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Feasibility Study
Revision 1

for

Former Robert E. Derecktor Shipyard
Naval Station Newport
Newport, Rhode Island

Naval Facilities Engineering Command
Mid-Atlantic

Contract Number N62472-03-D-0057
Contract Task Order 26

March 2007

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Reference: CLEAN Contract No. N62472-03-D-0057
Contract Task Order No. 26

Subject: Draft Final Feasibility Study – Revision 1
Former Robert E. Derecktor Shipyard
Naval Station Newport, Newport, Rhode Island

Dear Mr. Colter:

Enclosed you will find four copies (two CD and two paper) of the Draft Final Feasibility Study – Revision 1 Report for the Derecktor Shipyard Site (Site 19) at the Naval Station Newport, in Newport, Rhode Island. This draft final Feasibility Study (FS) report is a revision of the final FS report for the site submitted in July 1999. This revised FS report has been prepared to incorporate additional marine sediment data collected since July 1999 and to address the USEPA's and RIDEM's outstanding issues with the 1999 FS report, as discussed at the NAVSTA Newport RPM's meeting/call of November 15, 2006.

In accordance with the task order, copies of this report have been provided to the persons on the distribution list below for their review and comment. If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Diane M. Baxter

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FEASIBILITY STUDY
REVISION 1

FOR

FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION - NAVY (CLEAN) CONTRACT

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LIST OF ACRONYMS

AAL	Rhode Island Ambient Air Limit
ACOE	U.S. Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
AVS	Acid Volatile Sulfides
AWQC	Ambient Water Quality Criteria
B&RE	Brown & Root Environmental
CAD	Contained Aquatic Disposal
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
CT	Central Tendency
DAF	Dissolved Air Flotation
EPA	U.S. Environmental Protection Agency
ERA	Marine Ecological Risk Assessment
ER-L	Effects Range-Low: NOAA Adverse Effects Benchmark Value For Sediment
ER-M	Effects Range-Median: NOAA Adverse Effects Benchmark Value For Sediment
FFA	Federal Facilities Interagency Agreement
FS	Feasibility Study
FWENC	Foster Wheeler Environmental Corporation
GRA	General Response Action
HHRA	Human Health Risk Assessment
HI	Hazard Index Ratio
IAS	Initial Assessment Study
IEUBK	Integrated Exposure and Uptake Biokinetic Model
IRP	Installation Restoration Program
IU/BK	Integrated Uptake/Biokinetic Model
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/l	milligram per liter
MLW	Mean Low Water Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NETC	Naval Education and Training Center
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NORTHDIV	Northern Division

LIST OF ACRONYMS (cont.)

NPL	National Priorities List
NS	Nearshore
O&M	Operation and Maintenance
OS	Offshore
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDI	Pre-Design Investigation
POTW	Publicly-Owned Treatment Works
PPE	Personnel Protective Equipment
PRG	Preliminary Remedial Goal
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SAIC	Science Applications International Corporation
SARA	Superfund Amendment and Reauthorization Act
SEM	Simultaneously Extracted Metals
SER	Shore Establishment Realignment Program
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TBC	To Be Considered Guidance
TCL	Target Compound List
TCLP	Toxic Characteristic Leaching Procedure
TCR	Tissue Concentration Ratio
TEV-HQ	Threshold Effects Value - Hazard Quotient
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRC	TRC Environmental Corporation
TSDF	Treatment, Storage, and Disposal Facility

LIST OF ACRONYMS (cont.)

TSS	Total Suspended Solids
TtNUS	Tetra Tech NUS, Inc. (formerly Brown & Root Environmental)
TWA	Time-Weighted Average Concentration
µg/dl	microgram per deciliter
µg/kg	microgram per kilogram
µg/l	microgram per liter
URI	University of Rhode Island
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

OVERVIEW

This feasibility study (FS) report relates the process used to evaluate a variety of approaches to address contaminated marine sediment off-shore of the former Derecktor Shipyard at the Naval Station Newport in Newport, Rhode Island. Four alternatives are presented for consideration as the Navy's cleanup strategy for the off-shore portions of the site. Environmental concerns for the on-shore areas of the site were previously addressed through several removal actions, and no further on-shore activities are anticipated.

BACKGROUND

The Navy used information from four primary investigations to develop the FS.

A marine ecological risk assessment was conducted for Coddington Cove during 1995 and 1996. Sediment, fish, lobster, mussels, and clams were sampled and analyzed by the University of Rhode Island and University of Mississippi Laboratories. Data was evaluated with input from federal and state agencies and natural resource trustees. The risk assessment found an increased potential for adverse health effects to the ecological systems from their exposure to contaminants in sediment. The largest increase was found near the property leased by Derecktor between 1979 and 1992.

A marine human health risk assessment was performed in 1997 to estimate the potential for adverse effects to human health from the contaminants that are present in marine sediment and shellfish. This study found a potential for increased risk of cancer and non-cancer health effects to humans ingesting 36 meals per year or more of shellfish and lobster taken from the inner portions of Coddington Cove. The study also found negligible increases of risk from eating lesser amounts of shellfish taken from this area, and from recreational activities such as swimming, wading, and shellfish collection.

An evaluation of the so-called stillwater basin, which is a protected small-boat anchorage within Coddington Cove at Building 42, was completed in 1998. The objectives of this evaluation were to assess, and if possible, determine the cause of this apparent lack of indigenous biota. The investigation objectives were achieved through a focused program of data collection based on previous investigation findings and site background information. The study included the placement of synthetic media growth plates (artificial structures) suspended in the water column within and outside the stillwater basin to provide suitable habitat area for plant and animal colonization. In addition, samples of water from outfalls that discharge into the basin were analyzed to determine chemical content and other biological and physical parameters. Finally, the habitat quality of the substrate was evaluated through plan-view and

sediment profile photography. Results from this study were evaluated to determine if there are limiting factors within the basin that may be responsible for the biotic limitation. The findings of the evaluations indicated that the substrate (soft sand with low oxygen at depth) does not provide the optimum habitat for a subtidal benthic community. However, a so-called "Stage 1" community does exist, living within the limitations that are present. Limitations include introduced bacteria from outfalls, and low oxygen in sediment at depth, restricted circulation of water, and a sandy bottom substrate that is likely a result of the hydrodynamics. In addition, the nature of the subtidal environment was previously altered from the natural condition by dredging and construction of the pier structures and breakwater. A less than optimal community in an area altered in this way should be expected.

Supplemental sediment sampling was conducted in August 2004 to better understand the nature and extent of contamination in the offshore marine sediments in Coddington Cove. Samples were collected to confirm the presence, concentration and distribution of contaminants previously found in this area, and to identify the source of hydrocarbon contaminants that are present prior to undertaking potential remedial actions at the site. Sediments were analyzed for TAL metals, PCB congeners, TOC, and SEM/AVS using standard analytical methods. In addition, replicate samples from each station were analyzed using forensic-type petroleum “fingerprinting” to identify potential impacts from historical activities near the site, versus other inputs (ambient sources, storm runoff, non-point discharges, current fuel use, and boat traffic) near the study area. Turbidity was also monitored during this investigation because contaminants in resuspended sediments were considered potentially problematic. The results from these analyses were compared with the data from previously collected samples from this area. The investigation results indicated that concentrations of contaminants in surface sediments decreased from the values reported in the marine ERA, possibly due to new sedimentation on top of previously sampled substrate. The highest concentrations of contaminants were still primarily located along the shoreline and near the piers, with a decrease in contamination further from shore.

A comparison of these four studies shows that the contaminant levels in the sediments are particularly elevated near the storm water outfalls that previously discharged water collected from the paved areas around the former Derecktor property. This information was used to determine the types and locations of contaminants in the marine sediment in Coddington Cove that need to be addressed to protect human health and the environment.

FEASIBILITY STUDY PROCESS

The FS included development of preliminary remediation goals (PRGs) and remedial action objectives for sediment. PRGs are concentrations of contaminants that, if allowed to remain in the marine sediment, are not anticipated to pose an increased risk of adverse effects to human health or the environment. Areas

containing sediments with concentrations of contaminants exceeding the PRGs based on the 2004 investigation data were identified and are depicted on Figure E-1.

The FS evaluated a range of options to address the marine sediment exceeding the recommended PRGs. Current technologies were evaluated to determine if they could be effectively used to protect human health and the environment by containing, removing, or treating the contaminants and if they could be implemented in the areas where the contaminants are present. General technology options assessed were capping sediment in-place, dredging the sediment and removing it, restricting access to persons collecting shellfish and lobsters, and monitoring sediment concentrations to determine if natural degradation of contaminants occurs over time.

The detailed action alternatives that address the contaminants in the marine sediment were evaluated against seven criteria that are listed in the National Contingency Plan: overall protection, compliance with other environmental laws, long-term effectiveness, reduction of toxicity, short-term effectiveness, implementability, and cost. Two additional criteria, state and public acceptance, are not addressed in this Draft FS. State and public acceptance will be evaluated following receipt of state and public comments on the FS and the proposed plan, which are anticipated to be presented at a public meeting during the spring/summer of 2007.

The alternatives selected for the comprehensive evaluation are 1) no action, 2) limited action (access limitations and long-term monitoring), 3) a combination of capping, dredging, and off-base disposal, and 4) dredging and off-base disposal. The FS discusses how each of these alternatives meet the seven criteria and then evaluates how well each compares to one another.

SUMMARY OF ALTERNATIVES

Alternative 1 (no action) is evaluated as the baseline to which other alternatives can be compared. It would involve no protection of human health or the environment from the contaminants. Since contaminants would remain at the site, 5-year reviews would be required under the law. The 30-year present worth cost of this alternative is estimated at $88,604.

Alternative 2 (limited action) includes restricting access to portions of Coddington Cove from persons taking shellfish and lobster from the areas of the site with sediment COCs exceeding recommended PRGs. In addition, a ban on collection of shellfish and lobster would be imposed and posted for these areas. It should be noted that these areas are waters owned by the State of Rhode Island, therefore coordination with the state would be required for implementation and enforcement of the shellfishing and lobstering bans. Monitoring existing conditions would be performed annually to determine if the concentrations of contaminants remain elevated. A review of the alternative would be performed every 5

years to evaluate the need to take other action or to discontinue this action. The 10-year present worth cost of this alternative is estimated at $1,184,591. This alternative would provide protection to humans, but not to the environment.

Alternative 3 (combination of capping and dredging) includes capping one inactive port area that contains sediment contaminants in excess of the recommended PRGs (stations 3 and 29, shown on Figure E-1), and dredging the two active port areas that contain sediment contaminants in excess of PRGs (stations 27 and 103). Based on current data, approximately 23,819 cubic yards of sediment would be dredged and disposed off-base. In addition, the proposed cap would cover 245,000 square feet. Assuming the cap is properly maintained, this alternative would provide sufficient protection to humans and the environment. However, given that sediment contaminants would remain on-site beneath the cap, 5-year reviews and long-term cap maintenance would be required. The 30-year present worth cost of this alternative is estimated at $13,813,419.

Alternative 4 (dredging only) includes dredging and off-base disposal of all sediment that contains contaminants in excess of the recommended PRGs. Three areas near the shoreline of Coddington Cove (Figure E-1) would be affected by this action. Based on current data, approximately 32,893 cubic yards of sediment would be dredged and disposed off-base. The present worth cost of this alternative is estimated at $6,542,854. This alternative would provide the most protection to humans and the environment. No long-term monitoring or maintenance activities would be required.

Table E-1 presents a general comparison of the four remedial alternatives.

1.0 INTRODUCTION

At the request of the US Navy ("the Navy"), Tetra Tech NUS Inc. (TtNUS) has completed a revised Feasibility Study (FS) for the marine portions of the Former Robert E. Derecktor Shipyard - NAVSTA Site 19 (the site), located at the Naval Station Newport (NAVSTA) in Newport, Rhode Island. The original FS was completed in July 1999 under the Navy's Installation Restoration Program (IRP) in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). In response to U.S. Environmental Protection Agency (EPA) and Rhode Island Department of Environmental Management (RIDEM) comments on the Final FS (TtNUS, 1999), the Navy agreed to conduct additional sediment sampling and revise the FS report. This revised report has been prepared to incorporate additional marine sediment data collected since July 1999. This work is being conducted under Contract Number N62472-03-D-0057 for the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic.

Several studies were conducted between 1993 and 2004 to determine whether historical site activities have resulted in contamination of on-shore soils and groundwater and whether marine sediments near the site have been affected by site-related activities and contamination. Results of these studies were presented in the *Final Marine Ecological Risk Assessment Report, Former Robert E. Derecktor Shipyard* (prepared by Science Applications International Corporation (SAIC) and the University of Rhode Island (URI, May 1997) (Marine ERA); the *Draft Final Site Assessment Screening Evaluation (SASE) Report* (B&R Environmental, 1997); the *Human Health Risk Assessment for Off Shore Areas of the Derecktor Shipyard (HHRA)* (B&R Environmental, June 1998); and the *Final Marine Sediment Sampling and Analysis, Former Robert E. Derecktor Shipyard* (TtNUS, September 2005).

This FS was developed to address off-shore contamination issues at the site. Hot spot removals for the on-shore portion of the site have been largely completed (Foster Wheeler, March 2001). No further actions are anticipated for the on-shore areas.

This FS report is divided into five sections. Section 1.0 provides background information on the Derecktor Shipyard, including the site location and description; site history; site geology and hydrogeology; contaminant nature and distribution in the media of concern (marine sediment and biota); and the results of the site investigations and risk assessments.

Section 2.0 describes the development of remediation goals, including identification of potential applicable or relevant and appropriate requirements (ARARs) and media and chemicals of concern for the FS, and development of remedial action objectives (RAOs) and preliminary remediation goals (PRGs).

Section 3.0 describes the general response actions (GRAs) and presents the identification and preliminary screening of potential remedial technologies and the detailed evaluation of candidate technologies and process options.

Section 4.0 describes the remedial alternative development process and provides detailed descriptions of the proposed remedial alternatives.

Section 5.0 provides a detailed analysis of remedial alternatives on the basis of the evaluation criteria specified by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 CFR 300. The section also includes a comparative analysis of the remedial alternatives.

1.1 SITE LOCATION AND DESCRIPTION

NAVSTA is located approximately 60 miles southwest of Boston, Massachusetts, and 25 miles south of Providence, Rhode Island. It occupies approximately 1,063 acres, with portions of the facility located in the City of Newport and Towns of Middletown and Portsmouth, Rhode Island. The facility layout is long and narrow, following the western shoreline of Aquidneck Island for nearly 6 miles facing the east passage of Narragansett Bay. A general location map of NAVSTA is provided as Figure 1-1.

The Robert E. Derecktor Shipyard Site is located in Coddington Cove at the central portion of NAVSTA (Figure 1-2). The site is comprised of approximately 41 acres of shoreline land and improvements, which was leased to the Rhode Island Port Authority and Economic Development Corporation (RIPAEDC) by the Navy. RIPAEDC, in turn, leased this parcel to Robert E. Derecktor Shipyards of Rhode Island, Inc. This lease commenced January 1, 1979, and ran until the Derecktor Corporation filed for bankruptcy protection in January 1992. Detailed maps of the site are presented as Figures 1-3A and 1-3B.

1.2 SITE HISTORY

The NAVSTA facility (formerly the Naval Education and Training Center [NETC]) has been in use by the Navy since the Civil War era. During World Wars I and II, military activities at the facility increased significantly and the base provided housing for many servicemen. In subsequent peacetime years, use of on-site facilities was slowly phased out until Newport became the headquarters of the Commander Cruiser-Destroyer Force Atlantic in 1962. In April 1973, the Shore Establishment Realignment (SER) Program resulted in the reorganization of naval forces, and activity again declined. This reorganization resulted in the Navy excessing 1,629 of its former 2,420 acres.

NAVSTA was listed on the US Environmental Protection Agency (EPA) National Priorities List (NPL) of abandoned or uncontrolled hazardous waste sites in November 1989. The NPL identifies those sites that pose a significant threat to the public health and the environment.

A Federal Facilities Interagency Agreement (FFA) for NAVSTA was signed by the Navy, the State of Rhode Island, and the EPA on March 23, 1992. The FFA outlines response action requirements under the IRP at NAVSTA. The IRP is similar to the EPA's Superfund Program authorized under CERCLA in 1980, as amended by SARA in 1986. The FFA was developed, in part, to ensure that environmental impacts associated with past and present activities at NAVSTA are thoroughly investigated and remediated, as necessary. While the Derecktor Shipyard site was not originally on the list of IRP sites in the FFA, it was added in 1994 as a “Study Area.” Based on the findings of the Risk Assessment in 1997, the status was upgraded to a “Site.”

The shoreline of Coddington Cove was acquired in 1940 for use as a Navy supply station. Prior to this time, the Coddington Cove area was farmland with few buildings. During World War II, the Coddington Cove area experienced major development, including construction of barracks, warehouse space, and hundreds of Quonset huts. Although naval activity diminished following the end of World War II, some construction at Coddington Cove continued. In 1955, Pier 1 was completed to replace pier space lost in 1954 during Hurricane Carol. The adjacent Pier 2 was added in 1957.

In 1962, Newport became headquarters to the Commander Cruiser-Destroyer Force Atlantic. Dozens of naval warships and auxiliary support ships were home-ported at Newport. A 1962 aerial photograph of the Coddington Cove area shows 18 naval warships moored at Pier 1.

The Navy’s use of the Coddington Cove area continued until April 1973, when the Navy announced the SER program. The SER resulted in a reorganization of naval forces at Newport and the transfer of ships and activities to other naval stations. The SER also directed transferring or excessing non-essential land and facilities.

During the period between 1973 and 1979, buildings on-site were was leased to Coddington Yachts Inc. and the Newport Shipyard, Inc. One building was used by the Newport Seafood Group as a fish processing plant. In 1979, the Navy leased 41 acres to the RIPAEDC, which in turn subleased the property to Robert E. Derecktor Shipyards of Rhode Island Inc. During its lease period, Derecktor dismantled, moved, and reassembled site buildings and constructed a large addition to Building 234 (Figure 1-3a), which was used as a setup area so that ships could be constructed indoors.

The site was used by Derecktor to repair, maintain, and construct private and military ships. Repair and maintenance operations were concentrated around Pier 1. These operations largely consisted of

sandblasting and painting, hull inspections, and other on-board ship repairs. Two floating dry docks were moored at Pier 1, and a large ferry, known as the Greenport Ferry, was moored between Buildings A18 and 234 for use as work space.

Derecktor also constructed new ships under contract to the US Coast Guard and the US Army. These ships had steel structures, and were used as cutters and tugboats. Construction included cutting and welding steel, sandblasting, priming and painting the structure, and assembling the ship. Ship assembly was primarily conducted in Building 234. Supporting the ship maintenance and construction operations were an engineering department (Buildings 6 and A-18), an electrical and pipe shop (Building 6), and a vehicle maintenance shop (Huts 1 and 2).

In 1992, the Derecktor corporation filed for bankruptcy protection. Because there was a possibility of hazardous materials releases at the site, the Navy performed a Preliminary Assessment (PA) of the site. This was completed in May 1993 and concluded the following:

- Shipyard operations generated large quantities of hazardous wastes, including waste oil, paints, solvents, thinners, concentrated bases, and other waste solids and liquids.
- Housekeeping practices and hazardous material handling practices at the facility were poor.
- Waste materials, including spent sandblast grit and oily liquids from the dry dock, were known to be disposed of on the property.
- Sand blast grit and metals-contaminated marine sediments are present around Pier 1.
- Releases of hazardous material are suspected in the waterfront areas and around Building 6.
- Interiors of Buildings 42, 234, 6, and 40 require cleaning prior to re-use.
- Numerous unlabeled 55-gallon drums were present containing unknown liquids.
- Asbestos-containing materials were suspected in some buildings.
- Releases to the ground surface at the site would most likely cause contaminants to pass to the marine environment through groundwater flow or via storm drain systems.

- Sheetpiling at the North waterfront had become undermined, and debris had been placed within the void spaces.

Based on these conclusions, the Navy added the site to the FFA list as a Study Area. Subsequently, more thorough investigations were performed. The Site Assessment Screening Evaluation (SASE) (B&R Environmental, June 1997) was performed to identify and characterize contaminants in the on-shore portions of the site. A Marine Ecological Risk Assessment (ERA) (SAIC and URI, 1997) was performed to characterize the risk posed by contaminants in the marine sediment to ecological receptors near the site. A follow-up study to the ERA was performed in the summer of 1998. This study was referred to as the stillwater basin evaluation, and findings were published in a draft report (B&R Environmental, 1998). A Marine Human Health Risk Assessment report (HHRA) (B&R Environmental, 1998) was prepared using data collected as a part of the ERA to identify increased risks to humans from the contaminants in the marine environment. These documents were used to support the February 1999 FS. Additionally, marine sediment sampling and analysis was conducted in August 2004 to confirm the presence, concentration and distribution of contaminants previously found in the area and also identify the source of hydrocarbon contaminants present. Sections 1.4 through 1.6 of this report summarize these prior studies.

Between the publication of the PA report and the Draft FS (1998), other construction and site restoration activities occurred. Building 234 was removed in 1993, and the old transit shed was removed in 1997, leaving the slab foundations. Huts 3 and 4 were removed in 1993. Huts 1 and 2 were removed in 1997. The dry docks were removed from Pier 1 and the Greenport Ferry was removed in 1993. Building A-18 on T-Wharf south of Pier 1 was demolished in 1997; the wharf piling has deteriorated substantially.

Several removal actions were also considered in on-shore areas of the site after 1993 to address potential contaminant sources. These are briefly described below.

- NAVSTA Public Works Department (PWD) performed a preliminary removal at the site in 1994 that consisted of removing remaining debris, surface cleaning grossly contaminated concrete, and closing and removing underground storage tanks.

- In 1996, NAVSTA PWD contracted a removal of sand blast grit that was present on the ground to the north and east of Building 42. OHM Corporation removed approximately 16,600 cubic yards of this material and covered the ground with a crushed stone/gravel mix. Sandblast grit was transported and disposed of at McAllister Point Landfill.

- In 1997, the soil berm located to the south of the site was removed. This material was found to contain excavated soils and debris from construction and expansion of Building 234. Some of this

material was transported to Tank Farm Four for fill material within the imploded fuel oil bunkers. The remainder underwent disposal at Rhode Island landfills.

- In 1998 and 1999, Sump Pit S42-1 at Building 42 and PCB contaminated soil at TP-14 was removed. Also in 1999, excavation of the test pit area 7 feet south of MW-09 was finalized.

- In August 2000, removal of the Building 42 S42-5 Sump Pit was completed.

A summary of each of these removal actions was completed and submitted in March 2001 (Foster-Wheeler, 2001).

Finally, in 2005, excavations conducted for a new guard shack approximately 100' northeast of Building 6 encountered a small quantity of sandblast grit in a former drainage ditch. As of March 2007, a non-time critical removal action is underway to remove this material, and is anticipated to be completed in June 2007.

In the late summer of 1998, three inactive warships were moved from the Philadelphia Naval Shipyard to be temporarily berthed at Pier 1. These ships include two aircraft carriers, ex-FORRESTAL and ex-SARATOGA, and the battleship ex-IOWA. The Naval Inactive Ship Maintenance Facility in Philadelphia remains responsible for the ships. At the February 18, 1998, Restoration Advisory Board meeting, Captain Hall from Naval Sea Systems Command (NAVSEA) stated that these ships are in experimental hold status (would not likely be returned to duty). He also stated that the ships were never painted with tributyltin paints, and the potential for copper to leach from the bottom paints was minimal. Captain Hall and his staff stated that bottoms of these ships will not be repainted because they are inactive, and growth is not a concern. Prior to dockage, the vessels would be safety-cleaned and watertight. Oil booms would be installed and maintained around the ships, and a security staff and site manager would be present at all times to assure safety and cooperate with Coddington Cove restoration efforts.

1.3 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section summarizes the geologic, hydrogeologic, and marine characteristics of the site and region. This information is based on the drilling program performed as a part of the SASE, previously published data, and the reports of other contractors, which are presented in the Draft Final SASE Report (B&R Environmental, 1997). Information regarding physical characteristics of the on-shore areas is presented to provide context for better understanding of the marine areas, which are the focus of this report.

1.3.1 Regional Geology and Hydrogeology

The NAVSTA site is located at the southeastern end of the Narragansett Basin. The rock types of the Narragansett Basin are non-marine sedimentary rocks of Pennsylvanian age. The bedrock at NAVSTA facility is almost entirely of the Rhode Island Formation. A few areas of thick conglomerates are present within the Rhode Island Formation. They consist of pebbles, cobbles, and boulders inter-bedded with sandstone and graywacke. Coasters Harbor Island (Figure 1-2) is mostly covered with this conglomerate material. Overlying the Pennsylvanian rock of the Narragansett Basin are surficial deposits of Pleistocene sediments. These unconsolidated, glacial sediments range in thickness from 1 to 150 feet and consist of till, sand, gravel, and silt.

Many areas on Aquidneck Island, on which NAVSTA is located, obtain potable water from wells. Groundwater is obtained from the unconsolidated glacial till and outwash deposits, and from the underlying Pennsylvanian bedrock. The average depth to groundwater is 14 feet. In the NAVSTA area, glacial till deposits are typically less than 20 feet thick. Well yields in these materials range from 1 to 120 gallons per minute. Although till is considered an unconsolidated deposit, the upper limit of this well yield is likely from an outwash deposit that is well sorted and stratified. Till wells typically yield a few hundred gallons of water per day or less than 1 gallon per minute. Bedrock well yields range from less than 1 to as much as 55 gallons per minute and are highly dependent on the presence of joints and fractures. In scattered locations, pumping has led to salt water intrusion (EEI, 1983).

1.3.2 Site Geology

The information presented in this section is condensed from the SASE report (B&R Environmental, 1997). That investigation separated the site into four distinct areas (North Waterfront, Central Shipyard Area, Building 234 Area, and South Waterfront) as shown on Figure 1-3a. The following descriptions are specific to these four areas.

The uppermost surficial materials in the North Waterfront are described primarily as gravely sands, silty sands, and fine to medium poorly graded sands with varying proportions of silt, gravel, and traces of shell fragments in some soils. These sands continue at the deepest borings to approximate depths of between 10 feet below ground surface (bgs) (at MW03) to 24 feet bgs (at MW02), and are underlain by a tight and dense, silty, gravely, sand with trace clay (probable till). The probable till, encountered above weathered bedrock, varied between approximately 8 feet thick at MW03 to approximately 12 feet thick at MW04.

As observed in the borings advanced during this investigation, depths to bedrock at the North Waterfront vary from approximately 18 feet bgs at MW03 to approximately 34 feet bgs at MW02. Bedrock, as

described in the boring logs, is highly weathered, fissile phyllite, and schist. Some samples of bedrock were degraded to clay and silt (saprolite).

The uppermost surficial materials in the Central Shipyard Area, which is on-shore, are comprised primarily of gravely sands and sandy gravel with varying proportions of silt and silty sands.

As observed at the two deepest borings in the Central Shipyard Area, MW05 and MW07, a dense clayey, silty, gravely sand (probable till) was observed underlying the upper sands and gravel, from approximately 28 to 42 feet bgs at MW05, and from approximately 24 to 33 feet bgs at MW07. Dense silt or interlayered sands and silts were observed immediately above weathered bedrock at MW05 and MW07 from approximately 42.0 to 46.5 feet bgs and from 33.0 to 37.5 feet bgs, respectively.

The depth to bedrock in the Central Shipyard Area increases significantly from east to west, ranging from approximately 4.3 feet bgs at MW06 to 46.5 feet bgs at MW05, and 37.5 feet bgs at MW07. Bedrock in this area is described in the logs as weathered, fissile, gray phyllite. The rock quality designation (RQD) of bedrock cored at MW05 was 43 percent (poor rock quality).

The uppermost surficial materials at the Building 234 Area, which is on-shore, primarily consist of gravely, silty, sand; silty sand; and sand. As recorded on the boring logs, the majority of the sands are poorly graded, and include varying proportions of silt and subrounded to angular gravel. In one location, fragments of seashells were also observed within the gravely sand identified from 5 to 9 feet bgs. This material is believed to be fill installed behind the sheet piling when the waterfront was developed in the 1940s and 1950s.

At the deepest boring (MW-09), advanced to 51 feet bgs, dense gravely, silty, sand (till) was observed from approximately 10.5 to 18.0 feet bgs. From approximately 18 to 46 feet bgs in this boring, a dense sandy silt (till) with varying amounts of gravel was identified overlying weathered bedrock, which was encountered at approximately 46 feet.

As described in the logs, bedrock in the Building 234 Area is identified as fissile, grey to black phyllite, which is generally weathered and broken (at the depths observed in these subsurface investigations). Based on the subsurface investigations described above, the depth to bedrock in the area of Building 234 increases significantly toward the south, varying from approximately 8.5 feet bgs at TP09 to approximately 46.0 feet bgs at MW-09. At MW08, 4 inches of rock was recovered in a split-spoon sample from approximately 12.0 to 12.5 feet bgs, although coring was not conducted at this location for confirmation of bedrock. At MW-104 (installed by GZA Inc. in 1993), on the east side of the site, bedrock was reported at approximately 14 feet bgs. The RQD of bedrock cored at MW09 was 0 percent (very poor rock quality).

The South Waterfront was characterized by a strip of waterfront beach, with soil piles placed above the tidal area that were colonized by native and invasive shrubs and grasses. Six test pits were excavated in this area to characterize subsurface materials. Surficial materials in these soil piles are primarily gravely sands, consisting of mostly fine or fine to medium sands, with some fine to coarse subrounded to subangular gravel. These materials were thus believed to be fill. The gravely sands continued throughout the depth of most test pits (excavated from 7 to 16 feet bgs), with the following exceptions: a layer of sand (mostly fine to medium), identified as possible beach sand, was described at TP01 from 11 to 12 feet bgs (the bottom of test pit). In TP03, a sand layer (mostly fine sand) was identified from 3 to 9 feet bgs (the bottom of test pit), however, pieces of asphalt also identified in TP03 from 6 to 9 feet indicated this to be probable fill material. Bedrock was not encountered in any of the test pits in this area. These piles were removed in 1997 and disposed of off-site (Section 1.2 of this report).

1.3.3 Site Hydrogeology

The hydraulic conductivity of the geologic materials at the site was estimated by conducting slug tests. A description of the test procedure is presented in the SASE report. Data gathered during the slug tests were evaluated to provide an estimate of the hydraulic conductivity of the geologic material adjacent to the on-shore monitoring well being tested.

The hydraulic conductivity measured in overburden wells ranges from a low of 0.48 feet per day (MW03) to a high of 1.71 feet per day (MW12). These values are comparable to values reported in the literature for similar geologic materials.

Water levels were monitored over 5 days from September 19 to September 23, 1996, to determine tidal fluctuation. During this period, pressure transducers were suspended below the water surface in selected wells and from the sheet piling near Building 234. The data were normalized to elevation and vapor pressure, and the changes over time were evaluated. This information clearly indicated that tide influences both the shallow bedrock groundwater and the overburden groundwater. Tidal fluctuations were noted in wells more than 100 feet inland (east) of the sheet piling wall.

Another notable finding was that the elevation of water in the bedrock well (MW05) was continually below the elevation of the seawater during the time of the survey. Since this was not expected, the measurements were checked and it was confirmed that although the bedrock groundwater fluctuates with the tide, the elevation of the bedrock groundwater is below the elevation of the ocean.

Salinity was measured to be 1.0 parts per thousand (ppt) or less in on-site wells. Salinity of the seawater adjacent to the sheet piling wall was measured as 22 ppt. The low salinity of the water within the on-shore wells indicates that the source of the water is from upgradient or from the unconsolidated material above

the bedrock. Density of the stratum and a lack of observed water-carrying fractures in the core indicates that the bedrock carries water poorly at this location. Since there are not co-located wells, it cannot be determined conclusively that the bedrock is receiving water from the overburden, but this is likely to be the case.

The Rhode Island Department of Environmental Management (RIDEM) has classified groundwater in Rhode Island to protect the quality of the state's groundwater resources for use as drinking water and other beneficial uses, and to ensure protection of the public health and welfare, and the environment. Groundwater at the site has been classified as GB (RIGIS 1997). Groundwater classified GB is typically located at highly urbanized areas or is located in the vicinity of disposal sites for solid waste, hazardous waste, or sewerage sludge, and is not suitable for a drinking water supply without treatment. This site is located within an area that has been highly urbanized since the 1950s; much of the site is fill, and is within 200 feet of the ocean. Groundwater at the site is tidally influenced, which further precludes it from possible use as a drinking water supply.

1.3.4 Marine Hydrographics

A hydrographic survey was performed by the University of Rhode Island in 1995 to measure current velocity and water column profiling of conductivity, temperature, and depth to determine patterns of water circulation within the study area. This study evaluated the area during several different wind and tidal pattern cycles, but did not account for seasonal variation of wind patterns and effect of winter storms. The complete results are reported in the Ecological Risk Assessment for Derecktor Shipyard Coddington Cove (July 1996).

The hydrographic surveys showed that the characteristic flow pattern occurs as a net counter-clockwise circulation within the interior of Coddington Cove. On average, maximum bottom velocities were found to be highest at the mouth of the cove and decreased in a counterclockwise manner following a general circulation pattern around the cove. Flow was such that, in general, the water column appeared well mixed vertically. High bottom velocities extending into the southeastern section of the cove were expected to prevent deposition of silt-sized particles, while the interior sections of the region between the piers and the northeastern region were generally sluggish and expected to be depositional zones (except nearshore and/or shallow areas that may be strongly affected by wave energy or propeller wash).

This study did not account for the localized disturbance of sediments from ship activity at the piers and bulkheads. It is recognized that propeller wash from ships maneuvering to and from the piers will disturb sediments in and around these areas, and that some of the sediments could become resuspended during such activity. Later data assessments have been performed to identify expected areas of high energy and low energy, based on anticipated high traffic areas and on projected future use of the property. High

energy areas are those areas of the cove where there is a possibility for deposited sediment to be resuspended either through natural wave action or shipping traffic. These include areas along the piers and bulkheads at the waterfront.

1.3.5 Geophysics and Bathymetry of Coddington Cove

Side-scan sonar, sub-bottom profiling sonar, and sediment vibracore surveys were undertaken to determine the characteristics of both surface and underlying sediments within the Derecktor Shipyard/Coddington Cove study area. This combination of techniques provides more complete information than surface and core samples alone. The complete results are reported in the Ecological Risk Assessment for Derecktor Shipyard Coddington Cove (July 1996).

The results indicated that sediments in the Derecktor Shipyard/Coddington Cove study area were predominantly fine-grained at some stations (less than 40 percent sand content) and predominantly sandy (sand greater than 70 percent) at others. Surface sediments in Coddington Cove tended to be finer-grained (contained more silt and clay) than underlying sandy sediments, probably due to the significantly decreased bottom energy and increased likelihood of fine-grained sediment deposition resulting from construction of the Coddington Cove breakwater in 1957. A “sub-bottom reflector”, which is a second reflection of the sonar pulse reflected off something below the surface of the sediment, was observed in some of the geophysical profiles. These second reflectors may delineate different lithologic units. In other locations, no strong sub-bottom reflectors were observed, indicating a likely uniform lithology vertically.

Figure 1-4 summarizes the grain size characteristics of Coddington Cove surface sediments inferred from the geotechnical and geophysical investigations performed at the site.

To attempt to locate any significant deposits of sandblast grit, a limited investigation was focused around the pier areas, using vibracore techniques to determine sediment characteristics at depth. The analysis of these cores was performed by URI and is presented in the ERA report (SAIC, 1997). The locations of the vibracore stations are presented on Figure 1-4.

While some possible sandblast material was noted in some of the coves, no large deposits of this material were found during this investigation program. However, due to the observed presence of minor amounts of sandblast grit observed by the field crew, samples from V-4 and V-9 were analyzed for metals and inorganic contaminants by a laboratory. Results from laboratory analysis of sediments are discussed in Section 1.4.

Evaluation of the cores provided specific grain size data. Based on the 10 foot penetrations, there was high sand content and a lower silt content in subsurface sediments north of (V-1) and between the piers (V-2). Southwest of Pier 1 (V-3 and V-12), there was a higher silt content in the deeper sediments, as well as at V-10, 11, 13 and 14, which were placed along both sides of Pier 1. These observations of deeper sediment differ somewhat from surface sediments evaluated by geophysical techniques (Figure 4-1).

1.3.6 Surface Drainage at Derecktor Shipyard

As a part of the SASE, the surface drainage systems at the site were investigated in detail. A complete description of the findings is presented in the SASE report.

To summarize, 45 catch basins were inspected at the site. Four were found to be blocked or filled with debris, and these were cleaned with a vactor for purposes of inspection. All catch basins were found to have consolidated bottoms of poured concrete or brick. In general, catch basins were not observed to be contaminated with oils or other contaminants. Primary storm drain lines were inspected with robotic video cameras, and were found to be of concrete piping in good condition.

Two primary avenues of stormwater drainage were found. One collects water from the north end of the Building 6 area and Huts 1 and 2, as well as the north side of Building 42, and discharges to outfall 3B (Figure 1-3A). The second collects water from the south end of Building 6 area, Building 234, and the area around the steam plant, and discharges to outfall 9B. Other outfalls were found to be discharging water from smaller individual areas, including roof drains and scuppers at the sheet piling wall. A complete set of storm drain maps is provided in the SASE report.

The material removed from the catchbasins was combined with other waste material collected from Building 234 investigations. Samples of this composite material were analyzed for disposal parameters. The results from this analysis are presented below:

Analyte Detected	Concentration
Benzene	0.04 mg/l
TCLP Barium	1.00 mg/l
TCLP Cadmium	0.10 mg/l
Total Beryllium	0.3 mg/kg
Total Cadmium	7.4 mg/kg
Total Chromium	86.0 mg/kg
Total Copper	220.0 mg/kg
Total Lead	190.0 mg/kg
Total Nickel	53.0 mg/kg
Total Thallium	50.0 mg/kg
Total Zinc	1300.0 mg/kg
PCBs (Aroclor 1254)	1.3 mg/kg

Source: B&R Environmental, 1997

1.4 PREVIOUS INVESTIGATIONS

The findings of the previous investigations are presented in recent documents prepared for the Navy, including the marine ERA and Marine Sediment Sampling and Analysis report. This section summarizes the results of the studies pertinent to the media of concern for this FS (marine sediment and biota) and describes the nature and extent of the contamination. Analytical data for sediment and biota are presented in Appendix A. As previously stated, environmental concerns associated with on-shore areas of the site have been addressed by several removal actions (Section 1.2). No further actions are anticipated for the on-shore areas.

1.4.1 Marine Risk Assessment Investigations (1995-1996)

1.4.1.1 Marine Sediment

Sediment samples were first collected as a part of the marine ecological risk assessment for the site. Surface sediment samples were collected from the 0-18 cm interval, and core sediments were collected from selected locations and depths, within 1 meter of the surface. In addition, elutriate was prepared from sediment and seawater collected at selected locations to evaluate contaminants in resuspended sediment. Elutriate samples were prepared using a 4:1 dilution of water to sediment. This test is typically used to determine toxicity during ocean disposal of dredge material, and is considered highly conservative for determining toxicity to receptors from sediments resuspended from the bottom.

Samples were analyzed for TAL metals, PCB congeners, TOC, PAH, butyltins, and SEM/AVS using standard analytical methods. In addition, replicate samples from each station were analyzed using forensic-type petroleum “fingerprinting.” Sample stations and media collected are depicted on Figure 1-5. The following paragraphs describe the chemical constituents found in these sediment samples collected during this investigation.

Metals

Measurements of bulk sediment concentrations of nine metals was performed at 15 Coddington Cove stations and two reference locations as a part of the marine ecological risk assessment. These measurements were made as a means of assessing the degree of sediment contamination by trace metals and the potential availability/toxicity of the metals to biota. Ranges of concentrations (mg/kg dry wt.) observed at the site were as follows: arsenic - 3.0 to 12.5; cadmium - 0.1-1.5; chromium - 24-112; copper - 1.5 to 180; lead - 13 to 193; mercury - 0.02-1.1; nickel - 5-78; silver - 0.2-1.8; and zinc - 28-547.

Samples were also analyzed for metals from the subsurface stations (Vibracore locations) that were suspected to contain sandblast grit. Samples from stations V-4 and V-9 (Figure 1-4) were analyzed, but only copper was found to be elevated (168 mg/kg at V-4 and 180 mg/kg at V-9). V-9 was located within 3 meters of surface sediment station 27. V-4 was located within 3 meters of surface sediment station 28 (Figure 1-4).

Three additional approaches to evaluate metals included: 1) aluminum normalization, 2) determination of the relative concentrations of acid-volatile sulfides (AVS) and simultaneously-extracted metals (SEM), and 3) measurement of contaminant concentrations in sediment elutriates. In general, the aluminum-normalized values for all measured anthropogenic trace metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc) demonstrated a decreasing trend moving offshore from the shipyard areas. This pattern suggested that the shipyard is a point source for these metals.

The SEM/AVS ratio is a method of assessing divalent metal bioavailability. SEM/AVS values greater than 0.5 were assumed to be bioavailable and potentially toxic to biota. This can be considered a conservative assumption, as a value of 1.0 is many times used as a benchmark. The results showed that metals were likely to be bioavailable (ratio greater than 0.5) at only three stations in Coddington Cove (Stations 33, 35, and 37), as well as at the Jamestown Potter Cove reference Station JPC-2. The remaining 14 Coddington Cove stations and reference station JPC-1 had low SEM/AVS ratios and relatively abundant AVS, indicating that metals are likely to be sequestered in insoluble sulfides and therefore are not bioavailable within most of the study area under present reduced oxygen conditions (not posing risk).

Metals detected in surface sediment elutriates (analysis of water after mixing with sediment) were compared to marine ambient water quality criteria (AWQC) (1999, chronic). This comparison showed that the EPA salt water chronic criterion for arsenic was exceeded at Coddington Cove stations DSY-36 and -38, and the chronic criterion for lead was equaled or exceeded at all stations analyzed except for station DSY-36. In addition, the salt water acute criterion for arsenic was exceeded at station DSY-39. The salt water chronic criterion for copper was exceeded at DSY-31.

Organic Contaminants

Concentrations of organic contaminants at some subtidal stations in the Coddington Cove study area were found to exceed NOAA Effects Range-Low (ER-L) or Effects Range-Medium (ER-M) guidelines, indicating potential adverse impacts. Concentrations of total PCBs at all stations except DSY-35 and -41 exceeded the ER-L benchmark value, while total PCB concentrations at stations DSY-27, -29, -30, -31, and -32 exceeded the ER-M benchmark value of 180 µg/kg.

Concentrations of total PAHs exceeded the ER-L benchmark of 4,022 µg/kg at approximately half of the Derecktor Shipyard/Coddington Cove stations, and the concentration of 46,400 µg/kg at station DSY-29 (field duplicate sample) exceeded the ER-M value. Concentrations of tributyltin (TBT) exceeded 5 µg Sn/kg, a level considered indicative of a degraded ecological condition, at six stations (DSY-27, -28, -29, -30, -31, and -36).

TBT values ranged from non-detected (less than l µg Sn/kg) to 228 µg Sn/kg at station DSY-31. Concentrations of the pesticide p,p'-DDE exceeded the ER-L benchmark value of 2.2 µg/kg at five stations; overall values ranged from 0.1 µg/kg at stations DSY-35 and -41 to slightly less than 7.0 µg/kg at stations DSY-27 and -29 (including the field duplicate sample).

Samples from the subsurface stations (Vibracore locations) that were suspected to contain sandblast grit were also analyzed for organics. Samples from stations V-4 and V-9 (Figure 1-4) were analyzed, but only PAHs were found to be elevated, and concentrations decreased with depth. This correlates with the high PAH concentrations detected in surface sediment at stations 27, which is co-located with V-9. It should be noted that the core run at V-9 was 0-4 feet below top of sediment. This was the third attempt for a core at this location, and refusal at 4 feet below sediment surface indicates a hard-pan layer below this depth.

Petroleum odors were noted in cores collected at V-5 (top of the core), V-10, and V-13 (middle-bottom of the 10-foot core run). The top of the core at V-5 was not analyzed for organic contaminants because V-5 is co-located with surface station 30, which already indicated the presence of elevated levels of PAHs. The subsurface core samples were not analyzed for organic contaminants because samples at this depth would not be available for exposure to ecological receptors, which was the main focus of the study at the time.

TOC was measured during sediment analysis (URI/SAIC, 1995). The organic carbon content of surface sediment varied between 0.6 and 6.0 percent, typical for Narragansett Bay sediments (King et al, 1995). TOC concentrations were used to evaluate organic contaminant levels because the two factors are interrelated.

Organic carbon-normalized concentrations of organic contaminants followed a similar trend as that for direct sediment concentration measurements. One exception was at station DSY-40, which had elevated ratios of all contaminants due to a combination of moderate contaminant levels and low organic carbon concentrations.

The mixtures of individual PCB congeners and PAH analytes in sediments in the Coddington Cove study area suggest certain substances as the main contributors of the contamination. The major PCB congeners were the 3- to 6-chlorine compounds (congeners 66, 101, 118, 153, and 138), which probably

derived from Aroclor 1254, the major Aroclor formulation found in Narragansett Bay surface sediments. Major sources of PCBs to Narragansett Bay include rivers, combined sewer overflows/sewage discharges, and atmospheric deposition.

In general, it is presumed that the presence of these Aroclors in Coddington Cove sediments are also likely to be a result of past industrial and shipping activities which included storage and transfer of PCB transformers. However, the PCB composition at Coddington Cove station DSY-29 FD was different from that at the other stations, with congener 209 (decachlorobiphenyl) accounting for approximately 60 percent of the total congeners measured in the sample. Congener 206 was also present in relatively large concentrations. This unique distribution of congeners is presumed to be indicative of the presence of a rare compound known in the chemical industry as "Deka". This compound is used as an ingredient in “investment casting wax,” and also may be present in sediment as the result of past activities at Derecktor Shipyard.

Concentrations of four- and five-ring pyrogenic PAH compounds (fluoranthene, pyrene, and benzo(b,j,k)fluoranthene) were consistently the highest PAH concentrations observed at stations in the Derecktor Shipyard/Coddington Cove study area. Concentrations were highest near Pier 1. Sources of these compounds include combustion products of compounds in motor oil, atmospheric deposition, creosote/coal tar and asphalt from local activities, terrestrial runoff, and sewage effluent and overflows. There was no evidence of fresh (unweathered) fuel oil in any of the samples, as indicated by qualitative measurements of total petroleum hydrocarbons. However, some of these materials may be present as a result of historic fueling operations at Pier 1.

Analyses of elutriate samples showed the presence of PCBs, PAHs, and small amounts of p,p'-DDE. Elutriate from Station DSY-25 had the highest concentration of both total PAHs and total PCBs; in addition, several other stations showed elevated levels of one or both contaminants relative to reference station values (stations DSY-27, -29, -31 for PCBs; DSY-25, -27, -29, -32, -33, and -40 for PAHs). Additionally, eight of the elutriate samples exceeded the EPA marine chronic criterion (30 ng/L) for total PCBs, including Jamestown Potter Cove reference station JPC-1.

1.4.1.2 Marine Biota Tissue

Marine biota samples were collected as a part of the marine ERA investigations. Samples were collected from local populations of indigenous blue mussels, hard clams, lobster, and finfish (mummichog and cunner). In addition, blue mussels collected from an unaffected area were deployed in the water (suspended off the bottom) at selected stations to test for contaminant loading from exposure to the water column. Samples were collected from selected stations as depicted on Figure 1-4. The following paragraphs describe the highlights of the chemical analyses of these samples.

Metals

Indigenous blue mussels from the Derecktor Shipyard/Coddington Cove study area and reference stations at Jamestown Potter Cove and Castle Hill Cove were analyzed for trace metal contaminants. Tissue concentrations of cadmium, mercury, chromium, lead, and nickel at Coddington Cove stations were comparable to reference values and did not exhibit any distinct spatial patterns. Tissue concentrations of copper, silver, and arsenic exceeded reference levels at only a few stations in the study area, while zinc tissue concentrations were highest and exceeded the reference levels at stations DSY-25, -27, -28, -35, and -40.

Blue mussels from unaffected areas were deployed for approximately 30 days along a transect extending from the shoreline to the mouth of Coddington Cove, as well as at the two reference stations JPC-1 and CHC-1. Following the deployment period, tissue concentrations of arsenic, cadmium, copper, silver, and mercury in these deployed mussels were either lower than or comparable to mussels not deployed ("time-zero") mussels, while tissue concentrations of lead, nickel, and chromium concentrations were comparable to reference values. However, zinc concentrations exceeded both reference and time zero values at most stations, implying that shellfish might be loading zinc from the water column.

Tissue concentrations of arsenic, cadmium, copper, silver, mercury, lead, nickel, chromium, and zinc in the hard clams *Mercenaria mercenaria and Pitarmorrhuana* collected from the Derecktor Shipyard/Coddington Cove study area were, in general, comparable to or only slightly higher than those from the reference stations. Metal concentrations in the muscle tissue of American lobsters and fish (cunner and mummichog) from the Derecktor Shipyard/Coddington Cove study area similarly were mostly comparable to or only slightly higher than those from reference stations. Such minor increases can be a result of the depositional nature of the areas where samples were collected.

Organic Contaminants

Tissue concentrations of organic contaminants were analyzed in both indigenous and deployed (30-day deployment period) blue mussels. Generally, levels of organic contaminants (total PCBs, total PAHs) in the reference station samples were lower than in the study area samples. The highest tissue levels of organic contaminants in deployed mussels were generally observed at stations DSY-26 through -33 and stations DSY-38 through -40. Indigenous mussels showed high values relative to reference station values at a number of stations, including stations DSY-26, -27, -28, -35, -36, and -40.

Tissue concentrations of PCBs, PAHs, and TBT in hard clams from the reference site at Jamestown Potter Cove were generally lower than tissue concentrations in samples from the Derecktor Shipyard/Coddington Cove study area. The highest concentrations of organic contaminants in hard clams

were observed at stations DSY-31, -32, -36, and -41. Concentrations of organic contaminants in the muscle tissue of both fish and lobsters from the study area generally were in the same range as those from the reference stations. TBT was not detected in any of the lobster muscle tissue samples.

1.4.2 Stillwater Basin Evaluation

The so-called stillwater basin is a protected small-boat anchorage within Coddington Cove at Building 42. The basin is bounded to the North and partially to the west by a stone breakwater, to the east by the sheet-piling wall at Building 42, and to the south by a pier leading to the former location of Building A-18 (Figure 1-3).

The findings of the ERA regarding the still water basin were inconclusive: while it appeared that there were low concentrations of chemical contaminants present in the sediment, there appeared to be a lack of indigenous biota within the basin. The objectives of the Stillwater Basin Evaluation were to assess, and if possible, determine the cause of this apparent lack of indigenous biota in the still water basin near Building 42. The investigation objectives were achieved through a focused program of data collection that was based on previous investigation findings and site background information.

This investigation attempted to determine what factor(s) may be influencing the apparent lack of indigenous biota in the still water basin. The study included the placement of synthetic media growth plates (artificial structures) suspended in the water column within and outside the stillwater basin which were to provide suitable habitat area for plant and animal colonization. In addition, samples of water from outfalls that discharge into the basin were analyzed to determine chemical content and other biological and physical parameters. Finally, the habitat quality of the substrate was evaluated through plan-view and sediment profile photography. Results from this study were evaluated to determine if there are limiting factors within the basin that may be responsible for the biotic limitation.

The findings of the evaluations indicated that the substrate (soft sand with low oxygen at depth) does not provide the optimum habitat for a subtidal benthic community. However, a so-called "Stage 1" community does exist, living within the limitations that are present. Limitations include introduced bacteria from outfalls, and low oxygen in sediment at depth, restricted circulation of water, and a sandy bottom substrate that is likely a result of the hydrodynamics.

In addition, the nature of the subtidal environment was previously altered from the natural condition by dredging and construction of the pier structures and breakwater. A less than optimal community in an area altered in this way should be expected.

The findings of the stillwater basin evaluation are presented in a separate report entitled "Stillwater Basin Evaluation Report, Former Robert E. Derecktor Shipyard, Tetra Tech NUS, Inc, December 1998.

1.4.3 Supplemental Sediment Investigation (2004)

Sediment sampling was conducted in August 2004 to better understand the nature and extent of contamination in the offshore marine sediments in Coddington Cove. Samples were collected to confirm the presence, concentration and distribution of contaminants previously found in this area, and to identify the source of hydrocarbon contaminants that are present prior to undertaking potential remedial actions at the site. Figure 1-6 depicts the supplemental sample locations and Figure 3-2 of the 2005 marine sediment report depicts the reference sample stations.

Sediments were analyzed for TAL metals, PCB congeners, TOC, and SEM/AVS using standard analytical methods. In addition, replicate samples from each station were analyzed using forensic-type petroleum “fingerprinting.” The results from the standard analyses were compared with the data from previously collected samples from this area (1993 – 1995 and reported in 1995). A complete table of all sediment sample results and analytical methods used is provided in Appendix A of this report.

Metals

AVS and SEM were measured in the sediment to determine bioavailability of metals present in the sediment. The presence of AVS has been found to bind metals in sedimentary environments and restrict them from being metabolized by the receptor organism. A ratio of SEM:AVS less than 1 indicates the presence of AVS that would thus restrict the metal from becoming available to benthic organisms. Ratios of >1 were observed for sediments at stations DSY-32 (399) -26 (7.4), -02 (10.7), -28 (19.4), -09 (1.9), and -31 (1.2). Stations where SEM:AVS ratios were close, but below 1.0 included DSY-101, -103, -20, -27, -04, -11, and -06. Stations where SEM:AVS ratios were well below 1.0 included DSY-03, -05, -08, and -29. Reference stations provided SEM:AVS ratios of between 0.2 – 13. Using these results for evaluating PRGs, it was observed that the highest lead concentrations measured in surface sediments in 2004 were reported for stations DSY-103 (168 mg/kg), -27 (138 mg/kg), -03 (114 mg/kg) and -29 (113 mg/kg). All these stations had low SEM:AVS ratios, indicating the lead and other metals in those samples are not particularly bioavailable.

Organic Contaminants

Total organic carbon was measured in sediment samples collected in 2004. High levels of TOC indicate presence of natural organic materials (plant matter, etc) in the sediment which tend to bind with some

organic contaminants. PCBs and PAHs bind with high-TOC sediments inhibiting their transport except with those sediment particles. Organic contaminants preferentially bind with smaller organic sediment particles, and not larger and smooth sand particles, which are typically low in TOC. Therefore, these PCB and PAH compounds tend to accumulate with organic sediments and stay in place better than in locations where there are loose sands and gravels. Higher TOC was noted in the restricted areas of the site (stations 29, 03, 02) and the reference areas (particularly Castle Hill Cove 01) than areas which are more subject to current flows (JPC stations; DSY-09, -11, and -32). Sample descriptions show organic sediments were found during sample collections around the carriers at Pier 1 (stations DSY-05, -04, -06, and -08), suggesting that the ships brought to the site in 1999 may be restricting flow and causing silts to settle.

The reference sediments contained varied hydrocarbon mixtures derived from petroleum (petrogenic), combustion (pyrogenic), and natural (diagenetic) origins (i.e. plant waxes). The dominant hydrocarbons consisted of weathered residual range petroleum mixed with plant waxes and pyrogenic PAHs. The concentration of the 16 EPA Priority Pollutant PAHs plus methyl naphthalene ranged from 220 µg/kg to 6,500 µg/kg. Sediments from Jamestown Cranston Cove contained the highest levels of plant waxes while Castle Hill Cove contained the highest levels of pyrogenic PAHs.

Sediment samples from the shallow cores at sampling locations DSY-101 (total PAHs equal to 9,500 µg/kg in the 6” to 12” interval) and -103 (total PAHs from 11,000 µg/kg to 44,000 µg/kg in the first two 6” intervals, respectively) at Pier 1 resembled the Castle Hill Cove reference sediments with slightly higher levels of pyrogenic 4- to 6-ring PAHs. The high level of anthracene relative to phenanthrene in these sediments was consistent with creosote used to treat marine pilings and other wooden structures.

Sediment samples collected from locations DSY-03 and -29 also contained slightly higher pyrogenic 4- to 6-ring PAHs (total PAHs equal to 22,000 µg/kg to 15,000 µg/kg, respectively). These elevated PAHs are attributable to higher soot loadings from proximal storm drains, exhaust from ship engines, or local industry. The reader should note that this area receives storm water from a large storm drain outfall, originating from the Building 234 area, and Building 7, a heating plant.

The sediment sample from DSY-09 contained levels of total PAHs consistent with background (total PAHs equal to 490 µg/kg to 700 µg/kg). However, compared to other Coddington Cove and background samples, this sediment contained slightly higher levels of hydrocarbons associated with middle to heavy residual range petroleum (e.g., slightly enriched petrogenic PAHs). This pattern was very similar to that at DSY-06 (total PAHs equal to 3,600 µg/kg). DSY-27 near Pier 2, contained a mixture of combustion derived PAHs plus slightly higher levels of hydrocarbons consistent with middle distillate (e.g., marine diesel) (total PAHs equal to 7,900 µg/kg).

The remaining sediment samples were indistinguishable from the background reference samples based on hydrocarbons concentration and composition. These samples included DSY-02, -04, -05, -08, -11, -20, -28, -31, -32, -26, -101, -104-0006, and -104-0612.

Comparison to Previous Investigation

Generally, concentrations of contaminants in surface sediments collected in 2004 show a decrease from the values reported in the marine ERA (1997). The highest concentrations of benzo(a)pyrene, PCBs, and PAHs are primarily located along the shoreline and/or near the piers. Analytical results from samples collected further from shore show a decrease in contamination. Historically, the number of sample stations with high contaminant concentrations was greater and these high concentrations extended farther from shore. Three locations, DSY-27, -28 and -29, were sampled at three different depths in the past and had multiple contaminants with the highest on-site concentrations in the mid and/or bottom depth samples. The analytical results from surface samples collected at DSY-27 and -29 had one high value. Figure 1-6 depicts these station locations, in addition to two turbidity monitoring stations. Turbidity was monitored during the 2004 investigation because contaminants in resuspended sediments were considered potentially problematic (Section 1.4.1.1).

There are several possible reasons contaminant concentrations differ between sampling events, including changes to inputs of contaminants to sediment; natural attenuation processes; sediment movement due to ship traffic, seasonal or tidal currents; spatial heterogeneity of sediment; mixing of sediment and sediment deposition.

1.5 HUMAN HEALTH RISK ASSESSMENT

This section summarizes of the results of the human marine human health risk assessment performed to evaluate potential risks from human exposure to shellfish and, to a limited degree, sediment in the marine environment near the former Derecktor Shipyard. All data used for this assessment were collected and validated as a part of the 1995-1996 marine ERA.

Risks to humans were evaluated under several exposure scenarios: ingestion of shellfish by recreational fishermen (adults and children) and ingestion of shellfish by subsistence fishermen (adults). In addition, exposure to sediments by trespassing adults and children swimming and wading was evaluated in a more qualitative manner. The term shellfish includes hard clams, mussels and lobster, which were sampled in 1995 and 1996. Samples were collected from stations depicted on Figure 1-4.

Sediment exposure was evaluated because RIDEM was concerned about the possibility of trespassers using the beach area to the south of the site for swimming, wading, and shellfishing. To address this, the

HHRA selected a single sediment sample between the site and the beach (station 29, Figure 1-4), and used the data from this station alone to estimate exposure to trespassers at this beach. This is a conservative approach, considering that surface sediments from station 29 is actually not where the exposure would occur, and considering this station had some of the highest concentrations of chemical constituents measured in the marine environment for this site. Additionally, the sediment collected from station 35, on the south end of the beach area, had some of the lowest concentrations of chemical constituents measured in the area. By using only the sample with the high concentration, the exposure concentrations are not "diluted" through calculating means of concentrations.

In general, cancer and non-cancer risks were highest for human exposure to lobster, because the contaminant concentrations were highest in that species. This fact adds a level of uncertainty to the findings, because lobster are known to migrate and those that are big enough to be collected may have been exposed to contaminants from other source areas. Additionally, contaminant concentrations in lobsters collected from the site are similar to those found in reference stations, further suggesting that the risk is not entirely site related. Unacceptable cancer and non-cancer risks were identified under the subsistence fisherman scenario (36 meals per year taken from this area); however, this may be an overestimate of actual risk because collection of other shellfish (bivalves) in an industrial port such as this one is less likely to occur than in other locations, primarily due to the depth of the water and amount of ship traffic in this area.

Results of the marine human health risk assessment are summarized on Table 1-1, and described below.

Ingestion of Shellfish by Children (Recreational Fishermen): The calculated cancer risks to this receptor from shellfish ingestion were between 1.4E-5 and 1.1 E-5 for lobster, 5.1E-6 and 3.4E-6 for clams, and 1.0E-5 and 4.2E-6 for mussels. These estimates were all within the EPA target risk range of 1E-4 to 1E-6. Non-cancer risks was below 1.0 for all contaminants detected. The Hazard Index for the scenario (sum of all the contaminants) was also below 1.0

Ingestion of Shellfish by Adult Recreational Fishermen: The calculated cancer risks to this receptor from shellfish ingestion were between 4.4E-5 and 3.4E-5 for lobster, 1.6E-5 and 1.1E-5 for clams, and 2.8E-5 and 1.3E-5 for mussels. These estimates were all within the EPA target risk range of 1E-4 to 1E-6. Non-cancer risks were below 1.0 for all contaminants detected. The Hazard Index for the scenario was also below 1.0

Ingestion of Shellfish by Adult Subsistence Fishermen: The calculated cancer risks to this receptor from shellfish ingestion were between 5.7E-4 and 4.4E-4 for lobster, 2.0E-4 and 1.4 E-4 for clams, and 3.3E-4 and 1.6 E-4 for mussels. Non-cancer risks were between 3.9 and 2.9 for lobster, 3.3 and 1.6 for mussels,

and 0.19 and 1.2 for clams. This is the only scenario under which risks exceeded EPA's target risk range for carcinogens and exceeded a HI of 1.0 for non-carcinogens.

Exposure to Sediments (incidental ingestion and dermal contact) by Trespassers: The cancer risks to this receptor from incidental ingestion and contact with sediments were calculated to be 9.9E-7 for the child and 5.4 E-7 for the adult for all contaminants detected in the sample used for evaluation. The Hazard Index for the scenario was also below 1.0 (0.06 - child, 0.0066 - adult).

The principal contaminant contributing to the calculated risks from exposure to shellfish and sediment described above (both cancer and non-cancer) is arsenic. This is a highly conservative evaluation for arsenic because of the toxicity criteria used. The toxicity value used for arsenic is derived from an inorganic form of arsenic in drinking water called arsenic trioxide. It has been documented that 80 to 99 percent of arsenic in shellfish tissue is in the organic form, which is not toxic (USFDA, 1993). In addition, arsenic concentrations have been noted to be elevated in natural soils at Aquidneck Island due to the geologic formations and parent material of the soils. This indicates that arsenic may not be a contaminant specific to the industrial activities at the former Derecktor Shipyard.

The primary contributor to human health risk is from ingestion of lobster. Contaminant concentration in lobsters from the site are similar to those from reference stations, suggesting this risk is not entirely site related.

Secondary contaminants contributing to risk in the marine environment were PCBs and PAHs, both of which can be attributed to the site activities. Non-cancer risks from PCBs and PAHs were below 1.0 for all scenarios. The subsistence fisherman had the highest possibility for PCB and PAH-related non-cancer risk (from PCBs in mussels - 0.86 and PAHs less than 0.01) as well as cancer risk (from PCBs - 1.55E-5, and PAHs - 1.6E-4 in mussels). These results indicate an unacceptable risk to individuals ingesting shellfish from the study area at rates equal to or greater than 15.6 g/day as an annual consumption average.

Finally, the risk is based on the conservative assumptions associated with the shellfish scenarios themselves (particularly the ingestion rates). The rates used fall between the rates recommended by the EPA and the RIDEM. The shellfish ingestion rates used for this site are three (recreational fisherman: 1.2 g/day) to 30 (subsistence fisherman: 15.6g/day) times higher than those recommended by the EPA for the national average (0.5g/day), although the RIDEM recommends the use of a higher annual average rate of 20 g/day for the Narragansett Bay area. The risk assessment conservatively assumes that all the shellfish ingested by these individuals is collected from this one site. While it is recognized that shellfishing by residents of Rhode Island coastal areas is well above the national average, it is unlikely that shellfishing in such an industrial port could be productive enough to encourage shellfish harvesting in the area to this

intensity. Additionally, the study area is located in an area that is closed to collection of bivalves (clams and mussels), indicating that the lobster ingestion risks may be the only active human exposure pathway.

1.6 ECOLOGICAL RISK ASSESSMENT

The marine ERA completed by SAIC and URI in 1997, under contract to B&R Environmental, evaluated the ecological risks to the marine environment within Coddington Cove. It was presumed that contaminants in the sediments near the Derecktor site were present from activities formerly occurring at that site before and during the Derecktor Inc. lease. This section summarizes the methods and conclusions of the marine ERA, which is based on the data collected in 1995-1996. Detailed information on the methodology, results, and conclusions are presented in the (Final) Marine Ecological Assessment Report (SAIC/URI, June 1997).

1.6.1 Summary of Investigation

Data used to develop the marine ERA were collected between June and December 1995 and 1996. Data were analyzed in 1995 and 1996 and are described in Section 1.4.1 of this report. The final report was issued in May 1997.

The marine ERA incorporated field investigations and modeling approaches to develop a line-of-evidence assessment of potential risks to a variety of receptor species and endpoints. Investigation activities included benthic, infaunal, and epifaunal surveys in Coddington Cove, sediment and biota chemical analysis, and toxicity testing. Additionally, studies describing benthic communities within Narragansett Bay were reviewed to provide background information for the assessment.

The Marine Ecological Risk Assessment followed the guidance set forth in the Work/Quality Assurance Project Plan for Narragansett Bay Ecorisk and Monitoring for Navy sites (URI GSO and SAIC, 1994). The work/quality assurance project plan incorporated risk assessment processes set forth in the EPA Risk Assessment Guidance for Superfund, and EPA Region I guidance documents. The process involved risk assessment steps: problem formulation, site characterization, exposure assessment, ecological effects assessment, risk characterization, and uncertainty analysis. These steps are discussed in the subsections below.

PROBLEM FORMULATION

Problem formulation involved determining the nature and extent of contamination of off-shore (subtidal) media associated with Derecktor Shipyard sources. Specifically, this activity involved identifying

contaminated media, identifying contaminants of concern (COCs), evaluating the spatial extent of contamination, identifying the ecological receptors potentially at risk from COCs, and identifying appropriate assessment and measurement endpoints.

The analytical results identified the specific classes of compounds that are present at elevated concentrations in the marine sediments adjacent to Derecktor Shipyard. The list of COCs generated is conservative in that the screening procedure involved using maximum contaminant concentrations and conservative benchmark concentrations. Sediment samples were collected from stations indicated on Figure 1-5. A discussion of the results from the analysis of these samples is presented in Section 1.4. Indigenous blue mussels, hard clams *(Mercenaria mercenaria),* cunner fish *(Tautogolabrus adpersus),* and American lobster *(Homarus americanus),* were also collected at a selected subset of stations (shown on Figure 1-4) to allow characterization of long-term contaminant exposure effects. Results from these tissue residue samples are discussed above in Section 1.4 also. Blue mussels collected at an unaffected area were also deployed at selected locations to assess pelagic exposure pathways for contaminants and contaminant loading from water.

SITE CHARACTERIZATION

Side-scan sonar, sub-bottom profiling sonar, and sediment core surveys were undertaken to determine the characteristics of both surface and underlying sediments within the Derecktor Shipyard/Coddington Cove study area; this combination of techniques provides more complete information than surface and core samples alone. In addition, hydrographic surveys were performed to measure current velocity and water column profiling of conductivity, temperature, and depth to determine patterns of water circulation within the study area. The results are described in previous sections.

Dissolved oxygen was above 7 mg/L in water at the sampling stations. A water quality model (WASP5) predicted that, in general, undesirably low dissolved oxygen levels should not occur throughout most of Coddington Cove during the critical summer months and therefore do not pose a threat to indigenous biota.

EXPOSURE ASSESSMENT

Exposure assessments included evaluating the concentrations of COCs in environmental media in the exposure pathways from contaminant sources to ecological receptors. Several exposure pathways, which allow contaminant sources associated with historic activities at Derecktor Shipyard to impact biota, were identified. These include contaminant exposure to and bioaccumulation of contaminants from water, sediments, and pore water through partitioning across organism cell membranes, incidental contact, sediment ingestion by deposit-feeding invertebrates, and/or contaminated prey consumption. The

exposure assessment addressed the spatial distribution and concentration of contaminants in bottom sediments and biological tissues, as well as the possible fate and transport mechanisms by which shipyard-associated COCs might reach receptors of concern. Receptors of concern for the site included bivalves, lobsters, the benthic community, fish, and avian aquatic predators.

ECOLOGICAL EFFECTS ASSESSMENT

The ecological effects assessment involved combining toxicological literature review, site-specific investigations of the status of receptor species, toxicity evaluations of exposure media, and modeling exercises to predict the occurrence of adverse ecological impact. Ecological effects were quantified by determining the relationships between exposure patterns and resulting responses of ecological systems.

Site-specific evaluations of toxicity were conducted for bulk surface sediments using the 10-day amphipod *(Ampelisca abdita)* mortality test. Sea urchin *(Arbacia punctulata)* fertilization and larval development tests were used for sediment elutriates (suspended sediment). Tissue residue effects (effects due to COCs in tissue of animals) was evaluated for fish, mussels, hard clams, and lobster. Toxicity reference values for avian predators were compared with concentrations detected in their prey species. In addition, field-based assessments were conducted including benthic community structure analyses, biota condition, neoplasia, and presence of fecal indicators.

Findings of these effects assessments are presented in Table 6.2-2 of the ecological risk assessment report.

RISK CHARACTERIZATION

Risk characterization is an integration of the results of the exposure and ecological effects assessments. The line of evidence approach used in the ERA involved analysis of COC concentrations versus observations of adverse effects, analysis of COC bioaccumulation, comparisons of toxicity evaluations with observed ecological effects, comparisons of exposure point concentrations with established standards and criteria for off-shore media, comparisons of exposure point concentrations with published information regarding the toxicity of COCs, and qualitative comparisons of apparent adverse impacts with conditions at reference stations. The results of these analyses were summarized with information obtained during each study to characterize ecological risks associated with the Derecktor Shipyard.

The marine ERA incorporated the assessment of the exposure and effects endpoints within a line-of-evidence framework. There were eight lines of evidence in the exposure assessment, which are described below. Stations described below are presented on Figure 1-3B.

1. Sediment Hazard Quotient Adverse Exposure Ranking. The sediment HQs were high (2x Effects Range-Medium [ER-M]) at stations DSY-27, -29, and -31. None of the sediment HQs were assigned as intermediate (>ER-M and < 2xERM). The remaining low adverse exposure stations had multiple COCs exceeding the Effects Range-Low (ER-L) but none exceeding the ER-M. Finally, baseline adverse exposure were assigned to stations DSY-33, -35, and -41, and the two reference stations, since no more than one COC exceeded the ER-L benchmark.

2. Elutriate Hazard Quotient (HQ) Adverse Exposure Ranking. COC concentrations measured in sediment elutriate preparations suggested low overall probability of adverse exposure at all stations (concentration of COCs in supernatant > AWQC-Chronic, <AWQC-Acute).

3. SEM Bioavailability Adverse Exposure Ranking. Measures of sediment AVS and SEM suggested possible but low adverse exposure from bioavailable metals at stations DSY-27 through -30 (high total SEM) and at stations DSY-33, -35, -37, and JPC-2. Intermediate or higher adverse exposure due to divalent SEM metals was not generally evident for the Coddington Cove study area.

4. Tissue Concentration Ratio Adverse Exposure Ranking. COC concentrations in target species from site stations compared to tissue concentrations at reference station concentrations suggest the highest probability of adverse exposure for shoreline stations DSY-25 through -27, due to relatively high concentrations (ratio>=10) of contaminants in indigenous mussels and intermediate concentrations in cunner, deployed mussels, and/or lobster. Intermediate exposure ranking was assigned to DSY-24, -28, -29, and -36 (ratio>=3), and low exposure ranking was assigned to stations DSY-33 and -35 (ratio>=1).

5. Tissue Residue Adverse Effects Rankings. The highest probability of effects from tissue COCs was observed at stations DSY-27 and -29 due primarily to bioaccumulation of copper in lobster. Five stations were assigned intermediate probability for adverse effects (DSY-25, -33, -35, -38, and -39) while the remaining stations (DSY-24, -26, -28, -31, -32, -34, -36, -37, -40, and -41) were evaluated as low probability of adverse effects overall.

6. Laboratory Toxicity Adverse Effects Ranking. An overall intermediate adverse effects probability was assigned to Stations DSY-26, -28, and -29, while nine stations (stations DSY-25, -31 through -33, -37 through -39, and -41) were given a low adverse effects ranking. Baseline was assigned to DSY-34 through -36 and -40 and the two reference stations.

7. Field Effects Ranking. The overall adverse effects ranking for field effects indicators (benthic community structure, bivalve condition, hematopoietic neoplasia, Cytochrome P450 activity,

and fecal pollution indicators) suggested high potential for adverse effects at stations DSY-29 and -40/41, and intermediate potential for adverse effects for stations DSY-25, -26, and -33, while low potential for adverse effects were observed for stations DSY-27, -28, -30, -31, -32, -36, -38, and -39. At the remaining stations, field effects indicators suggest no adverse effects to target species.

8. Avian Predator Effects Ranking. The food web modeling for avian aquatic predators assumed that the target bird species were feeding exclusively on the most contaminated of prey items available at a given station. Despite the conservative assumptions employed, high adverse effects were not apparent, and intermediate adverse effects were assigned to stations DSY-28, -29, and -36. The remaining stations were assigned to the low adverse effects category.

The lines of evidence described above were based on the analysis of exposure and effects data, as represented by the endpoints discussed in the previous sections. The lines of evidence were then evaluated in combination to categorize the overall risk for each station. The following categorization of ecological risks was developed for the Derecktor Shipyard ERA:

Baseline risk is defined as the probability of adverse exposure and/or ecological effects equivalent to that from contamination and other environmental conditions not associated with the site.

A Low probability of ecological risks suggests possible, but minimal impacts based on some of the exposure or effects-based lines of evidence, while impacts are undetectable by the majority of exposure and effects-based lines of evidence. Conditions of low risk probability typically lack demonstrable exposure-response relationships.

An Intermediate probability of ecological risk occurs for site conditions falling between high and low probabilities of risk. As such, the intermediate risk probability condition is typically characterized by multiple exposure or effects lines of evidence suggesting that measurable exposure or effects, but not both, are occurring at the site. Typically, quantitative exposure-response relationships are lacking. Intermediate risk probability may also be indicated if the spatial extent of apparent impact is highly localized (a single station), or if the impact occurs for periods of very limited duration.

A *High* probability of ecological risk is assigned to areas where numerous lines of evidence suggest pronounced contaminant exposure and effects, the spatial extent of apparent impact is great, the impact is likely to be persistent over long periods of time, and the available data support demonstrable exposure-response relationships.

A single ranking strategy for synthesizing the lines of evidence was used to obtain the probability of adverse Exposure/Effect (E/E) line designation to evaluate the data in a manner consistent with the risk definitions discussed above. The findings of exposure and effects lines are evaluated jointly by evaluating strength of exposure-response relationships and overall probability of adverse ecological risks by sampling station.

1.6.2 Findings of the Marine ERA

A summary of environmental risk for the Derecktor Shipyard/Coddington cove study area is presented in Table 1-2. The risks for each station are based on summaries of each line of evidence, with special attention paid to concurrence between the two endpoint groups. This evaluation only addresses current conditions and levels of activity and does not address future land or harbor use.

The conclusions from the ERA are presented below:

- Stations DSY-27 and -29 were determined to pose a high probability of risk to fish, shellfish, and seabirds from shipyard-related contaminants including PCBs, PAHs, tributyltin, copper, lead, and zinc. Plausible exposure-response relationships were observed for benthic community structure possibly affected by PAHs in sediment, and indigenous mussel condition possibly affected by PCBs in sediment.

- Stations DSY-24, -25, -26, -28, -31, -33, -40, and -41, as well as the reference station CHC-1, were determined to pose an intermediate probability of risk to ecological receptors. Intermediate risk was assigned to these stations due to suggested but not quantifiable exposure response relationships. In general, the same receptors and COCs were observed at intermediate and high risk stations. However, in addition, elevated levels of PAHs were observed in mussels at stations DYS-25 and -26, north of the shipyard, and elevated tributyltin was present in sediment at station DYS-31. Seabirds may be at risk from PCBs in fish at station DYS-28. A review of the station map presented as Figure 1-5 shows that these stations, in conjunction with the high risk probability stations described above, combine the data set for the areas near the shoreline and piers of Coddington Cove, with one exception, station DSY-35.

- Stations DYS-30, -32, -34, -35, -36, -37, -38, and -39, as well as the reference station JPC-1 were determined to pose a low probability of risk to ecological receptors. Although data suggest possible adverse effects, COC concentrations were low, and definitive exposure-response relationships were not observed. These stations are outer harbor stations located away from the active areas.

- Station JPC-2, a reference station at Jamestown Potter Cove, showed no evidence of adverse exposure or effects. These conditions were determined to be relatively pristine, and a “baseline” probability of risk was assigned.

2.0 DEVELOPMENT OF REMEDIATION OBJECTIVES

This section presents the initial steps in developing remedial alternatives to address the human health and ecological concerns identified at the site and comply with all applicable regulations. The process includes:

- Identifying applicable or relevant and appropriate requirements (ARARs) and other environmental criteria that must be considered in developing remedial action objectives (RAOs).

- Developing media-specific RAOs that are protective of human health and the environment and comply with ARARs. RAOs may specify COCs, exposure pathways and receptors, and PRGs that identify potentially acceptable contaminant levels or ranges of levels for each exposure route.

- Developing initial estimates of areas or volumes of media that should be addressed by the remedial alternatives.

After these steps are completed, general response actions (GRAs) that will satisfy the site-specific RAOs can be formulated, and applicable technologies identified and evaluated. GRA development and technology identification, screening, and evaluation are presented in Section 3.0.

2.1 ARARS AND TBCS

ARARs are promulgated federal and state environmental and facility siting requirements that are determined to be legally applicable or relevant and appropriate to the hazardous substances, remedial actions, or other circumstances at a CERCLA site. This section summarizes what constitutes ARARs and standards and guidance to be considered (TBCs), and the various types of ARARs that must be considered in the FS. Section 5.0 identifies the potential ARARs and TBCs for each of the proposed remedial alternatives for the site and describes the actions that must be taken to comply with these requirements. The two categories of requirements are defined below:

Applicable Requirements - Section 300.5 of the NCP defines applicable requirements as "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site."

Relevant and Appropriate Requirements - Section 300.5 of the NCP defines relevant and appropriate requirements as "those cleanup standards, standards of control, and other

> substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site."

The NCP Section 300.430(E) states that on-site remedial actions at CERCLA sites must meet ARARs unless there are grounds for invoking a waiver. A waiver is required if ARARs cannot be achieved.

TBCs are non-promulgated criteria, advisories, and guidance issued by the federal or state governments. Along with ARARs, TBCs may be used to develop the remedial action alternatives necessary to protect human health and the environment.

ARARs and TBCs are further divided into three categories: chemical-specific, location-specific, and action-specific. These categories are briefly discussed in Sections 2.1.1 through 2.1.3.

2.1.1 Chemical-Specific ARARs and TBCs

Chemical-specific ARARs and TBCs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in numerical values that establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. In general, chemical-specific requirements are set for a single chemical or a closely-related group of chemicals. These requirements do not consider the mixture of chemicals. Chemical-specific ARARs and TBCs for the remedial alternatives under consideration are identified and discussed in Section 5.0.

2.1.2 Location-Specific ARARs and TBCs

Location-specific ARARs and TBCs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in specific areas. The general types of location-specific requirements that may be applied to the Derecktor Shipyard site include coastal zone, water resources, and floodplain regulations. Location-specific ARARs and TBCs for the remedial alternatives under consideration are identified and discussed in Section 5.0.

2.1.3 Action-Specific ARARs and TBCs

Action-specific ARARs and TBCs are usually technology- or activity-based requirements or limitations on actions taken with respect to managing hazardous substances, pollutants, or contaminants. These

requirements generally focus on actions taken to remediate, handle, treat, transport, or dispose of hazardous substances, pollutants, or contaminants. These action-specific requirements determine how a selected alternative must be implemented. Action-specific ARARs and TBCs for the remedial alternatives under consideration are identified and discussed in Section 5.0.

2.2 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES (RAOs)

RAOs consist of media-specific goals for protecting human health and the environment. The RAOs specify the media and COCs, exposure pathways and receptors, and acceptable contaminant level or range of levels for each exposure pathway. By specifying both an exposure pathway and target contaminant level(s), the RAOs permit development of a range of alternatives that may achieve protectiveness by reducing exposure to contaminated media or reducing contaminant concentrations.

Sections 2.2.1 through 2.2.6 present the major components of the RAO development process: identify the media of concern, identify the COCs for each medium, develop PRGs, identify area and volume requiring remedial action, and formulate RAOs.

2.2.1 Identification of Media of Concern

The media of concern are identified based on the results of site investigations, the site-specific marine HHRA and marine ERA, and an evaluation of compliance with chemical-specific ARARs. The investigations conducted have identified marine sediment and shellfish (bivalves and lobster) as potential media of concern. This section presents an evaluation of media of concern for this FS.

As discussed in Section 1.6, the Marine HHRA (Brown and Root Environmental, June 1998) evaluated human health risks associated with plausible exposure pathways for human contact with contaminants in the marine sediment and shellfish at the site. This assessment indicated that the human health risks from direct exposure to the sediment did not exceed the target risk range of 1E-04 to 1E-06 for cancer risk or the 1E+00 target for non-cancer HIs.

However, the HHRA identified unacceptable human health risks associated with ingestion of shellfish from the site, which are presumed to accumulate contaminants from site sediment. Cancer risks for shellfish ingestion under the subsistence fisherman exposure scenario exceeded the target risk range of 1E-04 to 1E-06 for cancer risk and the 1E+00 threshold for non-cancer HIs. Risks were evaluated on a site-wide basis, using maximum and average concentrations detected. Cancer and non-cancer risks under this exposure scenario exceeded the target levels under both maximum and average exposure assumptions.

As discussed in Section 1.6.2, the marine ERA identified two areas of Coddington Cove as having high probability of site-related risk to ecological receptors from COCs measured (stations 27 and 29). Intermediate probability of risk was identified for several other stations near the shoreline and piers. Low probability of site-related COC risk to ecological receptors was identified for offshore stations, west of the site shoreline. Ecological receptors included avian predators and aquatic organisms.

The results of the HHRA and marine ERA indicate that the conditions in the site sediment are directly associated with increased probability for risks to ecological receptors and is indirectly associated with unacceptable risks to humans and increased risk to marine and avian predators from ingestion of shellfish that have accumulated contaminants from the site sediment. Therefore, Coddington Cove sediments were identified as a medium of concern for the FS.

Shellfish are not identified as a media of concern for the FS because they are considered to be a receptor of COCs from site sediment and a vehicle for contaminant transfer to other organisms rather than a contaminated media that can be addressed directly by a remedial action. It is assumed that by addressing contaminated site sediment COC concentrations in shellfish will be reduced, which will translate to reduced risk to the people and ecological receptors that consume the shellfish.

2.2.2 Identification of Sediment Contaminants of Concern

The sediment COCs are those chemicals that were found to pose increased incremental human health or ecological risks. Sediment contaminants that pose excess human carcinogenic risk greater than 1E-06 or have chemical-specific hazard quotients greater than 1.0 for human non-cancer risk would be selected as COCs. As stated in Section 2.2.1.1, sediments were not found to pose human health risks above these target levels due to direct exposure. However, risks above these thresholds were identified for ingestion of shellfish under the subsistence fisherman exposure scenario. Those contaminants that posed excess risk above the compound-specific risk thresholds for the subsistence fisherman receptor are listed below:

HUMAN HEALTH CONTAMINANTS OF CONCERN	
PAHS	**INORGANICS**
Benzo(a)anthracene [(1)]	Arsenic[(1,2)]
Benzo(b,j,k)fluoranthene [(1)]	
Benzo(a)pyrene[(1)]	**PCBs**
Indeno(1,2,3-cd)pyrene[(1)]	Total PCBs[(1)]
Dibenzo(a,h)anthracene[(1)]	

Notes:
(1) Chemical constituent with estimated cancer risk of 1E-6 or greater
(2) Chemical constituent with estimated non-cancer HQ of 1.0 or greater

It should be noted that the human health risk calculated for arsenic is based on the inorganic form of arsenic. This may be an overly conservative assumption, considering that it has been documented that arsenic in shellfish is 80 to 90 percent organic, which is not toxic (USFDA, 1993) and because elevated concentrations of arsenic are gradually occurring in soils (and thus sediments also) on Aquidneck Island. Therefore, while arsenic contributes to estimated risk, risk managers should consider arsenic as a COC that may not be related to site releases.

COCs identified as posing potential increased risk for ecological receptors are:

ECOLOGICAL CONTAMINANTS OF POTENTIAL	
PAHS	**INORGANICS**
Acenaphthylene	Arsenic
Acenaphthene	Cadmium
Anthracene	Chromium
Benzo(a)anthracene	Copper
Benzo(a)pyrene	Lead
Chrysene	Mercury
Dibenzo(a,h)anthracene	Nickel
Fluoranthene	Silver
Fluorene	Zinc
2-Methylnaphthalene	**PCBs**
Naphthalene	Total PCBs
Phenanthrene	**PESTICIDES**
Pyrene	Aldrin
High Molecular Weight PAHs	p,p'-DDE
Low Molecular Weight PAHs	**BUTYLTINS**
Total PAHs	Tributyltin

2.2.3 Sediment Preliminary Remediation Goals

The objective of the preliminary remediation goals (PRGs) development is to select a manageable number of COCs and corresponding concentrations that, when implemented as cleanup criteria, will address the areas of unacceptable human health and ecological risk. The PRGs must be protective of each of the principal receptors identified at the site: humans, aquatic organisms, and avian aquatic predators; additionally, they should be reasonable and practical to implement.

This section provides a summary of how the PRGs were developed and identifies the recommended PRGs for the marine sediment at the site. The PRGs were developed by SAIC based on the results of the marine ecological and human health risk assessments. The details of PRG development and

identification of recommended PRGs is documented in the Final Preliminary Remediation Goals for Derecktor Shipyard/Coddington Cove (November 1998), which is presented in Appendix B.

Sediment PRGs were developed for the site using an approach developed by SAIC that considered the human health and ecological risk, as well as ARARs and TBCs, and reference station (background) concentrations. The complete PRG development process for this site is presented in Appendix B, and briefly described below.

PRGs were developed only for the contaminants identified as “limiting” COCs, which are those contaminants determined to be the largest contributor to the baseline risk at each station. Because the COCs at the site are generally co-located (i.e. they tend to occur simultaneously at sample stations) addressing the limiting COCs that exceed the recommended PRGs will reduce the concentrations of other co-located COCs to acceptable levels.

The PRG process uses a quotient method that measures the ratio of the detected concentration (the concentration of the COC detected in the sediment) over the threshold effects value or TEV (the concentration above which adverse effects to the receptor are possible). As described in Appendix B, the TEVs are developed for human and aquatic receptors based on the target acceptable risk values (human cancer risk of 1E-6, and non-cancer risk HQ of 0.1 or less; and ecological risk quotient of 1.0 or less) and reference station concentrations. The calculated PRGs are then adjusted based on various factors to ensure that the recommended PRGs target the areas that pose the greatest potential for increased risk. The recommended PRGs are selected to achieve the greatest practical risk reduction among the identified receptor pathways.

The potential and recommended PRGs selected for the site are presented in Table 2-1. This table shows the potential PRGs for each of the receptor groups and the recommended PRGs selected to be protective of all receptor groups.

2.2.4 Identification of Areas Requiring Remedial Action

Sediment data from the historical and the 2004 supplemental investigations of the site were compared with the recommended PRGs presented in Table 2-1 to identify the locations that have exceeded PRGs in the past and those that require remediation based on the most recent data. The results of this comparison are presented in Table 2-2 and shown on Figures 2-1 and 2-2. Appendix A presents the sediment and biota data in full.

As presented in Section 1.4, comparison of the 2004 sediment data with historical data collected prior to 1999 shows that the concentrations of contaminants in site surface sediments have generally decreased

since the historical data were collected between 1993 and 1996. This decrease in contaminant concentrations has resulted in the number of site sample stations with COCs exceeding the recommended PRGs decreasing from 8 locations based on the historical data to 4 locations based on the 2004 results. Additionally, the number of COCs exceeding the PRGs at each station has decreased. Historically, most of the locations had exceedances of at least 3 COCs, whereas 3 of the 4 locations 2004 locations had exceedances of only COC. The total number of COCs with any exceedances has also decreased; none of the 2004 sample results exceeded the PRG for lead.

Several factors may contribute to the decrease in contaminant concentrations, including a decrease in contaminant inputs to the area resulting from removal of on-site source areas and changes in site activity; natural attenuation processes; sediment movement due to ship traffic and seasonal or tidal currents; and deposition of sediment from other areas of Narragansett Bay. Because the decrease in contaminant concentrations appears to be consistent across the site and not a result of sampling variability, it was determined that the 2004 data should be used to determine the areas requiring remediation.

Four sample stations (3, 29, 27, and 103) were identified as exceeding the PRGs based on the 2004 data, and therefore those stations require remedial action. Review of the data from these stations shows that sample stations 3 and 29 exceed the PRG for benzo(a)pyrene. This PRG was developed for protection of human health because the HHRA found that benzo(a)pyrene would contribute to an elevated cancer risk under the subsistence fisherman scenario. Sample station 27 exceeded the PRG for total PCBs. This PRG was developed for protection of aquatic organisms exposed to bedded and resuspended sediment. Sample station 103 exceeded the PRGs for benzo(a)pyrene and high molecular weight (HMW) PAHs. The PRG for HMW PAHs was developed for protection of aquatic organisms exposed to contaminants in bedded sediment.

2.2.5 Estimation of Areas and Volumes Requiring Remedial Action

The areas and volumes of sediment requiring remedial action were estimated based on the 2004 sediment data, which identified four locations where COCs exceeded the recommended PRGs. For the purposes of the FS, the proposed remediation area associated with each sediment COC exceedance location was roughly estimated by assuming the exceedance area extended half way to the nearest sample location, given the limitations of the samples available. The estimated areas requiring remediation and the type of receptors driving remediation of each area are presented on Figure 2-3. Prior to remediation design, the actual area of COCs exceeding PRGs would have to be refined based on further sampling in a pre-design investigation, described elsewhere in this report.

Depths of sediments with concentrations of COCs exceeding the recommended PRGs were estimated based on available data. As indicated in Table 2-2, most of the data show that sediments with

concentrations of COCs above recommended PRGs are within the uppermost sediment interval (0 to 0.5 ft). This is supported by tables presented in Appendix A and Table 2-2. An exception is Station 103 which has elevated COC concentrations in the 0.5 to 1 foot interval. For the purposes of the FS it was assumed that the top 1 foot of sediment in each area would require remedial action. The actual depth of COCs exceeding PRGs would have to be refined based on further sampling in a pre-design investigation. However, it should be noted that most remedial technologies would be limited in precision to one-foot intervals.

Area and volume estimates for the areas requiring remedial action are presented in Table 2-3. The total area and volume of sediment requiring remedial action is estimated to be approximately 888,000 square feet and 32,900 cubic yards (in-place volume). These estimates are limited by the number and frequency of samples collected. Particularly regarding the number of samples collected at depth, these limitations result in very high uncertainty in the estimated volumes of sediment requiring remediation. As a result, the actual volume of sediments exceeding the PRGs could be significantly higher or lower. This uncertainty will be considered in the evaluation of alternative costs. The actual area and volume will need to be further refined during the pre-design investigation.

2.2.6 Formulation of Sediment Remedial Action Objectives

RAOs for site sediment were formulated based on the site-specific marine risk assessments, site investigations, COC identification, and PRG development presented in the preceding sections. RAOs were identified for the marine portions of the site as an entire area, since, and although there are physical separations within the study area, the same exposure scenarios apply to all areas. Therefore, all off-shore areas were considered in developing RAOs and in developing and evaluating remedial alternatives.

The RAOs for the off-shore areas address the COC-related risks identified in the HHRA and the marine ERA. In accordance with CERCLA, the RAOs developed for these areas address unacceptable risks to humans identified in the HHRA, and potential risks to the environment and ecological receptors identified in the marine ERA. The RAOs identified for the Coddington Cove marine sediment are presented below.

The RAO for the protection of human health:

- Prevent human ingestion of shellfish that are both impacted by sediments with COC concentrations exceeding the selected PRGs and within areas where shellfishing could regularly occur.

The RAOs for protection of the environment and ecological receptors:

- Prevent exposure of aquatic organisms to sediments with COC concentrations exceeding the recommended PRGs, for both bedded (in-place) sediments and sediment areas where resuspension could occur.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Technology identification and screening are important preliminary steps in developing remedial alternatives. In this phase of the FS, potentially applicable technology types and process options are identified. The technologies and process options are then screened by evaluating each with respect to technical implementability, thereby further reducing the number considered. The technologies and process options considered to be implementable are then evaluated in greater detail, and representative options are selected for subsequent development and evaluation of remedial alternatives.

The identification, screening, and evaluation of technology types and process options are summarized below by completing the following steps:

- Developing general response actions (GRAs) for each medium of concern that satisfy the remedial action objectives (RAOs)
- Identifying and screening remedial technologies applicable to each general response action
- Evaluating and selecting representative technology types and process options

Section 3.1 identifies the GRAs that may be implemented at the site. Section 3.2 discusses the technologies to be considered and provides a preliminary screening to identify the technology types deemed applicable. Section 3.3 presents a discussion of the final evaluation and selection of representative technologies. A summary of the technologies retained for further consideration as site-specific remedial alternatives is provided in Section 3.4.

3.1 GENERAL RESPONSE ACTIONS

General response actions describe categories of actions that could be implemented to satisfy the RAOs for each medium of concern at a site. GRAs may include treatment, containment, excavation, extraction, disposal, institutional controls, or a combination. Typically, in developing remedial alternatives, combinations of GRAs are identified to fully address all the RAOs.

GRAs identified as applicable for addressing the marine sediment at the site include the following:

- No Action
- Limited Action
- Containment

- Removal and Disposal
- Removal, Treatment, and Disposal

These GRAs are summarized below.

3.1.1 No Action

Under the no-action option, the site is left "as is," without implementing institutional controls, containment, removal, or treatment. This option does not provide for monitoring or placing access restrictions on contaminated media at the site. Examination of this option is retained throughout the FS process, as required by the National Contingency Plan. Because this option involves no remedial action, it provides a baseline against which other GRAs can be evaluated.

3.1.2 Limited Action

The limited-action option is comprised primarily of institutional controls and access restrictions that limit use or access to the site to reduce or eliminate risks of exposure to hazardous materials. Limited action options also include implementing a long-term monitoring program to assess changes in environmental conditions existing at the site. While institutional controls and access restrictions alone would not reduce the volume, mobility, or toxicity of contaminated media through direct means, naturally occurring attenuation processes may reduce contaminant concentrations that are already near PRG levels over an extended period of time. Data generated from long-term monitoring activities would provide information to assist in determining the rate of attenuation, as well as any migration of COCs from or within the marine sediment. Should migration be observed, monitoring would also provide information on which to base a decision regarding the need to implement additional remedial actions.

3.1.3 Containment

Containment options reduce potential exposure risks through the application of physical means. Physical barriers prevent direct contact with and manage potential erosion/migration of contaminated media. Barriers may consist of permeable or impermeable caps and be comprised of natural and/or synthetic materials. Containment reduces the mobility of the contaminated media but does not affect volume or toxicity.

Containment of sediment in an underwater marine environment would require consideration of the feasibility of settling the capping material adequately during placement, and the permeability and

transmissivity of the cap once in place. The cap would need to be designed to include materials that would to withstand erosion forces of tides, waves, and localized currents.

3.1.4 Removal and Disposal

Removal technologies are used to collect contaminated media from their present locations and move them for subsequent disposal. For marine sediment, removal is typically performed by the use of excavation and/or dredging equipment. Removal would reduce the volume of contaminated media remaining on-site and allow site conditions to attenuate more rapidly than they would under natural conditions.

Removal of marine sediment would involve materials-handling issues related to sediment suspension, sediment dewatering, and residual water treatment/disposal. The sediment would be handled under hazardous waste standards until the material can be tested to confirm whether it qualifies as either solid or hazardous waste for disposal purposes. Sediment dewatering would be necessary as a processing step to render the removed material suitable for disposal as a consolidated solid. Residual water generated from dewatering the sediment removed from the marine environment may require treatment prior to discharge back into Narragansett Bay or disposal at an off-site facility such as a local publicly-owned treatment works (POTW).

Sediment disposal technologies in combination with removal, or removal and treatment, comprise several potential alternatives to remediate the contaminated marine sediment. Based on the nature of the contaminated media, disposal options include the following: disposal on land at a designated on-site/on-base location, or disposal off-base in either currently existing contained aquatic disposal (CAD) cells or at hazardous or solid waste landfills.

3.1.5 Removal, Treatment, and Disposal

Treatment technologies are used in combination with removal and disposal options. Following removal, contaminated sediments may require treatment to reduce the volume, mobility, and/or toxicity of contaminants prior to disposal. Treatment options include technology types and process options using thermal, physical, chemical, and/or biological means. Treatment options include in-situ and ex-situ processes. Ex-situ processes may further include both on-site/on-base and off-base options.

In-situ treatment options may not be viable, primarily due to the location of the remedial areas within the marine environment. The nature of the contaminants, their relatively low concentrations, and the extremely

low PRGs set for the coastal area may further deem in-situ options ineffective and inefficient in achieving the RAOs. However, options are identified and evaluated for applicability in Section 3.2.

Ex-situ treatment options are included for consideration in combination with disposal options. Based on existing analytical data, most of the marine sediments removed from the site are expected to be of acceptable quality for direct disposal in a solid waste landfill or Confined Aquatic Disposal (CAD) cell without pretreatment. However, because the available data regarding contaminant concentrations at depth is limited, and sediments have not been sampled for all disposal parameters, a contingency may have to be included for treating a fraction of the materials removed. In addition, use of a bulking agent may be necessary for dredged materials due to free liquids that may be present.

3.2 IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

A variety of technologies and process options exist for each GRA described in Section 3.1. These technology types and process options were identified and a preliminary screening was performed to focus on relevant technologies and process options. A summary of the identification and preliminary screening of technologies and process options associated with the remediation of marine sediment at the site is provided in Table 3-1. Many options are eliminated based on technology screening. All options not eliminated due to overall applicability concerns (technical implementability) are retained for detailed evaluation in Section 3.3.

3.3 EVALUATION AND SELECTION OF REPRESENTATIVE TECHNOLOGIES AND PROCESS OPTIONS

The technologies retained during the preliminary screening are evaluated in more detail in this section. The final evaluation and selection of the representative process options for remediation of marine sediment at the site are based on the criteria presented in Section 3.3.1. A discussion of the detailed evaluation of representative technologies and process options is presented in the Sections 3.3.2 through 3.3.7 and summarized in Table 3-2.

3.3.1 Criteria for Evaluation of Technologies and Process Options

In this step, process options considered implementable following the preliminary screening are evaluated in greater detail prior to selecting representative process options to use in developing remedial alternatives. One representative process option is selected, if possible, from each technology category to simplify subsequent development and evaluation of alternatives without limiting flexibility during remedy selection or remedial design. The evaluation criteria include effectiveness, implementability, and cost, with a focus on effectiveness. Brief descriptions of the criteria are as follows:

- Effectiveness focuses on the potential feasibility of a process option to remediate the estimated areas or volumes of media. Specifically, it is considered whether the process option meets the remediation goals identified in the RAOs, limits the potential impacts to human health and the environment during construction and implementation, and is technically reliable (considering effectiveness of innovative versus well-proven technologies) with respect to the contaminants and conditions at a site.

- Implementability encompasses both the technical and institutional feasibility of implementing a process. The preliminary screening of technology types and process options was based on an evaluation of technical implementability issues in order to eliminate options that were clearly ineffective or unworkable at the site. The subsequent, more detailed, evaluation places greater emphasis on the institutional aspects of implementability (coordination with various regulatory agencies and contractors; the availability of treatment, storage, and disposal services; and the availability of necessary equipment and skilled workers to provide long-term operational and maintenance (O&M) services, etc.).

- Cost plays a limited role in the screening of process options. Options are evaluated based on relative capital and O&M costs (whether the costs are high, medium, or low relative to the other options of the same technology type). At this point in the evaluation, the cost analysis is based on engineering judgment and not on detailed estimates.

A discussion of the screening and detailed evaluation of technology types and process options using these criteria is provided in the following sections.

3.3.2 No Action

The no-action option consists of taking no remedial action at the site. It is included in the FS process to serve as a baseline against which other alternatives may be compared.

Assessment of this option is as follows:

- Effectiveness**:** The option would not be effective in achieving the RAOs for contaminated marine sediment. Contaminants would remain and could continue to pose a risk to the marine environment and/or human health. Impacted sediments could be resuspended through propeller wash at high energy areas and migrate to other areas within Narragansett Bay and connected waterways.

- Implementability**:** The option would be readily implementable with no associated concerns.

- Cost**:** The option would have no capital costs, and O&M costs associated with the 5-year reviews would be relatively low.

The no-action option is retained for further consideration, as required by the NCP, to provide a baseline comparison against which other GRAs can be evaluated for contaminated marine sediment at the site.

3.3.3 Limited Action

The limited action GRA consists of activities designed to minimize potential risks to human health and the environment primarily by prohibiting or controlling access to impacted areas. The technology types/process options include institutional controls, access restrictions, and long-term monitoring. These options may be conducted independently or in conjunction with other process options to protect human health and the environment.

3.3.3.1 Institutional Controls

Institutional controls include administrative actions to restrict future uses of the site that could result in unacceptable exposure risks. Because the subtidal areas are property of the State of Rhode Island, any efforts to restrict access or activities must be coordinated with the state. Use restrictions could be implemented to restrict shellfishing and prohibit lobstering. A state-imposed ban on bivalve collection is already in effect in the area of Narragansett Bay off NAVSTA and Coddington Cove due to known and potential sewage discharges in the area. RIDEM has designated the area as a Permanent Shellfish Closure Area (for bivalves only); however RIDEM has noted that the shellfish closure could be lifted if the sewage discharges are addressed through tertiary treatment. Collection of lobster is not prohibited by the shellfishing ban. To prevent human exposure to shellfish and lobster impacted by site COCs, the shellfish collection ban could be expanded to include a closure for site contamination and to include lobster.

Assessment of this option is as follows:

- Effectiveness**:** This option would offer no containment or removal of contaminated marine sediment. Use restrictions, effectively enforced by the State of Rhode Island or the Navy, would deter fishermen and recreational users and thus reduce human health risks associated with ingestion of contaminated shellfish. Current restrictions are reportedly not complete. Institutional controls would not prevent contaminant resuspension/migration, reduce toxicity, or reduce contaminated sediment volume. Institutional controls would not protect aquatic (ecological)

receptors. Use restrictions could reduce disturbances of the contaminated media by deterring access. No additional risks to human health and the environment would result from implementing use restrictions.

- Implementability: Use restrictions could be implemented by the State of Rhode Island to prohibit lobstering and shellfishing in contaminated areas. Institution of access restrictions and enforcement by NAVSTA police is implementable. Prohibition of lobstering within Coddington Cove is implementable, but as is the case with shellfish collection prohibitions, adequate enforcement is necessary. Cooperation/coordination between Rhode Island authorities and the Navy on enhanced enforcement of the existing restrictions would be required because the impacted marine sediment area is located on state property.

- Cost: The capital and O&M costs for administrative actions and 5-year reviews would be relatively low.

Institutional controls are retained for further consideration. Although controls prohibiting some shellfishing activities are already in place, they are not comprehensive and are not permanent. They could be made permanent and expanded to include prohibition of lobster collection. Institutional controls could be implemented in conjunction with long term-monitoring and access restrictions.

3.3.3.2 Access Restrictions

Access restrictions include placing physical barriers or markings to limit site use. Placement of fencing, signs, and buoys would demarcate the impacted area and identify the use restrictions (shellfishing and lobstering prohibitions) and associated risks. These actions would deter access to the site and the impacted sediment, thus reducing the likelihood of exposure to humans.

Assessment of this option is as follows:

- Effectiveness**:** Enforced access restrictions (proper placement of signs and buoys, as well as fencing the north breakwater from shore access) would deter commercial fishermen, recreational boaters, and anyone else collecting shellfish, effectively reducing the potential for risk to humans. Access restrictions would not prevent contaminant migration, reduce toxicity, or reduce contaminated sediment volume. Access restrictions would not protect ecological receptors.

- Implementability: The Navy currently allows some commercial crab and lobster fishing in areas of Coddington Cove that they control. Additionally, it was once reported that recreational divers

access the breakwater at the north boundary of Coddington Cove. The Navy could limit access to this breakwater and waters in the areas of concern by placing buoys and signs at appropriate locations within Coddington Cove. Since 2001, the Navy has restricted recreational boaters from access to portions of the cove. This action would make that restriction complete and permanent. The Navy would monitor and maintain the buoys, fences, and signs as long as the contaminated sediments remained in place.

- Cost: The capital and O&M costs for placement and long term maintenance of fencing, buoys, and signs would be considered to be moderate.

Access restrictions were retained for further consideration in conjunction with institutional controls, to protect human health only. Access restrictions would not provide protection to ecological receptors.

3.3.3.3 Long-Term Monitoring

Long-term monitoring includes collecting sediment samples from selected locations to assess the migration of contaminants and migration of contaminated sediment. Monitoring would also provide a means of measuring any natural attenuation processes (intrinsic abiotic and biotic degradation) occurring within the contaminated marine sediment; it would additionally provide information to assess the potential need for future remedial action.

Assessment of this option is as follows:

- Effectiveness**:** Data collected from monitoring activities would help to identify trends in contaminant concentrations associated with natural attenuation and potential contaminant migration off-site. Monitoring would also provide information to assess the need for future remedial action, in addition to characterizing the effectiveness of any remedial action conducted. Monitoring would not offer environmental protection or attain the RAOs. Monitoring would not be effective in preventing contaminant migration or reducing toxicity, mobility, or volume of contaminated sediment.

- Implementability: A long-term monitoring plan would be readily implementable, since trained personnel are locally available for sample collection and analysis/reporting.

- Cost: The capital and O&M costs for a periodic sediment monitoring program would be relatively low, although cost would increase based on frequency, duration, and magnitude of the monitoring program.

The long-term monitoring option is retained for further consideration. While providing no direct protection of human health and the environment, monitoring would provide a means of assessing changes to contaminant concentrations if active remediation cannot be implemented for some reason. In addition, it could be used to monitor for potential contaminant migration or changes from natural attenuation processes at the site. Combined with other process options, monitoring would provide a means of determining the effectiveness of remedial action activities.

3.3.4 Containment (In-Situ Capping)

The containment GRA involves using engineering controls to limit potential risks to human health and the environment. It would consist of installing and maintaining a physical barrier to isolate and contain the contaminated marine sediment. The barrier would consist of a natural cap constructed by placing natural fill materials such as sand, gravel and stone over the contaminated sediment. The cap would be thick enough to contain sediment and prevent exposure by burrowing marine organisms. A pre-design investigation would be required to make final determinations regarding the size of the area (horizontal extent) affected by the action and to provide a basis for the design requirements for the cap.

Assessment of this option is as follows:

- Effectiveness**:** In-situ capping would achieve the site-specific RAOs by isolating the contaminated sediments from potential receptors. The cap thickness would need to be sufficient to prevent deep-burrowing organisms from accessing the sediments. Long-term maintenance would be required to maintain the cap's effectiveness. Capping would not reduce the volume of contaminated media on-site. The use of appropriate turbidity control measures during cap installation would minimize contaminant migration during implementation. Five-year reviews pursuant to CERCLA would be required.

- Implementability: Capping is a proven and reliable technology, although underwater implementation would present additional challenges. Specifically, dispersion of the contaminated sediments would potentially occur during cap implementation. Cap implementation would need to occur by slow, uniform placement of layers to minimize resuspension. Cap materials, comprised of common fill materials, are readily available for purchase. The ocean floor would need to be suitable to support the weight of the cap, and exhibit suitable depth and slope (bathymetry) characteristics. This alternative is implementable by local marine contracting companies with trained personnel familiar with this process.

Capping can not be implemented in the shipping/traffic areas or near the piers because a cap would interfere with or be impacted by maintenance dredging of the port. These areas are intended to be maintained at a 30 foot depth.

- Cost: The capital costs are moderate to high for capping the contaminated sediment. Moderate to high O&M costs are also associated with this option.

The in-situ capping containment option is retained for further consideration for the remediation areas away from Pier 1 and 2 (DSY-3 and -29 areas). This area is bounded on three sides to minimize dispersion of cap materials and is out of shipping and large boat traffic areas. By creating a physical barrier over the contaminated sediments, human health and the environment would be protected; however, no reduction in volume of contaminated sediments would occur.

3.3.5 Removal

Removal technologies are key components of both the removal/disposal and removal/treatment/disposal GRAs. Removal activities involve excavating and/or dredging contaminated marine sediment to reduce or eliminate on-site toxicity, mobility, and volume. These operations require instituting sediment resuspension/turbidity control measures, excavating or dredging, transporting removed materials, dewatering sediment, treating water generated during dewatering, and restoring altered intertidal and subtidal habitats. A pre-design investigation would be required to make final determinations regarding removal equipment, and better delineate the area (vertical and horizontal extents) affected by the action.

In general, selection of the most efficient and cost-effective excavation and/or dredging techniques depends on sediment required removal rates and target depths which, in turn, depend on the following factors:

- Volume and depth of contaminated material
- Sediment characteristics (amount of debris, sediment grain size, and water content)
- Location/navigational constraints (bridges, water depth, currents, etc.)
- Weather conditions
- Post-removal treatment requirements (dewatering, water treatment, and sediment treatment, etc.)
- Marine ecological concerns related to resuspension of contaminated sediments during removal and associated turbidity control (silt curtains, booms, etc.)
- Health and safety issues related to sediment handling
- Equipment (type and size) that can access the areas
- Mode of transport to disposal or treatment facility

- Method/location of disposal or treatment
- Permanent and floating obstructions present

Land-based removal could be conducted in some areas around existing piers and bulkheads. Contaminated sediment that cannot be reached from the shoreline would be removed using barge-mounted dredging equipment.

The sediment removal options may include the following excavation and dredging technology types.

3.3.5.1 Mechanical Dredging and Excavation

Mechanical dredging and excavation may be conducted using a number of techniques including clamshells, dippers, bucket ladders, drag lines, and conventional earth-moving equipment. This equipment operates by directly applying mechanical force to dislodge materials to be removed.

Clamshells. The most commonly used mechanical dredge for removing contaminated soils and sediment is the clamshell dredge. Clamshells can recover all types of material and debris, except highly consolidated sediment. This type of dredge is generally equipped with an open, hinged bucket with a capacity of 1 to 12 cubic yards. The bucket is attached by a cable to a land-based crane or flat-bottomed barge. The clamshell dredge can excavate to a target depth, restricted only by the crane-lifting capacity and penetration into the substrate.

The clamshell dredge is operated by opening the jaws of the bucket, lowering the bucket into the material to be removed, closing the jaws, and hoisting the bucket by means of the crane cable. The dredge removes a heaped bucket of material, part of which is excavated by drag forces during hoisting. If properly operated, conventional clamshell dredges can operate with limited loss of sediment and can efficiently remove a large volume of material. For marine dredging applications, a modified, watertight bucket is sometimes used to minimize the resuspension of solids into the water column. The clamshell dredge would allow removal of sediment with limited removal of water. However, use of the watertight bucket would increase the water captured with the sediment. It is anticipated that 25 percent of the material removed would be water using the watertight bucket, and less using a non-watertight bucket.

Dippers. The dipper is a powered 8 to 12 cubic yard shovel designed for digging out rock and very hard, compacted material. Its use is suited for excavation of soft rock and highly consolidated sediment within a working depth of 50 feet. Since this technique operates with a violent digging action and tends to drop small particles, its application for marine dredging is often limited. Dippers allow removal of sediment with

minimal water included with the dredge spoils. However, excessive resuspended sediment would be generated and not captured if fine-grained material, such as is present in Coddington Cove, is dredged.

Bucket Ladders. A bucket ladder dredge is comprised of a submersible ladder that supports a continuous chain of buckets that rotate around two pivots. When the buckets rotate around the underside of the ladder, they scoop up material and transport it up the ladder for discharge into a storage bin. These dredges are most commonly used in mining operations abroad, such as sand and gravel production. The bucket ladder dredge generates considerable turbidity because of the mechanical agitation of sediment and leakage from the bucket. The water captured by this method is equivalent to that of the clamshell dredge. Water content would be higher if dredging fine grained sediments, as the principal is to allow the sediment to displace water within each bucket as it is raised up the ladder. Fine-grained material would become suspended in water and not stay within the buckets as effectively as coarser grained sediment and gravel.

Drag lines. Drag lines use the same basic equipment as the clamshell dredge. However, the drag line operates by using a drag cable to pull the bucket through the material being excavated toward the crane. Drag line dredges typically provide for a longer reach than clamshell dredges operated by the same crane. Since drag lines cause a great deal of mechanical agitation of the material being removed and because the buckets are generally open, their use usually results in excessive sediment resuspension. The amount of water captured by this method would be equivalent to that of the clamshell dredge. It is anticipated that watertight and non-watertight buckets are available for this application.

A summary of the advantages and disadvantages of mechanical dredging follows:

> Advantages of mechanical dredging include the fact that excavation can be conducted to maximize the solids content (approximately 75 percent) and, thereby, minimize the scale of the dewatering and handling activities. Mechanical dredges are highly maneuverable, are able to remove many types of debris, and provide dredging accuracy. Clamshell dredges and excavators are capable of efficiently removing materials with depth. Many techniques are available for shoreline use, while fewer options are suited for barge-mounted operations.
>
> Disadvantages of mechanical dredging include the potential for resuspending large amounts of sediment, as well as offering a lower production capacity with typically higher costs than other dredging techniques. Mechanical dredging operations, also require significant rehandling of materials. Finally, mechanical dredging equipment is not effective in removing shallow amounts of sediment; it is specifically designed to remove large vertical amounts of sediment.

Assessment of this option is as follows:

- Effectiveness**:** Mechanical dredging would be effective in removing debris and contaminated sediment at thicknesses of 2 feet or more from the marine environment. Removal would minimize future contaminant exposure risks to human health and the marine environment while preventing contaminant migration within Narragansett Bay. The effectiveness of mechanical dredging is limited by the difficulty of achieving precision removal in an underwater environment. Multiple passes over the contaminated area may be required to remove all contaminated materials, and excess sediment may be removed in the process. The effectiveness can be improved by state-of-the-art positioning equipment, but not to 100 percent. The use of appropriate turbidity control measures during dredging of marine sediment would minimize contaminant migration during implementation. However, mechanical dredging activities could result in excessive resuspension of contaminated sediment that may be difficult to control, particularly in water 30 feet or more in depth.

- Implementability: Mechanical dredging is readily implementable by local companies with trained personnel familiar with the dredging of contaminated sediment. Separate vendors would be required for treatment of dewatered sediment; however, qualified companies are assumed to be readily available within the Rhode Island coastal business community. Dredging under the piers may not be implementable.

  Mechanical dredging is readily implementable by both shoreline and barge-mounted operations because of the nature of the site and surrounding shorelines. However, mechanical dredging may cause alterations of aquatic habitats and require mitigation measures.

- Cost: The capital costs are moderate to high for dredging contaminated materials. No O&M costs are associated with this option unless O&M of habitat restoration is required.

Mechanical dredging is a viable removal option for this site and has, therefore, been retained for detailed consideration. The final selection of the most appropriate mechanical dredging method would be made after the vertical and lateral extents of contamination are delineated during predesign.

3.3.5.2 Hydraulic Dredging

Hydraulic dredges use centrifugal pumps to remove sediment in a liquid slurry form for transport by suction to a designated location on a barge or along the shoreline. Slurries of 10 to 20 percent solids by weight are typically achieved. A cutterhead, or similar device, is often fitted at the suction end of the

dredge to assist in dislodging bottom materials and allow for transport of sediment to the suction pipe. The cutterhead is one of the most efficient and versatile type of hydraulic dredge available. However, new hydraulic dredge designs are available that attempt to increase the solids content of the pumped slurry while minimizing sediment resuspension caused by the dredging activity.

Both cutterhead and plain suction hydraulic dredges can efficiently remove large volumes of relatively fine materials. Typical hydraulic dredges cannot remove stones or debris larger than approximately 4 to 6 inches in diameter because they are limited by the size of the suction head and slurry pipeline. The plain suction dredges are capable of removing relatively free-flowing sediments (sand, gravel, and unconsolidated material), while cutterhead dredges are capable of removing free-flowing as well as very hard and cohesive sediments. Portable dredges (with or without a cutterhead) can be used to remove moderate volumes of materials that are more surficial in nature (depths of up to approximately 18 inches). The cutterhead, plain suction, and portable dredges can all be operated from the shoreline or from barge-mounted equipment in deep water.

A summary of the advantages and disadvantages of hydraulic dredging follows:

> Advantages of hydraulic dredging include limiting the resuspension of sediment in surrounding waters and minimizing the handling of dredged material by transporting the dredged slurries by suction through pipelines. The cutterhead can efficiently dredge and pump all types of alluvial materials or compacted deposits, such as clay or hardpan. The cutterhead is also capable of removing shallow intervals of sediment (minimum effective depth of 0.5 feet) and grading and finishing slopes efficiently.
>
> Disadvantages of hydraulic dredging include the fact that large volumes of water, which may require treatment prior to disposal or release, are typically removed along with the sediment (80 to 90 percent water by weight). The slurry pipelines used to transport dredged material may temporarily obstruct navigational traffic. Nonhopper dredges cannot be operated in rough water, and hopper dredges may require drafts of over 10 feet. The presence of large stones and debris such as wire, cable, conduit, and pipe, all of which are present at the site, may limit the effectiveness and suitability of hydraulic dredging. Hydraulic dredges cannot remove material with diameters greater than the diameter of the suction head or slurry pipeline; therefore, their use in areas where debris is present may be limited.

Assessment of this option follows:

- Effectiveness**:** Hydraulic dredging would be effective in removing contaminated marine sediment at thicknesses of 0.5 feet and more. However, in areas where the marine environment contains

obstructions or debris greater than the diameter of the dredge, mechanical excavation and dredging techniques may be required to prepare the area prior to hydraulic dredging. The effectiveness of hydraulic dredging is limited by difficulty of horizontal control in an underwater environment. The effectiveness can be improved, but not to 100 percent, by state-of-the-art positioning equipment. Removal of impacted sediment would minimize future exposure risks to human health and the marine environment, and prevent contaminant migration within Narragansett Bay. The use of appropriate turbidity control measures during dredging activities would minimize contaminant migration during implementation.

- Implementability: Hydraulic dredging is readily implementable by local companies with trained personnel familiar with dredging contaminated sediment. Separate vendors would be required for treatment of water generated during dredging. However, qualified companies are available within the Rhode Island or New York/New England coastal business community. Dredging under the piers may not be implementable.

  Hydraulic dredging is implementable by both shoreline and barge-mounted operations because of the industrial nature of the site and surrounding shorelines. However, hydraulic dredging may cause alterations of aquatic habitats, such as wetlands, that would require potential mitigation measures.

- Cost: The capital costs are moderate to high for hydraulic dredging of contaminated materials. No O&M costs are associated with this option unless O&M of habitat restoration is required.

Hydraulic dredging using barge- and pier-mounted equipment is viable for this site, particularly for areas where sediments with contaminants exceeding recommended PRGs are bound only within the upper 1.0 feet or less of the substrate. However, some debris is known to be present along the piers and bulkheads and therefore, limited mechanical dredging may be necessary to prepare the area first. Therefore, hydraulic dredging has been retained along with mechanical dredging for further consideration for use in the areas of concern, pending collection of additional information on sediment grain size, elutriate quality, and the vertical extents of contamination during a pre-design investigation (PDI). The final selection of the most appropriate dredging method should be made after collection and evaluation of PDI data.

For the purposes of this FS evaluation, hydraulic dredging (see Section 3.3.5.1) has been selected as the primary dredging technology for removal of sediment at the site. Mechanical dredging is retained for potential use in dredging large rocks and debris.

3.3.6 Materials Disposal and Handling

Disposal technologies are included as key components of the removal GRAs. Disposal media include sediment excavated and/or dredged from the marine environment and debris removed near the piers. Disposal options may include both on-shore and off-shore facilities located off-base.

Additional activities associated with excavation/dredging operations are related to materials handling. These activities include transporting dredged materials for processing, screening, and dewatering sediment, and treating/disposing of both the residual water and the dewatered sediment.

3.3.6.1 Confined Aquatic Disposal

Confined aquatic disposal (CAD) is a type of sub-aqueous capping in which the dredged sediment is placed within a natural or excavated depression at an off-shore location away from the dredged area and capped with clean materials. CAD would involve disposing of the contaminated sediments by placing them into a bottom-dump scow for transport by tugboat to a designated CAD cell disposal location. CAD is being considered as viable disposal option for the site based on the current (2007) availability of sufficient storage capacity within a group of existing CAD cells located in the upper Narragansett Bay near Providence, Rhode Island.

These CAD cells were construction by the U.S. Army Corps of Engineers and are operated and maintained by the Rhode Island Coastal Resources Management Council (CRMC).

CAD cells can be used for disposal of contaminated or non-contaminated materials. CAD cells are not governed by RCRA Subtitle C or D land disposal facility requirements and may accept materials that would be classified as hazardous under RCRA. Some testing may be required to determine the handling requirements and disposal location within the CAD cell; however testing requirements would be less than required for land disposal.

Assessment of this option is as follows:

- Effectiveness**:** CAD is an effective, viable means of off-base disposal. Disposal in a CAD cell would effectively contain the contaminated sediment and prevent human or ecological exposure to the contaminants. Because the sediments would be disposed underwater, dewatering may not be necessary prior to disposal or dewatering requirements may be minimal (i.e. removal of free water only). Prior to transport off-site, any water generated from passive or active dewatering of the contaminated sediments may need to be discharged for treatment and/or disposal. Any treatment

processes necessary for sediment or water would be completed on the barge(s) used to conduct the work.

- Implementability: CAD would be highly feasible to implement. A group of CAD cells, constructed for a Providence River dredging project are currently available in the upper Narragansett Bay near Providence, Rhode Island. The cells are reported to have more than sufficient capacity to accept the volume of sediment expected to be generated from the site. (Goulet, 2007) A sufficient fleet of scows and tugboats would be required to ensure that the work is not stalled due to lack of on-site disposal capacity. These are expected to be available within the Rhode Island coastal business community.

- Cost: The capital costs are expected to be moderate. No O&M costs are associated with this option.

The confined aquatic disposal option is retained for further consideration. By disposing of the contaminated media off-site, human health and the environment would be protected.

3.3.6.2 Off-Base Landfill

Disposal of contaminated sediments at an off-site landfill would require dewatering and possibly addition of a bulking agent to make the sediment suitable for land disposal. The material would also require testing for hazardous characteristics to determine the appropriate type of disposal facility. It is expected that most or all of the material would be acceptable for disposal at a solid waste landfill (RCRA Subtitle D or equivalent). If any of the sediment is determined to be classified as hazardous, it would require treatment and/or disposal in a hazardous waste landfill (RCRA Subtitle C or equivalent).
Assessment of this option follows:

- Effectiveness: Disposal at a licensed solid or hazardous waste landfill are effective means of off-base disposal. These facilities would effectively contain the contaminated sediments and prevent exposure to or migration of contaminants. Furthermore, these facilities may be capable of providing treatment of selected materials if required prior to disposal.

- Implementability: RCRA Subtitle D landfills are available locally, but a single location may not be able to accept the volumes of materials removed from the site. RCRA Subtitle C facilities are available for disposing and/or treating a small volume. Therefore, a number of disposal facilities may have to be used, and some or all of the material may need to be shipped out of state. Proper handling and transport of contaminated materials, complete with bill of lading or hazardous waste

manifest, would be required. Some stabilization of the materials may be required prior to transport to minimize the presence of free liquids. Disposal in landfill would be more difficult than disposal in a CAD cell because of the additional dewatering, treatment, and testing requirements and load limitations for truck transport.

- Cost: The capital costs of landfill disposal and the associated treatment and transport are expected to be relatively high (higher than CAD). No O&M costs are associated with this option.

Off-base disposal of sediment in landfills is retained for further consideration as an alternate option to CAD. Land disposal would be employed only if it is determined that disposal in the CAD cells off-shore of Providence, Rhode Island, is not possible due to capacity or other reasons.

3.3.6.3 Dredged Materials Processing

Processing of dredged materials would take place either at a designated shoreline location or on a barge/scow located near the removal location. All excavated/dredged materials would be placed directly on a barge or scow, or on a staging area at the site waterfront for processing.

Dewatering Activities. Dewatering is the first step in processing dredged materials. This is generally required to reduce the moisture content of the sediment, enhance the handling characteristics, and prepare the sediment for further treatment, transportation, and disposal. Typically, dredged material is first screened to remove large objects and debris that may plug or foul the dewatering equipment.

Dewatering technologies appropriate for marine sediment include centrifuging, filtration, and gravity thickening. The effectiveness of these technologies is influenced by the relative concentrations of clay, silt, and organic matter in the sediment.

Centrifuging techniques use the force developed by fast rotation of a cylindrical drum or bowl to separate solids and liquids based on differences in densities. They generally achieve a product composed of 10 to 35 percent solids. The effectiveness of using centrifuges is limited by sediments containing tars, small particle sizes, low density particles, large objects, or fibrous materials. Centrifuges are generally compact and, therefore, well-suited for use in areas with space limitations.

Filtration is a physical process whereby liquid is forced through a permeable medium and dewatered solids are retained. Filtration techniques are able to dewater fine-grained sediment over a wide range of solids concentrations. The effectiveness depends on the type of filter, particle size, and water content of the sediment. Three commonly used filtration systems include belt press filtration, vacuum filtration, and

pressure filtration. The achievable solids content of dewatered sediment is expected to be in the range of 10 to 50 percent.

Gravity thickeners concentrate solids in a tank, similar to a conventional sedimentation tank or clarifier. They concentrate dredged sediment slurries of nearly any grain size down to approximately 2 to 15 percent solids. Heavier material dewaters quickly and more efficiently than fine-grained material. Thickened material is typically further dewatered by other methods. The use of gravity thickening techniques for dewatering marine sediment has limited applicability. However, it may be used as a preliminary dewatering technique in cases when the solids content is very low, as in the case of slurries generated from hydraulic dredging operations.

The selection of a dewatering process or combination of processes depends on the sediment volume and solids content (a function of the dredging technique), available land space, and degree of dewatering required. The system may be operated on the barge/scow or at on-shore portions of the site in the vicinity of the removal activities. Final selection will take place during the remedial design.

Treatment/Disposal of Residual Water. The water generated from sediment dewatering processes may require treatment to remove dissolved and colloidal contaminants prior to discharge/disposal.

Treatment could take place on the dredging platform or at a NAVSTA-owned shoreline property, using a skid-mounted clarifier and membrane filter prior to discharge into Narragansett Bay. The clarifier would remove inorganic constituents by metals precipitation. Unsettled metals precipitant and other suspended particles would be removed by sedimentation and/or filtration. Organic constituents (PAHs and PCBs) are expected to be adsorbed onto the surface of the suspended particles, and thereby removed along with these particles. However, should a need arise to further reduce the concentrations of these organic constituents, additional process units may be added to the skid-mounted treatment train. These may include dissolved air flotation and/or granulated activated carbon process units. The treated effluent would be required to meet specific contaminant concentration limits prior to discharge into Narragansett Bay.

Selection of materials that would be used for precipitation (alum etc.) and the volumes required would be determined based on the performance of a pilot scale test. This is appropriate for design of any treatment plant. The volume of water to be treated would be determined based on the dredging equipment to be used and recovery rate of the dredged sediments. The water treatment plant would be designed to keep pace with the dredging schedule, once it is determined. Current estimates indicate that under optimal conditions, dredging could progress at a rate of 435 cubic yards per day. Assuming dredge spoils are 80 percent water, the plant would need to treat and discharge up to 75,000 gallons per day. Backup storage would need to be available to store as much pretreatment water as could be produced during a full day of dredging at the optimal rate. This safeguard will assure that the treatment plant is not over-taxed at any

time, and that dredging could be delayed if there is a delay in treatment production. It is anticipated that the Piers and North Waterfront areas of the former Shipyard would be available for handling and treatment of water and sediment.

3.3.6.4 Transportation of Excavated/Dredged Materials

Marine sediment removed from the impacted areas would be transported for processing (removal of debris, dewatering, etc.) prior to disposal. The type of transport would depend on the method of excavation/dredging, treatment required, and whether disposal is on-shore or off-shore. At the site, the proximity of the piers and bulkheads to the areas evaluated for remedial action is such that transportation should not be difficult. Final transportation methods would be selected after the dredging method and disposal location is selected.

3.3.7 Treatment

Sediment treatment is included as a potentially required component of the removal/treatment/disposal GRA. Contaminated marine sediment removed by dredging techniques may require treatment, following dewatering and prior to disposal. Treatment would ensure that all contaminated solids are of acceptable quality for disposal at the selected off-base facility. Treatment may include stabilization or solidification to immobilize contaminants within the material, or use of bulking agents to remove excess water for transportation and land disposal.

It is expected that no treatment of sediment would be required for CAD. Landfill disposal is more likely to require treatment prior to disposal, but primarily for removal of free water. Potential treatment technologies are discussed below.

3.3.7.1 On-Base Treatment

If landfill disposal is employed, on-site treatment may be required for sediment contaminated with elevated concentrations of metals. Potential on-base treatment technologies include chemical/physical (stabilization/solidification) options. Additional thermal, physical, chemical, and biological options were eliminated during preliminary screening (Table 3-1).

Chemical/Physical Treatment (Solidification/Stabilization). Solidification/stabilization is a technique that mixes reactive materials with contaminated solids, semi-solids, and sludge to immobilize the contaminants by forming a chemically-stable matrix of limited permeability. Volume increases exceeding 20 percent can result. Solidification/stabilization agents may include cement, siliceous materials, lime, or

proprietary agents. Bulking agents may also be used to reduce free liquids in dewatered sediment to make it suitable for transport and land disposal. Selection of the most appropriate agent, the waste-to-additive ratio, mixing variables, and curing conditions all depend on the chemical and physical characteristics of the waste and the requirements of the disposal facility. Solidification/stabilization techniques are most successful in treating wastes containing inorganics; however, some success has been experienced with oily sludge and solvents. Solidification/stabilization is not effective for immobilizing VOCs.

Assessment of this option follows:

- Effectiveness: Solidification/stabilization is a well accepted technique to treat inorganic contaminants and reduce free liquids in sediment. Success in forming a chemically stable matrix depends on the selection of the stabilizing agents, the mix ratios of waste to agent, and proper mixing and curing. Its effectiveness in treating organics is inconclusive. Treatability studies would be required to confirm the effectiveness in treating the contaminants of concern, as well as to determine the optimum processing steps to reduce leaching of constituents from the solidified/stabilized medium. Addition of stabilizing agents is used effectively to reduce the amount of free liquid present in sediment that is otherwise of acceptable quality for disposal without additional treatment.

- Implementability: The implementation of the solidification/stabilization process may prove difficult for sediment or sediment slurries with high water content. Initial dewatering of these materials would be necessary to minimize the amount of stabilizing agent required. This preparatory step would reduce the time required to stabilize the contaminants and minimize volume increases associated with bulking of the contaminated material. Treatability studies would be required to determine appropriate treatment processes. Adequate space is available for these processes on-site.

- Cost: The capital costs are expected to be relatively low. Dredged and dewatered sediment requiring solidification/stabilization are expected to be treatable on-site for a minimal cost per cubic yard. The volume of contaminated sediment expected to require treatment is approximately 20 percent of the dredged materials, quantified in following sections. No O&M costs are associated with this option.

Solidification/stabilization is a viable treatment option for inorganic contaminants and for removal of free liquid. It is retained for further consideration if land disposal is employed.

3.3.7.2 Off-Base Treatment

Off-base treatment has been evaluated as a contingency should on-shore portions of the site not be available for treatment. The volume of sediment requiring treatment can be handled more cost-effectively off site. The appropriate off-base treatment technologies would be determined by the disposal facility accepting the material. It is expected that most of the sediment would not require treatment prior to landfill disposal. Off-base treatment would likely be required for only a small fraction of the sediment disposed in a landfill.

Assessment of this option follows:

- Effectiveness: Treatment is an effective means of rendering the contaminated material acceptable for off-base disposal. Treatment would reduce the toxicity and mobility of the contaminated media. The volume of the media would increase (typically by up to 20 percent) following solidification/ stabilization processes.

- Implementability: This option is implementable at a licensed off-base landfill facility. Many landfill facilities offer stabilization/solidification. Fewer facilities are available for treatment of organics. Proper handling and transport of contaminated materials, complete with bills of lading, would be required. Some stabilization of the materials may be required prior to transport to minimize the presence of free liquids.

- Cost: The capital costs are expected to be relatively low. Materials requiring solidification/ stabilization are expected to be treatable off-site for a minimal cost per cubic yard. No O&M costs are associated with this option.

Off-base treatment is retained for further consideration for the site area if landfill disposal of sediment is employed.

3.4 SUMMARY OF SELECTION OF REPRESENTATIVE PROCESS OPTIONS

All remedial technologies and process options retained following the detailed evaluation process discussed in Section 3.3 are summarized in Table 3-3. As discussed in Section 4.0, these technologies will be grouped to form a variety of alternatives to consider in remediating marine sediment at the site.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Development and screening of alternatives is conducted to assemble an appropriate range of remedial options to achieve the site RAOs. In this phase of the FS, remedial technologies retained for further consideration in Section 3.0 are combined to form remedial alternatives for the sediment, which has been identified as the medium of concern. The alternatives are then screened as necessary to eliminate alternatives that would not be protective or do not enhance the range of available alternatives to narrow the field of potential alternatives to be selected for subsequent detailed evaluation.

The remedial alternatives are developed to comply with regulatory criteria applicable to the site conditions and media of concern, as directed by the following regulations and guidance:

- Navy/Marine Corps Installation Restoration Manual (February 1992), which dictates that remedial alternatives be consistent with the procedures outlined in the NCP (40 CFR 300.430).

- National Oil and Hazardous Substance Pollution Contingency Plan (NCP) (40 CFR 300), which further suggests consideration of applicable EPA directives and guidance.

- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1988).

These documents require that a range of alternatives be developed to eliminate, reduce, or control human and ecological risks. The goal is to select remedies that protect human health and the environment, maintain protection over time, and minimize untreated waste. According to Section 121 of CERCLA, as amended by SARA, the statutory preference is for remedies that result in permanent and significant decrease in toxicity, mobility, or volume of contaminants and provide long-term protection. In addition, the NCP specifies that certain expectations be considered while developing and screening remedial alternatives. These expectations are as follows:

- Treatment will address the principal threats posed by the site, wherever practical. Principal threats are considered to be liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials.

- Engineering controls, such as containment, will be used for waste that poses a relatively low, long-term threat and for which treatment is impractical.

- A combination of methods will be used, as appropriate, to achieve protection of the environment. In appropriate solutions, treatment of principal threats will be combined with engineering and institutional controls for dealing with residuals and relatively low, long-term threats.

- Institutional controls, such as deed restrictions, will supplement engineering controls for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants.

- The use of innovative technologies will be considered when such use offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts, or lower costs for similar levels of performance compared to previously demonstrated technologies.

- Environmental media will be returned to their beneficial uses, when practical, within a reasonable time frame. When restoration of a medium is not practical, actions are expected to prevent further migration and exposure to contaminated media, and evaluate further risk reduction measures.

The remedial alternatives developed for the marine sediment at the Derecktor Shipyard/Coddington Cove site are described in Section 4.2 and screened in Section 4.3. The alternatives retained in Section 4.3 are evaluated in detail in Section 5.0.

4.1 RATIONALE FOR DEVELOPMENT OF ALTERNATIVES

To select the remedial options, the GRAs and process options chosen to be representative of the various technology types (see Section 3.0) were combined to form remedial alternatives that represent a range of possible options to reduce human health and ecological risks posed by COCs in site sediment. The alternatives developed include a range of risk reduction measures and future land use restrictions. These alternatives also achieve compliance with ARARs and recommended PRGs.

The remedial alternatives developed to address marine sediment contamination consist of combinations of no action, long-term monitoring, institutional controls, access restrictions, containment (capping), removal, disposal, and treatment technologies. The purpose of each remedial alternative is to prevent or control receptor contact with the contaminated media in order to reduce exposure risks. A range of remedial alternatives from no action to complete removal and off-base disposal of impacted media were developed for detailed evaluation.

Five remedial alternatives have been developed to address contaminants present in sediment at the site. The alternatives include:

- Alternative 1: No Action
- Alternative 2: Limited Action (institutional controls, access restrictions, long-term monitoring)
- Alternative 3: Containment (capping, long-term O&M and monitoring) and Removal and Off-shore disposal
- Alternative 4: Removal and Off-shore disposal

4.2 REMEDIAL ALTERNATIVES

The alternatives were developed to address sediments in Coddington Cove identified by the risk assessments as presenting elevated risks to humans and ecological receptors due to concentrations of PAHs, PCBs, and metals. The contamination is presumed to be associated with industrial activities at the shipyard and at and near Piers 1 and 2 in Coddington Cove. The risk assessment results and inputs were used to determine recommended preliminary remediation goals recommended (PRGs), which are concentrations of COCs above which these ecological and human receptors are likely to be affected.

Sediment contaminants that exceed the recommended PRGs are currently estimated to cover 888,100 square feet of surface area around stations 3, 27, 29, and 103. The estimated thickness of contaminants exceeding PRGs in these areas is less than one foot. For estimating purposes, it is assumed that the remedial actions would address the 888,100 square-foot area and removal alternatives would involve dredging the top one foot of sediment. The remedial alternatives developed for the site are described in detail in the following sections and summarized on Table 4-1. The rationale for including each alternative in the range of alternatives to be evaluated is also discussed in the following sections.

4.2.1 Alternative 1: No Action

Evaluation of the no-action alternative is required under the NCP. This alternative would involve no remedial response activities for the site. It is included to provide a baseline against which other alternatives may be compared. Since contamination exceeding PRGs would remain and unrestricted future use of the environment would be allowed, 5-year reviews of the no-action decision would be required to evaluate the future protectiveness of the alternative.

Under this alternative, no remedial actions would be performed and no direct protection of human health or the environment would be provided.

4.2.2 Alternative 2: Limited Action

The limited-action alternative would involve indirect and non-intrusive remedial action for contaminated marine sediment at Coddington Cove. This alternative would include three primary elements: 1) institutional controls, 2) access restrictions, and 3) long-term monitoring. Since sediment contamination exceeding PRGs would remain, 5-year reviews of the alternative would be required to evaluate whether the remedy remains protective in the future. The institutional controls and access restrictions would be implemented to protect humans from exposure to contaminants in affected shellfish. Long-term monitoring would be implemented to assess changes in contaminant levels and associated risks to human and ecological receptors.

Institutional Controls

Institutional controls would be placed to ban shellfishing and lobster collection in affected areas of Coddington Cove. RIDEM's cooperation would be needed to enforce the ban, and notify persons with lobster collection permits about the restricted area, which is depicted on Figure 4-1. This restriction would be publicly posted at shore access points on the western side of Aquidneck Island and eastern side of Conanicut Island (Jamestown). The restriction would also be appended to the paperwork normally distributed to those receiving collection permits. Finally, RIDEM's fisheries enforcement division would patrol the area, as it now does for other shellfish closure areas.

Access Restrictions

Access restrictions would be placed to prevent access from the water. Access to the affected areas from the shore is already patrolled by the NAVSTA police, therefore no additional shoreline access restrictions would be installed.

To prevent access to the affected area by water, a buoy line identifying a "restricted zone" would be placed and maintained as shown on Figure 4-1. This line would be marked using USCG "fifth class" warning buoys or "cans" marked orange on white with the international navigation hazard pattern. Placards would need to be posted stating that the area is restricted to Navy vessels only, and access is allowable only by permission of the NAVSTA police and Navy dockmaster. One such placard would be placed at the western-most extensions of each of the existing piers. These placards would need to be large enough to be visible to boaters entering the area. Maintenance of the buoy tethers would occur every two years and maintenance of the buoys would be needed every five years. The maintenance activities would be conducted to preserve the original conditions and effectiveness of the buoy system.

The access restriction would need to be enforced by the Navy police or military personnel as is currently done. The Navy currently patrols and prevents public access to the Navy portions of Coddington Cove (including the affected areas) but allows access to selected commercial fishing vessels. This limited access would need to be further restricted.

Long-Term Monitoring and 5-Year Reviews

A long-term monitoring program would be performed to annually monitor sediment contaminant concentrations and other parameters (i.e. toxicity and elutriate chemistry) that contribute risk to ecological receptors. This program would determine on a regular basis if the risk to the ecological receptors is increasing and if a more protective alternative needs to be implemented. Conversely, it would determine through trend analysis if conditions are improving, and if monitoring can later be terminated.

The long-term monitoring program would include sediment, biota, elutriate, and toxicity testing. For costing purposes, it is assumed that samples would be collected from a total of 10 locations within the 4 areas at the site found to contain contaminant concentrations in excess of the recommended PRGs. The analyses would include sediment chemistry (PCBs, PAHs, metals, SEM/AVS); biota chemistry (PCBs, PAHs, metals, butyltins in both indigenous blue mussels and lobster); elutriate chemistry (PCBs, PAHs, metals); and amphipod and arabacia toxicity.

Given the nature of the sediment contamination and slow changes in sediment quality anticipated, a single sampling event per year is anticipated to be sufficient to monitor long-term sediment quality trends for the duration of the monitoring effort. The results of the monitoring would be compiled and an evaluation of the contamination and its associated risks would be conducted as a part of the 5-year reviews, which are required by CERCLA for sites where contaminants exceeding PRGs are allowed to remain. The monitoring data would be used to identify any changes in the contaminant concentrations and determine the need to increase or decrease the frequency of monitoring events, or implement more aggressive response actions at the site.

For costing purposes, it is assumed that long-term monitoring and 5-year reviews would be performed for 10 years. This duration is expected to provide adequate time to determine whether a decreasing trend in COC concentrations exists and whether concentrations have decreased to acceptable levels. At the end of the 10-year time-frame, site conditions would be thoroughly re-evaluated to determine appropriate future actions.

4.2.3 Alternative 3: Containment and Dredging/Disposal

This alternative was developed to prevent continued exposure to the contaminated sediments by capping the sediments where feasible and dredging the sediments where capping is not feasible (i.e. areas where the port is actively used). Under this alternative, all sediments in the areas of stations 3 and 29 with COCs exceeding the recommended PRGs would be capped to eliminate potential human and ecological exposure pathways, and all the sediments around stations 27 and 103 with COCs exceeding the human health and ecological PRGS would be removed by an appropriate dredging technique and disposed at off-base CAD cells. The dredging technique would be selected, in part, by its ability to minimize resuspension of solids into the water column during operation. Capping or removal at the respective stations would be conducted for all the areas determined by a pre-design investigation to have sediment COCs exceeding the recommended PRGs (see Figure 4-2). Elements of Alternative 3 include:

- Pre-design investigation to refine limits of remediation
- Controlling sedimentation during implementation
- Capping of all contaminated sediments exceeding PRGs around stations 3 and 29
- Dredging all contaminated sediments exceeding PRGs around stations 27 and 103
- Disposing of excavated sediment in off-base CAD cells
- Possible mitigation of wetland resource areas if any are impacted
- Conducting long term O&M to maintain cap structure integrity
- Conducting 5-year reviews

Pre-Design Investigation

A PDI would be performed to better delineate the areas to be capped or dredged and obtain geotechnical and bathymetric information needed for design. The PDI would include collection of samples in the areas around stations 3, 29, 27, and 103 to better delineate the horizontal and vertical extent of sediments with COCs exceeding the recommended PRGs and evaluate physical/geotechnical characteristics of the sediment and areas to be addressed. These areas of focus for the PDI are depicted on Figure 4-2.

The investigation would include collection of both surface and subsurface sediment samples. Surface sediment samples would be collected in areas proposed for capping (stations 3 and 29) in order to delineate the required lateral extent of the cap. Surface and subsurface sediment samples would be collected from borings in areas proposed for dredging (stations 27 and 103) in order to determine the required lateral and vertical extent of dredging. In both cases, sample stations would be set in a 200 foot grid pattern. This approach would result in location of approximately 15 surface sediment sample stations

and 34 boring stations (Figure 4-2). All samples would be sent for laboratory analysis of PAHs, PCBs, and metals, as well as geotechnical testing.

The PDI will evaluate accessibility of dredging equipment to areas under Piers 1 and 2. Piles supporting these piers may prevent access to basic dredging equipment and a specialized apparatus may be needed.

In the vicinity of stations 3 and 29, surface sediment samples would be collected from 0 to 1 foot below sediment surface, with one sample collected per location. Samples would be collected using a ponar-type grab sampler deployed from a boat or by a diver. In the vicinity of stations 27 and 103, vibracoring techniques would be used to collect samples to a depth of 3 feet below the sediment surface, with three one-foot interval samples collected per location.

The PDI would include a pilot test to determine treatment methods that would be required for water gravity-drained from sediment after dredging.

The PDI would also include a bathymetric survey of the area around stations 3 and 29 to determine contours of the seafloor, identify debris present, and determine the depth of water in the areas to be capped. The areas to be capped or dredged would be reevaluated to determine the presence of wetland resource areas or special habitats that would need to be mitigated either on-site or elsewhere in Narragansett Bay. The PDI would also include bench-scale testing and evaluations to aid in selecting dredging methods; determining the de-watering method, water treatment and materials handling requirements, and turbidity control measures; and identifying the technical and logistic requirements for capping and dredging, (i.e. use of barges or pier space and the need to move the warships currently docked on-site). A pre-design report would be prepared to document the findings of the investigations and delineate the areas that would be capped or dredged (areas exceeding the recommended PRGs).

Sedimentation Control

A floating silt curtain or other appropriate particulate resuspension/turbidity control feature would be placed around the perimeter of each capping or removal area during implementation of this alternative. Physical features (breakwaters and piers) would be used to the extent possible. Sediment control structures would help minimize potential adverse environmental effects associated with sediment suspension.

Capping

The area around stations 3 and 29 is potentially suitable for capping because it is not actively used for shipping or port activities. The area of the cap would be 245,000 square feet with a thickness of three feet.

The cap materials would be natural, comprised of sand and/or gravel. The most suitable cap material would need to be selected following completion of the PDI, which includes a bathymetry study of the area. In order to maintain the natural habitat to the extent possible, cap materials similar to materials currently in place are preferred. The cap thickness and area would be sufficient to completely isolate the contaminated sediments from the surrounding environment, including burrowing benthic organisms.

Large (> 6 inches) debris materials would be removed from the area to be capped. Structures and obstructions would need to be removed prior to cap installation.

Capping would be conducted from a barge or the adjacent onshore area, and would occur by slowly depositing the cap material in layers over the designated area. Prior to placement, capping materials would be staged as necessary onshore or at Pier 1.

Complete details regarding the cap design would be finalized based on PDI results during the remedial design phase.

Dredging and Disposal

Contaminated sediment would be dredged using methods selected to minimize water column turbidity. The final determination of the most appropriate technique would be made following the PDI based on the sediment grain size distribution, dewatering options, and the horizontal and vertical extent of sediment to be removed. For the purposes of this FS, it is assumed that removal would be accomplished by a combination of mechanical and hydraulic (suction) dredging conducted from a barge or the piers: mechanical dredging to remove debris and any large rocks and hydraulic dredging to remove the bulk of the sediment.

Confirmation sampling of dredged areas would be performed to determine that the appropriate limits of the excavation area have been achieved.

The dredged sediment would be staged and processed as described below. Dredged materials would be contained in a bottom-dump scow, de-watered, tested for disposal characteristics as required by the receiving facility, and then transported off-base for disposal in CAD cells in the upper Narragansett Bay near Providence, Rhode Island. These CAD cells are operated and managed by the Rhode Island CRMC. An estimated 23,819 cubic yards of contaminated sediment would be excavated as part of Alternative 3. Surface sediment is anticipated to be dredged to one foot below the top of the sediment. Some limitations on depth precision would be incurred due to the accuracy limitations of dredging equipment. For estimating purposes, it is assumed that the volume of sediment to be dredged includes

the sediment beneath the piers that has COC concentrations exceeding the recommended PRGs. However, the feasibility of dredging in these areas would need to be evaluated in the PDI.

The sediment would be de-watered and processed prior to disposal to make it suitable for transport and disposal in a CAD cell. Free liquid would be removed from the sediment, and the separated liquid would be treated, if necessary, prior to discharge to Narragansett Bay or the POTW. For the purposes of this FS, it is anticipated that removal of free liquid would be accomplished through gravity draining. This activity would be conducted from the barge and within the bottom-dump scow in accordance with applicable waste handling standards. Actual dewatering operations and requirements would be determined following completion of the PDI.

It is anticipated that CAD, which is preferable to landfill disposal, will be a viable option for disposal of project sediment at the time when work is commenced. As of January 2007, there was reported to be significantly more than enough available capacity to accommodate sediment from this action in the CAD cells near Providence, RI (Goulet, 2007). However, if a CAD unit is not available, the dredged sediments would require landfill disposal. Dewatered and stabilized sediment samples would be collected and analyzed to verify that the material meets applicable criteria before being transported for landfill disposal. Evaluation of the existing sediment analytical data indicates that the contaminant levels are low enough that the material would likely meet requirements for disposal in a RCRA Subtitle D landfill without treatment. Additionally, larger debris removed from the dredging areas may require landfill disposal if they do not meet the requirements for CAD.

Dewatering would occur by gravity draining. The resultant water would be treated to meet applicable state and federal discharge standards prior to discharge into Narragansett Bay. Water would be treated by means of a skid-mounted clarifier and filtration system. The clarifier would remove inorganic constituents by precipitation. Unsettled metals precipitant and other suspended particles and fines would be removed by filtration. Any organic constituents (PAHs and PCBs) present are expected to be adsorbed onto the surface of the suspended particles, and thereby be removed by filtration along with these particles. Based on available data, the need for additional treatment for dissolved contaminants is not anticipated; however, treatment requirements would be more completely evaluated during the PDI and through a pilot test.

Based on previous investigations, the sediment within the areas to be dredged under this alternative is relatively uniform within the upper four feet. Therefore, removal of surface sediment is not expected to significantly alter the composition of the seafloor. Placement of backfill within the dredged area to match existing grades was not considered warranted and not consistent with the objectives of the designated land use within an industrial port.

Wetland Resource Mitigation

If wetland resource areas (intertidal areas or special habitats such as eelgrass beds) identified during the PDI are impacted by the capping or dredging activity, these resource areas would require mitigation. Additionally, PDI steps would have to clearly identify which resource areas can be impacted and be expected to be mitigated. Eelgrass mitigation measures in Narragansett Bay have met limited success after impacts to those areas near McAllister Point Landfill. Such wetland resource areas do not include sheetpiling or other vertical wall structures; they do include rip-rap intertidal shoreline. Wetland resource areas would be identified in the PDI.

Long-Term Monitoring, Maintenance, and 5-Year Reviews

Since contamination exceeding PRGs would remain on-site, 5-year reviews of the capped area would be required to evaluate the future protectiveness of the alternative. In addition, the capped area would require long-term monitoring and maintenance. Cap inspections would be conducted annually and repairs made as necessary. Sampling around the cap area would also be conducted annually to ensure the continued effectiveness of the cap. The 5-year reviews would be completed based on the results of the annual monitoring and maintenance activities.

4.2.4 Alternative 4: Dredging and Disposal

This alternative was developed to provide an alternative that reduces or eliminates the on-site toxicity, mobility, and volume of contaminated sediment through removal and off-base disposal. All sediment in excess of recommended PRGs stated in Section 2 would be removed by an appropriate dredging technique selected, in part, by its ability to minimize resuspension of solids into the water column during operation. Removal would be conducted over all the areas that were found to have sediments exceeding recommended PRGs (see Figure 4-3). Elements of Alternative 4 include:

- Pre-design investigation
- Controlling sedimentation during dredging
- Dredging all contaminated sediment exceeding PRGs
- Disposing of excavated sediment in off-base CAD cells
- Possible mitigation of wetland resource areas if any are impacted

Pre-Design Investigation

A PDI would be performed to better delineate the areas to be dredged and obtain information needed for design. The PDI would include collection of samples in the areas around stations 3, 29, 27, and 103 to better delineate the horizontal and vertical extent of sediments with COCs exceeding the recommended PRGs and evaluate physical characteristics of the sediment and areas to be addressed. These areas of focus for the PDI are depicted on Figure 4-3.

The investigation would include collection of both surface and subsurface sediment samples from borings in the areas proposed for dredging in order to determine the required lateral and vertical extent of dredging. Sample stations would be set in a 200 foot grid pattern. Vibracoring techniques would be used to collect samples to a depth of 3 feet below the sediment surface, with three one-foot interval samples collected per location. This approach would result in location of approximately 48 boring stations (Figure 4-3) and 144 sediment samples collected. All samples would be sent for laboratory analysis of PAHs, PCBs, metals, and geotechnical testing parameters.

The PDI would include a pilot test to determine treatment methods that would be required for water gravity-drained from sediment after dredging.

The PDI would also include an evaluation of areas to be dredged to determine the presence of wetland resource areas or special habitats that would need to be mitigated either on-site or elsewhere in Narragansett Bay. The PDI would also include bench-scale testing and evaluations to aid in selecting dredging methods; determining the de-watering method, water treatment and materials handling requirements, and turbidity control measures; and identifying the technical and logistical requirements for dredging, (i.e. use of barges or pier space and the need to move the warships currently docked on-site). A pre-design report would be prepared to document the findings of the investigations and delineate the areas that would be dredged (areas exceeding the recommended PRGs).

Sedimentation Control

A floating silt curtain or other appropriate particulate resuspension/turbidity control feature would be placed around the perimeter of each removal area during implementation of this alternative. Physical features (breakwaters and piers) would be used to the extent possible. Sediment control structures would help minimize potential adverse environmental effects associated with sediment suspension.

Dredging and Disposal

Contaminated sediment would be dredged using methods selected to minimize water column turbidity. The final determination of the most appropriate technique would be made following the PDI based on the sediment grain size distribution, dewatering options, and the horizontal and vertical extent of sediment to be removed. For the purposes of this FS, it is assumed that removal would be accomplished by a combination of mechanical and hydraulic (suction) dredging conducted from a barge or the piers: mechanical dredging to remove debris and any large rocks and hydraulic dredging to remove the bulk of the sediment.

Confirmation sampling of dredged areas would be performed to determine that the appropriate limits of the excavation area have been achieved.

The dredged sediment would be staged and processed as described below. Dredged materials would be contained in a bottom-dump scow, de-watered, tested for disposal characteristics as required by the receiving facility, and then transported off-base for disposal in confined aquatic disposal cells in the upper Narragansett Bay near Providence, Rhode Island. These CAD cells are operated and managed by the Rhode Island CRMC. An estimated 32,893 cubic yards of contaminated sediment would be excavated as part of Alternative 4. Surface sediment is anticipated to be dredged to one foot below the top of the sediment. Some limitations on depth precision would be incurred due to the accuracy limitations of dredging equipment. For estimating purposes, it is assumed that the volume of sediment to be dredged includes the sediment beneath the piers that has COC concentrations exceeding the recommended PRGs. However, the feasibility of dredging in these areas would need to be evaluated in the PDI.

The sediment would be de-watered and processed prior to disposal to make it suitable for transport and disposal in a CAD cell. Free liquid would be removed from the sediment, and the separated liquid would be treated, if necessary, prior to discharge to the bay or POTW. For the purposes of this FS, it is anticipated that removal of free liquid would be accomplished through gravity draining. This activity would be conducted from the barge and within the bottom-dump scow in accordance with applicable waste handling standards. Actual dewatering operations and requirements would be determined following completion of the PDI.

It is anticipated that CAD, which is preferable to landfill disposal, will be a viable option for disposal of project sediment at the time when work is commenced. As of January 2007, there was reported to be significantly more than enough available capacity to accommodate sediment from this action in the CAD cells off-shore of Providence, RI (Goulet, 2007). However, if a CAD unit is not available, the dredged sediments would require landfill disposal. Dewatered and stabilized sediment samples would be collected and analyzed to verify that the material meets applicable criteria before being transported for landfill

disposal. Evaluation of the existing sediment analytical data indicates that the contaminant levels are low enough that the material would likely meet requirements for disposal in a RCRA Subtitle D landfill without treatment. Additionally, larger debris removed from the dredging areas may require landfill disposal if they do not meet the requirements for CAD.

Dewatering would occur by gravity draining. The resultant water would be treated to meet applicable state and federal discharge standards prior to discharge into Narragansett Bay. Water would be treated by means of a skid-mounted clarifier and filtration system. The clarifier would remove inorganic constituents by precipitation. Unsettled metals precipitant and other suspended particles and fines would be removed by filtration. Any organic constituents (PAHs and PCBs) present are expected to be adsorbed onto the surface of the suspended particles, and thereby be removed by filtration along with these particles. Based on available data, the need for additional treatment for dissolved contaminants is not anticipated; however, treatment requirements would be more completely evaluated during the PDI and through a pilot test.

Based on previous investigations, the sediment within the area to be dredged under this alternative is relatively uniform within the upper four feet. Therefore, removal of surface sediment is not expected to significantly alter the composition of the seafloor. Placement of backfill within the dredged area to match existing grades was not considered warranted and not consistent with the objectives of the designated land use within an industrial port.

Wetland Resource Mitigation

If wetland resource areas (intertidal areas or special habitats such as eelgrass beds) identified during the PDI are impacted by the capping or dredging activity, these resource areas would require mitigation. Additionally, PDI steps would have to clearly identify which resource areas can be impacted and be expected to be mitigated. Eelgrass mitigation measures in Narragansett Bay have met limited success after impacts to those areas near McAllister Point Landfill. Such wetland resource areas do not include sheetpiling or other vertical wall structures; they may include rip-rap intertidal shoreline.

4.3 SCREENING OF ALTERNATIVES

Screening is conducted to eliminate alternatives that do not achieve protection of human health or the environment or do not enhance the range of available alternatives. Alternatives are eliminated if they are determined to be significantly less effective than other more promising alternatives, are not technically or administratively implementable, or have measurably higher costs. The four alternatives developed and described on the preceding pages are considered to represent an appropriate range of remediation alternatives for impacted sediment at the site. Therefore, they are all retained for detailed analysis. A brief rationale for retaining each alternative for detailed analysis is provided below.

Alternative 1 (No Action) is retained, as required under the NCP, as a baseline against which other alternatives can be compared.

Alternative 2 (Limited Action) is worthy of consideration because although risk to human and ecological receptors was identified, this risk may not warrant a full-scale removal of sediment, which would resuspend sediments and may cause significant adverse effects to the ecology of the cove. Highly conservative elements were incorporated in developing the marine ERA, HHRA and PRGs. In the ERA, ecological receptor exposure – effects relationships are not completely certain. In the HHRA, the subsistence fisherman exposure scenario over-estimates the amount of shellfish that could reasonably be taken from affected areas for a subsistence-level diet. Additionally, contaminant concentrations in shellfish at the site are similar to those found at the reference stations, suggesting that the contaminants in shellfish may be derived from background conditions in the bay rather than site-related contaminants. Therefore, the potential for ecological and human health risk from exposure to site COCs may be over estimated. Additionally, as discussed in Sections 1 and 2, sediment COC concentrations at the site have decreased over time. COC concentrations are likely to continue to decrease and pose less risk to human and ecological receptors.

The limited action alternative is the only alternative available that is not intrusive to the environment and would not cause significant short term impacts, but provides some protection of human health and the environment. The limited action alternative provides protection of human health through implementation and enforcement of institutional controls and access restrictions. Long-term monitoring would provide a means to evaluate whether ecological receptors are being adversely affected by site COCs. Additionally, given that the removal of both ships is planned for the near future, this option would allow for re-evaluation of the site contaminants (without the ships present) at the five-year review phase. Removal of the ships is anticipated to cause significant sediment resuspension.

Alternative 3 (Containment and Dredging/Disposal) is worthy of consideration because it employs on-site containment where possible to limit the volume of material that required off-site disposal. Subaqueous capping is used to address contaminated sediments outside active port areas where a cap would not interfere with shipping and future port maintenance activities. Dredging is used in active port areas where capping would not be feasible. This alternative would be protective of both human and ecological receptors.

Alternative 4 (Dredging and Disposal) is worthy of consideration because it would provides effective and permanent long-term protection of human health and ecological receptors by removing all sediments with COCs exceeding PRGs and disposing them at an off-base disposal facility. Because all sediments exceeding PRGs would be removed from the site, this alternative would require no long-term monitoring and no five-year reviews.

5.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The detailed analysis of alternatives provides relevant information to support selection of a remedial action. Each alternative remaining following screening in Section 4.0 (see Table 4-1) is fully evaluated according to a prescribed set of criteria. The evaluation results are used to compare alternatives and identify key tradeoffs between the options, as well as to provide a basis for regulatory agency and public review of potential remediation alternatives for the site.

Section 5.1 describes the criteria used to support the detailed analysis. Section 5.2 presents a brief description and a detailed evaluation of each site alternative based on these criteria, along with a comparative analysis of the developed alternatives. Section 5.3 presents a summary of the comparison of these alternatives pertaining to the evaluated criteria.

5.1 CRITERIA FOR DETAILED ANALYSIS

In accordance with the NCP and CERCLA guidance, the detailed analysis of alternatives was conducted in accordance with nine evaluation criteria. These criteria are divided into three groups: threshold criteria related to statutory requirements; balancing criteria that are technical in nature; and modifying criteria that are formally assessed following a public review and comment period. The nine evaluation criteria include the following:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs) and to be considered (TBCs) guidance

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- State acceptance
- Community acceptance

A description of each criterion and discussion of how each applies to the types of alternatives being evaluated are as follows:

THRESHOLD CRITERIA

Threshold criteria are the criteria which must be met in order for an alternative to be selected as the remedy for a site. The two threshold criteria are described below.

Overall Protection of Human Health and the Environment: The primary concern, and one of the statutory requirements in remedy selection, is the overall protection of human health and the environment. The evaluation of protection is based on the ability of the remedy to eliminate, reduce, or control current and potential future exposure risks to human and ecological receptors through each applicable exposure pathway. This protection may be in the form of treatment, engineering controls, and/or institutional controls. The overall determination of protection draws on assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Furthermore, evaluation of protection considers the short-term risks or cross-media impacts posed by implementation of a remedy.

This criterion will be used to evaluate the effectiveness of each alternative in eliminating, reducing, or controlling human health and environmental risks at the site. The effectiveness issues related to alternatives for the site would be based on human health risks (consumption of contaminated shellfish tissue by subsistence fishermen) and environmental risks of toxic effects to aquatic receptors from resuspended and bedded sediments. The criterion will be evaluated based on the ability of the alternative to meet the recommended PRGs as described in Section 2.

Compliance with ARARs: Compliance with ARARs is one of the statutory requirements for selection of a remedy. This evaluation criterion is used to determine whether each alternative would meet all of its respective ARARs or whether justification exists for a waiver of ARARs, as allowed under CERCLA in certain circumstances. Chemical-, location-, and action-specific ARARs are reviewed as they apply to each alternative. Alternatives are refined, as necessary, to ensure compliance with these requirements.

This criterion will be used to evaluate each alternative in complying with chemical- and location-specific federal and state ARARs and TBCs for protection of human health and the environment. Alternatives requiring sediment monitoring and removal, coupled with subsequent disposal or treatment activities, will also be evaluated for compliance with action-specific ARARs related to sediment handling, sediment treatment and/or disposal, as well as treatment and discharge of water generated from sediment dewatering activities.

BALANCING CRITERIA

Balancing criteria are used to evaluate the advantages and disadvantages of each alternative, in order to differentiate between alternatives that meet the threshold criteria. The five balancing criteria are described below.

Long-Term Effectiveness and Permanence: Alternatives are assessed in terms of their long-term effectiveness and degree of permanence in offering protection of human health and the environment following implementation. The evaluation focuses on the extent and effectiveness of controls required to manage risks remaining on the site following completion of the remedial action. The analysis considers the magnitude of risks to human and ecological receptors from residuals (untreated waste or treatment by-products) remaining on-site at the completion of remedial activities, the adequacy of engineering and/or institutional controls to manage residuals, the reliability of the controls to provide continued protection from residuals, and potential needs to maintain and/or replace technical components of an alternative.

This criterion will be used to evaluate each alternative for its ability to eliminate or manage risks remaining on-site following implementation. The no action, limited action, and containment alternatives will be evaluated based on future risks associated with leaving sediment contaminants on-site. Alternatives will also be evaluated in relation to the management of residuals formed as a result of sediment excavation/dredging operations, dewatering activities, and disposal. Evaluation of the alternatives will further address the potential risks associated with residuals remaining following sediment treatment.

Reduction of Toxicity, Mobility, or Volume through Treatment: Alternatives are evaluated to address the statutory preference for remedies that employ treatment as a principal element to reduce toxicity, mobility, or volume of hazardous substances. The evaluation focuses on the following factors:

- Treatment processes employed by the remedy, as well as the materials they treat.
- Amount of hazardous materials to be destroyed or treated.
- Degree of expected reduction in toxicity, mobility, or volume, including how the principal threats would be addressed.

- Degree to which the treatment would be irreversible.
- Type and quantity of treatment residuals that remain following treatment.
- Whether the alternative satisfies the statutory preference for treatment as a principal element.

This criterion is used to evaluate the effectiveness of alternatives that incorporate treatment of sediments to reduce risks by destroying sediment contaminants, generating process residuals, and reducing the volume and prohibiting mobility of sediment contaminants. Other alternatives will be evaluated for their ability to reduce mobility and/or effectiveness in reducing risks through natural attenuation processes, containment, or removal with off-site disposal.

Short-Term Effectiveness: The short-term effectiveness criterion assesses potential effects to human health and the environment during the construction and implementation phase of a remedy until remedial response objectives are met. The analysis includes considering protection of both the community and on-site workers during remedial activities, environmental impacts that may result from construction or implementation activities, the reliability of measures to be taken to prevent or reduce potential impacts, and the time required to meet remedial response objectives.

This criterion will be used to evaluate each alternative for its ability to protect human health and the environment during implementation, as well as during any associated long-term monitoring activities. While no-action alternatives require no implementation activities, limited-action alternatives will be evaluated for the protection they offer during implementation of institutional controls, use restrictions, and long-term monitoring. Evaluation of the remaining alternatives will address sediment containment or sediment removal and dewatering activities. The time required by each alternative to reach the sediment cleanup goals will also be assessed.

Implementability: Implementability considerations include the technical and administrative feasibility of implementing an alternative, as well as the availability of goods and services on which the viability of the alternative depends. These considerations often affect the timeliness of undertaking an alternative.

Technical feasibility issues include:

- Ability to construct and operate an alternative as a whole
- Likelihood of a technology to meet specified process efficiencies and performance goals
- Ease of undertaking any required future remedial actions
- Ability to monitor the effectiveness of the remedy

Administrative feasibility deals with the activities needed and time required for coordinating with various federal, state, and local agencies to obtain any necessary approvals and permits.

Issues related to the availability of goods and services include:

- Accessibility of adequate capacity and location of needed treatment, storage, and disposal services
- Ease in obtaining necessary equipment and specialists, and provisions to ensure any additional resources
- Timing and availability of technologies under consideration
- Availability of services and materials, plus the potential for obtaining competitive bids

These issues will be reviewed to evaluate the implementability of each remedial alternative. Issues will also be evaluated for both the ease of implementation and associated time frame required to coordinate subcontractors, activities, and required regulatory approvals.

Cost: This criterion encompasses all capital outlays, as well as O&M costs incurred over the lifetime of the remedial action. The detailed analysis of costs associated with each alternative will be based on accurate cost estimates and net present worth cost analysis for the estimated period of performance.

MODIFYING CRITERIA

Modifying criteria are not formally addressed in the FS. They are evaluated after receipt of state and public comments on the FS and proposed plan. The modifying criteria may be used to change the preferred alternative. The two modifying criteria are described below.

State Acceptance: State acceptance, an ongoing concern throughout the remedial process, reflects the statutory requirement to provide for substantial and meaningful state involvement. State acceptance must be considered during remedy selection.

This criterion will not be evaluated until the RIDEM has reviewed and provided comments on the revised FS report. Therefore, this criterion will not be included in the detailed analysis. RIDEM comments would be addressed through the comment response process as required by NAVSTA's FFA. In this manner, their concerns and issues would be incorporated into later versions of this FS report.

Community Acceptance: Community acceptance refers to the issues and concerns of "all interested parties," as they relate to each of the alternatives under consideration. Community acceptance must be considered during remedy selection.

This criterion will not be evaluated until NAVSTA Restoration Advisory Board (RAB) has reviewed and provided comments on the revised FS report, and the public has been invited to ask questions based on the proposed plan and share their concerns during the public comment period. Therefore, this criterion will not be included in the detailed analysis.

5.2 INDIVIDUAL ANALYSIS OF REMEDIAL ALTERNATIVES

Four remedial alternatives were developed and retained for further evaluation in Section 4. These alternatives were developed to address risks to the environment (exposure of aquatic receptors to contaminants in bedded and resuspended sediment) and human health (exposure of persons ingesting shellfish taken from the area). In Sections 5.2.1 through 5.2.4, each alternative is briefly described and evaluated in detail in relation to the two threshold criteria and the five balancing criteria described in Section 5.1. A comparative analysis of the alternatives is presented in Section 5.2.5. Detailed cost estimates and associated assumptions for each alternative are presented in Appendix C.

5.2.1 Alternative 1: No Action

Consideration of a no-action alternative is required under the NCP to provide a baseline against which other alternatives may be compared. This alternative would involve no remedial response activities with respect to impacted marine sediment in Coddington Cove. No containment, removal, or treatment of sediment contaminants would be conducted. The alternative would provide no mechanism to minimize potential risks to ecological or human receptors or evaluate changes in risk due to increases or decreases in COC concentrations. Because sediment containing COCs in excess of the recommended PRGs would remain on-site, 5-year reviews of site conditions and risks would be required under the NCP.

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 1 would not meet the RAOs for the protection of the human health or the environment. This alternative would offer little or no protection of the environment, because it would not address potential risks by eliminating, reducing, or controlling exposures to impacted site sediment. Sediment contaminants would not be contained or removed, no institutional controls or use restrictions would prohibit access to the area or collection of shellfish, and no reduction of exposure to humans through ingestion of shellfish would be achieved.

Potential for exposure would remain in the exposure zones identified in Section 2. Ecological receptors would continue to be exposed to sediment with COC concentrations exceeding PRGS. Subsistence fishermen could continue to be exposed to site COCs through ingestion of shellfish and lobster impacted by exposure to sediment COCs exceeding PRGs.

Over time, site COC concentrations may naturally attenuate to levels below the recommended PRGs; however, no monitoring would be conducted to evaluate changes in site conditions.

Because contaminants exceeding the recommended PRGs would remain at the site, 5-year reviews would be conducted, as required by CERCLA, to assess the long-term protectiveness of the remedy. Results of the review would be used to determine the need to implement future remedial actions at the site.

Compliance with ARARs: Tables 5-1, 5-2, and 5-3 identify chemical**-,** location-, and action-specific ARARs and TBCs, for Alternative 1. This section provides a summary of the alternatives, overall compliance with ARARs and describes what actions would be taken to achieve ARARs.

Alternative 1 fails to meet sediment PRGs that have been derived, in part, from federal and state water quality chemical specific ARARs. Over time, COC concentrations may naturally attenuate to levels below PRGs; however, no monitoring would be conducted to evaluate changes. There are no location-specific or action-specific ARARs for this alternative.

Long-Term Effectiveness and Permanence: The no-action alternative would offer no long-term effectiveness or permanence in addressing sediment contamination at the site. The existing risks to human and ecological receptors would remain, and no controls would be provided to manage future exposures to sediment contaminants or evaluate changing site conditions. Potential contaminant migration pathways would not be addressed. Because sediments with COCs at concentrations in excess of the recommended PRGs would remain on-site, 5-year reviews would be required.

Reduction of Toxicity, Mobility, or Volume through Treatment: This alternative would not include any sediment treatment processes or, sediment contaminant removal. Therefore, the alternative would offer no reduction in toxicity, mobility, or volume of contamination through treatment.

Short-Term Effectiveness: Since no remedial activities are associated with implementation of this alternative, no short-term effects would occur. No increase or reduction in short-term risks would be offered to the local community, the personnel at NAVSTA, or the environment. Furthermore, remedial response objectives would not be achieved.

Implementability: This alternative would require no implementation other than completion of the 5-year reviews. This activity would not require any permits, but it may require a minimal amount of coordination between regulatory agencies. Implementation of the no-action alternative would not limit future implementation of additional remedial actions at the site.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 1 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 3 percent discount rate (30-year real interest rate per OMB Circular No. A-94, January 2007).

Cost Item	Estimated Cost
Capital Costs	$0
O&M/Long-Term Monitoring	$0
5-Year Reviews	$24,000 each
30-Year Present Worth	$88,604

5.2.2 Alternative 2: Limited Action

Alternative 2 is a limited action option that would provide no direct remedial response activities. No containment, removal, and/or treatment of contaminated marine sediments would be conducted. This alternative would provide access restrictions preventing recreational and commercial fishing within the affected areas of Coddington Cove, and institutional controls consisting of an enforceable ban on shellfishing and lobster collection to reduce risk to human health. A long-term monitoring program and 5-year reviews would be conducted to evaluate risks to aquatic ecological receptors posed by the sediment contaminants and determine whether contaminant concentrations naturally decrease to acceptable levels over time. For costing purposes, it is assumed that sediment concentrations in the affected areas will continue to decrease and reach acceptable levels within 10 years, and monitoring and 5-year reviews will be performed for 10 years.

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 2 would meet the RAOs for protection of human health through institutional controls designed to prevent human ingestion of shellfish and lobster from the exposure zones described in Section 2 (areas with sediment COCs exceeding PRGs). Through the placement of signs and buoys, and through police enforcement of the access limitation and the shellfishing/lobster ban, this alternative would reduce the likelihood of shellfish and lobster collection from this site at a volume that would pose unacceptable risk to persons ingesting shellfish and lobster taken from the site. This alternative would only be effective with adequate enforcement of the lobstering and shellfishing ban by the State and NAVSTA police.

Initially, the potential for ecological receptor exposure would remain unchanged within the exposure zones described in Section 2; however, contaminant concentrations are expected to continue to decrease over time and eventually reach levels below the recommended PRGs. Therefore, Alternative 2 would not meet the RAOs for the protection of the environment in the short-term, but would be expected to eventually meet the RAOs.

The limited action alternative would provide a means of evaluating potential risks on a continual basis through implementation of the long-term monitoring program. Although long-term monitoring would not provide protection to the environment, it would document changes in sediment quality that may affect future exposure and associated risks to ecological receptors. Sediment concentrations at the site have decreased since the marine risk assessments were completed (see discussion in Sections 1 and 2). It is assumed that this trend will continue in the future and COC concentrations may naturally attenuate until they no longer pose an unacceptable risk to human health or the environment. Five-year reviews would be conducted to assess changing site conditions and potential risks. Results of the reviews would be used to determine the need to implement future remedial actions at the site or discontinue long-term monitoring.

The potential effectiveness of the lobstering ban may be somewhat limited due to the mobility of lobster and the fact that contaminants in lobster may be derived largely from non-site-related sources. There is an assumption that most of the lobsters impacted by the contaminants in the sediment would remain in the area. Seasonally, lobsters can be territorial and less prone to distant movement. However, lobsters do move around, and would cross the boundaries at their own preference. Regardless, the lobstering ban is assumed to reduce the risk to humans by elimination of the harvest of animals from the most highly impacted areas. The effectiveness of the shellfishing ban would be high, because the bivalves that are present in this area are not particularly mobile.

Compliance with ARARs: Tables 5-4, 5-5, and 5-6 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively for Alternative 2. This section provides a summary of the alternative's overall compliance with ARARs and describes what actions would be taken to achieve ARARs.

Alternative 2 initially fails to meet sediment PRGs that have been derived, in part, from federal and state water quality chemical-specific ARARs. However, the PRGs may eventually be achieved if contaminant concentrations continue to naturally attenuate as anticipated.

Alternative 2 would meet location-specific ARARs that require that the action proposed be protective of wetland and floodplains. No damage to wetlands or floodplains is anticipated from implementing the long-term monitoring program. All other state and federal location-specific and action-specific ARARs would be

achieved by coordinating with appropriate agencies to minimize adverse effects to fish, wildlife, and endangered species; and conducting activities in accordance with applicable regulations.

Alternative 2 is a non-intrusive remedy that would include no activities that would adversely affect marine organisms or sensitive habitats.

Long-Term Effectiveness and Permanence:

The access restrictions and institutional controls would offer long-term protection of human health, provided that the shellfishing ban was adequately enforced. Because contamination would remain in place, enforcement would be essential to maintaining the level of protectiveness.

This alternative would offer no immediate protection of ecological receptors; however, sediment COC concentrations at the site have decreased since 1996 and are expected to continue to decrease over time. If COC concentrations naturally attenuate to levels below the PRGs, this alternative would be protective of ecological receptors in the long-term. The long-term monitoring program will provide a means to evaluate changes in site conditions and determine whether PRGs have been achieved or whether actions are needed to protect ecological receptors. Since sediments containing COCs at concentrations in excess of the recommended PRGs would remain on-site, 5-year reviews of this alternative would be required to evaluate its effectiveness until it is concluded that COC concentrations have decreased to below PRGs.

Reduction in Toxicity, Mobility, or Volume through Treatment: This alternative would not include any sediment treatment processes. No sediment containment or removal activities would be conducted. Therefore, the limited action alternative would offer no reduction in contaminant toxicity, mobility, or volume through treatment.

Short-Term Effectiveness: Since the only on-site actions conducted under this alternative would be monitoring and installation of buoys, minimal short-term impacts to the environment and workers would be expected. These activities can be readily implemented without adversely affecting marine organisms or their habitats. Potential exposures of on-site workers during sample collection for the long-term monitoring program would be effectively controlled through the use of PPE. No short-term impacts to the local community would result from implementing this alternative.

Implementability: Implementation of Alternative 2 would involve placing access restrictions preventing recreational and commercial fishing within the affected areas of Coddington Cove, and institutional controls consisting of an enforceable ban on shellfishing and lobster collection in this area. A long-term monitoring program and 5-year reviews would be conducted to evaluate risks to human and aquatic ecological receptors posed by the sediment contaminants.

The establishment of the access restriction is implementable, based on the current use of the port. However, coordination with one or more state agencies would be required. The land adjacent to the cove is property of the US Navy, and is patrolled by NAVSTA Police Department. Currently, NAVSTA police patrol the shoreline and generally prohibit access to the water from the shoreline for swimming, wading, fishing, and shellfishing. However, NAVSTA police do not prohibit entry to the waters of the cove from Narragansett Bay. Limited commercial fishing is allowed. The existing shellfishing ban imposed by the state (RIDEM) for sewerage contamination restricts collection of clams and mussels, but does not ban collection of lobster or finfish. The current ban would have to be extended to lobstering and the shellfish ban expanded to include a closure for site contamination as well as for known or potential sewerage levels. The simplest way to achieve this restriction is to deny access to all commercial and recreational fishing vessels.

Implementing access restrictions would require installing hazard warning buoys along the buoy line shown on Figure 4-1. In addition, a placard would be placed at the end of each pier to mark the shelfishing/lobstering prohibition areas. These placards would have to be large enough to be visible to boaters entering the area. Finally, NAVSTA police would have to patrol and restrict boating activity within the restricted area, as is currently done.

Implementation of the institutional controls would require cooperation by RIDEM to institute and help enforce a lobster and shellfish collection ban. Public notification would have to be made annually, and RIDEM fisheries enforcement personnel may have to assist enforcement when such activity was reported by NAVSTA police.

The establishment of a long-term monitoring program to assess sediment quality would be easily implementable, given the availability of area services. The results of the sediment sampling would be reported annually and summarized as part of the 5-year reviews.

Implementation of the limited action alternative would not limit future implementation of additional remedial actions at the site. Additionally, given that the removal of both ships is planned for the near future, Alternative 2 would allow for reevaluation of the site contaminants (without the ships present) at the five-year review phase. Removal of the ships is anticipated to cause significant sediment resuspension, which could significantly alter the contaminant extent and site conditions in the area surrounding the piers.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 2 is provided in Appendix D and is summarized below. For the purposes of costing it was assumed that long-term monitoring and 5-year reviews would be required for a 10-year period. Present-worth costs were developed for a 10-year period at a 2.8 percent discount rate (10-year real interest rate per OMB circular No. A-94, January 2007).

Cost Item	Estimated Cost
Capital Item	$72,984
O&M/Long-Term Monitoring	Varies: between $123,290 and $127,490 annually (see Appendix C)
5-Year Reviews	$24,000 each
10-Year Present Worth	$1,184,591

5.2.3 Alternative 3: Containment and Dredging/Disposal

This alternative involves capping or removing the sediments containing COCs at concentrations above the recommended PRGs described in Section 2. This activity would involve capping the sediment with COCs exceeding PRGs in the area of stations 3 and 29 and removing the sediment exceeding PRGs around stations 27 and 103. Dredged sediment would be tested and dewatered as necessary for disposal, and disposed of at an approved disposal facility. It is anticipated that the dredged sediments would be disposed within the available CAD cells in the upper Narragansett Bay, near Providence, Rhode Island. Treatment of water removed from the sediment is likely to be necessary prior to discharge to the bay or to a POTW. Capping is planned for stations 3 and 29 because these areas are outside shipping and pier areas. Dredging, instead of capping, is planned for stations 27 and 103 because these areas are within the active port area, where adequate depth must be maintained for port/shipping activity.

The affected areas are all within the designated port and are likely to be within areas that have been previously altered by port construction or maintenance activities. However, if wetland resource areas or special habitats are damaged either directly or inadvertently through the execution of the capping or dredging efforts, those resource areas would be mitigated following completion of the remedial action.

Because contaminants in excess of the recommended PRGs would not entirely be removed, 5-year reviews and long-term O&M of the capped area would be required. An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 3 would meet the RAOs for the protection of human health and the environment through isolation or removal and appropriate disposal of sediments with COC concentrations exceeding recommended PRGs. Because sediment with COC concentrations exceeding the recommended PRGs in the capping areas would be isolated but not removed, long-term maintenance of the cap system would be required to ensure the long-term effectiveness and permanence of the remedy. Off-site, the long-term protection of the environment and human health would ultimately depend on the long-term maintenance of the disposal facility by its operators.

Implementation of this alternative would result in increased short-term impacts to the environment due to the potential for suspension and migration of contaminated sediment during the capping and dredging operations. Implementation of this alternative would destroy existing biota within the impacted areas and may temporarily degrade the surrounding habitat. However, the long-term impact to the marine biota in dredged areas would be minimal, considering that the habitat type (subtidal sand and silt) would not be changed, and natural processes would allow restoration of the ecological community that is currently present. The capping of selected areas may cause permanent alteration of the existing habitat depending on the composition of the capping materials, which would be determined during design based on characterization of the existing materials and construction and performance requirements of the cap. However this area also is anticipated to recover with natural ecological communities.

Compliance with ARARs: Tables 5-7, 5-8, and 5-9 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively for Alternative 3. Alternative 3, which involves capping, dredging and permanent removal, meets the sediment PRGs derived, in part, from federal and state water quality chemical-specific ARARs.

Implementation of Alternative 3 would meet all state and federal location-specific ARARs by conducting the activities in accordance with wetlands, coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations. Mitigation of intertidal areas (excluding sheetpiling and vertical structures) and special habitats such as eelgrass beds that are damaged either directly or inadvertently may be required.

Best engineering practices would be used to minimize sediment suspension and contaminant migration during capping and dredging. Federal and state hazardous waste handling requirements would be complied with if any of the sediment is characterized as hazardous waste. It is presumed that sediments are not RCRA-regulated material.

Alternative 3 would be conducted in accordance with all identified state and federal action-specific ARARs. The action-specific ARARs identified for this alternative include federal and state requirements for identification, listing, and disposal of hazardous wastes, Clean Water Act (CWA) requirements for discharges to surface water, and Clean Air Act (CAA) requirements for emissions monitoring.

Long-Term Effectiveness and Permanence: This alternative would eliminate risks to humans and marine biota by isolating or removing sediments with COC concentrations exceeding the recommended PRGs. Where sediments are isolated and not permanently removed, the need for long-term management of remaining contaminated sediments would exist. The cap would be designed to ensure that contaminated sediment is fully contained, not vulnerable to bioturbation by deep burrowing organisms, and resistant to erosion. Because the area proposed for capping is a low-energy marine environment, cap construction

should pose minimal difficulty, and there is a high potential that the cap will remain effective for long-term containment of contaminants. Collection of physical and chemical characterization data for the sediments and area to be capped would help ensure the cap design is adequate.

Following implementation, the cap would have to be routinely monitored and maintained to ensure that the contaminated sediments are effectively isolated to prevent long-term contaminant migration. Routine monitoring and maintenance will allow the long-term effectiveness to be evaluated and ensured.

Reduction in Toxicity, Mobility, or Volume through Treatment: This alternative would not include any treatment as a principal element in the action; therefore it would not reduce the toxicity, mobility, or volume through treatment. Treatment of the removed sediment would be limited to removal of free liquids. Treatment of water prior to discharge to Narragansett Bay would be necessary to meet discharge requirements.

The alternative would reduce the mobility and volume of impacted sediment present in the site area through isolation or removal of sediment containing concentrations of COCs in excess of the recommended PRGs. A reduction in overall contaminant mobility in the environment would be expected due to disposal of much of the material in off-site CAD cells. However, since this alternative would not include any sediment treatment, no ultimate reduction in toxicity, mobility, or volume of contaminants would be offered.

Short-Term Effectiveness: Implementation of this alternative would result in increased short-term impacts to the environment, including the destruction of existing biota within the capping and dredging areas and suspension of contaminated sediment that may degrade aquatic habitat or affect biota in the surrounding area.

These impacts would be partially mitigated through good remedial design and proper implementation (selection of the least disruptive capping/dredging methods possible for the site conditions and effective use of turbidity control measures). Natural restoration of the aquatic habitat within the dredged areas would be expected to occur within a few years, encouraged by the remainder of native materials similar to those that were present on the surface before dredging. Restoration of the aquatic habitat within the capped area would also occur naturally. The time required for restoration of the capped area would be dependent on the materials used for capping. If capping materials similar to the existing substrate can be used, the habitat may regenerate more quickly than in dredged areas (EPA, 2005). However, if cap materials more coarse than the native materials are required for erosion protection, habitat restoration may take longer or habitat could be permanently altered (EPA, 2005). Because the area to be capped is a low-energy environment, it is likely that cap materials can be selected that will allow full restoration or even

enhancement of the existing habitat. In the long-term, natural rehabilitation is expected to replace whatever aquatic habitat functions and values that the area supports.

Potential exposures of on-site workers to contaminants during capping/dredging and handling activities would be minimized through the use of PPE and proper engineering controls that are standard in the industry.

Implementability: Implementation of this alternative would require a significant effort, both administratively and technically. Factors affecting ease of implementation include securing site access and a shoreline staging area, and obtaining appropriate sediment characterization and disposal pre-approvals.

There would be easy access to the affected areas from the shore and with barge-mounted equipment because it is assumed that at least part of Pier 1 and the on-shore portions of the site would be available as staging areas. Implementation of the sediment dewatering and water treatment operations would increase the complexity of implementing this alternative, however, it is anticipated that space would be available for these actions as well. The nature and grain-size distribution of the sediment could greatly impact the success of the proposed gravity separation process. A sufficient fleet of equipment (barges, bottom-dump scows, and tugboats) would need to be available to facilitate off-site CAD cell disposal without slowing capping or dredging operations. It is expected that the specialized equipment and personnel required to carry out capping, dredging, dewatering, treatment, transport, and disposal are available in the Rhode Island coastal business community.

Access to contaminated sediments under the piers will require special consideration. Piles supporting piers may prevent access to standard dredging equipment.

The State of Rhode Island generally requires capping/dredging projects to be conducted between November 1 and January 15 to protect sensitive species. The Navy would investigate the affected areas to determine potential impacts from remedial actions during different times of the year. It is anticipated that the long-term benefits of conducting the remedial action during a single dredging period (estimated to be 6 months or more) would outweigh any potential short-term risks to sensitive species.

Implementation of capping or dredging is difficult given the imprecision of the action. Equipment must be guided remotely, and visual confirmation of completion is difficult. Confirmation samples would be taken following completion in each area; however, there is a large margin of error associated with implementing these actions.

Implementation of Alternative 3 would generate a significant amount material for disposal (anticipated to be 23,819 cubic yards). Adequate capacity to accommodate this volume of sediment is reportedly

available in the CAD cells off-shore of Providence, Rhode Island (Goulet, 2007). If this disposal facility becomes unavailable, adequate capacity would be available in landfills; although, out of state disposal may be required.

Implementation of this alternative would not prevent any future implementation of additional remedial actions at the site, should they be found to be required. However, by capping the area at stations 3 and 29, the feasibility of future dredging of those contaminated sediments would be reduced.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 3 is provided in Appendix D and summarized below. Present-worth costs were developed for a 30-year period at a 3 percent discount rate (30-year real interest rate per OMB Circular A-94, January 2007).

Because there is a high degree of uncertainty in the estimated volume of sediment exceeding PRGs, a cost sensitivity analysis was performed to assess the sensitivity of the cost estimate to a significant change in the volume of sediment to be addressed under this alternative. The sensitivity analysis evaluated the costs of the alternative if the volume of sediment was either increased by 50 percent or decreased by 30 percent. The results of the sensitivity analysis are presented in Appendix D. The results of the detailed cost estimate and cost sensitivity analysis are summarized below.

		Sensitivity Analysis	**Sensitivity Analysis**
Cost Item	**Estimated Cost**	**50% Volume Increase**	**30% Volume Decrease**
Capital Costs	$7,516,386	$10,940,493	$5,461,923
O&M/Long-Term Monitoring	$302,510 annually	$396,838 annually	$245,914 annually
5-Year Reviews	$24,000 each	$24,000 each	$24,000 each
Total Present Worth	$13,813,419	$19,173,601	$10,597,310

5.2.4 Alternative 4: Dredging and Disposal

This alternative involves removing the sediments containing COCs at concentrations above the recommended PRGs described in Section 2. This activity would involve removing all the sediment exceeding PRGs in the area of stations 3, 29, 27, and 103; testing and dewatering the removed materials as required for disposal, and disposing of the solids at an approved disposal facility. It is anticipated that the dredged sediments would be disposed within available CAD cells in the upper Narragansett Bay near Providence, Rhode Island. Treatment of water removed from the sediment is likely to be necessary prior to discharge to the bay.

The affected areas are all within the designated port and are likely to be within areas that have been previously altered by port construction or maintenance activities. However, if wetland resource areas or

special habitats are damaged either directly or inadvertently through the execution of the dredging efforts, those resource areas would be mitigated following completion of the dredging action.

Because all contaminants in excess of the recommended PRGs would be removed, no 5-year reviews or long-term monitoring would be required. An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 4 would meet the RAOs for the protection of human health and the environment through removal and appropriate disposal of sediments with COC concentrations exceeding recommended PRGs. Because sediment with contaminant concentrations exceeding the recommended PRGs would be removed and disposed, the long-term protection of humans and aquatic receptors and long-term permanence would be ensured. No long-term maintenance or monitoring would be required. The long-term protection of the environment and human health would ultimately depend on the maintenance of the disposal facility. Implementation of this alternative would result in increased short-term risks due to the potential for suspension and migration of contaminated sediment during the dredging operations. This alternative would destroy existing biota within dredged sediments from the impacted area and may degrade the surrounding habitat. However, the long-term impact to the marine biota would be minimal, considering that the habitat type (subtidal sand and silt) would not be changed, and natural processes would allow restoration of the populations that are currently present.

Compliance with ARARs: Tables 5-10, 5-11, and 5-12 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively for Alternative 4. Alternative 4, which involves dredging and permanent removal, meets the sediment PRGs derived from federal and state water quality chemical-specific ARARs.

Implementation of Alternative 4 would meet all state and federal location-specific ARARs by conducting the activities in accordance with wetlands, coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations. Mitigation of intertidal areas (excluding sheetpiling and vertical structures) and special habitats such as eelgrass beds that are damaged either directly or inadvertently may be required.

Best engineering practices would be used to minimize sediment suspension and contaminant migration during dredging. Federal and state hazardous waste handling requirements would be followed if any of the sediment is characterized as hazardous waste. It is presumed that sediments are not RCRA-regulated material.

Alternative 4 would be conducted in accordance with all identified state and federal action-specific ARARs. The action-specific ARARs identified for this alternative include federal and state requirements for identification, listing, and disposal of hazardous wastes, Clean Water Act (CWA) requirements for discharges to surface water, and Clean Air Act (CAA) requirements for emissions monitoring.

Long-Term Effectiveness and Permanence: The removal and disposal alternative would eliminate unacceptable risks to humans and marine biota by removing sediments with COC concentrations exceeding the recommended PRGs. Disposal of contaminated sediment off-site would eliminate the need for long-term management of untreated sediments or residuals on-site.

Reduction in Toxicity, Mobility, or Volume through Treatment: This alternative would not include any treatment as a principal element in the action; therefore it would not reduce the toxicity, mobility, or volume through treatment. Treatment of the removed sediment would be limited to removal of free liquids. Treatment of water prior to discharge to Narragansett Bay would be necessary to meet discharge requirements.

The alternative would reduce the volume of impacted sediment present in the site area through complete removal of sediment containing concentrations of COCs in excess of the recommended PRGs. A reduction in overall contaminant mobility in the environment would be expected due to disposal of the material in off-site CAD cells. However, since this alternative would not include any sediment treatment, no ultimate reduction in toxicity, mobility, or volume of contaminants would be offered.

Short-Term Effectiveness: Implementation of this alternative would result in increased short-term risks, including the destruction of existing biota within the impacted area and suspension of contaminated sediment that may degrade aquatic habitat or affect biota in the surrounding area.

These impacts would be partially mitigated through proper design and implementation of the remedy (i.e. selection of the least disruptive dredging methods practical for the site and effective use of turbidity control measures). Natural restoration of the aquatic habitat would be expected to occur within a few years, encouraged by the remainder of native materials similar to those that were present on the surface before dredging. In the long-term, natural rehabilitation is expected to replace whatever aquatic habitat functions and values that the area can support.

Potential exposures of on-site workers to contaminants during dredging and handling activities would be minimized through the use of PPE and proper engineering controls that are standard in the industry.

Implementability: Implementation of this alternative would require a significant effort, both administratively and technically. Factors affecting ease of implementation include securing site access and a shoreline staging area, and obtaining appropriate sediment characterization and disposal pre-approvals.

There would be easy access to the affected areas from the shore and with barge-mounted dredging equipment because it is assumed that at least part of Pier 1 and the on-shore portions of the site would be available as staging areas. Implementation of the sediment dewatering and water treatment operations would increase the complexity of implementing this alternative, however it is anticipated that space would be available for these actions as well. The nature and grain-size distribution of the sediment could greatly impact the success of the proposed gravity separation process. It is expected that the specialized equipment and personnel required to conduct the proposed dredging, dewatering, treatment, transport, and disposal activities are available in the Rhode Island coastal business community.

The State of Rhode Island generally requires dredging projects to be conducted between November 1 and January 15 to protect sensitive species. The Navy would investigate the use of aquatic habitats on-site by sensitive species to determine potential impacts from dredging during different times of the year. It is anticipated that the long-term benefits of conducting the remedial action during a single dredging period (estimated to be 6 months or more) would outweigh any potential short-term risks to sensitive species.

Access to contaminated sediments under the piers will require special consideration. Piles support piers may prevent access to standard dredging equipment.

Implementation of dredging is difficult given the imprecision of the action. Equipment must be guided remotely, and visual confirmation of completion is difficult. Confirmation samples would be taken following completion in each area; however, there can be a large margin of error associated with implementing this type of activity, depending on the precision of the equipment used.

Implementation of Alternative 4 would generate a large amount material for disposal (anticipated to be 32,893 cubic yards). Adequate capacity to accommodate this volume of sediment is reportedly available in the CAD cells off-shore of Providence, Rhode Island (Goulet, 2007). If this disposal facility becomes unavailable, adequate disposal capacity would be available in landfills; however, out of state disposal would be required.

Implementation of this alternative would not limit any future implementation of additional remedial actions at the site, should they be found to be required.

Cost: A detailed of estimate of capital, O&M, and present-worth costs for Alternative 4 is provided in Appendix D and summarized below. Present-worth costs are equal to the capital costs because no additional long-term costs are required.

Because there is a high degree of uncertainty in the estimated volume of sediment exceeding PRGs, a cost sensitivity analysis was performed to assess the sensitivity of the cost estimate to a significant change in the volume of sediment to be addressed under this alternative. The sensitivity analysis evaluated the costs of the alternative if the volume of sediment was either increased by 50 percent or decreased by 30 percent. The results of the sensitivity analysis are presented in Appendix D. The results of the detailed cost estimate and cost sensitivity analysis are summarized below.

		Sensitivity Analysis	Sensitivity Analysis
Cost Description	**Estimated Cost**	**50% Volume Increase**	**30% Volume Decrease**
Capital Costs	$6,542,854	$9,469,345	$4,786,960
O&M/Long-Term Monitoring	None	None	None
5-Year Reviews	None	None	None
Total Present Worth	$6,542,854	$9,469,345	$4,786,960

5.2.5 Comparative Analysis of Site Alternatives

A comparative analysis is conducted to evaluate the significant differences between the site alternatives based on the threshold and balancing criteria. This analysis is provided below.

Overall Protection of Human Health and the Environment: Alternative 4 would provide the greatest protection of human health and the environment by removing all sediments that are in excess of the recommended PRGs. Implementation of this alternative would destroy the existing biota and could result in some resuspension and migration of sediment contamination during dredging operations. However, appropriate engineering controls and mitigation of altered habitats should reduce the long-term effects of these actions. Off-site disposal of the removed sediment would eliminate the need for long-term management of untreated sediments on-site. The overall protection from future exposures to the removed material would depend on the maintenance of the off-base disposal facility. This alternative would meet the RAOs for both protection of human health and the environment.

Alternative 3 would be nearly comparable to Alternative 4 in its overall protectiveness. It would effectively reduce risk to the human health and the environment by isolating or removing all sediments with COCs that exceed the recommended PRGs. However, long-term monitoring and maintenance of the capped areas would be required to ensure the long-term protectiveness. Implementation of this alternative would also destroy the existing biota and could result in some resuspension and migration of sediment

contamination during capping/dredging operations. However, appropriate engineering controls and mitigation of altered aquatic habitats should reduce the long-term effects of these actions. The overall protection from future exposures to the contaminated material would depend on maintenance of both the cap and disposal facility. This alternative would meet the RAOs for both protection of human health and the environment.

The limited action alternative (Alternative 2) would provide protection to human health by reducing the risk to humans by implementing access restrictions and fishing bans to prevent exposure to lobster and shellfish from impacted areas. However, the long-term protectiveness would depend on adequate enforcement of access restrictions and the shellfishing and lobstering ban by the Navy and RIDEM. Alternative 2 may provide protection of the environment and ecological receptors in the long-term if COC concentrations continue to decrease to levels below the recommended PRGs. However, long-term monitoring would be required to measure reductions in COC concentrations or identify any changes in site conditions that would warrant consideration of additional actions to mitigate increased risks. No adverse impacts or damage to existing biota or marine habitats would be caused by implementation of this alternative. Minimal short-term impacts would be expected from implementing monitoring and access restrictions. Alternative 2 would meet the RAO for protection of human health, provided that access restrictions/institutional controls were adequately enforced, and would eventually meet the RAO for protection of the environment.

The no-action alternative (Alternative 1) would provide no protection of human health or the environment. Contaminants would remain on-site, posing continued risk to humans ingesting shellfish and to marine biota. Alternative 1 would not meet RAOs for protecting human health or the environment.

Compliance with ARARs: Alternatives 4 and 3 can be performed in accordance with all applicable ARARs, and PRGs would be achieved upon completion of construction/removal.

Alternative 2 currently fails to meet sediment PRGs that have been derived from federal and state water quality chemical-specific ARARs. Eventual compliance is possible but would take significantly longer to achieve than Alternatives 3 and 4. Alternative 2 can be performed to meet all location- and action-specific ARARs.

Alternative 1 fails to meet sediment PRGs that have been derived from federal and state water quality chemical-specific ARARs. There are no location-specific or action-specific ARARs for this alternative.

Long-Term Effectiveness and Permanence: Alternatives 4 and 3 would offer similar degrees of reduction of the long-term risks to the aquatic receptors. Alternative 4 would be the most effective alternative in eliminating long-term risks to the human health and marine biota by removing all the sediment

contaminants exceeding recommended PRGs from the marine environment. There is slightly less certainty in the long-term effectiveness and permanence of Alternative 3 because it would leave some sediment exceeding PRGs in place; however, these sediments would be fully isolated from human and ecological receptors by a subaqueous cap. Therefore, Alternative 3 would provide the same level of protection as Alternative 4 provided that the long-term effectiveness of the cap is maintained. Because the area to be capped is a low-energy marine environment, there is a high potential that the cap would remain effective for long-term containment of contaminated sediment. Neither Alternative 3 or 4 would require long-term enforcement of the shellfishing ban. Alternative 3 would require 5-year reviews since sediments would remain on-site with COCs in excess of the recommended PRGs. Alternative 4 would not require 5-year reviews since all sediment with contaminant concentrations above the recommended PRGs would be removed and disposed off-site.

Alternative 2 would provide long-term protection of human health, provided that shellfishing restrictions were adequately enforced by the Navy and RIDEM over the long term. Alternative 2 would provide limited long-term protection of ecological receptors. Contaminant levels would be addressed through natural processes and monitoring. Monitoring would document effectiveness of these processes by verifying adequately decreasing contaminant levels. Alternative 1 would provide no long-term effectiveness and permanence in addressing sediment contamination at the site. These alternatives would require 5-year reviews since sediments with COCs at concentrations above the recommended PRGs would remain on-site.

Reduction in Toxicity, Mobility or Volume through Treatment: None of the alternatives would provide reduction of toxicity, mobility, or volume through treatment.

Short-Term Effectiveness: The no-action alternative (Alternative 1) would offer no change in short-term risks. The limited action alternative (Alternative 2) would result in minimal increase in short-term risks to workers and the environment due to implementation of monitoring activities and installation of buoys. No damage to marine biota or habitats would result from implementing Alternative 2.

Implementation of either Alternative 3 or 4 would result in short-term human and environmental impacts from capping/dredging and handling operations. Proper use of PPE would minimize human risks from direct contact with contaminated sediment. Engineering controls would reduce, but not eliminate, environmental impacts caused by resuspension and transport of sediment during capping/dredging operations. Short-term destruction of marine biota would occur but natural processes would restore the natural communities that the area can support. The short-term impacts would be similar for Alternatives 3 and 4. The rate of natural habitat restoration for Alternative 3 is highly dependent on materials used for capping (which would be determined during design). Depending on the materials used, natural restoration of capped areas may be faster or slower than for dredged areas.

Implementability: The no-action alternative is the most readily implementable. It would require no construction activities. Implementation would include completion of the 5-year reviews only.

Alternative 2 would be somewhat more difficult to implement. This alternative would require Navy coordination with RIDEM for assistance in instituting a permanent lobstering and shellfishing ban for the affected area. The state would have to provide public notification and posting of the restriction. The Navy would have to install and maintain buoys and placards, and increase patrols to prevent access to the affected areas. The long-term monitoring program is readily implementable given the availability of services in the Rhode Island scientific community.

Alternatives 3 and 4 would be more difficult to implement than Alternative 2, but would both be readily implementable at the site. These alternatives would be possible because of the availability of qualified marine contractors to conduct site dredging and capping activities using barge-mounted or shore-based equipment, and the availability of the pier and on-shore areas for staging, treatment, and storage. Capping/dredging actions of this type are moderately difficult to implement, due to the imprecision of the technology. Pre-design and confirmation testing would be performed to improve the implementation of the actions, but some margin of error (improper horizontal extents of a cap, dredging clean sediments or not dredging contaminated sediments exceeding recommended PRGs) is possible.

Implementation of any of these alternatives would not prevent the implementation of any future remedial actions if required; however, the cap system proposed under Alternative 3 would significantly lessen the feasibility of future dredging.

Cost: Capital, O&M, present worth costs, and cost sensitivity analyses for the four site alternatives is summarized as follows:

Costs	Alternative 1: No Action	Alternative 2: Limited Action	Alternative 3: Capping and Dredging	Alternative 4: Dredging
Capital	0	$72,984	$7,516,386	$6,542,854
O&M	0	Between $123,290 and $127,490 annually	$302,510 annually	$ 0
Five Year Reviews	$24,000 each	$24,000 each	$24,000 each	$ 0
Net Present Worth*	$88,604	$1,184,591	$13,813,419	$6,542,854
NPW Sensitivity: +50% Vol.	No Change	No Change	$19,173,601	$9,469,345
NPW Sensitivity: -30% Vol.	No Change	No Change	$10,597,310	$4,786,960

*Net present worth time periods: Alternatives 1 and 3 = 30 years, Alternative 2 = 10 years, Alternative 4 = NA (capital cost only)

The costs provided for Alternatives 3 and 4 assume no regulatory restrictions on periods of dredging activities. If dredging periods are limited, significant additional mobilization and demobilization costs would be incurred.

TABLES

TABLE E-1

GENERAL COMPARISON OF REMEDIAL ALTERNATIVES
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Alternative	Overall Protection of Human Health and the Environment	Compliance with Applicable or Relevant and Appropriate Requirements	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Cost
1 No Action	Not protective.	Does not comply.	Not effective.	No treatment included.	Not effective. However, no additional short-term risks or nuisances would occur.	Easily implementable.	Capital: $0 ; Total Present Value: $88,604
2 Limited Action	Protective of human health only in short-term; potentially protective of ecological receptors in long-term.	Currently does not comply; potential future compliance through natural processes.	Effective in long-term to mitigate human health risks; potentially effective in long-term to mitigate ecological health risks, based on rate of natural attenuation.	No treatment included.	Minimal short-term risks to the ecological habitat during implementation.	Feasible to implement; requires placing access restrictions and enforcing institutional controls	Capital: $72,984 ; Total Present Value: $1,184,591
3 Capping and Dredging	Protective if cap system is properly maintained.	Complies.	Effective and permanent, assuming proper cap maintenance. Well-proven technology.	No treatment included as principal action; potential treatment of dewatering fluid would be completed as necessary prior to discharge.	Some risk/nuisance (minor and controllable) to community and workers during implementation. Disruption of existing ecological habitat (would require mitigation).	Feasible to implement; however, would require significant planning and coordination. Would require PDI.	Capital: $7,516,386; Total Present Value: $13,813,419
4 Dredging Only	Protective.	Complies.	Effective and permanent. Well-proven technology.	No treatment included as principal action; potential treatment of dewatering fluid would be completed as necessary prior to discharge.	Some risk/nuisance (minor and controllable) to community and workers during implementation. Disruption of existing ecological habitat would require mitigation	Feasible to implement; however, would require significant planning and coordination. Would require PDI.	Capital: $6,542,854; Total Present Value: $6,542,754

TABLE 1-1

SUMMARY OF MARINE HUMAN HEALTH RISK ASSESSMENT RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Exposure Scenario	Child Resident		Adult Resident		Subsistence Fisherman*		Trespasser Child	Trespasser Adult
	RME	CTE	RME	CTE	RME	CTE	RME	RME
CANCER RISKS								
Ingestion of Hard Shell Clams	5.1E-06	3.4E-06	1.6E-05	1.1E-05	2.0E-04	1.4E-04	NA	NA
Ingestion of Blue Mussels	1.0E-05	4.2E-06	2.8E-05	1.3E-05	3.3E-04	1.6E-04	NA	NA
Ingestion of Lobster	1.4E-05	1.1E-05	4.4E-05	3.4E-05	5.7E-04	4.4E-04	NA	NA
Sediment Ingestion and Dermal Contact	NA	NA	NA	NA	NA	NA	9.9E-07	5.4E-07
NONCANCER RISKS								
Ingestion of Hard Shell Clams	2.2E-01	1.4E-01	1.4E-01	8.9E-02	1.9E+00	1.2E+00	NA	NA
Ingestion of Blue Mussels	4.0E-01	1.9E-01	2.6E-01	1.3E-01	3.3E+00	1.6E+00	NA	NA
Ingestion of Lobster	4.6E-01	3.4E-01	3.0E-01	2.2E-01	3.9E+00	2.9E+00	NA	NA
Sediment Ingestion and Dermal Contact	NA	NA	NA	NA	NA	NA	6.0E-02	6.6E-03

Notes:

Shading indicates significant risks (cancer risk > 1.00E-04 or non-cancer hazard index > 1.0)
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
* Subsistence fisherman exposure scenario assumes 36 meals per year taken from the study area.

TABLE 1-2

SUMMARY OF THE FINDINGS OF THE ECOLOGICAL RISK ASSESSMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 1 OF 2

STATION	LINES OF EVIDENCE										OVERALL RISK PROBABILITY RANKING[10]
	EXPOSURE					EFFECTS					
	Sediment Hazard Quotients [1]	Elutriate HQs[2]	SEM and AVS[3]	Tissue Conc. Ratio[4]	Rank[9]	Tissue Residue Effects[5]	Laboratory Toxicity[6]	Field Effects[7]	Avian Predators[8]	Rank[9]	
DSY-24				++	I	+		-	+	L	**Intermediate**
DSY-25	+	+	-	+++	I	++	+	++	+	I	**Intermediate**
DSY-26	+		-	+++	I	+	++	++	+	I	**Intermediate**
DSY-27	+++	+	+	+++	H	+++	-	++	+	H	**HIGH**
DSY-28	+		+	++	L	+	++	+	++	I	**Intermediate**
DSY-29	+++	+	+	++	H	+++	++	+++	++	H	**HIGH**
DSY-30	+		+		L		-	+		B	Low
DSY-31	+++	+	-	+	I	+	+	+	+	L	**Intermediate**
DSY-32	+	+	-	+	L	+	+	++	+	L	Low
DSY-33	-	+	+	+	L	++	+	++	+	I	**Intermediate**
DSY-34	+		-	+	L	+	-	-	+	L	Low
DSY-35	-		+	+	L	++	-	-	+	L	Low
DSY-36	+	+	-	++	L	+	-	+	++	L	Low
DSY-37	+	+	+	+	L	+	+	-	+	L	Low
DSY-38	+	+	-	+	L	++	+	+	+	L	Low
DSY-39	+	+	-	+	L	++	+	+	+	L	Low
DSY-40	+	+	-	+	L	+	-	+++	+	I	**Intermediate**
DSY-41	-	+	-	+	L	+	+	+++	+	I	**Intermediate**
JPC-1	-	+	-		B	+++	-	-	+	I	Low
JPC-2	-		+		B		-	-	+	B	Baseline
CHC-1						+++		-		I	**Intermediate**

TABLE 1-2

SUMMARY OF THE FINDINGS OF THE ECOLOGICAL RISK ASSESSMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 2

Notes:

1 Sediment Hazard Quotient Risk Ranking: see Table 6.6-1.
2 Elutriate Hazard Quotient Risk Ranking: see Table 6.6-1.
3 SEM and AVS Risk Ranking: see Table 6.6-1.
4 Tissue Concentration Ratios Risk Ranking: see Table 6.6-1.
5 Tissue-based Risk Ranking: Based on Site vs. Reference Tissue Concentration Ratio (Table 6.6-1), Tissue Screening Concentration (Table 6.6-2) and Critical Body Residues (Table 6.6-2).
6 Laboratory Toxicity Risk Ranking: see Table 6.6-2.
7 Field Effects Ranking: Based on results of Condition Index, Benthic Community Structure. Hematopoietic neoplasia, cytochrome P450, and fecal pollution indicators; see Table 6.6-2.
8 Avian Predator effects ranking based on Toxicity Reference Value Hazard Quotients; see Table 6.6-2.
9 Overall Exposure/Effects (E/E) Ranking: B = Baseline Risk; L = Low Risk Probability; I = Intermediate Risk Probability; H = High Risk Probability
B = Low (+) E/E ranking observed for only one indicator or baseline E/E ranking observed for all indicators;
L = Intermediate (++) E/E ranking observed for only one indicator or low (+) E/E ranking observed for two or more indicators;
I = High (+++) E/E ranking observed for only one indicator or intermediate (++) E/E ranking observed for two or more indicators;
H = Intermediate (++) or greater E/E ranking observed for two indicators <u>including</u> high (+++) E/E ranking observed for one indicator.
10 Overall Risk Ranking (See also Section 6.6): Baseline = No greater than Baseline (B) ranking for E/E WoE summaries;
Low = No greater than Low (S) ranking for E/E WoE summaries; Intermediate = No greater than intermediate (I) ranking for E/E WoE summaries, <u>or</u> High (H) ranking for one WoE and no greater than Low (L) ranking for the other WoE summary;
High = High (H) ranking for one WoE summary and Intermediate (I) or greater ranking for the other WoE summary.

Source: SAIC and URI, May 1997: Ecological Risk Assessment - Derecktor Shipyard/Coddington Cove.

TABLE 2-2

DRAFT FINAL

HISTORICAL AND CURRENT PRG EXCEEDANCES FOR SEDIMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location			DSY-02			DSY-03		DSY-18	DSY-20	
Sample Number			DSY-2	DSY-SD-02-082504	DSY-SD-DUP01-082504	DSY-3	DSY-SD-03-082604	DSY-18	DSY-20	DSY-SD-20-082604
Date Sampled			11/3/1993	8/25/2004	8/25/2004	11/3/1993	8/26/2004	6/13/1994	6/13/1994	8/26/2004
Depth Sampled (feet)			0 - 0.1	0 - 0.5	0 - 0.5	0 - 0.1	0 - 0.5	0 - 0.1	0 - 0.1	0 - 0.5
QC Identifier	**Recommended PRG (HIST)2**	**Recommended PRG (2004)2**		Field Duplicate of DSY-SD-02-082504	Field Duplicate of DSY-SD-02-082504					
BENZO(A)PYRENE (UG/KG)	**539**	**539**	**3320**	160 J	200 J	**4710**	**1000**	**1190**	**880**	230 J
HIGH MOLECULAR WEIGHT PAHS (UG/KG)	**13903**	**13903**	**63994**	1392	1650	**72956**	9760	12860	**20406**	2048
TOTAL PCBs[1] (UG/KG)	**1060**	**1060**	209	114	106	733	349	293	367	202
LEAD (MG/KG)	**168**	168	**181**	48.2 J	50.8 J	**201**	114 J	60	77	47.9 J

2004 RESULT EXCEEDS PRG

HISTORICAL RESULT EXCEEDS PRG

(Additional notes on last page)

Black Background - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2

DRAFT FINAL

HISTORICAL AND CURRENT PRG EXCEEDANCES FOR SEDIMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location			DSY-27				DSY-28					
Sample Number			DSY-27-SUR	DSY-V9-MID	DSY-V9-BOT	DSY-SD-27-082604	DSY-28-SUR	DSY-28-MID	DSY-28-BOT	DSY-V4-MID	DSY-V4-BOT	DSY-SD-28-082504
Date Sampled			10/12/1995	1/11/1996	1/11/1996	8/26/2004	10/19/1995	11/16/1995	11/16/1995	1/11/1996	1/11/1996	8/25/2004
Depth Sampled (feet)			0 - 0.5	0.3 - 0.7	1.3 - 1.5	0 - 0.5	0 - 0.5	0.8 - 1.1	2.5 - 2.8	3.4 - 3.8	4.3 - 4.6	0 - 0.5
QC Identifier	**Recommended PRG (HIST)2**	**Recommended PRG (2004)2**										
BENZO(A)PYRENE (UG/KG)	**539**	**539**	**924**	**2380**	236	530	377	**698**	**4130**	0.00	6	220 J
HIGH MOLECULAR WEIGHT PAHS (UG/KG)	**13903**	**13903**	5527	**21497**	2075	3796	2210	4116	**34321**	19	65	1656
TOTAL PCBs[1] (UG/KG)	**1060**	**1060**	**3310**	**1380**	91	**2960**	134	430	204	17	7	80
LEAD (MG/KG)	**168**	168	151	**182**	16	138 J	78	148	**193**	16	13	51 J

2004 RESULT EXCEEDS PRG

HISTORICAL RESULT EXCEEDS PRG

(Additional notes on last page)

Black Background - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2

HISTORICAL AND CURRENT PRG EXCEEDANCES FOR SEDIMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 3 OF 4

Sample Location			DSY-29					DSY-30		
Sample Number			DSY-29-SUR	DSY-29-SUR-D	DSY-29-MID	DSY-29-BOT	DSY-SD-29-082604	DSY-30-SUR	DSY-30-MID	DSY-30-BOT
Date Sampled			10/19/1995	10/19/1995	11/16/1995	11/16/1995	8/26/2004	10/12/1995	11/16/1995	11/16/1995
Depth Sampled (feet)			0 - 0.5	0 - 0.5	0.5 - 0.9	1.4 - 1.8	0 - 0.5	0 - 0.5	0.6 - 0.9	2.2 - 2.6
QC Identifier	**Recommended PRG (HIST)2**	**Recommended PRG (2004)2**								
BENZO(A)PYRENE (UG/KG)	**539**	**539**	**2380**	**3200**	**1550**	10	**1200**	**812**	138	2
HIGH MOLECULAR WEIGHT PAHS (UG/KG)	**13903**	**13903**	**18467**	**28223**	11413	82	10970	5594	847	9
TOTAL PCBs[1] (UG/KG)	**1060**	**1060**	546	936	81	3	410	315	13	5
LEAD (MG/KG)	**168**	168	**186**	**173**	87	19	113 J	80	35	22

2004 RESULT EXCEEDS PRG

HISTORICAL RESULT EXCEEDS PRG

(Additional notes on last page)

Black Background - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2

HISTORICAL AND CURRENT PRG EXCEEDANCES FOR SEDIMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 4 OF 4

Sample Location			DSY-SD-103		MCA-JCC-MD-01 (Reference Station)				
Sample Number			DSY-SD-103-0006	DSY-SD-103-0612	JCC-D1-SUR	JCC-M1	JCC-D1-MID	JCC-D1-BOT	DSY-SD-CC01-082604
Date Sampled			8/25/2004	8/25/2004	8/29/1994	8/29/1994	6/1/1995	6/1/1995	8/26/2004
Depth Sampled (feet)			0 - 0.5	0.5 - 1.0	0 - 0.1	0 - 0.1	0.3 - 0.4	1.5 - 1.6	0 - 0.5
QC Identifier	**Recommended PRG (HIST)2**	**Recommended PRG (2004)2**							
BENZO(A)PYRENE (UG/KG)	**539**	**539**	360	**1400 ***	10	10	**3000**	1	270 J
HIGH MOLECULAR WEIGHT PAHS (UG/KG)	**13903**	**13903**	4223	**23070**	117	117	**24703**	8	2461
TOTAL PCBs[1] (UG/KG)	**1060**	**1060**	764	749	15	11	20	4	6
LEAD (MG/KG)	**168**	168	71.6 J	168 J	23	23	25	17	10 J

2004 RESULT EXCEEDS PRG

HISTORICAL RESULT EXCEEDS PRG

Data is shown only for sample stations that had exceedance of at least one PRG in historical or 2004 data. Refer to Appendix A for complete data.

Refer to Appendix B for details of PRG selection.

1. TOTAL PCBs = Sum of PCB Congeners X 2 (ug/kg)
2. Shading in Recommended PRG column indicates that RPRG was exceeded in at least one historical or 2004 sample (corresponding to shading type).

Black Background - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate; R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3

SUMMARY OF AREAS EXCEEDING PRGS – 2004 DATA
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Station ID	PRGs Exceeded				Extent of Sediment		
	Human[1]	Aquatic Bedded[2]	Aquatic Resuspended[3]	Avian[4]	Surface Area (sf)	Expected Depth (ft)	Volume (cy)
27	NA	X	X	NA	505,300	1	18,715
103	X	X	NA	NA	137,800	1	5,104
3 & 29	X	NA	NA	NA	245,000	1	9,074
				TOTALS:	888,100		32,893

Notes:

X - Exceeds PRG developed for protection of this receptor
sf - Square Feet
ft - Feet
cy - Cubic Yards
NA - Not Applicable - No recommended PRG was selected, or recommended PRG was not exceeded.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 1 OF 7

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
No Action	None	Not Applicable	No activities conducted to address contamination.	Retained. Use for baseline comparison, as required by NCP.
Limited Action	Institutional Controls	Use Restrictions/ Shellfishing Ban	Implementation of administrative action to restrict recreational use and prohibit lobstering. Permanent ban on shellfishing for bivalves is already in place and the area is closely patrolled by Navy security details. However, the ban would be expanded to include lobster collections and a closure for site contamination as well as for known and potential sewerage levels from off-site sources.	Retained for protection of human health. Not protective of ecological receptors.
	Access Restrictions	Fencing/Signs/ Buoys/Enforcement	Placement of fencing and buoys, and posting of warning signs to inform public of use restrictions and to deter access.	Retained for protection of human health. Not protective of ecological receptors.
	Long-Term Monitoring	Sediment Monitoring	Periodic sediment sampling and analysis to assess potential contaminant migration and reduction by attenuation. Provides information to evaluate changing exposure risks.	Retained as potentially applicable. Can be combined with other GRAs for assessment of existing site conditions and exposure risks.
Containment	Permeable Cap	Natural Cap	Placement of natural materials (silts, sand, gravel, and/or crushed stone) and stone/rock bedding over contaminated sediment to prevent direct contact and minimize erosion/contaminant migration.	Retained for areas outside active shipping channels and piers. Eliminated for shipping/traffic areas and piers, because the cap would interfere with or be impacted by any future maintenance dredging in these areas.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 7

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
Containment (cont.)	Permeable Cap (Cont'd)	Multi-Media Cap	Placement of multi-media cap (natural materials, with added geotextile, and armament material) over contaminated sediment to prevent direct contact and minimize erosion/contaminant migration.	Eliminated. Difficult to implement.
	Impermeable Cap	Natural (Clay) Cap	Placement of natural materials (clay) and stone/rock bedding over contaminated sediment to prevent direct contact and minimize erosion and contaminant migration.	Eliminated. Impermeable (low permeability and transmissivity) cap not appropriate for underwater application. Any water movement and gas formation under the cap could become trapped and stress the integrity of the cap. Placement of cap would cause excessive turbulence in water column because of low settleability of fine clay particles.
		Multi-Media Cap	Placement of multi-media cap (natural material, geomembrane, and bedding material) over contaminated sediment to prevent direct contact and minimize erosion and contaminant migration.	Eliminated. Impermeable (low permeability and transmissivity) cap not appropriate for underwater application. Any water movement and gas formation under the cap could become trapped and stress the integrity of the cap. Placement of the geomembrane would be difficult; it would tend to float on the water surface and need to be anchored to the bottom.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
Removal (in combination with Disposal or Treatment and Disposal)	Excavation/Dredging	Mechanical Excavation/ Dredging	Use of mechanical force to dislodge contaminated sediment. Includes clamshell, dipper, bucket ladder, or dragline dredges. Also applicable for removal of debris.	Retained. Potentially applicable. Extensive erosion control measures required. Particularly useful in areas where large debris is present.
		Hydraulic Dredging	Use of centrifugal force to remove contaminated sediment in slurry form. Includes suction, cutterhead, and/or portable hydraulic dredges.	Retained. Potentially applicable. Less extensive erosion control measures required. Dewatering of slurry is required.
		Pneumatic Dredging	Use of compressed air and/or hydraulic pressure to remove contaminated sediment in slurry form. Includes Airlift, Pneuma, and Oozer dredges.	Eliminated. Not widely available in USA.
Disposal	On-Site/On-Base Disposal	Upland On-Site or On-Base Disposal	Disposal of dredged sediment at on-site location adjacent to McAllister Point Landfill cap or at other on-base location.	Eliminated. Sufficient space not available at on-base disposal locations.
	Off-Base Disposal	Confined Aquatic Disposal (CAD)	Disposal of dredged sediment in an existing permitted CAD cell.	Retained. Fully-contained disposal cells available for use in upper Narragansett Bay near Providence, RI.
		Off-Base Landfill or TSDF	Transport and disposal of dredged sediment at off-base landfill or TSDF licensed to accept the contaminant types detected.	Retained. Potentially applicable if confined aquatic disposal cells are unavailable.
Treatment (In-Situ)	Chemical Treatment	Neutralization/ Precipitation/ Oxidation	Injection of treatment reagents into contaminated media to convert the contaminants to a less toxic form through chemical reactions. Reagents are typically chosen for treatment of specific contaminants. Toxic byproducts may form.	Eliminated. Containment of affected area and/or diversion of water required for the duration of treatment. Difficult to ensure that treatment reagents are thoroughly mixed with contaminated sediment. Reagents are not typically suited for treatment of all contaminants present.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
Treatment (In-Situ) (cont.)	Biological Treatment	Aerobic/Anaerobic Treatment	Biodegradation of contaminants by injection of nutrients and/or organisms into contaminated media. Effective for destruction of VOCs and SVOCs. Ineffective for inorganics.	Eliminated. Containment of affected area and/or diversion of water required. Difficult to ensure complete mixing of nutrients. Not effective treatment for all site contaminants. Lack of nutrients and low temperature may impede degradation process.
		Phytoremediation	Use of plants to naturally remediate contaminants via three mechanisms: direct uptake and accumulation in plant tissue, release of enzymes that stimulate microbial activity and biochemical transformation, and enhancement of mineralization in plants' roots. Effective for destruction of some VOCs and SVOCs and effective for absorbing many inorganics but not demonstrated applicable for PCBs.	Eliminated. Root systems of aquatic plants may not extend deep enough to remediate contaminants at depth. Wave action and excessive water depth in some areas may impede adequate rooting and growth of plants. Not effective in treating all site contaminants. Inorganics accumulate in plants, so plants would require harvesting and replanting.
	Physical Treatment	Solidification/ Stabilization	Immobilization of sediment and contaminants by treatment with reagents to solidify/fix them. Most suitable for treatment of inorganics in a controlled environment.	Eliminated. Not feasible in area where solidified mass cannot be tolerated.
Treatment (Ex-Situ; On-Site/On-Base) (in combination with Removal and Disposal)	Thermal Treatment	Thermal Desorption	Volatilization of organic contaminants by an externally-fired rotary dryer and removal as a condensed liquid. Proven for treatment of VOCs. Limited applicability to remove SVOCs, PAHs, and PCBs. Not applicable for inorganics or contaminants with low vapor pressures.	Eliminated: Does not address inorganic contaminants. Dredged sediment may require significant dewatering prior to treatment. Would require pilot testing.
		Infrared Incineration	Pyrolysis of organic contaminants using near infrared radiation. Not effective for treating inorganics. Most applicable to low BTU soils and homogeneous waste streams.	Eliminated. Does not address inorganic contaminants. Not cost effective; simpler processes available to treat contaminants.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
Treatment (Ex-Situ; On-Site/On-Base) (in combination with Removal and Disposal) (cont.)	Thermal Treatment (cont.)	Vitrification	Contaminated sediment is melted into a glassy, crystalline monolith using electric current. Applicable to treatment of both inorganics and organics.	Eliminated. Inefficient for high water content material. Not cost effective.
	Chemical/Physical Treatment	Soil Washing	Particle-size separation process to reduce volume of materials requiring aggressive treatment. Fraction containing fines is separated from coarse by washing process; fines containing majority of contaminants require additional treatment. Contaminant removal using extractant solution. Solutions used include water, surfactants, acids, bases, and/or oxidizing or reducing agents. Can remove both organics and inorganics in multiple extraction process.	Eliminated. Only suitable for materials with low fines content. The sediment at this site has high content of silt. Would require numerous extraction tests to remove the various contaminants identified in site sediments. Residual solvents and surfactants may be difficult to remove from treated sediment. Not cost effective; simpler processes available to treat contaminants.
		Solvent Extraction	Preferential dissolution of contaminants from sediment into solvent. Most effective for organic contaminants. Can treat sediments in slurry form. Solvent requires further processing or disposal. Treated material requires dewatering prior to disposal.	Eliminated. Residual solvents may be difficult to remove from treated sediment. Requires bench-scale testing. Not cost effective; simpler processes available to treat contaminants.
		Wet Air Oxidation	Oxidation of organic and inorganic contaminants in an aqueous reactor using molecular oxygen at elevated temperatures/ pressures. Effectiveness proportional to sediment particle size; less effective on large grain sizes and heterogeneous waste streams.	Eliminated. Most effective on concentrated waste streams.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
Treatment (Ex-Situ; On-Site/On-Base) (in combination with Removal and Disposal) (cont.)	Chemical/Physical Treatment (cont.)	Solidification/ Stabilization	Mixing of sediment with Portland cement, siliceous materials, lime, and/or proprietary agents, to form a chemically-stable matrix of limited permeability. Most suitable for immobilizing inorganics. Not proven effective for many organic contaminants. May be used for bulking agents to reduce free liquids in dewatered sediment.	Retained. Potentially applicable for treatment of inorganics and/or for use as a bulking agent prior to disposal. Space is available on site for treatment.
		Acid Extraction	Washing of sediment with acid, and processing of effluent through a membrane or ion exchange system. Most effective for inorganics. Not effective for organic wastes or waste materials.	Eliminated. Similar to solvent extraction, but for treatment of inorganics only. Better suited for material with low fines content. Requires bench-scale testing. Not cost effective; simpler processes available to treat contaminants.
		Dechlorination	Stripping of chlorine atoms from hazardous halogenated hydrocarbons using alkali metals or alkali metal/polyethylene glycol. Effective for destruction of chlorinated organics, dioxin, and PCBs. Ineffective for treatment of inorganics.	Eliminated. Not effective for treatment of PAHs, or metals. Effective for treatment of PCBs only.
	Biological Treatment	Slurry Phase Biodegradation	Preparation of dredged sediment into a pumpable slurry to which a nutrient-rich bacteria is added for degradation in a reactor system. Most effective for organic contaminants. Not effective for inorganics. Limited effectiveness for PCBs and PAHs. Treated material requires dewatering prior to disposal.	Eliminated. Not effective in treating site contaminants.

TABLE 3-1

IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
Treatment (Ex-Situ; On-Site/On-Base) (in combination with Removal and Disposal) (cont.)	Biological Treatment (cont.)	Landfarming	Aerobic biodegradation of contaminants in sediment applied to the ground surface and amended with nutrients. Effective for destruction of VOCs. Ineffective for inorganics. Limited effectiveness for PCBs, PAHs.	Eliminated. Not effective in treating site contaminants.
		Phytoremediation	Use of plants to naturally remediate contaminants via three mechanisms: direct uptake and accumulation in plant tissue, release of enzymes that stimulate microbial activity and biochemical transformation, and enhancement of mineralization in plants' roots. Effective for destruction of some VOCs and SVOCs and effective for absorbing many inorganics but not demonstrated applicable for PCBs.	Eliminated. Not effective in treating all site contaminants. Would require harvesting of plants and subsequent treatment/disposal and replanting.
	Thermal/Physical/ Chemical/Biological Treatment	Multiple Processes	Treatment to be determined by off-site disposal facility, as necessary for acceptance in licensed landfill.	Retained. Potentially applicable. Estimated 20% of dredged material requiring treatment to stabilize metals prior to disposal at RCRA Subtitle C or D landfill/ TSDF.

TABLE 3-2

EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 1 OF 2

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Conclusion
No Action	None	Not Applicable	Not effective in achieving remedial action objectives.	No implementation required.	Capital: none O&M: low	Retained, as required by NCP.
Limited Action	Institutional Controls	Use Restrictions/ Lobstering and Shellfishing Bans	Effectiveness in preventing human health risks depends on continued future enforcement. Not effective in minimizing ecological risks or preventing contaminant migration. No contaminant reduction.	Readily implementable. However, requires coordination with multiple state agencies and state enforcement. Shellfishing ban currently in effect.	Capital: low O&M: low	Retained for protection of Human Health.
	Access Restrictions	Posting/Fencing	Effectiveness in preventing human health risks depends on continued future enforcement. Not effective in minimizing ecological risks or preventing contaminant migration. No contaminant reduction.	Readily implementable. However, requires coordination with multiple state agencies and state enforcement. Shellfishing ban currently in effect.	Capital: low O&M: low	Retained for protection of Human Health.
	Long-Term Monitoring	Sediment Monitoring	Would not reduce risk to receptors, but would provide data for assessment of long-term exposure risks and contaminant migration.	Readily implementable.	Capital: low O&M: low to moderate	Retained. May be combined with other process options.
Containment	Permeable Cap	Natural Cap	Would reduce risk to aquatic receptors by eliminating exposure pathway; would not reduce volume of on-site contaminants.	Implementable by both pier/shoreline and barge-mounted operations.	Capital: moderate O&M: moderate to high	Retained. Potentially viable for areas outside active shipping channels and piers. Also viable for containing sediments under piers which cannot be dredged.
Removal (in combination with Disposal or Treatment and Disposal)	Excavation/ Dredging	Mechanical Excavation/Dredging	Effectively removes debris and contaminated sediment from marine environment. Would eliminate future exposure risks at the site. Requires aggressive turbidity control measures to minimize contaminant migration.	Implementable by both pier/shoreline and barge-mounted operations.	Capital: moderate to high O&M: none	Potentially viable for removal of debris (cable, conduit, piping etc.) retained along with hydraulic dredging. Will not be able to obtain sediments under piers.

TABLE 3-2

EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 2

General Response Action	Technology	Process Option	Effectiveness	Implementability	Cost	Conclusion
Removal (in combination with Disposal or Treatment and Disposal) (cont.)	Excavation/ Dredging (cont.)	Hydraulic Dredging	Effectively removes contaminated sediment, but not able to remove debris >6 inches in diameter. Would eliminate future exposure risks at the site. Less sediment resuspension during implementation than mechanical dredging.	Implementable by both pier/shoreline and barge-mounted operations.	Capital: moderate to high O&M: none	Retained.
Disposal	Off-Base Disposal	Confined Aquatic Disposal	Offers off-shore disposal option that potentially reduces dewatering and treatment requirements. Suitable for dredged sediment without excessive debris.	Implementable by barge-mounted operations, including tug-boat and bottom-dump scow.	Capital: moderate to high O&M: none	Retained.
		Off-Base Landfill	Offers full range of disposal and treatment/disposal options for all types of materials.	Local RCRA Subtitle D landfills may not have capacity to accept large volumes. RCRA Subtitle C TSDFs are available to accept the volume anticipated to require such disposal and/or treatment.	Capital: high O&M: none	Retained as an alternate option to be used only if disposal in the CAD cells off-shore of Providence, RI, is determined to be unfeasible.
Treatment (Ex-Situ; On-Site/ On-Base) (in combination with Removal and Disposal)	Physical/ Chemical Treatment	Solidification/ Stabilization	Widely demonstrated as effective in immobilizing metals and for use as bulking agent to reduce free liquid content.	Requires initial dewatering of sediment. May require bench-scale testing using site-specific materials.	Capital: low to moderate O&M: low	Retained for reducing free liquids prior to landfill disposal and potentially for treatment of inorganics.
Treatment (Ex-Situ; Off-Base) (in combination with Removal and Disposal)	Thermal/ Physical/ Chemical/ Biological Treatment	Multiple Processes	Effective treatment at properly licensed facility to render the contaminated media acceptable for off-base disposal.	Readily implementable at licensed disposal facility. Requires proper handling transport, complete with bill of lading.	Capital: low O&M: none	Retained for treatment of sediment prior to landfill disposal.

TABLE 3-3

SUMMARY OF SELECTED REPRESENTATIVE PROCESS OPTIONS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

General Response Action	Technology	Process Option
No Action	None	• Not Applicable
Limited Action	Institutional Controls	• Use Restrictions • Shellfishing/Lobstering Ban in affected areas
	Access Restrictions	• Fencing from shore access to breakwater • Buoys warning of restricted area from access by water
	Long-Term Monitoring	• Sediment Monitoring
Containment	Permeable Cap	• Natural Cap
Removal (in combination with Disposal or Treatment/Disposal)	Excavation/Dredging	• Mechanical Excavation/Dredging • Hydraulic Dredging
Disposal (in combination with Removal or Removal/Treatment)	Off-Base Disposal	• Confined Aquatic Disposal • Solid waste (RCRA Subtitle D) Landfill; • Hazardous Waste (RCRA Subtitle C) Landfill or TSDF
Treatment (On-Base) (in combination with Removal/Disposal)	Physical/Chemical Treatment	• Stabilization/Solidification
Treatment (Off-Base) in combination with Removal/Disposal)	Thermal/Physical/ Chemical/Biological Treatment	• Multiple Processes • Stabilization/Solidification

TABLE 4-1

SUMMARY OF REMEDIAL ALTERNATIVES AND THEIR COMPONENTS
MARINE SEDIMENT
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Alternative	Receptor Addressed	Key Components
1. No Action	None	• Five-year reviews
2. Limited Action	Human receptors exposed through shellfish ingestion.	• Institutional controls - Shellfish and lobster fishing ban • Buoy line preventing access to affected area by boat, NAVSTA police enforcement of access • Long-term monitoring (sediment sampling and analysis) • Five-year reviews
3. Containment, Dredging and Disposal	Ecological receptors exposed to bedded and resuspended sediment Human receptors exposed through shellfish ingestion	• Pre-design investigation: 49 new stations sampled collected around former stations 3, 27, 29 and 103 • Sedimentation control • Permeable cap (comprised of natural materials) installed to fully contain sediments in non-shipping areas around stations 3 and 29 (245,000 square feet) • Hydraulic and/or mechanical dredging of areas around stations 27 and 103 (643,100 square feet) [active shipping areas] • Sediment dewatering to remove free liquid • Water treatment and discharge • Disposal of approximately 23,800 cubic yards of sediment at confined aquatic disposal unit • Possible mitigation of wetland resource areas if any are impacted by capping or dredging • Long term O&M conducted to maintain cap structure integrity • Five-year reviews
4. Dredging and Disposal	Ecological receptors exposed to bedded and resuspended sediment Human receptors exposed through shellfish ingestion	• Pre-design investigation: 54 new stations sampled around former stations 3, 27, 29, and 103 • Site preparation (removal of debris along piers and bulkheads) • Hydraulic and/or mechanical dredging (888,100 SF) • Sediment dewatering to remove free liquid. • Water treatment and discharge • Disposal of approximately 32,900 cubic yards of sediment at confined aquatic disposal unit • Possible mitigation of wetland resource areas if any are impacted by dredging

TABLE 5-1

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
ALTERNATIVE 1: NO ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Guidelines established for the protection of human health and /or aquatic organisms. These guidelines are used by states to set water quality standards for surface water.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). This alternative fails to meet this standard since sediment PRGs derived from water quality criteria are not adequately addressed by the remedy.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). This alternative fails to meet this standard since sediment PRGs derived from water quality criteria are not adequately addressed by the remedy.

TABLE 5-2

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 1: NO ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no federal location-specific ARARs.				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no state location-specific ARARs.				

TABLE 5-3

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 1: NO ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no federal action-specific ARARs.				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no state action-specific ARARs.				

TABLE 5-4

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
ALTERNATIVE 2: LIMITED ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs)		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Guidelines established for the protection of human health and /or aquatic organisms. These guidelines are used by states to set water quality standards for surface water.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). This alternative currently fails to meet this standard since sediment PRGs derived from water quality criteria are not adequately addressed by the remedy. Natural attenuation and future compliance is anticipated.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). This alternative currently fails to meet this standard since sediment PRGs derived from water quality criteria are not adequately addressed by the remedy. Natural attenuation and future compliance is anticipated.

TABLE 5-5

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 2: LIMITED ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 1 OF 2

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11990 RE: Protection of Wetlands	40 CFR Part 6, Appendix A	Applicable	This order requires federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this executive order.	If wetlands, as defined by Executive Order 11990, are identified at the site, and if these wetlands may be disturbed by the remedial action, the action will be performed to minimize the wetland destruction and preserve the value of the wetland.
Executive Order 11988 RE: Flood plain management	40 C.F.R. Part 6, Appendix A	Applicable	The order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year Flood plain of a waterway to avoid adversely impacting flood plains wherever possible.	If flood plains are present at the site, and these flood plains are disturbed by the remedial action, the action will be performed to minimize destruction and preserve the value of the flood plain. Flood plains damaged by the action will be mitigated.
Fish and Wildlife Coordination Act	16 USC Part 661 *et. seq.*; 40 CFR 122.49	Applicable	This statute requires consultation with appropriate agencies to protect fish and wildlife when federal actions result in control or structural modification of a body of water or to critical habitat upon which endangered or threatened species depends.	Appropriate agencies will be consulted to find ways to minimize adverse effects to fish and wildlife through monitoring the presence of contaminants. Data from monitoring projects will be distributed to these agencies if it is requested.
Rivers and Harbors Act, Section 10	33 USC 403; 33 CFR Parts 165, 320-323	Applicable	Sets forth criteria for obstructions and alterations of navigable waters.	Installation of access restriction markers and monitoring activities will be performed in compliance with the substantive requirements of the statute. In addition, use of the navigation markers will be coordinated with the U.S. Coast Guard Aids to Navigation Office.
Endangered Species Act	16 USC 1531 *et seq.*, 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S. Fish & Wildlife Service or the National Marine Fisheries Service must be consulted.	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat from monitoring activities.

TABLE 5-5

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 2: LIMITED ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 2

FEDERAL REQUIREMENTS (Cont.)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Zone Management Act	16 USC Parts 1451 *et. seq*.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore, activities conducted under this alternative would be conducted in compliance with applicable coastal zone management requirements**.**
National Historic Preservation Act	16 USC 470 *et seq.*, 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks	Historic vessels may be sunken in the area. Monitoring activities will be carried out to minimize potential harm to historic sites.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area, therefore, activities conducted under this alternative would be conducted in compliance with applicable coastal resource management requirements**.**
Endangered Species Act	RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat.	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat from monitoring activities.

TABLE 5-6

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 2: LIMITED ACTION
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Resource conservation and Recovery Act (RCRA), Subtitle C – Standards for Hazardous Waste Facilities	42 USC 6291 *et seq*.; 40 CFR Part 264	Applicable	RI is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. The standards of 40 CFR Part 264 are incorporated by reference.	Monitoring will assess whether any of the sediment is characterized as hazardous waste. The sediment is not expected to be characterized as hazardous.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Hazardous Waste Management – Identification and Listing of Hazardous Wastes	RIGL 23-19.1; CRIR 12-030-003(3.25)	Relevant and Appropriate	RI is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. The standards of 40 CFR Part 261 regarding RCRA identification and listing are incorporated by reference.	Monitoring will test sediment according to the requirements of this regulation. Sediments which are determined not to be hazardous may be handled and disposed of as solid waste. Leaving wastes in place which are hazardous does not meet standards for protectiveness to human health and the environment.
Hazardous Waste Management – Standards for Treatment, Storage, and Disposal Facilities	RIGL 23-19.1 *et seq*.; CRIR 12-030-003(10.00)	Applicable	Outlines specifications and standards for design, operation, closure, and monitoring of performance for hazardous waste storage, treatment, and disposal facilities. The standards of 40 CFR Part 264 are incorporated by reference.	Monitoring and institutional controls, including sampling and installation of access restrictions within areas containing hazardous waste will comply with these standards.
Water Pollution Control – Water Quality	RIGL 42-16 *et seq*.; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state.	Monitoring and institutional control measures will not cause degradation of surface water quality in Narragansett Bay.

TABLE 5-7

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
ALTERNATIVE 3: CAPPING AND DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs)		To Be Considered	Guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Guidelines established for the protection of human health and /or aquatic organisms. These guidelines are used by states to set water quality standards for surface water.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). Sediments exceeding these PRGs will be dredged and permanently removed.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). Sediments exceeding these PRGs will be dredged and permanently removed.

TABLE 5-8

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 3: CAPPING AND DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 1 OF 2

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11990 Re: Protection of Wetlands	40 CFR Part 6, Appendix A	Applicable	This order requires federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this executive order.	If wetlands, as defined by Executive Order 11990, are identified at the site, and if these wetlands are disturbed by the removal action, the action would be performed to minimize wetland destruction and preserve the value of the wetland. Wetlands and special habitats that are damaged by the action would be mitigated - see text.
Executive Order 11988 RE: Flood plain management	49 CFR Part 6, Appendix A	Applicable	The order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year Flood plain of a waterway to avoid adversely impacting flood plains wherever possible.	If floodplains are present at the site, and these flood plains are disturbed by the removal action, the action would be performed to minimize destruction and preserve the value of the flood plain. Flood plains damaged by the action would be mitigated.
Clean Water Act, Section 404	33 USC 1344; 40 CFR Part 230 and 33 CFR Parts 320-323	Applicable	This statute regulates the discharge of dredge and fill materials in the waters of the United States, including special aquatic sites - such as wetlands, intertidal habitats and vegetated shallows. Such discharges are not allowed if practicable alternatives are available.	Water discharged to the bay would be filtered to eliminate solids, and meet the requirement by not discharging dredge or fill materials to the water. Restoration of excavated/dredged special aquatic habitats (including intertidal wetlands and eelgrass beds) may be required to mitigate for the proposed remedial action. Mitigation measures would satisfy this requirement if no practicable alternative that has less effect is available.
Rivers and Harbors Act, Section 10	33 USC 403; 33 CFR Parts 165, 320-323	Applicable	Sets forth criteria for obstructions and alterations of navigable waters.	Dredging would be performed in compliance with the substantive requirements of the statute.
Fish and Wildlife Coordination Act	16 USC Part 661 *et. seq.*; 40 CFR 122.49	Applicable	This statute requires consultation with appropriate agencies to protect fish and wildlife when federal actions result in control or structural modification of a body of water or to critical habitat upon which endangered or threatened species depends.	Appropriate agencies would be consulted to find ways to minimize adverse effects to fish and wildlife by monitoring the presence of contaminants.
Endangered Species Act	16 USC 1531 *et seq.*, 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S. Fish & Wildlife Service or the National Marine Fisheries Service must be consulted.	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies would be consulted to find ways to minimize adverse effects to the listed species and its habitat from dredging activities.

TABLE 5-8

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 3: CAPPING AND DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 2

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
FEDERAL REQUIREMENTS (cont.)				
Coastal Zone Management Act	16 USC Parts 1451 *et. seq*.	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The entire site is located in a coastal zone management area; therefore, applicable coastal zone management requirements need to be addressed**.**
National Historic Preservation Act	16 USC 470 *et seq.*, 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimize harm to National Historic Landmarks.	Historic vessels may be sunken in the area. Dredging design would be conducted in consultation with local historical groups to minimize potential harm to historic sites.
STATE OF RHODE ISLAND REQUIREMENTS				
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area; therefore, applicable coastal resource management requirements need to be addressed**.**
Endangered Species Act	RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat.	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies would be consulted to find ways to minimize adverse effects to the listed species and its habitat from dredging activities.

TABLE 5-9

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 3: CAPPING AND DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Resource Conservation and Recovery Act (RCRA), Subtitle C - Standards for Hazardous Waste Facilities	42 USC 6291 *et seq.;* 40 CFR Part 264	Applicable (assuming landfill disposal)	RI is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. The standards of 40 CFR Part 264 are incorporated by reference.	If landfill disposal is required for sediment or debris, materials will be tested. If determined to be hazardous waste, materials handling and disposal will be conducted in accordance with the requirements of these sections.
Resource Conservation and Recovery Act (RCRA), Subtitle D - Standards for Solid Waste Facilities	40 CFR Part 268	Applicable (assuming landfill disposal)	This regulation sets standards for location restrictions, operating criteria, monitoring, closure, and post closure.	If landfill disposal is required for sediment or debris, materials will be tested. If determined to be solid waste, materials handling and disposal will be conducted in accordance with the requirements of these sections.
Refuse Disposal – Solid Waste Management Facilities	RIGL 23-18.9 *et seq*; CRIR 12-030-21	Applicable	Rules and regulations more stringent than the federal standards under 40 CFR Part 258 are applicable. The standards require minimization of environmental hazards associated with the operation of solid waste facilities.	Removal of non-hazardous sediments and dewatering prior to disposal would satisfy the substantive requirements of these provisions.
Clean Water Act (CWA) Section 402, National Pollutant Discharge Elimination System	33 USC 1342;40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Regulated discharges must meet ambient water quality criteria.	Any drainage or discharges from the sediment dewatering operations would be treated in an on-site treatment plant prior to discharge to Narragansett Bay.
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7411, 7412; 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Initial monitoring of air emissions from the dewatering facility would be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities would be carried out in a manner that would minimize potential air releases.

TABLE 5-9

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 3: CAPPING AND DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 3

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Hazardous Waste Management - Identification and Listing of Hazardous Wastes	RIGL 23-19.1; CRIR 12-030-003(3.25)	Applicable	RI is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. The standards of 40 CFR Part 261 regarding RCRA identification and listing are incorporated by reference.	Excavated sediment would be analytically tested according to the requirements of this regulation. If sediment is determined to be hazardous waste (assuming landfill disposal), it would be properly disposed of as such.
Hazardous Waste Management - Standards for Treatment, Storage, and Disposal Facilities	RIGL 23-19.1 *et seq.*; CRIR 12-030-003(10.00)	Applicable	Outlines specifications and standards for design, operation, closure, and monitoring of performance for hazardous waste storage, treatment, and disposal facilities. The standards of 40 CFR Part 264 are incorporated by reference.	Dewatering of materials classified as RCRA hazardous wastes (assuming landfill disposal) would be conducted in accordance with these requirements.
Clean Air Act - Fugitive Dust Control	RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precautions be taken to prevent particulate matter from becoming airborne.	Removal, processing, and temporary storage of debris and sediments during dewatering and before shipment would be implemented to prevent material from becoming airborne.
Clean Air Act - Emissions Detrimental to Persons or Property	RIGL 23-23 *et seq.*; CRIR 12-31-07	Applicable	Prohibits emissions of contaminants that may be injurious to humans, plant or animal life, or cause damage to property or which reasonably interfere with the enjoyment of life and property.	Removal, processing, and temporary storage of sediments during dewatering and before shipment would be implemented to prevent emissions of contaminants. Initial monitoring of air emissions from the dewatering facility would be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act - Air Pollution Control	RIGL 23-23 *et seq.*; CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	Site processing of sediment and treatment of dewatering liquid would meet the substantive provisions of the standards if threshold levels are reached.
Clean Air Act - Odors	RIGL 23-23 *et seq.*; CRIR 12-31-17	Applicable	Prohibits the release of objectionable odors across property lines.	Site processing of sediment and treatment of dewatering liquid would meet the substantive provisions of the standards.
Clean Air Act - Air Toxics	RIGL 23-23 *et seq.*; CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates that would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as specified in the regulations.	Initial monitoring of air emissions from the dewatering facility would be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities would be carried out in a manner that would minimize potential air releases.

TABLE 5-9

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 3: CAPPING AND DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
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STATE OF RHODE ISLAND REQUIREMENTS (cont.)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control - Water Quality	RIGL 42-16 *et seq.*; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state. Also establishes criteria for discharge to a water body.	Any drainage from the temporary sediment storage area and any dewatering discharge would be treated as required to meet this ARAR and discharged into Narragansett bay.
Water Pollution Control - Pollution Discharge Elimination Systems	RIGL 42-16 *et seq.*; CRIR 12-190-003	Applicable	Contains applicable effluent monitoring requirements, and standards and special conditions for discharges.	The substantive provisions of these standards would be satisfied through on-site treatment of all discharges prior to being released into the bay.

TABLE 5-10

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
ALTERNATIVE 4: DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs)		To Be Considered	Guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Guidelines established for the protection of human health and /or aquatic organisms. These guidelines are used by states to set water quality standards for surface water.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). Sediments exceeding these PRGs will be dredged and permanently removed.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria (including equilibrium partitioning). Sediments exceeding these PRGs will be dredged and permanently removed.

TABLE 5-11

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 4: DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11990 Re: Protection of Wetlands	40 CFR Part 6, Appendix A	Applicable	This order requires federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this executive order.	If wetlands, as defined by Executive Order 11990, are identified at the site, and if these wetlands are disturbed by the removal action, the action will be performed to minimize wetland destruction and preserve the value of the wetland. Wetlands and special habitats that are damaged by the action will be mitigated - see text.
Executive Order 11988 RE: Flood plain management	49 CFR Part 6, Appendix A	Applicable	The order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year Flood plain of a waterway to avoid adversely impacting flood plains wherever possible.	If flood plains are present at the site, and these flood plains are disturbed by the removal action, the action will be performed to minimize destruction and preserve the value of the flood plain. Flood plains damaged by the action will be mitigated.
Clean Water Act, Section 404	33 USC 1344; 40 CFR Part 230 and 33 CFR Parts 320-323	Applicable	This statute regulates the discharge of dredge and fill materials in the waters of the United States, including special aquatic sites - such as wetlands, intertidal habitats and vegetated shallows. Such discharges are not allowed if practicable alternatives are available.	Water discharged to the bay will be filtered to eliminate solids, and meet the requirement by not discharging dredge or fill materials to the water. Restoration of excavated/dredged special aquatic habitats (including intertidal wetlands and eelgrass beds) may be required to mitigate for the proposed remedial action. Mitigation measures would satisfy this requirement if no practicable alternative that has less effect is available.
Rivers and Harbors Act, Section 10	33 USC 403; 33 CFR Parts 165, 320-323	Applicable	Sets forth criteria for obstructions and alterations of navigable waters.	Dredging would be performed in compliance with the substantive requirements of the statute.

TABLE 5-11

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 4: DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
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Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
FEDERAL REQUIREMENTS (cont.)				
Fish and Wildlife Coordination Act	16 USC Part 661 *et. seq.*; 40 CFR 122.49	Applicable	This statute requires consultation with appropriate agencies to protect fish and wildlife when federal actions result in control or structural modification of a body of water or to critical habitat upon which endangered or threatened species depends.	Appropriate agencies will be consulted to find ways to minimize adverse effects to fish and wildlife by monitoring the presence of contaminants.
Endangered Species Act	16 USC 1531 *et seq.*, 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S. Fish & Wildlife Service or the National Marine Fisheries Service must be consulted.	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat from dredging activities.
Coastal Zone Management Act	16 USC Parts 1451 *et. seq*.	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The entire site is located in a coastal zone management area; therefore, applicable coastal zone management requirements need to be addressed**.**
National Historic Preservation Act	16 USC 470 *et seq.*, 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimize harm to National Historic Landmarks.	Historic vessels may be sunken in the area. Dredging design will be conducted in consultation with local historical groups to minimize potential harm to historic sites.

TABLE 5-11

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 4: DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
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Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
STATE OF RHODE ISLAND REQUIREMENTS				
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area; therefore, applicable coastal resource management requirements need to be addressed**.**
Endangered Species Act	RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat.	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat from dredging activities.

TABLE 5-12

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 4: DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Resource Conservation and Recovery Act (RCRA), Subtitle C - Standards for Hazardous Waste Facilities	42 USC 6291 *et seq.;* 40 CFR Part 264	Applicable (assuming landfill disposal)	RI is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. The standards of 40 CFR Part 264 are incorporated by reference.	If landfill disposal is required for sediment or debris, materials will be tested. If determined to be hazardous waste, materials handling and disposal will be conducted in accordance with the requirements of these sections.
Resource Conservation and Recovery Act (RCRA), Subtitle D - Standards for Hazardous Waste Facilities	40 CFR Part 268	Applicable (assuming landfill disposal)	This regulation sets standards for location restrictions, operating criteria, monitoring, closure, and post closure.	If landfill disposal is required for sediment or debris, materials will be tested. If determined to be solid waste, materials handling and disposal will be conducted in accordance with the requirements of these sections.
Refuse Disposal – Solid Waste Management Facilities	RIGL 23-18.9 *et seq*; CRIR 12-030-21	Applicable	Rules and regulations more stringent than the federal standards under 40 CFR Part 258 are applicable. The standards require minimization of environmental hazards associated with the operation of solid waste facilities.	Removal of non-hazardous sediments and dewatering prior to disposal would satisfy the substantive requirements of these provisions.
Clean Water Act (CWA) Section 402, National Pollutant Discharge Elimination System	33 USC 1342;40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Regulated discharges must meet ambient water quality criteria.	Any drainage or discharges from the sediment dewatering operations would be treated in an on-site treatment plant prior to discharge to Narragansett Bay.
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7411, 7412; 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Initial monitoring of air emissions from the dewatering facility would be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities would be carried out in a manner that would minimize potential air releases.

TABLE 5-12

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
ALTERNATIVE 4: DREDGING
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Hazardous Waste Management - Identification and Listing of Hazardous Wastes	RIGL 23-19.1; CRIR 12-030-003(3.25)	Applicable	RI is delegated to administer the federal Resource Conservation and Recovery Act (RCRA) statute through its state regulations. The standards of 40 CFR Part 261 regarding RCRA identification and listing are incorporated by reference.	Excavated sediment would be analytically tested according to the requirements of this regulation. If sediment is determined to be hazardous waste (assuming landfill disposal), it would be properly disposed of as such.
Hazardous Waste Management - Standards for Treatment, Storage, and Disposal Facilities	RIGL 23-19.1 *et seq.*; CRIR 12-030-003(10.00)	Applicable	Outlines specifications and standards for design, operation, closure, and monitoring of performance for hazardous waste storage, treatment, and disposal facilities. The standards of 40 CFR Part 264 are incorporated by reference.	Dewatering of materials classified as RCRA hazardous wastes (assuming landfill disposal) would be conducted in accordance with these requirements.
Clean Air Act - Fugitive Dust Control	RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precautions be taken to prevent particulate matter from becoming airborne.	Removal, processing, and temporary storage of debris and sediments during dewatering and before shipment would be implemented to prevent material from becoming airborne.
Clean Air Act - Emissions Detrimental to Persons or Property	RIGL 23-23 *et seq.*; CRIR 12-31-07	Applicable	Prohibits emissions of contaminants that may be injurious to humans, plant or animal life, or cause damage to property or which reasonably interfere with the enjoyment of life and property.	Removal, processing, and temporary storage of sediments during dewatering and before shipment would be implemented to prevent emissions of contaminants. Initial monitoring of air emissions from the dewatering facility would be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act - Air Pollution Control	RIGL 23-23 *et seq.*; CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	Site processing of sediment and treatment of dewatering liquid would meet the substantive provisions of the standards if threshold levels are reached.

TABLE 5-12

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
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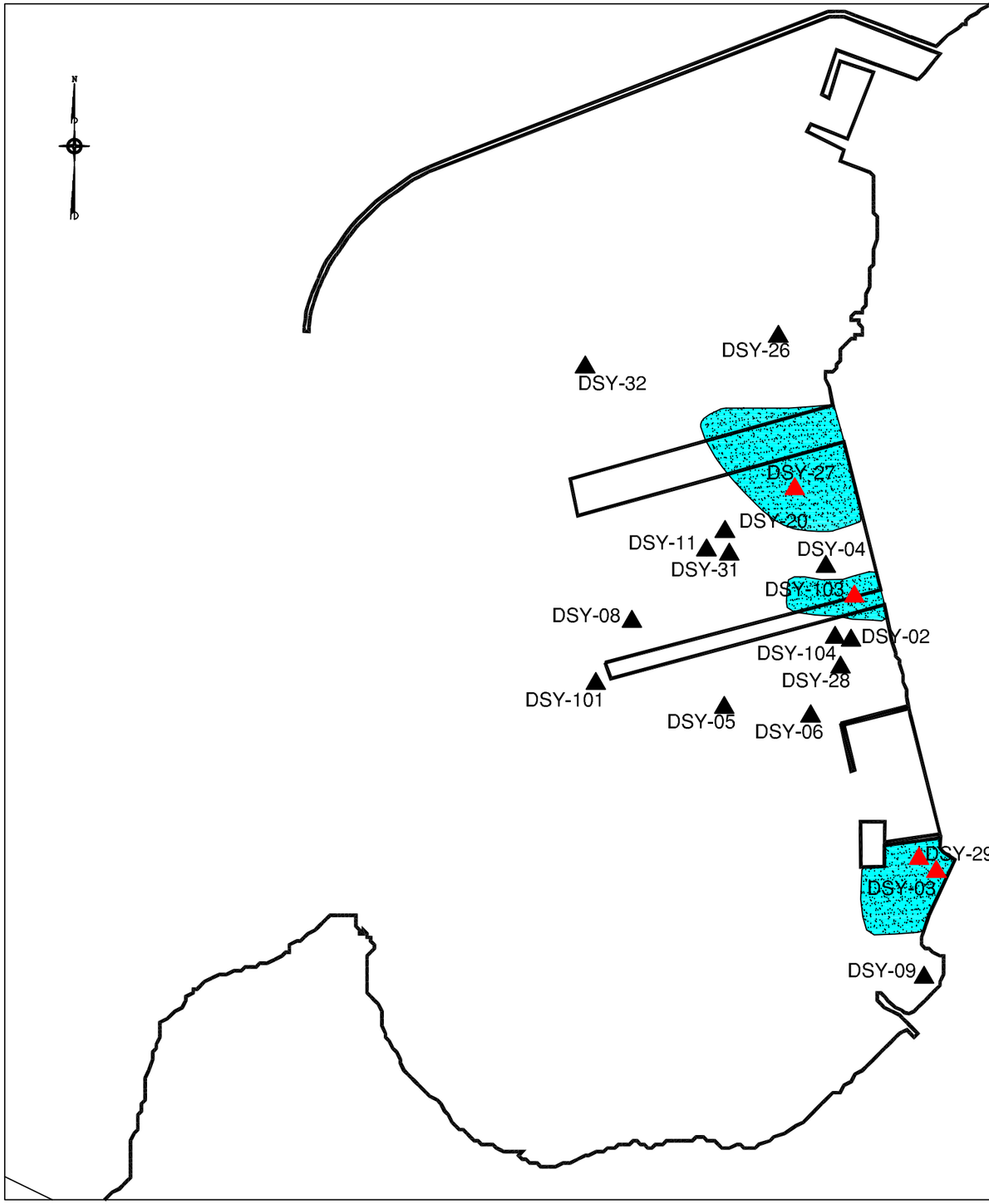
STATE OF RHODE ISLAND REQUIREMENTS (cont.)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Odors	RIGL 23-23 *et seq.*; CRIR 12-31-17	Applicable	Prohibits the release of objectionable odors across property lines.	Site processing of sediment and treatment of dewatering liquid would meet the substantive provisions of the standards.
Clean Air Act - Air Toxics	RIGL 23-23 *et seq.*; CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates that would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as specified in the regulations.	Initial monitoring of air emissions from the dewatering facility would be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities would be carried out in a manner that would minimize potential air releases.
Water Pollution Control - Water Quality	RIGL 42-16 *et seq.*; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state. Also establishes criteria for discharge to a water body.	Any drainage from the temporary sediment storage area and any dewatering discharge would be treated as required to meet this ARAR and discharged into Narragansett bay.
Water Pollution Control - Pollution Discharge Elimination Systems	RIGL 42-16 *et seq.*; CRIR 12-190-003	Applicable	Contains applicable effluent monitoring requirements, and standards and special conditions for discharges.	The substantive provisions of these standards would be satisfied through on-site treatment of all discharges prior to being released into the bay.

FIGURES



LEGEND

PROPOSED REMEDIATION AREA (EXCEEDS RECOMMENDED PRG FOR COMBINED EXPOSURE PATHWAY)

DSY-02 SEDIMENT SAMPLE

DSY-03 SEDIMENT SAMPLE WITH ONE OR MORE COC EXCEEDING RECOMMENDED PRGS

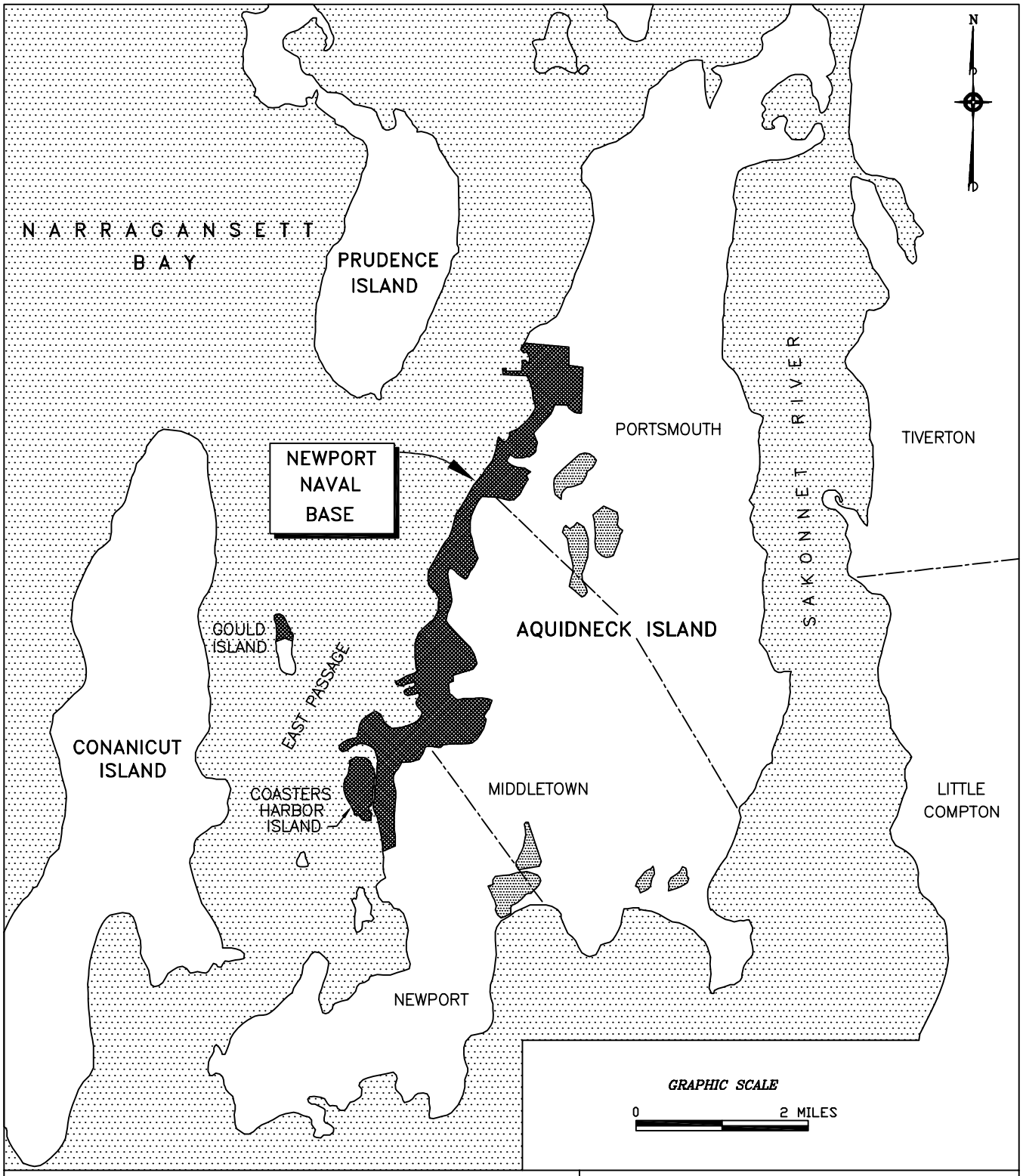
NOTES:
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0′ 700′ 1400′

1 INCH = 700 FEET

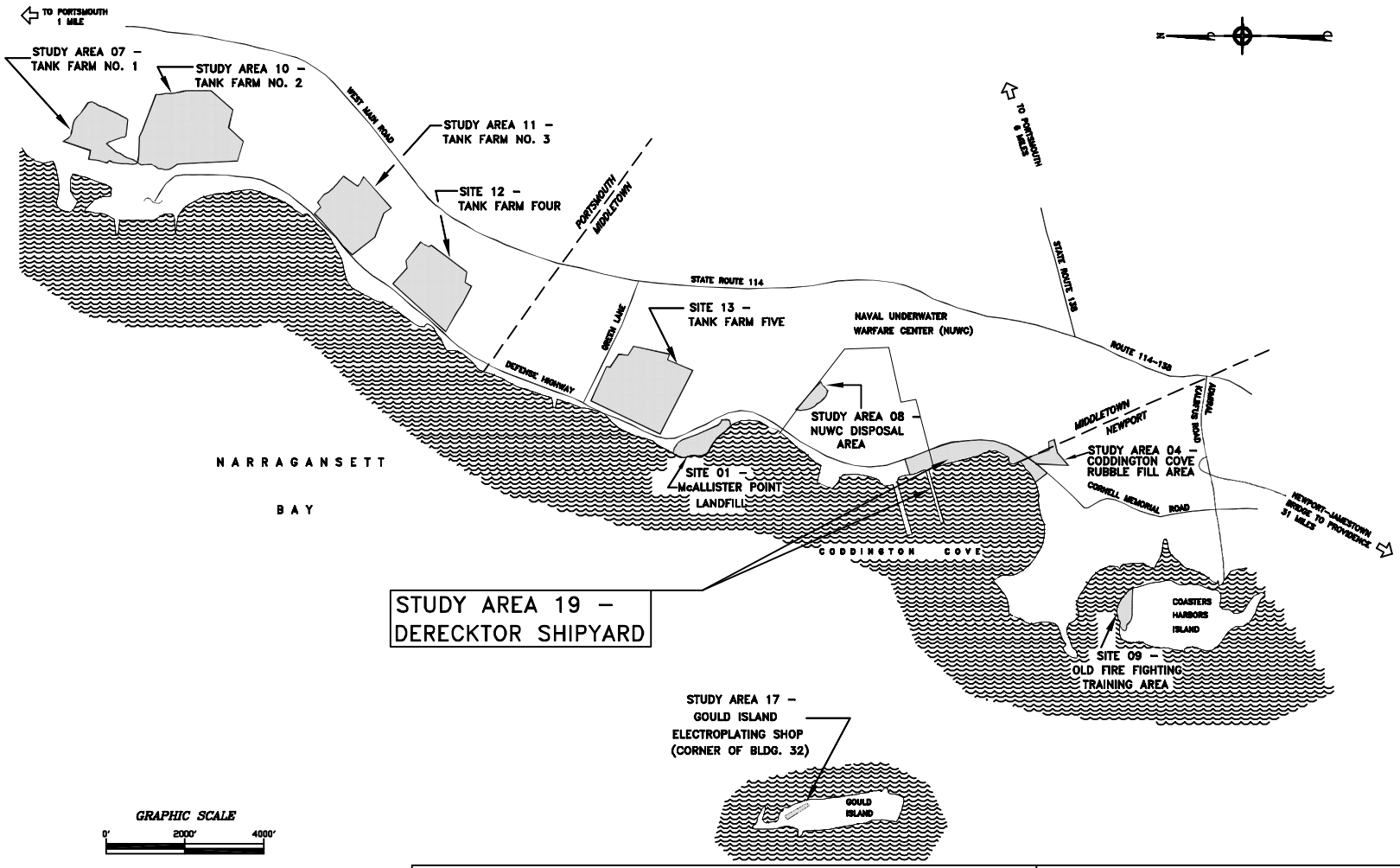
ESTIMATED AREAS REQUIRING REMEDIATION			FIGURE E–1
FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY			TETRA TECH NUS, INC.
NSN – NEWPORT, RHODE ISLAND			
DRAWN BY:	D.W. MACDOUGALL	REV.: 0	
CHECKED BY:	A. CHIVERS	DATE: MARCH 13, 2007	55 Jonspin Road Wilmington, MA 01887 (978)658–7899
SCALE:	AS NOTED	FILE NO.: 5340\1130\FIG_E–1.DWG	



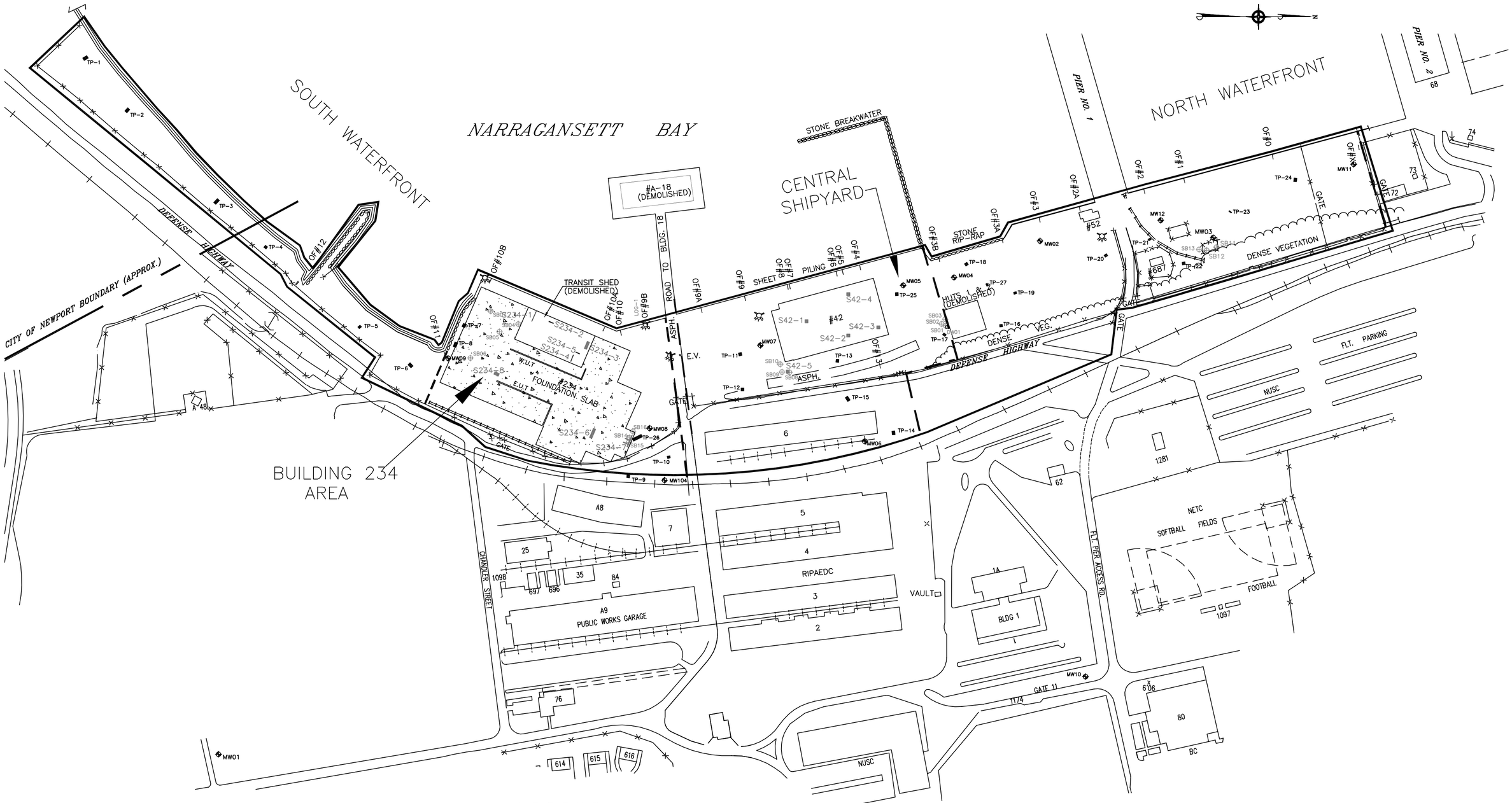
SITE LOCUS	FIGURE 1–1
NAVAL EDUCATION AND TRAINING CENTER	TETRA TECH NUS, INC.
NEWPORT, RHODE ISLAND	

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	A. CHIVERS	DATE:	JANUARY 30, 2007
SCALE:	AS NOTED	ACAD NAME:	5340\1130\FIG_1–1.DWG

55 Jonspin Road Wilmington, MA 01887
(978)658–7899



SITE LOCATION MAP			FIGURE 1–2
DERECKTOR SHIPYARD / CODDINGTON COVE			TETRA TECH NUS, INC.
NEWPORT, RHODE ISLAND			55 Jonspin Road Wilmington, MA 01887 (978)658–7899
DRAWN BY:	D.W. MACDOUGALL	REV.: 0	
CHECKED BY:	A. CHIVERS	DATE: MARCH 13, 2007	
SCALE:	AS NOTED	FILE NO.: 5340\1130\REV1\FIG_1–2.DWG	



LEGEND

	FENCE
S234-7	SUMP WITH IDENTIFIER
OF#10A	OUTFALL LOCATION WITH IDENTIFIER
	HYDRANT LOCATION
#A-18	BUILDING OF INTEREST
2	BUILDING
TP-5	TEST PIT LOCATION
MW11	MONITORING WELL LOCATION
	SITE BOUNDARY

GRAPHIC SCALE

200' 0' 200' 400'

NOTES:

1. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. COMPILED FROM ACTUAL FIELD SURVEY PLAN BY LOUIS FEDERICI & ASSOC., PROVIDENCE, RI AND U.S. NAVY PLANS

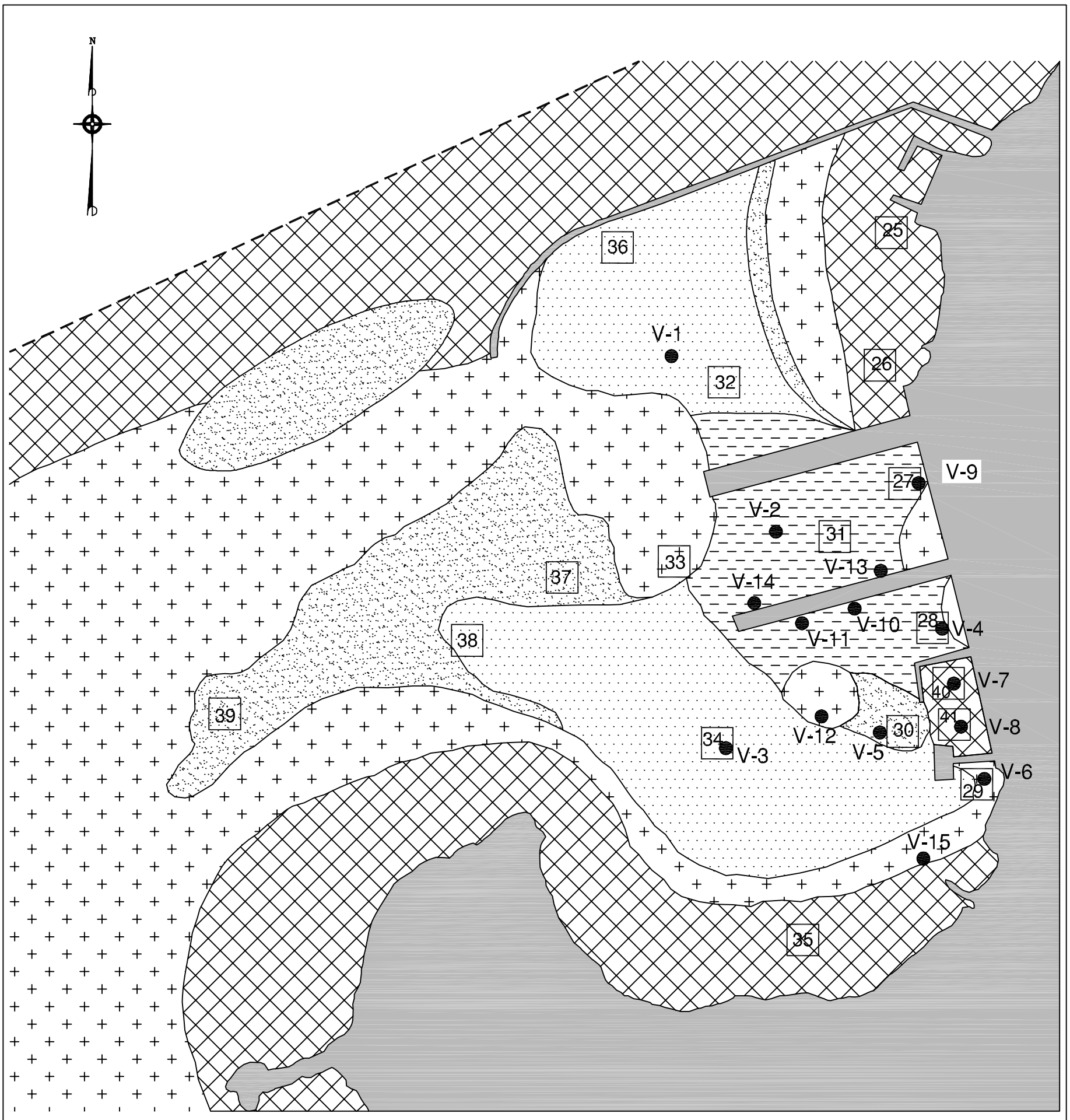
DRAWN BY: D.W. MACDOUGALL	TITLE: ON-SHORE SITE PLAN FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY NSN – NEWPORT, RHODE ISLAND		TETRA TECH NUS, INC.
PREPARED BY: A. CHIVERS			
CHECKED BY: D. BAXTER			
	SOURCE: BASE PLAN BY SEE NOTE 3		55 JONSPIN ROAD WILMINGTON, MASSACHUSETTS 01887 (978)658-7899
	SCALE: AS NOTED / DATE: MARCH 13, 2007 / PROJ. NO: 5340		
PROJECT MANAGER: D. BAXTER	DRAWING NO: 1-3A	ACFILE NAME: 5340\1130\REV1\FIG_1-3A.DWG	REV: 0
PROGRAM MANAGER: J. TREPANOWSKI			

Source:
1997 aerial photograph, Rhode Island Department of Administration, Division of Planning

300 0 300 600 900 1200 Feet

N

OFF-SHORE SITE PLAN		FIGURE 1-3B
MARINE SEDIMENT SAMPLING AND ANALYSIS FORMER ROBERT E. DERECKTOR SHIPYARD		TETRA TECH NUS, INC.
NAVSTA NEWPORT - NEWPORT, RHODE ISLAND		55 JONSPIN ROAD WILMINGTON, MA 01887 (978)658-7899
DRAWN BY: D. MACDOUGALL	DATE: MARCH 5, 2007	
CHECKED BY: A. CHIVERS	FILE: I:\5340\1130\Derecktor.apr	



LEGEND

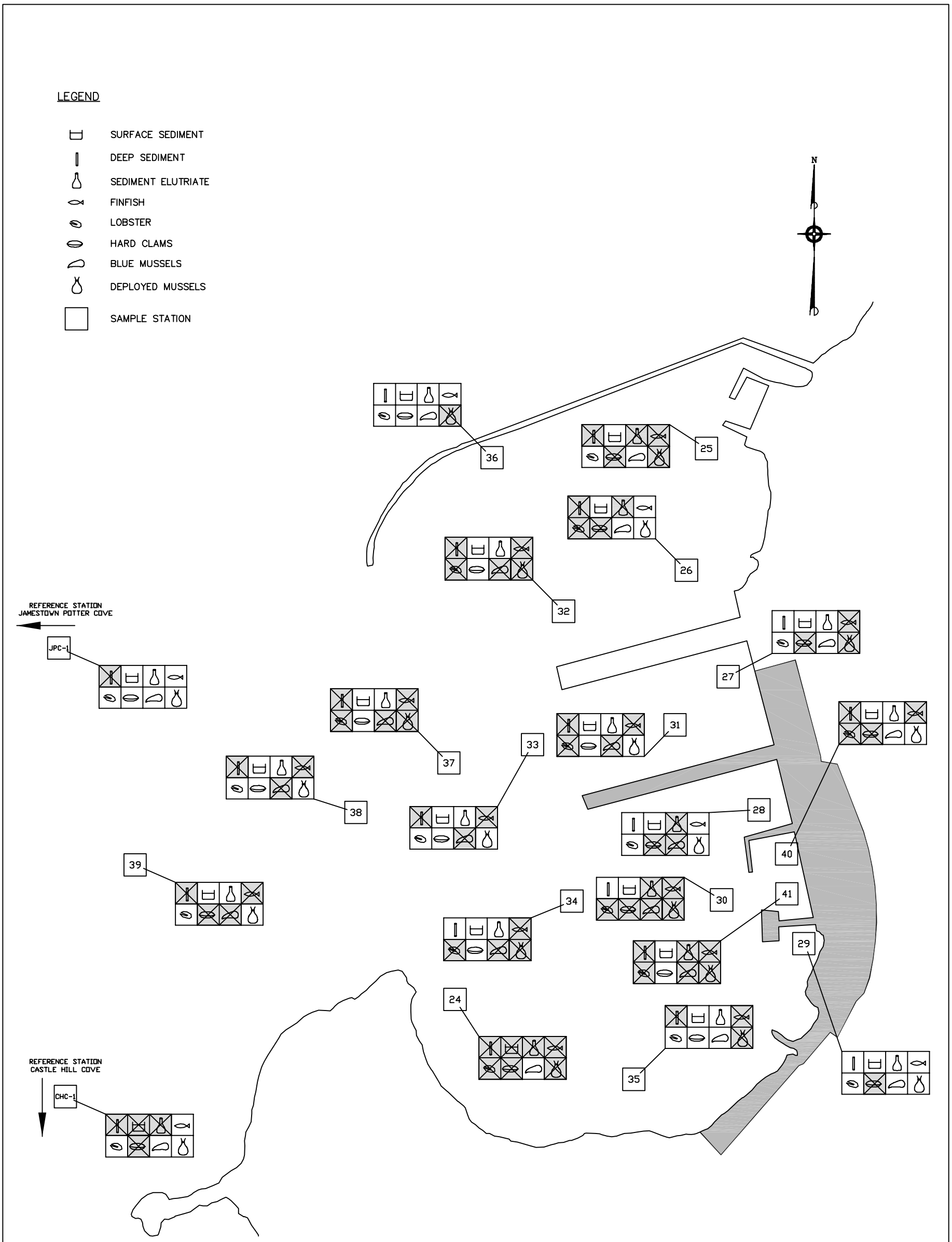
- GREATER THAN 75% SAND OR LARGER
- 50 – 75% SAND OR LARGER
- 20 – 25% SAND OR LARGER
- 10 – 25% SAND OR LARGER
- LESS THAN 10% SAND OR LARGER
- EXTENT OF DATA
- 35 — ERA SAMPLE LOCATION WITH ID #
- V-3 — VIBRACORE STATION WITH ID

NOTES:
1. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. SOURCE: DATA GATHERED BY UNIVERSITY OF RHODE ISLAND, 1995 (SAIC AND URI, MAY 1997).

GRAPHIC SCALE
0′ 800′ 1600′

GRAIN SIZE CHARACTERISTICS OF SURFACE SEDIMENTS	FIGURE 1–4
DERECKTOR SHIPYARD / CODDINGTON COVE	TETRA TECH NUS, INC.
NETC – NEWPORT, RHODE ISLAND	55 Jonspin Road Wilmington, MA 01887 (978)658–7899

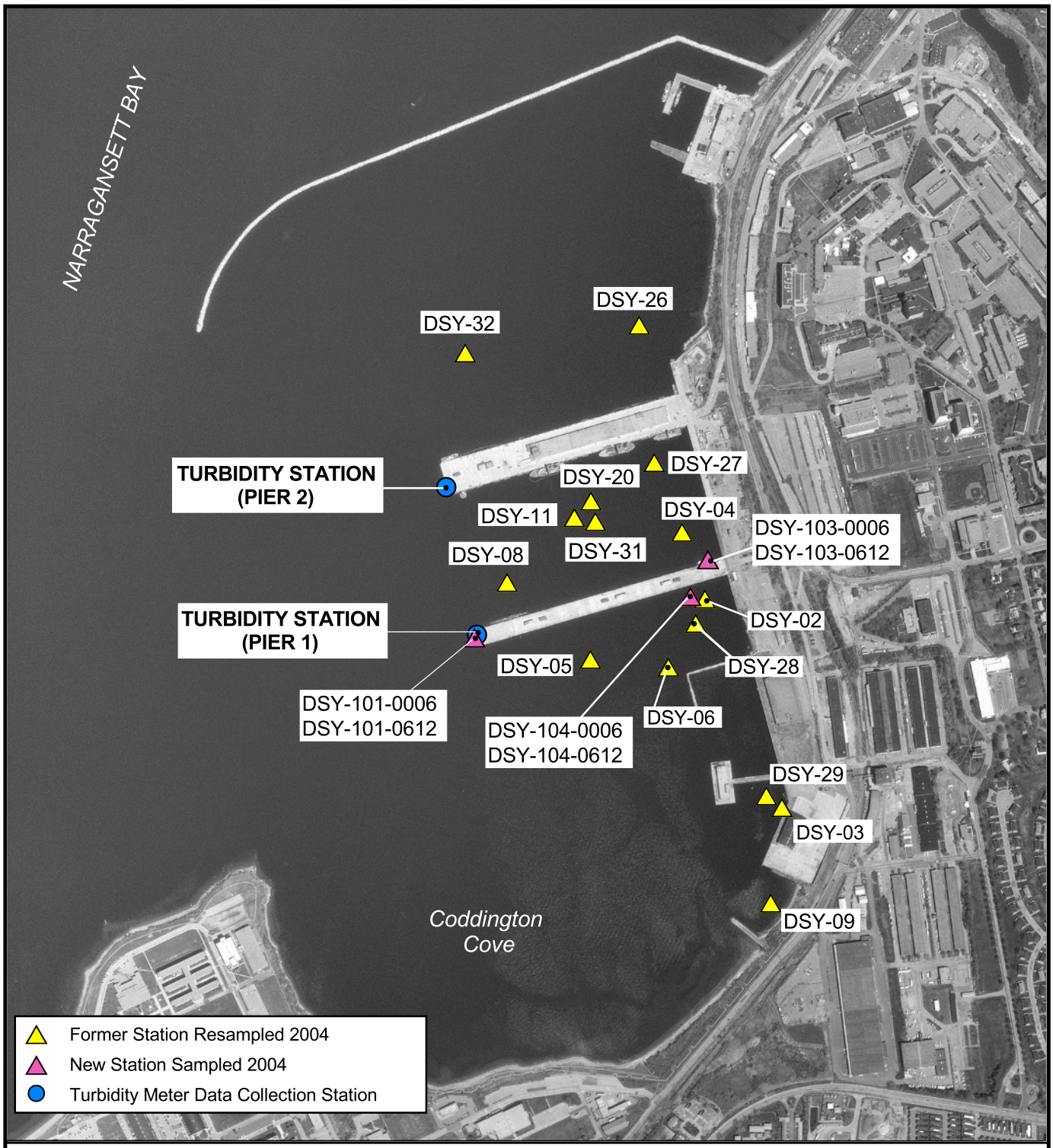
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	A. CHIVERS	DATE:	JANUARY 30, 2007
SCALE:	AS NOTED	FILE NO.:	5340\1130\FIG_1–4.DWG



NOTES:
1. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE
0′ 800′ 1600′

MARINE ECOLOGICAL RISK ASSESSMENT SAMPLE STATIONS AND MEDIA SAMPLED	FIGURE 1–5
FORMER DERECKTOR SHIPYARD FEASABILITY STUDY	TETRA TECH NUS, INC.
NETC – NEWPORT, RHODE ISLAND	55 Jonspin Road Wilmington, MA 01887 (978)658–7899
DRAWN BY: D.W. MACDOUGALL / REV.: 0	
CHECKED BY: A. CHIVERS / DATE: JANUARY 30, 2007	
SCALE: AS NOTED / FILE NO.: 5340\1130\FIG_1–5.DWG	

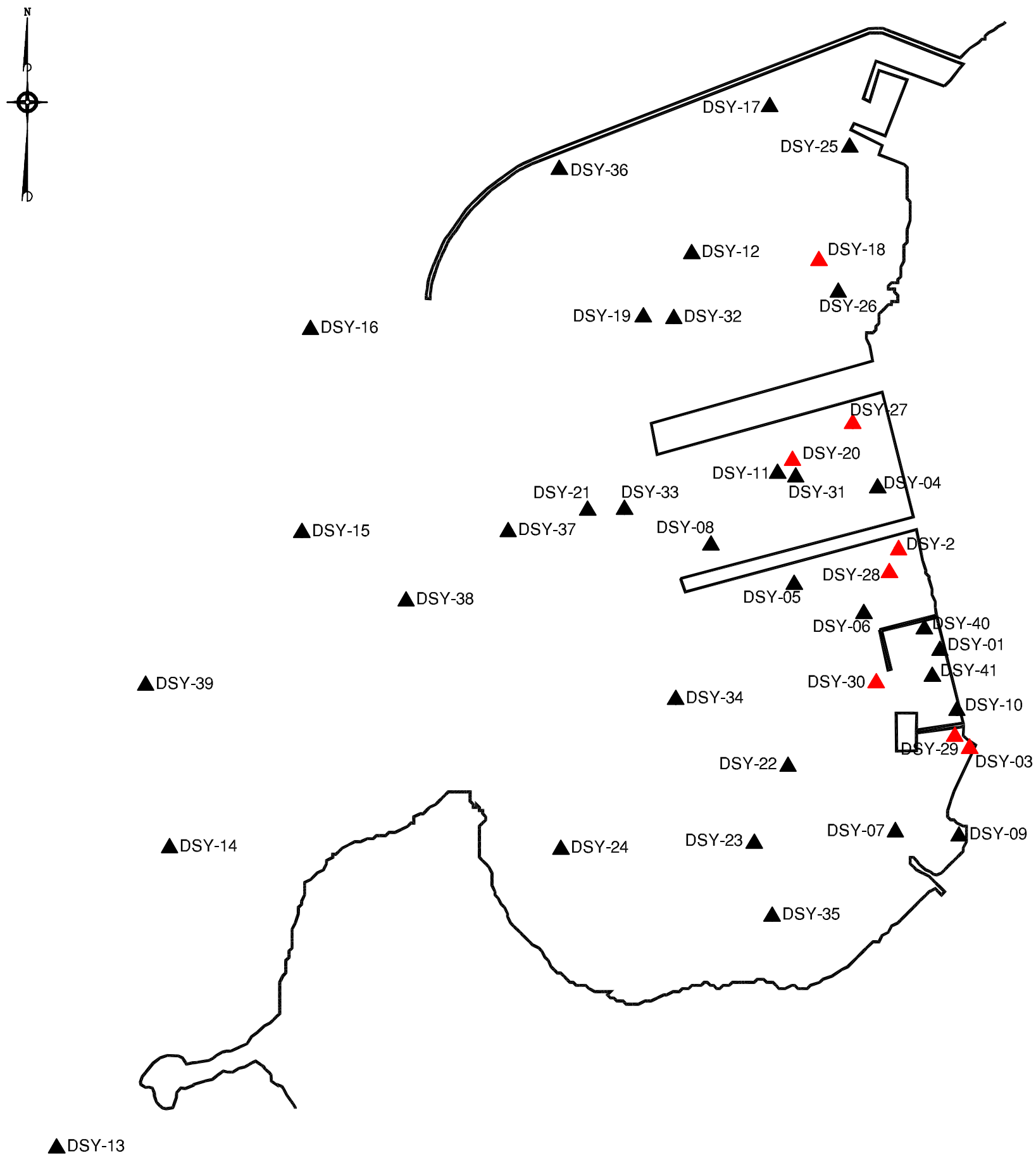


SOURCE: 1997 AERIAL PHOTOGRAPH, RHODE ISLAND DEPARTMENT OF ADMINISTRATION, DIVISION OF PLANNING
NOTE: FIGURE 3-2 OF THE 2005 MARINE SEDIMENT REPORT DEPICTS THE REFERENCE SAMPLE STATIONS.

300 0 300 600 900 1200 Feet

N

2004 SEDIMENT SAMPLE STATIONS	FIGURE 1-6
MARINE SEDIMENT SAMPLING AND ANALYSIS FORMER ROBERT E. DERECKTOR SHIPYARD	TETRA TECH NUS, INC.
NAVSTA NEWPORT - NEWPORT, RHODE ISLAND	55 JONSPIN ROAD WILMINGTON, MA 01887 (978)658-7899
DRAWN BY: D. MACDOUGALL — DATE: MARCH 8, 2007	
CHECKED BY: A. CHIVERS — FILE: I:\5340\1130\Derecktor.apr	



LEGEND

DSY-26 SEDIMENT SAMPLE

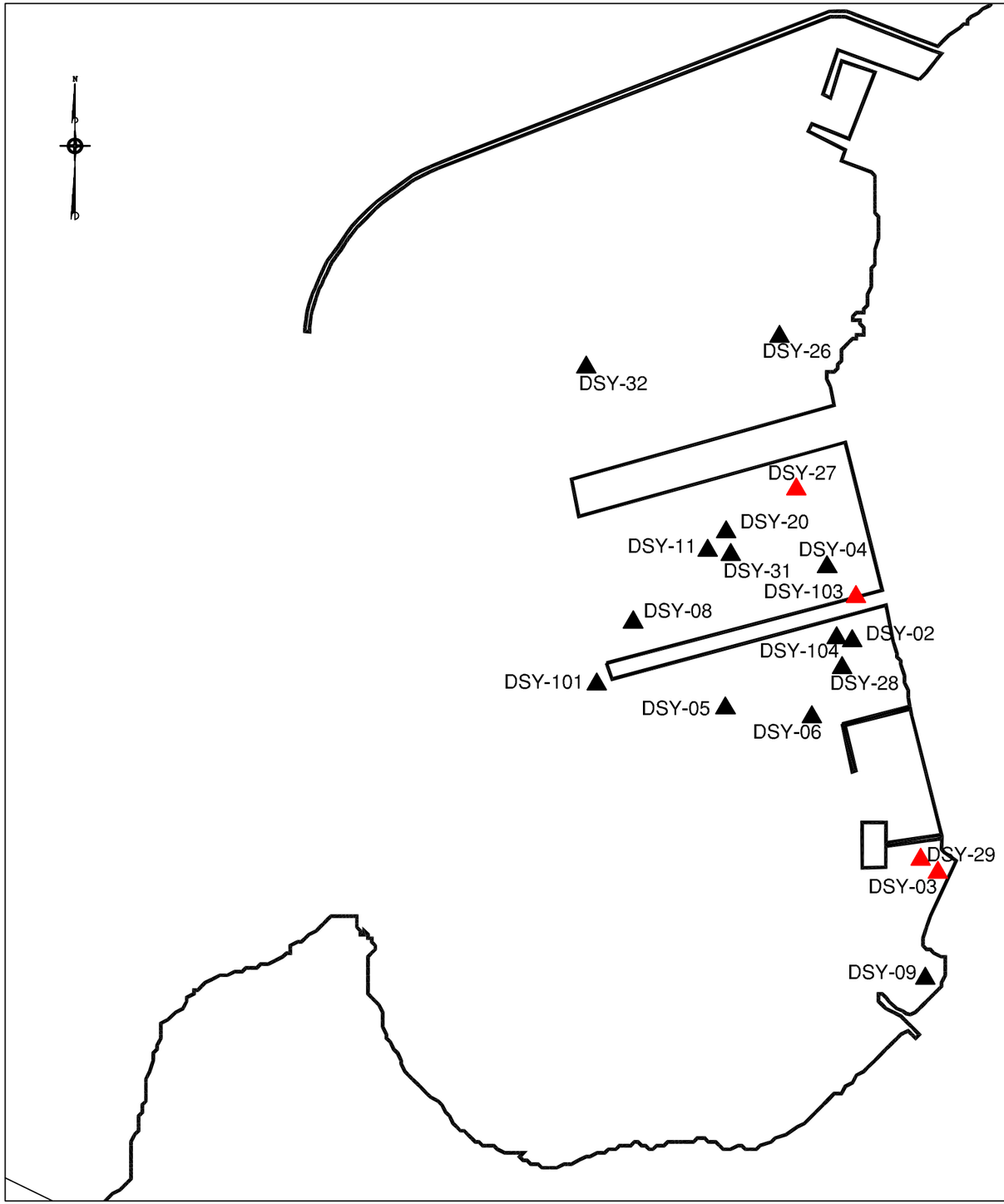
DSY-18 SEDIMENT SAMPLE WITH ONE OR MORE COC EXCEEDING RECOMMENDED PRGS

NOTES:
1. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE
0′ 800′ 1600′

SEDIMENTS EXCEEDING PRGs – PRE–1999	FIGURE 2–1
FORMER DERECKTOR SHIPYARD FEASABILITY STUDY	TETRA TECH NUS, INC.
NETC – NEWPORT, RHODE ISLAND	
DRAWN BY: D.W. MACDOUGALL / REV.: 0	
CHECKED BY: A. CHIVERS / DATE: MARCH 8, 2007	
SCALE: AS NOTED / FILE NO.: 5340\1130\REV1\FIG_2–1.DWG	

55 Jonspin Road Wilmington, MA 01887
(978)658–7899



LEGEND

DSY-02 SEDIMENT SAMPLE

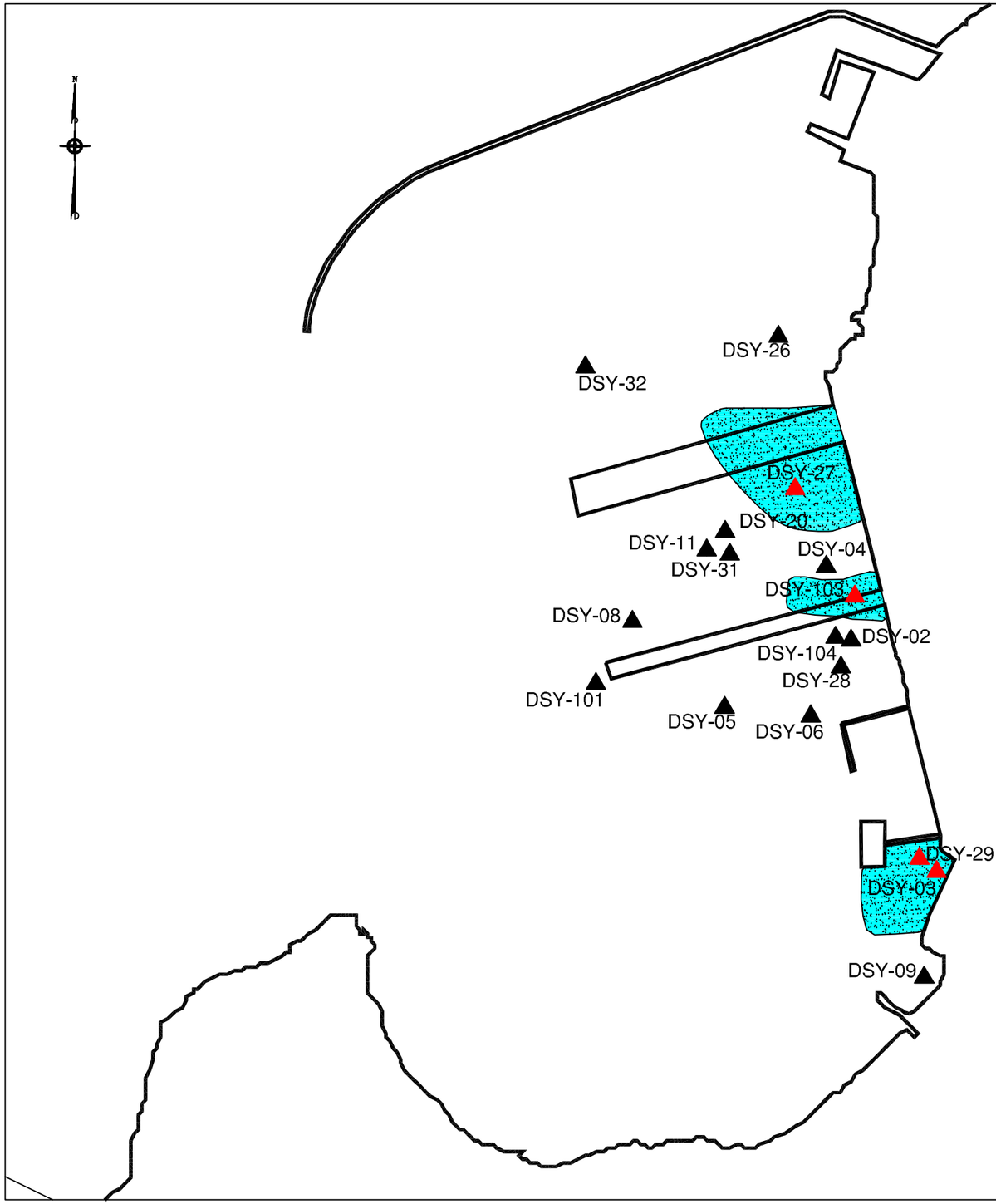
DSY-03 SEDIMENT SAMPLE WITH ONE OR MORE COC EXCEEDING RECOMMENDED PRGS

NOTES:
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0′ 700′ 1400′

SEDIMENTS EXCEEDING PRGs – 2004 DATA			FIGURE 2–2
FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY			TETRA TECH NUS, INC.
NSN – NEWPORT, RHODE ISLAND			55 Jonspin Road Wilmington, MA 01887 (978)658–7899
DRAWN BY: D.W. MACDOUGALL		REV.: 0	
CHECKED BY: A. CHIVERS		DATE: MARCH 8, 2007	
SCALE: AS NOTED		FILE NO.: 5340\1130\REV1\FIG_2–2.DWG	



LEGEND

PROPOSED REMEDIATION AREA (EXCEEDS RECOMMENDED PRG FOR COMBINED EXPOSURE PATHWAY)

DSY-02 SEDIMENT SAMPLE

DSY-03 SEDIMENT SAMPLE WITH ONE OR MORE COC EXCEEDING RECOMMENDED PRGS

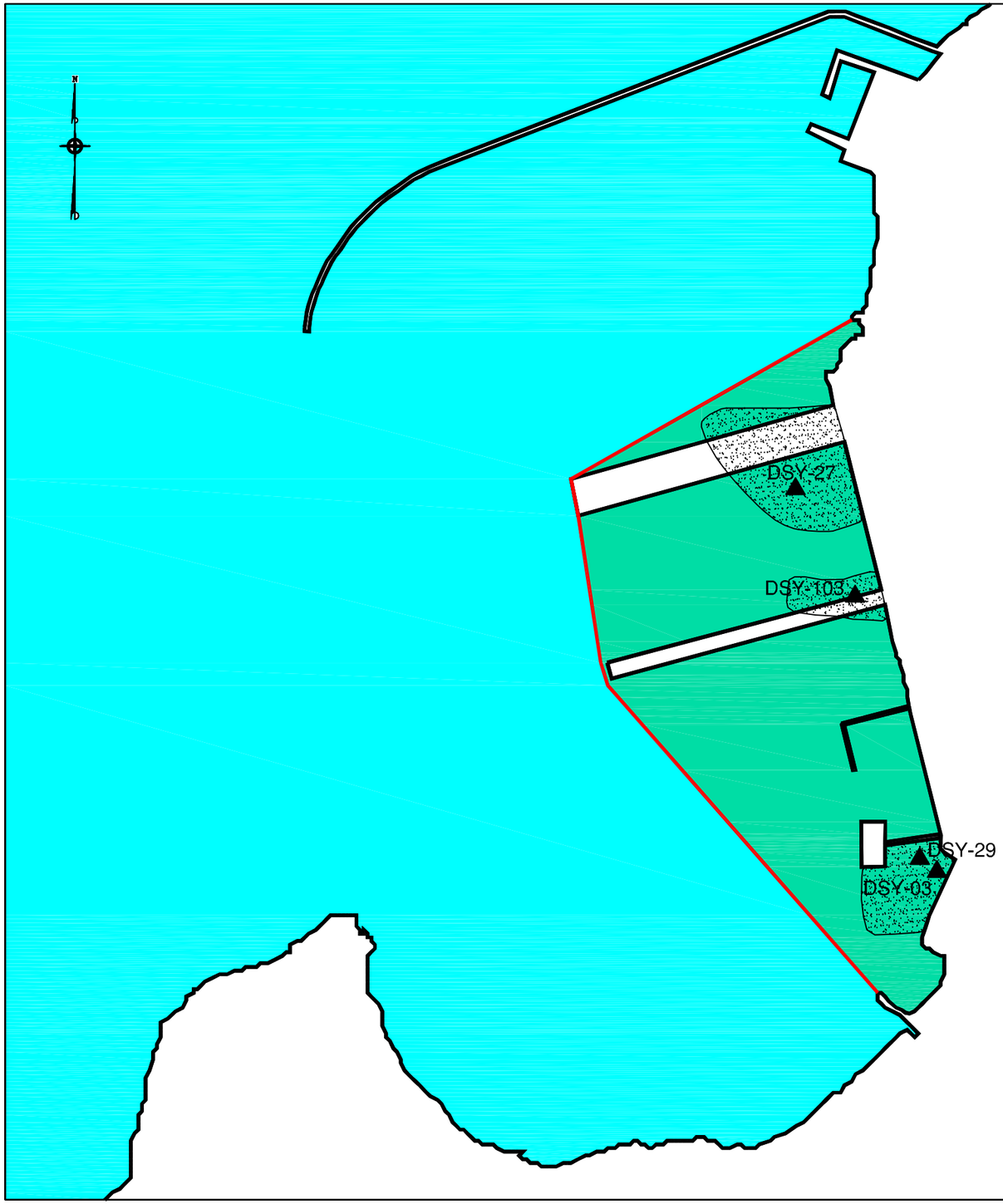
NOTES:
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0′ 700′ 1400′

1 INCH = 700 FEET

PROPOSED REMEDIATION AREAS		FIGURE 2–3
FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY		TETRA TECH NUS, INC.
NSN – NEWPORT, RHODE ISLAND		
DRAWN BY: D.W. MACDOUGALL	REV.: 0	
CHECKED BY: A. CHIVERS	DATE: MARCH 12, 2007	55 Jonspin Road Wilmington, MA 01887 (978)658–7899
SCALE: AS NOTED	FILE NO.: 5340\1130\REV1\FIG_2–3.DWG	



LEGEND

AREA UNAFFECTED BY ALTERNATIVE

RESTRICTED ACCESS AND SHELLFISH/LOBSTER COLLECTION BAN AREA

LONG-TERM MONITORING SAMPLE COLLECTION AREAS

DSY-02 SEDIMENT SAMPLE

BUOY LINE

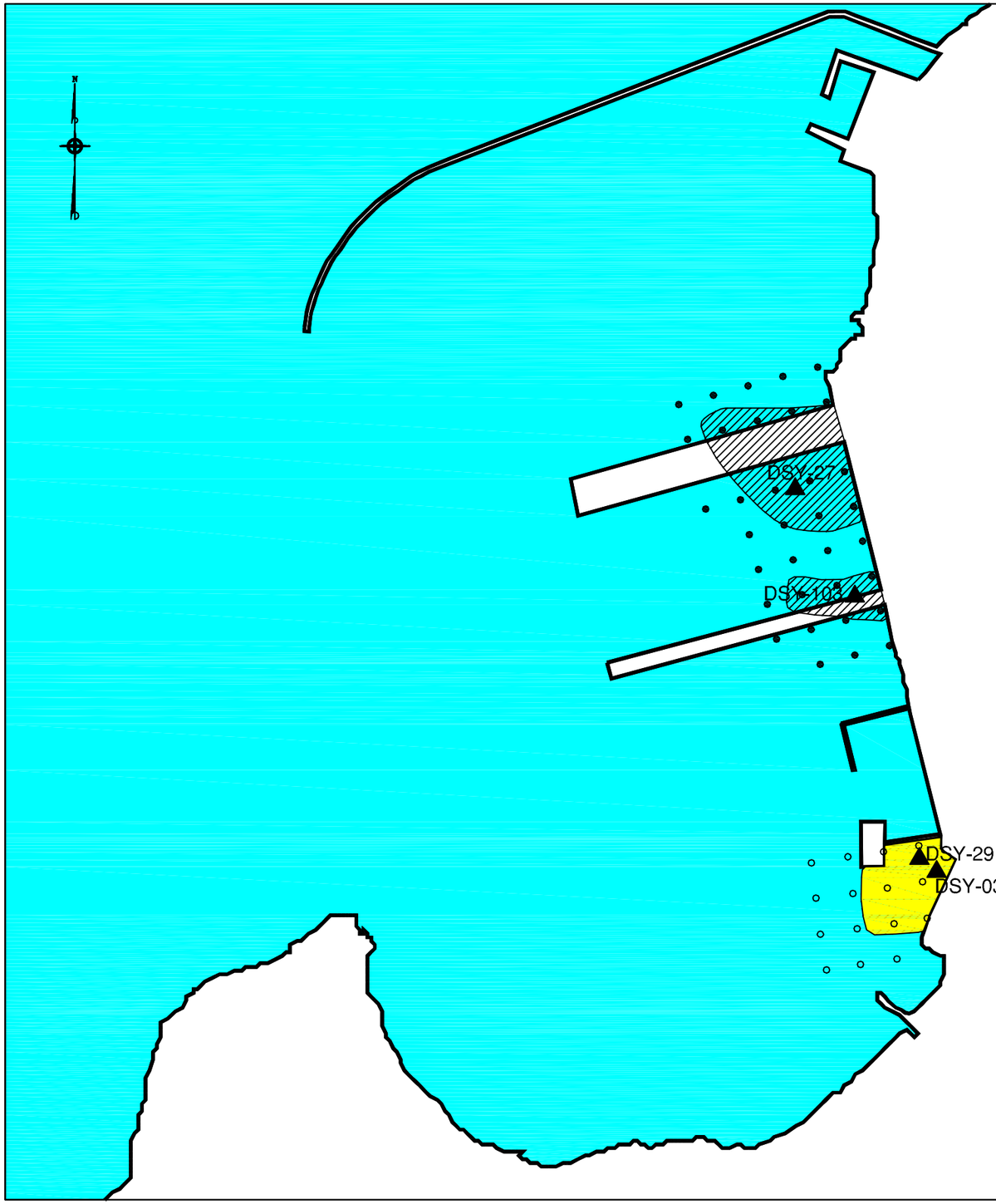
NOTES:
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0′ 700′ 1400′

ALTERNATIVE 2 – INSTITUTIONAL CONTROLS, ACCESS RESTRICTIONS			FIGURE 4–1
FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY			TETRA TECH NUS, INC.
NSN – NEWPORT, RHODE ISLAND			
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	A. CHIVERS	DATE:	MARCH 8, 2007
SCALE:	AS NOTED	FILE NO.:	5340\1130\REV1\FIG_4–1.DWG

55 Jonspin Road Wilmington, MA 01887
(978)658–7899



LEGEND

AREA UNAFFECTED BY ALTERNATIVE

PROPOSED DREDGING AREA

PROPOSED CAPPING AREA

PREDESIGN INVESTIGATION SAMPLE STATION (SURFACE SEDIMENT)

PREDESIGN INVESTIGATION SAMPLE STATION (BORING)

DSY-02 SEDIMENT SAMPLE

ESTIMATED VOLUME OF DREDGED SEDIMENTS

STATION	AREA (SF)	VOLUME (CY)
27	505,300	18,715
103	137,800	5,104
TOTAL:	643,100	23,819

ESTIMATED AREA FOR CAP (STATIONS 3 AND 29) = 245,000 SF

NOTES:
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE
0' 700' 1400'

ALTERNATIVE 3 – CAPPING AND DREDGING

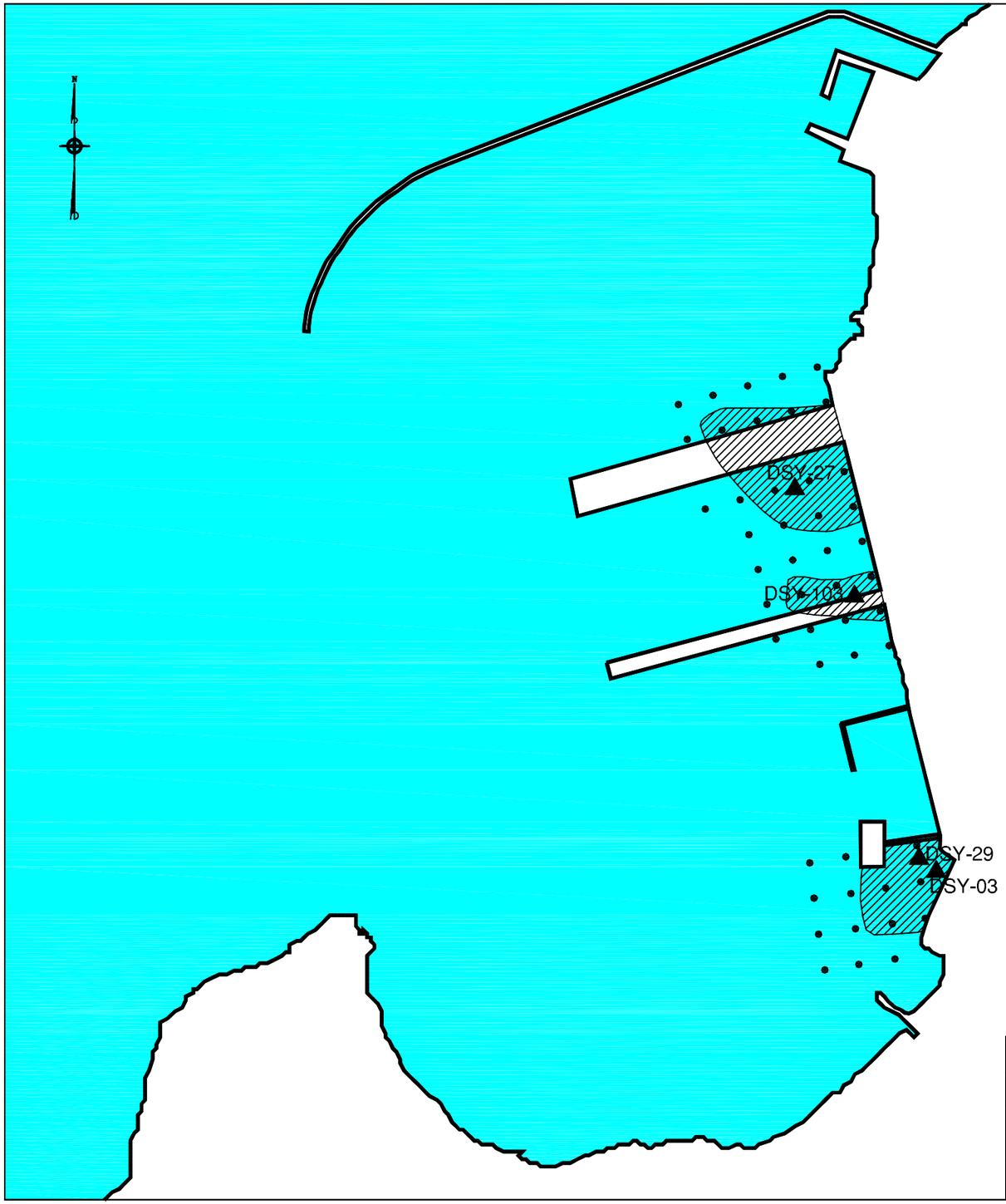
FIGURE 4–2

FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY

NSN – NEWPORT, RHODE ISLAND

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	A. CHIVERS	DATE:	MARCH 6, 2007
SCALE:	AS NOTED	FILE NO.:	5340\1130\REV1\FIG_4–2.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658–7899



LEGEND

AREA UNAFFECTED BY ALTERNATIVE

PROPOSED DREDGING AREA

PREDESIGN INVESTIGATION SAMPLE STATION (BORING)

DSY-02 SEDIMENT SAMPLE

ESTIMATED VOLUME OF DREDGED SEDIMENTS

STATION	AREA (SF)	VOLUME (CY)
3 & 29	245,000	9,074
27	505,300	18,715
103	137,800	5,104
TOTAL:	888,100	32,893

NOTES:
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0′ 700′ 1400′

ALTERNATIVE 4 – COMPLETE DREDGING

FIGURE 4–3

FORMER DERECKTOR SHIPYARD REVISED FEASIBILITY STUDY

NSN – NEWPORT, RHODE ISLAND

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	A. CHIVERS	DATE:	MARCH 8, 2007
SCALE:	AS NOTED	FILE NO.:	5340\1130\REV1\FIG_4–3.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658–7899

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APPENDIX A

CHEMICAL DATA FOR SAMPLES COLLECTED

APPENDIX A

SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location	DSY-JPC-01					DSY-JPC-02				DSY-JPC-03	
Sample Number	JPC-1-SUR	JPC-1-SURa	JPC-1-SURb	JPC-1-SUR-D	DSY-SD-JPC01-082604	JPC-2-SUR	JPC-2-SURa	JPC-2-SURb	JPC-2-SUR-D	DSY-SD-JPC03-082604	DSY-SD-DUP03-082604
Date Sampled	10/19/1995	10/19/1995	10/19/1995	10/19/1995	8/26/2004	10/27/1995	10/27/1995	10/27/1995	10/27/1995	8/26/2004	8/26/2004
QC Identifier										FIELD DUP	FIELD DUP
LEAD	29.7	NA	NA	28.3	11.3 J	53.2	NA	NA	46.0	4.4 J	4.3 J
MAGNESIUM	NA	NA	NA	NA	2460	NA	NA	NA	NA	1940	1940
MANGANESE	293.5	NA	NA	253.5	98.6	284.25	NA	NA	256	68.0	65.9
MERCURY	0.2445	NA	NA	0.13	0.014 J	0.106	NA	NA	0.13	0.022	0.0089 J
NICKEL	14.25	NA	NA	11.25	6.2 J	14.0	NA	NA	14.75	4.7 J	4.8 J
POTASSIUM	NA	NA	NA	NA	859	NA	NA	NA	NA	480	495
SELENIUM	NA	NA	NA	NA	0.22 U	NA	NA	NA	NA	0.25 U	0.24 U
SILVER	0.1375	NA	NA	0.0625 J	0.11 U	0.2625	NA	NA	0.1625	0.12 U	0.12 U
SODIUM	NA	NA	NA	NA	3590	NA	NA	NA	NA	2870	3150
THALLIUM	NA	NA	NA	NA	0.57 J	NA	NA	NA	NA	0.43 J	0.35 J
VANADIUM	NA	NA	NA	NA	10.2	NA	NA	NA	NA	6.3	6.3
ZINC	58.0	NA	NA	36.25	33.0 J	79.25	NA	NA	63.75	18.8	18.5 J
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)											
CADMIUM	NA	NA	NA	NA	0.1300 B	NA	NA	NA	NA	0.08500 B	0.07100 B
CHROMIUM	NA	NA	NA	NA	2.600	NA	NA	NA	NA	1.200	1.100
COPPER	NA	NA	NA	NA	3.400 *	NA	NA	NA	NA	1.200 *	1.100 *
LEAD	NA	NA	NA	NA	8.000	NA	NA	NA	NA	2.900	2.700
MERCURY	NA	NA	NA	NA	0.002300 B	NA	NA	NA	NA	0.001500 U	0.001600 U
NICKEL	NA	NA	NA	NA	1.100 BE	NA	NA	NA	NA	0.8000 BE	0.5500 BE
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	18.40	NA	NA	NA	NA	7.400	6.800
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)											
CADMIUM	NA	NA	NA	NA	0.001460 U	NA	NA	NA	NA	0.001410 U	0.001460 U
CHROMIUM	NA	NA	NA	NA	0.05090	NA	NA	NA	NA	0.02280	0.02180
COPPER	NA	NA	NA	NA	0.05360 UJ	NA	NA	NA	NA	0.01870 UJ	0.01730 UJ
LEAD	NA	NA	NA	NA	0.03880	NA	NA	NA	NA	0.01400	0.01300
MERCURY	NA	NA	NA	NA	0.00003300 U	NA	NA	NA	NA	0.00003200 U	0.00003300 U
NICKEL	NA	NA	NA	NA	0.02789 UJ	NA	NA	NA	NA	0.02702 UJ	0.02795 UJ
SEM/AVS RATIO	-1.1934	0.3785	0.7266	NA	1.8959	0.1444	1.1926	0.8944	NA	0.2000	2.5401
SULFIDE	NA	NA	NA	NA	0.1959 J	NA	NA	NA	NA	0.7471 J	0.05480 J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	NA	NA	0.3714	NA	NA	NA	NA	0.1494	0.1392
ZINC	NA	NA	NA	NA	0.2817 J	NA	NA	NA	NA	0.1126 J	0.1044 J
Miscellaneous Analysis (UG/KG)											
DIBUTYLTIN	0.50	NA	NA	NA	NA	0.50	NA	NA	NA	NA	NA
MONOBUTYLTIN	0.50	NA	NA	NA	NA	0.50	NA	NA	NA	NA	NA
TETRABUTYLTIN	0.50	NA	NA	NA	NA	0.37 J	NA	NA	NA	NA	NA
TRIBUTYLTIN	0.28 J	NA	NA	NA	NA	0.41 J	NA	NA	NA	NA	NA
Total Organic Carbon Analysis (MG/KG)											
CARBON	NA	NA	NA	NA	5400	NA	NA	NA	NA	3100	4800

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

APPENDIX A

SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
PAGE 2 OF 10

Sample Location	MCA-JCC-S-01		MCA-JCC-MD-01						MCA-JCC-MD-01 cont.			DSY-JCC-02
Sample Number	JCC-S1	JCC-S1d	JCC-D1-SUR	JCC-D1-SURd	JCC-M1	JCC-M1d	JCC-D1-BOT	JCC-D1-BOTd	JCC-D1-MID	JCC-D1-MIDd	DSY-SD-CC01-082604	DSY-SD-CC02-082604
Date Sampled	8/29/1994	8/29/1994	8/29/1994	8/29/1994	8/29/1994	8/29/1994	6/1/1995	6/1/1995	6/1/1995	6/1/1995	8/26/2004	8/26/2004
QC Identifier												
LEAD	28.4024	NA	23.1756	NA	23.1756	NA	16.6	NA	25.3	NA	9.6 J	8.4 J
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2700	2400
MANGANESE	861.86	NA	625.07	NA	1018.4	NA	372.5	NA	314	NA	89.9	88.1
MERCURY	0.10 J	NA	0.10 J	NA	0.10 J	NA	0.015 J	NA	0.10 J	NA	0.036	0.031
NICKEL	16.6548	NA	10.5675	NA	14.0248	NA	12.75	NA	34.5	NA	7.2 J	6.2 J
POTASSIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	888	777
SELENIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.21 U	0.21 U
SILVER	0.065 J	NA	0.15	NA	0.3314	NA	0.065 J	NA	0.065 J	NA	0.10 U	0.10 U
SODIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3000	2960
THALLIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.66 J	0.59 J
VANADIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12.1	10.4
ZINC	62.467	NA	45.721	NA	45.721	NA	42.0	NA	56.0	NA	40.3 J	28.9 J
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)												
CADMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.06200 B	0.06900 B
CHROMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.200	2.100
COPPER	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.300 *	2.600 *
LEAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.100	7.100
MERCURY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001500 U	0.003800 B
NICKEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.9600 BE	1.100 BE
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.80	16.10
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)												
CADMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001420 U	0.001420 U
CHROMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.04320	0.04130
COPPER	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.05180 UJ	0.04170 UJ
LEAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.03410	0.03420
MERCURY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00003200 U	0.00003200 U
NICKEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.02727 UJ	0.02717 UJ
SEM/AVS RATIO	-5.5925	3.0425	1.8905	2.1505	1.289	1.849	0.3618	0.4118	0.4059	0.5359	13.0171	3.6029
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.03510 J	0.08940 J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4569	0.3221
ZINC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.3796 J	0.2466 J
Miscellaneous Analysis (UG/KG)												
DIBUTYLTIN	2.3	NA	0.50 U	NA	0.50 U	NA	NA	NA	0.45	NA	NA	NA
MONOBUTYLTIN	0.50 U	NA	0.50 U	NA	0.16	NA	NA	NA	0.42	NA	NA	NA
TETRABUTYLTIN	0.50 U	NA	0.50 U	NA	0.50 U	NA	NA	NA	0.020	NA	NA	NA
TRIBUTYLTIN	4.8	NA	0.50 U	NA	0.50 U	NA	NA	NA	6.82	NA	NA	NA
Total Organic Carbon Analysis (MG/KG)												
CARBON	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5500	4600

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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Sample Location	DSY-CHC-01	DSY-CHC-02	DSY-01	DSY-02			DSY-03		DSY-04	
Sample Number	DSY-SD-CH01-082604	DSY-SD-CH02-082604	DSY-1	DSY-2	DSY-SD-02-082504	DSY-SD-DUP01-082504	DSY-3	DSY-SD-03-082604	DSY-4	DSY-SD-04-082604
Date Sampled	8/26/2004	8/26/2004	11/3/1993	11/3/1993	8/25/2004	8/25/2004	11/3/1993	8/26/2004	11/3/1993	8/26/2004
QC Identifier					FIELD DUP	FIELD DUP				
LEAD	65.7 J	21.3 J	35.393	180.764	48.2 J	50.8 J	201.061	114 J	51.348	50.4 J
MAGNESIUM	6620	4450	NA	NA	11000	10700	NA	7120	NA	8440
MANGANESE	191	125	NA	NA	271	268	NA	250	NA	251
MERCURY	0.26	0.13	NA	NA	0.21	0.38	NA	0.27	NA	0.25
NICKEL	16.4 J	10.7 J	38.595	85.275	19.2 J	20.3 J	128.18	38.5 J	37.406	18.5 J
POTASSIUM	2780	1010	NA	NA	4240	4360	NA	3340 J	NA	3890 J
SELENIUM	0.43 U	0.27 U	NA	NA	0.62 U	0.67 U	NA	R	NA	0.54 U
SILVER	0.22 U	0.13 U	0.5987	0.823	0.31 UJ	0.34 UJ	1.2668	0.26 UJ	13.776	0.27 UJ
SODIUM	14700	4450	NA	NA	25200	26700	NA	17100 J	NA	20500
THALLIUM	1.6 J	0.95 J	NA	NA	1.7 UJ	1.8 UJ	NA	2.4 UJ	NA	1.9 UJ
VANADIUM	33.2	17.1	NA	NA	47.3	47.0	NA	53.6	NA	41.7
ZINC	168	52.6 J	149.431	593.456	141 J	158 J	1231.421	377	189.526	171 J
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)										
CADMIUM	0.5900	0.1600 B	NA	NA	0.2700 B	0.3000 B	NA	0.8100	NA	0.4400
CHROMIUM	4.600	2.100	NA	NA	9.700	9.800	NA	10.70	NA	24.70
COPPER	20.50 *	13.60 *	NA	NA	28.50 N*	31.20 N*	NA	36.80 N*	NA	30.40 N*
LEAD	51.00	17.20	NA	NA	38.90	44.20	NA	73.40	NA	49.90
MERCURY	0.002900 U	0.001700 B	NA	NA	0.001600 UN	0.001800 UN	NA	0.001300 UN	NA	0.001300 UN
NICKEL	3.100 BE	20.20 E	NA	NA	4.800 N*	4.800 N*	NA	75.50 N*	NA	24.00 N*
SULFIDE	NA	NA	NA	NA	6.100	400.0	NA	2400	NA	370.0
ZINC	106.0	24.80	NA	NA	78.80	88.90	NA	233.0	NA	163.0
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)										
CADMIUM	0.005200	0.001520 U	NA	NA	0.003630 U	0.003940 U	NA	0.007100	NA	0.003900
CHROMIUM	0.08760	0.04050	NA	NA	0.1865	0.1882	NA	0.2052 U	NA	0.4753 U
COPPER	0.3235 J	0.2145 J	NA	NA	0.4488 J	0.4918 J	NA	0.5791 J	NA	0.4783 UJ
LEAD	0.2463	0.08320	NA	NA	0.1878	0.2134	NA	0.3544	NA	0.2409
MERCURY	0.00006000 U	0.00003400 U	NA	NA	0.00008100 UJ	0.00008800 UJ	NA	0.00006600 UJ	NA	0.00006700 UJ
NICKEL	0.05260 J	0.3448 J	NA	NA	0.08110 UJ	0.08190 UJ	NA	1.286 UJ	NA	0.4091 UJ
SEM/AVS RATIO	0.2858	0.6606	NA	NA	10.7172	0.1814	NA	0.05990	NA	0.2391
SULFIDE	8.1566 J	1.6083 J	NA	NA	0.1892 J	12.4186 J	NA	75.2023 J	NA	11.4438 J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	2.331	1.0624	NA	NA	2.0277	2.2532	NA	4.5028	NA	2.7358
ZINC	1.6158 J	0.3794 J	NA	NA	1.2046 J	1.3598 J	NA	3.5622 J	NA	2.491 J
Miscellaneous Analysis (UG/KG)										
DIBUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MONOBUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TETRABUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TRIBUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon Analysis (MG/KG)										
CARBON	35000	7600	2.06	1.3	31000	26000	2.63	25000	3.17	26000

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SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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Sample Location	DSY-05			DSY-06		DSY-07	DSY-08		DSY-09		DSY-10
Sample Number	DSY-5	DSY-SD-05-082604	DSY-SD-DUP02-082604	DSY-6	DSY-SD-06-082504	DSY-7	DSY-8	DSY-SD-08-082604	DSY-9	DSY-SD-09-082604	DSY-10
Date Sampled	11/3/1993	8/26/2004	8/26/2004	11/3/1993	8/25/2004	11/3/1993	11/3/1993	8/26/2004	11/3/1993	8/26/2004	11/3/1993
QC Identifier		FIELD DUP	FIELD DUP								
LEAD	43.296	46.5 J	46.2 J	48.579	49.9 J	31.699	50.604	46.5 J	14.856	29.1 J	22.132
MAGNESIUM	NA	7630	7230	NA	6630	NA	NA	7730	NA	2810	NA
MANGANESE	NA	262	236	NA	228	NA	NA	256	NA	102	NA
MERCURY	NA	0.27	0.21	NA	0.33	NA	NA	0.37	NA	0.026 J	NA
NICKEL	38.347	17.0 J	16.2 J	40.837	17.1 J	37.406	40.238	17.9 J	33.898	12.6 J	31.421
POTASSIUM	NA	3690	3520	NA	3050 J	NA	NA	3830	NA	493 J	NA
SELENIUM	NA	0.47 U	0.44 U	NA	R	NA	NA	0.50 U	NA	R	NA
SILVER	2.3207	0.23 UJ	0.22 UJ	1.5936	0.20 UJ	5.4065	1.7387	0.25 UJ	0.7328	0.12 UJ	0.5636
SODIUM	NA	17500	16700	NA	14700	NA	NA	16400	NA	3850	NA
THALLIUM	NA	1.8 UJ	1.5 UJ	NA	1.4 UJ	NA	NA	1.8 UJ	NA	R	NA
VANADIUM	NA	39.9	37.0	NA	36.1	NA	NA	40.7	NA	14.3	NA
ZINC	173.311	125 J	117 J	175.299	148 J	118.703	184.302	129 J	58.824	67.9 J	63.84
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)											
CADMIUM	NA	0.2300 B	0.2000 B	NA	0.5900	NA	NA	0.2000 B	NA	0.05900 B	NA
CHROMIUM	NA	13.80	8.800	NA	9.500	NA	NA	9.300	NA	2.800	NA
COPPER	NA	34.30 N*	33.50 N*	NA	47.70 N*	NA	NA	26.00 N*	NA	23.10 N*	NA
LEAD	NA	44.30	38.60	NA	55.50	NA	NA	40.70	NA	26.10	NA
MERCURY	NA	0.002600 BN	0.005100 BN	NA	0.003300 BN	NA	NA	0.001800 BN	NA	0.0006700 UN	NA
NICKEL	NA	4.600 N*	39.70 N*	NA	19.80 N*	NA	NA	24.50 N*	NA	70.20 N*	NA
SULFIDE	NA	2600	1100	NA	210.0	NA	NA	510.0	NA	39.00	NA
ZINC	NA	84.20	68.30	NA	146.0	NA	NA	94.60	NA	37.70	NA
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)											
CADMIUM	NA	0.002770 U	0.002660 U	NA	0.005200	NA	NA	0.002760 U	NA	0.001500 U	NA
CHROMIUM	NA	0.2660 U	0.1690 U	NA	0.1820	NA	NA	0.1797 U	NA	0.05340 U	NA
COPPER	NA	0.5401 J	0.5274 J	NA	0.7510 J	NA	NA	0.4101 UJ	NA	0.3631 J	NA
LEAD	NA	0.2140	0.1863	NA	0.2680	NA	NA	0.1965	NA	0.1259	NA
MERCURY	NA	0.00006200 UJ	0.00006000 UJ	NA	0.00005800 UJ	NA	NA	0.00006200 UJ	NA	0.00003400 UJ	NA
NICKEL	NA	0.07800 UJ	0.6757 UJ	NA	0.3381 J	NA	NA	0.4177 UJ	NA	1.1955 J	NA
SEM/AVS RATIO	NA	0.02540	0.05170	NA	0.5787	NA	NA	0.1034	NA	1.8791	NA
SULFIDE	NA	80.3209 J	33.9942 J	NA	6.5229 J	NA	NA	15.8906 J	NA	1.2031 J	NA
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	2.0418	1.7573	NA	3.7747	NA	NA	1.6427	NA	2.2607	NA
ZINC	NA	1.2877 J	1.0436 J	NA	2.2304 J	NA	NA	1.4462 J	NA	0.5762 J	NA
Miscellaneous Analysis (UG/KG)											
DIBUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MONOBUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TETRABUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TRIBUTYLTIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon Analysis (MG/KG)											
CARBON	6.7	25000	23000	4.37	22000	2.67	4.63	22000	1.51	4100	1.53

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location	DSY-11			DSY-12	DSY-13	DSY-14	DSY-15	DSY-16	DSY-17	DSY-18	DSY-19	DSY-20		
Sample Number	DSY-11	DSY-SD-11-082604		DSY-12	DSY-13	DSY-14	DSY-15	DSY-16	DSY-17	DSY-18	DSY-19	DSY-20	DSY-SD-20-082604	
Date Sampled	11/3/1993	8/26/2004		11/3/1993	6/13/1994	6/13/1994	6/13/1994	6/13/1994	6/13/1994	6/13/1994	6/13/1994	6/13/1994	8/26/2004	
QC Identifier														
LEAD	46.082	65.6	J	45.99	35.2	28.9404	42.025	31.5291	32.9018	60.2299	57.8157	76.9119	47.9	J
MAGNESIUM	NA	6660		NA	NA	NA	NA	NA	NA	NA	NA	NA	8150	
MANGANESE	NA	234		NA	NA	NA	NA	NA	NA	NA	NA	NA	253	
MERCURY	NA	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23	
NICKEL	167.916	17.6	J	40.399	16.87	9.155	10.127	4.438	5.902	25.361	22.794	23.066	18.4	J
POTASSIUM	NA	3270		NA	NA	NA	NA	NA	NA	NA	NA	NA	3920	
SELENIUM	NA	0.46	U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.49	U
SILVER	1.2244	0.23	U	1.5811	0.0638	0.0531	0.0533	0.0473	0.0534	0.1591	0.4008	0.8837	0.24	UJ
SODIUM	NA	14400		NA	NA	NA	NA	NA	NA	NA	NA	NA	18800	
THALLIUM	NA	1.9	J	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.8	UJ
VANADIUM	NA	38.2		NA	NA	NA	NA	NA	NA	NA	NA	NA	42.0	
ZINC	1104.448	162		160.599	89.479	67.598	83.129	48.315	71.286	163.324	139.453	157.727	158	J
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)														
CADMIUM	NA	0.7600		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2300	B
CHROMIUM	NA	10.40		NA	NA	NA	NA	NA	NA	NA	NA	NA	11.90	
COPPER	NA	32.90	*	NA	NA	NA	NA	NA	NA	NA	NA	NA	32.90	N*
LEAD	NA	51.70		NA	NA	NA	NA	NA	NA	NA	NA	NA	43.10	
MERCURY	NA	0.003200	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001300	UN
NICKEL	NA	7.000	E	NA	NA	NA	NA	NA	NA	NA	NA	NA	51.40	N*
SULFIDE	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	80.00	
ZINC	NA	120.0		NA	NA	NA	NA	NA	NA	NA	NA	NA	88.00	
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)														
CADMIUM	NA	0.006800		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002860	U
CHROMIUM	NA	0.2000		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2286	U
COPPER	NA	0.5185	J	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5176	J
LEAD	NA	0.2498		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2081	
MERCURY	NA	0.00005500	U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00006400	UJ
NICKEL	NA	0.1200	J	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.8757	UJ
SEM/AVS RATIO	NA	0.9544		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.8330	
SULFIDE	NA	3.0763	J	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.4862	J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	2.936		NA	NA	NA	NA	NA	NA	NA	NA	NA	2.0709	
ZINC	NA	1.8409	J	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.3452	J
Miscellaneous Analysis (UG/KG)														
DIBUTYLTIN	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
MONOBUTYLTIN	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
TETRABUTYLTIN	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
TRIBUTYLTIN	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Total Organic Carbon Analysis (MG/KG)														
CARBON	6.17	16000		5.33	0.64	1.01	2.06	0.26	1.01	2.95	4.21	3.29	18000	

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SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location	DSY-21	DSY-22	DSY-23	DSY-24	DSY-25			DSY-26			
Sample Number	DSY-21	DSY-22	DSY-23	DSY-24	DSY-25-SUR	DSY-25-SURb	DSY-25-SURc	DSY-26-SUR	DSY-26-SURb	DSY-26-SURc	DSY-SD-26-082604
Date Sampled	6/13/1994	6/13/1994	6/13/1994	6/13/1994	9/28/1995	9/28/1995	9/28/1995	10/19/1995	10/19/1995	10/19/1995	8/26/2004
QC Identifier											
LEAD	41.8304	52.5276	54.1921	39.1522	35.9	NA	NA	40.4	NA	NA	27.0 J
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4030
MANGANESE	NA	NA	NA	NA	268.5	NA	NA	148.5	NA	NA	161
MERCURY	NA	NA	NA	NA	0.134	NA	NA	0.137	NA	NA	0.060
NICKEL	7.909	25.281	23.196	11.742	21.0	NA	NA	20.5	NA	NA	15.3 J
POTASSIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1530
SELENIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25 U
SILVER	0.0822	0.1222	0.1223	0.0553	0.2625	NA	NA	0.1875	NA	NA	0.13 U
SODIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6500
THALLIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.2 J
VANADIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.7
ZINC	174.732	142.782	140.573	98.084	110	NA	NA	101.5	NA	NA	74.1 J
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)											
CADMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1600 B
CHROMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.500
COPPER	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16.20 *
LEAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	19.70
MERCURY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002300 B
NICKEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.400 E
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.50
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)											
CADMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001610 U
CHROMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.08620
COPPER	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2553 J
LEAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.09500
MERCURY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00003600 U
NICKEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.07530 J
SEM/AVS RATIO	NA	NA	NA	NA	-21.7015	0.1171	2.8785	-2.8926	0.2902	1.1824	7.3725
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1514 J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.1162
ZINC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6044 J
Miscellaneous Analysis (UG/KG)											
DIBUTYLTIN	NA	NA	NA	NA	0.82 J	NA	NA	2.58	NA	NA	NA
MONOBUTYLTIN	NA	NA	NA	NA	0.50	NA	NA	1.05	NA	NA	NA
TETRABUTYLTIN	NA	NA	NA	NA	0.50	NA	NA	0.29 J	NA	NA	NA
TRIBUTYLTIN	NA	NA	NA	NA	0.73 J	NA	NA	2.27	NA	NA	NA
Total Organic Carbon Analysis (MG/KG)											
CARBON	1.15	2.94	2.86	1.4	NA	NA	NA	NA	NA	NA	2900

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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APPENDIX A

SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND
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Sample Location	DSY-27						DSY-28				
Sample Number	DSY-27-SUR	DSY-27-SURb	DSY-27-SURc	DSY-V9-BOT	DSY-V9-MID	DSY-SD-27-082604	DSY-28-SUR	DSY-28-SURb	DSY-28-SURc	DSY-28-BOT	DSY-28-MID
Date Sampled	10/12/1995	10/12/1995	10/12/1995	1/11/1996	1/11/1996	8/26/2004	10/19/1995	10/19/1995	10/19/1995	11/16/1995	11/16/1995
QC Identifier											
LEAD	150.7	NA	NA	15.5	182	138 J	77.7	NA	NA	192.6	148.4
MAGNESIUM	NA	NA	NA	NA	NA	5040	NA	NA	NA	NA	NA
MANGANESE	346.5	NA	NA	189	193.5	209	302.5	NA	NA	338	331.5
MERCURY	0.5875	NA	NA	0.015 U	0.015 U	0.31	0.315	NA	NA	1.0775	0.4075
NICKEL	43.5	NA	NA	15.5	13.0	14.0 J	24.25	NA	NA	45.5	77.75
POTASSIUM	NA	NA	NA	NA	NA	2370 J	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	0.37 U	NA	NA	NA	NA	NA
SILVER	0.6875	NA	NA	0.17	1.82	0.18 UJ	0.5125	NA	NA	1.0	0.96
SODIUM	NA	NA	NA	NA	NA	13000	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	R	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	36.8	NA	NA	NA	NA	NA
ZINC	547.25	NA	NA	36.0	29.75	546 J	169.25	NA	NA	327.75	455
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)											
CADMIUM	NA	NA	NA	NA	NA	0.3700	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	24.50	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	60.70 N*	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	93.90	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	0.001000 UN	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	5.700 N*	NA	NA	NA	NA	NA
SULFIDE	NA	NA	NA	NA	NA	710.0	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	598.0	NA	NA	NA	NA	NA
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)											
CADMIUM	NA	NA	NA	NA	NA	0.003300	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	0.4708	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	0.9555 J	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	0.4534	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	0.00005100 UJ	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	0.09680 UJ	NA	NA	NA	NA	NA
SEM/AVS RATIO	-164.3531	0.06840	12.0719	NA	NA	0.5015	-55.482	0.1186	7.468	NA	NA
SULFIDE	NA	NA	NA	NA	NA	21.9848 J	NA	NA	NA	NA	NA
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	NA	NA	NA	11.0261	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	9.1431 J	NA	NA	NA	NA	NA
Miscellaneous Analysis (UG/KG)											
DIBUTYLTIN	5.56	NA	NA	0.50	5.25	NA	21.0	NA	NA	43.4	5.03
MONOBUTYLTIN	4.8	NA	NA	0.50	3.38	NA	8.88	NA	NA	14.99	2.9
TETRABUTYLTIN	0.50	NA	NA	0.50	0.50	NA	0.60 J	NA	NA	0.50	0.50
TRIBUTYLTIN	8.52	NA	NA	0.50	7.27	NA	65.36	NA	NA	140.54	12.87
Total Organic Carbon Analysis (MG/KG)											
CARBON	NA	NA	NA	NA	NA	15000	NA	NA	NA	NA	NA

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APPENDIX A

SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location	DSY-28 (cont.)			DSY-29						
Sample Number	DSY-V4-BOT	DSY-V4-MID	DSY-SD-28-082504	DSY-29-SUR	DSY-29-SURb	DSY-29-SURc	DSY-29-SUR-D	DSY-29-BOT	DSY-29-MID	DSY-SD-29-082604
Date Sampled	1/11/1996	1/11/1996	8/25/2004	10/19/1995	10/19/1995	10/19/1995	10/19/1995	11/16/1995	11/16/1995	8/26/2004
QC Identifier										
LEAD	12.8	16.1	51.3 J	185.9	NA	NA	172.5	19.0	87.1	113 J
MAGNESIUM	NA	NA	9310	NA	NA	NA	NA	NA	NA	7820
MANGANESE	343.25	268.25	278	282.25	NA	NA	289.75	113	137	251
MERCURY	0.015 U	0.86	0.17	0.5025	NA	NA	0.51	0.015 U	0.565	0.27
NICKEL	30.75	37.25	19.9 J	34.75	NA	NA	36.0	15.25	23.25	24.2 J
POTASSIUM	NA	NA	4360	NA	NA	NA	NA	NA	NA	3420 J
SELENIUM	NA	NA	R	NA	NA	NA	NA	NA	NA	0.54 U
SILVER	0.16	0.15	0.32 UJ	0.7875	NA	NA	0.9875	0.065 U	0.61	0.27 UJ
SODIUM	NA	NA	24300	NA	NA	NA	NA	NA	NA	20800
THALLIUM	NA	NA	1.7 UJ	NA	NA	NA	NA	NA	NA	1.9 UJ
VANADIUM	NA	NA	45.6	NA	NA	NA	NA	NA	NA	49.4
ZINC	71.25	466.5	142 J	392.75	NA	NA	403.25	34.5	130.5	252
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)										
CADMIUM	NA	NA	0.2300 B	NA	NA	NA	NA	NA	NA	0.7200
CHROMIUM	NA	NA	9.900	NA	NA	NA	NA	NA	NA	10.90
COPPER	NA	NA	31.00 N*	NA	NA	NA	NA	NA	NA	42.30 N*
LEAD	NA	NA	45.50	NA	NA	NA	NA	NA	NA	88.70
MERCURY	NA	NA	0.001600 UN	NA	NA	NA	NA	NA	NA	0.001500 UN
NICKEL	NA	NA	4.200 BN*	NA	NA	NA	NA	NA	NA	84.50 N*
SULFIDE	NA	NA	3.600	NA	NA	NA	NA	NA	NA	2300
ZINC	NA	NA	83.00	NA	NA	NA	NA	NA	NA	169.0
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)										
CADMIUM	NA	NA	0.003660 U	NA	NA	NA	NA	NA	NA	0.006400
CHROMIUM	NA	NA	0.1897	NA	NA	NA	NA	NA	NA	0.2102 U
COPPER	NA	NA	0.4884 J	NA	NA	NA	NA	NA	NA	0.6664 J
LEAD	NA	NA	0.2198	NA	NA	NA	NA	NA	NA	0.4281
MERCURY	NA	NA	0.00008200 UJ	NA	NA	NA	NA	NA	NA	0.00007300 UJ
NICKEL	NA	NA	0.07220 UJ	NA	NA	NA	NA	NA	NA	1.4396 UJ
SEM/AVS RATIO	NA	NA	19.4047	-175.5936	0.04130	7.5664	NA	NA	NA	0.05250
SULFIDE	NA	NA	0.1117 J	NA	NA	NA	NA	NA	NA	70.1675 J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	2.1675	NA	NA	NA	NA	NA	NA	3.6869
ZINC	NA	NA	1.2696 J	NA	NA	NA	NA	NA	NA	2.586 J
Miscellaneous Analysis (UG/KG)										
DIBUTYLTIN	0.50	0.50	NA	20.58	NA	NA	30.04	0.50	0.50	NA
MONOBUTYLTIN	0.50	0.50	NA	8.65	NA	NA	18.06	0.50	0.50	NA
TETRABUTYLTIN	0.50	0.50	NA	0.50	NA	NA	0.54 J	0.50	0.50	NA
TRIBUTYLTIN	0.50	0.50	NA	60.89	NA	NA	66.17	0.50	0.50	NA
Total Organic Carbon Analysis (MG/KG)										
CARBON	NA	NA	24000	NA	NA	NA	NA	NA	NA	32000

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APPENDIX A

SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location	DSY-30					DSY-31					
Sample Number	DSY-30-SUR	DSY-30-SURb	DSY-30-SURc	DSY-30-BOT	DSY-30-MID	DSY-31-SUR	DSY-31-SURb	DSY-31-SURc	DSY-31-BOT	DSY-31-MID	DSY-SD-31-082604
Date Sampled	10/12/1995	10/12/1995	10/12/1995	11/16/1995	11/16/1995	10/12/1995	10/12/1995	10/12/1995	11/16/1995	11/16/1995	8/26/2004
QC Identifier											
LEAD	80.0	NA	NA	21.7	34.9	81.0	NA	NA	29.9	52.7	47.9 J
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8250
MANGANESE	276.5	NA	NA	214	140.75	307.5	NA	NA	253.5	219.75	264
MERCURY	0.47	NA	NA	0.015 B	0.1398	0.395	NA	NA	0.0712	0.275	0.23
NICKEL	27.25	NA	NA	13.5	16.75	24.75	NA	NA	12.5	21.75	18.3 J
POTASSIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4000
SELENIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.4 R
SILVER	0.7375	NA	NA	0.065 U	0.14	0.5125	NA	NA	0.065 U	0.57	0.25 UJ
SODIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18600
THALLIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.0 UJ
VANADIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	42.9
ZINC	192.75	NA	NA	48.5	64.5	167	NA	NA	36.0	122.75	140 J
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)											
CADMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1700 B
CHROMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.900
COPPER	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.400 N*
LEAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	33.00
MERCURY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001300 UN
NICKEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.100 BN*
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16.00
ZINC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	76.30
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)											
CADMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002890 U
CHROMIUM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1718 U
COPPER	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.05350 UJ
LEAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1593
MERCURY	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00006500 UJ
NICKEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	R
SEM/AVS RATIO	-19.5035	0.2202	5.5065	NA	NA	-47.2728	0.05570	2.7872	NA	NA	2.6391
SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5027 J
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.3267
ZINC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.1674 J
Miscellaneous Analysis (UG/KG)											
DIBUTYLTIN	4.06	NA	NA	0.50	0.50	86.93	NA	NA	0.50	0.50	NA
MONOBUTYLTIN	2.45	NA	NA	0.50	0.50	45.5	NA	NA	0.50	0.50	NA
TETRABUTYLTIN	0.50	NA	NA	0.50	0.50	0.45 J	NA	NA	0.50	0.50	NA
TRIBUTYLTIN	6.86	NA	NA	0.50	0.50	228.12	NA	NA	0.50	0.50	NA
Total Organic Carbon Analysis (MG/KG)											
CARBON	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	28000

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APPENDIX A

SUMMARY OF HISTORIC SEDIMENT ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND

Sample Location	DSY-32				DSY-33			DSY-34			
Sample Number	DSY-32-SUR	DSY-32-SURb	DSY-32-SURc	DSY-SD-32-082604	DSY-33-SUR	DSY-33-SURb	DSY-33-SURc	DSY-34-SUR	DSY-34-SURb	DSY-34-SURc	DSY-34-MID
Date Sampled	9/28/1995	9/28/1995	9/28/1995	8/26/2004	9/28/1995	9/28/1995	9/28/1995	10/12/1995	10/12/1995	10/12/1995	11/16/1995
QC Identifier											
LEAD	124.8	NA	NA	43.6 J	40.0	NA	NA	47.6	NA	NA	24.5
MAGNESIUM	NA	NA	NA	7970	NA	NA	NA	NA	NA	NA	NA
MANGANESE	293.5	NA	NA	233	133.5	NA	NA	280	NA	NA	294.25
MERCURY	0.3725	NA	NA	0.27	0.1278	NA	NA	0.1533	NA	NA	0.015 B
NICKEL	25.75	NA	NA	17.7 J	18.25	NA	NA	20.5	NA	NA	17.0
POTASSIUM	NA	NA	NA	4140	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	0.56 U	NA	NA	NA	NA	NA	NA	NA
SILVER	0.8125	NA	NA	0.28 U	0.2375	NA	NA	0.2875	NA	NA	0.065 U
SODIUM	NA	NA	NA	20000	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	2.0 J	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	41.5	NA	NA	NA	NA	NA	NA	NA
ZINC	201.25	NA	NA	111 J	72.25	NA	NA	105.5	NA	NA	47.0
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (MG/KG)											
CADMIUM	NA	NA	NA	0.2000 B	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	11.50	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	140.0 *	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	40.20	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	0.006400 B	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	402.0 E	NA	NA	NA	NA	NA	NA	NA
SULFIDE	NA	NA	NA	0.08500 U	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	70.20	NA	NA	NA	NA	NA	NA	NA
Acid Volatile Sulfides/Simultaneously Extracted Metals Analysis (UMOLE/G)											
CADMIUM	NA	NA	NA	0.003150 U	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	0.2221	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	2.2047 J	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	0.1938	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	0.00007100 U	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	6.856 J	NA	NA	NA	NA	NA	NA	NA
SEM/AVS RATIO	-14.5054	0.1569	2.6996	399.0	1.0704	2.3636	1.8554	-28.0893	0.04850	1.4307	NA
SULFIDE	NA	NA	NA	0.02644 UJ	NA	NA	NA	NA	NA	NA	NA
TOTAL SIMULTANEOUSLY EXTRACTED METALS	NA	NA	NA	10.5504	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	1.0738 J	NA	NA	NA	NA	NA	NA	NA
Miscellaneous Analysis (UG/KG)											
DIBUTYLTIN	2.71	NA	NA	NA	0.50	NA	NA	3.38	NA	NA	0.50
MONOBUTYLTIN	1.12	NA	NA	NA	0.50	NA	NA	1.85	NA	NA	0.50
TETRABUTYLTIN	0.38 J	NA	NA	NA	0.50	NA	NA	0.50	NA	NA	0.50
TRIBUTYLTIN	4.26	NA	NA	NA	0.50	NA	NA	4.13	NA	NA	0.50
Total Organic Carbon Analysis (MG/KG)											
CARBON	NA	NA	NA	130	NA	NA	NA	NA	NA	NA	NA

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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-CN	CHC-1-DM	CHC-1-IBM	CHC-1-LOB	DSY-24-IBM	DSY-25-IBM	DSY-25-LOB	DSY-26-CN	DSY-26-DM	DSY-26-IBM	DSY-27-IBM
Sample Location	CHC-1	CHC-1	CHC-1	CHC-1	DSY-24	DSY-25	DSY-25	DSY-26	DSY-26	DSY-26	DSY-27
Date Sampled	12/7/1995	11/21/1995	11/2/1995	12/5/1995	10/24/1995	10/12/1995	11/2/1995	12/13/1995	11/21/1995	10/12/1995	10/24/1995
Matrix	Cunner Fish	Deployed Mussels	Mussels	Lobster	Mussels	Mussels	Lobster	Cunner Fish	Deployed Mussels	Mussels	Mussels
Polyaromatic Hydrocarbons (PAH) (ng/g)											
1,6,7-Trimethylnaphthalene	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	2.68247
1-Methylnaphthalene	9.554146	3.104542	0.7938 U	0.7938 U	I	2.081548	0.7938 U	0.7938 U	0.7938 U	0.7938 U	0.7938 U
1-Methylphenanthrene	151.2	2.130996 J	1.267 U	11.448136	1.192254 J	3.640532	1.267 U	1.267 U	1.267 U	5.087166	6.9643
2,6-Dimethylnaphthalene	1.7178	9.91242	3.10198	0.735 U	6.142234	1.9327	0.735 U	0.735 U	3.773098	2.252278	3.458546
2-Methylnaphthalene	12.737256	7.758324	1.316 U	1.316 U	I	3.930346	1.316 U	1.316 U	1.316 U	1.316 U	1.316 U
Acenaphthene	1.40084	7.721294	0.371 U	0.371 U	0.371 U	2.19268	0.371 U	4.046	9.42319	0.371 U	0.371 U
Acenaphthylene	0.714042 J	5.58446	2.44552	0.4039 U	1.611134	10.430126	0.4039 U	0.4039 U	6.93287	12.531904	8.275666
Anthracene	1.12 U	5.99039	3.51316	0.890638 J	2.481598	25.745986	1.12 U	1.12 U	9.096136	33.190906	23.347674
Benzo(a)anthracene	I	6.354124	6.62354	0.4704 U	2.135588	39.272366	0.4704 U	1.778	10.585134	145.61148	40.559778
Benzo(a)pyrene	0.52577 J	3.04318	4.339314	0.5061 U	1.107246	16.033346	0.5061 U	2.674	0.5061 U	76.726482	10.234532
Benzo(b,j,k)fluoranthene	0.868 U	13.277558	15.347976	0.868 U	6.06151	77.188664	0.868 U	6.748	16.747598	323.4	55.024144
Benzo(e)pyrene	0.546 U	9.449776	12.055792	0.546 U	5.171684	38.427928	0.546 U	3.038	12.408116	114.800812	32.73739
Benzo(g,h,i)perylene	0.2177 U	0.2177 U	4.255692	0.2177 U	2.917768	6.728148	0.2177 U	2.73	0.2177 U	20.665694	4.087888
Biphenyl	0.995806 J	0.798 U	0.798 U	0.798 U	0.798 U	1.628088	0.798 U	1.988	0.798 U	0.798 U	1.805272
Chrysene	I	5.049716	6.928936	0.7364 U	2.906848	42.163618	0.7364 U	2.156	9.582944	87.612014	41.610198
Dibenz(a,h)anthracene	0.0686 U	2.96569	0.0686 U	0.0686 U	1.109192	1.895152	0.0686 U	0.0686 U	0.0686 U	6.954248	0.0686 U
Fluoranthene	1.076894 J	14.466284	11.884656	2.024316 J	8.251222	103.680192	14.06818	4.452	48.003732	183.4	162.4
Fluorene	1.910986	0.273 U	2.338336	0.273 U	0.963844	4.15702	0.273 U	3.374	0.273 U	4.672136	5.480636
High Molecular Weight PAHs	5.062036 Z	44.287348 Z	40.190136 Z	6.545546 Z	22.262744 Z	273.757218 Z	27.83949 Z	14.1106 Z	106.644076 Z	645.904238 Z	369.525898 Z
Indeno(1,2,3-cd)pyrene	0.2156 U	0.2156 U	2.17168	0.2156 U	1.66173	4.965114	0.2156 U	1.988	0.2156 U	16.929542	3.749564
Low Molecular Weight PAHs	24.894534 Z	31.87933 Z	14.281036 Z	5.512752 Z	8.774444 Z	86.67673 Z	5.0421 Z	16.1371 Z	38.159576 Z	109.454016 Z	77.173264 Z
Naphthalene	4.855228	0.2352 U	0.2352 U	0.2352 U	I	18.999862	0.2352 U	0.2352 U	0.2352 U	25.638774	0.2352 U
Perylene	1.040186	5.413898	I	0.49 U	I	11.474568	0.49 U	0.49 U	0.49 U	25.784304	I
Phenanthrene	2.15621 J	4.316648	4.061834	2.023014 J	3.346868	21.220724	1.323 U	5.642	10.883166	31.733282	38.147088
Pyrene	3.390772	12.408354	10.34509	2.73973	6.752648	70.71253	11.989824	2.982	37.897552	145.6	114.652776
Total Polycyclic Aromatic Hydrocarbons	193.2 Z	118.947654 Z	89.413492 Z	19.18 Z	53.813368 Z	508.2 Z	26.04 Z	45.08 Z	175 Z	1262.8 Z	555.8 Z

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-CN	CHC-1-DM	CHC-1-IBM	CHC-1-LOB	DSY-24-IBM	DSY-25-IBM	DSY-25-LOB	DSY-26-CN	DSY-26-DM	DSY-26-IBM	DSY-27-IBM
Sample Location	CHC-1	CHC-1	CHC-1	CHC-1	DSY-24	DSY-25	DSY-25	DSY-26	DSY-26	DSY-26	DSY-27
Date Sampled	12/7/1995	11/21/1995	11/2/1995	12/5/1995	10/24/1995	10/12/1995	11/2/1995	12/13/1995	11/21/1995	10/12/1995	10/24/1995
Matrix	Cunner Fish	Deployed Mussels	Mussels	Lobster	Mussels	Mussels	Lobster	Cunner Fish	Deployed Mussels	Mussels	Mussels
PCB (ng/g)											
101 (2 2'3 5 5')	6.09728	2.3604	2.32316	2.48514	3.8948	3.55516	1.16634	13.0585	5.54456	5.78046	7.94962
105 (2 3 3'4 4')	1.721104	0.490364 J	0.48076 J	0.786408 J	0.663404 J	0.554806 J	1.024982 J	4.255426	73.96018	1.014804 J	1.3489
118 (2 3'4 4'5)	9.015342	2.961672	2.706592	1.56282	2.943052	2.690212	5.180266	16.34906	4.327568	4.14386	6.236454
128 (2 2'3 3'4 4')	1.041852	1.383662	1.851458	1.105342	2.021866	1.112342	0.651966	3.42601	1.646512	2.294614	2.732982
138 (2 2'3 4 4'5)	11.185286	4.822118	4.46908	2.091096	8.464008	6.560022	5.009928	26.413856	9.774002	12.27758	17.610152
153 (2 2'4 4'5 5')	20.579692	6.83774	6.73092	3.094574	12.815838	9.772742	8.17635	40.966744	11.541418	17.445442	24.198342
170 (2 2'3 3'4 4'5)	2.529772	0.459564	0.261128	0.575904	0.66073	0.223468	0.916804	6.56579	1.16228	0.36057	0.638988
18 (2 2'5)	0.292502 J	0.455 U	0.455 U	8.097852	0.392784 J	0.455 U	0.455 U	0.328454 J	2.363578	0.382424 J	0.874412 J
180 (2 2'3 4 4'5 5')	6.340292	1.249276	0.679154	0.54922	1.639092	1.175244	2.102912	16.16237	2.67456	1.692278	3.865484
187 (2 2'3 4'5 5'6)	4.930436	1.673924	1.9635	4.412604	4.083856	3.309166	2.129694	12.033952	3.59009	5.69072	7.802774
195 (2 2'3 3'4 4'5 6)	0.570248	0.258734	0.176428	0.056 U	0.056 U	0.165172	0.224686	0.665644	0.199388	0.056 U	0.131698
206 (2 2'3 3'4 4'5 5'6)	0.770644	0.259448	0.532756	2.380112	0.44093	0.275884	0.821436	1.00058	0.522928	0.767886	0.31409
209 (2 2'3 3'4 4'5 5'6 6')	0.228536	0.262934	0.61565	0.1008 U	0.657594	0.21483	0.52416	0.264012	0.463302	0.579712	0.08883 J
28 (2 4 4')	0.684586	1.067682	2.294824	2.881396	0.809648	1.991934	1.271326	1.107568	1.426376	2.293914	1.42149
44 (2 2'3 5')	0.17437	0.656334	0.0532 U	0.0532 U	0.937132	0.776412	0.72807	0.6706	1.894116	1.12217	1.547308
52 (2 2'5 5)	2.515884	1.98422	1.78962	1.604288	1.635494	2.97556	1.057126	5.032608	2.86027	1.992564	2.778874
66 (2 3'4 4')	2.341906	0.5397 U	0.5397 U	0.642908 J	0.5397 U	0.576996 J	1.76526	5.830888	0.5397 U	0.5397 U	0.5397 U
8 (2 4)	I	0.28693 J	0.328076 J	0.329 U	1.021076	1.049426	0.329 U	I	0.348614 J	0.346752 J	0.859754
PCB Sum of Congeners	71.01976	27.014988	27.203092	32.269664	43.081304	36.97939	32.751334	154	124.299742	58.18575	80.40018
PCB Sum of Congeners x 2	141.4 Z	54.02999 Z	54.406198 Z	64.539328 Z	86.162594 Z	73.95878 Z	65.502654 Z	308 Z	249.2 Z	116.371514 Z	161 Z
Butyltins (ng Sn/g)											
Dibutyltin	0.42 U	0.42 U	2.1378	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	5.7232
Monobutyltin	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U
Tetrabutyltin	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U
Tributyltin	3.6106	5.6952	9.3184	0.42 U	1.8928	3.5056	0.42 U	1.4784	4.5794	2.7832	136.7814

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-CN	CHC-1-DM	CHC-1-IBM	CHC-1-LOB	DSY-24-IBM	DSY-25-IBM	DSY-25-LOB	DSY-26-CN	DSY-26-DM	DSY-26-IBM	DSY-27-IBM
Sample Location	CHC-1	CHC-1	CHC-1	CHC-1	DSY-24	DSY-25	DSY-25	DSY-26	DSY-26	DSY-26	DSY-27
Date Sampled	12/7/1995	11/21/1995	11/2/1995	12/5/1995	10/24/1995	10/12/1995	11/2/1995	12/13/1995	11/21/1995	10/12/1995	10/24/1995
Matrix	Cunner Fish	Deployed Mussels	Mussels	Lobster	Mussels	Mussels	Lobster	Cunner Fish	Deployed Mussels	Mussels	Mussels
Metals (ug/g)											
Aluminum	2.0888	8.5526	8.3468	0.007 U	20.4022	7.8694	0.007 U	2.3478	11.8328	25.4716	52.1668
Arsenic	0.4872	1.0472	0.6552	3.0352	1.4308	1.7584	4.0096	0.5096	0.7448	1.1508	0.9352
Cadmium	0.1316	0.1036	0.0812	0.0322	0.2604	0.1694	0.0504	0.1162	0.1316	0.1022	0.1078
Chromium	0.1708	0.245	0.2576	0.2002	0.441	0.42	0.2324	0.1946	0.3024	0.3416	0.4004
Copper	2.5746	1.5456	1.6702	14.2688	0.5824	1.6716	21.2226	2.4472	1.8592	1.0766	2.086
Iron	9.5746	22.2572	26.9024	3.5588	61.2066	29.5148	5.6378	7.4088	24.647	42.126	51.674
Lead	0.1176	0.3626	0.1092	0.0252	0.8134	0.000042 U	0.02198	0.1106	0.1904	0.000042 U	0.4228
Manganese	0.4494	0.693	0.6972	NA	2.4276	1.5736	0.3584	0.3136	0.9772	0.7826	4.4576
Mercury	0.023772	0.022302	0.025802	0.031934	0.039088	0.024444	0.036792	0.018046	0.02268	0.016576	0.020706
Nickel	0.000042 U	0.5754	0.5376	0.2198	0.7616	0.4802	0.2128	0.1428	0.2548	0.000042 U	0.6636
Silver	0.2212	0.000014 U	0.000014 U	0.5376	0.000014 U	0.000014 U	0.7658	0.0728	0.000014 U	0.000014 U	0.000014 U
Zinc	3.0758	10.4496	12.8352	16.6572	10.6862	15.7402	12.3018	5.8114	14.4088	12.7358	19.9178

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-27-LOB	DSY-28-CN	DSY-28-DM	DSY-28-IBM	DSY-28-LOB	DSY-29-CN	DSY-29-DM	DSY-29-LOB	DSY-31-DM	DSY-31-PM	DSY-32-PM
Sample Location	DSY-27	DSY-28	DSY-28	DSY-28	DSY-28	DSY-29	DSY-29	DSY-29	DSY-31	DSY-31	DSY-32
Date Sampled	11/2/1995	12/13/1995	11/21/1995	11/2/1995	11/2/1995	12/13/1995	11/21/1995	11/2/1995	11/21/1995	10/20/1995	10/20/1995
Matrix	Lobster	Cunner Fish	Deployed Mussels	Mussels	Lobster	Cunner Fish	Deployed Mussels	Lobster	Deployed Mussels	Hard Clam	Hard Clam
Polyaromatic Hydrocarbons (PAH) (ng/g)											
1,6,7-Trimethylnaphthalene	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U
1-Methylnaphthalene	0.738402 J	1.7444	0.7938 U	0.7938 U	1.856442	4.588486	0.7938 U	1.378832 J	0.7938 U	0.7938 U	0.7938 U
1-Methylphenanthrene	6.245134	169.4	1.267 U	1.267 U	11.720968	4.558344	1.267 U	11.036494	1.267 U	I	8.508948
2,6-Dimethylnaphthalene	0.735 U	0.735 U	0.735 U	0.735 U	1.758554	0.735 U	6.600958	0.735 U	0.735 U	0.735 U	0.735 U
2-Methylnaphthalene	1.07093 J	1.9768 J	1.316 U	1.316 U	1.718654 J	3.352888	1.316 U	2.083774 J	1.316 U	1.316 U	1.316 U
Acenaphthene	4.555992	6.397482	0.371 U	0.371 U	0.371 U	5.528278	21.07497	0.371 U	0.371 U	0.371 U	0.371 U
Acenaphthylene	0.4039 U	0.547568 J	0.4039 U	4.869424	0.4039 U	0.4039 U	4.36947	0.4039 U	0.4039 U	0.4039 U	1.892618
Anthracene	1.148714 J	0.833 J	3.315578	9.546054	0.581434 J	0.861476 J	5.63388	1.12 U	4.67705	4.250022	3.854858
Benzo(a)anthracene	4.060714	6.0018	5.916232	10.047338	3.401902	0.4704 U	7.512582	0.4704 U	8.249416	18.6032	11.089498
Benzo(a)pyrene	4.021598	0.2212 J	0.5061 U	4.739798	3.493014	1.678502	0.5061 U	1.831956	0.5061 U	6.298936	5.963398
Benzo(b,j,k)fluoranthene	8.534512	0.868 U	10.73457	17.862866	8.17215	3.776136	9.936024	3.310454	12.50186	18.0348	13.212472
Benzo(e)pyrene	2.80133	0.546 U	8.509956	15.105524	2.817038	0.546 U	8.30445	1.35226	6.38897	0.546 U	0.546 U
Benzo(g,h,i)perylene	1.149638	0.2177 U	0.2177 U	0.2177 U	1.639974	0.2177 U	0.2177 U	1.773366	0.2177 U	3.607394	4.79108
Biphenyl	0.798 U	1.036 J	0.798 U	0.798 U	1.131382 J	0.882784 J	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U
Chrysene	4.31011	4.5052	4.11558	12.024082	5.402124	0.7364 U	5.229252	0.7364 U	5.356106	9.4318	8.362186
Dibenz(a,h)anthracene	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U
Fluoranthene	12.105086	3.4776	16.266376	34.41011	10.205524	5.39189	23.910194	5.464074	16.627282	25.004756	21.3185
Fluorene	0.273 U	5.294744	0.273 U	3.520272	0.273 U	3.611538	0.273 U	2.088296	0.273 U	0.273 U	0.273 U
High Molecular Weight PAHs	37.69906 Z	17.7408 Z	43.202614 Z	85.83736 Z	39.873568 Z	13.440896 Z	60.077164 Z	18.299344 Z	47.239038 Z	87.008362 Z	72.244662 Z
Indeno(1,2,3-cd)pyrene	1.209082	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U	1.47945	0.2156 U	2.859598	3.761744
Low Molecular Weight PAHs	11.942756 Z	19.591208 Z	12.065872 Z	35.822654 Z	9.52959 Z	20.617688 Z	39.53236 Z	12.730298 Z	13.014736 Z	10.180688 Z	11.968292 Z
Naphthalene	1.67993	0.2352 U	0.2352 U	0.2352 U	1.680084	0.2352 U	0.2352 U	2.719248	0.2352 U	0.2352 U	0.2352 U
Perylene	1.510824	0.36813 J	0.49 U	I	1.664684	0.452662 J	0.49 U	0.49 U	0.49 U	I	1.447138
Phenanthrene	2.810304	4.3064	6.151194	15.964718	4.501532	6.624422	6.629854	3.94408	5.738586	3.331566	4.025602
Pyrene	13.132952	3.4664	16.32974	24.547432	17.302404	5.09509	22.85045	9.727914	16.431534	27.601056	25.44248
Total Polycyclic Aromatic Hydrocarbons	71.12 Z	210 Z	71.339212 Z	152.6 Z	79.1 Z	46.34 Z	122.05207 Z	48.16 Z	75.97079 Z	119 Z	113.68 Z

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-27-LOB	DSY-28-CN	DSY-28-DM	DSY-28-IBM	DSY-28-LOB	DSY-29-CN	DSY-29-DM	DSY-29-LOB	DSY-31-DM	DSY-31-PM	DSY-32-PM
Sample Location	DSY-27	DSY-28	DSY-28	DSY-28	DSY-28	DSY-29	DSY-29	DSY-29	DSY-31	DSY-31	DSY-32
Date Sampled	11/2/1995	12/13/1995	11/21/1995	11/2/1995	11/2/1995	12/13/1995	11/21/1995	11/2/1995	11/21/1995	10/20/1995	10/20/1995
Matrix	Lobster	Cunner Fish	Deployed Mussels	Mussels	Lobster	Cunner Fish	Deployed Mussels	Lobster	Deployed Mussels	Hard Clam	Hard Clam
PCB (ng/g)											
101 (2 2'3 5 5')	1.6079	24.1836	5.25308	5.68162	1.63324	16.76514	4.46894	1.3041	6.83298	3.0289	2.26352
105 (2 3 3'4 4')	13.4008	5.55611	1.45243	0.8988 J	5.07003	5.458348	17.64875	0.462714 J	1.495578	34.219528	1.493716
118 (2 3'4 4'5)	7.249942	21.576716	5.44978	3.67934	9.650522	20.192634	4.100278	2.084726	6.346256	2.581096	1.894578
128 (2 2'3 3'4 4')	1.049566	5.360348	1.70401	1.620584	1.734278	4.399976	1.54231	0.495264	1.63184	0.653898	0.492212
138 (2 2'3 4 4'5)	6.47213	50.971984	9.197678	11.746308	9.965172	39.209604	8.38509	3.62712	9.415112	5.152658	3.716398
153 (2 2'4 4'5 5')	9.214366	77.008148	11.663428	16.672782	13.87477	58.457028	10.981754	4.961474	13.419924	7.328412	5.287898
170 (2 2'3 3'4 4'5)	1.00975	10.571218	0.502586	0.523852	1.71143	12.934656	0.603218	0.91245	0.490742	0.802074	0.86821
18 (2 2'5)	0.312928 J	0.195804 J	0.455 U	0.455 U	0.494858 J	0.20699 J	0.455 U	0.57799 J	0.455 U	0.382102 J	0.455 U
180 (2 2'3 4 4'5 5')	2.642136	28.380772	2.17805	2.364068	4.793432	29.383732	2.408826	1.988518	2.219938	2.56214	1.995168
187 (2 2'3 4'5 5'6)	2.536744	25.467414	3.548902	5.314624	4.409538	18.431364	3.350074	1.908592	3.802162	2.27178	1.790684
195 (2 2'3 3'4 4'5 6)	0.372974	0.817782	0.240646	0.41608	0.656516	1.15073	0.221312	0.600908	0.27321	0.320166	0.20699
206 (2 2'3 3'4 4'5 5'6)	0.63042	0.997136	0.696318	0.50883	0.9758	1.7367	0.510818	0.888314	0.79205	1.097082	0.701218
209 (2 2'3 3'4 4'5 5'6 6')	0.484834	0.317856	0.589638	1.162056	0.58275	0.952266	0.574518	0.798882	0.658574	0.902286	0.645526
28 (2 4 4')	1.0171	0.810698	1.55491	1.38474	0.632366	0.616672	0.91315	0.899766	1.152424	1.647506	1.747424
44 (2 2'3 5')	0.365988	0.542626	1.591814	0.83258	0.057204 J	0.390124	1.474942	0.047642 J	2.235912	0.537782	0.0532 U
52 (2 2'5 5)	1.3461	6.691566	2.229262	3.059574	1.293978	4.328702	2.896572	1.71157	3.805718	1.26399	1.135904
66 (2 3'4 4')	2.117444	11.52501	0.5397 U	0.5397 U	2.12989	7.09429	0.5397 U	1.590806	0.5397 U	1.784426	1.485232
8 (2 4)	0.531468 J	I	0.384776 J	0.263424 J	0.572194 J	I	0.66773	0.329 U	0.426566 J	0.329 U	0.329 U
PCB Sum of Congeners	52.362576	271.6	48.23728	56.129206	60.237954	221.2	60.748296	24.86085	54.998972	66.535882	25.724664
PCB Sum of Congeners x 2	104.725152 Z	541.8 Z	96.474574 Z	112.258426 Z	120.475908 Z	443.8 Z	121.496592 Z	49.7217 Z	109.997944 Z	133.07175 Z	51.449342 Z
Butyltins (ng Sn/g)											
Dibutyltin	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	NA
Monobutyltin	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	NA
Tetrabutyltin	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	NA
Tributyltin	0.42 U	4.683	1.54	6.8712	0.42 U	4.8328	2.527	0.42 U	1.33	6.7074	NA

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-27-LOB	DSY-28-CN	DSY-28-DM	DSY-28-IBM	DSY-28-LOB	DSY-29-CN	DSY-29-DM	DSY-29-LOB	DSY-31-DM	DSY-31-PM	DSY-32-PM
Sample Location	DSY-27	DSY-28	DSY-28	DSY-28	DSY-28	DSY-29	DSY-29	DSY-29	DSY-31	DSY-31	DSY-32
Date Sampled	11/2/1995	12/13/1995	11/21/1995	11/2/1995	11/2/1995	12/13/1995	11/21/1995	11/2/1995	11/21/1995	10/20/1995	10/20/1995
Matrix	Lobster	Cunner Fish	Deployed Mussels	Mussels	Lobster	Cunner Fish	Deployed Mussels	Lobster	Deployed Mussels	Hard Clam	Hard Clam
Metals (ug/g)											
Aluminum	4.35456	1.6912	10.9802	14.903	0.007 U	3.5868	9.5802	0.007 U	11.1468	7.7014	3.2158
Arsenic	2.4066	0.6846	2.3576	0.3752	NA	1.0738	1.2516	3.9984	0.7294	1.3104	0.6888
Cadmium	0.0364	0.1526	0.1078	0.0868	NA	0.161	0.1134	0.0658	0.0756	0.1092	0.0826
Chromium	0.2954	0.1316	0.3332	0.3556	NA	0.1652	0.2828	0.2394	0.3206	0.2772	0.2436
Copper	23.3506	2.142	1.5372	0.1582	NA	3.0534	0.8848	14.0532	1.2474	2.0132	1.5288
Iron	11.4296	5.7176	26.943	15.092	4.8104	9.2946	16.5522	3.9172	27.3448	23.0328	24.9018
Lead	0.00966	0.000042 U	0.000042 U	0.000042 U	NA	0.1274	0.1316	0.0308	0.1876	0.2436	0.3878
Manganese	0.1946	0.3276	2.0174	5.3648	NA	0.2758	2.6348	0.2436	1.8074	1.6002	2.2288
Mercury	0.06356	0.014406	0.018732	0.020202	NA	0.023478	0.023702	0.040236	0.020356	0.019082	0.021686
Nickel	0.168	0.1806	0.6818	0.000042 U	NA	0.2436	0.4018	0.2436	0.2898	0.5586	0.3038
Silver	0.9618	0.0434	0.1652	0.000014 U	NA	0.000014 U	0.000014 U	0.8176	0.000014 U	0.000014 U	0.1932
Zinc	15.785	3.7058	13.335	16.891	NA	3.9956	10.4916	18.1174	22.9446	12.2276	15.7528

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-33-DM	DSY-33-LOB	DSY-33-PM	DSY-34-PM	DSY-35-IBM	DSY-35-LOB	DSY-35-MM	DSY-35-PM	DSY-36-CN	DSY-36-IBM	DSY-36-LOB
Sample Location	DSY-33	DSY-33	DSY-33	DSY-34	DSY-35	DSY-35	DSY-35	DSY-35	DSY-36	DSY-36	DSY-36
Date Sampled	11/21/1995	11/2/1995	10/20/1995	10/20/1995	10/12/1995	11/2/1995	10/20/1995	10/20/1995	12/7/1995	10/24/1995	10/12/1995
Matrix	Deployed Mussels	Lobster	Hard Clam	Hard Clam	Mussels	Lobster	Hard Clam	Hard Clam	Cunner Fish	Mussels	Lobster
Polyaromatic Hydrocarbons (PAH) (ng/g)											
1,6,7-Trimethylnaphthalene	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U
1-Methylnaphthalene	0.7938 U	1.62113	0.7938 U	0.7938 U	0.7938 U	I	0.7938 U	0.7938 U	I	I	I
1-Methylphenanthrene	1.267 U	12.166952	22.188978	17.541104	1.38509 J	1.267 U	0.600082 J	6.592642	29.278578	0.950124 J	1.267 U
2,6-Dimethylnaphthalene	0.735 U	0.735 U	0.735 U	0.735 U	2.695406	0.735 U	0.735 U	0.735 U	0.735 U	0.638232 J	0.735 U
2-Methylnaphthalene	1.316 U	1.927618 J	1.316 U	1.316 U	1.316 U	I	1.316 U	1.316 U	I	I	I
Acenaphthene	0.371 U	0.371 U	0.395948 J	0.371 U	0.371 U	0.371 U	0.371 U	0.371 U	0.371 U	0.371 U	0.371 U
Acenaphthylene	0.4039 U	0.4039 U	0.4039 U	0.4039 U	0.4039 U	0.4039 U	0.4039 U	0.4039 U	0.4039 U	2.141664	0.4039 U
Anthracene	1.12 U	1.12 U	1.871198 J	2.774548	3.566794	0.43491 J	1.12 U	0.924546 J	1.12 U	4.059566	0.741174 J
Benzo(a)anthracene	0.4704 U	0.4704 U	4.934468	6.46044	4.3554	0.4704 U	2.200786	3.01427	NA	4.236092	0.4704 U
Benzo(a)pyrene	0.5061 U	0.5061 U	3.106544	3.142202	0.5061 U	0.5061 U	0.975982 J	2.260664	0.5061 U	1.754298	0.5061 U
Benzo(b,j,k)fluoranthene	0.868 U	3.21538	4.9826	6.81163	9.244662	0.868 U	1.284066 J	2.291408	0.868 U	9.933	4.307394
Benzo(e)pyrene	0.546 U	1.663956	0.546 U	0.546 U	7.316372	0.546 U	0.253288 J	0.518154 J	0.546 U	6.799114	0.546 U
Benzo(g,h,i)perylene	0.2177 U	0.2177 U	1.855518	1.56786	1.980468	0.2177 U	0.2177 U	0.2177 U	0.2177 U	1.40798	0.2177 U
Biphenyl	0.798 U	1.9929	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U
Chrysene	0.7364 U	0.7364 U	5.91766	3.419248	5.633712	0.7364 U	0.954226 J	1.565606	NA	5.67336	0.7364 U
Dibenz(a,h)anthracene	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U
Fluoranthene	12.227642	4.500188	8.002582	10.274502	14.67585	4.603634	6.650868	9.69549	2.721474	14.715358	5.41086
Fluorene	0.273 U	0.273 U	0.725928	0.72989	1.626128	0.273 U	0.405118 J	0.768586	2.794288	0.70112	0.273 U
High Molecular Weight PAHs	26.38293 Z	13.721064 Z	29.823612 Z	34.208622 Z	36.237586 Z	9.827832 Z	15.827714 Z	24.293108 Z	10.124044 Z	38.388308 Z	13.232184 Z
Indeno(1,2,3-cd)pyrene	0.2156 U	0.2156 U	1.229872	1.105188	1.453214	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.838754	0.2156 U
Low Molecular Weight PAHs	5.0421 Z	11.801692 Z	6.95184 Z	10.750236 Z	13.357918 Z	3.329802 Z	6.448358 Z	7.97986 Z	7.29995 Z	11.237366 Z	4.384968 Z
Naphthalene	0.2352 U	4.928602	0.2352 U	0.2352 U	0.2352 U	I	0.2352 U	0.2352 U	I	I	I
Perylene	0.49 U	0.49 U	0.7441 J	0.547372 J	I	0.49 U	1.764966	2.257962	1.460928	I	0.49 U
Phenanthrene	1.323 U	2.777572	2.003666 J	4.919684	5.838896	1.846992 J	2.59714 J	3.960628	2.610762 J	3.964016	2.595908 J
Pyrene	12.373788	7.439376	7.793758	10.843644	10.997924	3.442698	4.977252	7.688464	6.82787	11.940586	6.03981
Total Polycyclic Aromatic Hydrocarbons	24.60143 Z	42.28 Z	65.8 Z	70.14 Z	70.76993 Z	10.36 Z	22.68 Z	41.58 Z	45.64 Z	69.753278 Z	19.04 Z

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-33-DM	DSY-33-LOB	DSY-33-PM	DSY-34-PM	DSY-35-IBM	DSY-35-LOB	DSY-35-MM	DSY-35-PM	DSY-36-CN	DSY-36-IBM	DSY-36-LOB
Sample Location	DSY-33	DSY-33	DSY-33	DSY-34	DSY-35	DSY-35	DSY-35	DSY-35	DSY-36	DSY-36	DSY-36
Date Sampled	11/21/1995	11/2/1995	10/20/1995	10/20/1995	10/12/1995	11/2/1995	10/20/1995	10/20/1995	12/7/1995	10/24/1995	10/12/1995
Matrix	Deployed Mussels	Lobster	Hard Clam	Hard Clam	Mussels	Lobster	Hard Clam	Hard Clam	Cunner Fish	Mussels	Lobster
PCB (ng/g)											
101 (2 2'3 5 5')	4.97476	1.49506	2.73546	1.0703	4.84932	0.73038	0.74634	2.61898	17.16554	5.58544	1.75574
105 (2 3 3'4 4')	0.87591 J	5.84458	4.81803	1.504972	0.847098 J	0.53592 J	0.271908 J	0.5726 U	4.493286	0.893508 J	29.20855
118 (2 3'4 4'5)	5.492802	3.089282	2.203614	0.812784	3.712688	1.944586	0.558264 J	1.996246	18.763626	4.09248	4.6683
128 (2 2'3 3'4 4')	1.44725	0.597184	0.495446	0.210252	2.835504	0.342692	0.137634 J	0.915642	4.18474	2.78138	0.822654
138 (2 2'3 4 4'5)	8.48589	4.553738	4.755576	2.607528	10.32948	2.974902	1.10957	5.359368	39.505942	14.04137	5.35549
153 (2 2'4 4'5 5')	12.060286	6.58854	7.28903	3.300976	14.514458	4.28239	2.398032	7.432852	60.35379	20.21537	6.43328
170 (2 2'3 3'4 4'5)	0.521962	0.772212	1.078854	0.756266	0.23828	0.719054	0.676438	0.927766	11.629436	0.504224	1.112874
18 (2 2'5)	0.203518 J	0.174034 J	0.455 U	0.455 U	0.455 U	1.501584	0.455 U	0.455 U	0.10857 J	0.455 U	0.455 U
180 (2 2'3 4 4'5 5')	2.152206	2.056138	2.804844	1.91289	1.576274	1.480612	1.585262	2.626526	26.316066	2.4521	2.095702
187 (2 2'3 4'5 5'6)	3.665858	1.982876	2.4451	1.482376	5.179482	1.428994	0.933744	2.815204	19.51271	6.722758	1.730414
195 (2 2'3 3'4 4'5 6)	0.142296	0.575176	0.567336	0.244958	0.056 U	0.280588	0.149968	0.425572	1.201018	0.056 U	0.354746
206 (2 2'3 3'4 4'5 5'6)	0.258958	0.903826	0.902748	0.896854	0.360206	0.50477	0.682136	1.019018	2.438268	0.408548	0.678314
209 (2 2'3 3'4 4'5 5'6 6')	0.058282 J	0.610792	0.724738	0.92421	0.370412	0.429128	0.354984	0.868154	1.1102	0.466438	0.636874
28 (2 4 4')	0.735126	0.53081	1.542086	3.372292	1.258488	0.758534	0.177254 J	2.915542	0.680512	1.233736	0.560826
44 (2 2'3 5')	1.372042	0.68901	1.65011	1.032402	0.877296	1.21184	0.089866 J	0.161966	0.365904	0.969318	0.866628
52 (2 2'5 5)	1.778056	0.673512	0.939974	0.701442	1.466556	1.058302	0.392784 J	1.626184	4.86157	1.794688	1.013026
66 (2 3'4 4')	0.5397 U	1.443414	1.70884	0.96761 J	0.5397 U	0.95249 J	0.890484 J	2.177616	6.314042	0.5397 U	1.48638
8 (2 4)	0.447314 J	0.255808 J	0.329 U	0.329 U	0.307244 J	1.019844	I	0.329 U	I	0.46557 J	0.329 U
PCB Sum of Congeners	44.672516	32.835978	36.661786	21.798098	48.722772	22.156596	11.154668	33.886636	218.4	62.626942	58.779812
PCB Sum of Congeners x 2	89.345032 Z	65.671956 Z	73.323558 Z	43.59621 Z	97.445544 Z	44.313206 Z	22.309322 Z	67.773258 Z	438.2 Z	125.253884 Z	117.55961 Z
Butyltins (ng Sn/g)											
Dibutyltin	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	NA	0.42 U	0.42 U	0.42 U
Monobutyltin	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	NA	0.49 U	0.49 U	0.49 U
Tetrabutyltin	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	NA	0.35 U	0.35 U	0.35 U
Tributyltin	2.8784	0.42 U	7.532	5.495	1.2852	0.42 U	5.474	NA	1.7598	4.9672	0.42 U

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-33-DM	DSY-33-LOB	DSY-33-PM	DSY-34-PM	DSY-35-IBM	DSY-35-LOB	DSY-35-MM	DSY-35-PM	DSY-36-CN	DSY-36-IBM	DSY-36-LOB
Sample Location	DSY-33	DSY-33	DSY-33	DSY-34	DSY-35	DSY-35	DSY-35	DSY-35	DSY-36	DSY-36	DSY-36
Date Sampled	11/21/1995	11/2/1995	10/20/1995	10/20/1995	10/12/1995	11/2/1995	10/20/1995	10/20/1995	12/7/1995	10/24/1995	10/12/1995
Matrix	Deployed Mussels	Lobster	Hard Clam	Hard Clam	Mussels	Lobster	Hard Clam	Hard Clam	Cunner Fish	Mussels	Lobster
Metals (ug/g)											
Aluminum	14.1288	0.54516	11.8468	9.9932	11.459	0.007 U	13.2132	9.051	2.6488	11.8384	1.4644
Arsenic	1.7402	3.115	0.8232	1.2068	0.8722	2.2722	0.8988	1.1858	0.5026	0.861	2.7776
Cadmium	0.1302	0.0224	0.0924	0.0994	0.1022	0.0784	0.0896	0.0924	0.1358	0.0546	0.000042 U
Chromium	0.3542	0.2786	0.259	0.2982	0.3108	0.3024	0.3332	0.2814	0.1204	0.3976	0.2758
Copper	1.1816	8.449	1.2096	1.4196	1.05	17.9746	0.8988	1.1802	2.1756	0.9856	6.8824
Iron	40.3564	4.361	26.7246	28.2268	28.6482	5.649	35.9408	17.3096	6.8936	27.6248	5.8576
Lead	0.2058	0.0658	0.000042 U	0.2324	0.245	0.1064	0.000042 U	0.2324	0.1358	0.000042 U	0.0476
Manganese	0.8008	0.4354	1.7808	2.1854	0.3808	0.3584	1.6268	2.7902	0.2422	1.5778	NA
Mercury	0.014266	0.031766	0.017234	0.016646	0.023226	0.03724	0.016954	0.014028	0.020328	0.026418	0.045906
Nickel	0.2436	0.2436	0.000042 U	0.2954	0.000042 U	0.1274	0.4088	0.217	0.2002	0.6062	0.2044
Silver	0.000014 U	0.4802	0.000014 U	0.000014 U	0.000014 U	0.9156	0.000014 U	0.000014 U	0.000014 U	0.000014 U	0.4018
Zinc	17.0576	14.7196	14.2422	12.9388	18.144	15.407	15.519	17.4636	7.6846	11.8384	16.1084

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-36-PM	DSY-37-PM	DSY-38-DM	DSY-38-LOB	DSY-38-PM	DSY-39-DM	DSY-39-LOB	DSY-40-DM	DSY-40-IBM	DSY-41-MM	DSY-41-PM
Sample Location	DSY-36	DSY-37	DSY-38	DSY-38	DSY-38	DSY-39	DSY-39	DSY-40	DSY-40	DSY-41	DSY-41
Date Sampled	10/20/1995	10/20/1995	11/21/1995	10/24/1995	10/20/1995	11/21/1995	10/24/1995	11/21/1995	11/2/1995	10/20/1995	10/20/1995
Matrix	Hard Clam	Hard Clam	Deployed Mussels	Lobster	Hard Clam	Deployed Mussels	Lobster	Deployed Mussels	Mussels	Hard Clam	Hard Clam
Polyaromatic Hydrocarbons (PAH) (ng/g)											
1,6,7-Trimethylnaphthalene	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U
1-Methylnaphthalene	0.7938 U	I	I	0.7938 U	0.7938 U	0.7938 U	0.7938 U	0.7938 U	0.7938 U	0.7938 U	0.7938 U
1-Methylphenanthrene	16.831472	1.267 U	1.267 U	1.267 U	10.573318	1.267 U	1.267 U	1.267 U	1.267 U	0.934906 J	10.73212
2,6-Dimethylnaphthalene	0.735 U	0.735 U	0.890554 J	0.735 U	0.735 U	1.832488	0.735 U	4.570888	0.735 U	0.735 U	0.735 U
2-Methylnaphthalene	1.316 U	I	I	1.316 U	1.316 U	1.316 U	1.316 U	1.316 U	1.316 U	1.316 U	1.316 U
Acenaphthene	0.371 U	0.371 U	0.371 U	0.371 U	0.781438	9.437694	0.371 U	18.320652	0.371 U	0.914564	0.902216
Acenaphthylene	0.4039 U	0.4039 U	1.664502	0.4039 U	0.756098 J	4.550896	0.4039 U	6.95366	3.169992	0.638596 J	1.195082
Anthracene	4.197074	1.41995 J	1.666392 J	0.39704 J	1.49205 J	1.12 U	0.251986 J	5.732034	4.780734	1.52754 J	2.75345
Benzo(a)anthracene	9.267272	7.837886	2.070824	0.4704 U	6.397608	2.486428	0.4704 U	5.896394	3.455662	I	5.79516
Benzo(a)pyrene	4.524296	3.239334	1.129338	0.5061 U	2.893856	0.5061 U	0.5061 U	0.5061 U	0.873012 J	1.55085	2.427992
Benzo(b,j,k)fluoranthene	12.687206	8.131186	4.571714	0.868 U	5.669244	0.868 U	0.868 U	0.868 U	7.765282	1.856428	3.194632
Benzo(e)pyrene	0.546 U	1.147734	4.305616	0.546 U	0.546 U	6.213186	0.546 U	6.79917	6.580014	0.427448 J	0.420448 J
Benzo(g,h,i)perylene	2.04631	3.688734	0.2177 U	0.2177 U	1.795612	3.231102	0.2177 U	0.2177 U	0.2177 U	0.51989	0.2177 U
Biphenyl	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U
Chrysene	7.173082	5.26834	2.015734	0.7364 U	3.915296	2.757384	0.7364 U	3.186974	4.128558	I	4.394166
Dibenz(a,h)anthracene	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	4.641658	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U
Fluoranthene	17.405388	10.470082	5.456822	2.317364 J	6.08972	5.7267	1.292704 J	20.16679	14.762762	9.589832	11.15807
Fluorene	0.273 U	0.273 U	0.273 U	0.273 U	0.663656	0.273 U	0.273 U	0.273 U	2.008118	0.535024 J	1.11321
High Molecular Weight PAHs	54.628322 Z	38.528546 Z	16.790956 Z	5.36494 Z	25.420136 Z	22.181208 Z	4.55238 Z	47.16467 Z	34.694926 Z	20.374606 Z	35.487592 Z
Indeno(1,2,3-cd)pyrene	1.524628	0.2156 U	0.2156 U	0.2156 U	1.281098	3.900106	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U
Low Molecular Weight PAHs	11.232816 Z	6.302898 Z	6.5618 Z	4.404582 Z	6.531448 Z	18.25579 Z	3.895444 Z	42.477106 Z	22.064224 Z	7.030338 Z	9.804774 Z
Naphthalene	0.2352 U	I	I	0.2352 U	0.2352 U	0.2352 U	0.2352 U	0.2352 U	2.11106	0.2352 U	0.2352 U
Perylene	2.320556	3.585932	0.202258 J	0.49 U	0.567518 J	0.49 U	0.49 U	0.49 U	I	1.737232	1.891372
Phenanthrene	4.436642	3.835048	2.58692 J	1.408456 J	1.287006 J	1.323 U	1.044358 J	9.646546	8.30732	1.8634 J	2.289616 J
Pyrene	16.189684	11.644304	6.049652	1.266076	6.05507	6.062924	1.478176	17.339798	11.406332	9.165324	11.64359
Total Polycyclic Aromatic Hydrocarbons	98.56 Z	60.2 Z	32.610312 Z	5.32 Z	50.26 Z	50.840594 Z	4.06 Z	98.61292 Z	69.348846 Z	31.22 Z	59.92 Z

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-36-PM	DSY-37-PM	DSY-38-DM	DSY-38-LOB	DSY-38-PM	DSY-39-DM	DSY-39-LOB	DSY-40-DM	DSY-40-IBM	DSY-41-MM	DSY-41-PM
Sample Location	DSY-36	DSY-37	DSY-38	DSY-38	DSY-38	DSY-39	DSY-39	DSY-40	DSY-40	DSY-41	DSY-41
Date Sampled	10/20/1995	10/20/1995	11/21/1995	10/24/1995	10/20/1995	11/21/1995	10/24/1995	11/21/1995	11/2/1995	10/20/1995	10/20/1995
Matrix	Hard Clam	Hard Clam	Deployed Mussels	Lobster	Hard Clam	Deployed Mussels	Lobster	Deployed Mussels	Mussels	Hard Clam	Hard Clam
PCB (ng/g)											
101 (2 2'3 5 5')	1.91394	1.6947	3.94506	1.00352	NC	3.42496	5.23306	4.1461	6.1775	1.13988	1.06652
105 (2 3 3'4 4')	1.234884	0.718886 J	0.78659 J	0.359814 J	NC	1.05658 J	1.165626	0.68817 J	1.107652 J	0.77035 J	0.5726 U
118 (2 3'4 4'5)	1.97771	1.561686	3.458966	1.833734	NC	2.28438	3.98398	3.382358	4.919726	1.154762	1.0269
128 (2 2'3 3'4 4')	0.679672	0.711858	1.121372	0.320348	NC	1.016204	0.778218	1.621774	3.220644	0.612024	0.267694
138 (2 2'3 4 4'5)	6.621356	5.581856	6.82675	3.009454	NC	5.88861	6.033832	7.508396	13.74205	2.07984	3.022656
153 (2 2'4 4'5 5')	7.062888	7.864682	10.004176	4.512592	NC	8.203006	8.442714	9.831612	19.085752	3.16407	4.618138
170 (2 2'3 3'4 4'5)	0.95193	1.034516	0.625156	0.866908	NC	0.442232	0.993076	0.75509	0.500836	1.568882	0.611436
18 (2 2'5)	0.42161 J	0.231756 J	0.455 U	0.455 U	NC	0.455 U	0.455 U	0.390264 J	0.455 U	0.455 U	0.140854 J
180 (2 2'3 4 4'5 5')	3.313016	3.66338	1.78801	1.71311	NC	1.432592	2.629578	2.461326	2.730168	1.810998	2.691528
187 (2 2'3 4'5 5'6)	2.829862	2.872072	2.893464	1.38726	NC	2.213834	2.40086	3.006486	6.26339	1.049216	1.831074
195 (2 2'3 3'4 4'5 6)	0.14441	0.437332	0.400064	0.295106	NC	0.215586	0.357364	0.35014	0.39137	0.152054	0.39788
206 (2 2'3 3'4 4'5 5'6)	1.131102	0.58275	0.696948	0.532882	NC	0.76594	1.00989	0.64582	0.490784	0.691936	0.615244
209 (2 2'3 3'4 4'5 5'6 6')	1.380484	0.71155	1.56443	0.436688	NC	0.759472	0.809424	0.981876	0.580524	0.267904	0.479864
28 (2 4 4')	0.147322 J	0.352254 J	0.89453	0.598696	NC	0.940282	5.711846	0.516068	1.246868	0.743848	0.037156 J
44 (2 2'3 5')	0.564102	0.114408	1.156148	1.008966	NC	1.22689	0.94493	0.894656	1.111236	0.284914	0.316008
52 (2 2'5 5)	0.984284	0.361354 J	1.967882	0.733264	NC	2.073554	1.83351	1.598632	1.869322	0.52353 J	0.70329
66 (2 3'4 4')	3.124912	1.420734	0.5397 U	1.482124	NC	0.5397 U	2.715174	0.5397 U	0.5397 U	1.545796	1.36171
8 (2 4)	0.329 U	NC	0.300776 J	0.252042 J	NC	0.293846 J	0.329 U	0.165172 J	0.384272 J	I	0.329 U
PCB Sum of Congeners	34.483498	29.915746	38.43035	20.346522	NA	32.237982	45.043068	38.943968	63.82208	17.559976	19.187938
PCB Sum of Congeners x 2	68.966996 Z	59.831506 Z	76.860714 Z	40.693044 Z	Z	64.47595 Z	90.086136 Z	77.887936 Z	127.644174 Z	35.119966 Z	38.375876 Z
Butyltins (ng Sn/g)											
Dibutyltin	0.42 U	NA	0.42 U	0.42 U	NA	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	NA
Monobutyltin	0.49 U	NA	0.49 U	0.49 U	NA	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	NA
Tetrabutyltin	0.35 U	NA	0.35 U	0.35 U	NA	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	NA
Tributyltin	9.3996	NA	1.1648	0.42 U	NA	1.3524	0.42 U	0.42	4.438	4.2854	NA

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APPENDIX A

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FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-36-PM	DSY-37-PM	DSY-38-DM	DSY-38-LOB	DSY-38-PM	DSY-39-DM	DSY-39-LOB	DSY-40-DM	DSY-40-IBM	DSY-41-MM	DSY-41-PM
Sample Location	DSY-36	DSY-37	DSY-38	DSY-38	DSY-38	DSY-39	DSY-39	DSY-40	DSY-40	DSY-41	DSY-41
Date Sampled	10/20/1995	10/20/1995	11/21/1995	10/24/1995	10/20/1995	11/21/1995	10/24/1995	11/21/1995	11/2/1995	10/20/1995	10/20/1995
Matrix	Hard Clam	Hard Clam	Deployed Mussels	Lobster	Hard Clam	Deployed Mussels	Lobster	Deployed Mussels	Mussels	Hard Clam	Hard Clam
Metals (ug/g)											
Aluminum	6.0144	10.3348	12.3634	0.007 U	13.4988	15.0808	0.007 U	18.5724	17.6218	14.1624	8.4014
Arsenic	1.0402	1.0402	0.8512	3.6512	0.8512	1.2516	2.6124	0.8344	0.7378	1.0444	0.3024
Cadmium	0.1162	0.0896	0.0868	0.0686	0.0826	0.0448	0.042	0.0854	0.0882	0.126	0.1008
Chromium	0.3444	0.2422	0.3668	0.273	0.2576	0.4186	0.2296	0.3794	0.3122	0.2464	0.2716
Copper	1.6744	1.2502	1.6016	23.128	1.4616	1.2026	27.5646	0.8848	0.9786	1.841	1.666
Iron	24.5616	17.073	52.8038	4.0838	22.4532	20.02	4.2406	34.3406	41.118	18.4114	15.2194
Lead	0.3052	0.4158	0.2702	0.0364	0.000042 U	0.000042 U	0.0252	0.4158	0.3416	0.22512	0.000042 U
Manganese	1.5176	1.4616	2.191	0.6118	2.2372	1.8774	0.6356	1.6702	2.1532	1.911	1.7976
Mercury	0.020986	0.021546	0.017948	0.046046	0.023464	0.019726	0.057456	0.018018	0.023114	0.01673	0.020902
Nickel	0.2618	0.2198	0.4074	0.2632	0.000042 U	0.4676	0.2044	0.4802	0.000042 U	0.000042 U	0.2632
Silver	0.000014 U	0.091	0.2408	0.854	0.000014 U	0.1372	0.1148	0.000014 U	0.000014 U	0.1764	0.000014 U
Zinc	16.9176	14.8624	12.5146	23.996	18.3876	18.2868	18.0222	16.3744	14.6846	9.205	11.7138

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

SUMMARY OF HISTORIC SHELLFISH ANALYTICAL RESULTS
FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-BT	JPC-1-DM	JPC-1-IBM	JPC-1-LOB	JPC-1-MF	JPC-1-MM	JPC-1-PM	T0-DM
Sample Location	DSY-BT	JPC-1	JPC-1	JPC-1	JPC-1	JPC-1	JPC-1	T-0
Date Sampled	10/20/1995	11/21/1995	10/24/1995	12/5/1995	10/20/1995	10/20/1995	10/20/1995	10/24/1995
Matrix	Trap Bait	Deployed Mussels	Mussels	Lobster	Mummichog Fish	Hard Clam	Hard Clam	Deployed Mussel Control
Polyaromatic Hydrocarbons (PAH) (ng/g)								
1,6,7-Trimethylnaphthalene	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U	0.5257 U
1-Methylnaphthalene	0.7938 U	0.7938 U	I	0.7938 U	0.7938 U	0.7938 U	0.7938 U	I
1-Methylphenanthrene	1.267 U	1.267 U	1.267 U	14.63812	1.267 U	4.14001	10.92364	1.267 U
2,6-Dimethylnaphthalene	0.735 U	0.735 U	0.735 U	0.735 U	0.735 U	0.735 U	0.735 U	0.735 U
2-Methylnaphthalene	1.316 U	1.316 U	I	1.316 U	1.316 U	1.316 U	1.316 U	I
Acenaphthene	13.082706	9.0132	0.371 U	0.371 U	0.371 U	0.371 U	0.371 U	0.371 U
Acenaphthylene	0.4039 U	0.4039 U	1.584198	0.4039 U	0.4039 U	0.366632 J	0.424354 J	0.4039 U
Anthracene	1.12 U	3.04066	1.650978 J	1.12 U	0.282352 J	0.84833 J	0.860132 J	0.838754 J
Benzo(a)anthracene	0.4704 U	2.312814	2.211342	0.4704 U	I	1.474004	3.706626	0.4704 U
Benzo(a)pyrene	0.5061 U	0.5061 U	1.093904	0.5061 U	0.5061 U	0.588056 J	1.120574	0.845362 J
Benzo(b,j,k)fluoranthene	0.868 U	5.019462	5.006624	0.868 U	0.868 U	0.86555 J	2.225734	1.512532 J
Benzo(e)pyrene	0.546 U	4.474442	3.694348	0.546 U	0.546 U	0.151564 J	0.275618 J	1.912106
Benzo(g,h,i)perylene	0.2177 U	0.2177 U	0.2177 U	0.2177 U	0.2177 U	0.2177 U	0.2177 U	0.2177 U
Biphenyl	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U	0.798 U
Chrysene	0.7364 U	1.95496	2.366966	0.7364 U	I	1.367226 J	2.43873	0.7364 U
Dibenz(a,h)anthracene	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U	0.0686 U
Fluoranthene	1.197 U	6.735932	6.470828	1.42751 J	1.197 U	3.023328	3.61445	2.226742 J
Fluorene	3.24653	0.273 U	0.90412	1.757812	3.822	0.519568 J	0.44513 J	0.861532
High Molecular Weight PAHs	3.5875 Z	19.487902 Z	17.106642 Z	4.896696 Z	7.81284 Z	9.536618 Z	15.319192 Z	6.21474 Z
Indeno(1,2,3-cd)pyrene	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U	0.2156 U
Low Molecular Weight PAHs	20.582016 Z	18.170096 Z	6.994736 Z	7.379442 Z	7.713664 Z	4.480028 Z	4.834578 Z	6.671672 Z
Naphthalene	0.2352 U	0.2352 U	I	0.2352 U	0.2352 U	0.2352 U	0.2352 U	I
Perylene	0.49 U	0.49 U	I	0.49 U	0.49 U	0.593908 J	0.58884 J	I
Phenanthrene	1.17768 J	3.888136	2.48444 J	2.17553 J	1.283212 J	0.823298 J	1.182762 J	4.196472
Pyrene	0.609 U	7.909496	4.895016	1.6877	6.04114	3.015418	4.370212	1.867236
Total Polycyclic Aromatic Hydrocarbons	17.506916 Z	44.349102 Z	32.36275 Z	21.7 Z	11.48 Z	17.78 Z	32.2 Z	14.26075 Z

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
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APPENDIX A

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FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-BT	JPC-1-DM	JPC-1-IBM	JPC-1-LOB	JPC-1-MF	JPC-1-MM	JPC-1-PM	T0-DM
Sample Location	DSY-BT	JPC-1	JPC-1	JPC-1	JPC-1	JPC-1	JPC-1	T-0
Date Sampled	10/20/1995	11/21/1995	10/24/1995	12/5/1995	10/20/1995	10/20/1995	10/20/1995	10/24/1995
Matrix	Trap Bait	Deployed Mussels	Mussels	Lobster	Mummichog Fish	Hard Clam	Hard Clam	Deployed Mussel Control
PCB (ng/g)								
101 (2 2'3 5 5')	3.297	3.69054	3.5175	1.03684	11.2028	0.8603	1.30074	3.12998
105 (2 3 3'4 4')	1.51452	8.361304	0.493472 J	0.936124 J	3.020752	0.197582 J	0.328762 J	0.300678 J
118 (2 3'4 4'5)	3.909486	3.120096	2.420362	1.929088	12.687612	0.797972	1.05308	0.65023 J
128 (2 2'3 3'4 4')	1.204238	1.285088	1.345008	0.780976	2.732856	0.169106	0.14812	1.275666
138 (2 2'3 4 4'5)	5.441604	6.978972	6.935222	3.002832	22.404228	1.477938	3.147326	2.478588
153 (2 2'4 4'5 5')	6.568212	9.954448	11.240838	4.389434	36.932294	3.799824	4.33881	2.48962
170 (2 2'3 3'4 4'5)	0.837382	0.553434	0.440468	1.110312	5.318516	0.59731	0.627984	0.153538
18 (2 2'5)	1.194228	0.364532 J	0.15169 J	3.616452	0.38283 J	0.455 U	0.139888 J	0.312032 J
180 (2 2'3 4 4'5 5')	1.697486	1.992634	1.77226	1.477616	13.845048	2.249534	1.904616	0.557872
187 (2 2'3 4'5 5'6)	2.34654	2.705934	3.518074	2.841566	11.506586	1.474816	1.512392	0.891828
195 (2 2'3 3'4 4'5 6)	0.209048	0.144214	0.664608	0.056 U	0.623504	0.066542 J	0.23849	0.056 U
206 (2 2'3 3'4 4'5 5'6)	0.403592	0.45388	0.593446	1.336762	0.78533	0.411712	0.976206	1.18293
209 (2 2'3 3'4 4'5 5'6 6')	0.267848	0.385028	0.363748	1.168258	0.417116	0.395346	0.704424	1.317652
28 (2 4 4')	0.844872	0.5621	2.409134	2.064132	1.505602	0.26873 J	0.210378 J	1.974168
44 (2 2'3 5')	3.433836	0.805238	0.9338	0.29302	0.52619	0.169806	0.28707	1.974014
52 (2 2'5 5)	2.244284	1.423366	1.767962	0.853538	2.98487	0.392798 J	0.486584 J	2.065378
66 (2 3'4 4')	0.600628 J	0.5397 U	0.5397 U	0.963956 J	6.013434	0.97951 J	1.261316	0.5397 U
8 (2 4)	0.329 U	0.382886 J	0.962346	0.329 U	I	I	0.329 U	0.329 U
PCB Sum of Congeners	36.014832	43.163722	39.529952	27.800934	132.889582	14.30884	18.666186	20.754174
PCB Sum of Congeners x 2	72.029664 Z	86.327444 Z	79.059904 Z	55.601882 Z	266 Z	28.617666 Z	37.332372 Z	41.508348 Z
Butyltins (ng Sn/g)								
Dibutyltin	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U	0.42 U
Monobutyltin	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U	0.49 U
Tetrabutyltin	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U
Tributyltin	0.42	1.5624	0.42 U	0.42 U	1.2222	1.869	6.937	0.42 U

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

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FORMER ROBERT E. DERECKTOR SHIPYARD
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

Sample Number	DSY-BT	JPC-1-DM	JPC-1-IBM	JPC-1-LOB	JPC-1-MF	JPC-1-MM	JPC-1-PM	T0-DM
Sample Location	DSY-BT	JPC-1	JPC-1	JPC-1	JPC-1	JPC-1	JPC-1	T-0
Date Sampled	10/20/1995	11/21/1995	10/24/1995	12/5/1995	10/20/1995	10/20/1995	10/20/1995	10/24/1995
Matrix	Trap Bait	Deployed Mussels	Mussels	Lobster	Mummichog Fish	Hard Clam	Hard Clam	Deployed Mussel Control
Metals (ug/g)								
Aluminum	0.8862	33.8268	47.3466	0.007 U	0.007 U	15.2362	5.5468	14.0196
Arsenic	NA	0.6188	0.9478	2.7202	0.8288	1.0822	1.5456	5.047
Cadmium	NA	0.0756	0.0826	0.0252	0.1652	0.0994	0.0896	0.07
Chromium	NA	0.4074	0.3416	0.2352	0.1512	0.2954	0.3024	0.273
Copper	NA	1.0094	1.2068	19.9766	3.1836	0.9618	1.6758	1.7024
Iron	5.4166	12.6504	42.5558	5.4166	10.5602	20.9972	19.4488	25.0348
Lead	NA	0.000042 U	0.4592	0.0546	0.0602	0.2968	0.3318	0.0861
Manganese	0.3248	1.3748	3.0632	0.4368	0.2618	2.4682	0.8568	0.6006
Mercury	NA	0.018802	0.02387	0.041818	0.015918	0.017962	0.015652	0.018606
Nickel	NA	0.4312	0.000042 U	0.1946	0.182	0.1848	0.000042 U	0.000042 U
Silver	NA	0.000014 U	0.000014 U	0.3066	0.000014 U	0.000014 U	0.000014 U	0.2044
Zinc	NA	14.9464	12.9962	14.7868	4.7684	16.2764	16.8896	12.0162

U or ND - Not detected; J - Quantitation approximate; Z - Calculated Value; I - Interference;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX B

PRELIMINARY REMEDIATION GOALS (PRGs) FOR DERECKTOR SHIPYARD/CODDINGTON COVE (FINAL, SAIC, NOVEMBER 1998)

Final

Preliminary Remediation Goals (PRGs) for Derecktor Shipyard/Coddington Cove

November 1998

Prepared by:

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List of Acroynms and Units

ACL/MCL	Alternate Concentration Levels/Maximum Contaminant Concentration Levels
ADI	Average Daily Intake
AE	Average Exposure
AET	Apparent Effects Threshold
ARAR	Applicable or Relevant and Appropriate Requirements
AT	Averaging Time
AVS	Acid Volatile Sulfide
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
BPJ	Best Professional Judgment
BSAF	Biota-Sediment Accumulation Factor
BW	Body Weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Conversion Factor
CFR	Code of Federal Regulations
CoC	Constituent (Chemical) of Concern
CV	Coefficient of Variation
CWA	Clean Water Act
DEP	Depurated Sample
DQ	Data Qualifier
DoD	Department of Defense
DW	Dry-Wet Ratio
ED	Exposure Duration
EF	Exposure Frequency
ELU	Elutriate
EMAP	Environmental Monitoring and Assessment Program
EPA (USEPA)	Environmental Protection Agency
EqP	Equilibrium Partitioning
ER-L	Effects Range Low
ER-M	Effects Range Medium
ERA	Ecological Risk Assessment
FA	Freshwater Acute
FC	Freshwater Chronic
FCR	Food Consumption Rate
FFA	Federal Facility Agreement
FI	Factor Ingested
FS	Feasibility Study
HHRA	Human Health Risk Assessment

List of Acroynms and Units (continued)

HI	Hazard Index
HQ	Hazard Quotient
HMW	High Molecular Weight
IF	Intake Factor
IR	Installation Restoration
L-CoC	Limiting Chemical of Concern
LADI	Lifetime Average Daily Intake
LOAEL	Lowest Observed Adverse Effect Levels
LMW	Low Molecular Weight
NA	Not Available
NCP	National Contingency Plan
ND	Non-Depurated Sample
NETC	Naval Education and Training Center
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NOEC	No Observable Effect Concentration
NOEQ	No Observable Effect Quotient
OSWER	Office of Solid Waste Enforcement Regulations
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PRG	Preliminary Remediation Goal
PW	Porewater
RAF	Relative Absorption Factor
RAO	Remedial Action Objectives
RBC	Risk Based Concentration
RBV	Risk-Based Value
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RIDEM	Rhode Island Department of Environmental Management
RIDOH	Rhode Island Department of Health
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
RPRG	Recommended Preliminary Remediation Goal
RSV	Reference Screening Value
SA	Saltwater Acute
SAIC	Science Applications International Corporation
SC	Saltwater Chronic
SD	Standard Deviation
SDWA	Safe Drinking Water Act
SEM	Simultaneously Extractable Metals

List of Acroynms and Units (continued)

SF	Slope Factor
SQC	Sediment Quality Criteria
SQRT	Square Root
STDEV	Standard Deviation
TBC	To Be Considered
TCLP	Toxic Concentration Leachate Procedure
TEV	Threshold Effects Value
TOC	Total Organic Carbon
TRV	Toxic Reference Value
TSCA	Toxic Substance Control Act
UCL	Upper Confidence Limit
URI	University of Rhode Island
WQC	Water Quality Criteria
WQSV	Water Quality Screening Value
μg/L	micro grams per liter
μg/g dw sediment	micro grams per gram of dry weight sediment
ng/g dw sediment	nano grams per gram of dry weight sediment
mg/L	milligrams per liter
kg/L	kilogram grams per liter

1. Background and Objectives

The purpose of this document is to present a plan for the development of Preliminary Remediation Goals (PRGs) for the offshore area of the Derecktor Shipyard/ Coddington Cove Superfund Site. The general framework for this activity was based upon the "Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation manual (Part B, Development of Risk-based Preliminary Remediation Goals, USEPA, 1991a).

The Derecktor Shipyard/Coddington Cove site is located at the Naval Education and Training Center (NETC), Newport, RI, located in the lower East Passage of Narragansett Bay. As a Department of Defense (DoD) facility, investigation and cleanup are conducted as part of the Navy's IR (Installation Restoration) Program, although requirements are also to be consistent with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), pursuant to the Federal Facility Agreement (FFA) agreement of March 1992 between the Navy, USEPA and RIDEM.

As part of the IR Program, numerous investigations have been conducted to determine the type and extent of constituents of concern (CoCs) in soil, groundwater, and offshore sediment and shellfish, including associated risks to the environment and human health. Results of these investigations revealed elevated ecological and human health risks for offshore (e.g. sediment and shellfish tissue) media.

Based on the results of these investigations, the Navy will prepare a Feasibility Study (FS) for Derecktor Shipyard describing options for remedial actions. The remedy options will be evaluated with regard to effectiveness for meeting objectives for mitigation of existing and potential threats to public health and the environment. These Remedial Action Objectives (RAOs) are based on knowledge of the types of CoCs, the environmental media (e.g., soil, water, sediment) in which they are found or could be found in the future and the projected use of the site (Table 1).

Although it is recognized that the remedy will provide a mechanism to meet the RAOs, the spatial extent of the remedy will have to be sufficient to ensure that residual CoCs do not remain at levels higher than Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) or To-Be-Considered (TBC) standards. The applicable chemical-specific ARARs/TBCs are likely to be focused on sediment as the media of concern.

Among the chemical-specific ARARs described in Table 2 are the Federal ARARs/TBCs derived from promulgated USEPA Water Quality Criteria and proposed USEPA Sediment Quality Criteria, which are intended to be protective of 95% of all aquatic species. The threshold chemical concentrations that comply with the ARAR or TBC criteria are called the PRGs for the site. The CoCs and associated concentrations to be used as PRGs are supposed to be risk-based, i.e., reflective of the results of the risk assessment with respect to the selection of those CoCs that "limit" remediation

(USEPA, 1991a). Here, "limiting" CoCs (L-CoCs) are those analytes that are responsible for much of the baseline risk (because of high concentrations and/or strong correlations with high toxicity), such that by cleaning up these CoCs to their PRG concentrations, other co-located CoCs will be cleaned up to levels much lower than their corresponding goals.

In this report, PRGs are developed to permit remedial alternatives evaluation in accordance with the requirements of the National Contigency Plan (NCP) and CERCLA guidance. Two threshold criteria (overall protection of human health and the environment, and compliance with ARARs) and one of five "balancing" criteria (reduction of toxicity) that are used to evaluate the RAOs are directly applicable to PRG selection. The other balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability and cost) are evaluated in the FS that also directly affect the acceptability of various remedial alternatives. Hence, the PRGs developed in this report do not represent absolute levels which must be removed from the site, rather the application of the seven criteria with Trustee involvement will be necessary to select the Final Remediation Goals for the site.

Based on this information, the objectives of this investigation are as follows:

- Derive PRGs;
- Implement PRGs to determine potential spatial extent of remedial action;
- Assess PRG-based results against human health/ecological risk findings and ARAR compliance.

Derivation and implementation of PRGs are discussed in Sections 2.0 and 3.0, respectively. In Section 4.0, the effectiveness of selected PRGs are discussed relative to risk reduction achieved versus type and concentration of CoCs constituting the PRGs.

2. PRG DERIVATION

The objective of the overall PRG development process is to select the L-CoCs for the site and identify their respective concentrations that, when implemented as cleanup criteria, will focus remedial action in those areas where risk is higher than acceptable levels. Risk at the site is determined by aquatic, avian predator, and human health concerns, hence the derivation of PRGs to protect each of these principal exposure pathways is required. The general approach for PRG derivation is presented in Section 2.1; pathway-specific procedures and results are presented in Section 2.2, Section 2.3 and Section to 2.4 for aquatic, avian predator, and human health, respectively.

In the PRG development process, it is assumed that the final PRGs developed for various CoCs can be used as a basis for intercomparison of relative risks contributed by the CoCs, both within and between exposure pathways. Implementing aquatic PRGs for a few CoCs exhibiting the maximum observed exceedences of PRG concentrations would be assumed to be protective of all co-located CoCs contributing risk in the aquatic exposure pathway. The ability to draw such conclusions is critical to the derivation of "Limiting" PRGs as described throughout Section 2.0.

As indicated earlier, a second critical assumption in PRG development involves the degree to which the remediation of the chemical causing the highest risk will lead to reduction of risks caused by other CoCs. For the Derecktor Shipyard/Coddington Cove study area, all the various CoCs tend to be found in each environmental sample, such that it can be reasonably expected that a similar condition of co-located CoCs will exist for unsampled areas. In addition, any CoC found to be "limiting" at a given location and exposure pathway is included in the final list of CoCs selected for the pathway. Thus, when remedial technologies are applied, the implementation of the most conservative (i.e., limiting) PRG can be expected to lead to risk reduction for all CoCs at those locations.

It is important to note that the limiting PRG approach will be effective only when various chemical contaminants and exposure pathways remain co-located at the sampling location. "Dis-location" of CoCs from one another might arise from application of treatment technologies that preferentially remove one CoC class over another. Dis-location of pathways may occur if different remedial solutions for a given location are selected (e.g., monitoring to protect human health vs. capping to protect the marine ecosystem) to protect various classes of receptors (e.g., marine organisms, birds, humans). If either of these practices are instituted, then the available data must be re-evaluated for each CoC class and exposure pathway to ensure all receptors are adequately protected.

2.1. PRG Development Approach

It is the objective of PRG development to determine sediment-based concentrations which represent thresholds below which adverse effects on aquatic biota are not expected to be ecologically significant. Since sediments are the primary reservoir of shipyard-related chemical contamination, the primary exposure mechanism of concern to be addressed by PRGs are the CoC exposures which occur via sediment which may directly expose aquatic biota, or accumulate in tissues of prey organisms for terrestrial, avian, and human receptors. The exposure pathways being addressed by PRGs can vary greatly; in this document, the process is used to address bedded (i.e., in-place) and, resuspended sediment effects on aquatic biota, shellfish predation by avian predators and shellfish harvesting by subsistent fishermen in the Derecktor Shipyard Coddington Cove study area.

The PRG process has been designed to address and integrate these various exposure pathways using a consistent and systemic approach. For the present report, PRGs for the four distinct exposure pathways are evaluated using standardized procedures; development of risk-based PRGs involves refinement of the CoC list and calculation of protective concentrations (derivation), followed by an analysis of site-specificity and practicality for supporting risk reduction (implementation). The general procedures outlined below in 5 steps (1-5) and in Table 3 are discussed in detail in later sections will be followed to derive candidate PRGs for the site. Steps 6 and 7 involve PRG implementation and assessment and are discussed in Section 3.

1. *Identify primary exposure pathways and select/derive benchmarks to express risks of CoC exposure to target receptors.* For the aquatic exposure pathways identified in the Marine ERA, the media of concern for PRG derivation is the concentration of CoCs in the water of bedded and resuspended sediments, while prey tissue residues are the focus of avian exposures. The principal pathway of concern for human health exposure was determined in the HHRA to be shellfish ingestion by subsistence fishermen. For aquatic pathways Water Quality Criteria and/or water-based screening values derived from sediment benchmarks are used. For avian predators and human health, the exposure pathway of concern are CoCs contained in biota; tissue residue benchmarks are based on safe levels of shellfish ingestion and require consideration of site-specific factors discussed in Step 2, below.

2. *Calculate site-specific no effect threshold concentrations for each CoC-receptor pair.* For each CoC, site-specific factors may exist that modify the degree of chemical exposure/bioavailability to target receptors. For the aquatic pathway, site-specific factors include the bound form of the CoC in the environment (e.g., some CoCs present as paint chips, scrap metal, sand blast material, etc.) which could result in CoC bioavailability being less than predicted directly by bulk sediment concentrations. Here, aquatic toxicity tests are used to discern possible site-specific modification in CoC bioavailability. Similarly, avian and human receptors may have varying CoC exposure depending on the age and weight of receptors and factors related to their feeding/harvesting habits.

   Using the site-specific information discussed above, the second step in the PRG development process is to calculate no effect threshold concentrations (NOEC) for each CoC and exposure pathway. The NOEC represents the highest chemical concentration for which effects are unlikely to occur. For example, if an effect was observed at 2, 3, and 4 ppm but not at 0.5 and 1 ppm, the 1 ppm concentration would be selected at the NOEC. Full details of the NOEC derivation are discussed on a pathway-specific basis in Section 2.

3. *Retain CoCs substantially contributing to risk.* An objective of PRG derivation is to identify and retain CoCs for which PRG implementation will lead to effective risk reduction at the site while eliminating other CoCs that would not. For this

step, it was assumed that if a CoC was a substantial risk contributor, the highest concentration associated with toxic samples must be greater than the NOEC. All CoCs satisfying this requirement were retained for further consideration as PRGs.

4. *Evaluate the feasibility of the CoC and pathway-specific NOEC as a long-term remediation goal.* Because of the general exchange of water and sediment in the region of the study area, it must be assumed that it would not technically feasible in the long term to remediate to CoC concentrations that are lower than those generally found in the region. For this step, regional CoC concentrations were summarized and the greater of the NOEC and reference-based concentration was determined. The resulting value was adopted as the Threshold Effects Value (TEV) for each exposure pathway.

5. *Assess CoC exceedences of TEVs to identify "limiting," pathway-specific CoCs for PRG selection.* The CoCs and associated concentrations to be used as PRGs are supposed to be risk-based, i.e., reflective of the results of the risk assessment with respect to the selection of those CoCs that "limit" remediation (USEPA, 1991a). Here, L-CoCs are those analytes that are responsible for much of the baseline risk (because of high concentrations and/or strong correlations with high toxicity) such that by cleaning up these CoCs to their PRG concentrations other co-located CoCs will be reduced to levels much lower than their corresponding effects-based concentrations.

   The approach for selection of L-CoCs for aquatic, avian and human health exposure pathways involved the straightforward application of pathway-specific TEV values to derive Hazard Quotients (HQs). These HQ values were inter-compared for each station and CoC to identify the L-CoC, e.g., that CoC-exposure pathway pair that represents the maximum TEV-HQ observed for the station. This procedure greatly reduces the reliance on assumption of CoC co-location across the site because the broad spatial distribution of sampling locations minimizes the potential that a novel CoC (unique in distribution, concentration or speciation) would be missed and thus fail to be included as a L-CoC.

6. *Calculate PRGs from TEVs.* Based on the selection of L-CoC and the media-specific concentrations that will achieve optimal risk reduction (TEVs), the TEV values are recalculated as necessary into appropriate (sediment-based) concentration (PRG) units to be implemented during site remediation. The calculated values are also discussed relative to traditional benchmarks so as to compare the relative degree of protection afforded to exposure pathways by site-specific and generic approaches.

7. *Evaluate the practicality of the PRGs for effective risk reduction.* In this spatial analysis, a candidate PRG that, upon implementation as part of a remedial

action, would result in risk reduction in the most affected areas should be favored over other candidate PRGs that do not. Note that this step, unlike the previous steps, is a qualitative, risk-based interpretation based on best professional judgment. In this analysis, the location of PRG exceedences (e.g., PRG-HQ > 1) for each of the L-CoCs is reviewed with respect to the spatial distribution and likelihood of observed risks at the site as concluded from the results of the ecological risk assessment (ERA) or human health risk assessment (HHRA). The extent of concurrence between the degree of apparent risk reduction and remediated area is discussed and presented as Recommended PRGs (RPRGs) so as to provide input into risk management decisions regarding the setting of Final Remediation Goals (established as part of the final Record of Decision for the site). As such, this focused discussion is intended to be primarily supportive of the FS analysis of the five balancing criteria (see Section 1) in which extent of risk reduction is assessed against monetary and engineering implications of remedial alternatives.

In summary, steps 1-5 above involve the identification of L-CoCs and matrix-specific (water, sediment, shellfish tissue) concentrations below which no adverse effects are expected. These steps are discussed in detail for aquatic, avian, and human health exposure pathways in Section 2.2 to Section 2.4, respectively; a summary of L-CoC selections is provided in Section 2.5. Separate from the above, steps 6-7 involve PRG implementation and assessment on a pathway-specific basis and are discussed in detail in Section 3.

2.2. Aquatic PRG Derivation

As identified in Section 1, five steps are required for aquatic PRG derivation. Each of these steps is fully addressed in the following sections.

1. Pathway Identification/Benchmark selection. The Marine ERA identified sediments as the principal exposure pathway of concern for aquatic receptors. Sediment Quality Criteria (SQC) for sediments and Water Quality Criteria (WQC) for surface waters are logical choices as ARARs for the Derecktor Shipyard/Coddington Cove study area. Although the direct applicability of SQC has been limited by the number of available criteria to date (presently five non-ionic organic compounds including three PAHs (acenaphthene (USEPA, 1993a), fluoranthene (USEPA, 1993b), phenanthrene (USEPA, 1993c) included as CoCs in the Marine ERA), the SQC derivation process has demonstrated the applicability of WQC to porewater concentrations for prediction of sediment toxicity when partitioning characteristics of the CoC between water and the organic carbon fraction of the sediment (K_{oc}) is taken into account using the equilibrium partitioning (EqP) model of Di Toro *et al.* (1991) as follows:

$$1) \qquad C_p = C_s/(f_{oc} * K_{oc});$$

In the above equation, organic chemical porewater concentrations (C_p, µg/L) are calculated from the corresponding sediment concentration (C_s; µg/kg), based on the fraction of organic carbon (Foc) in the site sediment; [foc = %TOC/100 (Total Organic Carbon)] and the organic carbon/water partitioning coefficient (Koc) for the CoC. Values for K_{oc} (Table 5) were determined from the relationship developed by the EPA (Karickhoff, 1989):

$$2) \quad \log_{10}K_{oc} = 0.00028 + 0.983*\log_{10}K_{ow};$$

where K_{ow} = the octanol/water partition coefficient.

By adopting the EqP approach for the development of aquatic PRGs for the present investigation, the chemical concentration in porewater in relation to WQC is used as the primary measure of potential adverse effects (i.e., risk) to aquatic biota. The EqP model also allows incorporation of station-specific conditions (principally TOC content of sediment measured at the location) that control sediment-porewater partitioning and hence chemical bioavailability in bedded sediments. In contrast to the bedded sediment exposure pathway, direct measurements of CoCs in elutriates for the resuspended pathway obviates the need for partitioning calculations for this medium.

As discussed in Section 1, determination of organic and metal CoCs responsible for the majority of the risk is assessed through normalizing concentrations to benchmarks so as to adjust for differences in the inherent toxicity of the chemical. For this investigation, Water Quality Screening Values (WQSV) adopted primarily from EPA Water Quality Criteria - Saltwater Chronic (WQC-SC) values (or estimated equivalents, discussed below) were used as the benchmarks.

Water-based CoC criteria are proposed for calculation following the decision tree presented in Figure 2.2-1. This approach allows for calculation of "WQC-SC equivalent" benchmarks, and assigns a data qualifier (DQ) to identify the benchmark source for derivation of the HQ. In Table 4, the DQ "A" is applied to benchmarks derived directly from existing WQC-SC values. For CoCs possessing WQC-saltwater acute values (WQC-SA), an 8:1 acute:chronic ratio is applied to derive the equivalent WQC-SC value (DQ = "B"). The conversion factor was derived from the mean overall acute:chronic ratio for paired chemical data contained in the EPA AQUIRE database (Shepard, 1998). Freshwater chronic data (WQC-FC) are used directly as screening values, with assigned data qualifier "C". As with WQC-SA values, freshwater acute (FA) values were converted to chronic values using an 8:1 acute:chronic ratio, and assigned DQ = "D".

Some sediment-based correlative benchmarks are required to complete the assessment of site-related CoCs where water quality benchmarks are lacking (Table 4). In these cases, NOAA Effects Range-Low (ER-L) (Long et al., 1995) concentrations were selected and translated into porewater equivalent concentrations using the EqP model. In this process, it is assumed that the resultant value provides a level of

protection equivalent to other water quality based benchmarks. This assumption is not unreasonable given that the WQC values are designed to be protective of 95% of all species, while NOAA ER-L values represent concentrations below which 90% of all sediment samples had no measurable adverse effect. Hence, sediment benchmark values (NOAA ER-L) were transformed into water-equivalent benchmarks using the EqP model by assuming 1% sediment TOC concentration (DQ = E). Finally, compounds for which no benchmark screening values were available are designated "NA" in Table 4.

Research by the USEPA into the development of SQC for divalent metals (Cu, Cd, Pb, Ni, and Zn) in sediment has shown that sediment toxicity can be predicted when the quantity of Simultaneously Extractable Metal (SEM) present in excess of the Acid Volatile Sulfide (AVS) concentration in sediment is measured (Berry *et al.*, 1996). The expression of SEM relative to AVS has been historically expressed as the SEM/AVS ratio, although the difference of SEM and AVS (SEM-AVS) is now preferred, as the metric is less sensitive to conditions where AVS is near detection limits (e.g., resulting in very high SEM/AVS ratios). The use of SEM-AVS is based on the fact that AVS will bind divalent metals in direct proportion to their respective molar concentrations (Hansen *et al.*, 1996). In the EPA National Sediment Quality Inventory (USEPA, 1996a) the SEM-AVS value of 5 µmol/g dry wt is recommended as a screening value for identification of bedded sediments of concern with regard to potential divalent metal effects on aquatic biota in bedded sediments.

The above application of SEM:AVS data to bedded sediments can be modified to be relevant to sediments recently deposited as a result of resuspension. By assuming that all AVS is oxidized during resuspension (AVS = 0) and that the SEM concentration of settled particulates is the same as that of bedded sediment (conservatively assuming no losses in the water column), the potential effect of metals in sediments subject to resuspension can be assessed by direct comparison of SEM metal concentration against the SEM benchmark (5 µMol/g). It is noted that this evaluation was also performed in the ERA (Table 6.1-1). The SEM-AVS method is not directly amenable to PRG development since it does not directly identify CoC-specific PRGs. However, the data are useful for evaluation of the overall need for metals-based site-specific PRGs.

The WQSV presented in Table 4 represent thresholds for adverse effects to aquatic biota as derived from available water quality criteria and modified sediment benchmarks. Porewater and elutriate concentrations (reported in Tables A-3.1 and A-4.1, respectively) are divided by the WQSV to obtain Porewater Hazard Quotients (PW-HQs; Table A-3.2) and Elutriate Hazard Quotients (ELU-HQs; Table A-4.2). These quotients are used to determine no effect concentrations as discussed in the following section.

2. *Calculate site-specific no effect threshold concentrations for each CoC-receptor pair.* A common element of correlative benchmark development is the process

of establishing statistical confidence limits for sediment concentrations with varying likelihood of biological effects. For example, the NOAA ER-L benchmark (Long and Morgan, 1990; Long *et al.*, 1995) was developed by matching of chemical concentrations with incidence of benthic effects (e.g., toxicity, reduced benthic composition, biomarker response) measured in field samples, and statically estimating the sediment concentration below which no adverse effect was observed 90% of the time.

As introduced in Section 1, it is expected that site-specific factors exist which control the bioavailability of CoCs in the marine sediments of the shipyard/cove study area and thus modify the degree of chemical impacts on target receptors. For the present investigation, the primary indicator of site-specific CoC bioavailability in bedded sediment are toxicity results from the amphipod (*Ampelisca abdita*) 10-day bulk sediment test, while for resuspended sediments, results of the sea urchin (*Arbacia punctulata*) fertilization and larval development elutriate tests are used. An amphipod and sea urchin biotoxicity test was conducted at each location where a bulk sediment or elutriate chemistry sample was collected, respectively.

Adapting the general approach presented for ER-L derivation (discussed above), PW-HQ data were paired with co-located amphipod toxicity results, while elutriate hazard quotient (ELU-HQ) data were paired with co-located sea urchin toxicity results. The paired data sets were subsequently segregated in non-toxic and toxic samples defined for each as follows: amphipod survival $\geq$ 80% = non-toxic; sea urchin successful fertilization $\geq$ 70% = non-toxic, and sea urchin larval development $IC_{10} \geq 50\%$ = non toxic. The PW-HQ or ELU-HQ database test endpoint are reported in (Tables A-3.3A, A-3.3B, A-4.3, and A-4.4).

The HQ databases include statistical summaries of the mean, maximum, and upper 95% of CoC-specific HQs. The non-toxic data sets available for derivation of no effect thresholds include 15 co-located stations for the bedded sediment pathway and 9-11 stations for the resuspended sediment pathway.

For each CoC, the highest concentration for which adverse effects are unlikely, called the No Observable Effect Quotient (NOEQ), was estimated as the upper 95% confidence limit (UCL) of the non-toxic PW-HQ or ELU-HQ data set (e.g., expected risk threshold at maximum CoC bioavailability). The 95% UCL approached was adopted as a method comparable to the USEPA WQC level of protection for chronic effects as calculated from single species/single toxicant bioassay results. For NOEQ values < 1, an NOEQ = 1 was adopted for the CoC assuming that it is unlikely that site specific factors could increase CoC bioavailability to levels above that occurring in water-only tests.

NOEQ results for the bedded and resuspended sediment exposure pathways are provided in Tables 5A and 5B, respectively. The listed CoCs include metals, PAHs, Total PCBs, and pesticides as well as aggregate values for Low Molecular Weight

(LMW) PAHs, High Molecular Weight (HMW) PAHs and Total PAHs, and a sediment-based measure of divalent metal bioavailability (SEM-AVS). The aggregate CoC classes were included to address the potential additive effects of PAH and metal mixtures.

For most CoCs, the NOEQ was less than 1, indicating good agreement between measured toxicity and the literature-based WQC data; indicating that toxicity was not observed where criteria values predict that toxicity should not occur. In such cases where the *CoC-specific* NOEQ was less than 1, a NOEQ value of 1 was retained. For some CoCs, the NOEQ did exceed unity somewhat; this is attributed to the fact site-specific conditions have slightly reduced CoC bioavailability relative to conditions under which the WQC are derived (i.e., single-species, water-only laboratory bioassays). Here, the NOEQ was selected as the greater of the upper 95% HQ and the default HQ (e.g., HQ=1).

3. Retain CoCs substantially contributing to risk. Also listed in Table 5 are the maximum PW-HQ values for sediment samples found to be toxic to amphipods and maximum ELU-HQ values for elutriate samples found to be toxic to sea urchin larval development. No toxicity to sea urchin fertilization exposed to elutriates was observed in the ERA investigation. Those CoCs which were found to exceed the NOEQ benchmark (Max. HQ > NOEQ) for a given test endpoint were retained for further PRG derivation. For bedded sediment, the CoCs included HMW PAHs and Total PCBs. For resuspended sediments, CoCs included arsenic, copper, lead, HMW PAHs, Total PAHs, Total PCBs, and the pesticide o,p'-DDE. In assessing the potential for metals effects in resuspended sediment only four stations (DSY-27, 28, 29, 30) marginally exceeded the benchmark (e.g. SEM concentration >5 μmole/g), and only one station by more than a factor of two (DSY-27 12.1 μmole/g). Given that the SEM value the sum of five metals (Cu, Cd, Pb, Ni, Zn), and that AVS was extremely high in this sediment (176 μmole/g) it is unlikely that the combined effect of metals (let alone individual metals) are responsible for adverse effects at this or any other sample location.

The Aquatic NOEQ value used for further PRG development was taken as the minimum of the test-specific endpoints. Given the comparability of the NOEQ data among test endpoints and the observation that the calculated NOEQs are generally less than three (LMW and Total PAH for resuspended sediment was ~7.3), it is apparent that the site-specific CoC bioavailability is similar to that found for laboratory bioassay experiments. This good agreement is attributed to the fact that the test species employed in the Marine ERA are sensitive to site CoCs and serve as adequate surrogates for the most sensitive species in the shipyard/cove study area.

4. Evaluate the feasibility of the CoC and pathway-specific NOEC as a long-term remediation goal. Table 6 presents a summary of aquatic Reference Screening Values (RSVs) for the candidate CoCs identified in Steps 1-3, above. The database was assembled from measured or predicted porewater and elutriate concentrations at

reference locations used for the Allen Harbor (SAIC, 1996), McAllister Point (SAIC and URI, 1997a), and Derecktor Shipyard (SAIC and URI, 1997b) Marine ERAs (Table 6).

Prior to the use of these data, a limited assessment of these reference locations in lower Narragansett Bay to reference stations selected for the Derecktor Shipyard/Coddington Cove study area was conducted to demonstrate comparability of habitat and hence suitability as sites for background data. Data presented in Table A-2.2 show that the sand (66-88%), silt (12-33%), and TOC (1.1-1.7%) content for Derecktor Shipyard/Coddington Cove reference locations were within the range observed for Narragansett Bay stations as a whole; these similar geotechnical characteristics imply comparability of habitats. Hence it was assumed that the reference database can serve as suitable indicator of background CoC concentrations for derivation of aquatic PRGs.

In the development of the reference databases for the aquatic exposure pathways, the porewater reference data were screened for statistical outliers (defined as values greater than + 2 S.D. of the mean) to ensure that the RSV was not inappropriately elevated by atypical CoC distribution. The mean and 95% UCL of porewater concentrations after outlier removal were recalculated to obtain the RSV for the bedded sediment exposure pathway. In the case of the resuspended sediment scenario, only a single reference location (JPC-1) was measured for elutriate concentrations, hence the value obtained were used without modification.

Data for determination of aquatic TEVs are presented in Table 7. The Aquatic NOEQ values (from Step 3) were converted into the NOEC (e.g., water concentration units) to permit comparison against porewater and elutriate RSVs derived as described in Step 4. Subsequently the Aquatic TEV (AQ-TEV) was taken as the greater of the Aquatic NOEC and Aquatic RSV concentrations. The comparison of the two values show that the NOEC concentration exceeds the background concentration in most cases, suggesting that it would be feasible to remediate to the TEV concentrations, as background concentrations (represented as the aquatic RSV) would not be expected contribute to recontamination of the site. For lead and o,p'-DDE, however, the RSV exceeds the TEV, and thus the RSV is selected as the TEV for these CoCs.

5. *Assess CoC exceedences of TEVs to identify "limiting," pathway-specific CoCs for PRG selection.* As discussed in Section 2.1 (step 5), the list of CoCs to be retained as candidate PRGs are supposed to be "limiting", such that by cleaning up these CoCs to their PRG concentrations, other co-located CoCs will be reduced to levels much lower than their corresponding effects thresholds. In this step, the L-CoCs are derived by intercomparing TEV-HQs (in turn, derived from normalization of CoC concentrations in site to respective TEVs) and selecting the CoC with the maximum risk within and among pathways on a station-by-station basis.

To further ensure that all important L-CoCs be retained for the aquatic exposure pathway, the CoC with the maximum TEV-HQ for the station-pathway was selected

whenever the station-pathway sum TEV-HQ > 1. This step was taken to further address the uncertainty in the co-location assumption by identifying any CoC which might substantially contribute to risk at the site. The process was repeated for all sampled locations to identify the collection of all possible L-CoCs. Because of the large number of stations used in this analysis (19) and the broad spatial distribution of sampling locations, the potential that a novel CoC (unique in distribution, concentration or speciation) would be missed and hence fail to be included as a L-CoC was greatly reduced.

Table A-5 presents the maximum observed TEV-HQs by exposure pathway and station. Results show that among all the possible CoC candidates for both exposure pathways, only a small number of CoCs had TEV-HQs > 1. For the bedded sediment exposure pathway, the two L-CoCs were HMW PAHs and Total PCBs. Arsenic, copper, lead, Total PCBs, and o,p'-DDE were identified as L-CoCs for the resuspended sediment exposure pathway. These CoCs are identified as Limiting CoCs in Table 7 which will be brought forward to Section 3.1 (Aquatic PRG implementation) for further development as PRGs.

It is noted that the application of a toxicity screen for the identification of L-CoCs did not appear to have greatly affected those CoCs which would have been selected based on direct WQSV comparisons alone. For porewater, SEM-AVS values suggest that divalent metals are not biologically available (SEM-AVS < 0, Table A-3.3A), hence analyte-specific porewater concentrations, although not measured, would be expected to be less than ambient water quality criteria. Some high molecular weight PAHs were predicted to exceed WQSVs (e.g., anthracene, benzo(a)anthracene, flourene, chrysene), but were not identified by the toxicity evaluation. In this case, however, these PAHs were addressed by adopting a HMW PAH aggregate PRG. Thus, while not specifically selecting these CoCs, the potential cumulative risks responsible from these PAHs were accounted for. Finally, pesticides were not identified in the toxicity screen, nor were any of these CoCs above WQSV values. Hence, it can be concluded that the toxicity screen did not exclude any key CoCs which might have been selected by the application of WQSV alone.

2.3. Avian Predator PRG Derivation

1. Pathway Identification/Benchmark derivation. Findings of the Marine ERA indicate that avian aquatic predators are at potential risk because of CoCs contained in the tissue of prey that they consume. Initial selection of CoCs and benchmarks for avian predator PRG derivation were based on the Derecktor Shipyard Marine ERA results comparing prey species tissue residue concentrations to Toxicity Reference Value (TRV) benchmarks for any CoC and predator-prey combination in the shipyard/cove study area (ERA Table 6.3-2). These TRVs already incorporate site-specific factors as described in Step 2, below. The resulting HQ values (TRV-HQs), derived as the prey species concentration (mg/kg dry weight) divided by the TRV

(mg/kg dry weight), are reported in Appendix A-2-4 of the Final Marine ERA (SAIC and URI, 1997b).

2. *Calculate site-specific no effect threshold concentrations for each CoC-receptor pair.* Site-specific factors controlling CoC bioavailability to local birds selected for the ERA (great blue heron and herring gull) include the species, age and weight, and factors related to their feeding habits and migratory range in the New England region. The following description of methods and results for deriving TRVs for great blue heron follows is the same as used in the Marine ERA (Section 6.3).

A literature survey was conducted to identify studies where No Observed Adverse Effect Levels (NOAELs) and/or Lowest Observed Adverse Effect Levels (LOAELs) were determined for avian test species. The resulting data set included NOAEL/LOAELs for both domestic and wild birds; where possible, aquatic bird test data was selected in preference over data for other bird species. Subsequently, the equivalent NOAEL for the receptor of concern (wildlife NOAEL) was obtained by scaling the laboratory data (test NOAEL) on the basis of differences in body size according to the following equation:

NOAEL-wildlife = test NOAEL x $[\text{test bw/wildlife bw}]^{1/3}$ (Opresko *et al.*, 1994)

where: wildlife bw = body weight of wildlife species in kg
test bw = body weight of laboratory species in kg
test NOAEL = experimental dose in mg CoC/kg RoC/day

The TRV is defined as the concentration in food (in mg CoC/kg dry weight of food) which would result in a dose equivalent to the NOAEL (assuming no exposure through other environmental media), after Opresko *et al.*, 1996. The TRV was calculated from the food factor *f*, which is the amount of food consumed per unit body weight per day:

TRV = wildlife NOAEL/f (Opresko *et al.*, 1994)

Food factors for aquatic predators were derived from the Food Consumption Rate (FCR, in kg prey dry weight/day) and the receptor body weight (bw in kg):

f = FCR/bw (Opresko *et al.*, 1994).

For the Derecktor Shipyard ERA, the FCR for great blue heron were estimated from the allometric regression model of Kushlan (1978, as cited in USEPA, 1993).

3. *Retain CoCs substantially contributing to risk.* Using the above model and results for great blue heron, all CoCs with TRV-HQs > 1 were retained for further PRG derivation (ERA Table A-2-4.6). CoCs meeting the TRV-HQ >1 criteria include eight metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc) as well as

Total PCBs. Note that in the ERA, maximum TRV-HQs for the PAHs and pesticides were found to be uniformly less than unity and thus were eliminated from further development as PRGs for the avian exposure pathway.

4. *Evaluate the feasibility of the CoC and pathway-specific no effect threshold concentration as a long-term remediation goal.* As done for the aquatic RSV derivation, a reference database consisting of prey species tissue concentrations was developed for CoCs identified in Step 3, above, to derive Avian Reference Screening Values (AV-RSVs), being the mean + upper 95% confidence band statistics of reference tissue data after outlier removals. These results are reported in Table 8.

The resulting avian predator RSVs are compared against TRVs in Table 9 to evaluate the feasibility of implementation. The TRV values for cadmium, copper, lead, and mercury were higher than avian predator RSV concentrations, while the reverse was true for arsenic, chromium, silver, zinc, and Total PCBs. The avian TEV was taken as the greater of the TRV and avian RSV concentration to ensure that PRGs are not set to concentrations below regional background values.

5. *Assess CoC exceedences of TEVs to identify "limiting," pathway-specific CoCs for PRG selection.* Following the aquatic pathway procedure, the list of L-CoCs to be retained as candidate PRGs was derived by intercomparing avian TEV-HQs and selecting the CoC with the maximum risk for each station.

Results of this comparison are presented in Table A-6. Analytes identified as L-CoCs include copper, lead, silver, zinc and Total PCBs. These CoCs are identified in Table 9 and will be brought forward to Section 3.2 (Avian Predator PRG implementation) where a spatial implementation analysis will be used to determine the L-CoCs needed for protection of the avian predator exposure pathway.

2.4. Human Health PRG Derivation

Chemical-specific PRGs are concentration goals for individual CoCs for specific medium and land use combinations at CERCLA sites. Two general sources of chemical-specific PRGs for human health are concentrations based on ARARs and concentrations based on risk assessment. ARARs include concentration limits set by other environmental regulations (e.g., non-zero maximum contaminant level goals (MCLGs) set under the Safe Drinking Water Act (SDWA)). The second source for PRGs, and the focus of this section, is risk assessment or risk-based calculations that set concentration limits using carcinogenic and/or noncarcinogenic toxicity values under site-specific exposure conditions.

1. *Pathway Identification/Benchmark selection.* Findings of the HHRA indicate that consumption of shellfish containing elevated CoCs by subsistence fishermen is the primary pathway of concern for the Derecktor Shipyard/Coddington Cove study area.

Hence, the list of benchmarks for human health PRG development focus only on CoCs in shellfish tissue caught in the vicinity of Derecktor Shipyard/Coddington Cove. Four indigenous species were used in the Derecktor Shipyard HHRA (BRE, 1998) to characterize edible shellfish. This included hard shell clams (*Mercenaria mercenaria* and *Pitar morrhuana*), blue mussels (*Mytilus edulis*), and lobster (*Homarus americanus*). The CoCs determined to exceed the carcinogenic effects threshold representing a 1×10^{-6} probability of risk included arsenic, benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1.2.3-cd)pyrene, and Total PCBs. The HHRA also found arsenic concentrations in shellfish to exceed the non-carcinogenic effects threshold (e.g., HQ≥1). Based on these findings, this exposure pathway was evaluated for PRG development. The site-specific benchmarks for shellfish tissue residues, called Risk Based Values (RBVs), are derived as described in Step 2, below.

2. *Calculate site-specific no effect threshold concentrations for each CoC-receptor pair.* Threshold chemical intake rates assumed to be protective of potential adverse effects from carcinogenic and non-carcinogenic CoCs were used to determine no effect threshold concentrations in shellfish tissue, or RBC. The majority of exposure parameters needed for RBC derivation were obtained from USEPA Standard Default Exposure Factors (USEPA, 1993e), reported in Table 10. These same exposure parameters and values were used in the HHRA. The main site-specific parameter was the annual shellfish consumption rate for New Englanders published by Rupp *et al.* (1980). The survey showed the 95th percentile of total shellfish consumption for adults in the range of 18 to 65 years of age was 15.6 g/day (Rupp *et al.*, 1980). As had been done in the HHRA, it was conservatively assumed that all shellfish consumption by subsistence fishermen will occur in Derecktor Shipyard/Coddington Cove.

The CoC-specific RBC is typically taken as the concentration in shellfish which is unlikely to cause adverse health effects, even in sensitive populations (USEPA, 1991a). For non-carcinogenic CoCs, the RBC representing a baseline (HQ=1) hazard to humans from ingestion of CoCs is following USEPA guidance (USEPA, 1989a) as follows:

$$C,\ non\text{-}carcinogen\ (mg/kg\ wet\ tissue) = \frac{HI \times RfD \times BW \times AT}{IF \times CF \times FI \times EF \times ED \times RAF}$$

Where:

HI	=	Total Hazard Index; ratio of average daily intake level to acceptable daily intake level (unitless)
ADI	=	Average Daily Intake (mg/kg-day)
RfD	=	Reference dose (acceptable daily intake level; mg CoC/kg-day; see Table 11)
C	=	Concentration in shellfish tissue (mg/kg)
CF	=	Conversion factor (1 kg/10^3 g)
IF	=	Intake factor[1] (i.e., shellfish consumption rate, g/day)

FI	=	Fraction ingested (i.e., fraction of shellfish ingested)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
RAF	=	Relative absorption factor (unitless; analyte-specific; see Table 10)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Assuming the reasonable maximum exposure scenario is the reduced form of the equation using the site-specific exposure parameters from Table 10 is as follows:

$$C,\ non\text{-}carcinogen\ (mg/kg\ wet\ tissue) = \frac{4679.5 \times RfD}{RAF} \quad (1)$$

For carcinogenic effects, a concentration range (i.e., the preliminary shellfish remediation goal range) is calculated which corresponds to a range between 10^{-4} and 10^{-6} incremental risk of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen from all significant exposure pathways for a given medium (USEPA, 1991a). This is based on USEPA's interpretation of the significance of the cancer risk estimate as stated in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300).

By setting the total risk for carcinogenic effects at a target risk level of 10^{-6} (the NCP's point of departure for determination of PRGs), the risk-based shellfish concentration (C) is calculated as follows:

$$C,\ carcinogen\ (mg/kg\ wet\ tissue) = \frac{Risk \times BW \times AT}{SF \times IF \times CF \times FI \times EF \times ED \times RAF}$$

Where:

Risk	=	The unitless probability of an exposed individual developing cancer
LADI	=	Lifetime average daily intake (mg/kg-day)
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$

and remaining exposure parameters are as defined above. The equation shown below reflects the use of Reasonable Maximum Exposure (RME) parameters identified in Table 10.

$$C,\ carcinogen\ (mg/kg\ wet\ tissue) = \frac{0.011}{SF \times RAF} \quad (2)$$

The above equation is used to calculate CoC-specific threshold tissue residue concentrations below which adverse effects on subsistent shellfish consumers are not expected to occur. The CoC-specific parameters include RAF and SF values identified in Table 10 and Table 11, respectively.

Table 12 presents the calculated CoC-specific non-carcinogenic (Equation 1) and carcinogenic (Equation 2) RBC values assuming the RME exposure scenario. The overall Risk Based Values (RBVs) were taken as the minimum of RBC concentrations for each analyte. For comparison, the RBC concentration at 1×10^{-4} is also presented. As the RBV values will be compared against dry weight-based reference shellfish concentrations for the study area (Table A-2.4) and RBCs are calculated as wet (e.g. live) weight concentrations, % solids content (g dry/g live wt) statistics were developed for tissue samples to permit conversion of the RBV data to dry weight units. Data reported in Table A-2.3 indicates good agreement in solids content for various species allowing use of the average of 14% solids content (i.e., 86% water content) for conversion of wet weight values into dry weight concentrations. Thus, the RBVs for CoCs represent the dry weight shellfish tissue concentrations that are protective of subsistent fishermen consuming locally caught shellfish.

3. *Retain CoCs substantially contributing to risk.* All CoCs found in environmental samples above the RBV (as calculated in Step 2) are retained for further PRG derivation. In effect, the HHRA has already performed this calculation and identified these CoCs as presenting possible cancer and non-cancer risks although here threshold effect concentrations are also presented. A more detailed evaluation of the exposure assumptions (e.g., 10^{-6} vs. 10^{-5} cancer risk assumption) and exposure parameters will be performed to assess reasonableness during PRG implementation (Section 3.3). This will afford the opportunity to correct for overly conservative assumptions in the risk assessment and incorporate the most recent literature values published since the HHRA was completed.

4. *Evaluate the feasibility of the CoC and pathway-specific no effect threshold concentration as a long-term remediation goal.* The efficacy of these human health RBVs are further evaluated by comparison against human health RSVs derived from measured CoC concentrations in mussels and clams collected from reference locations (Table 13). These values are carried forward to Table 14, where Human Health TEVs (HH-TEVs) are obtained by selecting the greater of the RBV data and the RSV data. With the exception of arsenic, the RBV was higher than the reference (RSV) concentration. Elevated arsenic concentrations in shellfish tissues was addressed in the ERA and attributed to high arsenic in crustal materials typical of the Rhode Island formation (see text in ERA Section 4.3.1.1).

5. *Assess CoC exceedences of TEVs to identify "limiting," pathway-specific CoCs for PRG selection.* Following the same procedures as employed for the aquatic and avian predator exposure pathways, the list of CoCs retained as candidate PRGs for Human Health were derived by intercomparing TEV-HQs and selecting the CoC with the maximum risk within and among pathways on a station-by-station basis (Table A-7). The results indicate that arsenic, benzo(a)pyrene and dibenz(a,h)anthracene are L-CoCs for the human health pathway (Table 14). A single occurrence of TEV exceedence by dibenz(a,h)anthracene was noted for deployed mussels at off shore station DSY-39. Given that this media would not be available to shellfishermen and

that other species collected from this location did not show similar exceedence, this analyte was not selected as a L-CoC. The above results demonstrate that relatively few CoCs account for the majority of risk in the study area, and further supports the selection of L-CoCs as PRGs for risk reduction at the site.

2.5. PRG Derivation Summary

The above PRG derivation process has identified pathway-specific L-CoCs and media-specific concentrations (TEVs) for protection of aquatic, avian, and human receptors. Table 15 presents a summary of maximum observed TEV-HQs observed by exposure pathway and station that constitute the list of L-CoCs for PRG implementation. Results show that among all the possible CoC candidates, only a small number of CoCs for the aquatic, avian predator, and human health observations, respectively, had TEV-HQs>1. For the bedded sediment aquatic exposure pathway, the two L-CoCs were HMW PAHs and Total PCBs, while arsenic, copper, lead, Total PCBs, and o,p'-DDE were identified as L-CoCs during resuspended sediment exposure. Additional L-CoCs included copper, lead, silver, zinc, and Total PCBs for the avian predator pathway, while arsenic and benzo(a)pyrene were identified for the human health pathway with the single exception of o,p-DDE (TEV-HQ = 0.8). The same list of CoCs is retained for all pathways combined.

The above results demonstrate that relatively few CoCs account for the majority of risk in the Derecktor Shipyard/Coddington Cove study area, and further supports the selection of chosen L-CoCs as PRGs for risk reduction at the site. It should be noted that the small number of identified CoCs is a reflection of the relative similarity of CoC bioavailability and related risk sources across the site. This observation provides some assurance that a novel CoC (unique in distribution, concentration or speciation) has not been missed and thus wrongly excluded as a L-CoC.

3. PRG Implementation

The second phase of PRG development involves a qualitative assessment of the practicality for spatial implementation, i.e., whether the spatial implementation of the PRG preferentially target areas of higher risk as identified in the Marine ERA (aquatic and avian) and HHRA. In this regard, candidate PRG values are "tested" through comparison against measured chemical concentrations at the site. This requires that the TEV values be translated into sediment based units (PRGs) so the available data at the site can be considered with respect to PRG compliance and risk reduction (Section 3.1). Subsequently, the relationship among the degree of risk reduction achieved in consideration of remediated area is discussed to recommend appropriate PRGs from a risk-based perspective (Section 3.2). These recommendations are used as input into the FS and resulting risk management decisions regarding the setting of Remediation Goals discussed in Section 3.3.

3.1. Translation of TEV Values into PRGs

3.1.1. Aquatic PRGs-Calculation Method.

With respect to the translation of the TEV for porewater and elutriate media back to sediment-based concentrations, the primary intention is to derive a PRG number that both protects the receptor, and when applied to measured sediment chemistry, reflects a comparable degree of risk as indicated by the matrix-specific risk indicator (i.e., the TEV-HQ). For example, a sediment porewater concentration at a given location that is two-fold above the TEV (e.g., TEV-HQ = 2) should ideally have a corresponding PRG concentration that, when implemented, will reduce the risk by a factor of two (e.g. from PRG-HQ = 2 to a PRG-HQ < 1). Inherent in this application of PRGs is the assumption that risk at a given location when expressed as a unitless quotient is the same regardless of whether the benchmark is TEV-based or PRG-based, thus:

$$\text{PRG-HQ}_{\text{Sta., CoC, Pathway}} = \text{TEV-HQ}_{\text{Sta., CoC, Pathway}} \quad (3)$$

Where the risk equivalency assumption in Equation 3, the previous statement holds true only for a given location, CoC, and exposure pathway.

The concept of cross-matrix risk equivalency is not new. This approach, for example, was used in the ERA to assess risks as a result of CoCs in tissues (from Shepard, 1998) based on WQC, wherein the tissue concentration in the biota achieved at the water-based effects threshold (e.g., WQC-chronic) is the relevant tissue-based effects threshold because CoCs must reach the site of toxic action (e.g., tissues) to exert their effect. Similarly, the degree of risk associated with porewater/elutriate concentration of causing the effect in bedded/resuspended sediment (i.e., TEV-HQ) must equal the risk associated with bulk sediment concentration (PRG-HQ) responsible for generating (via partitioning) that porewater concentration:

The relationship described in Equation 3 can be used to solve for the location-CoC-pathway as follows. Substituting for PRG-HQ:

$$\frac{[\text{Sed}]}{\text{PRG}} = \text{TEV-HQ} \quad (4)$$

Given the TEV-HQ and associated sediment concentration ([SED]), the PRG concentration can be solved:

$$\frac{[\text{Sed}]}{\text{TEV-HQ}} = \text{PRG} \quad (5)$$

The important feature of this TEV-to-PRG translation method is that the measured risk data is used to derive the PRG value, whereas traditionally the EqP models would be used to back-calculate PRGs. In some cases, the models may still be needed, for example, where characteristics of a particular media sampled at a given location (e.g., TOC content of sediment, inert CoC materials such as metal fragments) result in an estimated PRG that is outside the expected range about the value at PRG-HQ = 1. In these instances, the predicted values can be validated against model estimates in relation to the model parameter inputs for the given location and the cause for atypical (high or low) PRG values can be isolated. In the present study, the procedure described above was used to calculate station-specific PRG estimates from which the mean PRG value was taken as the site-wide PRG concentration. Results of this process are discussed in Section 3.2.

3.1.2. Avian Predator/Human Health PRGs- Calculation Method.

The translation of both Avian Predator and Human Health PRGs require the conversion of tissue-based TEVs to sediment-based concentrations. This method of translation involves the application of Bioaccumulation Factors (BAFs) for metals and Biota-Sediment Accumulation Factors (BSAFs) for organics as discussed in the marine ERA (SAIC, 1997). For metals, the sediment-based concentration (μg/g gry wt) is calculated from the tissue-based TEV concentration according to the formula:

$$BAF = \frac{tissue\ concentration}{sediment\ concentration}$$

therefore:

$$sediment\ concentration = \frac{TEV}{BAF} \quad (6)$$

BAF values for arsenic (0.875), copper (0.33), lead (5.0E-6), silver (6.0E-4), and zinc (1.05) were derived in the Marine ERA (Marine ERA Figure 6.3-3).

For organic CoCs, the corresponding sediment concentration (ng/g dry wt) can be estimated from the formula:

$$BSAF = \frac{tissue\ concentration\ /\ lipid\ concentration}{sediment\ concentration\ /\ TOC\ concentration}$$

therefore:

$$sediment\ conc = \frac{TOC\ conc\ [TEV\ /\ lipid\ conc]}{BSAF} \quad (7)$$

The site-specific BSAF values for PCBs, PAHs, and pesticides derived in the ERA were 5.00, 0.12 and 3.85 respectively (ERA Figure 6.3-2). These values were found to compare well with literature BSAF values reported by USEPA (EPA, 1998). Also assumed for the above calculation is a mean sediment TOC (2.78%; Appendix Table A-2.1), and a mean biota lipid (4.59%; Appendix Table A-2.3).

3.1.3. PRG Calculation Results

Table 16 presents a summary of calculated PRGs for each of the three exposure pathways using methods described in Section 3.1.1, above. The analyte list includes only L-CoCs, i.e., those CoCs identified in Table 15 as having the maximum TEV-HQ by station and pathway. For the aquatic PRGs, the station-specific estimates used to derive the site-wide baseline PRG (HQ=1) shown in Table 16 are reported in Table A-8. Baseline PRGs for Avian Predator and Human Health pathways were calculated directly from the TEV values presented in Table 9 and Table 14, respectively.

Also included in Table 16 are RPRG concentrations for aquatic, avian, human health and combined exposure pathways discussed in the Section 3.3-1, Section 3.3-2, Section 3.3-3, respectively based on spatial implementation considerations discussed in Section 3.2, below. Baseline PRGs for the combined exposure pathway were taken as the minimum of the pathway-specific baseline PRGs.

3.2. Approach for Spatial Implementation of PRGs

Implementation of PRGs to determine areas of potential remedial action requires that the CoC data obtained from point samples be assigned to non-sampled locations to produce a map of complete spatial coverage. Numerous methods for spatial extrapolation of point data to larger areas (such as contouring) have been developed for environments and sampling strategies in which the assumptions of continuity (e.g., constant CoC dilution with distance) and gradation (e.g., regular spacing of sampling locations) are met. In the case of the Derecktor Shipyard/Coddington Cove study area, these assumptions are not met because of heterogeneous CoC distributions and station clustering in focused areas. Thus, for this investigation, a method using Thiessen polygons was used as it does not require the presumption of continuity in the data (ESRI, 1989). An approach of this type was undertaken during the USEPA EMAP Demonstration Study for the Virginian Province (Weisberg *et al.*, 1993). Here, the Thiessen polygon technique creates irregularly shaped polygons around sampled locations with a geometry such that any location in the polygon is closer to the sampled point than to any other sampled point. Hence, the concentration of the entire polygon is assumed to be equal to the value measured at the sampled location within the polygon.

The Thiessen polygon model constructed for the Derecktor Shipyard/Coddington Cove study area is shown in Figure 3.2-1. Geographic Information Systems software

(ESRI, 1989) was used for polygon construction and subsequent generation of PRG implementation maps. The inshore boundary of the site polygons was established as the shoreline at high tide, offshore polygons are unbounded. Shading of polygons obtained from PRG implementation will be used to demonstrate the locations in which CoC concentration data exceed the PRG (lightly-shaded), hence the area of potential remedial action. However, the polygonal area does not necessarily represent the final remediation area because the final area will depend on final PRG selection and additional sampling to improve spatial resolution.

Because it is desirable to use as much of the available site-specific data as possible to reduce spatial uncertainty, the Marine ERA evaluated chemical and biological results at 19 sampling locations throughout the Derecktor Shipyard/Coddington Cove study area (Stations 25-41) were combined with data from 24 stations obtained from a previous investigation (URI, 1993), hence accounting for the number of polygons shown in Figure 3.2-1.

Although both the ERA and URI investigations used similar sampling protocols and chemical analytical procedures, one notable difference was the depth of sediment sampling in the URI investigation (0-2 cm depth) vs. the ERA investigation (0-15 cm depth). The potential effect of this sampling variation on data comparability (hence usability) was evaluated by comparison of chemical results obtained from closely located stations between the two studies. The station pairs included DSY-1/40, DSY-1/41, DSY-2/28, DSY-3/29, DSY-10/41, DSY-11/31, DSY-18/26, DSY-19/32, DSY-20/31, and DSY-21/33 (Figure 3.2-1). The Relative Percent Difference (RPD) between stations for all stations and measured CoCs was 36%, while the mean RPD among PRG analytes for all stations was 47% (Table A-9). However, those stations within a proximity of 30 m had about a two-fold reduction in RPD relative to station pairs with >30m spatial separation.

Because the observed variation among datasets is well within the range generally considered to be acceptable among field duplicates (i.e., 30-40%), it can be concluded that the two data sets are sufficiently comparable to permit the incorporation of the URI data set into the PRG assessment. The data would further suggest that chemical distributions at the site are fairly homogeneous on the scale of 25-30 m. Heterogeneity on smaller scales (e.g., < 25 m) may represent 'hot spots' that were not detected. Still, the ERA sampling density was intended to characterize chemical risks at ecologically significant spatial scales, such that hot spots, if present, are more likely of ecological significance as potential CoC sources than for the loss of habitat.

Results of the Marine ERA have been used to classify the study area polygons based on the probability of adverse ecological risk caused by site-related CoCs to aquatic/avian aquatic receptors (Figure 3.2-2). The map shows the highest probability of adverse ecological risk ("+++") is occurring at harborfront stations DSY-27 and DSY-29 while the lowest probability of risk ("+") was observed for outer cove areas. The risk assessment for human health did not provide comparable spatial resolution,

but rather concluded that adverse risk to subsistence fishermen due to consumption of CoCs in biota does exist within Coddington Cove. Because the implementation of PRGs are intended to reduce risk, the spatial distribution of risk should be considered when evaluating the results of PRG implementation, discussed in the following section.

3.3. Assessment of PRGs for Risk Reduction

The assessment of PRG suitability as cleanup goals for the site involve the separate evaluation of L-CoCs listed in Table 16 as baseline (HQ=1) concentrations to determine the relationship between the degree of PRG exceedence and risk at the site. In the following sections, RPRG concentrations for aquatic, avian, and human health exposure pathways (discussed in the Section 3.3-1, Section 3.3-2, Section 3.3-3, respectively) are proposed that (based on best professional judgment) reflect a risk-based perspective on the optimal balance between degree of risk reduction and remediated area. These recommended values are further evaluated in the FS with respect to technical and fiscal constraints of PRG implementation.

3.3.1. Aquatic Exposure Pathways.

Bedded sediments. L-CoCs for the bedded sediment exposure pathway (Table 16) include HMW PAHs and Total PCBs.

HMW PAHs. The baseline PRG for HMW PAHs (6951 ng/g dry weight) was exceeded at eight shipyard/cove stations (DSY-2, DSY-3, DSY-18, DSY-19, DSY-20, DSY-27, DSY-29, and DSY-30; Figure 3.3-1). PRG exceedences were observed primarily for the harborfront stations, particularly Stations DSY-3/29 where PRG-HQs ranged from 4.3 to 10.5 (Table A-10). Another area in the vicinity of Station DSY-20 also exceeded the PRG by approximately three-fold, although closely located stations did not show similar exceedences (PRG-HQs <1 were observed for DSY-11 and DSY-31).

Among the stations exhibiting PRG exceedences, only Station DSY-29 was at high probability of risk, the extent PRG exceedences at this station (PRG-HQ= 4.3) and proximal station DSY-3 (PRG-HQ=10.5) indicate HMW PAHs are a significant source of risk. In contrast, the extent of PRG exceedences at low risk probability station DSY-30 (PRG-HQ = 1.49) are equivalent to that found at high risk Station DSY-27 (PRG-HQ=1.47), suggesting that PRG exceedences less than two are likely to preferentially address higher risk vs. lower risk areas. Further support for a RPRG equal to 2 times the baseline PRG (13903 ng/g) is seen in the risk/PRG comparison of the Station DSY-32 area; this location was classified as low risk while nearby station DSY-19 was exceeded the PRG by less than two fold. Similarly, PRG exceedence at Station DSY-18 (PRG-HQ = 1.86) is adjacent to intermediate risk station DSY-26 with no PRG exceedence (PRG-HQ < 1) such that implementing a PRG-HQ < 2 would not reliably address intermediate risks.

Based on the above analysis of PRG exceedence vs. risk reduction potential, a RPRG equal to two times higher than the baseline PRG is selected. The RPRG value (13903 ng/g) was compared to the literature-based effects concentrations as a check on the degree of protection that would be afforded to aquatic biota. The RPRG concentration was found to be 1.4X higher than the NOAA ER-M (9600 ng/g dry weight (Long *et al.*, 1995)) but 1.2X less than the State of Washington Apparent Effects Threshold - Low (AET-L; 17,000ng/g) concentration (Barrick et al., 1988). Hence, the RPRG is within the range of values expected to protect aquatic biota from adverse exposures.

Total PCBs. In contrast to HMW PAHs, the PRG for Total PCBs (1638 ng/g dry wt) was exceeded only at Station DSY-27 (Figure 3.3-2). In contrast, the lack of PRG exceedences for this CoC at all other sampled locations suggests that risks due to PCBs are not widespread, and implementation of a lower PRG value is not needed. Still, this station was identified as high risk in the Marine ERA, and thus implementation of the RPRG at a PRG-HQ = 1 concentration is recommended to address risk at this location.

The RPRG concentration (1638 ng/g) is nine-fold higher than the NOAA ER-M (180 ng/g dry weight), but is intermediate between the AET-low (1000 ng/g dry) and AET-high (3100 ng/g dry) benchmarks and about 1.5X lower than the Sediment Effect Concentration of 2700 ng/g calculated by MacDonald (1994) based on a PCB-spiked sediment bioassay. Thus the RPRG is within the range of independent estimates of threshold effects levels for aquatic biota.

It is also of interest to note that the corresponding TEV value for Total PCBs was set equal to the WQC-SC value (0.03 µg/L) without site-specific modification (Table 7) such that there would appear to be a discrepancy between the level of protection afforded by water- vs. sediment-based benchmarks, with the latter being overly conservative. This is attributed to the fact that the sediment benchmarks are field-based and correlative in nature, i.e., reflective of effects caused by complex mixtures of CoCs, not PCBs acting alone. In this case, the sediment-based PCB benchmark is artificially lowered because the presence of other CoCs in the mixture which will cause the sample to be more toxic than would otherwise occur in the PCB-only case. In contrast, the WQC is based solely on PCB toxicity. Thus, the baseline PRG value, being set equivalent to the WQC-SC concentration, is expected to be completely protective of risks to aquatic biota from PCB exposure in sediment. It is also noted that the TEV value (i.e., 0.03 µg/L) is 300X less than the WQC-SA criteria (10 µg/L), and in contrast to the WQC-SA, the WQC-SC was selected for protection of birds not aquatic biota. Hence, the comparability of sediment benchmarks (ER-L/ER-M values aside) with the PRG calculated from WQC suggests that the RPRG should be adequately protective of aquatic receptors.

Overall Assessment. From the above comparison of PRG exceedences with observed risk at the site, PRG-HQs above two were observed for both high risk

locations determined by the Marine ERA (Figure 3.2-2). Hence, adopting a RPRG of 13903 ng/g for HMW PAHs and 1638 ng/g for PCBs would ensure risk reduction at the two high risk areas for the site. A summary of areas exceeding the RPRG threshold is shown in Figure 3.3-3. Below these PRG-HQ thresholds, there was a poor correlation between the degree of risk reduction achieved by adopting lower PRG-HQ thresholds (i.e., PRG-HQ=1 for HMW PAHs) and the potentially affected area. As a result, PRG thresholds could not be discerned which could discriminate between intermediate or lower risks. Hence, adopting PRG concentrations below the recommended values would not appear supportable from a risk reduction perspective.

Resuspended Sediments. L-CoCs for resuspended sediments include arsenic, copper, lead, Total PCBs and o,p'-DDE.

Arsenic. Although TEV-HQ exceedences for arsenic were observed at two locations (DSY-38: TEV-HQ=1.01; DSY-39:TEV-HQ = 1.88), the poor proximity between the location of exceedences and lack of associated risks indicated that arsenic was a poor candidate for PRG selection. Application of the baseline PRG (24.6 μg/g) against sediment concentrations revealed PRG-HQ (Table A-10). Hence, as shown in Table 16, the implementation of a RPRG for this analyte is not recommended.

Copper. For copper, a TEV-HQ= 1.76 at Station DSY-31 was found based on a concentration of 5.1 μg/L measured in the elutriate sample. Following the methodology for PRG translation from TEVs, the PRG-HQ=1 concentration of 74 μg/g dry wt was calculated and the spatial implementation of the sediment PRG is found in Figure 3.3-4. While several stations had sediment concentrations above the PRG, a number of these locations had non-detectable elutriate Cu concentrations (e.g.,Station DSY-27 and DSY-29), such that it is clear that the predicted exceedences are erroneous. This is consistent with the fact that copper concentrations at DSY-27 and DSY-29 are not high; measured bulk concentrations were marginally above the ER-L and SEM-AVS was < 5, indicating that metals including copper are not at concentrations high enough to contribute significantly to risk. The lack of measured copper in elutriates is also consistent with the low/non-bioavailable concentrations in sediments evaluated for the ERA. Two additional URI stations (DSY-2 and DSY-3) did have Cu concentrations in sediment higher than was observed for ERA locations, but the increase was marginal (less than two-fold) and hence aquatic biota would be presumed to be at minimal risk due to Cu in resuspended sediments. Hence, the data demonstrate that copper is not a primary contributor to risk and thus retaining a PRG for remediation of sediments subject to resuspension is not recommended (Table 16).

Lead. The PRG for lead (84 μg/g dry weight) was exceeded at five stations (DSY-2, DSY-3, DSY-27, DSY-29, and DSY-32; Figure 3.3-5; Table A-10).

In the ERA exposure response relationships between benthic community (% dominant taxa) and Pb concentration in sediments suggest possible impact above about 150 μg/g (ERA Figure 6.5-1). The ordinance analysis (ERA Figure 6.5-4D) also

suggested that Pb at DSY-29 may explain the degraded conditions at this location. Hence, implementing a PRG for Pb would appear to be warranted to achieve risk reduction at this area.

In contrast to Station DSY-29, there was no evidence of Pb effects at the other high risk station (DSY-27) or any other stations from exposure-response analyses presented in the ERA. Since there was no apparent effect of Pb at DSY-27, a PRG for Pb should not be set to concentrations below that observed at DSY-27. Given that the DSY-27 (no effect) and DSY-29 concentrations are 150 and 185 μg/g, respectively, an intermediate PRG of 166 μg/g (2X baseline PRG) would appear to be adequately conservative to protect risk to aquatic biota such as was observed at DSY-29. This recommendation is consistent with the observation that tissue residues of Pb in biota at these locations are not elevated relative to reference (see ERA Figure 4.3-8 to Figure 4.3-10) .

Total PCBs. The PRG for Total PCBs (530 ng/g dry weight) was exceeded at four stations (DSY-3, DSY-11, DSY-27 and DSY-29; Figure 3.3-6). Good agreement was found between observed risk and PRG exceedence; the highest PRG-HQ (6.25) occurred at high risk Station DSY-27. Sediment PCB concentration at DSY-27 was 3310 ng/g dry wt, which is six-fold higher than the next highest surface sediment concentration (DSY-29). Reduced condition of indigenous mussels at DSY-27 was associated with increased tissue PCB concentration (ERA Figure 6.5-5), and possible PCB effects on for amphipod survival were noted (ERA Figure 6.4-2B), hence supporting the selection of Total PCBs as a PRG to address risks at this location.

Station DSY-29 was also a high risk area with a marginal PRG exceedence (PRG-HQ = 1.03). However, unlike Station DSY-27, PCBs effects at Station DSY-29 were not indicated in exposure-response analyses for amphipod survival (ERA Figure 6.4-2) or benthic community structure (ERA Figure 6.5-3D). Thus, there is a lack of supporting data to suggest that implementation of a PRG for PCBs is needed to address risks at Station DSY-29. Instead, risks are more likely related to other CoCs, notably Pb (see discussion above).

As with lead, PCB PRG thresholds below PRG-HQ < 2 could not be discerned which could discriminate between high and low risks, and thus adopting a PRG concentration below 1060 ng/g is not recommended, whereas adopting a RPRG at 1060 ng/g would conservatively ensure risk reduction in one of the high risk areas. While the RPRG is well above the NOAA ER-M (180 ng/g dry weight), the value is comparable to the State of Washington AET-low (1000 ng/g dry) and well below the AET-high (3100 ng/g dry) benchmarks. Thus the RPRG is within the range of independent estimates of protective threshold effects levels for aquatic biota.

o,p'-DDE. A single exceedence of the PRG value for o,p'-DDE (9.06 ng/g) was observed for Station DSY-27 (PRG-HQ = 7.2, Table A-10). Although this station is one of two high risk areas identified in the Marine ERA (Figure 3.2-1), the corresponding

TEV-HQ for this station (TEV-HQ = 0.78, Table A-5) was below the presumed threshold for aquatic risks. The CoC was retained as a L-CoC only to permit a more thorough evaluation of all sediment data available, and in doing so, facilitate the detection of any locations where this CoC might be a primary risk driver to the maximum extent possible. Given that no other location contained sediment concentrations above the PRG, it is recommended that this CoC not be retained as a PRG.

Resuspension Evaluation. The ERA concluded that there exists considerable uncertainty as to whether short term risks during resuspension events would actually occur to produce exposure concentrations equivalent to 1:4 dilution used in elutriate exposures (corresponding to g/L total suspended solids concentrations). Two scenarios which have been proposed include 1) prolonged resuspension of sediments in shallow water due to severe storm events, and 2) short-term, high scouring events caused by propellor wash from large vessels during docking maneuvers. A preliminary spatial assessment of these scenarios is presented below.

Wind and wave action during storms in addition to the prevailing current are expected to have a dominant influence on patterns of sediment resuspension. These forces are expected to be particularly important for fine grained sediments which resuspend most easily and generally contain the highest bulk concentration of contaminants. Geotechnical and hydrodynamic studies of Coddington Cove conducted as part of the ERA provide insight as to the distribution of such sediments and the background currents to which they are exposed. From the analysis of cove bathymetry (ERA Figure 3.1-2), grain size distribution (ERA Figure 4.2-5) and near-bottom deposition/erosion energies (ERA Figure 4.2-17) the area of the cove most likely to contain silt/clay (< 0.8 mm diameter) sediments available for resuspension are generally restricted in water depths less than 7m (Figure 3.3-8). This zone includes bottom sediment throughout much of southern Coddington Cove, the eastern and northern portion of the cove out to 150-200 m. Resuspension of sands is also possible due to storms and/or vessel activity, however this CoC transport pathway should be considered to be of minor concern relative to fine grained sediments because of the generally lower CoC concentrations found in sandy sediments. Hence, as a rough, worst-case approximation, sediments above RPRGs within this zone could adversely effect biota depending upon the strength and duration of the resuspension event. Given the considerable uncertainties about the delineation of this zone and nature of actual resuspension conditions (location, intensity), a more detailed study of actual resuspension events are strongly recommended if concern over resuspension is the primary motivation for remedial action.

The effect of large vessel propellor turbulence as a cause of sediment resuspension (i.e., "prop scour") has been investigated by a number of authors, most recently by Maynord (1998). This USACE study was conducted to validate earlier models developed to simulate prop scour and hence predict stability of waterway channels to erosion from ship traffic. The study found good agreement between predicted and measured bottom velocity (V_b) currents for the model:

$$V_b = (C_j * V_j * D_p)/H_p \quad (8)$$

where C_j = constant for a ducted propellor, Vj = jet velocity at surface created by a docked vessel in gear at high RPM, D_p = propellor diameter, and H_p = height of propellor shaft above bottom. For Derecktor Shipyard, worst-case conditions for prop wash would appear to exist for vessel tenders that may frequently escort larger vessels into the pier. Larger vessels, such as offshore Coast Guard vessels, are presumed to only infrequently dock or may only do so with vessel tender assistance hence, as a less likely contribution to overall resuspension in the Cove. Substituting representative characteristic of vessel tenders (C_j = 0.3, D_p = 1 m) and moderately high RPM operations (Vj = 3 m sec^{-1}), and bottom currents typical for Coddington Cove (V_b = 0.1 m sec^{-1}, ERA Figure 4.2-12B), the water depth (~H_p) at which the prop wash current is no greater than the ambient current can be determined:

$$H_p = (C_j * V_j * D_p)/V_b \quad (9)$$
$$= (0.3 * 3 * 1)/0.1$$
$$= 9 \text{ m}$$

Adding 1 m for vessel draft, this result suggests that wherever the water depth in the cove is greater than 10 m, the contribution of propellor current to the bottom flow is no greater than the ambient current.

This first order approximation is translated into a prediction of bottom area potentially affected by prop wash produced by vessel tenders (Figure 3.3-8), and accordingly, potentially the resuspension of contaminated sediments above PRGs which could adversely effect biota. The map shows the 10 m bathymetry contour; bottom areas in <10 m water depth may be subject to prop wash from vessel tenders while maneuvering deeper draft vessels. It should be noted that water depth will also limit the operational area and thus the locations where prop wash scouring might occur.

The above analysis was intended to provide a conservative, yet realistic assessment of bottom areas frequently affected by prop wash. Of course, more conservative assumptions (larger vessels, higher RPM operations) would lead to potential resuspension at greater water depth. As discussed for storm resuspension, there are large uncertainties about the delineation of this zone and nature of actual resuspension conditions (location, frequency) that might occur. Finally, as noted in the ERA, it is unlikely that the intensity of resuspension would come close to the high slurry concentration represented as by 1:4 dilution used to prepare sediments for testing the toxicity of elutriates. More detailed studies of actual prop wash events are strongly recommended if concern over resuspension is used as the primary motivation for remedial action.

Overall Assessment. Based on the above information, it is recommended that sediment concentrations of 168 μg/g and 1060 ng/g respectively be adopted for lead and Total PCBs for the resuspended sediment exposure pathway since good

correspondence was observed between areas exceeding PRGs and areas of high risk. A summary of areas exceeding the RPRG threshold is shown in Figure 3.3-7. Unlike bedded sediments, however, it is difficult to independently assess the level of protection afforded by the RPRGs since benchmarks for resuspended sediments are not available. In addition, it is unclear whether the high risk areas identified in the ERA were due to exposures from bedded or resuspended sediments, or both. It is of interest to note that based on present data, areas exceeding resuspension PRGs are a subset of the total area above the bedded PRG, such that addressing bedded risks will rectify resuspension risks as presently delineated. Finally, the likelihood of resuspension does vary spatially within the cove and is dependent on the source of resuspension energy (wave action vs. ship traffic). Information on the active intensity, frequency and duration of such events will be required to effectively implement PRGs for protection of aquatic biota based solely from resuspended CoCs.

3.3.2. Avian Predator Exposure Pathway.

For the avian predator exposure pathway, five metals (arsenic, copper, lead, silver, and zinc) and Total PCBs were identified as L-CoCs and thus are included as candidate PRGs in Table 16. Sediment-based PRGs for the metals were back-calculated using the BAF-based model (Equation 5), while for Total PCBs the BSAF model was used (Equation 6).

Metals. Among the metals, sediment concentrations of arsenic did not exceed the PRG at any location (Table A-11). Copper also exceeded the PRG at two locations (Stations DSY-2 and DSY-3; Figure 3.3-9), with PRG-HQs ranging from = 1.07 to 1.43. Zinc was above the sediment PRG at 21 stations with PRG-HQs ranging from = 1.0 to 10.4 (Figure 3.3-10). Among these two CoCs, only five stations had PRG-HQs > 2 (DSY-2, DSY-3, DSY-11, DSY-27, and DSY-29). PRGs were not exceeded for the remaining metal-related L-CoCs (lead and silver).

In the Marine ERA, generally intermediate risks to avian predators were assigned to Stations DSY-28, DSY-29, and DSY-36, while slight risks were apparent elsewhere, including reference locations (SAIC, 1997; Table 6.6-3). Although there is an apparent concordance between PRG exceedence and observed risk including areas represented by Station pairs DSY-2/DSY-28 and DSY-3/DSY-29, implementation of remedial action based on this PRG does not appear warranted given the limitation of the conservative exposure assumptions in the ERA and subsequent conclusion that CoCs in Coddington Cove do not likely pose an unacceptable risk to avian receptors (ERA Section 6.3). Thus, despite the fact that PRGs were exceeded, the avian predator would have to spend its entire life feeding in the affected area for true risks to occur. This overly conservative assumption leads to the recommendation that the PRGs for risk reduction for the avian aquatic exposure pathway metals not be adopted at this time except perhaps for purposes of monitoring to ensure continued lack of significant risks via food chain transfer from prey species to aquatic predators.

Total PCBs. PRGs for Total PCBs were exceeded at 24 stations (Table A-11; Figure 3.3-11), with PRG-HQs ranging from 1.0 (Station DSY-21) to 35.7 (Station DSY-27). Among these locations, only four stations exhibited PRG-HQs > 5 (DSY-3, DSY-11, DSY-27, and DSY-29). As noted above for metals, intermediate risks were assigned to avian predators feeding at Stations DSY-28, DSY-29, and DSY-36. The agreement between PRG exceedence and observed risk included areas represented by Station pairs DSY-28 (PRG-HQ=1.45, Table A-11A and A-11B) and particularly DSY-29 (PRG-HQ=35.9), might ordinarily suggest implementation of remedial action, but because of the conservative exposure assumptions unacceptable risk to avian receptors due to PCB exposure is unlikely.

An additional consideration for the indirect effects that PCBs might have on avian predators through reduction in the supply food from PCB-sensitive species. The maximum predicted porewater concentration of PCBs was found at Station DSY-27 (0.027 µg/L) is slightly below the USEPA WQC-SC value (0.03 µg/L), but is nearly 1500-fold lower than the measured Aroclor-1254 LC_{50} for the amphipod, *Ampelisca abdita* (40 µg/L; Ho et al., 1997) used in the ERA and found to exhibit slight toxicity when exposed to sediments from this location. Hence it is unlikely that PCBs in Derecktor Shipyard/Coddington Cove would impact avian predators through reduction in their food supply. Thus, as shown in Table 16, a PRG for Total PCBs to protect the avian predator exposure pathway is not recommended for implementation.

3.3.3. Human Health Exposure Pathway.

The L-CoCs identified for protection of risks to subsistence fishermen from consumption of shellfish were arsenic and benzo(a)pyrene (Table 16). Baseline PRGs presented in Table 16 represent threshold concentrations for protection of carcinogenic effects at 1×10^{-6} risk and non-carcinogenic risks at HQ=1. However, there is a high probability that the exposure scenario is overly conservative (a subsistent fisherman is not likely to derive all seafood exclusively from Coddington Cove for 30+ years, nor could the cove support such intensive pressure from a subsistence population). Perhaps a more plausable (yet conservative) assumption is that the shellfishing population might rely on the cove for up to 10% of the amounts noted in Table 10, such that 10 times the PRG-HQ threshold is a realistic point of departure for assumption of possible adverse health effects due to shellfish consumption. With this assumption in mind, the PRGs were evaluated below at PRG-HQ = 1 and at 10 times the PRG-HQ thresholds.

Arsenic. Arsenic was identified as a L-CoC for protection of risks to human health exposure from consumption of shellfish (Table 16). While arsenic concentrations marginally exceeded the TEV (TEV-HQ < 2, Appendix Table A-7), the corresponding PRG-HQs were all less than unity (Appendix Table A-12). This discrepancy is attributed in part to uncertainty in the BAF factor for arsenic used to calculate the sediment PRG (19.7 µg/g) from the tissue-based TEV value. However, any overlooked risk because of the BAF limitation would appear to be outweighed by

the fact that the true risk to arsenic may be overestimated by an order of magnitude since the toxic fraction (i.e., the organic component) is typically about 10% of the total arsenic content (USFDA, 1993). Further, a review of the literature regarding the methodology used to derive the TRV value (extrapolated from mice), reveals that the route of exposure evaluated was arsenic in drinking water, and since arsenic was administered in soluble form, it is likely to be far more bioavailable than arsenic bound to sediment particles. Finally, arsenic risks are unlikely to be significant as all areas of the cove had sediment concentrations well below the baseline PRG.

Based on the above data, it is recommended that an arsenic value not be selected as a Final Remediation Goal, but monitoring for organic arsenic concentrations should be performed at least once to confirm that bioavailable concentrations are below toxic levels. Revision of the PRG list could occur pending outcome of the monitoring results.

Benzo(a)pyrene. Benzo(a)pyrene was also identified as a L-CoC for protection of risks from consumption of shellfish (Table 16). The sediment-based PRG concentration at PRG-HQ=1 (53.9 ng/g dry wt) was exceeded at 34 of 41 stations (Appendix Table A-12; Figure 3.3-12). The areas with highest PRG-HQs (HQs > 10) were confined to the nearshore areas including Stations DSY-2, DSY-3, DSY-18, DSY-20, DSY-27, DSY-29, and DSY-30. Much of the area exceeding the PRG-HQ=10 threshold are not fishable due to industrial/military activity in the shipyard/cove (approximately all areas between and eastward of the piers and dock areas shown in Figure 3.3-12). Perhaps the area represented by polygons around Stations DSY-18 and DSY-30 may be fishable and PRGs could be implemented in some manner to guard against adverse risk from shellfish consumption. It is recommended that the 10 X PRG concentration (535 ng/g dry weight) be adopted given the conservative nature of the subsistence fishermen scenario, but a careful cost/benefit analysis (including more detailed delineation of the affected area) should be conducted to weigh the advantages of risk reduction against the disruptive nature of remediation.

Summary. A summary of areas exceeding the RPRG for benzo(a)pyrene (539 ng/g dry weight) threshold is shown in Figure 3.3-13. Based on present data, it is unlikely that the shellfishing population is substantially at risk since fishable areas above RPRG concentrations are limited and would not be expected to support a subsistence fishing population. However, it would seem reasonable to monitor for this CoC to confirm that harvested shellfish remain below toxic levels.

4. Conclusions/Recommendations

The PRG development strategy for the Derecktor Shipyard/ Coddington Cove study area was developed in a manner consistent with site ARARs and has identified RPRGs that are consistent with the findings of the risk assessments. The magnitudes of the PRGs are generally comparable to correlative benchmarks which increases the

certainty that minimal residual risk associated with the CoCs will remain when the PRGs are implemented.

The RPRG concentrations identified in Table 16 for aquatic, avian, and human health exposure pathway are listed for consideration as Final Remediation Goals (pending further evaluation in the FS). These values may differ from concentrations assumed to represent the baseline risk condition (i.e., PRG-HQ=1) because of the need to ensure that the PRG implementation leads to effective and practical risk reduction; selecting all PRGs or remediating to baseline concentrations would affect nearly all of Coddington Cove (light and densely shaded areas of Figure 3.3-14; Table A-13), and thus does not appear to provide an optimal balance between the degree of risk reduction achieved and potential environmental impacts that would occur on adjacent areas during the remediation process. In contrast, the RPRG concentrations are based on interpretation of the data in light of observed distribution and severity of estimated risks at the site; high and some intermediate risk areas are addressed (densely shaded areas noted B or R in Figure 3.3-14), while simultaneously, a number of areas above RPRG concentrations for human health are also included (densely shaded areas noted H in Figure 3.3-14). Other considerations presented in FS report regarding cost and engineering constraints may also modify the Final Remediation Goals to be adopted by risk managers.

Depending on the nature of the remedial action, a PRG list based on a combined pathway analysis may be suitable. It is acknowledged that the spatial resolution of the analysis depends on the density of stations within the study area. Some areas which might require remedial action may presently be depicted larger than they actually are, and thus will require confirmation sampling during the pre-design investigation in order to reduce uncertainty and to better define the extent of the areas to be remediated.

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Figure 2.2-1. Water quality screening value selection process and associated data qualifiers.

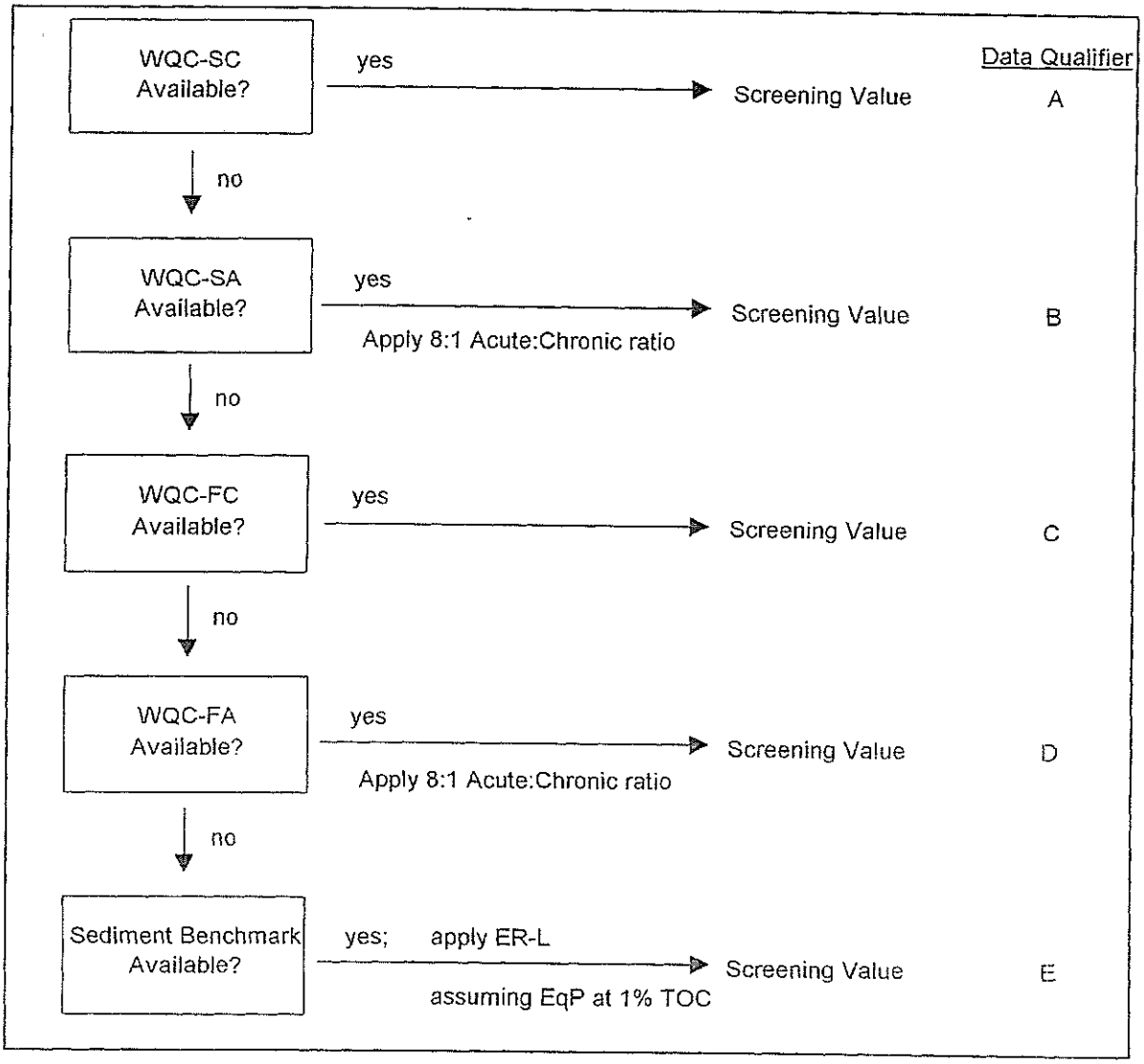


Figure 3.2-1. Thiessen polygons for PRG implementation for the Derecktor Shipyard/ Coddington Cove study area.

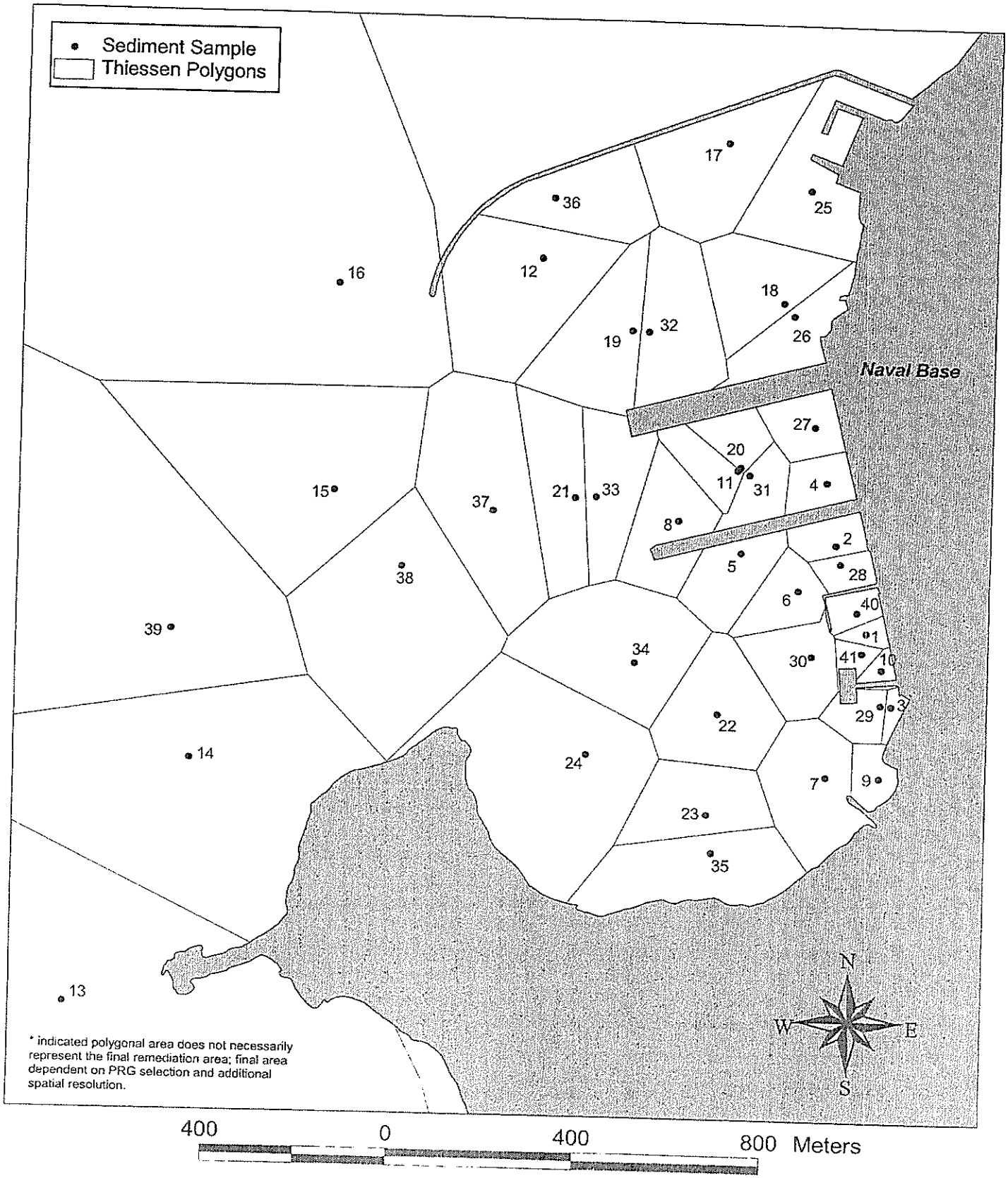


Figure 3.2-2. Risk probability for the Derecktor Shipyard/Coddington Cove study area.

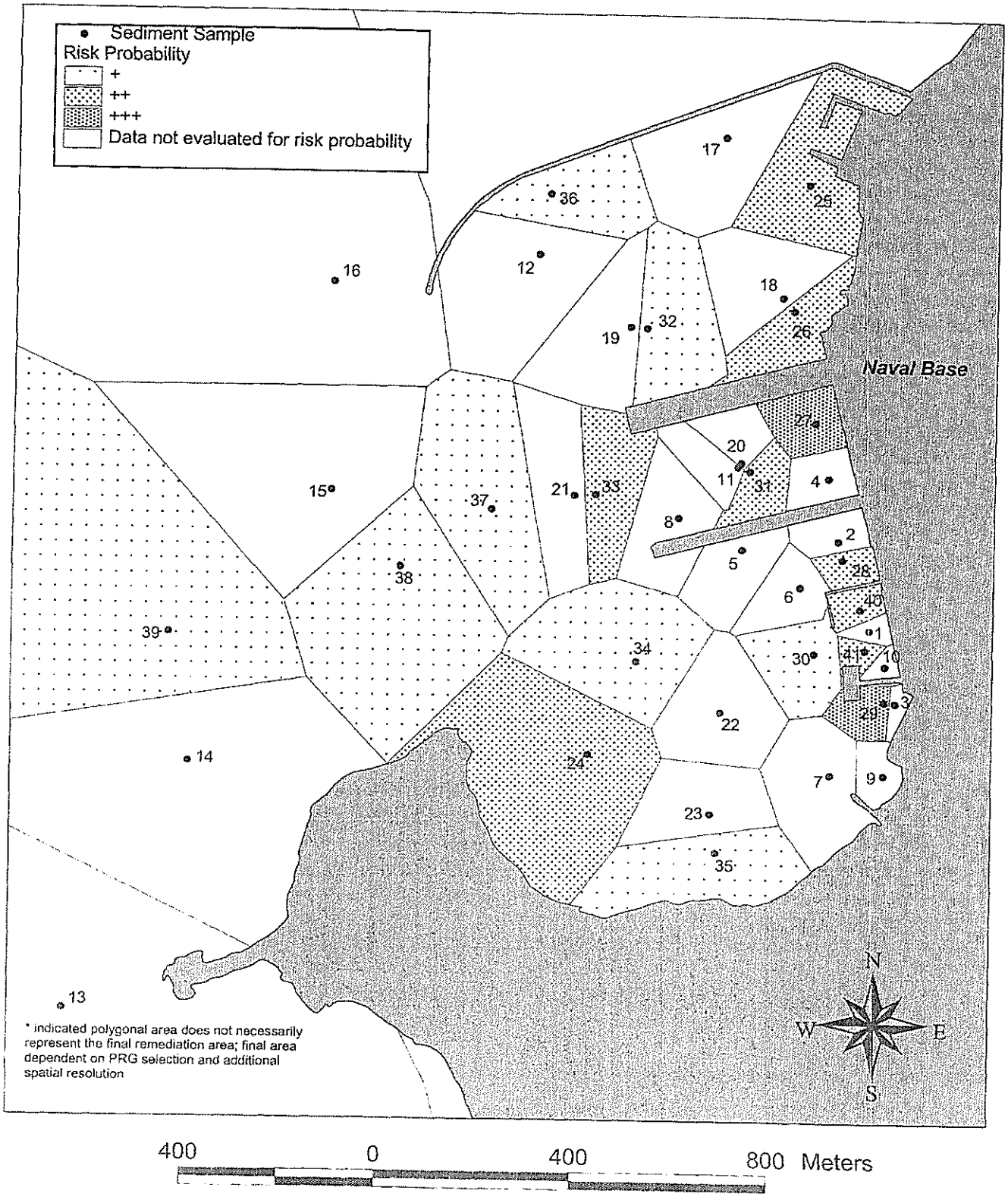


Figure 3.3-1. Summary of CoCs exceeding PRGs for protection of aquatic biota by location for sediments in the Derecktor Shipyard/Coddington Cove study area:*

Bedded Sediment Exposure Pathway for HMW PAHs

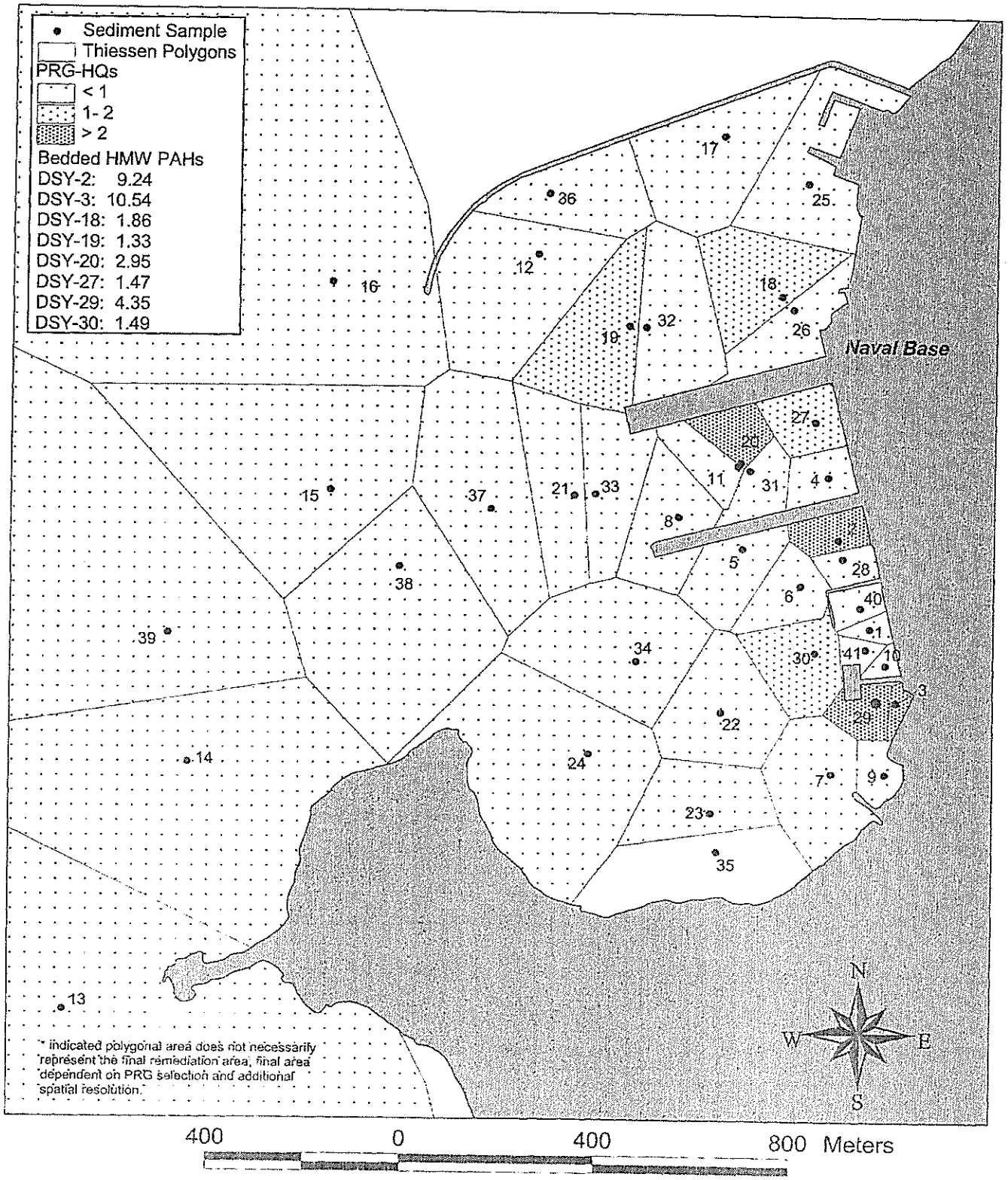


Figure 3.3-2. Summary of CoCs exceeding PRGs for protection of aquatic biota by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Bedded Sediment Exposure Pathway for Total PCBs

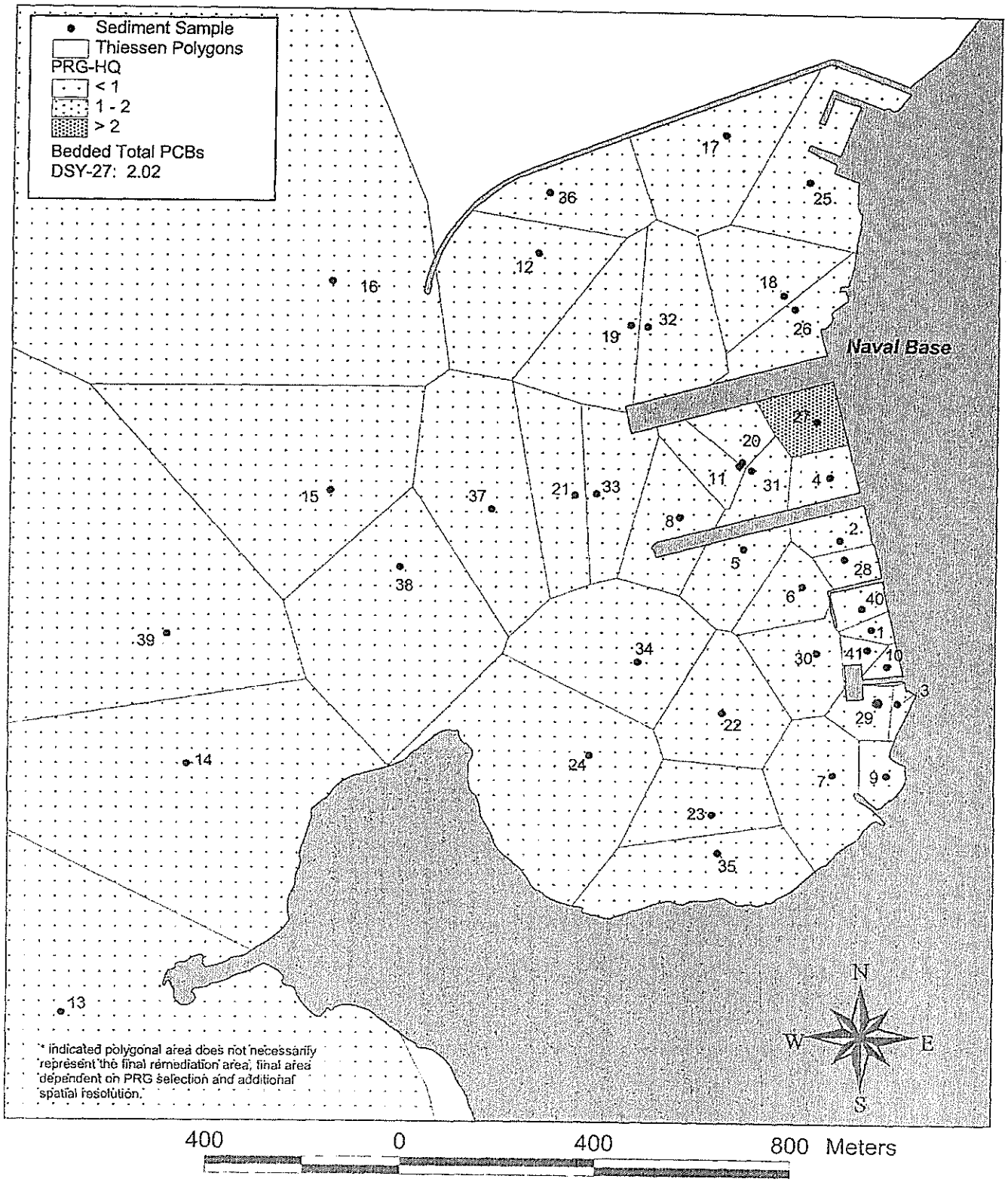


Figure 3.3-3. Summary of CoCs exceeding aquatic PRGs by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Recommended PRG Implementation for the Bedded Sediment Exposure Pathway

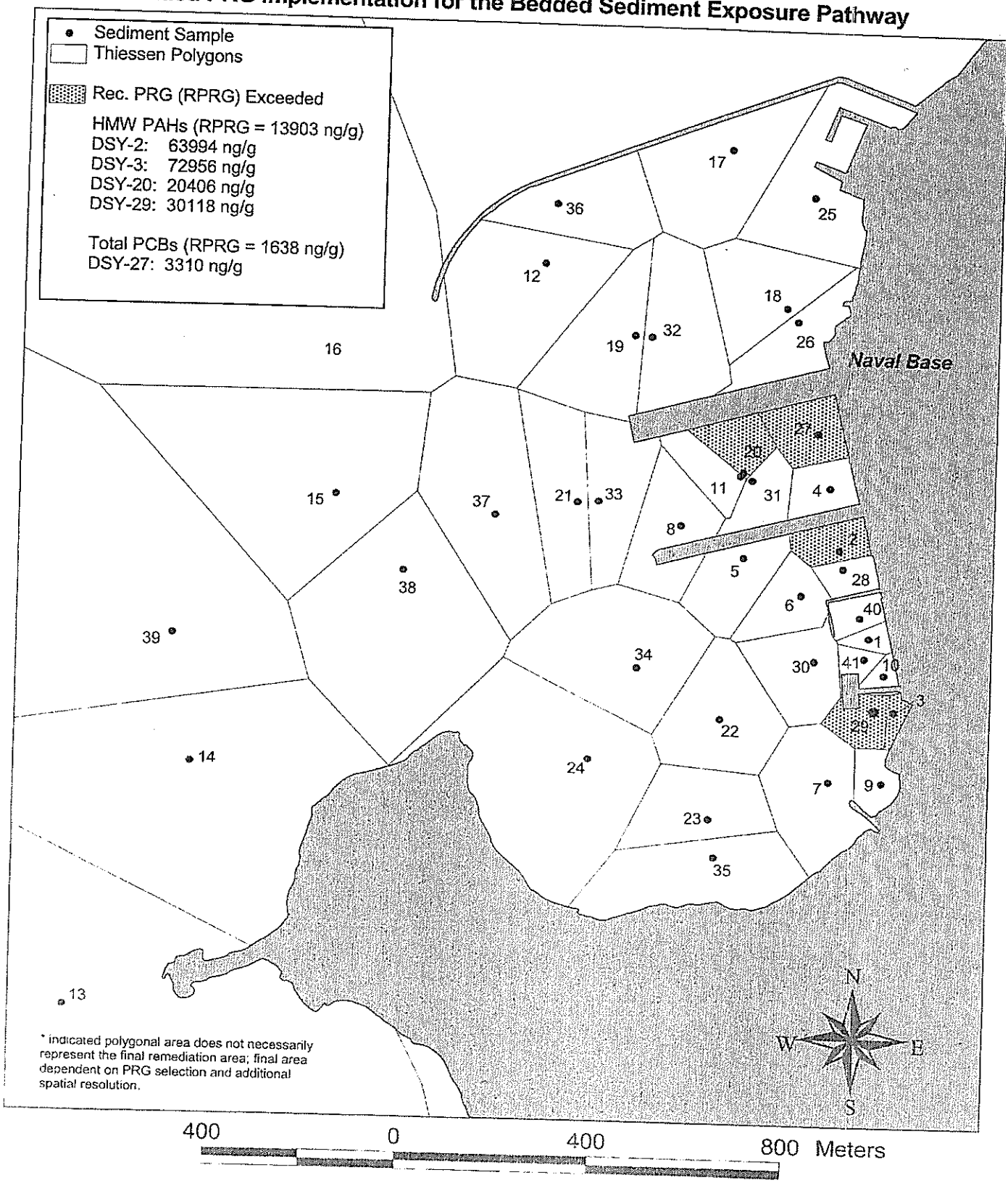


Figure 3.3-4. Summary of CoCs exceeding PRGs for protection of aquatic biota by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Resuspended Sediment Exposure Pathway for Copper

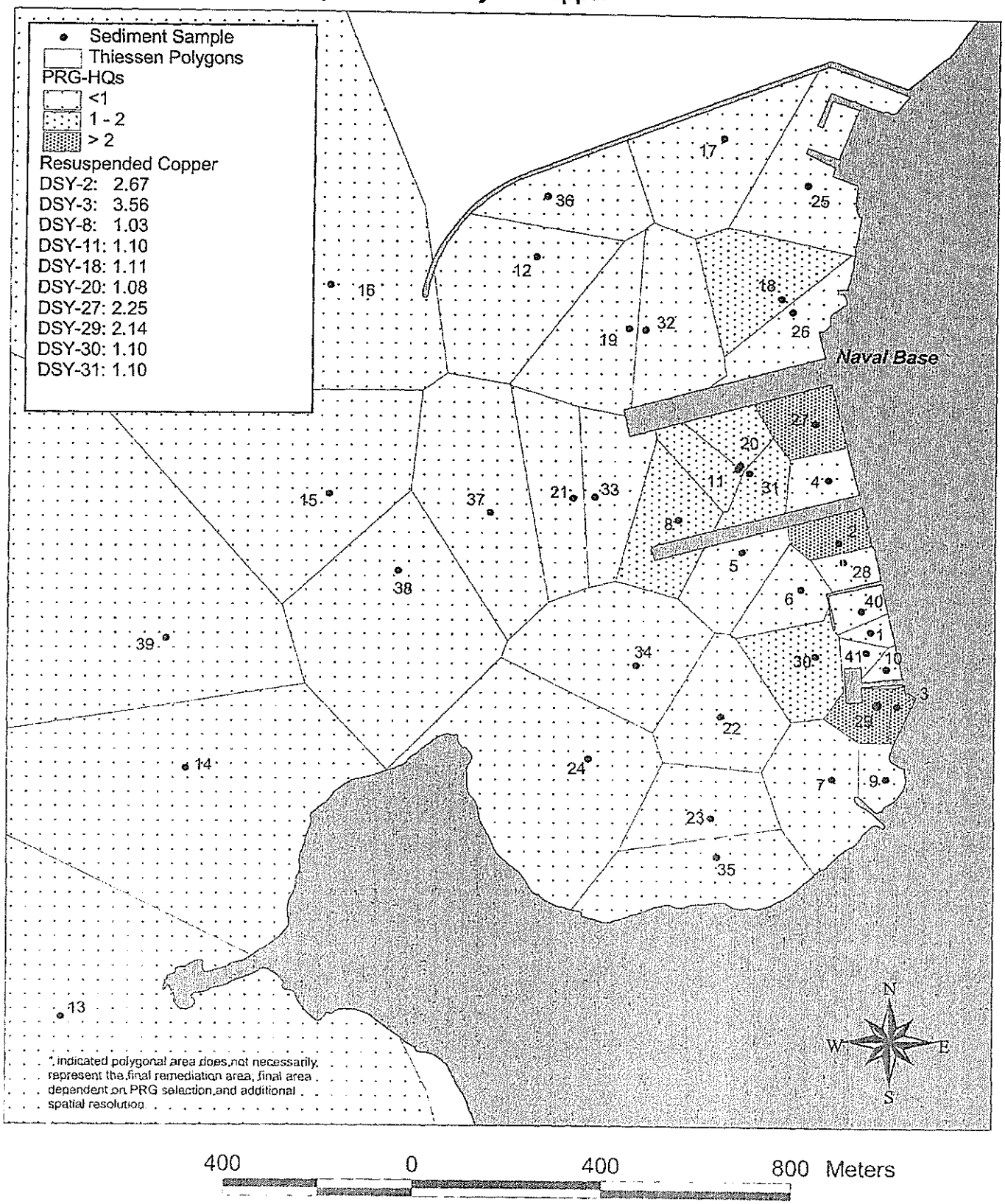


Figure 3.3-5. Summary of CoCs exceeding PRGs for protection of aquatic biota by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Resuspended Sediment Exposure Pathway for Lead

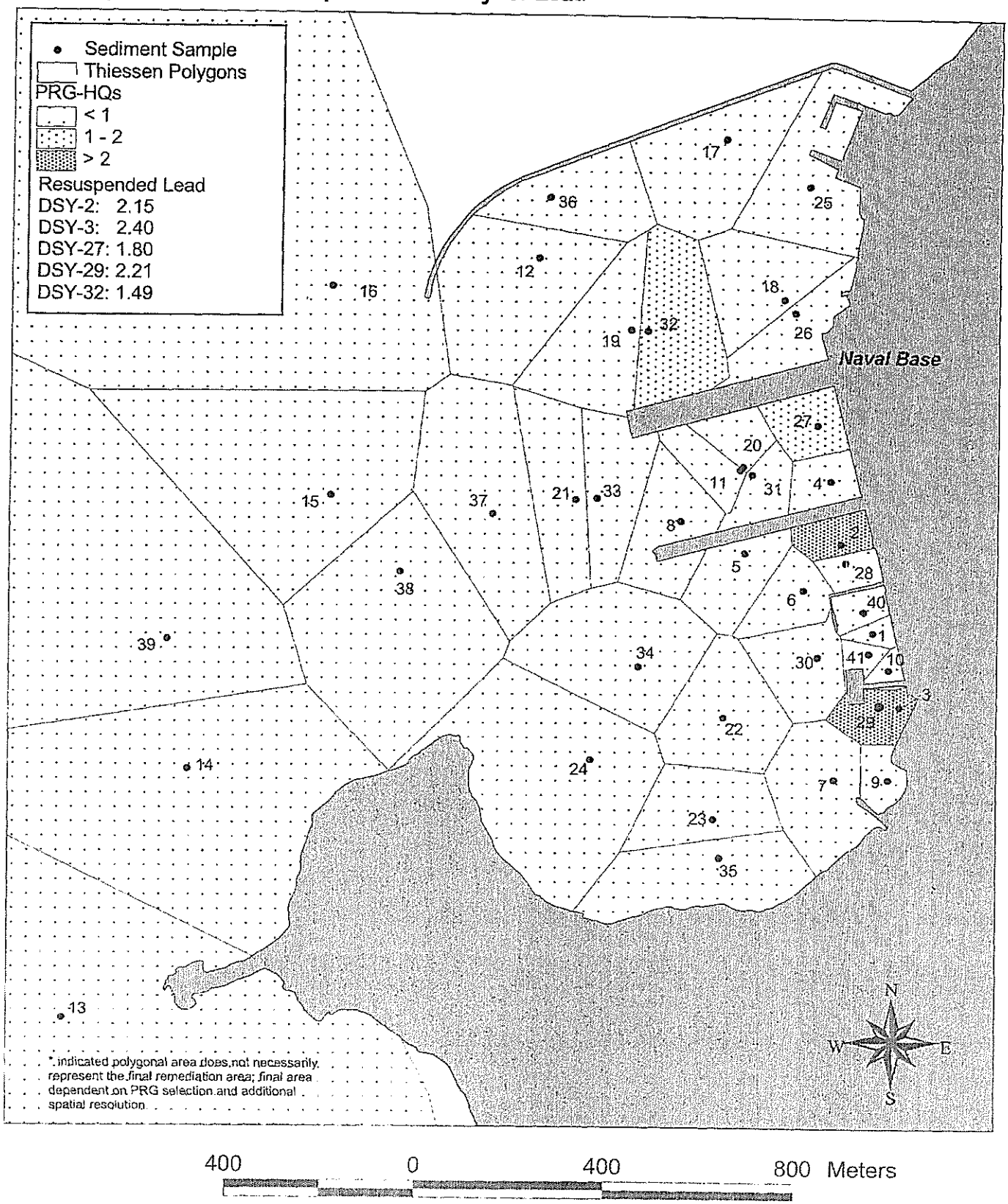
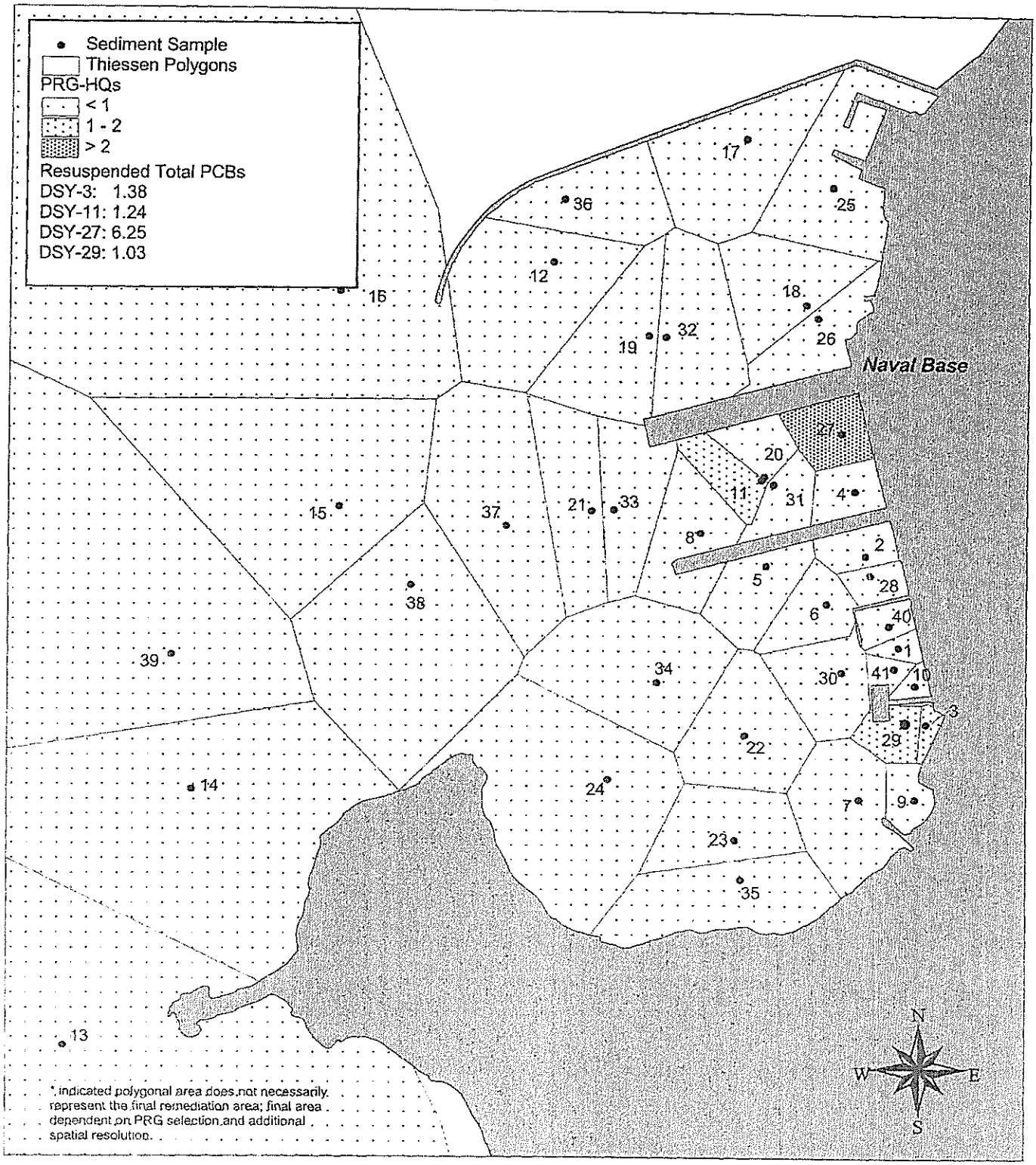


Figure 3.3-6. Summary of CoCs exceeding PRGs for protection of aquatic biota by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Resuspended Sediment Exposure Pathway for Total PCBs



400 0 400 800 Meters

Figure 3.3-7. Summary of CoCs exceeding aquatic PRGs by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Recommended PRG Implementation for the Resuspended Sediment Exposure Pathway

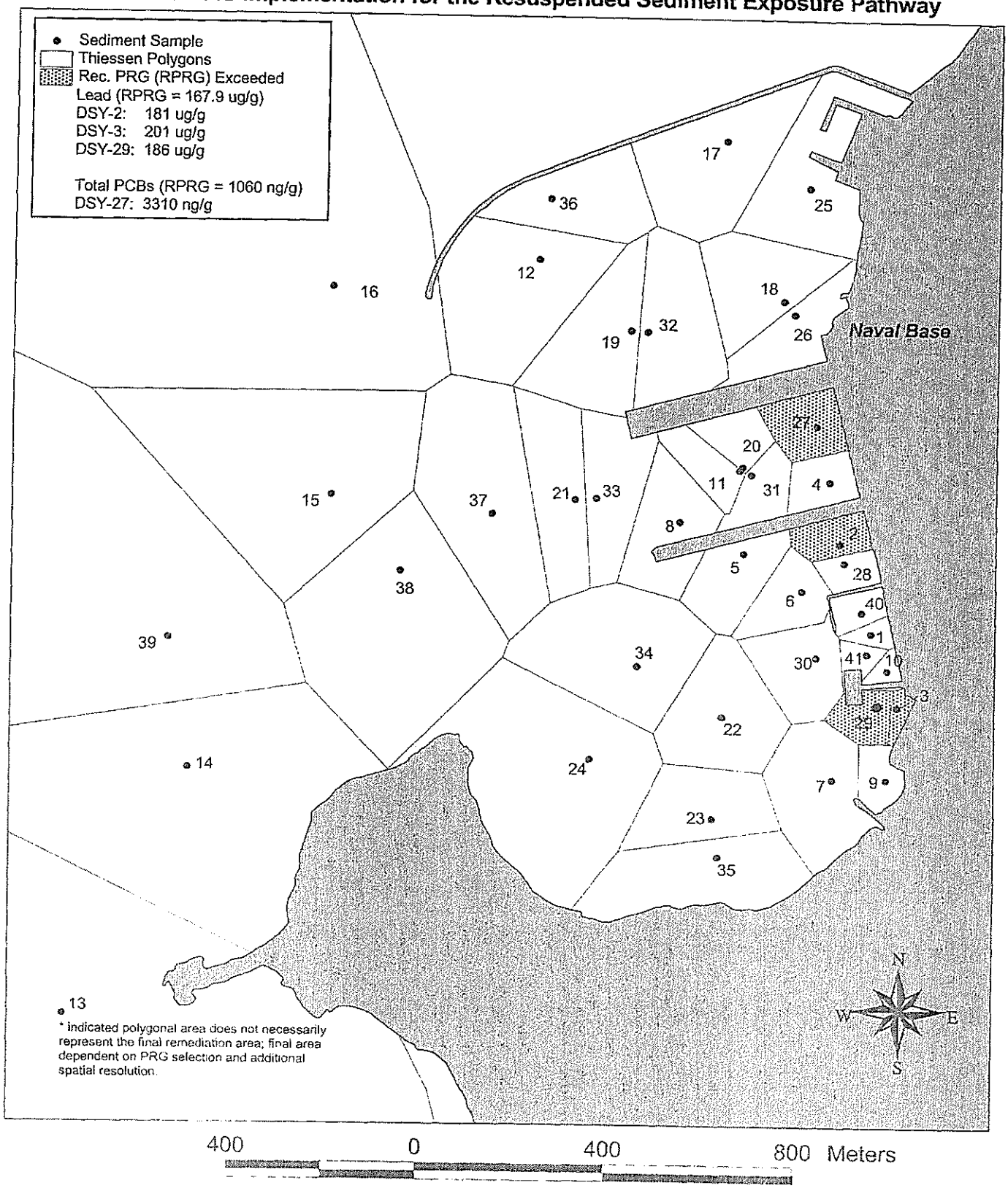


Figure 3.3-8. Bathymetry of Coddington Cove, NETC Newport, RI and the inferred zone of potential sediment resuspension.

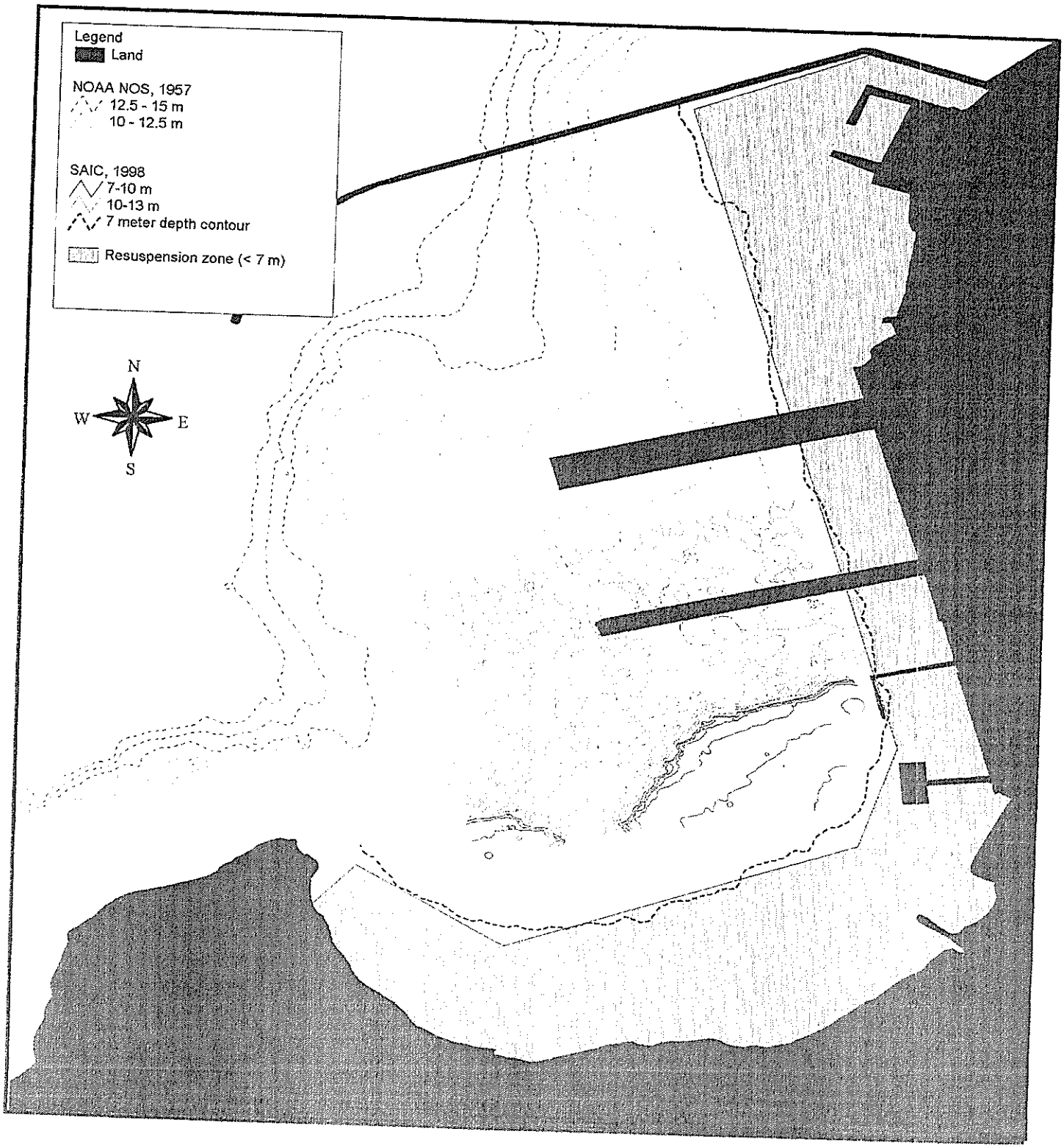


Figure 3.3-9. Summary of CoCs exceeding PRGs for protection of avian predators by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Avian Predator Exposure Pathway for Copper

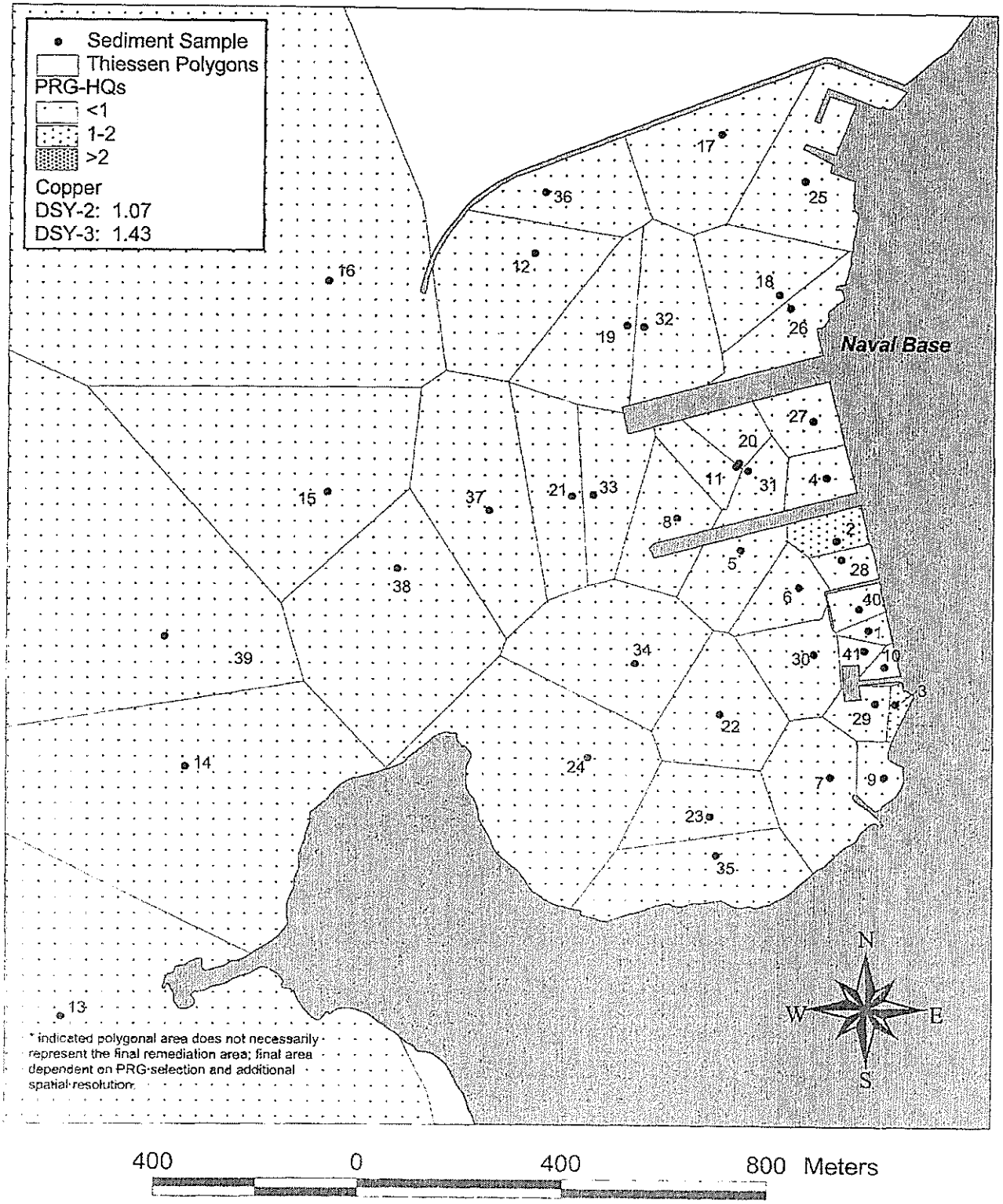


Figure 3.3-10. Summary of CoCs exceeding PRGs for protection of avian predators by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Avian Predator Exposure Pathway for Zinc

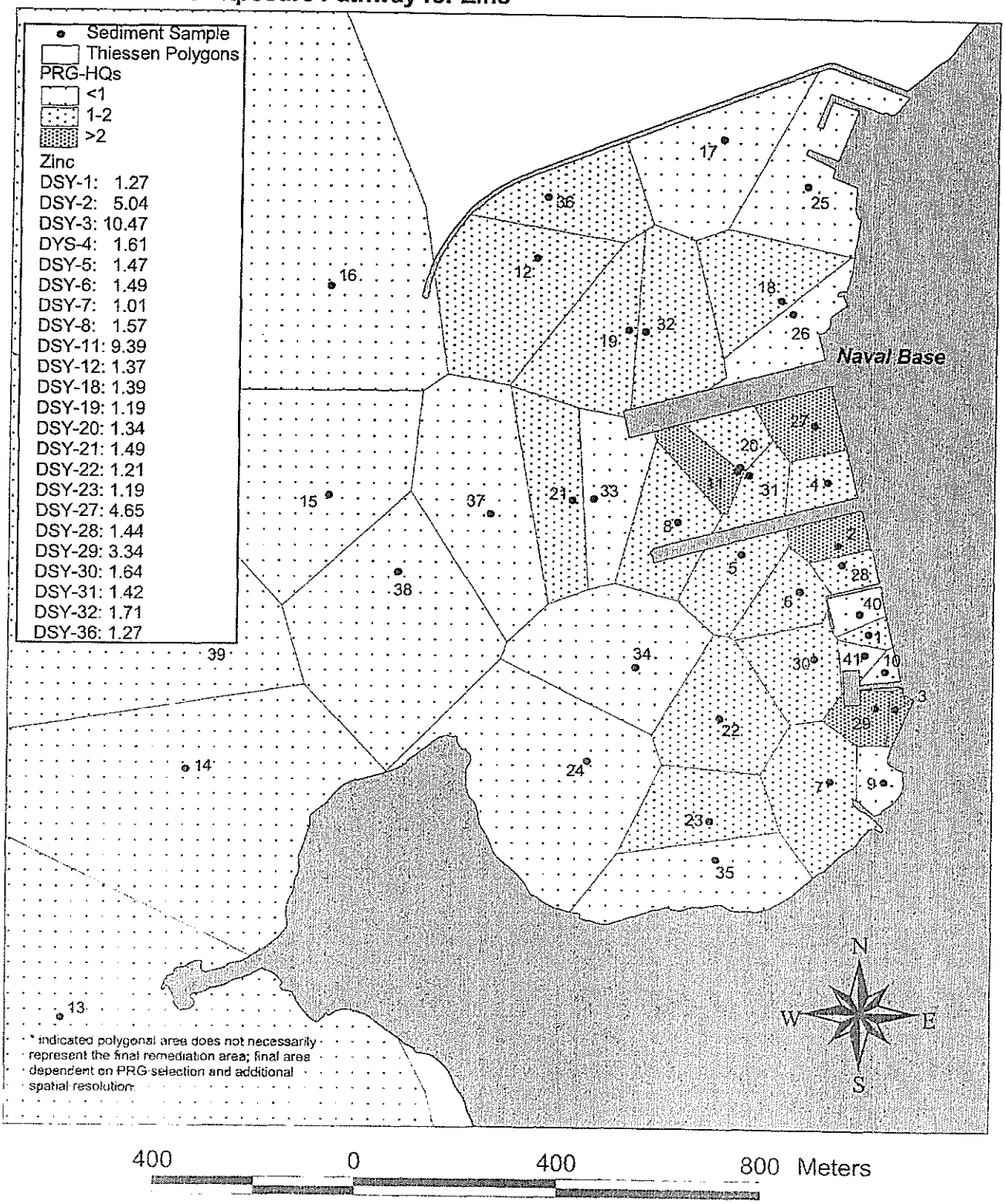


Figure 3.3-11. Summary of CoCs exceeding PRGs for protection of avian predators by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Avian Predator Exposure Pathway for Total PCBs

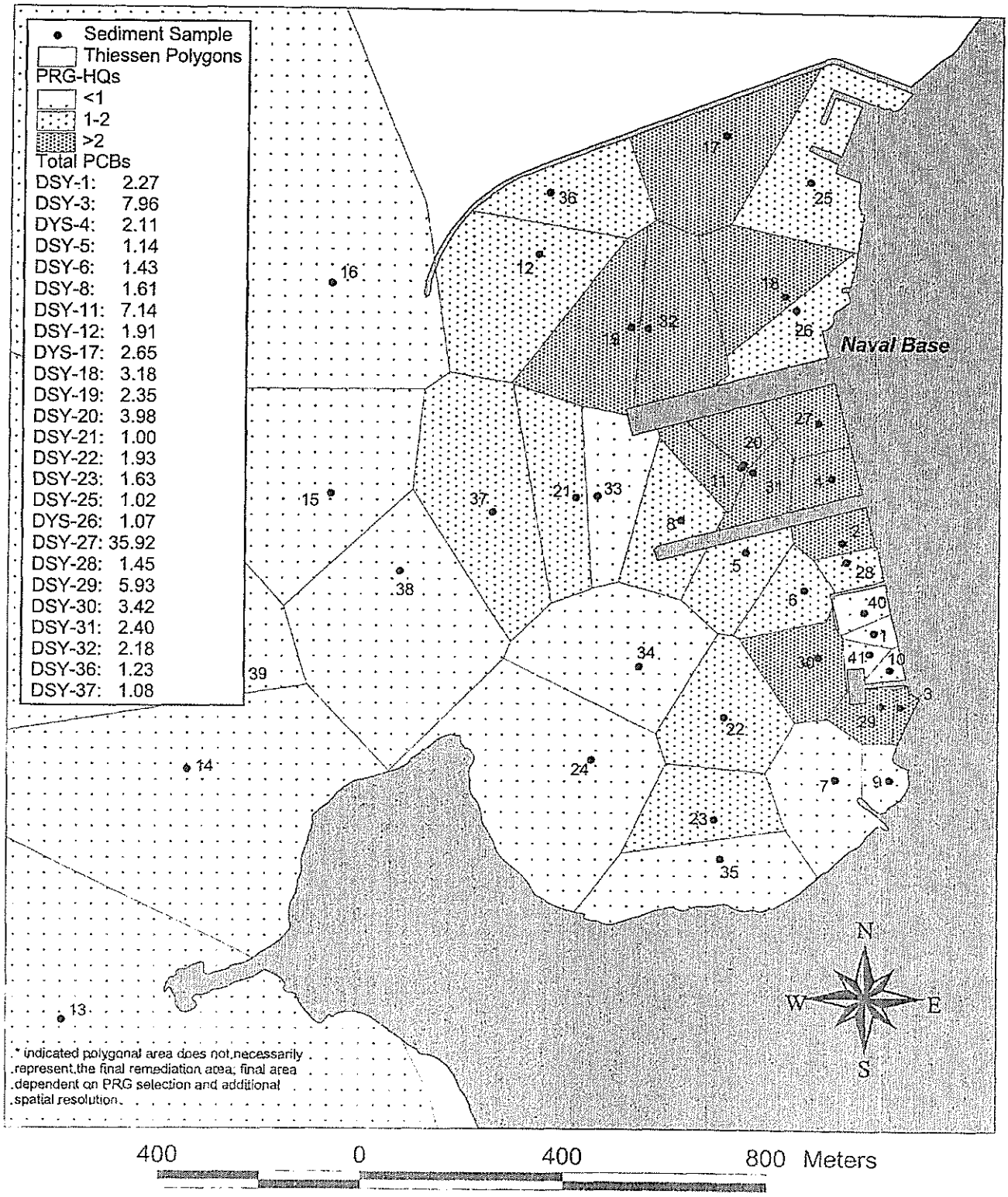


Figure 3.3-12. Summary of CoCs exceeding PRGs for protection of human health by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Human Health Exposure Pathway for Benzo(a)pyrene

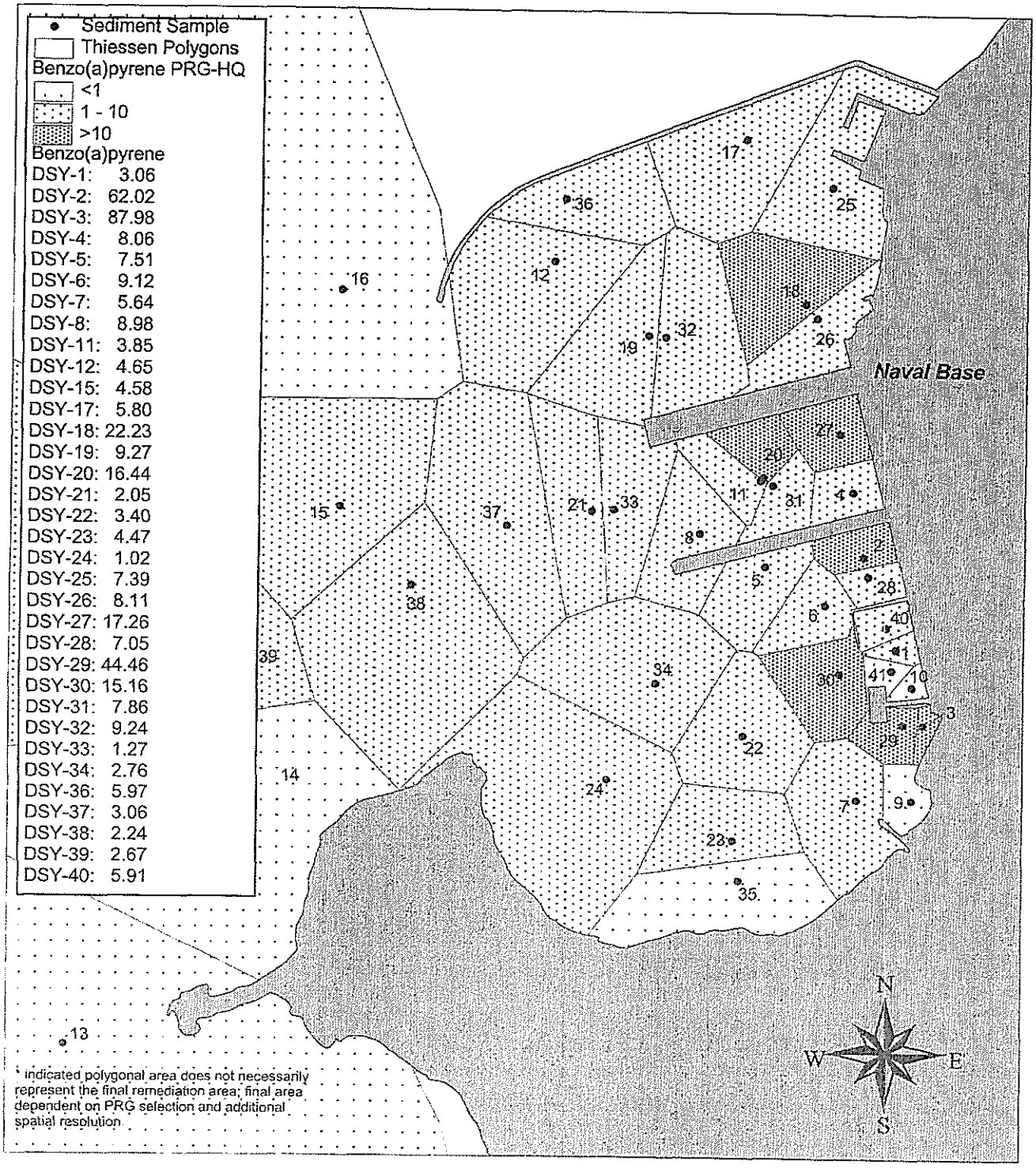


Figure 3.3-13. Summary of CoCs exceeding human health PRGs by location for sediments from the Derecktor Shipyard/Coddington Cove study area:*

Recommended PRG Implementation for the Human Health Exposure Pathway

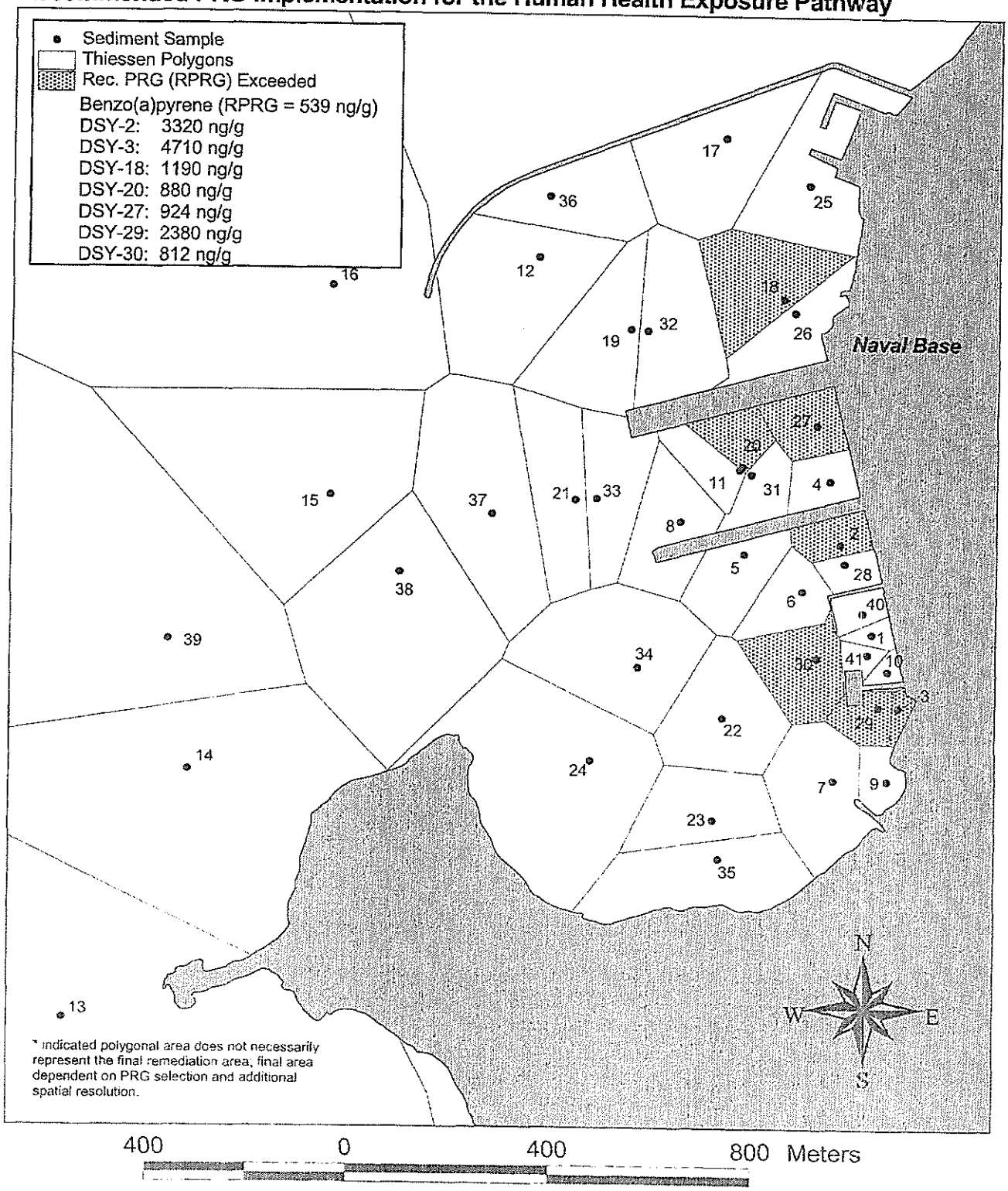


Figure 3.3-14. Summary of PRG exceedences by pathway for Derecktor Shipyard/Coddington Cove study area.

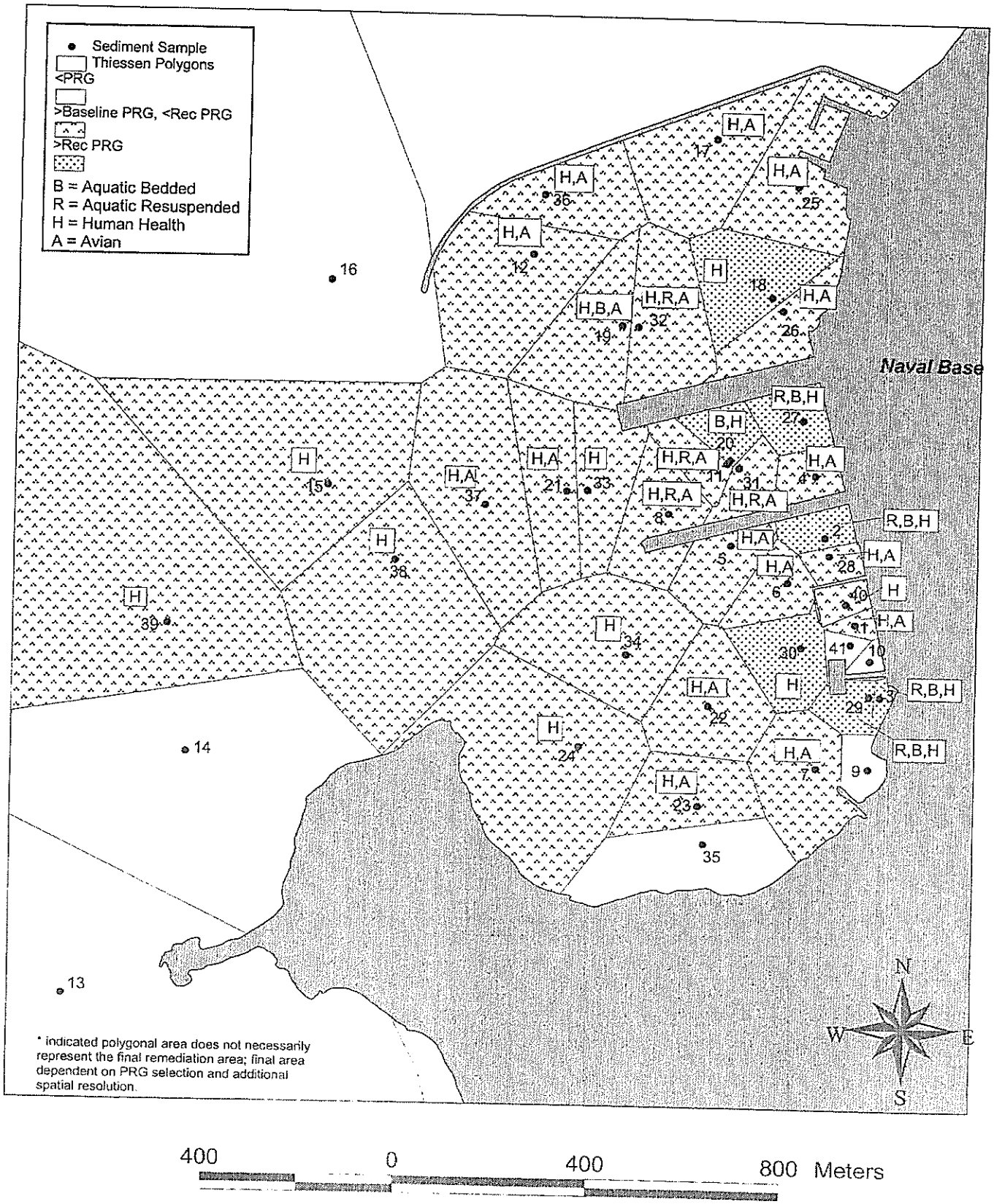


Table 1. Potential Remedial Action Objectives for the Derecktor Shipyard/ Coddington Cove study area.

Media/Receptor	Remedial Action Objectives (RAOs)
Aquatic Organisms	• Prevent exposure of aquatic organisms to bedded (in place) sediments with CoC concentrations exceeding the recommended PRGs. • Prevent exposure of aquatic organisms to sediments with CoC concentrations exceeding the recommended PRGs and that are present within areas where resuspension could occur.
Avian	• Prevent exposure of avian predators to shellfish that are impacted by sediments with CoC concentrations exceeding the selected PRGs and are within areas where shellfish predation could regularly occur.
Human Health	• Prevent human ingestion of shellfish that are impacted by sediments with CoC concentrations exceeding the selected PRGs, and are within areas where shellfishing could regularly occur.

Table 2. Chemical-specific ARARs for the Derecktor Shipyard/Coddington Cove study area.

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Groundwater (Federal)	Federal Resource Conservation and Recovery Act (RCRA), Subpart F (40 CFR 264.94), Ground-Water Protection Standards and Alternate Concentration Levels.	To Be Considered	Allows for the development of ACL for facilities which treat, store, or dispose of hazardous wastes when the characteristics of the ground water (e.g. high salinity) limit the application of MCLs or health-based criteria. Exposure-based ACL may be developed which take into account potentially adverse effects on groundwater quality and hydraulically connected surface water quality.	Although currently undeveloped, ACL for groundwater may be relevant and appropriate to the development of site-specific PRGs.
	Federal Clean Water Act (CWA) (33 USC 1251-1376); Clean Water Act, Water Quality Criteria, Section 404 (40 CFR 230)	To Be Considered	Non-enforceable guidelines established for the protection of human health and/or aquatic organisms. These guidelines are used by states to set water quality standards for surface water.	AWQC, with modification, may be relevant and appropriate for the development of PRGs for groundwater which enters a surface water.
	Federal Safe Drinking Water Act	Relevant and Appropriate	Establishes drinking water MCLs and health-based criteria.	Appropriate for the development of PRGs for remedial actions involving the discharge of treated groundwater.
Surface Water (Federal)	Federal Clean Water Act (CWA) (33 USC 1251-1376); Clean Water Act, Water Quality Criteria, Section 404 (40 CFR 230)	Relevant and Appropriate or Applicable	Non-enforceable guidelines established for the protection of human health and/or aquatic organisms. These guidelines are used by states to set water quality standards for surface water.	AWQC are relevant and appropriate to the development of PRGs for surface water. AWQC will also be applicable to remedial alternatives which involve discharges to surface water.
Soil/Sediment (Federal)	Toxicity Characteristic (40 CFR 261-24)	To Be Determined	Establishes maximum concentrations of CoC for the TCLP test method described in 40 CFR 261, Appendix II.	Applicable where wastes produced during remedial action require handling as a hazardous waste based upon results of TCLP analysis.
	Land Disposal Restrictions (40 CFR 268)	To Be Determined	Establishes maximum concentrations of CoCs on the basis of which hazardous wastes area restricted from land disposal.	Applicable to remedial alternatives which specify the land disposal of hazardous wastes.
	Toxic Substances Control Act (TSCA) (40 CFR 761.125)	Relevant and Appropriate	Establishes PCB cleanup levels for soils and solid surfaces.	Applicable to spills of materials containing PCBs at concentrations of 50 mg/kg or greater that occurred after May 4 1987. Although landfill operations ceased in 1972, this regulation may still be relevant and appropriate for the development of the PRG
	EPA Proposed Sediment Quality Criteria (Fed. Reg. Vol. 59, No. 11, 18 January 1994)	To Be Considered	Establishes proposed levels of five priority pollutants in fresh and saltwaters for the protection of benthic organisms.	To be considered for the development of PRGs.
	EPA Interim Sediment Criteria Values for Non Polar Hydrophobic Organic Contaminants (EPA SCD#17 May 1988)	To Be Considered	Screening values for contaminants in sediments.	To be considered for the development of PRGs. EPA's proposed criteria are contained in the 1994 document (above).
	Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OWSER 9355, 4-02)	To Be Considered	Sets as an interim soil cleanup level for lead at 500 to 1,000 mg/kg.	To be considered for the development of PRGs.
Groundwater (State)	Rules and Regulations for Groundwater Quality Criteria (CRIR No. 12-100-006)	To Be Considered	Establishes water classifications and water quality criteria. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	Class GA WQS, with modification, may be relevant and appropriate to the development of PRGs for groundwater based upon the potential discharge following treatment to fishable surface water.
	Groundwater Protection Act of 1985 (RIGL 46 13 1)	Applicable	Establishes the policy for maintaining and restoring groundwater quality and presents groundwater classifications.	Applicable to Class GB groundwater within the state of Rhode Island
Surface Water (State)	Rules and Regulations for Groundwater Quality Criteria (CRIR No. 12-100-006)	Relevant and Appropriate or Applicable	Establishes water classifications and water quality criteria. Also establishes acute and chronic water quality criteria for the protection of aquatic life	WQS are relevant and appropriate to the development of PRGs for surface water. WQS will also be applicable for remedial alternatives which involve discharges to surface water.
	Water Quality Regulations for Water Pollution Control	Applicable	Establishes water quality criteria and water classifications.	Applicable to Class SA surface water for the development of PRGs
Soils (State)	Rules and Regulations for Lead Poisoning Prevention	Applicable	RIDEM, in conjunction with RIDOH, established a permissible level of lead in soil at 500 mg/kg for surface soils and 1,000 mg/kg for subsurface soils. A "lead-free" level in soil was defined as 150 mg/kg	Applicable to the development of soil PRGs
	RI Hazardous Waste Management Act of 1987 (RIGL 23-19.1 et seq.)	Relevant and Appropriate or Applicable	Defines Type 6 - Extremely hazardous waste at including wastes which contain PCB at a concentration of 50 mg/kg or greater or showing 10 µg/100 cm² or greater as measured by a standard wipe test	Relevant and appropriate for the development of soil PRGs. Applicable for remedial actions which involve handling hazardous wastes
	Rules and Regulations for Solid Waste Management	Relevant and Appropriate or Applicable	Defines solid waste as including any soil, debris, or other material with a concentration of PCBs of 10 ppm or greater as measured by a standard wipe test	Relevant and appropriate for the development of soil PRGs. Applicable for remedial action which involve handling solid wastes.

Table 3. Procedure for Preliminary Remediation Goals (PRGs) development for aquatic, avian predator and human health exposure pathways in the Derecktor Shipyard/Coddington Cove study area.

PROCEDURE	EXPOSURE PATHWAY			
	Aquatic Bedded	Aquatic Resuspended	Avian Predator	Human Health
1 - Identify primary CoC exposure pathways and benchmarks to be used to express risks.	Exposure pathway = porewater; Benchmark = Water Quality Screening Values (WQSV); PW-HQ = Porewater (PW) concentration/WQSV.	Exposure pathway = Elutriate water; Benchmark = Water Quality Screening Values (WQSV); Elu-HQ = Elutriate (Elu) concentration/WQSV.	Exposure pathway = Fish and shellfish consumption; Benchmark = Toxicity Reference Value (TRV); TRV-HQ = Tissue concentration of prey species/TRV.	Exposure pathway = Shellfish consumed by subsistence fishermen; Benchmark = minimum Reasonable Maximum Exposure (RME) value; RME-HQ = Shellfish tissue concentration/RME.
2 - Evaluate CoC bioavailability under site-specific conditions.	Estimate 95% Upper Confidence Limit (95% UCL) of PW-HQs associated with non-toxic samples; set NOEQ = 1 where 95% UCL<1.	Estimate 95% Upper Confidence Limit (95% UCL) of Elu-HQs associated with non-toxic samples; set NOEQ = 1 where 95% UCL<1.	TRV based on avian predator exposure model for species living in the New England region.	RME based on human health exposure model for recreational shellfishing characteristics in the New England region.
3 - Retain CoCs substantially contributing to risk at the site.	Retain CoCs for which the Maximum PW-HQ associated with toxic samples > NOEQ.	Retain CoCs for which the Maximum Elu-HQ associated with toxic samples > NOEQ.	Retain CoCs with TRV-HQ>1.	Retain carcinogenic CoCs with risk > $1x10^{-6}$; Retain non-carcinogenic CoCs with HQ>1.
4 - Evaluate feasibility of pathway/CoC-specific PRG as a long-term remedial goal.	Compare Aquatic NOEC[1] and Reference Screening Value (RSV) for CoCs in porewater; select greater of two values as aquatic Threshold Effects Value (TEV).	Compare Aquatic NOEC[1] and Reference Screening Value (RSV) for CoCs in resuspended sediment; select greater of two values as aquatic Threshold Effects Value (TEV).	Compare Avian Predator TRV and Reference Screening Value (RSV) for CoCs in prey species tissues; select greater of two values as avian predator Threshold Effects Value (TEV).	Compare human health RME and Reference Screening Value (RSV) for CoCs in shellfish species tissues; select greater of two values as human health Threshold Effects Value (TEV).
5 - Rank pathway-specific TEV-HQs and select CoCs with maximum HQs by station and pathway as "limiting" CoCs.	Calculate Aquatic TEV-HQs as station-specific PW conc./TEV; identify maximum TEV-HQ by station; compile resulting list as "limiting" Aquatic CoCs for PRG development.	Calculate Aquatic TEV-HQs as station-specific Elu conc./TEV; identify maximum TEV-HQ by station; compile resulting list as "limiting" Aquatic CoCs for PRG development.	Calcluate Avian Predator TEV-HQs as station-specific prey tissue conc./TEV; identify maximum TEV-HQ by station; compile resulting list as "limiting" Avian Predator CoCs for PRG development.	Calcluate Human Health TEV-HQs as station-specific shellfish tissue conc./TEV; identify maximum TEV-HQ by station; compile resulting list as "limiting" Human Health CoCs for PRG development.
6 - Determine PRGs for "limiting" CoCs, i.e., convert TEV values in concentration-based units to be used during remediation.	For metal CoCs, use aquatic TEVs as PRGs (units = µg/L); derive organic PRGs (units = ng/g dry wt sediment) from TEV using EqP model.	For metal CoCs, use aquatic TEVs as PRGs (units = µg/L); derive organic PRGs (units = ng/g dry wt sediment) from TEV using EqP model.	Calculate PRGs (units = ng/g dry wt sediment) from avian TEVs using BAF (metals) and BSAF (organics) models.	Calculate PRGs (units = ng/g dry wt sediment) from human health TEVs using BAF (metals) and BSAF (organics) models.
7 - Evaluate practicality of pathway-specific PRGs for effective risk reduction.	Compare PRG exceedence to aquatic risk distribution.	Compare PRG exceedence to aquatic risk distribution.	Compare PRG exceedence to avian predator risk distribution.	Compare PRG exceedence to human health risk distribution.

1 - NOEC = NOEQ x WQSV

Table 4. Water Quality Criteria for target analytes selected for aquatic PRG development and derived Water Quality Screening Values.

Chemical Class	Analyte[3,4]	EPA Water Quality Criteria[1]				NOAA	WQSV[1,2]	
		WQC-FA	WQC-FC	WQC-SA	WQC-SC	ER-L	Conc.	DQ
Metals	Arsenic	360	190	69.00	36.00	8.20	36.00	A
	Cadmium	3.90	1.10	43.00	9.30	1.20	9.30	A
	Chromium	1700	210	1100	50.00	81.00	50.00	A
	Copper	18.00	12.00	2.90	2.90	34.00	2.90	A
	Lead	83.00	3.20	220	8.50	46.70	8.50	A
	Mercury	2.40	0.01	2.10	0.03	0.15	0.03	A
	Nickel	1400	160	75.00	8.30	20.90	8.30	A
	Silver	0.92	0.12	7.20	0.92	1.00	0.92	A
	Zinc	120	110	95.00	86.00	150	86.00	A
	SEM:AVS						5.00	F
PAHs	1,6,7-Trimethylnaphthalene							NA
	1-Methylnaphthalene							NA
	1-Methylphenanthrene							NA
	2,6-Dimethylnaphthalene							NA
	2-Methylnaphthalene					70.00	0.88	E
	Acenaphthene	1700	520	970	710	16.00	710	A
	Acenaphthylene					44.00	0.46	E
	Anthracene					85.30	0.29	E
	Benzo(a)anthracene					261	0.07	E
	Benzo(a)pyrene					430	0.04	E
	Benzo(b)fluoranthene							NA
	Benzo(e)pyrene							NA
	Benzo(g,h,i)perylene							NA
	Benzo(k)fluoranthene							NA
	Biphenyl							NA
	Chrysene					384	0.10	E
	Dibenz(a,h)anthracene					63.40	1.68E-03	E
	Fluoranthene	3980		40.00	16.00	600	16.00	A
	Fluorene					19.00	0.14	E
	Indeno(1,2,3-cd)pyrene							NA
	Naphthalene	2300	620	2350		160	620	B
	Perylene							NA
	Phenanthrene	30.00	6.30	7.70	4.60	240	0.81	A
	Pyrene					665	0.63	E
	LMW PAHs					552	5.26	E
	HMW PAHs					1700	0.29	E
	Total PAHs					4022	5.09	NA
PCBs	Total PCBs	2.00	0.01	10.00	0.03	22.70	0.03	A
Pesticides	Aldrin	3.00		1.30			0.16	B
	Hexachlorobenzene	6.00	3.68				3.68	C
	Mirex		1.00E-03		1.00E-03		1.00E-03	A
	o,p'-DDE			0.13	1.00E-03	2.20	1.00E-03	B
	p,p'-DDE			0.13	1.00E-03	2.20	1.00E-03	B
TBT	Tributyltin							NA

DQ - Data Qualifier (see Figure 2.2-1).
WQC-FA = Water Quality Criteria = Freshwater Acute Value
WQC-FC = Water Quality Criteria = Freshwater Chronic Value
WQC-SA = Water Quality Criteria = Saltwater Acute Value
WQC-SC = Water Quality Criteria = Saltwater Chronic Value
WQSV = Water Quality Screening Value
WQSV CODES.
NA= Benchmark not available to derive Screening Value
A- WQC-SC VALUE
B- 8.1 ACUTE/CHRONIC RATIO APPLIED TO WQ-SA VALUE (Shepard, 1995). * = Acute value based on LOAEL
C- WQC-FC VALUE
D- 8.1 ACUTE/CHRONIC RATIO APPLIED TO WQ-FA VALUE (Shepard, 1995)
E- EqP PARTITIONING OF ER-L SEDIMENT BENCHMARK INTO POREWATER AT 1% TOC
1- Units: µg/L.
2- See text and Figure 2.2-1 for WQSV derivation process.
3- LMW PAH = ten 2-ring & 3-ring PAHs, HMW-PAH = eight 4-ring and 5-ring PAHs. Total PAH = sum of LMW and HMW PAHs (NOAA, 1991)
LMW PAH, HMW PAH Kow = median of analyte specific Kows
4 - Assumed to be the same as DDT

Table 5A. Distribution of toxic and non-toxic aquatic Hazard Quotients and derivation of No Observable Effect Quotients for the aquatic receptors exposed to CoC via bedded and resuspended sediment aquatic exposure pathways for the Derecktor Shipyard/Coddington Cove study area.

BEDDED SEDIMENT		Bedded Sediment Exposure (Amphipod Survival)						
		Non-Toxic Samples			Toxic Samples			
Class	Analyte[2]	N	95% UCL PW-HQ[3]	AMP-NOEQ	N	Max. PW-HQ[3]	Max. PW-HQ > NOEQ?	AQ-BED NOEQ[4]
MET	Arsenic	0			0		NO	
MET	Cadmium	0			0		NO	
MET	Chromium	0			0		NO	
MET	Copper	0			0		NO	
MET	Lead	0			0		NO	
MET	Mercury	0			0		NO	
MET	Nickel	0			0		NO	
MET	Silver	0			0		NO	
MET	Zinc	0			0		NO	
MET	SEM:AVS	15.00	-0.67	5.00	2.00	-11.10	NO	
PAH	1,6,7-Trimethylnaphthalen	0			0		NO	
PAH	1-Methylnaphthalene	0			0		NO	
PAH	1-Methylphenanthrene	0			0		NO	
PAH	2,6-Dimethylnaphthalene	0			0		NO	
PAH	2-Methylnaphthalene	15.00	0.16	1.00	2.00	0.16	NO	
PAH	Acenaphthene	15.00	3.60E-04	1.00	2.00	1.27E-04	NO	
PAH	Acenaphthylene	15.00	0.84	1.00	2.00	0.87	NO	
PAH	Anthracene	15.00	1.38	1.38	2.00	1.21	NO	
PAH	Benzo(a)anthracene	15.00	0.73	1.00	2.00	0.83	NO	
PAH	Benzo(a)pyrene	15.00	0.45	1.00	2.00	0.58	NO	
PAH	Benzo(b)fluoranthene	0			0		NO	
PAH	Benzo(e)pyrene	0			0		NO	
PAH	Benzo(g,h,i)perylene	0			0		NO	
PAH	Benzo(k)fluoranthene	0			0		NO	
PAH	Biphenyl	0			0		NO	
PAH	Chrysene	15.00	0.59	1.00	2.00	0.64	NO	
PAH	Dibenz(a,h)anthracene	15.00	0.45	1.00	2.00	0.56	NO	
PAH	Fluoranthene	15.00	0.02	1.00	2.00	0.01	NO	
PAH	Fluorene	15.00	1.23	1.23	2.00	0.87	NO	
PAH	Indeno(1,2,3-cd)pyrene	0			0		NO	
PAH	Naphthalene	15.00	1.22E-03	1.00	2.00	9.01E-04	NO	
PAH	Perylene	0			0		NO	
PAH	Phenanthrene	15.00	0.67	1.00	2.00	0.38	NO	
PAH	Pyrene	15.00	0.64	1.00	2.00	0.79	NO	
PAH	LMW PAHs	15.00	3.38	3.38	2.00	2.58	NO	
PAH	HMW PAHs	15.00	2.87	2.87	2.00	3.41	YES	2.87
PAH	Total PAHs	15.00	6.22	6.22	2.00	5.99	NO	
PCB	Total PCBs	15.00	0.11	1.00	2.00	1.78	YES	1.00
PST	Aldrin	15.00	1.91E-05	1.00	2.00	6.72E-06	NO	
PST	Hexachlorobenzene	15.00	2.83E-06	1.00	2.00	1.46E-06	NO	
PST	Mirex	15.00	6.14E-03	1.00	2.00	0.01	NO	
PST	o,p'-DDE	15.00	0.02	1.00	2.00	0.40	NO	
PST	p,p'-DDE	15.00	0.02	1.00	2.00	0.04	NO	

PW-HQ=Porewater Hazard Quotient, ELU-HQ=Elutriate Hazard Quotient

1 - NOEQ = No Observable Effect Quotient = greater of 95% Upper Confidence Limit (UCL) HQ or 1.

2 - SEM-AVS expressed as µmol/g dry wt. sediment (benchmark from USEPA, 1996)

3- Porewater Hazard Quotients: from Table A-3.2; segregated by amphipod survival results, see Tables A-3.3A (no toxicity) and A-3.3B (toxicity).

4 - If Max PW-HQ>NOEQ, AQ BED-NOEQ = NOEQ

Table 5B. Distribution of toxic and non-toxic aquatic Hazard Quotients and derivation of No Observable Effect Quotients for the aquatic receptors exposed to CoC via bedded and resuspended sediment aquatic exposure pathways for the Derecktor Shipyard/Coddington Cove study area.

RESUSPENDED SEDIMENT		Resuspended Sediment (Sea Urchin Fertilization)							Resuspended Sediment (Sea Urchin Development)							
		Non-Toxic Samples			Toxic Samples				Non-Toxic Samples			Toxic Samples				
Class	Analyte[6]	N	95% UCL ELU-HQ[3]	NOEQ[1]	N	Max. ELU-HQ[3]	Max. ELU-HQ > NOEQ?	FERT[4A] NOEQ	N	95% UCL ELU-HQ[3]	NOEQ[1]	N	Max. ELU-HQ[3]	Max. ELU-HQ > NOEQ?	DEV[4B] NOEQ	AQ ELU[5] NOEQ
MET	Arsenic	9.00	0.84	1.00	0		NO		2.00	1.12	1.12	7.00	2.11	YES	1.12	1.12
MET	Cadmium	9.00	0.01	1.00	0		NO		2.00	0.01	1.00	7.00	0.01	NO		
MET	Chromium	9.00	8.00E-03	1.00	0		NO		2.00	8.00E-03	1.00	7.00	8.00E-03	NO		
MET	Copper	9.00	0.59	1.00	0		NO		2.00	0.43	1.00	7.00	1.76	YES	1.00	1.00
MET	Lead	9.00	1.29	1.29	0		NO		2.00	1.06	1.06	7.00	1.87	YES	1.06	1.06
MET	Mercury	9.00	4.00	4.00	0		NO		2.00	4.00	4.00	7.00	4.00	NO		
MET	Nickel	9.00	0.48	1.00	0		NO		2.00	0.48	1.00	7.00	0.48	NO		
MET	Silver	9.00	0.27	1.00	0		NO		2.00	0.27	1.00	7.00	0.27	NO		
MET	Zinc	9.00	0.05	1.00	0		NO		2.00	0.05	1.00	7.00	0.05	NO		
MET	SEM:AVS	17.00	1.06	1.06	0		NO		6.00	1.70	1.70	8.00	1.51	NO		
PAH	1,6,7-Trimethylnaphthale	0			0		NO		0			0		NO		
PAH	1-Methylnaphthalene	0			0		NO		0			0		NO		
PAH	1-Methylphenanthrene	0			0		NO		0			0		NO		
PAH	2,6-Dimethylnaphthalene	0			0		NO		0			0		NO		
PAH	2-Methylnaphthalene	9.00	7.34E-03	1.00	0		NO		2.00	6.57E-03	1.00	7.00	0.01	NO		
PAH	Acenaphthene	11.00	6.53E-06	1.00	0		NO		3.00	3.45E-06	1.00	8.00	3.90E-05	NO		
PAH	Acenaphthylene	11.00	8.44E-03	1.00	0		NO		3.00	0.01	1.00	8.00	0.03	NO		
PAH	Anthracene	10.00	0.04	1.00	0		NO		2.00	0.05	1.00	8.00	0.16	NO		
PAH	Benzo(a)anthracene	10.00	0.23	1.00	0		NO		2.00	0.19	1.00	8.00	0.71	NO		
PAH	Benzo(a)pyrene	11.00	0.29	1.00	0		NO		3.00	0.28	1.00	8.00	0.97	NO		
PAH	Benzo(b)fluoranthene	0			0		NO		0			0		NO		
PAH	Benzo(e)pyrene	0			0		NO		0			0		NO		
PAH	Benzo(g,h,i)perylene	0			0		NO		0			0		NO		
PAH	Benzo(k)fluoranthene	0			0		NO		0			0		NO		
PAH	Biphenyl	0			0		NO		0			0		NO		
PAH	Chrysene	9.00	0.08	1.00	0		NO		2.00	0.06	1.00	7.00	0.33	NO		
PAH	Dibenz(a,h)anthracene	11.00	3.69	3.69	0		NO		3.00	6.84	6.84	8.00	6.84	NO		
PAH	Fluoranthene	11.00	1.87E-03	1.00	0		NO		3.00	1.19E-03	1.00	8.00	7.36E-03	NO		
PAH	Fluorene	11.00	0.04	1.00	0		NO		3.00	0.04	1.00	8.00	0.18	NO		
PAH	Indeno(1,2,3-cd)pyrene	0			0		NO		0			0		NO		
PAH	Naphthalene	9.00	1.57E-05	1.00	0		NO		2.00	1.55E-05	1.00	7.00	2.36E-05	NO		
PAH	Perylene	0			0		NO		0			0		NO		
PAH	Phenanthrene	11.00	0.01	1.00	0		NO		3.00	0.01	1.00	8.00	0.04	NO		
PAH	Pyrene	11.00	0.19	1.00	0		NO		3.00	0.44	1.00	8.00	0.49	NO		
PAH	LMW PAHs	11.00	0.09	1.00	0		NO		3.00	0.08	1.00	8.00	0.39	NO		
PAH	HMW PAHs	11.00	4.44	4.44	0		NO		3.00	7.32	7.32	8.00	8.37	YES	7.32	7.32
PAH	Total PAHs	11.00	4.54	4.54	0		NO		3.00	7.37	7.37	8.00	8.46	YES	7.37	7.37
PCB	Total PCBs	11.00	1.43	1.43	0		NO		3.00	2.31	2.31	8.00	2.59	YES	2.31	2.31
PST	Aldrin	11.00	9.05E-03	1.00	0		NO		3.00	9.82E-03	1.00	8.00	9.82E-03	NO		
PST	Hexachlorobenzene	11.00	6.58E-05	1.00	0		NO		3.00	2.45E-04	1.00	8.00	2.45E-04	NO		
PST	Mirex	11.00	0.32	1.00	0		NO		3.00	0.60	1.00	8.00	0.71	NO		
PST	o,p'-DDE	11.00	2.48	2.48	0		NO		3.00	2.80	2.80	8.00	3.52	YES	2.80	2.80
PST	p,p'-DDE	11.00	0.48	1.00	0		NO		3.00	0.59	1.00	8.00	0.71	NO		

PW-HQ=Porewater Hazard Quotient, ELU-HQ=Elutriate Hazard Quotient

1 - NOEQ = No Observable Effect Quotient = greater of 95% Upper Confidence Limit (UCL) HQ or 1.

2 - SEM-AVS expressed relative to 5 µmol/g dry wt. sediment benchmark (from USEPA, 1996)

3- Elutriate Hazard Quotients, from Table A-4.2, segregated by sea urchin fertilization results, see Table A-4.3A (no toxicity) and Table A-4.3B (toxicity); for sea urchin larval development (elutriates), see Tables A-4.4A (no toxicity) and A-4.4B (toxicity).

4A - If Max FERT ELU-HQ > NOEQ, FERT NOEQ = NOEQ

4B - If Max DEV ELU-HQ > NOEQ, DEV NOEQ = NOEQ

5 - Aquatic NOEQ = minimum of TEST-specific NOEQs

6 - SEM concentration used; AVS assumed = 0 in resuspended sediment.

Table 6. Derivation of Aquatic Reference Screening Values based on concentrations for selected contaminants in porewater[1] and elutriates from Narragansett Bay reference locations.

POREWATERS

Class	Analyte[2,4]	Pathway	JCC-D1	JCC-D1-BOT	JCC-D1-MID	JCC-M1	JCC-S1	JPC-1	JPC-2	JSC-D1	JSC-DC1	JSC-V1	JSC-W1	PCC-D1	PCC-DC1[2]	PCC-V1	PCC-W1	n	T0.975	Mean	95% UCL	Aquatic RSV[3]
PAH	HMW PAHs	PW	0.07	8.63E-03		0.03	0.07	0.10		2.70E-03	2.44E-03	0.04	0.54	1.62E-03	2.14E-03	0.01	1.08	13.00	2.13	0.15	0.19	0.34
PCB	Total PCBs	PW		1.59E-04	2.92E-04	1.44E-04	2.07E-04	2.67E-04		3.58E-05	6.71E-05	1.06E-04		1.12E-04	7.54E-05	7.62E-05		11.00	2.13	1.40E-04	5.39E-05	1.94E-04
MET	Arsenic	ELU						18.30										1.00	2.13	18.30		
MET	Copper	ELU						1.25										1.00	2.13	1.25		
MET	Lead	ELU						13.20										1.00	2.13	13.20		
PAH	HMW PAHs	ELU						209										1.00	2.13	209		
PAH	Total PAHs	ELU						237										1.00	2.13	237		
PCB	Total PCBs	ELU						48.37										1.00	2.13	48.37		
PST	o,p'-DDE	ELU						3.59										1.00	2.13	3.59		
TOC	% TOC	ELU	1.79	1.47	3.73	4.01	6.09	3.79	3.84	3.57	1.66	3.18	0.61	3.55	2.55	1.48	0.81	15.00	2.13	2.81		

Missing PW values indicate outliers removed from the RSV calculation. Outliers are defined as values greater than the mean + 2 standard deviations of the mean for all data.

Only one sample was available for ELU data; hence no outlier analysis was performed.

1-Porewater concentration (µg/L) = sediment concentration/(foc X Koc). See Table A-1 for Koc values.

foc = %TOC/100.

Data Sources: SAIC, 1996 (JSC/PCC - Allen Harbor ERA reference locations), Appendix A-1-1 (sediment concentrations) and A-1-3 (porewater concentrations);

SAIC and URI, 1997a (JCC - McAllister Point ERA reference location), Appendix A-1-1-1 (sediment organic chemistry), A-1-2-1 (sediment metals chemistry), and A-1-2-3 (porewater metals chemistry);

SAIC and URI, 1997b (JPC/CHC - Derecktor Shipyard ERA reference locations), Appendix A-1-1 (sediment chemistry) and A-1-2 (elutriate chemistry).

2 - List includes analytes for which NOEQs were developed; see Table 5A (PW) and Table 5B (ELU).

3 - Aquatic Reference Screening Value (RSV) calculated as 95% Upper Confidence Limit based on sample size as follows:

Mean + ($t_{0.975}(df)$*(STDEV/(SQRT(n))); where STDEV=standard deviation; n=sample size;

$t_{0.975}(df)$ = sample size-dependent percentage points of the t distribution, (Ott, 1993).

4 - Koc for Aroclor 1254 assumed for Total PCBs (see Table A-1).

Table 7. Derivation of Threshold Effects Values (TEVs) for bedded (PW) and resuspended (ELU) aquatic exposure pathways in the Derecktor Shipyard/Coddington Cove study area.

Class	Analyte[1]	Exposure Pathway[1]	Aquatic NOEQ[2]	NOEC[3,5] (µg/L)	Aquatic RSV[4] (µg/L)	Aquatic TEV[5] (µg/L)	L-CoC?[6]
PAH	HMW PAHs	PW	2.87	0.82	0.34	0.82	yes
PCB	Total PCBs	PW	1.00	0.03	1.94E-04	0.03	yes
MET	Arsenic	ELU	1.12	40.40	18.30	40.40	yes
MET	Copper	ELU	1.00	2.90	1.25	2.90	yes
MET	Lead	ELU	1.06	9.00	13.20	13.20	yes
PAH	HMW PAHs	ELU	7.32	2.09	0.21	2.09	no
PAH	Total PAHs	ELU	7.37	37.51	0.24	37.51	no
PCB	Total PCBs	ELU	2.31	0.07	0.05	0.07	yes
PST	o,p'-DDE	ELU	2.80	2.80E-03	3.59E-03	3.59E-03	yes

PW=Porewater, ELU=Elutriate.

NOEQ=No Observable Effect Quotient; WQSV=Water Quality Screening Value; NOEC=No Observable Effect Concentration; RSV=Reference Screening Value; TEV=Toxicity Effect Value.

1 - List includes analytes for which Aquatic NOEQs were developed; see Table 5.

2 - Aquatic NOEQ = minimum of exposure pathway-specific NOEQs; see Table 5.

3 - NOEC = Aquatic NOEQ x WQSV (Table 4).

4 - RSV = reference data compiled by SAIC (Table 6).

5 - Aquatic TEV is the greater of the NOEC and RSV.

6- L-CoC = Limiting CoC; see Table A-5 for L-CoC derivation.

Table 8 Avian Predator Reference Screening Values for selected CoCs in tissues of prey from Narragansett Bay reference locations.

Class	Analyte[1]	C1-1/2/3-HC	C1-4-HC	CHC-1-CN	CHC-1-IBM	CHC-1-LOB	JCC-D1-LOB-HPP	JCC-D1-LOB-MUS	JCC-M1-HC	JCC-S1-HC	JPC-1-IBM	JPC-1-LOB	JPC-1-MF	JSCD1HCND	JSCW1MFMIX	PCCD1HCND	PCCW1HCND	PCCW1MFCOM	PCCW1MFMIX	PCCW1MFSTP	Mean	Avian Predator RSV[2]
Metals	Arsenic	11.30	19.30	3.48	4.68	21.68	19.77	19.82			6.77	19.43	5.92	5.91	2.88	10.44	17.66	1.25	6.83		11.07	14.96
	Cadmium	0.58	0.65	0.94	0.58	0.23	8.27	1.50E-03			0.59	0.18	1.18	0.20	0.11	0.30	0.37	0.19	0.10		0.41	0.60
	Chromium	7.57	8.73	1.22	1.84	1.43	0.11	0.11			2.44	1.68	1.08	2.65	0.69	2.82	4.06	1.36	1.76		2.05	3.08
	Copper	10.60	8.50	18.39	11.93	102	10.77	45.71			8.62	143	22.74	5.33	1.94	33.84	3.75	2.69	3.67		10.98	16.54
	Lead	0.65	0.99	0.84	0.78	0.18	0.09	0.14			3.28	0.39	0.43	0.79	0.14	0.91	0.59	0.70	0.26		0.54	0.72
	Mercury	0.08	0.13	0.17	0.18	0.23	0.11	0.56			0.17	0.30	0.11	0.01	0.07	0.10	0.01	0.10	0.01		0.12	0.16
	Silver		0.93	1.56	1.50E-04	3.84	1.25	0.84			1.50E-04	2.19	1.50E-04	1.79	0.81	4.15	1.69	0.69	0.92		0.98	1.41
	Zinc	112	97.50	21.97	91.68	119	65.15	102			92.83	106	34.06	74.10	167	89.64	86.11	160	186		100	124
PCBs	Total PCBs	53.54		1010	389	461	4210	106	91.43	37.73	565	397	1900	50.96	616	120	68.11			1191	470	766

Missing values indicate outliers removed from the RSV calculation. Outliers are defined as values greater than the mean + 2 standard deviations of the mean for all data.

Metals units=µg/g dry tissue wt.; organics units=ng/g dry tissue wt.

CN=cunner, HC=hard clams, IBM=indigenous blue mussels, LOB=lobster, LOB-HPP= lobster hepatopancreas, LOB-MUS=lobster muscle,

MF=marine fish, ND=non-depurated, DEP=depurated.

Data Sources: SAIC, 1996 (JSC/PCC - Allen Harbor ERA reference locations), Appendix A-1-2 (tissue concentrations);

SAIC and URI, 1997a (JCC - McAllister Point ERA reference location), Appendix A-1-1-2 (tissue organic chemistry) and A-1-2-2 (tissue metals chemistry),

SAIC and URI, 1997b (JPC/CHC - Derecktor Shipyard ERA reference locations), Appendix A-1-3 (tissue chemistry);

TRC, 1994 (C1 - NETC reference location).

1 - Analytes for which maximum TRV-HQs<1 were excluded from PRG development; see ERA Appendix A-2-4 (SAIC and URI 1997).

2 - Avian Predator Reference Screening Value (RSV) calculated as 95% Upper Confidence Limit based on sample size as follows:

Mean + ($t_{0.95}(df)$*(STDEV/(SQRT(n))), where STDEV=standard deviation; n=sample size;

$t_{0.95}(df)$ = sample size-dependent percentage points of the t distribution (Ott, 1993).

Table 9. Derivation of Threshold Effects Values for the avian predator exposure pathway in the Derecktor Shipyard/Coddington Cove study area.

Class	Analyte[1]	Maximum TRV-HQ[2]	Avian Predator TRV[3] (mg/kg dry tiss. wt.)	Avian Predator RSV[4] (mg/kg dry tiss. wt.)	Avian Predator TEV[5] (mg/kg dry tiss. wt.)	L-CoC?[6]
Metals	Arsenic	3.50	8.18	14.96	14.96	no
	Cadmium	1.02	1.83	0.60	1.83	no
	Chromium	1.84	1.72	3.08	3.08	no
	Copper	3.24	60.71	16.54	60.71	yes
	Lead	1.87	3.11	0.72	3.11	yes
	Mercury	1.19	0.38	0.16	0.38	no
	Silver	6.16	1.11	1.41	1.41	yes
	Zinc	5.96	28.77	124	124	yes
PCBs	Total PCBs	13.50	0.29	0.77	0.77	yes

TRV=Toxicity Reference Value.

1 - Analytes identified in Table 8.

2 - Maximum TRV-HQ=maximum Hazard Quotient observed for any prey-receptor combination in the Derecktor Shipyard/Coddington Cove study area: see Appendix A-2-4 in Final Derecktor Shipyard Marine ERA (SAIC and URI, 1997b).

3 - TRV = minimum of receptor-specific TRV; see Table 6.3-2 in Final Derecktor Shipyard Marine ERA (SAIC and URI, 1997b).

4 - Avian Predator Reference Screening Value (RSV) ; see Table 8.

5 - Avian Threshold Effects Value (TEV); selected as greater of TRV and RSV.

6- L-CoC = Limiting CoC; see Table A-6 for L-CoC derivation.

Table 10. Summary of exposure parameter values used in estimating CoC exposures via shellfish consumption by subsistence fishermen in the Derecktor Shipyard/Coddington Cove study area.

Parameter	RME Value	Rationale	Reference
Global variables			
Body Weight (kg)			
- Shellfishing	70.00	Average of adults between 18-65 years of age.	USEPA 1994
Exposure Duration (yr)			
- Shellfishing and Residential (yr)	30.00	Median and upper-bound time at one residence, adults.	USEPA 1994
Averaging Time (days)			
- Cancer risks	25550	Based on 70 year life expectancy.	USEPA 1989b
- Noncancer risks			
Shellfishing and Residential	10950	Based on exposure duration.	USEPA 1989b
Relative Absorption Factors			
- Ingestion of shellfish			USEPA 1989b
VOCs	1.00		
PAHs	1.00		
PCBs	0.30		
Pesticides	0.30	Pesticides in this study are considered high sorption (logKow=5.89-6.89).	
Inorganics	1.00		
Lead	0.30		
Consumption of Locally-Caught Shellfish Scenario			
Exposure Frequency (day/yr)	350	Assumes two weeks vacation.	USEPA 1994
Ingestion Rate (g/day)	15.60	Based on 150 g shellfish per serving and 36.5 servings of shellfish per year.	USEPA 1994; Rupp *et al*. (1980)
Fraction of Ingested Shellfish Caught Locally	1.00	Conservative assumption in absence of site-specific data.	BPJ

NOTES:
RME: Reasonable Maximum Exposure.
BPJ: Best professional judgment.

Table 11. Toxicity values for Chemicals of Concern in shellfish tissue for the Derecktor Shipyard/Coddington Cove study area.

		Cancer Slope Factor (SF)[1] (mg CoC/kg body wt-day^{-1})	Non-cancer Chronic Reference Dose (RfD)[1,3] (mg CoC/kg body wt-day^{-1})
Class	Analyte	Ingestion	Ingestion
MET	Arsenic	1.50	3.00E-04
PAH	Benzo(a)anthracene	0.73	
PAH	Benzo(a)pyrene	7.30	
PAH	Dibenz(a,h)anthracene	7.30	
PAH	Indeno(1,2,3-cd)pyrene	0.73	
PCB	Total PCBs	2.00	

Cancer Slope Factors for all carcinogenic PAHs were set equal to the most toxic PAH, Benzo(a)pyrene.

1 - Original source for SF and RfD values from IRIS database (USEPA, 1997).

2 - Value adjusted in comparison to SF for benzo(a)pyrene; as per USEPA (1993) *Provisional Guidance For Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons.*

3 - Missing values indicates this CoC is not a non-carcinogenic CoC.

Table 12. Summary of risk-based concentration thresholds for CoCs in shellfish tissue for the Derecktor Shipyard/Coddington Cove study area.

		Risk-based Concentration (mg CoC/kg wet tissue wt.)[1]			Human Health Risk-Based Value (RBV)[5]
Class	Analyte	1×10^{-6} Cancer Risk[2]	1×10^{-4} Cancer Risk[2]	HQ = 1 Non-cancer Risk[3,4]	
MET	Arsenic	7.28E-03	0.73	1.40	0.05
PAH	Benzo(a)anthracene	0.01	1.50		0.11
PAH	Benzo(a)pyrene	1.50E-03	0.15		0.01
PAH	Dibenz(a,h)anthracene	1.50E-03	0.15		0.01
PAH	Indeno(1,2,3-cd)pyrene	0.01	1.50		0.11
PCB	Total PCBs	0.18	18.20		1.30

1 - Assumes Reasonable Maximum Exposure scenario.

Benchmarks calculated for CoCs with > 1×10-6 cancer risk or HQ>1.0 non-cancer risk for HH ERA under RME exposure scenario.

2 - Derived using Equation 2 in Section 2.4.3 of text.

3 - Derived using Equation 1 in Section 2.4.3 of text.

4 - Missing values indicates this CoC is not a non-carcinogenic CoC in shellfish tissue under RME conditions based on baseline human health risk assessment results.

5 - Human Health Risk-based Value (RBV); minimum of risk-based RME values for carcinogenic and non-carcinogenic CoCs.

Units: mg CoC/kg dry wt. tissue. Value converted to dry weight units dry wt=wet wt/% solids content (Table A-2.3).

Table 13. Derivation of Human Health Reference Screening Values based on concentrations of selected contaminants in tissues of shellfish harvested from lower Narragansett Bay for consumption by subsistence fishermen.

Class	Analyte[1]	C1-1/2/3	C1-4	CHC-1-IBM	CHC-1-LOB	JCC-D1-LOB-HPP	JCC-D1-LOB-MUS	JCC-M1-HC	JCC-S1-HC	JPC-1-IBM	JPC-1-LOB	JPC-1-MM	JPC-1-PM	JSCD1HCND	PCCD1HCND	PCCW1HCND	Mean	Human Health RSV[2]
MET	Arsenic	11.30	19.30	4.68	21.68	19.77	19.82			6.77	19.43	7.73	11.04	5.91	10.44	17.66	13.50	17.27
PAH	Benzo(a)anthracene	3.57	3.18	47.31	3.36	120	0.90	3.36	0.75	15.80	3.36	10.53	26.48	1.83	1.91	1.13	8.82	16.46
PAH	Benzo(a)pyrene	1.60	2.62	31.00	3.62	51.92	4.90	4.00	1.23	7.81	3.62	4.20	8.00	1.33	1.54	1.26	5.48	9.91
PAH	Dibenz(a,h)anthracene	0.79	1.12	0.49	0.49	0.49	0.49	0.49	0.18	0.49	0.49	0.49	0.49	1.30	1.05	1.40	0.68	0.88
PAH	Indeno(1,2,3-cd)pyrene	4.07	4.96	15.51	1.54	41.42	0.10	2.00	1.65	1.54	1.54	1.54	1.54	0.53	2.10	0.99	2.83	5.06
PCB	Total PCBs	53.54		389	461	4210	106	91.43	37.73	565	397	204	267	50.96	120	68.11	216	325

Units: metals units=µg/g dry tissue weight; organics=ng/g dry tissue weight.

HC=hard clams, PM=*Pitar morrhuana*, MM=*Mercenaria mercenaria*, ND=non-depurated, LOB=lobster, MUS=lobster muscle, HPP=lobster hepatopancreas, IBM=indigenous blue mussel.

Data Sources. JSC/PCC = Allen Harbor ERA reference locations (SAIC, 1996, Appendix Tables A-1-2 (tissue data));

JCC = McAllister Point ERA reference location (SAIC and URI, 1997a, Appendix A-1-1-2 (tissue organic data) and A-1-2-2 (tissue metals data));

JPC/CHC = Derecktor Shipyard ERA reference locations (SAIC and URI, 1997b, Appendix Tables A-1-3 (tissue data)).

TRC, 1994 (C1 - NETC reference location).

1 - List includes CoCs for which RBVs were developed; see Table 12.

2 - Human Health Reference Screening Value (RSV) calculated as 95% Upper Confidence Limit based on sample size as follows:

Mean + ($t_{0.975}(df)$*(STDEV/(SQRT(n))); where STDEV=standard deviation; n =sample size;

$t_{0.975}(df)$ = sample size-dependent percentage points of the t distribution (Ott, 1993).

Table 14. Derivation of Threshold Effects Values for the human health exposure pathway in the Derecktor Shipyard/Coddington Cove study area.

Class	Analyte	Human Health RBV[1] (mg/kg dry tiss. wt)	Human Health RSV[2] (mg/kg dry tiss. wt)	Human Health TEV[3] (mg/kg dry tiss. wt)	L-CoC?[4]
Metals	Arsenic	0.05	17.27	17.27	yes
	Benzo(a)anthracene	0.11	0.02	0.11	no
	Benzo(a)pyrene	0.01	9.91E-03	0.01	yes
	Dibenz(a,h)anthracene	0.01	8.83E-04	0.01	no
	Indeno(1,2,3-cd)pyrene	0.11	5.06E-03	0.11	no
PCBs	Total PCBs	1.30	0.33	1.30	no

1 - Human Health Risk-based Value (RBV); see Table 12.
2 - Human Health Reference Screening Value (RSV), see Table 13.
3 - Human Health Threshold Effects Values (TEV) = greater of RBV and RSV.
4 - L-CoC = Limiting CoC; see Table A-7 for L-CoC derivation.

Table 15. Summary of maximum TEV-HQs and identification of Limiting CoCs by sampling location for aquatic, avian predator and human health exposure pathways for the Derecktor Shipyard/Coddington Cove study area.

Exposure Pathway	Parameter	DSY-24	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
Aquatic (A)	TEV-HQ[1,2]		0.89	1.42	1.78		2.34	1.15										1.74	
Bedded	L-CoC		HMW PAHs	HMW PAHs	Total PCBs		HMW PAHs	HMW PAHs										HMW PAHs	
Aquatic (A)	TEV-HQ[1,2]		1.12		1.00		0.83		1.76	0.71	1.20			1.00	0.98	1.01	1.88	0.74	
Resuspended	L-CoC		Total PCBs		Total PCBs		o,p'-DDE		Copper	Lead	Lead			Arsenic	Lead	Arsenic	Arsenic	Arsenic	
Avian Predator (P)	TEV-HQ[1,3]	1.87	3.89	2.87	4.89	5.05	4.16		1.33		2.44		4.65	4.08		4.34	3.24	1.19	
	L-CoC	Lead	Silver	Total PCBs	Silver	Total PCBs	Silver		Zinc		Silver		Silver	Total PCBs		Silver	Copper	Total PCBs	
Human Health (HH)	TEV-HQ[1,4]		10.72	51.30	6.84	3.17	1.65		4.21	3.99	2.08	2.10	1.51	3.02	2.17	1.93	1.08		1.62
	L-CoC		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Arsenic		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Arsenic		Benzo(a) pyrene
Combined	TEV-HQ[1,5]	1.87	10.72	51.30	6.84	5.05	4.16	1.15	4.21	3.99	2.44	2.10	4.65	4.08	2.17	4.34	3.24	1.74	1.62
Exposure	L-CoC	Lead	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Total PCBs	Silver	HMW PAHs	Benzo(a) pyrene	Benzo(a) pyrene	Silver	Benzo(a) pyrene	Silver	Total PCBs	Benzo(a) pyrene	Silver	Copper	HMW PAHs	Benzo(a) pyrene
Pathway	Pathway[6]	P	HH	HH	HH	P	P	A	HH	HH	P	HH	P	P	HH	P	P	A	HH

TEV-HQ=Threshold Effects Value Hazard Quotient. L-CoC=Limiting Chemical of Concern. See text, Section 1.0. TEV-HQs<1 not reported

1 - TEV-HQ = media-specific concentration/analyte-pathway-specific TEV value.

2 - Values presented are maximum of Aquatic TEV-HQs by station. Complete TEV-HQ values presented in Tables A-5

3 - Values presented are maximum of Avian Predator TEV-HQs by station. Complete TEV-HQ values presented in Table A-6

4 - Values presented are maximum of Human Health TEV-HQs by station. Complete TEV-HQ values presented in Table A-7

5 - Values presented are maximum of individual exposure pathway TEV-HQs by station.

6 - Limiting Exposure Pathway. A = Aquatic, P = Avian Predator, HH = Human Health

Table 16. Summary of Preliminary Remediation Goals (PRGs) for aquatic, avian predator, human health, and combined exposure pathways for the Derecktor Shipyard/Coddington Cove study area.

		Preliminary Remediation Goal[1]									
		Aquatic-Bedded[3A]		Aquatic-Resuspended[3B]		Avian Predator[4]		Human Health[5]		Combined Pathway	
Class	Analyte[2]	HQ=1	RPRG	HQ=1	RPRG	HQ=1	RPRG	HQ=1	RPRG	HQ=1	RPRG
MET	Arsenic			24.63	NR	17.09	NR	19.74	NR	17.09	NR
MET	Copper			73.74	NR	184	NR			73.74	NR
MET	Lead			83.94	168	622000	NR			83.94	168
MET	Silver					2342	NR			2342	NR
MET	Zinc					118	NR			118	NR
PAH	Benzo(a)pyrene							53.92	539	53.92	539
PAH	HMW PAHs	6951	13903							6951	13903
PCB	Total PCBs	1638	1638	530	1060	92.82	NR			92.82	1060
PST	o,p'-DDE			9.06	NR					9.06	NR

RPRG - Recommended Preliminary Remediation Goal
NR - Not Recommended
1 - Pathway-specific PRGs expressed in concentration units for use during remediation.
PAHs, PCBs, pesticides: units = ng/g dry weight sediment
metals: units = µg/g dry weight sediment

2 - List includes only limiting CoCs, i.e., CoCs with maximum TEV-HQs by station and pathway (Table 15).

3A - Aquatic Bedded PRG at HQ=1 calculated as the mean (TEV*[Sed])/[PW];
REC = 2 x PRG at HQ = 1; adjusted to reduce risk to CoC exposure in bedded sediment of high risk areas. See text in Section 3.3.

3B - Aquatic Resuspended sediment PRG at HQ=1 calculated as the mean (TEV*[Sed])/[Elutriate]).
REC = 2 x PRG at HQ = 1; adjusted to reduce risk to CoC exposure during sediment resuspension in high risk areas. See text in Section 3.3.

4 - Avian predator PRG (at HQ=1) for organics calculated as [$\%TOC_{avg}$ x ((Avian TEV*1000)/$\%lipid_{avg}$))/BSAF];
For Metals, PRG conc. = [Avian TEV/BAF].
REC = NR; due to low risk and lack of probable exposure. See text Section 3.3.

5 - For PCBs, PRG (ng/g dry wt. sediment) = [$\%TOC_{avg}$ x ((Human Health TEV)*(1000/$\%lipid_{avg}$))/BSAF];
For metals, PRG (µg/g dry wt. sediment) = ((Human Health TEV)/BAF).
REC=10x PRG at HQ=1; adjusted for site usage ratio to address risk above HQ=$10/1x10^{-5}$. See text Section 3.3.

Data Sources:
- see Table 7 for Aquatic TEV concentrations (µg/L);
- see Table 9 for Avian Predator TEV concentrations (mg/kg dry weight);
- see Table 14 for Human Health TEV concentrations (mg/kg wet tissue weight);
- see Table 15 for maximum of pathway-specific TEV-HQ values;
- see Table A8 for calculation of mean aquatic bedded and resuspended pathway PRGs from station-specific PRGs;
- site average %lipid = 4.59, see Table A-2.3 for derivation;
- site average %TOC = 2.78, see Table A-2.1A for derivation;
- site average BAF for arsenic = 0.875, see Derecktor Shipyard ERA Figure 6.3-3;
- site average BAF for copper = 0.33, see Derecktor Shipyard ERA Figure 6.3-3;
- site average BAF for lead = 5.0E-6, see Derecktor Shipyard ERA Figure 6.3-3;
- site average BAF for silver = 0.0006, see Derecktor Shipyard ERA Figure 6.3-3;
- site average BAF for zinc = 1.05, see Derecktor Shipyard ERA Figure 6.3-3;
- site average BSAF for pesticides = 3.85, see Derecktor Shipyard ERA Figure 6.3-2;
- site average BSAF for PCBs = 5.00, see Derecktor Shipyard ERA Figure 6.3-2;
- site average BSAF for PAHs = 0.12, see Derecktor Shipyard ERA Figure 6.3-2.

Table A-1. Summary of Kow and Koc values used in calculations of organic contaminant concentrations in porewaters by equilibrium partitioning.

Class	Analyte	CAS No.	Full Analyte Name	$Log_{10}K_{ow}$	Source[1]	$Log_{10}K_{oc}$[2]	K_{oc}
MET	As		Arsenic	NA			
	Cd		Cadmium	NA			
	Cr		Chromium	NA			
	Cu		Copper	NA			
	Pb		Lead	NA			
	Hg		Mercury	NA			
	Ni		Nickel	NA			
	Ag		Silver	NA			
	Zn		Zinc	NA			
	SEM:AVS		SEM-AVS	NA			
PAH	T167NAP	2245387	1,6,7-Trimethylnaphthalene	4.61	b	4.53	34034
	M1NAPH	90120	1-Methylnaphthalene	3.97	b	3.90	7994
	M1PHEN	832699	1-Methylphenanthrene	5.08	b	4.99	98610
	D26NAPH	581420	2,6-Dimethylnaphthalene	4.61	b	4.53	34034
	M2NAPH	91576	2-Methylnaphthalene	3.97	b	3.90	7994
	ACENAPH	83329	Acenaphthene	3.92	a	3.85	7139
	ACENAPL	208968	Acenaphthylene	4.05	b	3.98	9581
	ANTHRAC	120127	Anthracene	4.55	a	4.47	29712
	BENAAN	56553	Benzo(a)anthracene	5.70	a	5.60	401218
	BENAPYR	50328	Benzo(a)pyrene	6.11	a	6.01	1014869
	BENBFLU	205992	Benzo(b)fluoranthene	6.20	a	6.09	1244171
	BENEPYR	192972	Benzo(e)pyrene	6.11	b	6.01	1014869
	BGHIPER	191242	Benzo(g,h,i)perylene	6.70	a	6.59	3858156
	BENKFLU	207089	Benzo(k)fluoranthene	6.20	a	6.09	1244171
	BIPHEN	92524	Biphenyl	3.96	a	3.89	7816
	CHRYSEN	218019	Chrysene	5.70	a	5.60	401218
	DBAHANT	53703	Dibenz(a,h)anthracene	6.69	a	6.58	3771812
	FLUORAN	206440	Fluoranthene	5.12	a	5.03	107954
	FLUOREN	86737	Fluorene	4.21	a	4.14	13763
	I123CDP	193395	Indeno(1,2,3-cd)pyrene	6.65	a	6.54	3445323
	NAPH	91203	Naphthalene	3.36	a	3.30	2010
	PERYL	198550	Perylene	6.05	b	5.95	885992
	PHENAN	85018	Phenanthrene	4.55	a	4.47	29712
	PYRENE	129000	Pyrene	5.11	a	5.02	105538
	LMWPAH	NA	Low Molecular Weight PAH	4.09	c	4.02	10489
	HMWPAH	NA	High Molecular Weight PAH	5.88	c	5.78	596216
	TOTPAH	NA	Total PAHs[3]	4.98	c	4.90	79082
PCB	PCB101	37680732	101 (2 2'3 5 5')	6.38	b	6.27	1869907
	PCB105	32598144	105 (2 3 3'4 4')	6.65	b	6.54	3445323
	PCB118	31508006	118 (2 3'4 4'5)	6.74	b	6.63	4223767
	PCB128	39380073	128 (2 2'3 3'4 4')	6.74	b	6.63	4223767
	PCB138	35065282	138 (2 2'3 4 4'5)	6.83	b	6.71	5178095
	PCB153	35065271	153 (2 2'4 4'5 5')	6.92	b	6.80	6348045
	PCB170	35065306	170 (2 2'3 3'4 4'5)	7.27	b	7.15	14018127
	PCB18	37680652	18 (2 2'5)	5.24	b	5.15	141645
	PCB180	35065293	180 (2 2'3 4 4'5 5')	7.36	b	7.24	17185414
	PCB187	52663680	187 (2 2'3 4'5 5'6)	7.17	b	7.05	11178687
	PCB195	52663782	195 (2 2'3 3'4 4'5 6)	7.56	b	7.43	27024645
	PCB206	40186729	206 (2 2'3 3'4 4'5 5'6)	8.09	b	7.95	89691234
	PCB209	2051243	209 (2 2'3 3'4 4'5 5'6 6')	8.18	b	8.04	109956270
	PCB28	7012375	28 (2 4 4')	5.67	b	5.57	374878
	PCB44	41464395	44 (2 2'3 5')	5.75	a	5.65	449293
	PCB52	35693993	52 (2 2'5 5)	5.84	b	5.74	550908
	PCB66	32598100	66 (2 3'4 4')	6.20	b	6.09	1244171
	PCB8	34883437	8 (2 4)	5.07	b	4.98	96403
	TOTPCB	NA	Total PCBs[4]	6.54	b	6.43	2685963
PST	ALDRIN	309002	Aldrin	6.50	a	6.39	2453456
	HCB	118741	Hexachlorobenzene	5.89	a	5.79	616806
	MIREX	2385855	Mirex	6.89	a	6.77	5931301
	DDE_OP	3424826	o,p'-DDE	6.76	a	6.65	4419366
	DDE_PP	72559	p,p'-DDE	6.76	a	6.65	4419366

1 - Literature source of $Log_{10}K_{ow}$ values.

a - Karickhoff and Long, 1995

b - Karickhoff *et al.*, 1989

c - Calculated value

2 $\log_{10}K_{oc} = 0.00025 + 0.983 * \log_{10}K_{ow}$, Karickhoff *et al.* 1989

3 LMW PAH = ten 2-ring & 3-ring PAHs; HMW-PAH = eight 4-ring and 5-ring PAHs, Total PAH = sum of LMW and HMW PAHs (NOAA 1991)

LMW PAH, HMW PAH Kow = median of analyte specific Kow, Total PAH Kow = mean of LMW, HMW PAH Kow

4 Sum of Congeners X 2

NA = not applicable

Table A-2.1A Concentrations of chemical contaminants in surface sediment (0-15 cm) collected in the Derecktor Shipyard/Coddington Cove study area.

ERA investigation.

Class	Analyte[1]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29[2]	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
Metals	Arsenic	6.36	9.43	11.60	8.68	12.46	10.30	10.22	10.93	7.39	9.66	3.39	11.21	7.41	8.94	7.58	6.79	11.43
	Cadmium	0.34	0.18	1.03	0.55	1.45	1.20	0.76	0.72	0.19	0.32	0.09	0.40	0.32	0.25	0.18	0.50	0.18
	Chromium	55.00	53.50	103	80.50	86.50	79.25	76.75	84.75	46.50	64.25	24.25	83.25	56.50	66.00	56.50	44.50	36.75
	Copper	23.50	39.25	166	71.75	158	81.25	80.75	66.75	17.25	33.50	1.88	54.00	27.00	28.00	20.00	29.75	9.25
	Lead	35.90	40.40	151	77.70	186	80.00	81.00	125	40.00	47.80	14.00	78.80	56.90	62.20	54.00	42.10	17.00
	Mercury	0.13	0.14	0.59	0.32	0.50	0.47	0.40	0.37	0.13	0.15	0.07	0.38	0.28	0.26	0.15	0.19	0.02
	Nickel	21.00	20.50	43.50	24.25	34.75	27.25	24.75	25.75	18.25	20.50	5.00	25.75	16.75	22.00	17.75	17.25	14.50
	Silver	0.26	0.19	0.69	0.51	0.79	0.74	0.51	0.81	0.24	0.29	0.07	0.56	0.39	0.16	0.26	0.21	0.07
	Zinc	110	102	547	169	393	193	167	201	72.25	106	28.50	144	93.50	109	97.25	100	47.25
	SEM-AVS																	
PAHs	1,6,7-Trimethylnaphthalene	6.19	4.34	7.87	8.41	27.94	19.25	7.90	7.89	2.04	4.43	0.16	6.41	4.74	4.04	4.57	4.66	0.45
	1-Methylnaphthalene	10.93	7.83	20.47	19.85	50.07	55.11	20.42	17.57	5.11	12.70	0.37	16.71	12.63	9.17	9.27	9.41	1.27
	1-Methylphenanthrene	52.56	43.54	61.44	38.57	267	114	32.53	51.57	6.88	18.31	0.50	33.92	39.80	30.93	20.22	38.26	2.22
	2,6-Dimethylnaphthalene	27.20	18.65	38.46	34.23	112	70.71	34.64	43.59	9.91	9.56	1.69	46.60	18.82	18.31	14.31	17.33	2.35
	2-Methylnaphthalene	11.22	13.86	32.72	43.87	73.47	88.19	36.86	32.08	9.66	24.22	0.65	23.00	17.64	13.96	15.17	16.39	2.01
	Acenaphthene	41.74	12.21	23.89	17.27	189	197	17.14	14.29	3.31	8.55	0.23	11.00	7.41	6.53	10.15	16.20	1.71
	Acenaphthylene	75.65	93.84	142	74.63	300	91.94	71.00	131	11.85	28.68	0.61	74.94	34.51	25.06	22.52	95.65	0.77
	Anthracene	302	268	383	183	1220	456	200	298	31.49	64.35	1.60	158	141	94.02	77.19	234	11.10
	Benzo(a)anthracene	328	518	809	294	2700	697	281	388	50.03	101	2.76	222	144	112	97.70	234	13.76
	Benzo(a)pyrene	396	434	924	377	2380	812	421	495	67.85	148	4.14	319	164	120	143	317	18.55
	Benzo(b)fluoranthene																	
	Benzo(e)pyrene	345	365	829	362	1950	773	401	417	63.45	141	5.02	275	140	112	126	333	19.44
	Benzo(g,h,i)perylene	200	201	500	247	1110	452	215	287	50.33	97.60	4.12	195	126	94.65	96.67	184	12.18
	Benzo(k)fluoranthene	877	999	2240	911	5350	1640	1040	1100	155	348	10.95	700	308	260	302	836	47.26
	Biphenyl	6.89	6.66	15.06	12.61	29.91	23.76	14.41	15.37	3.18	6.42	0.42	10.50	5.79	5.70	5.64	6.02	0.66
	Chrysene	485	592	912	364	2800	716	399	491	58.78	128	3.63	287	154	107	120	444	20.65
	Dibenz(a,h)anthracene	60.86	61.34	131	66.60	317	130	62.93	72.22	12.41	26.45	0.92	48.30	28.80	21.03	27.35	52.77	3.18
	Fluoranthene	490	686	801	459	4970	1490	399	535	95.23	208	7.22	345	262	230	216	779	37.83
	Fluorene	44.13	53.89	61.63	31.45	294	177	28.12	25.73	6.57	13.92	0.58	18.02	9.74	6.42	14.73	19.09	2.09
	Indeno(1,2,3-cd)pyrene	195	209	473	223	1020	398	218	264	45.31	93.27	3.15	178	100	80.23	91.28	166	11.44
	Naphthalene	17.96	16.16	41.75	37.54	76.08	136	45.30	42.67	10.87	22.27	0.66	34.06	26.88	23.22	23.66	21.00	1.84
	Perylene	104	133	249	133	611	207	142	150	23.92	61.03	2.11	97.64	53.29	51.09	51.92	78.70	7.31
	Phenanthrene	283	317	335	220	1610	1270	216	182	46.16	110	3.69	138	83.10	67.14	116	304	20.16
	Pyrene	584	740	1950	650	5300	1750	846	917	107	250	6.45	482	362	254	227	1190	49.54
	Low Molecular Weight PAHs	597	539	828	502	2639	1429	509	680	103	213	7.46	433	319	237	217	478	26.49
	High Molecular Weight PAHs	4318	5256	10153	4308	30118	10334	4640	5298	776	1712	54.18	3286	1926	1509	1615	4917	261
	Sum of PAHs	4944	5795	10981	4809	32757	11763	5149	5978	879	1925	61.65	3719	2245	1746	1832	5395	288
PCBs	Total PCBs (Sum Congeners x2)	93.61	98.24	3310	134	546	315	221	201	39.93	64.56	6.70	113	99.90	59.33	58.16	84.13	13.75
Pesticides	Aldrin	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Hexachlorobenzene	0.08	0.12	0.12	0.06	0.16	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Mirex	0.10	0.19	2.59	0.17	0.10	5.03	0.33	0.71	0.10	0.29	0.10	0.37	0.36	0.34	0.10	0.23	0.10
	o,p'-DDE	0.10	1.52	65.22	1.67	4.96	5.66	3.63	0.26	0.63	0.90	0.26	0.25	0.10	0.10	0.71	1.07	0.40
	p,p'-DDE	0.87	0.61	7.00	2.03	6.29	4.44	1.95	2.38	0.42	0.96	0.03	2.60	1.35	1.29	0.73	1.14	0.08
TOC	% TOC	1.78	1.47	3.72	4.01	6.00	3.79	3.84	3.57	1.66	3.18	0.61	3.54	2.21	3.07	2.66	1.47	0.81

Units: Metals=µg/g, PAHs, PCBs and Pesticides=ng/g

1- TOC value for DSY-29 = average for DSY-29 and DSY-29FD samples: see ERA Table A-1-5.2

Mean TOC%[1]
2.78

Table A-2.1B. Concentrations of chemical contaminants in surface sediment (0-2 cm) collected in the Derecktor Shipyard/Coddington Cove study area.

URI investigation[1]

Class	Analyte	DSY-1	DSY-2	DSY-3	DSY-4	DSY-5	DSY-6	DSY-7	DSY-8	DSY-9	DSY-10	DSY-11	DSY-12	DSY-13	DSY-14	DSY-15	DSY-16	DSY-17	DSY-18	DSY-19	DSY-20	DSY-21	DSY-22	DSY-23	DSY-24
Metals	Arsenic																								
	Cadmium	0.20	0.15	1.00	0.12	0.22	0.21	0.17	0.19	0.85	0.07	0.31	0.23	0.04	1.60E-03	0.05	0.03	0.04	0.22	0.17	0.25	0.19	0.21	0.21	0.01
	Chromium	95.99	152	195	84.79	106	109	79.30	103	65.30	60.85	132	114	56.46	60.54	72.28	55.45	57.34	107	105	89.23	142	106	98.85	71.90
	Copper	45.52	197	262	62.84	52.29	57.77	27.93	76.01	3.99	12.47	81.46	53.87	18.09	7.75	18.61	6.41	17.23	81.67	66.91	79.68	29.66	51.26	49.44	14.43
	Lead	35.39	181	201	51.35	43.30	48.58	31.70	50.60	14.86	22.13	46.08	45.99	35.20	28.94	42.03	31.53	32.90	60.23	57.62	76.91	41.83	52.53	54.19	39.15
	Mercury																								
	Nickel	38.60	85.28	128	37.11	38.35	40.84	37.41	40.24	33.90	31.42	168	40.40	16.87	9.16	10.13	4.44	5.90	25.36	22.79	23.07	7.91	25.28	23.20	11.74
	Silver	0.60	0.82	1.27	13.78	2.32	1.59	5.41	1.74	0.73	0.56	1.22	1.58	0.06	0.05	0.05	0.05	0.05	0.16	0.40	0.88	0.08	0.12	0.12	0.06
	Zinc	149	593	1231	190	173	175	119	184	58.82	63.84	1104	161	89.48	67.60	63.13	48.32	71.29	163	139	156	175	143	141	98.08
	SEM AVS																								
PAHs	1,6,7-Trimethylnaphthalene	2.36	16.10	51.69	0	10.33	3.91	4.02	11.00	0	1.01	8.15	0	0	1.61	0	1.82	0	1.01	0	4.30	4.19	7.06	9.73	3.28
	1-Methylnaphthalene	0.84	0.50	9.71	0	1.75	0	3.47	0.12	0	0	10.97	9.85	0	6.92	0	2.36	0	0	0	0	14.95	78.68	35.72	10.82
	1-Methylphenanthrene	27.68	308	441	15.40	42.66	14.03	34.59	81.87	4.33	1.27	51.06	21.94	59.60	4.16	177	21.19	82.13	228	311	421	15.41	28.68	108	9.02
	2,6-Dimethylnaphthalene	6.55	7.55	23.04	0	3.35	0	1.79	1.89	0	0	12.33	7.35	0	0.73	0	0.67	0	0	0	0	3.04	1.18	5.39	3.48
	2-Methylnaphthalene	0	2.47	8.22	0	4.74	0	0	2.37	0	0.74	6.93	0.98	0	11.32	0	1.46	0	0	0	0	20.10	35.18	53.40	14.58
	Acenaphthene	18.26	63.47	193	0	12.70	16.16	18.28	11.93	0	2.29	20.89	10.01	0	1.00	0	1.05	0	14.84	0	17.13	7.12	10.79	21.57	2.20
	Acenaphthylene	58.86	427	867	89.27	26.56	24.65	28.05	37.66	2.74	1.03	57.61	95.69	1.99	8.33	0	2.78	32.21	167	0	64.60	30.23	42.38	65.31	31.85
	Anthracene	201	1330	3360	260	129	203	161	181	18.58	17.37	254	284	59.38	15.76	257	7.83	213	753	799	922	99.90	130	166	38.28
	Benzo(a)anthracene	166	7380	10600	414	378	405	277	562	34.55	26.14	274	185	28.21	40.13	134	14.48	168	898	399	1420	196	272	414	66.15
	Benzo(a)pyrene	164	3320	4710	431	402	468	302	461	49.13	38.47	206	249	43.73	26.07	245	11.76	311	1190	496	880	110	182	239	54.52
	Benzo(b)fluoranthene	358	10100	9230	646	683	801	399	874	67.28	70.46	381	438	80.42	34.34	324	20.17	477	1890	1050	1500	159	252	318	69.42
	Benzo(e)pyrene	273	5140	5600	443	404	452	303	487	53.22	40.07	257	388	51.55	20.88	221	11.44	265	1020	576	743	88.94	146	187	38.08
	Benzo(g,h,i)perylene	97.41	2070	3060	272	313	355	233	328	19.41	29.52	132	226	41.20	32.57	165	13.71	163	563	280	280	134	215	310	61.29
	Benzo(k)fluoranthene	224	2070	1980	489	248	287	245	294	55.60	24.16	245	347	130	13.19	230	32.56	243	699	791	2300	47.04	75.13	118	106
	Biphenyl	5.01	12.81	40.77	0.62	11.03	8.90	1.66	11.37	0	0	18.53	13.32	0	1.85	0	1.50	0	9.37	0	0	5.62	9.35	10.93	2.67
	Chrysene	406	4980	6390	764	479	603	376	624	70.60	47.47	538	523	140	27.18	444	13.57	387	1460	1170	1580	122	193	234	57.66
	Dibenz(a,h)anthracene	21.20	784	1460	93.38	85.16	89.09	52.05	118	14.96	9.34	28.43	35.93	9.31	11.72	20.50	3.62	54.18	243	39.28	56.80	43.99	63.36	117	16.11
	Fluoranthene	1050	12000	13600	886	644	788	831	818	114	94.27	1320	817	117	66.58	464	34.36	477	1590	1830	5850	325	550	827	224
	Fluorene	42.73	439	859	25.15	42.69	55.07	53.56	53.56	4.86	0.92	74.94	48.75	0	8.49	0	4.95	24.42	92.44	0	216	29.36	78.14	63.94	18.21
	Indeno(1,2,3-cd)pyrene	98.85	1720								18.33	132	168	36.45	25.85	143	9.44	143	529	255	276	99.71	164	226	45.89
	Naphthalene	0.27	1.97	2.94	0	8.02	3.82	0	3.53	0	1.00	11.75	12.71	0	5.15	0	2.59	0	0	0	9.13	2.98	15.99	11.92	1.65
	Perylene	57.17	1050	1338	165	147	203	116	203	17.40	22.57	95.53	131	41.60	16.32	130	12.63	90.70	311	244	300	54.42	95.61	118	26.20
	Phenanthrene	305	3990	4890	217	224	264	385	309	41.14	21.15	392	263	41.00	52.73	112	18.25	201	627	550	1400	171	548	478	180
	Pyrene	794	9390	10100	710	518	601	661	758	79.30	93.92	990	723	113	67.98	496	41.29	409	1640	1550	3820	373	514	823	198
	Low Molecular Weight PAHs	369	2662	5856	391	293	332	307	398	30.51	26.53	528	504	121	65.32	434	48.21	351	1266	1110	1854	233	437	551	136
	High Molecular Weight PAHs	4013	63994	72956	5532	4526	5336	4198	5856	617	536	4991	4494	873	436	3129	237	3418	12860	9212	20406	1923	3271	4409	1162
	Sum of PAHs	4383	66655	78812	5922	4818	5668	4505	6252	647	562	5519	4998	994	501	3563	285	3769	14126	10322	22060	2156	3708	4960	1298
PCBs	Total PCBs (Sum Congeners x2)	67.58	209	733	195	105	132	73.36	148	28.15	11.73	656	176	22.32	22.98	54.84	9.40	244	293	217	367	92.31	178	150	25.87
Pesticides	Aldrin	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0	0.18	0	0	0	0
	Hexachlorobenzene	0	0.24	0.17	0	0	0	0	0.06	0	0	0	0.06	0	0	0.06	0	0.07	0.10	0.10	0.12	0.24	0.08	1.47	0
	Mirex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0.39	0.23	0.32	0.09	0.28	0.22	0
	o,p'-DDE	0.98	5.71	3.81	4.03	2.92	2.58	1.54	2.10	0.38	0.74	8.71	2.43	0.75	0.42	1.57	0	0.65	4.34	2.39	6.26	1.18	2.53	1.58	0.30
	p,p'-DDE	0.18	3.13	13.61	0	1.75	2.12	3.58	1.82	0.78	3.46	1.45	2.51	0.63	0.40	1.20	0.36	0.44	0	1.79	0	0.76	2.02	3.71	0.47
TOC	% TOC	2.06	1.30	2.63	3.17	6.70	4.37	2.67	4.63	1.51	1.53	6.17	5.33	0.64	1.01	2.06	0.25	1.01	2.95	4.21	3.29	1.15	2.94	2.86	1.40
																								Mean TOC%	
																								2.74	

Units: Metals=µg/g, PAHs, PCBs and Pesticides=ng/g

1 Quinn et al. (1994)

Table A-2.1C. Concentrations of PCB congeners and calculation of Total PCBs in surface sediment (0-15 cm) collected in the Derecktor Shipyard/Coddington Cove study area.

ERA investigation.

Class	Analyte	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
PCBs	PCB101	6.48	5.72	220	5.51	16.70	19.00	12.75	14.32	1.74	2.87	0.51	6.73	6.36	2.80	2.09	3.93	0.52
	PCB105	1.75	1.82	137	2.04	6.61	7.04	4.39	2.63	0.56	0.79	0.04	1.37	1.41	0.58	0.54	1.55	0.11
	PCB118	5.02	6.20	242	7.09	18.38	19.56	13.74	11.28	2.34	3.51	0.14	6.11	5.30	2.49	2.25	4.85	0.36
	PCB128	1.37	1.34	73.00	1.89	5.14	6.25	3.07	3.14	0.55	0.87	0.04	1.86	1.77	0.83	0.60	1.42	0.23
	PCB138	5.92	7.21	265	10.86	27.04	26.57	16.11	15.16	2.89	4.86	0.14	9.08	7.39	5.13	4.14	7.10	0.59
	PCB153	4.37	6.16	174	9.97	22.80	20.54	14.43	12.23	2.72	4.81	0.21	8.00	5.85	4.46	4.42	5.87	0.52
	PCB170	0.89	1.53	44.16	3.13	7.25	6.29	3.83	2.30	0.80	1.39	0.13	1.75	1.40	1.34	1.52	1.71	0.17
	PCB18	0.67	0.79	8.36	0.45	0.68	1.30	1.34	0.91	0.26	0.24	0.02	0.49	0.34	0.68	0.25	0.34	0.27
	PCB180	1.86	2.74	53.17	5.77	13.79	11.57	6.80	4.52	1.50	2.46	0.28	3.20	2.54	2.52	2.77	3.46	0.33
	PCB187	1.81	1.92	25.82	3.94	8.54	7.02	4.66	4.26	1.19	1.89	0.08	3.40	2.40	1.91	1.85	2.26	0.29
	PCB195	0.16	0.51	2.93	0.96	3.83	1.01	1.80	0.53	0.19	0.49	0.09	0.32	0.18	0.27	0.57	0.56	0.17
	PCB206	1.52	2.13	7.45	3.12	17.39	6.27	4.33	2.68	1.12	1.81	0.44	2.23	2.79	1.12	1.93	2.39	0.69
	PCB209	0.91	2.04	5.05	3.99	105	6.82	4.50	4.34	1.29	1.98	0.38	2.40	3.10	1.55	2.07	2.84	0.79
	PCB28	2.06	1.26	12.92	1.50	1.66	2.54	3.67	2.61	0.57	0.88	0.24	1.27	0.76	0.56	0.79	0.67	0.20
	PCB44	2.04	1.98	65.05	1.47	3.94	4.49	3.69	2.59	0.54	0.85	0.36	1.12	1.05	0.47	0.93	0.80	0.52
	PCB52	3.21	3.62	130	2.85	9.69	9.22	7.23	4.43	0.96	1.37	0.51	1.37	2.10	0.71	1.20	1.47	0.73
	PCB66	6.16	1.63	180	1.65	3.87	0.94	2.72	11.28	0.46	0.88	0.12	5.36	4.77	2.08	0.90	0.71	0.24
	PCB8	0.59	0.53	5.64	0.66	0.60	1.22	1.43	1.23	0.29	0.33	0.06	0.60	0.46	0.17	0.26	0.15	0.17
	SUMPCB	46.81	49.12	1650	66.85	273	158	110	100	19.97	32.29	3.35	56.64	49.95	29.67	29.08	42.07	6.88
	TOTPCB	93.61	98.24	3310	134	546	315	221	201	39.93	64.58	6.70	113	99.90	59.33	58.16	84.13	13.75
TOC	% TOC	1.79	1.47	3.73	4.01	6.09	3.79	3.84	3.57	1.66	3.18	0.61	3.55	2.21	3.08	2.55	1.48	0.81

Units: PCBs =ng/g dry wt.

SUMPCB = Sum of congener concentrations.

TOTPCB = Total PCBs - SUMPCB x 2.

Table A-2.2. Geotechnical characteristics of reference sediments in Narragansett Bay, Rhode Island.

Site	Station	Depth	%Sand	%Silt	%Clay	%TOC
MCL	JCC-D1	SUR	92.14	6.67	1.19	0.84
MCL	JCC-M1	SUR	90.49	7.63	1.88	0.85
MCL	JCC-S1	SUR	75.02	10.30	14.67	2.07
DSY	JPC-1	SUR	88.10	11.90	0	1.06
DSY	JPC-2	SUR	66.65	33.17	0.18	1.71
AH	JSC-D1	SUR	99.88	0.12	3.74E-05	0.45
AH	JSC-V1	SUR	97.49	2.50	0.02	0.67
AH	JSC-W1	SUR	94.12	5.88	0	0.65
AH	PCC-D1	SUR	99.99	6.21E-03	1.87E-05	0.39
AH	PCC-V1	SUR	86.52	13.43	0.05	1.60
AH	PCC-W1	SUR	97.02	2.94	0.04	1.36
		Mean:	89.77	8.60	1.64	1.06
		S.D.	10.53	9.32	4.37	0.55

MCL = McAllister Point Landfill ERA (SAIC and URI, 1997a)
AH = Allen Harbor Landfill ERA (SAIC, 1996)
DSY= Derecktor Shipyard ERA (SAIC and URI, 1997b)
Data Sources: SAIC, 1996 (JSC/PCC - Allen Harbor ERA reference locations), Appendix A-1-1 (sediment concentrations) and A-1-3 (porewater concentrations); SAIC and URI, 1997a (JCC - McAllister Point ERA reference location), Appendix A-1-1-1 (sediment organic chemistry), A-1-2-1 (sediment metals chemistry), and A-1-2-3 (porewater metals chemistry); and
SAIC and URI, 1997b (JPC/CHC - Derecktor Shipyard ERA reference locations), Appendix A-1-1 (sediment chemistry) and A-1-2 (elutriate chemistry).

Table A-2.3. Lipid and solids content data for species collected for the Derecktor Shipyard ERA.

	Solids content (g dry/g live wt)						Lipid content (%)				
FIELDID	CN/MF	HC	IBM	LOB	MM	PM	CN	IBM	LOB	MM	PM
DSY-24			0.09					5.41			
DSY-25			0.09	0.15				4.44	2.53		
DSY-26	0.15		0.13				9.09	5.40			
DSY-27			0.13	0.15				6.77	2.33		
DSY-28	0.17		0.11	0.14			11.40	5.40	2.83		
DSY-29	0.16			0.14			8.69		2.44		
DSY-31						0.09					2.79
DSY-32						0.11					3.25
DSY-33				0.17		0.09			2.51		3.21
DSY-34						0.10					3.69
DSY-35		0.14	0.14	0.15		0.12		5.00	2.36	2.01	2.40
DSY-36	0.15		0.12	0.14		0.07	8.37	5.37	1.79		2.40
DSY-37						0.03					1.10
DSY-38				0.11		0.10			2.57		4.03
DSY-39				0.15					2.02		
DSY-40			0.14					6.31			
DSY-41		0.15				0.12				2.14	2.11
JPC-1	0.17		0.11	0.12	0.18	0.09	12.47	6.07	2.53	2.59	0.93
CHC-1	0.15		0.10	0.13			11.83	4.28	2.28		
Species Mean	0.16	0.15	0.11	0.14	0.18	0.09	10.31	5.45	2.38	2.25	2.59
N	6.00	2.00	10.00	11.00	1.00	10.00	6.00	10.00	11.00	3.00	10.00
Mean % solids/lipid content	0.14						4.59				

CN = cunner, HC = hard clam, IBM = indigenous blue mussels, LOB = lobster, MM = *Mercenaria mercenaria*, PM = *Pitar morrhuana*, MF = mummichog.

Table A-2.4. Concentrations of selected contaminants in tissues of prey in the Derecktor Shipyard/Coddington Cove study area available for consumption by avian predators and subsistence fishermen[1].

Class	Analyte	DSY-24-IBM	DSY-25-IBM	DSY-25-LOB	DSY-26-CN	DSY-26-DM	DSY-25-IBM	DSY-27-IBM	DSY-27-LOB	DSY-28-CN	DSY-28-DM	DSY-28-IBM	DSY-28-LOB	DSY-29-CN	DSY-29-DM	DSY-29-LOB	DSY-31-DM	DSY-31-PM	DSY-32-PM	DSY-33-DM	DSY-33-LOB	DSY-33-PM	DSY-34-PM	DSY-35-IBM	DSY-35-LOB
MET	Arsenic	10.22	12.56	28.64	3.64	5.32	9.22	6.68	17.19	4.89	15.81	2.69		7.67	9.94	28.66	5.21	9.36	4.92	12.43	22.25	5.88	8.62	6.23	18.23
MET	Cadmium	1.86	1.21	0.36	0.83	0.94	0.73	0.77	0.26	1.09	0.77	0.62		1.15	0.81	0.47	0.64	0.78	0.69	0.93	0.16	0.66	0.71	0.73	0.50
MET	Chromium	3.15	3.00	1.68	1.39	2.16	2.44	2.80	2.11	0.94	2.39	2.64		1.18	2.02	1.71	2.29	1.98	1.74	2.53	1.99	1.85	2.13	2.22	2.16
MET	Copper	4.16	11.94	152	17.48	13.28	7.69	14.80	167	15.30	19.98	1.13		21.81	5.32	100	8.91	14.39	10.92	8.44	60.35	8.64	10.14	7.50	128
MET	Lead	5.81	3.00E-04	0.16	0.79	1.36	3.00E-04	3.02	0.07	3.00E-04	3.00E-04	3.00E-04		0.81	0.94	0.22	1.34	1.74	2.77	1.47	0.47	3.00E-04	1.68	1.75	0.78
MET	Mercury	0.28	0.17	0.26	0.13	0.16	0.12	0.15	0.45	0.10	0.13	0.14		0.17	0.17	0.29	0.15	0.14	0.16	0.10	0.23	0.12	0.12	0.17	0.27
MET	Nickel	5.44	3.43	1.52	1.02	1.82	3.00E-04	4.74	1.20	1.29	4.87	3.00E-04		1.74	2.87	1.74	2.07	3.99	2.17	1.74	1.74	3.00E-04	2.11	3.00E-04	0.91
MET	Silver	1.00E-04	1.00E-04	5.47	0.52	1.00E-04	1.00E-04	1.00E-04	0.87	0.31	1.18	1.00E-04		1.00E-04	1.00E-04	6.94	1.00E-04	1.00E-04	1.38	1.00E-04	3.43	1.00E-04	1.00E-04	1.00E-04	8.54
MET	Zinc	76.33	112	87.87	41.51	103	80.87	142	113	26.47	95.25	121		28.54	74.94	129	164	87.34	113	122	106	102	92.42	130	110
MET	SEM/AVS																								
PAH	1,6,7-Trimethylnaphthalene	3.76	3.76	3.76	3.76	3.76	3.76	19.18	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76
PAH	1-Methylnaphthalene		14.87	5.67	5.67	5.67	5.67	5.67	5.27	12.46	5.67	5.67	13.26	32.77	5.67	9.85	5.67	5.67	5.67	5.67	11.58	5.67	5.67	5.67	
PAH	1-Methylphenanthrene	8.52	20.00	9.05	9.05	9.05	36.34	49.75	44.61	1210	9.05	9.05	83.72	32.56	9.05	78.63	9.05		40.70	9.05	99.91	159	125	9.89	9.05
PAH	2,6-Dimethylnaphthalene	43.87	13.81	5.25	5.25	26.95	16.69	24.70	5.25	5.25	6.25	5.25	12.56	5.25	47.15	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.25	19.25	5.25
PAH	2-Methylnaphthalene		28.67	9.40	9.40	9.40	9.40	9.40	7.65	14.12	9.40	9.40	12.28	23.85	9.40	14.88	9.40	9.40	9.40	9.40	13.77	9.40	9.40	9.40	
PAH	Acenaphthene	2.65	15.68	2.65	28.90	57.31	2.65	2.65	32.54	45.70	2.65	2.65	2.65	39.49	151	2.85	2.65	2.65	2.65	2.65	2.65	2.83	2.65	2.65	2.65
PAH	Acenaphthylene	11.61	74.60	2.89	2.89	49.62	89.51	59.11	2.89	3.91	2.89	34.78	2.89	2.89	31.21	2.88	2.89	2.89	13.52	2.89	2.89	2.89	2.89	2.89	2.89
PAH	Anthracene	17.73	184	8.00	8.00	64.97	237	167	8.21	5.95	23.68	69.19	4.15	6.15	40.24	8.00	33.41	30.36	27.53	8.00	8.00	13.37	19.82	25.48	3.11
PAH	Benzo(a)anthracene	15.26	291	3.36	12.70	75.61	1040	290	28.01	42.87	42.26	71.77	24.30	3.36	53.86	3.36	56.92	133	79.21	3.36	3.36	35.25	46.15	31.11	3.36
PAH	Benzo(a)pyrene	7.91	115	3.62	19.10	3.62	548	73.10	28.73	1.58	3.62	33.86	24.95	11.98	3.62	13.09	3.62	44.99	42.80	3.62	3.62	22.19	22.44	3.62	3.62
PAH	Benzo(b)fluoranthene	43.30	661	8.20	48.20	120	2316	393	60.86	6.20	78.69	128	58.37	28.97	70.97	23.65	89.30	129	94.37	6.20	22.87	35.59	48.65	88.03	6.20
PAH	Benzo(g,h,i)perylene	36.94	274	3.90	21.70	99.63	820	234	20.01	3.90	60.79	108	20.12	3.90	59.32	9.66	45.64	3.90	3.90	3.90	11.69	3.90	3.90	52.26	3.90
PAH	Benzo(k)fluoranthene	20.84	48.05	1.58	19.50	1.58	148	29.20	8.21	1.58	1.58	1.58	11.71	1.58	1.58	12.67	1.58	26.77	34.22	1.58	1.58	13.25	11.20	14.16	1.58
PAH	Biphenyl	5.70	11.63	5.70	14.20	5.70	5.70	12.89	5.70	7.40	5.70	5.70	8.09	6.31	5.70	5.70	5.70	5.70	6.70	5.70	14.24	5.70	5.70	5.70	5.70
PAH	Chrysene	20.78	301	5.28	15.40	88.45	826	297	30.79	32.18	29.40	85.89	38.59	5.26	37.35	5.28	38.25	67.37	59.73	5.28	5.26	42.27	24.42	40.24	5.26
PAH	Dibenz(a,h)anthracene	7.62	13.54	0.49	0.49	0.49	49.67	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.40	0.49	0.49
PAH	Fluoranthene	59.94	741	100	31.90	343	1319	1169	98.46	24.84	118	246	72.90	38.51	171	38.03	119	179	152	87.34	32.14	57.16	73.39	105	32.98
PAH	Fluorene	6.88	29.69	1.95	24.10	1.95	30.37	39.15	1.95	37.92	1.95	25.14	1.95	25.80	1.95	14.92	1.95	1.95	1.95	1.95	1.95	5.19	5.21	11.62	1.95
PAH	Indeno(1,2,3-c,d)pyrene	11.87	35.47	1.54	14.20	1.54	121	26.78	8.64	1.54	1.54	1.54	1.54	1.54	1.54	10.57	1.54	20.43	26.87	1.54	1.54	8.78	7.89	10.38	1.54
PAH	Naphthalene		136	1.68	1.68	1.68	183	1.68	12.00	1.68	1.68	1.68	12.00	1.68	1.68	18.42	1.68	1.68	1.68	1.68	35.20	1.68	1.68	1.68	
PAH	Perylene		81.99	3.50	3.50	3.50	184		10.78	2.63	3.50		11.09	3.23	3.50	3.50	3.50		10.34	3.50	3.50	6.32	3.91		3.50
PAH	Phenanthrene	23.91	152	9.45	40.30	77.74	227	272	20.07	30.76	43.94	114	32.15	47.32	47.36	28.17	40.99	23.80	28.75	9.45	19.84	14.31	35.14	41.71	13.19
PAH	Pyrene	48.22	306	95.84	21.30	271	1040	819	93.01	24.70	117	175	124	36.39	163	69.49	117	187	182	88.38	53.14	55.57	77.45	78.56	24.59
PAH	LMW PAHs	62.67	619	36.02	115	273	782	551	85.31	140	86.18	256	68.07	147	282	90.93	92.86	72.72	85.49	36.02	84.30	49.66	76.79	95.41	23.78
PAH	HMW PAHs	169	1955	109	101	762	4814	2638	289	127	309	613	285	99.01	429	131	337	621	516	188	99.01	213	244	259	70.20
PAH	Total PAHs	384	3639	186	322	1250	6020	3970	508	1500	510	1090	565	331	872	344	543	850	812	176	302	470	501	505	74.00
PCB	Total PCBs	612	528	469	2200	1700	931	1150	748	3870	689	992	861	3170	868	355	766	951	367	636	469	524	311	696	317
PST	Aldrin	0.15	0.15	0.15	0.40	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
PST	Hexachlorobenzene	0.15	0.15	0.23	0.15	40.52	0.15	0.15	1.12	0.15	0.15	0.15	1.16	0.15	2.30	1.18	0.15	0.97	0.34	0.15	0.49	1.14	0.52	0.15	1.26
PST	Mirex	3.55	0.46	0.76		5.32	2.24	2.02	1.24		3.02	3.69	0.65		2.08	1.07	3.66	0.48	1.09	2.70	1.55	0.66	0.66	1.32	0.59
PST	p,p'-DDE	4.23	4.77	0.15	3.62	11.43	5.64	8.95	0.15	5.47	13.00	5.81	0.15	3.20	10.75	0.15	15.16	3.83	0.15	10.23	0.15	0.15	0.15	3.94	0.15
PST	p,p'-DDE	7.85	4.85	5.88	29.10	12.65	7.56	11.60	8.43	44.83		7.30	9.80	67.05	15.68	6.31	14.54	2.99	2.62	12.98	6.64	3.80	1.52	12.15	4.88
Total	Mercury	13.62	25.04	3.00	10.53	32.71	19.88	977	3.00	33.45	11.00	49.08	3.00	34.52	18.06	3.00	9.60	47.81		20.56	3.00	53.80	39.25	9.18	3.00

units: metals (µg/g); organics (ng/g dry wt)

[1] Tissue concentration data as reported in Derecktor Shipyard ERA, Appendix A-1-3 (SAIC and URI, 1997)

Table A-2.4 (continued). Concentrations of selected contaminants in tissues of prey in the Derecktor Shipyard/Coddington Cove study area available for consumption by avian predators and subsistence fishermen[1].

Class	Analyte	DSY-35-MM	DSY-35-PM	DSY-35-OM	DSY-36-IBM	DSY-36-LOB	DSY-36-PM	DSY-37-PM	DSY-38-DM	DSY-38-LOB	DSY-38-PM	DSY-39-DM	DSY-39-LOB	DSY-40-DM	DSY-40-IBM	DSY-41-MM	DSY-41-PM
MET	Arsenic	6.42	8.47	3.58	6.15	15.84	7.43	7.43	6.09	26.08	6.09	8.94	18.66	5.96	5.27	7.46	2.18
MET	Cadmium	0.64	0.66	0.97	0.39	3.00E-04	0.03	0.04	0.82	0.48	0.59	0.32	0.30	0.61	0.63	0.90	0.72
MET	Chromium	2.38	2.01	0.86	2.84	1.97	2.46	1.73	2.62	1.95	1.84	2.89	1.64	2.71	2.23	1.76	1.84
MET	Copper	6.42	8.43	15.64	7.04	49.16	11.98	6.93	11.44	165	10.44	8.68	197	6.32	6.99	13.15	11.90
MET	Lead	3.00E-04	1.68	0.97	3.00E-04	0.34	2.18	2.97	1.93	0.28	3.00E-04	3.00E-04	0.18	2.97	2.44	1.81	3.00E-04
MET	Mercury	0.12	0.10	0.15	0.19	0.33	0.15	0.15	0.13	0.33	0.17	0.14	0.41	0.13	0.17	0.12	0.15
MET	Nickel	2.92	1.55	1.43	4.33	1.46	1.87	1.57	2.91	1.88	3.00E-04	3.34	1.46	3.43	3.00E-04	3.00E-04	1.98
MET	Silver	1.00E-04	1.00E-04	1.00E-04	1.00E-04	2.87	1.00E-04	0.85	1.72	6.10	1.00E-04	0.99	0.82	1.00E-04	1.00E-04	1.26	1.00E-04
MET	Zinc	111	125	54.89	84.58	116	121	105	89.39	171	131	131	129	117	105	65.75	83.67
MET	SEM-AVS																
PAH	1,6,7-Trimethylnaphthalene	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76
PAH	1-Methylnaphthalene	5.67	5.67				5.67			5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67
PAH	1-Methylphenanthrene	4.28	47.05	209	6.79	9.05	120	9.05	9.05	9.05	75.52	9.05	9.05	9.05	9.05	6.68	76.66
PAH	2,6-Dimethylnaphthalene	5.25	5.25	5.25	4.58	5.25	5.25	5.25	6.36	5.25	5.25	13.09	5.25	32.85	5.25	5.25	5.25
PAH	2-Methylnaphthalene	9.40	9.40				9.40			9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40
PAH	Acenaphthene	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65	5.58	67.41	2.65	131	2.65	6.53	6.44
PAH	Acenaphthylene	2.89	2.89	2.89	15.30	2.89	2.89	2.89	11.89	2.89	5.40	32.51	2.89	49.97	72.04	4.58	9.54
PAH	Anthracene	9.00	6.00	8.00	28.00	5.29	29.88	10.14	11.90	2.84	10.66	8.00	1.80	40.94	34.15	10.91	19.67
PAH	Benzo(a)anthracene	16.72	21.53		30.26	3.36	66.19	55.88	14.79	3.36	45.70	17.76	3.36	42.12	24.89		41.39
PAH	Benzo(a)pyrene	8.97	16.15	3.62	12.53	3.62	32.32	23.14	8.07	3.62	20.67	3.62	3.62	3.62	6.24	11.08	17.34
PAH	Benzo(b)fluoranthene	9.17	16.37	6.20	70.95	30.77	90.62	58.08	32.66	6.20	40.49	6.20	6.20	6.20	65.47	13.26	22.82
PAH	Benzo(e)pyrene	1.81	3.70	3.90	18.57	3.90	3.90	8.20	30.75	3.90	3.90	44.38	3.90	48.57	47.00	3.05	3.00
PAH	Benzo(g,h,i)perylene	1.56	1.56	1.56	10.06	1.56	14.82	28.35	1.56	1.56	12.83	23.08	1.56	1.56	1.56	3.71	1.56
PAH	Benzo(k)fluoranthene																
PAH	Biphenyl	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70
PAH	Chrysene	6.82	11.18		40.52	5.26	61.24	37.63	14.40	5.26	27.97	19.70	5.26	22.76	29.48		31.39
PAH	Dibenz(a,h)anthracene	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	33.16	0.49	0.49	0.49	0.49	0.49
PAH	Fluoranthene	47.51	89.25	19.44	105	38.05	124	74.78	38.98	16.55	43.50	40.91	9.23	144	105	60.50	78.70
PAH	Fluorene	2.89	5.49	19.96	6.01	1.95	1.95	1.95	1.95	1.95	4.74	1.95	1.95	1.95	14.34	3.92	7.95
PAH	Indeno(1,2,3-cd)pyrene	1.54	1.54	1.54	5.99	1.54	10.99	1.54	1.54	1.54	9.15	27.66	1.54	1.54	1.54	1.54	1.54
PAH	Naphthalene	1.68	1.68				1.68			1.68	1.68	1.68	1.68	1.68	16.08	1.68	1.68
PAH	Perylene	12.81	18.13	10.44		3.50	16.58	25.61	1.44	3.50	4.05	3.50	3.50	3.50		12.41	13.51
PAH	Phenanthrene	18.55	29.29	18.65	28.31	18.64	31.69	27.39	19.48	10.06	9.19	9.46	7.46	68.90	59.34	13.31	16.35
PAH	Pyrene	35.55	54.92	48.77	85.28	43.14	116	63.17	43.21	9.04	43.25	43.31	10.56	124	81.47	85.47	83.17
PAH	LMW PAHs	48.06	57.00	52.14	80.27	31.32	80.23	45.02	46.87	31.46	46.85	130	27.82	303	168	50.22	70.03
PAH	HMW PAHs	113	174	72.31	274	84.52	390	275	120	39.32	182	158	32.52	337	248	148	253
PAH	Total PAHs	162	267	326	488	136	704	430	233	39.00	358	363	29.00	704	495	223	428
PCB	Total PCBs	156	404	3130	895	840	493	427	549	291		461	643	556	912	251	274
PST	Aldrin	0.15	0.15	0.97	0.15	0.15	0.15		0.15	0.15		0.15	0.15	0.15	0.15	0.15	0.15
PST	Hexachlorobenzene	0.16	0.71	0.15	0.15	0.42	2.82		0.67	0.58		0.93	0.03	0.48	0.15	0.15	0.58
PST	Mirex		0.06		2.94	0.35	0.41	0.20	5.54	0.30		3.21	0.81	2.24	2.83		0.40
PST	o,p' DDE	1.11	0.15	1.84	4.05	3.69	2.60	2.09	7.09	0.15		9.84	7.09	5.42	5.08	0.15	1.82
PST	p,p'-DDE	1.97	4.75	53.56	8.10	4.10	2.88	2.93	8.84	7.06		9.82	2.39	9.96	10.37	4.33	1.81
Total	Total	39.10		12.57	36.48	3.00	67.14		8.32	3.00		9.66	3.00	3.00	31.70	30.61	

units: metals (µg/g); organics (ng/g dry wt)

1 - Tissue concentration data as reported in Derecktor Shipyard ERA, Appendix A-1-3 (SAIC and URI, 1997).

Table A-3.1A. Equilibrium-partitioning calculated concentrations of organic contaminants in sediment porewaters from the Derecktor Shipyard/Coddington Cove study area[1].

Class	Analyte[2,3,4,5]	Logkoc[2]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
MET	Arsenic																		
MET	Cadmium																		
MET	Chromium																		
MET	Copper																		
MET	Lead																		
MET	Mercury																		
MET	Nickel																		
MET	Silver																		
MET	Zinc																		
MET	SEM AVS	NA	-21.70	-2.09	-164.35	-55.48	-175.56	-19.50	-47.27	-14.51	1.07	-28.69	-0.32	-35.50	0.38	-27.87	-19.24	-15.62	-3.21
PAH	1,6,7-Trimethylnaphthalene	4.53	0.01	8.88E-03	6.22E-03	6.16E-03	0.01	0.01	6.04E-03	8.49E-03	3.62E-03	4.09E-03	7.80E-04	5.32E-03	6.30E-03	3.86E-03	5.26E-03	9.32E-03	1.63E-03
PAH	1-Methylnaphthalene	3.90	0.08	0.07	0.07	0.06	0.10	0.18	0.07	0.06	0.04	0.05	7.53E-03	0.06	0.07	0.04	0.05	0.08	0.02
PAH	1-Methylphenanthrene	4.99	0.03	0.03	0.02	9.75E-03	0.05	0.03	8.55E-03	0.01	5.42E-03	5.84E-03	8.05E-04	9.72E-03	0.02	0.01	8.04E-03	0.03	2.77E-03
PAH	2,6-Dimethylnaphthalene	4.53	0.04	0.04	0.03	0.03	0.06	0.05	0.03	0.04	0.02	8.83E-03	8.14E-03	0.04	0.03	0.02	0.02	0.03	8.58E-03
PAH	2-Methylnaphthalene	3.90	0.08	0.12	0.11	0.14	0.15	0.29	0.12	0.11	0.07	0.10	0.01	0.08	0.10	0.05	0.07	0.14	0.03
PAH	Acenaphthene	3.85	0.33	0.12	0.09	0.06	0.44	0.73	0.06	0.06	0.03	0.04	5.24E-03	0.04	0.05	0.03	0.06	0.15	0.03
PAH	Acenaphthylene	3.58	0.44	0.67	0.40	0.19	0.52	0.25	0.19	0.38	0.07	0.09	0.01	0.22	0.16	0.09	0.09	0.68	9.92E-03
PAH	Anthracene	4.47	0.57	0.81	0.35	0.15	0.68	0.40	0.18	0.28	0.06	0.07	8.81E-03	0.15	0.21	0.10	0.10	0.54	0.05
PAH	Benzo(a)anthracene	5.60	0.05	0.09	0.05	0.02	0.11	0.05	0.02	0.03	7.51E-03	7.91E-03	1.13E-03	0.02	0.02	9.06E-03	8.55E-03	0.04	4.23E-03
PAH	Benzo(a)pyrene	6.01	0.02	0.03	0.02	9.28E-03	0.04	0.02	0.01	0.01	4.03E-03	4.57E-03	6.70E-04	8.89E-03	7.30E-03	3.86E-03	5.53E-03	0.02	2.26E-03
PAH	Benzo(b)fluoranthene	6.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAH	Benzo(e)pyrene	6.01	0.02	0.02	0.02	8.91E-03	0.03	0.02	0.01	0.01	3.77E-03	4.37E-03	8.11E-04	7.65E-03	6.22E-03	3.59E-03	4.87E-03	0.02	2.37E-03
PAH	Benzo(g,h,i)perylene	6.59	2.91E-03	3.55E-03	3.46E-03	1.60E-03	4.80E-03	3.09E-03	1.45E-03	2.08E-03	7.86E-04	7.95E-04	1.75E-04	1.43E-03	1.48E-03	7.99E-04	9.83E-04	3.24E-03	3.90E-04
PAH	Benzo(k)fluoranthene	6.09	0.04	0.05	0.05	0.02	0.07	0.03	0.02	0.02	7.52E-03	8.90E-03	1.44E-03	0.02	0.01	6.80E-03	9.53E-03	0.05	4.89E-03
PAH	Biphenyl	3.09	0.05	0.06	0.05	0.04	0.08	0.08	0.05	0.06	0.02	0.03	9.89E-03	0.04	0.03	0.02	0.03	0.05	0.01
PAH	Chrysene	5.60	0.07	0.10	0.08	0.02	0.12	0.05	0.03	0.03	8.83E-03	0.01	1.49E-03	0.02	0.02	8.70E-03	0.01	0.08	6.35E-03
PAH	Dibenz(a,h)anthracene	6.58	9.06E-04	1.11E-03	9.35E-04	4.40E-04	1.40E-03	9.10E-04	4.34E-04	5.36E-04	1.98E-04	2.21E-04	4.01E-05	3.62E-04	3.45E-04	1.02E-04	2.84E-04	9.52E-04	1.04E-04
PAH	Fluoranthene	5.03	0.26	0.43	0.20	0.11	0.77	0.38	0.10	0.14	0.05	0.06	0.01	0.09	0.11	0.07	0.08	0.49	0.04
PAH	Fluorene	4.14	0.18	0.27	0.12	0.08	0.36	0.34	0.05	0.05	0.03	0.03	6.90E-03	0.04	0.03	0.02	0.04	0.09	0.02
PAH	Indeno(1,2,3-cd)pyrene	6.54	3.19E-03	4.13E-03	3.69E-03	1.61E-03	4.93E-03	3.05E-03	1.65E-03	2.14E-03	7.92E-04	8.51E-04	1.50E-04	1.46E-03	1.32E-03	7.59E-04	1.04E-03	3.27E-03	4.10E-04
PAH	Naphthalene	3.39	0.50	0.55	0.56	0.47	0.63	1.79	0.59	0.59	0.33	0.35	0.05	0.48	0.61	0.38	0.46	0.71	0.11
PAH	Perylene	5.85	8.55E-03	0.01	7.55E-03	3.75E-03	0.01	6.18E-03	4.16E-03	4.76E-03	1.63E-03	2.17E-03	3.91E-04	3.11E-03	2.72E-03	1.88E-03	2.30E-03	6.04E-03	1.02E-03
PAH	Phenanthrene	4.47	0.54	0.73	0.30	0.19	0.90	1.13	0.19	0.17	0.09	0.12	0.02	0.13	0.13	0.07	0.15	0.70	0.08
PAH	Pyrene	5.02	0.31	0.48	0.50	0.15	0.84	0.44	0.21	0.24	0.08	0.07	0.01	0.13	0.16	0.08	0.08	0.77	0.06
PAH	LMW PAHs		2.40	2.58	1.70	1.20	3.44	5.02	1.34	1.44	0.70	0.79	0.13	1.07	1.27	0.74	0.99	2.52	0.36
PAH	HMW PAHs		0.73	1.16	0.87	0.32	1.92	0.94	0.37	0.47	0.14	0.16	0.03	0.28	0.32	0.19	0.20	1.42	0.12
PAH	Total PAHs		3.13	3.74	2.56	1.52	5.35	5.97	1.71	1.91	0.84	0.95	0.16	1.34	1.59	0.92	1.18	3.95	0.48
PCB	Total PCBs	6.43	4.40E-03	4.74E-03	0.05	1.70E-03	2.41E-03	4.47E-03	3.97E-03	3.73E-03	1.53E-03	1.10E-03	1.17E-03	1.80E-03	2.49E-03	1.08E-03	1.21E-03	2.39E-03	1.85E-03
PST	Alpha	6.39	2.29E-06	2.77E-06	1.10E-06	1.02E-06	6.79E-07	1.09E-06	1.08E-06	1.14E-06	2.46E-06	1.28E-06	6.68E-06	1.15E-06	1.84E-06	1.33E-06	1.80E-06	2.77E-06	5.03E-06
PST	Hexachlorobenzene	5.76	7.29E-06	1.31E-05	5.36E-06	2.24E-06	4.22E-06	3.42E-06	3.38E-06	3.63E-06	7.81E-06	4.08E-06	2.13E-05	3.65E-06	5.87E-06	4.22E-06	5.09E-06	8.82E-06	1.60E-05
PST	Mirex	6.77	9.47E-07	2.15E-06	1.18E-06	7.12E-07	2.81E-07	2.24E-06	1.44E-05	3.34E-06	1.02E-06	1.56E-06	2.76E-06	1.75E-06	2.76E-06	1.89E-06	8.81E-07	2.61E-06	2.08E-06
PST	o,p' DDE	6.69	1.27E-06	2.34E-05	3.97E-04	9.44E-06	1.87E-05	3.38E-05	2.14E-05	1.65E-06	8.63E-06	6.37E-06	9.58E-06	1.58E-06	1.02E-06	7.37E-07	6.33E-08	1.64E-05	1.11E-05
PST	p,p' DDE	6.69	1.11E-05	9.35E-05	4.26E-05	1.15E-05	2.37E-05	2.85E-05	1.15E-05	1.51E-05	5.70E-06	6.82E-06	9.27E-07	1.66E-05	1.38E-05	8.53E-06	6.50E-06	1.75E-05	2.15E-06
TOC	% TOC		1.78	1.47	3.72	4.01	6.03	3.76	3.84	3.57	1.66	3.18	0.61	3.54	2.21	3.07	2.55	1.47	0.81

1 - Porewater concentration (µg/L) = sediment concentration/(foc X Koc),(foc=%TOC/100).

2 - See Table A-1 for Koc values

3 - sum of Low Molecular Weight P: 1-Methylnaphthalene, 1-Methylphenanthrene, 2,6-Dimethylnaphthalene, 2-Methylnaphthalene, Acenaphthene, Anthracene, Biphenyl, Fluorene, Naphthalene, and Phenanthrene.

4 - sum of High Molecular Weight P: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(e)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Perylene, and Pyrene.

5 - Total PAHs - sum of LMW & HMW PAHs

6 - Sum of individual PCB congeners x 2, see Table A-3.1b

Table A-3 1B Concentrations of PCB congeners and calculation of Total PCBs in surface sediment (0-15 cm) collected in the Derecktor Shipyard/Coddington Cove study area.

PCB CONGENERS

ERA investigation.

Class	Analyte	$Log_{10}Koc$	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
PCB	PCB101	6.27	1.94E-04	2.08E-04	3.16E-03	7.34E-05	1.47E-04	2.68E-04	1.77E-04	2.14E-04	5.60E-05	4.83E-05	4.49E-05	1.01E-04	1.54E-04	4.87E-05	4.37E-05	1.42E-04	3.39E-05
PCB	PCB105	6.54	2.64E-06	3.59E-05	1.07E-03	1.48E-05	3.15E-05	5.39E-05	3.32E-05	2.14E-05	9.84E-06	7.24E-06	1.66E-06	1.12E-05	1.85E-05	5.44E-06	6.09E-06	3.04E-05	3.83E-06
PCB	PCB118	6.63	6.65E-05	9.96E-05	1.54E-03	4.18E-05	7.15E-05	1.22E-04	8.47E-05	7.48E-05	3.34E-05	2.61E-05	5.24E-06	4.08E-05	5.67E-05	1.91E-05	2.09E-05	7.76E-05	1.06E-05
PCB	PCB126	6.63	1.81E-06	2.15E-05	4.63E-04	1.11E-05	2.00E-05	3.90E-05	1.89E-05	2.08E-05	7.84E-06	6.49E-06	1.36E-06	1.24E-05	1.89E-05	6.41E-06	5.59E-06	2.27E-05	6.72E-06
PCB	PCB138	6.71	6.39E-05	9.45E-05	1.37E-03	5.23E-05	8.57E-05	1.35E-04	8.09E-05	8.20E-05	3.36E-05	2.95E-05	4.43E-06	4.94E-05	6.46E-05	3.22E-05	3.13E-05	9.27E-05	1.40E-05
PCB	PCB153	6.80	3.85E-05	6.58E-05	7.35E-04	3.92E-05	5.90E-05	8.53E-05	5.91E-05	5.40E-05	2.59E-05	2.38E-05	5.33E-06	3.55E-05	4.17E-05	2.28E-05	2.73E-05	6.25E-05	1.01E-05
PCB	PCB170	7.15	3.56E-06	7.43E-06	8.45E-05	5.56E-06	8.49E-06	1.18E-05	7.10E-06	4.60E-06	3.42E-06	3.12E-06	1.51E-06	3.52E-06	4.53E-06	3.11E-06	4.24E-06	8.24E-06	1.48E-06
PCB	PCB18	5.15	2.63E-04	3.76E-04	1.58E-03	7.92E-05	7.91E-05	2.42E-04	2.47E-04	1.79E-04	1.12E-04	5.22E-05	1.74E-05	9.79E-05	1.07E-04	1.56E-04	6.82E-05	1.62E-04	2.31E-04
PCB	PCB180	7.24	6.05E-06	1.08E-05	8.30E-05	8.37E-06	1.32E-05	1.78E-05	1.03E-05	7.37E-06	5.27E-06	4.51E-06	2.66E-06	5.24E-06	6.67E-06	4.76E-06	6.32E-06	1.36E-05	2.38E-06
PCB	PCB187	7.05	9.03E-06	1.17E-05	6.19E-05	8.78E-06	1.25E-05	1.66E-05	1.09E-05	1.07E-05	6.43E-06	5.30E-06	1.14E-06	8.57E-06	9.69E-06	5.55E-06	6.47E-06	1.37E-05	3.23E-06
PCB	PCB195	7.43	3.39E-07	1.27E-06	2.91E-06	8.90E-07	2.33E-06	9.82E-07	1.73E-06	5.53E-07	4.16E-07	5.74E-07	5.55E-07	3.38E-07	3.08E-07	3.25E-07	8.30E-07	1.40E-06	7.57E-07
PCB	PCB206	7.95	9.46E-07	1.61E-06	2.23E-06	8.66E-07	3.18E-06	1.84E-06	1.26E-06	8.38E-07	7.50E-07	6.34E-07	7.97E-07	7.01E-07	1.40E-06	4.05E-07	8.42E-07	1.80E-06	9.46E-07
PCB	PCB209	8.04	4.65E-07	1.26E-06	1.23E-06	9.05E-07	1.57E-05	1.63E-06	1.07E-06	1.10E-06	7.06E-07	5.66E-07	5.68E-07	6.14E-07	1.28E-06	4.60E-07	7.38E-07	1.75E-06	8.84E-07
PCB	PCB28	5.57	3.07E-04	2.28E-04	9.24E-04	9.95E-05	7.27E-05	1.79E-04	2.55E-04	1.95E-04	9.14E-05	7.33E-05	1.04E-04	9.56E-05	9.22E-05	4.88E-05	8.28E-05	1.20E-04	6.67E-05
PCB	PCB44	5.65	2.54E-04	2.98E-04	3.88E-03	8.14E-05	1.44E-04	2.63E-04	2.14E-04	1.61E-04	7.18E-05	5.93E-05	1.32E-04	7.00E-05	1.06E-04	3.41E-05	8.11E-05	1.21E-04	1.41E-04
PCB	PCB52	5.74	3.26E-04	4.46E-04	6.35E-03	1.29E-04	2.89E-04	4.41E-04	3.42E-04	2.25E-04	1.05E-04	7.82E-05	1.52E-04	7.00E-05	1.72E-04	4.17E-05	8.55E-05	1.81E-04	1.63E-04
PCB	PCB66	5.09	2.77E-04	8.67E-05	3.87E-03	3.31E-05	5.10E-05	1.99E-05	5.69E-05	2.54E-04	2.20E-05	2.23E-05	1.62E-05	1.21E-04	1.73E-04	5.45E-05	2.83E-05	3.87E-05	2.35E-05
PCB	PCB8	4.36	3.45E-04	3.76E-04	1.57E-03	1.72E-04	1.02E-04	3.34E-04	3.87E-04	3.58E-04	1.79E-04	1.07E-04	9.35E-05	1.74E-04	2.15E-04	5.71E-05	1.05E-04	1.03E-04	2.13E-04
PCB	SUMPCB	0	2.29E-03	2.37E-03	2.68E-02	8.52E-04	1.21E-03	2.23E-03	1.99E-03	1.87E-03	7.65E-04	5.48E-04	5.85E-04	8.99E-04	1.24E-03	5.42E-04	6.05E-04	1.20E-03	9.27E-04
PCB	TOTPCB	0	4.40E-03	4.74E-03	5.35E-02	1.70E-03	2.41E-03	4.47E-03	3.97E-03	3.73E-03	1.53E-03	1.10E-03	1.17E-03	1.80E-03	2.49E-03	1.08E-03	1.21E-03	2.39E-03	1.85E-03
TOC	% TOC		1.79	1.47	3.73	4.01	6.09	3.79	3.84	3.57	1.66	3.18	0.61	3.55	2.21	3.08	2.55	1.48	0.81

Units: µg/L

SUMPCB = Sum of congener concentrations

TOTPCB = Total PCBs = SUMPCB x 2

* Porewater concentration (µg/L) = sediment concentration/(foc X K_{oc}) The foc=%TOC/100; sediment PCB congener concentrations reported in Table A-2.1c.

2 See Table A-1 for Koc values

Table A-3.2. Hazard Quotients calculated for CoCs in sediment porewaters from the Derecktor Shipyard/Coddington Cove study area[1]

Class	Analyte	WQSV[2]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
MET	Arsenic	36.00																	
MET	Cadmium	9.30																	
MET	Chromium	50.00																	
MET	Copper	2.90																	
MET	Lead	8.50																	
MET	Mercury	0.03																	
MET	Nickel	8.30																	
MET	Silver	0.92																	
MET	Zinc	86.00																	
MET	SEM AVS	5.00	-4.34	-0.58	-32.87	-11.10	-35.12	-3.90	-9.45	-2.90	0.21	-5.82	-0.06	-7.10	0.08	-5.57	-3.85	-3.32	-0.64
PAH	1,6,7-Trimethylnaphthalene																		
PAH	1-Methylnaphthalene																		
PAH	1-Methylphenanthrene																		
PAH	2,6-Dimethylnaphthalene																		
PAH	2-Methylnaphthalene	0.88	0.09	0.13	0.13	0.16	0.17	0.33	0.14	0.13	0.08	0.11	0.02	0.09	0.11	0.08	0.08	0.16	0.04
PAH	Acenaphthene	710	4.83E-04	1.64E-04	1.27E-04	8.50E-05	6.20E-04	1.03E-03	8.81E-05	7.90E-05	3.94E-05	5.31E-05	7.36E-06	6.13E-05	6.82E-05	4.20E-05	7.86E-05	2.17E-04	4.17E-05
PAH	Acenaphthylene	0.46	0.97	1.45	0.87	0.42	1.14	0.55	0.42	0.84	0.16	0.21	0.02	0.48	0.35	0.19	0.20	1.46	0.02
PAH	Anthracene	0.29	1.99	2.14	1.21	0.54	2.38	1.41	0.61	0.98	0.22	0.24	0.03	0.52	0.75	0.36	0.35	1.87	0.16
PAH	Benzo(a)anthracene	0.07	0.71	1.35	0.83	0.28	1.72	0.70	0.28	0.42	0.12	0.12	0.02	0.24	0.25	0.14	0.15	0.81	0.07
PAH	Benzo(a)pyrene	0.04	0.52	0.69	0.58	0.22	0.92	0.50	0.25	0.32	0.10	0.11	0.02	0.21	0.17	0.08	0.13	0.50	0.05
PAH	Benzo(b)fluoranthene																		
PAH	Benzo(e)pyrene																		
PAH	Benzo(g,h,i)perylene																		
PAH	Benzo(k)fluoranthene																		
PAH	Biphenyl																		
PAH	Chrysene	0.13	0.71	1.05	0.64	0.24	1.22	0.49	0.27	0.36	0.09	0.10	0.02	0.21	0.18	0.09	0.12	0.79	0.07
PAH	Dibenz(a,h)anthracene	1.85E-03	0.54	0.08	0.56	0.26	0.83	0.54	0.26	0.32	0.12	0.13	0.02	0.22	0.21	0.11	0.17	0.57	0.08
PAH	Fluoranthene	16.00	7.02	0.03	0.01	6.52E-03	0.05	0.02	6.02E-03	8.66E-03	3.32E-03	3.78E-03	6.85E-04	5.64E-03	6.87E-03	4.34E-03	4.90E-03	0.03	2.70E-03
PAH	Fluorene	0.14	1.30	1.93	0.87	0.41	2.58	2.45	0.39	0.38	0.21	0.23	0.05	0.27	0.23	0.11	0.30	0.68	0.14
PAH	Indeno(1,2,3-cd)pyrene																		
PAH	Naphthalene	620	5.11E-04	8.82E-04	9.31E-04	7.51E-04	1.02E-03	2.88E-03	9.47E-04	9.59E-04	5.25E-04	5.62E-04	6.67E-05	7.72E-04	9.76E-04	6.07E-04	7.45E-04	1.15E-03	1.82E-04
PAH	Perylene																		
PAH	Phenanthrene	0.61	0.68	0.90	0.38	0.23	1.12	1.40	0.23	0.21	0.12	0.14	0.03	0.16	0.16	0.09	0.19	0.86	0.10
PAH	Pyrene	0.63	0.49	0.76	0.79	0.24	1.33	0.60	0.33	0.39	0.10	0.12	0.02	0.20	0.25	0.12	0.13	1.22	0.09
PAH	LMW PAHs		4.05	5.10	2.58	1.34	6.26	5.60	1.37	1.70	0.63	0.72	0.12	1.05	1.25	0.63	0.93	3.57	0.44
PAH	HMW PAHs		2.98	4.53	3.41	1.25	6.07	2.95	1.40	1.81	0.52	0.59	0.09	1.09	1.06	0.56	0.71	3.71	0.34
PAH	Total PAHs		7.03	9.63	5.99	2.58	12.33	8.55	2.77	3.51	1.15	1.31	0.21	2.13	2.31	1.18	1.64	7.28	0.78
PCB	Total PCBs	0.03	0.15	0.16	1.78	0.06	0.08	0.15	0.13	0.12	0.05	0.04	0.04	0.06	0.08	0.04	0.04	0.08	0.08
PST	Aldrin	0.16	1.40E-05	1.70E-05	6.72E-08	6.24E-06	4.17E-06	6.60E-06	6.51E-06	7.00E-06	1.51E-05	7.86E-06	4.10E-05	7.00E-06	1.13E-05	8.15E-06	9.81E-06	1.70E-05	3.09E-05
PST	Hexachlorobenzene	3.68	1.98E-06	3.55E-06	1.40E-06	6.03E-07	1.15E-06	9.30E-07	9.18E-07	9.87E-07	2.12E-06	1.11E-06	5.78E-06	9.96E-07	1.59E-06	1.15E-06	1.38E-06	2.40E-06	4.35E-06
PST	Mirex	1.00E-03	9.47E-04	2.15E-03	0.01	7.12E-04	2.81E-04	0.02	1.44E-03	3.34E-03	1.02E-03	1.56E-03	2.76E-03	1.75E-03	2.70E-03	1.89E-03	6.61E-04	2.81E-03	2.08E-03
PST	o,p'-DDE	1.00E-03	1.27E-03	0.02	0.40	8.44E-03	0.02	0.03	0.02	1.65E-03	6.63E-03	6.37E-03	9.58E-03	1.58E-03	1.02E-03	7.37E-04	6.33E-03	0.02	0.01
PST	p,p'-DDE	1.00E-03	0.01	9.35E-03	0.04	0.01	0.02	0.03	0.01	0.02	5.70E-03	6.82E-03	9.27E-04	0.02	0.01	9.53E-03	6.50E-03	0.02	2.15E-03

1 - Hazard Quotients calculated as EqP-calculated porewater concentration (Table A-3.1A)/WQSV

2 - Water Quality Screening Value (Table 4)

Table A-3.3A. Porewater Hazard Quotients[1] (PW-HQs) for Derecktor Shipyard Marine ERA stations exhibiting **NO TOXICITY**[2] to amphipods (*Ampelisca abdita*).

Class	Analyte	DSY-25	DSY-26	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41	n	Mean	95% UCL[3]
MET	Arsenic																0		
MET	Cadmium																0		
MET	Chromium																0		
MET	Copper																0		
MET	Lead																0		
MET	Mercury																0		
MET	Nickel																0		
MET	Silver																0		
MET	Zinc																0		
MET	SEM:AVS	-4.34	-0.58	-35.12	-3.90	-9.45	-2.90	0.21	-5.62	-0.06	-7.10	0.08	-5.57	-3.85	-3.32	-0.04	15	-5.48	-0.07
PAH	1,6,7-Trimethylnaphthalene																0		
PAH	1-Methylnaphthalene																0		
PAH	1-Methylphenanthrene																0		
PAH	2,6-Dimethylnaphthalene																0		
PAH	2-Methylnaphthalene	0.09	0.13	0.17	0.33	0.14	0.13	0.08	0.11	0.02	0.09	0.11	0.06	0.08	0.16	0.04	15.00	0.12	0.16
PAH	Acenaphthene	4.65E-04	1.64E-04	6.20E-04	1.03E-03	8.81E-05	7.90E-05	3.94E-05	5.31E-05	7.38E-06	6.13E-05	6.62E-05	4.20E-05	7.86E-05	2.17E-04	4.17E-05	15.00	2.03E-04	3.60E-04
PAH	Acenaphthylene	0.97	1.45	1.14	0.55	0.42	0.84	0.16	0.21	0.02	0.48	0.35	0.19	0.20	1.48	0.02	15.00	0.56	0.84
PAH	Anthracene	1.99	2.14	2.38	1.41	0.61	0.98	0.22	0.24	0.03	0.52	0.75	0.36	0.35	1.87	0.16	15.00	0.93	1.38
PAH	Benzo(a)anthracene	0.71	1.35	1.72	0.70	0.28	0.42	0.12	0.12	0.02	0.24	0.25	0.14	0.15	0.61	0.07	15.00	0.46	0.73
PAH	Benzo(a)pyrene	0.52	0.69	0.92	0.50	0.25	0.32	0.10	0.11	0.02	0.21	0.17	0.09	0.13	0.50	0.05	15.00	0.31	0.45
PAH	Benzo(b)fluoranthene																0		
PAH	Benzo(e)pyrene																0		
PAH	Benzo(g,h,i)perylene																0		
PAH	Benzo(k)fluoranthene																0		
PAH	Biphenyl																0		
PAH	Chrysene	0.71	1.05	1.22	0.49	0.27	0.36	0.09	0.10	0.02	0.21	0.18	0.09	0.12	0.79	0.07	15.00	0.38	0.59
PAH	Dibenz(a,h)anthracene	0.54	0.66	0.83	0.54	0.26	0.32	0.12	0.13	0.02	0.22	0.21	0.11	0.17	0.67	0.06	15.00	0.32	0.45
PAH	Fluoranthene	0.02	0.03	0.05	0.02	6.02E-03	8.69E-03	3.32E-03	3.78E-03	6.85E-04	5.64E-03	6.87E-03	4.34E-03	4.90E-03	0.03	2.70E-03	15.00	0.01	0.02
PAH	Fluorene	1.30	1.93	2.58	2.45	0.39	0.38	0.21	0.23	0.05	0.27	0.23	0.11	0.30	0.68	0.14	15.00	0.75	1.23
PAH	Indeno(1,2,3-cd)pyrene																0		
PAH	Naphthalene	6.11E-04	8.82E-04	1.02E-03	2.86E-03	9.47E-04	9.59E-04	5.25E-04	5.62E-04	8.67E-05	7.72E-04	9.76E-04	6.07E-04	7.45E-04	1.15E-03	1.82E-04	15.00	8.73E-04	1.22E-03
PAH	Perylene																0		
PAH	Phenanthrene	0.63	0.90	1.12	1.40	0.23	0.21	0.12	0.14	0.03	0.16	0.16	0.09	0.19	0.86	0.10	15.00	0.42	0.67
PAH	Pyrene	0.49	0.76	1.33	0.69	0.33	0.39	0.10	0.12	0.02	0.20	0.25	0.12	0.13	1.22	0.09	15.00	0.42	0.64
PAH	LMW PAHs	4.05	5.10	6.25	5.60	1.37	1.70	0.63	0.72	0.12	1.05	1.25	0.63	0.93	3.57	0.44	15.00	2.23	3.38
PAH	HMW PAHs	2.98	4.53	6.07	2.95	1.40	1.81	0.52	0.59	0.09	1.09	1.06	0.56	0.71	3.71	0.34	15.00	1.89	2.87
PAH	Total PAHs	7.03	9.63	12.33	8.55	2.77	3.51	1.15	1.31	0.21	2.13	2.31	1.18	1.64	7.28	0.78	15.00	4.12	6.22
PCB	Total PCBs	0.15	0.16	0.08	0.15	0.13	0.12	0.05	0.04	0.04	0.06	0.08	0.04	0.04	0.08	0.06	15.00	0.09	0.11
PST	Aldrin	1.40E-05	1.70E-05	4.17E-06	6.60E-06	6.51E-06	7.00E-06	1.51E-05	7.86E-06	4.10E-05	7.06E-06	1.13E-05	8.15E-06	9.81E-06	1.70E-05	3.09E-05	15.00	1.36E-05	1.91E-05
PST	Hexachlorobenzene	1.98E-06	3.55E-06	1.15E-06	9.30E-07	9.18E-07	9.87E-07	2.12E-06	1.11E-06	5.78E-06	9.96E-07	1.59E-06	1.15E-06	1.38E-06	2.40E-06	4.35E-06	15.00	2.03E-06	2.83E-06
PST	Mirex	9.47E-04	2.15E-03	2.81E-04	0.02	1.44E-03	3.34E-03	1.02E-03	1.50E-03	2.76E-03	1.75E-03	2.76E-03	1.89E-03	0.61E-04	2.61E-03	2.08E-03	15.00	3.18E-03	6.14E-03
PST	o,p'-DDE	1.27E-03	0.02	0.02	0.03	0.02	1.65E-03	8.63E-03	6.37E-03	9.58E-03	1.58E-03	1.02E-03	7.37E-04	6.33E-03	0.02	0.01	15.00	0.01	0.02
PST	p,p'-DDE	0.01	9.35E-03	0.02	0.03	0.01	0.02	5.70E-03	6.62E-03	9.27E-04	0.02	0.01	9.53E-03	6.50E-03	0.02	2.15E-03	15.00	0.01	0.02

1 - Hazard Quotients from Table A-3.2

2 - Toxicity data contained in Derecktor Shipyard Marine ERA (SAIC and URI, 1997), Table 5-2-1

3 - 95% Upper Confidence Limit based on sample size as follows: Mean+($t_{0.95}$(df)*(STDEV/SQRT(n))), where STDEV=standard deviation; n=sample size; $t_{0.95}$(df)=sample size dependent percentage points of the t distribution (Ott, 1993)

Table A-3.3B. Porewater Hazard Quotients[1] (PW-HQs) for the Derecktor Shipyard Marine ERA stations exhibiting **TOXICITY**[2] to amphipods (*Ampelisca abdita*).

Class	Analyte	DSY-27	DSY-28	N	Mean	Maximum HQ
MET	Arsenic			0		
MET	Cadmium			0		
MET	Chromium			0		
MET	Copper			0		
MET	Lead			0		
MET	Mercury			0		
MET	Nickel			0		
MET	Silver			0		
MET	Zinc			0		
MET	SEM:AVS	-32.87	-11.10	2.00	-21.98	-11.10
PAH	1,6,7-Trimethylnaphthalene			0		
PAH	1-Methylnaphthalene			0		
PAH	1-Methylphenanthrene			0		
PAH	2,6-Dimethylnaphthalene			0		
PAH	2-Methylnaphthalene	0.13	0.16	2.00	0.14	0.16
PAH	Acenaphthene	1.27E-04	8.50E-05	2.00	1.06E-04	1.27E-04
PAH	Acenaphthylene	0.87	0.42	2.00	0.65	0.87
PAH	Anthracene	1.21	0.54	2.00	0.87	1.21
PAH	Benzo(a)anthracene	0.83	0.28	2.00	0.56	0.83
PAH	Benzo(a)pyrene	0.58	0.22	2.00	0.40	0.58
PAH	Benzo(b)fluoranthene			0		
PAH	Benzo(e)pyrene			0		
PAH	Benzo(g,h,i)perylene			0		
PAH	Benzo(k)fluoranthene			0		
PAH	Biphenyl			0		
PAH	Chrysene	0.64	0.24	2.00	0.44	0.64
PAH	Dibenz(a,h)anthracene	0.56	0.26	2.00	0.41	0.56
PAH	Fluoranthene	0.01	6.62E-03	2.00	9.55E-03	0.01
PAH	Fluorene	0.87	0.41	2.00	0.64	0.87
PAH	Indeno(1,2,3-cd)pyrene			0		
PAH	Naphthalene	9.01E-04	7.61E-04	2.00	8.26E-04	9.01E-04
PAH	Perylene			0		
PAH	Phenanthrene	0.38	0.23	2.00	0.30	0.38
PAH	Pyrene	0.79	0.24	2.00	0.52	0.79
PAH	LMW PAHs	2.58	1.34	2.00	1.96	2.58
PAH	HMW PAHs	3.41	1.25	2.00	2.33	3.41
PAH	Total PAHs	5.99	2.58	2.00	4.28	5.99
PCB	Total PCBs	1.78	0.06	2.00	0.92	1.78
PST	Aldrin	6.72E-06	6.24E-06	2.00	6.48E-06	6.72E-06
PST	Hexachlorobenzene	1.46E-06	6.09E-07	2.00	1.03E-06	1.46E-06
PST	Mirex	0.01	7.12E-04	2.00	6.23E-03	0.01
PST	o,p'-DDE	0.40	9.44E-03	2.00	0.20	0.40
PST	p,p'-DDE	0.04	0.01	2.00	0.03	0.04

1 - Hazard Quotients from Table A-3.2.

2 - Toxicity data contained in Derecktor Shipyard Marine ERA (SAIC and URI 1997), Table 5.2-1

Table A-4 1. Elutriate concentrations for sediments collected from the Derecktor Shipyard study area[1].

Class	Analyte[2]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
MET	Arsenic	12.40						27.20	24.80	2.50			40.40	19.60	40.70	76.00	30.00	
MET	Cadmium	0.10						0.10	0.10	0.10			0.10	0.10	0.10	0.10	0.10	
MET	Chromium	0.40						0.40	0.40	0.40			0.40	0.40	0.40	0.40	0.40	
MET	Copper	1.25						5.10	1.25	1.25			1.25	1.25	1.25	1.25	1.25	
MET	Lead	9.40						8.50	9.40	15.90			8.30	12.90	10.70	14.60	9.00	
MET	Mercury	0.10						0.10	0.10	0.10			0.10	0.10	0.10	0.10	0.10	
MET	Nickel	4.00						4.00	4.00	4.00			4.00	4.00	4.00	4.00	4.00	
MET	Silver	0.25						0.25	0.25	0.25			0.25	0.25	0.25	0.25	0.25	
MET	Zinc	4.50						4.50	4.50	4.50			4.50	4.50	4.50	4.50	4.50	
MET	SEM-AVS	2.88	1.18	12.10	7.47	7.57	5.51	2.79	2.70	1.88	1.43	1.02	1.44	2.77	1.91	2.43	2.18	1.31
PAH	1,6,7-Trimethylnaphthalene																	
PAH	1-Methylnaphthalene																	
PAH	1-Methylphenanthrene																	
PAH	2,6-Dimethylnaphthalene																	
PAH	2-Methylnaphthalene	11.35						4.58	4.81	9.76			5.75	6.21	8.07	5.08	4.27	
PAH	Acenaphthene	27.69		1.95		3.95		2.22	2.65	2.22			1.97	1.70	2.07	2.13	2.45	
PAH	Acenaphthylene	12.65		1.70		1.70		2.89	3.92	6.82			2.99	1.60	1.11	2.18	4.84	
PAH	Anthracene	40.78				8.05		6.33	9.60	8.08			5.91	4.44	2.97	4.43	14.08	
PAH	Benzo(a)anthracene	46.47				42.13		8.77	7.50	11.94			6.56	4.53	3.78	4.82	12.15	
PAH	Benzo(a)pyrene	40.92		6.56		16.10		11.01	11.25	17.42			7.76	3.73	1.77	7.74	11.69	
PAH	Benzo(b)fluoranthene																	
PAH	Benzo(e)pyrene																	
PAH	Benzo(g,h,i)perylene																	
PAH	Benzo(k)fluoranthene																	
PAH	Biphenyl																	
PAH	Chrysene	31.67						3.85	4.17	12.12			4.55	3.25	2.38	3.98	5.80	
PAH	Dibenz(a,h)anthracene	8.25		11.50		11.50		1.99	4.51	3.80			0.59	1.40	11.50	11.50	1.61	
PAH	Fluoranthene	78.24		17.03		118		11.30	12.47	25.27			13.31	12.53	11.00	12.02	19.00	
PAH	Fluorene	24.80		6.15		6.15		1.62	2.18	4.75			1.99	1.84	2.40	1.96	1.82	
PAH	Indeno(1,2,3-cd)pyrene																	
PAH	Naphthalene	14.80						5.24	11.64	12.82			9.58	8.22	10.91	6.65	7.66	
PAH	Perylene																	
PAH	Phenanthrene	26.71		8.73		10.07		10.75	8.92	14.97			8.99	12.67	8.37	9.06	11.28	
PAH	Pyrene	327		203		311		87.72	79.89	31.70			33.60	27.37	14.17	14.49	274	
PAH	LMW PAHs	154		16.84		28.23		30.72	39.81	53.21			34.19	35.09	32.80	29.31	41.56	
PAH	HMW PAHs	433		238		499		125	120	102			66.37	52.82	44.60	54.55	325	
PAH	Total PAHs	586		255		527		155	160	155			101	87.90	77.39	83.85	368	
PCB	Total PCBs	77.02		59.45		54.32		56.60	39.09	26.02			26.26	37.43	19.20	25.87	36.66	
PST	Aldrin	1.60		0.88		0.94		1.60	1.60	1.60			1.60	1.60	1.60	1.60	1.60	
PST	Hexachlorobenzene	0.08		0.11		0.90		0.26	0.06	0.08			0.90	0.05	0.05	0.05	0.11	
PST	Mirex	0.40		0.09		0.71		0.60	0.13	0.60			0.60	0.09	0.10	0.05	0.10	
PST	o,p'-DDE	3.52		2.80		2.97		3.21	1.90	1.33			2.04	3.39	1.44	2.25	2.48	
PST	p,p'-DDE	0.42		0.42		0.63		0.64	0.30	0.31			0.39	0.71	0.25	0.61	0.59	

Units: metals - µg/L, organics- ng/L

1 - Elutriate concentration as reported in Derecktor Shipyard ERA, Appendix A-1-2 (SAIC, 1997)

2 - SEM concentration used; AVS assumed = 0 in resuspended sediment

Table A-4.2. Elutriate Hazard Quotients (ELU-HQs) for sediments collected from the Derecktor Shipyard study area[1].

Class	Analyte	WQSV[2]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
MET	Arsenic	38.00	0.34						0.76	0.69	0.07			1.12	0.54	1.13	2.11	0.83	
MET	Cadmium	9.30	0.01						0.01	0.01	0.01			0.01	0.01	0.01	0.01	0.01	
MET	Chromium	53.00	8.00E-03						8.00E-03	8.00E-03	8.00E-03			8.00E-03	8.00E-03	8.00E-03	8.00E-03	8.00E-03	
MET	Copper	2.90	0.43						1.70	0.43	0.43			0.43	0.43	0.43	0.43	0.43	
MET	Lead	8.50	1.11						1.00	1.11	1.87			0.98	1.52	1.26	1.72	1.06	
MET	Mercury	0.03	4.00						4.00	4.00	4.00			4.00	4.00	4.00	4.00	4.00	
MET	Nickel	8.30	0.48						0.48	0.48	0.48			0.48	0.48	0.48	0.48	0.48	
MET	Silver	0.92	0.27						0.27	0.27	0.27			0.27	0.27	0.27	0.27	0.27	
MET	Zinc	85.00	0.05						0.05	0.05	0.05			0.05	0.05	0.05	0.05	0.05	
MET	SEM AVS	5.00	0.58	0.24	2.42	1.48	1.51	1.10	0.56	0.54	0.37	0.29	0.20	0.29	0.55	0.38	0.49	0.43	0.26
PAH	1,6,7-Trimethylnaphthalene																		
PAH	1-Methylnaphthalene																		
PAH	1-Methylphenanthrene																		
PAH	2,6-Dimethylnaphthalene																		
PAH	2-Methylnaphthalene	0.96	0.01						5.21E-03	5.49E-03	0.01			6.57E-03	7.10E-03	6.94E-03	5.80E-03	4.86E-03	
PAH	Acenaphthene	710	3.90E-05		2.75E-06		5.56E-06		3.13E-06	3.74E-06	3.13E-06			2.77E-06	2.39E-06	2.91E-06	3.01E-06	3.45E-06	
PAH	Acenaphthylene	0.46	0.03		3.70E-03		3.70E-03		6.30E-03	8.54E-03	0.01			6.52E-03	3.49E-03	2.41E-03	4.75E-03	0.01	
PAH	Anthracene	0.29	0.16				0.03		0.02	0.03	0.03			0.02	0.02	0.01	0.02	0.05	
PAH	Benzo(a)anthracene	0.07	0.71				0.06		0.13	0.12	0.18			0.10	0.07	0.06	0.07	0.19	
PAH	Benzo(a)pyrene	0.04	0.97		0.15		0.38		0.28	0.27	0.41			0.18	0.09	0.04	0.18	0.28	
PAH	Benzo(b)fluoranthene																		
PAH	Benzo(e)pyrene																		
PAH	Benzo(g,h,i)perylene																		
PAH	Benzo(k)fluoranthene																		
PAH	Biphenyl																		
PAH	Chrysene	0.10	0.33						0.04	0.04	0.13			0.05	0.03	0.02	0.04	0.06	
PAH	Dibenz(a,h)anthracene	1.08E-03	4.91		6.84		6.84		1.18	2.68	2.26			0.35	0.83	6.84	6.84	0.96	
PAH	Fluoranthene	16.00	4.09E-03		1.06E-03		7.36E-03		7.07E-04	7.79E-04	1.56E-03			8.32E-04	7.83E-04	6.87E-04	7.51E-04	1.19E-03	
PAH	Fluorene	0.14	0.16		0.04		0.04		0.01	0.02	0.03			0.01	0.01	0.02	0.01	0.01	
PAH	Indeno(1,2,3-cd)pyrene																		
PAH	Naphthalene	620	2.36E-05						8.45E-06	1.88E-05	2.07E-05			1.55E-05	1.33E-05	1.76E-05	1.07E-05	1.24E-05	
PAH	Perylene																		
PAH	Phenanthrene	0.51	0.04		0.01		0.01		0.01	0.01	0.02			0.01	0.02	0.01	0.01	0.01	
PAH	Pyrene	0.03	0.36		0.32		0.49		0.14	0.13	0.05			0.05	0.04	0.02	0.02	0.44	
PAH	LMW PAHs		0.39		0.05		0.09		0.05	0.07	0.09			0.05	0.05	0.05	0.05	0.08	
PAH	HMW PAHs		7.20		7.32		8.37		1.76	3.23	3.03			0.74	1.07	6.90	7.16	1.92	
PAH	Total PAHs		7.68		7.37		8.46		1.81	3.30	3.13			0.79	1.12	7.03	7.21	2.00	
PCB	Total PCBs	0.03	2.59		2.31		1.81		1.98	1.30	0.89			0.88	1.25	0.64	0.88	1.22	
PST	Aldrin	0.16	9.82E-03		5.17E-02		6.79E-03		9.82E-03	9.82E-03	9.82E-03			9.82E-03	9.82E-03	9.82E-03	9.82E-03	9.82E-03	
PST	Hexachlorobenzene	3.68	2.14E-05		3.01E-05		2.45E-04		7.19E-05	1.58E-05	2.27E-05			2.45E-04	1.36E-05	1.38E-05	1.45E-05	3.03E-05	
PST	Dieldrin	1.00E-03	0.40		0.03		0.71		0.60	0.13	0.60			0.60	0.09	0.10	0.05	0.10	
PST	o,p'-DDE	1.00E-03	3.52		2.80		2.97		3.21	1.90	1.33			2.04	3.39	1.44	2.25	2.46	
PST	p,p'-DDE	1.00E-03	0.42		0.42		0.63		0.64	0.30	0.31			0.39	0.71	0.25	0.61	0.59	

1. ELU-HQ calculated as elutriate concentration (Table A-4.1)/WQSV
2. Water Quality Screening Value (Table 4)

Table A-4 3A. Elutriate Hazard Quotients[1] (ELU-HQs) for Derecktor Shipyard Marine ERA stations exhibiting **NO TOXICITY**[2] to sea urchin (*Arbacia punctulata*) FERTILIZATION.

Class	Analyte[3]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41	n	Mean	95% UCL[3]
MET	Arsenic	0.34						0.76	0.69	0.07			1.12	0.54	1.13	2.11	0.83		9.00	0.84	0.84
MET	Cadmium	0.01						0.01	0.01	0.01			0.01	0.01	0.01	0.01	0.01		9.00	0.01	0.01
MET	Chromium	8.00E-03						8.00E-03	8.00E-03	8.00E-03			8.00E-03	8.00E-03	8.00E-03	8.00E-03	8.00E-03		9.00	8.00E-03	8.00E-03
MET	Copper	0.43						1.76	0.43	0.43			0.43	0.43	0.43	0.43	0.43		9.00	0.58	0.58
MET	Lead	1.11						1.00	1.11	1.67			0.98	1.52	1.26	1.72	1.00		9.00	1.29	1.29
MET	Mercury	4.00						4.00	4.00	4.00			4.00	4.00	4.00	4.00	4.00		9.00	4.00	4.00
MET	Nickel	0.48						0.48	0.48	0.48			0.48	0.48	0.48	0.48	0.48		9.00	0.48	0.48
MET	Silver	0.27						0.27	0.27	0.27			0.27	0.27	0.27	0.27	0.27		9.00	0.27	0.27
MET	Zinc	0.05						0.05	0.05	0.05			0.05	0.05	0.05	0.05	0.05		9.00	0.05	0.05
MET	SEM:AVS	0.58	0.24	2.42	1.49	1.51	1.10	0.58	0.54	0.37	0.29	0.20	0.29	0.55	0.38	0.49	0.43	0.26	17.00	0.69	1.06
PAH	1,6,7-Trimethylnaphthalene																		0		
PAH	1-Methylnaphthalene																		0		
PAH	1-Methylphenanthrene																		0		
PAH	2,6-Dimethylnaphthalene																		0		
PAH	2-Methylnaphthalene	0.01						5.21E-03	5.49E-03	0.01			6.57E-03	7.10E-03	6.94E-03	5.80E-03	4.86E-03		9.00	7.34E-03	7.34E-03
PAH	Acenaphthene	3.90E-05		2.75E-06		5.56E-06		3.13E-06	3.74E-06	3.13E-06			2.77E-06	2.39E-06	2.91E-06	3.01E-06	3.45E-06		11.00	6.53E-06	6.53E-06
PAH	Acenaphthylene	0.03		3.70E-03		3.70E-03		6.30E-03	8.54E-03	0.01			6.52E-03	3.49E-03	2.41E-03	4.75E-03	0.01		11.00	8.44E-03	8.44E-03
PAH	Anthracene	0.16				0.03		0.02	0.03	0.03			0.02	0.02	0.01	0.02	0.05		10.00	0.04	0.04
PAH	Benzo(a)anthracene	0.71				0.65		0.13	0.12	0.18			0.10	0.07	0.06	0.07	0.19		10.00	0.23	0.23
PAH	Benzo(a)pyrene	0.97		0.15		0.39		0.26	0.27	0.41			0.18	0.09	0.04	0.18	0.28		11.00	0.29	0.29
PAH	Benzo(b)fluoranthene																		0		
PAH	Benzo(e)pyrene																		0		
PAH	Benzo(g,h,i)perylene																		0		
PAH	Benzo(k)fluoranthene																		0		
PAH	Biphenyl																		0		
PAH	Chrysene	0.33						0.04	0.04	0.13			0.05	0.03	0.02	0.04	0.06		9.00	0.08	0.08
PAH	Dibenzo(a,h)anthracene	4.91		6.84		6.84		1.18	2.68	2.28			0.35	0.83	6.84	6.84	0.96		11.00	3.89	3.89
PAH	Fluoranthene	4.80E-03		1.06E-03		7.36E-03		7.07E-04	7.79E-04	1.58E-03			8.32E-04	7.83E-04	6.87E-04	7.51E-04	1.19E-03		11.00	1.87E-03	1.87E-03
PAH	Fluorene	0.18		0.04		0.04		0.01	0.02	0.03			0.01	0.01	0.02	0.01	0.01		11.00	0.04	0.04
PAH	Indeno(1,2,3-cd)pyrene																		0		
PAH	Naphthalene	2.36E-05						8.45E-06	1.88E-05	2.07E-05			1.55E-05	1.33E-05	1.76E-05	1.07E-05	1.24E-05		9.00	1.57E-05	1.57E-05
PAH	Perylene																		0		
PAH	Phenanthrene	0.04		0.01		0.01		0.01	0.01	0.02			0.01	0.02	0.01	0.01	0.01		11.00	0.01	0.01
PAH	Pyrene	0.36		0.32		0.49		0.14	0.13	0.05			0.05	0.04	0.02	0.02	0.44		11.00	0.19	0.19
PAH	LMW PAHs	0.39		0.06		0.09		0.05	0.07	0.09			0.05	0.05	0.05	0.05	0.08		11.00	0.09	0.09
PAH	HMW PAHs	7.29		7.32		8.37		1.76	3.23	3.03			0.74	1.07	6.99	7.16	1.92		11.00	4.44	4.44
PAH	Total PAHs	7.68		7.37		8.46		1.81	3.30	3.13			0.79	1.12	7.03	7.21	2.00		11.00	4.54	4.54
PCB	Total PCBs	2.59		2.31		1.81		1.96	1.30	0.89			0.86	1.25	0.64	0.86	1.22		11.00	1.43	1.43
PST	Aldrin	9.62E-03		5.37E-03		5.79E-03		9.82E-03	9.82E-03	9.82E-03			9.82E-03	9.82E-03	9.82E-03	9.82E-03	9.82E-03		11.00	9.05E-03	9.05E-03
PST	Hexachlorobenzene	2.14E-05		3.01E-05		2.45E-04		7.19E-05	1.56E-05	2.27E-05			2.45E-04	1.36E-05	1.38E-05	1.45E-05	3.03E-05		11.00	6.58E-05	6.58E-05
PST	Mirex	0.40		0.09		0.71		0.60	0.13	0.60			0.60	0.09	0.10	0.05	0.10		11.00	0.32	0.32
PST	o,p'-DDE	3.52		2.80		2.97		3.21	1.93	1.33			2.04	3.38	1.44	2.25	2.48		11.00	2.48	2.48
PST	p,p'-DDE	0.42		0.42		0.83		0.64	0.30	0.31			0.39	0.71	0.25	0.61	0.59		11.00	0.48	0.48

1 ELU-HQ from Table A-4.2

2 Toxicity data contained in Derecktor Shipyard Marine ERA (SAIC and URI, 1997), Table 5.2-1

3 95% Upper Confidence Limit based on sample size as follows: Mean+($t_{0.975}$(df)*(STDEV/SQRT(n))) where STDEV=standard deviation; n=sample size; $t_{0.975}$(df)=sample size-dependent percentage points of the t distribution (Olt, 1993)

Table A-4.3B Elutriate Hazard Quotients[1] (ELU-HQs) based on data from the Derecktor Shipyard Marine ERA for stations exhibiting **TOXICITY**[2] to sea urchin (*Arbacia punctulata*) FERTILIZATION.

Class	Analyte			c	Mean	Maximum HQ
MET	Arsenic			0		
MET	Cadmium			0		
MET	Chromium			0		
MET	Copper			0		
MET	Lead			0		
MET	Mercury			0		
MET	Nickel			0		
MET	Silver			0		
MET	Zinc			0		
PAH	1,6,7-Trimethylnaphthalene			0		
PAH	1-Methylnaphthalene			0		
PAH	1-Methylphenanthrene			0		
PAH	2,6-Dimethylnaphthalene			0		
PAH	2-Methylnaphthalene			0		
PAH	Acenaphthene			0		
PAH	Acenaphthylene			0		
PAH	Anthracene			0		
PAH	Benzo(a)anthracene			0		
PAH	Benzo(a)pyrene			0		
PAH	Benzo(b)fluoranthene			0		
PAH	Benzo(e)pyrene			0		
PAH	Benzo(g,h,i)perylene			0		
PAH	Benzo(k)fluoranthene			0		
PAH	Biphenyl			0		
PAH	Chrysene			0		
PAH	Dibenz(a,h)anthracene			0		
PAH	Fluoranthene			0		
PAH	Fluorene			0		
PAH	Indeno(1,2,3-cd)pyrene			0		
PAH	Naphthalene			0		
PAH	Perylene			0		
PAH	Phenanthrene			0		
PAH	Pyrene			0		
PAH	LMW PAHs			0		
PAH	HMW PAHs			0		
PAH	Total PAHs			0		
PCB	Total PCBs			0		
PST	Aldrin			0		
PST	Hexachlorobenzene			0		
PST	Mirex			0		
PST	o,p'-DDE			0		
PST	p,p'-DDE			0		

1 - ELU-HQ from Table A-4.2.

2 - Toxicity data contained in Derecktor Shipyard Marine ERA (SAIC and URI, 1997), Table 5.2-1

No samples found to be toxic to sea urchin fertilization.

Table A-4.4A. Elutriate Hazard Quotients[1] (ELU-HQs) for Dorecktor Shipyard Marine ERA stations exhibiting NO TOXICITY[2] to sea urchin (*Arbacia punctulata*) normal larval development.

Class	Analyte[1]			DSY-27	DSY-30	DSY-34	DSY-35	DSY-36	DSY-40		n	Mean	95% UCL[3]
MET	Arsenic							1.12	0.83		2.00	0.98	1.12
MET	Cadmium							0.01	0.01		2.00	0.01	0.01
MET	Chromium							8.00E-03	8.00E-03		2.00	8.00E-03	8.00E-03
MET	Copper							0.43	0.43		2.00	0.43	0.43
MET	Lead							0.98	1.06		2.00	1.02	1.06
MET	Mercury							4.00	4.00		2.00	4.00	4.00
MET	Nickel							0.48	0.48		2.00	0.48	0.48
MET	Silver							0.27	0.27		2.00	0.27	0.27
MET	Zinc							0.05	0.05		2.00	0.05	0.05
MET	SEM AVS			2.42	1.10	0.29	0.20	0.29	0.43		6.00	0.79	1.70
PAH	1,6,7-Trimethylnaphthalene										0		
PAH	1-Methylnaphthalene										0		
PAH	1-Methylphenanthrene										0		
PAH	2,6-Dimethylnaphthalene										0		
PAH	2-Methylnaphthalene							6.57E-03	4.86E-03		2.00	5.72E-03	6.57E-03
PAH	Acenaphthene			2.75E-06				2.77E-06	3.45E-06		3.00	2.99E-06	3.45E-06
PAH	Acenaphthylene			3.70E-03				6.52E-03	0.01		3.00	6.92E-03	0.01
PAH	Anthracene							0.02	0.05		2.00	0.03	0.05
PAH	Benzo(a)anthracene							0.10	0.19		2.00	0.14	0.19
PAH	Benzo(a)pyrene			0.15				0.18	0.28		3.00	0.20	0.28
PAH	Benzo(b)fluoranthene										0		
PAH	Benzo(e)pyrene										0		
PAH	Benzo(g,h,i)perylene										0		
PAH	Benzo(k)fluoranthene										0		
PAH	Biphenyl										0		
PAH	Chrysene							0.05	0.06		2.00	0.05	0.06
PAH	Dibenz(a,h)anthracene			6.84				0.35	0.96		3.00	2.72	6.84
PAH	Fluoranthene			1.06E-03				8.32E-04	1.19E-03		3.00	1.03E-03	1.19E-03
PAH	Fluorene			0.04				0.01	0.01		3.00	0.02	0.04
PAH	Indeno(1,2,3-cd)pyrene										0		
PAH	Naphthalene							1.55E-05	1.24E-05		2.00	1.39E-05	1.55E-05
PAH	Perylene										0		
PAH	Phenanthrene			0.01				0.01	0.01		3.00	0.01	0.01
PAH	Pyrene			0.32				0.05	0.44		3.00	0.27	0.44
PAH	LMW PAHs			0.06				0.05	0.08		3.00	0.06	0.08
PAH	HMW PAHs			7.32				0.74	1.92		3.00	3.33	7.32
PAH	Total PAHs			7.37				0.79	2.00		3.00	3.39	7.37
PCB	Total PCBs			2.31				0.68	1.22		3.00	1.47	2.31
PST	Aldrin			5.37E-03				9.82E-03	9.82E-03		3.00	8.33E-03	9.82E-03
PST	Hexachlorobenzene			3.01E-05				2.45E-04	3.03E-05		3.00	1.02E-04	2.45E-04
PST	Mirex			0.09				0.09	0.10		3.00	0.26	0.60
PST	o,p'-DDE			2.60				2.04	2.48		3.00	2.44	2.80
PST	p,p'-DDE			0.47				0.39	0.59		3.00	0.47	0.59

1 - ELU-HQ data from Table A-4.2

2 - Toxicity data contained in Dorecktor Shipyard Marine ERA (SAIC and ORI, 1997), Table 5.2-1.

3 - 95% Upper Confidence Limit based on sample size as follows: Mean+($t_{0.975}$(df)*(STDEV/SQRT(n))); where STDEV=standard deviation, n=sample size; $t_{0.975}$(df)=sample size-dependent percentage points of the t distribution (Ott, 1993). Maximum values or range taken where no samples<3.

Table A-4.4B. Elutriate Hazard Quotients[1] (ELU-HQs) for Derecktor Shipyard Marine ERA stations exhibiting **TOXICITY**[2] to sea urchin (*Arbacia punctulata*) normal larval development.

Class	Analyte	DSY-25	DSY-29	DSY-31	DSY-32	DSY-33	DSY-37	DSY-38	DSY-39	n	Mean	Maximum HQ
MET	Arsenic	0.34		0.76	0.69	0.07	0.54	1.13	2.11	7.00	0.81	2.11
MET	Cadmium	0.01		0.01	0.01	0.01	0.01	0.01	0.01	7.00	0.01	0.01
MET	Chromium	8.00E-03		8.00E-03	8.00E-03	8.00E-03	8.00E-03	8.00E-03	8.00E-03	7.00	8.00E-03	8.00E-03
MET	Copper	0.43		1.76	0.43	0.43	0.43	0.43	0.43	7.00	0.62	1.76
MET	Lead	1.11		1.00	1.11	1.87	1.52	1.26	1.72	7.00	1.37	1.87
MET	Mercury	4.00		4.00	4.00	4.00	4.00	4.00	4.00	7.00	4.00	4.00
MET	Nickel	0.48		0.48	0.48	0.48	0.48	0.48	0.48	7.00	0.48	0.48
MET	Silver	0.27		0.27	0.27	0.27	0.27	0.27	0.27	7.00	0.27	0.27
MET	Zinc	0.05		0.05	0.05	0.05	0.05	0.05	0.05	7.00	0.05	0.05
MET	SEM:AVS	0.58	1.51	0.56	0.54	0.37	0.55	0.38	0.49	8.00	0.62	1.51
PAH	1,6,7-Trimethylnaphthalene									0		
PAH	1-Methylnaphthalene									0		
PAH	1-Methylphenanthrene									0		
PAH	2,6-Dimethylnaphthalene									0		
PAH	2-Methylnaphthalene	0.01		5.21E-03	5.49E-03	0.01	7.10E-03	6.94E-03	5.80E-03	7.00	7.81E-03	0.01
PAH	Acenaphthene	3.90E-05	5.56E-06	3.13E-06	3.74E-06	3.13E-06	2.39E-06	2.91E-06	3.01E-06	8.00	7.86E-06	3.90E-05
PAH	Acenaphthylene	0.03	3.70E-03	6.30E-03	8.54E-03	0.01	3.49E-03	2.41E-03	4.75E-03	8.00	9.00E-03	0.03
PAH	Anthracene	0.16	0.03	0.02	0.03	0.03	0.02	0.01	0.02	8.00	0.04	0.16
PAH	Benzo(a)anthracene	0.71	0.65	0.13	0.12	0.18	0.07	0.06	0.07	8.00	0.25	0.71
PAH	Benzo(a)pyrene	0.97	0.38	0.26	0.27	0.41	0.09	0.04	0.18	8.00	0.32	0.97
PAH	Benzo(b)fluoranthene									0		
PAH	Benzo(e)pyrene									0		
PAH	Benzo(g,h,i)perylene									0		
PAH	Benzo(k)fluoranthene									0		
PAH	Biphenyl									0		
PAH	Chrysene	0.33		0.04	0.04	0.13	0.03	0.02	0.04	7.00	0.09	0.33
PAH	Dibenz(a,h)anthracene	4.91	6.64	1.18	2.68	2.26	0.83	6.84	6.84	8.00	4.05	6.84
PAH	Fluoranthene	4.89E-03	7.36E-03	7.07E-04	7.79E-04	1.58E-03	7.83E-04	6.87E-04	7.51E-04	8.00	2.19E-03	7.36E-03
PAH	Fluorene	0.18	0.04	0.01	0.02	0.03	0.01	0.02	0.01	8.00	0.04	0.18
PAH	Indeno(1,2,3-cd)pyrene									0		
PAH	Naphthalene	2.36E-05		8.45E-06	1.88E-05	2.07E-05	1.33E-05	1.76E-05	1.07E-05	7.00	1.61E-05	2.36E-05
PAH	Perylene									0		
PAH	Phenanthrene	0.04	0.01	0.01	0.01	0.02	0.02	0.01	0.01	8.00	0.02	0.04
PAH	Pyrene	0.35	0.49	0.14	0.13	0.05	0.04	0.02	0.02	8.00	0.16	0.49
PAH	LMW PAHs	0.39	0.09	0.05	0.07	0.09	0.05	0.05	0.05	8.00	0.10	0.39
PAH	HMW PAHs	7.28	8.37	1.76	3.23	3.03	1.07	6.99	7.16	8.00	4.86	8.37
PAH	Total PAHs	7.68	8.46	1.81	3.30	3.13	1.12	7.03	7.21	8.00	4.97	8.46
PCB	Total PCBs	2.59	1.81	1.95	1.30	0.89	1.25	0.64	0.86	8.00	1.41	2.59
PST	Aldrin	9.82E-03	5.79E-03	9.82E-03	9.82E-03	9.82E-03	9.82E-03	9.82E-03	9.82E-03	8.00	9.31E-03	9.82E-03
PST	Hexachlorobenzene	2.14E-05	2.45E-04	7.19E-05	1.58E-05	2.27E-05	1.36E-05	1.38E-05	1.45E-05	8.00	5.23E-05	2.45E-04
PST	Mirex	0.40	0.71	0.60	0.13	0.60	0.09	0.10	0.05	8.00	0.34	0.71
PST	o,p'-DDE	3.52	2.97	3.21	1.90	1.33	3.39	1.44	2.25	8.00	2.50	3.52
PST	p,p'-DDE	0.42	0.63	0.64	0.30	0.31	0.71	0.25	0.61	8.00	0.48	0.71

1 - Hazard Quotients from Table A-4.2.

2 - Toxicity data contained in Derecktor Shipyard Marine ERA (SAIC and URI, 1997), Table 5.2-1.

Table A-5 Comparing aquatic Threshold Effects Value Hazard Quotients[1] for CoCs in porewaters and elutriates for identification of Limiting CoCs for the Derecktor Shipyard/Coddington Cove study area.

Class	Analyte[3,4]	Aquatic Pathway[2]	Aquatic TEV (µg/L)	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
PAH	HMW PAHs	PW	0.61	0.89	1.42	1.06	0.39	2.34	1.15	0.46	0.58	0.17	0.20	0.03	0.34	0.39	0.21	0.24	1.74	0.14
PCB	Total PCBs	PW	0.03	0.15	0.16	1.78	0.06	0.08	0.15	0.13	0.12	0.05	0.04	0.04	0.06	0.08	0.04	0.04	0.08	0.06
	SUM TEV-HQ			1.04	1.58	2.84	0.45	2.42	1.30	0.59	0.70	0.22	0.24	0.07	0.40	0.47	0.25	0.28	1.82	0.21
	MAX TEV-HQ			0.89	1.42	1.78		2.34	1.15										1.74	
	Limiting CoC			HMW PAHs	HMW PAHs	Total PCBs		HMW PAHs	HMW PAHs										HMW PAHs	
MET	Arsenic	ELU	40.40	0.31						0.67	0.61	0.06			1.00	0.49	1.01	1.88	0.74	
MET	Copper	ELU	2.90	0.43						1.76	0.43	0.43			0.43	0.43	0.43	0.43	0.43	
MET	Lead	ELU	13.20	0.71						0.64	0.71	1.20			0.63	0.98	0.81	1.11	0.68	
PAH	HMW PAHs	ELU	2.09	0.21		0.11		0.24		0.06	0.06	0.05			0.03	0.03	0.02	0.03	0.16	
PAH	Total PAHs	ELU	37.51	0.02		6.79E-03		0.01		4.14E-03	4.25E-03	4.14E-03			2.68E-03	2.34E-03	2.06E-03	2.24E-03	9.77E-03	
PCB	Total PCBs	ELU	0.07	1.12		1.00		0.78		0.85	0.56	0.38			0.38	0.54	0.28	0.37	0.53	
PST	o,p'-DDE	ELU	2.59E-03	0.98		0.78		0.83		0.89	0.53	0.37			0.57	0.94	0.40	0.62	0.69	
	SUM TEV-HQ			3.76	0	1.89	0	1.85	0	4.86	2.91	2.50	0	0	3.04	3.40	2.95	4.44	3.23	0
	MAX TEV-HQ			1.12		1.00		0.83		1.76	0.71	1.20			1.00	0.98	1.01	1.88	0.74	
	Limiting CoC			Total PCBs		Total PCBs		o,p'-DDE		Copper	Lead	Lead			Arsenic	Lead	Arsenic	Arsenic	Arsenic	

1 - Threshold Effects Value Hazard Quotient (TEV-HQ) = CoC concentration/Threshold Effect Value (TEV) (Table 7).

2 - PW - bedded sediment exposure pathway. CoCs measured in porewater (PW, Table A-3.1a). ELU- Resuspended sediment exposure pathway, CoCs measured in sediment elutriates (ELU; Table A-4.1).

3 - TEV units: µg/g dry weight for metals, ng/g dry weight for organics

4 - Sum TEV-HQ = sum of TEV-HQs for all analytes at a given station

Max TEV-HQ = maximum TEV-HQs observed for all analytes at a given station

Table A-6. Avian predator Threshold Effects Value Hazard Quotients[1] for CoCs in tissue of prey species consumed by avian aquatic predators in the Derecktor Shipyard/Coddington Cove study area.

Class	Analyte[3]	Avian TEV[3]	DSY-24-IBM	DSY-25-IBM	DSY-25-LOB	DSY-26-CN	DSY-26-DM	DSY-26-IBM	DSY-27-IBM	DSY-27-LOB	DSY-28-CN	DSY-28-DM	DSY-28-IBM	DSY-28-LOB	DSY-29-CN	DSY-29-DM	DSY-29-LOB	DSY-31-DM	DSY-31-PM	DSY-32-PM	DSY-33-DM	DSY-33-LOB	DSY-33-PM	DSY-34-PM
MET	Arsenic	14.96	0.69	0.84	1.91	0.24	0.36	0.55	0.45	1.15	0.33	1.13	0.18		0.51	0.60	1.91	0.35	0.63	0.33	0.83	1.49	0.39	0.58
MET	Cadmium	1.83	1.02	0.66	0.20	0.45	0.51	0.40	0.42	0.14	0.60	0.42	0.34		0.63	0.44	0.26	0.29	0.43	0.32	0.51	0.09	0.36	0.39
MET	Chromium	3.28	1.02	0.97	0.54	0.46	0.70	0.79	0.93	0.69	0.31	0.77	0.83		0.38	0.66	0.56	0.74	0.64	0.57	0.82	0.65	0.60	0.69
MET	Copper	60.71	0.07	0.20	2.50	0.29	0.22	0.13	0.25	2.75	0.25	0.18	0.02		0.36	0.10	1.65	0.15	0.24	0.18	0.14	0.99	0.14	0.17
MET	Lead	3.11	1.87	9.65E-05	0.05	0.26	0.44	9.65E-05	0.97	0.02	9.65E-05	9.65E-05	9.65E-05		0.29	0.30	0.07	0.43	0.56	0.89	0.47	0.15	9.65E-05	0.53
MET	Mercury	0.28	0.73	0.46	0.69	0.34	0.43	0.31	0.39	1.19	0.27	0.35	0.38		0.44	0.44	0.75	0.36	0.36	0.41	0.27	0.60	0.32	0.31
MET	Silver	1.41	7.12E-05	7.12E-05	3.89	0.37	7.12E-05	7.12E-05	7.12E-05	4.89	0.22	0.84	7.12E-05		7.12E-05	7.12E-05	4.16	7.12E-05	7.12E-05	0.98	7.12E-05	2.44	7.12E-05	7.12E-05
MET	Zinc	124	0.62	0.91	0.71	0.34	0.83	0.74	1.15	0.91	0.21	0.77	0.98		0.23	0.61	1.05	1.33	0.71	0.91	0.99	0.85	0.82	0.75
PCB	Total PCBs	266	0.80	0.69	0.61	2.87	2.32	1.08	1.50	0.95	5.05	0.90	1.05	1.12	4.14	1.13	0.46	1.03	1.24	0.48	0.63	0.61	0.68	0.41
	MAX TEV-HQ		1.87	0.97	3.89	2.87	2.32	1.08	1.50	4.89	5.05	1.13	1.05	1.12	4.14	1.13	4.16	1.33	1.24	0.98	0.99	2.44	0.82	0.75
	MAX CoC[4]		Lead		Silver	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Silver	Total PCBs	Arsenic	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Silver	Zinc	Total PCBs			Silver		
	Limiting CoC		Lead	Silver		Total PCBs			Silver		Total PCBs				Silver			Zinc			Silver			

1 - Threshold Effects Value Hazard Quotient (TEV-HQ) = CoC concentration (Table A-2.4)/Threshold Effect Value (TEV) (Table 9)

2 - Sum TEV-HQ = sum of TEV-HQs for all analytes at a given station.

Max TEV-HQ = maximum TEV-HQs observed for all analytes at a given station.

3 - TEV units: µg/g dry weight for metals, ng/g dry weight for organics.

4 - CoC associated with maximum observed TEV-HQ by sample.

Table A-6 (continued). Avian predator Threshold Effects Value Hazard Quotients[1] for CoCs in tissue of prey species consumed by avian aquatic predators in the Derecktor Shipyard/Coddington Cove study area.

Class	Analyte[2]	Avian TEV[3]	DSY-35-IBM	DSY-35-LOB	DSY-35-MM	DSY-35-PM	DSY-36-CN	DSY-36-IBM	DSY-36-LOB	DSY-36-PM	DSY-37-PM	DSY-38-DM	DSY-38-LOB	DSY-38-PM	DSY-39-DM	DSY-39-LOB	DSY-40-DM	DSY-40-IBM	DSY-41-MM	DSY-41-PM
MET	Arsenic	14.96	0.42	1.09	0.43	0.57	0.24	0.41	1.33	0.50	0.50	0.41	1.74	0.41	0.60	1.25	0.40	0.35	0.50	0.14
MET	Cadmium	1.83	0.40	0.31	0.35	0.36	0.53	0.21	1.64E-04	0.45	0.35	0.34	0.27	0.32	0.17	0.16	0.33	0.34	0.49	0.39
MET	Chromium	3.08	0.72	0.70	0.77	0.65	0.28	0.92	0.64	0.80	0.56	0.65	0.63	0.60	0.97	0.53	0.88	0.72	0.57	0.63
MET	Copper	60.71	0.12	2.11	0.11	0.14	0.26	0.12	0.81	0.20	0.15	0.19	2.72	0.17	0.14	3.24	0.10	0.12	0.22	0.20
MET	Lead	3.11	0.56	0.24	9.65E-05	0.53	0.31	9.65E-05	0.11	0.70	0.95	0.62	0.08	9.65E-05	9.65E-05	0.06	0.95	0.78	0.52	9.65E-05
MET	Mercury	0.38	0.44	0.70	0.32	0.26	0.38	0.50	0.86	0.39	0.40	0.34	0.86	0.44	0.37	1.08	0.34	0.43	0.31	0.39
MET	Silver	1.41	7.12E-05	4.66	7.12E-05	7.12E-05	7.12E-05	7.12E-05	2.04	7.12E-05	0.46	1.22	4.34	7.12E-05	0.70	0.58	7.12E-05	7.12E-05	0.90	7.12E-05
MET	Zinc	124	1.05	0.89	0.90	1.01	0.44	0.68	0.93	0.98	0.86	0.72	1.39	1.06	1.06	1.04	0.95	0.85	0.53	0.68
PCB	Total PCBs	760	0.91	0.41	0.21	0.63	4.08	1.17	1.10	0.64	0.56	0.72	0.38		0.60	0.84	0.73	1.19	0.33	0.36
	MAX TEV-HQ		1.05	4.66	0.90	1.01	4.08	1.17	2.04	0.98	0.95	1.22	4.34	1.06	1.06	3.24	0.95	1.19	0.90	0.68
	MAX CoC[4]		Zinc	Silver		Zinc	Total PCBs	Total PCBs	Silver			Silver	Silver	Zinc	Zinc	Copper		Total PCBs		
	2 metal CoC		Silver				Total PCBs					Silver			Copper		Total PCBs			

1 - Threshold Effects Value Hazard Quotient (TEV-HQ) = CoC concentration (Table A-2 4)/Threshold Effect Value (TEV) (Table 9)

2 Sum TEV-HQ = sum of TEV-HQs for all analytes at a given station

Max TEV-HQ = maximum TEV-HQs observed for all analytes at a given station

3 See Table 14 for TEVs TEV units µg/g dry weight for metals, ng/g dry weight for organics

4 - CoC associated with maximum observed TEV-HQ by sample

Table A-7. Human Health Threshold Effects Value Hazard Quotients[1] based on concentrations of selected contaminants in tissues of shellfish harvested from lower Narragansett Bay for consumption by subsistence fishermen.

Class	Analyte	[3] TEV	DSY-24-IBM	DSY-25-IBM	DSY-25-LOB	DSY-26-DM	DSY-26-IBM	DSY-27-IBM	DSY-27-LOB	DSY-28-DM	DSY-28-IBM	DSY-28-LOB	DSY-29-DM	DSY-29-LOB	DSY-31-DM	DSY-31-PM	DSY-32-PM	DSY-33-DM	DSY-33-LOB	DSY-33-PM	DSY-34-PM
MET	Arsenic	17.27	0.59	0.73	1.66	0.31	0.48	0.39	1.00	0.98	0.16		0.62	1.65	0.30	0.54	0.28	0.72	1.29	0.34	0.50
PAH	Benzo(a)anthracene	107	0.14	2.63	0.03	0.71	9.74	2.71	0.27	0.40	0.67	0.23	0.60	0.03	0.55	1.24	0.74	0.03	0.03	0.33	0.43
PAH	Benzo(a)pyrene	10.68	0.74	10.72	0.34	0.34	51.30	6.84	2.69	0.34	3.17	2.34	0.34	1.22	0.34	4.21	3.99	0.34	0.34	2.08	2.10
PAH	Dibenz(a,h)anthracene	10.68	0.74	1.27	0.05	0.05	4.65	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
PAH	Indeno(1,2,3-cd)pyrene	107	0.11	0.33	0.01	0.01	1.13	0.25	0.08	0.01	0.01	0.01	0.01	0.10	0.01	0.19	0.25	0.01	0.01	0.08	0.07
PCB	Total PCBs	1300	0.47	0.41	0.36	1.37	0.64	0.88	0.58	0.53	0.62	0.66	0.67	0.27	0.60	0.73	0.28	0.49	0.36	0.40	0.24
	MAX TEV-HQ		0.74	10.72	1.66	1.37	51.30	6.84	2.69	0.98	3.17	2.34	0.67	1.65	0.60	4.21	3.99	0.72	1.29	2.08	2.10
	MAX CoC[4]		Dibenz(a,h)anthracene	Benzo(a)pyrene	Arsenic	Total PCBs	Benzo(a)pyrene	Benzo(a)pyrene	Benzo(a)pyrene	Arsenic	Benzo(a)pyrene	Benzo(a)pyrene	Total PCBs	Arsenic	Total PCBs	Benzo(a)pyrene	Benzo(a)pyrene	Arsenic	Arsenic	Benzo(a)pyrene	Benzo(a)pyrene
	Limiting CoC			Benzo(a)pyrene		Benzo(a)pyrene		Benzo(a)pyrene		Benzo(a)pyrene			Arsenic		Benzo(a)pyrene		Benzo(a)pyrene	Benzo(a)pyrene			Benzo(a)pyrene

1 - Threshold Effects Value Hazard Quotient (TEV-HQ) = CoC concentration (Table A-2.4)/Threshold Effect Value (TEV) (Table 14)

2 - Sum TEV-HQ = sum of TEV-HQs for all analytes at a given station

Max TEV-HQ = maximum TEV-HQs observed for all analytes at a given station

3 - TEV units: µg/g dry weight for metals, ng/g dry weight for organics.

4 - CoC associated with maximum observed TEV-HQ by sample

5 - Arsenic selected as L-CoC for this station (see Text Section 2.4).

Table A-7 (continued). Human Health Threshold Effects Value Hazard Quotients[1] based on concentrations of selected contaminants in tissues of shellfish harvested from lower Narragansett Bay for consumption by subsistence fishermen.

Class	Analyte[3]	H-H TEV[3]	DSY-35-IBM	DSY-35-LOB	DSY-35-MM	DSY-35-PM	DSY-36-IBM	DSY-36-LOB	DSY-36-PM	DSY-37-PM	DSY-38-DM	DSY-38-LOB	DSY-38-PM	DSY-39-DM	DSY-39-LOB	DSY-40-DM	DSY-40-IBM	DSY-41-MM	DSY-41-PM
MCI	Arsenic	17.27	0.36	0.94	0.37	0.49	0.36	1.15	0.43	0.43	0.35	1.51	0.35	0.52	1.08	0.35	0.31	0.43	0.13
PAH	Benzo(a)anthracene	107	0.29	0.03	0.15	0.20	0.28	0.03	0.62	0.52	0.14	0.03	0.43	0.17	0.03	0.39	0.23		0.39
PAH	Benzo(a)pyrene	10.68	0.34	0.34	0.65	1.51	1.17	0.34	3.02	2.17	0.76	0.34	1.93	0.34	0.34	0.34	0.58	1.04	1.62
PAH	Dibenz(a,h)anthracene	10.68	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	3.10	0.05	0.05	0.05	0.05	0.05
PAH	Indeno(1,2,3-cd)pyrene	107	0.10	0.01	0.01	0.01	0.06	0.01	0.10	0.01	0.01	0.01	0.09	0.26	0.01	0.01	0.01	0.01	0.01
PCB	Total PCBs	1300	0.54	0.24	0.12	0.37	0.69	0.65	0.38	0.33	0.42	0.22		0.35	0.50	0.43	0.70	0.19	0.21
	MAX TEV-HQ		0.54	0.94	0.65	1.51	1.17	1.15	3.02	2.17	0.76	1.51	1.93	3.10	1.08	0.43	0.70	1.04	1.62
	MAX CoC[4]		Total PCBs	Arsenic	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Arsenic	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Arsenic	Benzo(a) pyrene	Dibenz(a, h)anthracene	Arsenic	Total PCBs	Total PCBs	Benzo(a) pyrene	Benzo(a) pyrene
	Limiting CoC		Benzo(a)pyrene				Benzo(a)pyrene			Benzo(a) pyrene	Benzo(a)pyrene			Arsenic[5]				Benzo(a)pyrene	

1 - Threshold Effects Value Hazard Quotient (TEV-HQ) = CoC concentration (Table A-2.4)/Threshold Effect Value (TEV) (Table 14).

2 - Sum TEV-HQ = sum of TEV-HQs for all analytes at a given station.
Max TEV-HQ = maximum TEV-HQs observed for all analytes at a given station

3 - TEV units: µg/g dry weight for metals, ng/g dry weight for organics

4 - CoC associated with maximum observed TEV-HQ by sample.

5 - Arsenic selected as L-CoC for this station (see Text Section 2.4)

Table A-8. Derivation of aquatic PRGs for CoCs in porewaters and elutriates obtained from sediments collected in the Derecktor Shipyard/Coddington Cove study area[1].

Class	Analyte[2]	Aquatic Pathway[2]	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41	n	PRG Mean[3,4]
PAH	HMW PAHs	PW	4886	3700	9589	10922	12858	8969	10129	9146	4530	8530	1738	9776	4996	7048	6710	2826	1819	17.00	6951
PCB	Total PCBs	PW	638	621	1855	2354	6788	2117	1668	1616	783	1767	172	1891	1205	1643	1443	1056	222	17.00	1638
MET	Arsenic	ELU	20.72						15.18	17.81	119			11.21	15.27	8.87	4.03	9.14		9.00	24.63
MET	Copper	ELU	54.52						45.92	155	40.02			125	62.64	64.96	46.40	69.02		9.00	73.74
MET	Lead	ELU	50.41						126	175	33.21			125	58.22	76.73	48.82	61.75		9.00	83.94
PCB	Total PCBs	ELU	83.53		3310		699		261	357	104			300	185	215	156	159		11.00	530
PST	o,p'-DDE	ELU	0.10		83.81		5.99		4.06	0.49	1.71			0.44	0.11	0.25	1.14	1.55		11.00	9.06

1 - Station-specific estimate of PRG = sediment concentration (Table A-2.1)/TEV-HQ (Table A-5).

2 - Analytes include Limiting CoCs identified in Table A-5.

3 - PW - bedded sediment exposure pathway, CoCs measured in porewater (PW); ELU- Resuspended sediment exposure pathway, CoCs measured in sediment elutriates (ELU).

4 - Baseline PRG calculated as the mean of station-specific estimates.

Table A-9 Comparison of sediment concentrations measured in URI (Quinn et al., 1994) and ERA (1997) investigations of the Derecktor Shipyard/Coddington Cove study area[1].

Class	Analyte	DSY-1	DSY-40	RPD[2]	DSY-1	DSY-41	RPD	DSY-2	DSY-28	RPD	DSY-3	DSY-29	RPD	DSY-10	DSY-41	RPD	DSY-11	DSY-31	RPD	DSY-18	DSY-28	RPD
Metals	Arsenic		9.79			11.43			8.68			12.46			11.43			10.22			9.43	
	Cadmium	0.20	0.59	-0.85	0.20	0.18	0.11	0.15	0.55	-1.13	1.00	1.45	-0.37	0.07	0.18	-0.86	0.31	0.76	-0.84	0.22	0.18	0.21
	Chromium	95.99	44.50	3.73	95.99	36.75	0.89	152	80.50	0.82	195	88.50	0.77	80.85	36.75	0.49	132	76.75	0.53	107	53.50	0.66
	Copper	45.52	29.75	0.42	45.52	9.25	1.32	187	71.75	0.93	262	158	0.50	12.47	9.25	0.30	81.46	80.75	0.01	81.87	39.25	0.70
	Lead	35.39	42.10	-0.17	35.39	17.00	0.70	181	77.70	0.80	201	186	0.08	22.13	17.00	0.26	46.09	81.00	-0.55	60.23	40.40	0.39
	Mercury		0.19			0.02			0.32	-2.00		0.50			0.02			0.40			0.14	
	Nickel	38.60	17.25	0.76	38.60	14.60	0.91	85.28	24.25	1.11	128	34.75	1.15	31.42	14.50	0.74	168	24.75	1.49	25.38	20.50	0.21
	Silver	0.60	0.21	0.95	0.60	0.07	1.61	0.02	0.51	0.46	1.27	0.79	0.47	0.56	0.07	1.59	1.22	0.51	0.82	0.18	0.19	-0.16
	Zinc	149	109	0.39	149	47.25	1.04	593	169	1.11	1231	393	1.03	63.64	47.25	0.30	1104	167	1.47	163	102	0.47
	SEM-AVS																					
PAHs	1,6,7-Trimethylnaphthalene	2.38	4.66	-0.65	2.38	0.46	1.36	10.10	8.41	0.18	51.89	27.94	0.60	1.01	0.45	0.77	9.15	7.90	0.03	1.01	4.34	-1.25
	1-Methylnaphthalene	6.84	9.41	-0.32	6.84	1.27	1.37	0.50	19.85	-1.90	9.71	50.07	-1.35		1.27		10.97	20.42	-0.60		7.83	
	1-Methylphenanthrene	27.68	38.26	-0.32	27.68	2.22	1.70	368	38.57	1.62	441	267	0.49	1.27	2.22	-0.54	51.06	32.53	0.44	228	43.54	1.36
	2,6-Dimethylnaphthalene	6.56	17.33	-0.90	6.56	2.36	0.84	7.55	34.23	-1.28	23.04	112	-1.32		2.36		12.33	34.64	-0.95		18.65	
	2-Methylnaphthalene	0	16.35	-2.00		2.01		2.47	43.87	-1.79	8.22	73.47	-1.80	0.74	2.01	-0.93	5.93	38.80	-1.37		13.86	
	Acenaphthene	18.26	16.20	0.12	18.26	1.71	1.68	83.47	17.27	1.14	193	189	0.02	2.29	1.71	0.29	20.89	17.14	0.20	14.84	12.21	0.19
	Acenaphthylene	58.88	95.65	-0.48	58.86	0.77	1.95	427	74.63	1.40	867	300	0.97	1.03	0.77	0.29	57.61	71.00	-0.21	167	83.84	0.56
	Anthracene	201	234	-0.15	201	11.10	1.79	1330	103	1.52	3360	1220	0.93	17.37	11.10	0.44	254	200	0.24	753	268	0.95
	Benzo(a)anthracene	166	234	-0.34	166	13.76	1.69	7360	294	1.85	10600	2700	1.19	26.14	13.76	0.62	274	281	-0.02	898	518	0.54
	Benzo(a)pyrene	164	317	-0.64	164	18.55	1.59	3320	377	1.59	4710	2380	0.66	38.47	18.55	0.70	206	421	-0.68	1180	434	0.93
	Benzo(b)fluoranthene	358			358			10100			9230			70.46			361			1890		
	Benzo(e)pyrene	273	333	-0.20	273	19.44	1.73	5140	362	1.74	5600	1950	0.97	40.07	19.44	0.89	257	401	-0.44	1020	365	0.95
	Benzo(g,h,i)perylene	97.41	184	-0.61	97.41	12.18	1.56	2070	247	1.57	3060	1110	0.94	29.52	12.18	0.83	132	215	-0.48	563	201	0.95
	Benzo(k)fluoranthene	224	836	-1.18	224	47.26	1.30	2070	911	0.78	1980	5350	-0.82	24.16	47.26	-0.65	245	1040	-1.24	899	999	-0.11
	Biphenyl	5.01	6.02	-0.18	5.01	0.66	1.53	12.81	12.61	0.02	40.77	29.91	0.31	0	0.66	-2.00	18.53	14.41	0.25	9.37	8.66	0.34
	Chrysene	406	444	-0.09	406	20.65	1.81	4980	364	1.73	6390	2800	0.78	47.47	20.65	0.79	538	399	0.30	1460	592	0.85
	Dibenz(a,h)anthracene	21.20	52.77	-0.85	21.20	3.18	1.48	784	66.60	1.69	1460	317	1.29	9.34	3.18	0.99	28.43	62.83	-0.76	243	81.34	1.19
	Fluoranthene	1350	773	0.30	1050	37.83	1.88	12000	458	1.85	13600	4970	0.93	94.27	37.83	0.65	1320	399	1.07	1590	686	0.79
	Fluorene	42.73	19.06	0.78	42.73	2.09	1.81	439	31.45	1.73	859	294	0.98	0.92	2.09	-0.78	74.94	28.12	0.91	92.44	53.89	0.53
	Indeno(1,2,3-cd)pyrene	98.85	105	-0.50	98.85	11.44	1.58	1720	223	1.54		1020		18.33	11.44	0.46	132	210	-0.49	529	209	0.87
	Naphthalene	9.27	21.90	-1.95	9.27	1.84	-1.49	1.97	37.54	-1.80	2.94	76.08	-1.86	1.90	1.84	0.03	11.75	45.30	-1.16		18.16	
	Perylene	57.17	78.10	-0.32	57.17	7.31	1.55	1050	133	1.55	1338	611	0.74	22.57	7.31	1.02	85.53	142	-0.39	311	133	0.80
	Phenanthrene	305	394	0.60	305	20.16	1.75	3920	223	1.79	4890	1610	1.01	21.15	20.16	0.05	392	216	0.58	627	317	0.68
	Pyrene	794	1190	-0.40	794	49.54	1.76	9390	850	1.74	10100	5300	0.62	93.92	49.54	0.62	990	846	0.16	1640	740	0.76
	Low Molecular Weight PAHs	369	478	-0.26	369	26.49	1.73	2862	502	1.37	5856	2639	0.76	26.53	26.49	0.00	528	509	0.04	1266	539	0.81
	High Molecular Weight PAHs	4013	4917	-0.20	4013	281	1.76	60994	4308	1.75	72958	30118	0.83	536	281	0.69	4951	4640	0.07	12860	5258	0.84
	Sum of PAHs	4383	5395	-0.21	4383	288	1.75	66656	4809	1.73	78812	32757	0.83	562	288	0.65	5519	5149	0.07	14126	5795	0.84
PCBs	Total PCBs (Sum Congeners x2)	67.59	84.13	-0.22	67.59	13.75	1.32	209	134	0.44	733	546	0.29	11.73	13.75	-0.16	558	221	0.99	293	98.24	0.99
Pesticides	Alpha		0.10			0.10		0.06	0.10	-0.57		0.10			0.10			0.10		0.09	0.10	-0.14
	Hexachlorobenzene		0.08			0.08		0.24	0.06	1.26	0.17	0.16	0.11		0.08			0.08		0.10	0.12	-0.12
	Mirex		0.03			0.10		0	0.17	-2.00		0.10			0.10			0.33		0.39	0.19	0.70
	p,p'-DDE	0.98	1.07	-0.09	0.98	0.40	0.84	5.71	1.67	1.09	3.81	4.96	-0.26	0.74	0.40	0.60	8.71	3.93	0.82	4.34	1.52	0.96
	p,p'-DDE	0.18	1.14	-1.44	0.18	0.08	0.82	3.13	2.03	0.42	13.61	6.29	0.74	3.46	0.08	1.91	1.45	1.95	-0.29		0.81	
TOC	% TOC	2.26	1.48	0.33	2.06	0.81	0.87	1.30	4.01	-1.02	2.63	6.09	-0.79	1.53	0.81	0.61	6.17	3.84	0.46	2.85	1.47	0.67
	All CoDs	-3.07E-01			1.35			0.69			0.37			0.33			2.72E-04			0.67		
	PRGs[4]	-4.37E-02			1.28			0.88			0.42			0.27			0.13			0.73		
	Station Separation Distance (m)	46.27			47.24			44.42			24.98			61.06			27.21			41.24		

1 - ERA Sediment data source: Table A-2.1A. URI Sediment data source: Table A-2.1B
2 - RPD = Relative Percent Difference of co-located station sediment concentrations (URI vs. ERA, respectively). See Figure 3.2-1 for station locations.
3 - CV = Coefficient of Variation of mean RPD across station pairs
4 - PRGs identified in Table 13 for aquatic exposure pathways

Table A-9 (continued). Comparison of sediment concentrations measured in URI (Quinn et al., 1994) and ERA (1997) investigations of the Derecktor Shipyard/Coddington Cove study area[1].

											All Data			Separation Distance <30m			Separation Distance >30m		
Class	Analyte	DSY-19	DSY-22	RPD	DSY-20	DSY-21	RPD	DSY-21	DSY-33	RPD	RPD Mean	RPD STDEV	RPD CV[3]	RPD Mean	RPD STDEV	RPD CV[3]	RPD Mean	RPD STDEV	RPD CV[3]
Metals	Arsenic		10.93			10.22			7.39										
	Cadmium	0.17	9.72	-1.23	0.25	0.76	-1.00	0.19	0.19	0.00	-5.95E-01	0.54	-0.90	-7.34E-01	0.33	-0.45	-0.53	0.62	-1.15
	Chromium	105	84.75	0.21	99.20	76.75	0.26	142	46.50	1.02	0.62	0.26	0.41	0.52	0.26	0.50	0.68	0.26	0.40
	Copper	68.91	66.75	0.00	79.68	80.75	-0.01	29.66	17.25	0.53	0.47	0.43	0.92	0.16	0.29	1.76	0.60	0.43	0.72
	Lead	57.82	125	-0.73	76.91	81.00	-0.05	41.83	40.00	0.04	0.08	0.49	6.37	-1.74E-01	0.33	-1.90	0.18	0.53	2.87
	Mercury		0.37			0.40			0.13										
	Nickel	22.79	25.75	-0.12	23.07	24.75	-0.07	7.91	18.25	-0.79	0.54	0.71	1.31	0.85	0.82	0.96	0.40	0.68	1.68
	Silver	0.46	0.81	-0.68	0.88	0.51	0.53	0.08	0.24	-0.97	0.46	0.88	1.87	0.61	0.19	0.31	0.40	1.04	2.61
	Zinc	139	201	-0.36	158	167	-0.06	175	72.25	0.83	0.62	0.57	0.92	0.02	0.79	0.97	0.54	0.51	0.94
	SEM AVS																		
PAHs	1 & 2-Trimethylnaphthalene		7.89		4.30	7.60	-0.59	4.19	2.04	0.69	0.13	0.83	6.56	0.01	0.59	47.07	0.18	0.97	5.31
	1-Methylnaphthalene		17.57		0	20.42	-2.00	14.95	5.11	0.98	-5.45E-01	1.33	-2.44	-1.32E+00	0.70	-0.53	0.03	1.46	44.03
	1-Methylphenanthrene	311	51.57	1.43	421	32.53	1.71	15.41	8.68	0.54	0.84	0.84	1.00	0.88	0.72	0.81	0.83	0.94	1.14
	2,6-Dimethylnaphthalene		43.59			34.64		3.04	9.91	-1.05	-7.61E-01	0.85	-1.12	-1.13E+00	0.28	-0.23	-0.57	1.02	-1.78
	2-Methylnaphthalene		32.08			36.88		20.10	9.66	0.70	-1.16E+00	0.99	-0.85	-1.49E+00	0.16	-0.11	-1.00	1.23	-1.22
	Acenaphthene		14.29		17.13	17.14	0.00	7.12	3.31	0.73	0.48	0.58	1.19	0.07	0.11	1.48	0.69	0.61	0.89
	Acenaphthylene		131		64.60	71.00	-0.06	30.23	11.85	0.87	0.59	0.80	1.36	0.22	0.85	2.92	0.77	0.85	1.11
	Anthracene	789	258	0.91	922	200	1.29	59.80	31.49	1.04	0.90	0.58	0.66	0.82	0.53	0.65	0.93	0.65	0.70
	Benzo(a)anthracene	399	388	0.03	1420	281	1.34	196	50.03	1.19	0.81	0.76	0.94	0.83	0.75	0.89	0.80	0.82	1.03
	Benzo(a)pyrene	496	495	0.00	880	421	0.71	110	87.65	0.47	0.53	0.79	1.48	0.23	0.79	3.48	0.66	0.81	1.22
	Benzo,b)fluoranthene	1000			1500			159											
	Benzo(e)pyrene	576	417	0.32	743	401	0.60	88.94	63.45	0.33	0.67	0.72	1.08	0.38	0.73	1.94	0.80	0.73	0.92
	Benzo(g,h,i)perylene	260	287	-0.10	280	215	0.26	134	59.33	0.81	0.58	0.78	1.34	0.24	0.71	2.93	0.73	0.81	1.12
	Benzo(k)fluoranthene	791	1100	-0.33	2300	1040	0.75	47.04	155	-1.07	-2.63E-01	0.92	-3.49	-4.68E-01	1.07	-2.29	-0.18	0.92	-5.27
	Biphenyl		15.37			14.41		5.62	3.18	0.55	0.10	0.98	9.72	0.26	0.04	0.14	0.04	1.17	27.10
	Chrysene	1170	491	0.82	1590	399	1.19	122	58.78	0.70	0.89	0.58	0.65	0.76	0.45	0.59	0.94	0.65	0.69
	Dibenz(a,h)anthracene	39.28	72.22	-0.59	56.80	62.93	-0.10	43.98	12.41	1.12	0.54	1.00	1.84	0.14	1.04	7.30	0.72	1.01	1.41
	Fluoranthene	1830	535	1.09	5850	399	1.74	325	85.23	1.09	1.16	0.51	0.44	1.25	0.44	0.35	1.12	0.57	0.51
	Fluorene		25.73		218	28.12	1.54	29.38	6.57	1.27	0.97	0.79	0.81	1.14	0.34	0.30	0.89	0.96	1.08
	Indeno(1,2,3-cd)pyrene	256	264	-0.03	276	218	0.24	99.71	45.31	0.75	0.49	0.77	1.58	-1.29E-01	0.52	-4.00	0.87	0.77	1.15
	Naphthalene		42.67		9.13	45.30	-1.33	2.98	10.87	-1.14	-1.34E+00	0.63	-0.47	-1.45E+00	0.35	-0.24	-1.27	0.78	-0.62
	Perylene	244	150	0.48	300	142	0.72	54.42	23.92	0.78	0.69	0.65	0.94	0.38	0.65	1.80	0.84	0.65	0.77
	Phenanthrene	550	182	1.01	1400	216	1.47	171	46.16	1.15	0.95	0.63	0.67	1.02	0.44	0.44	0.92	0.73	0.80
	Pyrene	1550	917	0.51	3820	846	1.27	373	107	1.11	0.82	0.68	0.83	0.69	0.56	0.82	0.87	0.76	0.87
	Low Molecular Weight PAHs	1110	680	0.48	1654	509	1.06	233	103	0.77	0.68	0.63	0.93	0.62	0.53	0.85	0.70	0.70	1.01
	High Molecular Weight PAHs	9212	5298	0.54	20406	4640	1.26	1923	776	0.85	0.84	0.63	0.76	0.72	0.60	0.83	0.89	0.69	0.78
	Sum of PAHs	10322	5978	0.53	22060	5148	1.24	2156	879	0.84	0.83	0.63	0.77	0.71	0.59	0.83	0.88	0.69	0.79
PCBs	Total PCBs (Sum Congeners x2)	217	201	0.07	367	221	0.50	92.31	39.93	0.78	0.50	0.52	1.03	0.59	0.38	0.61	0.46	0.60	1.29
Pesticides	Aldrin		0.10		0.18	0.10	0.56		0.10		-5.03E-02	0.57	-11.40	0.56		0.00	-0.36	0.31	-0.86
	Hexachlorobenzene	0.15	0.08	0.26	0.12	0.08	0.39	0.24	0.08	1.01	0.48	0.54	1.11	0.25	0.20	0.80	0.60	0.64	1.07
	Mirex	0.23	0.71	-1.02	0.32	0.33	-0.01	0.09	0.10	-0.14	-4.94E-01	1.04	-2.11	-8.90E-03		0.00	-0.62	1.16	-1.89
	o,p'-DDE	2.39	0.26	1.61	6.26	3.63	0.53	1.19	0.63	0.60	0.67	0.54	0.81	0.36	0.56	1.54	0.60	0.52	0.85
	p,p'-DDE	1.79	2.38	-0.28		1.95		0.76	0.42	0.58	0.31	0.99	3.24	0.22	0.73	3.26	0.33	1.13	3.37
TOC	% TOC	4.21	3.57	0.16	3.29	3.94	-0.16	1.15	1.66	-0.36	0.08	0.64	-1.57	-1.81E-01	0.63	-3.50	0.19	0.67	3.70
	All CoCs	0.17			0.45			0.52			0.36	0.72	0.79	0.24	0.52	1.98	0.42	0.78	2.49
	PRGs[4]				0.42			0.55			0.47	0.52	2.27	0.33	0.40	0.32	0.53	0.56	1.41
	Mean Separation Distance (m)	29.03			26.09			47.87											

1 - ERA Sediment data source: Table A-2.1A; URI Sediment data source: Table A-2.1B.
2 - RPD = Relative Percent Difference of co-located station sediment concentrations (URI vs. ERA, respectively). See Figure 3.2-1 for station locations
3 - CV = Coefficient of Variation of mean RPD across station pairs.
4 - PRGs identified in Table 16 for aquatic exposure pathways

Table A-10A. PRG Hazard Quotients[1] for CoCs in the aquatic exposure pathways for the Derecktor Shipyard/Coddington Cove study area:

ERA investigation.

Class	Analyte[2]	Aquatic Pathway[3]	Aquatic PRG	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
PAH	HMW PAHs	PW	6951	0.63	0.76	1.46	0.62	4.33	1.49	0.67	0.76	0.11	0.25	7.79E-03	0.47	0.28	0.22	0.23	0.71	0.04
PCB	Total PCBs	PW	1638	0.06	0.06	2.02	0.08	0.33	0.19	0.13	0.12	0.02	0.04	4.09E-03	0.07	0.06	0.04	0.04	0.05	8.40E-03
PST	o,p'-DDE	PW																		
	SUM PRG-HQ			0.68	0.82	3.48	0.70	4.67	1.68	0.80	0.88	0.14	0.29	0.01	0.54	0.34	0.25	0.27	0.76	0.05
	MAX PRG-HQ					2.02		4.33	1.49											
	MAX CoC					Total PCBs		HMW PAHs	HMW PAHs											
MET	Arsenic	ELU	24.63	0.26	0.38	0.47	0.35	0.51	0.42	0.41	0.44	0.30	0.39	0.14	0.46	0.30	0.36	0.31	0.28	0.46
MET	Copper	ELU	73.74	0.32	0.53	2.25	0.97	2.14	1.10	1.10	0.91	0.23	0.45	0.03	0.73	0.37	0.38	0.27	0.40	0.13
MET	Lead	ELU	83.94	0.43	0.48	1.80	0.93	2.21	0.95	0.96	1.49	0.48	0.57	0.17	0.94	0.68	0.74	0.64	0.50	0.20
PCB	Total PCBs	ELU	530	0.18	0.19	6.25	0.25	1.03	0.59	0.42	0.38	0.08	0.12	0.01	0.21	0.19	0.11	0.11	0.16	0.03
PST	o,p'-DDE	ELU	9.06	0.01	0.17	7.20	0.18	0.55	0.63	0.40	0.03	0.07	0.10	0.03	0.03	0.01	0.01	0.08	0.12	0.04
	SUM PRG-HQ			1.19	1.75	17.97	2.69	6.44	3.69	3.29	3.24	1.16	1.63	0.37	2.37	1.54	1.61	1.41	1.46	0.86
	MAX PRG-HQ			0.43	0.53	7.20	0.97	2.21	1.10	1.10	1.49	0.48	0.57		0.94	0.68	0.74	0.64	0.50	
	MAX PRG CoC					o,p'-DDE		Lead	Copper	Copper	Lead									

1 - Aquatic PRG-HQ = sediment CoC concentration(Table A-2.1A)/Aquatic pathway-specific Preliminary Remediation Goal (PRG) (Table 16).

2 - Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station.

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station.

3 - PW - bedded sediment exposure pathway, CoCs measured in porewater (PW); ELU- Resuspended sediment exposure pathway, CoCs measured in sediment elutriates (ELU).

Table A-10B. PRG Hazard Quotients[1] for CoCs in the aquatic exposure pathways for the Derecktor Shipyard/Coddington Cove study area:

URI Investigations.

Class	Analyte[2]	Aquatic Pathway[3]	Aquatic PRG	DSY-1	DSY-2	DSY-3	DSY-4	DSY-5	DSY-6	DSY-7	DSY-8	DSY-9	DSY-10	DSY-11	DSY-12	DSY-13	DSY-14	DSY-15	DSY-16	DSY-17	DSY-18	DSY-19
PAH	HMW PAHs	PW	6951	0.58	9.21	10.50	0.80	0.65	0.77	0.60	0.84	0.09	0.08	0.72	0.65	0.13	0.06	0.45	0.03	0.49	1.85	1.33
PCB	Total PCBs	PW	1638	0.04	0.13	0.45	0.12	0.06	0.08	0.04	0.09	0.02	0.01	0.40	0.11	0.01	0.01	0.03	0.01	0.15	0.18	0.13
PST	o,p'-DDE	PW																				
	SUM PRG-HQ			0.62	9.33	10.94	0.91	0.72	0.85	0.65	0.93	0.11	0.08	1.12	0.75	0.14	0.08	0.48	0.04	0.64	2.03	1.46
	MAX PRG-HQ				9.21	10.50								0.72							1.85	1.33
	MAX CoC				HMW PAHs	HMW PAHs															HMW PAHs	HMW PAHs
MET	Arsenic	ELU	24.63																			
MET	Copper	ELU	73.74	0.62	2.67	3.56	0.85	0.71	0.78	0.38	1.03	0.05	0.17	1.10	0.73	0.25	0.11	0.25	0.09	0.23	1.11	0.91
MET	Lead	ELU	83.94	0.42	2.15	2.40	0.61	0.52	0.58	0.38	0.60	0.18	0.26	0.55	0.55	0.42	0.34	0.50	0.38	0.39	0.72	0.69
PCB	Total PCBs	ELU	530	0.13	0.39	1.38	0.37	0.20	0.25	0.14	0.28	0.05	0.02	1.24	0.33	0.04	0.04	0.10	0.02	0.46	0.55	0.41
PST	o,p'-DDE	ELU	9.06	0.11	0.63	0.42	0.44	0.32	0.29	0.17	0.23	0.04	0.08	0.96	0.27	0.08	0.05	0.17	0	0.07	0.48	0.26
	SUM PRG-HQ			1.27	5.85	7.76	2.28	1.75	1.90	1.07	2.15	0.33	0.54	3.86	1.88	0.79	0.54	1.03	0.48	1.16	2.86	2.27
	MAX PRG-HQ			0.62	2.67	3.56	0.85	0.71	0.78	0.38	1.03			1.24	0.73			0.50		0.46	1.11	0.91
	MAX PRG CoC				Copper	Copper					Copper			PCBs							Copper	

1 - Aquatic PRG-HQ = sediment CoC concentration(Table A-2.1B)/Aquatic pathway-specific Preliminary Remediation Goal (PRG) (Table 16).

2 - Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station.

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station.

3 - PW - bedded sediment exposure pathway, CoCs measured in porewater (PW); ELU- Resuspended sediment exposure pathway, CoCs measured in sediment elutriates (ELU).

Table A-10B (continued). PRG Hazard Quotients[1] for CoCs in the aquatic exposure pathways for the Derecktor Shipyard/Coddington Cove study area:

URI Investigations.

Class	Analyte[2]	Aquatic Pathway[3]	Aquatic PRG	DSY-20	DSY-21	DSY-22	DSY-23	DSY-24
PAH	HMW PAHs	PW	6951	2.94	0.28	0.47	0.03	0.49
PCB	Total PCBs	PW	1638	0.22	0.06	0.11	0.01	0.15
PST	o,p'-DDE	PW						
	SUM PRG-HQ			3.16	0.33	0.58	0.04	0.64
	MAX PRG-HQ			2.94				
	MAX CoC			HMW PAHs				
MET	Arsenic	ELU	24.63					
MET	Copper	ELU	73.74	1.08	0.40	0.70	0.09	0.23
MET	Lead	ELU	83.94	0.92	0.50	0.63	0.38	0.39
PCB	Total PCBs	ELU	530	0.69	0.17	0.34	0.02	0.46
PST	o,p'-DDE	ELU	9.06	0.69	0.13	0.28	0	0.07
	SUM PRG-HQ			3.38	1.20	1.94	0.48	1.16
	MAX PRG-HQ			1.08	0.50	0.70		0.46
	MAX PRG CoC			Copper				

1 - Aquatic PRG-HQ = sediment CoC concentration(Table A-2.1B)/Aquatic pathway-specific Preliminary Remediation Goal (PRG) (Table 16).

2 - Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station.
Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station.

3 - PW - bedded sediment exposure pathway, CoCs measured in porewater (PW); ELU- Resuspended sediment exposure pathway, CoCs measured in sediment elutriates (ELU).

Table A-11A PRG Hazard Quotients[1] for CoCs in the avian predator exposure pathway for the Derecktor Shipyard/Coddington Cove study area.

ERA investigation.

Class	Analyte[2]	AV-PRG	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
MET	Arsenic	17.09	0.37	0.55	0.68	0.51	0.73	0.60	0.60	0.64	0.43	0.57	0.20	0.66	0.43	0.52	0.44	0.40	0.67
MET	Copper	184	0.13	0.21	0.90	0.39	0.86	0.44	0.44	0.36	0.09	0.18	0.01	0.29	0.15	0.15	0.11	0.16	0.05
MET	Lead	622000	5.77E-05	6.50E-05	2.42E-04	1.25E-04	2.99E-04	1.29E-04	1.30E-04	2.01E-04	6.43E-05	7.85E-05	2.25E-05	1.27E-04	9.15E-05	1.00E-04	8.68E-05	6.77E-05	2.73E-05
MET	Silver	2342	1.12E-04	8.00E-05	2.94E-04	2.19E-04	3.36E-04	3.15E-04	2.19E-04	3.47E-04	1.01E-04	1.23E-04	2.77E-05	2.40E-04	1.65E-04	6.94E-05	1.12E-04	9.07E-05	2.77E-05
MET	Zinc	118	0.94	0.86	4.65	1.44	3.34	1.64	1.42	1.71	0.61	0.90	0.24	1.23	0.79	0.93	0.83	0.85	0.40
PCB	Total PCBs	92.82	1.01	1.06	35.66	1.44	5.89	3.40	2.38	2.16	0.43	0.70	0.07	1.22	1.08	0.64	0.63	0.91	0.15
	SUM PRG-HQ		2.44	2.69	41.90	3.78	10.81	6.08	4.84	4.88	1.57	2.34	0.52	3.40	2.45	2.24	2.01	2.32	1.27
	MAX PRG-HQ		1.01	1.06	35.66	1.44	5.89	3.40	2.38	2.16				1.23	1.08				
	MAX PRG CoC		Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs				Zinc	Total PCBs				

1 - Avian PRG-HQ = sediment CoC concentration (Table A-2 1)/Avian (HQ=1) Preliminary Remediation Goal (PRG) (Table 16).

2 Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station.

Table A-11B. PRG Hazard Quotients[1] for CoCs in the avian predator exposure pathway for the Derecktor Shipyard/Coddington Cove study area.

URI Investigation.

Class	Analyte[2]	AV-PRG	DSY-1	DSY-2	DSY-3	DSY-4	DSY-5	DSY-6	DSY-7	DSY-8	DSY-9	DSY-10	DSY-11	DSY-12	DSY-13	DSY-14	DSY-15	DSY-16
MET	Arsenic	17.09																
MET	Copper	184	0.25	1.07	1.43	0.34	0.28	0.31	0.15	0.41	0.02	0.07	0.44	0.29	0.10	0.04	0.10	0.03
MET	Lead	622000	5.69E-05	2.91E-04	3.23E-04	8.26E-05	6.96E-05	7.81E-05	5.10E-05	8.14E-05	2.39E-05	3.56E-05	7.41E-05	7.39E-05	5.66E-05	4.65E-05	6.76E-05	5.07E-05
MET	Silver	2342	2.56E-04	3.51E-04	5.41E-04	5.88E-03	9.91E-04	6.80E-04	2.31E-03	7.42E-04	3.13E-04	2.41E-04	5.23E-04	6.75E-04	2.72E-05	2.27E-05	2.28E-05	2.02E-05
MET	Zinc	118	1.27	5.04	10.47	1.61	1.47	1.49	1.01	1.57	0.50	0.54	9.39	1.37	0.76	0.57	0.71	0.41
PCB	Total PCBs	92.82	0.73	2.25	7.90	2.10	1.14	1.42	0.79	1.60	0.30	0.13	7.09	1.90	0.24	0.25	0.59	0.10
	SUM PRG-HQ		2.25	8.37	19.80	4.05	2.89	3.23	1.95	3.58	0.83	0.74	16.92	3.56	1.10	0.86	1.40	0.55
	MAX PRG-HQ		1.27	5.04	10.47	2.10	1.47	1.49	1.01	1.60			9.39	1.90				
	MAX PRG CoC		Zinc	Zinc	Zinc	Total PCBs	Zinc	Zinc	Zinc	Total PCBs			Zinc	Total PCBs				

1 - Avian PRG-HQ = sediment CoC concentration (Table A-2.1)/Avian (HQ=1) Preliminary Remediation Goal (PRG) (Table 16).

2 - Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station.

Table A-11B (continued). PRG Hazard Quotients[1] for CoCs in the avian predator exposure pathway for the Shipyard/Coddington Cove study area.

URI investigation.

Class	Analyte[2]	DSY-17	DSY-18	DSY-19	DSY-20	DSY-21	DSY-22	DSY-23	DSY-24
MET	Arsenic								
MET	Copper	0.09	0.44	0.36	0.43	0.16	0.28	0.27	0.08
MET	Lead	5.29E-05	9.68E-05	9.30E-05	1.24E-04	6.73E-05	8.44E-05	8.71E-05	6.29E-05
MET	Silver	2.28E-05	6.79E-05	1.71E-04	3.77E-04	3.51E-05	5.22E-05	5.22E-05	2.36E-05
MET	Zinc	0.61	1.39	1.19	1.34	1.49	1.21	1.19	0.83
PCB	Total PCBs	2.63	3.15	2.33	3.95	0.99	1.92	1.62	0.28
	SUM PRG-HQ	3.33	4.99	3.88	5.73	2.64	3.41	3.08	1.19
	MAX PRG-HQ	2.63	3.15	2.33	3.95	1.49	1.92	1.62	
	MAX PRG CoC	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Zinc	Total PCBs	Total PCBs	

1 - Avian PRG-HQ = sediment CoC concentration (Table A-2.1)/Avian (HQ=1) Preliminary Remediation Goal (PRG) (Table 16).

2 - Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station.

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station

Table A-12A. PRG Hazard Quotients[1] for CoCs in the human health exposure pathway for the Derecktor Shipyard/Coddington Cove study area.

ERA investigation.

Class	Analyte[2]	HH-PRG	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
MET	Arsenic	19.74	0.32	0.48	0.59	0.44	0.63	0.52	0.52	0.55	0.37	0.49	0.17	0.57	0.38	0.45	0.38	0.34	0.58
PAH	Benzo(a)pyrene	53.92	7.34	8.05	17.14	7.00	44.14	15.06	7.80	9.17	1.26	2.74	0.08	5.92	3.04	2.22	2.65	5.87	0.34
	SUM PRG-HQ		7.66	8.53	17.72	7.44	44.77	15.58	8.32	9.73	1.63	3.23	0.25	6.49	3.41	2.68	3.04	6.22	0.92
	MAX PRG-HQ		7.34	8.05	17.14	7.00	44.14	15.06	7.80	9.17	1.26	2.74		5.92	3.04	2.22	2.65	5.87	
	MAX PRG CoC		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	

1 - Human Health PRG-HQ = sediment CoC concentration(Table A-2.1)/HH (HQ=1) Preliminary Remediation Goal (PRG) (Table 16).

2 - Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station.

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station.

Table A-12B. PRG Hazard Quotients[1] for CoCs in the human health exposure pathway for the Derecktor Shipyard/Coddington Cove study area.

URI Investigation.

Class	Analyte[2]	HH-PRG	DSY-1	DSY-2	DSY-3	DSY-4	DSY-5	DSY-6	DSY-7	DSY-8	DSY-9	DSY-10	DSY-11	DSY-12	DSY-13	DSY-14	DSY-15	DSY-16	DSY-17	DSY-18	DSY-19	DSY-20	DSY-21	DSY-22	DSY-23	DSY-24
MET	Arsenic	19.74																								
PAH	Benzo(a)pyrene	53.92	3.04	61.57	87.35	8.00	7.45	9.06	5.60	8.92	0.91	0.71	3.83	4.61	0.81	0.48	4.54	0.22	5.76	22.07	9.20	16.33	2.03	3.38	4.44	1.01
	SUM PRG-HQ		3.04	61.57	87.35	8.00	7.45	9.06	5.60	8.92	0.91	0.71	3.83	4.61	0.81	0.48	4.54	0.22	5.76	22.07	9.20	16.33	2.03	3.38	4.44	1.01
	MAX PRG-HQ		3.04	61.57	87.35	8.00	7.45	9.06	5.60	8.92			3.83	4.61			4.54		5.76	22.07	9.20	16.33	2.03	3.38	4.44	1.01
	MAX PRG CoC		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene			Benzo(a) pyrene	Benzo(a) pyrene			Benzo(a) pyrene		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene

1 Human Health PRG-HQ = sediment CoC concentration(Table A-2.1)/HH (HQ=1) Preliminary Remediation Goal (PRG) (Table 16).

2 Sum PRG-HQ = sum of PRG-HQs for all analytes at a given station

Max PRG-HQ = maximum PRG-HQs observed for all analytes at a given station

Table A-13. Summary of maximum PRG-HQs and identification of Limiting CoCs by sampling location for aquatic, avian, and human health exposure pathways for the Derecktor Shipyard study area.

Exposure Pathway	*Parameter*	DSY-1	DSY-2	DSY-3	DSY-4	DSY-5	DSY-6	DSY-7	DSY-8	DSY-9	DSY-10	DSY-11	DSY-12	DSY-13	DSY-14	DSY-15	DSY-16
Aquatic (A-B)	*PRG-HQ1,2*		9.21	10.50								0.72					
Bedded Sediment	*L-CoC*		HMW PAHs	HMW PAHs													
Aquatic (A-R)	*PRG-HQ1,2*	0.62	2.67	3.56	0.85	0.71	0.78	0.38	1.03			1.24	0.73			0.50	
Resuspended Sediment	*L-CoC*		Copper	Copper					Copper			Total PCBs					
Avian Predator (P)	*PRG-HQ1,3*	1.27	5.04	10.47	2.10	1.47	1.49	1.01	1.60			9.39	1.90				
	L-CoC	Zinc	Zinc	Zinc	Total PCBs	Zinc	Zinc	Zinc	Total PCBs			Zinc	Total PCBs				
Human Health (HH)	*PRG-HQ1,4*	3.04	61.57	87.35	8.00	7.45	9.06	5.60	8.92			3.83	4.61			4.54	
	L-CoC	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene			Benzo(a) pyrene	Benzo(a) pyrene			Benzo(a) pyrene	
Combined	*PRG-HQ 1,5*	3.04	61.57	87.35	8.00	7.45	9.06	5.60	8.92			3.83	4.61			4.54	
Exposure	*L-CoC*	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene			Benzo(a) pyrene	Benzo(a) pyrene			Benzo(a) pyrene	
Pathway	*Pathway*	HH	HH	HH	HH	HH	HH	HH	HH			HH	HH			HH	

PRG-HQ=Preliminary Remediation Goal Hazard Quotient. L-CoC=Limiting Chemical of Concern. See text, Section 1.0. PRG-HQs<1 not reported.

1 - PRG-HQ = analyte pathway-specifc concentration/analyte-pathway-specific TEV value.

2 - Values presented are maximum of Aquatic PRG-HQs by station. Complete PRG-HQ values presented in Tables A-10A and A-10B.

3 - Values presented are maximum of Avian Predator PRG-HQs by station. Complete PRG-HQ values presented in Table A-11A and A-11-B.

4 - Values presented are maximum of Human Health PRG-HQs by station. Complete PRG-HQ values presented in Table A-12A and A-12B.

5 - Values presented are maximum of individual exposure pathway PRG-HQs by station.

Table A-13 (continued). Summary of maximum PRG-HQs and identification of Limiting CoCs by sampling location for aquatic, avian, and human health exposure pathways for the Derecktor Shipyard study area.

Exposure Pathway	Parameter	DSY-17	DSY-18	DSY-19	DSY-20	DSY-21	DSY-22	DSY-23	DSY-24	DSY-25	DSY-26	DSY-27	DSY-28	DSY-29	DSY-30	DSY-31	DSY-32
Aquatic (A-B)	PRG-HQ1,2		1.85	1.33	2.94							2.02		4.33	1.49		
Bedded Sediment	L-CoC		HMW PAHs	HMW PAHs	HMW PAHs							Total PCBs		HMW PAHs	HMW PAHs		
Aquatic (A-R)	PRG-HQ1,2	0.46	1.11	0.91	1.08	0.50	0.70		0.46	0.43	0.53	7.20	0.97	2.21	1.10	1.10	1.49
Resuspended Sediment	L-CoC		Copper		Copper							o,p'-DDE		Lead	Copper	Copper	Lead
Avian Predator (P)	PRG-HQ1,3	2.63	3.15	2.33	3.95	1.49	1.92	1.62		1.01	1.06	35.66	1.44	5.89	3.40	2.38	2.16
	L-CoC	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Zinc	Total PCBs	Total PCBs		Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs	Total PCBs
Human Health (HH)	PRG-HQ1,4	5.76	22.07	9.20	16.33	2.03	3.38	4.44	1.01	7.34	8.05	17.14	7.00	44.14	15.06	7.80	9.17
	L-CoC	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene
Combined	PRG-HQ 1,5	5.76	22.07	9.20	16.33	2.03	3.38	4.44	1.01	7.34	8.05	17.14	7.00	44.14	15.06	7.80	9.17
Exposure	L-CoC	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene
Pathway	Pathway	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH

PRG-HQ=Preliminary Remediation Goal Hazard Quotient. L-CoC=Limiting Chemical of Concern. See text, Section 1.0. PRG-HQs<1 not reported.

1 - PRG-HQ = analyte pathway-specifc concentration/analyte-pathway-specific TEV value.

2 - Values presented are maximum of Aquatic PRG-HQs by station. Complete PRG-HQ values presented in Tables A-10A and A-10B.

3 - Values presented are maximum of Avian Predator PRG-HQs by station. Complete PRG-HQ values presented in Table A-11A and A-11-B.

4 - Values presented are maximum of Human Health PRG-HQs by station. Complete PRG-HQ values presented in Table A-12A and A-12B.

5 - Values presented are maximum of individual exposure pathway PRG-HQs by station.

Table A-13 (continued). Summary of maximum PRG-HQs and identification of Limiting CoCs by sampling location for aquatic, avian, and human health exposure pathways for the Derecktor Shipyard study area.

Exposure Pathway	*Parameter*	DSY-33	DSY-34	DSY-35	DSY-36	DSY-37	DSY-38	DSY-39	DSY-40	DSY-41
Aquatic (A-B)	*PRG-HQ1,2*									
Bedded Sediment	*L-CoC*									
Aquatic (A-R)	*PRG-HQ1,2*	0.48	0.57		0.94	0.68	0.74	0.64	0.50	
Resuspended Sediment	*L-CoC*									
Avian Predator (P)	*PRG-HQ1,3*				1.23	1.08				
	L-CoC				Zinc	Total PCBs				
Human Health (HH)	*PRG-HQ1,4*	1.26	2.74		5.92	3.04	2.22	2.65	5.87	
	L-CoC	Benzo(a) pyrene	Benzo(a) pyrene		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	
Combined	*PRG-HQ 1,5*	1.26	2.74		5.92	3.04	2.22	2.65	5.87	
Exposure	*L-CoC*	Benzo(a) pyrene	Benzo(a) pyrene		Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	Benzo(a) pyrene	
Pathway	*Pathway*	HH	HH		HH	HH	HH	HH	HH	

PRG-HQ=Preliminary Remediation Goal Hazard Quotient. L-CoC=Limiting Chemical of Concern. See text, Section 1.0. PRG-HQs<1 not reported.

1 - PRG-HQ = analyte pathway-specifc concentration/analyte-pathway-specific TEV value.

2 - Values presented are maximum of Aquatic PRG-HQs by station. Complete PRG-HQ values presented in Tables A-10A and A-10B.

3 - Values presented are maximum of Avian Predator PRG-HQs by station. Complete PRG-HQ values presented in Table A-11A and A-11-B.

4 - Values presented are maximum of Human Health PRG-HQs by station. Complete PRG-HQ values presented in Table A-12A and A-12B.

5 - Values presented are maximum of individual exposure pathway PRG-HQs by station.

Confirmation

Expense report number 90033 for 23.43 has been submitted to Ostrofsky, Arnold N (Arnold) for approval.

Expense Report 90033

Hint:Use your browser navigation to exit the printable page view of this page.

Submission Instructions

Your manager (or specified approver) will be notified requesting approval for this expense report. Upon approval, a notification will be sent to you and Accounts Payable. This expense report will be paid after it has been approved, and Accounts Payable verifies the receipts.

General Information

Name	Fellows-Swenson, Chelsea B. (Chelsea) (521318)	Report Submit Date	09-MAR-2007
		Attachments	None
Expense Dates	23-FEB-2007 - 23-FEB-2007	Report Total	23.43 USD
Cost Center	101003	Reimbursement Amount	23.43 USD
Purpose	Field Equipment		
Approver	Ostrofsky, Arnold N (Arnold)		
Receipts Status	Required		

Expense Details Weekly Summary Approval Notes [0]

Business Expenses

Cash Expenses

Date	Receipt Amount	Exchange Rate	Expense Type	Justification	Expense Location	Merchant Name	Project Number	Task Number	Receipt Required	Receipt Missing	Reimbursable Amount (USD)	Details	Att
23-Feb-2007	23.43 USD	1	Field Supplies	Needed a clipboard, with a cover, for field work			112G00033	0000.1804	✔		23.43		
										Total	23.43		

Expense Details Weekly Summary Approval Notes [0]

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APPENDIX C

COST ESTIMATES FOR SELECTED REMEDIAL ALTERNATIVES

PRESENT WORTH
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 1
Newport, Rhode Island

YEAR	PRESENT WORTH FACTOR	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT VALUE
0	1.000	$0			$0
1	0.971		$0		$0
2	0.943		$0		$0
3	0.915		$0		$0
4	0.888		$0		$0
5	0.863		$0	$24,000	$20,703
6	0.837		$0		$0
7	0.813		$0		$0
8	0.789		$0		$0
9	0.766		$0		$0
10	0.744		$0	$24,000	$17,858
11	0.722		$0		$0
12	0.701		$0		$0
13	0.681		$0		$0
14	0.661		$0		$0
15	0.642		$0	$24,000	$15,405
16	0.623		$0		$0
17	0.605		$0		$0
18	0.587		$0		$0
19	0.570		$0		$0
20	0.554		$0	$24,000	$13,288
21	0.538		$0		$0
22	0.522		$0		$0
23	0.507		$0		$0
24	0.492		$0		$0
25	0.478		$0	$24,000	$11,463
26	0.464		$0		$0
27	0.450		$0		$0
28	0.437		$0		$0
29	0.424		$0		$0
30	0.412		$0	$24,000	$9,888
				TOTAL PRESENT WORTH =	$88,604

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.

Tetra Tech NUS, Inc.			*Calculation Sheet*
Client: Navy CLEAN	File No. 5340	**By:** AC	**Page** 1 of 1
Subject: Assumptions and Cost Basis, Derecktor Shipyard/Coddington Cove Revised FS, Alt-1, CTO 26		**Checked by:** SP	**Date:** 3/13/2007

Alternative 1: No Action

ASSUMPTIONS:

1. 5-year reviews at 200 LOE @ $105/hr. Approx. $3000 ODCs. Total = $ 24,000 per event. Reviews to occur in years 5, 10, 15, 20, 25, and 30.

CAPITAL COSTS
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 2
Newport, Rhode Island

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE
1.0 Long-Term Monitoring						
1.1	Prepare work plan	1	LS	$45,000	$45,000	see cost assumptions
2.0 Access Restriction & Institutional Control						
2.1	Purchase & install buoys	6	LS	$2,000	$12,000	see cost assumptions
2.2	Purchase & install warning placards	2	LS	$1,200	$2,400	see cost assumptions
2.3	Institute shellfish & lobster collection ban	1	LS	$12,000	$12,000	see cost assumptions
				Subtotal	**$26,400**	
				TOTAL DIRECT COSTS	**$71,400**	
3.0 Other Costs						
3.1	Project Management (6% of direct costs)				$1,584	OSWER 9355.0-75
				TOTAL OTHER COSTS	**$1,584**	
				TOTAL CAPITAL COST	**$72,984**	

Notes:
Means 2006 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2006.
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).

OPERATIONS/MAINTENANCE COSTS (ANNUAL)
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 2
Newport, Rhode Island

DESCRIPTION		UNIT	UNIT COST	QUANTITY	TOTAL COST	SOURCE
OM 1.0	**Long-Term Monitoring (annually)**					
OM 1.1	Total Labor + ODCs	EA	$73,710	1	$73,710	see cost assumptions
OM 1.2	Analytical Costs	EA	$48,600	1	$48,600	see cost assumptions
				Subtotal	**$122,310**	
OM 2.0	**Access Restriction & Institutional Control**					
OM 2.1	Maintenance of 6 Buoy Moorings/Tethers (years 2, 4, 6, 8, 10)	LS	$1,200	1	$1,200	see cost assumptions
OM 2.2	Maintenance of 6 Buoys (years 5 and 10 only)	LS	$3,000	1	$3,000	see cost assumptions
OM 2.3	Collection Ban Notification (annually)	LS	$500	1	$500	see cost assumptions
OM 2.4	RIDEM Collection Ban Enforcement (annually)	LS	$480	1	$480	see cost assumptions

ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE (YEARS 1, 3, 7, 9)	**$123,290**
ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE (YEARS 2, 4, 6, 8)	**$124,490**
ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE (YEAR 5)	**$126,290**
ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE (YEAR 10)	**$127,490**

PRESENT WORTH
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 2
Newport, Rhode Island

Year	Capital	O&M	5-Yr Review	Total	Discount Rate	Present Value
0	$72,984	$0	$0	$72,984	2.8%	$72,984
1	$0	$123,290	$0	$123,290	2.8%	$119,932
2	$0	$124,490	$0	$124,490	2.8%	$117,801
3	$0	$123,290	$0	$123,290	2.8%	$113,488
4	$0	$124,490	$0	$124,490	2.8%	$111,471
5	$0	$126,290	$24,000	$150,290	2.8%	$130,907
6	$0	$124,490	$0	$124,490	2.8%	$105,481
7	$0	$123,290	$0	$123,290	2.8%	$101,619
8	$0	$124,490	$0	$124,490	2.8%	$99,814
9	$0	$123,290	$0	$123,290	2.8%	$96,159
10	$0	$127,490	$24,000	$151,490	2.8%	$114,935
TOTAL	**$72,984**	**$1,244,900**	**$48,000**	**$1,365,884**	**TOTAL PV**	**$1,184,591**
					PV O&M	**$1,111,607**

Discount rate of 2.8% = 10-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.

The present value of Alternative 2 is calculated for a ten year period. Refer to text Sections 4.2.2 and 5.2.2 for rationale.

Alternative 2: Limited Action

ASSUMPTIONS:

1. Long-term Monitoring Elements:

   - Prepare UFP-compliant work plan for long-term monitoring = $45,000.

   Samples/event (1 event annually) –
   - Sediment chemistry (PCBs, PAHs, metals, Simultaneously Extracted Metals/Acid Volatile Sulfides (SEM/AVS)); 8 samples plus 2 QC samples
   - Elutriate chemistry (PCBs, PAHs, metals; 8 samples plus 2 QC samples)
   - Biota chemistry 8 samples for lobster and bivalves, plus 2 QC samples each (PCBs, PAHs, metals);
     - Toxicity Amphipod; 10 samples
     - Toxicity Arabacia; 10 samples

   Labor and ODCs for sampling, management, validation, reporting:

   - Sediment sampling: Sample collection equipment and crew = approximately $956/sample. Collection of 10 sediment/elutriate samples = $9560
   - Biota sampling : Sample collection by scuba divers including equipment and crew = approximately $1150/sample. Collection of 20 samples = $23,000
   - Proj. mgmt/coord: 30 hours/year @ $110/hr = $3,300
   - M&IE @$500; ODCs & supplies @ $300; shipping @ $300 = total other $1,100.
   - Data Management and Validation $12,000.
   - Report prep. $24,750.

   Total Labor + ODCs ≅ $73,710 annually for years 1-10

   Estimated analytical costs:

   - Sediment chemistry (PCBs, PAHs, metals, SEM/AVS) $1,020/sample @10 samples/yr = $10,200
   - Elutriate chemistry (PCBs, PAHs, metals) $1,020/sample @10 samples/yr = $10,200
   - Biota chemistry (PCBs, PAHs, metals) @ $1,020/sample @ 10 samples/yr = $10,200
   - Toxicity Amphipod @ $1,200/sample @ 10 samples/yr = $12,000
   - Toxicity Arabacia @ $600/sample @ 10 samples/yr = $6,000

   Total Analytical ≅ $48,600 annually for years 1-10

2. Access Restriction and Institutional Control

   - Installation of six buoys USCG fifth class: steel buoys 8' tall and 2' diameter warning "cans" purchase and install at $2,000 each for a total of 12,000.
   - Purchase of two warning placards 6'x6' stating access restriction and installation at outermost point of Piers 1 and 2, at $1,200 each or $2,400.
   - Maintenance of buoy moorings and tethers of $200 each buoy (6 buoys) every two years for 10 years = $1200 each event ($6,000 total).
   - Maintenance of 6 buoys at $500 each buoy every 5 years for 10 years = $3000 each event ($6,000 total).

- Institution of ban on shellfish and lobster collection within described area: Legal action to institute use restriction, fact sheets, public meetings, other outreach efforts: lump sum of $12,000.
- Description of area on permit paperwork distributed with collection permits, posting at local water access points and fishing piers annually for 10 years: $500 per year
- RIDEM fisheries enforcement visits after notification of trespass and suspicious activity by NETC police: 2 events per year requiring 2 officers, one boat and miscellaneous equipment for one hour on each visit: $240 per visit = $480 per year

3. 5-year reviews at 200 LOE @ $105/hr. Approx. $3,000 ODCs. Total = $24,000 per event
Reviews to occur in years 5 and 10.

CAPITAL COSTS
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE
1.0 Pre-Design Investigation						
1.1	Prepare UFP-compliant work plan	1	LS	$28,000	$28,000	See assumptions
1.2	Sediment borings and analyses	1	LS	$343,315	$343,315	See assumptions
1.3	Bench Scale Treatability Study	1	LS	$60,000	$60,000	See assumptions
1.4	Wetlands & Habitat Evaluation	1	LS	$50,500	$50,500	See assumptions
1.5	Bathymetry Study	1	LS	$25,000	$25,000	See assumptions
				Subtotal	**$478,815**	
2.0 Mobilization/Demobilization						
2.1	Office Trailer (1 ea)	7	MO	$400	$2,800	Historical data
2.2	Storage Trailer (1 ea)	5	MO	$300	$1,500	Historical data
2.3	Personnel Decon. Trailer	7	MO	$100	$700	Vendor catalog
2.4	PPE rolloff cont.	7	MO	$50	$350	Historical data
2.5	Portable Communication Equipment	8	SETS	$400	$3,200	Historical data
2.6	Equipment Mobilization/Demobilization	1	LS	$35,000	$35,000	Historical data
2.7	Site Utility Hook-ups (elec., phone, etc.)	1	LS	$3,000	$3,000	Historical data
2.8	Site Utilities	7	MO	$3,000	$21,000	Historical data
2.9	Vehicles and Equipment	7	MO	$3,300	$23,100	Historical data
2.10	Certification/Close-out Reports	1	LS	$27,000	$27,000	Historical data
				Subtotal	**$117,650**	
3.0 Dredging/Capping/Water Treatment						
3.1	Erosion control, silt boom	5,000	LF	$25	$125,000	Historical data
3.2	Mob/Demob (barge and pier based equip.)	1	LS	$217,880	$217,880	Vendor Info.
3.3	Prep., maint., and removal of staging area	1	LS	$40,000	$40,000	Vendor Info.
3.4	Dredge sediments	23,819	CY	$45	$1,063,757	Vendor Info.
3.5	Install permeable cap	27,200	CY	$55	$1,496,000	Vendor Info.
3.6	Treatment of dredge water	60	DAY	$5,900	$354,000	Vendor Info.
3.7	Sediment confirmation testing	40	EA	$1,620	$64,800	Historical data
3.8	Water Quality Testing	60	DAY	$4,700	$282,000	Historical data
3.9	Analysis of Sediment Prior to Transport	55	EA	$1,000	$55,000	Vendor Info.
3.10	Transport/Disposal	23,819	CY	$20	$476,380	Vendor Info.
3.11	Miscellaneous Solid Waste Disposal (landfill)	300	TN	$110	$33,000	Vendor Info.
				Subtotal	**$4,207,817**	
4.0 Long-Term Monitoring						
4.1	Prepare work plan	1	LS	$45,000	$45,000	see cost assumptions
				TOTAL DIRECT COSTS	**$4,849,282**	
5.0 Other Costs						
5.1	Project Management (6% of direct costs)				$290,957	OSWER 9355.0-75
5.2	Engineering and Design (12% direct costs)				$581,914	OSWER 9355.0-75
5.3	Construction management (8% of direct costs)				$387,943	OSWER 9355.0-75
5.4	Location Adjustment (9%)				$436,435	Means 2004 ER
5.5	Contingency (20%)				$969,856	OSWER 9355.0-75
				TOTAL OTHER COSTS	**$2,667,105**	
				TOTAL CAPITAL COST	**$7,516,386**	

Notes:

Means 2007 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2007.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).

OPERATIONS/MAINTENANCE COSTS
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE
OM 1.0 Long-Term Monitoring (annually)						
OM 1.1	Total Non-Analytical Costs	1	EA	$172,110	$172,110	see cost assumptions
OM 1.2	Analytical Costs	1	EA	$48,600	$48,600	see cost assumptions
				Subtotal	**$220,710**	
OM 2.0 Cap Inspections & Maintenance						
OM 2.1	Cap Inspections (twice per year)	2	DAY	$3,500	$7,000	see cost assumptions
OM 2.2	Cap Repairs (5% per year)	1360	CY	$55	$74,800	see cost assumptions
				Subtotal	**$81,800**	
ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE					**$302,510**	

PRESENT WORTH
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

Year	Capital	O&M	5-Yr Review	Total	Discount Rate	Present Value
0	$7,516,386	$0	$0	$7,516,386	3.0%	$7,516,386
1	$0	$302,510	$0	$302,510	3.0%	$302,510
2	$0	$302,510	$0	$302,510	3.0%	$293,699
3	$0	$302,510	$0	$302,510	3.0%	$285,145
4	$0	$302,510	$0	$302,510	3.0%	$276,840
5	$0	$302,510	$0	$302,510	3.0%	$260,948
6	$0	$302,510	$24,000	$326,510	3.0%	$273,447
7	$0	$302,510	$0	$302,510	3.0%	$245,968
7	$0	$302,510	$0	$302,510	3.0%	$245,968
8	$0	$302,510	$0	$302,510	3.0%	$238,804
9	$0	$302,510	$0	$302,510	3.0%	$231,849
10	$0	$302,510	$24,000	$326,510	3.0%	$242,954
11	$0	$302,510	$0	$302,510	3.0%	$218,540
12	$0	$302,510	$0	$302,510	3.0%	$212,174
13	$0	$302,510	$0	$302,510	3.0%	$205,995
14	$0	$302,510	$0	$302,510	3.0%	$199,995
15	$0	$302,510	$24,000	$326,510	3.0%	$209,574
16	$0	$302,510	$0	$302,510	3.0%	$188,514
17	$0	$302,510	$0	$302,510	3.0%	$183,024
18	$0	$302,510	$0	$302,510	3.0%	$177,693
19	$0	$302,510	$0	$302,510	3.0%	$172,517
20	$0	$302,510	$24,000	$326,510	3.0%	$180,781
21	$0	$302,510	$0	$302,510	3.0%	$162,614
22	$0	$302,510	$0	$302,510	3.0%	$157,878
23	$0	$302,510	$0	$302,510	3.0%	$153,279
24	$0	$302,510	$0	$302,510	3.0%	$148,815
25	$0	$302,510	$24,000	$326,510	3.0%	$155,943
26	$0	$302,510	$0	$302,510	3.0%	$140,272
27	$0	$302,510	$0	$302,510	3.0%	$136,187
28	$0	$302,510	$0	$302,510	3.0%	$132,220
29	$0	$302,510	$0	$302,510	3.0%	$128,369
30	$0	$302,510	$24,000	$326,510	3.0%	$134,518
TOTAL	**$7,516,386**	**$9,377,810**	**$144,000**	**$17,038,196**	**TOTAL PV**	**$13,813,419**
					PV O&M	**$6,297,033**

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.

Alternative 3: Capping and Removal/Off-Base Disposal

ASSUMPTIONS:

CAPITAL COST ITEMS:

1. Pre-Design Investigation

   - Prepare UFP-compliant work plan = $28,000.

   - Sediment sampling to further determine the grain size and nature of the sediments and delineate lateral and vertical extent of contaminants exceeding the PRGs. Assume 34 soil borings with samples in one foot intervals to a maximum 3-foot depth (102 samples) and 15 surface samples. All samples analyzed for PCBs, PAHs, Metals and geotechnical testing.
     - Mob./demob. @ $17,500.
     - Sample collection of 102 samples (from borings) @ $1,040 each and 15 surface samples @ $600 each = $115,080.
     - Analytical @ $1130/sample for 117 samples ($132,210).
     - Data validation $22,275.
     - Reporting @ $40,000.
     - Oversight and management @ $16,250.
     - Total costs = $343,315.

   - Bench-scale treatability study to determine method to dewater dredged sediment and necessary treatment for the water generated as a result of dewatering of these dredged sediments. Assume the study will include preparation of a work plan detailing the planned study; sample collection; shipment of sample for testing; treatability testing to be conducted by one person for approximately one week (to include solids separation, metals precipitation, and carbon absorption); analysis of associated water samples for metals, PAHs, and PCBs; and preparation of a report summarizing the results of the testing. Total cost is estimated at $60,000.

   - Review of existing information and additional field investigations to identify and evaluate habitats and wetlands that will or may be impacted by the alternative. Review of existing information - $5,000, biologist inspection of the seafloor to be dredged (five dives for each area to be dredged) - $25,500, evaluation report - $20,000. Total cost is estimated at $50,500.

   - Bathymetry study in vicinity of stations 3 and 29 to better understand seafloor contours. Assume the study will include preparation of a work plan detailing the planned study; diver inspection of seafloor (five dives); and evaluation report. Total cost is estimated at $25,000.

2. Mobilization/Demobilization includes providing office trailers, temporary utilities and sanitary facilities, delivery and removal of major construction equipment, and providing all other facilities and materials needed by the management staff.

3. It is assumed that subgrade preparation will be required prior to capping or dredging the contaminated sediments. Miscellaneous debris (cable, conduit, piping, etc.) will be removed from the sediments with diver assistance and cranes.

4. Erosion controls will be provided to reduce the migration of sediments during the capping/dredging operations by means of a silt boom. The silt boom will be anchored around the perimeter of the capping or dredging area.

5. This alternative requires the dredging of sediments at stations 27 and 103 with contaminant concentrations in excess of the recommended PRGs. The dredging depth would be approximately one foot. The dredging area is estimated by current data to be 643,100 square feet, by one foot thick, which equates to a volume of approximately 23,819 cubic yards of sediment.

   - Preparation, maintenance, and removal of the Pier 1 staging area was estimated at a lump sum of $40,000, which includes 2 laborers and a backhoe for 10 days and misc. materials.

   - The actual dewatering and wastewater treatment process will be determined based on a bench-scale laboratory study using samples of the site sediments. The dewatering process will likely include the following: screening of the dredged material to remove material greater than 0.25 inches; a series of hydrocyclones to remove sand and silt; a plate and frame filter press with pH adjustment by chemical addition. The resulting filtercake will be stabilized and disposed off-site. The filtrate will require additional treatment and testing prior to discharge into Coddington Cove. It is assumed that crew and equipment for wastewater treatment will cost $5,900 per day. It is assumed that water quality testing for both filtered water, and ambient water outside the work area, will be performed daily at a cost of $4,700 per day (min. 3 samples per day). It is assumed that the production rate for the dredging operation will be approximately 435 cubic yards per day and the operation will take approximately 60 work days for one dredge crew.

   - It is assumed that the dredging activities will not be subject to CRMC restrictions which only allow dredging to occur between October-December. As a result, all dredging/construction work will occur within one mobilization period.

   - Six-inch and smaller material dredged from the work site will be hauled by barge/scow to CAD disposal cells. Any boulders, cobbles, concrete, and metal debris greater than 6 inches will be rinsed of fine-grained sediment and stockpiled for disposal on land. It is assumed that <5% of the volume of dredged materials will be larger than 6 inches and that chemical testing of the screened materials prior to moving off-site will not be required. It is assumed that 300 tons of oversized debris and stones will be disposed on land.

   - An 8-hour work day is assumed for all construction activities. However, due to accessibility, it is assumed that one hour per day will be required to maintain and mobilize equipment and to secure the work areas and remove equipment from each work site (net production = 7 hours per day). An analysis of overtime labor versus daily equipment rates should be performed at the design phase to determine if cost-benefits exist by working overtime.

   - It is assumed that Pier 1 at Coddington Cove will be used as a materials and office staging area at no cost. Dewatered dredge spoils will be staged within the bottom-dump scows pending transport to the disposal facility.

   - It is assumed that a total of 40 confirmation samples will be collected during the site work to verify the all contaminated sediments exceeding the PRGs is addressed. Samples will be analyzed for PCBs, metal, and PAHs. Analytical costs are assumed to be $1,620/sample including collection and shipping costs.

   - Water quality testing will be performed daily during dredging activities. It assumed that two samples will be collected daily from outside of the silt curtain work area and one sample will be collected from the dewatering waste stream. Samples will be analyzed for PCBs, PAHs, metals, and total suspended solids (TSS).

6. This alternative also requires the capping of sediments at stations 3 & 29 with contaminant concentrations in excess of the recommended PRGS. The capping area is estimated to be 245,000 square feet, with a cap thickness of 3 feet, and total cap volume of 27,200 CY. These estimations will be further refined during the predesign investigation.

   - It is assumed that the capping material will be natural, comprised of sediment, sand or gravel. The most appropriate capping material will be refined based on the bathymetry study conducted as part of the pre-design investigation.

   - It is assumed that installing the cap, including labor, equipment, and materials, will cost $55/CY for 27,200 CY, yielding an estimated total cost of $1,496,000.

   - The method of cap installation would be by slow, uniform application that would allow the capping material to accumulate in layers, in order to minimize the potential for contaminated sediment resuspension and mazimize the precision of the cap installation.

   - An 8-hour work day is assumed for all construction activities. However, due to accessibility, it is assumed that one hour per day will be required to maintain and mobilize equipment and to secure the work areas and remove equipment from each work site (net production = 7 hours per day). An analysis of overtime labor versus daily equipment rates should be performed at the design phase to determine if cost-benefits exist by working overtime.

   - It is assumed that Pier 1 at Coddington Cove will be used as a materials and office staging area at no cost.

   - It is assumed that a total of 40 confirmation samples will be collected during the site work operations to verify the all contaminated sediments exceeding the PRGs have been addressed. Samples will be analyzed for PCBs, metal, and PAHs. Analytical costs are assumed to be $1,620/sample including collection and shipping costs.

7. <u>Long-term Cap Monitoring and Maintenance</u>
   (Assume no long-term monitoring or maintenance required for dredged areas.)

   - Prepare UFP-compliant work plan for long-term monitoring = $45,000.

   - Sediment chemistry (PCBs, PAHs, metals, Simultaneously Extracted Metals/Acid Volatile Sulfides (SEM/AVS)); 8 samples plus 2 QC samples
   - Elutriate chemistry (PCBs, PAHs, metals; 8 samples plus 2 QC samples
   - Biota chemistry 8 samples for lobster and bivalves, plus 2 QC samples each (PCBs, PAHs, metals);
   - Toxicity Amphipod; 10 samples
   - Toxicity Arabacia; 10 samples

   <u>Assume:</u> 1 event/year (monitoring); 2 events/year (maintenance)

   Monitoring (non-analytical costs):
   - Sediment sampling: Sample collection equipment and crew = approximately $156/sample. Collection of 10 sediment/elutriate samples = $1560
   - Biota sampling : Sample collection by scuba divers including equipment and crew = approximately $1150/sample. Collection of 20 samples = $23,000
   - Proj. mgmt/coord: 30 hours/year @ $110/hr (w/O&P) = $3,300
   - M&IE @ $500; ODCs & supplies @ $300; & shipping @ $300 >> total = $1100
   - Data Management and Validation $24,750.

- Report prep. $40,000.

Maintenance:
- 2 cap inspections annually @ $1,800/inspection = $3,600 annually.
- Cap repairs annually (assuming repair of 5 percent of total cap volume) @ $55/CY = $74,800.

- Total Non-Analytical Costs ≅ $172,110 annually for years 1-30

Estimated analytical costs:
- Sediment chemistry (PCBs, PAHs, metals, SEM/AVS) $1,020/sample @10 samples/yr = $10,200
- Elutriate chemistry (PCBs, PAHs, metals) $1,020/sample @10 samples/yr = $10,200
- Biota chemistry (PCBs, PAHs, metals) @ $1,020/sample @ 10 samples/yr = $10,200
- Toxicity Amphipod @ $1,200/sample @ 10 samples/yr = $12,000
- Toxicity Arabacia @ $600/sample @ 10 samples/yr = $6,000

Total Analytical ≅ $48,600 annually for years 1-30

8. 5-year reviews at 200 LOE @ $105/hr. Approx. $3,000 ODCs. Total = $24,000 per event
Reviews to occur in years 5,10, 15, 20, 25, 30.

ASSUMPTIONS FOR SENSITIVITY ANALYSES

Cost sensitivity analyses were performed for this alternative to evaluate the impact on costs of a significant increase (+ 50 percent) or decrease (- 30 percent) of the volume of sediment with COCs exceeding PRGs. It is assumed that the area of sediment to be addressed would also increase or decrease by + 50/-30 percent.

The estimated costs were determined by applying to each cost item in the alternative cost tables an adjustment factor corresponding to the estimated change in quantity that would result from the increase or decrease in sediment area and volume to be addressed. For many of the cost items, the increase or decrease in cost is expected to be directly proportional to the increase/decrease in sediment volume addressed. For some, the change would be less than proportional. Some items would not be expected to change at all. The adjustment factors for each item are shown on the sensitivity analysis cost tables.

CAPITAL COST SENSITIVITY ANALYSIS: +50% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

DESCRIPTION		ADJUSTMENT FACTOR	ADJUSTED QUANTITY	UNIT	UNIT COST	ADJUSTED TOTAL COST	SOURCE
1.0 Pre-Design Investigation							
1.1	Prepare UFP-compliant work plan	1	1.0	LS	$28,000	$28,000	See assumptions
1.2	Sediment borings and analyses	1.5	1.5	LS	$343,315	$514,973	See assumptions
1.3	Bench Scale Treatability Study	1	1.0	LS	$60,000	$60,000	See assumptions
1.4	Wetlands & Habitat Evaluation	1.5	1.5	LS	$50,500	$75,750	See assumptions
1.5	Bathymetry Study	1.5	1.5	LS	$25,000	$37,500	See assumptions
					Subtotal	**$688,223**	
2.0 Mobilization/Demobilization							
2.1	Office Trailer (1 ea)	1.5	10.5	MO	$400	$4,200	Historical data
2.2	Storage Trailer (1 ea)	1.5	7.5	MO	$300	$2,250	Historical data
2.3	Personnel Decon. Trailer	1.5	10.5	MO	$100	$1,050	Vendor catalog
2.4	PPE rolloff cont.	1.5	10.5	MO	$50	$525	Historical data
2.5	Portable Communication Equipment	1	8.0	SETS	$400	$3,200	Historical data
2.6	Equipment Mobilization/Demobilization	1	1.0	LS	$35,000	$35,000	Historical data
2.7	Site Utility Hook-ups (elec., phone, etc.)	1	1.0	LS	$3,000	$3,000	Historical data
2.8	Site Utilities	1.5	10.5	MO	$3,000	$31,500	Historical data
2.9	Vehicles and Equipment	1.5	10.5	MO	$3,300	$34,650	Historical data
2.10	Certification/Close-out Reports	1	1.0	LS	$27,000	$27,000	Historical data
					Subtotal	**$142,375**	
3.0 Dredging/Capping/Water Treatment							
3.1	Erosion control, silt boom	1.5	7,500	LF	$25	$187,500	Historical data
3.2	Mob/Demob (barge and pier based equip.)	1	1	LS	$217,880	$217,880	Vendor Info.
3.3	Prep., maint., and removal of staging area	1	1	LS	$40,000	$40,000	Vendor Info.
3.4	Dredge sediments	1.5	35,729	CY	$45	$1,595,635	Vendor Info.
3.5	Install permeable cap	1.5	40,800	CY	$55	$2,244,000	Vendor Info.
3.6	Treatment of dredge water	1.5	90	DAY	$5,900	$531,000	Vendor Info.
3.7	Sediment confirmation testing	1.5	60	EA	$1,620	$97,200	Historical data
3.8	Water Quality Testing	1.5	90	DAY	$4,700	$423,000	Historical data
3.9	Analysis of Sediment Prior to Transport	1.5	83	EA	$1,000	$82,500	Vendor Info.
3.10	Transport/Disposal	1.5	35,729	CY	$20	$714,570	Vendor Info.
3.11	Miscellaneous Solid Waste Disposal (landfill)	1.5	450	TN	$110	$49,500	Vendor Info.
					Subtotal	**$6,182,785**	
4.0 Long-Term Monitoring							
4.1	Prepare work plan	1	1	LS	$45,000	$45,000	see cost assumptions
					TOTAL DIRECT COSTS	**$7,058,382**	
5.0 Other Costs							
5.1	Project Management (6% of direct costs)					$423,503	OSWER 9355.0-75
5.2	Engineering and Design (12% direct costs)					$847,006	OSWER 9355.0-75
5.3	Construction management (8% of direct costs)					$564,671	OSWER 9355.0-75
5.4	Location Adjustment (9%)					$635,254	Means 2004 ER
5.5	Contingency (20%)					$1,411,676	OSWER 9355.0-75
					TOTAL OTHER COSTS	**$3,882,110**	
					TOTAL CAPITAL COST	**$10,940,493**	

Notes:

Means 2007 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2007.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).

Costs adjusted from base costs. Adjustment factor applied to base quantities using adjustment factor. See assumptions.

OPERATIONS/MAINTENANCE COST SENSITIVITY ANALYSIS: +50% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

DESCRIPTION		ADJUSTMENT FACTOR	ADJUSTED QUANTITY	UNIT	UNIT COST	ADJUSTED TOTAL COST	SOURCE
OM 1.0 Long-Term Monitoring (annually)							
OM 1.1	Total Non-Analytical Costs	1.25	1.25	EA	$172,110	$215,138	see cost assumptions
OM 1.2	Analytical Costs	1.25	1.25	EA	$48,600	$60,750	see cost assumptions
					Subtotal	**$275,888**	
OM 2.0 Cap Inspections & Maintenance							
OM 2.1	Cap Inspections (twice per year)	1.25	2.5	DAY	$3,500	$8,750	see cost assumptions
OM 2.2	Cap Repairs (5% per year)	1.5	2,040	CY	$55	$112,200	see cost assumptions
					Subtotal	**$120,950**	
ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE						**$396,838**	

Costs adjusted from base costs. Adjustment factor applied to base quantities using adjustment factor. See assumptions.

PRESENT WORTH SENSITIVITY ANALYSIS: +50% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

Year	Adjusted Capital	Adjusted O&M	5-Yr Review	Total	Discount Rate	Adjusted Present Value
0	$10,940,493	$0	$0	$10,940,493	3.0%	$10,940,493
1	$0	$396,838	$0	$396,838	3.0%	$396,838
2	$0	$396,838	$0	$396,838	3.0%	$385,279
3	$0	$396,838	$0	$396,838	3.0%	$374,057
4	$0	$396,838	$0	$396,838	3.0%	$363,163
5	$0	$396,838	$0	$396,838	3.0%	$342,316
6	$0	$396,838	$24,000	$420,838	3.0%	$352,445
7	$0	$396,838	$0	$396,838	3.0%	$322,665
7	$0	$396,838	$0	$396,838	3.0%	$322,665
8	$0	$396,838	$0	$396,838	3.0%	$313,267
9	$0	$396,838	$0	$396,838	3.0%	$304,143
10	$0	$396,838	$24,000	$420,838	3.0%	$313,143
11	$0	$396,838	$0	$396,838	3.0%	$286,684
12	$0	$396,838	$0	$396,838	3.0%	$278,334
13	$0	$396,838	$0	$396,838	3.0%	$270,227
14	$0	$396,838	$0	$396,838	3.0%	$262,356
15	$0	$396,838	$24,000	$420,838	3.0%	$270,120
16	$0	$396,838	$0	$396,838	3.0%	$247,296
17	$0	$396,838	$0	$396,838	3.0%	$240,093
18	$0	$396,838	$0	$396,838	3.0%	$233,100
19	$0	$396,838	$0	$396,838	3.0%	$226,311
20	$0	$396,838	$24,000	$420,838	3.0%	$233,008
21	$0	$396,838	$0	$396,838	3.0%	$213,320
22	$0	$396,838	$0	$396,838	3.0%	$207,107
23	$0	$396,838	$0	$396,838	3.0%	$201,074
24	$0	$396,838	$0	$396,838	3.0%	$195,218
25	$0	$396,838	$24,000	$420,838	3.0%	$200,994
26	$0	$396,838	$0	$396,838	3.0%	$184,011
27	$0	$396,838	$0	$396,838	3.0%	$178,652
28	$0	$396,838	$0	$396,838	3.0%	$173,448
29	$0	$396,838	$0	$396,838	3.0%	$168,397
30	$0	$396,838	$24,000	$420,838	3.0%	$173,379
TOTAL	**$10,940,493**	**$12,301,963**	**$144,000**	**$23,386,455**	**TOTAL PV**	**$19,173,601**
					PV O&M	**$8,233,109**

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.
Costs adjusted from base costs. See assumptions.

CAPITAL COST SENSITIVITY ANALYSIS: -30% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

DESCRIPTION		ADJUSTMENT FACTOR	ADJUSTED QUANTITY	UNIT	UNIT COST	ADJUSTED TOTAL COST	SOURCE
1.0 Pre-Design Investigation							
1.1	Prepare UFP-compliant work plan	1	1.0	LS	$28,000	$28,000	See assumptions
1.2	Sediment borings and analyses	0.7	0.7	LS	$343,315	$240,321	See assumptions
1.3	Bench Scale Treatability Study	1	1.0	LS	$60,000	$60,000	See assumptions
1.4	Wetlands & Habitat Evaluation	0.7	0.7	LS	$50,500	$35,350	See assumptions
1.5	Bathymetry Study	0.7	0.7	LS	$25,000	$17,500	See assumptions
					Subtotal	**$353,171**	
2.0 Mobilization/Demobilization							
2.1	Office Trailer (1 ea)	0.7	4.9	MO	$400	$1,960	Historical data
2.2	Storage Trailer (1 ea)	0.7	3.5	MO	$300	$1,050	Historical data
2.3	Personnel Decon. Trailer	0.7	4.9	MO	$100	$490	Vendor catalog
2.4	PPE rolloff cont.	0.7	4.9	MO	$50	$245	Historical data
2.5	Portable Communication Equipment	1	8.0	SETS	$400	$3,200	Historical data
2.6	Equipment Mobilization/Demobilization	1	1.0	LS	$35,000	$35,000	Historical data
2.7	Site Utility Hook-ups (elec., phone, etc.)	1	1.0	LS	$3,000	$3,000	Historical data
2.8	Site Utilities	0.7	4.9	MO	$3,000	$14,700	Historical data
2.9	Vehicles and Equipment	0.7	4.9	MO	$3,300	$16,170	Historical data
2.10	Certification/Close-out Reports	1	1.0	LS	$27,000	$27,000	Historical data
					Subtotal	**$102,815**	
3.0 Dredging/Capping/Water Treatment							
3.1	Erosion control, silt boom	0.7	3,500	LF	$25	$87,500	Historical data
3.2	Mob/Demob (barge and pier based equip.)	1	1	LS	$217,880	$217,880	Vendor Info.
3.3	Prep., maint., and removal of staging area	1	1	LS	$40,000	$40,000	Vendor Info.
3.4	Dredge sediments	0.7	16,673	CY	$45	$744,630	Vendor Info.
3.5	Install permeable cap	0.7	19,040	CY	$55	$1,047,200	Vendor Info.
3.6	Treatment of dredge water	0.7	42	DAY	$5,900	$247,800	Vendor Info.
3.7	Sediment confirmation testing	0.7	28	EA	$1,620	$45,360	Historical data
3.8	Water Quality Testing	0.7	42	DAY	$4,700	$197,400	Historical data
3.9	Analysis of Sediment Prior to Transport	0.7	39	EA	$1,000	$38,500	Vendor Info.
3.10	Transport/Disposal	0.7	16,673	CY	$20	$333,466	Vendor Info.
3.11	Miscellaneous Solid Waste Disposal (landfill)	0.7	210	TN	$110	$23,100	Vendor Info.
					Subtotal	**$3,022,836**	
4.0 Long-Term Monitoring							
4.1	Prepare work plan	1	1	LS	$45,000	$45,000	see cost assumptions
					TOTAL DIRECT COSTS	**$3,523,821**	
5.0 Other Costs							
5.1	Project Management (6% of direct costs)					$211,429	OSWER 9355.0-75
5.2	Engineering and Design (12% direct costs)					$422,859	OSWER 9355.0-75
5.3	Construction management (8% of direct costs)					$281,906	OSWER 9355.0-75
5.4	Location Adjustment (9%)					$317,144	Means 2004 ER
5.5	Contingency (20%)					$704,764	OSWER 9355.0-75
					TOTAL OTHER COSTS	**$1,938,102**	
					TOTAL CAPITAL COST	**$5,461,923**	

Notes:

Means 2007 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2007.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).

Costs adjusted from base costs. Adjustment factor applied to base quantities using adjustment factor. See assumptions.

OPERATIONS/MAINTENANCE COST SENSITIVITY ANALYSIS: -30% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

DESCRIPTION		ADJUSTMENT FACTOR	ADJUSTED QUANTITY	UNIT	UNIT COST	ADJUSTED TOTAL COST	SOURCE
OM 1.0	**Long-Term Monitoring (annually)**						
OM 1.1	Total Non-Analytical Costs	0.85	0.85	EA	$172,110	$146,294	see cost assumptions
OM 1.2	Analytical Costs	0.85	0.85	EA	$48,600	$41,310	see cost assumptions
					Subtotal	**$187,604**	
OM 2.0	**Cap Inspection and Maintenance**						
OM 2.1	Cap Inspections (twice per year)	0.85	1.7	DAY	$3,500	$5,950	see cost assumptions
OM.2.2	Cap Repairs (5% per year)	0.7	952	CY	$55	$52,360	see cost assumptions
					Subtotal	**$58,310**	
	ANNUAL MONITORING, INSPECTIONS, AND MAINTENANCE					**$245,914**	

Costs adjusted from base costs. Adjustment factor applied to base quantities using adjustment factor. See assumptions.

PRESENT WORTH SENSITIVITY ANALYSIS: -30% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 3
Newport, Rhode Island

Year	Adjusted Capital	Adjusted O&M	5-Yr Review	Total	Discount Rate	Adjusted Present Value
0	$5,461,923	$0	$0	$5,461,923	3.0%	$5,461,923
1	$0	$245,914	$0	$245,914	3.0%	$245,914
2	$0	$245,914	$0	$245,914	3.0%	$238,751
3	$0	$245,914	$0	$245,914	3.0%	$231,797
4	$0	$245,914	$0	$245,914	3.0%	$225,046
5	$0	$245,914	$0	$245,914	3.0%	$212,127
6	$0	$245,914	$24,000	$269,914	3.0%	$226,048
7	$0	$245,914	$0	$245,914	3.0%	$199,950
7	$0	$245,914	$0	$245,914	3.0%	$199,950
8	$0	$245,914	$0	$245,914	3.0%	$194,126
9	$0	$245,914	$0	$245,914	3.0%	$188,472
10	$0	$245,914	$24,000	$269,914	3.0%	$200,841
11	$0	$245,914	$0	$245,914	3.0%	$177,653
12	$0	$245,914	$0	$245,914	3.0%	$172,479
13	$0	$245,914	$0	$245,914	3.0%	$167,455
14	$0	$245,914	$0	$245,914	3.0%	$162,578
15	$0	$245,914	$24,000	$269,914	3.0%	$173,247
16	$0	$245,914	$0	$245,914	3.0%	$153,245
17	$0	$245,914	$0	$245,914	3.0%	$148,782
18	$0	$245,914	$0	$245,914	3.0%	$144,448
19	$0	$245,914	$0	$245,914	3.0%	$140,241
20	$0	$245,914	$24,000	$269,914	3.0%	$149,445
21	$0	$245,914	$0	$245,914	3.0%	$132,191
22	$0	$245,914	$0	$245,914	3.0%	$128,340
23	$0	$245,914	$0	$245,914	3.0%	$124,602
24	$0	$245,914	$0	$245,914	3.0%	$120,973
25	$0	$245,914	$24,000	$269,914	3.0%	$128,912
26	$0	$245,914	$0	$245,914	3.0%	$114,029
27	$0	$245,914	$0	$245,914	3.0%	$110,708
28	$0	$245,914	$0	$245,914	3.0%	$107,483
29	$0	$245,914	$0	$245,914	3.0%	$104,352
30	$0	$245,914	$24,000	$269,914	3.0%	$111,201
TOTAL	**$5,461,923**	**$7,623,319**	**$144,000**	**$13,229,241**	**TOTAL PV**	**$10,597,310**
					PV O&M	**$5,135,387**

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.

Costs adjusted from base costs. See assumptions.

CAPITAL COSTS
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 4
Newport, Rhode Island

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE
1.0 Pre-Design Investigation						
1.1	Prepare UFP-compliant work plan	1	LS	$14,000	$14,000	See assumptions
1.2	Sediment borings and analyses	1	LS	$408,505	$408,505	See assumptions
1.3	Bench Scale Treatability Study	1	LS	$60,000	$60,000	See assumptions
1.4	Wetlands & Habitat Evaluation	1	LS	$50,500	$50,500	See assumptions
				Subtotal	**$533,005**	
2.0 Mobilization/Demobilization						
2.1	Office Trailer (1 ea)	7	MO	$400	$2,800	Historical data
2.2	Storage Trailer (1 ea)	5	MO	$300	$1,500	Historical data
2.3	Personnel Decon. Trailer	7	MO	$100	$700	Vendor catalog
2.4	PPE rolloff cont.	7	MO	$50	$350	Historical data
2.5	Portable Communication Equipment	8	SETS	$400	$3,200	Historical data
2.6	Equipment Mobilization/Demobilization	1	LS	$35,000	$35,000	Historical data
2.7	Site Utility Hook-ups (elec., phone, etc.)	1	LS	$3,000	$3,000	Historical data
2.8	Site Utilities	7	MO	$3,000	$21,000	Historical data
2.9	Vehicles and Equipment	7	MO	$3,300	$23,100	Historical data
2.10	Certification/Close-out Reports	1	LS	$27,000	$27,000	Historical data
				Subtotal	**$117,650**	
3.0 Dredging/Water Treatment						
3.1	Erosion control, silt boom	5,000	LF	$25	$125,000	Historical data
3.2	Mob/Demob (barge and pier based equip.)	1	LS	$217,880	$217,880	Vendor Info.
3.3	Prep., maint., and removal of staging area	1	LS	$40,000	$40,000	Vendor Info.
3.4	Dredge sediments	32,893	CY	$45	$1,469,001	Vendor Info.
3.5	Treatment of dredge water	80	DAY	$5,900	$472,000	Vendor Info.
3.6	Sediment confirmation testing	40	EA	$1,620	$64,800	Historical data
3.7	Water Quality Testing	80	DAY	$4,700	$376,000	Historical data
3.8	Analysis of Sediment Prior to Transport	70	EA	$1,000	$70,000	Vendor Info.
3.9	Transport/Disposal	32,893	CY	$20	$657,860	Vendor Info.
3.10	Miscellaneous Solid Waste Disposal (landfill)	300	TN	$110	$33,000	Vendor Info.
				Subtotal	**$3,525,541**	
4.0 Long-Term Monitoring						
4.1	Prepare work plan	1	LS	$45,000	$45,000	see cost assumptions
				TOTAL DIRECT COSTS	**$4,221,196**	
5.0 Other Costs						
5.1	Project Management (6% of direct costs)				$253,272	OSWER 9355.0-75
5.2	Engineering and Design (12% direct costs)				$506,544	OSWER 9355.0-75
5.3	Construction management (8% of direct costs)				$337,696	OSWER 9355.0-75
5.4	Location Adjustment (9%)				$379,908	Means 2004 ER
5.5	Contingency (20%)				$844,239	OSWER 9355.0-75
				TOTAL OTHER COSTS	**$2,321,658**	
				TOTAL CAPITAL COST	**$6,542,854**	

Notes:
Means 2007 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2006.
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).

PRESENT WORTH
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 4
Newport, Rhode Island

Year	Capital	O&M	5-Yr Review	Total	Discount Rate	Present Value
0	$6,542,854	$0	$0	$6,542,854	3.0%	$6,542,854
1	$0	$0	$0	$0	3.0%	$0
2	$0	$0	$0	$0	3.0%	$0
3	$0	$0	$0	$0	3.0%	$0
4	$0	$0	$0	$0	3.0%	$0
5	$0	$0	$0	$0	3.0%	$0
6	$0	$0	$0	$0	3.0%	$0
7	$0	$0	$0	$0	3.0%	$0
8	$0	$0	$0	$0	3.0%	$0
9	$0	$0	$0	$0	3.0%	$0
10	$0	$0	$0	$0	3.0%	$0
11	$0	$0	$0	$0	3.0%	$0
12	$0	$0	$0	$0	3.0%	$0
13	$0	$0	$0	$0	3.0%	$0
14	$0	$0	$0	$0	3.0%	$0
15	$0	$0	$0	$0	3.0%	$0
16	$0	$0	$0	$0	3.0%	$0
17	$0	$0	$0	$0	3.0%	$0
18	$0	$0	$0	$0	3.0%	$0
19	$0	$0	$0	$0	3.0%	$0
20	$0	$0	$0	$0	3.0%	$0
21	$0	$0	$0	$0	3.0%	$0
22	$0	$0	$0	$0	3.0%	$0
23	$0	$0	$0	$0	3.0%	$0
24	$0	$0	$0	$0	3.0%	$0
25	$0	$0	$0	$0	3.0%	$0
26	$0	$0	$0	$0	3.0%	$0
27	$0	$0	$0	$0	3.0%	$0
28	$0	$0	$0	$0	3.0%	$0
29	$0	$0	$0	$0	3.0%	$0
30	$0	$0	$0	$0	3.0%	$0
TOTAL	**$6,542,854**	**$0**	**$0**	**$6,542,854**	**TOTAL PV**	**$6,542,854**
					PV O&M	**$0**

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.

Alternative 4: Removal and Off-Base Disposal

ASSUMPTIONS:

CAPITAL COST ITEMS:

1. Pre-Design Investigation
   - Prepare UFP-compliant work plan = $28,000.

   - Sediment sampling to further determine the grain size and nature of the sediments and to delineate lateral and vertical extent of contaminants exceeding the PRGs. Assume 48 soil borings with samples in one foot intervals to a maximum 3-foot depth (144 samples). All samples anayzed for PCBs, PAHs, Metals and geotechnical testing.
     - Mob./demob. @ $17,500.
     - Sample collection of 144 samples @ $1,040 each = $149,760.
     - Analytical 144 samples @ $1130/sample = $162,720.
     - Data validation $40,000.
     - Reporting @ $22,275.
     - Oversight and management @ $16,250.
     - Total costs = $408,505.

   - Bench-scale treatability study to determine method to dewater dredged sediment and necessary treatment for the water generated as a result of dewatering of these dredged sediments. Assume the study will include preparation of a work plan detailing the planned study; sample collection; shipment of sample for testing; treatability testing to be conducted by one person for approximately one week (to include solids separation, metals precipitation, and carbon absorption); analysis of associated water samples for metals, PAHs, and PCBs; and preparation of a report summarizing the results of the testing. Total cost is estimated at $60,000.

   - Review of existing information and additional field investigations to identify and evaluate habitats and wetlands that will or may be impacted by the alternative. Review of existing information - $5,000, biologist inspection of the seafloor to be dredged (five dives for each area to be dredged) - $25,500, evaluation report - $20,000. Total cost is estimated at $50,500.

2. Mobilization/Demobilization includes providing office trailers, temporary utilities and sanitary facilities, delivery and removal of major construction equipment, and providing all other facilities and materials needed by the management staff.

3. It is assumed that subgrade preparation will be required prior to dredging the contaminated sediments. Miscellaneous debris (cable, conduit, piping, etc.) will be removed from the sediments with diver assistance and cranes.

4. Erosion controls will be provided to reduce the migration of sediments during the dredging operations by means of a silt boom. The silt boom will be anchored around the perimeter of the dredge area.

5. This alternative requires the dredging of all sediments exceeding with contaminant concentrations in excess of the recommended PRGS (areas 3, 27, 29, and 103). The dredging depth is estimated to be approximately one foot. The area is estimated by current data to be 888,100 square feet by one foot thick, for an estimated volume of 32,893 cubic yards of sediment.

   - Preparation, maintenance, and removal of the Pier 1 staging area was estimated at a lump sum of $40,000, which includes 2 laborers and a backhoe for 10 days and misc. materials.

- The actual dewatering and wastewater treatment process will be determined based on a bench-scale laboratory study using samples of the site sediments. The dewatering process will likely include the following: screening of the dredged material to remove material greater than 0.25 inches; a series of hydrocyclones to remove sand and silt; a plate and frame filter press with pH adjustment by chemical addition. The resulting filtercake will be stabilized and disposed off-site. The filtrate will require additional treatment and testing prior to discharge into Coddington Cove. It is assumed that crew and equipment for wastewater treatment will cost $5,900 per day. It is assumed that water quality testing for both filtered water, and ambient water outside the work area, will be performed daily at a cost of $4,700 per day (min. 3 samples per day). It is assumed that the production rate for the dredging operation will be approximately 435 cubic yards per day and the operation will take approximately 80 work days for one dredge crew.

- It is assumed that the dredging activities will not be subject to CRMC restrictions which only allow dredging to occur between October-December. As a result, all dredging/construction work will occur within one mobilization period.

- Six-inch and smaller material dredged from the work site will be hauled by barge/scow to CAD disposal cells. Any boulders, cobbles, concrete, and metal debris greater than 6 inches will be rinsed of fine-grained sediment and stockpiled for disposal on land. It is assumed that <5% of the volume of dredged materials will be larger than 6 inches and that chemical testing of the screened materials prior to moving off-site will not be required. It is assumed that 300 tons of oversized debris and stones will be disposed on land.

- An 8-hour work day is assumed for all construction activities. However, due to accessibility, it is assumed that one hour per day will be required to maintain and mobilize equipment and to secure the work areas and remove equipment from each work site (net production = 7 hours per day). An analysis of overtime labor versus daily equipment rates should be performed at the design phase to determine if cost-benefits exist by working overtime.

- It is assumed that Pier 1 at Coddington Cove will be used as a materials and office staging area at no cost. Dewatered dredge spoils will be staged within the bottom-dump scows pending transport to the disposal facility.

- It is assumed that 40 confirmation samples will be collected during the dredging operation to verify the all contaminated sediments exceeding the PRGs is removed. Samples will be analyzed for PCBs, metal, and PAHs. Analytical costs are assumed to be $1,620/sample including collection and shipping costs.

- Water quality testing will be performed daily during dredging activities. It assumed that two samples will be collected daily from outside of the silt curtain work area and one sample will be collected from the dewatering waste stream. Samples will be analyzed for PCBs, PAHs, metals, and total suspended solids (TSS).

6. No O&M costs are associated with this task.

ASSUMPTIONS FOR SENSITIVITY ANALYSES

Cost sensitivity analyses were performed for this alternative to evaluate the impact on costs of a significant increase (+ 50 percent) or decrease (- 30 percent) of the volume of sediment with COCs exceeding PRGs. It is assumed that the area of sediment to be addressed would also increase or decrease by + 50/-30 percent.

The estimated costs were determined by applying to each cost item in the alternative cost tables an adjustment factor corresponding to the estimated change in quantity that would result from the increase or decrease in sediment area and volume to be addressed. For many of the cost items, the increase or decrease in cost is expected to be directly proportional to the increase/decrease in sediment volume addressed. For some, the change would be less than proportional. Some items would not be expected to change at all. The adjustment factors for each item are shown on the sensitivity analysis cost tables.

CAPITAL COST SENSITIVITY ANALYSIS: +50% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 4
Newport, Rhode Island

	DESCRIPTION	ADJUSTMENT FACTOR	ADJUSTED QUANTITY	UNIT	UNIT COST	ADJUSTED TOTAL COST	SOURCE
1.0	**Pre-Design Investigation**						
1.1	Prepare UFP-compliant work plan	1	1	LS	$14,000	$14,000	See assumptions
1.2	Sediment borings and analyses	1.5	1.5	LS	$408,505	$612,758	See assumptions
1.3	Bench Scale Treatability Study	1	1	LS	$60,000	$60,000	See assumptions
1.4	Wetlands & Habitat Evaluation	1.5	1.5	LS	$50,500	$75,750	See assumptions
					Subtotal	**$762,508**	
2.0	**Mobilization/Demobilization**						
2.1	Office Trailer (1 ea)	1.5	10.5	MO	$400	$4,200	Historical data
2.2	Storage Trailer (1 ea)	1.5	7.5	MO	$300	$2,250	Historical data
2.3	Personnel Decon. Trailer	1.5	10.5	MO	$100	$1,050	Vendor catalog
2.4	PPE rolloff cont.	1.5	10.5	MO	$50	$525	Historical data
2.5	Portable Communication Equipment	1	8	SETS	$400	$3,200	Historical data
2.6	Equipment Mobilization/Demobilization	1	1	LS	$35,000	$35,000	Historical data
2.7	Site Utility Hook-ups (elec., phone, etc.)	1	1	LS	$3,000	$3,000	Historical data
2.8	Site Utilities	1.5	10.5	MO	$3,000	$31,500	Historical data
2.9	Vehicles and Equipment	1.5	10.5	MO	$3,300	$34,650	Historical data
2.10	Certification/Close-out Reports	1	1	LS	$27,000	$27,000	Historical data
					Subtotal	**$142,375**	
3.0	**Dredging/Water Treatment**						
3.1	Erosion control, silt boom	1.5	7500	LF	$25	$187,500	Historical data
3.2	Mob/Demob (barge and pier based equip.)	1	1	LS	$217,880	$217,880	Vendor Info.
3.3	Prep., maint., and removal of staging area	1	1	LS	$40,000	$40,000	Vendor Info.
3.4	Dredge sediments	1.5	49340	CY	$45	$2,203,502	Vendor Info.
3.5	Treatment of dredge water	1.5	120	DAY	$5,900	$708,000	Vendor Info.
3.6	Sediment confirmation testing	1.5	60	EA	$1,620	$97,200	Historical data
3.7	Water Quality Testing	1.5	120	DAY	$4,700	$564,000	Historical data
3.8	Analysis of Sediment Prior to Transport	1.5	105	EA	$1,000	$105,000	Vendor Info.
3.9	Transport/Disposal	1.5	49340	CY	$20	$986,790	Vendor Info.
3.10	Miscellaneous Solid Waste Disposal (landfill)	1.5	450	TN	$110	$49,500	Vendor Info.
					Subtotal	**$5,159,372**	
4.0	**Long-Term Monitoring**						
4.1	Prepare work plan	1	1	LS	$45,000	$45,000	see cost assumptions
					TOTAL DIRECT COSTS	**$6,109,255**	
5.0	**Other Costs**						
5.1	Project Management (6% of direct costs)					$366,555	OSWER 9355.0-75
5.2	Engineering and Design (12% direct costs)					$733,111	OSWER 9355.0-75
5.3	Construction management (8% of direct costs)					$488,740	OSWER 9355.0-75
5.4	Location Adjustment (9%)					$549,833	Means 2004 ER
5.5	Contingency (20%)					$1,221,851	OSWER 9355.0-75
					TOTAL OTHER COSTS	**$3,360,090**	
					TOTAL CAPITAL COST	**$9,469,345**	

Notes:

Means 2007 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2007.
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).
Costs adjusted from base costs. Adjustment factor applied to base quantities using adjustment factor. See assumptions.

PRESENT WORTH SENSITIVITY ANALYSIS: +50% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 4
Newport, Rhode Island

Year	Adjusted Capital	Adjusted O&M	5-Yr Review	Total	Discount Rate	Adjusted Present Value
0	$9,469,345	$0	$0	$9,469,345	3.0%	$9,469,345
1	$0	$0	$0	$0	3.0%	$0
2	$0	$0	$0	$0	3.0%	$0
3	$0	$0	$0	$0	3.0%	$0
4	$0	$0	$0	$0	3.0%	$0
5	$0	$0	$0	$0	3.0%	$0
6	$0	$0	$0	$0	3.0%	$0
7	$0	$0	$0	$0	3.0%	$0
8	$0	$0	$0	$0	3.0%	$0
9	$0	$0	$0	$0	3.0%	$0
10	$0	$0	$0	$0	3.0%	$0
11	$0	$0	$0	$0	3.0%	$0
12	$0	$0	$0	$0	3.0%	$0
13	$0	$0	$0	$0	3.0%	$0
14	$0	$0	$0	$0	3.0%	$0
15	$0	$0	$0	$0	3.0%	$0
16	$0	$0	$0	$0	3.0%	$0
17	$0	$0	$0	$0	3.0%	$0
18	$0	$0	$0	$0	3.0%	$0
19	$0	$0	$0	$0	3.0%	$0
20	$0	$0	$0	$0	3.0%	$0
21	$0	$0	$0	$0	3.0%	$0
22	$0	$0	$0	$0	3.0%	$0
23	$0	$0	$0	$0	3.0%	$0
24	$0	$0	$0	$0	3.0%	$0
25	$0	$0	$0	$0	3.0%	$0
26	$0	$0	$0	$0	3.0%	$0
27	$0	$0	$0	$0	3.0%	$0
28	$0	$0	$0	$0	3.0%	$0
29	$0	$0	$0	$0	3.0%	$0
30	$0	$0	$0	$0	3.0%	$0
TOTAL	**$9,469,345**	**$0**	**$0**	**$9,469,345**	**TOTAL PV**	**$9,469,345**
					PV O&M	**$0**

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.
Costs adjusted from base costs. See assumptions.

CAPITAL COST SENSITIVITY ANALYSIS: -30% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 4
Newport, Rhode Island

DESCRIPTION		ADJUSTMENT FACTOR	ADJUSTED QUANTITY	UNIT	UNIT COST	ADJUSTED TOTAL COST	SOURCE
1.0 Pre-Design Investigation							
1.1	Prepare UFP-compliant work plan	1	1	LS	$14,000	$14,000	See assumptions
1.2	Sediment borings and analyses	0.7	0.7	LS	$408,505	$285,954	See assumptions
1.3	Bench Scale Treatability Study	1	1	LS	$60,000	$60,000	See assumptions
1.4	Wetlands & Habitat Evaluation	0.7	0.7	LS	$50,500	$35,350	See assumptions
					Subtotal	**$395,304**	
2.0 Mobilization/Demobilization							
2.1	Office Trailer (1 ea)	0.7	4.9	MO	$400	$1,960	Historical data
2.2	Storage Trailer (1 ea)	0.7	3.5	MO	$300	$1,050	Historical data
2.3	Personnel Decon. Trailer	0.7	4.9	MO	$100	$490	Vendor catalog
2.4	PPE rolloff cont.	0.7	4.9	MO	$50	$245	Historical data
2.5	Portable Communication Equipment	1	8	SETS	$400	$3,200	Historical data
2.6	Equipment Mobilization/Demobilization	1	1	LS	$35,000	$35,000	Historical data
2.7	Site Utility Hook-ups (elec., phone, etc.)	1	1	LS	$3,000	$3,000	Historical data
2.8	Site Utilities	0.7	4.9	MO	$3,000	$14,700	Historical data
2.9	Vehicles and Equipment	0.7	4.9	MO	$3,300	$16,170	Historical data
2.10	Certification/Close-out Reports	1	1	LS	$27,000	$27,000	Historical data
					Subtotal	**$102,815**	
3.0 Dredging/Water Treatment							
3.1	Erosion control, silt boom	0.7	3500	LF	$25	$87,500	Historical data
3.2	Mob/Demob (barge and pier based equip.)	1	1	LS	$217,880	$217,880	Vendor Info.
3.3	Prep., maint., and removal of staging area	1	1	LS	$40,000	$40,000	Vendor Info.
3.4	Dredge sediments	0.7	23025	CY	$45	$1,028,301	Vendor Info.
3.5	Treatment of dredge water	0.7	56	DAY	$5,900	$330,400	Vendor Info.
3.6	Sediment confirmation testing	0.7	28	EA	$1,620	$45,360	Historical data
3.7	Water Quality Testing	0.7	56	DAY	$4,700	$263,200	Historical data
3.8	Analysis of Sediment Prior to Transport	0.7	49	EA	$1,000	$49,000	Vendor Info.
3.9	Transport/Disposal	0.7	23025	CY	$20	$460,502	Vendor Info.
3.10	Miscellaneous Solid Waste Disposal (landfill)	0.7	210	TN	$110	$23,100	Vendor Info.
					Subtotal	**$2,545,243**	
4.0 Long-Term Monitoring							
4.10	Prepare work plan	1	1	LS	$45,000	$45,000	see cost assumptions
					TOTAL DIRECT COSTS	**$3,088,361**	
5.0 Other Costs							
5.1	Project Management (6% of direct costs)					$185,302	OSWER 9355.0-75
5.2	Engineering and Design (12% direct costs)					$370,603	OSWER 9355.0-75
5.3	Construction management (8% of direct costs)					$247,069	OSWER 9355.0-75
5.4	Location Adjustment (9%)					$277,953	Means 2004 ER
5.5	Contingency (20%)					$617,672	OSWER 9355.0-75
					TOTAL OTHER COSTS	**$1,698,599**	
					TOTAL CAPITAL COST	**$4,786,960**	

Notes:

Means 2007 HC: R.S. Means Heavy Construction Cost Data, 20th Annual Edition, 2006.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004 (adjusted 8.5% for inflation per ENR Construction Cost Index).

Costs adjusted from base costs. Adjustment factor applied to base quantities using adjustment factor. See assumptions.

PRESENT WORTH SENSITIVITY ANALYSIS: -30% VOLUME
Derecktor Shipyard/Coddington Cove Revised FS
Alternative 4
Newport, Rhode Island

Year	Adjusted Capital	Adjusted O&M	5-Yr Review	Total	Discount Rate	Adjusted Present Value
0	$4,786,960	$0	$0	$4,786,960	3.0%	$4,786,960
1	$0	$0	$0	$0	3.0%	$0
2	$0	$0	$0	$0	3.0%	$0
3	$0	$0	$0	$0	3.0%	$0
4	$0	$0	$0	$0	3.0%	$0
5	$0	$0	$0	$0	3.0%	$0
6	$0	$0	$0	$0	3.0%	$0
7	$0	$0	$0	$0	3.0%	$0
8	$0	$0	$0	$0	3.0%	$0
9	$0	$0	$0	$0	3.0%	$0
10	$0	$0	$0	$0	3.0%	$0
11	$0	$0	$0	$0	3.0%	$0
12	$0	$0	$0	$0	3.0%	$0
13	$0	$0	$0	$0	3.0%	$0
14	$0	$0	$0	$0	3.0%	$0
15	$0	$0	$0	$0	3.0%	$0
16	$0	$0	$0	$0	3.0%	$0
17	$0	$0	$0	$0	3.0%	$0
18	$0	$0	$0	$0	3.0%	$0
19	$0	$0	$0	$0	3.0%	$0
20	$0	$0	$0	$0	3.0%	$0
21	$0	$0	$0	$0	3.0%	$0
22	$0	$0	$0	$0	3.0%	$0
23	$0	$0	$0	$0	3.0%	$0
24	$0	$0	$0	$0	3.0%	$0
25	$0	$0	$0	$0	3.0%	$0
26	$0	$0	$0	$0	3.0%	$0
27	$0	$0	$0	$0	3.0%	$0
28	$0	$0	$0	$0	3.0%	$0
29	$0	$0	$0	$0	3.0%	$0
30	$0	$0	$0	$0	3.0%	$0
TOTAL	**$4,786,960**	**$0**	**$0**	**$4,786,960**	**TOTAL PV**	**$4,786,960**
					PV O&M	**$0**

Discount rate of 3% = 30-year real interest rate per OMB Circular No. A-94 Appendix C, January 2007.
Costs adjusted from base costs. See assumptions.