND

-  ESTIMATED EXTENT OF SOLID WASTE MANAGEMENT UNIT
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-24
SWMU 14 - Q-50 SATELLITE ACCUMULATION AREA
 Naval Base Norfolk





LEGEND



ESTIMATED EXTENT OF SOLID WASTE MANAGEMENT UNIT

Figure 2-25
 SWMU 15 - W-130 HWAA
 Naval Base Norfolk



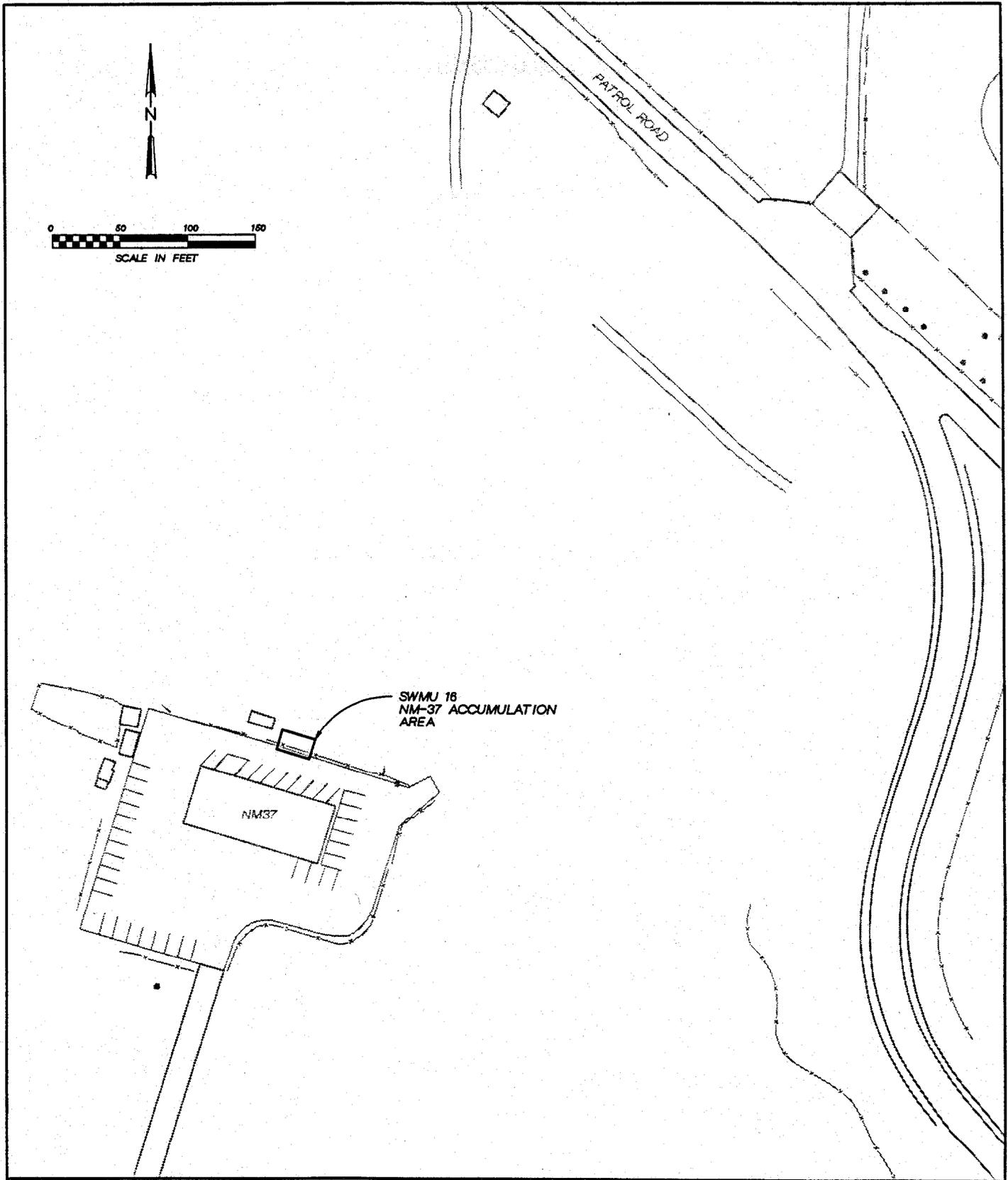
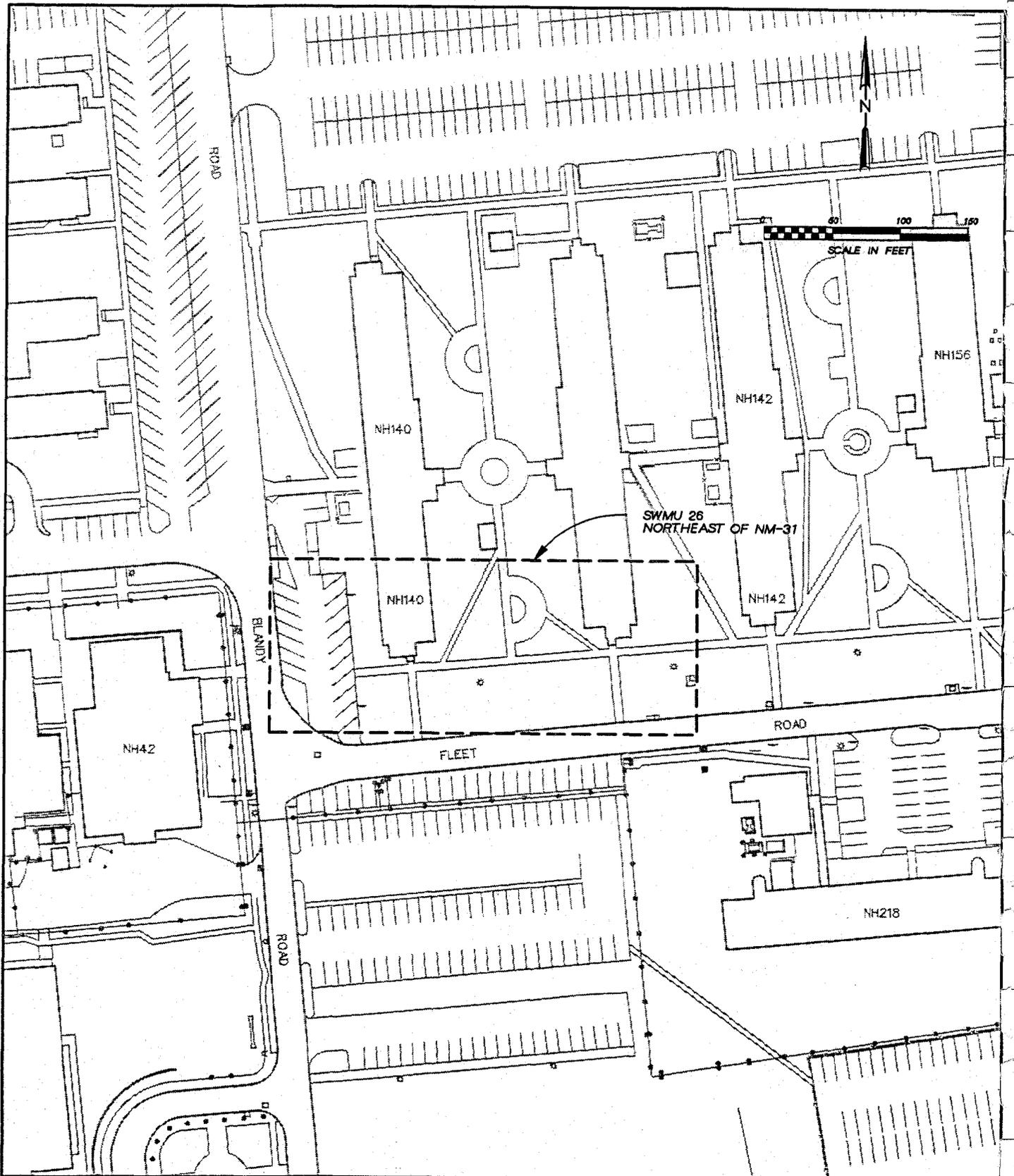


Figure 2-26
SWMU 16 - NM-37
ACCUMULATION AREA
Norfolk Naval Base



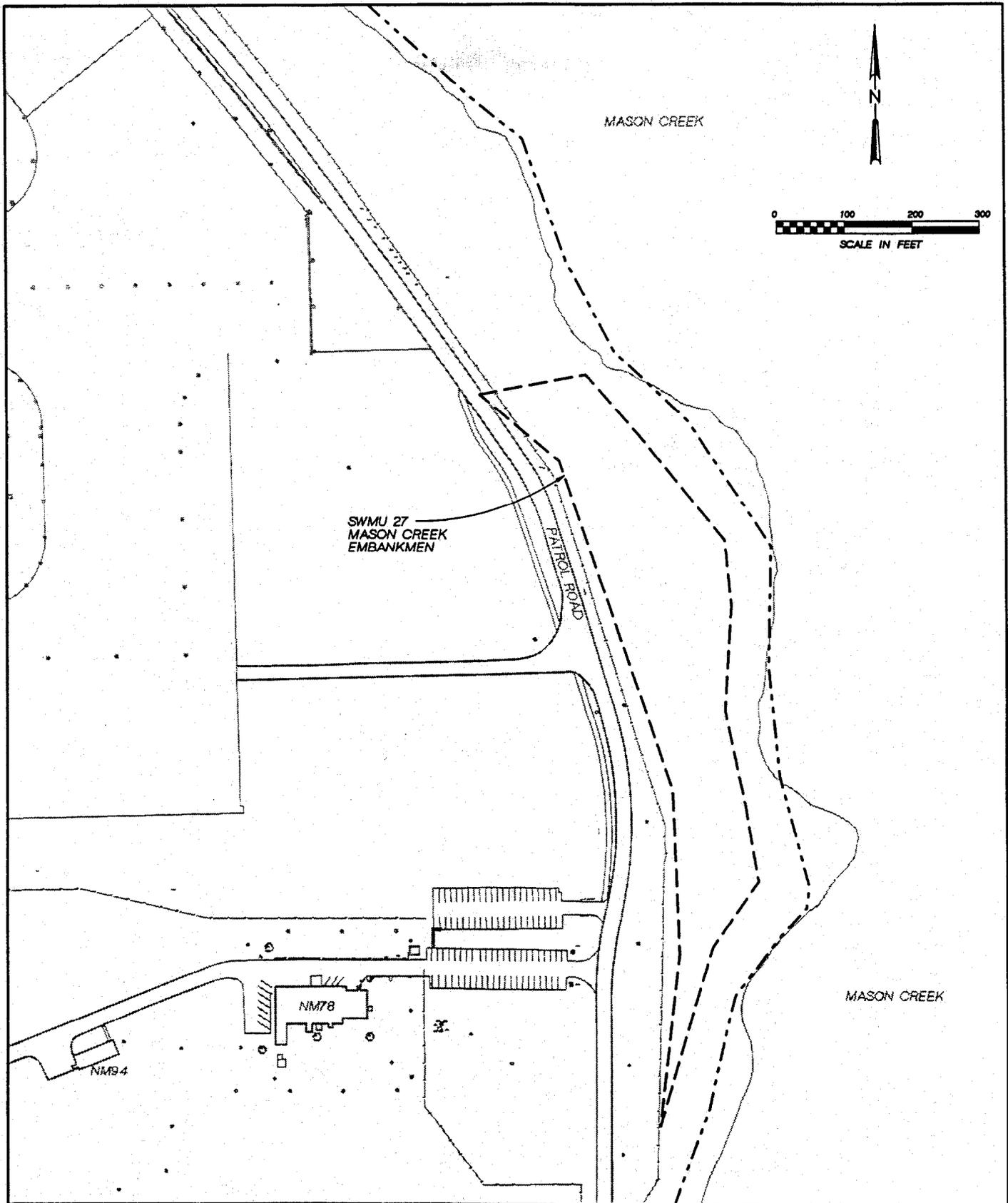


LEGEND

 ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-27
 SWMU 26 -
 NORTHEAST OF NM-31
 Norfolk Naval Base





LEGEND

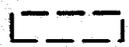
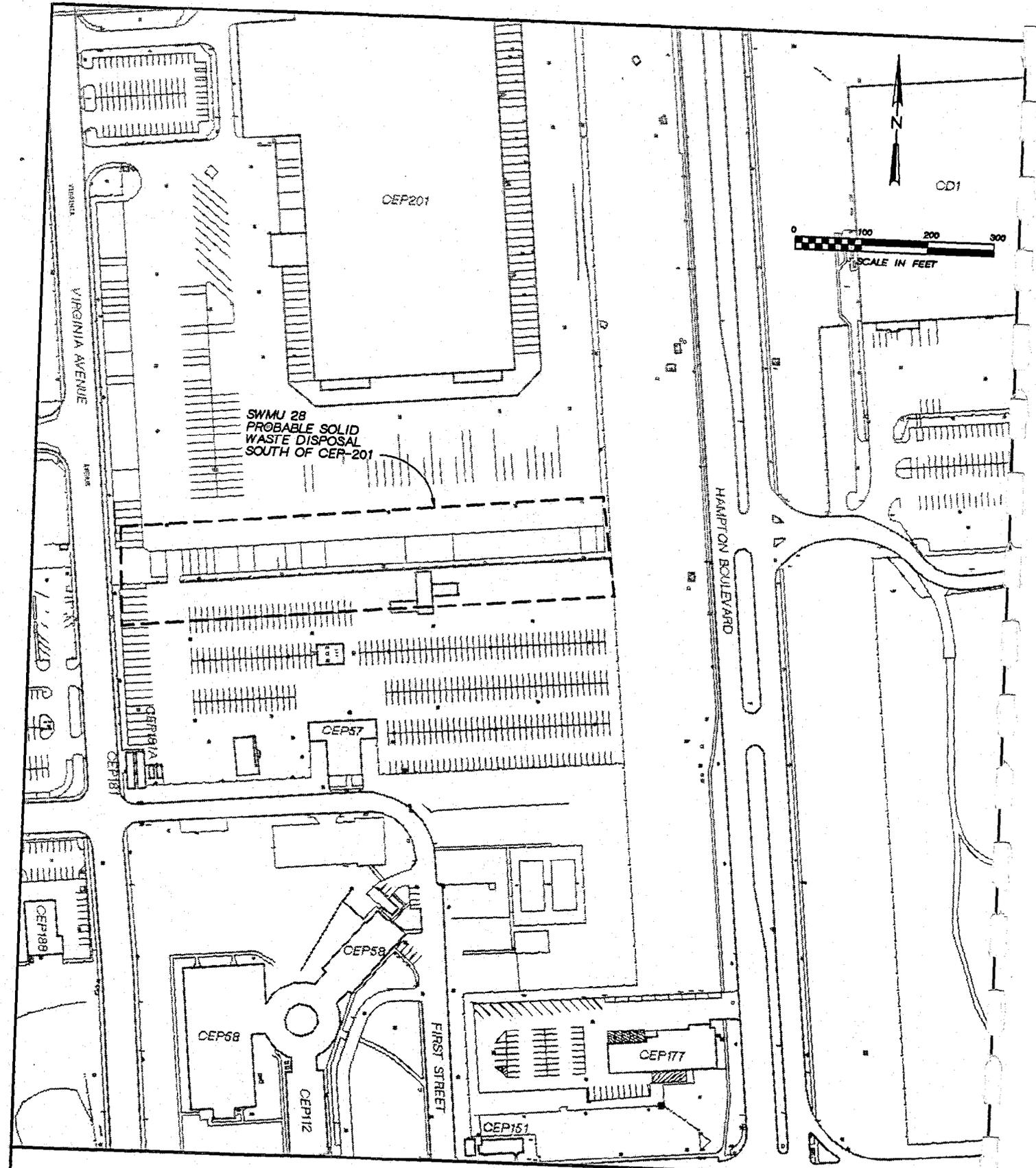
-  ESTIMATED EXTENT OF WASTE DISPOSAL AREA
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-28
SWMU 27 - MASON
CREEK EMBANKMENT
Norfolk Naval Base





SWMU 28
 PROBABLE SOLID
 WASTE DISPOSAL
 SOUTH OF CEP-201

LEGEND

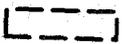
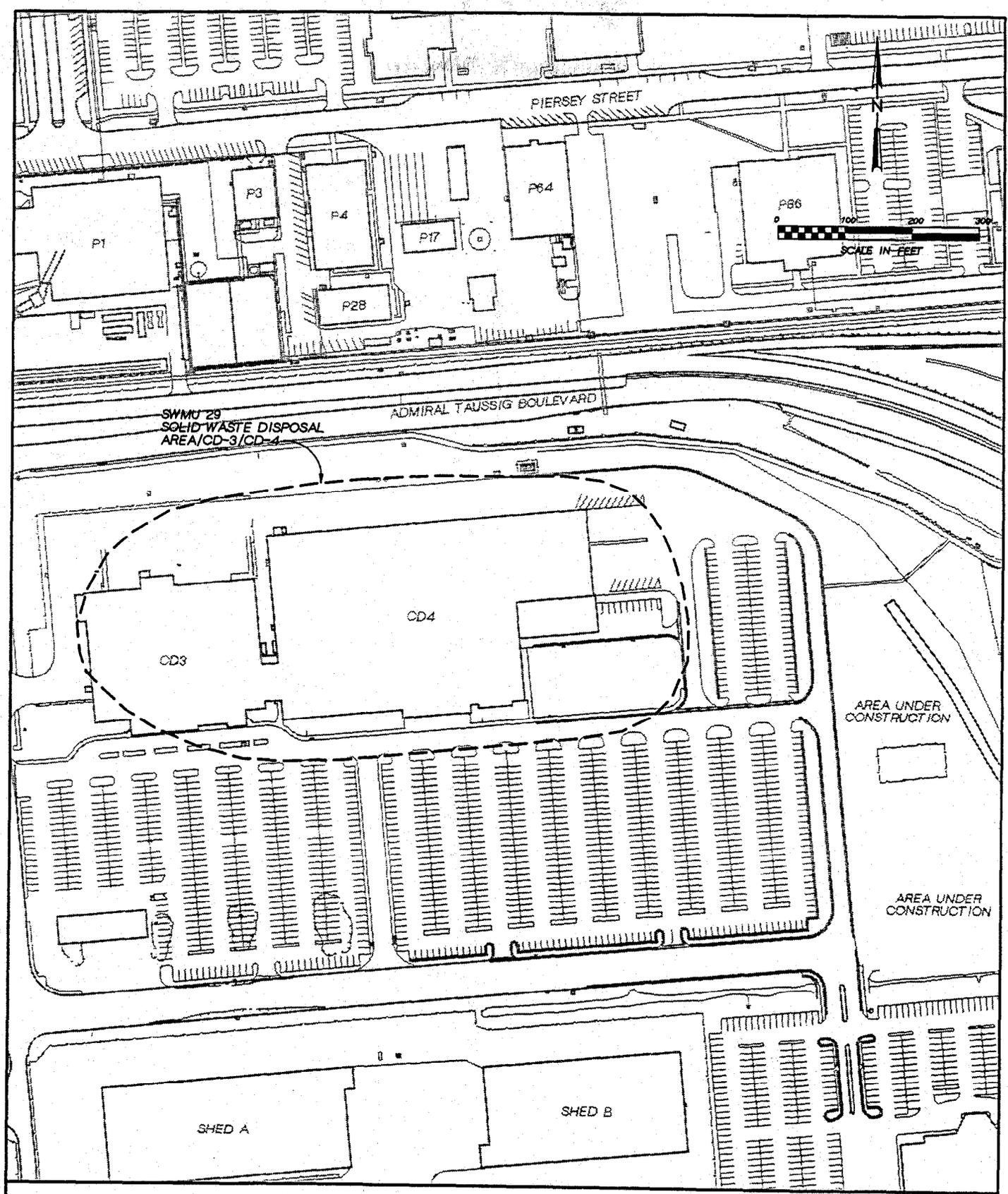
 ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-29
 SWMU 28 - PROBABLE SOLID WASTE
 DISPOSAL SOUTH OF CEP-201
 Norfolk Naval Base





LEGEND

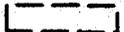
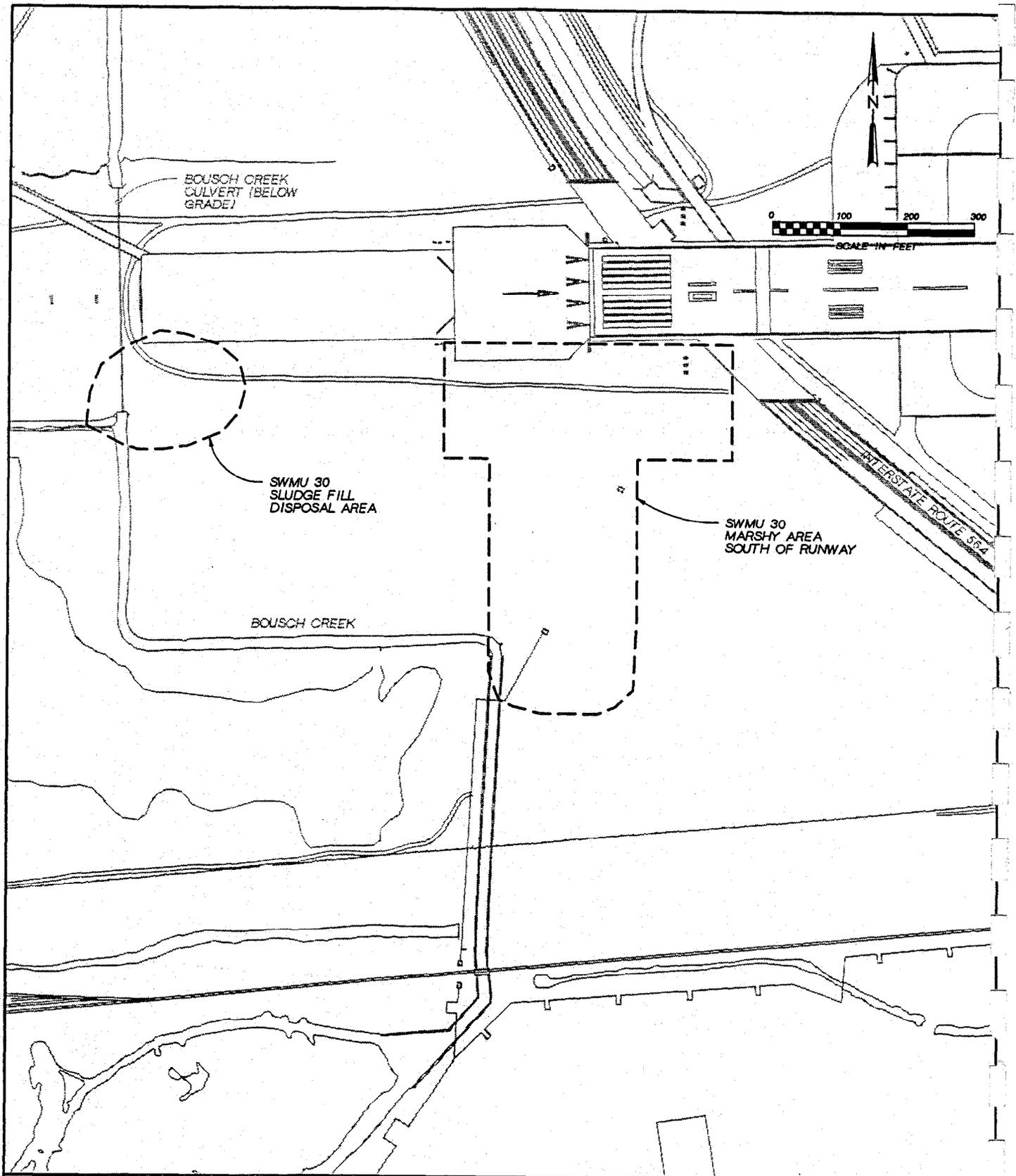
 ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-30
 SWMU 29 - SOLID WASTE
 DISPOSAL AREA/CD-3/CD-4
 Norfolk Naval Base





LEGEND

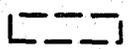
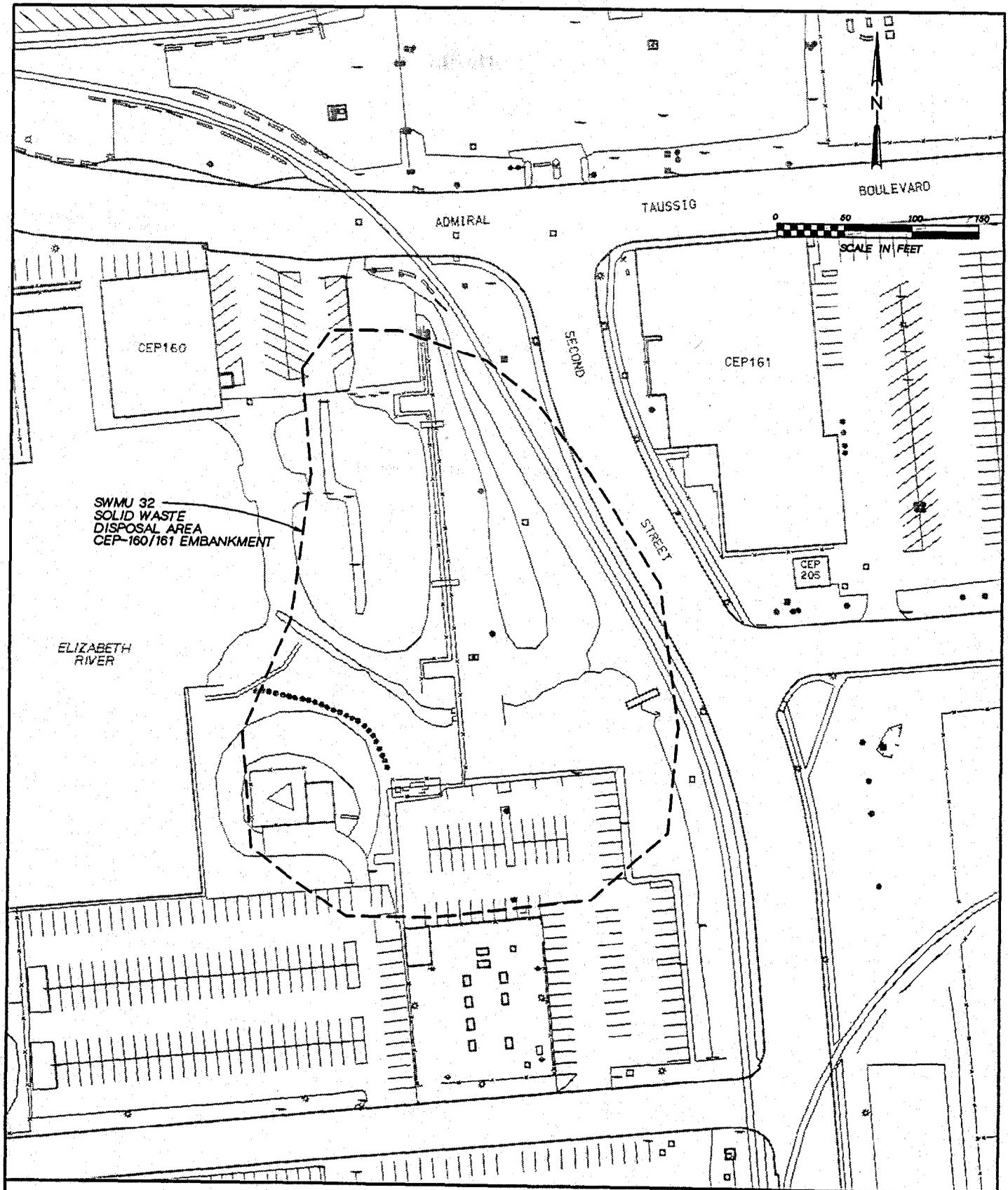
 ESTIMATED EXTENT OF WASTE DISPOSAL AREA

Figure 2-31
 SWMU 30 - SLUDGE FILL DISPOSAL AREA/
 MARSHY AREA SOUTH OF RUNWAY
 Norfolk Naval Base





SWMU 32
SOLID WASTE
DISPOSAL AREA
CEP-160/161 EMBANKMENT

ELIZABETH
RIVER

LEGEND

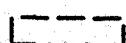
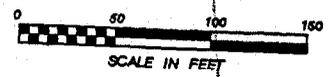
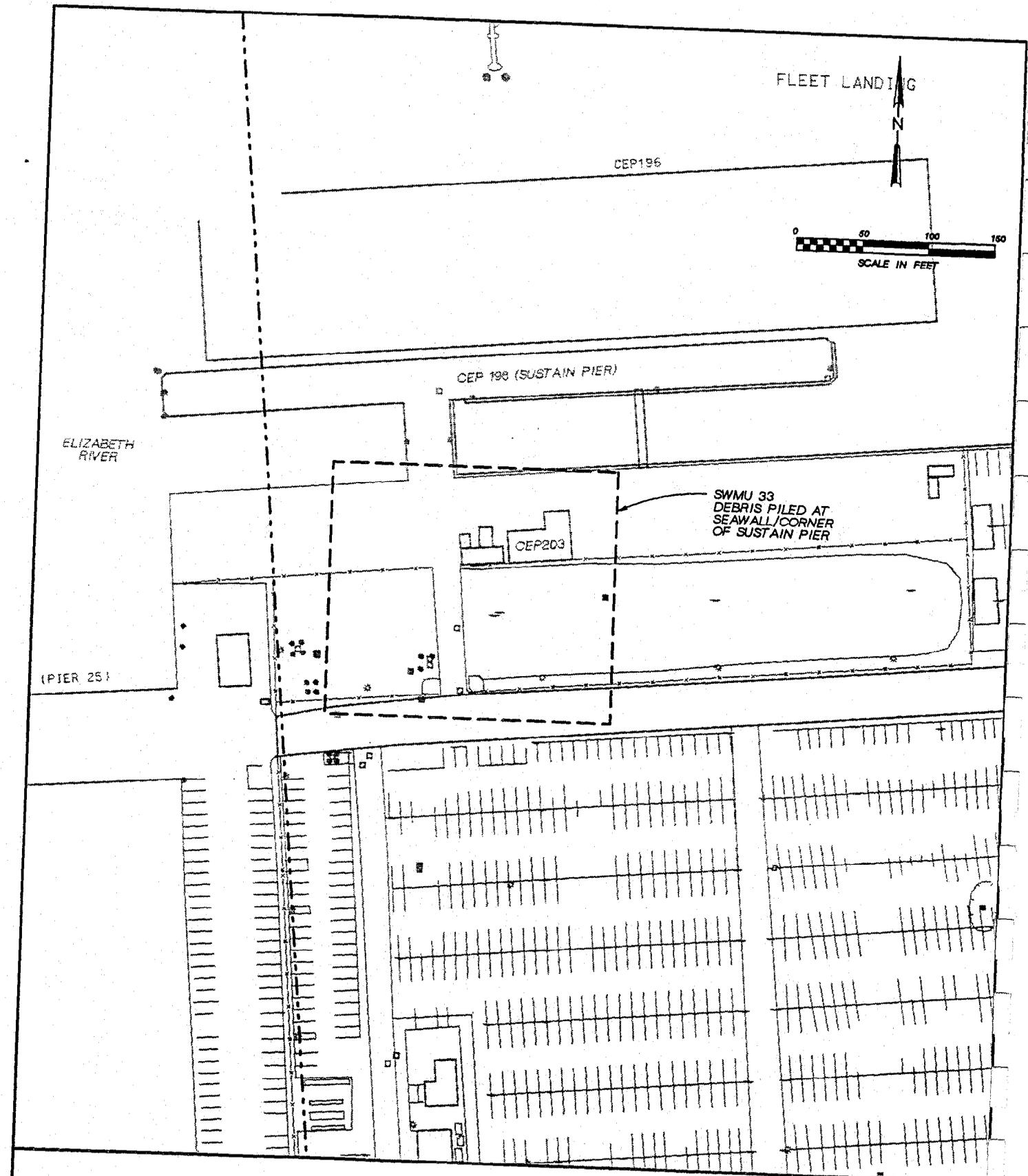
 ESTIMATED EXTENT OF
WASTE DISPOSAL AREA

Figure 2-32
SWMU 32 - SOLID WASTE DISPOSAL
AREA CEP-160/161 EMBANKMENT
Norfolk Naval Base



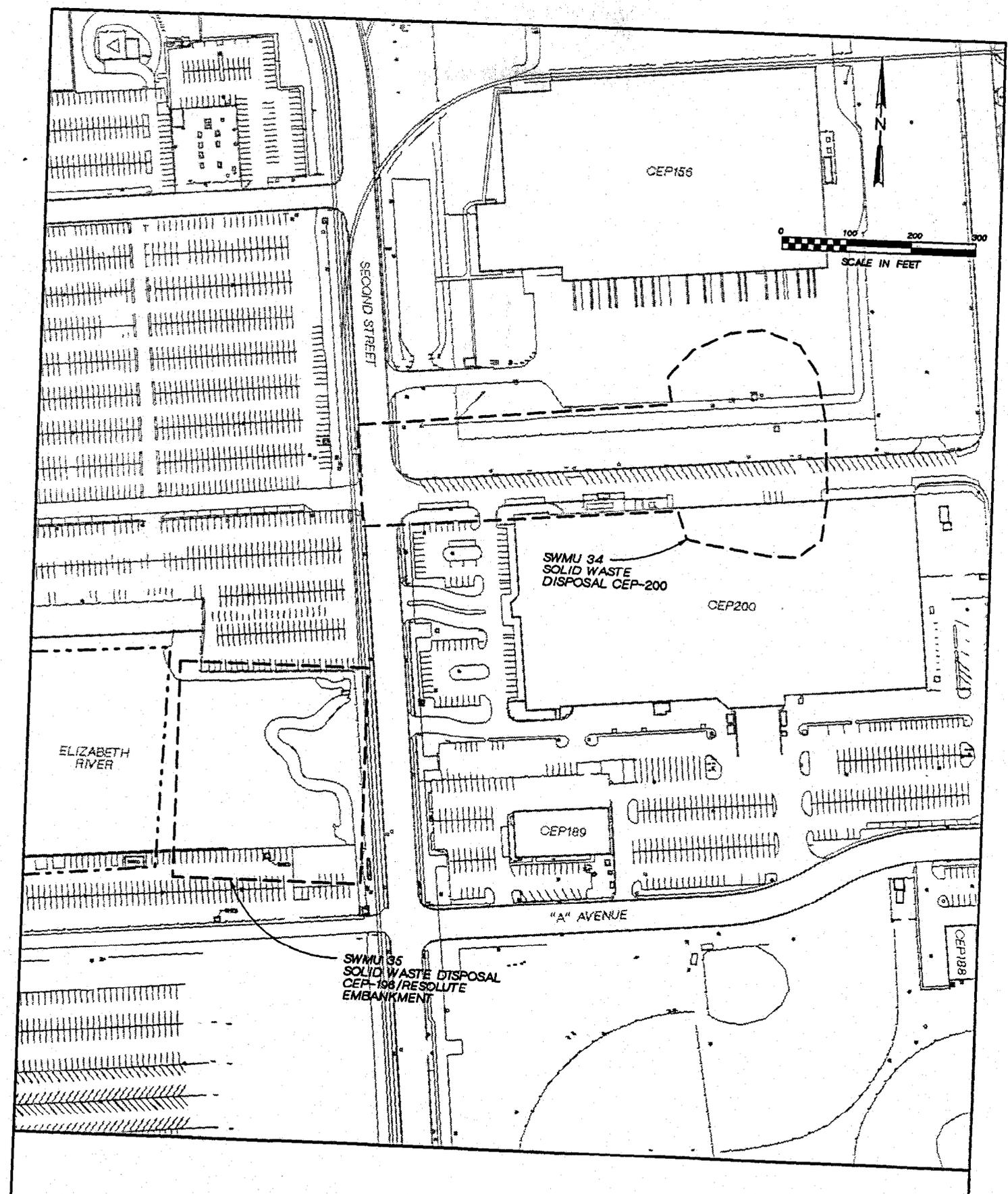


LEGEND

- ESTIMATED EXTENT OF WASTE DISPOSAL AREA
- PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-33
SWMU 33 - DEBRIS PILED AT SEAWALL/CORNER OF SUSTAIN PIER
Norfolk Naval Base





LEGEND

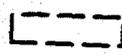
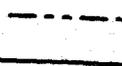
-  ESTIMATED EXTENT OF WASTE DISPOSAL AREA
-  PROPERTY BOUNDARY - NORFOLK NAVAL BASE

Figure 2-34
 SWMU 34 - SOLID WASTE DISPOSAL
 CEP-200 AND SWMU 35 - SOLID WASTE
 DISPOSAL CEP-196/RESOLUTE EMBANKMENT
 Norfolk Naval Base



3. Site Ranking

The relative risk evaluation of NBN sites presented in this section has been performed to give each of the sites a relative risk designation. Relative risk is a management tool that uses actual media concentrations, potential exposure, and potential migration to indicate which sites may pose a risk to human health and/or the environment. Based on the relative risk results, the Navy can focus available resources for study and remediation on the sites ranked "high".

The primary factors considered in the relative risk methodology are human health and ecological risks presented by the site. The site ranking is based on the best information available at the time the Final Relative Risk Ranking System Data Collection, Sampling, and Analysis Report was submitted in January 1996. It is anticipated that the site designations will be updated periodically as additional information becomes available.

The Department of the Navy developed a computer-based relative risk model, the Relative Risk Ranking Evaluation (RRRE), which was used in this study to give the sites at the NBN a relative risk designation. The model is both quantitative and qualitative in nature. A description of model input parameters, calculations, and results are summarized in the following sections.

3.1. Quantitative Analysis

For the quantitative screening analysis, human health risk was evaluated assuming that the groundwater was used as drinking water (both ingestion and inhalation exposure scenarios were included in the drinking water determination). To be conservative, soil contact was assumed to be under a residential use scenario, including both ingestion and dermal contact. Ecological risk was determined for the aquatic environment only (surface water and sediment), since benchmark values for terrestrial ecological risk are not readily available.

To initially categorize the sites, Contaminant Hazard Factors (CHF) for human health and ecological risk were calculated based on available chemical data at the time the Relative Risk Ranking was performed for each site. Appendix A presents the available chemical data used for each site. The CHF values were determined by dividing the maximum detected concentration of particular compounds in the environmental media (groundwater, soil, surface water and sediment) by the appropriate corresponding screening value.

Equations for these calculations are as follows:

Human Contaminant Hazard Factor Calculation—Groundwater

$$\text{CHF}_{\text{gw}} = (C_{\text{maxgw}} / S_{\text{gw}})$$

where: CHF_{gw} = Contaminant Hazard Factor groundwater

C_{max} = Maximum detected groundwater concentration ($\mu\text{g}/\text{L}$)

S_{gw} = Standard for groundwater ($\mu\text{g}/\text{L}$)

Human Contaminant Hazard Factor Calculation—Soil

$$\text{CHF}_{\text{soil}} = (C_{\text{maxsoil}} / S_{\text{soil}})$$

where: CHF_{soil} = Contaminant Hazard Factor soil

C_{maxsoil} = Maximum detected soil concentration (mg/kg)

S_{soil} = Standard for soil (mg/kg)

**Human and Ecological Contaminant Hazard Factor Calculation—Surface Water/
Sediment**

Surface Water

Sediment (ecological only)

$$\text{CHF}_{\text{sw}} = (C_{\text{maxsw}} / S_{\text{sw}})$$

$$\text{CHF}_{\text{sd}} = (C_{\text{maxsd}} / S_{\text{sed}})$$

where: CHF_{sw} = Contaminant Hazard Factor, surface water

C_{maxsw} = Maximum detected surface water concentration ($\mu\text{g}/\text{L}$)

S_{sw} = Standard for surface water ($\mu\text{g}/\text{L}$)

CHF_{sd} = Contaminant Hazard Factor, sediment

C_{maxsd} = Maximum detected sediment concentration (mg/kg)

S_{sed} = Standard for sediment (mg/kg)

Table 3-1 presents the CHF's for the various environmental media for the 45 NBN sites. Sites 4, 11, 13, 19, and SWMU 2 were not included in the risk ranking process because the cleanup is complete or the sites have been removed from the IR program.

3.2. Qualitative Analysis

Once the quantitative assessment was complete, a qualitative assessment addressing potential exposure pathways and potential contaminant transport was performed. This analysis was conducted to ensure that sites where human and/or ecological exposure to the contaminated media exists and/or the potential for contaminant migration is significant would be ranked higher than sites with less potential to impact human health and the environment. This analysis was performed by qualitative analysis of the CHF's, Receptor Factors (exposure potential) and Migration Pathway Factors (contaminant transport potential), as described in the following sections.

Table 3-1

Contaminant Hazard Factors
Naval Base, Norfolk, Site Management Plan

SITE	SITE NAME	Groundwater		Soil		Sediment		Surface Water			
		CHF _{gw}	CHF	CHF _s	CHF	CHF _{sd}	CHF	CHF _{swe}	CHF	CHF _{swh}	CHF
1	Camp Allen Landfill	270.502	significant	--	--	--	--	--	--	--	--
2	NM Slag Pile	--	--	--	--	--	--	59.394	moderate	30.197	moderate
3	Q- Area Drum Storage Yard	261.163	significant	1.495	minimal	--	--	--	--	--	--
5	Pesticide Disposal Site	43.927	moderate	0.163	minimal	--	--	--	--	--	--
6	CD Landfill	281.12	significant	3.237	moderate	--	--	27,128.55	significant	221.492	significant
7	Inert Chemical Landfill	1.33	minimal	1.57	minimal	--	--	--	--	--	--
8	Asbestos Landfill	1.33	minimal	1.01	minimal	--	--	--	--	--	--
9	Q-Area Landfill	1.618	minimal	2.720	moderate	--	--	--	--	--	--
10	Apollo Fuel. Disposal Sites	--	--	0.48	minimal	--	--	--	--	--	--
12	Alleged Mercury Disposal Site	--	--	--	--	0.466	minimal	--	--	--	--
16	Chemical Fire, Building X-136	381.02	significant	1.45	minimal	--	--	--	--	--	--
17	Chemical Fire, Building SDA-215	0.77	minimal	0.23	minimal	--	--	--	--	--	--
18	Former NM Waste Storage Area	--	--	0.44	minimal	--	--	--	--	--	--

Notes: No data for Site 4, 11, 13, 19, SWMU2; site cleanup complete or site removed from IR program

-- Not detected or analyzed

CHF_{gw} Contaminant Hazard Factor groundwater

CHF_s Contaminant Hazard Factor soil

CHF_{sd} Contaminant Hazard Factor sediment

CHF_{swe} Contaminant Hazard Factor surface water eco-fresh

CHF_{swh} Contaminant Hazard Factor surface water human

Table 3-1 (Cont.)

Contaminant Hazard Factors

Naval Base, Norfolk, Site Management Plan

SITE	SITE NAME	Groundwater		Soil		Sediment		Surface Water			
		CHF _{gw}	CHF	CHF _s	CHF	CHF _{sd}	CHF	CHF _{swe}	CHF	CHF _{swh}	CHF
20	Building LP-20	654.79	significant	--	--	--	--	--	--	--	--
21	Building W-316	--	--	0.0213	minimal	--	--	--	--	--	--
22	Camp Allen Salvage Yard	--	--	10.12	moderate	--	--	--	--	--	--

Notes: No data for Site 4, 11, 13, 19, SWMU2; site cleanup complete or site removed from IR program

-- Not detected or analyzed

CHF_{gw} Contaminant Hazard Factor groundwater

CHF_s Contaminant Hazard Factor soil

CHF_{sd} Contaminant Hazard Factor sediment

CHF_{swe} Contaminant Hazard Factor surface water eco-fresh

CHF_{swh} Contaminant Hazard Factor surface water human

Table 3-1 (Cont.)

Contaminant Hazard Factors

Naval Base, Norfolk, Site Management Plan

SITE NO.	SITE NAME	Groundwater		Soil		Sediment	Surface Water	
		CHF _{gw}	CHF	CHF _s	CHF	CHF _{sd}	CHF _{swe}	CHF _{swh}
SWMU-01	SP2B Accumulation Area	--	--	3.060	moderate	--	--	--
SWMU-03	Building Z309 Oil/Lubricant Storage Area	0.030	minimal	0.38	minimal	--	--	--
SWMU-04	PWC Sandblast Area	0.609	minimal	2.21	moderate	--	--	--
SWMU-05	LF61 Waste Holding Tank	5.620	moderate	0.510	minimal	--	--	--
SWMU-06	Building V28 Waste Pit	12.65	moderate	0.06	minimal	--	--	--
SWMU-07	LF18 Aircraft Ramp	11.790	moderate	0.443	minimal	--	--	--
SWMU-08	Fire Training School	7.030	moderate	0.560	minimal	--	--	--
SWMU-09	LP200/MAC Terminal	--	--	2.650	moderate	--	--	--
SWMU-10	LP200/MAC Terminal East	70.56	moderate	1.61	minimal	--	--	--
SWMU-11	Old Weapons Station Entrance	10.89	moderate	0.99	minimal	--	--	--
SWMU-12	Disposal Area Near NM37	--	--	12.68	moderate	--	--	--
SWMU-13	Disposal Area PWC Operations	8.930	moderate	0.27	minimal	--	--	--
SWMU-14	Q-50 Satellite Accumulation Area	--	--	0.890	minimal	--	--	--

Notes: No data for Site 4, 11, 13, 19, SWMU2; site cleanup complete or site removed from IR program

-- Not detected or analyzed

CHF_{gw} Contaminant Hazard Factor groundwater

CHF_s Contaminant Hazard Factor soil

CHF_{sd} Contaminant Hazard Factor sediment

CHF_{swe} Contaminant Hazard Factor surface water eco-fresh

CHF_{swh} Contaminant Hazard Factor surface water human

Table 3-1 (Cont.)

Contaminant Hazard Factors

Naval Base, Norfolk, Site Management Plan

SITE NO.	SITE NAME	Groundwater		Soil		Sediment	Surface Water	
		CHF _{gw}	CHF	CHF _s	CHF	CHF _{sd}	CHF _{swc}	CHF _{swh}
SWMU-15	W130 Hazardous Waste Accumulation Area	--	--	13.07	moderate	--	--	--
SWMU-16	NM-37 Accumulation Area	0.530	minimal	0.280	minimal	--	--	--
SWMU-26	NE of NM-31	--	--	1.06	minimal	--	--	--
SWMU-27	Mason Creek Embankment	--	--	0.60	minimal	--	--	--
SWMU-28	Probable Solid Waste Disposal (SWD) South of CEP 201	--	--	--	--	--	no data/ minimal	--
SWMU-29	SWD Areas/ CD-3/CD-4	--	--	1.64	minimal	--	--	--
SWMU-30	Sludge Fill Disposal Area	--	--	2.27	moderate	--	--	--
SWMU-32	SWD Area CEP-160/161 Embankment	--	--	0.66	minimal	--	--	--
SWMU-33	Debris Piled at Seawall/ Corner of Sustain Pier	--	--	0.99	minimal	--	--	--
SWMU-34	SWD CEP 200	--	--	1.46	minimal	--	--	--
SWMU-35	SWD Area CEP 196/ Resolute Embankment	--	--	1.68	minimal	--	--	--

Notes: No data for Site 4, 11, 13, 19, SWMU2; site cleanup complete or site removed from IR program

-- Not detected or analyzed

CHF_{gw} Contaminant Hazard Factor groundwater

CHF_s Contaminant Hazard Factor soil

CHF_{sd} Contaminant Hazard Factor sediment

CHF_{swc} Contaminant Hazard Factor surface water eco-fresh

CHF_{swh} Contaminant Hazard Factor surface water human

3.2.1. Contaminant Hazard Factors (CHF)

The quantitative CHFs calculated in Section 3.1 were assigned the following qualitative designations.

- Significant (S) CHF values greater than 100
- Moderate (O) CHF values between 2 and 100
- Minimal (M) CHF values less than 2

3.2.2. Receptor Factor

Receptor Factors (RFs) identify the actual and/or potentially exposed human and ecological populations at each site. The RF was determined for each of the environmental media that had quantitative data. It is based on the selection of statements that best represent site conditions, as described below. Table 3-2 presents the RF statements that were selected for each environmental media analyzed for each site.

Groundwater

For human receptors potentially exposed to contaminated groundwater, one of each of the following three statements was selected to represent conditions at a particular site:

- Identified (I) There is threatened or potentially threatened water supply downgradient of the site. The groundwater is a current drinking water source or is equivalent to Class I or IIA groundwater under EPA's Groundwater Classification System.
- Potential (P) There is no potentially threatened water supply well downgradient of the site. The groundwater is potentially usable for drinking water, irrigation or agriculture, but not presently used (Class IIB groundwater).
- Limited (L) There is no potentially threatened water supply well downgradient of the site. The groundwater is not considered a potential source of drinking water or is of limited beneficial use (IIIA, IIIB or perched groundwater).

Surface Soil

For human receptors potentially exposed to contaminated soil, one of each of the following three statements was selected to represent conditions at a particular site:

- Identified (I) Receptors identified that have access to contaminated soil.
- Potential (P) Potential for receptors to have access to contaminated soil.
- Limited (L) Little or no potential for receptors to have access to contaminated soil.

TABLE 3-2

Receptor Factor and Migration Pathway Factors
 Naval Base Norfolk, Site Management Plan

Site No.	Site Name	Groundwater		Soil		Sediment		Surface Water			
		RF	MPF	RF	MPF	RF	MPF	Ecofresh		Human	
								RF	MPF	RF	MPF
1	Camp Allen Landfill	I	P	--	--	--	--	--	--	--	--
2	NM Slag Pile	--	--	--	--	--	--	L	C	L	P
3	Q- Area Drum Storage Yard	P	E	L	P	--	--	--	--	--	--
5	Pesticide Disposal Site	L	C	P	P	--	--	--	--	--	--
6	CD Landfill	P	P	L	E	--	--	L	C	L	C
7	Inert Chemical Landfill	L	C	P	P	--	--	--	--	--	--
8	Asbestos Landfill	L	C	P	P	--	--	--	--	--	--
9	Q-Area Landfill	P	E	L	P	--	--	--	--	--	--
10	Apollo Fuel. Disposal Sites	--	--	P	C	--	--	--	--	--	--
12	Alleged Mercury Disposal Site	--	--	--	--	P	E	--	--	--	--
16	Chemical Fire, Building X-136	L	P	L	C	--	--	--	--	--	--
17	Chemical Fire, Building SDA-215	L	P	L	C	--	--	--	--	--	--
18	Former NM Waste Storage Area	--	--	P	P	--	--	--	--	--	--
20	Building LP-20	P	E	--	--	--	--	--	--	--	--
21	Building W-316	--	--	L	P	--	--	--	--	--	--
22	Camp Allen Salvage Yard	--	--	I	P	--	--	--	--	--	--
SWMU-001	SP2B Accumulation Area	--	--	P	P	--	--	--	--	--	--
SWMU-003	Building Z309 Oil/Lubricant Storage Area	P	P	P	P	--	--	--	--	--	--
SWMU-004	PWC Sandblast Area	L	P	I	P	--	--	--	--	--	--
SWMU-005	LF61 Waste Holding Tank	L	P	P	P	--	--	--	--	--	--
SWMU-006	Building V28 Waste Pit	P	P	L	C	--	--	--	--	--	--
SWMU-007	LF18 Aircraft Ramp	P	P	L	C	--	--	--	--	--	--
SWMU-008	Fire Training School	P	E	L	P	--	--	--	--	--	--
SWMU-009	LP200/MAC Terminal	--	--	P	P	--	--	--	--	--	--
SWMU-010	LP200/MAC Terminal East	P	P	P	P	--	--	--	--	--	--
SWMU-11	Old Weapons Station Entrance	P	P	P	P	--	--	--	--	--	--
SWMU-12	Disposal Area Near NM37	--	--	P	P	--	--	--	--	--	--

NOTES: -- NOT EXAMINED

RF = RECEPTOR FACTOR

I = IDENTIFIED

P = POTENTIAL

L = LIMITED

MPF= MIGRATION PATHWAY FACTOR

E = EVIDENT

P = POTENTIAL

C = CONFINED

TABLE 3-2
 Receptor Factor and Migration Pathway Factors
 Naval Base Norfolk, Site Management Plan

Site No.	Site Name	Groundwater		Soil		Sediment		Surface Water			
		RF	MPF	RF	MPF	RF	MPF	Ecofresh		Human	
								RF	MPF	RF	MPF
SWMU-13	Disposal Area PWC Operations	P	P	P	P	--	--	--	--	--	--
SWMU-14	Q-50 Sattelite Accumulation Area	--	--	P	P	--	--	--	--	--	--
SWMU-15	W-130 HW Accumulation Area	--	--	P	P	--	--	--	--	--	--
SWMU-16	NM-37 Accumulation Area	L	P	P	C	--	--	--	--	--	--
SWMU-26	NE of NM-31	--	--	P	P	--	--	--	--	--	--
SWMU-27	Mason Creek Embankment	--	--	L	P	--	--	--	--	--	--
SWMU-28	Probable Solid Waste Disposal (SWD) South of CEP 201	--	--	--	--	--	--	P	P	--	--
SWMU-29	SWD Area CD-3/CD-4	--	--	no factor	no factor	--	--	--	--	--	--
SWMU-30	Sludge Fill Disposal Area	--	--	--	--	--	--	--	--	--	--
SWMU-32	SWD Area CEP 160-161	--	--	no factor	no factor	--	--	--	--	--	--
SWMU-33	Debris Piled at Seawall	--	--	no factor	no factor	--	--	--	--	--	--
SWMU-34	SWD CEP 200	--	--	no factor	no factor	--	--	--	--	--	--
SWMU-35	SWD CEP 196/Resolute Embankment	--	--	no factor	no factor	--	--	--	--	--	--

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NOTES: -- NOT EXAMINED

RF = RECEPTOR FACTOR

I = IDENTIFIED

P = POTENTIAL

L = LIMITED

MPF= MIGRATION PATHWAY FACTOR

E = EVIDENT

P = POTENTIAL

C = CONFINED

Surface Water (Aquatic Freshwater Ecological Receptors and Humans)

For aquatic ecological receptors and human receptors potentially exposed to contaminated surface water, one of the following three statements was selected to represent conditions at a particular site:

- Identified (I) Receptors identified that have access to surface water.
- Potential (P) Potential for receptors to have access to surface water.
- Limited (L) Little or no potential for receptors to have access to surface water.

Sediment (Ecological Receptors, only)

For aquatic ecological receptors potentially exposed to contaminated sediment, one of the following three statements was selected to represent conditions at a particular site:

- Identified (I) Receptors identified that have access to sediment.
- Potential (P) Potential for receptors to have access to sediment.
- Limited (L) Little or no potential for receptors to have access to sediment.

3.2.3. Migration Pathway Factor

The Migration Pathway Factor (MPF) was used to identify the likelihood of off-site contaminant migration from any of the environmental media at the site. Table 3-2 presents the MPF statements that were selected for each environmental media for each site. The MPF was determined for each media sampled at a particular site by selecting one of the following statements as it applies to the sampled environmental media:

- Evident (E) Analytical data or observable evidence indicates that contamination in the media is present at or is moving toward a point of exposure.
- Potential (P) Possible for contamination to be present at or migrate to a point of exposure, or the information is not sufficient to make a determination of Evident or Confined.
- Confined (C) Information indicates a low potential for contamination to migrate to a potential point of exposure (could be due to the presence of geological structures or physical controls).

3.3. Relative Risk Designation

The qualitative values for the CHF, MPF, and RF were then used to assign a relative risk designation of High (H), Medium (M) or Low (L) for each environmental media evaluated for a given site. The relative risk designations are summarized in Table 3-3.

Table 3-3
 Site Relative Risk Designation
 Naval Base, Norfolk, Site Management Plan

Site No.	Site Name	Groundwater	Soil	Sediment	Surface Water	
					Eco-Fresh	Human
1	Camp Allen Landfill	H	--	--	--	--
2	NM Slag Pile	--	--	--	L	H
3	Q- Area Drum Storage Yard	H	L	--	--	--
5	Pesticide Disposal Site	L	L	--	--	--
6	CD Landfill	H	M	--	L	L
7	Inert Chemical Landfill	L	L	--	--	--
8	Asbestos Landfill	L	L	--	--	--
9	Q-Area Landfill	M	M	--	--	--
10	Apollo Fuel. Disposal Sites	--	L	--	--	--
12	Alleged Mercury Disposal Site	--	--	M	--	--
16	Chemical Fire, Building X-136	M	L	--	--	--
17	Chemical Fire, Building SDA-215	L	L	--	--	--
18	Former NM Waste Storage Area	--	L	--	--	--
20	Building LP-20	H	--	--	--	--
21	Building W-316	--	L	--	--	--
22	Camp Allen Salvage Yard	--	H	--	--	--
SWMU-001	SP2B Accumulation Area	--	M	--	--	--
SWMU-003	Building Z309 oil/Lubricant Storage Area	L	L	--	--	--
SWMU-004	PWC Sandblast Area	L	H	--	--	--
SWMU-005	LF61 Waste Holding Tank	L	L	--	--	--
SWMU-006	Building V28 Waste Pit	M	L	--	--	--
SWMU-007	LF18 Aircraft Ramp	M	L	--	--	--
SWMU-008	Fire Training School	H	L	--	--	--
SWMU-009	LP200/MAC Terminal	--	M	--	--	--
SWMU-010	LP200/MAC Terminal East	M	M	--	--	--
SWMU-11	Old Weapons Station Entrance	M	L	--	--	--
SWMU-12	Disposal Area Near NM37	--	M	--	--	--

Note: No data for SWMU -02

-- Not examined

Risk Designation: H = High; M = Medium; L = Low

Table 3-3 (cont.)

Site Relative Risk Designation

Naval Base, Norfolk, Site Management Plan

Site No.	Site Name	Groundwater	Soil	Sediment	Surface Water	
					Eco-Fresh	Human
SWMU-13	Disposal Area PWC Operations	M	L	--	--	--
SWMU-14	Q-50 Satellite Accumulation Area	--	L	--	--	--
SWMU-15	W130 Hazardous Waste Accumulation Area	--	M	--	--	--
SWMU-16	NM-37 Accumulation Area	L	L	--	--	--
SWMU-26	NE of NM-31	--	L	--	--	--
SWMU-27	Mason Creek Embankment	--	L	--	--	--
SWMU-28	Probable Solid Waste Disposal (SWD) South of CEP-201	--	--	--	L	--
SWMU-29	SWD Area/ CD-3/CD-4	--	L	--	--	--
SWMU-30	Sludge Fill Disposal Area	--	M	--	--	--
SWMU-32	SWD Area CEP-160/161	--	L	--	--	--
SWMU-33	Debris Pile at Seawall	--	L	--	--	--
SWMU-34	SWD CEP 200	--	L	--	--	--
SWMU-35	SWD CEP 196	--	L	--	--	--

Note: No data for SWMU -02

-- Not examined

Risk Designation: H = High; M = Medium; L = Low

3.3.1. Significant CHF

Table 3-4 was used to determine the relative risk designation for each site with a significant CHF.

TABLE 3-4
Relative Risk Designation for Significant CHF sites

MIGRATION PATHWAY FACTOR	evident	H	H	M
	potential	H	H	M
	confined	M	M	L
		identified	potential	limited
		RECEPTOR FACTOR		

To determine the relative risk designation for a significant site the MPF and RF must be known. For example:

- If the RF is potential and the MPF is potential the relative risk designation for the site is High (H).

3.3.2. Moderate CHF

Table 3-5 was used to determine the relative risk designation for each site with a moderate CHF.

TABLE 3-5
Relative Risk Designation for Moderate CHF sites

MIGRATION PATHWAY FACTOR	evident	H	H	M
	potential	H	M	L
	confined	L	L	L
		identified	potential	limited
		RECEPTOR FACTOR		

To determine the relative risk designation for a moderate site the MPF and RF must be known. For example:

- If the RF is potential and the MPF is potential the relative risk designation for the site is Medium (M).

3.3.3. Minimal CHF

Table 3-6 was used to determine the relative risk designation for each site with a minimal CHF.

TABLE 3-6
Relative Risk Designation for Minimal CHF sites

MIGRATION PATHWAY FACTOR	evident	H	M	L
	potential	M	L	L
	confined	L	L	L
		identified	potential	limited
		RECEPTOR FACTOR		

To determine the relative risk designation for a minimal site the MPF and RF must be known. For example:

- If the RF is potential and the MPF is potential the relative risk designation for the site is Low (L).

3.4. Summary

The following sites at the NBN have a relative risk designation of High for the indicated environmental media (Table 3-3):

- Site 1 Camp Allen Landfill—groundwater
- Site 2 NM Slag Pile- surface water human
- Site 3 Q-Area Drum Storage Yard—groundwater
- Site 6 CD Landfill—groundwater
- Site 20 Building LP-20—groundwater
- Site 22 Camp Allen Salvage Yard—Soil
- SWMU 4 PWC Sandblast Area—soil
- SWMU 8 Firefighting School—groundwater

The following sites at the NBN have a relative risk designation of Medium for the indicated environmental media:

- Site 6 CD Landfill—Soil
- Site 9 Q-Area Landfill—groundwater and soil
- Site 12 Alleged Mercury Disposal Site—sediment
- Site 16 Chemical Fire, Building X-136—groundwater
- SWMU 1 SP2B Accumulation Area—Soil
- SWMU 6 Building V28 Waste Pit—groundwater
- SWMU 7 LF18 Aircraft Ramp—groundwater
- SWMU 9 LP200/MAC Terminal—soil
- SWMU 10 LP200/MAC Terminal East—groundwater and soil
- SWMU11 Oil Weapons Station Entrance—groundwater
- SWMU 13 Disposal Area PWC Operations—groundwater
- SWMU 15 W130 Hazardous Waste Accumulation Area—soil
- SWMU 30 Sludge Fill Disposal Area—soil

The following sites at the NBN have a relative risk designation of Low for the indicated environmental media:

- Site 2 NM Slag Pile—surface water eco-fresh
- Site 3 Q-Area Drum Storage Yard—Soil
- Site 5 Pesticide Disposal Site—groundwater and soil
- Site 6 CD Landfill—surface water eco-fresh and human
- Site 7 Inert Chemical Landfill—groundwater and soil
- Site 8 Asbestos Landfill—groundwater and soil
- Site 10 Apollo Fuel Disposal Sites- soil
- Site 16 Chemical Fire Building X136—soil
- Site 17 Chemical Fire Building SDA215—groundwater and soil
- Site 18 Former NM Waste Storage Area—soil
- Site 21 Building W-316—soil
- SWMU 3 Building Z309 Oil/Lubricant Storage Area—groundwater and soil
- SWMU 4 PWC Sandblast Area—groundwater
- SWMU 5 LF61 Waste Holding Tank—groundwater and soil
- SWMU 6 Building V28 Waste Pit—soil
- SWMU 7 LF18 Aircraft Ramp—soil
- SWMU 8 Firefighting School—soil
- SWMU 11 Oil Weapons Station Entrance—soil
- SWMU 13 Disposal Area PWC Operations—soil
- SWMU 14 Q-50 Satellite Accumulation Area—soil
- SWMU 16 NM-37 Accumulation Area—groundwater and soil
- SWMU 26 NE of NM-31—soil
- SWMU 27 Mason Creek Embankment—soil
- SWMU 28 Probable SWD South of CEP 201—surface water eco-fresh
- SWMU 29 SWD Area/CD-2/CD-3—soil
- SWMU 32 SWD Area CEP-160/161- soil
- SWMU 33 Debris Pile at Seawall—soil
- SWMU 34 SWD CEP 200—soil
- SWMU 25 SWD CEP 196—soil

4. CERCLA Process Activities

As previously discussed (in Section 1.0), the NBN is expected to be listed on the USEPA CERCLA NPL. A Federal Facility Assessment (FFA) has not yet been developed for this Base and the environmental status of the Base is currently being investigated through the IRP. The IRP at NBN is being implemented in accordance with applicable federal and state environmental regulations and requirements. The Navy has structured the IRP to be consistent with the terminology and structure of the USEPA CERCLA Program, which is described below.

4.1. CERCLA RI/FS Process

The CERCLA RI/FS process refers to the process of site investigation and remedial action that is used for CERCLA sites. For this SMP, the RI/FS process is applicable to the 20 IRP sites (Sites 1 through 13 and 16 through 22) as well as the 25 SWMUs.

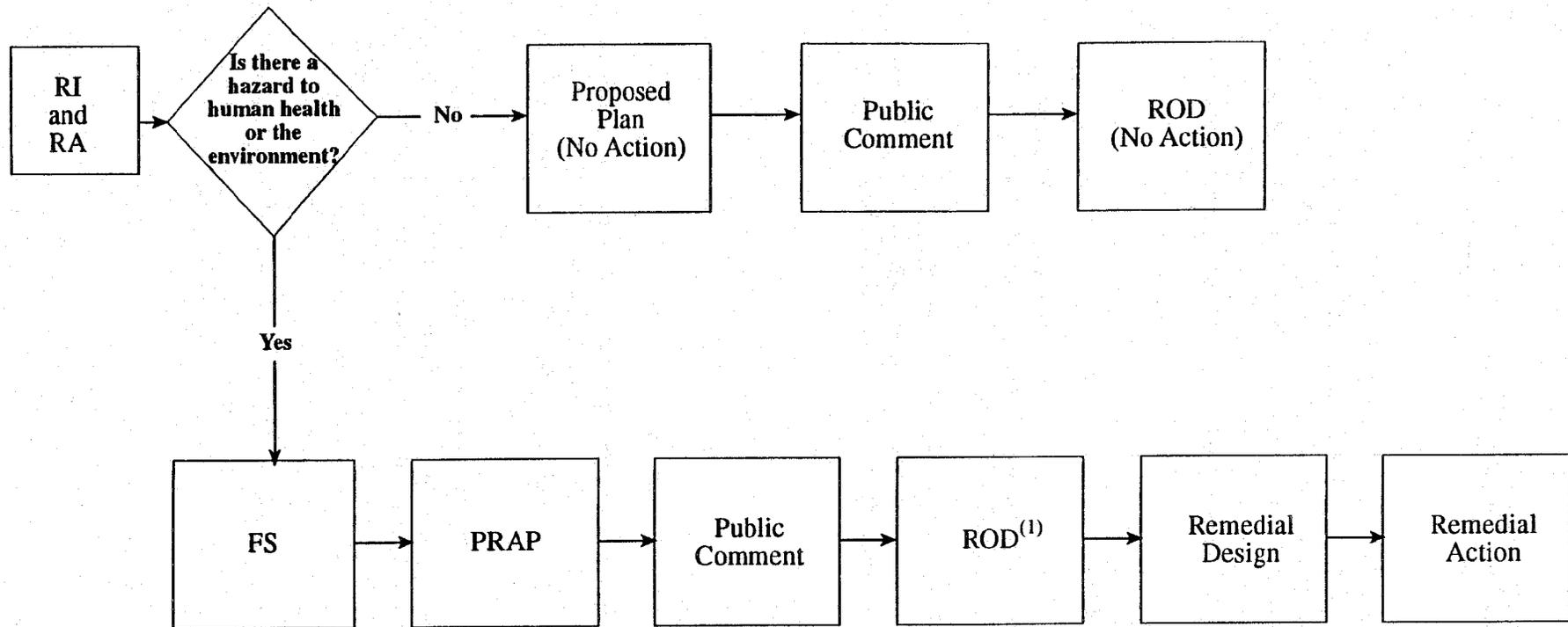
The objectives of the CERCLA RI/FS process are to evaluate the nature and extent of contamination at a site, and to identify, develop, and implement appropriate remedial actions in order to protect human health and the environment. The RI/FS process includes the following major elements:

- RI—Remedial Investigation
- RA—Risk Assessment
- FS—Feasibility Study
- PRAP—Proposed Remedial Action Plan
- ROD—Record of Decision or Decision Document

These steps ultimately lead to either implementation of a remedial design/remedial action or the decision to take no action at the site, as illustrated in Figure 4-1. Where no further action is required at a site, a no-action ROD would be signed and the site removed from the program.

The RI, RA, FS, and PRAP documents are maintained in information repositories for review by the public. A formal public comment period and a public meeting (if required) generally follow the issuance of the Final PRAP. Public comments received on the Final PRAP are addressed as part of the Responsiveness Summary in the ROD. Subsequent to completion of the ROD, remedial design/remedial action activities are initiated. In accordance with CERCLA, remedial action is required to begin within 15 months of the Final ROD.

RI/FS processes currently are in progress at several NBN sites: Camp Allen Salvage Yard, NM Slag Pile, and the Pesticide Disposal Site. In addition, RI/FS processes are planned to begin at several additional sites in late 1996 or 1997 including the Building W-316 site.



RI = Remedial Investigation
 RA = Baseline Risk Assessment (human health and ecological risks)
 FS = Feasibility Study
 PRAP = Proposed Remedial Action Plan
 ROD = Record of Decision or Decision Document (including Responsiveness Summary)

⁽¹⁾ Includes summary of any Interim Remedial Actions or Removal Actions

Figure 4-1
 CERCLA RI/FS PROCESS
 NAVAL BASE NORFOLK SITE MANAGEMENT PLAN



4.2. Removal Action Process

Removal actions are implemented to clean-up or remove hazardous substances from the environment at a site in order to mitigate the spread of contamination. Removal actions may be implemented at any time during the RI/FS process.

Removal actions are classified as either time-critical or non-time-critical. Actions taken immediately to mitigate an imminent threat to human health or the environment, such as the removal of corroded or leaking drums, are classified as time-critical removal actions. Removal actions that may be delayed for six months or more without significant additional harm to human health or the environment are classified as non-time-critical removal actions.

For non-time-critical removal actions, an Engineering Evaluation/Cost Analysis (EE/CA) is prepared rather than the more extensive FS. An EE/CA focuses only on the substances to be removed rather than on all contaminated substances at the site. It is possible for a removal action to become the final remedial action if the risk assessment results indicate that no further remedial action is required in order to protect human health and the environment.

A non-time-critical soil removal action was completed at Area B of the Camp Allen Landfill in 1994; however, this was not considered a final remedy for the site. A soil removal action also was completed in the Q-Area that involved the removal of 750 cubic yards of petroleum-contaminated soil from the northwest corner of the site to allow construction of a parking lot. In addition, a soil removal action was completed in the NM Area (Taussig Can Area) in 1979 with the approval of the Commonwealth of Virginia. A monitoring well also was installed at this location.

4.3. Interim Remedial Action Process

Interim remedial actions are implemented to provide temporary mitigation of human health risks or to mitigate the spread of contamination in the environment. Similar to removal actions, they may be implemented at any time during the RI/FS process. Examples of interim remedial actions include installation of a pump-and-treat system for product recovery from the groundwater or installation of a fence to prevent direct contact with hazardous materials.

For interim remedial actions, a focused FS is prepared rather than the more extensive FS. As with the removal action, an interim remedial action may become the final remedial action if the risk assessment results indicate that no further remedial action is required in order to protect human health and the environment. In this case, a no-action ROD would be signed and the site removed from the program upon completion of the interim remedial action. No interim remedial actions have been completed to date at the NBN.

4.4. Treatability Studies

Treatability studies are performed to assist in the evaluation of a potentially promising remedial technology. The primary objectives of treatability testing are:

- to provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the FS, and/or
- to support the remedial design of a selected alternative

Treatability studies may be conducted at any time during the RI/FS process. The need for a treatability study is generally identified during the FS.

Treatability studies may be classified as either bench-scale (laboratory study) or pilot-scale (field studies). For technologies that are well-developed and tested, bench-scale studies are often sufficient to evaluate performance. For innovative technologies, pilot tests may be required to obtain the desired information. Pilot tests simulate the physical and chemical parameters of the full-scale process, and are designed to bridge the gap between bench-scale and full-scale operations.

Pilot-scale treatability studies have been conducted at the Camp Allen Landfill Site to evaluate air stripping and dual-phase vacuum extraction technologies. Additionally, soil vapor extraction and air sparging pilot-scale treatability studies were completed at the Q-Area Drum Storage Area and LP-20 site.

5. Site Management Plan Schedules

The purpose of this section is to present project-specific schedules for projects that are or potentially will be active in 1996 or 1997, as well as model schedules for IRP and SWMU sites that will be initiated beyond 1997. Project-specific schedules for active projects will be updated periodically in the SMP. Potentially active projects for 1996/1997, for which project-specific schedules have been developed, are summarized in Table 5-1.

For projects that are currently active, the current project schedules as developed by LANTDIV and/or the project manager are presented. For projects that have not yet been initiated or for which project schedules have not been developed, model schedules are presented which illustrate potential overall schedules for "typical" projects. For these projects, scheduling assumptions are discussed below.

In October 1996, LANTDIV convened an environmental partnership among the Navy, the RAB, US EPA, VDEQ, and the Navy's contractors. The partnership is implementing an approach to site remediation referred to as Variable Oversight (VO). The implementation of the VO process has promoted a higher degree of communication, understanding, and cooperation among all of the involved groups.

The scheduling assumptions presented below represent an ideal flow of work for sites that are addressed through the conventional clean-up approach. These assumptions do not account for how the VO process may affect schedules and potentially affect the sequence of tasks, as the partnership evaluates project progress on an accelerated basis, and expedites the decision-making process. The goal of the VO process is to streamline the regulatory review processes of implementation, decision-making, reporting, and other environmental regulatory documentation, and to achieve significant savings of time and funding.

5.1. Scheduling Assumptions

Assumptions regarding durations of field investigations, laboratory analysis, data validation, document preparation, document review, and remedial design/remedial action are discussed below.

5.1.1. Field Investigation and Laboratory Analysis/Validation

The time required for RI field investigations depends on the size and complexity of the site and the overall scope of the field investigation (i.e., types of field investigation activities, number of sampling rounds, etc.). Generally, field investigations require from 2 to 6 months to complete.

A 30-day turnaround time was assumed for laboratory analysis. Twenty-eight days is the standard turnaround time for Naval Facilities Engineering Support Center (NFESC)-approved laboratories under the current Navy CLEAN Contract. A 14-day duration was assumed for validation of laboratory data.

5.1.2. Document Preparation and Document Review

The time required for document preparation under the RI/FS process (see Section 4.1) has been estimated based on prior experience in preparing the various types of documents. A summary of the estimated times required for development of the various types of documents typically prepared during the RI/FS process is presented in Table 5-2. The durations presented in Table 5-2 represent the time required to prepare the initial draft document and do not include time required for review and subsequent revisions of the document.

The time required for document review generally will vary according to the length and complexity of the document, as well as the availability of resources on the part of the reviewing agency. Since the NBN is not currently operating under a Federal Facility Agreement (FFA), specific document review periods for various types of documents have not been negotiated and agreed to by the Navy and the regulatory agencies. Therefore, review periods have been assumed based on FFAs that are in place at other naval installations and LANTDIV experience with review periods under the current IRP. Since the NBN will soon be an NPL Site, an FFA will be negotiated and the assumed document review process may be revised.

For purposes of this SMP, it is assumed that three versions of each document will be produced—a Draft, Draft Final, and Final version. The following corresponding document review periods were assumed.

- Draft Document: 45-day review by LANTDIV
- Draft Final Document: 60-day review by LANTDIV/agencies

For this SMP, it was assumed that 30 days would be required by the consultant to incorporate LANTDIV comments on the Draft Document and to prepare and submit the Draft Final Document. Also, it was assumed that 21 days would be required by the consultant to incorporate LANTDIV/agency comments on the Draft Final Document and to prepare and submit the Final Document.

Table 5-1
 Active Projects for 1996/1997
 Naval Base, Norfolk Site Management Plan

ACTIVE PROJECT	ESTIMATED START DATE
Site 1 - Camp Allen Landfill RD/RA	In Progress
Site 2 - NM Slag Pile RI/FS NM Slag Pile PRAP/ROD	In Progress Fiscal Year 1997
Site 3 - Q-Area RI/FS Q-Area PRAP/ROD Q-Area RD Q-Area RA	Completed 1996 Completed 1996 In Progress Fiscal Year 1997
Site 5 - Pesticide Disposal Site RI/FS Pesticide Disposal Site PRAP/ROD	In Progress Fiscal Year 1997
Site 6 - CD Landfill PRAP/ROD CD Landfill RA	Completed 1996 Fiscal Year 1997
Site 20 - LP-20 RI/FS LP-20 RD LP-20 PRAP/ROD	Completed 1996 In Progress Fiscal Year 1997
Site 21 - Building W-316 PA/SI	In Progress
Site 22 - Camp Allen Salvage Yard RI/FS Camp Allen Salvage Yard PRAP/ROD	In Progress Fiscal Year 1997
SWMU 1 - Accumulation Area PA/SI	In Progress
SWMU 4 - Q-72 Sandblasting Grit Disposal Area PA/SI	In Progress
SWMU 6 - Bldg V-28 Waste Pit PA/SI	In Progress
SWMU 8 - Firefighting School PA/SI	In Progress

- PA = Preliminary Assessment
- SI = Site Inspection
- RI = Remedial Investigation (Includes Risk Assessment)
- FS = Feasibility Study
- PRAP = Proposed Remedial Action Plan
- ROD = Record of Decision or Decision Document
- RD = Remedial Design
- RA = Remedial Action

Note: Fiscal Year 1997 runs from October 1, 1996 to September 30, 1997. Starting dates are contingent upon available funding and site risk relative to all Navy sites.

TABLE 5-2
 Document Preparation Durations
Naval Base Norfolk Site Management Plan

Document	Duration (Months) ⁽¹⁾
Preliminary Assessment/Site Inspection	2
RI/FS Work Plans	2
Remedial Investigation Report	3-4
Feasibility Study	3-4
Proposed Plan	2
Record of Decision	2
Pre-Final Remedial Design	2
Final Design	1-2
Engineering Evaluation/Cost Analysis	1-2
Removal Action Work Plan	2
Removal Action Report	1-2
Treatability Study Work Plan	2
Treatability Study Report	1-2

⁽¹⁾ Durations represent estimated time required to complete Draft Documents.

5.1.3. Remedial Design/Remedial Action

The time required for remedial design/remedial action (RD/RA) depends on the type and complexity of the proposed remedial action. For example, the remedial design of a groundwater pump-and-treat system generally is much more complex than the remedial design for a soil removal/off-site disposal remedial action. Therefore, the groundwater pump-and-treat remedial design process may require up to one year, whereas the soil removal/off-site disposal remedial design may require less than three months. Similarly, the groundwater pump-and-treat system may operate for a long period of time (10- to 20-year period for remedial action), whereas the soil removal/off-site disposal remedial action may be completed in less than one year. Therefore, schedules for RD/RA activities are only provided for projects where the type of remedial action to be performed is known. The remaining sites are only scheduled up through the ROD phase of the RI/FS process.

5.2. IRP Site Project Schedules

Project-specific schedules for IRP projects that are or potentially will be active in 1996/1997 are presented in Figures 5-1 through 5-9. Because the work on the SWMUs will be done simultaneously, one schedule is included for these four projects. In addition, two model schedules have been developed which illustrate potential overall schedules for "typical" IRP projects. The two model schedules, one illustrating a small or simple site and one illustrating a large or complex site, are presented in Figures 5-10 and 5-11, respectively. Two model schedules have been developed which illustrate potential overall schedules for "typical" SWMU projects. The two model schedules, one illustrating a small or simple site and one illustrating a large or complex site, are presented in Figures 5-12 and 5-13, respectively.

The basic strategy used during development of the IRP project schedules was to overlap the RI/FS and RD/RA activities to the maximum extent practicable in order to compress the overall project schedules as much as possible without compromising the interdependencies of the various tasks and documents in the RI/FS process. The amount of overlap of tasks was based on the degree of dependency between the various tasks and documents. Key dependencies and related assumptions are outlined below.

- Remedial Investigation (RI): Preparation of the Draft RI was assumed to start once all of the analytical data have been received, but prior to data validation. Certain RI tasks can begin before the data are validated. However, in order to prevent duplication of effort, this overlap was assumed to be only two weeks.
- Feasibility Study (FS): Preparation of the Draft FS was assumed to begin approximately four months following the start of the RI. Many FS tasks are dependent on the nature and extent of contamination, which are generally defined in the RI Report.
- Proposed Remedial Action Plan (PRAP): Preparation of the Draft PRAP was assumed to start following receipt of agency comments of the Draft Final FS, since selection of the proposed remedial action(s) in the PRAP is contingent upon agency approval of the recommended alternative.
- Record of Decision or Decision Document (ROD): Preparation of the Draft ROD was assumed to begin following receipt of agency comments on the Draft Final PRAP. Since

public comments received during the public comment period must be responded to in the ROD, preparation of the Final ROD would not begin until closure of the public comment period.

5.3. Submittals List

Table 5-3 presents a summary list of submittals that have been or may be required throughout the life of each project or site. The table summarizes final documents that have been submitted, documents that are planned or are in progress, and documents that may be required in the future.

**Table 5-3
Submittals List Summary
Naval Base Norfolk IRP Sites**

Document Name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13
Preliminary Assessment	X	X	X	X	X	X	X	X	X	X	X	X	X
Site Inspection Report	X	X	X	X	X	X	NO	NO	MAYBE	NO	NO	NO	NO
RI/FS Work Plans	X	O	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Community Relations Plan	X	O	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Health and Safety Plan	X	O	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Remedial Investigation Report	X	O	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Feasibility Study Report	X	O	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Pilot/Treatability Work Plan	X	NO	X	NO	MAYBE	MAYBE	NO	NO	MAYBE	NO	NO	NO	NO
Pilot/Treatability Report	X	NO	X	NO	MAYBE	MAYBE	NO	NO	MAYBE	NO	NO	NO	NO
Proposed Remedial Action Plan	X	YES	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Record of Decision	X	YES	X	X	O	X	NO	NO	MAYBE	NO	NO	NO	NO
Focused Feasibility Study	NO	NO	NO	NO	MAYBE	MAYBE	NO	NO	MAYBE	NO	NO	NO	NO
Engineering Evaluation/Cost Analysis	X	NO	NO	NO	MAYBE	MAYBE	NO	NO	MAYBE	NO	NO	NO	NO
Removal Action Plan	X	NO	NO	NO	MAYBE	MAYBE	NO	NO	MAYBE	NO	NO	NO	NO
Removal Action Memorandum	X	NO	NO	NO	MAYBE	MAYBE	NO	NO	MAYBE	NO	NO	NO	NO
Remedial Design Work Plan	X	MAYBE	O	X	MAYBE	O	NO	NO	MAYBE	NO	NO	NO	NO
Remedial Design Documents	X	MAYBE	O	X	MAYBE	O	NO	NO	MAYBE	NO	NO	NO	NO
Remedial Action Work Plan	X	MAYBE	O	X	MAYBE	O	NO	NO	MAYBE	NO	X	NO	NO
Remedial Action Completion Report	O	MAYBE	O	X	MAYBE	O	NO	NO	MAYBE	NO	X	NO	NO
Operations & Maintenance Plan	O	MAYBE	O	NO	MAYBE	YES	NO	NO	MAYBE	NO	NO	NO	NO
Long-Term Monitoring Plan	O	MAYBE	O	X	MAYBE	YES	NO	NO	MAYBE	NO	NO	NO	NO
Periodic Review Assessment Reports	O	MAYBE	O	YES	MAYBE	YES	NO	NO	MAYBE	NO	NO	NO	NO

**Table 5-3 (Cont.)
Submittals List Summary
Naval Base Norfolk IRP Sites**

Document Name	Site 16	Site 17	Site 18	Site 19	Site 20	Site 21	Site 22	SWMU 1	SWMU 2	SWMU 3	SWMU 4	SWMU 6	SWMU 8
Preliminary Assessment	X	X	X	X	X	O	X	O	X	X	O	O	O
Site Inspection Report	NO	NO	MAYBE	X	X	O	X	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
RI/FS Work Plans	NO	NO	MAYBE	X	X	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Community Relations Plan	NO	NO	MAYBE	X	X	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Health and Safety Plan	NO	NO	MAYBE	X	X	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Remedial Investigation Report	NO	NO	MAYBE	X	O	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Feasibility Study Report	NO	NO	MAYBE	X	O	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Pilot/Treatability Work Plan	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Pilot/Treatability Report	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Proposed Remedial Action Plan	NO	NO	MAYBE	X	O	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Record of Decision	NO	NO	MAYBE	X	O	MAYBE	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Focused Feasibility Study	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Engineering Evaluation/Cost Analysis	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Removal Action Plan	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Removal Action Memorandum	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Remedial Design Work Plan	NO	NO	MAYBE	X	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Remedial Design Documents	NO	NO	MAYBE	X	O	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Remedial Action Work Plan	X	X	MAYBE	X	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Remedial Action Completion Report	X	X	MAYBE	X	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Operations & Maintenance Plan	NO	NO	MAYBE	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Long-Term Monitoring Plan	NO	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE
Periodic Review Assessment Reports	NO	NO	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE	MAYBE

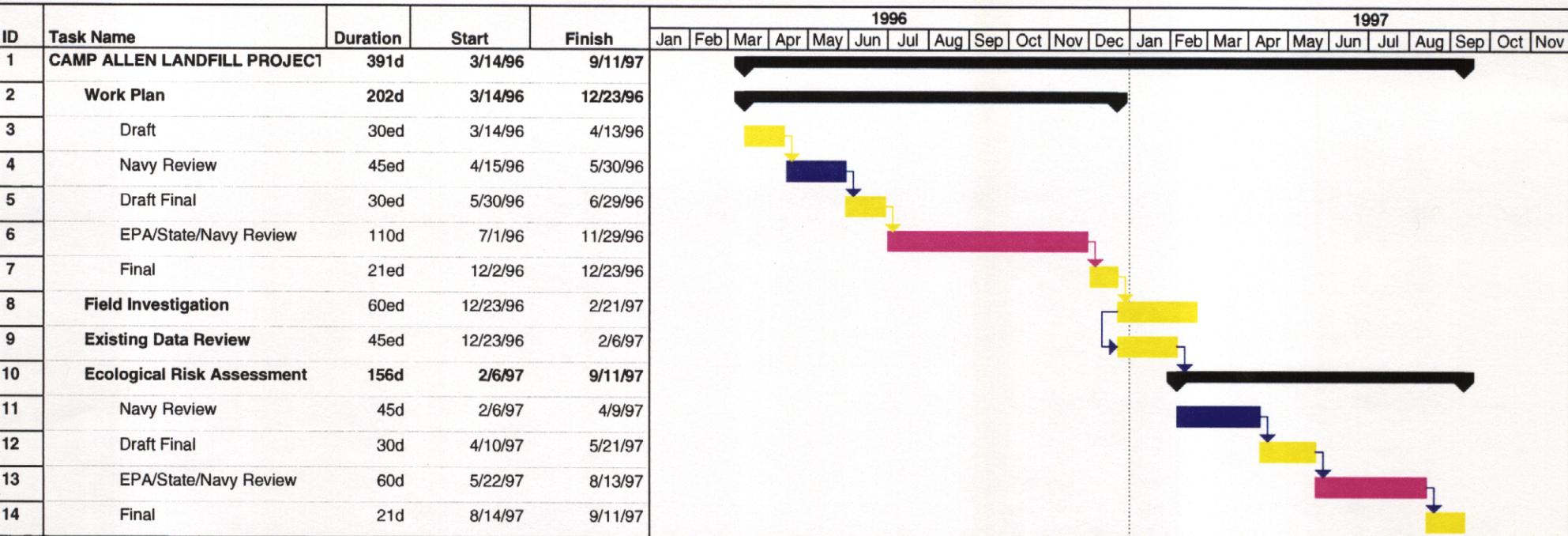
**Table 5-3 (Cont.)
Submittals List Summary
Naval Base Norfolk IRP Sites**

Notes:

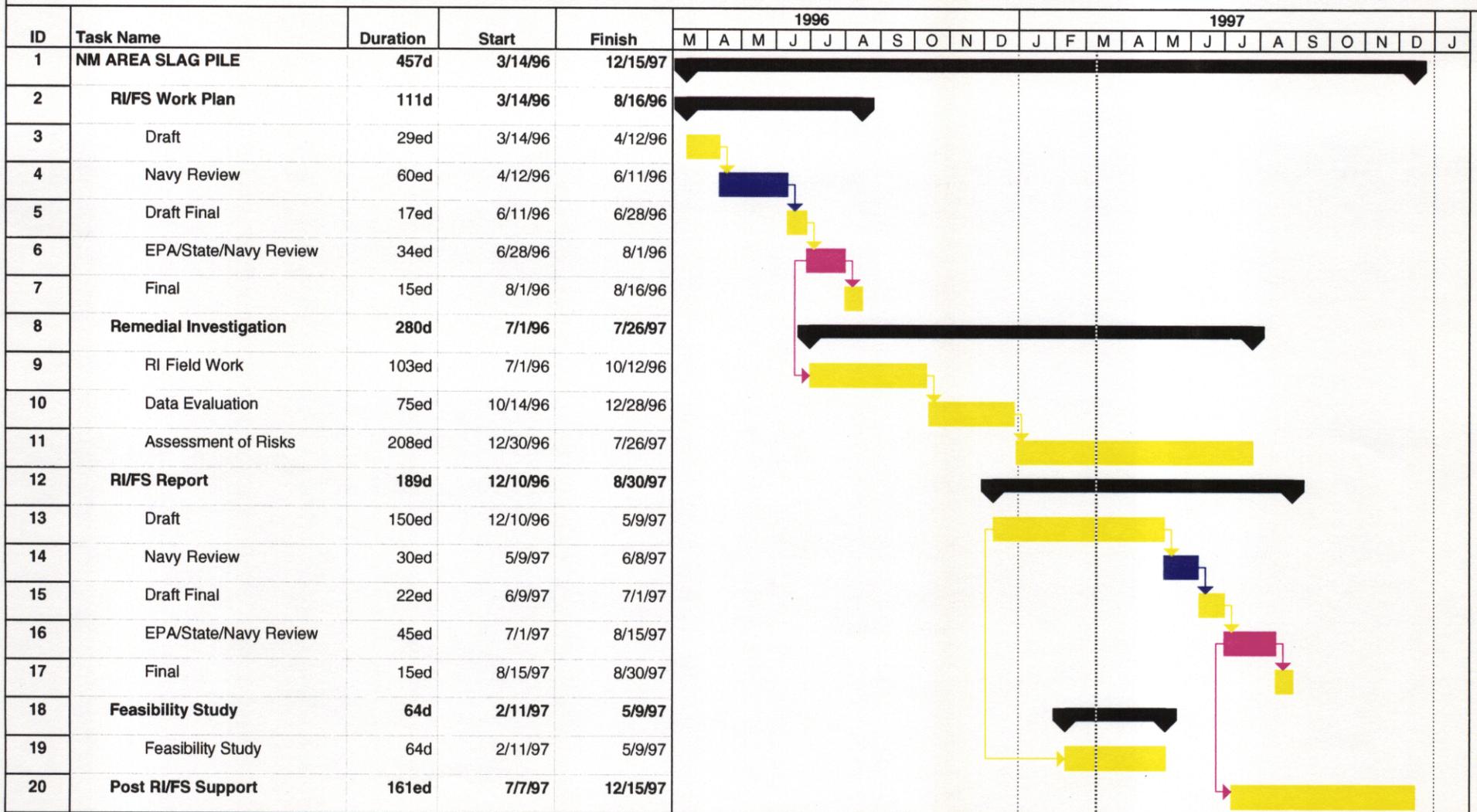
X = Final document submittal
O = Document planned or in progress
YES = Document likely to be required
MAYBE = Document may or may not be required
NO = Document likely not to be required

Site 1 - Camp Allen Landfill
Site 2 - NM Slag Pile
Site 3 - Q-Area Drum
Site 4 - P-71 Transformer
Site 5 - Pesticide Disposal
Site 6 - CD Landfill
Site 7 - Inert Landfill
Site 8 - Asbestos Landfill
Site 9 - Q-Area Landfill
Site 10 - Apollo Disposal
Site 11 - Shop Drains
Site 12 - Mercury Disposal
Site 13 - Past Outfalls
Site 16 - Building X-136 Fire
Site 17 - Building SDA-215 Fire
Site 18 - NM Waste Storage
Site 19 - Buildings V60/V90
Site 20 - LP-20 Site
Site 21 - Building W-316
Site 22 - Camp Allen Salvage Yard
SWMU 1 - SP-2B Accumulation Area
SWMU 2 - Z-309 Ash Hopper
SWMU 3 - Z-309 O/L Storage
SWMU 4 - Q-72 Sandblasting Grit Disposal Area
SWMU 6 - Bldg V-28 Waste Pit
SWMU 8 - Firefighting School

**Figure 5-1
Site1 - Camp Allen Landfill
Field Investigation and Ecological Risk Assessment**



**Figure 5-2
Site 2 - NM Area Slag Pile
Remedial Investigation, Feasibility Study, and Risk Assessment**



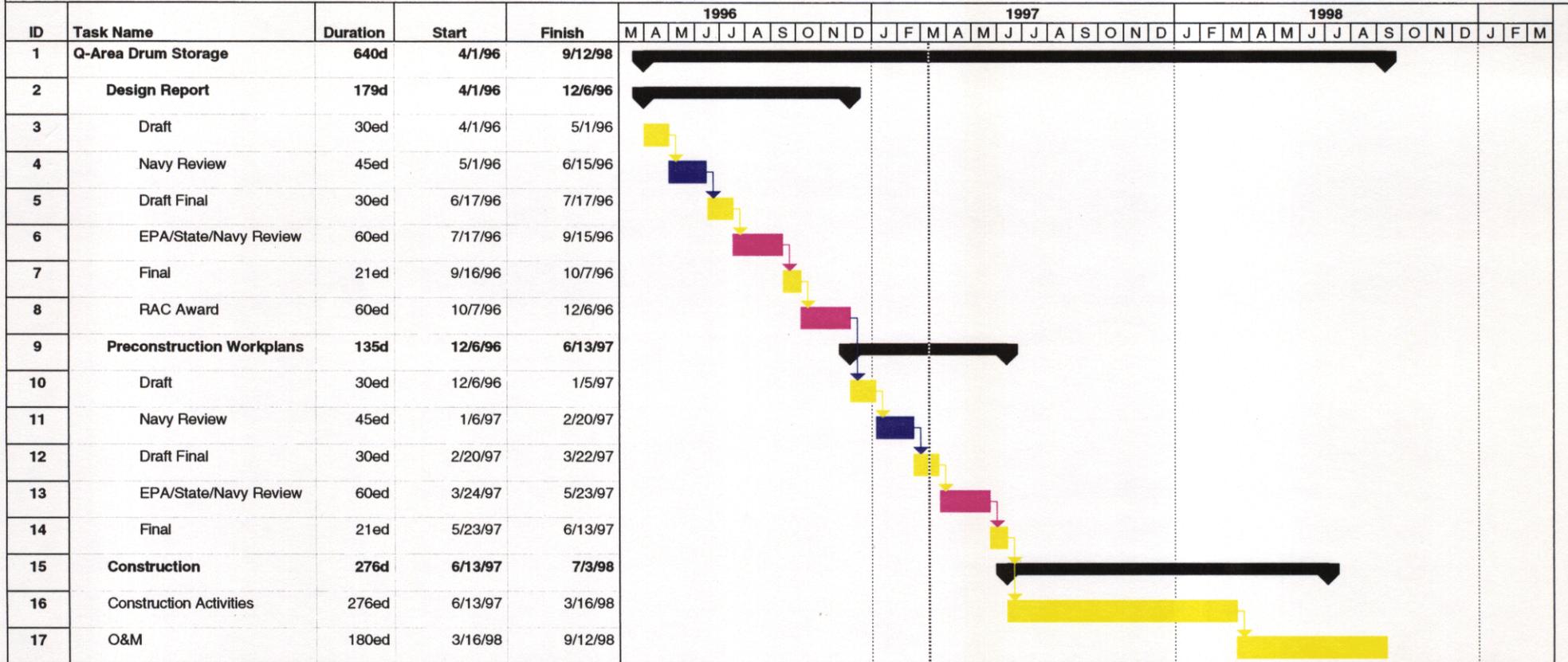
Project: Site 2
Date: 3/10/97

Navy Review [Blue Box]
Agency Review [Pink Box]

Contractor Work Progress [Yellow Box]
Milestone [Black Diamond]

Summary Task [Black Arrow]

**Figure 5-3
Site 3 - Q-Area Drum Storage
Design, Construction**



Project: Site 3
Date: 3/10/97

Navy Review
Agency Review



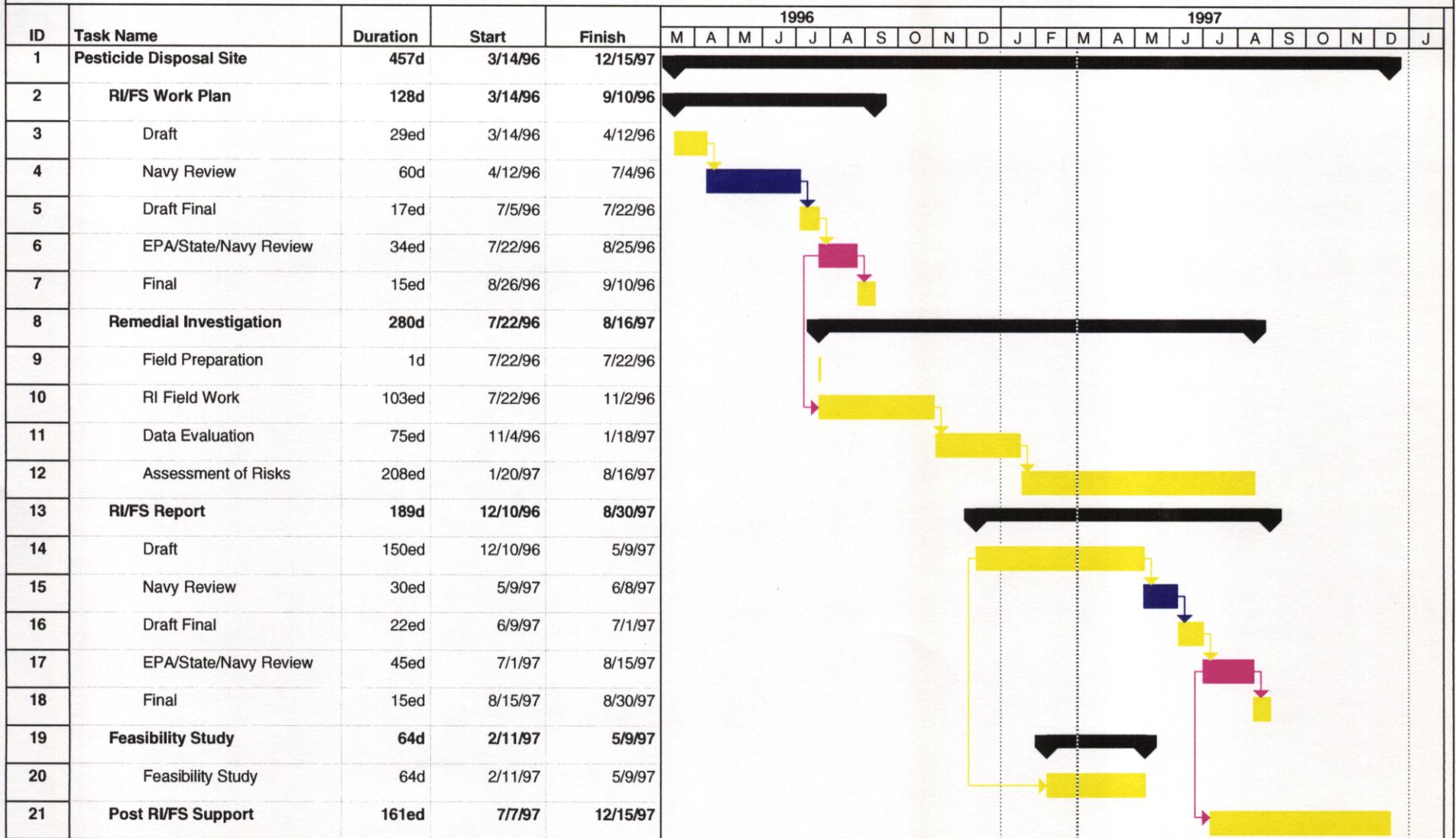
Contractor Work Progress
Milestone



Summary



Figure 5-4
Site 5 - Pesticide Disposal Site
Remedial Investigation, Feasibility Study, and Risk Assessment



Project: Site 5
 Date: 3/10/97

Navy Review



Contractor Work Progress



Summary Task



Agency Review



Milestone



**Figure 5-5
Site 6 - CD Landfill
Design and Construction**

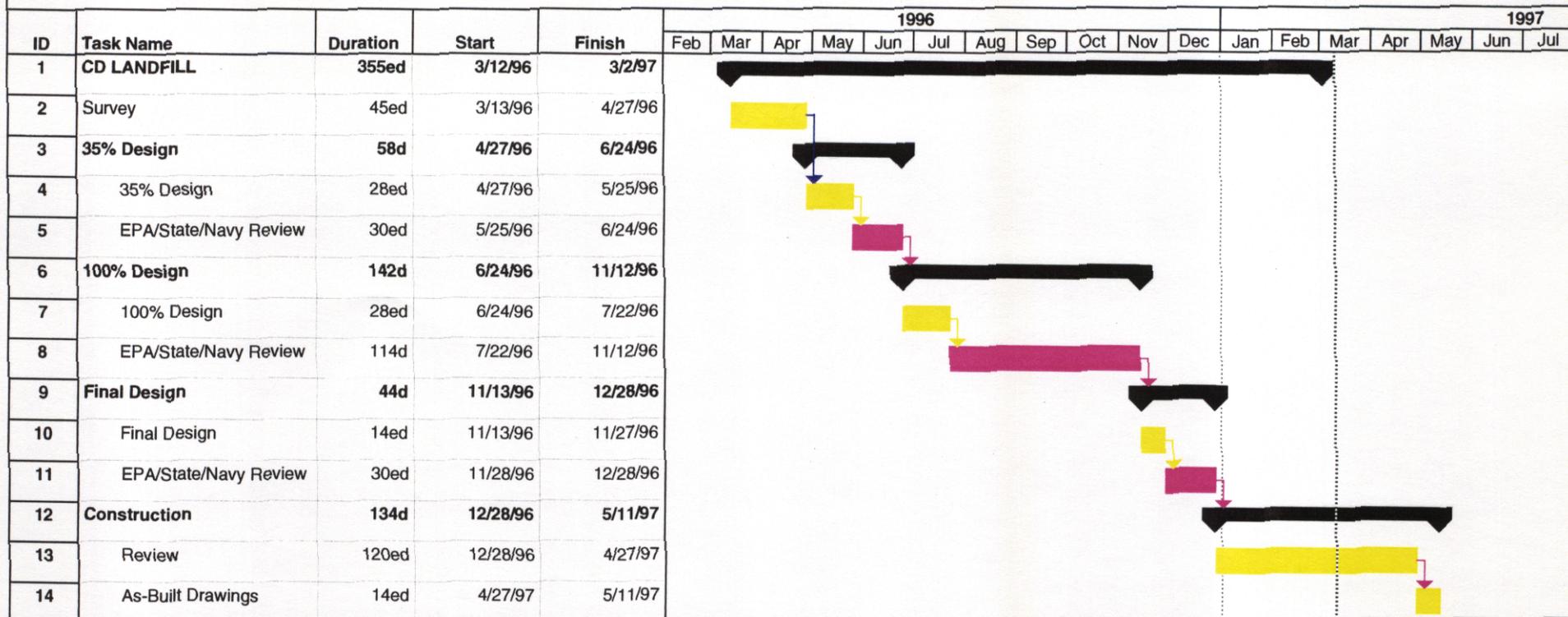


Figure 5-5
Date: 3/10/97

Navy Review
Agency Review



Contractor Work Progress
Milestone



Summary



**Figure 5-6
Site 20 - LP20 Site
RA Design and Construction**

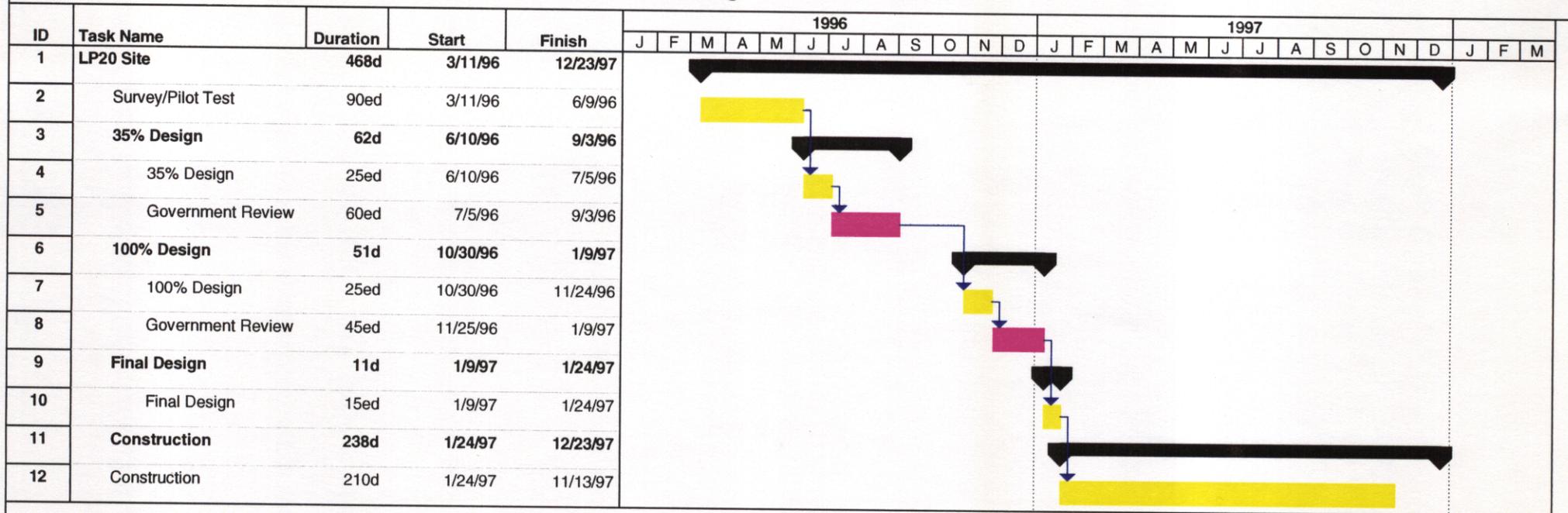


Figure 5-6
3/10/97

Navy Review
Agency Review



Contractor Work Progress
Summary



Milestone

**Figure 5-7
Site 21 - Building W-316
Preliminary Assessment, Site Investigation**

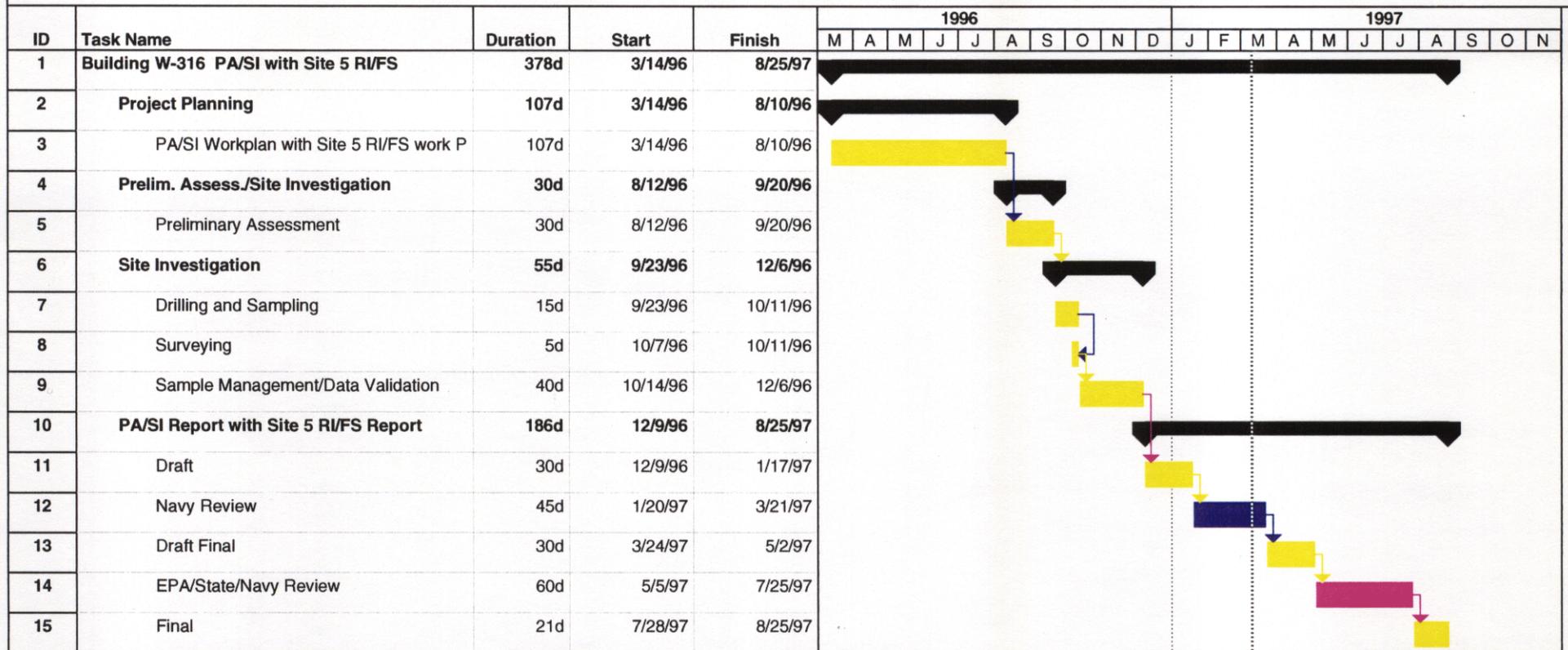


Figure 5-7
Date: 3/10/97

Navy Review
Agency Review



Contractor Work Progress
Milestone



Summary



Figure 5-8
Site 22 - Camp Allen Salvage Yard Site
Remedial Investigation, Feasibility Study, Proposed Remedial Action Plan, and Record of Decision

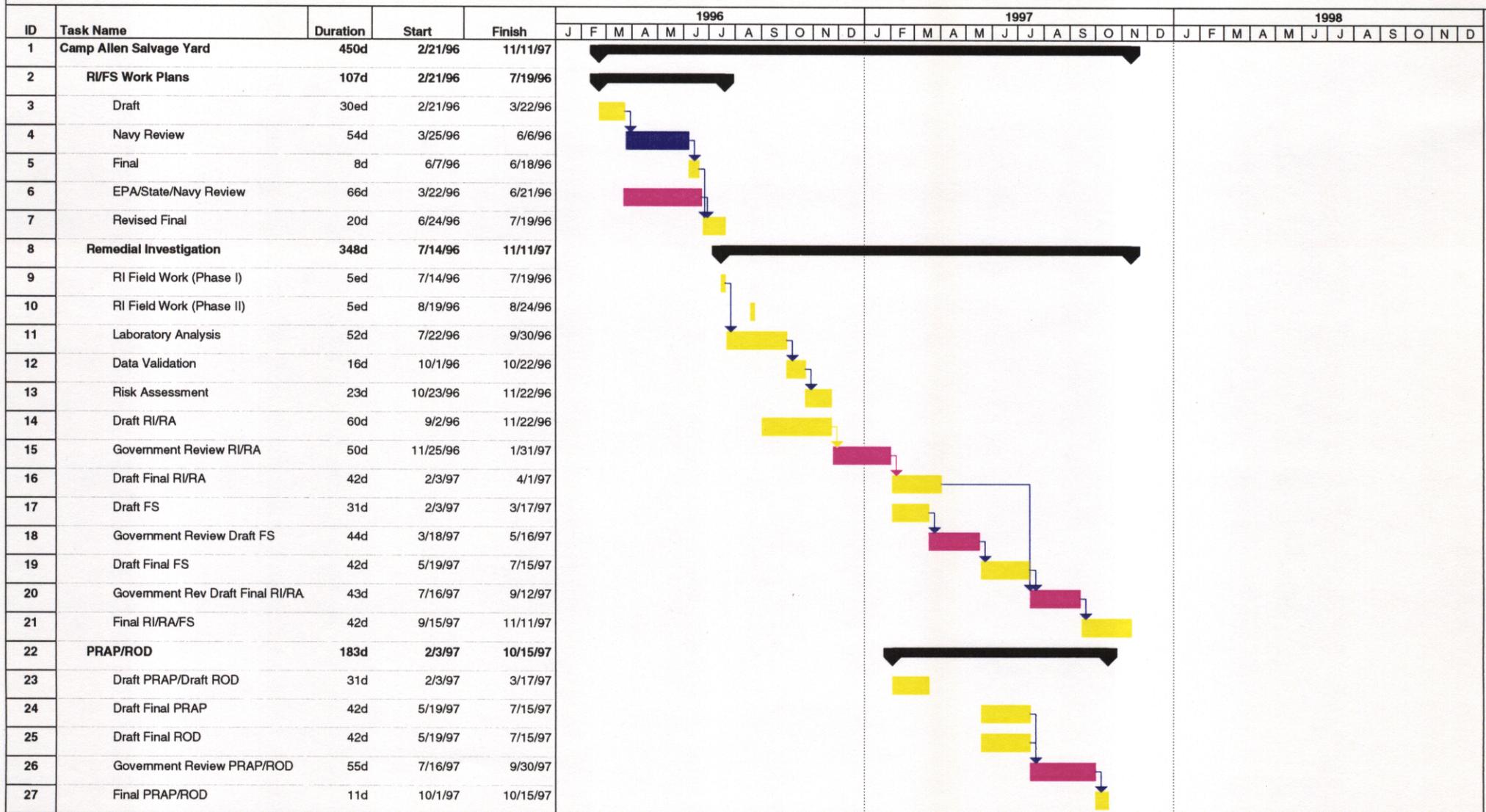


Figure 5-8
3/10/97

Navy Review
Agency Review



Contractor Work Progress
Summary

Milestone

**Figure 5-9
SWMU 1, 4, 6, and 8
Preliminary Assessment, Site Investigations**

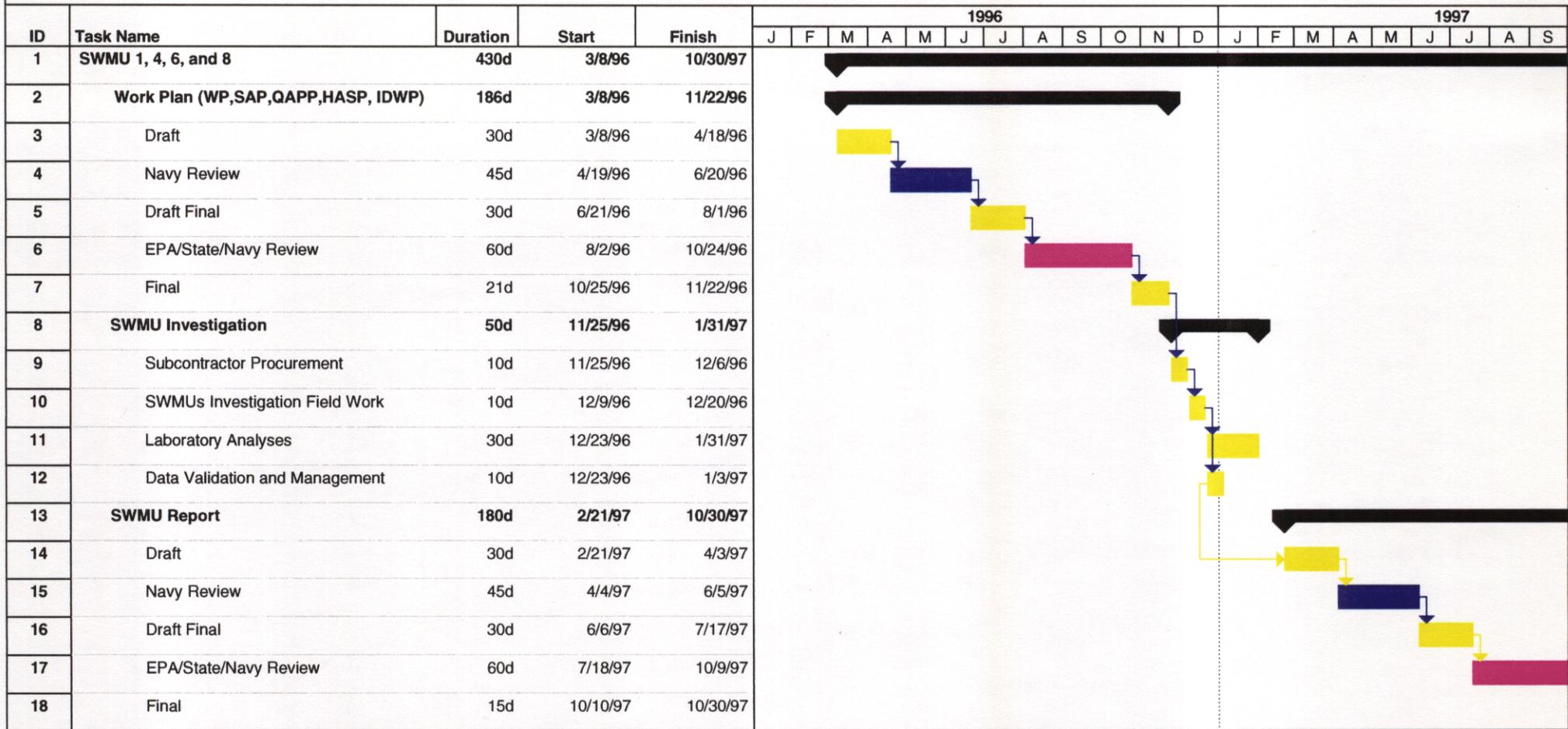


Figure 5-9
3/10/97

Navy Review
Agency Review



Contractor Work Progress
Summary



Milestone



**Figure 5-9
SWMU 1, 4, 6, and 8
Preliminary Assessment, Site Investigations**

ID	Task Name	Duration	Start	Finish	1998												1								
					O	N	D	J	F	M	A	M	J	J	A	S		O	N	D	J	F	M	A	M
1	SWMU 1, 4, 6, and 8	430d	3/8/96	10/30/97																					
2	Work Plan (WP,SAP,QAPP,HASP, IDWP)	186d	3/8/96	11/22/96																					
3	Draft	30d	3/8/96	4/18/96																					
4	Navy Review	45d	4/19/96	6/20/96																					
5	Draft Final	30d	6/21/96	8/1/96																					
6	EPA/State/Navy Review	60d	8/2/96	10/24/96																					
7	Final	21d	10/25/96	11/22/96																					
8	SWMU Investigation	50d	11/25/96	1/31/97																					
9	Subcontractor Procurement	10d	11/25/96	12/6/96																					
10	SWMUs Investigation Field Work	10d	12/9/96	12/20/96																					
11	Laboratory Analyses	30d	12/23/96	1/31/97																					
12	Data Validation and Management	10d	12/23/96	1/3/97																					
13	SWMU Report	180d	2/21/97	10/30/97																					
14	Draft	30d	2/21/97	4/3/97																					
15	Navy Review	45d	4/4/97	6/5/97																					
16	Draft Final	30d	6/6/97	7/17/97																					
17	EPA/State/Navy Review	60d	7/18/97	10/9/97																					
18	Final	15d	10/10/97	10/30/97																					

Figure 5-9 3/10/97	Navy Review		Contractor Work Progress		Milestone	
	Agency Review		Summary			

**Figure 5-10
Model Schedule - Simple SWMU Site
RCRA Facility Investigation, Corrective Measures Study, Corrective Measures Implementation**

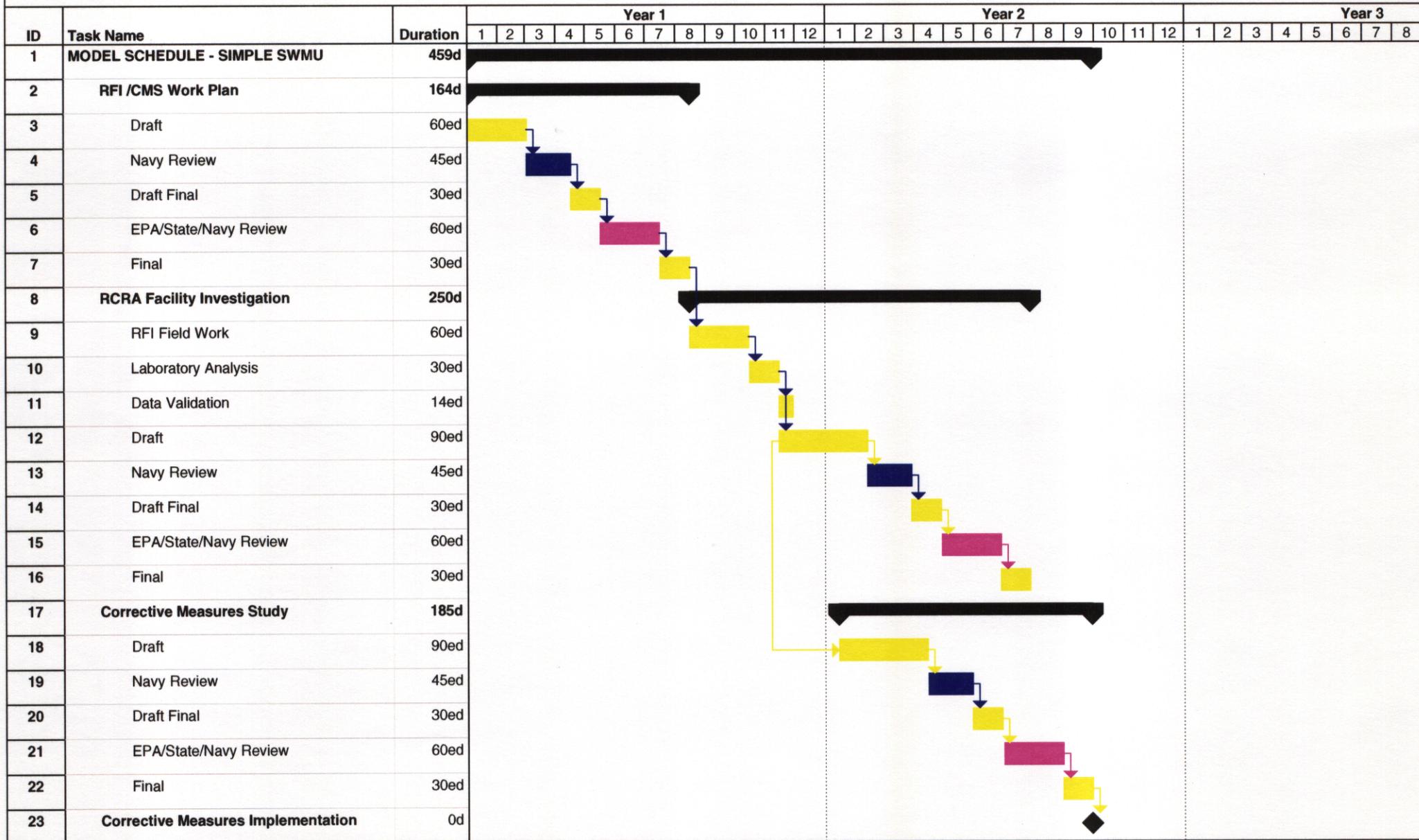


Figure 5-10
3/7/97

Navy Review
Agency Review



Contractor Work Progress
Summary



Milestone



Figure 5-11
Model Schedule - Complex SWMU Site (w/Treat Study & Interim Measures)
RCRA Facility Investigation, Corrective Measures Study, Treatability Study, and Corrective Measures Implementation

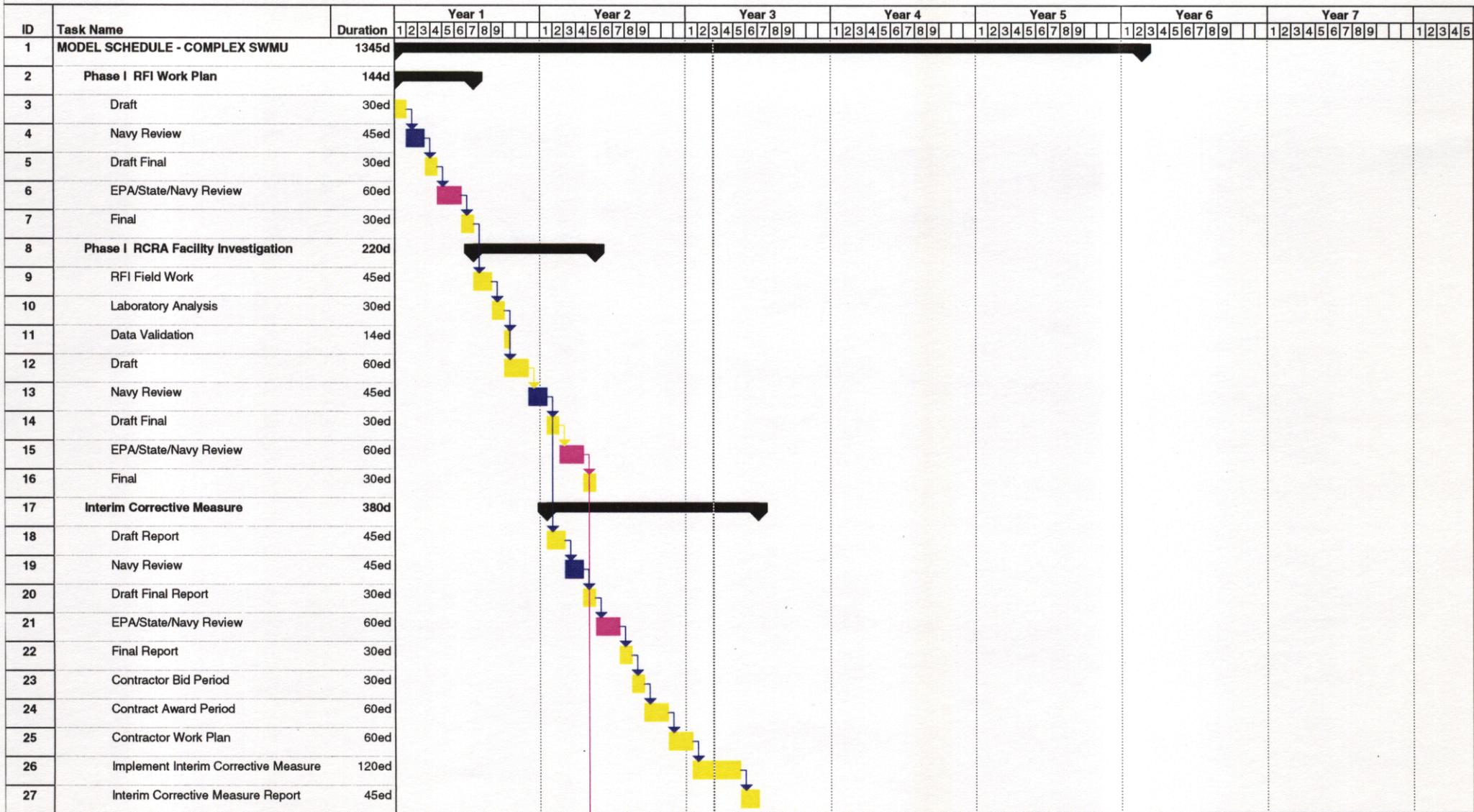


Figure 5-12
Model Schedule - Simple IRP Site (No-Action ROD)
Remedial Investigation, Feasibility Study, Proposed Plan, and Decision Document

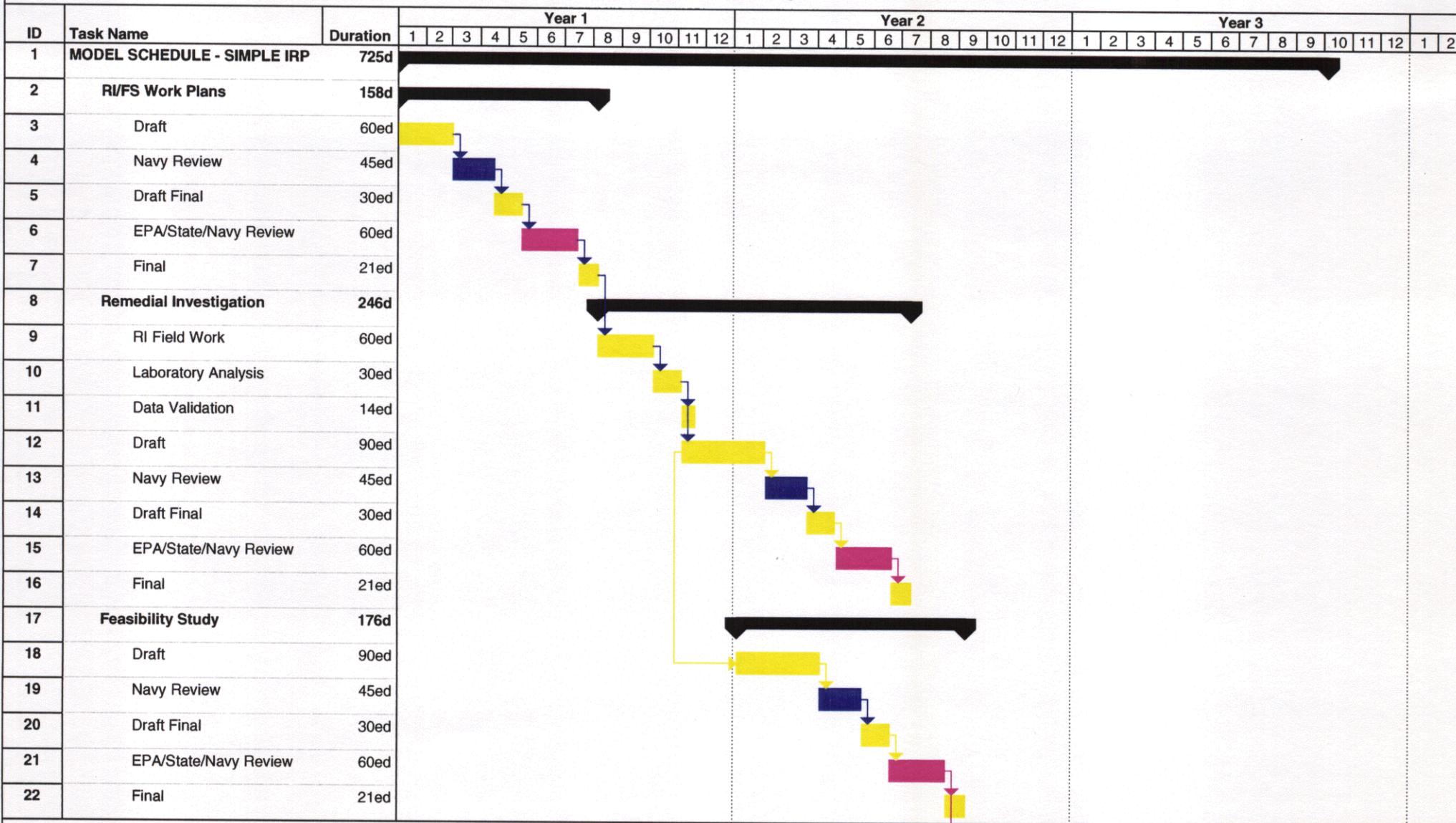


Figure 5-12
3/10/97

Navy Review
Agency Review



Contractor Work Progress
Summary



Milestone



Figure 5-13

Model Schedule - Complex IRP Site (w/Treat Study & Removal Action)

RI/FS, Proposed Plan, Decision Document, Removal Action, Treatability Study, Remedial Design and Remediation

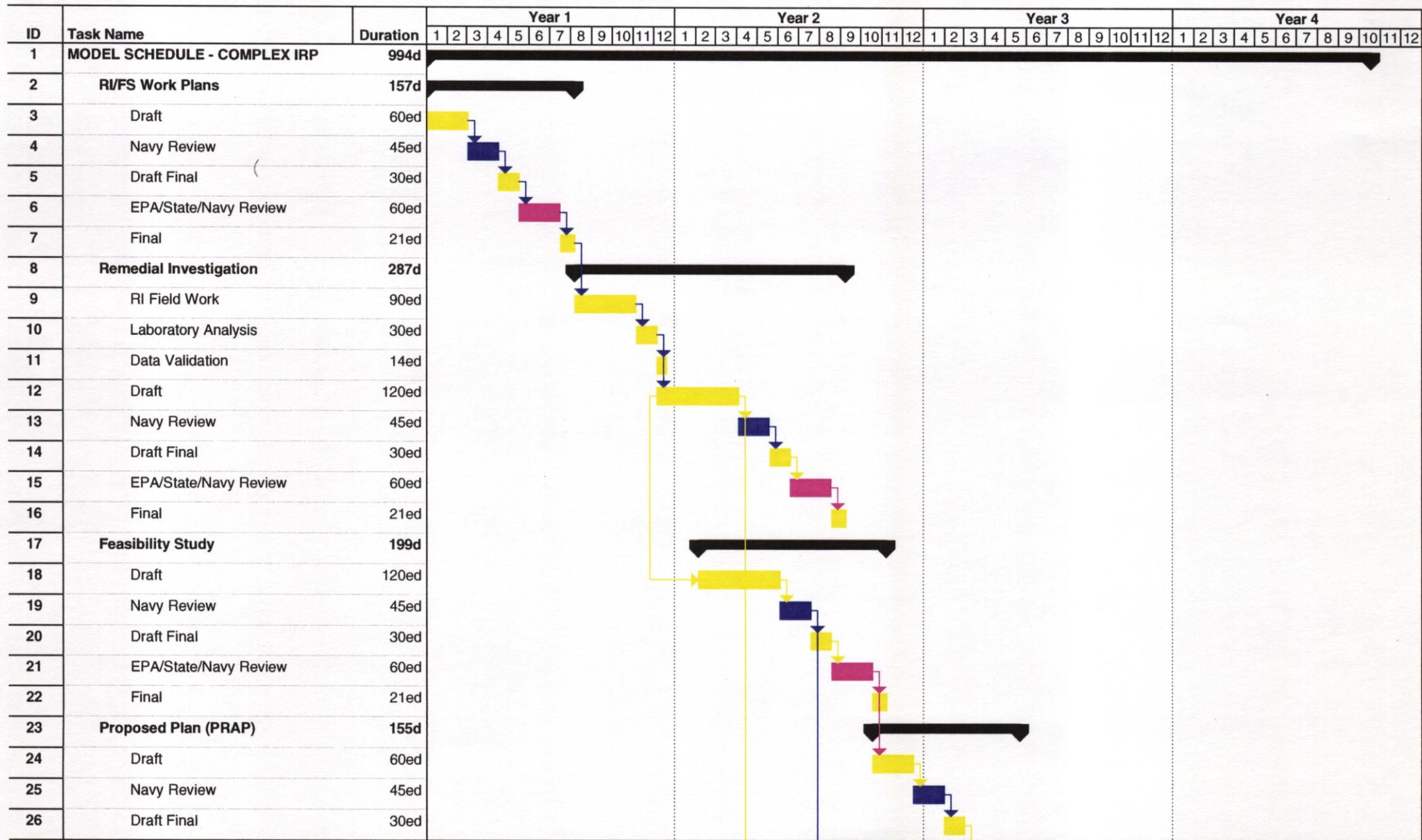


Figure 5-13
3/10/97

Navy Review
Agency Review



Contractor Work Progress
Summary

Milestone



Appendix A

Quantitative Site Data Used for the Final Relative Risk Ranking System Data Collection, Sampling, and Analysis Report

**Site 1 Camp Allen Landfill
Groundwater Data
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
1,1,1, Trichloroethane	50
Acetone	100
Toluene	10,000
Benzene	10,000

**Surface Water Eco-Fresh and Surface Water Human Data
Site 2 - NM Slag Pile
Naval Base Norfolk**

Surface Water Eco-Fresh	
Contaminant	Maximum Concentration (ug/L)
Zinc	300
Copper and Compounds	230
Lead	120

Surface Water Human	
Contaminant	Maximum Concentration (ug/L)
Zinc	300
Copper and Compounds	230
Lead	120

**Groundwater and Soil Data
Site 3 - Q-Area Drum Storage
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Arsenic	337
Mercury and Compounds	0.38
Zinc	1,580
Copper and Compounds	261
Selenium	90.0
Nickel and Compounds	472
Dichloroethane (1,1-)	540
Trichloroethane (1,1,1-)	1,100
Methylene Chloride	680
Acetone	1,300
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Trichloroethylene (PCE)	150
Arsenic	27.0

**Groundwater and Soil Data
Site 5 - Pesticide Disposal Site
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Phenol	10.0
Zinc	240
Mercury and Compounds	0.41
Chromium (total)	50.0
Cadmium and Compounds	20.0
Lead	170
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Fluoranthene	0.54
Pyrene	0.51
Indeno[1,2,3-cd]pyrene	0.39
Benzo[a]anthracene	0.72
Chrysene	0.67
Benzo[a]pyrene	0.71

**Groundwater, Soil, Surface Water Eco Fresh and Surface Water Human Data
Site 6 - CD Landfill
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Phenanthrene	1.00
Arsenic	57.0
Dichlorobenzene, 1,3-	5.00
DDD	0.020
Butyl benzyl phthalate	0.60
Phenol	5.00
Diethyl phthalate	7.00
Anthracene	1.00
Dimethyphenol, 2,4-	0.50
Fluoranthene	1.00
Soil	
Contaminant	Maximum Concentration (mg/Kg)
DDD	0.001
DDE	0.003
DDT	0.008
Aldrin	0.001
Cyanide	0.98
Arsenic	0.035
Selenium	0.64
Dieldrin	0.051
Barium and compounds	106
Mercury and compounds	0.56
Surface Water Eco Fresh	
Contaminant	Maximum Concentration (ug/L)
DDD	0.016
Vanadium	1,180
Barium and Compounds	1,420
Aluminum	176,000
Dichlorobenzene, 1,4-	1.00
Dichlorobenzene, 1,2-	2.00
Arsenic	34.9
Antimony and compounds	22.5
Nickel and compounds	253
Cyanide	25.1

**Groundwater, Soil, Surface Water Eco Fresh and Surface Water Human Data
Site 6 - CD Landfill
Norfolk Naval Base**

Surface Water Human	
Contaminant	Maximum Concentration (ug/L)
DDD	0.016
Arsenic	34.9
Dichlorobenzene, 1,2-	2.00
Dichlorobenzene, 1,4-	1.00
Cyanide	25.1
Silver and Compounds	7.20
Mercury and Compounds	0.74
Dieldrin	0.035
Zinc	2,640
Copper and Compounds	425

**Groundwater and Soil Data
Site 7 - Inert Chemical Landfill
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	2,130
Zinc	162
Aluminum	790
Manganese and compounds	236
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Pyrene	0.96
Acetone	0.020
Benzo[k]fluoranthene	0.78
Phenanthrene	0.64
Iron	249,000
Zinc	61.2
Barium and compounds	0.69
Naphthalene	0.29
Fluoranthene	1.10
Toluene	1.80

**Groundwater and Soil Data
Site 8 - Asbestos Landfill
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	2,130
Zinc	162
Aluminum	790
Manganese and compounds	236
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Benzo[k]fluoranthene	0.57
Pyrene	0.92
Phenanthrene	1.10
Naphthalene	0.44
Fluoranthene	1.10
Selenium	1.60
Zinc	98.1
Indeno[1,2,3-cd] pyrene	0.20
Iron	20,800
Mercury	0.15

**Groundwater and Soil Data
Site 9- Q-Area Landfill
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Xylene	1.90
Dichlorobenzene, 1,2-	2.00
Fluorene	13.0
Acenaphthene	22.0
Benzene	4.90
Chlorobenzene	6.50
Manganese and compounds	220
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Phenanthrene	12.0
Carbazole	1.50
Benzo[k]fluroanthene	2.60
Acetone	0.14
Pyrene	13.0
Napthalene	5.70
Fluoranthene	19.0
Dibenz[ah]anthracene	0.18
Benzo[a]anthracene	4.60

Soil Data
Site 10 - Apollo Fuel Disposal Sites
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Copper and compounds	4.00
Chromium (III)	8.50
Iron	6,230
Dibutyl phthalate	0.56
Zinc	14.3
Barium and compounds	36.0
Chromium VI and compounds	8.50
Vandium	13.8
Lead	10.9
Manganese and compounds	29.8

Sediment Data
Site 12 - Alleged Mercury Disposal Site
Norfolk Naval Base

Sediment Human	
Contaminant	Maximum Concentration (mg/Kg)
Cyanide	28.30
Chromium VI and compounds	22.20
Aluminum	5,520
Arsenic	6.90

Groundwater and Soil Data
Site 16 - Chemical Fire, Building X-136
Norfolk Naval Base

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Chromium (III)	52.2
Iron	46,300
Arsenic	18.8
Toluene	1.50
Ethylbenzene	3.80
Xylene	6.60
Zinc	108
2,4- Dimethylphenol	7.60
Benzene	3.40
Trichloroethylene (TCE)	41.0
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	6,230
Phenanthrene	0.33
Copper and compounds	4.00
Zinc	14.3
Pyrene	1.20
Benzene	0.0034
Ethyl benzene	0.0038
Trichloroethylene (TCE)	0.041
Naphthalene	0.090
Xylene	0.007

**Groundwater and Soil Data
Site 17 - Chemical Fire, Building SDA-215
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Zinc	32.2
Iron	3,760
Dibutyl phthalate	2.00
Aluminum	2,430
Cyanide	58.0
Manganese	112
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Zinc	7.30
Iron	3,170
Manganese	4.70
Lead	4.70
Manganese and Compounds	4.70
Vandium	11.30
Chromium VI and compounds	9.80
Aluminum	4,690
Arsenic	2.80

Soil Data
Site 18 - Former NM Hazardous Waste Storage Area
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Pyrene	0.40
Iron	5.40
Copper and compounds	8.60
Nickel and compounds	5.20
DDE, 4,4-	0.067
Zinc	39.5
Mercury	0.56
Benzo[k]fluoranthene	0.28
Ideno[1,2,3-cd]pyrene	0.13
Phenanthrene	0.20

**Groundwater Data
Site 20 - LP-20 Site
Norfolk Naval Base**

Ground Water	
Contaminant	Maximum Concentration (ug/L)
Arsenic	25.4
Phenol	250
Acenaphthene	10.0
Zinc	318
Silver and compounds	6.59
Copper and compounds	122.13
Ethylbenzene	130
Tetrachloroethylene (PCE)	15.0
Xylene (mixed)	250
Nickel and compounds	156.3

Soil Data
Site 21 - Building W-316
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
DDT	0.0062
Polychlorinated biphenyls (PCBs)	0.14

Soil Data
Site 22 - Camp Allen Salvage Yard
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Phenanthrene	0.44
Methyl Chloride	17.0
Toluene	0.001
Xylene	0.002
Dichloroethane, 1,1-	0.007
Tetrachloroethylene (PCE)	0.004
Methylphenol, 2-	0.041
Butyl benzyl phthalate	0.22
Trichloroethylene (TCE)	0.028
Naphthalene	0.088

Soil Data
SWMU 1 - SP-2B Hazardous Waste Accumulation Area
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Fluorene	1.20
Phenanthrene	8.60
Copper and compounds	6.70
Iron	5,340
Naphthalene	0.45
Zinc	15.3
Mercury	0.12
Carbazole	2.00
Methyl ethyl ketone	0.0075
Acetone	0.067

Groundwater and Soil Data
SWMU 3 - Building Z-309 Oil/Lubricant Storage Area
Norfolk Naval Base

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Zinc	37.0
Iron	936
Aluminum	0.89
Selenium	6.00
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Phenanthrene	1.10
Pyrene	2.60
Fluorene	0.16
Fluoranthene	2.40
Carbazole	0.21
Acenaphthene	0.16
Dibutyl phthalate	0.35
Benzo [k] fluoranthene	0.66
Indeno[1,2,3-cd]pyrene	0.55
Anthracene	0.28

**Groundwater and Soil Data
SWMU 4 - PWC Sandblast Area
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Cadmium and compounds	2.00
Lead	2.00
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	25,800
Zinc	81.4
Mercury and compounds	0.0001
Vanadium	0.044
Manganese and compounds	0.262
Nickel and compounds	16.1
Copper and compounds	23.2
Lead	8.20
Aluminum	2,780
Chromium VI and compounds	20.4

**Groundwater and Soil Data
SWMU 5 - LF-61 Waste Holding Tank
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	8,350
Arsenic	22.4
Zinc	61.4
Chromium VI and compounds	18.1
Aluminum	11,000
Manganese	58.7
Lead	19.5
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	2,590
Zinc	5.50
Bis(2-ethylhexyl)phthalate	0.0630
Acetone	0.024
Aluminum	11.0
Cyanide	0.38
Chromium VI and compounds	4.10
Lead	3.70
Manganese	13.2
Arsenic	9.90

Groundwater and Soil Data
SWMU 6 - Building V-28 Waste Pit
Norfolk Naval Base

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	15,600
Zinc	30.0
1,1,1-Trichloroethane	2.40
Trichloroethylene (TCE)	1.00
Aluminum	1,670
Nickel and compounds	75.7
Manganese and compounds	127
Cadmium and compounds	14.3
Lead	5.50
Chromium VI and compounds	1,760
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Zinc	4.90
Iron	680
Lead	2.70
Chromium VI and compounds	3.20
Aluminum	392
Manganese	9.60

Groundwater and Soil Data
SWMU 7 - LF-18 Aircraft Ramp
Norfolk Naval Base

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	31,600
Zinc	49.4
Dibutyl phthalate	1.00
Dichlorophenol, 2,4-	1.10
Aluminum	6,150
Lead	6.00
Manganese	1,820
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Methyl ethyl ketone	0.0063
Methylene chloride	0.0064
Acetone	0.057
Bis(2-ethylhexyl)phthalate (DEHP)	0.16
Benzo[a]pyrene	0.27

**Groundwater and Soil Data
SWMU 8 - Firetraining School
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	4,000
Diethyl phthalate	2.00
Naphthalene	2.00
Xylene	17.00
Aluminum	1,490
1,2,-Dichloroethane (EDC)	5.30
Manganese and compounds	162
Benzene	220
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Nickel and compounds	6.80
Fluoranthene	0.13
Phenanthrene	0.098
Pyrene	0.24
Dieldrin	0.0064
Iron	20,200
Benzo[k]fluoranthene	0.15
Zinc	30.6
Toluene	0.0013
Chlorobenzene	0.0018

Soil Data
SWMU 9 - LP-200 MAC Terminal
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Fluorene	0.060
Pyrene	0.82
Indeno[1,2,3-de]pyrene	0.13
Copper and compounds	11.30
Fluoranthene	1.00
Carbazole	0.078
Benzo[k]fluroanthene	0.47
Zinc	63.9
Iron	24,500
Phenanthrene	0.54

**Groundwater and Soil Data
SWMU 10- LP-200 MAC Terminal East
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	107,000
Zinc	443
Vandium	54.0
Nickel and compounds	276
Aluminum	13,900
Beryllium and compounds	11.00
Arsenic	48.7
Manganese and compounds	9,100
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Acenaphthylene	0.042
Acetone	0.014
Methyl chloride	0.0013
Copper and compounds	4.70
Benz(a)anthracene	0.12
Carbazole	0.12
Dimehtyl phthalate	0.29
Phenol	0.23
Zinc	29.2
Pentachlorophenol	0.23

Groundwater and Soil Data
SWMU 11 - Old Weapons Station Entrance
Norfolk Naval Base

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	4,150
Zinc	328
Aluminum	1,120
Nickel and compounds	90.0
Cadmium and compounds	23.0
Beryllium and compounds	6.00
Manganese and compounds	1,040
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	17,900
Zinc	37.9
1,3-Dichlorobenzene	0.060
Nickel and compounds	12.0
Cadmium and compounds	0.89
Lead	12.5
Chromium VI and compounds	23.2
Vandium	34.8
Arsenic	5.30
Aluminum	20,500

Soil Data
SWMU 12 - Disposal Area Near NM-37
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	13,100
Zinc	20.7
Mercury	0.11
Nickel and compounds	8.70
Barium and Compounds	98.60
Chromium VI and compounds	17.4
Lead	23.0
Vandium	31.6
Manganese and compounds	65.7
Aluminum	20,700

Groundwater and Soil Data
SWMU 13 - Disposal Area PWC Operations
Norfolk Naval Base

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	8,290
Toluene	1.10
1,1,1- Trichloroethane	2.00
Tetrachloroethylene (PCE)	2.00
Carbon Tetrachloride	2.00
Aluminum	4,860
Manganese and compounds	1,580
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	3,590
Copper and compounds	6.80
Methyl chloride	0.012
Acetone	0.038
Zinc	34.7
Chromium VI and compounds	6.40
Vandium	9.40
Cadmium and compounds	1.10
Manganese	10.9
Lead	14.0

Soil Data
SWMU 14 - Q-50 Satellite Accumulation Area
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Iron	13,900
2,4-Dimethylphenol	0.040
Pyrene	1.30
Zinc	77.1
Fluoranthene	0.33
Phenanthrene	2.50
Indeno[1,2,3-cd]pyrene	0.14
Naphthalene	0.19
Barium and compounds	0.0586
Cyanide	0.0177

Soil Data
SWMU 15 - W-130 Hazardous Waste Accumulation Area
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Mercury	0.31
Pyrene	0.91
Phenanthrene	0.56
Iron	13,600
Tetrachloroethylene (PCE)	0.0084
Fluoranthene	1.30
Benzo[k]fluoranthene	0.43
Anthracene	0.091
Indeno[1,2,3-cd]pyrene	0.30
Benzo(a)anthracene	0.42

**Groundwater and Soil Data
SWMU 16 - NM-37 Accumulation Area
Norfolk Naval Base**

Groundwater	
Contaminant	Maximum Concentration (ug/L)
Iron	1,160
Zinc	25.0
Aluminum	1.24
Chloroform	0.033
Manganese	96.0
Soil	
Contaminant	Maximum Concentration (mg/Kg)
Copper and compounds	6.10
Iron	4,840
Zinc	31.1
Xylene	0.022
Aluminum	6.48
Arsenic	0.27
Cadmium and compounds	0.68
Chromium VI and compounds	8.50
Vanadium	12.2
Lead	35.7

Soil Data
SWMU 26 - NE of NM-31
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Phenanthrene	4.00
Naphthalene	0.51
Benzo[k]fluoranthene	0.95
Zinc	88.4
Iron	6,060
Copper and compounds	6.40
Pyrene	3.00
Fluoranthene	4.30
Mercury and compounds	0.12
Barium and compounds	32.1

Soil Data
SWMU 27 - Mason Creek Embankment
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Zinc	23.4
Mercury	0.12
Benzo[k]fluroanthene	0.11
Fluoranthene	0.11
Indeno[1,2,3-cd]pyrene	0.064
Pyrene	0.23
Benzo[b]fluoranthene	0.092
Benzo(a)anthracene	0.10
Chrysene	0.16
Benzo[a]pyrene	0.11

Soil Data
SWMU 29 - Solid Waste Disposal Area/ CD-3/CD-4
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Naphthalene	0.074
Benzene	0.0047
Toluene	0.0032
Acenaphthylene	0.057
Acenaphthene	0.072
Butyl benzl phthalate	0.11
Carbazole	0.045
Fluoranthene	2.90
Acetone	0.045
Indeno[1,2,3-cd]pyrene	0.15

Soil Data
SWMU 30 - Sludge Fill Disposal Area
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Manganese	0.247
Naphthalene	0.98
Phenanthrene	14.0
Pyrene	7.60
Fluoranthene	10.0
Iron	18,900
Zinc	38.5
Acetone	0.039
Trichloroethylene (TCE)	0.0047
Acenaphthylene	0.25

Soil Data
SWMU 32 - Solid Waste Disposal Area CEP-160/161
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Copper and compounds	11.9
Zinc	28.2
Fluoranthene	0.42
Selenium	0.87
Nickel and compounds	6.20
Benzo(a)anthracene	0.18
Indeno[1,2,3-cd]pyrene	0.089
Iron	12,000
Pyrene	0.30
Phenanthrene	0.34

Soil Data
SWMU 33 - Debris Piled at Seawall
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Ideno[1,2,3-cd]pyrene	0.14
Methylene chloride	0.0037
Acenaphthylene	0.052
Acenaphthene	0.075
Carbazole	0.047
Benzene	0.0044
Fluorene	0.061
Zinc	52.2
Naphthalene	0.16
Phenanthrene	0.47

Soil Data
SWMU34 - Solid Waste Disposal CEP 200
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Zinc	49.5
Phenanthrene	0.20
Selenium	1.60
Pyrene	0.21
Benzo(a)anthracene	0.16
Fluoranthene	0.27
Iron	21,400
Naphthalene	0.23
Chrysene	0.34
Benzo[b]fluoranthene	0.35

Soil Data
SWMU 35 - Solid Waste Disposal CEP 196
Norfolk Naval Base

Soil	
Contaminant	Maximum Concentration (mg/Kg)
Fluorene	0.16
Phenanthrene	1.70
Carbazole	0.082
Pyrene	1.90
Indeno[1,2,3-cd]pyrene	0.24
Fluoranthene	2.40
Acenaphthene	0.12
Acenaphthylene	0.038
Acetone	0.041
Naphthalene	0.090