N00129.AR.001314
NSB NEW LONDON
5090.3a

Engineering Evaluation/Cost Analysis For Inner and Outer Pier 1

Naval Submarine Base New London

Groton, Connecticut

Naval Facilities Engineering Command Mid-Atlantic

Contract Number N62467-04-D-0055

Contract Task Order 424

October 2009

REVISION 0
OCTOBER 2009

ENGINEERING EVALUATION/COST ANALYSIS FOR INNER AND OUTER PIER 1

NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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CONTRACT NO. N62467-04-D-0055
CONTRACT TASK ORDER 424

OCTOBER 2009

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ABBREVIATIONS AND ACRONYMS

AACE	American Association of Cost Engineers
ARAR	Applicable or relevant and appropriate requirement
AVS/SEM	Acid volatile sulfide/simultaneously extracted metal
BAF	Bioaccumulation factor
BERA	Baseline ecological risk assessment
BERC	Berkeley Environmental Restoration Center
BMP	Best management practice
bss	Below sediment surface
CAD	Contained aquatic disposal
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cf	Cubic foot/feet
CFR	Code of Federal Regulation
CGS	Connecticut General Statutes
CIF	Controlled Industrial Facility
COC	Chemical of concern
COPC	Chemical of potential concern
CTDEP	Connecticut Department of Environmental Protection
cy	Cubic yard
°C	Degree Celsius
°F	Degree Fahrenheit
DoD	Department of Defense
DQO	Data quality objective
EE/CA	Engineering Evaluation/Cost Analysis
EFANE	Engineering Facilities Activity Northeast
ERM	Effects range median
ERM-Q	Effects range median-quotient
ETPH	Extractible total petroleum hydrocarbons
FS	Feasibility Study
GAC	Granular activated carbon
gpd	Gallons per day
gpm	Gallons per minute
HASP	Health and Safety Plan
HI	Hazard index
HMW	High molecular weight
LMW	Low molecular weight

LOAEL	Lowest observed adverse effect level
MLLW	Mean lower low water
MNR	Monitored natural recovery
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NOAEL	No observed adverse effect level
NPW	Net present worth
NSB-NLON	Naval Submarine Base - New London
O&M	Operation and maintenance
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PFD	Process flow diagram
PPE	Personal protective equipment
PRG	Preliminary remediation goal
RAC	Remedial Action Contractor
RAO	Removal Action Objective
RCP	Reasonable Confidence Protocols
RCRA	Resource Conservation and Recovery Act
RCSA	Regulations of Connecticut State Agencies
RSC	Rapid Sediment Characterization
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act of 1986
sf	Square foot/feet
SLERA	Screening-level ecological risk assessment
SUF	Site use factor
SVOC	Semivolatile organic compound
TBC	To be considered
tHPAH	Total high molecular weight polycyclic aromatic hydrocarbon
tLPAH	Total low molecular weight polycyclic aromatic hydrocarbon
TOC	Total organic carbon
tPCB	Total polychlorinated biphenyl
TRV	Toxicity reference value
TSS	Total suspended solids
UCL	Upper confidence limit

UHC	Underlying hazardous constituent
USC	United States Code
U.S. EPA	United States Environmental Protection Agency
ZVI	Zero valent iron

EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared to develop and evaluate potential removal action alternatives for a non-time-critical removal action to address sediment contamination for Inner and Outer Pier 1 at the Naval Submarine Base – New London (NSB-NLON), in Groton, Connecticut.

Although this document is a revision of the Inner Pier 1 EE/CA (Battelle, 2008), it has been significantly altered and expanded from its previous version. This is primarily a result of the New London Partnering Team's decision to incorporate evaluation of the Outer Pier 1 sediment and also because additional information has improved understanding of the Pier 1 area.

The Lower Subase is a narrow strip of land that generally forms the western boundary of NSB-NLON and parallels the Thames River. Pier 1 is located in the southwestern portion of NSB-NLON along the shore of the Thames River and was the location of a former Marine Railway that was used to pull ships and submarines out of the water for sandblasting, paint scraping, and maintenance.

Several field investigations and human health and ecological risk assessments were performed to characterize the sediment of Inner and Outer Pier 1. Results of field investigations showed elevated concentrations of several chemicals, particularly in Inner Pier 1 sediment. These chemicals included polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), metals, and pesticides.

The human health risk assessment concluded that there are no unacceptable human health risk associated with sediment at Inner and Outer Pier 1 because, under the current site use scenario, there is no potential for direct or indirect (through the food chain) human contact with this sediment.

The Baseline Ecological Risk Assessment (BERA) conducted as part of the Thames River Validation Study (Battelle and Neptune & Company, 2008) established unacceptable risks to ecological receptors as a result of direct and indirect (food chain) exposure to contaminated sediment. The BERA identified several chemicals of concern (COCs) including the previously mentioned PCBs, PAHs, metals, and pesticides. To better evaluate cumulative risk from a wide range of COCs that are not always spatially correlated, Effects Range Median-Quotient (ERM-Q) composite indices were also developed for the 13 identified COCs. The BERA developed preliminary remediation goals (PRGs) including an ERM-Q of 1.17 and a PCB concentration of 208 micrograms per kilogram (µg/kg), both of which correspond to a 50-percent reduction in offspring. Subsequently, the New London Partnering Team reached a consensus that an ERM-Q of 1.17 was the predominant PRG and that the PCB PRG could be increased to 1,000 µg/kg.

The specific Removal Action Objective (RAO) for Inner and Outer Pier 1 is to minimize the potential migration of, and mitigate the risk to ecological receptors posed by, COCs in Inner and Outer Pier 1 sediment.

Based on the results of site investigations and ecological risk assessment, the removal action area for this EE/CA has been established as the whole of Inner Pier 1 and a portion of Outer Pier 1 extending in an arc south of the boundary between Inner and Outer Pier 1. A separate area of sediment contamination also located in Outer Pier 1 in the vicinity of sampling location TRP1-SD-005 will be addressed as part of the Lower Subase Feasibility Study (FS). Inner Pier 1 has a surface area of approximately 18,500 square feet (sf) and the depth of sediment over bedrock in Inner Pier 1 ranges from 1 to 5 feet with an average of 4 feet for an estimated in-situ volume of 2,739 cubic yards (cy). The portion of Outer Pier 1 considered as part of the removal action area for this EE/CA covers an estimated surface area of 27,300 sf and extends to an estimated depth of 6 feet for an in-situ volume of 6,673 cy including 10 percent overdredge.

Several removal action alternatives were developed by assembling various removal action technologies and process options to address the project-specific RAO and to meet the PRGs while considering site-specific conditions. In screening potential removal action alternatives for Inner and Outer Pier 1, greater emphasis was placed on approaches capable of achieving sediment cleanup in a timely fashion, namely through physical removal of contaminated sediment. The No Action alternative was also evaluated as a basis of comparison with other alternatives as required by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP).

The removal action alternatives evaluated for Inner Pier 1 are as follows:

Alternative IP-1: No Action

Alternative IP-2: Land-Based Dredging to Bedrock, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative IP-3: Water-Based Dredging to Bedrock, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative IP-4: Land-Based Dredging to Bedrock, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-5: Water-Based Dredging to Bedrock, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-6: Drainage of Inner Pier 1, Excavation to Bedrock, Dewatering, On-Site Treatment and Discharge of Surface Water and Dewatering Fluid, and Off-Site Disposal of Sediment

Alternatives IP-2 to IP-5 would use dredging with dewatering of removed sediment on barges modified to perform as static drainage beds. Dewatered sediment would then be stabilized with fly ash and disposed in an appropriate off-site landfill. Alternatives IP-2 and IP-4 would use dredging equipment located on shore, and Alternatives IP-3 and IP-5 would use a barge-mounted excavator. Water released by the sediment dewatering operation would filter through the barges liner and flow back to the Thames River. The small fraction of the water released by the dewatering operation which does not drain and filter freely through the barges liner (hereafter designated as dewatering fluid and estimated at 10 percent of total) would be collected, tested, and either disposed off site with Alternatives IP-2 and IP-3 or treated on site and discharged to the Thames River with Alternatives IP-4 and IP-5.

Alternative IP-6 differs from Alternatives IP-2 to IP-5 in that Inner Pier 1 would be entirely drained to expose the sediment which would then be excavated using equipment operating within Inner Pier 1 itself. Excavated sediment would be handled and disposed in the same way as with the other alternatives and the surface water removed from Inner Pier 1 to drain it and keep it drained would be tested and, if necessary, treated on site prior to discharge to the Thames River. It is assumed that the last foot of surface water removed from Inner Pier 1 and any water pumped during sediment excavation would require treatment.

The Navy believes that Alternatives IP-2 to IP-6 are well suited to meet the RAO for Inner Pier 1. By permanently removing sediment with elevated concentrations of COCs, these alternatives would provide a high degree of protection for human health and the environment and would be highly effective in the long-term. However, the protectiveness and long-term effectiveness of Alternatives IP-2 to IP-5 could be slightly limited by the fact that the dredging process might not be able to completely remove all sediment. Alternatives IP-2 to IP-6 would also comply with the identified project Applicable or Relevant and Appropriate Requirements (ARARs). Reduction in toxicity, mobility, and volume of contaminated sediment would be high, but this reduction would be achieved through removal and off-site disposal rather than through treatment.

Alternative IP-1 would be easiest to implement because there would be nothing to implement. Alternatives IP-2 to IP-5 would be relatively easy to implement. Alternative IP-6 would be significantly harder to implement than Alternatives IP-2 to IP-5 because it would require the drainage of Inner Pier 1 which would be very technically challenging and might not be practical to achieve. A significant implementability challenge common to the Inner Pier 1 alternatives would be the limited site access and generally limited amount of work space in the immediate site area. Each of the alternatives would require the same resources for dewatering, stabilizing, and loading the dredged sediment and storing the

equipment and material required for the removal action. Alternatives IP-4, IP-5, and IP-6 would require additional space and resources for the on-site treatment of dewatering fluid and/or surface water.

The capital and operation and maintenance (O&M) costs and net present worth (NPW) of the Inner Pier 1 alternatives are as follows. Costs have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates.

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
IP-1	0	0	0
IP-2	1,463,000	0	1,463,000 (1 Year)
IP-3	1,498,000	0	1,498,000 (1 Year)
IP-4	1,622,000	0	1,622,000 (1 Year)
IP-5	1,660,000	0	1,660,000 (1 Year)
IP-6	2,524,000	0	2,524,000 (1 Year)

Alternative IP-1 (No Action) was only considered to provide a basis for comparison and to meet the regulatory requirements of the NCP. The Navy believes that Alternatives IP-2 through IP-6 are equally well suited to meeting the RAO for Inner Pier 1. Furthermore, the Navy believes that Alternatives IP-2 through IP-5 are sufficiently similar, in both approach and cost, to defer final selection of an alternative until the more detailed design/work plan stage. Alternative IP-6 is not recommended for further consideration because it has significant technical, effectiveness and implementability uncertainties, serious worker safety concerns, and higher costs.

The removal action alternatives evaluated for Outer Pier 1 are as follows:

Alternative OP-1: No Action

Alternative OP-2: Capping with Pre-Dredging to Meet the RAO, Dewatering, Off-Site Disposal of Dewatered Sediment and Dewatering Fluid, Land Use Controls (LUCs), and Monitoring

Alternative OP-3: Capping with Pre-Dredging to Meet the RAO, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, Off-Site Disposal of Dewatered Sediment, LUCs, and Monitoring

Alternative OP-4: Dredging to Meet PRGs, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative OP-5: Dredging, Dewatering to Meet PRGs, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternatives OP-2 and OP-3 would consist of dredging the 5,100 sf area of contaminated surface sediment (0 to 2-foot depth) and replacing it with a 3-foot layer of clean sand. Alternatives OP-4 and OP-5 would consist of dredging contaminated sediment to a depth of 6 feet. Assuming an overdredge

allowance of 10 percent, an estimated 416 in-situ cy of contaminated sediment would be removed by Alternatives OP-2 and OP-3, and an estimated 6,673 in-situ cy would be removed by Alternatives OP-4 and OP-5. Because contaminated sediment would be left on-site, Alternatives OP-2 and OP-3 would also require development and implementation of LUCs to prevent disturbance of the cap and performance of long-term monitoring to verify the continued effectiveness of that cap.

The sediment dredged from Outer Pier 1 would be handled and disposed similarly to that dredged from Inner Pier 1 with the use of modified barges for sediment dewatering, stabilization of dewatered sediment with fly ash, and off-site landfilling of stabilized sediment. As with Inner Pier 1, dewatering fluid would be collected, tested, and either disposed off site with Alternatives OP-2 and OP-4 or treated on site and discharged to the Thames River with Alternatives OP-3 and OP-5.

The Navy believes that Alternatives OP-2 to OP-5 are well suited to meeting the RAO for Outer Pier 1. By permanently removing sediment containing concentrations of COCs greater than the PRGs, Alternatives OP-4 and OP-5 would provide a higher degree of protection for human health and the environment than Alternatives OP-2 and OP-3 which would only cap the contaminated sediment. Alternatives OP-2 to OP-5 would also comply with the identified project ARARs and be long-term effective. However, the capping component of Alternatives OP-2 and OP-3 would restrict potential future deepening of Outer Pier 1 whereas the dredging component of Alternatives OP-4 and OP-5 would actually promote such possible future development. In addition, although Alternatives OP-2 and OP-3 would achieve some reduction of toxicity, mobility, and volume through the removal and off-site disposal of a small fraction of the contaminated sediment, these two alternatives would primarily reduce the mobility of sediment COCs through capping. Alternative OP-4 and OP-5 would achieve a much greater reduction in toxicity, mobility and volume through removal and off-site disposal of sediment with concentrations of COCs greater than the PRGs. None of the alternatives would reduce toxicity, mobility or volume of contaminated sediment through treatment.

Alternative OP-1 would be easiest to implement because there would be nothing to implement. Alternatives OP-2 and OP-3 would be relatively easy to implement. Alternatives OP-4 and OP-5 would be slightly harder to implement because of the much greater volume of sediment to be dredged and processed. As with the Inner Pier 1 alternatives, a significant implementability challenge common to the Outer Pier 1 alternatives would be the limited site access and generally limited amount of work space in the immediate site area. Each of the alternatives would require the same resources for dewatering, stabilizing, and loading the dredged sediment, and storing the equipment and material required for the removal action. Alternatives OP-3 and OP-5 would require additional space and resources for the on-site treatment of dewatering fluid.

The capital and O&M costs and NPW of the Outer Pier 1 alternatives are as follows.

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
OP-1	0	0	0
OP-2	476,000	295,000 (30-Year)	771,000 (30-Year)
OP-3	496,000	295,000 (30-Year)	791,000 (30-Year)
OP-4	2,459,000	0	2,459,000 (1-Year)
OP-5	2,710,000	0	2,710,000 (1-Year)

Alternative OP-1 (No Action) was only considered in this EE/CA to provide a basis for comparison and to meet the regulatory requirements of the NCP. The Navy believes that Alternatives OP-4 and OP-5 would be well suited to meeting the RAO for Outer Pier 1 and provide significantly greater protection and long-term effectiveness than Alternatives OP-2 and OP-3. Furthermore, the Navy believes that Alternatives OP-4 and OP-5 are sufficiently similar, in both approach and cost, to defer final selection of an alternative until the more detailed design/work plan stage.

The removal actions considered most appropriate for Inner and Outer Pier 1 will ultimately be selected in close coordination with the United States Environmental Protection Agency (U.S. EPA), the Connecticut Department of Environmental Protection (CTDEP), and other regulatory agencies and involved parties.

1.0 INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) has been developed for Inner and Outer Pier 1 at the Naval Submarine Base – New London (NSB-NLON) located in Groton, Connecticut under Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Contract No. N62467-04-D-0055. The purpose of this EE/CA is to develop and evaluate potential removal action alternatives for a non-time-critical removal action to address sediment contamination in Inner and Outer Pier 1. This EE/CA generally follows United States Environmental Protection Agency (U.S. EPA) *Guidance for Conducting Non-time-critical Removal Actions under CERCLA* (U.S. EPA, 1993).

Although this document is a revision of the Inner Pier 1 EE/CA (Battelle, 2008), it has been significantly altered and expanded from its previous version. This is primarily a result of the New London Partnering Team's decision to incorporate evaluation of the Outer Pier 1 sediment and also because additional information has improved understanding of the Pier 1 area.

1.1 SUBASE LOCATION

NSB-NLON is located along the east bank of the Thames River, approximately six miles north of Long Island Sound, within the towns of Ledyard and Groton, CT as shown on Figure 1-1. The Lower Subase is a narrow strip of land that generally forms the western boundary of NSB-NLON and parallels the Thames River. The Lower Subase is highly secure and is the general location of all submarine berthing at the Subase. NSB-NLON currently provides Base command for naval submarine activities in the Atlantic Ocean. It also provides housing for Navy personnel and their families and supports submarine training facilities, military offices, medical facilities, and facilities for submarine maintenance, repair, and overhaul.

1.2 SUBASE HISTORY AND BACKGROUND

Currently, NSB-NLON consists of more than 300 buildings on 687 acres of land; however, the origins of this facility date back to 1868. Approximately 112 acres of land on the east bank of the Thames River were obtained by the United States Navy (Navy) in 1867, and the parcel was officially designated a Navy Yard in 1868. The site was originally used to moor small craft and obsolete warships and served as a coaling station for the Navy's Atlantic fleet. In 1916, the Navy designated the facility as a Submarine Base. During World War I, infrastructure at the facility was extensively expanded, adding six piers and 81 buildings. In 1917, a Submarine School was established, and in 1918 the Submarine Medical Center was founded. Between 1935 and 1945, the Navy constructed more than 180 buildings and acquired land adjacent to NSB-NLON, expanding the facility from 112 acres to 497 acres. The growth of NSB-NLON continued after World War II. In 1946, the Medical Research Laboratory was established. In 1968, the

status of the Submarine School was changed from an Activity to a Command, and the school became the largest tenant on the base. The Naval Submarine Support Facility was established in 1974, and the Naval Undersea Medical Institute was established the following year.

Most of the construction at the Lower Subase south of Pier 15 took place in the early 1900s, with a major expansion from 1935 to 1940. In 1946, the waterfront area to the north of Pier 15 was developed extensively to accommodate berthing of the reserve fleet. The area was dredged and filled, and bulkheads, piers, support buildings, and utilities were constructed. Recently, dredging activities have occurred in the Thames River adjacent to the Lower Subase. The activities were conducted during 1995 and 1996 as part of the Pier 17 Replacement and Seawolf Class Submarine Homeporting projects. Dredged material was disposed at a designated open-water disposal site in Long Island Sound.

1.3 EE/CA ORGANIZATION

This EE/CA is organized as follows:

Section 1.0: Introduction: This section presents an introduction to the EE/CA, general location and background information for NSB-NLON, and the EE/CA organization.

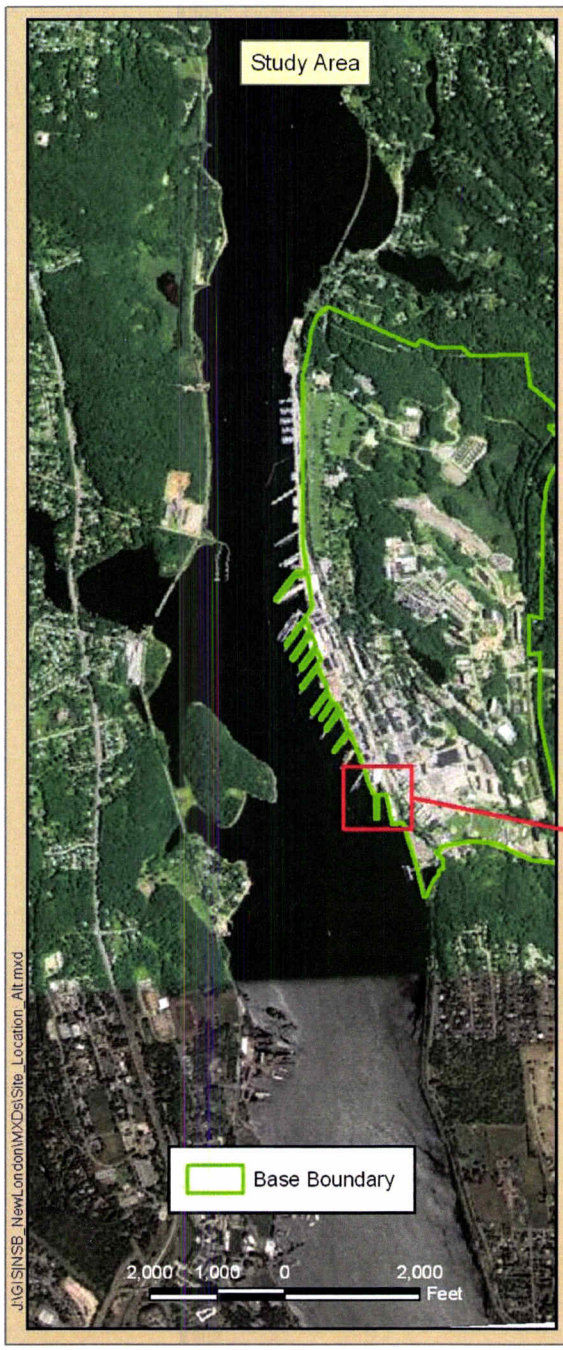
Section 2.0: Site Description and Background: This section presents site-specific information for Inner and Outer Pier 1, including a description and history of Pier 1, a summary of previous investigations, a discussion of the nature and extent of contamination, and a summary of the streamlined risk evaluations.

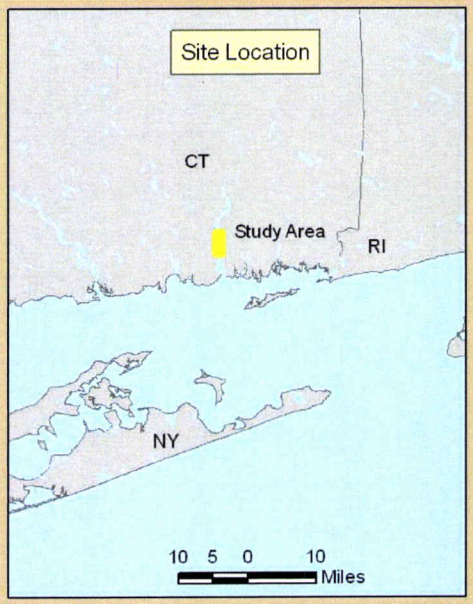
Section 3.0: Remedial Action Objective: This section presents the Removal Action Objective (RAO) and a listing of the Applicable or Relevant and Appropriate Requirements (ARARs) for the removal action.

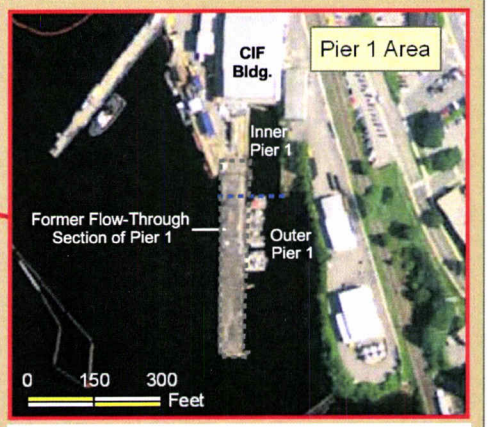
Section 4.0: Identification and Screening of Technologies: This section presents a summary of potentially applicable removal action technologies and process options, and screens these technologies and process options to identify those that are most suitable and appropriate to be incorporated into removal alternatives.

Section 5.0: Identification and Preliminary Analysis of Removal Action Alternatives: This section presents the identification and analysis of suitable removal action alternatives relative to critical evaluation criteria.

Section 6.0: Comparative Analysis of Alternatives: This section presents the evaluation of the removal action alternatives identified in Section 5.0 against one another relative to critical evaluation criteria. This section also presents the recommended removal action alternative.







Notes:
1. This figure was orignially published by Battelle as Figure 1-1 in the the following document: "Battelle, 2008. Final Engineering Evaluation/Cost Analysis for Pier 1 Inner Area, Naval Submarine Base New London, Groton, Connecticut. Prepared for NAVFAC MIDLANT OPNEEV, Norfolk, Virginia. March."

2. Pier 1 was demolished in August 2009.

DRAWN BY S. STROZ	DATE 07/27/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GLORIEUX	DATE 10/01/09	LOCATION OF NSB-NLON AND PIER 1 INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/9/09
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-1	REV 0

2.0 SITE DESCRIPTION AND BACKGROUND

This section describes the physical setting and history of the Pier 1 area at NSB-NLON, and provides a summary of previous investigations that have occurred in this area.

2.1 SITE BACKGROUND

Pier 1 is located in the southwestern portion of NSB-NLON (see Figure 1-1), along the shore of the Thames River. Pier 1 was the location of a former Marine Railway that operated from approximately 1930 to 1960. This railway was used to pull ships and submarines out of the water for sandblasting, paint scraping, and maintenance. Paint scraping activities often took place on the apron of the pull-out area. Several polychlorinated biphenyl (PCB)-containing transformers were located adjacent to Pier 1, and when these transformers were removed in 1996, there was no evidence of staining. A Controlled Industrial Facility (CIF) was constructed across the northern end of the Marine Railway in 1998. Pre-construction surveys for the CIF found elevated concentrations of polycyclic aromatic hydrocarbons (PAHs) in subsurface soil near groundwater and high concentrations of lead extending down to bedrock, necessitating removal and off-site disposal (in compliance with the Resource Conservation and Recovery Act [RCRA]) of soil and sediment from within the building footprint. Sediment in Inner Pier 1 and Outer Pier 1 has been found to contain high levels of PAHs and PCBs (SAIC, 2000; Battelle and Neptune & Company, 2004a).

2.2 PHYSICAL SETTING

Inner Pier 1 covers a surface area of approximately 18,500 square feet (sf) or 0.42 acres. The western boundary of Inner Pier 1 is Pier 1 itself, the northern part of which is constructed on a solid concrete foundation extending approximately 100 feet from the CIF building into the Thames River. South of this solid concrete foundation, the remainder of the pier has been demolished. Previously, Pier 1 extended to the southwestern limit of Outer Pier 1 and was flow-through (i.e., the pier was constructed on piles and not a solid foundation) in the Outer Pier 1 area. Along the western side of Inner Pier 1, steel interlocking sheet-pile extended from several feet above high water to several feet below bedrock to form a quay wall and prevent the mass exchange of sediment and surface water directly between Inner Pier 1 and the area under and west of Pier 1 (see Figures 2-1 and 2-2). The eastern boundary of Inner Pier 1 is a sheer bedrock wall, except for approximately 30 feet at the far southeastern corner of Inner Pier that consists of a steel and interlocking sheet-pile structure similar to former Pier 1. This small area of sheet-pile quay wall in the southeastern portion of Inner Pier 1 forms a small man-made peninsula that separates Inner Pier 1 from an adjacent concrete boat ramp (see Figure 2-2).

With the removal of Pier 1, Inner Pier 1 is now directly open to the Thames River along its southwestern limit, beyond the solid concrete foundation described above. Surface water depth in Inner Pier 1 is generally on the order of 3 feet relative to Mean Lower Low Water (MLLW) nearest the CIF building (i.e., to the north), and approaches 11 to 12 feet relative to MLLW near the mouth of Inner Pier 1 (i.e., to the south). The surface water level is tidally influenced in Inner Pier 1, demonstrating between 1.5 and 2 feet of tidal fluctuation (Battelle, 2003). The predominant direction of flow in the Thames River is towards Long Island Sound, or generally southward.

Sediment in Inner Pier 1 typically consists of a 1- to 5-foot thick layer of fine-grained, soft, organic-rich material overlying bedrock, with an average sediment depth of approximately 3.5 feet. Larger grain-size material (i.e., sand) is present in the sediment, and the proportion of larger grain size material tends to increase with distance away from the CIF building (Battelle, 2003). In addition, construction activities for the CIF building removed soil and sediment from the northern portion of Inner Pier 1, leaving behind little sediment material above bedrock. Historically measured levels of total organic carbon (TOC) in Inner Pier 1 sediment have generally been between 2 and 5 percent, and historically measured solids content in Inner Pier 1 sediment have generally ranged from 23 percent to 64 percent (SAIC, 2000.)

Inner Pier 1 is devoid of aquatic vegetation, and the area around Pier 1 generally does not support substantial upland or emergent habitat, with the exception of shrubby vegetation at ground surface (i.e., at the top of the natural geologic wall) along the northeastern Inner Pier 1 boundary.

Outer Pier 1 consists of natural bedrock shoreline and vertical face C-lock bulkhead on the east side and the former open-pile portion of Pier 1 on the west side (see Figure 2-2). Sediment in Outer Pier 1 consists of soft, organic-rich silt with some sand, clay, and shell material, similar to that found in Inner Pier 1. Sediment thickness, as well as water depth, increases with distance from the shoreline and Inner Pier 1.

2.3 PREVIOUS INVESTIGATIONS

Previous investigations that have occurred in the Pier 1 area include work by SAIC, Battelle and Neptune & Company, and TtNUS. These investigations are summarized below, and historical sampling locations in the Pier 1 area are shown graphically on Figure 2-2. The analytical data for all previous investigations are presented in Appendix A.

2.3.1 Pier 1 Marine Railway Investigation

Sediment from the Pier 1 Marine Railway area was sampled by SAIC in October 1999 after evidence of marine vessel overhaul activities was discovered during the draining of the railway for a building

construction project. A total of 7 surface sediment samples (SBP-1 to SBP-7) were collected and analyzed as shown on Figure 2-2. The purpose of the investigation was to evaluate whether chemicals from these activities had been released and transported to sediment in the Thames River. Results of this small-scale study indicated that concentrations of metals, PAHs, and PCBs in sediment exceed benchmark values, and that concentrations of these chemicals decrease from north to south away from the new building location (SAIC, 2000).

2.3.2 Rapid Sediment Characterization Pilot Study

A Rapid Sediment Characterization (RSC) Pilot Study was conducted in June 2003 to evaluate the potential for unacceptable ecological risk in three areas (Zone 4, Zone 7, and Pier 1) of the Lower Subase (Battelle and Neptune & Company, 2003). Twelve surface sediment samples were collected and analyzed by rapid (i.e., *in-situ*) screening techniques for metals, PCBs, and PAHs. Confirmatory samples were also analyzed at a laboratory for a subset of the samples (P1-48, 1-50, P1-53 and 1-55) collected (see Figure 2-2). Results of the RSC Study were used to develop data quality objectives (DQOs) and to develop a Screening-Level Ecological Risk Assessment (SLERA) (Battelle and Neptune & Company, 2004).

2.3.3 Validation Study

Surface and subsurface sediment samples were obtained from a total of 11 locations (P1, P1-C1, P2, P1-C2, P3, P1-C3, P4, P1-C4, P5, P1-C5, and P6) in the Pier 1 area in 2004 (see Figure 2-2) as part of the scope of a Validation Study for Thames River Zone 4, Zone 7, and Outer Pier 1 (Battelle and Neptune & Company, 2008). Samples were characterized for both physical and chemical parameters, including grain size, TOC, acid volatile sulfide/simultaneously extracted metals (AVS/SEM), metals, PCBs, PAHs, and pesticides. Fish tissue samples were collected from the Pier 1 area. The data were paired with available sediment chemistry from the areas of collection to calculate bioaccumulation factors (BAFs) to determine potential ecological risk.

Risk to ecological receptors, including benthic invertebrates and upper-trophic level piscivorous birds (represented by the double breasted cormorant) were evaluated in the Baseline Ecological Risk Assessment (BERA) of the Validation Study. To assess potential risk to benthic invertebrates, a 28-day laboratory bioassay was conducted. Results were evaluated for survival, growth, and reproduction using sediment data collected in 2007. Concentrations of chemicals of potential concern (COPCs) in whole body forage fish tissue collected in 2004 were used to estimate a range of site-specific BAFs to calculate dose inputs to the food chain model. Exposure point concentrations (EPCs) for estimating an ingestion dose in each area were calculated using the 95-percent upper confidence limit (UCL) of the mean sediment COPC concentrations.

Dose modeling to piscivorous birds showed potential low-level risk from mercury in Outer Pier 1 because hazard quotients (HQs) exceeded no observed adverse effect level (NOAEL) toxicity reference values (TRVs). Doses did not exceed lowest observed adverse effect levels (LOAEL) TRVs for any constituent. Evaluation of uncertainties associated with BAFs and cormorant site use factors (SUFs) combined with the low HQ for mercury in Outer Pier 1 suggest that mercury does not pose an unacceptable risk to piscivorous birds in the area.

Bioassay results were compared to chemistry results, including Effects Range Median-Quotients (ERM-Q), Metals ERM-Q, and Total PCB concentrations. From these correlations, the following preliminary remedial goals (PRGs) were identified:

- ERM-Qs associated with a 30-percent reduction in survival (1.43), a 30-percent reduction in growth (1.54), a 50-percent reduction in growth (2.34), a 25-percent reduction in offspring (0.53), and a 50-percent reduction in offspring (1.17);

- Metals ERM-Q associated with a 30-percent reduction in survival (1.64); and,

- Total PCBs associated with a 30-percent reduction in growth (270 µg/kg), a 50-percent reduction in growth (387 µg/kg), a 25-percent reduction in offspring (121 µg/kg), and a 50-percent reduction in offspring (208 µg/kg).

According to the Validation Study (Battelle and Neptune & Company, 2008), Outer Pier 1 contained approximately 7,400 sf (0.17 acres) that exceeded the Total PCB PRG for greater than 50 percent reduction in reproduction. This area is located just offshore of the boat ramp and the boundary line for Inner Pier 1.

2.3.4 Lower Subase Feasibility Study

The Navy planned to address Outer Pier 1 through the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) process, but subsequently decided to address it through an EE/CA to expedite remediation of the area and minimize remediation costs. As part of the Lower Subase FS (Tetra Tech NUS, 2008), a total of 10 surface sediment and core samples (TRP1-SD-001 through TRP1-SD-010) were collected in Outer Pier 1 during November 2008 (see Figure 2-2) to determine the lateral and vertical extent of contamination. At each sampling location, one 6-foot-long sediment core (Core A) and one 1-foot-long sediment core (Core B) were collected. For Core A, sampling intervals were 0 to 2 feet below sediment surface (bss), 2 to 4 feet bss, and 4 to 6 feet bss. For Core B, the sampling interval was from 0 to 1 feet bss. Samples were

analyzed for PAHs, metals, TCLP metals, pesticides, PCB congeners, PCB Aroclors, extractible total petroleum hydrocarbons (ETPH) and other parameters (pH, salinity, TOC, grain size distribution, moisture content, and bulk density).

2.4 NATURE AND EXTENT OF CHEMICAL CONTAMINATION

Results of the above-described site investigations have established that the Inner and Outer Pier 1 sediment is contaminated with a wide range of COPCs including high-molecular weight (HMW) and low-molecular weight (LMW) PAHs, PCBs, pesticides, and metals.

HMW PAHs included benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, pyrene. LMW PAHs included 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene. Detected PCBs included the following 18 congeners: 18 PCB congeners: Cl2(08), Cl3(18), Cl4(28), Cl4(44), Cl4(52), Cl5(66), Cl5(101), Cl5(105), Cl5(118), Cl6(128), Cl6(138), Cl6(153), Cl7(170), Cl7(180), Cl7(187), Cl8(195), Cl9(206), and Cl10(209). Pesticides included alpha chlordane and 4,4'-DDD, 4-4'-DDE, and 4-4'-DDT characterized as 4-4'-DDx. Metals included arsenic, cadmium, chromium, copper, lead, nickel, selenium, and zinc.

Table 2-1 provides a summary of sediment analytical results for Inner and Outer Pier 1 As shown on that table detected concentrations of sediment COCs were typically highest in Inner Pier 1. Concentrations of HMW PAHs ranged from 7.6 to 1,254.6 milligrams per kilogram (mg/kg) in Inner Pier 1 compared to 3.2 to 119 mg/kg in Outer Pier 1. Concentrations of LMW PAHs ranged from 1.5 to 466.3 mg/kg in Inner Pier 1 compared to 0.6 to 15.2 mg/kg in Outer Pier 1. Concentrations of total PCBs ranged from 131.1 to 19,190.6 micrograms per kilogram (µg/kg) in Inner Pier 1 compared to 38.4 to 1,186.8 µg/kg in Outer Pier 1. Concentrations of total pesticides ranged from 2.0 to 151.2 µg/kg in Inner Pier 1 compared to 3.4 to 142.8 µg/kg in Outer Pier 1. Concentrations of total metals ranged from 1,126.1 to 20,642.9 mg/kg in Inner Pier 1 compared to 289.9 to 15,140.2 mg/kg in Outer Pier 1. Detailed analytical data is provided in Appendix A.

Based on a review of the available data, it can be concluded that sediment contamination extends throughout Inner Pier 1 and down to bedrock. Outer Pier 1 sediment contamination extends mostly in the area adjacent to Inner Pier 1 and to an estimated depth of up to 6 feet bss.

2.5 STREAMLINED RISK EVALUATION

2.5.1 Human Health Risk Evaluation.

The only potential medium of concern for human health in Inner and Outer Pier 1 is surface and subsurface sediment. Surface water is not a medium of concern because of the relatively low solubility of the COCs (i.e., PCBs, PAHs, pesticides, and metals) and the constant mixing of water due to the connection between Inner Pier 1, Outer Pier 1, and the Thames River and the downstream flow of the river. The primary use of Pier 1 was to dock security boats and to store booms and buoys that are not being used elsewhere. The wooden part of Pier 1 has now been demolished. As such, there are no anthropogenic activities that involve the potential for direct human contact, ingestion, or inhalation of sediment COCs in Inner or Outer Pier 1. There are a number of Navy-designated freshwater fishing areas at NSB-NLON, but none of the designated areas include the Thames River waterfront. In addition, while public sport fishing does occur on the broader Thames River, there is no public access whatsoever to the Pier 1 area or any other secure location at NSB-NLON. Therefore, there are no reasonable human receptor/pathway combinations and no potential for unacceptable human health risks from contaminated sediment in Inner or Outer Pier 1, except as part of a sediment removal action as that being evaluated in this EE/CA.

Potential exposure of workers to contaminated sediment during remediation activities as those being evaluated in this EE/CA would be addressed through compliance with Occupational Safety and Health Act (OSHA) regulations and adherence to the Navy Remedial Action Contractor's (RAC's) Health and Safety Plan (HASP). Appropriate measures, such as the wearing of personal protective equipment (PPE) would be taken to protect workers from exposure to the contaminated sediment.

2.5.2 Ecological Risk Evaluation

As with human health, the only medium of potential ecological concern at Inner and Outer Pier 1 is surface and subsurface sediment, and surface water is not a medium of potential ecological concern at these locations. Concentrations of COCs in Inner and Outer Pier 1 sediment are elevated enough that the investigation and remediation process has proceeded directly to developing potential removal action alternatives as documented in this EE/CA. As such, no direct sediment toxicity testing was performed in the Pier 1 area. Toxicity testing was performed, however, in other areas of the Lower Subase (i.e., Zones 4 and 7) for the Thames River Validation Study (Battelle and Neptune & Company, 2008). Bioassay results from these other areas were correlated to sediment chemistry and extrapolated to Outer Pier 1 to determine if unacceptable risk exists in that area. Because no toxicity testing was performed on sediment in Inner Pier 1, risk for this area is being assessed through an interpretive approach, as discussed below.

Inner Pier 1 contains a wide range of individual contaminant concentrations that are not spatially correlated. Consequently, the risk analysis benefits from a composite index such as the ERM-Q to directly evaluate risk among different sampling stations. ERM-Qs were calculated for each surface sediment sample collected in the Pier 1 area, and provide a basis for comparing risks to benthic organisms (i.e., benthic invertebrates) on a station-by-station basis. Results were compared to ERM-Qs calculated in the Reference Area to demonstrate the potential relative risks in Inner and Outer Pier 1.

ERM-Qs were calculated using the 13 COCs which were carried forward from the SLERA (Battelle and Neptune & Company, 2004). Equation 1 is the formula used to calculate ERM-Qs; Table 2-2 lists the COPCs used in the numerator and their associated ERM values used in the denominator. Each of the 13 COCs in Table 2-2 are normalized by their ERM, summed, and divided by 13. ERM-Q calculations are presented in Appendix B.1.

$$\mathrm{ERM-Q} = \frac{1}{n}\sum_{i=1}^{n}\frac{[\mathrm{COCi}]}{\mathrm{ERMi}} \qquad \text{Equation 1}$$

where:

$[COC_i]$ =	the concentration of an individual COC
ERM_i =	the Effects Range-Median value for an individual COC
n =	the total number of COCs
i =	individual index of the COCs

ERM-Qs in the upstream Thames River Reference Area, which was sampled as part of the Validation Study, range from 0.09 to 0.95, with a mean of 0.23 (Battelle and Neptune & Company, 2008). ERM-Qs in Inner Pier 1 are up to 30 times higher than in the Reference Area, ranging from 0.78 to 32.4 with a mean value of 6.85. ERM-Qs in Outer Pier 1 are somewhat lower than those in Inner Pier 1, ranging from 0.2 to 5.1 with a mean value of 1.08.

Based upon these results, it can be concluded that current sediment contamination in Inner Pier 1, and to a lesser extent in Outer Pier 1, results in unacceptable ecological risks to benthic organisms receptors.

TABLE 2-1

SUMMARY OF SEDIMENT ANALYTICAL RESULTS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

COCs	Inner Pier 1		Outer Pier 1	
	Range of Detection	Location of Maximum	Range of Detection	Location of Maximum
SVOCs (mg/kg)				
Total HMW PAHs	7.6 – 1,254.6	P1	3.2 - 119	TRP1-SD-007
Total LMW PAHs	1.5 – 466.3	P1	0.6 – 15.2	TRP1-SD-008
PCBs & Pesticides (µg/kg)				
Total PCBs	131.1 – 19,190.6	P1-48	38.4 – 1,186.8	TRP1-SD-008
Alpha Chlordane	0.9 - 14.5 J	P1-C2	0.5 J - 21.2	P1-C4
Total 4-4' DDx	1.1 - 136.7	P1-C2	2.9 - 121.6	P1-C4
Metals (mg/kg)				
Arsenic	6.1 - 20.2	P1-C1	5.1 J - 23.3 J	TRP1-SD-007
Cadmium	0.3 - 1.8	P1-C2	0.4 J - 3.3 J	TRP1-SD-002
Chromium	58 - 405.9	P1	39 - 167 J	TRP1-SD-007
Copper	230.7 J – 2,589.6 J	P1	62.1 J – 8,620 J	TRP1-SD-007
Lead	229.7 J – 2,833.9 J	P1	62.1 J – 1,170 J	TRP1-SD-007
Nickel	28.1 J – 1,048.4	P1	12.7 J - 482	TRP1-SD-007
Selenium	0.2 - 3.2	P1	0.5 - 14.6	TRP1-SD-007
Zinc	573 J – 13,739.9	P1	108 J – 4,660 J	TRP1-SD-007

NOTES:
COC Chemical of concern
DDx Total 4-4' DDx includes 4,4'-DDD, 4-4'-DDE, and 4-4'-DDT.
µg/kg Microgram per kilogram
mg/kg Milligram per kilogram
PAHs Polycyclic aromatic hydrocarbons. High molecular weight (HMW) PAHs include benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and pyrene. Low molecular weight (LMW) PAHs include 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
PCBs Polychlorinated biphenyls. Total PCBs include the following 18 congeners: Cl2(08), Cl3(18), Cl4(28), Cl4(44), Cl4(52), Cl5(66), Cl5(101), Cl5(105), Cl5(118), Cl6(128), Cl6(138), Cl6(153), Cl7(170), Cl7(180), Cl7(187), Cl8(195), Cl9(206), and Cl10(209).
SVOCs Semi-volatile organic compounds

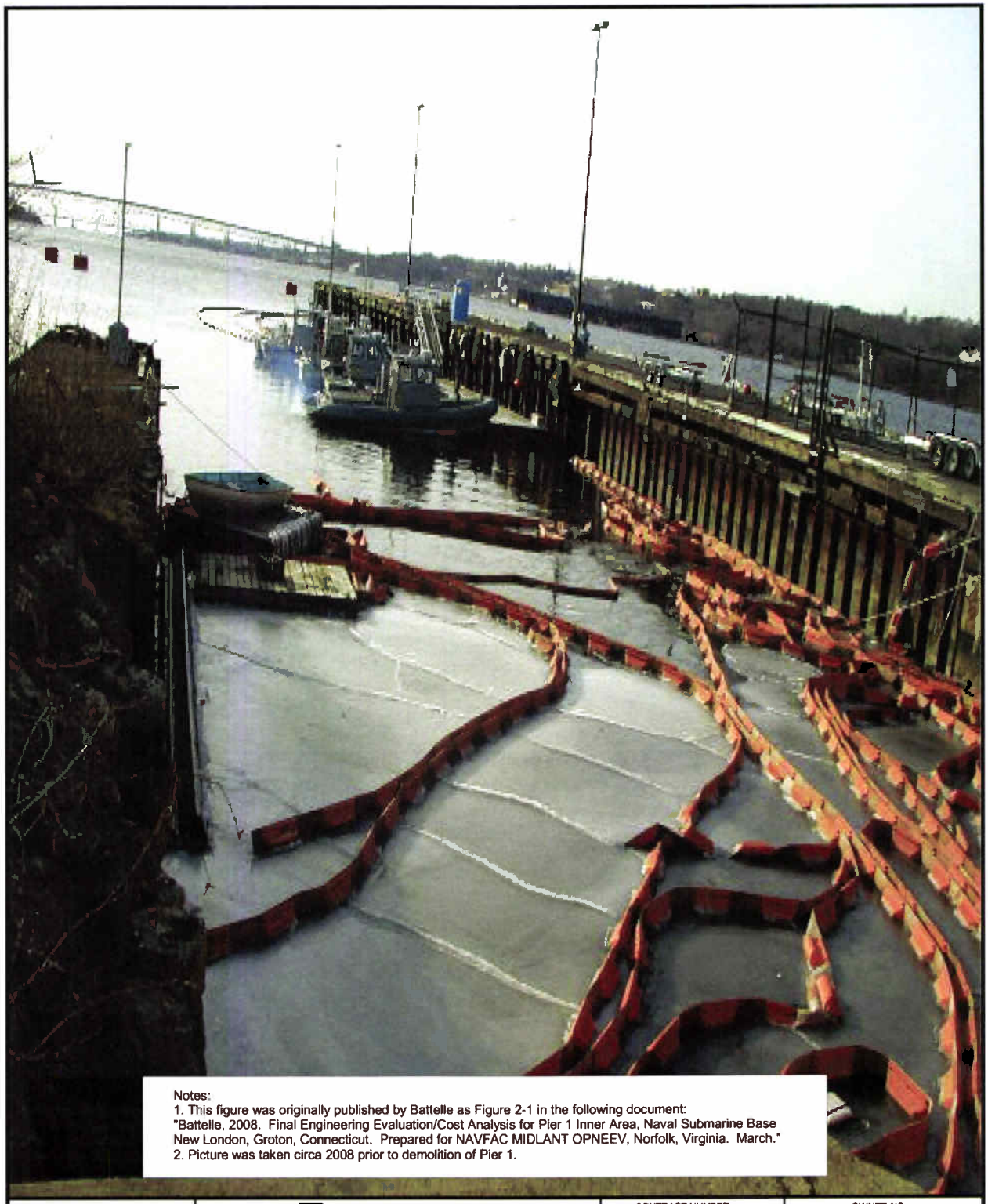
TABLE 2-2

COCs AND ERM VALUES USED FOR ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

COCs	ERM Value
SVOCs (µg/kg)	
Total HMW PAHs	9,600[1]
Total LMW PAHs	3,160[1]
PCBs & Pesticides (µg/kg)	
Total PCBs	180[1]
Alpha Chlordane	6[2]
Total 4-4' DDx	46.1[1]
Metals (mg/kg)	
Arsenic	70[1]
Cadmium	9.6[1]
Chromium	370[1]
Copper	270[1]
Lead	218[1]
Nickel	51.6[1]
Selenium	1.4[3]
Zinc	410[1]

NOTES:

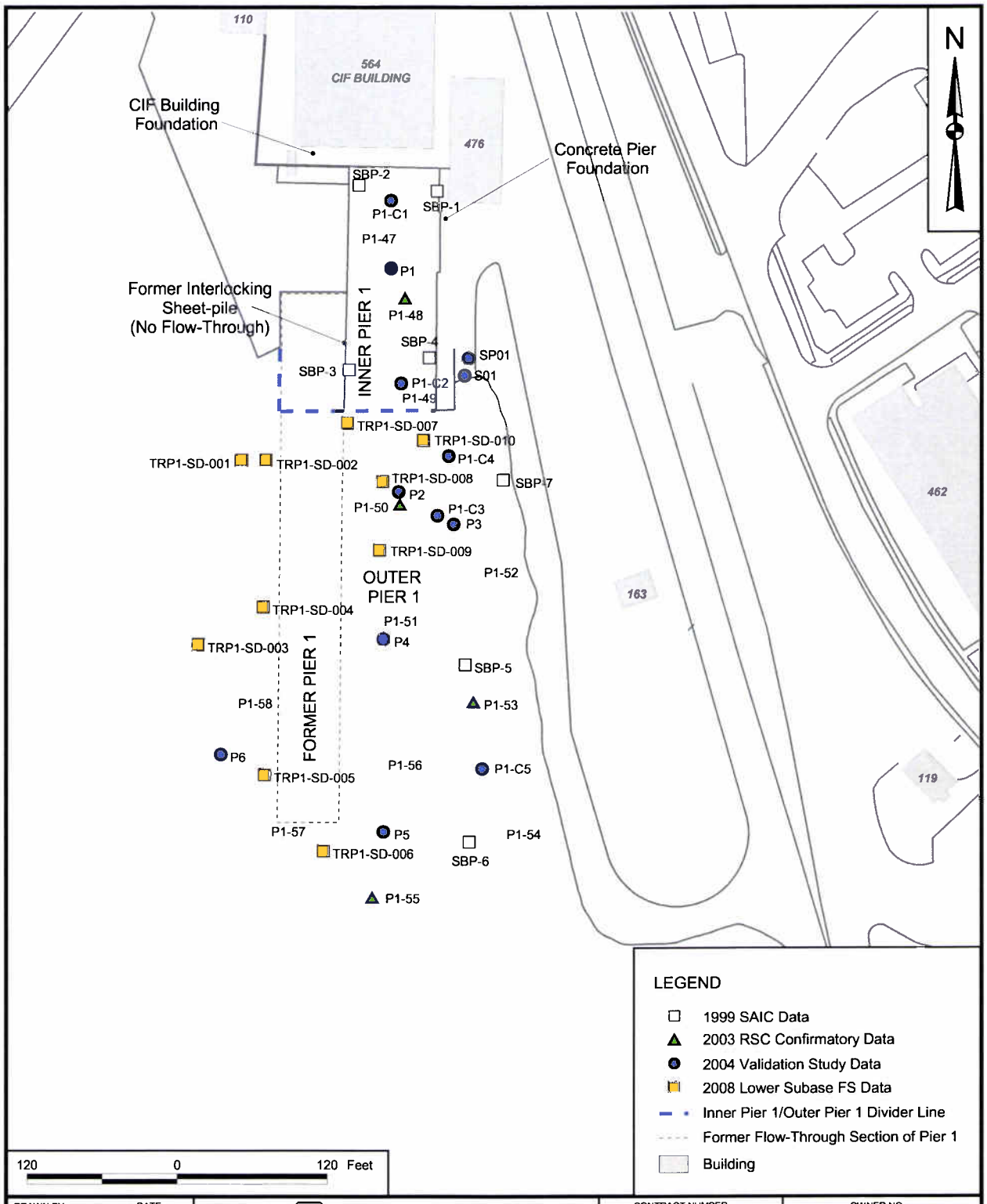
(1) Long, E.R., D.D. McDonald, S.L. Smith, et al., 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. In Environmental Management, Vol. 19, No. 1.
(2) Long, E.R., and L.G. Morgan, 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52.
(3) Wolfenden, J.D., and M.P. Carlin, 1992. Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse. California Environmental Protection Agency and California Regional Water Quality Control Board.
COC Chemical of concern
DDx Total 4-4' DDx includes 4,4'-DDD, 4-4'-DDE, and 4-4'-DDT.
ERM Effects range median
ERM-Q Effects range median quotient
µg/kg Microgram per kilogram
mg/kg Milligram per kilogram
PAHs Polycyclic aromatic hydrocarbons. High molecular weight (HMW) PAHs include benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and pyrene. Low molecular weight (LMW) PAHs include 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
PCBs Polychlorinated biphenyls. Total PCBs include the following 18 congeners: Cl2(08), Cl3(18), Cl4(28), Cl4(44), Cl4(52), Cl5(66), Cl5(101), Cl5(105), Cl5(118), Cl6(128), Cl6(138), Cl6(153), Cl7(170), Cl7(180), Cl7(187), Cl8(195), Cl9(206), and Cl10(209).
SVOCs Semi-volatile organic compounds



Notes:
1. This figure was originally published by Battelle as Figure 2-1 in the following document:
"Battelle, 2008. Final Engineering Evaluation/Cost Analysis for Pier 1 Inner Area, Naval Submarine Base New London, Groton, Connecticut. Prepared for NAVFAC MIDLANT OPNEEV, Norfolk, Virginia. March."
2. Picture was taken circa 2008 prior to demolition of Pier 1.

DRAWN BY S. STROZ	DATE 07/08/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GLORIEUX	DATE 08/05/09	SITE PHOTOGRAPH - INNER & OUTER PIER 1 INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 8/5/09
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 2-1	REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR INNER AND OUTER PIER 1 PHOTO LAYOUT 08/05/09 SS



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
S. STROZ	07/08/09		0424	0811
CHECKED BY	DATE	HISTORICAL SAMPLING LOCATIONS IN THE PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY	DATE
J. GLORIEUX	09/30/09		CAR	10/9/09
COST/SCHEDULE-AREA			APPROVED BY	DATE
			—	—
SCALE			DRAWING NO.	REV
AS NOTED			FIGURE 2-2	0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR PIER 1 SAMPLE LOCATIONS LAYOUT 09/30/09 SS

3.0 REMOVAL ACTION OBJECTIVE AND SCOPE

This section summarizes the statutory framework forming the basis of this EE/CA and the overall scope of the removal action for the Inner and Outer Pier 1 at NSB-NLON. This section also provides a brief introduction to the conceptual schedule for a removal action, defines the objective and area for the removal action, and summarizes the laws and regulations that are potentially pertinent to the removal action for Inner and Outer Pier 1.

3.1 STATUTORY FRAMEWORK

This EE/CA complies with the requirements of CERCLA, the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) in Title 40 of the Code of Federal Regulations (40 CFR) Part 300. This EE/CA has also been developed, to the extent practical, following the *U.S. EPA Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (U.S. EPA, 1993). These requirements are functionally equivalent to the requirements under the National Environmental Policy Act (NEPA).

This EE/CA is being pursued under 40 CFR Part 300.415(b)(2) which defines the right and responsibility of the lead agency to instigate an appropriate removal action to mitigate or eliminate the threat posed to the public or the environment from a contaminant release. The removal action contemplated through the alternatives described in this document is non-time-critical because it has been determined that the removal action would not need to be executed in six months or less to provide appropriate risk mitigation.

The Navy, with oversight from the U.S. EPA, is the lead agency for the removal action for Inner and Outer Pier 1.

3.2 REMOVAL ACTION OBJECTIVE

As discussed in Section 2.4, elevated levels of several COCs (PCBs, PAHs, pesticides, and metals have been identified in Inner and Outer Pier 1 sediment. Concentrations of these COCs are greater in Inner and Outer Pier 1 sediment than in sediment of other Lower Subase offshore locations (e.g., Zone 4 or Zone 7), and they are greatest in Inner Pier 1 sediment. As discussed in Section 2.5, these elevated concentrations of COCs are responsible for the most imminent potential risk to ecological receptors as a result of exposure to contaminated sediment.

Therefore, the RAO for Inner and Outer Pier 1 is to minimize the potential migration of, and mitigate the risk to ecological receptors posed by, COCs in the Inner and Outer Pier 1 sediment.

3.3 PRELIMINARY REMEDIAL GOALS

The BERA performed as part of the Thames River Validation Study (Battelle and Neptune & Company, 2008) developed PRGs for Inner and Outer Pier 1 sediment. Among these PRGs were an ERM-Q of 1.17 and a PCB concentration of 208 µg/kg, both of which correspond to a 50-percent reduction in offspring.

Subsequently, the New London Partnering Team reached a consensus that the ERM-Q of 1.17 was the dominant sediment PRG and that the PCB PRG should be adjusted from 208 to 1,000 µg/kg which is the typical criterion that has been used for other sediment remediation project in Connecticut and other parts of the U.S. (January 28, 2009 Team Meeting). Once these PRGs are met, no further action will need to be specified for the Inner and Outer Pier 1 sediment in the Lower Subase ROD.

The lateral extent of exceedances of the ERM-Q PRG in the Inner and Outer Pier 1 sediment at various depths is shown on Figures 3-1 through 3-3. The lateral extent of exceedances of the PCB PRG in the Inner and Outer Pier 1 sediment at various depths is shown on Figures 3-4 through 3-6.

3.4 REMOVAL ACTION AREA

3.4.1 Inner Pier 1

As discussed in Section 2.4, historical data show that the highest concentrations of COCs are found in Inner Pier 1 sediment and that most of that sediment contains concentrations of COCs greater than the PRGs. Because of the relatively small total volume of sediment and lack of space within Inner Pier 1, it would not be practical to segregate the small fraction of sediment which may be uncontaminated. Therefore, for the purpose of this EE/CA and as shown on Figure 3-1, the removal action area includes all of the Inner Pier 1 sediment to bedrock.

Inner Pier 1 covers approximately 18,500 sf or 0.42 acre. Sediment depth in Inner Pier 1 ranges from 1 to 5 feet, with an average depth of approximately 3.5 feet. However, for the purpose of this EE/CA, it assumed that the Inner Pier 1 removal action area includes a 4-foot depth of sediment for an estimated in-situ volume of 2,739 cubic yards (cy). The volume of Inner Pier 1 sediment is further discussed in Section 5.2 and computation of this volume is provided in Appendix B.2.

3.4.2 Outer Pier 1

As discussed in Section 2.4, the Thames River Validation Study (Battelle and Neptune & Company, 2008) and draft Lower Subase FS (TtNUS, 2008) have identified several areas of sediment with concentrations

of COCs greater than the PRGs in Outer Pier 1. As shown on Figure 3-7 the main such area extends in an arc immediately south of the boundary between Inner and Outer Pier 1.

Based on results from field investigations, Outer Pier 1 sediment with concentrations of COCs greater than the PRGs extends to a depth of 6 feet bss and covers approximate surface areas of 5,100 sf from 0 to 2 feet bss, 20,800 sf from 2 to 4 feet bss, and 27,300 sf from 4 to 6 feet bss. Accordingly, the total in-situ volume of contaminated Outer Pier 1 sediment has been computed to approximately 3,941 cy. However, the overall volume of sediment included in the removal action for this EE/CA is significantly larger because the removal of deeper contaminated sediment would require the removal of overlying clean sediment, because of the necessity to cut back the walls of the removal area for slope stability, and because of overdredging. Therefore, the estimated total in-situ volume of Outer Pier 1 sediment addressed by the removal action is approximately 6,673 cy. Estimated volumes of Outer Pier 1 sediment are further discussed in Section 5.3 and computations of these volumes are provided in Appendix B.2.

As also shown on Figure 3-7, a separate area of sediment contamination has also been identified in Outer Pier 1. This area is circular in shape, covers an estimated 14,400 sf, and is present at a depth of 4 to 6 feet bss around the southern tip of former Pier 1 in the vicinity of sediment sampling location TRP1-SD-005. This separate area of Outer Pier 1 sediment contamination will be addressed as appropriate through the Lower Subase FS.

3.5 SCOPE OF THE REMOVAL ACTION

The scope of the removal action for Inner and Outer Pier 1 is to address sediment with concentrations of COCs greater than the PRGs. The goal of the removal action is to meet the RAO for Inner and Outer Pier 1 which is to prevent the potential migration of contaminated sediment and to mitigate the unacceptable risk to ecological receptors from exposure to the impacted sediment. The removal action will address the areas and volumes of sediment contamination identified in Section 3.4, including the whole of Inner Pier 1 with 81,500 sf and 2,739 in-situ cy and 27,300 sf and 6,673 in-situ cy of Outer Pier 1 sediment.

3.6 REMOVAL ACTION SCHEDULE

This EE/CA identifies several removal action alternatives for Inner and Outer Pier 1 and ultimately recommends one or more removal action alternative for each of these two areas. The schedule for implementation of the selected removal action will depend on timely regulatory approval of the recommended action and adequate funding and contracting availability at the Navy. In addition, potential dredging windows linked to sensitive species' spawning or migration will be closely evaluated for the timing of the removal action. A formal project schedule will be developed as part of a removal action

decision document, such as an Action Memorandum or Removal Action Work Plan. The estimated duration of the alternatives evaluated in this EE/CA is described in the analysis and discussion of each alternative in Section 5.0.

3.7 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

This section provides an overview of the ARAR evaluation process. In addition, this section identifies and evaluates potential Federal and State of Connecticut ARARs that pertain to each removal action alternative included in this EE/CA.

3.7.1 ARARs Overview

The identification of ARARs is performed on a site-specific basis and involves a two-part analysis: first, a determination of whether a given requirement is directly applicable; and then, if it is not directly applicable, whether it is still relevant and appropriate. Regulations that are found not to be applicable may still be relevant and appropriate. According to CERCLA guidance on the development of ARARs, a requirement may be “applicable” or “relevant and appropriate,” but not both. In addition, a regulation that is found to be relevant and appropriate must be complied with to the same degree as if it were applicable.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable Federal requirement is an ARAR. An applicable State requirement is an ARAR only if it is more stringent than the corresponding Federal ARAR. To qualify as a State ARAR under CERCLA and the NCP, a State requirement must be:

A State law.
An environmental or facility siting law.
Promulgated (of general applicability and legally enforceable).
Substantive (not procedural or administrative).
More stringent than the Federal requirement.
Identified in a timely manner.
Consistently applied.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards,

standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not applicable, address problems or situations similar to the circumstances of the proposed remedial action and are well suited to the conditions of the site. A requirement must be determined to be both relevant and appropriate in order to be considered an ARAR. For the determination of relevance and appropriateness, the pertinent criteria typically examined include a determination of whether the requirements address problems or situations sufficiently similar to the circumstances of the release or response action contemplated, and whether the requirement is well suited to the site. The specific criteria for determining relevance and appropriateness are listed in 40 CFR Part 300.400(g)(2), and include the following:

The purpose of the requirement and the purpose of the CERCLA action.

The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site.

The substance(s) regulated by the requirement and the substance(s) found at the CERCLA site.

Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site.

The type of place regulated and the type of place affected by the release or CERCLA action.

The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action.

Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs are actually considered to be ARARs. Permits are considered to be procedural or administrative requirements. Provisions of generally relevant Federal and State statutes and regulations that are determined to be procedural or non-environmental, including permit requirements, are generally not considered to be ARARs. CERCLA 121(e)(1), 42 United States Code (USC) § 9621(e)(1), states that “No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section.” The term *on-site* is defined for purposes of this ARAR discussion as

"the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the remedial action" (40 CFR Part 300.5).

Because conditions vary widely from site to site, ARARs alone may not adequately protect human health and the environment. When ARARs are not fully protective, other Federal or State policies, guidelines, or proposed rules capable of reducing the risks posed by a site may be implemented. Such To-Be-Considered (TBC) standards, as defined in 40 CFR Part 300.400(g)(3), while not legally binding, may be used in conjunction with ARARs to achieve an acceptable level of risk mitigation. TBC requirements complement ARARs but do not override them.

3.7.2 Potential ARARs Affecting the Inner and Outer Pier 1 Removal Action

Pursuant to U.S. EPA guidance and to help in their identification, ARARs are generally divided into three categories including chemical-specific, location-specific, and action-specific. The Federal and State regulations that have been identified as potential chemical-specific, location-specific, and action-specific ARARs for the removal action in Inner and Outer Pier 1 are listed in Table 3-1, Table 3-2, and Table 3-3, respectively.

As shown in Tables 3-1 through 3-3, the ARARs identified for Inner and Outer Pier 1 generally apply to surface water protection, waste storage, handling, and disposal, and protection of aquatic environments and ecological receptors. It is expected that the removal action alternatives considered in this EE/CA will meet all ARARs identified in Tables 3-1 through 3-3.

TABLE 3-1

CHEMICAL-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation of Alternative Compliance with ARAR
FEDERAL				
Cancer Slope Factors (CSFs)	United States Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS) and others	To Be Considered (TBC) for all alternatives	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These standards would be used to determine that there are no unacceptable carcinogenic risks from direct exposure to contaminated sediment. The No Action alternatives would not meet these standards because risks identified would not be addressed.. The other alternatives would meet these standards because potential risk from adult exposure to contaminated sediment would be addressed through dredging and off-site disposal or capping of contaminated sediment.
Reference Doses (RfDs)	EPA IRIS and others	TBC for all alternatives	These are guidance values used in risk assessment to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	These standards would be used to determine that there are no unacceptable non-carcinogenic risks from direct exposure to contaminated sediment. The No Action alternatives would not meet these standards because risks identified would not be addressed.. The other alternatives would meet these standards because potential risk from adult exposure to contaminated sediment would be addressed through dredging and off-site disposal or capping of contaminated sediment.

TABLE 3-1

CHEMICAL-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation of Alternative Compliance with ARAR
FEDERAL (continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	TBC for all alternatives	These guidelines are used to perform human health risk assessments.	These standards would be used to determine that there are no unacceptable carcinogenic risks from direct exposure to contaminated sediment. . The No Action alternatives would not meet these standards because risks identified would not be addressed.. The other alternatives would meet these standards because potential risk from adult exposure to contaminated sediment would be addressed through dredging and off-site disposal or capping of contaminated sediment.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	TBC for all alternatives	These guidelines are used to perform human health risk assessments.	These standards would be used to determine that there are no unacceptable carcinogenic risks to children from direct exposure to contaminated sediment. . The No Action alternatives would not meet these standards because risks identified would not be addressed.. The other alternatives would meet these standards because potential risk from child exposure to contaminated sediment would be addressed through dredging and off-site disposal or capping of contaminated sediment.
Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil		TBC for all alternatives	EPA guidance for evaluating the risks posed by lead in sediment.	All alternatives would meet this standard. . The No Action alternatives would not meet these standards because risks identified from lead-contaminated sediment would not be addressed.. The other alternatives would meet this standard because potential lead risk from adult exposure to lead in contaminated sediment would be addressed through dredging and off-site disposal or capping.

TABLE 3-1

CHEMICAL-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation of Alternative Compliance with ARAR
STATE OF CONNECTICUT				
None				

TABLE 3-2

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation of Alternative Compliance with ARAR
FEDERAL				
Clean Water Act, Section 404	33 United States Code (USC) 1344; 40 CFR Part 230 and 33 Code of Federal Regulations (CFR) Parts 320-323	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	These rules regulate the discharge of dredge and fill materials in wetlands and navigable waters. Such discharges are not allowed if practicable alternatives are available.	All alternatives would comply. Dredging operations including sediment dewatering would be conducted in a manner that will minimize discharges to wetlands or navigable waters. Resource agencies have indicated that mitigation would not be required for altering aquatic habitat. Any capping remedy (Alternatives OP-2 and OP-3) would also meet these standards
Rivers and Harbors Act, Section 10	33 USC 403; 33 CFR Parts 320-323	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Sets forth criteria for obstructions or alterations of navigable waters.	The dredging, dewatering, and potentially capping (Alternatives OP-2 and OP-3) components of all alternatives would meet the substantive environmental requirements of these standards.
Fish and Wildlife Coordination Act	16 USC Part 661 *et seq.*,	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Protects fish and wildlife when actions at the site would result in the control or structural modification of a natural stream, body of water, wetlands, floodplain, or flood-prone areas. The statute requires federal agencies to take into account the effects of remedial actions and prevent loss or damage to resources.	The dredging, dewatering, and potentially capping (Alternatives OP-2 and OP-3) components of all alternatives would be conducted so as to minimize impacts to fish and wildlife in the Thames River. Federal and State resource agencies would be consulted to prevent, mitigate, or compensate for loss of fish and wildlife.
Coastal Zone Management Act	16 USC Parts 1451 *et seq*.	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The dredging, dewatering, and potentially capping components (Alternatives OP-2 and OP-3) of all alternatives would be conducted so as to comply with the substantive requirements of this act.
STATE OF CONNECTICUT				
Connecticut Coastal Management Act	Connecticut General Statutes (CGS) §22a-444	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The dredging, dewatering, and potentially capping (Alternatives OP-2 and OP-3) components of all alternatives would be conducted so as to as to comply with the substantive requirements of this act.

TABLE 3-2

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation of Alternative Compliance with ARAR
STATE OF CONNECTICUT (continued)				
Dredging and erection of structures and placement of fill in tidal, coastal or navigable waters	CGS §22a-359	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	This statute regulates dredging and the erection of structures and the placement of fill, and work incidental thereto, in the tidal, coastal or navigable waters of the state waterward of the high tide line. Work within the regulated zone must be conducted in due regard for indigenous aquatic life, fish and wildlife, the prevention or alleviation of shore erosion and coastal flooding, the use and development of adjoining uplands, the improvement of coastal and inland navigation for all vessels, including small craft for recreational purposes, the use and development of adjacent lands and properties and the interests of the state, including pollution control, water quality, recreational use of public water and management of coastal resources, with proper regard for the rights and interests of all persons concerned.	The dredging, dewatering, and potentially capping (Alternatives OP-2 and OP-3) components of all alternatives would be conducted so as to as to comply with the substantive requirements of this act.
Tidal Wetlands and Watercourses	Regulations of Connecticut State Agencies (RCSA) §22a-30-1 through 17	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	These rules regulate all activities within or affecting tidal wetlands and watercourses.	The dredging, dewatering, and potentially capping (Alternatives OP-2 and OP-3) components of all alternatives would be conducted so as to prevent erosion, sedimentation and other disturbance to tidal wetlands and watercourses
Flood Management Regulations	RCSA 25-68h-1 through 25-68h-3	Not relevant and appropriate to Alternatives IP-1 and OP-1 (No Action). Relevant and Appropriate to all other alternatives.	These regulations address activities by state agencies in flood plains to minimize flood risk and prevent flood hazards.	All alternatives would comply with this standard. Any shoreline activities within the 100-year coastal flood hazard zone would comply with the substantive provisions of these regulations.
Connecticut Endangered Species Act	CGS §26-303 through 314	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Remedial actions may not jeopardize the continued existence of state-listed endangered or threatened species, or adversely modify or destroy their critical habitat.	The dredging, dewatering, and potentially capping (Alternatives OP-2 and OP-3) components of all alternatives would be conducted so as to minimize disturbance to aquatic habitats in the Thames River which are used by the state-threatened Atlantic Sturgeon.

TABLE 3-3

ACTION-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis	Evaluation of Alternative Compliance with ARAR
FEDERAL				
Clean Water Act (CWA), Section 304; National Recommended Water Quality Criteria ("NRWQC")	33 United States Code (USC) 1314; 40 Code of Federal Regulations (CFR) 122.44	Not relevant and appropriate to Alternatives IP-1 and OP-1 (No Action). Relevant and Appropriate to all other alternatives.	Guidelines establish National Recommended Water Quality Criteria ("NRWQC") for the protection of human health and/or the aquatic organisms.	All alternatives would comply Water quality monitoring would ensure that these criteria are not exceeded during dredging and dewatering operations. Alternatives OP-2 and OP-3 that include capping and leaving waste in place might require long-term monitoring of water quality under these standards.
CWA, Section 402, National Pollution Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122 through 125	Not applicable to Alternatives IP-1 and OP-1 (No Action) and Alternatives IP-2, IP-3, OP-2, and OP-4 (off-site disposal). Applicable to Alternatives IP-4 to IP-6, OP-3, and OP-5 (discharge to Thames River.	These standards govern the discharge of water into surface waters.	Alternatives IP-4 to IP-6, OP-3, and OP-5 would comply. Dewatering operations would meet these standards through active or passive treatment before dewatering fluid is discharged back to the Thames River.
CWA; General Pretreatment Regulations for Existing and New Sources of Pollution	40 C.F.R. § 403	Not applicable to Alternatives IP-1 and OP-1 (No Action) and Alternatives IP-4 to IP-6, OP-3, and OP-5 (discharge to Thames River)). Potentially applicable to Alternatives IP-2, IP-3, OP-2, and OP-4 (off-site disposal)	Standards for direct discharge of dewatering fluid or any other discharge into a Publicly Owned Treatment Works (POTW).	Alternatives IP-2, IP-3, OP-2, and OP-4 would comply with these standards if off-site disposal of dewatering fluid involves discharge to a POTW.
Toxic Substance Control Act (TSCA), PCB Remediation Waste Risk-Based Standards	15 U.S.C. § 2601 *et seq.*; 40 C.F.R 761.61(c)	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Risk-based standards for the sampling, cleanup, or disposal of PCB remediation waste.	Alternatives OP-2 and OP-3 would comply by capping PCB contaminated sediment in place to prevent risks to humane health and the environment.. All other alternatives would comly because sediment exceeding the unrestricted use, risk-based standard of 1 mg/kg would be excavated/dredged and disposed of off-site.
Clean Air Act (CAA), National Emissions Standards for Hazardous Air Pollutants (NESHAPS),	42 U.S.C. § 12(b)(1); 40 C.F.R. Part 61	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	The regulations establish emissions standards for 189 hazardous air pollutants. Standards set for dust control and other release sources.	All alternatives would comply. If removal activities, including excavation/dredging or processing of contaminated sediment, generate regulated air pollutants, measures would be implemented to meet these standards.

TABLE 3-3

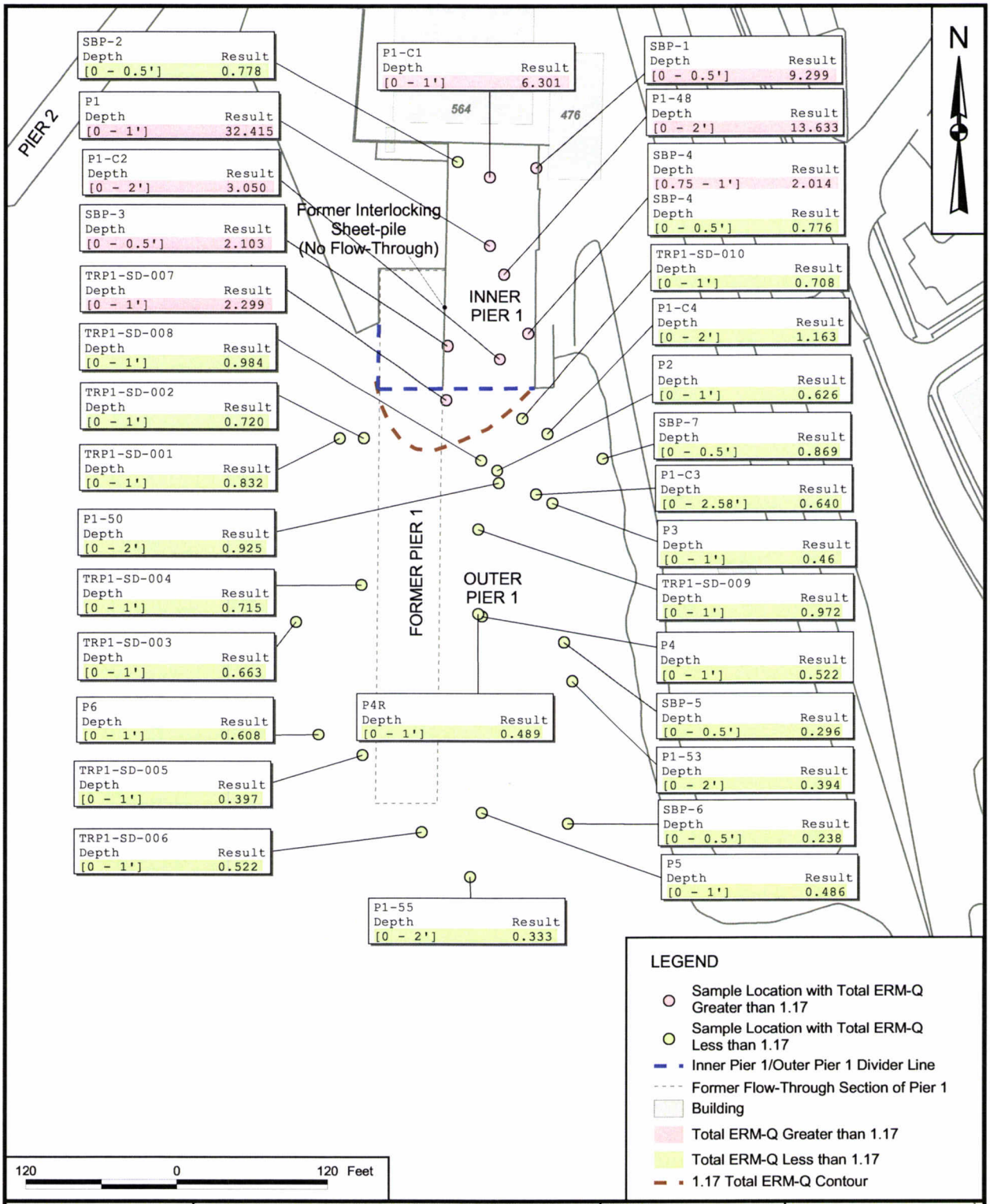
ACTION-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis	Evaluation of Alternative Compliance with ARAR
FEDERAL (continued)				
United States Environmental Protection Agency (U.S. EPA) Contaminated Sediment Remediation Guidance for Hazardous Waste Sites	EPA-540-R-05-012; OSWER 9355.0-85 December 2005	(Not applicable to Alternatives IP-1 and OP-1 (No Action). To Be Considered for all other alternatives.	Guidance on the remediation of contaminated sediments, including capping and dredging.	All Alternatives would comply. Capping and dredging alternatives would be designed and implemented utilizing this guidance.
STATE OF CONNECTICUT				
Hazardous Waste Management: Generator and Handler Requirements, Listing and Identification	Regulations of Connecticut State Agencies (RCSA) § 22a-449(c) 100-101	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Connecticut is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. These sections establish standards for listing and identification of hazardous waste. The standards of 40 CFR 260-261 are incorporated by reference	All alternatives would comply. Hazardous waste determinations would be performed on all contaminated sediment excavated/dredged to determine that the levels of regulated constituents do not exceed applicable limits. Any contaminated sediments which exceed hazardous waste standards would be managed in accordance with requirements of these regulations. Also, wastes produced from dewatering process would be tested to determine whether they exceed applicable limits.
Hazardous Waste Management: Generator Standards	RCSA § 22a-449(c)-102	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	This section establishes standards for various classes of generators. The standards of 40 CFR 262 are incorporated by reference.	All alternatives would comply. Any hazardous waste generated as a result of either excavation/dredging or dewatering operations would be handled and disposed of in compliance with these standards.
Hazardous Waste Management: TSDF Standards;	RCSA § 22a-449 (c) 104	Not relevant and appropriate to Alternatives IP-1 and OP-1 (No Action). Relevant and Appropriate to all other alternatives.	This section establishes standards for the treatment, storage, and disposal of hazardous waste. The standards of 40 CFR 264 are incorporated by reference; in particular 40 CFR Subpart G (Closure/Post Closure), Subpart I (Containers), Subpart J (Tank Systems), Subpart L (Waste Piles), Subpart N (Landfills).	All alternatives would comply. Any hazardous waste that is treated or temporarily stored on-site would be managed in accordance with the requirements of this section, particularly if waste piles, containers, or tanks are used to manage sediment or dewatering fluid exceeding hazardous waste thresholds.. If hazardous waste is left on site (Alternatives OP-2 and OP-3), it would be capped so that the capped area meets relevant and appropriate landfill and closure/post-closure standards under these regulations.
Hazardous Waste Management Facility Siting	RSCA § 22a-116-B-1	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	Any siting of a facility that manages or treats hazardous waste will meet these standards.	All alternatives would comply. Any sediment management and/or dewatering facility that manages material that exceeds hazardous waste thresholds would comply with these siting standards.

TABLE 3-3

ACTION-SPECIFIC ARARs AND TBCs
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis	Evaluation of Alternative Compliance with ARAR
STATE OF CONNECTICUT (continued)				
Solid Waste Management	RSCA §22a-209 -1 through	Not applicable or relenavt and appropriate to Alternatives IP-1 and OP-1 (No Action). Applicable to solid waste managed on-site (all alternatives). Relevant and Appropriate to waste left in place (Alternatives OP-2 and OP-3).	Management and siting requirements for the disposal of solid waste.	All alternatives would comply. All material that does not exceed hazardous waste threshold that would be managed on-site as solid waste and disposed off-site in an appropriate licensed solid waste facility. Any contaminated material that exceeds risk levels, but not hazardous waste thresholds, and would be left in place (Alternatives OP-2 and OP-3) would be capped/covered in accordance to the relevant and appropriate standards of these regulations – including closure/post closure and monitoring requirements.
Water Pollution Control	RCSA §22a-430-1 through 8	Not applicable to Alternatives IP-1 and OP-1 (No Action) and Alternatives IP-2, IP-3, OP-2, and OP-4 (off-site disposal). Applicable to Alternatives IP-4 to IP-6, OP-3, and OP-5 (discharge to Thames River.	These rules regulate water discharge to surface water.	Alternatives IP-4 to IP-6, OP-3, and OP-5 would comply. Dewatering operations would meet these standards through active or passive treatment before dewatering fluid is discharged back to the Thames River.
Air Pollution Control	RCSA §22a-174 1-20	Not applicable to Alternatives IP-1 and OP-1 (No Action). Applicable to all other alternatives.	These regulations require permits to construct and operate specified types of emission sources and contain emission standards that must be. Pollutant abatement controls may be required. Specific standards pertain to fugitive dust (18b).	All alternatives would comply. If removal activities, including excavation/dredging or processing of contaminated sediment, generates regulated air pollutants, measures would be implemented to meet these standards.
Connecticut Guidelines for Soil Erosion and Sediment Control	Connecticut Council on Soil and Water Conservation	Not TBC for Alternatives IP-1 and OP-1 (No Action). TBC for all other alternatives.	Technical and administrative guidance for development, adoption and implementation of erosion and sediment control program.	All alternatives would comply. Excavation/dredging operations would include an appropriate erosion and sedimentation control program that would comply with this guidance.



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
S. STROZ	04/22/09		0424	0811
CHECKED BY J. GLORIEUX	DATE 10/12/09	TOTAL ERM-Qs, 0-2 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/12/09
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-1	REV 0

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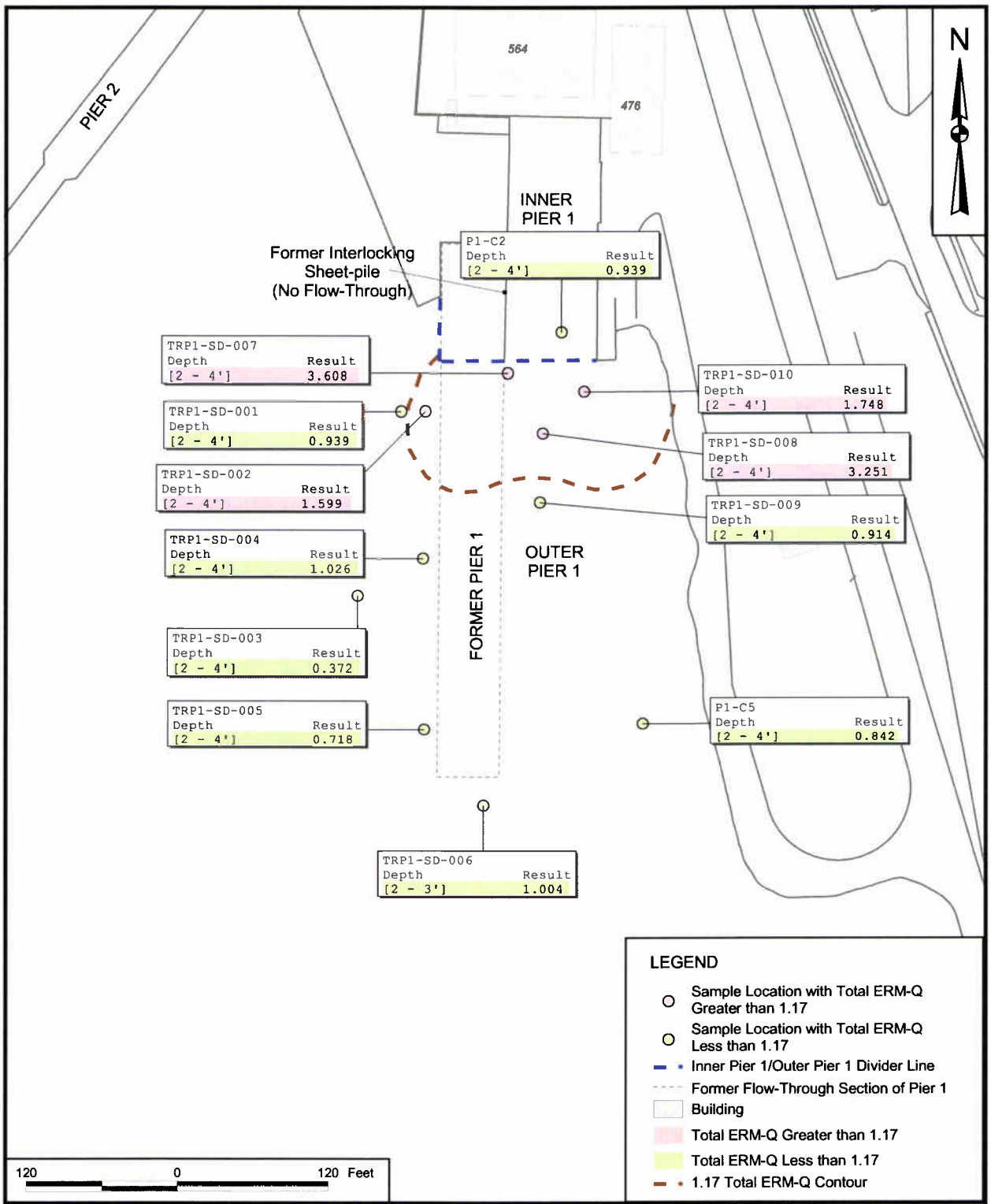

DRAWN BY S. STROZ — DATE 04/22/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GLOTHEUX — DATE 10/12/09	TOTAL ERM-Qs, 2-4 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR — DATE 10/12/09	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 3-2	REV 0

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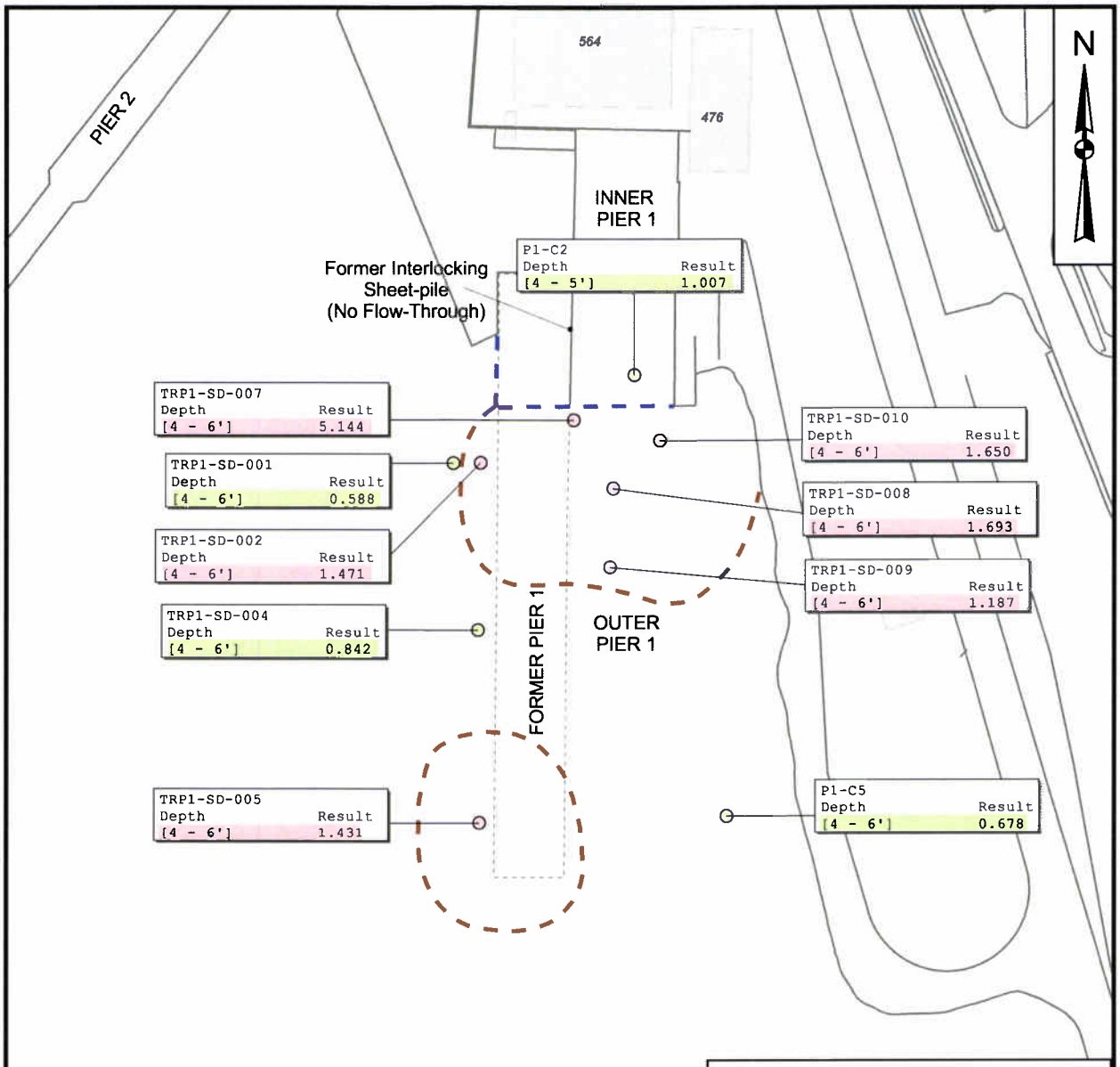
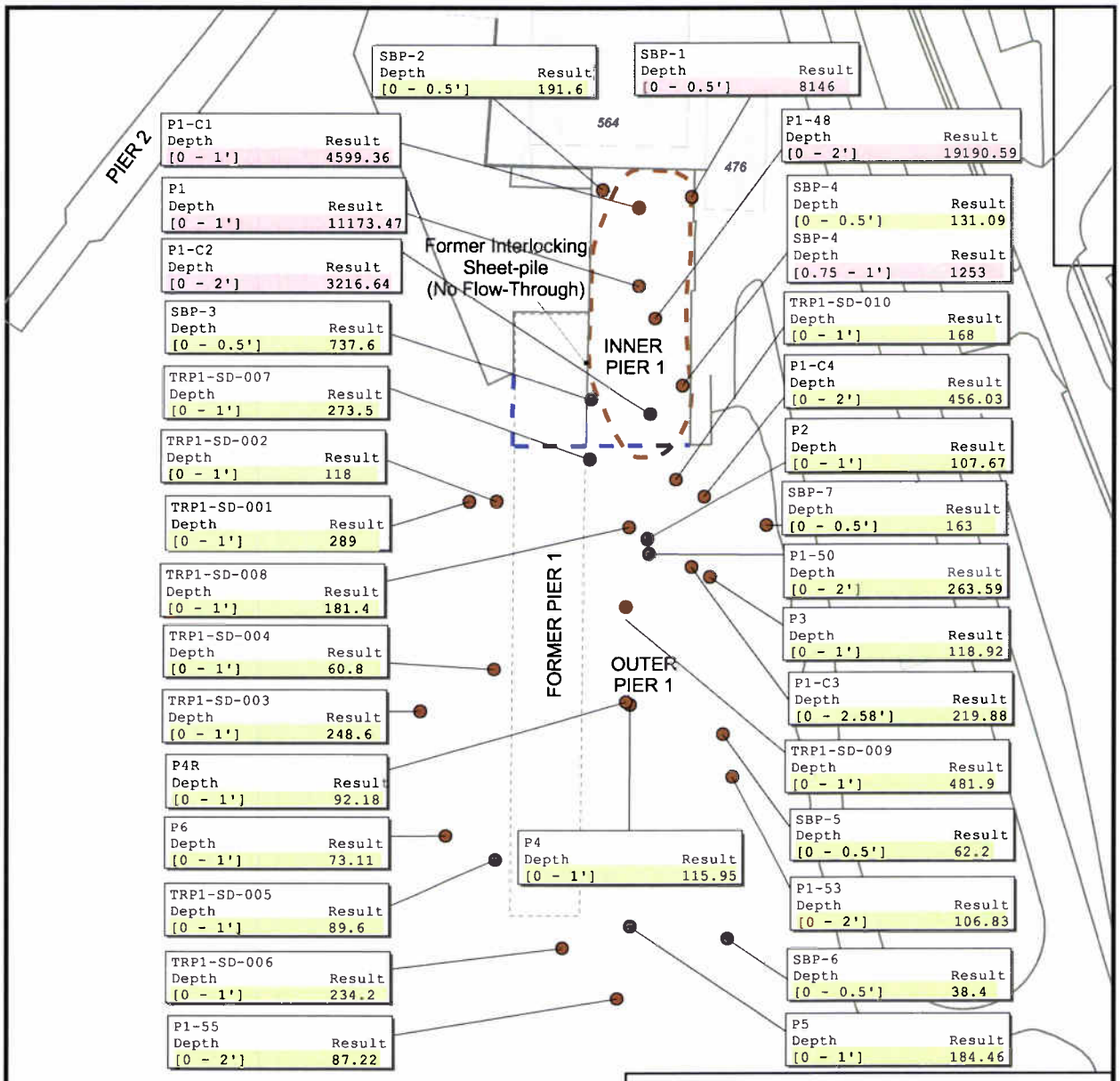


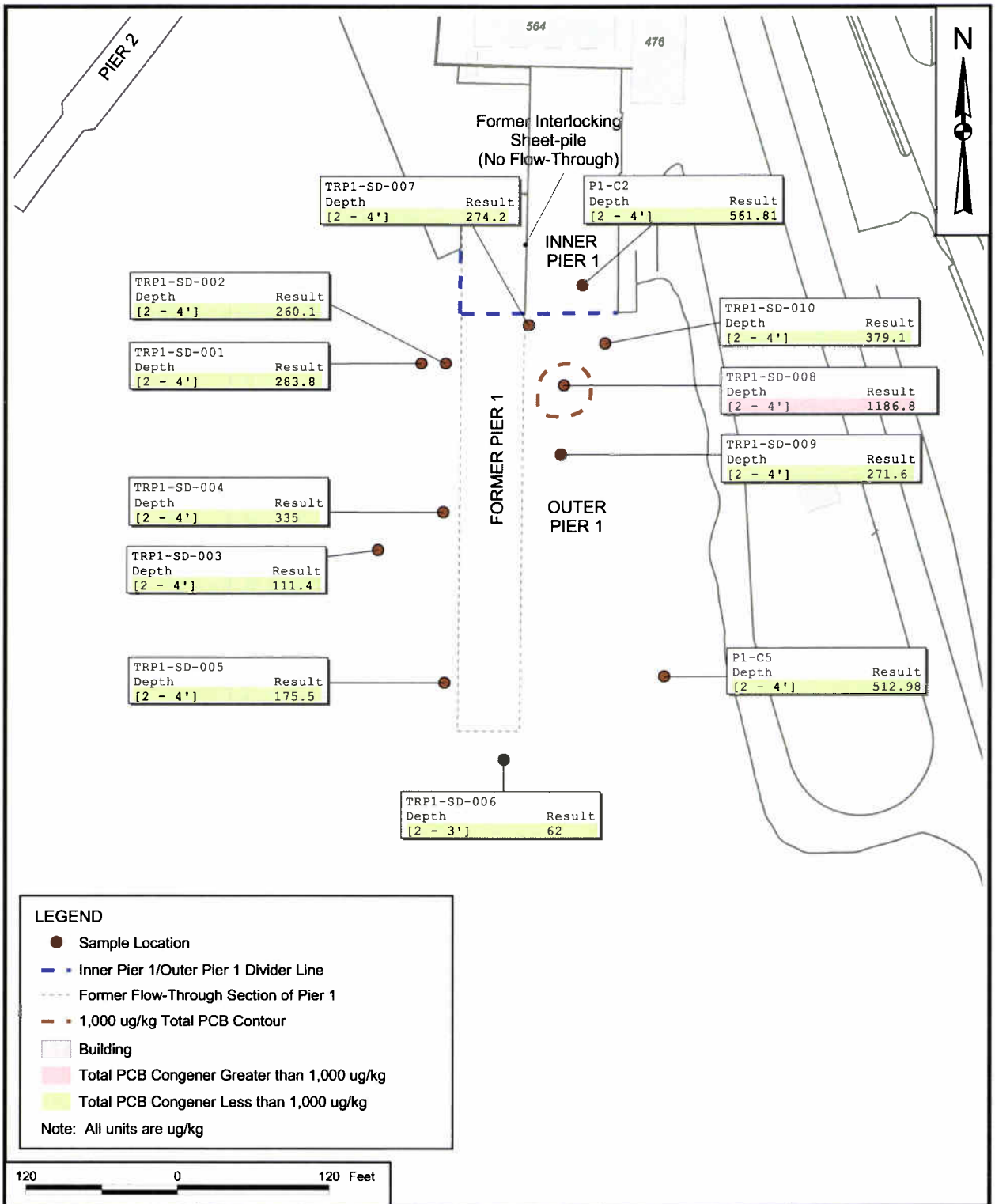
DRAWN BY S. STROZ	DATE 04/22/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424 / OWNER NO. 0811
CHECKED BY J. LAPORIEUX	DATE 10/12/09	TOTAL ERM-Qs, 4-6 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR / DATE 10/12/09
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR REV PIER 1 4 TO 6 TOTAL ERM-QS TAG LAYOUT 10/12/09 SS



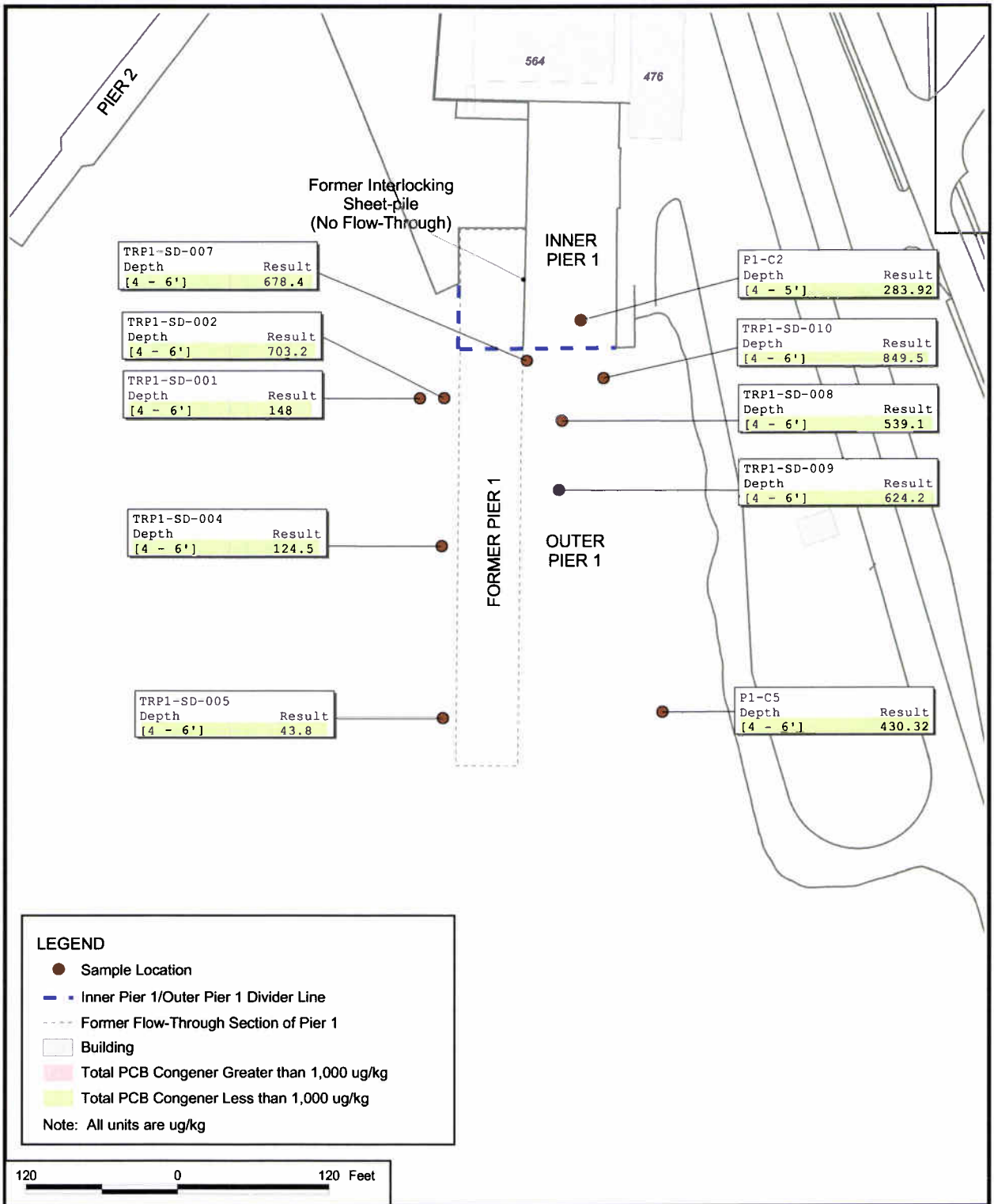
DRAWN BY S. STROZ — DATE 04/21/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GLORIEUX — DATE 10/12/09	TOTAL PCB CONGENERS, 0-2 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/12/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 3-4	REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR PIER 1 PCB CONGENERS 0-2 FOOT DEPTH LAYOUT 10/12/09 SS



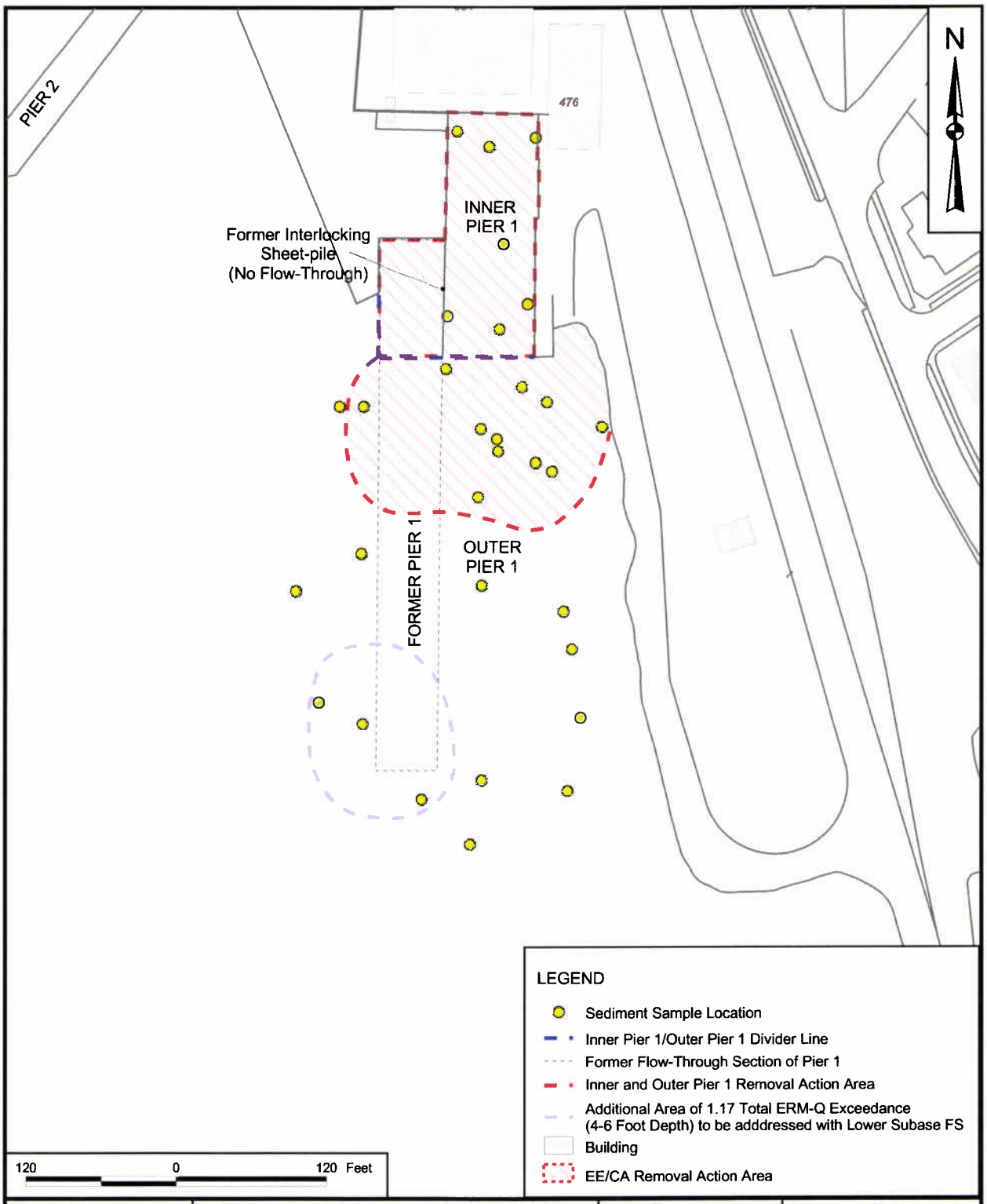
DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
S. STROZ	04/21/09		0424	0811
CHECKED BY J. GLORIEUX	DATE 10/12/09	TOTAL PCB CONGENERS, 2-4 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/12/09
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-5	REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR PIER 1 PCB CONGENERS 2-4 FOOT DEPTH LAYOUT 10/12/09 SS



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
S. STROZ	04/21/09		0424	0811
CHECKED BY	DATE	TOTAL PCB CONGENERS, 4-6 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY	DATE
J. GUERIEUX	10/12/09		CAR	10/12/09
COST/SCHEDULE-AREA			APPROVED BY	DATE
			—	—
SCALE			DRAWING NO.	REV
AS NOTED			FIGURE 3-6	0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR PIER 1 PCB CONGENERS 4-6 FOOT DEPTH LAYOUT 10/12/09 SS



DRAWN BY S. STROZ — DATE 07/07/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GOURIEUX — DATE 10/12/09	BOUNDARY BETWEEN INNER & OUTER PIER 1 AND REMOVAL ACTION AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/12/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 3-7	REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR PIER BOUNDARY AND REMOVAL ACTION AREA LAYOUT 10/12/09 SS

4.0 IDENTIFICATION AND SCREENING OF REMOVAL ACTION TECHNOLOGIES AND PROCESS OPTIONS

This section develops an appropriate range of possible removal action technologies and process options suitable to accomplish the RAO for Inner and Outer Pier 1 sediment (i.e., to mitigate risk posed by PCB, PAH, metals, and pesticides contamination in the sediment). Various removal action technologies and process options within larger technology categories (e.g., treatment and disposal options) were identified, described, and subjected to an initial screening analysis. The most suitable technologies and/or process options for a removal action for Inner and Outer Pier 1 were identified and carried forward to Section 5.0, where they were assembled in the development of appropriate removal action alternatives (U.S. EPA, 1988).

4.1 REMOVAL ACTION TECHNOLOGY AND PROCESS OPTION IDENTIFICATION AND SCREENING APPROACH

The initial screening analysis of potential removal action technologies and process options was based on an assessment of three CERCLA evaluation criteria, effectiveness, implementability, and cost as summarized below:

4.1.1 Effectiveness

The effectiveness of each technology or process option was evaluated based on the following criteria:

- Ability to meet the RAO
- Potential effects to human health and the environment during construction and implementation
- Reliability with respect to the chemical constituents and conditions at the site

COCs at the site include PAHs, PCBs, metals, and pesticides. A summary of the areas of contamination, contaminant concentrations, and areas to be addressed through the removal action is provided in Sections 2.0 and 3.0 of this EE/CA.

4.1.2 Implementability

Implementability encompasses both the technical and administrative feasibility of implementing a technology or process option. This includes the ability to obtain necessary permits and services, as well as the availability of necessary equipment and labor to implement the technology/process option.

4.1.3 Cost

Cost plays a limited role in screening of technologies and process options. The relative costs for each technology/option are qualitatively assessed as being low, moderate, or high. The costs are based on engineering judgment and available historical information associated with the respective technology/option.

Table 4-1 summarizes the removal action technology and process option screening results, and identifies technologies and process options given further consideration in the development of the removal action alternatives for Inner and Outer Pier 1 (see Section 5.0). Table 4-1 also provides a rationale for the screening decisions.

4.2 REMOVAL ACTION TECHNOLOGIES AND PROCESS OPTIONS EVALUATED

The primary technologies evaluated as being potentially suitable for a removal action for Inner and Outer Pier 1 include land use controls (LUCs), monitoring, direct excavation/dredging, in-situ capping, in-situ treatment, monitored natural recovery (MNR), ex-situ treatment, dewatering, transportation, and disposal. In addition, several process options were considered within certain primary technology categories. No Action was also evaluated as required by the NCP.

4.2.1 No Action.

Evaluation of the No Action option is required by the NCP as the baseline to which all other removal actions are compared. Under the No Action response, no removal activities would be conducted and there would be no short- or long-term monitoring. The No Action option may be appropriate if a site does not pose a potential threat to human health or the environment or if previous response actions have eliminated the need for further action.

Screening of No Action

Effectiveness

The No Action option would provide no control of exposure to contaminated sediment. The No Action option would not include any activities that provide for the removal or treatment of contaminated sediment. Therefore, No Action would not be effective in reducing the potential risk from sediment in Inner and Outer Pier 1 or in achieving the RAO.

Implementability

Because no action would be taken, this option would be easily implementable.

Cost

Because no action would be taken, no costs would apply to this option.

Screening Results

Per the NCP, the No Action option serves as a baseline for comparison with other response actions and is retained for solely for this reason for further evaluation in Section 5.0.

4.2.2 LUCs

LUCs are designed to protect human health and the environment from residual contamination at environmental sites. LUCs consist of administrative or legal mechanisms (e.g., deed or zoning restrictions, permits, etc.) designated as institutional controls and/or physical controls (e.g., capping, fencing, security guards, etc.) designated as engineering controls. Site-specific LUCs are typically formulated through a LUC Remedial Design (RD) prepared in accordance with the Navy's LUCs Principles (DoD, 2003) following approval of the Record of Decision (ROD). LUCs also typically include the performance of regular site inspections to verify their continued implementation.

Screening of LUCs

Effectiveness

LUCs consisting of restrictions to prevent disturbance of contaminated sediment would effectively minimize unacceptable risks from spreading of that contaminated sediment to previously uncontaminated areas. However, LUCs would not be effective for protecting ecological receptors from potential exposure to contaminated sediment.

Implementability

LUCs would be easy to implement on a military facility where access is already restricted. A LUC RD could be readily prepared. LUCs for the Lower Subase could easily be integrated within and implemented as part of NSB-NLON's existing SOPA Instructions 5090.25 (Navy, 2009)

Cost

The capital and O&M costs for LUCs would be low.

Screening Results

Although their stand-alone effectiveness for the protection of the environment would be somewhat limited, LUCs are retained for further evaluation in Section 5.0 because they could add a useful protective element to other removal technologies.

4.2.3 Monitoring

Monitoring would consist of sampling and analyzing sediment throughout the areas of sediment contamination to evaluate trends in concentrations of COCs and to assess the potential for off-site migration of contaminated sediment.

Screening of Monitoring

Effectiveness

Monitoring alone would not reduce the toxicity, mobility, or volume of COCs in the sediment. However, monitoring would allow for a determination of the effectiveness of natural attenuation or active removal actions and would also detect potential off-site migration of contaminated sediment.

Implementability

Sediment monitoring would be easy to implement. Such monitoring has already been performed on several occasions at Inner and Outer Pier 1. The resources and material required for monitoring are readily available.

Cost

The capital and O&M costs of monitoring would be low.

Screening Results

Monitoring is retained for further evaluation in Section 5.0.

4.2.4 Dredging/Excavation

Dredging/excavation technologies are those that directly remove contaminated material. The term dredging is more commonly associated with removing material beneath open water, and the term excavation is commonly associated with removing material from a terrestrial setting. However, subaqueous dredging can be accomplished using terrestrial excavation techniques if the body of water is located near shore or if terrestrial equipment can be operated from a stable floating platform and reach the contaminated sediment. Options within the primary removal action technology category of dredging/excavation include mechanical, hydraulic, hybrid, and pneumatic systems. These systems are discussed below in more detail.

Mechanical Dredging/Excavation

On land, mechanical excavation is commonly accomplished using a tracked or tired vehicle containing an excavator on a fixed arm (e.g., backhoe) or larger crane-based digging equipment. In open water, mechanical dredging typically uses either digging buckets (e.g., clamshell buckets) or dragline buckets suspended by a cable from a crane, or common terrestrial equipment staged on or permanently affixed to a floating platform. In addition, areas with impacted subaqueous sediment can be physically dewatered and then excavated as though they were terrestrial. Mechanical dredging buckets are similar to land-based crane and bucket excavators.

To remove subaqueous sediment, common excavation equipment can be deployed from onshore or a floating platform exactly as it would be operated (i.e., under hydraulic pressure) to remove earth in a terrestrial setting. Backhoes have not been extensively used for contaminated sediment removal projects, due to the generally large scale of sediment removal projects, some difficulty in excavating continuous level areas over long distances, and potential loss of sediment from the open excavator bucket. However, backhoes can be more effective than dredging systems for removing dense or hard material and are effective for dredging slopes along shorelines. Backhoes are most effective in shoreline or shallow-water work where they can be placed either on land or on shallow-draft pontoon barges, and can also be deployed in physically dewatered near-shore areas to remove sediment.

Dredging buckets are typically dropped through the water column and penetrate into the sediment by gravity. The bucket is closed and then lifted from the sediment through the water column. Typical dredging buckets are known as “clamshells” because they can be totally closed. Dragline dredges use a barge-mounted crane that is similar to a clamshell dredge. The difference is that dragline buckets are open on one side and are lowered into the sediment with a lifting cable, then pulled back towards the crane with a second cable. Draglines have been used in navigational dredging and also are used in mining operations because they are efficient at removing large quantities of sediment. They are rarely

used for contaminated sediment projects because the open side of the bucket does not effectively contain the dredged sediment, which can increase resuspension rates.

Using any system, when the dredge/excavator bucket is filled, it is moved to deposit the dredged material into a transport container or onto a suitable staging area. The container is typically a barge, hopper and conveyor system, or land-based truck, and the staging area is commonly a dedicated shoreline area (e.g., levee or dewatering area). Mechanical dredging/excavation typically removes subaqueous sediment at nearly the in-place density and water content. However, some water is picked up with the collected sediment because every bucket cannot be filled completely with sediment. Mechanical dredging/excavation through the water column typically adds a volume of water 20 to 50 percent of the bucket capacity.

Hydraulic Dredging

Hydraulic dredges are routinely used throughout the United States to move large sediment volumes. Hydraulic dredges add water to sediment to create a sediment/water slurry that is pumped via pipeline to a desired location (e.g., dewatering site or transport container). A large amount of water must be added to slurry the sediment for transport through the pump and pipeline. The volume of water added is typically 5 to 10 times the in-place volume of sediment removed. The main components of a hydraulic dredge are as follows:

A *dredge head* that sets into the sediment and contains a suction pipe inlet (and may contain some type of digging or cutting device).

A *support system* that usually consists of a ladder-shaped structure that is hinged and is used to support and control the location of the dredge head.

A *hydraulic pump* that provides suction at the dredge head to pull sediment and water into the system and propel the slurry.

A *pipeline* that carries the slurry to a desired location (e.g., dewatering site or transport container).

Hydraulic dredges are usually classified by the type of dredge head used to loosen sediment, as follows:

Cutter head dredges use a rotating head to cut into the sediment and add water.

Auger dredges use a horizontal auger to loosen sediment and pull it to the center of the dredge and suction inlet pipe.

Suction hydraulic dredges rely solely on suction to remove the sediment and do not use a cutting device.

The cutter head system is the most common hydraulic technology used to remove sediment. Cutter head hydraulic dredges can remove a wide variety of sediment types, including dense sand and hard clay. Because suction hydraulic dredges do not use a cutting device to loosen the sediment, they can only generally remove soft sediment with little debris. Suction hydraulic dredges often include water jets to help loosen and slurry the sediment.

Hybrid Dredging

Hybrid dredges use mechanical devices to remove sediment. Water then is added to the sediment, creating a slurry that is subsequently pumped to a desired location. The hybrid process option includes various pumps that can move slurries with higher solids content than traditional hydraulic dredges so that much less water may be required to make the slurry.

Pneumatic Dredging

Pneumatic dredges are similar to hydraulic dredges, except that in place of a pump, they use a pressure gradient created with compressed air to lift and move dredged material. Pneumatic dredges are not common and are used primarily for small-scale cleanup of spilled contaminants and marine archaeology.

Screening of Dredging/Excavation

Given their similarity, the screening assessment for dredging/excavation systems is completed simultaneously.

Effectiveness

Dredging has been demonstrated at numerous sites and is an effective technology to remove a contaminated medium such as sediment from an impacted aquatic environment. Dredging is effective at addressing any class of contaminant (i.e., organic or inorganic) because it physically and non-selectively removes impacted material. Thus, dredging would be capable of addressing the contamination present in Inner and Outer Pier 1 sediment. Dredging effectiveness can be limited due to the potential for surface sediment mixing, resuspension and redeposition, and limitations in the precision of dredging equipment. However, these limitations would only be significant for Outer Pier 1 because Inner Pier 1 is highly confined laterally by structures and vertically by bedrock.

The release of COCs into the water column can be minimized with an environmental bucket that provides a better seal than conventional buckets and/or the spread of resuspended contaminants beyond the dredge site can be minimized with a silt curtain. Mechanical dredging can leave a rougher bottom surface compared to some hydraulic systems, and mechanical dredges remove the least amount of water, thus minimizing dewatering and/or treatment needs. Some sloughing can occur, which can create the need for additional dredge passes. Hydraulic dredging typically creates a sediment slurry with a higher water content than mechanical dredging, which can require additional on-site processing. However, closed recirculation systems have been devised to reduce the slurry water content. Less sloughing typically occurs with hydraulic dredging than mechanical dredging.

Hybrid dredging consists of components of both mechanical and hydraulic dredging systems and is also an effective method of sediment removal. However, the effectiveness of hybrid dredging can be limited by its inherent inefficiency (i.e., by sequentially instead of simultaneously dredging, slurrying, and transporting). The effectiveness of pneumatic dredging for sediment remediation is largely undocumented because this technology is more commonly applied in other contexts (e.g., archaeology).

Implementability

Dredging is a proven technology and can be implemented readily at most sites. Debris in the sediment can result in some complications and cost increases. Because of the very confined nature of Inner Pier 1, dredging would not require additional characterization for the accurate design of dredge prisms (i.e., lateral and vertical zones requiring dredging). None of the COCs for which the removal actions at Inner and Outer Pier 1 Inner Area are specifically proposed would inhibit the ability to implement dredging.

Cost

Actual dredging/excavation costs are relatively low. However, post-dredging/excavation sediment management costs can substantially increase the overall costs of a dredging removal action. Removing contaminated sediment eliminates many long-term monitoring costs associated with capping and other in-situ actions.

Screening Results

Overall, dredging/excavation is a proven technology that is effective and highly implementable. Hybrid dredging is inherently less efficient than mechanical or hydraulic dredging, and pneumatic dredging is not well studied in the context of environmental sediment remediation. Hydraulic dredging typically functions more efficiently for larger-scale dredging projects than that for Inner and Outer Pier 1. In addition, the

limited site access, very confined space for support functions, and relative shallow depths of water and sediment all favor mechanical dredging/excavation as a reasonable removal action option for Inner and Outer Pier 1. Therefore, mechanical dredging/excavation is retained for further analysis in Section 5.0. For Inner Pier 1, both shore- and barge-mounted excavation equipment will be evaluated. For Outer Pier 1, only barge-mounted equipment will be evaluated.

4.2.5 In-Situ Capping

Capping involves the controlled placement of uncontaminated material over contaminated sediment to isolate contaminants from the surrounding environment and potential human or ecological receptors. Capping also stabilizes sediment, minimizing the potential for contaminant resuspension and transport or the flux of contamination to the overlying water column. Capping is generally most appropriate for locations where the risk associated with contaminants is low to moderate, routine disturbance (e.g., maintenance dredging) is not required to support local functions such as navigation, and in relatively low-energy environments that ensure cap stability. Capping also can be employed at higher risk sites where more invasive remediation techniques (i.e., dredging) are not viable or are cost-prohibitive.

Materials commonly used in sediment capping include clean sediment, sand, or gravel. In certain instances, a more complicated engineered capping system can involve geosynthetics (e.g., geomembranes or geotextiles) or multiple layers of various materials. Other capping materials are available that incorporate chemical additives to facilitate contaminant degradation. One example could be the use of an activated carbon cap, where granular activated carbon is used to sequester hydrophobic contaminants like PCBs.

Cap armoring can be employed to further stabilize cap materials and generally consists of the placement of riprap or gravel over the clean cap. Cap armoring can be used in higher energy environments where currents, waves, or mechanical disturbance (e.g., propeller wash) could potentially lift or disturb the cap material.

Capping can be implemented as a sole remedy or in conjunction with other remedial techniques. For example, dredging could be implemented to remove sediment contamination to a certain predetermined depth or to remove hotspots, and then a cap could be installed to isolate residual contamination remaining after dredging. Institutional and/or engineering controls are commonly employed in conjunction with caps, such as navigational restrictions, physical access restrictions, deed notices, or future dredging restrictions. These controls minimize the potential for cap disturbance and potential subsequent exposure of human or ecological receptors to sediment contamination.

A monitoring program is commonly required when a cap is used to remediate contaminated sediment sites. Monitoring techniques such as sediment coring, bathymetric surveying, video profiling, and surface sediment sampling can be used to evaluate the potential for upward contaminant migration into or through the clean cap layer, biological perturbation of the cap, or the potential for cap displacement, shifting, or erosion.

Screening of In-Situ Capping

Effectiveness

Capping would not remove contaminated sediment or reduce its toxicity. Nonetheless, capping is a well-established and proven technology that could be effective in preventing direct exposure of ecological receptors to the contaminated sediment. A cap could also be effective in minimizing the potential for off site migration of contaminated sediment principally as a result of erosion and sedimentation. However, the continued effectiveness of a cap depends on the long-term maintenance of its integrity, and this could be difficult to achieve because the areas to be capped are subject to a high level of ship traffic and may have to be periodically dredged to remain navigable. For Inner and Outer Pier 1, the effectiveness of a sediment cap could be significantly enhanced by the previously evaluated LUCs, which would prevent uncontrolled disturbance of contaminated sediment.

Implementability

Installation of a cap over contaminated sediment is typically fairly easy to implement, and the required material and services are readily available. However, this technology would be difficult to implement at the Lower Subase because it would significantly interfere with the activities of the facility. Not only would the initial construction of the cap interfere with normal ship movements and harbor activities, but, as mentioned above, these same movements and activities could also undermine the long-term structural integrity of cap, which would thus require frequent monitoring and maintenance. Because of the need to maintain a specified depth of water for navigation purposes, it is likely that placement of a cap would require pre-dredging of a significant thickness of sediment. For Inner Pier 1, this pre-dredging would probably result in removal of most of the sediment, thereby eliminating the need for capping.

Cost

The capital costs for capping would be low to moderate. Because of the need for frequent and long-term monitoring and maintenance, O&M costs would be relatively high.

Screening Results

Although there are some significant concerns about its long-term effectiveness and practical implementability, capping of the Outer Pier 1 area is retained for further analysis in Section 5.0 because, with adequate long-term maintenance, it would be effective and constitute a viable alternative to the more complex and costly removal and off-site disposal of contaminated sediment. However, capping is eliminated from further consideration for Inner Pier 1 because, as noted above, its implementation would likely result in the removal of most of the contaminated sediment, thus eliminating the need for capping.

4.2.6 In-Situ Treatment

Several technologies are emerging that allow contaminated sediment to be treated in place to destroy or immobilize contaminants without the need for sediment removal (i.e., dredging/excavation). In-situ treatment technologies are applied to protect potential human or ecological receptors from contact with contaminated sediment or to minimize the mobility, toxicity or bioavailability of contamination. Four in-situ treatment options potentially applicable to Inner and Outer Pier 1, granular activated carbon (GAC) amendment, nanoscale iron amendment, in-situ bioremediation, and in-situ stabilization, are described below.

GAC Amendment

Adsorption of sediment COCs onto GAC would limit their mobility and bioavailability to receptors by sequestering them from the aqueous phase (i.e., pore water and the water column). At Inner and Outer Pier 1, GAC could be applied to adsorb organic COCs such as PCBs and PAHs from contaminated sediment. However, this technology has not been significantly field tested and would likely be ineffective at addressing metals.

Nanoscale Iron Amendment

Nanoscale iron [i.e., synthesized nanometer-size zero-valent iron (ZVI) particles] can be used to chemically reduce and dechlorinate halogenated organic COCs. In the laboratory, nanoscale iron reduction of PCBs has led to complete dechlorination to biphenyls (Gardner and Aulisio, 2003). Notably, microscale (i.e., micrometer-size) ZVI is ineffective at dechlorinating PCBs except at elevated temperatures and pressures (Yak et al., 2000). Like GAC amendment, nanoscale iron amendment has not yet been significantly field tested. In addition, the effectiveness of nanoscale iron amendment for the removal of heavy metals also remains untested.

Bioremediation

In-situ bioremediation is an emerging technology that may include biostimulation and/or bioaugmentation. Biostimulation involves the addition of chemicals and/or nutrients to sediment and bioaugmentation involve the addition of microorganisms to the sediment to initiate or enhance biologically mediated contaminant destruction. In-situ bioremediation would likely be effective for the removal of organic COCs in Inner and Outer Pier 1 sediment, but it would probably not remove inorganic COCs. Studies have been completed on PCB-contaminated sediment in the Hudson River to determine the viability of in-situ bioremediation. During the early 1990s, test cells were established in the river and some were inoculated with microorganisms and nutrients under relatively controlled conditions. The results of the study suggested that naturally occurring microorganisms were actively degrading PCBs. However, PCB degradation efficiencies were not very high, and the inoculated test cells did not exhibit increased PCB degradation rates compared to non-inoculated cells (Reynolds, 1998).

Stabilization

In-situ stabilization involves the addition of cementitous (e.g., Portland cement) or other binding material (e.g., pozzolanic materials such as lime or fly ash) to contaminated sediment to bind or encapsulate COCs, making them less soluble and less mobile or toxic. Inorganic COCs can be chemically bound within the cement matrix, whereas organic COCs tend not to react with the binding matrix and instead become encapsulated. The addition of binding agents can be accomplished by direct placement using mechanical devices or by broadcast surface spreading. The binding agent can be mixed into the upper layers of the contaminated sediment.

Screening of In-Situ Treatment Technologies

Effectiveness

The potential advantages of in-situ technologies are that they generally do not ultimately require off-site waste disposal and they tend to minimize potential contamination redistribution effects inherent during removing, handling, and transporting sediment. In addition, in-situ bioremediation may be capable of completely degrading and/or detoxifying contaminants.

The disadvantages are that field verification is virtually non-existent for sediment remediation projects. In addition, in-situ technologies are generally only viable for one class of COCs (e.g.., organic compounds), and treatment efficiencies can be significantly lower than ex-situ technologies given the inherent difficulty in remedial process control (e.g., amendment distributions and variability in sediment grain size). In-situ stabilization is less contaminant specific, but it does not destroy COCs. Rather, stabilization binds COCs in a less mobile and less bioavailable form. In addition, stabilizing agents might alter the chemical

conditions of the local sediment environment, which can actually increase the solubility or mobility of certain constituents. A long-term monitoring plan would be required to ensure the stability and function of any in-situ treatment.

It is unclear how effective GAC amendment, nanoscale iron amendment, in-situ bioremediation, or in-situ stabilization would be for the treatment of contaminated sediment at Inner and Outer Pier 1. These technologies have not been extensively field tested; therefore, field-effectiveness is unknown. None of these technologies are readily suitable to address all of the COCs in Inner and Outer Pier 1 sediment, and a thorough in-situ treatment strategy would likely be difficult to formulate.

Implementability

Implementation methods for in-situ sediment treatment technologies have not been thoroughly developed, and the full-scale implementability of these technologies remains largely unknown. The materials and equipment necessary to implement in-situ treatment technologies are limited in availability. Detailed pilot-scale studies would be necessary to determine the actual implementability of these technologies or combinations of technologies.

Cost

In-situ treatment technologies would be expected to be less costly than ex-situ technologies. For in-situ treatment options, cost would vary depending on the type and volume of reactants or amendments required. Determination of actual costs for in-situ treatment would require bench- and pilot-scale studies and the development of a detailed design approach.

Screening Results

In-situ treatment technologies are insufficiently mature, making their effectiveness and implementability uncertain. Also, no single technology has been proven to address all of the COCs present in Inner and Outer Pier 1 sediment. Therefore, in-situ treatment technologies are not carried forward to Section 5.0.

4.2.7 MNR

MNR involves leaving contaminated sediment in place and allowing existing processes to contain, destroy, alter, and/or otherwise reduce the bioavailability and/or toxicity of COCs, while closely monitoring conditions to verify progress of remediation. Natural recovery could involve physical processes (sedimentation, advection, dilution, dispersion, bioturbation, or volatilization), biological processes (biodegradation, biotransformation, or phytoremediation), or chemical processes (natural oxidation/reduction or sorption).

Natural recovery relies primarily on natural sedimentation in depositional environments. Natural sedimentation can create a clean surface sediment layer through physical burial of contaminated sediment with increasingly clean sediment over time (U.S. EPA, 2001; Brenner et al., 2004). Such "natural capping" can form a protective barrier that inhibits diffusion of contaminants into the water column, minimizes the potential for resuspension of contaminated sediment, and isolates contamination from potential contact with ecological and human receptors.

Natural biological or chemical activity can also reduce concentrations of COCs to levels where they are no longer of concern through biotic and/or abiotic transformations and interactions. Typical forms of natural contaminant reduction include volatilization, biotransformation, biodegradation, sequestration, and benthic mixing. For certain contaminants, sorption/sequestration can act to reduce contaminant bioavailability. Once sufficiently buried, the hydrophobic binding of organic contaminants to sediment renders these contaminants unavailable to the biological food web. PCB toxicity also can be reduced through dechlorination in buried anaerobic sediment. Dechlorination results in the transformation of higher chlorinated PCBs to lower chlorinated and generally less toxic PCBs (Bedard and Quensen, 1995). Aroclors, typically dominated by tetra-, penta-, and hexachlorobiphenyl congeners, can be transformed to mono-, di-, and trichlorobiphenyl congeners. Metals also can be strongly bound in sediment. For example, metal-sulfide precipitates can stabilize metals in anaerobic sulfide-rich sediment, although changes in oxidation/reduction conditions can remobilize some of these metals (BERC, 1999).

Because sorption/sequestration and metals precipitation processes do not remove contaminants from the environment but simply render them less mobile, natural recovery generally must rely on contaminant burial. Therefore, sediment stability also must be an integral component of natural recovery. Sediments must be stable enough to protect buried contaminants from resuspension and environmental exposure during high-energy events. Sediment stability can be assessed using measurements of critical shear strength (i.e., cohesive strength measurements to create a vertical profile of erosion potential with depth) combined with surface-water hydrodynamic studies (i.e., to measure the potential bottom shear stress from wave-induced and current-induced forces). The primary objective of these measurements is to show that buried sediment (primarily the most contaminated sediment) is stable and would not be resuspended during normal or high flows.

Natural recovery is most appropriate for locations where the inherent risk from contamination is relatively low or where other remedial options are technically not feasible or are cost prohibitive. Significant site characterization would be required to ensure that contaminant levels and ongoing surface sediment recovery processes that support natural recovery are well understood before implementing this strategy.

Natural recovery can be implemented as a sole remedy, or as part of a larger remedial strategy incorporating other, more active technologies, and/or following the implementation of other active remedial technologies. LUCs such as navigational restrictions, physical access restrictions, deed notices, or future dredging restrictions are commonly employed in conjunction with MNR. These controls minimize the potential for sediment disturbance, resuspension, and disruption of the natural recovery processes.

The advantages of MNR are that it relies on natural ongoing processes, acute disturbance to the ecosystem is minimized because of the lack of physical impact to contaminated sediment, and implementation costs are low. Disadvantages are that natural recovery can take a significant length of time to complete (decades can be required in some cases for natural processes to accomplish RAOs), an extensive long-term monitoring plan is generally considered necessary, and COCs are left in place, leading to potential long-term liabilities and risks.

Screening of MNR

Effectiveness

Insufficient analytical data are currently available to establish clear trends in concentrations of COCs for Inner and Outer Pier 1 sediment. With the exception of sedimentation, the above-mentioned physical natural recovery processes are not likely to significantly reduce the risks from the sediment COCs such as PAHs, PCBs, metals, and pesticides. Sedimentation could reduce risks from these COCs as a result of natural capping; however, sedimentation is not a significant occurrence in this part of the Thames River. Biological natural recovery processes might reduce the concentrations of such organic sediment COCs as PAHs but other organic COCs such as PCBs and inorganic COCs such as metals would not be removed. As for chemical natural recovery processes, sorption would only be significant with the finer particles which represent only a relatively small fraction of Inner and Outer Pier 1 sediment, and natural oxidation/reduction would not impact the organic COCs or significantly alter the toxicity of the metallic COCs.

Implementability

MNR would be relatively simple to implement because, in and of itself, it would require no action other than initial characterization and long-term monitoring. The greatest implementability challenge for MNR would be the ability to implement and maintain ancillary requirements, such as LUCs and monitoring.

Cost

MNR generally has a relatively low cost compared to other more active removal action technologies. Monitoring costs associated with MNR can be appreciable, particularly if monitoring is required over a

large area and long duration. Costs for MNR are still generally low in comparison with other sediment remedy technologies even when considering ancillary monitoring and control costs. For Inner and Outer Pier 1, it is assumed that the monitoring program that would be associated with MNR would not be excessively costly because of the limited area covered by contaminated sediment.

Screening Results

At Inner and Outer Pier 1, MNR would likely require a very long time to achieve the RAO, and high concentrations of several contaminants would remain in place and potentially continue to contribute to unacceptable risk. As such, MNR is not retained for further analysis in Section 5.0.

4.2.8 Ex-Situ Treatment

Following sediment dredging/excavation, ex-situ treatment can be used to address contaminants and render the sediment suitable for reuse or support subsequent actions (e.g., disposal). Ex-situ treatment can also be applied to residual fluid from dewatering operations to allow it to be discharged directly on site. Ex-situ treatment technologies include physical, chemical, thermal, and biological processes. Ex-situ treatments are typically applied for one or more of the following reasons:

- To achieve contaminant levels compatible with final disposal locations (e.g., to meet landfill acceptance criteria).
- To reduce costs by generating material with less stringent disposal requirements or by reducing the volume of contaminated material.
- To generate material that can be beneficially reused or directly discharged either on or off site.
- To minimize liability.

Five ex-situ treatment options potentially applicable to Inner and Outer Pier 1 sediment, thermal desorption, incineration, stabilization, sediment washing, and biological treatment are described below. In addition, one option is described for ex-situ treatment of residual fluid from dewatering operations with filtration and liquid-phase GAC adsorption.

Thermal Desorption

Thermal desorption is typically used to treat organic or volatile organometallic COCs in non-aqueous media. The process involves heating and agitating the contaminated material in a thermal reactor while

exposing it to a carrier gas or vacuum. The process does not destroy COCs but rather volatilizes them, allowing the carrier gas to transport them to an off-gas treatment system. Typically, an off-gas treatment system consists of a particulate removal stage and a contaminant removal stage (e.g., vapor-phase GAC adsorption). In some cases, organic constituents are destroyed using a secondary combustion chamber or catalytic oxidizer. There are two different types of thermal desorption, low temperature and high temperature thermal desorption. Low temperature desorption is typically used to remove organic compounds of relatively low molecular weight and correspondingly low boiling point. High temperature desorption is typically used to remove organic compounds of higher molecular weight and boiling point such as the PCBs and PAHs in Inner and Outer Pier 1 sediment. Pre-treatment is typically necessary for any thermal desorption technique to achieve an appropriate moisture content in the feed material.

Incineration

Incineration can be applied to treat most organic and organometallic COCs in non-aqueous and aqueous media. Incinerators use controlled combustion of a fuel source to destroy organic COCs by high temperature oxidation reactions within a contained reactor. Incineration can be implemented on site using mobile or transportable units, or off site at a permitted incineration facility. Most organic compounds are destroyed at temperatures ranging from 1,100 to 1,200 degrees Fahrenheit (°F) [600 to 650 degrees Celsius (°C)]. Typical mobile incinerators operate between 1,400 and 2,200°F (750 to 1,200 C) and commercial hazardous waste incinerators operate from 1,200 to 3,000°F (650 to 1,650°C). Incineration thermally oxidizes organic COCs to basic mineral constituents, typically carbon dioxide, water, or simple acids (e.g., hydrochloric acid). Off-gas treatment is commonly required with incineration to remove particulates, to neutralize acid gases (e.g., nitrogen oxides, sulfur oxides, or hydrochloric acid) that may be generated during the combustion process, and to protect against the potential release of dioxins or dioxin-like organic compounds.

Stabilization

Stabilization is used to immobilize, chelate, or solidify metals or non-volatile organic constituents in contaminated non-aqueous media by encapsulation (i.e., physical entrapment) or chemical reaction (i.e., precipitation or covalent bonding), minimizing the potential for contaminants to be leached from the resulting treated material. Stabilization can be conducted on site or off site at a disposal facility. Stabilization also can achieve contaminant risk reductions significant enough to allow on- or off-site beneficial reuse. Sediment amendments used for stabilization typically include cementitous (e.g., Portland cement), polymeric, soluble phosphate, or pozzolanic (e.g., fly ash and kiln dust) materials. Limestone can be an effective metal binding agent and can lead to the precipitation or accretion of metals as carbonate precipitates. Pretreatment may be required before stabilization to achieve an appropriate moisture content and/or to screen out oversize debris. In addition, engineering controls can be required

to minimize dust generation or air emissions during the stabilization process. Stabilization often results in an increased waste volume for ultimate disposal due to the addition of the stabilizing agent(s).

Sediment Washing

Sediment washing involves contacting contaminated sediment with a wash or carrier solution and allowing COCs to migrate into that solution. The process generally involves particle-size separation followed by washing of the fine-grained contaminated fraction using a wash/carrier solution. The wash/carrier solution typically consists of water mixed with a solvent, acid, base, and/or specific binding agent depending on the nature of the contaminant(s). Proprietary technologies exist that use complex surfactants, and some research has been conducted using “green solvents” such as supercritical carbon dioxide or supercritical water. Sediment washing can be conducted on site, and is suitable for a wide range of contaminants including inorganic and organic compounds such as petroleum hydrocarbons, pesticides, PCBs, and PAHs.

Sediment washing generates an aqueous waste stream that typically requires treatment and/or disposal. Treated sediment is commonly disposed off site, but under appropriate circumstances it can be beneficially reused on site or off site. Specific wash system design, wash fluid(s), and wash time(s) are selected on a site-specific basis based on the results of bench-scale and/or pilot-scale treatability studies. Because sediment water content can dilute the wash/carrier solution, pretreatment may be required to achieve an appropriate moisture content. Pretreatment may also be required to screen out oversized debris.

Biological Treatment

Ex-situ biological treatment systems are designed to provide optimal water content, aeration, nutrient levels, pH, and temperature to promote biological transformation and/or degradation of contaminants. In general, biological treatment is suitable only for certain organic constituents and is accomplished by promoting degradation by indigenous organisms. However, microorganisms can be added to the reaction from some other source to accelerate biological degradation. Common types of biological treatment are windrowing/landfarming, composting, and slurry-phase biotreatment. Biological treatment can be implemented on or off site, but is more typically implemented on site.

Biological treatment of PCBs presents unique challenges. Higher chlorinated (tetra- through decachloro-biphenyl) congeners are relatively recalcitrant to aerobic degradation but are susceptible to anaerobic reductive dechlorination. Reductive dechlorination transforms higher chlorinated compounds to lower chlorinated compounds by sequentially removing chlorines and replacing them with hydrogen atoms. In contrast, the lower chlorinated (mono- through trichlorobiphenyl) congeners are more resistant to

reductive dechlorination but are able to be degraded aerobically. Alternating anaerobic and aerobic biological treatment processes can hypothetically improve contaminant destruction efficiencies for compounds like PCBs and pesticides, but successful application of such treatment technologies in the field is limited. Waste streams can still remain after treatment, requiring further treatment, proper management, and/or disposal.

Filtration/Liquid-Phase GAC Adsorption

Residual fluids from sediment dewatering operations can be treated on site to achieve an aqueous effluent free of contaminants, thereby allowing the water to be directly discharged on site and minimizing disposal costs associated with aqueous waste. Because sediment COCs are typically strongly bound to the solid matrix and do not readily partition to the aqueous phase, common treatment systems for residual fluids from sediment dewatering operations combine filtration to remove suspended solids and liquid-phase GAC adsorption as a final polishing step to further remove strongly bound organic and inorganic COCs and residual suspended solid particles.

Screening of Ex-Situ Treatment Technologies

Effectiveness

Thermal desorption and incineration are considered effective and viable treatment technologies for non-aqueous solid media contaminated with organic constituents. Incineration can also be effective to immobilize inorganic COCs if operated at higher temperatures. However, thermal desorption is generally not an effective means of treating metals in contaminated sediment and therefore would be ineffective for the removal of metal contamination in Inner and Outer Pier 1 sediment. The use of thermal desorption is also less well proven for the treatment of sediment than it is for the treatment of soil.

Stabilization can be an effective and viable treatment technology for non-aqueous media contaminated with inorganic constituents. Stabilization can also be effective for the immobilization of certain non-volatile organic compounds, but the effectiveness of this technology for the treatment of these types of compounds is typically much less than it is for the treatment of inorganic compounds.

Sediment washing can be an effective and viable treatment technology for non-aqueous media contaminated with inorganic and organic constituents. However, sediment washing is not very well proven on a full-scale basis.

Biological treatment is considered an effective and viable treatment technology for non-aqueous media contaminated with certain organic constituents. However, biological treatment is typically not an effective

means of treating metals in contaminated sediment. In addition, the mixed contaminant suite in Inner and Outer Pier 1 sediment could make the selection of an appropriate biological treatment system difficult.

The use of filtration and liquid-phase GAC adsorption is considered a standard and effective approach for the treatment of aqueous waste from dewatering processes.

For Inner and Outer Pier 1 sediment, a treatability study would be useful to determine the effectiveness of any ex-situ technology for the treatment of the sediment itself or that of an aqueous byproduct. In addition, air emissions control could be required following thermal treatment, particularly when there is a risk of transforming PCBs to dioxins.

Implementability

Stabilization, sediment washing, biological treatment, and aqueous waste treatment using filtration and liquid-phase GAC adsorption could be implemented using generally readily available equipment (e.g., mixers) and/or additives (e.g., Portland cement). All of these technologies also involve relatively low-energy and low-intensity processes. For stabilization, sediment washing, and biological treatment it would be difficult to formulate appropriate process conditions to successfully treat the complex suite of COCs present in Inner and Outer Pier 1 sediment.

Thermal desorption and incineration are readily implementable technologies for treatment of organic contaminants that can be implemented on site using mobile or transportable prefabricated equipment, or could be accomplished at a permitted off-site facility. In addition, most ancillary processes that would likely be required to implement thermal desorption or incineration for sediment (i.e., pretreatment and residual waste disposal) are considered readily implementable. Off-gas treatment may be more difficult to implement, particularly with the risk of transforming PCBs to dioxins. Permitting requirements for and public perception of thermal treatment are unknown at this time but may limit implementability of these technologies for Inner and Outer Pier 1.

Any ex-situ treatment technology would typically require bench-scale testing to confirm effectiveness and/or pilot-scale testing to develop site-specific design parameters.

Cost

In general, although ex-situ water treatment can be accomplished at relatively low cost, ex-situ sediment treatment technologies are expensive to implement. Thermal desorption is less expensive than incineration but is likely to be more expensive than dewatering and direct disposal of contaminated sediment, and is considered a moderate to high cost option. Dewaterability would impact the treatment

costs; sediment with poor dewaterability would retain a relatively high water content, which would increase the thermal treatment costs. Water vapors could have to be captured in a water trap or knockout tank and treated. The unit cost for thermal desorption, incineration, sediment washing, and biological treatment likely would be higher compared to off-site disposal at a permitted facility. For technologies like thermal treatment, stabilization, and biological treatment, which cannot treat all contaminant types, multiple technologies could be required, thus increasing the overall costs.

Screening Results

Thermal desorption, incineration, stabilization, and biological treatment are not retained for further analysis in Section 5.0 because the respective effectiveness of each of these technologies is uncertain given the high water content of the sediment and the presence of a complex suite of COCs including multiple organic and inorganic constituents. However, although not directly considered in assembling removal action alternatives for Inner and Outer Pier 1, some form of ex-situ treatment of sediment may be required in conjunction with off-site disposal and could be accomplished directly at the point of disposal.

Ex-situ treatment of residual fluid from dewatering operations with filtration and liquid-phase GAC adsorption is retained for further analysis in Section 5.0 because it is a standard and effective approach for minimizing off-site disposal requirements and costs.

4.2.9 Dewatering

Dredged/excavated sediment is generally too wet to be transported directly to or placed at a disposal facility. Mechanical dredging can increase the in-place sediment volume by up to 100 percent, and hydraulic dredging can add up to 5 to 10 times the in-place sediment volume as water. Therefore, some form of dewatering is typically performed as part of the management of contaminated dredged/excavated sediment. Dewatering can reduce the weight and volume of sediment designated for off-site disposal and can reduce controls and restrictions on transportation. Accordingly, dewatering can reduce transportation and disposal costs.

Dewatering is most commonly achieved by either passive (gravity-aided) drainage or mechanical expression. Dewatering can also be achieved by through the addition of chemical agents that adsorb free water and/or improve the physical texture of the material to be dewatered.

Passive Drainage

Passive drainage is typically performed by stockpiling the wet material to be dewatered on a drainage bed to let most of the free water drain as a result of gravity and the mechanical expression of the lower strata

of stockpiled sediment by the weight of the upper strata. The free water drains through a pad or membrane designed to filter out solid particles. If required, this pre-filtered water can then be treated by such technologies as GAC adsorption to meet the appropriate criteria for discharge to local surface water. Drainage beds can be installed on land or on a barge. For dewatering of Inner and Outer Pier 1 sediment, barge-mounted drainage beds would have the double advantage that they could be positioned next to the dredging equipment, thus minimizing the need to handle wet dredged sediment, and that they would not require any land space which is at a premium in the Pier 1 area. Previous experience with similar applications has also shown that the filtered drainage water does not require treatment.

Mechanical Expression

Mechanical expression of free water from the material to be dewatered can be achieved through the use of pressure or centrifugal forces developed by specialized equipment such as belt filter presses, plate-and-frame filter presses, vacuum filters, or centrifuges. If required, the released water can also be treated on site as with the stockpiling option.

Dewatering Additives

Chemical additives such as fly ash, Portland cement, or lime can adsorb free water, reduce the proportional moisture content, and improve the physical texture of the treated material. This type of dewatering can be referred to as physical stabilization and is somewhat similar to chemical stabilization/solidification with the difference that its primary aim is to improve the handling characteristics of the treated material rather than immobilize certain contaminant within the matrix of the treated material. Dewatering additives can be applied in a variety of ways ranging from as simple as being broadcast over the material to be dewatered and subsequently mixed in with such equipment as a front-end loader to as sophisticated as being blended in a carefully controlled manner with such equipment as a pug mill. The use of dewatering additives can result in a swelling effect that increases the overall volume of the dewatered material by 10 to 30 percent.

Screening of Dewatering

Effectiveness

Dewatering, either by passive drainage, mechanical expression, or the use of dewatering additives would not of itself reduce COC concentrations in Inner and Outer Pier 1 sediment. However, this technology is a required step for the overall treatment and disposal of dredged sediment.

Passive drainage, mechanical expression, and the use of dewatering additives are field-proven methods to reduce sediment water content. They have been used successfully to manage contaminated

dredged/excavated sediment and are effective dewatering technologies. Mechanical expression is generally more effective than passive drainage because the rate and extent of water removal are usually higher when forces greater than gravity alone are applied to separate liquids from solids. The use of dewatering additives is an effective method of adsorbing free water but it does not reduce the overall water content of the dewatered material and can significantly increase its volume. The effectiveness of these dewatering technologies would not be impacted by any of the COCs present in Inner and Outer Pier 1 sediment.

Implementability

Passive drainage and mechanical expression are readily implementable. Resources, equipment, and material to implement either of these options are readily available. As previously-mentioned, barge-mounted drainage beds would have the double advantage that they would minimize handling of wet sediment and would not require onshore space which is scarce in the vicinity of Pier 1 under the current industrial site use scenario. Mechanical expression would require more equipment and maintenance than passive drainage. As previously noted, these technologies would be expected to generate a filtered drainage water which can readily be discharged to surface water without further treatment. However, a small fraction of the water released by these dewatering technologies, and particularly passive static drainage, would not readily drain and filter and would require special handling. This fraction of released water, hereafter referred to as dewatering fluid, would be collected separately, tested, and either disposed off site or treated and discharged on site.

The use of dewatering additives would also be readily implementable. Local power plants could be a ready source of fly ash and this kind of technology would be typically available as a service from a number of off-site contractors. For Inner and Outer Pier 1 sediment dewatering, this technology would best be combined with passive drainage with the dewatering additive being applied to the drainage bed immediately following the removal of free water. This technology would not normally result in the release of any free water that might require treatment.

The implementability of these dewatering technologies would not be impacted by any of the COCs present in Inner and Outer Pier 1 sediment.

Cost

The cost of passive drainage would typically be low. The cost of mechanical expression would be moderate to high depending on the technology used. The cost of dewatering could be partially recovered as a result of the lower disposal costs due to sediment volume reduction. The cost of dewatering additives would be low to moderate depending on the type and quantity of agent required.

Screening Results

Passive drainage, mechanical expression, and the use of dewatering additives would all be effective and implementable. Because of their ease of implementation and because they would require little or no onshore space, barge-mounted drainage beds are considered as the most reasonable dewatering option for the site-specific conditions at and around Inner and Outer Pier 1. The use of additives would most likely also be required as part of the dewatering process and, as mentioned earlier, it could easily be combined with passive drainage. Therefore, both of these options are retained for further evaluation in Section 5.0.

4.2.10 Transportation

Dredged/excavated sediment material can be transported using either mechanical or hydraulic methods. Mechanical methods include floating barges, amphibious vehicles, wheeled vehicles (e.g., trucks), railroads, or conveyors. Mechanical methods are largely similar to conventional methods used for upland soil transport. Hydraulic methods use pumps and pipelines to transport sediment in a slurry form.

Mechanical transport technologies are commonly used for sediment that is dredged with mechanical equipment and for dewatered sediment. Hydraulic transport technologies are typically used for sediment with a high water content such as that resulting from hydraulic dredging and these technologies will not be considered because hydraulic dredging has been eliminated from further consideration. Viable mechanical sediment transportation methods, including barge, truck, and rail, are discussed below.

Barge

Barges are used to transport dredged/excavated sediment over water. Sediment can be loaded directly onto barges during dredging operations, after which the barge would transport sediment to a pier or shoreline where the sediment could be offloaded mechanically or hydraulically. Barges also can be used to transport dewatered sediment, in which case the sediment would be loaded from land and onto the barge for transport over water. Barges frequently require liners and a retaining system to protect against spillage.

Truck

After dewatering, trucks can be used for land transport of dredged/excavated sediment material to an appropriate disposal site. Truck containers frequently require liners and lids/covers to protect against spillage.

Rail

Rail transport can be available for movement of dredged/excavated sediment material to an appropriate disposal site. Rail transport requires the presence of an existing rail system that can connect a site with a selected disposal location. Rail containers frequently require liners and lids to protect against spillage. In the vicinity of NSB-NLON, a rail line known as the Providence & Worcester exists, and there appear to be connections and sidings in the vicinity of the base.

Screening of Transportation

Effectiveness

Transportation, either by barge, truck, or rail would not of itself reduce COC concentrations in Inner and Outer Pier 1 sediment. However, this technology is a required step for the overall treatment and disposal of dredged sediment.

Truck, rail, and barge options have been used successfully to transport contaminated dredged/excavated sediment, and all of these technologies are considered effective. Given the relatively small scale of the removal action for Inner and Outer Pier 1 and the confined nature of the site, truck transport would likely be the most effective approach. The effectiveness of these transportation technologies would not be impacted by the COCs present in the Inner and Outer Pier 1 sediment.

Implementability

Barge and truck transport are readily implementable. The existence of a usable rail network between all points of activity and disposition is not known, even with the known presence of the Providence & Worcester rail line; therefore the implementability of rail transport is uncertain. The implementability of these transportation technologies would not be impacted by the COCs present in Inner and Outer Pier 1 sediment; however, spill prevention management would be required.

Cost

Transportation costs would be low to moderate for bulk material such as sediment.

Screening Results

Transportation is not a stand-alone removal action technology, but is used in combination with other technologies such as dredging/excavation and disposal. Because of the relatively small scale of the project and the confined nature of the site, as well as uncertainty surrounding the availability of rail

transport, that technology is not retained for further evaluation. Given its known effectiveness, implementability, and relatively low cost, truck transportation is the most likely choice for Inner and Outer Pier 1 sediment. However, given the costal location of the site, barge transportation should also be considered, especially for Outer Pier 1 sediment. Therefore, both of these technologies are retained for further analysis in Section 5.0.

4.2.11 Disposal

Dredged/excavated sediment disposal options include off-site landfill disposal or aquatic disposal in a contained aquatic disposal (CAD) facility. Aqueous waste streams can also be disposed off-site at a permitted wastewater disposal facility. These options are discussed and assessed in more detail below.

Off-Site Landfill/Wastewater Disposal Facility

Solid or liquid wastes are typically classified immediately prior to disposal as non-hazardous or hazardous based on specific analytical characteristics. Non-hazardous waste can generally be disposed at any permitted and licensed off-site disposal facility, but hazardous wastes must be disposed at a facility permitted and licensed specifically to accept hazardous material.

Landfills often limit the moisture content of wastes for disposal; therefore, sediment dewatering likely would be required to meet off-site disposal requirements. Final classification of waste material streams from Inner and Outer Pier 1 would be required prior to disposal and after dredging/excavation, dewatering, and/or other treatment processes are implemented.

Major advantages of upland landfill disposal are that it is a proven and reliable technology, COCs are isolated from the environment in a secure and regulated environment, disposal sites are available, and costs can be competitive with treatment costs. Disadvantages are that dewatering is generally required, costs may be high and can change with time, transportation is required, and COCs are relocated but are not necessarily destroyed.

CAD

Disposal in a CAD facility typically involves the dredging/excavation of contaminated sediment from areas to be remediated, transport to an underwater disposal site, controlled placement in a pit previously dredged in the existing sediment floor, and capping. Pretreatment (including dewatering) and treatment are not typically performed prior to disposal in a CAD. Dredged/excavated sediment can also be placed in a mound and covered with a cap, a technique known as level-bottom capping. The cap prevents physical contact between the sediment and the benthic community, prevents sediment resuspension and

dispersion, and inhibits contaminant flux to the water column. CADs require monitoring to ensure cap integrity and stability of buried sediment and contaminants.

Contaminated sediment would likely be transported to a CAD site by barge. Sediment would be placed in the CAD using a pipeline or other method to minimize sediment resuspension or spreading outside of the CAD footprint. If practical, silt curtains would also be installed to confine sediment to the work area. After a period of natural consolidation and settling, a cap would be placed on top of the dredged sediment. The cap likely would be at least 3 feet thick (i.e., an isolation cap) to prevent penetration by benthic organisms and resuspension of emplaced sediment. The cap would consist of clean material or sediment, and could be amended by a layer of gravel or armor stone at the top of the cap.

After CAD construction, the CAD site would undergo routine monitoring to verify that the emplaced sediment was not adversely affecting the aquatic ecosystem. Monitoring of the physical integrity of the cap also would be conducted. Assessment of cap integrity would be conducted through underwater visual inspections, and by depth measurements through surveying or sampling to monitor the thickness of the cap. Institutional controls would likely be implemented to restrict activities that would potentially disturb the CAD cap. For example, institutional controls would include dredging restrictions to ensure long-term integrity of the CAD cap.

Screening of Disposal

Effectiveness

Off-site solid or aqueous waste disposal is an effective way of minimizing the risk associated with human and environmental exposure to sediment COCs and related wastes from on-site processing of sediment. Although concentrations of COCs are not reduced, disposal of contaminated sediment in an off-site landfill or dewatering fluid at an off-site wastewater disposal facility removes the contamination from the site and from potential ecological or human exposure, thereby eliminating potential ecological and human health risks. In addition, the mobility of the contaminants is reduced by containing the waste in the landfill cell or in a wastewater treatment system. CAD placement of sediment would not require dewatering or treatment, the disposal site would be unobtrusive, and contaminants would be isolated from contact with the environment. The effectiveness of any of the off-site disposal options would not be minimized by the specific COCs present in Inner and Outer Pier 1 sediment.

Implementability

Off-site disposal at a landfill or a wastewater disposal facility is an easily implemented and mature technology. There is extensive experience in the industry with respect to disposal of contaminated

dredged sediment in landfills and dewatering fluid at wastewater disposal facilities. Implementability of the off-site disposal option for contaminated sediment and/or dewatering fluid from Inner and Outer Pier 1 would depend on identifying a landfill and/or wastewater disposal facility with adequate capacity and with appropriate permits in place to accept the specific waste streams based on their waste characteristics.

CAD disposal is a relatively well-established and proven technology that could be readily implemented. A CAD facility has already been constructed by the Navy in the Thames River and is in the process of being filled with dredged sediment. Placement of dredged material within a CAD cell may have implementability challenges, particularly for the open channel of the Thames River where currents may preclude the use of silt curtains as an engineering control. However, CAD disposal would also be easier to implement than other disposal options because it would not require dewatering pretreatment and because transportation would be simple. CAD disposal would require long-term monitoring and maintenance of the integrity of the CAD cell and would also require long-term monitoring of the potential impact of the disposed sediment on the surrounding aquatic ecosystem. From the administrative point of view, the Connecticut Department of Environmental Protection (CTDEP) has indicated a strong dislike for this disposal technology on the grounds that CERCLA waste should not be disposed in a CAD and that the State might become legally responsible for the long-term care of this CAD because it is not located within the Navy's property but in the public domain (CTDEP, 2008).

Cost

The cost of disposal at an off-site landfill or wastewater disposal facility would be low to moderate for non-hazardous material requiring no pretreatment, moderate for non-hazardous material requiring pretreatment, and high for hazardous material. Because application of this technology would be contracted as a service, there would be no capital costs.

CAD disposal typically requires a substantial initial investment for the design and construction of the CAD cell and typically this can only be justified for the disposal of a very large volume of material. However, a CAD facility already exists and is currently in operation at NSB-NLON, which would allow for the disposal of smaller quantities of contaminated sediment. Accordingly, the cost of CAD disposal would be low compared to other disposal methods because there would be no need for dewatering and because transportation costs would normally be minimal.

Screening Results

Off-site landfill and/or wastewater disposal are effective, implementable, and reasonably costed. Therefore, these technologies are retained for further analysis in Section 5.0. Although CAD would be an

effective, technically implementable, and low cost disposal technology, it is not retained for further analysis in Section 5.0 because it would not be acceptable to CTDEP.

TABLE 4-1

SUMMARY SCREENING OF REMOVAL ACTION TECHNOLOGIES AND PROCESS OPTIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Removal Action Technology	Removal Action Technology or Process Option	Retained or Rejected for Further Evaluation	Rationale for Retention/Rejection
No Action	No Action	Retained	Retained as required by the National Contingency Plan (NCP) for comparison to other alternatives.
Land Use Controls (LUCs)	LUCs	Retained	Could be effective to minimize risk of exposure to contaminated sediment and would add protective element to other removal actions.
Monitoring	Monitoring	Retained	Effective to verify progress of removal action and warn of potential migration of chemicals of concern (COCs).
Physical Dreadging/ Excavation	Mechanical Dredging	Retained	Effective and implementable removal action technology.
	Hydraulic Dredging	Rejected	Generally not effective or implementable given small scale and limited access and lack of support area.
	Hybrid Dredging	Rejected	Generally inefficient, particularly for small scale of project.
	Pneumatic Dredging	Rejected	Uncommon and not generally used for remediation.
In-situ Capping	Capping	Rejected for Inner Pier 1. Retained for Outer Pier 1	Would require pre-dredging that would remove most of the Inner Pier 1 sediment thus eliminating the need for capping. Could be effective for Outer Pier 1 to minimize the volume of sediment to be dredged and disposed.
In-situ Treatment	Granular Activated Carbon (GAC) Amendment	Rejected	Not proven for full-scale treatment of sediment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Nanoscale Iron Amendment	Rejected	Not proven for full-scale treatment of sediment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Bioremediation	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Stabilization	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.

TABLE 4-1

SUMMARY SCREENING OF REMOVAL ACTION TECHNOLOGIES AND PROCESS OPTIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Removal Action Technology	Removal Action Technology or Process Option	Retained or Rejected for Further Evaluation	Rationale for Retention/Rejection
Monitored Natural Recovery (MNR)	MNR	Rejected	Would depend mainly on slow occurring deposition for effectiveness and would require excessively long duration to achieve RAO.
Ex-Situ Treatment	Thermal Desorption	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Incineration	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Stabilization	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Sediment Washing	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Biological Treatment	Rejected	Not proven for full-scale sediment treatment and not effective for mixed COCs in Inner and Outer Pier 1 sediment.
	Filtration & Liquid-Phase GAC Adsorption	Retained	Well-proven, effective, and easily implementable for treatment of dewatering fluid.
Dewatering	On-Shore Dewatering Beds	Rejected	Effective and economical, but would be hard to implement because of lack of space. Would require collection and treatment or disposal of all drainage water because of on-shore location.
	Barge-Mounted Dewatering Beds	Retained	Effective and implementable dewatering bed option. Would not require on-shore space. Would only require collection and treatment or disposal of a small fraction of the drainage water (dewatering fluid) because of off-shore location.

TABLE 4-1

SUMMARY SCREENING OF REMOVAL ACTION TECHNOLOGIES AND PROCESS OPTIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Removal Action Technology	Removal Action Technology or Process Option	Retained or Rejected for Further Evaluation	Rationale for Retention/Rejection
Dewatering (continued)	Mechanical Dewatering	Rejected	More effective than dewatering beds. On-shore space would either not be required (off-shore option) or minimal (on-shore option). Off-shore option would only require collection and treatment or disposal of a fraction of the filtered water. However, much more complex and costly to implement than dewatering beds
	Dewatering Additives	Retained	Effective for final sediment stabilization prior to disposal.
Transportation	Barge	Retained	Could be effective and implementable to convey Outer Pier 1 sediment to disposal.
	Truck	Retained	Effective and implementable option.
	Rail	Rejected	Not readily implementable and inefficient for scale of project.
Disposal	Off-Site Landfill/Wastewater Disposal Facility	Retained	Effective containment of contaminants and generally standard removal action component. Readily implementable based on concentrations of COCs in Inner and Outer Pier 1 sediment.
	Confined Aquatic Disposal (CAD)	Rejected	Would be effective and technically implementable but is not acceptable to the State of Connecticut.

5.0 IDENTIFICATION AND PRELIMINARY ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section develops and evaluates conceptual removal action alternatives designed to address contaminated sediment in Inner and Outer Pier 1. Section 5.1 briefly describes the evaluation approach. Sections 5.2 and 5.3 develop suitable removal action alternatives for Inner and Outer Pier 1, respectively, and screen them for further comparative evaluation. The removal action alternatives identified in Sections 5.2 and 5.3 include combinations of various removal action technologies and/or process options summarized and screened in Section 4.0.

5.1 PRELIMINARY ANALYSIS APPROACH

Guidance on conducting a non-time-critical removal action under CERCLA states that the goals of an EE/CA are to satisfy environmental review requirements for removal actions, satisfy administrative record requirements for improved documentation of removal action selections, and provide a framework for evaluating and selecting alternative technologies (U.S. EPA, 1993). This section identifies the removal action alternatives considered most appropriate and suitable to achieve the RAO for Inner and Outer Pier 1.

In screening potential removal action alternatives for Inner and Outer Pier 1, greater emphasis was placed on approaches capable of achieving sediment cleanup in a timely fashion, namely through physical removal of contaminated sediment. In-situ treatment technologies are generally not proven, particularly for the mixed nature of Inner and Outer Pier 1 COCs, and MNR would likely take many years to achieve the RAO while continuing to present ecological risk.

Several alternatives were developed by assembling various removal action technologies and process options screened in Section 4.0 to address the project-specific RAO while considering site-specific conditions. The most appropriate primary technology (e.g., dredging/excavation or capping) was combined with various process options and/or control measures (i.e., engineering controls, monitoring, treatment, and disposal options) to develop each of the preliminary alternatives. These alternatives were developed to function as standalone removal strategies that would be applicable to Inner and Outer Pier 1 sediment. The No Action alternative was also evaluated as a stand-alone preliminary removal action alternative per NCP requirements.

The following removal action alternatives are evaluated in this section for Inner Pier 1 sediment:

Alternative IP-1: No Action

Alternative IP-2: Land-Based Dredging to Bedrock, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative IP-3: Water-Based Dredging to Bedrock, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative IP-4: Land-Based Dredging to Bedrock, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-5: Water-Based Dredging to Bedrock, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-6: Drainage of Inner Pier 1, Excavation to Bedrock, Dewatering, On-Site Treatment and Discharge of Surface Water and Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

The following removal action alternatives are evaluated in this section for Outer Pier 1 sediment:

Alternative OP-1: No Action

Alternative OP-2: Capping with Pre-Dredging to Meet the RAO, Dewatering, Off-Site Disposal of Dewatered Sediment and Dewatering Fluid, LUCs, and Monitoring

Alternative OP-3: Capping with Pre-Dredging to Meet the RAO, Dewatering, On-Site Treatment of Dewatering Fluid, Off-Site Disposal of Dewatered Sediment, LUCs, and Monitoring

Alternative OP-4: Dredging to Meet PRGs, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative OP-5: Dredging to Meet PRGs, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

The alternatives were evaluated on the basis of three CERCLA criteria including effectiveness, implementability, and cost. However, the evaluation of removal action alternatives with respect to these three criteria extended beyond the evaluation of individual technologies and process options conducted in Section 4.0 by including more site- and technology-specific information, as described below.

Effectiveness

The potential effectiveness of each alternative was evaluated based on its ability to provide protection of human health and the environment and to reduce the toxicity, mobility, or volume of sediment COCs at the site. In this context, both short- and long-term effectiveness were considered (i.e., short-term referring to the construction/implementation period and long-term referring to post-removal action). The assessment of effectiveness also included a determination of each alternative's ability to comply with ARARs.

Implementability

Implementability encompasses both the technical and administrative feasibility of implementing a removal action alternative. Accordingly, each alternative was assessed for its technical feasibility, commercial availability, administrative feasibility, and likelihood of public acceptance.

Cost

In the evaluation of preliminary alternatives, the relative costs for each alternative are estimated so that alternatives may be compared to one another, recognizing that absolute accuracy may not be possible (and is not essential at this stage of the cleanup). The costs are based on a variety of cost-estimating data, including, but not limited to, vendor information, cost-estimating guides (e.g., RS Means), engineering judgment, and available historical information. The cost estimates developed for this EE/CA are considered "order-of-magnitude" estimates, which are defined by the American Association of Cost Engineers (AACE) as accurate to –30 percent to +50 percent. Where possible, quotes from qualified contractors or equipment vendors were obtained as a basis for the cost estimates. In some instances, an engineering estimate based on previous experience was used to estimate costs. Where applicable, estimates of ongoing operation and maintenance (O&M) and monitoring costs are provided. An estimate of the project's overall net present worth (NPW) is also provided.

Cost estimate details are provided in Appendix C. This appendix also identifies references for unit costs and assumptions used to develop the cost estimates, including monitoring requirements. The monitoring assumptions used for the cost estimates are considered reasonable and provide sufficient detail to compare technology costs in this EE/CA. However, monitoring assumptions (e.g., quantities and frequencies) are not intended to be prescriptive for the various remedies considered.

5.2 DESCRIPTION AND SCREENING OF INNER PIER 1 REMOVAL ACTION ALTERNATIVES

Removal action alternatives conceptually designed to address contaminated sediment in Inner Pier 1 are discussed below. These alternatives were developed to address the project-specific RAO by creating assemblages of technologies and process options deemed potentially suitable for the site, and are all consistent with a physical removal-based approach by integrating excavation/dredging as the primary removal action element. The No Action alternative is evaluated as a standalone preliminary alternative in accordance with NCP requirements.

5.2.1 Alternative IP-1: No Action

5.2.1.1 Description

The No Action alternative serves as a baseline for comparison to and among other alternatives. The No Action alternative would entail no activities to remove, contain, or remediate contaminated sediment in Inner Pier 1 and would provide no legal or administrative protection of human health or the environment.

5.2.1.2 Screening

Effectiveness

Alternative IP-1 would not be protective of human health and the environment because it would provide no control of exposure to contaminated sediment.

Alternative IP-1 would not meet the RAO for Inner Pier 1, would not comply with the action-specific ARARs identified in Table 3-1 (no location- or action-specific ARARs apply to this alternative), nor would it be long-term effective and permanent. In addition, Alternative IP-1 would not provide any reduction in toxicity, mobility, or volume. Concentrations of sediment COCs might be slightly reduced over the long term as a result of natural attenuation processes, but this reduction would not be verified by monitoring. There would be no short-term effectiveness impacts or concerns associated with Alternative IP-1 because no action would occur.

Implementability

The No Action alternative would be easily implemented because it would not require any actions to be taken.

Cost

There would be no costs associated with the Alternative IP-1 because no actions would be taken.

5.2.2 Alternative IP-2: Land-Based Dredging to Bedrock, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative IP-2 would consist of positioning excavation equipment around the periphery of Inner Pier 1 and mechanically dredging contaminated sediment through the water column. The dredged sediment would be dewatered on site, and the dewatered sediment and dewatering fluid would be disposed off site at appropriate disposal facilities (i.e., landfill and wastewater treatment facility, respectively). Appropriate

engineering controls and monitoring would also be implemented to ensure and confirm the effectiveness of the removal action.

5.2.2.1 Description

Dredging

Data available from previous sampling events indicate that the most significant contamination and potential for risk in Inner Pier 1 sediment is limited to the interval composed of soft organic-rich sediment above the underlying bedrock. Based on the available data, this soft sediment layer is, on average, approximately 4 feet thick. For this removal action alternative, sediment would be mechanically dredged to bedrock using excavation equipment positioned around the periphery of Inner Pier 1.

For purposes of developing a conceptual removal action approach and corresponding costs, it is assumed that 4 feet of sediment would be removed throughout the removal action area. In actuality, during execution of this removal action alternative, all soft sediment above bedrock would be removed from Inner Pier 1; however, the assumption that 4 feet of sediment would be removed within the area is reasonable and appropriate to define the conceptual approach given the available data. Based on this assumed dredge depth and on a surface area of approximately 18,500 sf, an estimated 2,739 cy of contaminated sediment would be dredged from Inner Pier 1. Figure 5-1 shows the extent of the area to be dredged for Inner Pier 1. Computations of the estimated volume of sediment are provided in Appendix B.2.

Land-based equipment would be positioned along Pier 1 and along the manageable slope along the eastern edge of Inner Pier 1. In addition, use would be made of a small man-made jetty of land surrounded by sheet piling between the southeastern limit of Inner Pier 1 Area and the adjacent boat ramp. This area would be filled with imported clean fill material to provide a stable platform from which to access sediment using land-based removal equipment. To remove the soft sediment above bedrock in Inner Pier 1, long-reach excavation equipment would be used.

For the purposes of this EE/CA, it is assumed that an environmental bucket would be preferred in conjunction with the mechanical dredging method because it would minimize the entrainment of free water and creation of residuals that could be redeposited on the bedrock floor. It is assumed that mechanical dredging of Inner Pier 1 sediment would entrain a volume of free water approximately equal to one-half of the in-situ volume of dredged sediment. Sediment would be removed using controlled movements of the excavator, and care would be taken to minimize the free water content of the removed sediment. The dredged sediment would be placed directly in a barge modified to be used as a static

gravity dewatering bed as further discussed below. The assumed production rate for this alternative would be approximately 120 in-situ cy of sediment dredged per 10-hour day.

It is assumed that no backfill would be required following dredging and that subsequent natural deposition of new sediment would provide a suitable means of restoring benthic habitat affected by the removal action. To ensure that resuspended sediment is not released beyond Inner Pier 1, a silt curtain approximately 170 feet long would be deployed at its southwestern limit as shown on Figure 5-1. This silt curtain would be properly anchored to fixed lateral features (e.g., Pier 1 to the west and the manmade jetty between Inner Pier 1 and the boat ramp to the east). Except for brief periodic openings to allow barge movement, the silt curtain would remain in place until the end of the removal action.

Prior to the removal action, a detailed removal action work plan (RAWP) would be completed to define precise dredge prisms and to confirm the volume of sediment to be dredged. Final selection of the precise excavation equipment would also be determined as part of the RAWP and would involve input from appropriate contractors.

The dredged sediment may contain debris that would potentially include metal, cables, broken concrete, brick, lumber, tree branches, and other rubble. It is assumed that debris would be processed simultaneously with the sediment and not segregated or processed separately. Large metallic debris would be washed and sent off site for recycling, to the extent practical. It is not currently known what, if any, remnants of the Marine Railway exist within the boundaries of Inner Pier 1. However, any removal action for Inner Pier 1 would be designed with the flexibility to address any structures related to the Marine Railway that were to be identified (i.e., by removing these structures and dealing with them as waste or by removing sediment from around the structures without removing the structures themselves).

Dewatering of Dredged Sediment

After sediment removal, the dredged sediment would likely be too wet to be transported or placed directly at a disposal facility. Dewatering would reduce the weight and volume of dredged sediment designated for disposal and would reduce transportation controls and restrictions (e.g., restrictions against transporting material with free water). For costing and comparative purposes, passive dewatering using a modified barge is the assumed approach.

Barges would be modified to be operated as static gravity drainage beds. For this purpose, concrete Jersey barriers would be used to construct an enclosure within the barge and this enclosure would be lined with a geotextile material that would let water filter through but would retain sediment particles. The enclosure would have a capacity of 200 to 300 cy, which would be adequate to hold and dewater 2 days' production of dredged sediment. Mixing and aerating would potentially be required to distribute wet

dredged sediment and accelerate dewatering. Dredged sediment would not be completely dried, as the primary purpose of dewatering would be to drain the free water entrained by the dredging process and recompact the sediment to its original in-situ volume and moisture content.

The rate of static sediment dewatering is unknown at this time. For the purpose of this EE/CA, it is assumed that the static gravity drainage bed described above would drain all free water and recompact the sediment to its original in-situ volume and moisture content within 1 day or less. A bench- or pilot-scale dewaterability study would be useful to determine effectiveness and rate of dewatering and to confirm the need for additives to enhance or sufficiently complete dewatering.

When the dewatering barge is full it would be brought to shore and the dewatered sediment would be characterized for disposal through sampling and moved into stockpiles. The proposed location of this on-shore staging area is shown on Figure 5-2. It is estimated that twelve barges full of dewatered sediment would be processed over 24 operating days. A chemical agent such as fly ash or Portland cement would be added to the dewatered sediment to adsorb any residual free water and to further stabilize the material for transportation and disposal. For the purpose of this EE/CA, it assumed that fly ash in the proportion of approximately 8 percent (by weight) of total would be added to the dewatered sediment prior to off-site transportation and disposal. It is also assumed that fly ash addition would result in an increase of approximately 10 percent in the volume of sediment to be disposed. Typical fly ash analysis would be obtained from the supplier and spot checks would be performed to verify that addition of this material would not change the character of the dewatered sediment and make its acceptance for off-site disposal more onerous.

As discussed in Section 4.2.9, the drainage water filtering through the geotextile liner would be allowed to discharge back into Inner Pier 1. Some of the water released by the dewatering process would not readily drain and filter through the geotextile liner and might pool on top of the dewatered sediment and would have to be removed by pumping. A small amount of residual free water might also be released by the dewatered sediment during on-shore staging. Altogether, it is assumed that this residual water, which is referred to as dewatering fluid, would amount to approximately 10 percent of the total volume of water released by the dewatering process. The dewatering fluid would be removed by pumping, containerized in appropriate holding structures (e.g., frac tank), characterized through sampling and analysis, and transported to an off-site wastewater disposal facility as further discussed below.

<u>Monitoring</u>

Construction quality control monitoring would be conducted prior to construction and during dredging activities, and post-construction confirmatory monitoring would be conducted immediately following

completion of dredging. In addition, monitoring would be required to determine the specific waste-disposal requirements for dewatered sediment and dewatering fluid.

Pre-construction monitoring would include establishing baseline turbidity within Inner Pier 1 to provide a basis of comparison for subsequent construction quality control monitoring. Baseline turbidity conditions would be established at one monitoring station with a buoy-mounted analyzer. Pre-construction monitoring would also include performance of a pre-removal action bathymetric survey.

During construction, turbidity monitoring would be conducted continuously beyond the southwestern perimeter of the dredge area (i.e., beyond the silt curtain) with buoy-mounted analyzers to determine potential suspension of contaminated sediment and to verify the integrity of the silt curtain. In addition, turbidity would also be monitored just inside the silt curtain with a hand-held analyzer prior to any barge movement through the curtain. Because the movement of contamination would be expected to be entirely correlated to the movement of suspended solids, turbidity monitoring data would be used to determine the potential for contaminant mobilization beyond the removal action area and the need for corrective action. For purposes of developing a reasonable removal action approach and related costs, it is assumed that construction quality control monitoring would be implemented using two buoy-mounted continuous turbidity analyzers located outside the silt curtain and one hand-held turbidimeter inside the silt curtain.

Post-construction monitoring would include performance of a post-removal action bathymetric survey. No post-construction sediment sampling would be required to confirm that all contaminated sediment was removed because this alternative would include complete removal of contaminated sediment to bedrock within the whole of Inner Pier 1.

Waste disposal monitoring would be required to support the dewatering and disposal component of this removal action alternative. Specifically, dewatered sediment and dewatering fluid would be characterized in accordance with landfill and/or wastewater treatment facility disposal requirements. For costing purposes, it is assumed that one sediment characterization sample would be required for every 250 cy requiring disposal, which would generate sufficient data to accurately segregate wastes on the basis of nonhazardous versus hazardous nature. For the dewatering fluid, it is assumed that one sample would be required for every 5,000 gallons to be disposed (i.e., one full tanker truck). It is further assumed that sediment samples would be analyzed for total and leachable PCBs, metals, PAHs, and pesticides and that dewatering fluid samples would be analyzed for total PCBs, metals, PAHs, and pesticides. Waste characterization sampling for sediment would be conducted prior to addition of fly ash to prevent any potential influence on measured levels of contamination in the solid waste stream. As previously mentioned, fly ash quality spot checks would be performed to verify that addition of this material would

not change the character of the dewatered sediment and make its acceptance for off-site disposal more onerous.

Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

The dewatered sediment and dewatering fluid would be transported to and disposed at a properly licensed and Navy-approved off-site landfill and wastewater disposal facility, respectively. Based on data available from previous sampling events, it is assumed that approximately 253 cy or 295 tons (one barge full, or 8 percent) of the sediment removed from Inner Pier 1 would be characterized as hazardous and disposed at a suitable RCRA hazardous facility. The remaining 2,760 cy or 3,225 tons (eleven barges full, or 92 percent) of dewatered sediment would be characterized as non-hazardous and disposed at a suitable solid waste landfill.

An estimated total of 27,650 gallons of dewatering fluid would be collected and would require disposal. Because of the typically low solubility of the sediment COCs, it is expected that this dewatering fluid would be characterized as a non-hazardous waste and would be disposed at an appropriate wastewater treatment facility.

Final classification of waste material from Inner Pier 1 would be conducted after dewatering and prior to addition of fly ash. Costs for disposal at a landfill or other off-site disposal facility would include truck transportation to that facility (i.e., dump trucks for sediment and tanker trucks for dewatering fluid) and volumetric (i.e., per ton or gallon) disposal costs. Residual solid material from the dewatering barge (e.g., the geotextile liner) would be disposed as a solid waste at a permitted and licensed landfill.

5.2.2.2 Screening

Effectiveness

Alternative IP-2 would meet the RAO through dredging and off-site disposal of Inner Pier 1 sediment with concentrations of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the site. Alternative IP-2 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment. The long-term effectiveness, degree of protectiveness, and toxicity, mobility, and volume reduction of this alternative could be slightly limited by the fact that the dredging process might not be able to completely remove all sediment.

In the short term, there would be increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. The magnitude of this risk, however, would be low and would be adequately addressed through the use of standard PPE and best management practices (BMPs). Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk from spillage in and around the area and between the site and commercial landfill and wastewater disposal facility during the removal action. These risks would be adequately mitigated by implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains) and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative IP-2 would be reasonably easy to implement because it would not require any highly specialized equipment to dredge, dewater, and transport contaminated sediment. However, the recent demolition of Pier 1 would make the positioning of shore-based dredging equipment more difficult. Dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to Inner Pier 1. There are commercial landfills and wastewater treatment facilities in the vicinity of NSB-NLON that would accept the waste. It is estimated that an on-site staging area approximately 0.25 acre in size would be required to temporarily stockpile, stabilize, and load the dewatered sediment and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Inner Pier 1 and generally limited amount of work space in the immediate site area.

Overall, the implementation time of Alternative IP-2 would be short and it is estimated that it could be completed within 1 month or less.

Cost

A summary of estimated costs for Alternative IP-2 is as follows:

Capital Cost	$1,463,000
NPW of O&M Costs	$0
NPW	$1,463,000 (1-year)

These costs have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates. A detailed cost estimate for this alternative is provided in Appendix C.

5.2.3 Alternative IP-3: Water-Based Dredging to Bedrock, Dewatering, and Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative IP-3 would be essentially identical to Alternative IP-2 with the difference that dredging equipment would be barge mounted instead of land based.

5.2.3.1 Description

Dredging

For the purpose of developing a conceptual removal approach and appropriate costs for Alternative IP-3, it is assumed that the removal area would be the same as the removal area discussed in Alternative IP-2 (i.e., an estimated 2,739 in-situ cy of contaminated sediment would be removed from approximately 18,500 sf defined as Inner Pier 1).

For this removal action alternative, sediment would be mechanically removed using a single excavator positioned on a barge within Inner Pier 1. A long-reach excavator would be used to remove the soft sediment above bedrock and also to minimize the need to reposition the barge and maximize the ability to reach temporary sediment holding containers.

For the purposes of this EE/CA it is assumed that an environmental bucket would be preferred in conjunction with the mechanical dredging method because it would minimize the entrainment of free water and the creation of residuals that could be redeposited on the bedrock floor. It is assumed that mechanical dredging of Inner Pier 1 sediment would entrain a volume of free water approximately equal to the in-situ volume of dredged sediment. Sediment would be removed using controlled movements of the excavator, and care would be taken to minimize the free water content of the removed sediment. As for Alternative IP-2, the dredged sediment would be placed directly in a barge modified to be used as a static gravity dewatering bed. The assumed production rate for this alternative would be the same as for Alternative IP-2 with approximately 120 in-situ cy of sediment dredged per 10-hour day.

It is assumed that no backfill would be required and that subsequent natural deposition of new sediment would provide a suitable means of restoring benthic habitat affected by the removal action. To ensure

that resuspended sediment is not released beyond Inner Pier 1, a silt curtain approximately 170 feet long would be deployed at the southwestern limit of the removal action area as shown Figure 5-1 and identical to that for Alternative IP-2. To avoid disrupting or opening the silt curtain during dredging, the excavation barge would be relocated within Inner Pier 1 and/or the excavator itself would be repositioned on the barge to allow full dredging rather than moving the barge in and out of Inner Pier 1.

Prior to the removal action, a RAWP would be completed to define precise dredge prisms and confirm the volume of sediment to be dredged. Final selection of the precise excavation equipment would be determined as part of the RAWP and would involve input from appropriate contractors. The final selection would be based on the method that best satisfies the RAO and mitigates site logistical concerns.

The dredged sediment may contain debris that would potentially include metal, cables, broken concrete, brick, lumber, tree branches, and other rubble. It is assumed that debris would be processed simultaneously with the sediment and not segregated or processed separately. Large metallic debris would be washed and sent off site for recycling, to the extent practical. It is not currently known what, if any, remnants of the Marine Railway exist within the boundaries of Inner Pier 1. However, any removal action for Inner Pier 1 would be designed with the flexibility to address any structures related to the Marine Railway that were to be identified (i.e., by removing these structures and dealing with them as waste or by removing sediment from around the structures without removing the structures themselves).

Dewatering of Dredged Sediment

The sediment dewatering element of Alternative IP-3 would be identical to the previously described sediment dewatering element of Alternative IP-2.

Monitoring

The monitoring element of Alternative IP-3 would be identical to the previously described monitoring element of Alternative IP-2.

Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

The off-site disposal element of Alternative IP-3 would be identical to the previously described off-site disposal element of Alternative IP-2.

5.2.3.2 Screening

Effectiveness

Alternative IP-3 would meet the RAO through dredging and off-site disposal of Inner Pier 1 sediment with concentrations of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the site. Alternative IP-3 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment. The long-term effectiveness, degree of protectiveness, and toxicity, mobility, and volume reduction of this alternative could be slightly limited by the fact that the dredging process might not be able to completely remove all sediment.

In the short term, there would be an increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. In addition, there would be increased worker hazards associated with work on open water. However, the magnitude of these risks would be low and would be adequately addressed through the use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk of spillage in and around the area and between the site and commercial landfill and wastewater disposal facility during the removal action. These risks would be adequately mitigated by implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains) and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative IP-3 would be reasonably easy to implement because it would not require any highly specialized equipment to dewater or transport contaminated sediment. However, Alternative IP-3 would require some specialized equipment to dredge sediment (i.e., a barge-mounted excavator). Dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to Inner Pier 1. There are commercial landfills and wastewater treatment facilities in the vicinity of NSB-NLON that would accept the waste. It is estimated that an on-site staging area approximately 0.25 acre in size would be required to temporarily stockpile, stabilize, and load the dewatered sediment and to store equipment required for the removal action.

Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action should not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates to the facility and a barge entering and exiting restricted water in the Lower Subase. Extensive coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Inner Pier 1 and limited amount of work space in the immediate site area. In addition, there is limited water depth in Inner Pier 1 and the water level fluctuates with the tides. A barge-based excavator would potentially be limited in its hours of operation or its ability to fully enter Inner Pier 1 due to insufficient water depth.

Overall, the implementation time of Alternative IP-3 would be short and it is estimated that it could be completed within one month or less.

Cost

A summary of estimated costs for Alternative IP-3 is as follows:

Capital Cost	$1,498,000
NPW of O&M Costs	$0
NPW	$1,498,000 (1-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.2.4 Alternative IP-4: Land-Based Dredging to Bedrock, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-4 would be essentially identical to Alternative IP-2 with the difference that the dewatering fluid would be treated and discharged on site instead of disposed off site.

5.2.4.1 Description

Dredging

The dredging element of Alternative IP-4 would be identical to the previously described dredging element of Alternative IP-2.

Dewatering of Dredged Sediment

The sediment dewatering element of Alternative IP-4 would be similar to the previously described sediment dewatering element of Alternative IP-2. However, the dewatering fluid held on the dewatering barge would be conveyed to an on-site treatment and discharge system as described below.

On-Site Treatment and Discharge of Dewatering Fluid

The dewatering fluid containerized on the dewatering barge would be conveyed to an on-site treatment system. For the purpose of developing a reasonable technical approach and costs, it was assumed that the treatment system would consist of a sediment pre-filter and liquid-phase GAC adsorption unit operating in series, with all necessary piping and instrument controls. This treatment system would remove COCs associated with suspended solid particles and COCs that might leach from dredged contaminated sediment and would allow discharge of the treated dewatering fluid to the Thames River. Alternatively, dewatering fluid could be discharged to the NSB-NLON oily water treatment system or to the sewer system to which the oily water treatment system currently discharges. However, for purposes of this EE/CA, direct discharge to the Thames River was assumed.

Based on current projections of dredged sediment volume, it is estimated that a total volume of approximately 27,650 gallons of dewatering fluid would have to be treated and discharged. For the purpose of this EE/CA, it is assumed that the on-site dewatering fluid treatment system would be designed for a capacity of 1,500 gallons per day (gpd) using commercially available units. Conceptual design calculations for this system are provided in Appendix B.3. A process flow diagram (PFD) for a typical on-site treatment system is provided as Figure 5-3. The on-site dewatering fluid treatment system would be located in the same area as that proposed for the on-shore staging and stabilization of dewatered sediment as shown on Figure 5-2. The treatment system area would be secured with fencing and other controls necessary to prevent any potential direct exposure risk to NSB-NLON personnel.

Monitoring

Construction quality control monitoring, post-construction confirmatory monitoring, and monitoring to determine the specific waste-disposal requirements for dewatered sediment would be identical for Alternative IP-4 as that previously described for Alternative IP-2.

Monitoring would also be required to evaluate the performance of the above-described on-site dewatering fluid treatment system. For costing purposes, it is assumed that one treatment system influent and one effluent sample would be collected for every day of system operation. It is further assumed that these samples would be analyzed for total PCBs, metals, PAHs, pesticides, and total suspended solids (TSS).

Off-Site Disposal of Dewatered Sediment

The off-site disposal element of Alternative IP-4 specifically related to the dewatered sediment would be identical to this element of Alternative IP-2. In addition, residual solid material from the water treatment system (i.e., clogged filter bags and spent GAC) would be sampled and disposed as solid waste in a similar fashion (i.e., at a permitted and licensed landfill). For costing purposes, it is assumed that samples of spent treatment system solids would be analyzed for total and leachable PCBs, metals, PAHs, and pesticides to verify waste disposal requirements.

5.2.4.2 Screening

Effectiveness

Alternative IP-4 would meet the RAO through dredging and off-site disposal of Inner Pier 1 sediment with concentrations of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the site. Alternative IP-4 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment. The long-term effectiveness, degree of protectiveness, and toxicity, mobility, and volume reduction of this alternative could be slightly limited by the fact that the dredging process might not be able to completely remove all sediment.

In the short term, there would be an increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. There would also be risk of worker exposure to contamination from O&M of the on-site dewatering fluid treatment system. However, the magnitude of these risks would be low and would be adequately addressed through the use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk from spillage in and around the area and between the site and commercial landfill during the removal action. These risks would be adequately mitigated by implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains), by the treatment of dewatering fluid prior to discharge, and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative IP-4 would be reasonably easy to implement because it would not require any highly specialized equipment to dredge, dewater, or transport contaminated sediment. However, the recent demolition of Pier 1 would make the positioning of shore-based dredging equipment slightly more difficult. In addition, Alternative IP-4 would require some fairly specialized equipment to treat dewatering fluid (i.e., a packaged or constructed treatment system). Dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to those at Inner Pier 1. On-site dewatering fluid treatment is also a well-proven removal action element. There are commercial landfills in the vicinity of NSB-NLON that would accept the solid waste. It is estimated that an on-site staging area approximately 0.5 acre in size would be required to temporarily stockpile, stabilize, and load the dredged sediment; to install and operate a dewatering fluid treatment system; and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Inner Pier 1 and limited amount of work space in the immediate site area. In addition, there may be some administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of dewatering fluid. Although a permit would not be required, discharge of the treated dewatering fluid to the Thames River would have to meet the substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit.

Overall, the implementation time of Alternative IP-4 would be short and it is estimated that it could be completed within 1 month or less.

Cost

A summary of estimated costs for Alternative IP-4 is as follows:

Capital Cost	$1,622,000
NPW of O&M Costs	$0
NPW	$1,622,000 (1-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.2.5 Alternative IP-5: Water-Based Dredging to Bedrock, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-5 would be essentially identical to Alternative IP-4 with the difference that the dredging equipment would be barge mounted instead of land based.

5.2.5.1 Description

Dredging

The dredging element of Alternative IP-5 would be identical to the previously described dredging element of Alternative IP-3.

Dewatering of Dredged Sediment

The sediment dewatering element of Alternative IP-5 would be identical to the previously described sediment dewatering element of Alternative IP-4.

On-Site Treatment and Discharge of Dewatering Fluid

The on-site treatment and discharge element of Alternative IP-5 would be identical to the previously described on-site treatment and discharge element of Alternative IP-4.

Monitoring

The monitoring element of Alternative IP-5 would be identical to the previously described monitoring element of Alternative IP-4.

Off-Site Disposal of Dewatered Sediment

The off-site disposal element of Alternative IP-5 would be identical to the previously described off-site disposal element of Alternative IP-4.

5.2.5.2 Screening

Effectiveness

Alternative IP-5 would meet the RAO through dredging and off-site disposal of Inner Pier 1 sediment with concentrations of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the

site. Alternative IP-5 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment. The long-term effectiveness, degree of protectiveness, and toxicity, mobility, and volume reduction of this alternative could be slightly limited by the fact that the dredging process might not be able to completely remove all sediment.

In the short term, there would be an increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. There would also be risk of worker exposure to contamination from O&M of the on-site dewatering fluid treatment system as well as the increased worker hazards associated with work on open water. However, the magnitude of these risks would be low and would be adequately addressed through the use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk of spillage in and around the area and between the site and commercial landfill during the removal action. These risks would be adequately mitigated by implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains), by the treatment of dewatering fluid prior to discharge, and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative IP-5 would be reasonably easy to implement because it would not require any highly specialized equipment to dewater or transport contaminated sediment. However, Alternative IP-5 would require some specialized equipment to dredge sediment (i.e., a barge-mounted excavator) and to treat dewatering fluid (i.e., a packaged or constructed treatment system). Dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to those in Inner Pier 1. On-site dewatering fluid treatment is also a well-proven removal action element. There are commercial landfills in the vicinity of NSB-NLON that would accept the types of solid waste generated. It is estimated that an on-site staging area approximately 0.5 acre in size would be required to temporarily stockpile, stabilize, and load the dredged sediment; to install and operate a dewatering fluid treatment system; and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular NSB-NLON activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A

significant implementability challenge for this alternative would be the limited access to Inner Pier 1 and limited amount of work space in the immediate site area. In addition, there may be some administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of treated dewatering fluid. Although a permit would not be required, discharge of the treated dewatering fluid to the Thames River would have to meet the substantive requirements of an NPDES permit.

Overall, the implementation time of Alternative IP-5 would be short and it is estimated that it could be completed within 1 month or less.

Cost

A summary of estimated costs for Alternative IP-5 is as follows:

Capital Cost	$1,660,000
NPW of O&M Costs	$0
NPW	$1,660,000 (1-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.2.6 Alternative IP-6: Drainage of Inner Pier 1, Excavation to Bedrock, Dewatering, On-Site Treatment and Discharge of Surface Water and Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative IP-6 would involve isolating and draining Inner Pier 1, positioning excavation equipment within the drained Inner Pier 1, and excavating contaminated exposed sediment to bedrock. The excavated sediment would be dewatered on site and disposed at an off-site landfill. Contaminated liquids from all dewatering processes (i.e., surface water from draining Inner Pier 1 and fluid from dewatering sediment) would be collected, treated, and discharged on site. Appropriate engineering controls and monitoring would also be implemented to ensure and confirm the effectiveness of the removal action.

5.2.6.1 Description

Drainage of Inner Pier 1

For the purpose of developing a conceptual removal action approach and appropriate costs, it is assumed that the removal area for Alternative IP-6 would be the same as the removal area discussed for the other alternatives (i.e., an estimated 2,739 in-situ cy of contaminated sediment would be removed from approximately 18,500 sf defined as Inner Pier 1). For Alternative IP-6, a temporary isolation structure would be installed along approximately one third of the perimeter of Inner Pier 1 to fully enclose and

isolate the area and to minimize the potential for surface water and/or groundwater to enter into the removal action area. The isolation structure would consist of a temporary coffer dam such as a Portadam® (http://www.portadam.com/index.html) or similar water diversion system. After installing the isolation structure, Inner Pier 1 would be drained using suitable high-capacity pumping equipment and conduit (i.e., hose). Water removed from Inner Pier 1 would be diverted and stored for on-site treatment and discharge as discussed below.

Excavation

Sediment would be mechanically removed using excavation equipment positioned within Inner Pier 1. Excavation equipment would be brought into Inner Pier 1 using an earthen ramp constructed of imported fill material at the far southeastern corner of the removal action area adjacent to the boat ramp, which would be a good location for an access ramp. Because of the limited depth of soft sediment above the underlying bedrock, it is assumed that a small area could be excavated from the base of the entrance ramp and then excavation equipment would be able to advance into Inner Pier 1. Suitable excavation equipment would be used to remove the soft sediment above bedrock and to ensure adequate reach to temporary sediment holding containers. The assumed production rate for this alternative would be approximately 120 in-situ cy of sediment excavated per 10-hour day.

All removed sediment would be placed directly in a spoil barge staged in Outer Pier 1. Following complete excavation, the temporary coffer dam installed around the Inner Pier 1 boundary would be removed and salvaged. It is assumed that no backfill would be required and that subsequent natural deposition of new sediment would provide a suitable means of restoring benthic habitat affected by the removal action.

Prior to the removal action, a RAWP would be completed to define precise excavation prisms and to confirm the volume of sediment to be excavated. The RAWP would also incorporate information about the adequacy of the temporary coffer dam to provide sufficient isolation for the drainage of Inner Pier 1. Final selection of the excavation equipment would be determined as part of the RAWP and would involve input from appropriate contractors.

Because Inner Pier 1 would be drained and the sediment would be exposed, excavation would entrain very little, if any, free water, and the excavated sediment would essentially have the same moisture content and other geotechnical properties as the in-situ sediment prior to drainage and excavation.

The excavated sediment may contain debris that would potentially include metal, cables, broken concrete, brick, lumber, tree branches, and other rubble. It is assumed that debris would be processed simultaneously with the sediment and not segregated or processed separately. Large metallic debris

would be washed and sent off site for recycling, to the extent practical. It is not currently known what, if any, remnants of the Marine Railway exist within the boundaries of Inner Pier 1. However, any removal action for Inner Pier 1 would be designed with the flexibility to address any structures related to the Marine Railway that were to be identified (i.e., by removing these structures and dealing with them as waste or by removing sediment from around the structures without removing the structures themselves).

Dewatering of Excavated Sediment

As previously mentioned, it is expected that, because exposed sediment would be excavated rather than dredged through a water column, very little free water would be entrained during excavation. Although the excavated sediment would be collected in a modified barge similar to that used for Alternatives IP-2 through IP-5, it is assumed that no significant passive dewatering through drainage would be required and that this barge would be mostly used as a mean of transferring the excavated sediment to a staging area for characterization and stabilization prior to off-site disposal. The location of the proposed sediment staging area is shown on Figure 5-2. As for Alternative IP-2, it is assumed that that fly ash in the proportion of approximately 8 percent (by weight) of total would be added to the dewatered sediment prior to off-site transportation and disposal. Typical fly ash analysis would be obtained from the supplier and spot checks would be performed to verify that addition of this material would not change the character of the dewatered sediment and make its acceptance for off-site disposal more onerous.

On-Site Treatment and Discharge of Surface Water and Dewatering Fluid

The on-site treatment and discharge element of Alternative IP-6 would be similar to the previously described on-site treatment and discharge element for Alternative IP-4. However, almost all of the liquid treated and discharged would be the surface water collected during the drainage of Inner Pier 1 which would be conveyed directly the on-site treatment system. It is assumed that drainage of Inner Pier 1 would require temporary pumping using high-capacity pumping equipment and that on-going pumping would be required during sediment excavation to keep the water level down. It is also assumed that the last foot of surface water removed during the initial drainage and the water removed during sediment excavation would be contaminated and require treatment. Overall, it is estimated that approximately 1,350,000 gallons would have to be treated over a period of 27 days. Because the volume of liquid requiring treatment under Alternative IP-6 would be significantly greater than that under Alternatives IP-4 or IP-5, the on-site treatment system would have to be much larger. For the purpose of this EE/CA it is estimated that an on-site treatment and discharge system with a capacity of 50,000 gpd would be required. Conceptual design calculations for this system are provided in Appendix B.3. The on-site treatment system would be located in the same area as that proposed for the on-shore staging and stabilization of the sediment as shown on Figure 5-2.

Monitoring

The monitoring element of Alternative IP-6 would be similar to the previously described monitoring element of Alternative IP-4. Construction monitoring and verification monitoring would not be required because Inner Pier 1 would be completely isolated from the rest of the Thames River environment throughout the excavation process.

Off-Site Disposal of Dewatered Sediment

The off-site disposal element of Alternative IP-6 would be identical to the previously described off-site disposal element of Alternative IP-4.

5.2.6.2 Screening

Effectiveness

Alternative IP-6 would meet the RAO through excavation and off-site disposal of Inner Pier 1 sediment with concentrations of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the site. Because sediment would be exposed prior to excavation, this alternative would be able to achieve verifiable complete removal. Alternative IP-6 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment.

There would be an increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. There would also be risk of worker exposure to contamination from O&M of the on-site surface water and dewatering fluid treatment system. However, the magnitude of these risks would likely be low and would be adequately addressed through use of standard PPE and BMPs. In addition to risk of contaminant exposure, there would be significant entrapment and drowning risks associated with working in wet organic sediment in a dewatered environment that is below the static water level of the surrounding Thames River. These risks would be mitigated by the limited thickness of sediment overlying bedrock (4 feet maximum), by the presence of an isolation structure, and by the use of cautious work practices inside the removal action area. However, to the extent that the ability of an isolation structure to withstand the hydrostatic force exerted by the Thames River is uncertain, the ability to fully mitigate the associated drowning hazard is also uncertain. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk of spillage in and around the area and between the site and commercial landfill during the removal action. These risks would be adequately mitigated by the implementation of appropriate traffic

control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the excavating area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g.., temporary coffer dam to fully isolate Inner Pier 1), by treating contaminated surface water and dewatering fluid prior to discharge, and by administrative controls such as the restriction of excavating operations to the period from October 1 to January 31 that corresponds to minimal ecological activity

Implementability

Alternative IP-6 would not require any highly specialized equipment to dewater or transport contaminated sediment. However, Alternative IP-6 would require difficult or potentially non-viable engineering techniques for the full drainage and ingress of excavation equipment into Inner Pier 1. This would probably be made even more difficult by the recent demolition of Pier 1. In addition, this alternative would also require large equipment to deal with the large volume of potentially contaminated surface water generated by the drainage of Inner Pier 1. However, sufficient on-site space should be available to accommodate such large treatment equipment. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required.

The greatest concern regarding the implementability of Alternative IP-6 is the uncertain ability of the isolation structure to adequately prevent surface water and/or groundwater intrusion. Associated with this challenge is the inherent risk that efforts at dewatering the area would not be effective or would require constant additional effort to sustain. Although it is assumed that the isolation structure would limit surface water intrusion to an estimated 35 gallons per minute (gpm), the ability of this structure to prevent groundwater intrusion is uncertain. If the isolation structure is unable to prevent greater surface water and/or groundwater intrusion, a much higher rate of maintenance pumping would be required, which would significantly increase both the time and costs required to execute the removal action and its associated elements.

Another significant implementability challenge for this alternative would be the limited access to Inner Pier 1 and limited amount of work space in the immediate site area. This is particularly true for this alternative because the scale of on-site treatment operations would be increased by the full drainage of Inner Pier 1. In addition, there may be some administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of surface water and dewatering fluid. Although a

permit would not be required, discharge of treated water to the Thames River would have to meet the substantive requirements of an NPDES permit.

Overall, the implementation time of Alternative IP-6 would be short and it is estimated that it could be completed within 2 months or less.

Cost

A summary of estimated costs for Alternative IP-6 is as follows:

Capital Cost	$2,524,000
NPW of O&M Costs	$0
NPW	$2,524,000 (1-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.3 DESCRIPTION AND SCREENING OF OUTER PIER 1 REMOVAL ACTION ALTERNATIVES

Removal action alternatives conceptually designed to address contaminated sediment in Outer Pier 1 are discussed below. Similarly to the alternatives for Inner Pier 1, these alternatives were developed to address the project-specific RAO by creating assemblages of technologies and process options deemed potentially suitable for the site, and are all consistent with a physical removal-based approach by integrating excavation/dredging as the primary removal action element. The No Action alternative is evaluated as a standalone preliminary alternative in accordance with NCP requirements.

5.3.1 Alternative OP-1: No Action

5.3.1.1 Description

The No Action alternative serves as a baseline for comparison to and among other alternatives. The No Action alternative would include no activities to remove, contain, or remediate contaminated sediment in Outer Pier 1 and would provide no legal or administrative protection of human health or the environment.

5.3.1.2 Screening

Effectiveness

Alternative OP-1 would not be protective of human health or the environment because it would provide no control of exposure to contaminated sediment.

Alternative OP-1 would not meet the RAO for Outer Pier 1, nor would it comply with the chemical-specific ARARs shown on Table 3-1 (no location- or action-specific ARARs apply to this alternative), or be long term effective and permanent. In addition, Alternative OP-1 would not provide any reduction in toxicity, mobility, or volume. Concentrations of sediment COCs might be slightly reduced over the long-term as a result of natural attenuation processes, but this reduction would not be verified by monitoring. There would be no short-term effectiveness impacts or concerns associated with Alternative OP-1 because no action would occur.

Implementability

The No Action alternative would be easily implemented because it would not require any actions to be taken.

Cost

There would be no costs associated with the No Action alternative because no actions would be taken.

5.3.2 Alternative OP-2: Capping with Pre-Dredging to Meet the RAO, Dewatering, Off-Site Disposal of Dewatered Sediment and Dewatering Fluid, LUCs, and Monitoring

Alternative OP-2 would consist of capping those areas of Outer Pier 1 with subsurface contamination, if the contamination extends to within two 2 feet from the surface of the sediment which would meet the RAO by preventing exposure to contaminated sediment. Prior to capping, these areas would be dredged to a depth of 2 feet. The pre-dredged areas would then be capped with a 3-foot-thick layer of clean fill material such as sand. The dredged sediment would be dewatered on site, and the dewatered sediment and dewatering fluid would be disposed off site at appropriate disposal facilities (i.e., landfill and water treatment facility, respectively). LUCs would be formulated and implemented to prevent disturbance of the cap and to ensure its long-term integrity and monitoring would be performed to confirm the effectiveness of the removal action.

5.3.2.1 Description

Capping with Pre-Dredging

The area of Outer Pier 1 sediment with subsurface concentrations of COCs greater than the PRGs, if these concentrations extend to within 2 feet from the surface of the sediment, would be capped. Based on available data, this area has been estimated to cover approximately 5,100 sf as shown on Figure 5-4.

Prior to capping, a 2-foot-thick layer of sediment would be dredged from the area to be capped. The primary purpose of this pre-dredging would be to adjust the depth of the sediment so that the placement of a cap would not result in unacceptably shallow water conditions. Another purpose for pre-dredging would be removal of the typically lighter and softer top layer of sediment to provide better support for the cap. Based on this pre-dredging depth of 2 feet and on the above-mentioned surface area of 5,100 sf to be capped and assuming a 10 percent overdredge factor, an estimated 416 in-situ cy of contaminated sediment would be dredged from Outer Pier 1. Computations of the estimated volume of sediment to be pre-dredged are provided in Appendix B.2.

For this removal action alternative, sediment would be mechanically removed using a single long reach excavator positioned on a barge within Outer Pier 1 and equipped with an environmental bucket to minimize the entrainment of free water. It is assumed that mechanical dredging of the Inner Pier 1 sediment would entrain a volume of free water approximately equal to the in-situ volume of dredged sediment. Sediment would be removed using controlled movements of the excavator, and care would be taken to minimize the free water content of the removed sediment. The dredged sediment would be placed directly in a barge modified to be used as a static gravity dewatering bed as further discussed below.

To ensure that resuspended sediment is not released beyond Outer Pier 1, a silt curtain approximately 400 feet long would be deployed along the southern perimeter of the removal action area.

Capping would consist of placing a layer of clean well-graded sand or sand and gravel with a minimum thickness of 3 feet over the area of contaminated sediment exposed by pre-dredging. Assuming a settling factor of approximately 20 percent following placement of the capping material, an estimated total volume of 499 cy of capping material would be required. Computations of the estimated volume of capping material are provided in Appendix B.2. The relatively small size of the area to be capped and the significant depth of the water column would require very precise placement of the capping material. Therefore, it is anticipated that the capping material would have to be placed with a mechanical clamshell bucket or tremie operating from a barge. In addition, to avoid excessive displacement of contaminated sediment, the cap material would be placed in multiple lifts of 6 inches or less. Capping would be performed in accordance with U.S. EPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (U.S. EPA, 2005) and the Navy's Implementation Guide for Assessing and Managing Contaminated Sediment at Navy Facilities (Navy, 2005).

Prior to the removal action, a detailed RAWP would be completed to confirm the surface of the area of contaminated sediment to be capped, volume of contaminated sediment to be dredged, and volume of

clean fill to be used for capping. Final selection of the precise dredging and capping equipment would be determined as part of the RAWP and would involve input from appropriate contractors.

The production rate for pre-dredging is estimated at approximately 200 in-situ cy of sediment removed per 10-hour operating day. The production rate for capping would be assumed to be in the same range.

The dredged sediment may contain debris that would potentially include metal, cables, broken concrete, brick, lumber, tree branches, and other rubble. It is assumed that debris would be processed simultaneously with the sediment and not segregated or processed separately. Large metallic debris would be washed and sent off-site for recycling, to the extent practical.

Dewatering of Dredged Sediment

The dredged sediment would be too wet to be transported or placed directly at a disposal facility. Dewatering would reduce the weight and volume of dredged sediment designated for disposal and would reduce transportation controls and restrictions (e.g., restrictions against transporting material with free water). For costing and comparative purposes, passive dewatering using a modified barge is the assumed approach.

Barges would be modified to be operated as static gravity drainage beds. For this purpose, concrete Jersey barriers would be used to construct an enclosure within the barge and this enclosure would be lined with a geotextile material that would let water filter through but would retain sediment particles. The enclosure would have a capacity of 200 to 300 cy, which would be adequate to hold and dewater 1 day's production of dredged sediment. Mixing and aerating would potentially be required to distribute wet dredged sediment and accelerate dewatering. Dredged sediment would not be completely dried, as the primary purpose of dewatering would be to drain the free water entrained by the dredging process and to recompact the sediment to its original in-situ volume and moisture content.

The rate of static sediment dewatering is unknown at this time. For the purpose of this EE/CA, it is assumed that the dewatering barge described above would drain all free water recompact the sediment to its original in-situ volume within 1 day or less. A bench- or pilot-scale dewaterability study would be useful to determine effectiveness and rate of dewatering, and confirm the need for additives to enhance or sufficiently complete dewatering.

When the dewatering barge is full it would be brought to shore and the dewatered sediment would be characterized for disposal through sampling and moved into stockpiles. The proposed location of this staging area is shown on Figure 5-2. It is estimated that a total of two barges full of dewatered sediment would be processed over 2 operating days. A chemical agent such as fly ash or Portland cement would

be added to the dewatered sediment to adsorb any residual free water and further stabilize the material for transportation and disposal. For the purpose of this EE/CA, it assumed that fly ash in the proportion of approximately 8 percent (by weight) of total would be added to the dewatered sediment prior to off-site transportation and disposal. It is also assumed that fly ash addition would result in an increase of approximately 10 percent in the volume of sediment to be disposed. Typical fly ash analysis would be obtained from the supplier and spot checks would be performed to verify that addition of this material would not change the character of the dewatered sediment and make its acceptance for off-site disposal more onerous.

As discussed in Section 4.2.9, the drainage water filtering through the geotextile liner would be allowed to discharge back into Outer Pier 1. Some of the water released by the dewatering process would not readily drain and filter through the geotextile liner and might pool on top of the dewatered sediment and would have to be removed by pumping. A small amount of residual free water might also be released by the dewatered sediment during on-shore staging. Altogether, it is assumed that this residual water, which is referred to as dewatering fluid, would amount to approximately 10 percent of the total volume of water released by the dewatering process. The dewatering fluid would be removed by pumping, containerized in appropriate holding structures (e.g., frac tank), characterized through sampling and analysis, and transported to an off-site wastewater disposal facility as further discussed below.

Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

The dewatered sediment and dewatering fluid would be transported to and disposed at a properly licensed and Navy-approved off-site landfill and wastewater disposal facility, respectively. Based on data available from previous sampling events, it is assumed that the dewatered sediment would be characterized as non-hazardous and would be disposed at a suitable landfill. An estimated 458 cy or 535 tons of dewatered and stabilized sediment would be disposed. Because of the generally low solubility of the sediment COCs, it is expected that the dewatering fluid would be characterized as non-hazardous waste and would be disposed at an appropriate wastewater treatment facility. An estimated 8,400 gallons of dewatering fluid would be disposed.

Final classification of waste material from Outer Pier 1 would be conducted after dewatering and prior to the addition of fly ash in accordance with destination-specific waste characterization requirements. Costs for disposal at a landfill or other off-site disposal facility would include truck transportation to that facility (i.e., dump trucks for sediment and tanker trucks for dewatering fluid) and volumetric (i.e., per ton or gallon) disposal costs. Residual solid material from the barge (e.g., the geotextile liner) would be disposed as solid waste at a permitted and licensed landfill.

LUCs

A LUC RD would be prepared to establish methods to prevent the uncontrolled disturbance of the capped area of contaminated sediment. This LUC RD would be developed in accordance with the Navy's LUC Principles (DoD, 2003). The LUC RD would also include procedures for the performance of regular site inspections to verify continued implementation of the LUCs, and for the incorporation of the LUCs in the Lower Subase ROD. LUCs would be implemented as part of NSB-NLON's SOPA Instructions 5090.25 (Navy, 2009) which would be modified to incorporate these LUCs.

Monitoring

Construction quality control monitoring would be conducted prior to construction and during the pre-dredging and capping activities, and post-construction confirmatory monitoring would be conducted immediately following completion of dredging. In addition, monitoring would be required to determine the specific waste-disposal requirements for dewatered sediment and dewatering fluid. Long-term monitoring would also be required to evaluate the continued effectiveness of the cap and the provisions of this monitoring would be incorporated in the Lower Subase ROD.

Pre-construction monitoring would include establishing baseline turbidity conditions within Outer Pier 1 to provide a basis of comparison for subsequent construction quality control monitoring. Baseline turbidity conditions would be established at one monitoring station with a buoy-mounted analyzer. Pre-construction monitoring would also include performance of a pre-removal action bathymetric survey.

During construction, turbidity monitoring would be conducted continuously beyond the southern perimeter of the dredge area (i.e., beyond the silt curtain) with buoy-mounted analyzers to determine potential suspension of contaminated sediment and to verify the integrity of the silt curtain. In addition, turbidity would also be monitored just inside the silt curtain with a hand-held analyzer prior to any barge movement through the curtain. Because the movement of contamination would be expected to be entirely correlated to the movement of suspended solids, turbidity monitoring data would be used to determine the potential for contaminant mobilization beyond the removal action area, and the need for corrective action. For purposes of developing a reasonable removal action approach and related costs, it is assumed that construction monitoring would be implemented using two buoy-mounted continuous turbidity analyzers located outside the silt curtain and one hand-held turbidimeter inside the silt curtain.

Post-construction monitoring would include performance of a bathymetric survey to verify that the cap is properly in place. Post-dredging confirmatory sediment sampling and analysis would not be required because it is understood that pre-dredging would expose an area of contaminated sediment that would be subsequently capped..

Waste disposal monitoring would be required to support the dewatering and disposal component of this removal action alternative. Specifically, dewatered sediment and dewatering fluid would be characterized in accordance with landfill and/or wastewater treatment facility disposal requirements. For costing purposes, it is assumed that one sediment characterization sample would be required for every 250 cy requiring disposal, which would generate sufficient data to accurately segregate wastes on the basis of non-hazardous versus hazardous nature. For the dewatering fluid, it is assumed that one sample would be required for every 5,000 gallons to be disposed (i.e., one full tanker truck). It is further assumed that sediment samples would be analyzed for total and leachable PCBs, metals, PAHs, and pesticides and that dewatering fluid samples would be analyzed for total PCBs, metals, PAHs, and pesticides. Waste characterization sampling for sediment would be conducted prior to addition of fly ash to prevent any potential influence on measured levels of contamination in the solid waste stream. As previously mentioned, fly ash quality spot checks would be performed to verify that addition of this material would not change the character of the dewatered sediment and make its acceptance for off-site disposal more onerous.

A long-term sediment and surface water monitoring program would be developed and implemented to verify the continued effectiveness of the cap. For the purpose of this EE/CA, it was assumed that sediment and surface water samples would be regularly collected from a total of four locations along the periphery of the Outer Pier 1 capped area. The collected samples would be analyzed for the sediment COCs (PAHs, PCBs, metals, and pesticides). Monitoring frequency would be semi-annual for the first 2 years and annual thereafter. In addition, long-term monitoring of the cap would include regular bathymetric measurements to ensure the cap thickness is maintained, and yearly site inspections to verify that the LUCs are in place, are being enforced, and remain effective. Frequency of bathimetric measurements would be yearly for the first year, bi-annual for the next 4 years, and every 5 years thereafter.

Reviews would be performed every 5 years to evaluate site status, to assess the continued adequacy of remedial activities and to determine whether further action is necessary. These site reviews are required because this alternative would allow COCs to remain in sediment at concentrations in excess of their PRGs.

5.3.2.2 Screening

<u>Effectiveness</u>

Alternative OP-2 would meet the RAO through removal and off-site disposal of Outer Pier 1 surface sediment with concentrations of COCs greater than PRGs and through capping of the remaining

contaminated sediment. Further, Alternative OP-2 would meet the RAO because LUCs and monitoring would prevent disturbance of the cap and verify that the remedy remains protective. Overall protection of human health and the environment would be adequate because subsurface contaminated sediment would be permanently and irreversibly removed from the site and exposure to subsurface contaminated sediment would be prevented by a cap. Alternative OP-2 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be adequate; however, this reduction would be achieved through on-site containment and partial removal and off-site disposal rather than through treatment. Another long-term effectiveness impact associated with this alternative is that capping the boundary area between Inner and Outer Pier 1 would prevent this area from being deepened at a later date, unless the sediment contamination exposed by this deepening would be adequately addressed.

In the short term, there would be increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. There would also be worker hazard associated with capping activities and work on open water. However, the magnitude of these risks would be low and would be adequately addressed through the use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk from spillage in and around the area and between the site and commercial landfill and wastewater disposal facility during the removal action. These risks would be adequately mitigated by implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the pre-dredging and capping area. However, placement of a cap over contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains) and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative OP-2 would be reasonably easy to implement because it would not require any highly specialized equipment to install a sand cap and to dredge, dewater, and transport contaminated sediment. Capping, dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to Outer Pier 1. There are commercial landfills and wastewater treatment facilities in the vicinity of NSB-NLON that would accept the waste. A small on-site staging area, approximately 0.25 acre in size, would be required to temporarily stockpile, stabilize, and load the dewatered sediment and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption

to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Outer Pier 1 and generally limited amount of work space in the immediate site area.

Overall, the implementation time of Alternative OP-2 would be short and it is estimated that it could be completed within 1 month or less. However, long-term monitoring would be required.

Cost

A summary of estimated costs for Alternative OP-2 is as follows:

Capital Cost	$476,000
NPW of O&M Costs	$295,000 (30-year)
NPW	$771,000 (30-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.3.3 Alternative OP-3: Capping with Pre-Dredging to Meet the RAO, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, Off-Site Disposal of Dewatered Sediment, LUCs, and Monitoring

Alternative OP-3 would be essentially identical to Alternative OP-2, with the difference that dewatering fluid would be treated and discharged on site rather than disposed off site.

5.3.3.1 Description

Capping with Pre-Dredging

The capping with pre-dredging element of Alternative OP-3 would be identical to the previously described capping with pre-dredging element of Alternative OP-2.

Dewatering of Dredged Sediment

The sediment dewatering element of Alternative OP-3 would be identical to the previously described sediment dewatering element of Alternative OP-2.

On-Site Treatment and Discharge of Dewatering Fluid

The dewatering fluid containerized on the dewatering barge would be conveyed to an on-site treatment system. As for Alternatives IP-4, IP-5, and IP-6, the treatment system would consist of a sediment pre-filter and liquid-phase GAC adsorption unit operating in series, with all necessary piping and instrument controls. This treatment system would remove the COCs associated with suspended solid particles and COCs that might leach from the dredged contaminated sediment and would allow discharge of the treated dewatering fluid to the Thames River.

Based on current projections of dredged sediment volume, it is estimated that a total volume of approximately 8,400 gallons of dewatering fluid would have to be treated and discharged. For the purpose of this EE/CA, it is assumed that the on-site dewatering fluid treatment system would be similar to that proposed for Alternatives IP-4 and IP-5 but with a design capacity of 5,000 gpd. A PFD for this treatment system is shown as Figure 5-3 and conceptual design calculations are provided in Appendix B.3. The treatment system would be located in the same area as that proposed for the on-shore staging and stabilization of the dewatered sediment as shown on Figure 5-2. The treatment system area would be secured with fencing and other controls necessary to prevent any potential direct exposure risk to NSB-NLON personnel.

Off-Site Disposal of Dewatered Sediment

The sediment disposal element of Alternative OP-3 would be identical to the previously described sediment disposal element of Alternative OP-2. There would be no off-site disposal of sediment dewatering fluid because that waste stream would be treated on site and discharged to the Thames River as discussed above.

LUCs

The LUCs element of Alternative OP-3 would be identical to the previously described LUCs element of Alternative OP-2.

Monitoring

The monitoring element of Alternative OP-3 would be similar to the previously described monitoring element of Alternative OP-2. In addition to the same construction quality control monitoring, post-construction confirmatory monitoring, sediment disposal monitoring, and long-term remedy effectiveness monitoring as for Alternative OP-2, the monitoring element for Alternative OP-3 would include an evaluation of the performance of the above-described on-site dewatering fluid treatment system. For costing purposes, it is assumed that one treatment system influent and one effluent sample would be

collected for every day of system operation. It is further assumed that these samples would be analyzed for total PCBs, metals, PAHs, pesticides, and TSS.

5.3.3.2 Screening

Effectiveness

Alternative OP-3 would meet the RAO through removal and off-site disposal of Outer Pier 1 surface sediment with concentrations of COCs greater than PRGs and through capping of the remaining contaminated sediment. Further, Alternative OP-3 would meet the RAO because LUCs and monitoring would prevent disturbance of the cap and verify that the remedy remains protective. Overall protection of human health and the environment would be adequate because subsurface contaminated sediment would be permanently and irreversibly removed from the site and exposure to subsurface contaminated sediment would be prevented by a cap. Alternative OP-3 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be adequate; however, this reduction would be achieved through on-site containment and partial removal and off-site disposal rather than through treatment. As for Alternative OP-2, capping of the boundary area between Inner and Outer Pier 1 would prevent this area from being deepened at a later date, unless the sediment contamination exposed by this deepening would be adequately addressed.

In the short term, there would be increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. There would also be risk of worker exposure to contamination from O&M of the on-site dewatering fluid treatment system as well as worker hazards associated with capping activities and work on open water. However, the magnitude of theses risks would be low and would be adequately addressed through use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk from spillage in and around the area and between the site and commercial landfill during the removal action. These risks would be adequately mitigated by the implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the pre-dredging and capping area. However, placement of a cap over the contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains), by the treatment of dewatering fluid prior to discharge, and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative OP-3 would be reasonably easy to implement because it would not require any highly specialized equipment to install a sand cap and to dredge, dewater, and transport contaminated sediment. Capping, dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to Outer Pier 1. On-site dewatering fluid treatment is also a well-proven removal action element. There are commercial landfills in the vicinity of NSB-NLON that would accept the dewatered sediment. An on-site area approximately 0.5 acre in size would be required to temporarily stockpile, stabilize, and load the dewatered sediment; to install and operate a dewatering fluid treatment system; and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Outer Pier 1 and generally limited amount of work space in the immediate site area. In addition, there may be some administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of treated dewatering fluid. Although a permit would not be required, discharge of the treated dewatering fluid to the Thames River would have to meet the substantive requirements of an NPDES permit.

Overall, the implementation time of Alternative OP-3 would be short and it is estimated that it could be completed within 1 month or less. However, long-term monitoring would be required.

Cost

A summary of estimated costs for Alternative OP-3 is as follows:

Capital Cost	$496,000
NPW of O&M Costs	$295,000 (30-year)
NPW	$791,000 (30-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.3.4 Alternative OP-4: Dredging to Meet PRGs, Dewatering, Off-Site Disposal of Dewatered Sediment and Dewatering Fluid

Alternative OP-4 would consist of dredging Outer Pier 1 contaminated sediment to a depth of 6 feet to meet PRGs. The dredged sediment would be dewatered on site, and the dewatered sediment and

contaminated dewatering fluid would be disposed off site at appropriate disposal facilities (i.e., landfill and wastewater treatment facility, respectively). Appropriate engineering controls and monitoring would also be implemented to ensure and confirm the effectiveness of the removal action.

5.3.4.1 Description

Dredging

The area of Outer Pier 1 sediment with concentrations of COCs greater than PRGs would be dredged to a depth of up to 6 feet. Based on available data, this area has been estimated to cover approximately 27,300 sf as shown on Figure 5-5. Assuming a 10 percent overdredge factor, an estimated 6,673 in-situ cy of sediment would be dredged from Outer Pier 1. Computations of the estimated volume of sediment to be dredged are provided in Appendix B.2.

For this removal action alternative, sediment would be mechanically removed using a single long reach excavator positioned on a barge within Outer Pier 1 and equipped with an environmental bucket to minimize the entrainment of free water. It is assumed that mechanical dredging of the Inner Pier 1 sediment would entrain a volume of free water approximately equal to the in-situ volume of dredged sediment. Sediment would be removed using controlled movements of the excavator, and care would be taken to minimize the free water content of the removed sediment. The dredged sediment would be placed directly in a barge modified to be used as a static gravity dewatering bed as further discussed below. The assumed production rate for this alternative would be approximately 200 in-situ cy of sediment dredged per 10-hour day.

To ensure that resuspended sediment is not released beyond Outer Pier 1, a silt curtain approximately 800 feet long would be deployed along the southern perimeter of the removal action area.

Prior to the removal action, a RAWP would be completed to define precise dredge prisms and to confirm the volume of sediment to be dredged. Final selection of the precise dredging equipment would be determined as part of the RAWP and would involve input from appropriate contractors. The final selection would be based on the method that best satisfies the RAO and mitigates site logistical concerns.

The dredged sediment may contain debris that would potentially include metal, cables, broken concrete, brick, lumber, tree branches, and other rubble. It is assumed that debris would be processed simultaneously with the sediment and not segregated or processed separately. Large metallic debris would be washed and sent off site for recycling, to the extent practical.

Dewatering of Dredged Sediment

The sediment dewatering element of Alternative OP-4 would be similar to the previously described sediment dewatering element of Alternative OP-2, with the difference that a much larger volume of dredged sediment would have to be dewatered. As for Alternative OP-2, the dredged sediment would be dewatered using barges modified to operate as static gravity drainage beds. Also as for Alternative OP-2, the dewatered sediment would be stabilized on shore prior to off-site transportation and disposal by adding approximately 8 percent (by weight) of fly ash. An estimated 34 barges full of dewaterd sediment would be processed over 34 operating days.

As for Alternative OP-2, it is anticipated that approximately 10 percent of the water released by the sediment dewatering process would either not readily drain and filter through the barge liner or would be released during on-shore staging of the dewatered sediment and would have to be handled separately. This dewatering fluid would be collected, containerized in an appropriate holding structure (e.g., frac tank), characterized through sampling, and transported to an off-site wastewater disposal facility as further discussed below.

Off-site Disposal of Dewatered Sediment and Dewatering Fluid

The off-site disposal element of Alternative OP-4 would be similar to the previously described off-site disposal element of Alternative OP-2, with the difference that much larger volumes of sediment and dewatering fluid would have to be disposed. As for Alternative OP-2, it is assumed that the dewatered sediment would be characterized as non-hazardous and would be disposed at a suitable landfill. An estimated 7,340 cy or 8,576 tons of dewatered and stabilized sediment would be disposed. Because of the typically low solubility of the sediment COCs, it is expected that the dewatering fluid would be characterized as non-hazardous waste and would be disposed at an appropriate wastewater treatment facility. Approximately 135,000 gallons of dewatering fluid would be disposed.

Final classification of waste material from Outer Pier 1 would be conducted after dewatering and prior to adding any stabilizing agent or disposal in accordance with destination-specific waste characterization requirements. Costs for disposal at a landfill or other off-site disposal facility would include truck transportation to that facility (i.e., dump trucks for sediment and tanker trucks for dewatering fluid) and volumetric (i.e., per ton or gallon) disposal costs. Residual solid material from the barge (e.g., the geotextile liner) would be disposed as solid waste at a permitted and licensed landfill.

Monitoring

The monitoring element of Alternative OP-4 would be similar to the previously described monitoring element of Alternative OP-2, with the difference that no long-term monitoring would be required to evaluate the continued effectiveness of a cap. As for Alternative OP-2, construction quality control monitoring would be conducted prior to construction and during the dredging activities, and post-construction confirmatory monitoring would be conducted immediately following completion of dredging. Confirmation sampling would consist of collecting one nine-point composite sample per 5,000 sf from the bottom of the dredged area. In addition, monitoring would be required to determine the specific waste-disposal requirements for dewatered sediment and dewatering fluid.

5.3.4.2 Screening

Effectiveness

Alternative OP-4 would meet the RAO through dredging and off-site disposal of Outer Pier 1 sediment with concentrations of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the site. Alternative OP-4 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment.

In the short term, there would be an increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. In addition, there would be increased worker hazards associated with work on open water. However, the magnitude of these risks would be low and would be adequately addressed through use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk of spillage in and around the area and between the site and commercial landfill and wastewater disposal facility during the removal action. These risks would be adequately mitigated by the implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains) and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative OP-4 would be reasonably easy to implement because it would not require any highly specialized equipment to dredge, dewater, and transport contaminated sediment. Dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to Outer Pier 1. There are commercial landfills and water treatment facilities in the vicinity of NSB-NLON that would accept the waste. A small on-site staging area, approximately 0.25 acre in size, would be required to temporarily stockpile, stabilize, and load the dewatered sediment and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Outer Pier 1 and generally limited amount of work space in the immediate site area.

Overall, the implementation time of Alternative OP-4 would be short and it is estimated that it could be completed within 3 months or less.

Cost

A summary of estimated costs for Alternative OP-4 is as follows:

Capital Cost	$2,459,000
NPW of O&M Costs	$0
NPW	$2,459,000 (1-year)

A detailed cost estimate for this alternative is provided in Appendix C.

5.3.5 Alternative OP-5: Dredging to Meet PRGs, Dewatering, On-Site Treatment and Discharge of Dewatering Fluid, and Off-Site Disposal of Dewatered Sediment

Alternative OP-5 would be essentially identical to Alternative OP-4 with the difference that dewatering fluid would be treated and discharged on site instead of disposed off site.

5.3.5.1 Description

Dredging

The dredging element of Alternative OP-5 would be identical to the previously described dredging element of Alternative OP-4.

Dewatering of Dredged Sediment

The sediment dewatering element of Alternative OP-5 would be identical to the previously described sediment dewatering element of Alternative OP-4.

On-Site Treatment and Discharge of Dewatering Fluid

The dewatering fluid treatment and discharge element of Alternative OP-5 would be similar to the previously described dewatering fluid treatment and discharge element of Alternative OP-3, with the difference that a significantly larger volume of dewatering fluid (135,000 gallons instead of 8,400 gallons) would need to be treated and discharged. A 5,000-gpd treatment system similar to that proposed for Alternative OP-3 would be used but with twin pre-filtration and liquid-phase GAC adsorption units. This system would be operated for an estimated 34 days. A PFD for this treatment system is presented as Figure 5-3 and conceptual design calculations are provided in Appendix B.3. The system would be located in the same area as that proposed for the staging and stabilization of the dewatered sediment as shown on Figure 5-2.

Off-Site Disposal of Dewatered Sediment

The sediment disposal element of Alternative OP-5 would be identical to the previously described sediment disposal element of Alternative OP-4. There would be no off-site disposal of contaminated dewatering fluid because that waste stream would be treated on site and discharged to the Thames River as discussed above.

Monitoring

The monitoring element of Alternative OP-5 would be similar to the previously described monitoring element of Alternative OP-4. In addition to the same construction quality control monitoring, post-construction confirmatory monitoring, sediment disposal monitoring as for Alternative OP-4, the monitoring element for Alternative OP-5 would include an evaluation of the performance of the above-described on-site dewatering fluid treatment system. For costing purposes, it is assumed that one treatment system influent and one effluent sample would be collected for every day of system operation.

It is further assumed that these samples would be analyzed for total PCBs, metals, PAHs, pesticides, and TSS.

5.3.5.2 Screening

Effectiveness

Alternative OP-5 would meet the RAO through dredging and off-site disposal of Outer Pier 1 sediment with concentration of COCs greater than PRGs. Overall protection of human health and the environment would be high because contaminated sediment would be permanently and irreversibly removed from the site. Alternative OP-5 would comply with the ARARs identified in Section 3.6. Long-term effectiveness and reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment.

In the short term, there would be an increased risk of exposure to on-site workers during the process of dredging, handling, dewatering, and loading out the contaminated sediment. There would also be risk of worker exposure to contamination from O&M of the on-site dewatering fluid treatment system as well as worker hazards associated with work on open water. However, the magnitude of these risks would be low and would be adequately addressed through use of standard PPE and BMPs. Increased risks to the surrounding community would be expected to be limited to increased truck traffic and risk of spillage in and around the area and between the site and commercial landfill during the removal action. These risks would be adequately mitigated by implementation of appropriate traffic control and spill prevention measures. This alternative would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtains), by the treatment of dewatering fluid prior to discharge, and by administrative controls such as the restriction of dredging operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

Implementability

Alternative OP-5 would be reasonably easy to implement because it would not require any highly specialized equipment to dredge, dewater, and transport contaminated sediment. Dredging and off-site disposal have been implemented successfully on several sediment projects and this is a relatively proven alternative for sites with conditions similar to Outer Pier 1. On-site dewatering fluid treatment is also a well-proven removal action element. There are commercial landfills in the vicinity of NSB-NLON that would accept the waste. An on-site area approximately 0.5 acre in size would be required to temporarily stockpile, stabilize, and load the dewatered sediment; to install and operate a dewatering fluid treatment

system; and to store equipment required for the removal action. Implementation of this alternative would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. The removal action would not pose a significant disruption to regular base activities, with the possible exception of truck traffic entering and exiting the security gates. Coordination with NSB-NLON facilities management and personnel would be required. A significant implementability challenge for this alternative would be the limited access to Outer Pier 1 and generally limited amount of work space in the immediate site area. In addition, there may be some administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of treated dewatering fluid. Although a permit would not be required, discharge of the treated dewatering fluid to the Thames River would have to meet the substantive requirements of an NPDES permit.

Overall, the implementation time of Alternative OP-5 would be short and it is estimated that it could be completed within 3 months or less.

Cost

A summary of estimated costs for Alternative OP-5 is as follows:

Capital Cost	$2,710,000
NPW of O&M Costs	$0
NPW	$2,710,000 (1-year)

A detailed cost estimate for this alternative is provided in Appendix C.

TABLE 5-1

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that will remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
			What is the magnitude of the effort associated with this remedy?	Low to Moderate
		Adequacy and reliability of controls	What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	No
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-1

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low

TABLE 5-1

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this alternative?	Low
		Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability study)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes

TABLE 5-1

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Cost	Immediate capital costs		Estimated costs	$1,463,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance

TABLE 5-2

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-3 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
		Adequacy and reliability of controls	What is the magnitude of the effort associated with this remedy?	Low to Moderate
			What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	No
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-2

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-3 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low
			Is it likely that necessary permits/ approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this removal alternative?	Low
		Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes

TABLE 5-2

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-3 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies (continued)	Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability study)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$1,498,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance

TABLE 5-3

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-4 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
		Adequacy and reliability of controls	What is the magnitude of the effort associated with this remedy?	Moderate
			What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	Yes, but treatment would only apply to liquid waste.
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-3

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-4 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/ approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this removal alternative?	Low to Moderate

TABLE 5-3

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-4 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability and treatability studies)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$1,622,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance

TABLE 5-4

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-5 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
		Adequacy and reliability of controls	What is the magnitude of the effort associated with this remedy?	Moderate
			What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	Yes, but treatment would only apply to dewatering effluent .
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-4

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-5 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/ approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this removal alternative?	Low to Moderate

TABLE 5-4

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-5 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability and treatability studies)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$1,660,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance

TABLE 5-5

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-6 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
		Adequacy and reliability of controls	What is the magnitude of the effort associated with this remedy?	Moderate to High
			What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Moderate
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	Yes, but treatment would only apply to liquid waste.
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Moderate to High
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Uncertain

TABLE 5-5

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-6 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Moderate to High
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Moderate to High
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/ approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low to Moderate
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this removal alternative?	Moderate

TABLE 5-5

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE IP-6 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability and treatability studies)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$2,524,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance

TABLE 5-6

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that will remain following the removal action?	Low to Moderate
			What is the likelihood that the technology will meet any necessary permit requirements?	High
			What is the magnitude of the effort associated with this remedy?	Low
		Adequacy and reliability of controls	What is the degree of long-term monitoring and management associated with this remedy?	Moderate
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	No
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	Low (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through containment and off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-6

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Moderate
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this alternative?	Low

TABLE 5-6

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-2 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability study)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$476,000
	O&M costs		Estimated costs	$295,000 30-Year NPW
	Future capital costs		Estimated costs	Future capital cost may be required to repair or replace cap.

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
NPW Net present worth
O&M Operation and maintenance

TABLE 5-7

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-3 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that will remain following the removal action?	Low to Moderate
			What is the likelihood that the technology will meet any necessary permit requirements?	High
			What is the magnitude of the effort associated with this remedy?	Low to Moderate
		Adequacy and reliability of controls	What is the degree of long-term monitoring and management associated with this remedy?	Moderate
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	Yes, but treatment would only apply to liquid waste
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	Low (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through containment and off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-7

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-3 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Moderate
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Moderate
			Is it likely that necessary permits/approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this alternative?	Low

TABLE 5-7

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-3 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (treatability study, dewaterability study)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$496,000
	O&M costs		Estimated costs	$295,000 30-Year NPW
	Future capital costs		Estimated costs	Future capital costs might be required to repair or replace cap.

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
NPW Net present worth
O&M Operation and maintenance

TABLE 5-8

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-4 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that will remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
			What is the magnitude of the effort associated with this remedy?	Moderate
		Adequacy and reliability of controls	What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	No
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-8

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-4 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this alternative?	Low

TABLE 5-8

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-4 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability study)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$2,459,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance

TABLE 5-9

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-5 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness	Overall Protection of Human Health and the Environment	Potential for exposure to humans and remaining health risks after the removal	Will a risk for exposure or a potential health risk remain?	No
		Potential for exposure to the environment and remaining environmental risks after the removal	Is there a risk for exposure to the environment or other potential environmental risks that will remain?	No
	Compliance with ARARs	Compliance with ARARs as described in Section 300.415(i) of the NCP	Is it expected that the removal approach will comply with the identified ARARs and RAO?	Yes
	Long-Term Effectiveness and Permanence	Magnitude of the residual risks	What is the expected magnitude of any long-term residual risks that remain following the removal action?	Low
			What is the likelihood that the technology will meet any necessary permit requirements?	High
		Adequacy and reliability of controls	What is the magnitude of the effort associated with this remedy?	Moderate to High
			What is the degree of long-term monitoring and management associated with this remedy?	None
			What is the potential need for replacement of technical components?	Low
	Reduction of Toxicity, Mobility, and Volume	Type of treatment process used	Will a treatment process address the COCs?	Yes, but treatment would only apply to liquid waste.
		Mass of contaminant destroyed or treated	What is the expected magnitude of the overall reduction in mass of contamination?	High (through off-site disposal)
		Reduction in toxicity and mobility	What is the expected magnitude of the overall reduction in toxicity and mobility?	High (through off-site disposal)
	Short-Term Effectiveness	Protection of the community during the removal actions	What is the expected magnitude of risks to the community during the removal action?	Low
			If there are risks to the community during the removal action, can they be addressed and mitigated satisfactorily?	Yes
		Protection of workers during the removal actions	What is the expected magnitude of risks to workers during the removal action?	Low
			If there are risks to the workers during the removal action, can they be addressed and mitigated satisfactorily?	Yes

TABLE 5-9

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-5 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Effectiveness (continued)	Short-Term Effectiveness (continued)	Environmental impacts	Are there adverse environmental impacts expected with the construction and implementation of the remedy?	Yes
			Are there measures and controls available to mitigate potential environmental impacts?	Yes
		Time until RAO is achieved	Is the time required to meet the RAO and address any potential threats caused by contamination acceptable?	Yes
Implementability	Technical Feasibility	Ability to construct and operate the technology	What is the expected magnitude of difficulty and uncertainty related to construction of the removal alternative?	Low
		Reliability of technology	What is the likelihood of encountering technical difficulties with implementing the remedy?	Low
		Ease of undertaking additional removal action if necessary	Is it likely that follow-on removal alternatives may be required?	No
		Monitoring considerations	What is the likelihood that migration or exposure pathways exist that cannot be monitored effectively?	Low
			What is the potential magnitude of exposure risk should monitoring be insufficient to detect failure?	Low
	Administrative Feasibility	Ability to obtain approvals from within the Navy and appropriate regulatory agencies	What is the amount of effort to coordinate with the appropriate agencies?	Low to Moderate
			Is it likely that necessary permits/ approvals from outside agencies can be obtained as needed?	Yes
	Availability of Services and Materials	Availability of treatment, storage, and disposal services and capacity as required	Are the necessary services related to treatment, storage, and disposal available?	Yes
			What capacity is required of these services to meet the needs of this removal alternative?	Low
		Availability of specific equipment, materials, and technical personnel to operate the necessary processes	Are the necessary services and facilities available?	Yes
			What is the relative amount of specialized equipment, materials, and technical personnel required for this removal alternative?	Low to Moderate

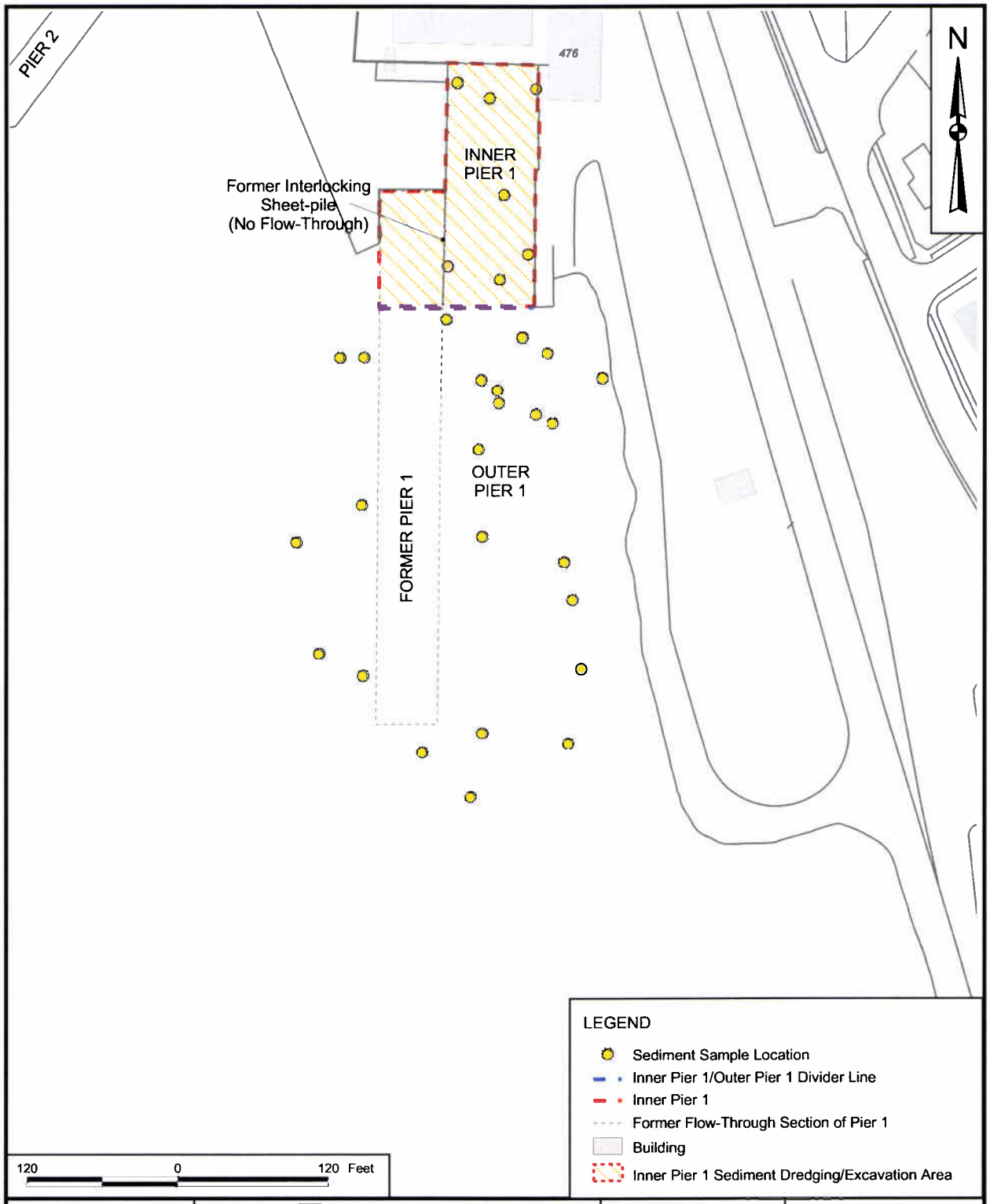
TABLE 5-9

SUMMARY OF EVALUATION CRITERIA ANALYSIS
ALTERNATIVE OP-5 - INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

General Category	Evaluation Criteria	Factors Included in Evaluation Criteria Analysis	Comments/Specific Considerations	Response to Specific Consideration
Implementability (continued)	Availability of Services and Materials (continued)	Availability of prospective technologies	Are the technologies under consideration generally available and sufficiently demonstrated for the specific application?	Yes
			Will the technologies require further development before they can be applied full-scale?	Possibly (dewaterability and treatability studies)
			Will more than one vendor be available to provide a competitive bid for the various components required to implement the technology?	Yes
	State Acceptance	Technical and administrative issues that the state or other regulatory agency may have regarding the alternative	Is the state likely to accept the proposed alternative?	Yes
	Community Acceptance	Concerns that the public may have regarding the alternative	Is the public likely to accept the proposed alternative?	Yes
Cost	Immediate capital costs		Estimated costs	$2,710,000
	O&M costs		Estimated costs	$0
	Future capital costs		Estimated costs	No future capital costs associated with the removal action

NOTES:

ARARs Applicable or relevant and appropriate requirements
COCs Chemicals of concern
NCP National Oil and Hazardous Substances Pollution Contingency Plan
O&M Operation and maintenance



DRAWN BY S. STROZ — DATE 07/07/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GLORIEUX — DATE 09/30/09	INNER PIER 1 SEDIMENT DREDGING/ EXCAVATION AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/9/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 5-1	REV 0

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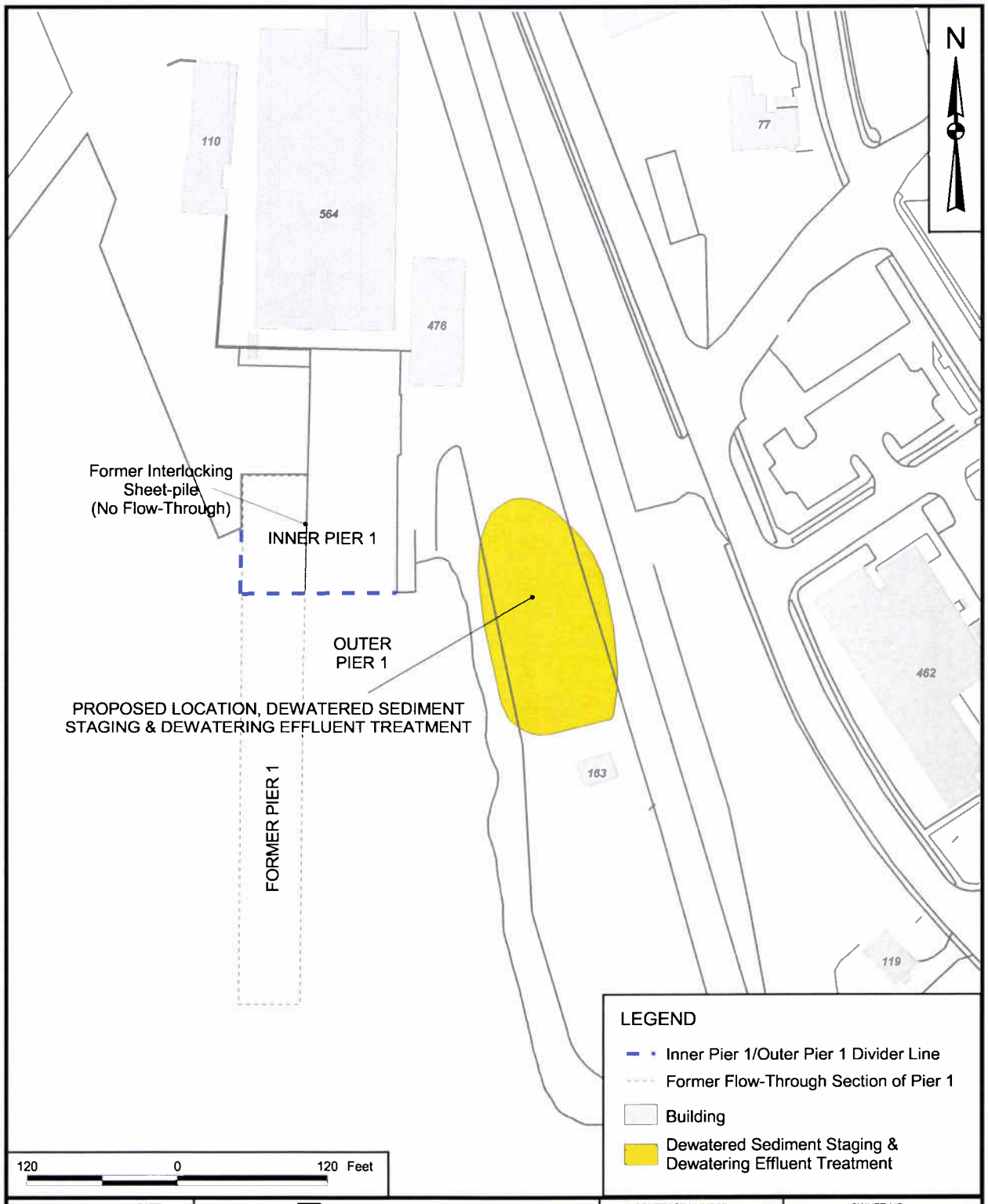
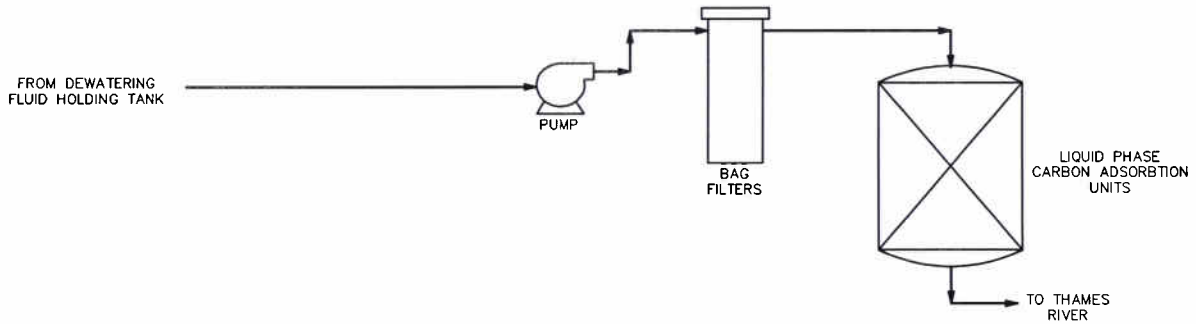


DRAWN BY S. STROZ — DATE 09/30/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. CLOUREDX — DATE 08/05/09	LOCATION OF ON-SITE DEWATERED SEDIMENT STAGING & DEWATERING EFFLUENT TREATMENT SYSTEM INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 6/9/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 5-2	REV 0

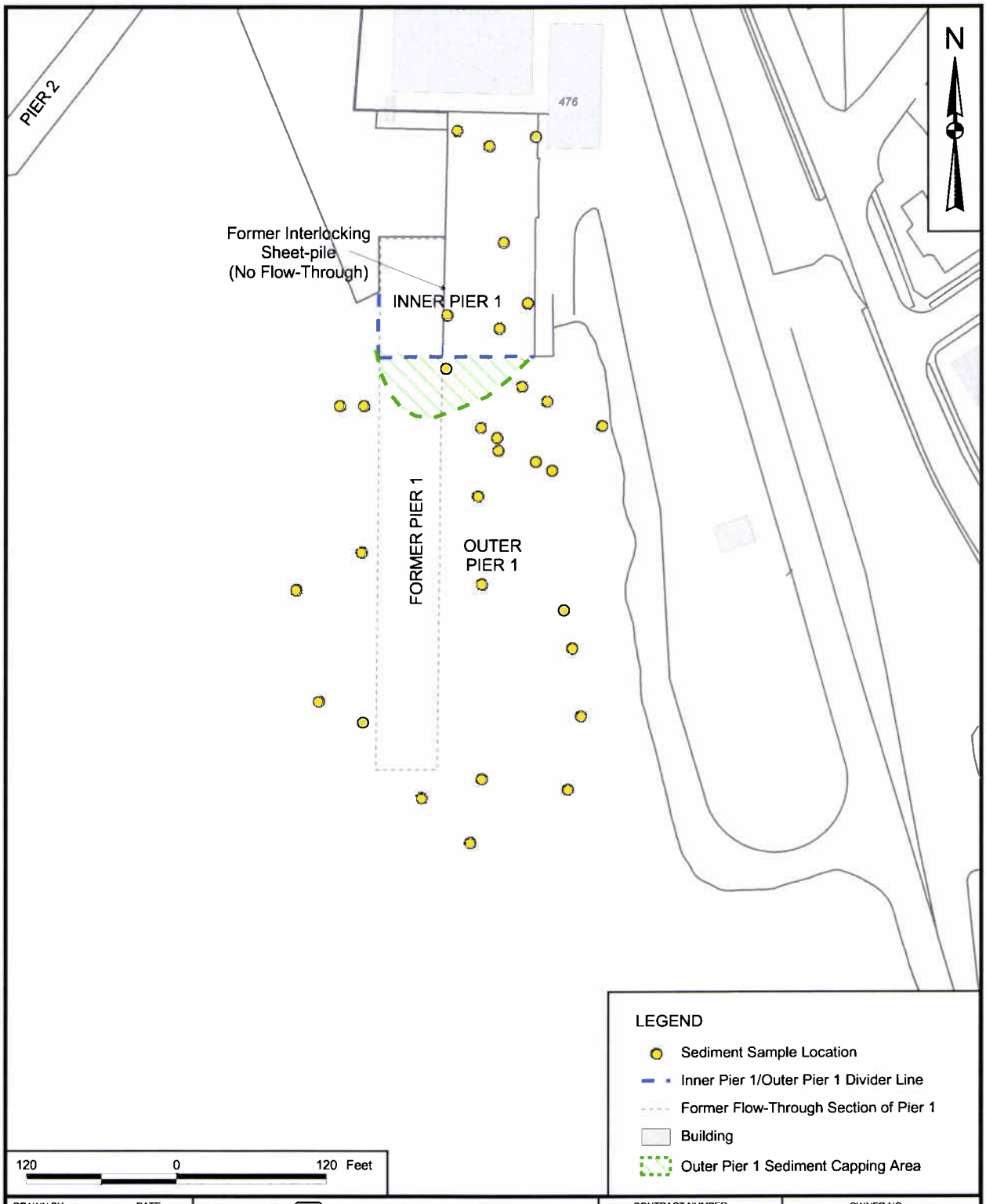
P:\GIS\NLON\SUBASE FEASIBILITY STUDY APR DEWATERING AND TREATMENT AREA LAYOUT 09/30/09 SS



DRAWN BY CK DATE 7/31/09	Tetra Tech NUS, Inc.	PROCESS FLOW DIAGRAM TYPICAL ON-SITE DEWATERING FLUID TREATMENT SYSTEM INNER AND OUTER PIER 1 EE/CA NSB-NON, GROTON, CONNECTICUT	CONTRACT NO. 0424
CHECKED BY DATE 08/05/09			OWNER NO.
REVISED BY DATE			APPROVED BY CAR DATE 8/5/09
SCALE NOT TO SCALE			DRAWING NO. FIGURE 5-3 REV. 0

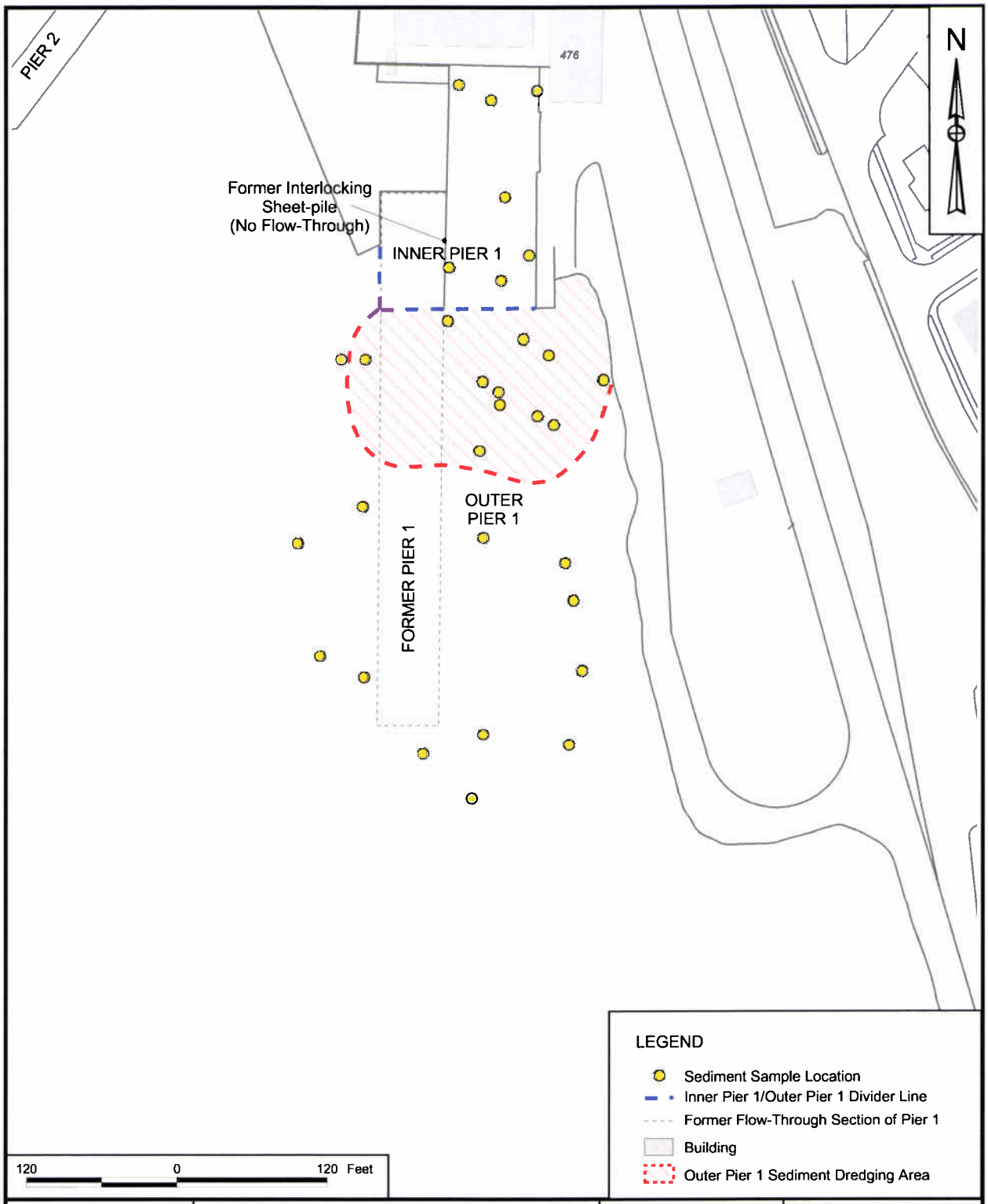
FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0811PF06.dwg 08/05/09 MF PIT



DRAWN BY S. STROZ — DATE 07/07/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GIGORIEUX — DATE 09/30/09	OUTER PIER 1 SEDIMENT CAPPING AREA INNER AND OUTER PIER 1 EE/CA ALTERNATIVES OP-2 AND OP-3 NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/9/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 5-4	REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY APR OUTER PIER 1 SEDIMENT CAPPING AREA LAYOUT 09/30/09 SS



DRAWN BY S. STROZ — DATE 07/07/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. GLORIEUX — DATE 09/30/09	OUTER PIER 1 SEDIMENT DREDGING AREA INNER AND OUTER PIER 1 EE/CA ALTERNATIVES OP-4 AND OP-5 NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/9/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 5-5	REV 0

P:\GIS\NLON\SUBASE FEASIBILITY STUDY APR OUTER PIER 1 SEDIMENT DREDGING AREA LAYOUT 09/30/09 SS

6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

In this section, the removal action alternatives presented and analyzed in Section 5.0 are compared to evaluate the anticipated performance of each alternative relative to standard evaluation criteria. The evaluation criteria used in this comparison are the same as in Section 5.0 (i.e., effectiveness, implementability, and cost), and these criteria are discussed in terms of the specific evaluation criteria identified in the alternative evaluation summary tables presented in Section 5.0.

6.1 INNER PIER 1 ALTERNATIVES

6.1.1 Effectiveness of Alternatives

6.1.1.1 Overall Protection of Human Health and the Environment

Alternative IP-1 would not be protective of human health and the environment. Alternatives IP-2 through IP-6 would be protective. The potential for human and ecological exposure to contaminated sediment within Inner Pier 1 would be eliminated through each of these five removal action alternatives. By permanently removing sediment containing elevated concentrations of COCs, Alternatives IP-2 through IP-6 would provide a high degree of protection of human health and the environment. Alternative IP-6 might be slightly more protective than Alternatives IP-2 through IP-5 because exposing of the sediment prior to excavation would allow for complete and verifiable removal, whereas dredging through the water column might leave a small hard-to-quantify residual volume of sediment.

6.1.1.2 Compliance with ARARs

Alternative IP-1 would not comply with the chemical-specific ARARs identified in Table 3-1. The location- and action-specific ARARs identified in Tables 3-2 and 3-3, respectively, do not apply to Alternative IP-1. The remaining five removal action alternatives would comply with the chemical-, location-, and action-specific ARARs identified in Tables 3-1, 3-2, and 3-3, respectively.

6.1.1.3 Long-term Effectiveness and Permanence

Alternative IP-1 would not be long-term effective and permanent. Alternatives IP-2 through IP-6 would be permanent and should be highly effective for the long term. Alternative IP-6 might be slightly more long-term effective and permanent than Alternatives IP-2 through IP-5 because exposing of the sediment prior to excavation would allow for complete verifiable removal, whereas dredging through the water column might leave a small hard-to-quantify residual volume of sediment.

6.1.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative IP-1 would not reduce toxicity, mobility, or volume of COCs through treatment. Concentrations of sediment COCs might be slightly reduced over the long-term as a result of natural attenuation processes, but this reduction would not be verified by monitoring. Alternatives IP-2 through IP-6 include removal and off-site disposal of contaminated sediment from Inner Pier 1. Therefore, the reduction in toxicity, mobility, and volume of contaminated sediment would be high; however, this reduction would be achieved through removal and off-site disposal rather than through treatment. Alternative IP-6 might achieve a slightly higher degree of toxicity, mobility, and volume than Alternatives IP-2 through IP-5 because exposing of the sediment prior to excavation would allow for complete verifiable removal, whereas dredging through the water column might leave a small hard-to-quantify residual volume of sediment.

6.1.1.5 Short-term Effectiveness

There would be no short-term effectiveness impacts or concerns associated with Alternative IP-1 because no action would occur. There would be short-term risks associated with the implementation of Alternatives IP-2 through IP-6. Potential short-term risks to on-site workers and to the environment would be low for Alternatives IP-2 through IP-5 and could be addressed through the use of standard PPE, engineering controls, and BMPs. There would also be short-term risks to the surrounding community from Alternatives IP-2 through IP-6 as a result of the off-site transportation of contaminated material. These risks would be slightly lower for Alternatives IP-4, IP-5, and IP-6 than for Alternatives IP-2 and IP-3 because no off-site transportation of dewatering fluid would be required. However, these risks would be adequately mitigated for all alternatives by the implementation of appropriate traffic controls and spill prevention measures.

The short-term effectiveness concerns associated with Alternative IP-6 would be significantly greater than those for the other alternatives because of the uncertain ability of the isolation structure around Inner Pier 1 to fully prevent surface water and/or groundwater intrusion, the worker hazards associated with the uncertain ability of the isolation structure to withstand the hydrostatic force of the Thames River, and the inherent risk that draining the area would not be effective or would require constant efforts to sustain. The short-term risks to site workers would be significantly increased under Alternative IP-6 due to working in wet, organic sediments in a dewatered environment below the static water level of the surrounding Thames River. The associated entrapment and drowning risks could be mitigated by the presence of an isolation structure (assuming it is feasible to erect) and by using careful work practices inside the removal action area.

Alternatives IP-2 to IP-6 would be destructive of ecological receptors (i.e., benthic macro-invertebrate) in the dredging or excavation area. However, removal of contaminated sediment would also create conditions favorable to the re-population of these same receptors. Impact to the surrounding environment would be mitigated by engineering controls (e.g., silt curtain or coffer dam) and by administrative controls such as the restriction of dredging/excavation operations to the period from October 1 to January 31 that corresponds to minimal ecological activity.

6.1.2 Implementability of Alternatives

Alternative IP-1 would be easiest to implement because there would be nothing to implement. Alternatives IP-2 through IP-5 would be relatively easy to implement. The two main technologies common to these alternatives, dredging and off-site disposal, have been implemented successfully on several sediment projects for sites with conditions similar to Inner Outer Pier 1. The dredging set-up and equipment used for Alternatives IP-3 and IP-5 (i.e., a barge-mounted excavator) would be slightly more complex than that used for Alternatives IP-2 and IP-3. However, the recent demolition of Pier 1 might also make the positioning of shore-based dredging equipment more difficult. Alternative IP-6 would be significantly harder to implement than Alternatives IP-2 through IP-5 because it would require the additional complication of installing an isolation structure and draining the pier area prior to excavation. Fully isolating and draining Inner Pier 1 would probably be quite technically challenging and might not be practical to achieve because of the mechanical impact of the Thames River's currents and the strong potential surface water and/or groundwater intrusion.

Commercial landfills in the vicinity of NSB-NLON would accept the dewatered sediment generated through each alternative and treatment facilities would accept the dewatering fluid generated by Alternatives IP-2 and IP-3. On-site treatment of dewatering fluid as is proposed in Alternatives IP-4 and IP-5, and on-site treatment of contaminated surface water and dewatering fluid as is proposed in Alternative IP-6, are relatively well-proven remedial elements; however, this would require at least some fairly specialized equipment such as a packaged or constructed treatment system. In addition, there may be greater administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of treated water. Although a permit would not be required, discharge of treated water to the Thames River would have to meet the substantive requirements of an NPDES permit.

A significant implementability challenge common to the Inner Pier 1 alternatives would be the limited site access and generally limited amount of work space in the immediate site area. Each of the alternatives would require the same resources for dewatering, stabilizing, and loading the dredged sediment, and storing the equipment and material required for the removal action. Alternatives IP-4, IP-5, and IP-6 would require additional space and resources or the treatment of dewatering fluid and/or surface water.

Implementation of these alternatives would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. However, the alternatives should not significantly disrupt regular base activities, with the possible exception of increased truck traffic at the security gates. Alternatives IP-2 and IP-3 would generate slightly more truck traffic than Alternatives IP-4 through IP-6 because of the off-site disposal of dewatering fluid. Extensive coordination with NSB-NLON management and personnel would be required for all alternatives.

Overall, the implementation time of Alternatives IP-2 to IP-6 would be short and it is estimated that Alternative IP-2 to IP-5 could be completed within 1 month or less and that Alternative IP-6 could be completed within 2 months or less.

6.1.3 Cost of Alternatives

The capital and O&M costs and NPW of the Inner Pier 1 alternatives are as follows. Costs have been rounded to the nearest $1,000 to reflect the preliminary nature of the estimates. Detailed cost estimates are provided in Appendix C.

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
IP-1	0	0	0
IP-2	1,463,000	0	1,463,000 (1 Year)
IP-3	1,498,000	0	1,498,000 (1 Year)
IP-4	1,622,000	0	1,622,000 (1 Year)
IP-5	1,660,000	0	1,660,000 (1 Year)
IP-6	2,524,000	0	2,524,000 (1 Year)

6.1.4 Conclusion

Alternative IP-1 (No Action) was only considered in this EE/CA to provide a basis for comparison and to meet the regulatory requirements of the NCP. The Navy believes that Alternatives IP-2 through IP-5 are equally well suited to meeting the RAO for Inner Pier 1. Furthermore, the Navy believes that Alternatives IP-2 through IP-5 are sufficiently similar, in both approach and cost, to defer final selection of an alternative until the more detailed design/work plan stage. Alternative IP-6 is not recommended for further consideration because it is characterized by significant technical, effectiveness and implementability uncertainties, serious worker safety concerns, and a significantly greater cost.

6.2 OUTER PIER 1 ALTERNATIVES

6.2.1 Effectiveness of Alternatives

6.2.1.1 Overall Protection of Human Health and the Environment

Alternative OP-1 would not be protective of human health and the environment. Alternatives OP-2 to OP-5 would be protective. The potential for human and ecological exposure to contaminated sediment within Outer Pier 1 would be eliminated through each of these four removal action alternatives. However, Alternatives OP-4 and OP-5 would be significantly more protective because they would permanently remove from the site all sediment with elevated concentrations of COCs, whereas Alternatives OP-2 and OP-3 would only remove a relatively small portion of that sediment and contain the rest.

6.2.1.2 Compliance with ARARs

Alternative OP-1 would not comply with the chemical-specific ARARs identified in Table 3-1. The location- and action-specific ARARs identified in Tables 3-2 and 3-3, respectively, do not apply to Alternative IP-1. The remaining four removal action alternatives would comply with the chemical-, location-, and action-specific ARARs identified in Tables 3-1, 3-2, and 3-3, respectively.

6.2.1.3 Long-term Effectiveness and Permanence

Alternative OP-1 would not be long-term effective and permanent. Alternatives OP-2 through OP-5 would be long-term effective and permanent. However, the degree of long-term effectiveness and permanence provided by Alternatives OP-4 and OP-5 would be significantly greater than that provided by Alternatives OP-2 and OP-3 because all contaminated sediment would be permanently and irreversibly removed from the site rather than merely contained on site. In addition, the capping component of Alternatives OP-2 and OP-3 would restrict potential future deepening of Outer Pier 1 whereas the dredging component of Alternatives OP-4 and OP-5 would actually promote such a possible future development.

6.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative OP-1 would not reduce toxicity, mobility, or volume of COCs through treatment. Concentrations of sediment COCs might be slightly reduced over the long-term as a result of natural attenuation processes, but this reduction would not be verified by monitoring. Although Alternatives OP-2 and OP-3 would achieve some reduction of toxicity, mobility, and volume through the removal and off-site disposal of a small fraction of the contaminated sediment, these two alternatives would primarily reduce the mobility of sediment COCs through capping. Alternative OP-4 and OP-5 would achieve a greater reduction in toxicity, mobility and volume through removal and off-site disposal of all sediment with

elevated concentrations of COCs. None of the alternatives would reduce toxicity, mobility or volume through treatment.

6.2.1.5 Short-term Effectiveness

There would be no short-term effectiveness impacts or concerns associated with Alternative OP-1 because no action would occur. There would be short-term risks associated with the implementation of Alternatives OP-2 through OP-5. Potential short-term risks to on-site workers, to the surrounding community, and to the environment would be low for Alternatives OP-2 through OP-5 and could be addressed through the use of standard PPE, engineering controls, and BMPs. There would also be short-term risks to the surrounding community from Alternatives OP-2 through OP-5 as a result of the off-site transportation of contaminated material. These risks would be lowest for Alternative OP-3 which would require the least off-site disposal and highest for Alternative OP-4 which would require the most off-site disposal. However, these risks would be adequately mitigated for all alternatives by the implementation of appropriate traffic controls and spill prevention measures.

6.2.2 Implementability of Alternatives

Alternative OP-1 would be easiest to implement because there would be nothing to implement. Alternatives OP-2 through OP-5 would all be implementable with various degrees of ease. The two main technologies common to these alternatives, dredging and off-site disposal, have been implemented successfully on several sediment projects for sites with conditions similar to Outer Pier 1. In addition, Alternatives OP-2 and OP-3 would require in-situ capping of sediment which is also a well-proven technology. Although the volume of sediment to be dredged for Alternatives OP-4 and OP-5 (6,673-in-situ cy) would be considerably greater than that for Alternatives OP-2 and OP-3 (416 in-situ cy), all four of these alternatives would use the same type of equipment and procedures.

Alternatives OP-2 and OP-3 would require long-term management including the development and implementation of LUCs and the performance of monitoring and five-year site reviews to verify the continued effectiveness of these alternatives.

There are commercial landfills and/or disposal facilities in the vicinity of NSB-NLON that would accept the dewatered sediment generated by each alternative, and the dewatering fluid generated by Alternatives OP-2 and OP-4. On-site treatment of dewatering fluid, as is proposed in Alternatives OP-3 and OP-5, is a well-proven remedial element; however, this would require at least some fairly specialized equipment such as a packaged or constructed treatment system. In addition, there may be greater administrative challenges and issues with public acceptance associated with the on-site treatment and discharge of

dewatering fluid. Although a permit would not be required, discharge of treated water to the Thames River would have to meet the substantive requirements of an NPDES permit.

As with the Inner Pier 1 alternatives, a significant implementability challenge common to the Outer Pier 1 alternatives would be the limited site access and generally limited amount of work space in the immediate site area. Each of the alternatives would require similar resources to stage, stabilize, and load the dewatered sediment and to store the equipment and material required for the removal action. Alternatives OP-3 and OP-5 would require additional space and resources for the treatment and discharge of dewatering fluid.

Implementation of these alternatives would add truck traffic into and out of the facility and on the relatively small roads that lead to the site. This increase in traffic would be minimal for Alternative OP-3, moderate for Alternative OP-2, significant for Alternative OP-5, and very significant for Alternative OP-4. However, with the possible exception of truck traffic through the security gates, none of the alternatives would pose a significant disruption to regular base activities. Extensive coordination with NSB-NLON facilities management and personnel would be required for all alternatives.

6.2.3 Cost of Alternatives

The capital and O&M costs and NPW of the Outer Pier 1 alternatives are as follows. Detailed cost estimates are provided in Appendix C.

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
OP-1	0	0	0
OP-2	476,000	295,000 (30-Year)	771,000 (30-Year)
OP-3	496,000	295,000 (30-Year)	791,000 (30-Year)
OP-4	2,459,000	0	2,459,000 (1-Year)
OP-5	2,710,000	0	2,710,000 (1-Year)

6.2.4 Conclusion

Alternative OP-1 (No Action) was only considered in this EE/CA to provide a basis for comparison and to meet the regulatory requirements of the NCP. The Navy believes that Alternatives OP-4 and OP-5 would be well suited to meeting the RAO for Outer Pier 1 and provide significantly greater protection and long-term effectiveness than Alternatives OP-2 and OP-3. Furthermore, the Navy believes that Alternatives OP-4 and OP-5 are sufficiently similar, in both approach and cost, to defer final selection of an alternative until the more detailed design/work plan stage.

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APPENDIX A

SUMMARY OF ANALYTICAL DATA

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		INNER PIER 1	INNER PIER 1	INNER PIER 1	INNER PIER 1	INNER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1
LOCATION		SBP-1	SBP-2	SBP-3	SBP-4	SBP-4	SBP-5	SBP-6	SBP-7
DEPTH (feet below sediment surface)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.75 - 1.0	0 - 0.5	0 - 0.5	0 - 0.5
SAMPLE ID		SBP-1-GRAB	SBP-2-GRAB	SBP-3-GRAB	SBP-4-GRAB	SBP-4-CORE	SBP-5-GRAB	SBP-6-GRAB	SBP-7-GRAB
SAMPLE DATE	ERM	19991028	19991028	19991028	19991028	19991028	19991028	19991028	19991028
Low Molecular Weight PAHs (ug/kg)									
2-METHYLNAPHTHALENE		310 U	14	60 U	8	38 U	10	10	69 U
ACENAPHTHENE		4000	64	630	36	74	17	16	300
ACENAPHTHYLENE		380	140	330	49	80	81	55	79
ANTHRACENE		22000	780	3700	290	2500	250	180	1300
FLUORENE		6100	120	860	43	120	29	24	230
NAPHTHALENE		310 U	29	93	13	38 U	38	21	69 U
PHENANTHRENE		65000	1300	13000	1100	2900	370	360	5700
LOW MOLECULAR WEIGHT PAHS	3160	97790	2447	18643	1539	5712	795	666	7678
High Molecular Weight PAHs (ug/kg)									
BENZO(A)ANTHRACENE		22000	1500	6200	910	3000	630	430	6300
BENZO(A)PYRENE		13000	1200	3900	940	2600	610	390	5300
CHRYSENE		24000	1800	8500	1300	4900	730	850	8200
DIBENZO(A,H)ANTHRACENE		1600	180	580	150	400	89	58	1000
FLUORANTHENE		68000	3600	18000	2200	6900	1200	990	12000
PYRENE		56000	2300	15000	2100	7000	810	790	9400
HIGH MOLECULAR WEIGHT PAHS	9600	184600	10580	52180	7600	24800	4069	3508	42200
Pesticides/PCBs (ug/kg)									
4,4'-DDD		16 U	2.2 U	2.4 U	8.1	15 U	1.5 U	1.5 U	17
4,4'-DDE		16 U	2.2 U	2.4 U	0.90 U	15 U	1.5 U	1.5 U	1.4 U
4,4'-DDT		16 U	2.2 U	2.4 U	0.90 U	15 U	1.5 U	1.5 U	1.4 U
TOTAL DDT	46.1	24	3.3	3.6	9	22.5	2.25	2.25	18.4
PCB-8		16 U	2.2 U	2.4 U	1 U	15 U	1.5 U	1.5 U	1.4 U
PCB-18		16 U	2.2 U	2.4 U	1 U	15 U	1.5 U	1.5 U	1.4 U
PCB-28		16 U	2.2 U	2.4 U	0.99 U	15 U	1.5 U	1.5 U	1.4 U
PCB-44		230	2.2 U	2.4 U	2.6 U	15 U	1.5 U	1.5 U	1.4 U
PCB-52		340	5.2	6.9	3.2 U	33	1.5 U	1.5 U	1.4 U
PCB-66		310	2.2 U	9.3	3 U	20	1.5 U	1.5 U	1.4 U
PCB-101		470	23	86	16	130	6.6	2.2	18
PCB-105		410	4.8	24	4.8	50	2.1	1.5 U	1.4 U
PCB-118		603	13	41	7.6 U	92	1.5 U	1.5 U	1.4 U
PCB-128		220	2.8	6	0.90 U	26	1.5 U	1.5 U	1.4 U
PCB-138		590	18	52	6.8	120	2.3	1.5 U	1.4 U
PCB-153		560	10	39	7.9	73	3.5	1.5 U	11
PCB-170		84	2.2 U	32	2.1	15 U	1.6	1.5 U	1.4 U
PCB-180		150	2.2 U	5.2	0.90 U	15 U	1.5 U	1.5 U	1.4 U
PCB-187		58	2.2 U	2.4 U	0.90 U	15	1.5 U	1.5 U	1.4 U
PCB-195		16 U	2.2 U	2.4 U	0.90 U	15 U	1.5 U	1.5 U	1.4 U
PCB-206		16 U	2.2 U	2.4 U	0.90 U	15 U	1.5 U	1.5 U	1.4 U
PCB-209		16 U	8	59	16	15 U	6	5	42
TOTAL PCB CONGENERS	180	8146	191.6	737.6	131.09	1253	62.2	38.4	163
ALPHA-CHLORDANE	6	16 U	2.2 U	2.4 U	0.90 U	15 U	1.5 U	1.5 U	1.4 U
Inorganics (mg/kg)									
ARSENIC	70	16	16	19	14	13	12	13	8.3
CADMIUM	9.6	0.94	0.88	0.64	0.34	0.39	0.5	0.42	0.91
CHROMIUM	370	130	71	100	58	64	61	58	39
COPPER	270	980	430	870	300	570	120	79	140
LEAD	218	620	290	350	330	350	110	86	100
NICKEL	51.6	130	53	89	56	120	25	22	14
SELENIUM	1.4	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	410	1900	690	970	1200	1900	220	160	250

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		INNER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	INNER PIER 1	INNER PIER 1	INNER PIER 1	OUTER PIER 1
LOCATION		P1-48	P1-50	P1-53	P1-55	P1-C2	P1-C2	P1-C2	P1-C3
DEPTH (feet below sediment surface)		0 - 0.17	0 - 0.17	0 - 0.17	0 - 0.17	0 - 2.0	2.0 - 4.0	4.0 - 5.0	0 - 2.58
SAMPLE ID		CAB-53	CAB-56	CAB-59	CAB-61	DAD-28-0002	DAD-28-0204	DAD-28-0405	DAD-29 -0003
SAMPLE DATE	ERM	20030617	20030617	20030617	20030617	20041011	20041011	20041011	20041011
Low Molecular Weight PAHs (ug/kg)									
2-METHYLNAPHTHALENE		106.03	61.97	38.23	34.64	52.19	26.55	19.18	52.41
ACENAPHTHENE		2616.45	220.72	29.04	22.79	121.15	64.73	213.17	44
ACENAPHTHYLENE		64.48	64.12	27.7	21.73	74.97	40.63	16.01	175.19
ANTHRACENE		9578.41 D	952.08	334.34	239.39	1116	942.73	601.02	522.33
FLUORENE		4166.58	355.3	67.58	48.49	192.65	123.57	83.74	105.31
NAPHTHALENE		124.23	101.48	63.81	55.34	92.79	63.33	61.61	90.5
PHENANTHRENE		41362.46 D	3258.73	596.82	400.77	2317.82	1786.14	993.49	737.51
LOW MOLECULAR WEIGHT PAHS	3160	58018.64	5014.4	1157.52	823.15	3967.57	3047.68	1988.22	1727.25
High Molecular Weight PAHs (ug/kg)									
BENZO(A)ANTHRACENE		26359.94 D	4769.39	1270.48	742.9	3865.98	2659.19	1101.7	2238.4
BENZO(A)PYRENE		17068.78 D	3420.77	1195.76	722.2	4329.69	2644.52	657.17	1864.69
CHRYSENE		24955.11 D	5702.15	1735.59	1025.88	4350.83	3141.59	1147.05	2585.02
DIBENZO(A,H)ANTHRACENE		2232.49 D	473.32	198.53	117.51	636.02	656.51	94.26	271.4
FLUORANTHENE		79548.58 D	8369.87	2169.83	1592.9	7427.24	4827.17	2618.69	2864.06
PYRENE		61819.33 D	10927.01	1918.82	1314.09	13809.73	9497.79	2623.55	5269.8
HIGH MOLECULAR WEIGHT PAHS	9600	211984.23	33662.51	8489.01	5515.48	34419.49	23426.77	8242.42	15093.37
Pesticides/PCBs (ug/kg)									
4,4'-DDD		78.16 D	8.39	4.91	3.33	118.8	5.04	1.08	7.49
4,4'-DDE		2.58	4.56	4.08	3.01	14.21 J	3.99	0.07 U	6.46
4,4'-DDT		3.53	59.65 D	3.7	0.98	3.72 J	0.19	0.06 U	1.83
TOTAL DDT	46.1	84.27	72.6	12.69	7.32	136.73	9.22	1.145	15.78
PCB-8		5.7	0.94 U	0.88 U	0.82 U	5.01 NJ	0.11 U	0.09 U	0.50 UJ
PCB-18		16.62	2.38	1.49	1.23	10.9 J	1.55	0.24	1.88
PCB-28		16.14	3.79	3.68	3.82	13.52 J	2.27	0.07 U	5.23
PCB-44		547.5 D	7.63	3.35	2.74	71.09	16.37	5.61	6.94
PCB-52		1206.27 D	11.14	3.15	2.56	157.97	35.99	23.43	9.7
PCB-66		245.52 D	4.86	4.14	3.83	37.53	6.61	2.29	9.18
PCB-101		2096.07 D	16.81	4.42	2.77	301.58	52.16	26.53	16.08
PCB-105		718.93 D	7.39	2.87	2.63	99.52	12.28	7.85	5.08
PCB-118		1591.08 D	14.41	4.83	3.41	244.42	44.71	21.23	11.65
PCB-128		0.37 U	0.57 U	0.53 U	0.50 U	53.2	7.02	4.67	3.35
PCB-138		1378.02 D	13.01	4.67	3.45	277.25	44.25	20.44	12.25
PCB-153		1364.96 D	15.17	6.02	4.28	268.18	44.33	21.78	14.19
PCB-170		138.25 D	3.2	1.87	1.33	11.31 J	3.32	1.88	2.15
PCB-180		176.34 D	3.76	3.28	2.67	44.77	5.47	2.92	4.33
PCB-187		78.91 D	2.52	2.16	1.66	9.32 J	2.89	1.6	3.4
PCB-195		6.97	2.74	1.61	1.3	NA	NA	NA	NA
PCB-206		4.62	6.2	2.04	2.11	1.67 J	0.81	0.95	1.63
PCB-209		3.21	16.03	3.13	3.16	1.08 J	0.82	0.46	2.65
TOTAL PCB CONGENERS	180	19190.59	263.59	106.83	87.22	3218.64	563.81	285.92	221.88
ALPHA-CHLORDANE	6	3.78 D	0.89	1.2	0.54 J	14.54 J	0.9	0.06 U	1.81
Inorganics (mg/kg)									
ARSENIC	70	15.5	15.2	14.4	14.6	8.66	6.08	6.23	11.6
CADMIUM	9.6	1.13	0.733	0.413	0.436	1.82	0.401	0.020 U	0.734
CHROMIUM	370	250 B	98.9 B	94.7 B	93.5 B	112	62	68.4	101
COPPER	270	1630	136	84	74	624	503	231 J	203
LEAD	218	1130	140	94	88	399 J	230 J	415 J	165 J
NICKEL	51.6	316	31.6	28.6	30.4	93.2 J	28.12 J	53.2	42.27 J
SELENIUM	1.4	2.23	0.969	0.827	0.868	1.03	0.252	0.444	0.828
ZINC	410	3180 B	300 B	167 B	149 B	1744 J	573 J	2300	368 J

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	INNER PIER 1	INNER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1
LOCATION		P1-C4	P1-C5	P1-C5	P1	P1-C1	P2	P3	P4
DEPTH (feet below sediment surface)		0 - 2.0	2.0 - 4.0	4.0 - 6.0	0 - 1.0	0 - 1.0	0 - 1.0	0 - 1.0	0 - 1.0
SAMPLE ID		DAD-30-0002	DAD-31-0204	DAD-31-0406	DAD-20	DAD-27	DAD-21	DAD-22	DAD-23
SAMPLE DATE	ERM	20041011	20041011	20041011	20041012	20041012	20041012	20041012	20041012
Low Molecular Weight PAHs (ug/kg)									
2-METHYLNAPHTHALENE		30.61	86.52	83.48	1122.56	40.17	49.47	46.58	41.23
ACENAPHTHENE		54.02	111.71	127.88	19264.51	396.85	39.46	33.72	40.27
ACENAPHTHYLENE		92.39	151.18	83.75	199.99	106.04	210.73	171.51	175.84
ANTHRACENE		380.23	447.88	474.39	106693.76	5628.99	3194.92	685.4	806
FLUORENE		86.29	201.38	224.3	30848.56	740.55	216.3	101.04	110.99
NAPHTHALENE		60.26	129.53	136.18	2397.65	79.33	72.91	72.96	81.95
PHENANTHRENE		822.69	985.24	877.34	305756.05	10987.62	1264.24	883.87	852.09
LOW MOLECULAR WEIGHT PAHS	3160	1526.49	2113.44	2007.32	466283.08	17979.55	5048.03	1995.08	2108.37
High Molecular Weight PAHs (ug/kg)									
BENZO(A)ANTHRACENE		1167.16	1325.63	908.78	143323.46	17586.11	4037.05	2013.88	2810.79
BENZO(A)PYRENE		1510.91	1374.96	828.52	88770.69	13934.4	2957.26	2069.45	2472.81
CHRYSENE		1635.16	1692.79	1047.95	136491.42	17333.41	5542.68	3113.26	4328.2
DIBENZO(A,H)ANTHRACENE		233.45	216.24	137.37	11119.14	1849.28	459.88	301.32	376.36
FLUORANTHENE		2422.82	3997.81	2604.65	499501.99	41012.43	5468.48	2965.52	4095.51
PYRENE		4123.02	3534.56	2652.9	375349.34	35029.09	6238.28	3273.45	4287.16 J
HIGH MOLECULAR WEIGHT PAHS	9600	11092.52	12141.99	8180.17	1254556.04	126744.72	24703.63	13736.88	18370.83
Pesticides/PCBs (ug/kg)									
4,4'-DDD		72.23	12.16	19.69	2.79 J	59.15	3.09	5.74	2.58 J
4,4'-DDE		17.96	11.04	13.05	10.21 J	0.11 U	3.98	5.83	3.69 J
4,4'-DDT		31.41	3.46	1.02	0.09 U	0.74 J	2.16	7.34	1.67 J
TOTAL DDT	46.1	121.6	26.66	33.76	13.045	59.945	9.23	18.91	7.94
PCB-8		15.52 U	7.04 NJ	2.5 NJ	0.13 U	2.12 NJ	0.23 U	0.49 U	0.21 U
PCB-18		11 U	10.81	10.89	0.09 U	2.96 J	0.95	0.35 U	1.16 J
PCB-28		11.62 U	18.93	18.86	7.72 J	4.49 J	2.96	2.95	3.45 J
PCB-44		20.68	17.16	17.67	334.21	119.58	3.58	3.84	4.13 J
PCB-52		16.81	22.02	23.21	772.95	285.58	3.98	4.29	5.12 J
PCB-66		20.54	23.61	20.97	163.84	60.06	5.88	5.3	5.65 J
PCB-101		33.7	31.94	24.13	1197.92	443.53	7.84	6.77	8.04 J
PCB-105		10.36 U	9.78	8.64	359.91	157.22	4.52	2.42	4.61 J
PCB-118		21.11	21.94	18.68	950.37	381.95	4.75	6.02	5.21 J
PCB-128		9.37 U	8.81	5.09	164.16	75.03	1.98	2.69	1.81 J
PCB-138		24.8	23.54	18	778.77	353.52	4.94	6.62	5.19 J
PCB-153		29.57	28.01	22.4	848.93	341.84	5.69	7.93	6.13 J
PCB-170		13.04 U	5.46	3.43	5.29 J	10.54 J	1	1.27	1.07 J
PCB-180		12.92 U	11.02	7.87	0.11 U	52.62	2.12	2.77	2.07 J
PCB-187		11.29 U	8.07	5.17	2.39 J	7.48 J	2.05	2.84	1.86 J
PCB-195		NA	NA	NA	NA	NA	NA	NA	NA
PCB-206		13.05 U	4.33	3.87	0.11 U	0.58 J	0.59	0.86	0.87 J
PCB-209		13.44 U	4.02	3.78	0.11 U	0.58 J	0.89	2.47	1.5 J
TOTAL PCB CONGENERS	180	458.03	514.98	432.32	11175.47	4601.36	109.67	120.92	117.95
ALPHA-CHLORDANE	6	21.2	4.45	2.5	4.61 J	2.16 J	0.66	1	0.71 J
Inorganics (mg/kg)									
ARSENIC	70	7.22	12.9	10.3	15.6	20.2	12.7	12.5	13.1
CADMIUM	9.6	0.746	1.88	1.84	0.020 U	0.598	0.6	0.501	0.563
CHROMIUM	370	73.8	123	111	406	254	92	78.9	89.6
COPPER	270	261	180	142	2590 J	2019 J	120	102	136 J
LEAD	218	157 J	165 J	147 J	2834 J	2435 J	111	90.8	123 J
NICKEL	51.6	30.70 J	56.0 J	35.60 J	1048	294	27.12	25.11	28.95
SELENIUM	1.4	0.541	0.885	0.794	3.2	1.82	0.624 J	0.630 J	0.722
ZINC	410	706 J	405 J	281 J	13740	3742	262	207	261

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1
LOCATION		P4R	P5	P6	TRP1-SD-001	TRP1-SD-001	TRP1-SD-001	TRP1-SD-002	TRP1-SD-002
DEPTH (feet below sediment surface)		0 - 1.0	0 - 1.0	0 - 1.0	0 - 1.0	2.0 - 4.0	4.0 - 6.0	0 - 1.0	2.0 - 4.0
SAMPLE ID		DAD-23-D	DAD-25	DAD-26	TRP1-SD-001B-0001	TRP1-SD-001A-0204	TRP1-SD-001A-0406	TRP1-SD-002B-0001	TRP1-SD-002A-0204
SAMPLE DATE	ERM	20041012	20041012	20041012	20081106	20081106	20081106	20081107	20081107
Low Molecular Weight PAHs (ug/kg)									
2-METHYLNAPHTHALENE		51.96	46.47	29.22 J	28	49	50	20	58
ACENAPHTHENE		49.76	45.12	66.65	40	92	77	31	110
ACENAPHTHYLENE		232.75	96	161.48 J	290	340	180	220	560
ANTHRACENE		1143.91 J	561.83	788.56 J	780	960	590	380	1900
FLUORENE		126.51	122.98	148.73	110	220	130	76	310
NAPHTHALENE		65.35	77.62	40.42 J	49	85	71	30	80
PHENANTHRENE		953.66 J	1218.22	1929.12	450	890	470	330	1700
LOW MOLECULAR WEIGHT PAHS	3160	2623.9	2168.24	3164.18	1747	2636	1568	1087	4718
High Molecular Weight PAHs (ug/kg)									
BENZO(A)ANTHRACENE		2888.87 J	2004.52	3292.41 J	2900	2100	1400	1200	4500
BENZO(A)PYRENE		2665.4 J	1243.82	1954.41 J	1900	1600	1100	1400	3100
CHRYSENE		4166.44 J	2080.32	3797.91	3800	2700	1700	1600	6100
DIBENZO(A,H)ANTHRACENE		363.71	160.14	220.56 J	220	230	140	160	370
FLUORANTHENE		5039.17 J	4301.28	7992.24	1400	4200	3800	1700	8900
PYRENE		3848.12 J	3961.3	6207.26 J	6000	5100	2800	2800	9400
HIGH MOLECULAR WEIGHT PAHS	9600	18971.71	13751.38	23464.79	16220	15930	10940	8860	32370
Pesticides/PCBs (ug/kg)									
4,4'-DDD		2.83	7.96	1.49 J	5.7 U	15 U	6.2 U	7.8 U	3.6 J
4,4'-DDE		4.41	4.14	3.02 J	5.7 U	39	7.5	7.8 U	5.8 J
4,4'-DDT		2.78	2.22	0.14 U	7 J	72 J	6.2 U	12 R	13 J
TOTAL DDT	46.1	10.02	14.32	4.58	12.7	118.5	13.7	7.8	22.4
PCB-8		0.58 U	0.67 NJ	0.19 U	4.8 J	6 J	1.8 U	4.1 J	3 J
PCB-18		1.14	1.62	0.14 U	7.3 J	3.2 J	1.8 U	4.4 J	6.8
PCB-28		3.22	2.83	2.7 J	15 J	6.7 J	1.8 U	9.5 J	14 J
PCB-44		3.64	5.21	3.21 J	6.6 J	6.8 J	1.8 U	2.7 R	7.5 J
PCB-52		2.88	9.29	3.11 J	16 J	19 J	6.6 J	2.7 R	17
PCB-66		5.71	4.46	3.34 J	14 J	2.2 U	1.8 U	2.4 U	2.1 U
PCB-101		5.29	16.02	3.96 J	16	12 J	3.3 R	6.2 J	17
PCB-105		1.44	3.85	1.43 J	4.1 J	7.9 J	3.2 J	2.4 U	5 J
PCB-118		3.51	9.75	2.78 J	13 J	13 J	6.3 J	8.6 J	12 J
PCB-128		2.01	2.87	2.02 J	2.2 U	2.2 U	1.8 U	2.4 U	2.1 U
PCB-138		3.78	10.37	3.02 J	13 J	12 J	7.3 J	6.5 J	13 J
PCB-153		4.75	13.27	3.75 J	13 J	14	9.4 J	6.1 J	13
PCB-170		1.09	1.8	1.14 J	2.2 U	5.6 J	3.5 R	2.4 U	3 R
PCB-180		1.94	3.72	1.8 J	6.5 J	7.5 J	3.3 R	2.7 J	8
PCB-187		2.37	2.39	2.42 J	2.2 R	3.1 J	1.9 J	2.5	3.6 J
PCB-195		NA	NA	NA	2.2 U	2.2 U	1.8 U	2.4 U	2.1 U
PCB-206		0.85	1.74	0.54 J	4.4	7.8	15	2.4 U	3.9 J
PCB-209		2.18	2.37	1.17 J	7.5 J	14 J	18	2.4 U	3.1 J
TOTAL PCB CONGENERS	180	94.18	186.46	75.11	289	283.8	148	118	260.1
ALPHA-CHLORDANE	6	0.83	1.11	0.96 J	2.9 U	7.6 U	3.2 U	4 U	1.1 J
Inorganics (mg/kg)									
ARSENIC	70	14.8	15.3	14.1	12.10 J	9.50 J	8.40 J	16.40 J	13.00 J
CADMIUM	9.6	0.532	0.41	0.439	0.820 J	1.10 J	1.50 J	0.600 J	0.850 J
CHROMIUM	370	84.6	88.6	76.7	78.8 J	88.8 J	98.4 J	68.7 J	84.6 J
COPPER	270	82.9	76.5	95.2 J	260 J	182 J	142 J	205 J	519 J
LEAD	218	83.8	78.9	295 J	204 J	157 J	210 J	144 J	298 J
NICKEL	51.6	25.46	26.48	26.03	51.6 J	27.60 J	18.90 J	31.60 J	124 J
SELENIUM	1.4	0.727 J	0.805 J	0.833	5.50 U	5.10 U	4.80 U	5.3	6.8
ZINC	410	199	183	218	457 J	283 J	208 J	261 J	1130 J

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1
LOCATION		TRP1-SD-002	TRP1-SD-003	TRP1-SD-003	TRP1-SD-004	TRP1-SD-004	TRP1-SD-004	TRP1-SD-005	TRP1-SD-005
DEPTH (feet below sediment surface)		4.0 - 6.0	0 - 1.0	2.0 - 4.0	0 - 1.0	2.0 - 4.0	4.0 - 6.0	0 - 1.0	2.0 - 4.0
SAMPLE ID		TRP1-SD-002A-0406	TRP1-SD-003B-0001	TRP1-SD-003A-0204	TRP1-SD-004B-0001	TRP1-SD-004A-0204	TRP1-SD-004A-0406	TRP1-SD-005B-0001	TRP1-SD-005A-0204
SAMPLE DATE	ERM	20081107	20081107	20081107	20081107	20081107	20081107	20081107	20081107
Low Molecular Weight PAHs (ug/kg)									
2-METHYLNAPHTHALENE		150	23	24	15	53	65	19	45
ACENAPHTHENE		660	32	20	100	790	450	110	140
ACENAPHTHYLENE		360	220	120	180	150	140	170	340
ANTHRACENE		1500	430	150	390	480	620	620	1300
FLUORENE		600 J	78	45	85	690	520 J	140	300
NAPHTHALENE		250	36	31	24	55	74	21	320
PHENANTHRENE		1900	450	210	420	1700	2000	630	1400
LOW MOLECULAR WEIGHT PAHS	3160	5420	1269	600	1214	3918	3869	1710	3845
High Molecular Weight PAHs (ug/kg)									
BENZO(A)ANTHRACENE		2400	1000	350	1700	1100	1100	1700	4700
BENZO(A)PYRENE		1900	1300	390	1100	620	720	1200	2300
CHRYSENE		3000	1500	430	1700	1200	1200	1900	4400
DIBENZO(A,H)ANTHRACENE		220	170	68	130	110	97	150	280
FLUORANTHENE		8500	1700	600	3100	3400	4100	4100	16000
PYRENE		6400	2600	1400	3600	3200	2800	3000	11000
HIGH MOLECULAR WEIGHT PAHS	9600	22420	8270	3238	11330	9630	10017	12050	38680
Pesticides/PCBs (ug/kg)									
4,4'-DDD		14 U	4.5 U	3.8 J	1.8 U	14 UJ	65 J	1.6 U	6.9 U
4,4'-DDE		14 J	4.5 U	3.8 J	3.6 J	14 UJ	12 U	1.6 U	6.9 U
4,4'-DDT		29 J	7.2 R	5.8 R	2.8 R	18 J	32 R	1.6 U	6.9 U
TOTAL DDT	46.1	50	4.5	7.6	4.5	32	71	2.4	10.35
PCB-8		7 J	2.7 J	1.5 U	2.6 U	3.7 R	3.5 J	5.9 J	9.5 J
PCB-18		18 J	5.6 J	1.5 U	2.6 U	7.4 J	1.7 U	6.9	9.5 R
PCB-28		25 J	16 J	1.7 J	2.6 UJ	13 J	1.7 U	2.5 U	14 J
PCB-44		22	9.9	1.7	2.6 U	9.1 J	1.7 U	3.9 J	9.6 J
PCB-52		35	15 J	4.9	2.6 UJ	19 J	3.6	2.5 U	13 J
PCB-66		26 J	9.2 J	1.5 U	2.6 U	9.3 R	1.7 U	2.5 U	2.1 U
PCB-101		48	16	5.6	2.6 U	28	2.8 R	3.3 R	8.9 J
PCB-105		16 J	4.1 J	2.1 J	2.6 U	8.2 J	3 J	2.5 U	2.1 U
PCB-118		30 J	9.9 J	3.8 J	8.3 J	16 J	5.2 J	5.8 J	5.8 J
PCB-128		4.7 R	2.2 U	1.5 U	2.6 U	2.3 R	1.7 U	2.5 U	2.1 U
PCB-138		38 J	12 J	5.2 J	2.6 U	20 J	6.2 J	3.8	6
PCB-153		36	12	5.2 J	2.6 U	21 J	8.1 J	3.3 J	6
PCB-170		12 J	3.7 R	5 J	2.6 U	5.6 R	2.6 R	2.5 U	2.1 U
PCB-180		21 J	3 J	3.5 J	2.6 U	14 J	2.7 J	2.5 U	4.9 J
PCB-187		5.8 J	2.2 U	1.5 U	2.6 UJ	3.6 J	1.7 U	2.5 U	2.1 U
PCB-195		2.4	2.2 U	1.5 U	2.6 U	2 U	1.7 U	2.5 U	2.1 U
PCB-206		9.4 J	3.8 R	5.8 J	2.6 UJ	6.2 J	12 J	2.7	2.7
PCB-209		2.7 R	5.6 J	6.7 J	2.6 UJ	2 U	12 J	2.5 U	2.1 U
TOTAL PCB CONGENERS	180	703.2	248.6	111.4	60.8	335	124.5	89.6	175.5
ALPHA-CHLORDANE	6	7.2 U	2.3 U	0.54 U	0.91 U	7 U	6.1 U	0.84 U	3.6 U
Inorganics (mg/kg)									
ARSENIC	70	9.90 J	15.00 J	5.10 J	13.80 J	12	7.9	8.3	10.2
CADMIUM	9.6	3.30 J	0.650 J	0.730 J	0.650 J	2.30 J	1.30 J	0.380 J	0.470 J
CHROMIUM	370	110 J	62.2 J	61.7 J	71.0 J	121 J	96.8 J	40.10 J	42.60 J
COPPER	270	197 J	106 J	62.1 J	130 J	203 J	207 J	64.9 J	78.7 J
LEAD	218	501 J	97.9 J	95.4 J	119 J	260 J	192 J	79.8 J	62.1 J
NICKEL	51.6	32.50 J	26.60 J	12.70 J	27.50 J	28.00 J	17.70 J	16.40 J	18.90 J
SELENIUM	1.4	5	4.7	2.4	6.5	5.2	3.7	1.8	1.5
ZINC	410	601 J	212 J	221 J	230 J	418 J	324 J	108 J	111 J

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1
LOCATION		TRP1-SD-005	TRP1-SD-006	TRP1-SD-006	TRP1-SD-007	TRP1-SD-007	TRP1-SD-007	TRP1-SD-008	TRP1-SD-008
DEPTH (feet below sediment surface)		4.0 - 6.0	0 - 1.0	2.0 - 3.0	0 - 1.0	2.0 - 4.0	4.0 - 6.0	0 - 1.0	2.0 - 4.0
SAMPLE ID		TRP1-SD-005A-0406	TRP1-SD-006B-0001	TRP1-SD-006A-0203	TRP1-SD-007B-0001	TRP1-SD-007A-0204	TRP1-SD-007A-0406	TRP1-SD-008B-0001	TRP1-SD-008A-0204
SAMPLE DATE	ERM	20081107	20081107	20081107	20081106	20081106	20081106	20081105	20081105
Low Molecular Weight PAHs (ug/kg)									
2-METHYLNAPHTHALENE		270	51	140	60	20	51	31	78
ACENAPHTHENE		620	290	1500	490	30	2100	150	4900
ACENAPHTHYLENE		560	120	250	760	170	230	440	490
ANTHRACENE		3000	260	1400	3100	330	2300	1200	2700
FLUORENE		450	180	1400	800	59	1500	240	2300
NAPHTHALENE		2700	120	210	51	22	59	34	120
PHENANTHRENE		2200	760	5700	2400	430	6800	1200	4600
LOW MOLECULAR WEIGHT PAHS	3160	9800	1781	10600	7661	1061	13040	3295	15188
High Molecular Weight PAHs (ug/kg)									
BENZO(A)ANTHRACENE		8700	660	3100	12000	960	3800	3300	5100
BENZO(A)PYRENE		4400	470	1200	5300	980	2700	2400	2700
CHRYSENE		8300	790	3300	13000	1200	4700	4100	6100
DIBENZO(A,H)ANTHRACENE		450	76	140	710 J	170	640	370	450 J
FLUORANTHENE		23000	2600	15000	52000	1500	14000	7800	21000
PYRENE		19000	2000	8600	36000	2800	12000	6100	16000
HIGH MOLECULAR WEIGHT PAHS	9600	63850	6596	31340	119010	7610	37840	24070	51350
Pesticides/PCBs (ug/kg)									
4,4'-DDD		6.7 U	1.7 U	7.4 U	6.5 UJ	4.8 U	18 J	2.1 U	1.8 U
4,4'-DDE		10 J	1.2 J	7.4 U	19	12	27 J	2.1 U	3 J
4,4'-DDT		20	1.7 UJ	7.4 U	59 J	22 J	36 J	2.1 UJ	12 J
TOTAL DDT	46.1	33.35	2.9	11.1	81.25	36.4	81	3.15	15.9
PCB-8		2 U	3.9 R	2.3 U	2.7 R	2.3	5.6 J	3 U	14 R
PCB-18		2 U	31	3	15 J	3.9 J	11	7.2	23 R
PCB-28		2 UJ	23 J	4.1 R	3.3 R	10 J	17 J	3.6 R	17 J
PCB-44		2 U	8.7 J	2.3 U	6.1 J	9.2	19	7.7 J	34
PCB-52		2 UJ	9.9 J	2.3 U	7.1 J	18 J	34	5.8 R	79
PCB-66		2 U	4.8 R	3 R	2.5 U	1.7 U	1.8 U	13	2.7 U
PCB-101		2 U	7.6 J	4.2 R	8.1	24 J	47	9.1 J	100 J
PCB-105		2 U	2.6 J	2.3 U	4.5 J	6.9 J	17 J	3 U	39 J
PCB-118		4.9 J	8.3 J	5 J	18 J	15 J	75 J	19 J	140 J
PCB-128		2 U	2.5 U	2.3 U	2.5 U	2.6 J	5.4 J	3 U	13 J
PCB-138		2 U	5.3 J	5.6	10	17 J	39 J	8.2	79 J
PCB-153		2 U	6.3 J	3.6 J	7.5 J	16 J	33 J	7.7	63 J
PCB-170		2 U	3.6 J	2.3 U	4.8	2.4 J	11 J	3 U	10 J
PCB-180		2 U	2.8 J	2.3 J	4.4 J	4.6 J	13 J	3.6 J	14 J
PCB-187		2 UJ	2.5 U	2.3 U	2.5 UJ	1.7 UJ	3.5 J	3 UJ	3.4 R
PCB-195		2 U	2.5 U	2.3 U	2.5 U	1.7 U	1.9 J	3 U	2.7 U
PCB-206		2 UJ	3 J	2.3 U	2.5 U	1.8 J	5 J	4.7 J	2.7 U
PCB-209		2 UJ	2.5 U	2.3 U	45 J	1.7 U	1.8 U	3 U	2.7 U
TOTAL PCB CONGENERS	180	43.8	234.2	62	273.5	274.2	678.4	181.4	1186.8
ALPHA-CHLORDANE	6	3.5 U	0.88 U	3.8 U	3.4 U	2.5 U	2.5 U	1.1 U	0.91 U
Inorganics (mg/kg)									
ARSENIC	70	8.7	12.90 J	12.80 J	15.60 J	18.40 J	23.30 J	15.40 J	13.40 J
CADMIUM	9.6	1.30 J	0.480 J	1.00 J	0.540 J	1.10 J	3.00 J	0.450 J	0.830 J
CHROMIUM	370	113 J	62.7 J	60.4 J	76.3 J	167 J	142 J	66.9 J	130 J
COPPER	270	201 J	80.6 J	463 J	791 J	1600 J	8620 J	226 J	1010 J
LEAD	218	253 J	88.4 J	80.8 J	192 J	1170 J	661 J	148 J	690 J
NICKEL	51.6	51.3 J	25.80 J	28.70 J	40.3	482	188	28.4	278
SELENIUM	1.4	3.5	5.90 U	4.50 U	7.6	14.6	9.8	6.9	8.6
ZINC	410	669 J	156 J	341 J	410 J	4660 J	2640 J	257 J	2470 J

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX A
SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1	OUTER PIER 1
LOCATION		TRP1-SD-008	TRP1-SD-009	TRP1-SD-009	TRP1-SD-009	TRP1-SD-010	TRP1-SD-010	TRP1-SD-010
DEPTH (feet below sediment surface)		4.0 - 6.0	0 - 1.0	2.0 - 4.0	4.0 - 6.0	0 - 1.0	2.0 - 4.0	4.0 - 6.0
SAMPLE ID		TRP1-SD-008A-0406	TRP1-SD-009B-0001	TRP1-SD-009A-0204	TRP1-SD-009A-0406	TRP1-SD-010B-0001	TRP1-SD-010A-0204	TRP1-SD-010A-0406
SAMPLE DATE	ERM	20081105	20081105	20081105	20081105	20081105	20081105	20081105
Low Molecular Weight PAHs (ug/kg)								
2-METHYLNAPHTHALENE		35	16	21	32	21	19	49
ACENAPHTHENE		250	32	600	290	31	82	220
ACENAPHTHYLENE		260	150	150	180	180	140	120
ANTHRACENE		620	480	660	750	410	840	770
FLUORENE		200	77	280	340	71	170	320
NAPHTHALENE		94	21	24	41	16	19	130
PHENANTHRENE		1100	520	650	2200	670	2800	2300
LOW MOLECULAR WEIGHT PAHS	3160	2559	1296	2385	3833	1399	4070	3909
High Molecular Weight PAHs (ug/kg)								
BENZO(A)ANTHRACENE		2000	1600	2100	1700	950	1600	2100
BENZO(A)PYRENE		1700	1100	1100	1200	930	1200	1600
CHRYSENE		2400	1800	2100	2000	1300	1700	2400
DIBENZO(A,H)ANTHRACENE		280	160	150	180	180	190	240
FLUORANTHENE		4500	1800	6400	4900	1800	5300	7000
PYRENE		4700	3200	4200	3900	3200	4700	5900
HIGH MOLECULAR WEIGHT PAHS	9600	15580	9660	16050	13880	8360	14690	19240
Pesticides/PCBs (ug/kg)								
4,4'-DDD		7.7 J	8.2 UJ	3.4 UJ	3 U	8.5 UJ	2 U	6.2 U
4,4'-DDE		6.6 U	8.4 J	3.4 U	3 U	8.5 U	5 R	35 R
4,4'-DDT		21 J	27 J	3.4 UJ	3 UJ	12 R	9.3 J	33 J
TOTAL DDT	46.1	32	39.5	5.1	4.5	8.5	10.3	36.1
PCB-8		8.6 J	2.5 U	4.9 J	4.6 J	2.8 R	4.5 J	6.7 J
PCB-18		8.2	9.3	13 J	6.4	3.5	5.2	12
PCB-28		18	18	18	17	3.1 R	8.3	18
PCB-44		13	14	18	9.2 J	13 J	8.1	20
PCB-52		30 J	27	15 J	23 J	5.2 R	19	46
PCB-66		2.5 U	2.5 U	7.2 J	2.2 U	13	1.5 U	2.9 R
PCB-101		43 J	38	10 J	41	9.2 J	31	82
PCB-105		12 J	11 J	3.3 J	18 J	2.8	9.5 J	21 J
PCB-118		57 J	48 J	17 J	76 J	15 J	47 J	93 J
PCB-128		3.8 J	3.7 J	2.5 U	8.3 J	2.5 U	2.9 J	6.8 J
PCB-138		28 J	26 J	8.8 J	47 J	12	20 J	47 J
PCB-153		28	25	8.6	38	5.5	19	40 J
PCB-170		4.1 J	3.9 J	2.7 R	7.4 J	2.5 U	5.1 J	13 J
PCB-180		8.6	7 J	3.8 J	9.1 J	2.5 J	5.5 J	12 J
PCB-187		2.7 R	2.5 UJ	2.5 UJ	2.2 UJ	2.5 UJ	1.8 R	3.6 R
PCB-195		2.5 U	2.5 U	2.5 U	2.2 U	2.5 U	1.5 U	1.9 U
PCB-206		3.5 J	3.8 J	3.2 J	2.7 J	2.5 U	2.2	6.3
PCB-209		2.5 U	2.5 U	2.5 U	2.2 U	2.5 U	1.5 U	2.4 R
TOTAL PCB CONGENERS	180	539.1	481.9	271.6	624.2	168	379.1	849.5
ALPHA-CHLORDANE	6	3.4 U	4.2 U	1.8 U	1.6 U	4.4 U	1 U	3.2 U
Inorganics (mg/kg)								
ARSENIC	70	12.90 J	10.30 J	15.80 J	12.30 J	12.40 J	12.00 J	14.50 J
CADMIUM	9.6	0.890 J	1.00 J	0.700 J	1.20 J	0.470 J	1.50 J	1.90 J
CHROMIUM	370	93.7 J	84.3 J	82.9 J	95.5 J	56.8 J	101 J	88.9 J
COPPER	270	576 J	190 J	181 J	255 J	201 J	670 J	625 J
LEAD	218	416 J	228 J	139 J	228 J	163 J	665 J	327 J
NICKEL	51.6	127	41.5	38.8	57.1	30.9	146	67.9
SELENIUM	1.4	7.9	4.7	6.3	6.1	4.3	5.6	6
ZINC	410	1200 J	387 J	249 J	433 J	356 J	1860 J	975 J

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B

CALCULATIONS

APPENDIX B.1

ERM-Q CALCULATIONS

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	INNER PIER 1 SBP-1 SBP-1-GRAB 19991028		INNER PIER 1 SBP-2 SBP-2-GRAB 19991028		INNER PIER 1 SBP-3 SBP-3-GRAB 19991028		INNER PIER 1 SBP-4 SBP-4-CORE 19991028	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	16	0.229	16	0.229	19	0.271	13	0.186
CADMIUM (mg/kg)	9.6	0.94	0.098	0.88	0.092	0.64	0.067	0.39	0.041
CHROMIUM (mg/kg)	370	130	0.351	71	0.192	100	0.270	64	0.173
COPPER (mg/kg)	270	980	3.630	430	1.593	870	3.222	570	2.111
LEAD (mg/kg)	218	620	2.844	290	1.330	350	1.606	350	1.606
NICKEL (mg/kg)	51.6	130	2.519	53	1.027	89	1.725	120	2.326
SELENIUM (mg/kg)	1.4	NA	NA	NA	NA	NA	NA	NA	NA
ZINC (mg/kg)	410	1900	4.634	690	1.683	970	2.366	1900	4.634
TOTAL PCB CONGENERS (ug/kg)	180	8146	45.256	191.6	1.064	737.6	4.098	1253	6.961
ALPHA-CHLORDANE (ug/kg)	6	16 U	1.333	2.2 U	0.183	2.4 U	0.200	15 U	1.250
TOTAL DDT (ug/kg)	46.1	24	0.521	3.3	0.072	3.6	0.078	22.5	0.488
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	184600	19.229	10580	1.102	52180	5.435	24800	2.583
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	97790	30.946	2447	0.774	18643	5.900	5712	1.808
ERM-Q			9.299		0.778		2.103		2.014

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		INNER PIER 1		OUTER PIER 1		OUTER PIER 1		OUTER PIER 1	
LOCATION		SBP-4		SBP-5		SBP-6		SBP-7	
SAMPLE ID		SBP-4-GRAB		SBP-5-GRAB		SBP-6-GRAB		SBP-7-GRAB	
SAMPLE DATE	ERM	19991028		19991028		19991028		19991028	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	14	0.200	12	0.171	13	0.186	8.3	0.119
CADMIUM (mg/kg)	9.6	0.34	0.035	0.5	0.052	0.42	0.044	0.91	0.095
CHROMIUM (mg/kg)	370	58	0.157	61	0.165	58	0.157	39	0.105
COPPER (mg/kg)	270	300	1.111	120	0.444	79	0.293	140	0.519
LEAD (mg/kg)	218	330	1.514	110	0.505	86	0.394	100	0.459
NICKEL (mg/kg)	51.6	56	1.085	25	0.484	22	0.426	14	0.271
SELENIUM (mg/kg)	1.4	NA	NA	NA	NA	NA	NA	NA	NA
ZINC (mg/kg)	410	1200	2.927	220	0.537	160	0.390	250	0.610
TOTAL PCB CONGENERS (ug/kg)	180	131.09	0.728	62.2	0.346	38.4	0.213	163	0.906
ALPHA-CHLORDANE (ug/kg)	6	0.90 U	0.075	1.5 U	0.125	1.5 U	0.125	1.4 U	0.117
TOTAL DDT (ug/kg)	46.1	9	0.195	2.25	0.049	2.25	0.049	18.4	0.399
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	7600	0.792	4069	0.424	3508	0.365	42200	4.396
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	1539	0.487	795	0.252	666	0.211	7678	2.430
ERM-Q			0.776		0.296		0.238		0.869

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC		INNER PIER 1		OUTER PIER 1		OUTER PIER 1		OUTER PIER 1	
LOCATION		P1-48		P1-50		P1-53		P1-55	
SAMPLE ID		CAB-53		CAB-56		CAB-59		CAB-61	
SAMPLE DATE	ERM	20030617		20030617		20030617		20030617	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	15.5	0.221	15.2	0.217	14.4	0.206	14.6	0.209
CADMIUM (mg/kg)	9.6	1.13	0.118	0.733	0.076	0.413	0.043	0.436	0.045
CHROMIUM (mg/kg)	370	250 B	0.676	98.9 B	0.267	94.7 B	0.256	93.5 B	0.253
COPPER (mg/kg)	270	1630	6.037	136	0.504	84	0.311	74	0.274
LEAD (mg/kg)	218	1130	5.183	140	0.642	94	0.431	88	0.404
NICKEL (mg/kg)	51.6	316	6.124	31.6	0.612	28.6	0.554	30.4	0.589
SELENIUM (mg/kg)	1.4	2.23	1.593	0.969	0.692	0.827	0.591	0.868	0.620
ZINC (mg/kg)	410	3180 B	7.756	300 B	0.732	167 B	0.407	149 B	0.363
TOTAL PCB CONGENERS (ug/kg)	180	19190.59	106.614	263.59	1.464	106.83	0.594	87.22	0.485
ALPHA-CHLORDANE (ug/kg)	6	3.78 D	0.630	0.89	0.148	1.2	0.200	0.54 J	0.090
TOTAL DDT (ug/kg)	46.1	84.27	1.828	72.6	1.575	12.69	0.275	7.32	0.159
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	211984.23	22.082	33662.51	3.507	8489.01	0.884	5515.48	0.575
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	58018.64	18.360	5014.4	1.587	1157.52	0.366	823.15	0.260
ERM-Q			13.633		0.925		0.394		0.333

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	INNER PIER 1 P1-C2 DAD-28-0002 20041011		INNER PIER 1 P1-C2 DAD-28-0204 20041011		INNER PIER 1 P1-C2 DAD-28-0405 20041011		OUTER PIER 1 P1-C3 DAD-29 -0003 20041011	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	8.66	0.124	6.08	0.087	6.23	0.089	11.6	0.166
CADMIUM (mg/kg)	9.6	1.82	0.190	0.401	0.042	0.020 U	0.001	0.734	0.076
CHROMIUM (mg/kg)	370	112	0.303	62	0.168	68.4	0.185	101	0.273
COPPER (mg/kg)	270	624	2.311	503	1.863	231 J	0.856	203	0.752
LEAD (mg/kg)	218	399 J	1.830	230 J	1.055	415 J	1.904	165 J	0.757
NICKEL (mg/kg)	51.6	93.2 J	1.806	28.12 J	0.545	53.2	1.031	42.27 J	0.819
SELENIUM (mg/kg)	1.4	1.03	0.736	0.252	0.180	0.444	0.317	0.828	0.591
ZINC (mg/kg)	410	1744 J	4.254	573 J	1.398	2300	5.610	368 J	0.898
TOTAL PCB CONGENERS (ug/kg)	180	3216.64	17.881	561.81	3.132	283.92	1.588	219.88	1.233
ALPHA-CHLORDANE (ug/kg)	6	14.54 J	2.423	0.9	0.150	0.06 U	0.005	1.81	0.302
TOTAL DDT (ug/kg)	46.1	136.73	2.966	9.22	0.200	1.145	0.025	15.78	0.342
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	34419.49	3.585	23426.77	2.440	8242.42	0.859	15093.37	1.572
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	3967.57	1.256	3047.68	0.964	1988.22	0.629	1727.25	0.547
ERM-Q			3.050		0.939		1.007		0.640

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 P1-C4 DAD-30-0002 20041011		OUTER PIER 1 P1-C5 DAD-31-0204 20041011		OUTER PIER 1 P1-C5 DAD-31-0406 20041011		INNER PIER 1 P1 DAD-20 20041012	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	7.22	0.103	12.9	0.184	10.3	0.147	15.6	0.223
CADMIUM (mg/kg)	9.6	0.746	0.078	1.88	0.196	1.84	0.192	0.020 U	0.001
CHROMIUM (mg/kg)	370	73.8	0.199	123	0.332	111	0.300	406	1.097
COPPER (mg/kg)	270	261	0.967	180	0.667	142	0.526	2590 J	9.593
LEAD (mg/kg)	218	157 J	0.720	165 J	0.757	147 J	0.674	2834 J	13.000
NICKEL (mg/kg)	51.6	30.70 J	0.595	56.0 J	1.085	35.60 J	0.690	1048	20.310
SELENIUM (mg/kg)	1.4	0.541	0.386	0.885	0.632	0.794	0.567	3.2	2.286
ZINC (mg/kg)	410	706 J	1.722	405 J	0.988	281 J	0.685	13740	33.512
TOTAL PCB CONGENERS (ug/kg)	180	456.03	2.545	512.98	2.861	430.32	2.402	11173.47	62.086
ALPHA-CHLORDANE (ug/kg)	6	21.2	3.533	4.45	0.742	2.5	0.417	4.61 J	0.768
TOTAL DDT (ug/kg)	46.1	121.6	2.638	26.66	0.578	33.76	0.732	13.045	0.283
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	11092.52	1.155	12141.99	1.265	8180.17	0.852	1254556.04	130.683
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	1526.49	0.483	2113.44	0.669	2007.32	0.635	466283.08	147.558
ERM-Q			1.163		0.842		0.678		32.415

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC	ERM	INNER PIER 1		OUTER PIER 1		OUTER PIER 1		OUTER PIER 1	
LOCATION		P1-C1		P2		P3		P4	
SAMPLE ID		DAD-27		DAD-21		DAD-22		DAD-23	
SAMPLE DATE		20041012		20041012		20041012		20041012	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	20.2	0.289	12.7	0.181	12.5	0.179	13.1	0.187
CADMIUM (mg/kg)	9.6	0.598	0.062	0.6	0.063	0.501	0.052	0.563	0.059
CHROMIUM (mg/kg)	370	254	0.686	92	0.249	78.9	0.213	89.6	0.242
COPPER (mg/kg)	270	2019 J	7.478	120	0.444	102	0.378	136 J	0.504
LEAD (mg/kg)	218	2435 J	11.170	111	0.509	90.8	0.417	123 J	0.564
NICKEL (mg/kg)	51.6	294	5.698	27.12	0.526	25.11	0.487	28.95	0.561
SELENIUM (mg/kg)	1.4	1.82	1.300	0.624 J	0.446	0.630 J	0.450	0.722	0.516
ZINC (mg/kg)	410	3742	9.127	262	0.639	207	0.505	261	0.637
TOTAL PCB CONGENERS (ug/kg)	180	4599.36	25.563	107.67	0.609	118.92	0.672	115.95	0.655
ALPHA-CHLORDANE (ug/kg)	6	2.16 J	0.360	0.66	0.110	1	0.167	0.71 J	0.118
TOTAL DDT (ug/kg)	46.1	59.945	1.300	9.23	0.200	18.91	0.410	7.94	0.172
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	126744.72	13.203	24703.63	2.573	13736.88	1.431	18370.83	1.914
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	17979.55	5.690	5048.03	1.597	1995.08	0.631	2108.37	0.667
ERM-Q			6.301		0.626		0.460		0.522

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 P4R DAD-23-D 20041012		OUTER PIER 1 P5 DAD-25 20041012		OUTER PIER 1 P6 DAD-26 20041012		OUTER PIER 1 TRP1-SD-001 TRP1-SD-001B-0001 20081106	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	14.8	0.211	15.3	0.219	14.1	0.201	12.10 J	0.173
CADMIUM (mg/kg)	9.6	0.532	0.055	0.41	0.043	0.439	0.046	0.820 J	0.085
CHROMIUM (mg/kg)	370	84.6	0.229	88.6	0.239	76.7	0.207	78.8 J	0.213
COPPER (mg/kg)	270	82.9	0.307	76.5	0.283	95.2 J	0.353	260 J	0.963
LEAD (mg/kg)	218	83.8	0.384	78.9	0.362	295 J	1.353	204 J	0.936
NICKEL (mg/kg)	51.6	25.46	0.493	26.48	0.513	26.03	0.504	51.6 J	1.000
SELENIUM (mg/kg)	1.4	0.727 J	0.519	0.805 J	0.575	0.833	0.595	5.50 U	1.964
ZINC (mg/kg)	410	199	0.485	183	0.446	218	0.532	457 J	1.115
TOTAL PCB CONGENERS (ug/kg)	180	92.18	0.523	184.46	1.036	73.11	0.417	289	1.606
ALPHA-CHLORDANE (ug/kg)	6	0.83	0.138	1.11	0.185	0.96 J	0.160	2.9 U	0.242
TOTAL DDT (ug/kg)	46.1	10.02	0.217	14.32	0.311	4.58	0.099	12.7	0.275
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	18971.71	1.976	13751.38	1.432	23464.79	2.444	16220	1.690
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	2623.9	0.830	2168.24	0.686	3164.18	1.001	1747	0.553
ERM-Q			0.489		0.486		0.608		0.832

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-001 TRP1-SD-001A-0204 20081106		OUTER PIER 1 TRP1-SD-001 TRP1-SD-001A-0406 20081106		OUTER PIER 1 TRP1-SD-002 TRP1-SD-002B-0001 20081107		OUTER PIER 1 TRP1-SD-002 TRP1-SD-002A-0204 20081107	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	9.50 J	0.136	8.40 J	0.120	16.40 J	0.234	13.00 J	0.186
CADMIUM (mg/kg)	9.6	1.10 J	0.115	1.50 J	0.156	0.600 J	0.063	0.850 J	0.089
CHROMIUM (mg/kg)	370	88.8 J	0.240	98.4 J	0.266	68.7 J	0.186	84.6 J	0.229
COPPER (mg/kg)	270	182 J	0.674	142 J	0.526	205 J	0.759	519 J	1.922
LEAD (mg/kg)	218	157 J	0.720	210 J	0.963	144 J	0.661	298 J	1.367
NICKEL (mg/kg)	51.6	27.60 J	0.535	18.90 J	0.366	31.60 J	0.612	124 J	2.403
SELENIUM (mg/kg)	1.4	5.10 U	1.821	4.80 U	1.714	5.3	3.786	6.8	4.857
ZINC (mg/kg)	410	283 J	0.690	208 J	0.507	261 J	0.637	1130 J	2.756
TOTAL PCB CONGENERS (ug/kg)	180	283.8	1.577	148	0.822	118	0.656	260.1	1.445
ALPHA-CHLORDANE (ug/kg)	6	7.6 U	0.633	3.2 U	0.267	4 U	0.333	1.1 J	0.183
TOTAL DDT (ug/kg)	46.1	118.5	2.570	13.7	0.297	7.8	0.169	22.4	0.486
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	15930	1.659	10940	1.140	8860	0.923	32370	3.372
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	2636	0.834	1568	0.496	1087	0.344	4718	1.493
ERM-Q			0.939		0.588		0.720		1.599

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-002 TRP1-SD-002A-0406 20081107		OUTER PIER 1 TRP1-SD-003 TRP1-SD-003B-0001 20081107		OUTER PIER 1 TRP1-SD-003 TRP1-SD-003A-0204 20081107		OUTER PIER 1 TRP1-SD-004 TRP1-SD-004B-0001 20081107	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	9.90 J	0.141	15.00 J	0.214	5.10 J	0.073	13.80 J	0.197
CADMIUM (mg/kg)	9.6	3.30 J	0.344	0.650 J	0.068	0.730 J	0.076	0.650 J	0.068
CHROMIUM (mg/kg)	370	110 J	0.297	62.2 J	0.168	61.7 J	0.167	71.0 J	0.192
COPPER (mg/kg)	270	197 J	0.730	106 J	0.393	62.1 J	0.230	130 J	0.481
LEAD (mg/kg)	218	501 J	2.298	97.9 J	0.449	95.4 J	0.438	119 J	0.546
NICKEL (mg/kg)	51.6	32.50 J	0.630	26.60 J	0.516	12.70 J	0.246	27.50 J	0.533
SELENIUM (mg/kg)	1.4	5	3.571	4.7	3.357	2.4	1.714	6.5	4.643
ZINC (mg/kg)	410	601 J	1.466	212 J	0.517	221 J	0.539	230 J	0.561
TOTAL PCB CONGENERS (ug/kg)	180	703.2	3.907	248.6	1.381	111.4	0.619	60.8	0.338
ALPHA-CHLORDANE (ug/kg)	6	7.2 U	0.600	2.3 U	0.192	0.54 U	0.045	0.91 U	0.076
TOTAL DDT (ug/kg)	46.1	50	1.085	4.5	0.098	7.6	0.165	4.5	0.098
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	22420	2.335	8270	0.861	3238	0.337	11330	1.180
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	5420	1.715	1269	0.402	600	0.190	1214	0.384
ERM-Q			1.471		0.663		0.372		0.715

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-004 TRP1-SD-004A-0204 20081107		OUTER PIER 1 TRP1-SD-004 TRP1-SD-004A-0406 20081107		OUTER PIER 1 TRP1-SD-005 TRP1-SD-005B-0001 20081107		OUTER PIER 1 TRP1-SD-005 TRP1-SD-005A-0204 20081107	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	12	0.171	7.9	0.113	8.3	0.119	10.2	0.146
CADMIUM (mg/kg)	9.6	2.30 J	0.240	1.30 J	0.135	0.380 J	0.040	0.470 J	0.049
CHROMIUM (mg/kg)	370	121 J	0.327	96.8 J	0.262	40.10 J	0.108	42.60 J	0.115
COPPER (mg/kg)	270	203 J	0.752	207 J	0.767	64.9 J	0.240	78.7 J	0.291
LEAD (mg/kg)	218	260 J	1.193	192 J	0.881	79.8 J	0.366	62.1 J	0.285
NICKEL (mg/kg)	51.6	28.00 J	0.543	17.70 J	0.343	16.40 J	0.318	18.90 J	0.366
SELENIUM (mg/kg)	1.4	5.2	3.714	3.7	2.643	1.8	1.286	1.5	1.071
ZINC (mg/kg)	410	418 J	1.020	324 J	0.790	108 J	0.263	111 J	0.271
TOTAL PCB CONGENERS (ug/kg)	180	335	1.861	124.5	0.692	89.6	0.498	175.5	0.975
ALPHA-CHLORDANE (ug/kg)	6	7 U	0.583	6.1 U	0.508	0.84 U	0.070	3.6 U	0.300
TOTAL DDT (ug/kg)	46.1	32	0.694	71	1.540	2.4	0.052	10.35	0.225
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	9630	1.003	10017	1.043	12050	1.255	38680	4.029
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	3918	1.240	3869	1.224	1710	0.541	3845	1.217
ERM-Q			1.026		0.842		0.397		0.718

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-005 TRP1-SD-005A-0406 20081107		OUTER PIER 1 TRP1-SD-006 TRP1-SD-006B-0001 20081107		OUTER PIER 1 TRP1-SD-006 TRP1-SD-006A-0203 20081107		OUTER PIER 1 TRP1-SD-007 TRP1-SD-007B-0001 20081106	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	8.7	0.124	12.90 J	0.184	12.80 J	0.183	15.60 J	0.223
CADMIUM (mg/kg)	9.6	1.30 J	0.135	0.480 J	0.050	1.00 J	0.104	0.540 J	0.056
CHROMIUM (mg/kg)	370	113 J	0.305	62.7 J	0.169	60.4 J	0.163	76.3 J	0.206
COPPER (mg/kg)	270	201 J	0.744	80.6 J	0.299	463 J	1.715	791 J	2.930
LEAD (mg/kg)	218	253 J	1.161	88.4 J	0.406	80.8 J	0.371	192 J	0.881
NICKEL (mg/kg)	51.6	51.3 J	0.994	25.80 J	0.500	28.70 J	0.556	40.3	0.781
SELENIUM (mg/kg)	1.4	3.5	2.500	5.90 U	2.107	4.50 U	1.607	7.6	5.429
ZINC (mg/kg)	410	669 J	1.632	156 J	0.380	341 J	0.832	410 J	1.000
TOTAL PCB CONGENERS (ug/kg)	180	43.8	0.243	234.2	1.301	62	0.344	273.5	1.519
ALPHA-CHLORDANE (ug/kg)	6	3.5 U	0.292	0.88 U	0.073	3.8 U	0.317	3.4 U	0.283
TOTAL DDT (ug/kg)	46.1	33.35	0.723	2.9	0.063	11.1	0.241	81.25	1.762
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	63850	6.651	6596	0.687	31340	3.265	119010	12.397
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	9800	3.101	1781	0.564	10600	3.354	7661	2.424
ERM-Q			1.431		0.522		1.004		2.299

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-007 TRP1-SD-007A-0204 20081106		OUTER PIER 1 TRP1-SD-007 TRP1-SD-007A-0406 20081106		OUTER PIER 1 TRP1-SD-008 TRP1-SD-008B-0001 20081105		OUTER PIER 1 TRP1-SD-008 TRP1-SD-008A-0204 20081105	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	18.40 J	0.263	23.30 J	0.333	15.40 J	0.220	13.40 J	0.191
CADMIUM (mg/kg)	9.6	1.10 J	0.115	3.00 J	0.313	0.450 J	0.047	0.830 J	0.086
CHROMIUM (mg/kg)	370	167 J	0.451	142 J	0.384	66.9 J	0.181	130 J	0.351
COPPER (mg/kg)	270	1600 J	5.926	8620 J	31.926	226 J	0.837	1010 J	3.741
LEAD (mg/kg)	218	1170 J	5.367	661 J	3.032	148 J	0.679	690 J	3.165
NICKEL (mg/kg)	51.6	482	9.341	188	3.643	28.4	0.550	278	5.388
SELENIUM (mg/kg)	1.4	14.6	10.429	9.8	7.000	6.9	4.929	8.6	6.143
ZINC (mg/kg)	410	4660 J	11.366	2640 J	6.439	257 J	0.627	2470 J	6.024
TOTAL PCB CONGENERS (ug/kg)	180	274.2	1.523	678.4	3.769	181.4	1.008	1186.8	6.593
ALPHA-CHLORDANE (ug/kg)	6	2.5 U	0.208	2.5 U	0.208	1.1 U	0.092	0.91 U	0.076
TOTAL DDT (ug/kg)	46.1	36.4	0.790	81	1.757	3.15	0.068	15.9	0.345
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	7610	0.793	37840	3.942	24070	2.507	51350	5.349
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	1061	0.336	13040	4.127	3295	1.043	15188	4.806
ERM-Q			3.608		5.144		0.984		3.251

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-008 TRP1-SD-008A-0406 20081105		OUTER PIER 1 TRP1-SD-009 TRP1-SD-009B-0001 20081105		OUTER PIER 1 TRP1-SD-009 TRP1-SD-009A-0204 20081105		OUTER PIER 1 TRP1-SD-009 TRP1-SD-009A-0406 20081105	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	12.90 J	0.184	10.30 J	0.147	15.80 J	0.226	12.30 J	0.176
CADMIUM (mg/kg)	9.6	0.890 J	0.093	1.00 J	0.104	0.700 J	0.073	1.20 J	0.125
CHROMIUM (mg/kg)	370	93.7 J	0.253	84.3 J	0.228	82.9 J	0.224	95.5 J	0.258
COPPER (mg/kg)	270	576 J	2.133	190 J	0.704	181 J	0.670	255 J	0.944
LEAD (mg/kg)	218	416 J	1.908	228 J	1.046	139 J	0.638	228 J	1.046
NICKEL (mg/kg)	51.6	127	2.461	41.5	0.804	38.8	0.752	57.1	1.107
SELENIUM (mg/kg)	1.4	7.9	5.643	4.7	3.357	6.3	4.500	6.1	4.357
ZINC (mg/kg)	410	1200 J	2.927	387 J	0.944	249 J	0.607	433 J	1.056
TOTAL PCB CONGENERS (ug/kg)	180	539.1	2.995	481.9	2.677	271.6	1.509	624.2	3.468
ALPHA-CHLORDANE (ug/kg)	6	3.4 U	0.283	4.2 U	0.350	1.8 U	0.150	1.6 U	0.133
TOTAL DDT (ug/kg)	46.1	32	0.694	39.5	0.857	5.1	0.111	4.5	0.098
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	15580	1.623	9660	1.006	16050	1.672	13880	1.446
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	2559	0.810	1296	0.410	2385	0.755	3833	1.213
ERM-Q			1.693		0.972		0.914		1.187

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.1

ERM-Q CALCULATIONS
INNER AND OUTER PIER 1 EE/CA
NSB-NLON, GROTON, CONNECTICUT

AOC LOCATION SAMPLE ID SAMPLE DATE	ERM	OUTER PIER 1 TRP1-SD-010 TRP1-SD-010B-0001 20081105		OUTER PIER 1 TRP1-SD-010 TRP1-SD-010A-0204 20081105		OUTER PIER 1 TRP1-SD-010 TRP1-SD-010A-0406 20081105	
		VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO	VAL_RES	ERM_RATIO
ARSENIC (mg/kg)	70	12.40 J	0.177	12.00 J	0.171	14.50 J	0.207
CADMIUM (mg/kg)	9.6	0.470 J	0.049	1.50 J	0.156	1.90 J	0.198
CHROMIUM (mg/kg)	370	56.8 J	0.154	101 J	0.273	88.9 J	0.240
COPPER (mg/kg)	270	201 J	0.744	670 J	2.481	625 J	2.315
LEAD (mg/kg)	218	163 J	0.748	665 J	3.050	327 J	1.500
NICKEL (mg/kg)	51.6	30.9	0.599	146	2.829	67.9	1.316
SELENIUM (mg/kg)	1.4	4.3	3.071	5.6	4.000	6	4.286
ZINC (mg/kg)	410	356 J	0.868	1860 J	4.537	975 J	2.378
TOTAL PCB CONGENERS (ug/kg)	180	168	0.933	379.1	2.106	849.5	4.719
ALPHA-CHLORDANE (ug/kg)	6	4.4 U	0.367	1 U	0.083	3.2 U	0.267
TOTAL DDT (ug/kg)	46.1	8.5	0.184	10.3	0.223	36.1	0.783
HIGH MOLECULAR WEIGHT PAHS (ug/kg)	9600	8360	0.871	14690	1.530	19240	2.004
LOW MOLECULAR WEIGHT PAHS (ug/kg)	3160	1399	0.443	4070	1.288	3909	1.237
ERM-Q			0.708		1.748		1.650

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

APPENDIX B.2

ESTIMATED VOLUMES OF INNER AND OUTER PIER 1 SEDIMENT

CLIENT: NSB-NLON, Groton, CT			JOB NUMBER: 112G00811
SUBJECT: Appendix B.2: Volumes of Contaminated Inner and Outer Pier 1 Sediment			
BASED ON: Various Reports			DRAWING NUMBER:
BY: JLG Date: 08-03-09		CHECKED BY: JMK Date: 8/3/09	APPROVED BY: DATE:

1.0 OBJECTIVE:

Determine the volumes of contaminated Thames River sediment in Inner and Outer Pier 1 along the Lower Subase at Naval Submarine Base - New London in Groton, Connecticut. Areas of contaminated sediment determined in Baseline Ecological Risk Assessment (Ref. 3). Use other information available in Refs. 1 through 7.

2.0 ASSUMPTIONS:

- The Inner Pier 1 sediment to be remediated under the EE/CA includes all of the Inner Pier 1 sediment to bedrock at an average depth of 4 feet.

- The Outer Pier 1 sediment to be remediated under the EE/CA includes all of the Outer Pier 1 contaminated sediment as defined under Ref. 3 minus the area of contaminated sediment centered around sampling point TRP1-SD-005 at a depth of 4-6 feet. This area of Outer Pier 1 contaminated sediment will be remediated under the FS.

- The sediment to be dredged is 100% saturated and has an in-situ solids content of 50% by weight.

- The sediment to be dredged is comprised of fines and sands with high total organic carbon (TOC) and has an average in-situ density of 88.1 pound per cubic foot (lb/cf), or 1.19 tons per cubic yard (ton/cy). Salt water has a density of 64 lb/cf, or 0.86 ton/cy.

  Therefore, the volume of solids per cf of in-situ sediment is:
  1 - (88.1 * 0.5 / 64) = 1 - 0.69 = 0.31 cf
  And the density of the solids in the sediment is:
  (88.1 * 0.5) / 0.31 = 142.1 lb/cf, or 1.92 ton/cy

- For Outer Pier 1, the actual in-situ volume of dredged sediment would be 10% higher than the estimated in-situ volume of sediment to be dredged to account for over-dredging and cut-back for slope stability. As all of the Inner Pier 1 sediment is assumed to be contaminated and will be dredged, no over-dredging factor will be applied to estimate sediment volume in that area.

- In the confined and relatively shallow Inner Pier 1, the mechanical dredging process would entrain water at the rate of 0.5 cf per in-situ cf of sediment. In the more open and deeper Outer Pier 1, the mechanical dredging process would entrain water at the rate of 1 cf per in-situ cf of sediment. No further bulking will be considered.

- In Outer Pier 1, uncontaminated sediment dredged to uncover contaminated sediment or to maintain slope stability in dredged areas shall be considered as contaminated.

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BASED ON: Various Reports			DRAWING NUMBER:
BY: JLG Date: 08-03-09		CHECKED BY: JAL Date: 8/31/09	APPROVED BY: DATE:

3.0 INNER PIER 1 (Alternatives IP-2 to IP-5)

3.1 Surface Area

As illustrated on Figure 1, the original dimensions of Inner Pier 1 were 189 feet (ft) long by 74 ft wide, for an estimated surface area of 13,986 square feet (sf).

The additional area resulting from the removal of Pier 1 is 90 ft long by 50 ft wide, for an estimated surface area of 4,500 sf

Total surface area of sediment to be dredged: 13,986 sf + 4,500 sf = 18,486 sf

3.2 Dredging Volume

As per above assumptions all of the Inner Pier 1 sediment is considered to be contaminated and will be dredged to an average depth of 4 feet.

In-situ volume of contaminated sediment to be dredged:
4 ft * 18,486 sf = 73,944 cf, or 2,739 cy

In-situ mass of contaminated sediment to be dredged:
2,739 cy * 1.19 ton/cy = 3,259 tons

Using the assumption that the in-situ sediment contains 50% solids by weight:

In-situ mass of dry solids in sediment to be treated and disposed: 0.5 * 3,259 tons = 1,630 tons
In-situ mass of water in sediment to be treated and disposed: 1,630 tons

The mechanical dredging of 1 in-situ cf of sediment would yield 1.5 cf of dredged material including 1 cf of sediment and 0.5 cf of entrained water. The 1 cf of sediment would weigh 88.1 lb and the 0.5 cf of salt water would weigh 32 lb. Therefore, the density of the dredged material is 120.1 lb/1.5 cf = 80.1 lb/cf. Each 1.5 cf of dredged material would include 88.1 lb * 0.5 = 44 lb of dry sediment and 44 lb + 32 lb = 76 lb of salt water. The overall solids concentration would be 44 lb / 120.1 lb = 37% by weight.

Volume of dredged material to be treated and disposed:
2,739 cy * 1.5 = 4,108 cy including 2,739 cy of sediment and 1,369 cy of free water.
Mass of dredged material to be treated and disposed:
3,259 tons + [(1,369 cy * 27 cf/cy * 64 lb/cf) / 2,000 lb/ton] = 3,259 tons + 1,183 tons = 4,442 tons

3.3 On-Site Dewatering & Off-Site Disposal

Assume on-site dewatering would proceed in two steps: gravity drainage followed by addition of fly ash. Gravity drainage would be conducted in the spoil barges and fly ash would be added either on shore prior to off-site transportation or at an off-site disposal facility.

Gravity drainage would remove approximately 100% of the free water entrained by dredging and re-compact the sediment to its original volume:

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BY: JLG Date: 08-03-09	CHECKED BY: JLL Date: 8/3/09		APPROVED BY: DATE:

Volume of drained sediment: 2,739 cy re-compacted sediment
Mass of drained sediment: 3,259 tons
Concentration of drained sediment: 50% solids by weight
Volume of water released by gravity drainage: 1,369 cy * 202 gal/cy = 276,538 gal

Assume that approximately 10% of drainage water, or 27,650 gal would be contaminated and would have to be collected either for off-site disposal or for on-site treatment and discharge.

Assume 8 percent (by weight) of fly ash added to drained sediment: 3,259 tons * 0.08 = 261 tons

Mass of treated sediment for off-site disposal: 3,259 tons + 261 tons = 3,520 tons

Bulk density of fly ash is approximately 100 lb/cf.

Volume of fly ash added: (261 tons * 2,000 lb/ton) / (100 lb/cf * 27 cf/cy) = 193 cy

Assume approximately 10 percent bulking occurs from addition of fly ash. Therefore, the total volume of treated sediment for disposal is: 2,739 cy * 1.1 = 3,013 cy

4.0 OUTER PIER 1

4.1 Surface Areas

As illustrated on Figures 1 to 7, the estimated surface areas of contaminated sediment at various depth are as follows for Outer Pier 1:

Based on ERM-Q exceedance: 0-2 feet: 5,100 sf
2-4 feet: 20,800 sf
4-6 feet: 27,300 sf (as mentioned above the separate 14,400 sf area around TRP1-SD-005 is to be remediated under the FS)

Based on PCB exceedance: 0-2 feet: 0 sf
2-4 feet: 1,600 sf
4-6 feet: 0 sf

Because all areas of PCB exceedance are included within the areas of ERM-Q exceedance, the surface of the areas of ERM-Q exceedance represents the total surface of contaminated sediment.

In addition, the footprint of the area of ERM-Q exceedance in the 0-2 feet zone is fully contained within the footprint of the area of ERM-Q exceedance in the 2-4 feet zone, which in turn is fully contained within the footprint of the area of ERM-Q exceedance in the 4-6 feet zone.

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BY: JLG Date: 08-03-09		CHECKED BY: JLL Date: 8/3/09	APPROVED BY: DATE:

4.2 Scenario 1: Dredging followed by Capping (Alternatives OP-2 & OP-3)

4.2.1 Pre-Dredging

Assume for Scenario 1 that surface sediment would be dredged to a depth of 2 feet and then replaced with 3 feet of clean sand or sandy sediment to account for over dredge and compaction. This would only be done in areas where sediment is contaminated at a depth of 0-2 feet. Areas where sediment is contaminated at a depth of 2-4 and/or 4-6 feet but not a depth of 0-2 feet would remain untreated as it is assumed that the natural layer of uncontaminated sediment will act as a cap.

In-situ volume of contaminated sediment to be dredged:
(2 ft * 5,100 sf) * 1.1 = 11,220 cf, or 416 cy

In-situ mass of dredged sediment: 416 cy * 1.19 ton/cy = 495 tons

Using the assumption that the in-situ sediment contains 50% solids by weight:

In-situ mass of dry solids in dredged sediment: 0.5 * 495 tons = 247.5 tons
In-situ mass of water in dredged sediment: 247.5 tons

The mechanical dredging of 1 in-situ cf of sediment would yield 2 cf of dredged material including 1 cf of sediment and 1 cf of entrained water. The 1 cf of sediment would weigh 88.1 lb and the 1 cf of salt water would weigh 64 lb. Therefore, the density of the dredged material is 152.1 lb/2 cf = 76 lb/cf. Each 2 cf of dredged material would include 88.1 lb / 2 = 44 lb of dry sediment and 44 lb + 64 lb = 108 lb of salt water. The overall solids concentration would be 44 lb / 152.1 lb = 29% by weight.

Volume of dredged material:
416 cy * 2 = 832 cy including 416 cy of sediment and 416 cy of free water.
Mass of dredged material:
495 tons + [(416 cy * 27 cf/cy * 64 lb/cf) / 2,000 lb/ton] = 495 tons + 359 tons = 854 tons

4.2.2 On-Site Dewatering and Off-Site Disposal

Assume on-site dewatering would proceed in two steps: gravity drainage followed by the addition of fly ash. Gravity drainage would be conducted in the spoil barges and fly ash would be added either on shore prior to off-site transportation or at an off-site disposal facility.

Gravity drainage would remove approximately 100% of the free water entrained by dredging and re-compact the sediment to its original volume:

Volume of drained sediment: 416 cy re-compacted sediment
Mass of drained sediment: 495 tons
Concentration of drained sediment: 50% solids by weight
Volume of water released by gravity drainage: 416 cy * 202 gal/cy = 84,032 gal

Assume that approximately 10% of drainage water, or 8,400 gal would be contaminated and would have to be collected either for off-site disposal or for on-site treatment and discharge.

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BY: JLG Date: 08-03-09		CHECKED BY: JAL Date: 8/3/09	APPROVED BY: DATE:

Assume 8 percent (by weight) of fly ash added to drained sediment: 495 tons * 0.08 = 40 tons

Mass of treated sediment for off-site disposal: 495 tons + 40 tons = 535 tons

Bulk density of fly ash is approximately 100 lb/cf.

Volume of fly ash added: (40 tons * 2,000 lb/ton) / (100 lb/cf * 27 cf/cy) = 30 cy

Assume approximately 10 percent bulking occurs from addition of fly ash. Therefore, the total volume of treated sediment for disposal is 416 cy * 1.1 = 458 cy.

4.2.3 Capping

Assume that a cap thickness of 3 feet would be installed to account for a 20% compaction/settling factor and that a decrease of 1 foot in water depth would not be a problem for Outer Pier 1 where smaller vessels are used and maintenance dredging is not a pressing need for the Navy.

Volume of cap material: (5,100 sf * 3 ft * 1.20) / (27 cf/cy) = 680 cy

Assume the sand has a bulk density of 100 lb/cf.

Mass of cap material: (680 cy * 27 cf/cy * 100 lb/cf) / 2000 lb/ton = 918 tons

4.3 Scenario 2: Dredging of All Contaminated Sediment (Alternatives OP-4 & OP-5)

4.3.1 Dredging

Assume for Scenario 2 that up to 6 feet of sediment would be dredged to remove all contaminated sediment.

In-situ volume of contaminated sediment:
(2 ft * 5,100 sf) + (2 ft * 20,800 sf) + (2 ft * 27,300 sf) = 106,400 cf = 3,941 cy

Total in-situ volume of dredged sediment: (6 ft * 27,300 sf) * 1.1 = 180,180 cf = 6,673 cy

In-situ mass of dredged contaminated sediment to be treated and disposed:
6,673 cy * 1.19 ton/cy = 7,941 tons

Using the assumption that the in-situ sediment contains 50% solids by weight:

In-situ mass of dry solids in sediment to be treated and disposed: 0.5 * 7,941 tons = 3,970.5 tons
In-situ mass of water in sediment to be treated and disposed: 3,970.5 tons

The mechanical dredging of 1 in-situ cf of sediment would yield 2 cf of dredged material including 1 cf of sediment and 1 cf of entrained water. The 1 cf of sediment would weigh 88.1 lb and the 1 cf of salt water

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BY: JLG	CHECKED BY: JLL		APPROVED BY: DATE:
Date: 08-03-09	Date: 8/3/09		

would weigh 64 lb. Therefore, the density of the dredged material is 152.1 lb/2 cf = 76 lb/cf. Each 2 cf of dredged material would include 88.1 lb / 2 = 44 lb of dry sediment and 44 lb + 64 lb = 108 lb of salt water. The overall solids concentration would be 44 lb / 152.1 lb = 29% by weight.

Volume of dredged material to be treated and disposed:
6,673 cy * 2 = 13,346 cy including 6,673 cy of sediment and 6,673 cy of free water.

Mass of dredged material to be treated and disposed:
7,941 tons + [(6,673 cy * 27 cf/cy * 64 lb/cf) / 2,000 lb/ton] = 7,941 tons + 5,765 tons = 13,706 tons

4.3.2 On-Site Dewatering and Off-Site Disposal

Assume on-site dewatering would proceed in two steps: gravity drainage followed by the addition of fly ash. Gravity drainage would be conducted in the spoil barges and fly ash would be added either on shore prior to off-site transportation or at an off-site disposal facility.

Gravity drainage would remove approximately 100% of the free water entrained by dredging and re-compact the sediment to its original volume:

Volume of drained sediment: 6,673 cy re-compacted sediment
Mass of drained sediment: 7,941 tons
Concentration of drained sediment: 50% solids by weight
Volume of water released by gravity drainage: 6,673 cy * 202 gal/cy = 1,347,946 gal

Assume that approximately 10% of drainage water, or 134,800 gal would be contaminated and would have to be collected either for off-site disposal or for on-site treatment and discharge.

Assume 8 percent (by weight) of fly ash added to drained sediment: 7,941 tons * 0.08 = 635 tons

Mass of treated sediment for off-site disposal: 7,941 tons + 635 tons = 8,576 tons

Bulk density of fly ash is approximately 100 lb/cf.

Volume of fly ash added: (635 tons * 2,000 lb/ton) / (100 lb/cf * 27 cf/cy) = 470 cy

Assume approximately 10 % bulking occurs from addition of fly ash. Therefore, the total volume of sediment for disposal is 6,673 cy * 1.1 = 7,340 cy.

4.0 REFERENCES

(1) U.S. Army Corps of Engineers, New England District, Public Notice for Dredging Permit for Piers 6, 10, 12, and 31, Naval Submarine Base New London, February 1, 2005.

(2) U.S. Army Corps of Engineers, New England District, Dredging Permit No. NAE-2004-3047 for Demolition and Dredging at Piers 6, 10, 12, and 31 and Thames River CAD Cell, Naval Submarine Base New London, Expiration December 1, 2008.

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SUBJECT: Appendix B.2: Volumes of Contaminated Inner and Outer Pier 1 Sediment			
BASED ON: Various Reports			DRAWING NUMBER:
BY: JLG Date: 08-03-09		CHECKED BY: JLL Date: 8/3/09	APPROVED BY: DATE:

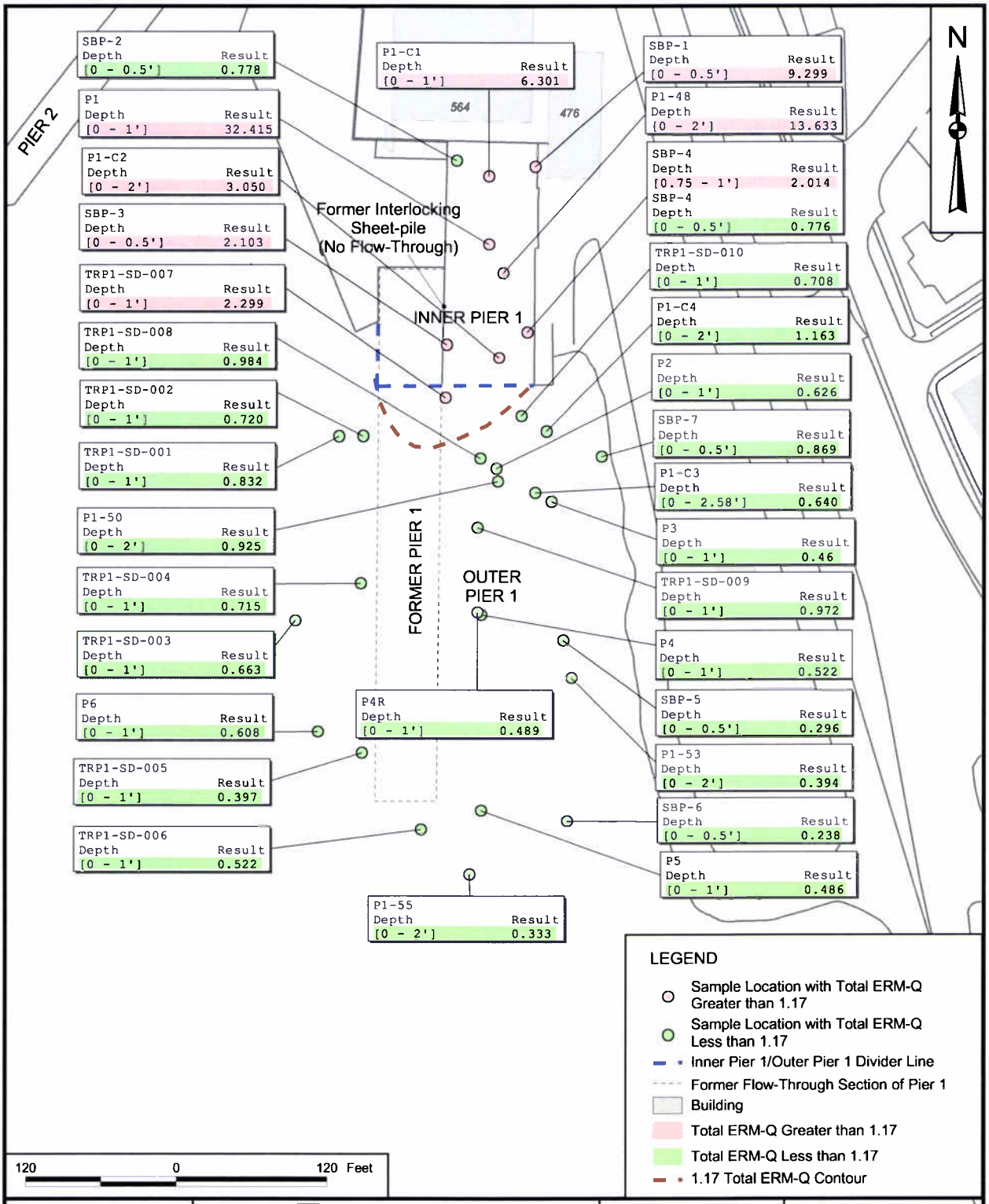
(3) Battelle and Neptune and Company, Draft Thames River Validation Study Report, Duxbury, Massachusetts and Los Alamos, New Mexico, October 2007 and Responses to Regulator Comments, January 17, 2008.

(4) Environmental Assessment, Pier 6 Replacement, SUBASE, NLON, Maguire Group, February 2004.

(5) Dredge Material Disposal Alternatives Analysis for Replacement of Pier 6 at Naval Submarine Base New London, Groton, Connecticut, Maguire Group, December 2004.

(6) Tetra Tech NUS, Inc., Lower Subase Remedial Investigation for Naval Submarine Base - New London, Groton, Connecticut, King of Prussia, Pennsylvania, January 1999.

(7) State of Connecticut Department of Environmental Protection, Water Quality Certificate No. 200402905-SG, Susan Gradante (CTDEP) to Nancy Kuntzleman (EFANE), April 5, 2005.



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CHECKED BY J. GLORIEUX	DATE 09/30/09	TOTAL ERM-Qs, 0-2 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR / DATE 10/1/09
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 / REV 0

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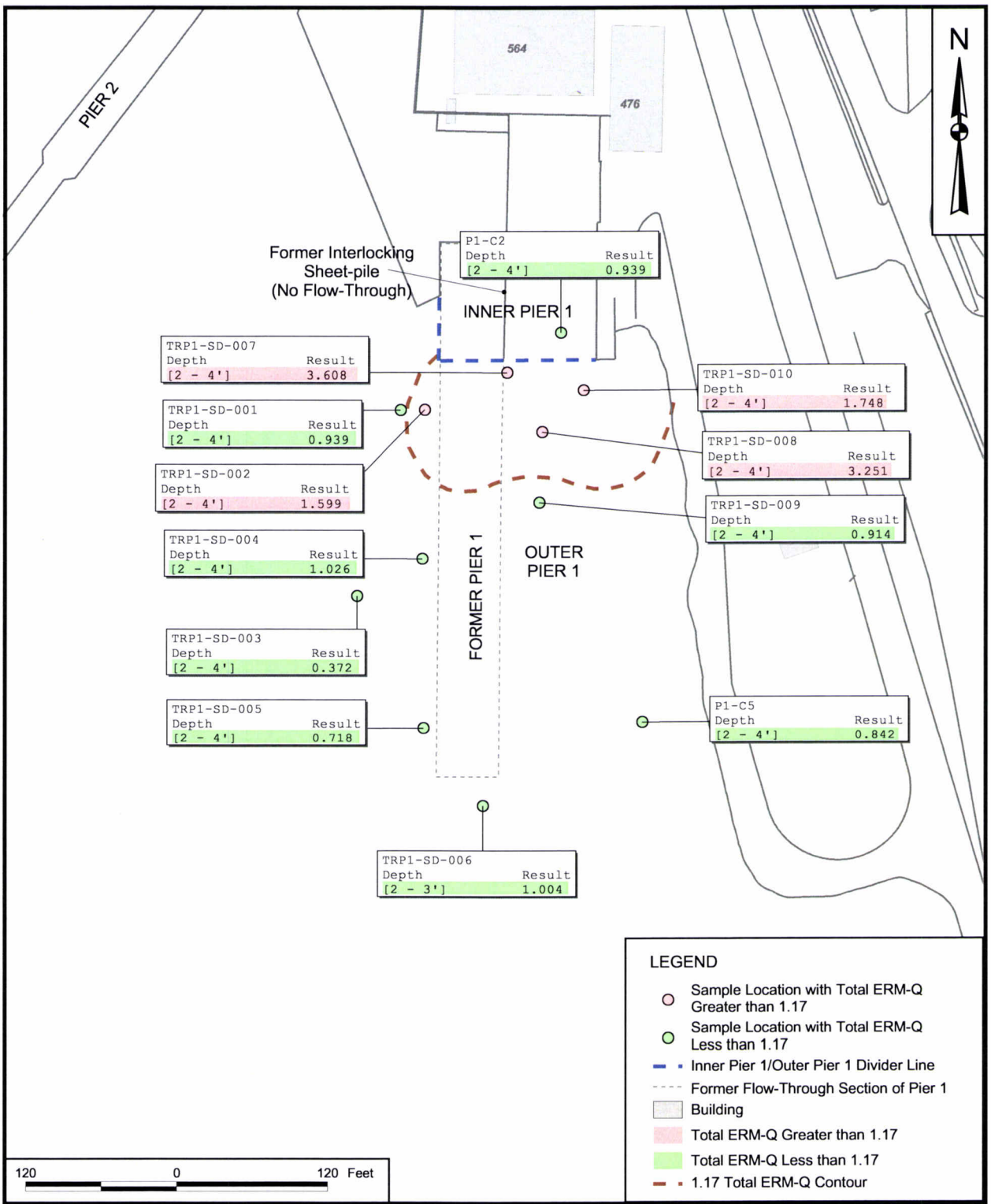

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CHECKED BY J. GLORIEUX DATE 09/30/09	TOTAL ERM-Qs, 2-4 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 10/11/09
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 2	REV 0

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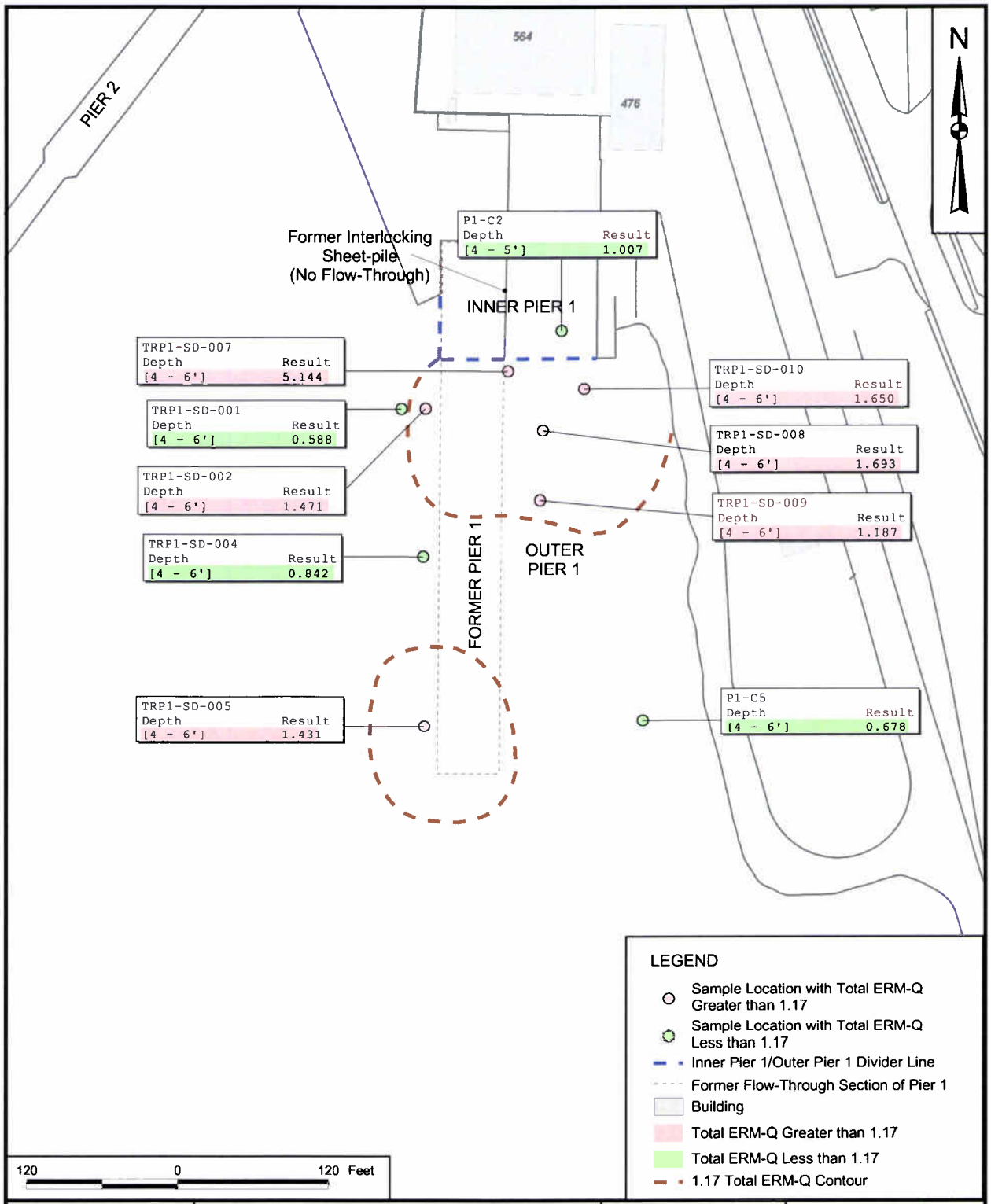

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CHECKED BY	DATE	TOTAL ERM-Qs, 4-6 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY	DATE
J. GRIEUX	09/30/09		CAR	10/11/09
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE			—	—
AS NOTED			DRAWING NO. FIGURE 3	REV 0

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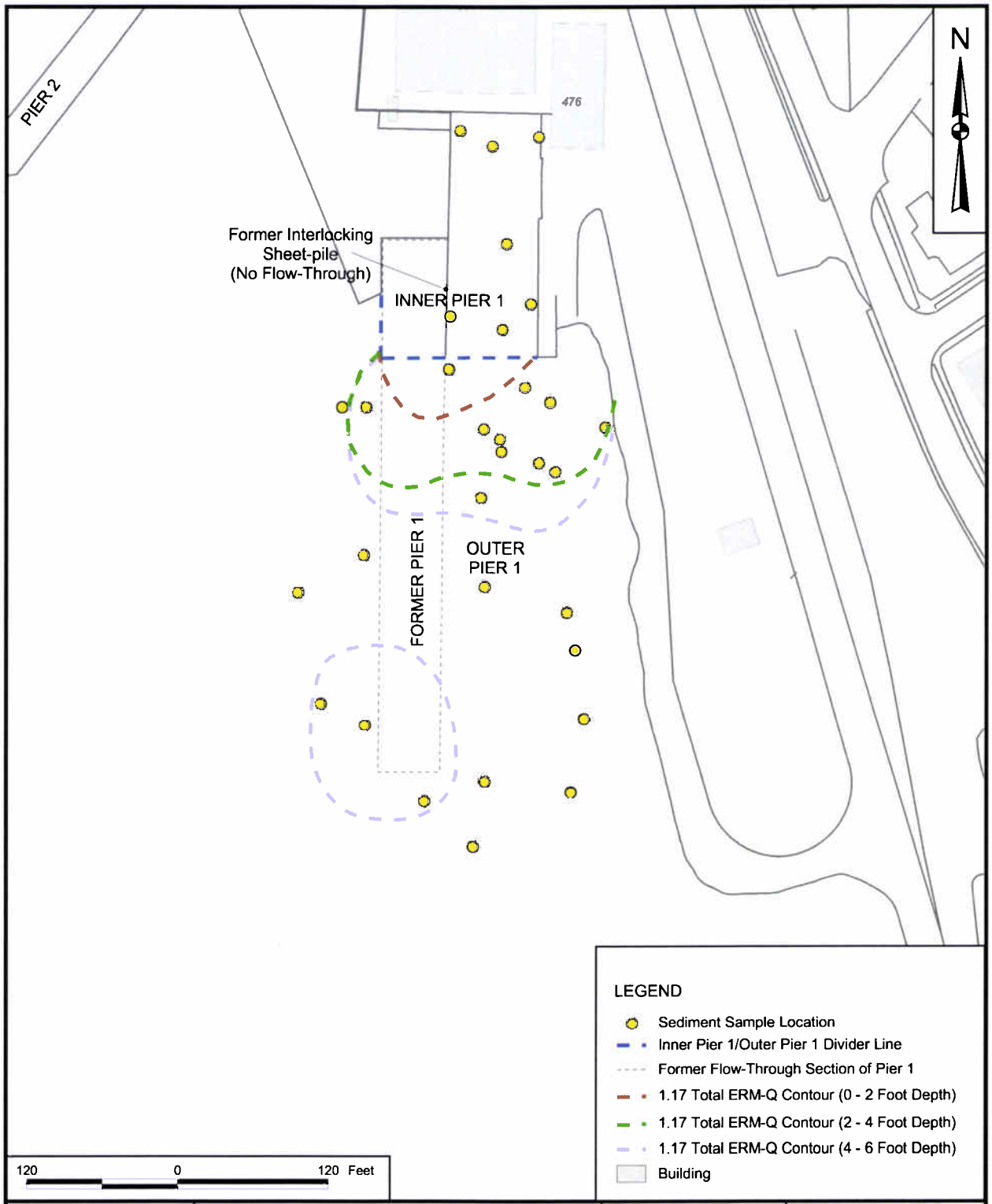

DRAWN BY S. STROZ — DATE 02/04/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0424	OWNER NO. 0811
CHECKED BY J. SUDRIEUX — DATE 09/30/09	TOTAL ERM-Qs PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB - NLON GROTON, CONNECTICUT	APPROVED BY CAR — DATE 10/11/09	
COST/SCHEDULE-AREA		APPROVED BY — — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 4	REV 0

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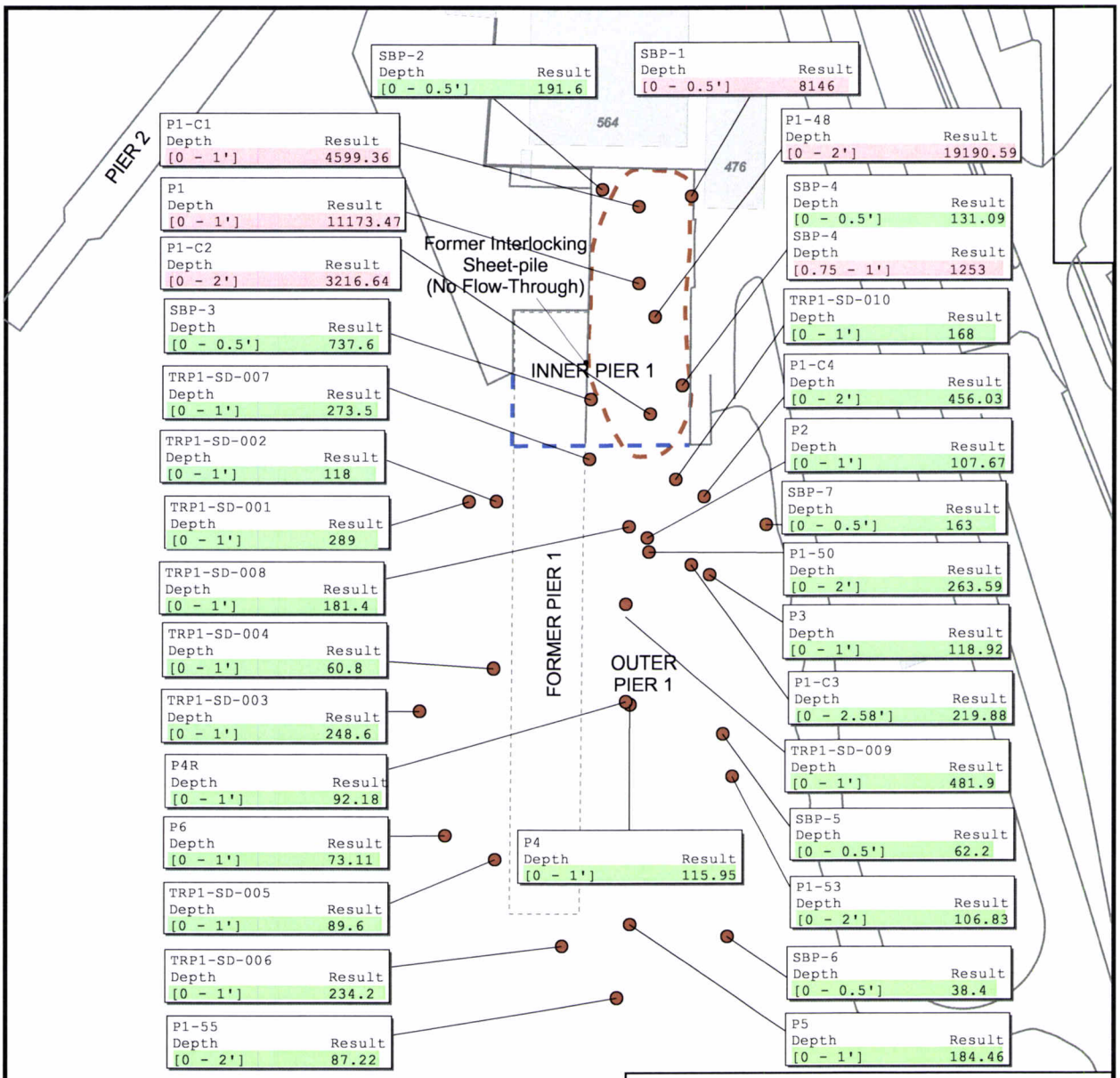

DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
S. STROZ	04/21/09		0424	0811
CHECKED BY	DATE	TOTAL PCB CONGENERS, 0-2 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY	DATE
J. CLORIEUX	09/30/09		CAR	10/11/09
COST/SCHEDULE-AREA			APPROVED BY	DATE
			—	—
SCALE			DRAWING NO.	REV
AS NOTED			FIGURE 5	0

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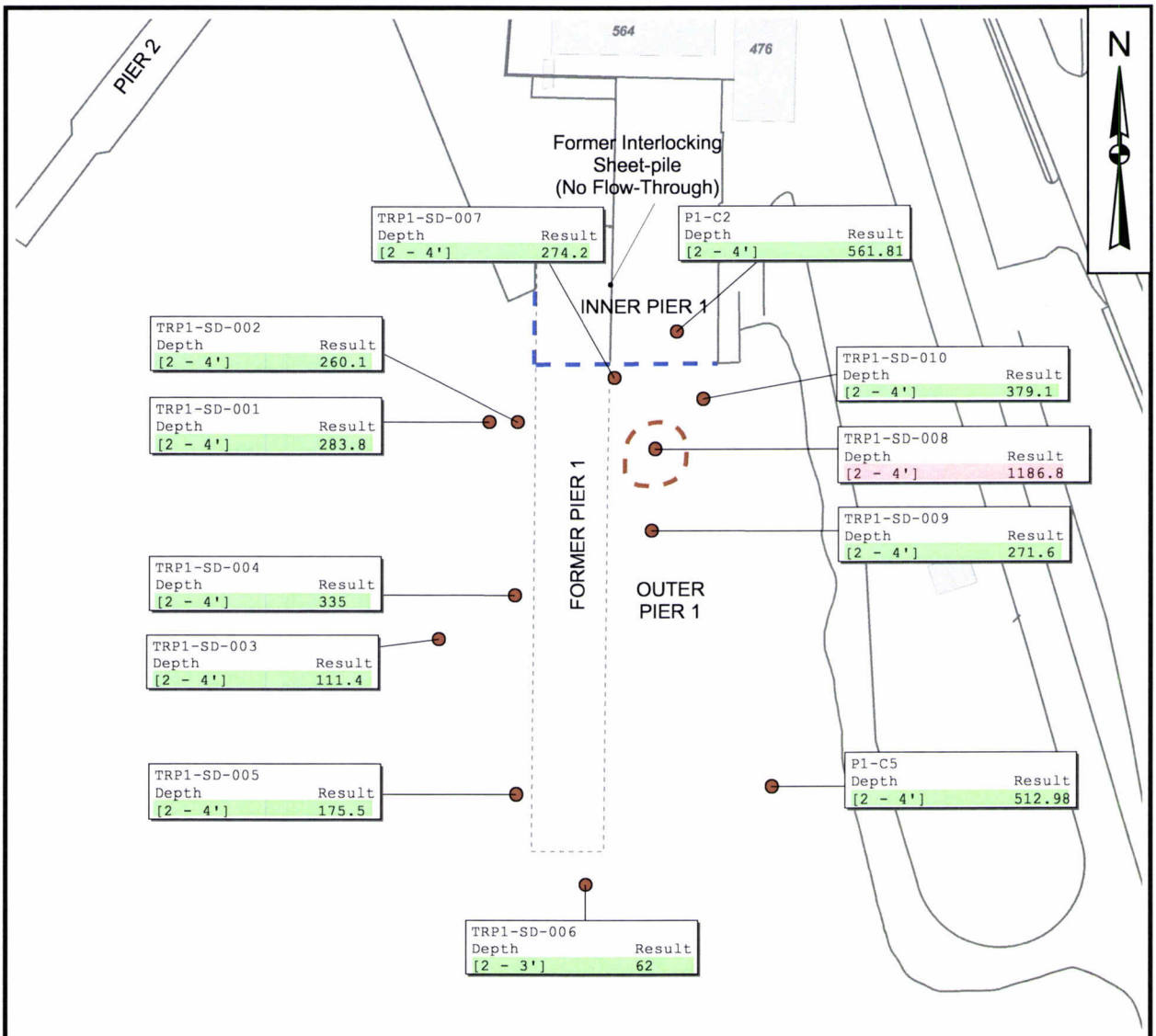

LEGEND

- Sample Location
- Inner Pier 1/Outer Pier 1 Divider Line
- Former Flow-Through Section of Pier 1
- 1,000 ug/kg Total PCB Contour
- Building
- Total PCB Congener Greater than 1,000 ug/kg
- Total PCB Congener Less than 1,000 ug/kg

Note: All units are ug/kg

120 0 120 Feet

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COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 6	REV 0

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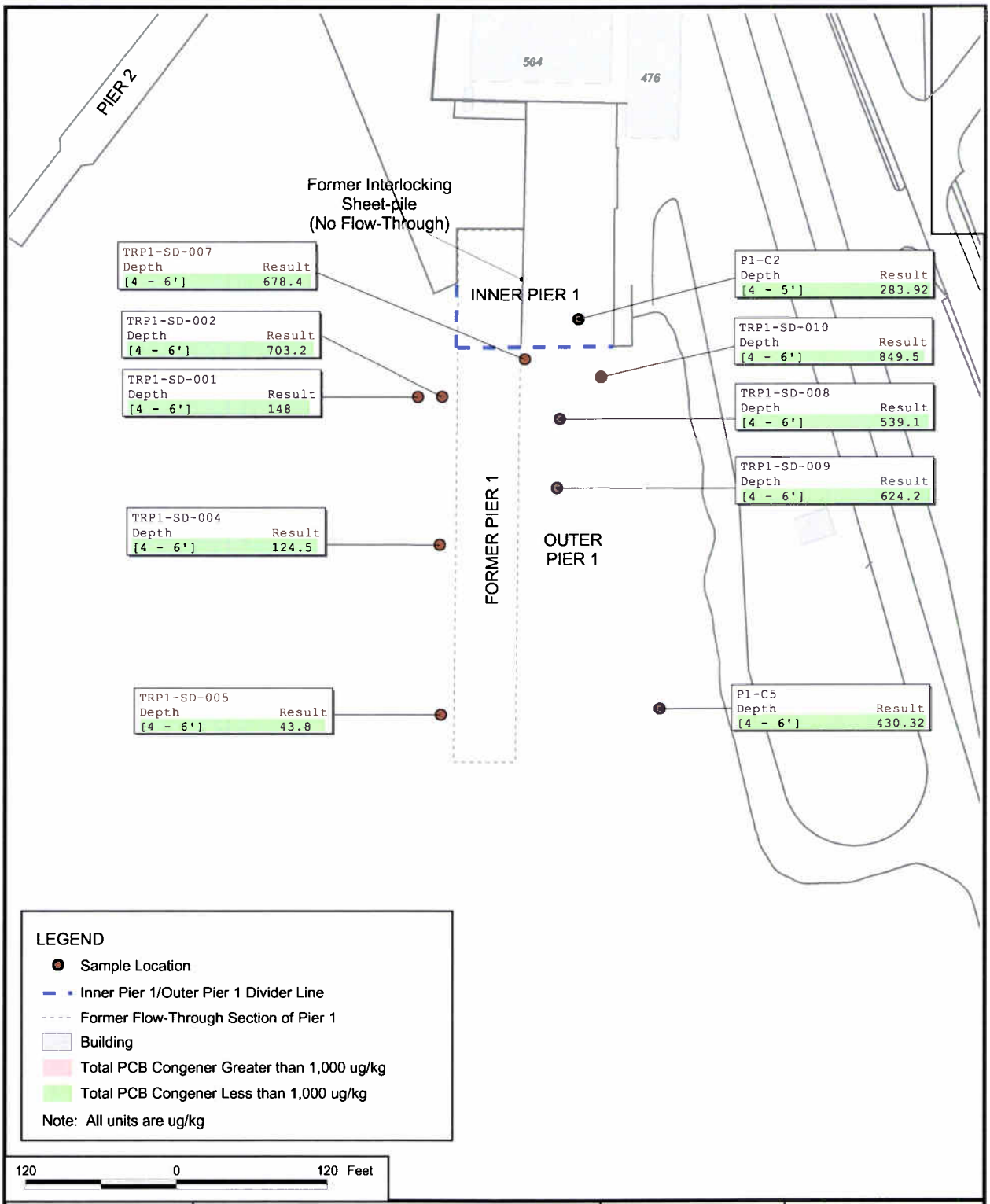

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CHECKED BY J. GLOMREUX — DATE 09/30/09	TOTAL PCB CONGENERS, 4-6 FEET DEPTH, PIER 1 AREA INNER AND OUTER PIER 1 EE/CA NSB-NLON GROTON, CONNECTICUT	APPROVED BY CAR — DATE 10/11/09	
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 7	REV 0

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APPENDIX B.3

ON-SITE DEWATERING FLUID AND SURFACE WATER TREATMENT AND DISCHARGE SYSTEMS

1.0 ASSUMPTIONS

The following design assumptions are made based upon available information and from experience with similar projects:

- The estimated volumes of dewatering fluid for Alternatives IP-4, IP-5, OP-3, and OP-5 are provided in Appendix B.2.
- The volume of contaminated surface water to be treated for Alternative IP-6 is estimated to be equal to the volume of last foot of surface water in Inner Pier 1 plus the volume of water intrusions and leaks [estimated at 35 gallons per minute (gpm)] into the work area for the duration of sediment excavation (24 days).
- The dewatering fluid for Alternatives IP-4, IP-5, OP-3, and OP-5 and the contaminated surface water for Alternative IP-6 would have an estimated total suspended solids (TSS) concentration of 100 milligrams per liter (mg/L) and an estimated total organic carbon (TOC) concentration of 1,000 mg/L.

2.0 TREATMENT SYSTEMS

2.1 Design Basis

2.1.1 Flow

From the above design assumptions, the design flow of the dewatering fluid/surface water treatment systems can be summarized as follows:

Alternative	Total Volume of Dewatering Fluid/Surface Water (gallons)	Treatment System Operating Time(4) (days)	Treatment System Design Flow(5) (gpd/gpm)
OP-3	8,400(1)	2	5,000/4
IP-4 & IP-5	27,650(1)	24	1,500/1
OP-5	134,800(1)	34	4,000/3
IP-6	138,300(2) + 1,209,600(3)	3 + 24	50,000/35

NOTES:

(1) As computed in Appendix B.2.
(2) Estimated contaminated surface water volume of Inner Pier 1 (last foot) based on surface area of 18,486 sf (18,486 sf * 1 ft * 7.4805 gal/cf = 138,300 gal)
(3) Based on pumping rate of 35 gpm during 24 days of excavation
(4) Operating times for Alternatives IP-4, IP-5, and IP-6 are based on and estimated dredging or excavation rate of 120 cy/day. Operating times for Alternatives OP-3 and OP-5 are based on a dredging rate of 200 cy/day.
(5) Design flows rounded to the next higher commercially available unit.

Because the treatment systems for Alternatives OP-3 and OP-5 have similar design flows, it is reasonable to assume that a system designed for the largest of these flows, i.e., 5,000 gpd and 4 gpm would be adequate as a single design for these two alternatives.

2.1.2 Water Quality

From the above design assumptions:

Alternative	TSS (mg/L)	TOC (mg/L)
OP-3, IP-4 & IP-5, OP-5, & IP-6	100	1,000

2.1.3 Treatment Scheme

The treatment systems would consist of the following three components:

- A Filtration System to remove TSS
- A Liquid-Phase Granular Activated Carbon (GAC) Adsorption System to remove soluble TOC
- Discharge to Thames River

Only the first two components require conceptual design at this time.

2.2 Filtration System

Use a bag type filter unit to avoid liquid residual stream from backwashing.

2.2.1 Alternatives IP-4, IP-5

Size bag filter unit for replacement of filter bag element every 6 days and assume 95% TSS removal.

TSS accumulation in the bag filter would be:

1,500 gpd * 6 days * 8.34 lb/gal * (100 * 0.95) mg/L TSS * 10^{-6} = 7.1 lb TSS

Assuming a typical solids capture capacity of approximately 0.5 lbs TSS per sf of bag filter element, required surface of bag element is:

7.1 lb / 0.5 lb/sf = 14.2 sf

→ Call for two (2) multi-bag pressurized Bag Filters (BF-1, BF-2) operating in parallel (1 operating, 1 spare) with an individual filter area of 18 sf (Rosedale Model 22 or equivalent w/ 4 bags each)

Frequency of filter changeover would be:
18 sf per filter unit / 14.2 sf required per 6 days of operation = 7.6 days
Required changeover for 24 days operation:
24 days / 7.6 days/changeover = 3.15, say 4 changeovers

Also need a pump to convey released water from barge to treatment system:

→ Call for one 2 gpm submersible centrifugal Transfer Pump (P-1) (100 feet TDH, 1/3 HP motor)

2.2.2 Alternatives OP-3 & OP-5

Size bag filter unit for replacement of filter bag element every 2 days (expected operating time for Alternative OP-3) and assume 95% TSS removal.

TSS accumulation in the bag filter would be:

5,000 gpd * 2 days * 8.34 lb/gal * (100 * 0.95) mg/L TSS * 10^{-6} = 7.9, say 8 lb TSS

Assuming a typical solids capture capacity of approximately 0.5 lbs TSS per sf of bag filter element, required surface of bag element is:

8 lb / 0.5 lb/sf = 16 sf

For Alternative OP-3, only one filter unit would be required because it has been sized to last for entire operating cycle:

→ Call for one (1) multi-bag pressurized Bag Filter (BF-1) with a filter area of 18 sf (Rosedale Model 22 or equivalent).

For Alternative OP-5, with multiple filter cycles, two filter units would be required:

→ Call for two (2) multi-bag pressurized Bag Filters (BF-1, BF-2) operating in parallel (1 operating, 1 spare) with an individual filter area of 18 sf (Rosedale Model 22 or equivalent w/ 4 bags each)

Frequency of filter changeover would be:
18 sf per filter unit / 16 sf required per 2 days of operation = 2.2 days
Required changeovers for 34 days operation:
34 days / 2.2 days/changeover = 15.4, say 16 changeovers

Also need a pump to convey released water from barge to treatment system:

→ Call for one 4 gpm submersible centrifugal Transfer Pump (P-1) (100 feet TDH, 0.5 HP motor)

2.2.3 Alternative IP-6

Size bag filter unit for replacement of filter bag element no more frequently than once a day and assume 95% TSS removal.

TSS accumulation in the bag filter would be:

50,000 gpd * 8.34 lb/gal * (100 * 0.95) mg/L TSS * 10^{-6} = 40 lb TSS /day

Assuming a typical solids capture capacity of approximately 0.5 lbs TSS per sf of bag filter element, required surface of bag element is:

40 lb / 0.5 lb/sf = 80 sf

→ Call for two (2) multi-bag pressurized Bag Filters (BF-1, BF-2) in parallel (1 operating, 1 spare) with an individual filter area of 100 sf (Rosedale Model 48 or equivalent w/ 23 bags each)

Frequency of filter changeover would be:
100 sf per filter unit / 80 sf required per day of operation = 1.25 days
Required changeovers for 27 days operation:
27 days / 1.25 day/changeover = 21.6, say 22 changeovers

Also need a pump to convey released water from barge to treatment system:

→ Call for one submersible centrifugal 35 gpm Transfer Pump (P-1) (100 feet TDH, 2 HP motor)

2.3 Liquid-Phase GAC Adsorption System

2.3.1 Alternatives IP-4 & IP-5

Size GAC adsorption units for an estimated frequency of replacement of approximately 6 days.
Assume GAC usage of 10 pounds per pound of TOC removed and breakthrough after usage of 3/4 of GAC

Required GAC quantity:
[(1,500 gpd * 6 days * 8.34 lb/gal * 1,000 mg/L TOC * 10^{-6}) * 10 lb GAC/lb TOC] / 0.75 =
1,001 lb GAC

→ Call for a liquid-phase GAC Adsorption System (GAC-1) consisting of two (2) adsorption units operating in parallel (1 operating, 1 spare), each holding 1,000 lb GAC (Carbonair Model PC 7 or equivalent).

Frequency of GAC unit replacement would be:
1,000 lb GAC per unit / 1,001 lb GAC per 6 days of operation = 6 days
Required replacements for 24 days operation:
24 days / 6 days/replacement = 4 replacements

2.3.2 Alternatives OP-3 & OP-5

Size GAC adsorption unit to last for the two days of operation for Alternative OP-3
Assume GAC usage of 10 pounds per pound of TOC removed and breakthrough after usage of 3/4 of GAC

Required GAC quantity:
[(5,000 gpd * 2 days * 8.34 lb/gal * 1,000 mg/L TOC * 10^{-6}) * 10 lb GAC/lb TOC] / 0.75 =
1,112 lb GAC

For Alternative OP-3, only one GAC unit would be required because it has been sized to last for entire operating cycle:

→ Call for a liquid-phase GAC Adsorption System (GAC-1) consisting of one (1) adsorption unit holding 1,500 lb GAC (Carbonair Model PC 13 or equivalent).

For Alternative OP-5, with multiple cycles, two GAC units would be required:

→ Call for a liquid-phase GAC Adsorption System (GAC-1) consisting of two (2) adsorption units operating in parallel (1 operating, 1 spare), each holding 1,500 lb GAC (Carbonair Model PC 13 or equivalent).

Frequency of GAC unit replacement would be:
1,500 lb GAC per unit / 1,112 lb GAC per 2 days of operation = 1.3 days
Required replacements for 34 days operation:
34 days / 1.3 days/replacement = 26.1, say 26 replacements

2.3.3 Alternative IP-6

Size GAC adsorption units for a maximum estimated frequency of replacement of approximately one day. Assume GAC usage of 10 pounds per pound of TOC removed and breakthrough after usage of 3/4 of GAC

Required GAC quantity:
[(50,000 gpd * 8.34 lb/gal * 1,000 mg/L TOC * 10^{-6}) * 10 lb GAC/lb TOC] / 0.75 =
5,560 lb/day

→ Call for a liquid-phase GAC Adsorption System (GAC-1) consisting of two (2) adsorption units operating in parallel (1 operating, 1 spare), each holding 10,000 lb GAC (Carbonair Model PC 50 or equivalent).

Frequency of GAC unit replacement would be:
10,000 lb GAC per unit / 5,560 lb GAC per day of operation = 1.8 days
Required replacements for 27 days operation:
27 days / 1.8 days/replacement = 15 replacements

2.4 Operating Parameters

Based on the water volumes presented in Section 2.1.1 of these calculations, the alternative-specific operating parameters of the above water treatment systems can be summarized in the following table:

Parameters	Alternative OP-3	Alternatives IP-4 & IP-5	Alternative OP-5	Alternative IP-6
Operating Days	2	24	34	27
Filter Changeovers	1	4	16	22
Filter Bags Used	4	16	64	506
GAC Replacements	1	4	26	15
GAC Usage (pounds)	1,000	4,000	39,000	150,000

Attachments

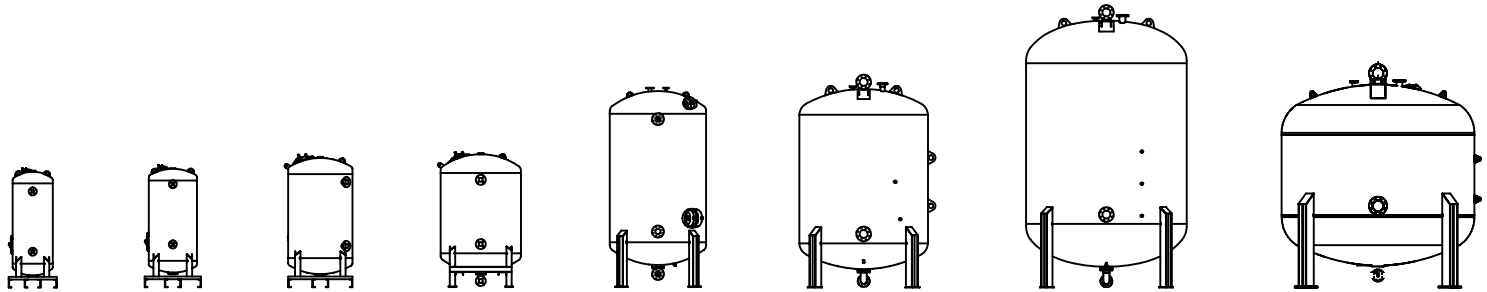
Rosedale bag filters literature
Carbonair liquid-phase GAC adsorption units literature

CARBONAIR
www.carbonair.com

PC Series
Carbon Vessels

Carbonair's carbon vessels are designed and manufactured in accordance with engineering standards set forth by the American Society of Mechanical Engineers (ASME). The materials used in construction are in accordance with standards established by AWWA, FDA, and EPA.

Specifications



Model	PC 5	PC 7	PC 13	PC 20	PC 28	PC 50	PC 78	PC 113
Flow Range (gpm)	3 - 35	4 - 50	6 - 100	10 - 130	14 - 200	25 - 360	40 - 550	55 - 800
Carbon Capacity (lb)	500	1000	1500	2500	5000	10,000	20,000	20,000
Vessel Diameter	2'-6"	3'	4'	5'	6'	8'	10'	12'
Vessel Height	**7'-3"**	**7'-7"**	**8'-4"**	**8'-5"**	**12'-5"**	13'-3"	17'-7"	**13'-11"**
Bed Area (ft²)	4.9	7.1	12.6	19.6	28.3	50	78	113
Empty Weight (lb)	780	980	1230	1800	3150	8100	10,900	16,600
Loaded Weight (lb)	1280	1980	2730	4300	8150	18,100	30,900	36,600
Operating Weight (lb)	2670	3670	6150	9200	17,450	40,600	75,600	82,650
Spent & Drained Weight (lb)	1900	3230	4600	7400	14,400	30,520	55,750	61,450
Design Pressure (psig)	90	90	90	75	75	75	75	75
Influent Connection	2"	2"	2"	3"	4"	6"	6"	8"
Effluent Connection	2"	2"	2"	3"	4"	6"	6"	8"

Design Features

- **Welded Steel Construction**
- **Corrosion Resistant Acrylic Polyurethane Coated Exterior**
- **Multi-Coated Corrosion Resistant Epoxy Interior**
- **Built to ASME code**
- **PVC and Stainless Steel Internals**
- **Two 12" x 16" Access Ports**

Options

- ☐ Influent/Effluent Sample and Pressure Taps
- ☐ Influent/Effluent Quick-Connect Couplings
- ☐ Flexible Interconnecting Hose
- ☐ External Sample/Gauge Ports
- ☐ Piping Packages
- ☐ Flow Instrumentation
- ☐ ASME Inspected and Stamped Vessels Available
- ☐ Complete line of granular activated carbon and other media

Service Centers

FLORIDA
4710 Dignan Street
Jacksonville, FL 32254
800.241.7833
904.387.4465
904.387.5058 Fax

MINNESOTA
2731 Nevada Ave. No.
New Hope, MN 55427
800.526.4999
763.544.2154
763.544.2151 Fax

TEXAS
4889 Hunter Rd. Bldg 1-C
San Marcos, TX 78666
800.893.5937
512.392.0085
512.392.0066 Fax

VIRGINIA
4328 West Main Street
Salem, VA 24153
800.204.0324
540.380.5913
540.380.5920 Fax

Dwg # 217327 PC

Multi-Basket Strainers and Multi-Bag Filters

These multi-basket strainers and bag filters offer a wide range of flow capacities and contaminant-holding capabilities. They contain from 2 to 23 baskets.

To serve as a strainer, a unit is ordered with perforated stainless steel baskets (mesh-lined if desired). When ordered as a filter, it's fitted with perforated stainless steel baskets designed to hold disposable or cleanable filter bags. Industry-standard size bags are used: the standard 30 inch baskets accept bag size 2, the optional 15 inch baskets take size 1.

The standard pressure rating for all models is 150 psi. All housings can be supplied with an ASME code stamp, if required.

Features

- *Multiple housing styles available (standard, quick access, low profile, hinged)*
- *Permanently piped housings are opened without tools and without disturbing the piping*
- *Machined cover gasket groove provides positive O-ring sealing*
- *Carbon steel, 304 or 316 stainless steel construction housings*
- *Large-area, 30 inch deep, heavy-duty, 9/64 inch perforated baskets*
- *Easy to clean*
- *Low pressure drop*
- *Four cover seal materials: Buna N, Ethylene Propylene, Viton®, and Teflon®*
- *Pressure rating 150 psi*
- *Flanged connections for 2 through 12 inch pipe*
- *Vent, drain and gage connections*

Options

- *ASME code stamp*
- *Higher pressure ratings*
- *Corrosion allowances*
- *Steam jackets*
- *Special connection locations*
- *Bag hold down assembly (standard on QAC design)*
- *Inner baskets for dual-stage straining or filtering*
- *Cleanable wire mesh lined or perforated strainer baskets*
- *Special alloy materials*
- *Hydraulic cover lifting assembly*
- *Sanitary fittings*
- *Differential pressure indicators*

Duplex Systems

All multi-basket models described here are also available as duplex systems. Two units come piped together with valves to permit continuous use of either unit while servicing the other. One lever actuates all valves simultaneously or it can be ordered for automatic service. See page 63.

Rosedale Quick Access "QAC" Low Maintenance Filter/Strainer
COUNTERBALANCED COVER - Stops In Any Position
COVER SEAL
COVER HINGE MECHANISM
SECONDARY SAFETY RELEASE
POSITIVE BAG RESTRAINT
CLAMP RELEASE BAR
INLET
COVER SUPPORT ASSEMBLY
INLET DRAIN/VENT
PRIMARY RELEASE SAFETY LEVER
OUTLET
LOW PROFILE CLEARANCE
DRAIN

Choose Baskets That Strain or Filter

Whatever your needs dictate

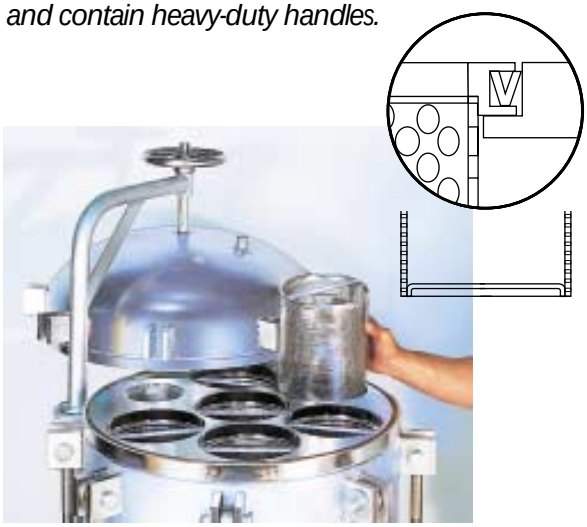
Strainer baskets are cleanable, reusable.

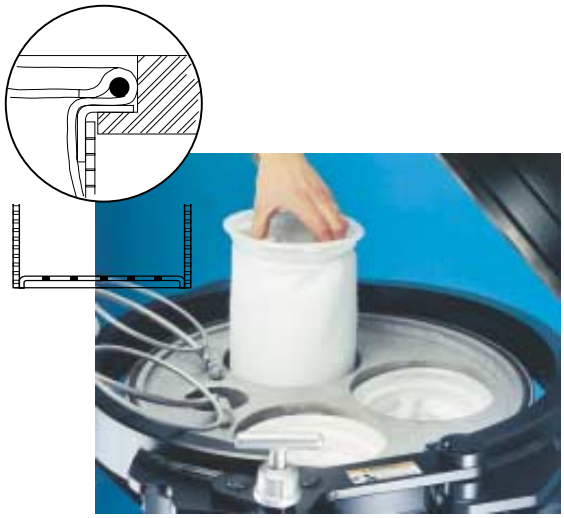
A seal is supplied on any strainer basket. It forms a seal between basket and housing to prevent dirty fluid bypass. Choose between various perforation sizes or wire mesh. Strainer baskets have flat, non-perforated bottoms and contain heavy-duty handles.

Filter bag baskets hold disposable filter bags.

Filter bags have an interference fit between the bags top rim and the housing causing a positive seal to prevent fluid bypass. Filter bag baskets have flat perforated bottoms.

Filter bags are available in a wide variety of felt, micro-fiber, monofilament and multifilament mesh materials. They are detailed completely on pages 126-128.





DUAL-STAGE– Dual-stage action will increase strainer or filter life and reduce servicing needs. This straining/filtering action can be achieved by ordering a second, inner basket. It is supported on the top flange of the outer basket. Both baskets can be utilized as strainers (with or without wire mesh linings), filter bag baskets, or a combination of strainer and bag basket.

Basket Data

Surface area of each 30 in. basket: 4.4 sq. ft. Volume of each 30 in. basket: 0.6 cu. ft.

Basket Construction

For cleanable strainer baskets, choose from the following perforation diameters: 1/4, 3/16, 9/64, 3/32, or 1/16 inch (for other not shown consult factory).

Any perforated basket can also be ordered lined with wire mesh. Stainless steel wire is used in mesh sizes 20, 30, 40, 50, 60, 70, 80, 100, 150, or 200.

Filter bag baskets, have standard 9/64 inch diameter perforations that are 51% open area. A wire mesh can also be utilized with bag baskets for two advantages:

1. *Fiber migration is minimized.*
2. *In the unlikely event of bag rupture, the wire mesh better contains the contaminant.*

Choose Housing Style

Designed to suit your requirements

The versatility of Rosedale Products provides a choice of several different designs.

- ***Quick Access Cover (QAC)*** *features a clamp and spring assisted hinged cover that is quick and easy to open and close with no tools required. This will significantly reduce change-out time and lower operating costs. The QAC is rated to 150 PSI and constructed to meet ASME code requirements. Built-in safety features ensure that the cover cannot be opened unless the internal pressure is first released. The QAC is offered with our low profile design making bags more accessible and easy to remove.*

- ***Low Profile Design (SLP) Housings*** *are compact and space saving, allowing for ease of bag change-out. Standard operating height is reduced, resulting in a safe design by eliminating platforms and ladders. The SLP is manufactured in any housing version, including our standard davit arm cover, QAC design, and spring assisted hinged cover.*

- ***Spring Assisted Hinged Cover (HLP)*** *opens and closes without effort. Simply loosen the swing bolts and lift the cover up to open. An automatic cover stop is provided. This design saves time by eliminating the labor intensive handwheel. It is offered standard with our low profile design, or can be ordered in the QAC design.*

- ***Standard Housing Design (STD)*** *is durable and economic. It includes a davit arm and handwheel to facilitate cover removal. It is our most versatile housing design offering a variety of options, including our low profile design.*

Quick Access Cover

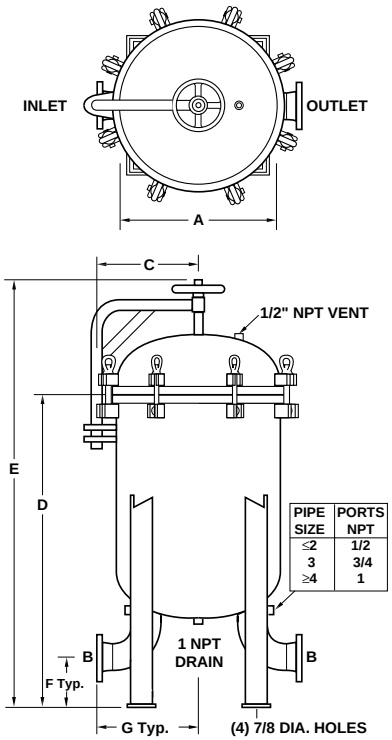
Low Profile Design

Standard Davit Arm

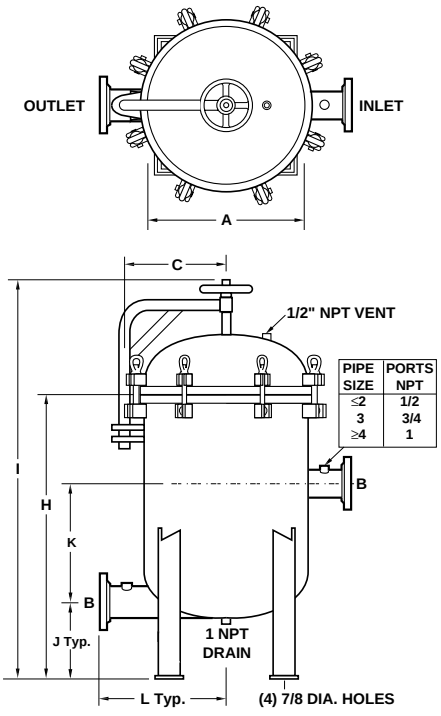
MODEL NUMBER & Dim. A	Pipe Sizes B	Leg Bolt Circle Dia.	Standard						Low Profile				
			C	D	E	F	G	Weight, lb (Approx)	H	I	J	K	L
16	2	14.0	10.9	40.1	57.1	4.50	10.5	400	37.9	54.9	8.00	15.0	13.0
	3			42.5	59.5	5.25	12.3	425	38.3	55.3	9.00	17.0	14.0
	4			44.9	61.9	6.00	14.0	450	N/A	N/A	N/A	N/A	N/A
18	2	16.0	11.9	40.5	58.0	4.50	11.1	450	39.6	58.5	8.00	15.0	14.0
	3			42.9	60.4	5.25	12.9	475	40.0	58.9	9.00	17.0	15.0
	4			45.3	62.8	6.00	14.6	500	N/A	N/A	N/A	N/A	N/A
22	2	20.0	14.0	41.4	60.0	4.50	11.9	485	39.5	58.0	8.00	15.0	16.0
	3			43.9	62.4	5.25	13.7	500	40.0	58.5	9.00	17.0	17.0
	4			46.2	64.7	6.00	15.4	515	39.5	58.0	9.00	19.0	18.0
	6			50.4	69.0	7.00	18.9	560	N/A	N/A	N/A	N/A	N/A
24	2	22.0	15.0	41.7	60.7	4.50	13.1	675	41.2	61.6	8.00	15.0	17.0
	3			44.1	63.1	5.25	14.8	700	41.6	62.0	9.00	17.0	18.0
	4			46.5	65.5	6.00	16.6	725	41.1	61.5	9.00	19.0	19.0
	6			50.7	69.7	7.00	20.1	750	N/A	N/A	N/A	N/A	N/A
30	2	28.0	18.0	42.8	63.3	4.50	15.2	635	41.3	61.9	8.00	15.0	20.5
	3			45.2	65.7	5.25	17.0	650	41.8	62.4	9.00	17.0	21.0
	4			47.6	68.1	6.00	18.7	665	41.3	61.9	9.00	19.0	22.5
	6			51.9	72.4	7.00	22.2	705	41.2	61.8	10.0	17.0	23.0
	8			56.4	76.8	8.25	25.7	850	N/A	N/A	N/A	N/A	N/A
36	3	34.0	21.0	46.4	68.4	5.25	18.8	840	43.3	64.5	9.00	17.0	24.0
	4			48.8	70.8	6.00	20.6	860	43.2	64.5	9.50	19.0	25.0
	6			53.1	75.1	7.00	24.1	870	43.2	64.4	10.5	17.0	26.0
	8			57.6	79.6	8.25	27.6	1010	43.2	64.4	11.5	17.0	27.0
	10			62.1	84.1	9.50	30.6	1150	N/A	N/A	N/A	N/A	N/A
42	4	40.0	24.0	50.0	73.5	6.00	22.6	1840	45.9	70.7	9.50	19.0	28.0
	6			54.3	77.8	7.00	26.1	1870	45.9	70.6	10.5	17.0	28.0
	8			58.8	82.3	8.25	29.6	1960	45.9	70.6	11.5	17.0	29.5
	10			63.3	86.8	9.50	32.6	2070	45.8	70.5	12.5	17.0	30.0
	12			68.0	91.5	11.0	36.1	2200	N/A	N/A	N/A	N/A	N/A
48	4	46.0	27.0	51.0	76.0	6.00	24.8	2015	46.5	71.5	9.50	19.0	32.0
	6			55.4	80.4	7.00	28.3	2075	46.4	71.4	10.5	17.0	32.0
	8			60.0	85.0	8.25	31.8	2200	46.4	71.4	11.5	17.0	32.5
	10			64.4	89.4	9.50	34.8	2350	46.4	71.4	12.5	17.0	33.0
	12			69.2	94.2	11.0	38.3	2530	N/A	N/A	N/A	N/A	N/A

Dimensions (IN)

(30-inch deep basket)



Standard

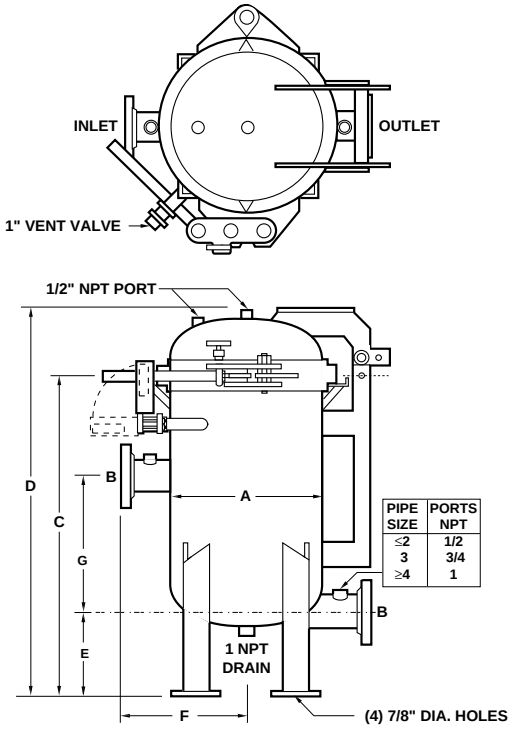


Low Profile

QAC Low Profile

MODEL NUMBER	A	Pipe Sizes B	Leg Bolt Circle Dia.	C	D	E	F	G
16 & 18	18	2	16.0	37.6	45.4	8.00	14.0	15.0
		3		38.1	45.9	9.00	15.0	17.0
22 & 24	24	2	22.0	41.2	49.9	8.00	17.0	15.0
		3		41.6	50.3	9.00	18.0	17.0
		4		41.1	49.8	9.00	19.0	19.0

Dimensions (IN)



QAC Low Profile

Model Selection (For all housings)

Model No.	Number of Baskets	Straining, Filtering Area, ft2	Nominal Flow Rate (gpm)**	Inlet/ Outlet Size (in)	Available Housing Styles
16	2	8.8	200	2,3,4*	Std,SLP,HLP,QAC
18	3	13.2	300	2,3,4*	Std,SLP,HLP,QAC
22	4	17.6	400	2,3,4,6*	Std,SLP,HLP,QAC
24	6	26.4	600	2,3,4,6*	Std,SLP,HLP,QAC
30	8	35.2	800	2,3,4,6,8*	Std,SLP,HLP
36	12	52.8	1200	2,3,4,6,8,10*	Std,SLP,HLP
42	17	74.8	1700	2,3,4,6,8,10,12*	Std,SLP,HLP
48	23	101.2	2300	2,3,4,6,8,10,12*	Std,SLP,HLP

*Not available on SLP, HLP, and QAC styles.

**Nominal flow rate is based on water @ 1 psi ΔP. For optimum filtering effectiveness, a maximum fluid velocity of 10 ft/sec should be maintained.

Pressure Drop Data

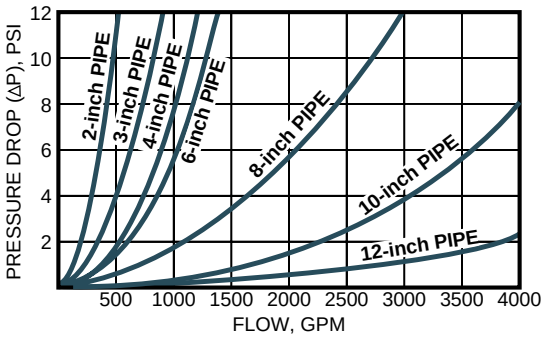
Basket strainers and bag filters are usually selected so that the pressure drop does not exceed 2 psi, when they are clean. Higher pressure drops may be tolerated when contaminant loading is low.

Determining housing pressure drop:

The pressure drops shown on the graph are reliable for all multi-basket housings, including strainer baskets or bag filter (perforated only or mesh lined). The pressure drop of any housing is governed by the size of the inlet and outlet, not the vessel itself.

1. *Using the desired pipe size and approximate flow rate, determine the basic pressure drop from the graph.*
2. *Multiply the pressure drop obtained in step 1 by the viscosity correction factor found in the accompanying table.*
3. *You now have the pressure drop for a clean multi-basket unit. If bag filters are to be employed, you must add the pressure drop they incur to get a true pressure drop for the assembly.*

Note: *Filter bags are specified separately. See pages 120-130.*



Recommended flow rates are based on housing only. Fluid viscosity, filter bag used, and expected dirt load should be considered when sizing a filter.

Viscosity Factors

CPS NUMBER								
1 (H_2O)	50	100	200	400	600	800	1000	2000
.65	.85	1.00	1.10	1.20	1.40	1.50	1.60	1.80

How To Order

Build an ordering code as shown in the example

Example: SLP-24-30-4F -1-150-C- B -S -M-20- C- 2P 1/16

Housings — Options — OPTIONAL INNER BASKET

HOUSING STYLE
- Standard (std) = **No Symbol**
- Standard Low Profile = **SLP**
- Quick Access Cover (16-24) = **QAC**
- Hinged Low Profile = **HLP**

MODEL NO.
- 16 = **16**, 30 = **30**
- 18 = **18**, 36 = **36**
- 22 = **22**, 42 = **42**
- 24 = **24**, 48 = **48**

BASKET DEPTH
- 15-in. = **15**
- 30-in. (std) = **30**

PIPE SIZE (FLANGED[1])
- 2-in. (Std,SLP,HLP16-48 / QAC 18 & 24) = **2F**
- 3-in.(Std, SLP, HLP 16-48 / QAC 18 & 24) = **3F**
- 4-in. (Std 16-48 / SLP, HLP 22-48 / QAC 24) = **4F**
- 6-in. (Std 22-48 / SLP, HLP 30-48) = **6F**
- 8-in. (Std 30-48 / SLP, HLP 36-48) = **8F**
- 10-in. (Std 36-48 / SLP, HLP 42 & 48) = **10F**
- 12-in. (Std 42, 48) = **12F**

OUTLET STYLE
- In-line, bottom (std) = **1**
- Side inlet/outlet (SLP, HLP, QAC) = **2**
- Side inlet/outlet, same side (SLP, HLP, QAC) = **4**

PRESSURE RATING[2]
- 150 psi (flanged) = **150**

HOUSING MATERIAL
- Carbon steel = **C**
- 304 stainless steel = **S**
- 316 stainless steel = **S316**

***COVER SEAL**
- Buna N = **B**
- Ethylene Propylene = **E**
- Viton® = **V**
- Teflon® Encapsulated Viton® = **TEV**
- Teflon® (solid white) = **TSW**

BASKET SEAL
- No seal = **N**
- Seal (only on strainer housings) = **S**

OPTIONAL INNER BASKET, MEDIA SIZE
Perforation diameters (for type 2P baskets)
1/4, 3/16, 9/64, 3/32, 1/16
Mesh sizes (for type 2M & 2BM baskets)
20, 30, 40, 50, 60, 70, 80, 100, 150, or 200

OPTIONAL INNER BASKET, TYPE
- **2B** = Filter bag basket, 9/64 perforations
- **2P** = Strainer basket, perforated metal
- **2BM** = Filter basket, mesh lined
- **2M** = Strainer basket, perforated, mesh lined

ASME CODE STAMP
- **C** = Code

BASKET, MEDIA SIZE No symbol if type B basket was selected
Perforation diameters (for type P baskets)
1/4, 3/16, 9/64, 3/32, 1/16
Mesh sizes (for type M & BM baskets)
20, 30, 40, 50, 60, 70, 80, 100, 150, or 200

BASKET, TYPE
- **PB** = Filter bag basket, 9/64 perforations
- **P** = Strainer basket, perforated metal
- **BM** = Filter bag basket, perforated, mesh lined
- **M** = Strainer basket, perforated, mesh lined
- **HWM** = Filter bag basket, heavy wire mesh

1. Flanges provided with the housing match the pressure rating of the vessel. Housings rated 150 psi have 150 class flanges. Housings rated 300 psi have 300 class flanges. Other styles and classes available. ANSI B16.5 Pressure-Temperature rating tables determine flange class for ASME code housings. Consult factory.
2. Higher pressure ratings available. Consult factory.

***Note:** The TEV and TSW cover seals are not available on the low profile QAC.

APPENDIX C

REMOVAL ACTION ALTERNATIVES COST ESTIMATES

APPENDIX C.1

INNER PIER 1 ALTERNATIVES COST ESTIMATES

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-2: LAND-BASED DREDGING TO BEDROCK, DEWATERING, and OFF-SITE DISPOSAL of SEDIMENT & DEWATERING FLUID
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	300	hr			$37.50		$0	$0	$11,250	$0	$11,250
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	2	ea				$2,500.00	$0	$0	$0	$5,000	$5,000
2.3 Equipment Mobilization/Demobilization	5	ea			$170.00	$522.00	$0	$0	$850	$2,610	$3,460
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	30	day		$169.00	$384.64		$0	$5,070	$11,539	$0	$16,609
3.5 Site Health & Safety	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.6 Site QA/QC	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.7 Bathymetric Survey (pre & post removal)	2	ea	$5,000.00				$10,000	$0	$0	$0	$10,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator, long-reach	25	day			$466.96	$3,689.00	$0	$0	$11,674	$92,225	$103,899
4.2 Spoil Barge, 90' by 30', 2 each	50	day				$748.40	$0	$0	$0	$37,420	$37,420
4.3 Tugboat, 2 each	50	day			$340.48	$663.40	$0	$0	$17,024	$33,170	$50,194
4.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
4.5 Trash Pumps, 2 each	50	day				$117.00	$0	$0	$0	$5,850	$5,850
4.6 Turbidity Curtain	170	ft		$39.90			$0	$6,783	$0	$0	$6,783
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 2 each	4	mo				$781.00	$0	$0	$0	$3,124	$3,124
4.9 Transfer Pumps, 2 each	50	day				$66.40	$0	$0	$0	$3,320	$3,320
4.10 Dredgeman/Laborers, 6 each	150	day			$309.86		$0	$0	$46,479	$0	$46,479
4.11 Fly Ash	264	tons		$40.00			$0	$10,560	$0	$0	$10,560
4.12 Front-End Loader	25	day			$430.24	$854.40	$0	$0	$10,756	$21,360	$32,116
4.13 Excavator	25	day			$466.96	$2,635.00	$0	$0	$11,674	$65,875	$77,549
4.14 Sampling Dewatered Sediment	12	ea	$1,290.00	$25.00	$50.00	$55.00	$15,480	$300	$600	$660	$17,040
4.15 Sampling Dewatering Fluid	6	ea	$645.00	$25.00	$50.00	$55.00	$3,870	$150	$300	$330	$4,650
5 TRANSPORTATION AND DISPOSAL											
5.1 Hazardous Sediment	295	tons	$350.00				$103,250	$0	$0	$0	$103,250
5.2 Non-Hazardous Sediment	3,225	tons	$40.00				$129,000	$0	$0	$0	$129,000
5.3 Disposal of Dewatering Fluid	27,650	gal	$0.15				$4,148	$0	$0	$0	$4,148
5.4 Transportation of Dewatering Fluid ($500/5,000 gal)	6	trip	$500.00				$3,000	$0	$0	$0	$3,000
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
6.2 Remedial Action Closeout Report	140	hr			$37.50		$0	$0	$5,250	$0	$5,250
Subtotal							$269,998	$44,048	$147,620	$286,567	$748,233
Overhead on Labor Cost @ 30%									$44,286		$44,286
G & A on Cost @ 10%							$27,000	$4,405	$14,762	$28,657	$74,823
Tax on Materials and Equipment Cost @ 6%								$2,643		$17,194	$19,837
Total Direct Cost							$296,997	$51,096	$206,668	$332,418	$887,179
* Indirects on Total Direct Cost @ 30%			(excluding transportation and disposal cost)								$194,334
Profit on Total Direct Cost @ 10%											$88,718
Total Field Cost											$1,170,231

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-2: LAND-BASED DREDGING TO BEDROCK, DEWATERING, and OFF-SITE DISPOSAL of SEDIMENT & DEWATERING FLUID
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Contingency on Total Field Costs @ 20%											$234,046
Engineering on Total Field Cost @ 5%											$58,512
TOTAL CAPITAL COST											**$1,462,789**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-3: WATER-BASED DREDGING TO BEDROCK, DEWATERING, and OFF-SITE DISPOSAL of SEDIMENT & DEWATERING FLUID
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	300	hr			$37.50		$0	$0	$11,250	$0	$11,250
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	2	ea				$2,500.00	$0	$0	$0	$5,000	$5,000
2.3 Equipment Mobilization/Demobilization	4	ea			$170.00	$522.00	$0	$0	$680	$2,088	$2,768
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	30	day		$169.00	$384.64		$0	$5,070	$11,539	$0	$16,609
3.5 Site Health & Safety	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.6 Site QA/QC	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.7 Bathymetric Survey (pre & post removal)	2	ea	$5,000.00				$10,000	$0	$0	$0	$10,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator on Barge, long-reach	25	day			$466.96	$4,437.40	$0	$0	$11,674	$110,935	$122,609
4.2 Spoil Barge, 90' by 30', 2 each	50	day				$748.40	$0	$0	$0	$37,420	$37,420
4.3 Tugboat, 2 each	50	day			$340.48	$663.40	$0	$0	$17,024	$33,170	$50,194
4.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
4.5 Trash Pumps, 2 each	50	day				$117.00	$0	$0	$0	$5,850	$5,850
4.6 Turbidity Curtain	170	ft		$39.90			$0	$6,783	$0	$0	$6,783
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 2 each	4	mo				$781.00	$0	$0	$0	$3,124	$3,124
4.9 Transfer Pump, 2 each	50	day				$66.40	$0	$0	$0	$3,320	$3,320
4.10 Dredgeman/Laborers, 6 each	150	day			$309.86		$0	$0	$46,479	$0	$46,479
4.11 Fly Ash	264	tons		$40.00			$0	$10,560	$0	$0	$10,560
4.12 Front-End Loader	25	day			$430.24	$854.40	$0	$0	$10,756	$21,360	$32,116
4.13 Excavator	25	day			$466.96	$2,635.00	$0	$0	$11,674	$65,875	$77,549
4.14 Sampling Dewatered Sediment	12	ea	$1,290.00	$25.00	$50.00	$55.00	$15,480	$300	$600	$660	$17,040
4.15 Sampling Dewatering Fluid	5	ea	$645.00	$25.00	$50.00	$55.00	$3,225	$125	$250	$275	$3,875
5 TRANSPORTATION AND DISPOSAL											
5.1 Hazardous Sediment	295	tons	$350.00				$103,250	$0	$0	$0	$103,250
5.2 Non-Hazardous Sediment	3,225	tons	$40.00				$129,000	$0	$0	$0	$129,000
5.3 Disposal of Dewatering Fluid	27,650	gal	$0.15				$4,148	$0	$0	$0	$4,148
5.4 Transportation of Dewatering Fluid ($500/5,000 gal)	6	trip	$500.00				$3,000	$0	$0	$0	$3,000
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
6.2 Remedial Action Closeout Report	140	hr			$37.50		$0	$0	$5,250	$0	$5,250
Subtotal							$269,353	$44,023	$147,400	$304,700	$765,476
Overhead on Labor Cost @ 30%									$44,220		$44,220
G & A on Cost @ 10%							$26,935	$4,402	$14,740	$30,470	$76,548
Tax on Materials and Equipment Cost @ 6%								$2,641		$18,282	$20,923
Total Direct Cost							$296,288	$51,067	$206,360	$353,452	$907,167
* Indirects on Total Direct Cost @ 30% (excluding transportation and disposal cost)											$200,331
Profit on Total Direct Cost @ 10%											$90,717
Total Field Cost											$1,198,214

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-3: WATER-BASED DREDGING TO BEDROCK, DEWATERING, and OFF-SITE DISPOSAL of SEDIMENT & DEWATERING FLUID
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Contingency on Total Field Costs @ 20%											$239,643
Engineering on Total Field Cost @ 5%											$59,911
TOTAL CAPITAL COST											**$1,497,768**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-4: LAND-BASED DREDGING TO BEDROCK, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, and OFF-SITE DISPOSAL of DEWATERED SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	350	hr			$37.50		$0	$0	$13,125	$0	$13,125
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	2	ea				$2,500.00	$0	$0	$0	$5,000	$5,000
2.3 Equipment Mobilization/Demobilization	5	ea			$170.00	$522.00	$0	$0	$850	$2,610	$3,460
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	30	day		$169.00	$384.64		$0	$5,070	$11,539	$0	$16,609
3.5 Site Health & Safety	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.6 Site QA/QC	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.7 Bathymetric Survey (pre & post removal)	2	ea	$5,000.00				$10,000	$0	$0	$0	$10,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator, long-reach	25	day			$466.96	$3,689.00	$0	$0	$11,674	$92,225	$103,899
4.2 Spoil Barge, 90' by 30', 2 each	50	day				$748.40	$0	$0	$0	$37,420	$37,420
4.3 Tugboat, 2 each	50	day			$340.48	$663.40	$0	$0	$17,024	$33,170	$50,194
4.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
4.5 Trash Pumps, 2 each	50	day				$117.00	$0	$0	$0	$5,850	$5,850
4.6 Turbidity Curtain	170	ft		$39.90			$0	$6,783	$0	$0	$6,783
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 2 each	4	mo				$781.00	$0	$0	$0	$3,124	$3,124
4.9 Transfer Pumps, 2 each	50	day				$66.40	$0	$0	$0	$3,320	$3,320
4.10 Dredgeman/Laborers, 6 each	150	day			$309.86		$0	$0	$46,479	$0	$46,479
4.11 Fly Ash	264	tons		$40.00			$0	$10,560	$0	$0	$10,560
4.12 Front-End Loader	25	day			$430.24	$854.40	$0	$0	$10,756	$21,360	$32,116
4.13 Excavator	25	day			$466.96	$2,635.00	$0	$0	$11,674	$65,875	$77,549
4.14 Sampling Dewatered Sediment	12	ea	$1,290.00	$25.00	$50.00	$55.00	$15,480	$300	$600	$660	$17,040
5 DEWATERING FLUID TREATMENT											
5.1 1,000 lb Liquid-Phase GAC Adsorption Units, 2 units	2	ea		$2,050.00	$485.00			$4,100	$970	$0	$5,070
5.2 18 sf Pressurized Bag Filters, 2 units	2	ea		$410.00	$258.00			$820	$516	$0	$1,336
5.3 Piping , 3/4" PVC, for Treatment System	200	ft		$1.67	$7.65		$0	$334	$1,530	$0	$1,864
5.4 Replace Filter Bag Element	16	ea		$10.00				$160	$0	$0	$160
5.5 Replace GAC Adsorption Unit	4,000	lb		$1.50				$6,000	$0	$0	$6,000
5.6 Dredgeman/Laborers, 3 each	75	day			$309.86		$0	$0	$23,240	$0	$23,240
5.7 Sampling Influent & Effluent	48	ea	$800.00	$25.00	$50.00	$55.00	$38,400	$1,200	$2,400	$2,640	$44,640
6 TRANSPORTATION AND DISPOSAL											
6.1 Hazardous Sediment	295	tons	$350.00				$103,250	$0	$0	$0	$103,250
6.2 Non-Hazardous Sediment	3,225	tons	$40.00				$129,000	$0	$0	$0	$129,000
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
7.2 Remedial Action Closeout Report	140	hr			$37.50		$0	$0	$5,250	$0	$5,250
Subtotal							$297,380	$56,512	$177,851	$288,877	$820,620
Overhead on Labor Cost @ 30%									$53,355		$53,355
G & A on Cost @ 10%							$29,738	$5,651	$17,785	$28,888	$82,062
Tax on Materials and Equipment Cost @ 6%								$3,391		$17,333	$20,723
Total Direct Cost							$327,118	$65,554	$248,991	$335,097	$976,760

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-4: LAND-BASED DREDGING TO BEDROCK, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, and OFF-SITE DISPOSAL of DEWATERED SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
* Indirects on Total Direct Cost @ 30% (excluding transportation and disposal cost)											$223,353
Profit on Total Direct Cost @ 10%											$97,676
Total Field Cost											$1,297,789
Contingency on Total Field Costs @ 20%											$259,558
Engineering on Total Field Cost @ 5%											$64,889
TOTAL CAPITAL COST											**$1,622,237**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-5: WATER-BASED DREDGING TO BEDROCK, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, and OFF-SITE DISPOSAL of DEWATERED SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	350	hr			$37.50		$0	$0	$13,125	$0	$13,125
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	2	ea				$2,500.00	$0	$0	$0	$5,000	$5,000
2.3 Equipment Mobilization/Demobilization	5	ea			$170.00	$522.00	$0	$0	$850	$2,610	$3,460
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	30	day		$169.00	$384.64		$0	$5,070	$11,539	$0	$16,609
3.5 Site Health & Safety	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.6 Site QA/QC	25	day		$169.00	$307.68		$0	$4,225	$7,692	$0	$11,917
3.7 Bathymetric Survey (pre & post removal)	2	ea	$5,000.00				$10,000	$0	$0	$0	$10,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator on Barge, long-reach	25	day			$466.96	$4,437.40	$0	$0	$11,674	$110,935	$122,609
4.2 Spoil Barge, 90' by 30', 2 each	50	day				$748.40	$0	$0	$0	$37,420	$37,420
4.3 Tugboat, 2 each	50	day			$340.48	$663.40	$0	$0	$17,024	$33,170	$50,194
4.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
4.5 Trash Pumps, 2 each	50	day				$117.00	$0	$0	$0	$5,850	$5,850
4.6 Turbidity Curtain	170	ft		$39.90			$0	$6,783	$0	$0	$6,783
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 2 each	4	mo				$781.00	$0	$0	$0	$3,124	$3,124
4.9 Transfer Pumps, 2 each	50	day				$66.40	$0	$0	$0	$3,320	$3,320
4.10 Dredgeman/Laborers, 6 each	150	day			$309.86		$0	$0	$46,479	$0	$46,479
4.11 Fly Ash	264	tons		$40.00			$0	$10,560	$0	$0	$10,560
4.12 Front-End Loader	25	day			$430.24	$854.40	$0	$0	$10,756	$21,360	$32,116
4.13 Excavator	25	day			$466.96	$2,635.00	$0	$0	$11,674	$65,875	$77,549
4.14 Sampling Dewatered Sediment	12	ea	$1,290.00	$25.00	$50.00	$55.00	$15,480	$300	$600	$660	$17,040
5 DEWATERING FLUID TREATMENT											
5.1 1,000 lb Liquid-Phase GAC Adsorption Units, 2 each	2	ea		$2,050.00	$485.00			$4,100	$970	$0	$5,070
5.2 18 sf Pressurized Bag Filters, 2 units	2	ea		$410.00	$258.00			$820	$516	$0	$1,336
5.3 Piping , 3/4" PVC, for Treatment System	200	ft		$1.67	$7.65		$0	$334	$1,530	$0	$1,864
5.4 Replace Filter Bag Element	16	ea		$10.00				$160	$0	$0	$160
5.5 Replace GAC Adsorption Unit	4,000	lb		$1.50				$6,000	$0	$0	$6,000
5.6 Dredgeman/Laborers, 3 each	75	day			$309.86		$0	$0	$23,240	$0	$23,240
5.7 Sampling Influent & Effluent	48	ea	$800.00	$25.00	$50.00	$55.00	$38,400	$1,200	$2,400	$2,640	$44,640
6 TRANSPORTATION AND DISPOSAL											
6.1 Hazardous Sediment	295	tons	$350.00				$103,250	$0	$0	$0	$103,250
6.2 Non-Hazardous Sediment	3,225	tons	$40.00				$129,000	$0	$0	$0	$129,000
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
7.2 Remedial Action Closeout Report	140	hr			$37.50		$0	$0	$5,250	$0	$5,250
Subtotal							$297,380	$56,512	$177,851	$307,587	$839,330
Overhead on Labor Cost @ 30%									$53,355		$53,355
G & A on Cost @ 10%							$29,738	$5,651	$17,785	$30,759	$83,933
Tax on Materials and Equipment Cost @ 6%								$3,391		$18,455	$21,846
Total Direct Cost							$327,118	$65,554	$248,991	$356,801	$998,464

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-5: WATER-BASED DREDGING TO BEDROCK, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, and OFF-SITE DISPOSAL of DEWATERED SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
* Indirects on Total Direct Cost @ 30% (excluding transportation and disposal cost)											$229,864
Profit on Total Direct Cost @ 10%											$99,846
Total Field Cost											$1,328,174
Contingency on Total Field Costs @ 20%											$265,635
Engineering on Total Field Cost @ 5%											$66,409
TOTAL CAPITAL COST											**$1,660,218**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-6: DRAIN of INNER PIER 1, EXCAVATION TO BEDROCK, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF SURFACE WATER & DEWATERING FLUID, and OFF-SITE DISPOSAL of DEWATERED SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	375	hr			$37.50		$0	$0	$14,063	$0	$14,063
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	2	ea				$2,500.00	$0	$0	$0	$5,000	$5,000
2.3 Equipment Mobilization/Demobilization	5	ea			$170.00	$522.00	$0	$0	$850	$2,610	$3,460
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	35	day		$169.00	$384.64		$0	$5,915	$13,462	$0	$19,377
3.5 Site Health & Safety	30	day		$169.00	$307.68		$0	$5,070	$9,230	$0	$14,300
3.6 Site QA/QC	30	day		$169.00	$307.68		$0	$5,070	$9,230	$0	$14,300
3.7 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DRAINAGE OF INNER PIER 1											
4.1 Portadam Material Rental	2	mo	$42,750.00				$85,500	$0	$0	$0	$85,500
4.2 Portadam Installation Crew	9	day	$3,110.00				$27,990	$0	$0	$0	$27,990
4.3 Portadam Misc Supplies	1	ls	$6,300.00				$6,300	$0	$0	$0	$6,300
4.4 Portadam Crew Travel & Living	2	trip	$1,845.00				$3,690	$0	$0	$0	$3,690
4.5 Pump, 4" submersible	30	day				$169.20	$0	$0	$0	$5,076	$5,076
4.6 Dredgeman/Laborers, 3 each	90	day			$309.86		$0	$0	$27,887	$0	$27,887
4.7 Excavator	7	day			$466.96	$2,635.00	$0	$0	$3,269	$18,445	$21,714
5 DREDGING											
5.1 Excavator, long-reach	25	day			$466.96	$3,689.00	$0	$0	$11,674	$92,225	$103,899
5.2 Spoil Barge, 90' by 30', 2 each	50	day				$748.40	$0	$0	$0	$37,420	$37,420
5.3 Tugboat, 2 each	50	day			$340.48	$663.40	$0	$0	$17,024	$33,170	$50,194
5.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
5.5 Trash Pumps, 2 each	50	day				$117.00	$0	$0	$0	$5,850	$5,850
5.6 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
5.7 Dewatering Effluent Tank, 2,000 gal, 2 each	4	mo				$600.00	$0	$0	$0	$2,400	$2,400
5.8 Dredgeman/Laborers, 6 each	150	day			$309.86		$0	$0	$46,479	$0	$46,479
5.9 Fly Ash	264	tons		$40.00			$0	$10,560	$0	$0	$10,560
5.10 Front-End Loader	25	day			$430.24	$854.40	$0	$0	$10,756	$21,360	$32,116
5.11 Excavator	25	day			$466.96	$2,635.00	$0	$0	$11,674	$65,875	$77,549
5.12 Sampling Dewatered Sediment	12	ea	$1,290.00	$25.00	$50.00	$55.00	$15,480	$300	$600	$660	$17,040
6 SURFACE WATER & DEWATERING FLUID TREATMENT											
6.1 10,000 lb Liquid-Phase GAC Adsorption Units, 2 each	2	ea		$20,000.00	$585.00			$40,000	$1,170	$0	$41,170
6.2 100 sf Pressurized Bag Filters, 2 units	2	ea		$1,650.00	$358.00			$3,300	$716	$0	$4,016
6.3 Piping , 3" PVC, for Treatment System	200	ft		$6.60	$13.25		$0	$1,320	$2,650	$0	$3,970
6.4 Replace Filter Bag Element	506	ea		$10.00				$5,060	$0	$0	$5,060
6.5 Replace GAC Adsorption Unit	150,000	lb		$1.50				$225,000	$0	$0	$225,000
6.6 Dredgeman/Laborers, 3 each	90	day			$309.86		$0	$0	$27,887	$0	$27,887
6.7 Sampling Influent & Effluent	54	ea	$800.00	$25.00	$50.00	$55.00	$43,200	$1,350	$2,700	$2,970	$50,220
7 TRANSPORTATION AND DISPOSAL											
7.1 Hazardous Sediment	295	tons	$350.00				$103,250	$0	$0	$0	$103,250
7.2 Non-Hazardous Sediment	3,225	tons	$40.00				$129,000	$0	$0	$0	$129,000
8 POST CONSTRUCTION COST											
8.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
8.2 Remedial Action Closeout Report	150	hr			$37.50		$0	$0	$5,625	$0	$5,625
Subtotal							$415,660	$315,680	$221,787	$308,684	$1,261,811

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE IP-6: DRAIN of INNER PIER 1, EXCAVATION TO BEDROCK, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF SURFACE WATER & DEWATERING FLUID, and OFF-SITE DISPOSAL of DEWATERED SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @ 30%									$66,536		$66,536
G & A on Cost @ 10%							$41,566	$31,568	$22,179	$30,868	$126,181
Tax on Materials and Equipment Cost @ 6%								$18,941		$18,521	$37,462
Total Direct Cost							$457,226	$366,189	$310,502	$358,073	$1,491,990
* Indirects on Total Direct Cost @ 30%		(excluding transportation and disposal cost)									$377,922
Profit on Total Direct Cost @ 10%											$149,199
Total Field Cost											$2,019,111
Contingency on Total Field Costs @ 20%											$403,822
Engineering on Total Field Cost @ 5%											$100,956
TOTAL CAPITAL COST											**$2,523,889**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

APPENDIX C.2

OUTER PIER 1 ALTERNATIVES COST ESTIMATES

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-2: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, OFF-SITE DISPOSAL OF DEWATERED SEDIMENT & EFFLUENT FLUID, LUCs, and MONITORING
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare LUC RD Documents	60	hr			$35.00		$0	$0	$2,100	$0	$2,100
1.2 Prepare Documents & Plans including Permits	300	hr			$35.00		$0	$0	$10,500	$0	$10,500
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	3	ea				$2,500.00	$0	$0	$0	$7,500	$7,500
2.3 Equipment Mobilization/Demobilization	5	ea			$170.00	$522.00	$0	$0	$850	$2,610	$3,460
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	1	mo				$375.00	$0	$0	$0	$375	$375
3.2 Field Office Equipment, Utilities, & Support	1	mo		$470.00			$0	$470	$0	$0	$470
3.3 Storage Trailer	1	mo				$99.00	$0	$0	$0	$99	$99
3.4 Site Superintendent	15	day		$169.00	$384.64		$0	$2,535	$5,770	$0	$8,305
3.5 Site Health & Safety	10	day		$169.00	$307.68		$0	$1,690	$3,077	$0	$4,767
3.6 Site QA/QC	10	day		$169.00	$307.68		$0	$1,690	$3,077	$0	$4,767
3.7 Bathymetric Survey (pre-removal)	1	ea	$5,000.00				$5,000	$0	$0	$0	$5,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator on Barge, long-reach	5	day			$466.96	$4,437.40	$0	$0	$2,335	$22,187	$24,522
4.2 Spoil Barge, 90' by 30', 2 each	10	day				$748.40	$0	$0	$0	$7,484	$7,484
4.3 Tugboat	5	day			$340.48	$663.40	$0	$0	$1,702	$3,317	$5,019
4.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
4.5 Trash Pumps, 2 each	10	day				$117.00	$0	$0	$0	$1,170	$1,170
4.6 Turbidity Curtain	400	ft		$39.90			$0	$15,960	$0	$0	$15,960
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 2 each	1	mo				$781.00	$0	$0	$0	$781	$781
4.9 Transfer Pumps, 2 each	10	day				$66.40	$0	$0	$0	$664	$664
4.10 Dredgeman/Laborers, 6 each	30	day			$309.86		$0	$0	$9,296	$0	$9,296
4.11 Fly Ash	40	tons		$40.00			$0	$1,600	$0	$0	$1,600
4.12 Front-End Loader	5	day			$430.24	$854.40	$0	$0	$2,151	$4,272	$6,423
4.13 Excavator	5	day			$466.96	$2,635.00	$0	$0	$2,335	$13,175	$15,510
4.14 Sampling Dewatered Sediment	2	ea	$1,290.00	$25.00	$50.00	$55.00	$2,580	$50	$100	$110	$2,840
4.15 Sampling Dewatering Fluid	2	ea	$645.00	$25.00	$50.00	$55.00	$1,290	$50	$100	$110	$1,550
5 CAPPING AND SITE RESTORATION											
5.1 Sand/Gravel Cap - 3 ft thick	680	cy		$21.60			$0	$14,688	$0	$0	$14,688
5.2 Load Barges with 3 CY Excavator	680	cy	$2.51				$1,707	$0	$0	$0	$1,707
5.3 Barge, 800 T, One for 2 Weeks for Sand/Gravel	2	wk				$2,256.00	$0	$0	$0	$4,512	$4,512
5.4 Barge-Mounted Clamshell to Unload Sand/Gravel	2	days	$4,020.25				$8,041	$0	$0	$0	$8,041
6 TRANSPORTATION AND DISPOSAL											
6.1 Non-Hazardous Sediment	535	tons	$40.00				$21,400	$0	$0	$0	$21,400
6.2 Disposal of Dewatering Fluid	8,400	gal	$0.15				$1,260	$0	$0	$0	$1,260
6.3 Transportation of Dewatering Fluid ($500/5,000 gal)	2	trip	$500.00				$1,000	$0	$0	$0	$1,000
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	80	hr			$35.00		$0	$0	$2,800	$0	$2,800
7.2 Remedial Action Closeout Report	140	hr			$35.00		$0	$0	$4,900	$0	$4,900
Subtotal							$43,527	$50,528	$52,932	$83,041	$230,029

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-2: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, OFF-SITE DISPOSAL OF DEWATERED SEDIMENT & EFFLUENT FLUID, LUCs, and MONITORING
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @ 30%									$15,880		$15,880
G & A on Labor Cost @ 10%									$5,293		$5,293
G & A on Material Cost @ 10%								$5,053			$5,053
G & A on Equipment Cost @ 10%										$8,304	$8,304
G & A on Subcontract Cost @ 10%							$4,353				$4,353
Tax on Materials and Equipment Cost @ 6%								$3,032		$4,982	$8,014
Total Direct Cost							$47,880	$58,612	$74,105	$96,328	$276,925
* Indirects on Total Direct Cost @ 30%		(excluding transportation and disposal cost)									$75,980
Profit on Total Direct Cost @ 10%											$27,693
Total Field Cost											$380,597
Contingency on Total Field Costs @ 20%											$76,119
Engineering on Total Field Cost @ 5%											$19,030
TOTAL CAPITAL COST											**$475,747**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

ALTERNATIVE OP-2: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, OFF-SITE DISPOSAL OF DEWATERED SEDIMENT & EFFLUENT FLUID, LUCs, and MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Year 2	Item Cost Year 3	Item Cost Years 4 through 30	Item Cost Every 5 Years	Notes
Bathymetric Survey	$5,000		$5,000		$5,000	Survey years 1, 3, 5, and every 5 years.
Sediment and Surface Water Sampling	$10,000	$10,000	$5,000	$5,000		Sediment and surface water at four locations on and around the cap. Sample semi-annually the first 2 years and annually thereafter.
Sediment Analysis	$3,752	$3,752	$1,876	$1,876		Analyze sediments for PAHs, PCBs, pesticides, and metals. Add 40% for QA
Surface Water Analysis	$3,752	$3,752	$1,876	$1,876		Analyze surface water for PAHs, PCBs, pesticides, and metals. Add 40% for QA
Annual Report	$5,000	$5,000	$5,000	$5,000		
Inspection	$1,000	$1,000	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review					$23,000	5-year review
Subtotal	$28,504	$23,504	$19,752	$14,752	$28,000	
Contingency at 10%	$2,850	$2,350	$1,975	$1,475	$2,800	
TOTAL	$31,354	$25,854	$21,727	$16,227	$30,800	

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
ALTERNATIVE OP-2: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, OFF-SITE DISPOSAL OF DEWATERED SEDIMENT & EFFLUENT FLUID, LUCs, and MONITORING
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$475,747		$475,747	1.000	$475,747
1		$31,354	$31,354	0.935	$29,316
2		$25,854	$25,854	0.873	$22,571
3		$21,727	$21,727	0.816	$17,729
4		$16,227	$16,227	0.763	$12,381
5		$47,027	$47,027	0.713	$33,530
6		$16,227	$16,227	0.666	$10,807
7		$16,227	$16,227	0.623	$10,110
8		$16,227	$16,227	0.582	$9,444
9		$16,227	$16,227	0.544	$8,828
10		$47,027	$47,027	0.508	$23,890
11		$16,227	$16,227	0.475	$7,708
12		$16,227	$16,227	0.444	$7,205
13		$16,227	$16,227	0.415	$6,734
14		$16,227	$16,227	0.388	$6,296
15		$47,027	$47,027	0.362	$17,024
16		$16,227	$16,227	0.339	$5,501
17		$16,227	$16,227	0.317	$5,144
18		$16,227	$16,227	0.296	$4,803
19		$16,227	$16,227	0.277	$4,495
20		$47,027	$47,027	0.258	$12,133
21		$16,227	$16,227	0.242	$3,927
22		$16,227	$16,227	0.226	$3,667
23		$16,227	$16,227	0.211	$3,424
24		$16,227	$16,227	0.197	$3,197
25		$47,027	$47,027	0.184	$8,653
26		$16,227	$16,227	0.172	$2,791
27		$16,227	$16,227	0.161	$2,613
28		$16,227	$16,227	0.15	$2,434
29		$16,227	$16,227	0.141	$2,288
30		$47,027	$47,027	0.131	$6,161
				TOTAL PRESENT WORTH	**$770,551**

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-3: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, ON-SITE DEWATERING FLUID TREATMENT & DISCHARGE, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare LUC RD Documents	60	hr			$35.00		$0	$0	$2,100	$0	$2,100
1.2 Prepare Documents & Plans including Permits	300	hr			$35.00		$0	$0	$10,500	$0	$10,500
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	2	ea				$2,500.00	$0	$0	$0	$5,000	$5,000
2.3 Equipment Mobilization/Demobilization	5	ea			$170.00	$522.00	$0	$0	$850	$2,610	$3,460
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	1	mo				$375.00	$0	$0	$0	$375	$375
3.2 Field Office Equipment, Utilities, & Support	1	mo		$470.00			$0	$470	$0	$0	$470
3.3 Storage Trailer	1	mo				$99.00	$0	$0	$0	$99	$99
3.4 Site Superintendent	15	day		$169.00	$384.64		$0	$2,535	$5,770	$0	$8,305
3.5 Site Health & Safety	10	day		$169.00	$307.68		$0	$1,690	$3,077	$0	$4,767
3.6 Site QA/QC	10	day		$169.00	$307.68		$0	$1,690	$3,077	$0	$4,767
3.7 Bathymetric Survey (pre-removal)	1	ea	$5,000.00				$5,000	$0	$0	$0	$5,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator on Barge, long-reach	5	day			$466.96	$4,437.40	$0	$0	$2,335	$22,187	$24,522
4.2 Spoil Barge, 90' by 30', 2 each	10	day				$748.40	$0	$0	$0	$7,484	$7,484
4.3 Tugboat	5	day			$340.48	$663.40	$0	$0	$1,702	$3,317	$5,019
4.4 Barge Barriers, fabric, membrane, etc.	2	ea		$4,875.00			$0	$9,750	$0	$0	$9,750
4.5 Trash Pumps, 2 each	10	day				$117.00	$0	$0	$0	$1,170	$1,170
4.6 Turbidity Curtain	400	ft		$39.90			$0	$15,960	$0	$0	$15,960
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 2 each	1	mo				$781.00	$0	$0	$0	$781	$781
4.9 Transfer Pumps, 2 each	10	day				$66.40	$0	$0	$0	$664	$664
4.10 Dredgeman/Laborers, 6 each	30	day			$309.86		$0	$0	$9,296	$0	$9,296
4.11 Fly Ash	40	tons		$40.00			$0	$1,600	$0	$0	$1,600
4.12 Front-End Loader	5	day			$430.24	$854.40	$0	$0	$2,151	$4,272	$6,423
4.13 Excavator	5	day			$466.96	$2,635.00	$0	$0	$2,335	$13,175	$15,510
4.14 Sampling Dewatered Sediment	2	ea	$1,290.00	$25.00	$50.00	$55.00	$2,580	$50	$100	$110	$2,840
5 CAPPING AND SITE RESTORATION											
5.1 Sand/Gravel Cap - 3 ft thick	680	cy		$21.60			$0	$14,688	$0	$0	$14,688
5.2 Load Barges with 3 CY Excavator	680	cy	$2.51				$1,707	$0	$0	$0	$1,707
5.3 Barge, 800 T, One for 2 Weeks for Sand/Gravel	2	wk				$2,256.00	$0	$0	$0	$4,512	$4,512
5.4 Barge-Mounted Clamshell to Unload Sand/Gravel	2	days	$4,020.25				$8,041	$0	$0	$0	$8,041
6 DEWATERING FLUID TREATMENT											
6.1 1,500 lb Liquid-Phase GAC Adsorption Units, 1 unit	1	ea		$3,000.00	$750.00			$3,000	$750	$0	$3,750
6.2 18 sf Pressurized Bag Filters, 1 unit	1	ea		$500.00	$300.00			$500	$300	$0	$800
6.3 Piping , 3/4" PVC, for Treatment System	200	ft		$1.67	$7.65		$0	$334	$1,530	$0	$1,864
6.4 Replace Filter Bag Element	4	ea		$10.00				$40	$0	$0	$40
6.5 Replace GAC Adsorption Unit	1,100	lb		$1.50				$1,650	$0	$0	$1,650
6.6 Dredgeman/Laborers, 1 each, 3 shifts/day	9	day			$309.86		$0	$0	$2,789	$0	$2,789
5.7 Sampling Influent & Effluent	4	ea	$800.00	$25.00	$50.00	$55.00	$3,200	$100	$200	$220	$3,720
7 TRANSPORTATION AND DISPOSAL											
7.1 Non-Hazardous Sediment	535	tons	$40.00				$21,400	$0	$0	$0	$21,400
8 POST CONSTRUCTION COST											
8.1 Contractor Completion Report	80	hr			$35.00		$0	$0	$2,800	$0	$2,800
8.2 Remedial Action Closeout Report	140	hr			$35.00		$0	$0	$4,900	$0	$4,900
Subtotal							$43,177	$56,102	$58,401	$80,651	$238,331

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-3: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, ON-SITE DEWATERING FLUID TREATMENT & DISCHARGE, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @ 30%									$17,520		$17,520
G & A on Labor Cost @ 10%									$5,840		$5,840
G & A on Material Cost @ 10%								$5,610			$5,610
G & A on Equipment Cost @ 10%										$8,065	$8,065
G & A on Subcontract Cost @ 10%							$4,318				$4,318
Tax on Materials and Equipment Cost @ 6%								$3,366		$4,839	$8,205
Total Direct Cost							$47,495	$65,078	$81,761	$93,555	$287,890
* Indirects on Total Direct Cost @ 30%		(excluding transportation and disposal cost)									$79,947
Profit on Total Direct Cost @ 10%											$28,789
Total Field Cost											$396,626
Contingency on Total Field Costs @ 20%											$79,325
Engineering on Total Field Cost @ 5%											$19,831
TOTAL CAPITAL COST											**$495,782**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

ALTERNATIVE OP-3: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, ON-SITE DEWATERING FLUID TREATMENT & DISCHARGE, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Year 2	Item Cost Year 3	Item Cost Years 4 through 30	Item Cost Every 5 Years	Notes
Bathymetric Survey	$5,000		$5,000		$5,000	Survey years 1, 3, 5, and every 5 years.
Sediment and Surface Water Sampling	$10,000	$10,000	$5,000	$5,000		Sediment and surface water at four locations on and around the cap. Sample semi-annually the first 2 years and annually thereafter.
Sediment Analysis	$3,752	$3,752	$1,876	$1,876		Analyze sediments for PAHs, PCBs, pesticides, and metals. Add 40% for QA
Surface Water Analysis	$3,752	$3,752	$1,876	$1,876		Analyze surface water for PAHs, PCBs, pesticides, and metals. Add 40% for QA
Annual Report	$5,000	$5,000	$5,000	$5,000		
Inspection	$1,000	$1,000	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review					$23,000	5-year review
Subtotal	$28,504	$23,504	$19,752	$14,752	$28,000	
Contingency at 10%	$2,850	$2,350	$1,975	$1,475	$2,800	
TOTAL	$31,354	$25,854	$21,727	$16,227	$30,800	

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
ALTERNATIVE OP-3: CAPPING WITH PRE-DREDGING TO MEET THE RAO, DEWATERING, ON-SITE DEWATERING FLUID TREATMENT & DISCHARGE, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$495,782		$495,782	1.000	$495,782
1		$31,354	$31,354	0.935	$29,316
2		$25,854	$25,854	0.873	$22,571
3		$21,727	$21,727	0.816	$17,729
4		$16,227	$16,227	0.763	$12,381
5		$47,027	$47,027	0.713	$33,530
6		$16,227	$16,227	0.666	$10,807
7		$16,227	$16,227	0.623	$10,110
8		$16,227	$16,227	0.582	$9,444
9		$16,227	$16,227	0.544	$8,828
10		$47,027	$47,027	0.508	$23,890
11		$16,227	$16,227	0.475	$7,708
12		$16,227	$16,227	0.444	$7,205
13		$16,227	$16,227	0.415	$6,734
14		$16,227	$16,227	0.388	$6,296
15		$47,027	$47,027	0.362	$17,024
16		$16,227	$16,227	0.339	$5,501
17		$16,227	$16,227	0.317	$5,144
18		$16,227	$16,227	0.296	$4,803
19		$16,227	$16,227	0.277	$4,495
20		$47,027	$47,027	0.258	$12,133
21		$16,227	$16,227	0.242	$3,927
22		$16,227	$16,227	0.226	$3,667
23		$16,227	$16,227	0.211	$3,424
24		$16,227	$16,227	0.197	$3,197
25		$47,027	$47,027	0.184	$8,653
26		$16,227	$16,227	0.172	$2,791
27		$16,227	$16,227	0.161	$2,613
28		$16,227	$16,227	0.15	$2,434
29		$16,227	$16,227	0.141	$2,288
30		$47,027	$47,027	0.131	$6,161
				TOTAL PRESENT WORTH	**$790,587**

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-4: DREDGING TO MEET PRGs, DEWATERING, and OFF-SITE DISPOSAL of SEDIMENT & DEWATERING FLUID
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	300	hr			$37.50		$0	$0	$11,250	$0	$11,250
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	3	ea				$2,500.00	$0	$0	$0	$7,500	$7,500
2.3 Equipment Mobilization/Demobilization	4	ea			$170.00	$522.00	$0	$0	$680	$2,088	$2,768
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	40	day		$169.00	$384.64		$0	$6,760	$15,386	$0	$22,146
3.5 Site Health & Safety	35	day		$169.00	$307.68		$0	$5,915	$10,769	$0	$16,684
3.6 Site QA/QC	35	day		$169.00	$307.68		$0	$5,915	$10,769	$0	$16,684
3.7 Bathymetric Survey (pre & post removal)	2	ea	$5,000.00				$10,000	$0	$0	$0	$10,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator on Barge, long-reach	35	day			$466.96	$4,437.40	$0	$0	$16,344	$155,309	$171,653
4.2 Spoil Barge, 90' by 30', 3 each	105	day				$748.40	$0	$0	$0	$78,582	$78,582
4.3 Tugboat, 3 each	105	day			$340.48	$663.40	$0	$0	$35,750	$69,657	$105,407
4.4 Barge Barriers, fabric, membrane, etc.	3	ea		$4,875.00			$0	$14,625	$0	$0	$14,625
4.5 Trash Pumps, 3 each	105	day				$117.00	$0	$0	$0	$12,285	$12,285
4.6 Turbidity Curtain	800	ft		$39.90			$0	$31,920	$0	$0	$31,920
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 3 each	3	mo				$781.00	$0	$0	$0	$2,343	$2,343
4.9 Transfer Pumps, 2 each	105	day				$66.40	$0	$0	$0	$6,972	$6,972
4.10 Dredgeman/Laborers, 6 each	210	day			$309.86		$0	$0	$65,071	$0	$65,071
4.11 Verification Sampling	6	ea	$645.00	$25.00	$50.00	$55.00	$3,870	$150	$300	$330	$4,650
4.12 Fly Ash	646	tons		$40.00			$0	$25,840	$0	$0	$25,840
4.13 Front-End Loader	40	day			$430.24	$854.40	$0	$0	$17,210	$34,176	$51,386
4.14 Excavator	40	day			$466.96	$2,635.00	$0	$0	$18,678	$105,400	$124,078
4.15 Sampling Dewatered Sediment	34	ea	$1,290.00	$25.00	$50.00	$55.00	$43,860	$850	$1,700	$1,870	$48,280
4.16 Sampling Dewatering Fluid	28	ea	$645.00	$25.00	$50.00	$55.00	$18,060	$700	$1,400	$1,540	$21,700
5 TRANSPORTATION AND DISPOSAL											
5.1 Non-Hazardous Sediment	8,600	tons	$40.00				$344,000	$0	$0	$0	$344,000
5.2 Disposal of Dewatering Fluid	136,000	gal	$0.15				$20,400	$0	$0	$0	$20,400
5.3 Transportation of Dewatering Fluid ($500/5,000 gal)	28	trip	$500.00				$14,000	$0	$0	$0	$14,000
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
6.2 Remedial Action Closeout Report	140	hr			$37.50		$0	$0	$5,250	$0	$5,250
Subtotal							$455,440	$95,660	$215,396	$493,675	$1,260,171
Overhead on Labor Cost @ 30%									$64,619		$64,619
G & A on Cost @ 10%							$45,544	$9,566	$21,540	$49,368	$126,017
Tax on Materials and Equipment Cost @ 6%								$5,740		$29,621	$35,360
Total Direct Cost							$500,984	$110,966	$301,554	$572,663	$1,486,167
* Indirects on Total Direct Cost @ 30% (excluding transportation and disposal cost)											$332,330
Profit on Total Direct Cost @ 10%											$148,617
Total Field Cost											$1,967,113

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-4: DREDGING TO MEET PRGs, DEWATERING, and OFF-SITE DISPOSAL of SEDIMENT & DEWATERING FLUID
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Contingency on Total Field Costs @ 20%											$393,423
Engineering on Total Field Cost @ 5%											$98,356
TOTAL CAPITAL COST											**$2,458,892**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-5: DREDGING TO MEET PRGs, DEWATERING, ON-SITE DEWATERING FLUID TREATMENT & DISCHARGE, and OFF-SITE DISPOSAL of SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.2 Prepare Documents & Plans including Permits	300	hr			$37.50		$0	$0	$11,250	$0	$11,250
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Barge Mobilization	3	ea				$2,500.00	$0	$0	$0	$7,500	$7,500
2.3 Equipment Mobilization/Demobilization	4	ea			$170.00	$522.00	$0	$0	$680	$2,088	$2,768
2.4 Long-Reach Equipment Mobilization/Demobilization	1	ea			$300.00	$975.00	$0	$0	$300	$975	$1,275
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,250.00				$1,250	$0	$0	$0	$1,250
3 FIELD SUPPORT											
3.1 Office Trailer	2	mo				$375.00	$0	$0	$0	$750	$750
3.2 Field Office Equipment, Utilities, & Support	2	mo		$470.00			$0	$940	$0	$0	$940
3.3 Storage Trailer	2	mo				$99.00	$0	$0	$0	$198	$198
3.4 Site Superintendent	40	day		$169.00	$384.64		$0	$6,760	$15,386	$0	$22,146
3.5 Site Health & Safety	35	day		$169.00	$307.68		$0	$5,915	$10,769	$0	$16,684
3.6 Site QA/QC	35	day		$169.00	$307.68		$0	$5,915	$10,769	$0	$16,684
3.7 Bathymetric Survey (pre & post removal)	2	ea	$5,000.00				$10,000	$0	$0	$0	$10,000
3.8 Turbidity Survey (1 week)	1	ls		$1,045.00	$1,540.00	$2,040.00	$0	$1,045	$1,540	$2,040	$4,625
4 DREDGING, AND DEWATERING											
4.1 Excavator on Barge, long-reach	35	day			$466.96	$4,437.40	$0	$0	$16,344	$155,309	$171,653
4.2 Spoil Barge, 90' by 30', 3 each	105	day				$748.40	$0	$0	$0	$78,582	$78,582
4.3 Tugboat, 3 each	105	day			$340.48	$663.40	$0	$0	$35,750	$69,657	$105,407
4.4 Barge Barriers, fabric, membrane, etc.	3	ea		$4,875.00			$0	$14,625	$0	$0	$14,625
4.5 Trash Pumps, 3 each	105	day				$117.00	$0	$0	$0	$12,285	$12,285
4.6 Turbidity Curtain	800	ft		$39.90			$0	$31,920	$0	$0	$31,920
4.7 Turbidity Monitoring Buoy	2	ea				$4,080.00	$0	$0	$0	$8,160	$8,160
4.8 Dewatering Effluent Tank, 5,000 gal, 3 each	3	mo				$781.00	$0	$0	$0	$2,343	$2,343
4.9 Transfer Pumps, 2 each	105	day				$66.40	$0	$0	$0	$6,972	$6,972
4.10 Dredgeman/Laborers, 6 each	210	day			$309.86		$0	$0	$65,071	$0	$65,071
4.11 Verification Sampling	6	ea	$645.00	$25.00	$50.00	$55.00	$3,870	$150	$300	$330	$4,650
4.12 Fly Ash	646	tons		$40.00			$0	$25,840	$0	$0	$25,840
4.13 Front-End Loader	40	day			$430.24	$854.40	$0	$0	$17,210	$34,176	$51,386
4.14 Excavator	40	day			$466.96	$2,635.00	$0	$0	$18,678	$105,400	$124,078
4.15 Sampling Dewatered Sediment	34	ea	$1,290.00	$25.00	$50.00	$55.00	$43,860	$850	$1,700	$1,870	$48,280
5 DEWATERING FLUID TREATMENT											
5.1 1,500 lb Liquid-Phase GAC Adsorption Units, 2 units	2	ea		$3,000.00	$750.00			$6,000	$1,500	$0	$7,500
5.2 18 sf Pressurized Bag Filters, 2 units	2	ea		$410.00	$258.00			$820	$516	$0	$1,336
5.3 Piping , 3/4" PVC, for Treatment System	200	ft		$1.67	$7.65		$0	$334	$1,530	$0	$1,864
5.4 Replace Filter Bag Element	64	ea		$10.00				$640	$0	$0	$640
5.5 Replace GAC Adsorption Unit	39,000	lb		$1.50				$58,500	$0	$0	$58,500
5.6 Dredgeman/Laborers, 3 each	105	day			$309.86		$0	$0	$32,535	$0	$32,535
5.7 Sampling Influent & Effluent	68	ea	$800.00	$25.00	$50.00	$55.00	$54,400	$1,700	$3,400	$3,740	$63,240
6 TRANSPORTATION AND DISPOSAL											
6.1 Non-Hazardous Sediment	8,600	tons	$40.00				$344,000	$0	$0	$0	$344,000
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	80	hr			$37.50		$0	$0	$3,000	$0	$3,000
7.2 Remedial Action Closeout Report	140	hr			$37.50		$0	$0	$5,250	$0	$5,250
Subtotal							$457,380	$162,954	$253,477	$495,875	$1,369,686
Overhead on Labor Cost @ 30%									$76,043		$76,043
G & A on Cost @ 10%							$45,738	$16,295	$25,348	$49,588	$136,969
Tax on Materials and Equipment Cost @ 6%								$9,777		$29,753	$39,530
Total Direct Cost							$503,118	$189,027	$354,868	$575,215	$1,622,228

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NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PIER 1 EE/CA
ALTERNATIVE OP-5: DREDGING TO MEET PRGs, DEWATERING, ON-SITE DEWATERING FLUID TREATMENT & DISCHARGE, and OFF-SITE DISPOSAL of SEDIMENT
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
* Indirects on Total Direct Cost @ 30%	(excluding transportation and disposal cost)										$383,468
Profit on Total Direct Cost @ 10%											$162,223
Total Field Cost											$2,167,919
Contingency on Total Field Costs @ 20%											$433,584
Engineering on Total Field Cost @ 5%											$108,396
TOTAL CAPITAL COST											**$2,709,898**

* Cost: Includes Erosion Control, Data Process, Bond Premium Insurance, Security, Testing & Analysis, Maintenance, Timekeeper, Photos, Pollution Insurance (if required), Normal Trash Disposal, and Site Clean up.