Technical Memorandum

for

Evaluating Soil Remediation Technologies

Site 1 – Former Drum Marshalling Area

Naval Weapons Industrial Reserve Plant

Bethpage, New York

Naval Facilities Engineering Command Mid-Atlantic

Contract Number N62472-03-D-0057
Contract Task Order 139

September 2008

TECHNICAL MEMORANDUM
FOR
EVALUATING SOIL REMEDIATION TECHNOLOGIES
SITE 1 – FORMER DRUM MARSHALLING AREA

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command
MidAtlantic
9742 Maryland Avenue
Norfolk, Virginia 23511

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62472-03-D-0057
CONTRACT TASK ORDER 139

SEPTEMBER 2008

PREPARED UNDER THE DIRECTION OF:

DAVID D. BRAYACK, P.E.
PROJECT MANAGER
TETRA TECH NUS, INC.
NORFOLK, VIRGINIA

APPROVED FOR SUBMISSION BY:

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH NUS, INC.
KING OF PRUSSIA, PENNSYLVANIA

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

FIGURES

ACRONYMS AND ABREVIATIONS

ARAR	Applicable and Relevant and Appropriate Requirements
AS	air sparging
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
CTO	Contract Task Order
DPT	direct-push technology
FS	Feasibility Study
GRA	General Response Action
IAS	Initial Assessment Study
IR	Installation Restoration
LDR	land Disposal Restriction
LUC	land use control
MCL	maximum contaminant level
mg/kg	milligram per kilogram
NCP	National Contingency Plan
NWIRP	Naval Weapons Industrial Reserve Plant
NYSDEC	New York State Department of Environmental Protection
O&M	operation and maintenance
OSHA	Occupational Safety and Health Act
PCB	polychlorinated biphenyl
PRAP	Proposed Remedial Action Plan
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
SCG	Soil Cleanup Goal
SVE	soil vapor extraction
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
µg/L	microgram per liter

1.0 INTRODUCTION

The Naval Facilities Engineering Command Mid-Atlantic has issued Contract Task Order (CTO) 139 to Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62472-03-D-0057 to prepare an evaluation of soil remediation technologies for Site 1 – Former Drum Marshalling Area at the Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage, located in Bethpage, New York. The report supports the preparation of a Work Plan to conduct a pilot test for in-situ remediation of deep polychlorinated biphenyl (PCB)-contaminated soil. This evaluation report is based on a information developed in 2007 during a "Tiger Team" evaluation of alternatives for soil remediation of Site 1.

1.1 FACILITY DESCRIPTION

NWIRP Bethpage was situated on 109 acres in Nassau County in the Hamlet of Bethpage, Town of Oyster Bay, New York (Figures 1-1 and 1-2) and located within the Northrop Grumman Aerospace complex, which covered approximately 605 acres. Prior to 2002, the NWIRP property was bordered on the north, west, and south by current or former Northrop Grumman facilities, and on the east by a residential neighborhood. By March 2008, approximately 100 acres of NWIRP property were transferred to Nassau County (Figure 1-3). The remaining 9 acres and access easements were retained by the Navy to continue remedial efforts at Installation Restoration (IR) Site 1 – Former Drum Marshalling Area and Site 4 – Former Underground Storage Tanks (Area of Concern 22). A parcel of land connecting the two sites was also retained (Figure 1-3). Currently, the 9-acre parcel of NWIRP is bordered on the east by the residential neighborhood and on the north, south, and west by County property. Access to the NWIRP is from South Oyster Bay Road to the west.

1.2 FACILITY HISTORY

NWIRP Bethpage was established in 1933. Since its inception, the plant's primary mission has been the research prototyping, testing, design engineering, fabrication, and primary assembly of military aircraft.

The facilities at NWIRP included four plants (Nos. 3, 5, and 20 used for assembly and prototype testing; and No. 10, a group of quality control laboratories), two warehouse complexes (north and south), a salvage storage area, water recharge basins, the Industrial Wastewater Treatment Plant (to process chemical effluents from the activity's manufacturing operations), and several smaller support buildings. In 1997, Grumman ceased its operations at NWIRP and control of the property returned to the Navy. In 2002, Plant 20 and four acres of associated property were transferred to Nassau County. In April 2008, Plants 3, 5, and 10, and 96 acres of related property were transferred to Nassau County.

1.3 GEOLOGY

NWIRP Bethpage is underlain by approximately 1,100 feet of unconsolidated sediments that unconformably overlie crystalline bedrock. The unconsolidated sediments consist of four distinct geologic units that, in descending order, are the Upper Glacial Formation, the Magothy Formation, the Raritan Clay Member of the Raritan Formation, and the Lloyd Sand Member of the Raritan Formation. The crystalline bedrock consists primarily of metamorphic and igneous rocks including schist, gneiss, and granite. The regional dip of the bedrock is to the south and southeast. All of the geologic units dip in these directions, although to varying degrees.

The Upper Glacial and the Magothy Formations were penetrated and sampled during previous site work; the Raritan Formation lies below the depth of historic investigations. The Upper Glacial Formation, which is about 30 to 45 feet thick, consists chiefly of coarse sands and gravels. The upper Magothy Formation consists chiefly of coarse sands to a depth of about 100 feet, below which finer sand, silts, and clays predominate. The clay is fairly common but laterally discontinuous; no individual clay horizon of regional extent underlies NWIRP Bethpage.

1.4 HYDROGEOLOGY

The Upper Glacial Formation, the Magothy Formation, and the Lloyd Sand Member (Raritan Formation) are regional aquifers. The principal aquifers of concern in this investigation are the Upper Glacial and Magothy aquifers because of their shallow depths. The Magothy aquifer is the major source of public water in Nassau County. The Lloyd Sand is not widely exploited because of its depth. In addition, the Lloyd Sand is isolated from the shallower aquifers by the Raritan Clay confining unit.

The water table beneath NWIRP Bethpage is below the bottom of the Upper Glacial Formation and therefore groundwater at the site is completely within the Magothy Formation. The magnitude of the seasonal water table fluctuation beneath the site is unknown, but it is unlikely that the water table rises to the Upper Glacial Formation.

The geologic and hydrologic information obtained from this study indicate that the Upper Glacial and Upper Magothy aquifers beneath NWIRP Bethpage are interconnected and may be considered a common aquifer. This confirms the fact that the site-specific geology is similar to the regional geology, as described in published reports. Groundwater in this aquifer occurs under water-table or unconfined conditions. The number and thickness of clay lenses increase with depth within the Magothy, but the horizontally discontinuous nature of these units prevents any one of them from functioning as an aquitard or semiconfining unit.

Regional groundwater beneath NWIRP Bethpage flows to the south southeast. Historically, when facility operations were in full production at different times, groundwater at Site 1 was determined to flow to the southwest, south, or southeast. The flow was influenced by the groundwater mounding that occurs at the recharge basins and the groundwater withdrawal at the facility production wells to the west. These wells have the potential to significantly change the local flow pattern. These wells operated on an irregular basis and in various combinations, which makes their influence on the local flow regime at any particular time difficult to predict.

The horizontal hydraulic gradient varied throughout NWIRP Bethpage due to the recharge basins and facility wells. The average hydraulic gradient calculated across the activity is about 5.3 feet/mile, which is significantly lower than the published regional gradient of 10 feet/mile. The average linear velocity of the groundwater at the water table is estimated to range from 0.2 feet/day to 0.9 feet/day, which is significantly less than the previously estimated 50 to 70 feet/day.

NWIRP Bethpage occupies an area of recharge. In the absence of effects from the recharge basins and production wells, vertical hydraulic gradients are in a downward direction, but are very low. This agrees with previously published regional data. Locally, much higher vertical gradients were measured.

In 1997, Northrop Grumman ceased operations at the facility, and since that time, production wells located on site have been abandoned. Current use of the recharge basins is limited to storm water inflow and groundwater flow at the facility approximates regional flow. In 1991, groundwater was encountered at a depth of approximately 44 feet below the ground surface at Site 1. In 2008, groundwater was encountered at depth of approximately 53 feet below ground surface at Site 1.

1.5 INVESTIGATIVE AND REMEDIAL HISTORY

An Initial Assessment Study (IAS) of NWIRP Bethpage conducted in 1986 indicated that three areas at the Bethpage Plant posed a threat to human health and the environment. These three sites included Site 1 – Former Drum Marshalling Area, Site 2 – Recharge Basin Area, and Site 3 – Salvage Storage Area.

Based on the data presented in the IAS, it was determined that there was a potential for volatile organic, semivolatile organic, and inorganic contamination at each of the three sites. In addition, based on site observations, there is the potential that transformers (possibly containing PCBs) may have also been stored at these sites. However, there are no historic records to backup these observations and it is unknown whether or not the transformers were properly drained prior to storage.

In August 1991, a Remedial Investigation (RI) was initiated at NWIRP Bethpage to attempt to determine the nature and extent of the contamination found during the IAS and how that contamination was related to each of the three sites.

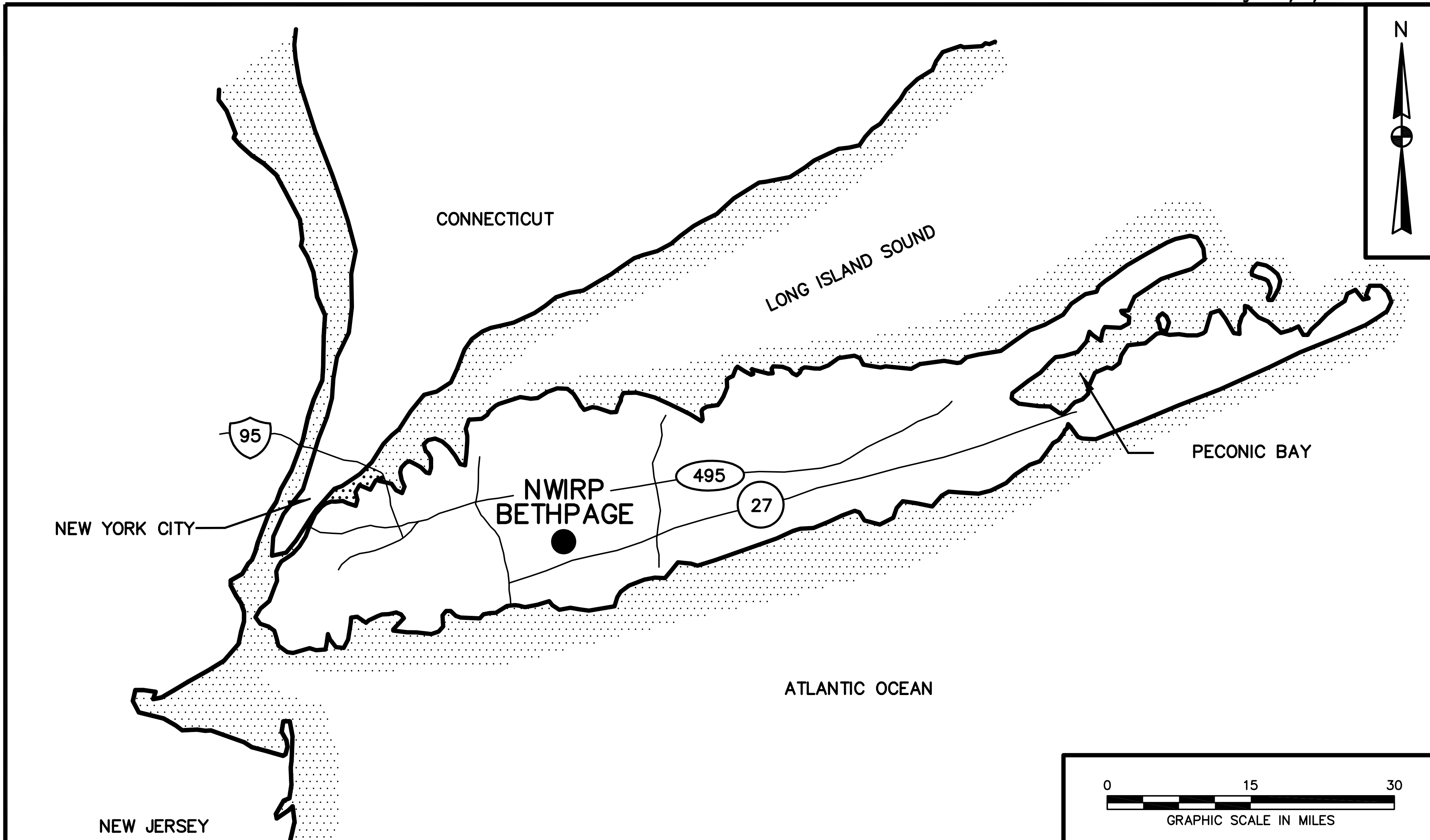
Based on the conclusions of the Phase 1 RI, it was decided to proceed with a Phase 2 RI. The objectives of this second phase study were to determine the extent of PCB contamination at all three sites as well as the extent of the offsite groundwater contamination to the east in the adjacent neighborhood. Also, there was an attempt to identify the source of the significant finding of trichloroethene at Site 1 discovered during the Phase 1 RI.

The analytical data generated during the RI was compared to Applicable or Relevant and Appropriate Requirements (ARARs) and used in developing remedial alternatives. Groundwater and drinking water criteria were based on the Federal drinking water standards Maximum Contaminant Levels (MCLs) and Title 10 Subpart 5 of the New York State Sanitary Code. For the evaluation of soil analytical results, Federal and State cleanup guidelines for the protection of groundwater, site background conditions, and risk-based remediation criteria were used to develop potential remediation goals.

In 1995, a Record of Decision (ROD) was signed for Sites 1, 2, and 3. The major components of the selected remedy for these sites included further delineation of contaminants, soil excavation, and the construction, operation, and maintenance of an air sparge/soil vapor extraction (AS/SVE) system. The AS/SVE system was installed and intermittently operated from 1997 through 2002. By 2002, the remedial activities for Sites 2 and 3 and the VOC component of Site 1 were completed.

In 2001, a second ROD for Operable Unit 2 (Groundwater) was signed. The major component of the second ROD was the groundwater remedial program created to address the regional groundwater contaminant plume associated with the Northrop Grumman and NWIRP Sites.

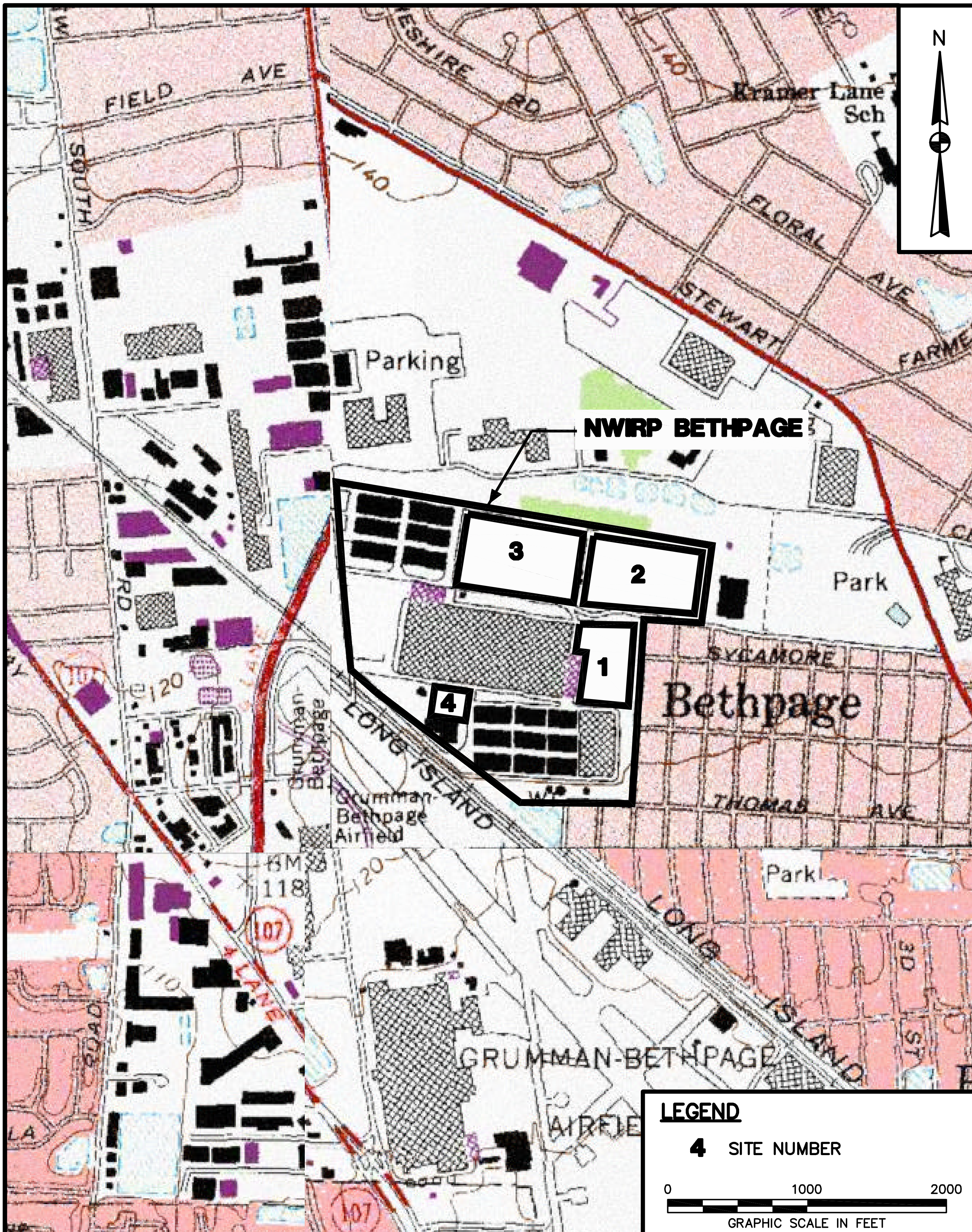
ACAD: 0804CM01.dwg 06/14/07 MF PIT



DRAWN BY MF / DATE 6/13/07	Tetra Tech NUS, Inc.	GENERAL LOCATION MAP NWIRP BETHPAGE BETHPAGE, NEW YORK	CONTRACT NO. 0804	
CHECKED BY / DATE			OWNER NO.	
REVISED BY / DATE			APPROVED BY / DATE	
SCALE AS NOTED			DRAWING NO. FIGURE 1-1	REV. 0

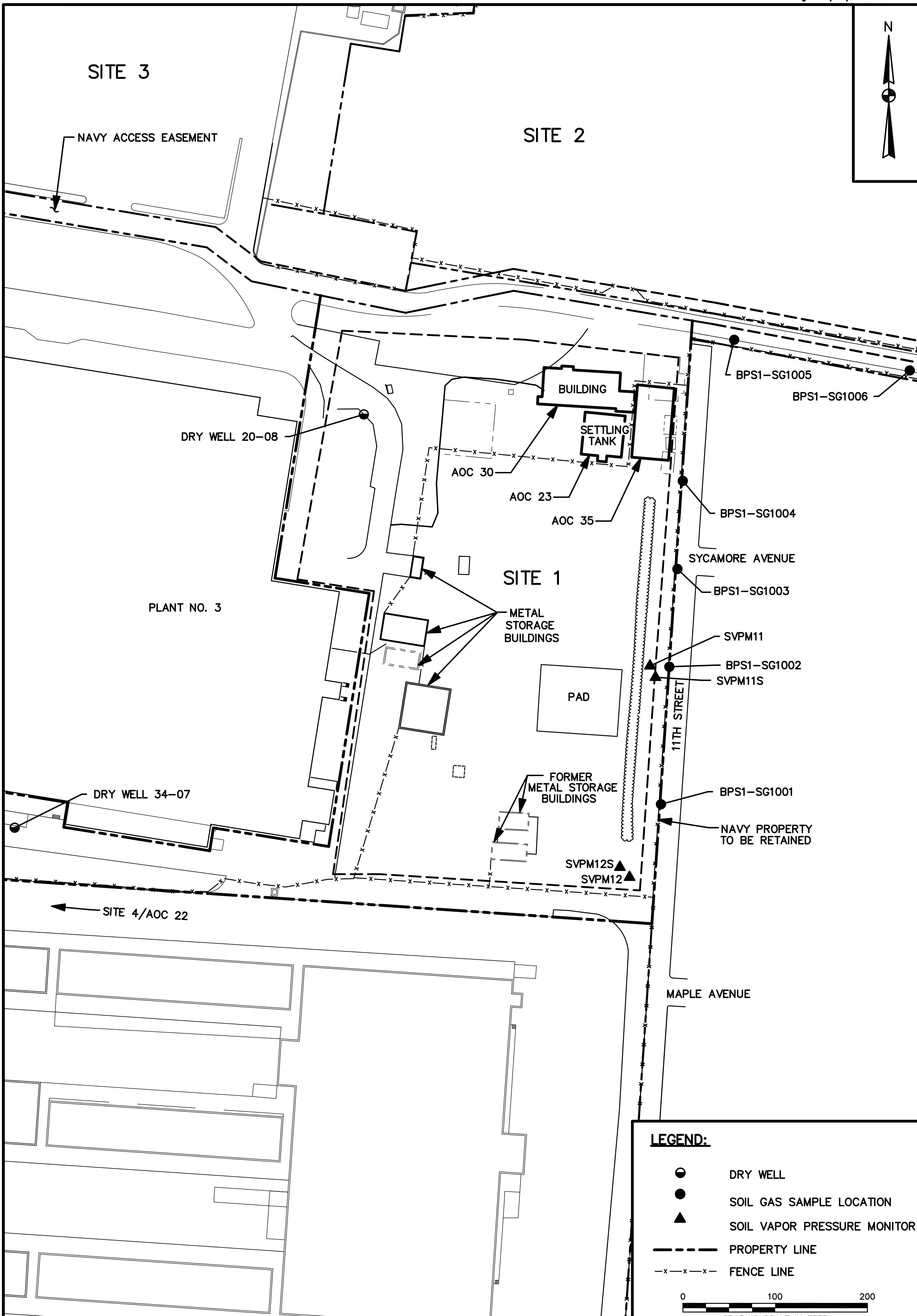
FORM CADD NO. TTNUS-AH.DWG - REV 1 -9/10/98

ACAD: 0804CM02.dwg 06/13/07 MF PIT



DRAWN BY MF	DATE 6/13/07	Tetra Tech NUS, Inc.	SITE LOCATION MAP SITE 1 NWIRP BETHPAGE BETHPAGE, NEW YORK	CONTRACT NO. 0804	
CHECKED BY	DATE			OWNER NO.	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 1-2	REV. 0

FORM CADD NO. TTNUS-AV.DWG - REV 1 -9/10/98



DRAWN BY MF	DATE 11/5/07	Tetra Tech NUS, Inc.	SITE 1 LAYOUT MAP NWIRP BETHPAGE BETHPAGE, NEW YORK	CONTRACT NO. 9845	
CHECKED BY	DATE			OWNER NO.	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 1-3	REV. 0

2.0 SUMMARY OF SITE 1 ACTIVITIES

Starting in 1969, hazardous waste management practices for Grumman facilities on Long Island included marshalling of drummed wastes on the Navy property at NWIRP Bethpage. This storage first took place on a cinder-covered surface over the cesspool field east of Plant 3. From the early 1950s through about 1978, drums containing liquid cadmium waste were stored here. In 1978, the collection and marshalling point was moved a few yards south of the original unpaved site, to an area on a 100- by 100-foot concrete pad. This pad had no cover and no berms for containment of spills. In 1982, drummed waste storage was transferred to a Drum Marshalling facility located in the Salvage Storage Area (Site 3); a cover was added in 1983.

Reportedly, all drums of waste marshaled at the Former Drum Marshalling Areas were taken off-site by a private contractor for treatment or disposal. There are no reports of leaks or spills of drum contents.

Materials stored at the Former Drum Marshalling Area included waste halogenated and nonhalogenated solvents. Cadmium and cyanide were also stored in this area from the early 1950s through 1974. Reportedly, 200 to 300 drums were stored at each area at any one time.

In 1986, the IAS was conducted at Site 1 followed by the two phase RI. The purpose of the RI was to identify the nature and extent of contamination associated with Site 1. Phase 1 conducted in May 1992 and Phase 2 conducted in October 1993 identified the nature of contamination but was unable to establish the extent of contamination. However, the RI process did adequately delineate the horizontal extent of soil contamination. The identified contamination was significant enough to require an Interim Remedial Measure that was conducted in July 1993. During the Interim Remedial Measure, a soil cover was placed over the limits of Site 1 to eliminate risk associated with fugitive dust and dermal contact. With the interim remedial measures complete, a Feasibility Study (FS) was conducted in March 1994. The results of the FS were the development of the Proposed Remedial Action Plan (PRAP) issued in October 1994 and the development of the Site 1 ROD that was issued in May 1995.

The 1995 ROD summarized what was at the time believed to be the nature and extent of contamination and identified where more data needed to be collected to further delineate the extent of contamination. The ROD also identified the Remedial Action Objective (RAOs) and the selected remedy for Site 1. The RAOs included:

- Compliance with contaminant-specific, location-specific, and action-specific requirements to achieve the soil cleanup goal (SCG) of 10 mg/kg of PCBs.

- Reduce, control, or eliminate the contamination present within site soils.

- Prevent human exposure to contaminated soils at concentrations greater than the remedial action goals.

- Prevent leaching of contaminants in soil which could result in groundwater contamination in excess of groundwater remediation goals.

- Prevent offsite migration of contamination.

The selected remedy included:

- Collection of additional samples that were needed to verify and provide details necessary for a soil excavation and disposal to remediate the inorganic and PCB contamination and AS/SVE system operation to remediate of the volatile organic compound (VOC) contamination.

- Excavation of arsenic-contaminated soil (600 cubic yards) and PCB-contaminated soil (1,400 cubic yards) for treatment and disposal (volumes reported in the ROD were based on sampling that extended 5-feet below ground surface [bgs]).

- Remediation of VOC-contaminated soils using the AS/SVE system.

- Remediation of VOC-contaminated groundwater using AS.

- Implementation of institutional controls. Institutional controls included a gravel or vegetative cover over residual contamination to remain in place (permeable cover to encourage natural attenuation of residual VOCs) and deed restrictions to limit the use and exposure of the Site 1 area.

- Provision for an interim remedial measure. Reimbursement of cost to the Bethpage Water District for providing water treatment to the public water supply wells.

Implementation of the ROD began in 1995 when the post-ROD remedial design studies began to delineate the extent of PCB contamination at depth. During the remedial design studies that were completed in 1998, it was determined that the depth of PCB contamination far exceeded the anticipated depth reported in the ROD and two former dry well areas (34-07 and 20-08) were added to the Site 1 scope of work. In 1998, the AS/SVE system went into operation and continued operating through 2002. In October 2002, the Navy reported that the objectives of the AS/SVE system had been met and recommended removal of the system. In December 2003, the New York State Department of Environmental Conservation (NYSDEC) concurred with this recommendation and the AS/SVE system was removed.

Currently, the vertical extent of PCB contamination is known to extend beyond the depth of groundwater at the site to approximately 65 feet and the volume of PCB contaminated soil (concentrations greater than 1 mg/kg) exceeds 38,000 cubic yards. Groundwater at the site is approximately 50 feet below ground surface. Figures 1 through 7 present the known extent of contamination of PCB-contaminated soils associated with Site 1 and the dry wells.

In the 1991, groundwater at the downgradient edge of the site contained up to 15,000 µg/L of chlorinated VOCs. By the end of 2006, through the AS/SVE treatment of the site soils and shallow groundwater and natural attenuation processes, groundwater at the downgradient edge of the site contained approximately 21 µg /L.

Sampling to evaluate the presence of PCBs in groundwater was first conducted in October 2006. A second round of testing was conducted in January 2008. Four monitoring wells, including three water table wells and one well at a depth of approximately 50 feet below the water table at the downgradient edge of the site were sampled. Low flow groundwater sampling techniques were used. PCBs (Aroclor-1242 and -1248) were detected in each of the wells, with concentrations ranging from 0.27 to 1.4 µg/L. The maximum contaminant level (MCL) is 0.5 µg/L.

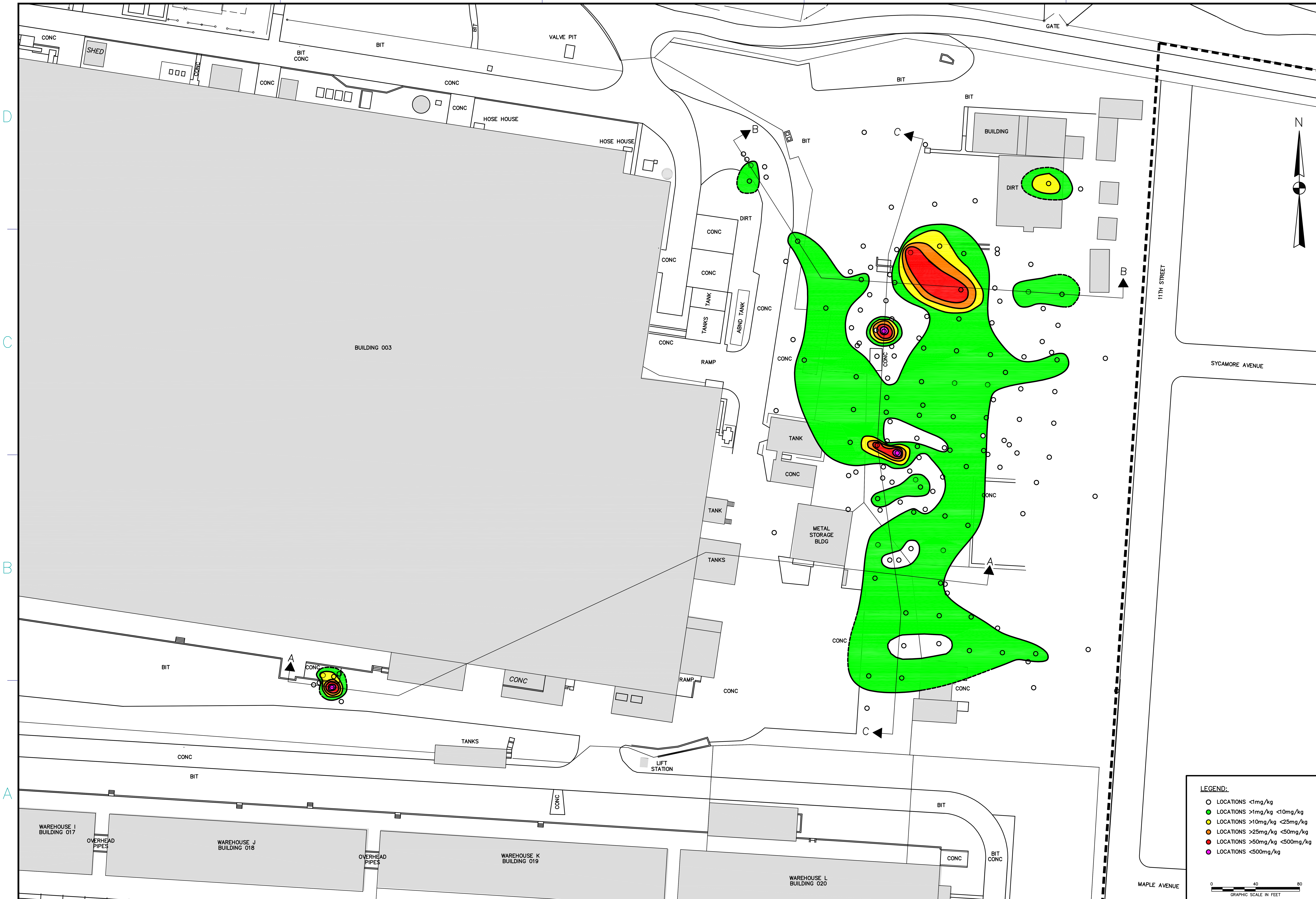
Because the extent of the PCB contamination is significantly greater than identified in the 1995 ROD, the Navy began looking into reopening the ROD for the purposes of re-evaluating remedial alternatives to remediate the PCB soil contamination. In the fall of 2006, the Navy began conducting internal meetings (Tiger Team meetings) to investigate remediation options and a direction forward for reopening the ROD. The Tiger Team concluded its work with a submission to the NYSDEC in March 2007 that outlined an approach to reopen the ROD. The submission included the current understanding regarding the nature and extent of Site 1 contamination and an evaluation (including cost and implementation) of remedial alternatives (including the original ROD remedy).


BUILDING 003
HOSE HOUSE
VALVE PIT
SHED
CONC
BIT
BIT CONC
DIRT
TANK
TANKS
ABND TANK
RAMP
METAL STORAGE BLDG
BUILDING
GATE
N
11TH STREET
SYCAMORE AVENUE
MAPLE AVENUE
LIFT STATION
WAREHOUSE I BUILDING 017
OVERHEAD PIPES
WAREHOUSE J BUILDING 018
WAREHOUSE K BUILDING 019
WAREHOUSE L BUILDING 020
LEGEND:
LOCATIONS <1mg/kg
LOCATIONS >1mg/kg <10mg/kg
LOCATIONS >10mg/kg <25mg/kg
LOCATIONS >25mg/kg <50mg/kg
LOCATIONS >50mg/kg <500mg/kg
LOCATIONS <500mg/kg
0 40 80
GRAPHIC SCALE IN FEET
NAVFAC
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT NAVAL STATION – NORFOLK, VIRGINIA
NWIRP BETHPAGE BETHPAGE, NEW YORK
PCBs CONCENTRATIONS - 0 - 2 FEET BGS
CODE ID. NO. 80091
SIZE D
SCALE:
MAXIMO NO.
JOB ORDER NO.
SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF
DES
DR MF
CHK TWS
QC
DESIGNER
REVIEWED BY
DESIGN MANAGER
FIRE PROTECTION
BRANCH MANAGER
ENGINEERING DIR.
ACAD: 9845GM07.dwg 11/07/06 DT PIT

FIGURE - 2-1

BUILDING 003
HOSE HOUSE
VALVE PIT
SHED
CONC
BIT
BIT CONC
DIRT
TANK
TANKS
ABND TANK
RAMP
BUILDING
GATE
11TH STREET
SYCAMORE AVENUE
MAPLE AVENUE
LIFT STATION
WAREHOUSE I BUILDING 017
WAREHOUSE J BUILDING 018
WAREHOUSE K BUILDING 019
WAREHOUSE L BUILDING 020
OVERHEAD PIPES
N
LEGEND:
LOCATIONS <1mg/kg
LOCATIONS >1mg/kg <10mg/kg
LOCATIONS >10mg/kg <25mg/kg
LOCATIONS >25mg/kg <50g/kg
LOCATIONS >50mg/kg <500mg/kg
LOCATIONS >500mg/kg
0 40 80
GRAPHIC SCALE IN FEET
NAVFAC
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT
NAVAL STATION – NORFOLK, VIRGINIA
NWIRP BETHPAGE
BETHPAGE, NEW YORK
PCBs CONCENTRATIONS - 2 - 15 FEET BGS
CODE ID. NO. 80091
SIZE D
SCALE:
MAXIMO NO.
JOB ORDER NO.
SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF
DES
DR MF
CHK TWS
QC
ACAD:9845GM05.dwg 11/07/06 DT PIT

FIGURE 2-2



DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT NAVAL STATION – NORFOLK, VIRGINIA

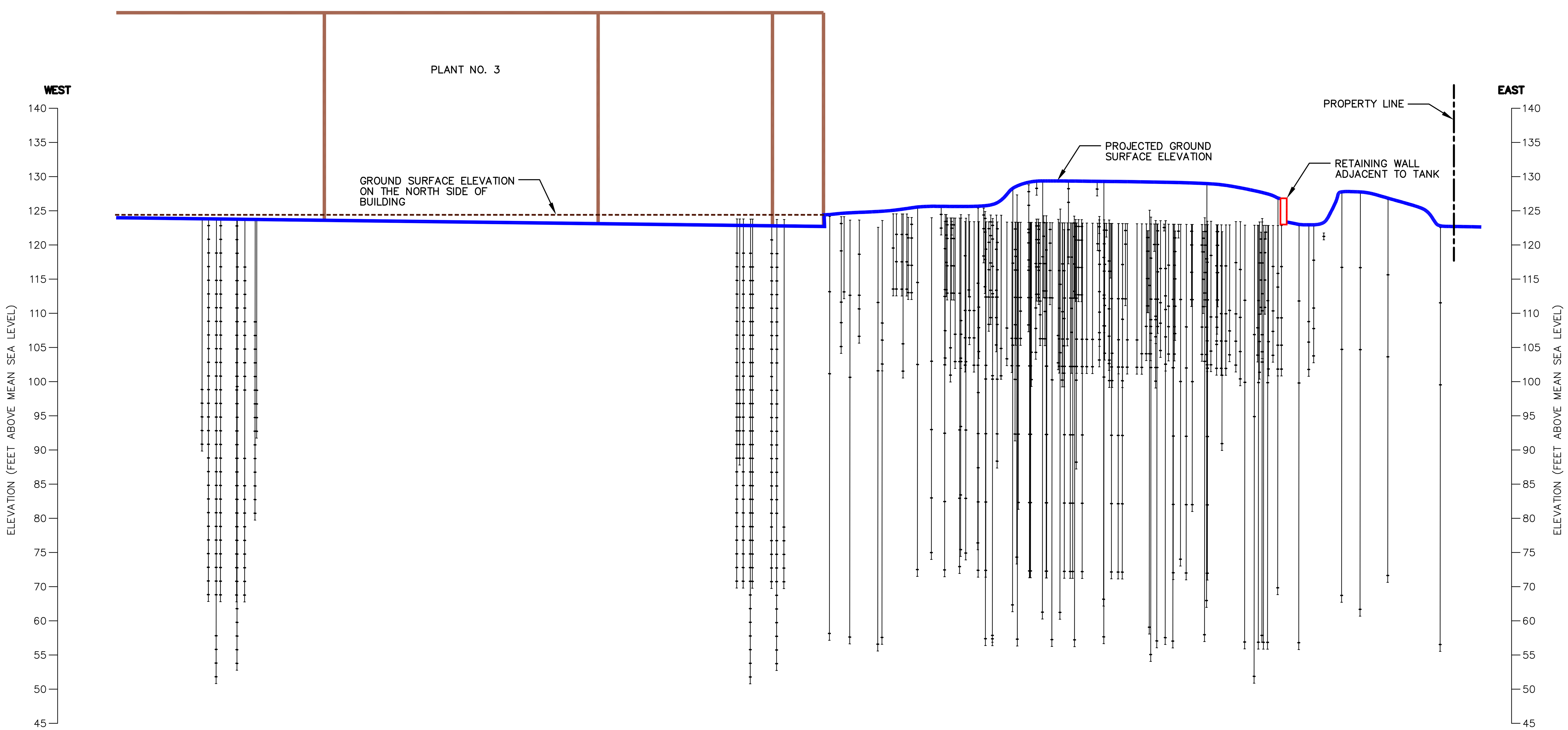
NWIRP BETHPAGE BETHPAGE, NEW YORK

PCBs CONCENTRATIONS - 15 - 25 FEET BGS

SUBMITTED BY
FIRM MEMBER DATE
APPROVED
ACTIVITY – SATISFACTORY TO DATE
APPROVED
FOR COMMANDER NAVFAC DATE
DES | DR MF
CHK TWS | QC
DESIGNER
REVIEWED BY
QC
DESIGN MANAGER
FIRE PROTECTION
BRANCH MANAGER
ENGINEERING DIR.
CODE ID. NO. 80091 | SIZE D
SCALE:
MAXIMO NO.
JOB ORDER NO.
SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF

FIGURE 2-3


LEGEND:
LOCATIONS <1mg/kg
LOCATIONS >1mg/kg <10mg/kg
LOCATIONS >10mg/kg <25mg/kg
LOCATIONS >25mg/kg <50mg/kg
LOCATIONS >50mg/kg <500mg/kg
LOCATIONS <500mg/kg
0 40 80
GRAPHIC SCALE IN FEET
N
BUILDING 003
WAREHOUSE I BUILDING 017
WAREHOUSE J BUILDING 018
WAREHOUSE K BUILDING 019
WAREHOUSE L BUILDING 020
OVERHEAD PIPES
HOSE HOUSE
VALVE PIT
SHED
BIT
CONC
DIRT
TANK
TANKS
ABND TANK
RAMP
METAL STORAGE BLDG
BUILDING
LIFT STATION
GATE
11TH STREET
SYCAMORE AVENUE
MAPLE AVENUE
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT
NAVAL STATION – NORFOLK, VIRGINIA
NWIRP BETHPAGE
BETHPAGE, NEW YORK
PCBs CONCENTRATIONS > 25 FEET BGS
NAVFAC
SUBMITTED BY
FIRM MEMBER
DATE
APPROVED
ACTIVITY – SATISFACTORY TO
FOR COMMANDER NAVFAC
DES
DR MF
CHK TWS
QC
DESIGNER
REVIEWED BY
QC
DESIGN MANAGER
FIRE PROTECTION
BRANCH MANAGER
ENGINEERING DIR.
CODE ID. NO. 80091
SIZE D
SCALE:
MAXIMO NO.
JOB ORDER NO.
SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF
FIGURE 2-4
ACAD: 9845GM06.dwg 11/07/06 DT PIT



0 40 80
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND:

TOP OF SOIL BORING
CENTER OF SOIL SAMPLE INTERVAL
BOTTOM OF SOIL BORING

SYM | DESCRIPTION | DATE | APPR

NAVFAC

SUBMITTED BY
FIRM MEMBER DATE
APPROVED
ACTIVITY – SATISFACTORY TO DATE
APPROVED
FOR COMMANDER NAVFAC DATE
DES | DR MF
CHK TWS | QC
DESIGNER
REVIEWED BY
QC
DESIGN MANAGER
FIRE PROTECTION
BRANCH MANAGER
ENGINEERING DIR.

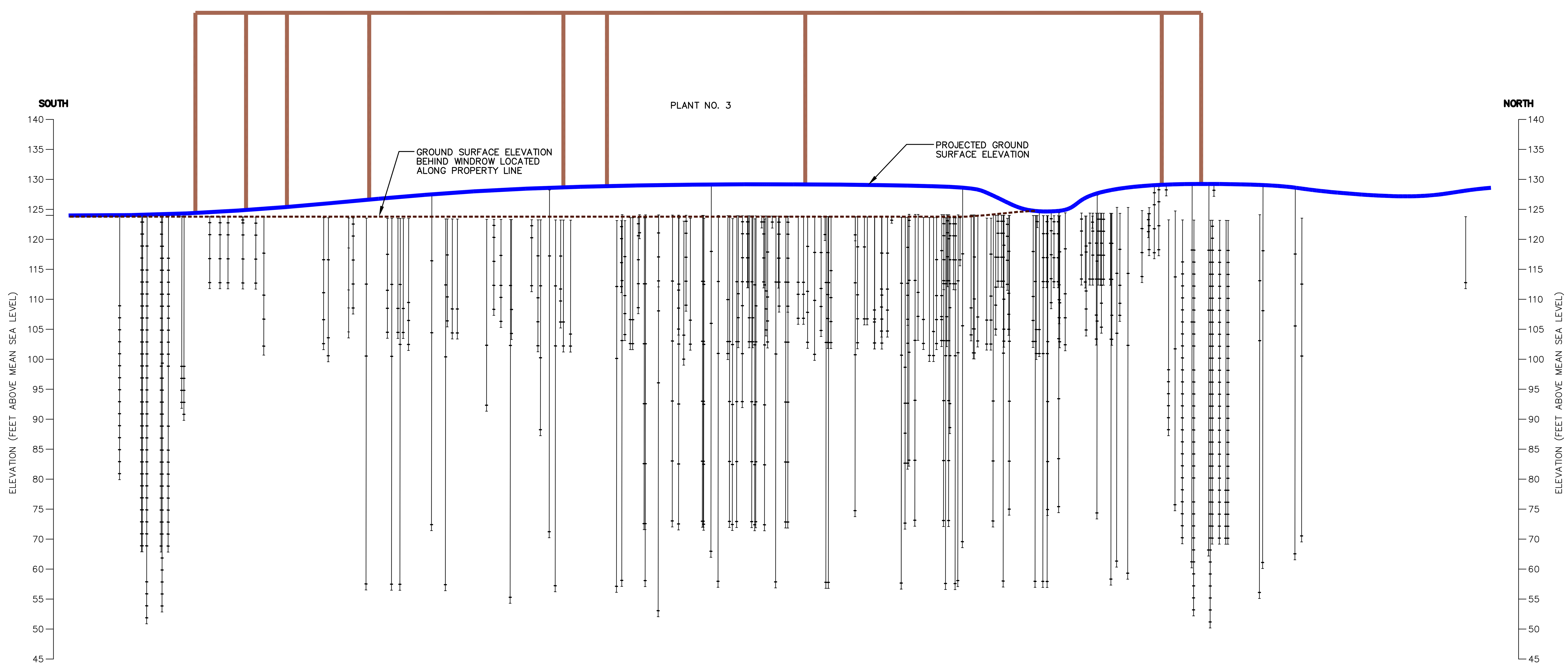
DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND – MID-ATLANTIC
NORTHEAST IPT NAVAL STATION – NORFOLK, VIRGINIA
NWIRP BETHPAGE BETHPAGE, NEW YORK

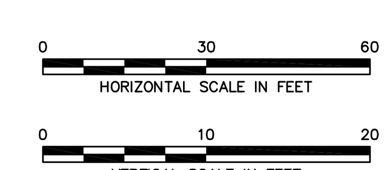
PCB SAMPLING LOCATIONS LOOKING NORTH

CODE ID. NO. 80091 | SIZE D
SCALE:
MAXIMO NO.
JOB ORDER NO.
SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF

FIGURE 2-5

ACAD: 9845CX02.dwg 11/09/06 MF PIT





LEGEND:

TOP OF SOIL BORING

CENTER OF SOIL SAMPLE INTERVAL

BOTTOM OF SOIL BORING

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT NAVAL STATION - NORFOLK, VIRGINIA

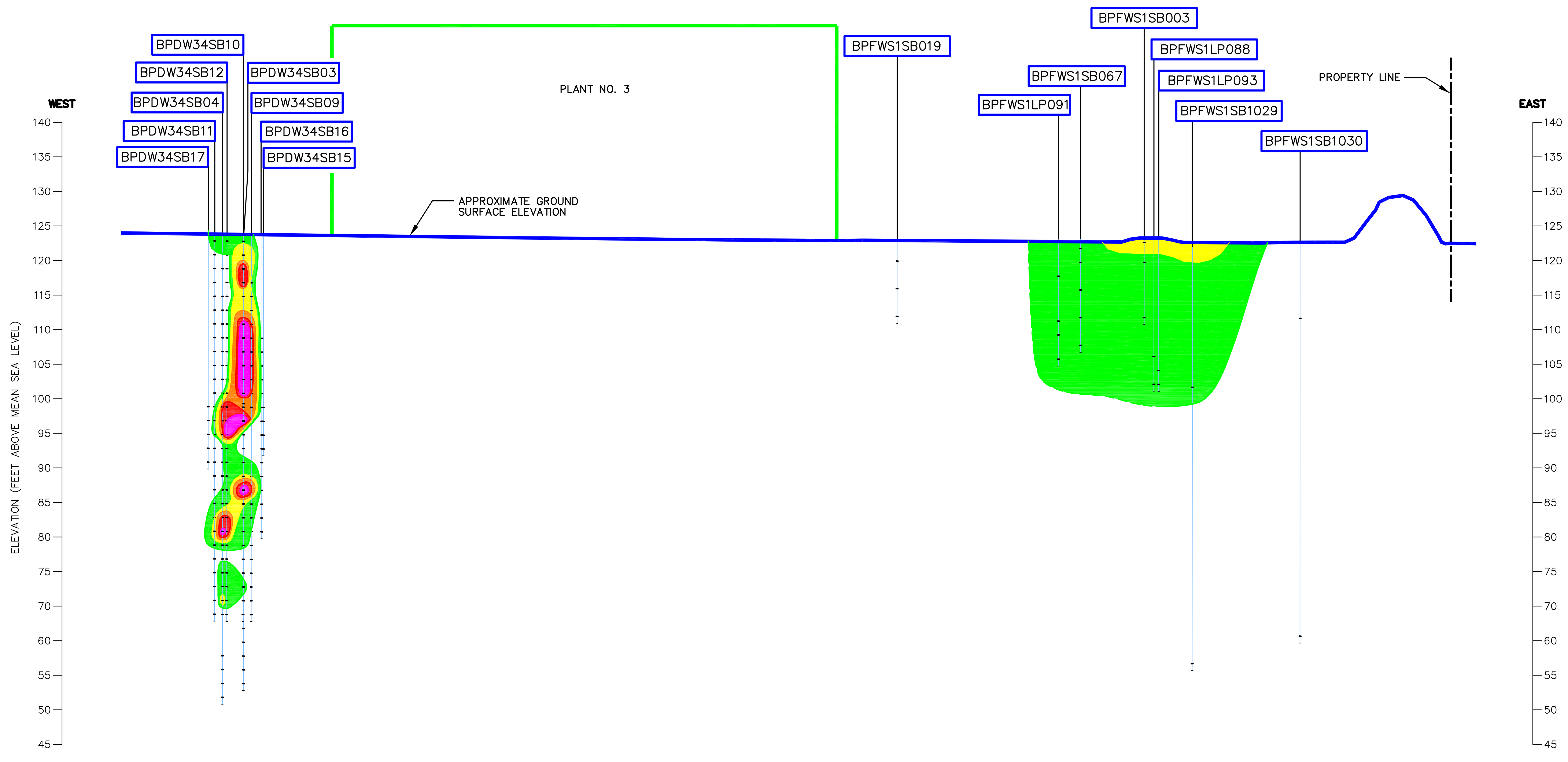
NWIRP BETHPAGE BETHPAGE, NEW YORK

PCB SAMPLING LOCATIONS
LOOKING WEST

CHK TWS
DR MF
CODE ID. NO. 80091 SIZE D

FIGURE 2-6

ACAD: 9845CX03.dwg 11/09/06 MF PIT



LEGEND:

- PCB CONTAMINATION >1mg/kg <10mg/kg
- PCB CONTAMINATION >10mg/kg <25mg/kg
- PCB CONTAMINATION >25mg/kg <50mg/kg
- PCB CONTAMINATION >50mg/kg <500mg/kg
- PCB CONTAMINATION >500mg/kg

TOP OF SOIL BORING

CENTER OF SOIL SAMPLE INTERVAL

BOTTOM OF SOIL BORING

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT NAVAL STATION - NORFOLK, VIRGINIA

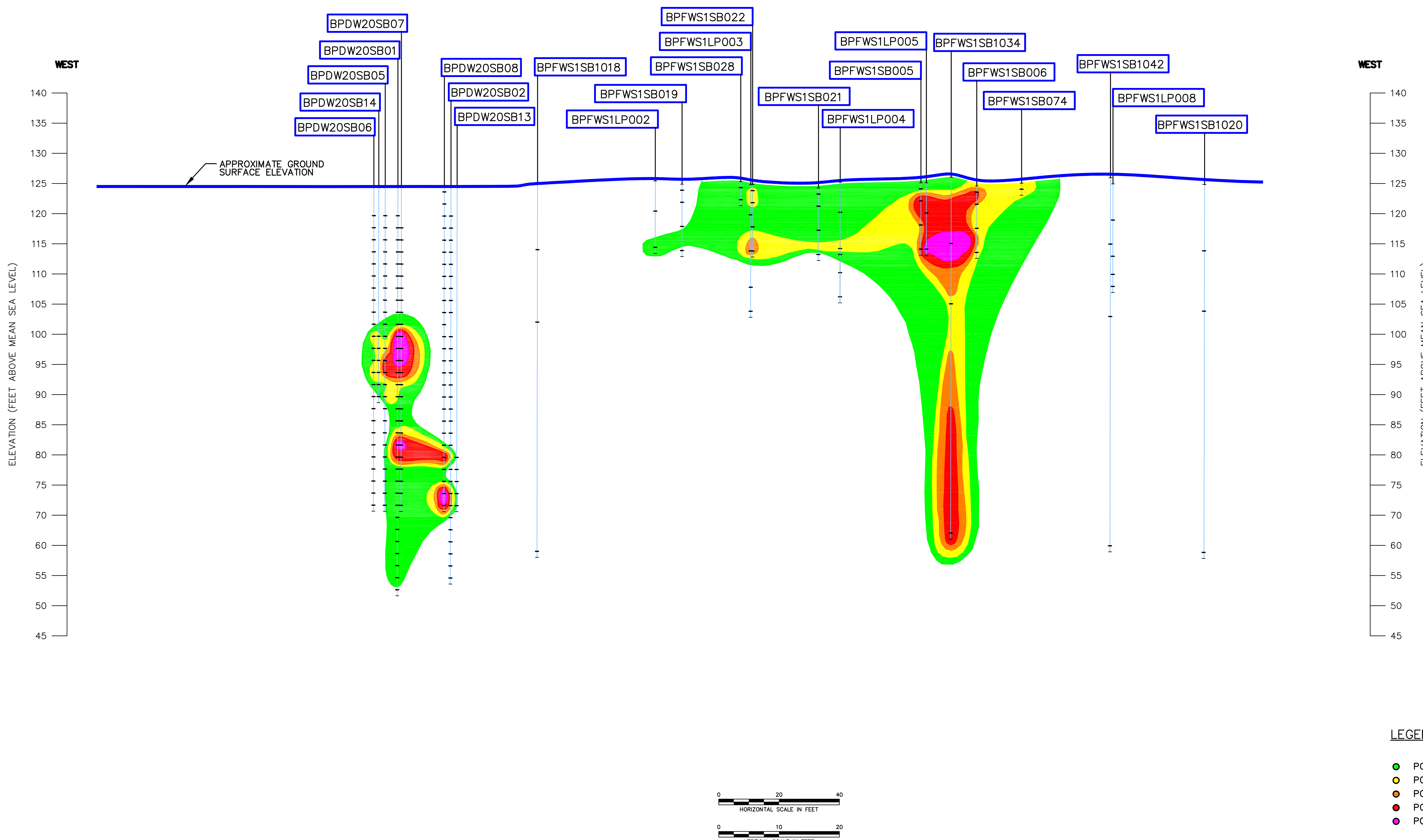
NWIRP BETHPAGE BETHPAGE, NEW YORK

PCB CONTAMINATION - SECTION A - A'

DR MF
CHK TWS
CODE ID. NO. 80091 SIZE D

FIGURE 2-7

ACAD: 9845CX04.dwg 11/12/06 DT PIT



LEGEND:

- PCB CONTAMINATION >1mg/kg <10mg/kg
- PCB CONTAMINATION >10mg/kg <25mg/kg
- PCB CONTAMINATION >25mg/kg <50mg/kg
- PCB CONTAMINATION >50mg/kg <500mg/kg
- PCB CONTAMINATION >500mg/kg

TOP OF SOIL BORING

CENTER OF SOIL SAMPLE INTERVAL

BOTTOM OF SOIL BORING

SYM | DESCRIPTION | DATE | APPR

NAVFAC

SEAL

SUBMITTED BY

FIRM MEMBER DATE

APPROVED

ACTIVITY – SATISFACTORY TO DATE

APPROVED

FOR COMMANDER NAVFAC DATE

DES	DR MF
CHK TWS	QC
DESIGNER	
REVIEWED BY	
QC	
DESIGN MANAGER	
FIRE PROTECTION	
BRANCH MANAGER	
ENGINEERING DIR.	

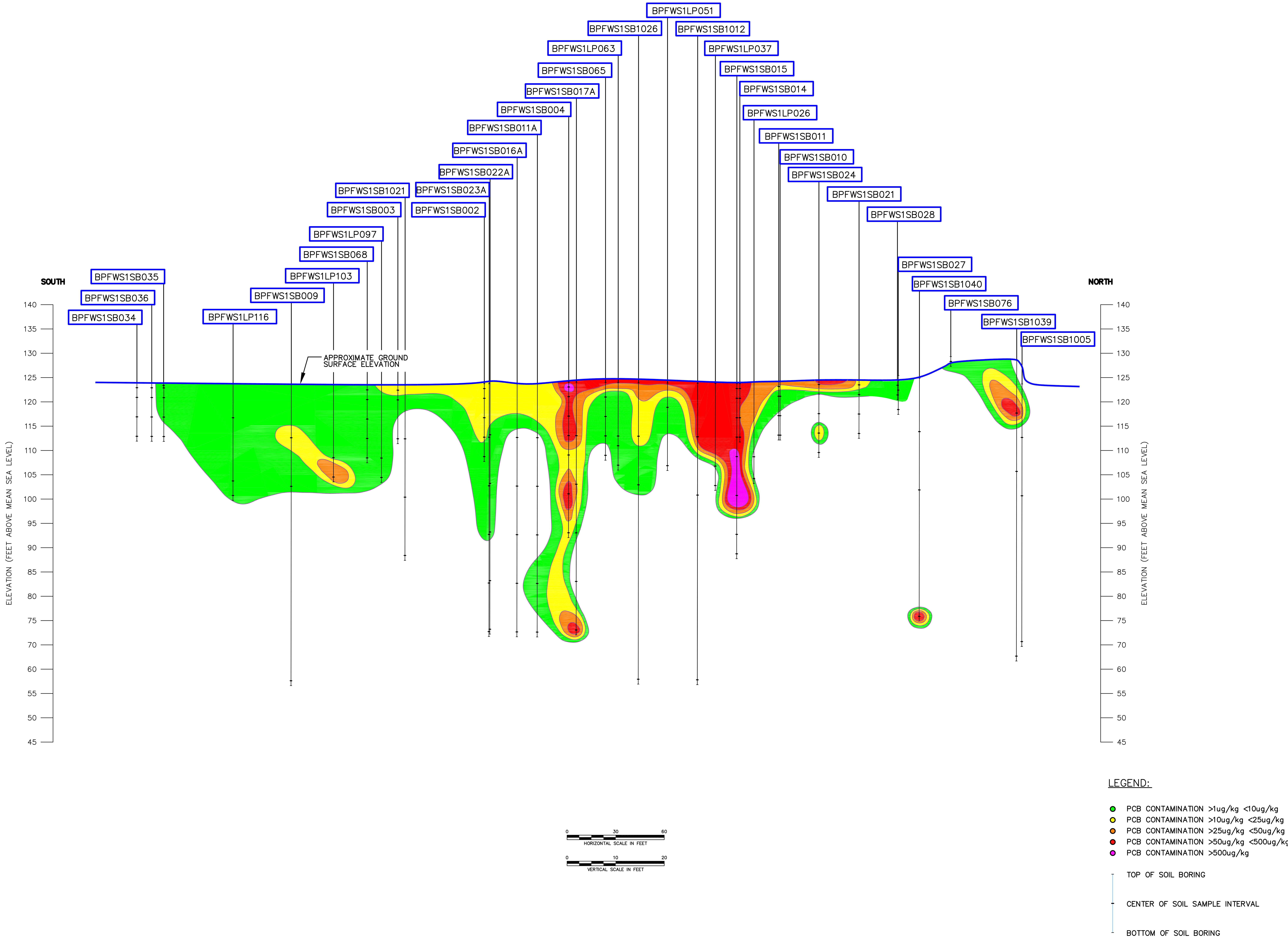
DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT NAVAL STATION – NORFOLK, VIRGINIA
NWIRP BETHPAGE BETHPAGE, NEW YORK

PCB CONTAMINATION - SECTION B - B'

CODE ID. NO. 80091	SIZE D
SCALE:	
MAXIMO NO.	
JOB ORDER NO.	
SPEC. NO.	
CONSTR. CONTR. NO.	
NAVFAC DRAWING NO.	
SHEET	OF

FIGURE 2-8

ACAD: 9845CX05.dwg 11/12/06 DT PIT



DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND ~ MID-ATLANTIC
NORTHEAST IPT NAVAL STATION - NORFOLK, VIRGINIA

NWIRP BETHPAGE
BETHPAGE, NEW YORK

PCB CONTAMINATION - SECTION C - C'

DES | DR MF
CHK TWS

ACAD: 9845CX06.dwg 11/13/06 MF PIT

FIGURE 2-9

3.0 SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential technologies and process options that may be applicable to the remedial alternatives for Site 1. The primary objective of this section is to develop an appropriate range of remedial technologies and process options that will be used for developing the remedial alternatives.

Technologies were identified and screened based on current data for the site and ARARs and RAOs developed in the previous RI/FS. RAOs include prevention of human exposure to contaminated soils at concentrations greater than the remedial action goal, prevention of leaching of contaminants to groundwater which could result in groundwater contamination in excess of groundwater remediation goals, and prevent offsite migration of contaminants.

General Response Actions (GRAs) are broadly defined remedial approaches that may be used (by themselves or in combination with one or more of the others) to attain the RAOs. GRAs describe categories of actions that could be implemented to satisfy or address a component of the RAOs for the site. Remedial action alternatives are formed using GRAs singly or in combination to meet the RAOs.

The following GRAs will be considered for soil at Site 1:

- No Action
- Existing Controls (Land use controls)
- Containment
- Removal
- In-Situ Treatment
- Ex-Situ (On-Site) Treatment
- Disposal

Technology screening evaluation is performed in this section with the completion of the following analytical steps:

- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

A variety of technologies and process options are identified under each GRA and screened. The selection of technologies and process options for initial screening is based on the Guidance for

Conducting Remedial Investigations/Feasibility Studies under CERCLA (USEPA, 1988). The screening is first conducted at a preliminary level to focus on relevant technologies and process options. Then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

The evaluation criteria for detailed screening of technologies and process options that have been retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

- Effectiveness
  - Protection of human health and the environment; reduction in toxicity, mobility, or volume; and permanence of the solution.
  - Ability of the technology to address the estimated areas or volumes of the contaminated medium.
  - Ability of the technology to attain the cleanup goals required to meet the RAOs.
  - Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term maintenance and operation requirements.

- Cost (Qualitative)
  - Capital cost.
  - land use controls (LUCs) costs.

Technologies and process options will be identified in the following sections.

3.1 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens technologies and process options at a preliminary stage based on implementation with respect to site conditions and contaminants of concern. Table 3-1 summarizes the preliminary screening of technologies and process options applicable to soil. It presents the general response actions, identifies the technologies and process options, and provides a brief description of each process option followed by the screening comments.

The following are the soil technology and process options remaining for the detailed screening:

General Response Action	Technology	Process Options
No Action	None	Not applicable
Existing Controls	Land Use Controls	Environmental Easements; Zoning/Ordinances; Defined Site Use; Site Management Plan
	Monitoring	Groundwater Sampling and Analysis
Containment	Capping	Asphalt; Soil/Gravel; Clay/Soil; RCRA Hazardous Waste Landfill Cap
Removal	Excavation	Mechanical
In-Situ Treatment	Solidification	Soil Mixing; Jet Grouting
Disposal	Off-Site Disposal	Hazardous Waste Landfill

3.2 DETAILED SCREENING OF SOIL TREATMENT TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and develops the representative process options, through a detailed screening procedure, that will be used in the formulation of remedial alternatives.

3.2.1 No Action

No Action consists of maintaining status quo at the site. As required under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations, the No Action alternative is carried through the evaluation to provide a baseline for comparison of alternatives and their effectiveness in mitigating risks posed by site contaminants.

Effectiveness: No action would not be effective in meeting the soil RAOs. No action would not actively reduce the toxicity, mobility, or volume of contaminants in the soil. There would be no reduction in risk through exposure control or treatment. PCB contamination would remain.

Implementability: There would be no implementability concerns because no action would be implemented.

Cost: There would be no costs associated with the No Action alternative.

Conclusion: No action is retained because of National Contingency Plan (NCP) requirements, although it would not be effective.

3.2.2 Existing Controls (Limited Action)

This GRA consists of LUCs to limit or restrict site use and environmental monitoring.

Land Use Controls

LUCs would be developed to prevent the site from being used in the future for residential purposes. Because the site would continue to be used, physical restrictions such as signage, fencing, physical barriers, and site security would not generally be applicable.

LUC performance objectives and restrictions for Site 1 soil would include:

- Prohibit residential reuse of the site unless prior written approval is obtained from the NYSDEC.
- Restrict excavation that could disturb subsurface soils without prior approval from NYSDEC.
- Restrict use of groundwater without prior approval from NYSDEC.

Annual inspections of the site would be conducted to confirm compliance with LUC objectives, and an annual compliance certificate would be prepared and provided to United States Environmental Protection Agency (U.S. EPA) and NYSDEC. Prior to any property conveyance, U.S. EPA and NYSDEC would be notified.

The LUCs would be implemented through a LUC Remedial Design (RD) that would be prepared as a component of the overall RD. LUCs would be implemented through deed restrictions and similar real estate documents.

The Navy does currently owns the site, but it is anticipated that once remedy is in place, the property would be transferred. Use of municipal regulations or codes (such as zoning laws) were considered further because of the potential difficulty for the municipality of enforcing such zoning laws in the future.

Effectiveness: LUCs would not reduce the toxicity, mobility, or volume of COCs in soil. PCB contamination would remain. Prohibiting future residential development of the site would effectively prevent the occurrence of unacceptable risks to human receptors from direct exposure to contaminated soil.

Implementability: LUCs would be readily implementable and have been implemented at other sites. Provisions would be incorporated in property transfer documents to insure the continued implementation of institutional controls. Resources are readily available for the preparation of a LUC RD.

Cost: Costs of LUCs would be low.

Conclusion: LUCs in the form of deed restrictions and similar real estate documents are retained in combination with other process options for the development of soil remedial alternatives.

Monitoring

Sampling and analysis of groundwater would be used to evaluate potential for contaminant migration to the groundwater. Sampling and analysis would also be performed to monitor the progress of active treatment. Groundwater sampling and analysis would also be conducted to determine if contaminant migration is occurring from the soil to the groundwater.

Effectiveness: Monitoring alone would not reduce the toxicity, mobility, or volume of contaminants in the soil. However, monitoring would allow for a determination to be made of the potential migration of contaminants.

Implementability: A sampling and analysis program could be readily implemented.

Cost: Capital and operation and maintenance (O&M) costs of monitoring would be low.

Conclusion: Monitoring is retained in combination with other process options for the development of remedial alternatives.

3.2.3 Containment

The technology considered under this GRA is capping. Capping would consist of providing a horizontal barrier to minimize the extent of potential contaminant migration to groundwater through percolation of precipitation through the vadose zone and to prevent exposure to contaminants in the soil. The cover would be designed to allow for residual VOCs to vent to the atmosphere.

The types of caps that were considered include asphalt, soil/gravel, clay/soil, and RCRA hazardous waste landfill cap.

Effectiveness: Capping would be effective in preventing potential receptors from direct contact with the contaminated soil. The cap would also be effective in minimizing the migration of contaminants in the environment by reducing the infiltration into the contaminated soil layer underlying the cap. Long-term maintenance of the cap and long-term monitoring would ensure that the cap is effective in minimizing migration of contaminants. Any exposure to on-site workers during installation of the cap or monitoring could be easily controlled.

Asphalt caps on the ground surface are subject to damage from weathering and vehicles and require regular maintenance to be effective. A gravel/soil cap would effectively prevent contact with contaminated subsurface soil, but would allow precipitation to pass through the contaminated soil to the groundwater.

A clay/soil cap and RCRA cap would be more effective than an asphalt or gravel/soil cap because they would further reduce infiltration and associated migration of contaminants from unsaturated soils to groundwater. None of the caps would address contaminants that are present in saturated soil. In the long-term, a RCRA cap, which contains more elements to minimize infiltration would be more effective than a clay/soil cap.

Implementability: Installation of a cap at Site 1 would be easy to implement and materials and services required to implement this technology are readily available.

Cost: Capital costs for a cap range from low for a soil/gravel, moderate for an asphalt or clay/soil cap, and high for a RCRA cap. O&M costs for RCRA, soil/gravel, and clay/soil caps would be low and for an asphalt cap would be moderate.

Conclusion: Based on the concentration of PCBs present, New York States classification of PCBs greater than 50 mg/kg as a hazardous waste, and the presence of a sole source aquifer, only a RCRA cap will be evaluated further.

3.2.4 <u>Removal</u>

The technology considered under this GRA is excavation. A variety of equipment such as front-end loaders, backhoes, grade-alls, and clam shell buckets could be used to perform the excavation. The type of equipment selected must take into consideration several factors such as the type of material to be removed, the load-bearing capacity of the ground surrounding the removal area, the depth and areal extent of removal, the required rate of removal, and the elevation of the groundwater table. Excavation is the technology of choice for the removal of well-consolidated material such as soil from well-defined areas of ground with significant load-bearing capacity (i.e., greater than 1,500 pounds per square foot).

The logistics of excavation must take into account the available space for operating the equipment, loading and unloading of the excavated material, location of the site, etc. After excavation is completed, the location would be filled and graded with clean fill material or treated soils.

Effectiveness: Excavation is a well-proven and effective method of removing contaminated material from a site. Properly designed excavation would remove soil with elevated concentrations of COCs, and the remaining soil would not pose an unacceptable risk to human health or the environment.

Implementability: Excavation of contaminated soil at Site 1 would be difficult to implement. Excavation equipment is readily available from multiple vendors. This technology is well proven and established in the construction/remediation industry. However, the sloping of the side walls necessary to accommodate this depth would extend to and undermine existing structures. Therefore, extensive shoring, such as sheet piles, would be needed to support the excavation walls.

During excavation, site-specific health and safety procedures and Occupational Safety and Health Administration (OSHA) regulations would have to be complied with to ensure that the exposure of workers to COCs is minimized. The soil is contaminated with a listed hazardous waste, so excavation, stockpiling, and transportation operations must conform to RCRA regulations.

Cost: Because of the depth of the excavation and need for shoring, the cost for excavation would be relatively high.

Conclusion: Excavation is retained in combination with other process options for the development of remedial alternatives.

3.2.5 In-Situ Treatment - Solidification

Portland cement or a Portland cement-bentonite mixture can be mixed with contaminated soil in-situ by two methods – soil mixing and jet mixing. After the cement slurry cures, a monolithic mass remains that traps contaminants, prevents contact with contaminants, and minimizes leaching of contaminants.

In soil mixing, a specialized, crane-mounted auger descends through the soil. The auger is equipped with nozzles which inject the cement slurry into the soil, and the mixing action blends the slurry with the soil. Auger diameters vary from 4 to 10 feet and smaller diameter augers are needed to reach greater depths.

In jet mixing, the cement slurry is injected through a special drilling head with nozzles that direct the spray perpendicular to the boring. The nozzles are rotated such that a cylinder of soil/cement slurry is created as the nozzles are gradually pulled to the surface. The diameter of the cylinder depends on the soil type, nozzles, and pressure and can range from 3 to 8 feet in diameter.

Both methods displace 10 to 30 percent of the original treated volume (referred to as “swell”), and this excess is forced to the surface as a cement-soil mixture. Both methods would be effective in treating saturated soil. Therefore, deep saturated soils area with groundwater contaminated by PCBs can be treated.

Effectiveness: Solidification will immobilize PCBs and will prevent exposure to PCBs. The PCBs would no longer be affected by leaching. Both technologies have been demonstrated, however, there have been few (if any) uses of soil mixing beyond a depth of 50 feet. Jet mixing has been applied at depths beyond 75 feet.

Implementability: Although small diameter augers could reach 75 feet, there is uncertainty about the actual application. Jet mixing can be applied to a depth of 75 feet, but there would be some uncertainty about the extent of the radius of the jet mixing. With shallow jet mixing applications, a test cell can be installed, allowed to cure, and then exposed by excavation to confirm the diameter. There are several companies that perform soil mixing and jet mixing.

Cost: Costs of both methods are relatively high, primarily because of the large equipment required.

Conclusion: There are uncertainties about the application of either process, but they could be effective for the remediation of the deep PCB contamination. Table 3-2 summarizes the advantages and disadvantages of each technology. Both processes will be retained for further consideration.

3.2.6 Disposal

The technology considered under this GRA is off-site landfilling. Off-site landfilling would consist of transporting excavated soil for burial at an off-site treatment, storage, or disposal facility. Because some of the soil contains PCBs greater than 50 milligrams per kilogram (mg/kg) that soil would have to be managed as a NYSDEC RCRA hazardous waste if disposed in New York. Contaminated soil containing less than 50 mg/kg can be disposed as non-hazardous wastes.

Effectiveness: Off-site landfilling does not permanently or irreversibly reduce contaminant concentrations. However, although the CERCLA preference for treatment relegates landfilling to a less preferable option, this technology can be an effective disposal option for contaminated soil. Off-site landfills are only permitted to operate if they meet certain requirements of design and operation governing foundation, liner, leak detection, leachate collection and treatment, daily cover, post-closure inspections and monitoring, etc., which ensure the effectiveness of these facilities. Prior to disposal, the soil may need to be treated to conform to land disposal restrictions (LDRs).

Implementability: Off-site landfilling would be easily implementable. Facilities and services are available. Because some of the soil is a NYSDEC characteristic waste, the treated soil would need to disposed in a RCRA Subtitle C landfill.

Cost: Cost of off-site landfilling would be high.

Conclusion: Off-site landfilling is retained in combination with other process options for the development of remedial alternatives.

3.3 SELECTION OF REPRESENTATIVE TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL

The following technologies, and process options, under the GRAs as noted, were retained for the development of soil remedial alternatives:

- No Action
- Limited Action: LUCs and Monitoring
- Removal: Excavation
- In-Situ Treatment: Solidification
- Disposal: Off-Site

Based on this evaluation, with the exception of in-situ treatment: solidification, there is adequate information to proceed with the development of alternatives. In-situ solidification is a potential viable solution for immobilizing depth PCB-contaminated soil below the water table; however, it is uncertain whether the process can effectively achieve depths required at this site.

TABLE 3-1

SCREENING OF REMEDIAL TECHNOLOGIES FOR SOIL
SITE 1
NWIRP BETHPAGE, NEW YORK
PAGE 1 OF 2

General Response	Technology	Process Option	Description	Screening Comment
No Action	None	Not Applicable	No activities conducted at the site.	Retain for baseline comparison to other technologies.
Existing Controls	Institutional Controls	Environmental Easement	Administrative action using property deeds or other land use prohibitions to restrict site activities.	Retain.
		Zoning / Ordinance	Administrative action using local municipal laws and regulations to restrict site activities.	Retain.
		Defined Site Use	Administrative action using property deeds or other land use prohibitions to restrict site activities.	Retain.
		Site Management Plan	Administrative action using property deeds or other land use prohibitions to restrict site activities.	Retain.
	Environmental Monitoring	Groundwater Monitoring	Provide early warning of potential groundwater impacts.	Retain.
		Monitored Natural Attenuation	Evaluate changes in concentrations from natural processes and provide early warning of potential groundwater impacts.	Retain.
Removal	Mechanical Excavation	Excavation	Contaminated soil is removed using conventional earthmoving equipment such as backhoes and clamshell buckets.	Retain - For deep soils, extensive shoring required. Extensive dewatering required for deep, saturated soils (sand).
Ex-Situ Treatment	Physical	Solidification/ Stabilization	Soil is mixed with Portland cement and bentonite in a pug-mill or by an excavator. Treated soil is returned to excavation or disposed off-site.	Eliminate - High cost of treatment provides little benefit over off-site disposal.
		Soil Flushing /Surfactant Solvent washing and recovery	Soil is mixed with solvent or surfactant mixture to remove contaminants from the soil. Fluid is treated to remove and/or destroy contaminants. Treated soil is returned to excavation or disposed off-site.	Eliminate - process has not been very effective with PCBs.
	Biological	Anaerobic/ Aerobic Dechlorination	Destruction of PCBs in soil using fungal or bacterial treatment in bioreactors or landfarming. Treated soil is returned to excavation or disposed off-site.	Eliminate - Process is an emerging technology and requires time and land area.
	Chemical	Oxidation	H_2O_2/Fenton's Reagent or Permanganate (KMnO4) is mixed with soil to destroy with PCBs. Treated soil is returned to excavation or disposed off-site.	Eliminate - Low Effectiveness
		Base Catalyzed Decomposition (BCD)	Contaminated soil is added to an oil-sodium hydroxide-catalyst mixture and heated. Contaminants are converted to non-toxic compounds. Treated soil is returned to excavation or disposed off-site.	Eliminate - Although applicable to PCB sites, high cost for treatment and is best applied to highly contaminated material.
		Lime Addition	Lime is mixed with soil to destroy with PCBs. Treated soil is returned to excavation or disposed off-site.	Eliminate - Low Effectiveness. Volatilization determined to be the loss mechanism.
	Combined Treatment	Chemical Oxidation/ Biological Treatment	Combines chemical and biological treatment in sequential steps. Treated soil is returned to excavation or disposed off-site.	Eliminate - Biological process is an emerging technology and requires time and land area.
		Surfactant Washing/ Chemical Treatment	Combines soil washing and chemical treatment in sequential steps. Treated soil is returned to excavation or disposed off-site.	Eliminate - Soil washing is not effective with PCBs.
Off-Site Treatment/ Disposal	Landfill	Hazardous waste landfilling (with off-site treatment, if needed)	Contaminated soil is disposed at a permitted landfill. Offsite treatment may be required to meet land disposal restriction requirements.	Retain.
In-Situ Treatment	Solidification	Soil Mixing	Soil is mixed in-situ with Portland cement and bentonite using an auger or bucket auger.	Retain - Uncertain application for depths greater than 50 feet.
		Jet Grout	Soil is mixed in-situ with Portland cement and bentonite using a high pressure rotating jet to inject the cement mixture.	Retain - Demonstrated for application greater than 50 feet. However, effectiveness of mixing is difficult to verify.
		Chemical Fixation with Polymer	Soil is mixed in-situ with polymer using a high pressure rotating jet to inject the polymer mixture.	Eliminate - Still in experimental stage.
	Thermal	Steam Stripping, Contained Removal of Wastes (CROW)	Heat is applied to soil to mobilize organic compounds for removal by vapor extraction or pumping.	Eliminate - Experimental for PCBs.

SCREENING OF REMEDIAL TECHNOLOGIES FOR SOIL
SITE 1
NWIRP BETHPAGE, NEW YORK

General Response	Technology	Process Option	Description	Screening Comment
	Biological	Sequential Anaerobic/ Aerobic Dechlorination	Destruction of PCBs in saturated soil using fungal or bacterial treatment.	Eliminate - Experimental for PCBs, and may not be effective against contaminants in unsaturated soil.
In-Situ Treatment (continued)	Chemical	Oxidation	H2O2/Fenton's Reagent or Permanganate (KMnO4) is mixed with soil to destroy with PCBs.	Eliminate - Low Effectiveness against PCBs.
		Soil Flushing /Surfactant Solvent washing and recovery	Solvent or surfactant mixture is injected into the soil to remove contaminants from the soil. Fluid is extracted and treated to remove and/or destroy contaminants.	Eliminate - Subsurface characteristics would make recovery of washing solution very difficult.
		Vitrification	Use of high temperature melting to fuse contaminants into a glass matrix.	Eliminate - Process is generally considered experimental.
	Combined Treatment: Destruction of PCBs in saturated soil.	Chemical Oxidation/ Biological Treatment	Combines chemical and biological treatment in sequential steps.	Eliminate - Both processes are not applicable to the site.
		Surfactant Washing/ Chemical Treatment	Combines soil washing and chemical treatment in sequential steps.	Eliminate - Site is not a good candidate for in-situ soil washing.
Containment - Soil	Capping	Asphalt	Site would be covered with asphalt to prevent contact with contaminated soil and to prevent infiltration of precipitation through the contaminated soil to the groundwater. Long-term maintenance would be required to ensure integrity of the cover.	Retain.
		Gravel/Soil	Site would be covered with gravel and soil to prevent contact with contaminated soil.	Retain - Infiltration would not be prevented
		Clay/Soil	Site would be covered with a clay liner with soil cover to prevent contact with contaminated soil and to prevent infiltration of precipitation through the contaminated soil to the groundwater. Water that flows over clay layer must be routed away from site.	Retain.
		RCRA hazardous waste landfill cap	Site would be covered with a RCRA cover to prevent contact with contaminated soil and to prevent infiltration of precipitation through the contaminated soil to the groundwater. The cover would consist of a soil layer, drainage layer, synthetic liner, and clay. Water that flows over liner must be routed away from site.	Retain.
Containment - Groundwater	Containment Cell Bottom	Pressure Grouting	Grout layer would be injected into soil below contaminated soil. In combination with vertical barriers, it prevents contact between saturated soils and surrounding groundwater.	Eliminate - Not a proven technology at depths below 30 feet. Also not applicable if cap is permeable, due to "bathtub" effect.
	Slurry Wall	Trench or soil-mixing methods	Portland cement/bentonite mixture would be mixed with soil to create walls. In combination with cell bottom and impermeable cap, prevents contact between saturated soils and surrounding groundwater.	Eliminate - No benefit would be provided because contaminants could still flow downward and out of the containment area.
	Grout Curtain	Injection of grout	Portland cement/bentonite mixture would be injected into the soil to create walls. In combination with cell bottom and impermeable cap, prevents contact between saturated soils and surrounding groundwater.	Eliminate - No benefit would be provided because contaminants could still flow downward and out of the containment area.
	Sheet Pile Wall	Steel	Sheet piles are driven into the ground to create a barrier. In combination with cell bottom and impermeable cap, prevents contact between saturated soils and surrounding groundwater.	Eliminate - No benefit would be provided because contaminants could still flow downward and out of the containment area.
		HDPE	Sheet piles are driven into the ground to create a barrier. In combination with cell bottom and impermeable cap, prevents contact between saturated soils and surrounding groundwater.	Eliminate - HDPE only has advantages over steel in low pH groundwater where steel will have too short a life. Also, eliminated because of depth..
	Hydraulic Containment	Downgradient Pump and Treat Capture Zone	Prevents potential migration of impacted groundwater.	Eliminate - Not applicable to unsaturated soil.

TABLE 3-2

COMPARISON OF SOIL MIXING AND JET MIXING
SITE 1
NWIRP BETHPAGE, NEW YORK

Process	Advantages	Disadvantages
Soil Mixing	- Well demonstrated. - Thoroughly mixes soil and slurry in a well-defined volume. - Cured mixture and extent of mixture can be readily tested and verified.	- Limited actual application beyond 50 feet. - more expensive than jet mixing. - Must treat entire depth of column from ground surface to bottom of boring. - Limited auger diameter available for deep borings. - 10 to 30% of original treated volume is generated as a waste.
Jet Mixing	- Well demonstrated. - Can treated a specific depth interval. - Lower cost compared to soil mixing. - Radius of influence often larger than that of soil mixing. Has been used beyond 100 feet.	- Some uncertainty about the radius of treatment, difficult to test. - Borehole in center must remain open to expel material displaced by jetting. - 10 to 30% of original treated volume is generated as a waste.

4.0 DATA GAPS

4.1 DATA REQUIREMENTS

Based on the technology screening presented in Section 3.0, in-situ solidification is a potentially viable remedy for addressing deep PCB contaminated soil. Two types of in-situ treatment are considered, consisting of soil mixing and jet grouting. However, a field pilot study would be required prior to implementation of either soil mixing or jet mixing to address uncertainties discussed below.

SOIL MIXING

Depth of treatment: Based on discussions with several soil mixing contractors, there have been few applications of the technology beyond a depth of 50 feet. A depth of 75 feet was believed to be attainable based on the use of specialized soil multiple auger equipment that is used to install slurry walls. However, so reach the depth of 75 feet a small diameter auger (3 to 5 feet) would need to be used because of the high torque requirements required for the project depth.

Slurry mixture: Although bench scale tests can be used to develop a preliminary slurry mix, the field pilot study would be used to confirm the effectiveness of the mix and the properties of the solidified soil-cement. This information would also be used to determine the total remedial cost.

JET GROUTING

Depth of treatment: Based on discussions with subcontractors for jet mixing and literature review, jet mixing has been applied at this depth, but confirmation of its effectiveness is still needed.

Diameter of column: Because soil characteristics at different depths can vary, the diameter of the soil-cement column that will be created by the jet mixing process is uncertain. A bench scale test and borings collected prior to the pilot test, along with experience by the contractor, would be used to develop a preliminary mix and application rate. After several test columns have cured, the diameter of the column would be confirmed using a combination of excavation and sample collection using DPT or hollow stem augers.

Slurry Mixture: Although bench scale tests can be used to develop a preliminary slurry mix, the field pilot study would be used to confirm the effectiveness of the mix and the properties of the solidified soil-cement. The test would also be used to determine the flowrate and pressure of the jet mixing. This information would also be used to determine the total remedial cost.

Costs for the field pilot study are significant, with mobilization/demobilization accounting for a significant portion of the cost. No firm quotes were obtained, but mobilization/demobilization costs for a pilot study are in the range of $100,00 to $300,000. The cost for the actual pilot work will depend on the area to be treated and the number of days to perform the test. Typical treatment costs are in the range of $15,000 per day to $20,000 per day, and the pilot study would last approximately 3 to 5 days. The mobilization costs for jet mixing equipment is slightly lower than that of soil mixing. Daily costs for both systems are similar because the amount of labor, cement/bentonite use, and waste generation will be similar for both processes.

4.2 CONFIRMATION OF EFFECTIVENESS OF PROCESS

Both processes leave a soil-cement mass in place. Because of the depth, methods to confirm the effectiveness of each process must be developed. Both processes generate excess soil-cement slurry that is displaced to the surface. This material is representative of material in the column being treated, and samples of this material can be collected cured, and then inspected and tested for strength, chemical, and leaching properties.

The diameter of the column created by soil mixing is well defined. The soil and slurry are well mixed within the diameter of the auger, and the excess material is representative of the soil-cement mixture. Thus, if the auger diameter is 5 feet, then the column created will be 5 feet in diameter.

For jet mixing, the diameter of the soil-cement column is predictable, but difficult to confirm. For shallow depth, the column can be exposed after curing and visually inspected. Using observations and measurements recorded during the injection (pressures, slurry flow rates, and rotation speed), the observations of the shallow portions of the column can be assumed to be applicable to the deeper portions. In addition, borings can be advanced through the column, and the results of this sampling assumed to be representative of the entire column. Note that jet mixing is a proven technology for both environmental and geotechnical applications and the difficulty in observing the full depth of the column is not considered to be a significant issue.

For both processes, the binding of the PCBs may need to be considered. Samples of the cured soil-cement can be analyzed for PCBs in the soil-cement and in a leachate. However, the significance of the results would be subject to interpretation because the PCB concentrations in the soil-cement will be similar to the original concentrations in soil, and representative leachate proceed for site condition would need to be developed.

4.3 WORK PLAN DEVELOPMENT

Prior to initiating a pilot study, a Work Plan would need to be developed. At a minimum, the Work Plan would identify the depth and area of the study, the number of borings, methods of tests and analyses, disposition of waste brought to the surface, and number of samples and analyses. NYSDEC would review and comment on the Work Plan. A pilot study should be performed for both technologies. This work plan would also be used as the basis for a scope of work for a contractor to perform the pilot study. There are several contractors capable of performing soil mixing or jet mixing or both. Selection of a pilot study contractor must also consider whether the same contractor performs the study for both technologies.

REFERENCES

Foster Wheeler Environmental Corporation, 2003. Final Close Out Report Construction of a Soil Vapor Extraction/Air Sparging System at The Naval weapons Industrial Reserve Plane, Bethpage, New York. December.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, U.S. EPA, OSWER 9355.3-01, EPA/540/G-89/004, October 1988.
http://www.epa.gov/superfund/resources/remedy/pdf/540g-89004-s.pdf

Haliburton NUS, 1992. Final Remedial Investigation Report Naval Weapons Industrial Reserve Plant Bethpage, New York. May.

Haliburton NUS, 1993. Phase 2 Remedial Investigation Report for Naval Weapons Industrial Reserve Plant, Bethpage, New York. October.

Haliburton NUS, 1994. Feasibility Study Report for Naval Weapons Industrial Reserve Plant, Bethpage, New York Northern Division Naval Facilities Engineering Command. March.

Naval Facilities Engineering Command (NFEC), 1995 . Record of Decision Bethpage, New York Sites 1, 2 3 NYS Registry: 1-30-003B. Prepared by Northern Division Naval Facilities Engineering Command and New York State Department of Environmental Conservation. May.

Naval Facilities Engineering Command (NFEC), 2003. Record of Decision Naval Weapons Industrial Reserve Plant, Bethpage, New York Operable Unit 2-Groundwater NYS Registry:1-30-003B Prepared by Engineering Field Avctivity, Northeast Naval Facilities engineering Command. April.

Rogers, Golden, & Halpern, 1986. Initial Assessment Study of NWIRP Bethpage, NY and NWIRP, Calverton, NY. December.