N62661 AR 000616
NAVSTA NEWPORT RI
5090 3a

Doc ID LOG 28776
ID -00221

ADDENDUM B:

DRAFT FINAL

PLAN FOR OFFSHORE ECOLOGICAL RISK ASSESSMENT

FOR

DERECKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

28 July 1995

PROJECT NAME: Offshore Ecological Risk Assessment for Derecktor Shipyard

PROJECT REQUESTED BY: US Navy Northern Division

PROJECT MANAGER: Stephen S. Parker, HNUS

PRINCIPAL INVESTIGATORS:
Dr. James Quinn, GSO/URI
Dr. John King, GSO/URI
Dr. Gregory Tracey, SAIC
Dr. Christopher Kincaid, GSO/URI

QUALITY ASSURANCE OFFICER: Ms. Andrea Helmstetter, SAIC

CONTENTS

List of Tables

List of Figures

1.0 BACKGROUND

This addendum has been prepared to supplement the Work/Quality Assurance Project Plan, Narragansett Bay Ecorisk and Monitoring for Navy Sites (URI and SAIC, 1994), referred to herein as the "Master Work Plan". This addendum has been prepared to describe the methodology to perform a baseline ecological risk assessment for Coddington Cove, proximate to the Derecktor Shipyard, part of the Naval Education and Training Center (NETC), Newport, RI.

Contamination in the off-shore area near Derecktor Shipyard may be a result of the on-shore activities and shipyard operations. A Site Assessment Screening Evaluation (SASE) has been scoped and every attempt will be made to perform the studies concurrently. Because of the timing of the onshore investigation, however, the information related to the on-shore studies is limited to that contained in published documents which were available to the authors at the time of preparation of this draft final work plan.

One of the objectives of the Site Assessment Screening Evaluation (SASE) at Derecktor Shipyard is to identify contaminants at the site and transport mechanisms which are available to them. This information will support the offshore study by identifying contaminant sources, thus supporting the third and fourth tiers of the conceptual model. These data and other study findings will be integrated in both on-shore and off-shore study reports, as is appropriate to the subject matter presented in each.

The Master Work Plan presents generic background information concerning the approaches to problem formulation, exposure and ecological effects assessments, and QA/QC requirements and activities. The intent of the Work Plan is to present a consistent approach to assess ecological risks for several Navy sites in Narragansett Bay.

This addendum presents the site specific ecological risk assessment activities and the sampling and analysis plan for offshore portions of the Derecktor Shipyard. This addendum includes descriptions of existing data, and a plan to supplement that data with additional information that is required for the performance of an ecological risk assessment for this site.

1.1 SITE DESCRIPTION

The Robert E. Derecktor of Rhode Island (Derecktor) Shipyard consists of 41.35 acres of land and improvements that was leased by the Rhode Island Port Authority and Economic Development Corporation (RIPAEDC) to Derecktor. RIPAEDC in turn leased this parcel from the U.S. Navy. The RIPAEDC lease commenced on January 1, 1979; Derecktor's sublease ran concurrently.

The area leased by Derecktor is surrounded on the north, east and south property boundaries by Naval Education & Training Center (NETC). The western boundary of the parcel opens onto Coddington Cove, an inlet of Narragansett Bay (Fig. B1-1). There are no restrictions on access to the Shipyard by water. No natural fresh water bodies were observed within the Derecktor Shipyard. Approximately 80 percent of the Shipyard is covered by buildings or pavement. As a result of these conditions, precipitation does not accumulate on the ground surface.

1.2 SUMMARY OF PREVIOUS SITE INVESTIGATIONS

This summary presents the general findings of previous environmental investigations at Derecktor Shipyard, with particular emphasis on their relationship to potential risks to ecological receptors in Narragansett Bay. Detailed information regarding the findings of these studies with respect to Problem Formulation is presented in Section 2.0 of this Addendum.

1.2.1 Onshore Investigations

The information provided in this section has been adapted from the Preliminary Assessment report (PA) for Derecktor Shipyard (ENSR, 1993). Based on the information reviewed and the observations made during the PA, a number of conclusions regarding the Derecktor Shipyard were made.

- The Derecktor operations generated large quantities of hazardous wastes. These wastes included waste oil, paints, solvents, thinner, sodium hydroxide, and other waste solids and liquids.

- Housekeeping and hazardous material handling practices at the facility were poor. General debris and scrap materials were widely scattered around the facility.

- Waste materials were known to be disposed of on the property, including spent sand blast grit and oily liquids from the dry dock.

- Releases of hazardous material to the ground in the hazardous waste storage area (North Waterfront) is suspected but has not been confirmed.

- The primary pathways for contaminants to migrate from the site would be through the storm drain system and groundwater flow. Coddington Cove would be the primary receptor of contaminants through these pathways.

1.2.2 Offshore investigations

In the Fall of 1993, scientists from the Graduate School of Oceanography (GSO), University of Rhode Island (URI), conducted a preliminary survey (Phase I) of organic (PCBs, PAHs, butyltins) and metal contaminants in marine sediments of Coddington Cove. In order to confirm and expand the findings of the initial study, additional sediments were collected on June 13, 1994 and were analyzed for the same contaminants as in the first sediment study. A final report including the results of the survey, as well as a comparison with the investigators' previous work in Narragansett Bay, was submitted to the Naval Education and Training Center (NETC) in May, 1994 (Quinn *et al.*, 1994), and a draft final report on Phase II was submitted in December 1994 (Quinn et al., 1994b)

The following conclusions were based on the combined data from the two studies.

1. Tributyltins, organic contaminant and trace metal concentrations of primarily anthropogenic origin are very high in Coddington Cove surface sediments relative to concentrations typical of lower Narragansett Bay sediments.

2. Elevated concentrations of PCBs and PAHs were found in the one clam sample of sufficient size for analysis. These values are very high relative to concentrations typical of lower Narragansett Bay biota.

3. The spatial distribution of organic contaminants and trace metals in the surface sediments of Coddington Cove, after normalization for lithologic variations, indicates that the primary sources for many of these components are the series of outfall pipes from the former Derecktor Shipyard and/or piers for shipping activity. Normalized concentrations are highest in the proximity of the outfall pipes and decrease with distance away from the outfalls.

4. The acid volatile sulfide (AVS) concentrations observed in Coddington Cove sediments are relatively high and are significantly higher than the sum of the concentrations of the simultaneously extracted metals (SEM). Therefore, the observed ratios of SEM/AVS are significantly lower than 1.0.

5. High concentrations of tributyltins, organic and trace metal contaminants are found in sediment cores sections down to 31 cm depth. Based on these chemical markers, the sedimentation rate is about 1 cm/yr. The elevated contaminant levels could extend down to 50-60 cm in depth. In some cases, subsurface maxima in concentrations suggest higher anthropogenic inputs to the Cove in the past relative to the present time.

1.3 OBJECTIVE AND SCOPE

In 1995, Halliburton NUS contracted the University of Rhode Island (URI) and Science Applications International Corporation (SAIC) to prepare this offshore ecological risk assessment work plan for Derecktor Shipyard. The purpose of this work plan addendum is to define the necessary steps to develop the information needed for evaluation of ecological risks to ecological receptors in Coddington Cove posed by contaminants which have originated from the former Derecktor Shipyard. The general approach taken in this investigation follows that described in the main body of the Master Work Plan (URI and SAIC, 1995).

The overall goal of this site-specific investigation is to use the U.S. EPA's Ecological Risk Assessment Framework and applicable EPA Region I guidance to generate and interpret the data required to complete an "off-shore" ecological risk assessment for the NETC Derecktor Shipyard. This Work Plan addendum follows the Master Work Plan with respect to the objectives of the site-specific ERA. Such objectives are:

- o To assess the ecological risks to offshore environments of Narragansett Bay from chemical stressors associated with Derecktor Shipyard;

- o To develop information sufficient to make informed risk management decisions regarding remedial options for this site; and

- o To support communication of the nature and extent of ecological risks associated with Derecktor Shipyard to the public.

Section 1 of the Master Work Plan describes the general requirements and data products of a site-specific ERA, including Problem Formulation, Exposure and Ecological Effects Assessments, and Characterization of Ecological Risks, as well as guidance used to meet these objectives.

In Problem Formulation, the activities will include:

- o Determination of the nature and extent of contamination of offshore media associated with Derecktor Shipyard;
- o Identification of contaminants of concern (CoCs);
- o Identification of ecological receptors potentially at risk from CoCs; and
- o Development of a site-specific conceptual model of ecological risks associated with Derecktor Shipyard.

In the Exposure and Ecological Effects Assessment phases, activities will include:

- o Collection of information needed to quantify or estimate the concentrations of CoCs in the relevant environmental media; and

- o Measurement of the toxicity of exposure media, and conduct of modeling exercises to predict the occurrence of adverse ecological impact.

Characterization of Ecological Risks activities will include:

- o Analysis of CoC concentration *versus* observations of adverse effects;
- o Analysis of CoC bioaccumulation;
- o Comparisons of toxicity evaluations with observed ecological effects;
- o Comparisons of exposure point concentrations with established standards and criteria for offshore media; and
- o Comparisons of exposure point concentrations with published information regarding the toxicity of CoCs.

The scope of activities described above will be conducted following procedures contained in the Master Work Plan ammended by comments provided by the Narragansett Bay Ecorisk Advisory Group. For reference, the following sections of the Master Work Plan should be consulted:

Master Work Plan Section	Section Description
3.0	Data quality objectives, and sample collection and analysis procedures
4.0	Analytical procedures
5.0	Sample and data management procedures
6.0	Descriptions of site-specific ecological risk assessment reports
7.0	Health and Safety
8.0	References (except for those which are site-specific)
Appendices	Standard Operating Procedures (A); Chemistry and Toxicity Testing Quality Assurance and Quality Control (B), and Health and Safety Plan (C).

Specific tasks unique to the investigation of Derecktor Shipyard are presented in this Addendum. The project-specific organization and responsibilities also are described in this Addendum.

Building upon the foundation provided in the master Work Plan, the sections to follow present results of Problem Formulation for Derecktor Shipyard, identifies existing data gaps and approaches to obtaining the necessary data (Field Sampling and Analysis Plan), and proposes Exposure Assessment, Ecological Effects Assessment, and Risk Characterization activities unique to Derecktor Shipyard.

2.0 SITE-SPECIFIC PROBLEM FORMULATION

2.1 SITE CHARACTERIZATION

The primary objectives of the site characterization are to identify the kinds and spatial extent of habitats that are present on and around Derecktor Shipyard, and identify the species and biological communities that may come in contact with chemical contaminants present in sediments, and surface waters. The following site characterization for the onshore portion of Derecktor Shipyard was extracted from the Preliminary Assessment Report (PA) for Derecktor Shipyard (ENSR, 1993).

2.1.1. Derecktor Shipyard Site Description

NETC is located at the southeastern end of the Narragansett Basin. This basin is a complex synclinal mass of Pennsylvanian aged sedimentary rocks that is the most prominent geologic feature in eastern Rhode Island and adjacent Massachusetts. Narragansett Basin is an ancient north to south trending structural basin originating near Hanover, Massachusetts. The basin is approximately 55 miles long and varies from 15 to 25 miles wide. The western margin of the basin is in the western portion of Providence, Rhode Island, and the eastern margin runs through Fall River, Massachusetts. Exposures of older rocks on Conanicut Island and in the vicinity of Newport suggest that the southern extent of the basin is near the mouth of Narragansett Bay.

The Rhode Island Formation is the most extensive and thickest of the Pennsylvania formations in Rhode Island. At NETC and most of the surrounding area, the bedrock is composed entirely of the Rhode Island Formation. Included within the Rhode Island Formation are fine to coarse conglomerate, sandstone, lithic grawacke, arkose, shale, and a small amount of meta-anthracite and anthracite. Most of the rock is gray, dark gray, and greenish, but the shale and anthracite are often black. Crossbedding and irregular, discontinuous bedding is characteristic of the formation. Rock in the southern portion of the basin, where the NETC is located, is metamorphosed, and contains quartz-mica schist, feldspathic quartzite, garnet-stacrolite schist, and some quartz-mica-sillimanite schist. The beds of meta-anthracite and anthracite are mostly thin, but many areas within basin have been mined. Vein quartz, fibrous quartz, and pyrite are commonly associated with these coal layers, and the ash content is high.

Many areas on Aquidneck Island, on which NETC is located, obtain their water supply from wells. Areas relying on groundwater are mostly north of the Middletown area, but wells exist throughout the island. Most groundwater is used for domestic needs, although some is used by small industries and businesses.

Groundwater on Aquidneck Island is obtained from the unconsolidated glacial deposits of till and outwash and from the underlying Pennsylvanian bedrock. Throughout the area, depth to groundwater ranges from less than one foot to about 30 feet, depending upon the topographic location, time of year, and character of subsurface deposits. The average depth to the groundwater is approximately 14 feet on Aquidneck Island and moves from areas of high elevations to Narragansett Bay or the Sakonnet River.

Seasonal water level fluctuations are common in the area. These fluctuations range from less than 5 feet to as much as 20 feet on the hills. In the valleys and lowland areas, the fluctuations are generally less than 5 feet. During the late spring and summer, the water table usually declines as a result of evaporation and the uptake of water by the plants, and rises during autumn and following winter thaws.

The chemical characteristics of the groundwater are similar throughout the area; water is generally satisfactory for most ordinary uses. Most groundwater in the area is soft or only moderately hard; groundwater from till generally contains less mineral material and is softer than groundwater from bedrock. Locations where groundwater has a high iron content are scattered, but are most numerous around Newport and Middletown and the northern part of Portsmouth. Wells that have a high iron content usually penetrate only rocks of Pennsylvanian age.

The groundwater at NETC is shallow (less than 10 feet below the surface in most areas). Pollutants that migrate into groundwater would flow to the west and discharge into Narragansett Bay. NETC extends along the western shoreline at Aquidneck Island, so the groundwater only has to migrate a short distance before discharging into Narragansett Bay.

The soils occurring at NETC have permeabilities that are moderate to moderately rapid, so they do not restrict the vertical movement of water. The glacial till, from which these soils were derived, is generally less permeable than the overlying soils but does not represent a barrier to the vertical migration of water. Therefore, it is possible that any contaminant transported in this water could contaminate the groundwater. Isolated areas also exist where the bedrock occurs at the surface. Contamination is possible at these outcrops through the cracks and fissures that commonly occur in the bedrock.

The Rhode Island Department of Environmental Management (RIDEM) has established a state and groundwater classification system to protect it's groundwater resources. The groundwater at Derecktor Shipyard is classified as GB. Groundwater classified as GB is considered not suitable for drinking water without treatment due to known or presumed degradation.

2.1.2. Offshore Survey Results

This section describes the biological and contaminant distribution studies which had been performed by URI in 1994 in support of site characterizations at Derecktor Shipyard (Quinn et al, 1994b). Station locations for this study are shown in Figure B2-1.

2.1.2.1. Organic Contaminants

Surface Sediments Table B2-1 is a summary of the organic contaminants in surface sediments (top 2 cm) from 24 stations in Coddington Cove collected during the Phase I and Phase II URI 1994 Surveys. The ΣPCBs is the total PCBs (Aroclors) which is calculated by multiplying the sum of individual congeners measured in each sample by a conversion factor (2.0) obtained from the analysis of individual Aroclor mixtures. The ΣPAHs is the sum of all the individual polycyclic aromatic hydrocarbon (24 PAHs) measured in each sample. Tributyltin (TBT) is the major butyltin species found in the sediments and pp'DDE is the most abundant OCP in the samples.

A comparison of TBTs, ΣPCBs, ΣPAHs and organic carbon for all 24 stations found, overall, stations 3 and 11 had the highest concentrations of ΣPCBs, stations 2 and 3 had the highest levels of TBTs and ΣPAHs, and stations 5 and 11 had the highest concentrations of organic carbon. Several of the stations (i.e. stations 1-4) were selected for sampling because of their proximity to outfalls discharging into Coddington Cove and to piers with shipping activity (i.e. Station 11). High levels of contaminants seen at several stations, especially stations 2, 3, 11 and 20, suggest these areas are the potential sources for this contamination.

The concentrations of individual PCB congeners in surface sediments from stations 5, 18 and 20 revealed, in all cases, CB077/154 (unresolved mixture of 2 congeners), CB138, CB153 and CB118 are the major congeners. The distribution of Individual PAHs indicate that the major PAHs include flouranthene, pyrene, and chrysene.

Sediment Cores. All of the cores measured in the study (stations 1, 3, and 12) revealed evidence of organic contaminants down to the deepest sections analyzed. Organic contaminant distributions in core sections from one station (Station 12) revealed that the contaminant concentrations either remain constant or increase with depth in the core. Based on the presence of TBT (and its approximate usage start date), all sections of this core were deposited after 1960; based on the presence of C_{10}^{-} benzotriazole (manufactured after 1970) in the 22-24 cm section and its absence in the last (deeper) section, the latter was deposited before 1970 (Pruell and Quinn, 1985). Thus, sedimentation rate at this location, based soley on these chemical markers. is the approximate 1 cm/yr.

2.1.2.2 Inorganic Contaminants

Grain Size Distributions: The results of grain size analysis of the surface sediment samples reveal that many shallow water stations, (1, 2, 4, 9, 10 and 17) and most offshore stations (13, 14, 16 and 24) have high sand contents, whereas other stations (5, 6, 8, 11, 12, 18, 19, 20, 22 and 23) are relatively fine grained (Fig. B2-1). Core sample analyses show that the sediments collected at Stations 1 and 3 are extremely variable down core, whereas the sediments collected at Station 12 are relatively fine-grained and uniform downcore.

Organic Carbon Content: The organic carbon content of the Coddington Cove surface sediments were inversely correlated to the grain size distribution e.g. coarse sediments have lower organic contents, whereas finer sediments have a higher organic content.

Partial Digestion and Metal Analysis: The results of the partial digestion and analysis of metals for the Coddington Cove surface sediment samples revealed a wide range of variation in metal concentrations, a significant component of which can be can be attributed to lithologic variation.

Acid Volatile Sulfide (AVS) and Simultaneously Extracted Metals (SEM): AVS and SEM studies were undertaken on the surface sediment samples obtained from Coddington Cove in order to determine the potential bioavailability of the trace metals. AVS concentrations in the surface sediments of Coddington Cove are relatively high and ratios of SEM/AVS are very low (i.e. <<1.0).

Total Digestion and Analysis of Selected Target Analyte List (TAL) Metals: The spatial distributions of nickel, lead, chromium, zinc, copper, mercury, and silver after normalization to grain size (<% 15.6μm) indicated that maximum concentrations are found adjacent to the outfall pipes at the former Derecktor Shipyard. Normalization of the trace metal concentrations to the total aluminum concentration was also performed. This indicated significantly higher metals concentrations adjacent to these outfall pipes and decrease with distance from the outfall pipes.

Metal Concentrations in Coddington Cove and Narragansett Bay: Previous studies of Narragansett Bay sediments (King, 1994; Corbin, 1989) have shown that anthropogenic metal concentrations decrease exponentially down-bay from the major sources in the Providence metropolitan area. For example, the maximum concentrations of copper are comparable to those found in the Providence River and the copper concentrations at Station 12 are comparable to those found at mid-bay stations. The concentrations of the anthropogenic metals -- copper, zinc, lead, and nickel -- observed in Coddington Cove are very elevated for a site located in lower Narragansett Bay. The concentrations of the anthropogenic metals, chromium and cadmium, are slightly elevated for a site in lower Narragansett Bay. These results indicate that a major local source of anthropogenic metals exists in Coddington Cove.

2.2 ASSESSMENT AND MEASUREMENT ENDPOINTS OF CONCERN, INCLUDING CONTAMINANTS AND SPECIES

2.2.1 Contaminants of Concern

A preliminary list of proposed Contaminants of Concern (CoCs) for this investigation have been identified using a rationale which links the source (Derecktor Shipyard) to potential marine receptors in Coddington Cove and Narragansett Bay through plausible exposure pathways. In this approach, Hazard Quotients (HQs) are calculated as the ratio of the chemical concentrations in matrix of concern (ground water, surface soil, sediment) to the appropriate biological benchmark for these media (Ambient Water Quality Criteria (AWQC), Effects Range-Low (ER-L), Proposed Action Limits (PALs) and New Jersey Environmental Clean-up Responsibility Act (NJ ECRA)). Compound-specific Hazard Quotients exceeding 0.7 identify contaminants, which, as part of a conservative approach, will be considered to pose a potential risk to ecological receptors.

The process for CoC identification involved a four-step process. Using a hazard quotient (HQ) approach, chemical concentrations in onshore ground water and surface soil were compared with ambient water quality criteria - chronic values for these media to identify contaminants elevated above levels presumed to be protective of biological systems (Table B2-2). Groundwater data were available only for metals in well samples collected in the vicinity of Building 42 at Derecktor Shipyard. Those elements with HQs exceeding 0.7 have been designated "preliminary on-shore groundwater CoCs" (TRC, 1994).

Similarly, chemical concentrations in soils measured during the TRC study cited above, were compared with a NOAA sediment benchmarks (Table B2-3), assuming potential similarity of soil and sediment concentrations in nearshore zones. The list included both metals and selected PAHs. The PAHs exceeded the ER-L only while the metals Cu, Pb, Ni and Zn exceeded both the ER-L and ER-M. All chemicals with HQs exceeding 0.7 were designated "preliminary on-shore soil CoCs".

Chemical concentrations in marine sediments, measured during the URI studies (1993, 1994) were also compared with the NOAA ER-L benchmark (Table B2-4).

Several PAHs, total PCBs, the pesticide DDE and all metals measured were found to have HQs exceeding 0.7, and were designated "preliminary offshore sediment CoCs".

The lists of preliminary onshore CoCs and preliminary offshore CoCs were compared to identify chemicals in common to both (Table B2-5). Chemicals common to both lists were designated "proposed offshore CoCs".

CoCs not common to both lists were further evaluated for their toxicity, persistence in the marine environment, potential for bioaccumulation, and concentration relative to background levels. Butltins were one such chemical that was retained on the list despite benchmark data for quotient derivation. Additional chemicals suspected of posing ecological risk based upon new data from the onshore SASE or additional offshore studies will also be evaluated for inclusion as proposed offshore CoCs. In addition, other chemicals considered to be of concern by regulatory agencies which would not otherwise be on either list will also be included as proposed offshore CoCs as appropriate. The final selection of off-shore CoCs for offshore exposure media will be made following completion of the Exposure Assessment (see Section 5.0 of this addendum) and regulatory review.

2.2.2 Ecological Systems/Species/Receptors of Concern

The rationale for identifying ecological systems/species/receptors of concern (hereafter termed "receptor of concern") at Derecktor Shipyard follows that provided in Section 2.0 of the master Work Plan. Receptors of concern associated with the site which are potentially at risk, include:

- nearshore habitats directly adjacent to past disposal areas;
- pelagic communities, including plankton and fish;
- infaunal benthic communities in sediment depositional areas;
- soft and hard bottom epibenthic communities; and
- commercially, recreational, and/or aesthetically important natural resource species.

This list leads to identification of target receptors of concern in this ecological risk assessment. Table B2-6 identifies target receptors of concern for Derecktor Shipyard. The rationale for selection of these receptors includes:

o Blue mussel (*Mytilus edulis*) - This species is a locally abundant and ecologically important bivalve filter-feeder found in intertidal and subtidal habitats. It is an important food source for birds, fish, starfish, and occasionally humans. Blue mussels are surrogates for epibenthic species in the intertidal environment that are potentially exposed to water-borne and particulate-bound contaminants. Blue mussels are also surrogates for pelagic species when deployed in the water column away from the seafloor.

- Mummichogs (*Fundulus* spp.) and cunners *(Tautogolabrus adspersus)* - These species are locally abundant and ecologically important estuarine fish species which feed opportunistically upon both animals and plants. Tthey are also territorial and primarily bottom dwellers, hence they are potentially exposed to both water-borne and bulk sediment contaminants. They are important food sources for birds and other fish and amenable to conventional collection techniques. . Thus, these species would appear to be a suitable candidates for exposure/effects assessment. The habitats in the vicinity of Derecktor Shipyard may variably support one species over the other. In each case, we intend to collect small individuals (5-20 cm) of each species.

- Winter flounder (*Pseudopleuronectes americanus*) - This species historically is locally abundant and ecologically and economically important fish species which feeds upon benthic organisms. It is an important food source for birds, other fish, and humans. Flounder represent demersal fish species potentially exposed to water-borne and bulk sediment contaminants. Present abundances do not permit their collection for this study.

- Lobster (*Homarus americanus*) - This species is a locally abundant and ecologically and economically important subtidal crustacean which feeds opportunistically as a scavenger. It likely is an important food source for fish and humans. Lobster represent epibenthic species potentially exposed to water-borne and bulk sediment contaminants.

- Hard shell clam (*Mercenaria mercenaria*, *Pitar morrhauna*) - These morphologically and ecologically similar subtidal bivalve filter-feeders are locally abundant and are ecologically and economically important. They are important food sources for birds and occasionally humans. Hard shell clams represent infaunal species potentially exposed to bulk sediment and pore water contaminants.

- Benthic community - The infaunal benthic community, including sponges, corals, mollusks, segmented worms, arthropods (including crustaceans), starfish, and chordates (tunicates and fish), is an ecologically important, potentially rich assemblage of species with numerous life histories and feeding strategies. It is an important food source for birds, fish, and benthic and epibenthic invertebrates. The benthic community is potentially exposed to bulk sediment and pore water contaminants.

- *Avian aquatic predators* - Avain aquatic predators, of which the osprey, *Pandion haliaetus*, is an example, are local species which feed upon fish. The osprey, in particular, is a natural resource species of great aesthetic importance. Avian predators potentially exposed to contaminants through trophic transfer. Federal and local regulations do not permit their collection for this study.

Plausible exposure pathways for each of these receptors are presented in Section 2.3 of this addendum.

2.2.3 Assessment and Measurement Endpoints

Based upon the preliminary considerations of stressors, their potential ecological effects, and ecosystems which may be at risk, and in keeping with the requirements of the RI/FS process, a suite of assessment endpoints were identified as being important in this assessment. As indicated in Table B2-7, these include the general quality of estuarine sediments and water, and the status of natural resource species.

Several measurement endpoints will therefore be employed at Derecktor Shipyard as indicators of the higher level ecological and societal values represented by the assessment endpoints (Table B2-7). The measurement endpoints have been selected based upon their relevance to:

- The assessment endpoint and receptors of concern, their relevance to expected modes of action and effects of CoCs;
- Determination of adverse ecological effects;
- The availability of practical methods for their evaluation; and
- Their utility in extrapolations to other endpoints.

Most of these measurement endpoints have been used in other studies, and have proven to be informative indicators of ecological status in marine and estuarine systems with respect to the stressors identified as important in this assessment. Many serve a dual purpose in that they provide information relevant to two or more assessment endpoints.

In addition to the measurement endpoints used to evaluate the occurrence of, or potential for, adverse ecological effects, exposure point measurements will be employed to evaluate exposure conditions. Shown in Table B2-8, these include chemistry measurements made in environmental media (water, sediment, elutriate, biota), as well as geochemical attributes of exposure media which may influence the availability of contaminants to receptors.

The protocols and methods used to evaluate measurement endpoints and exposure measures are discussed in Section 4.0 of this addendum.

2.3 CONCEPTUAL MODEL

The Master Work Plan describes the first three tiers of the conceptual model developed to describe potential ecological risks associated with the Navy disposal sites in middle and southern Narragansett Bay. These initial three tiers describe the origin, transport and fate of stressors at different spatial and temporal scales. To complete this model, receptors and stressors specific to Derecktor Shipyard are included in the fourth and final tier, which describes exposure pathways (from source to receptor) hypothesized for this site.

The first tier of the conceptual model (Figue 1-2 of Master Work Plan) describes the general north-to-south gradient in stressor concentration in Narragansett Bay. Although many sources contribute to this gradient, and local sources may influence specific stressor concentrations anywhere in Narragansett Bay, this model suggests that contaminant concentrations in Coddington Cove in the immediate vicinity of Derecktor Shipyard should be evaluated within the context of the lower Bay to evaluate the extent and significance of this potential contaminant source on the ecology of Coddington Cove and Narragansett Bay.

The second tier of the conceptual model (Fig. B2-2) describes the local release of contaminants from Derecktor Shipyard. Contaminants are hypothesized to be transported from onshore Shipyard sources *via* surface and ground (seep) water routes, and from the harbor to Narragansett Bay through direct contact of Bay water with Coddington Cove sediments. A localized gradient is expected in contaminant concentration, with highest levels occurring in areas nearest to Derecktor Shipyard.

The third tier of the model (Fig. B2-3) provides details of the aquatic behavior of contaminants leading to exposure of ecological systems in Narragansett Bay, and aides in identification of potential adverse ecological effects. The general principles of contaminant behavior have been described in the Master Work Plan. As shown in Figure B2-3, bound contaminants may be transported horizontally in association with particles, but may also settle to the bottom in localized depositional areas, such as the harbor sediment as found in previous site investigations.

As described by the first three tiers of the conceptual model for NETC sites, including Derecktor Shipyard, ecosystems potentially at risk include nearshore habitats, pelagic, benthic, and epibenthic communities, and natural resource species.

The description of stressor dynamics suggests risks to these systems to be highest in areas of Coddington Cove adjacent to Derecktor Shipyard. Although risks to other ecological systems present in the Narragansett Bay cannot be dismissed, this conceptual model focuses the assessment on ecosystems associated with depositional sediments in Coddington Cove. Chemical stressors in these areas include the proposed CoCs identified in Table B2-5, as described in Section 2.2.1 .

The fourth, final tier of the conceptual model for Derecktor Shipyard describes hypothesized exposure pathways relating CoCs in the Cove to the receptors of concern identified in Table B2-6. Developed for receptors by ecological habit (pelagic, epibenthic, infaunal, avian predator), these exposure pathways are illustrated in Figures B2-4 to B2-7. Illustrated in these figures are the routes of CoC transport from terrestrial sources, through intermediate sources (runoff, soils), to the proximal source of exposure and to receptors. These proximal sources become the exposure points in the Exposure Assessment. Also illustrated are the measurement endpoints which will be evaluated in the Ecological Effects Assessment.

3.0 Identification of Data Needs

Data needs for the ERA are those which represent information necessary to support the characterization of species and contaminants of concern (Site Characterization), transport and receptor pathways (Exposure Assessment), and the offshore ecological impacts related to Derecktor Shipyard (Ecological Effects Assessment).

The sampling proposed in this addendum is necessary for several reasons: 1) sediment organic and metal contaminant, and elutriate studies need to be conducted in conjunction with toxicity studies to assess the potential toxic effects of in-place or resuspended sediments on the biota; 2) contaminant studies need to be conducted in conjunction with biological indicators to assess the potential impact of contaminated sediments on individual species and the benthic community structure, and 3) fate and transport studies including geophysical, hydrographic and eutrophication surveys are needed to determine the spatial (both horizontal and vertical) distribution of sediment types, circulation patterns and strength, and hypoxia so as to elucidate and discriminate the pathways of contaminant movement and fate and associated effects.

3.1. CONTAMINANT DATA NEEDS

Sediment Chemical Analyses. Determination of the concentrations of selected metals, PCB congeners, pesticides, PAHs and butyltins from limited surface and core sediment samples is required to further document magnitude and extent of contamination, including the elucidation of vertical contamination gradients. In addition, the bioavailability of contaminants must be considered, thus measurements of total organic carbon for understanding bioavailability of non-ionic organic contaminants and SEM/AVS for metal bioavailability are critical and will be determined for sediments. Dissolved metals in elutriate preparations are measured to gain a clearer picture of possible metals exposure during resuspension events within the inhabited zone for infaunal and epibenthic invertebrates.

Tissue Chemical Analyses. Tissue analyses are needed for the same suite of analyses as performed in sediments. Data are needed on both indigeneous and deployed bivalves in order to assess the importance of habitat/trophic mode in discerning chemical exposure and pathways for contaminant transfer in the food chain. Similarly, fish tissue data are required to assess contaminant bioavailability for species with differing trophic modes and feeding/habitat preferences. Lipid content data are needed for all tissue samples to assist in the intercomparison of organic contaminant residue data between species and over time.

Geotechnical characteristics. The grain size distribution of surface and core samples is required to better understand habitat differences among sites, and as a correlate to TOC and AVS, to assess the relative binding capacity and potential contaminant content of sediments. The data are also used to interpret the results of remote sensing methods for habitat characterization such as side scan sonar, where acoustic reflection strength (side scan image whiteness) is proportional to grain size, thus allowing one to map sediment type from spatial variation in the image.

3.2. BIOLOGICAL DATA NEEDS

Toxicity Testing. Toxicity tests are essential tools to evaluate the bioavailability of contaminants in bulk sediment and resuspended sediments, and hence provide key data in the Ecological Effects component of the ERA. The proposed tests, including the sediment test with amphipods (10-day acute) and elutriate test with the sea urchin (48 hr embryo development) are widely used and standardized procedures for this purpose (USACE/USEPA, 1994).

Indigeneous Biota Condition Indices. Condition indices data are needed to determine whether site-related exposures have resulted in physiological impairment (e.g. reduced growth) or infection (e.g. fin rot) of indigeneous populations. Similarly, estimates of abundance, and distribution of the large bivalves within the study are needed to assess the potential for population-scale impacts on these ecologically, recreationally and economically important group of organisms.

Benthic Community Structure Analyses. Benthic community structure analyses focus on the smaller invertebrate population and are needed to evaluate impacts of physical and/or chemical insult on the stability and diversity of indigenous populations. Given that communities represent a higher level of organization than the species, this analysis is needed to augment results obtained from toxicity analysis. Identification to species is needed to calculate diversity measures, identify indicators, and compare results with previous studies. Diversity analyses are needed for both near shore and far shore sampling stations.

No previous studies of the benthic community structure have been undertaken in Derecktor Shipyard, and hence this survey will rectify this significant data gap. This survey is also needed to provide information on the potential role of bottom animals in the sedimentation, erosion, and vertical mixing of contaminated sediments, as well as to identify the primary organisms in the food chain through which pollutants may be transferred.

Mussel Deployment. Chemical residues and growth data from deployed mussels (Mytilus edulis) are needed to characterize water column exposure conditions and evaluate potential ecological effects for pelagic species. In addition, supporting measurements of temperature, salinity, dissolved oxygen, suspended solids and chlorophyll a concentration are needed at weekly intervals during the deployments to provide background data on the environmental conditions under which bioaccumulation and growth are occuring.

MFO/P450 measurements. Because extensive PAH bioaccumulation in fish is not typically observed (detoxification mechanisms breakdown and eliminate PAHs as they are accumulated), and previous studies of Drecktor Shipyard have revealed high PAH concentrations (Quinn et al., 1994b), an indicator of PAH exposure other than tissue residues is required to adequately characterize exposure to this target receptor group.

One such indicator is known as P450 activity. The cytochrome P450 system includes several families of heme proteins, enzymes, that catalyze detoxification reactions with foreign compound substrates. During these reactions, apolar (lipid-soluble) chemicals are converted to more water-soluble and readily excreted metabolites. This is accomplished through biotransformation involving oxidation by several monooxygenase reactions which are catalyzed by the cytochrome P450 system. In the environment, teleosts are exposed to aromatic contaminants such as PCBs, dioxins, and aromatic hydrocarbons, capable of inducing hepatic cytochrome P450 monooxygenase activity. The response of this enzyme system is well established in both freshwater and marine fish exposed to a variety of contaminants has been evaluated in a number of laboratory and field studies (Table B3-1). Results from these studies have indicated that this enzyme system responds rapidly, at very low levels of exposure, and is highly correlated with contaminant level in the environment.

Based on this information, P450 would appear to be a valuable exposure indicator for fish collected in the Derecktor Shipyard ERA. Thus, the measurement of

P450 responses in fish collected at the same stations as those collected for chemical analysis will be attempted. The data will be used cytochrome P450 measurements will be made on fish to infer PAH detoxification activity and also suggest potential adverse effects due the metabolic "overhead" of detoxification (reducing reproductive output, for example). The fish will be collected in conjunction with those collected for tissue residue and condition assessments.

3.3. HYDROGRAPHIC AND GEOPHYSICAL DATA NEEDS

Dissolved oxygen and ammonia concentration. Dissolved oxygen and ammonia concentration are two water column parameters for which organisms have minimum biological tolerances. Dissolved oxygen (DO) concentrations below 2-3 ppm are considered hypoxic, and can adversely impact a species physiology. Free-ammonia (NH_4) is highly toxic to marine organisms and may reach significant concentrations above the sediment water interface during hypoxic conditions. Data on these parameters are highly desirable for Coddington Cove where communities may be affected by episodes of hypoxia which occur because of restricted circulation in the harbor as well as added biological oxygen demand caused by nutrient loading. These data are also needed as companion data for similar measurements made in test chambers during toxicity tests.

Hydrographic studies of Coddington Cove. Characterization of both the magnitude and patterns of flow within the Coddington Cove region are required to discriminate between contaminant transport pathways to receptors resulting from exposure to sewage-derived sources vs. site-related sources. In addition, the magnitude of contamination already observed in Coddington Cove suggests that significant hot-spots of contamination exist which may be related to differential circulation and/or residence time (flushing rates) characteristics within various sections of Coddington Cove. The model of circulation to be developed from this work is also needed to predict the redistribution and flux of contamination out of the harbor which might occur under under varying hydrographic conditions (e.g. storms) and/or remediation options (e.g. application of use-based clean-up standards).

Geophysical Survey. The geophysical survey is needed to map the surficial distribution of sediment type such that the station-specific chemistry and toxicity results may be generalized to the entire study area. In addition, the sub-bottom profiling component will provide a third dimension to sediment distribution which could be used, in conjunction with contaminant data, to estimate the volume (if any) of contaminated material that should be removed by dredging. In addition, the results of the survey will be used to fine tune sediment sample locations by insuring that selected locations are regionally representative of habitat structure.

Nutrient Fate and Transport. Nutrient fate and transport issues at Derecktor Shipyard include potential impacts of hypoxia and nutrients from various sources to

Coddington Cove. Specific attention will be merited to the "dead zone" along the water front, with the objective that the results of the study be able to conclusively implicate or rule out Navy-related contaminant input as the primary stressor to this area. Because weight of evidence must support this conclusion and that hypoxia impacts are a plausible alternative hypothesis to contaminant impacts as the primary effects mechanism, water circulation and oxygen dynamics studies are required. Standard O_2 measurements in Coddington Cove (done in conjunction with mussel deployments) will be augmented by the collection of the data necessary to model O_2 concentrations under various scenarios (particulary water tempearture and stratification). These data will include measurement of water (BOD/COD) and sediment (SOD) oxygen demand at selected sediment sampling locations.

The Newport outfall dye study model and other existing data will be reviewed to assess inputs from the Newport CSO as a potential source of BOD to Coddington Cove. Measurement of tissue pathogen concentrations in deployed mussels being near outfall pipes along the waterfront as well as along a gradient extending from the harbor front outward towards Narragansett Bay, are needed to provide data to support this assessment.

4.0 Plan for Data Collection and Analysis (Field Sampling and Analysis Plan)

The primary purpose of the proposed data collection and analysis activities are to fill data gaps in the information base required to complete the ecological risk assessment. In the following sections, station locations, and plans for collection of sediments, biota and hydrographic/geophysical data are presented, as well as a general description of the methods and QA/QC procedures used in the sample and data analysis. A complete description of the methods and QA/QC procedures are for sediments and biota are contained in the Master Work Plan.

4.1. STATION LOCATIONS AND SAMPLING METHODS

4.1.1. Sediment Sampling Plan

The locations of the proposed sampling locations adjacent to Derecktor Shipyard are shown in Figure B4-1 and the rationale for their selection are summarized in Table B4-1. A total of 17 stations in Coddington Cove have been selected including two sites in the "dead zone" which is apparently devoid of biological activity. These include a surface sample (Station 40) and a core sample (Station 41). The stations have been selected to confirm results of high contaminants, to fill data gaps from prior studies, and to characterize the offshore gradient in contaminants.

Reference collections for sediments and species will also be attempted at

Potter Cove (PC) on Conanicut Island, which is due west of Coaster Harbor. This site is proximate to the Jamestown sewage treatment plant outfall. At this point in time, it is not possible to unequivocally state that contaminants from this plant (or the Newport sewage treatment plant outfall at Coddington Point) do not enter Coddington Cove. However, the results of the hrdrographic survey (discussed in section 4.1.2, below) will allow us to assess the magnitude and direction of contaminant fluxes in the study area. A second reference site, Castle Hill Cove, has been selected as a relatively unimpacted site with similar hydrograhic characteristics as Coddington Cove, but lacks significant industrial development or nutrient loading. Castle Hill Cove is a small embayment approximately 2 miles south of Coddington Cove. The U.S. Coast Guard Station Castle Hill is located there and a sewage outfall existed at that site approximately three years ago. Thus, it is also not a perfect reference site, but is best among available alternatives for unimpacted core sites that contain fine-grained sediment.

A sample collection and laboratory analysis summary is shown in Table B4-2. Surface grabs will be collected at 17 stations which are located in or proximal to Coddington Cove. The stations have been selected to detect an environmental gradient from highly contaminated near shore stations to less contaminated offshore stations. Reference collections for inshore and offshore sediments and biota will be attempted at Potter Cove (PC) and at Castle Hill Cove (CH).

At all 19 surface stations (including reference sites) , surface sediments (0-20 cm) will be collected. A biological corer will be used to collect sediments; 3-4 grabs may be required to collect a sufficient sample for both chemistry and toxicity analyses. The surface material from each grab is composited in a 12-liter, pre-cleaned polyethylene bucket, stirred with a titanium stirrer for ~30 seconds, and then scooped into pre-cleaned containers for organic and inorganic chemistry, elutriate analyses and toxicity studies. Additional box core samples will be obtained at each station and used for benthic infaunal analysis as described in Section 4.2.3 of this addendum. Between stations, the scoop is rinsed in sequence with distilled water, 1:1 nitric acid, methanol and de-ionized water. Field-rinsates of the scoop will be collected and analyzed as field blanks. The corer will also be washed-down with sea water between stations. The samples are stored on blue ice during collection and, upon return to the laboratory, at -20°C and 4°C for chemistry and toxicity studies, respectively.

Cores (down to ~ 1 meter) will be collected for chemical analysis at 6 surface stations and a mid (~ 50 cm) and deep section (~ 1 m) of each core will be analyzed for chemical contaminants. Core stations 2, 5, and 7 have been previously been found to have high surface contamination (Quinn et al., 1994a and b). These core data will provide estimates of the depth of contamination in Coddington Cove adjacent to Derecktor Shipyard. Core stations 11 and 12 are fine-grained, relatively homogeneous sediments and will be radiometrically dated to provide estimates of contaminant accumulation rates and determine trends in environmental quality.

A piston core will be used to take the (~1 m) cores. A standard piston corer, the biological corer, is used to retrieve cores from intermediate water depths (<20 m). The corer uses polycarbonate tubes and is deployed using a series of 3 meter long extension rods to push the corer into the sediment. Cores up to one meter long are recovered using this design. The cores are transported in the vertical position and are transported to the lab for storage at 4°C until logging and sectioning. Sectioning is completed within 48 hr of collection, sectioned sediment samples are stored -20°C until chemical analysis.

Fifteen vibra cores (down to approximately 3 meters) will be collected for the purpose of determining sediment lithology. (Grain size and TOC will be measured at 0.5 m intervals.) Six of these cores will be from the 6 core sites for chemical analyses. Up to 4 additional core sections from these vibracores at > 1 m depth may be analyzed for chemical contamination depending on thedata obtained from the one-meter piston cores. The remaining number of these cores will be located based on the results of the geophysical survey findings.

4.1.2. Biota Sampling Plan

The proposed biota sampling summary for the Derecktor Shipyard ERA is presented in Table B4-2. It will be necessary to maintain flexibility in this plan because the actual distribution of available organisms within Coddington Cove is not well known. If initial efforts fail to collect adequate species numbers, the stations may be relocated and/or the sampling effort extended over a longer period. Target species are the blue mussel, hard shell clam, soft shell clam, lobster and fish including mummichogs and/or cunner. Lobster and fish collections may

The distribution of sediment sampling locations investigated during the URI (1994) study is shown in Figure B4-1. The following discussion describes the location of biota sampling for the Derecktor Shipyard ERA. In each case, the biota sampling location is paired with a sediment sampling location (closed and open circles) so as to allow exposure-response relationships to be investigated.

- o *Benthic community structure*. Sampling for benthic community structure will involve sediment collections at each of the 17 sediment sampling locations in Coddington Cove (Fig. B4-1), one location in the Jamestown Potter Cove reference area, and one location at Castle Hill Cove (Table B4-2). Duplicate 400 cm^2 Van Veen grab samples will be obtained and sieved aboard ship to 0.5 mm. Organisms will be picked from the screen and preserved separately for taxonomic analyses.

- o *Epibenthic Receptors (Indigenous Blue mussels)*. Natural populations of blue mussels *(Mytilus edulis)* will be collected at harbor front stations 25-29 to characterize long-term exposure and effects on epibenthic populations in the immediate vicinity of Derecktor Shipyard. In addition, 3 additional samples will be collected shoreward of stations 35, 36 and URI (1994) station 24, to characterize the nearshore environment where epibenthic scavengers and birds may have more active feeding (Fig. B4-2). The environment above the sediment water interface is entirely artificial, consisting of docks/piers and concrete abutments. Collections will be made at low tide by hand-picking of specimens off the structures. Collections of indigenous mussels are also planned for intertidal areas at the two reference sites. Incidence of hematopoietic neoplasia will be assessed on samples collected from each of these locations.

- *Infaunal/epibenthic Receptors (Hard Shell Clams).* Natural populations of hard shell clams *(Mercenaria mercenaria)* will be collected at offshore stations 31-36 and 38 to characterize long-term exposure and effects on infaunal/epibenthic populations in Coddington Cove away from the immediate vicinity of Derecktor Shipyard water front (Fig. B4-3). One additional station will be attempted in the "dead zone" area, and if unsuccessful, will be relocated to the vicinity of station 30. No depuration bivalve samples will be performed. Collections of hard shell clams are also planned for deep areas at the two reference sites.

- *Fish Receptors* Natural populations of mummichogs and/or cunner will be collected at harbor front stations 26, 28, 29, 31 and 34 as well as shoreward of stations 35 and 36, to characterize the nearshore environment where avian predators may have more active feeding (Fig. B4-4). Collections of fish are also planned for intertidal areas at the two reference sites. Evidence of cytochrome P450 activiation in fish collected from each of these locations will be assessed.

- *Epibenthic scavengers (Lobsters).* Natural populations of the american rock lobster (*Homarus americanus*) are planned for 9 stations in Coddington Cove + 2 reference sites (Fig. B4-5). Traps will be deployed at harbor front stations 25, 27, 28, 29; at central Coddington Cove stations 33, 35 and 36, and at Outer Coddington Cove stations 38 and 39. Collections of lobsters are also planned for intertidal areas at the two reference sites.

- *Pelagic Exposure pathways.* Blue mussels will be deployed at 1 m above bottom at 8 stations in Coddington Cove and at 2 reference sites (Fig.B4-6). The strategy is to characterize harbor front water quality conditions via stations 26 , 28, 29 and between the new "dead zone" stations 40 and 41 as well as the gradient in water quality extending out of the harbor via stations 31, 33, 38 and 39. (The figure shows station 40 as the site; precise locationing will depend on logistical considerations such as vessel traffic, etc). Mussel deployments are also planned for deep areas at the two reference sites. Each station will consist of four cages on separate sub-surface floats. A composite of the four replicates will be generated for a single chemical analysis at that station; condition indices will be assesed on individual replicates. Mussels will be obtained from a known clean area in Barnstable, MA, often used by the EPA ERLN laboratory, or alternatively, purchased from an offshore mussel harvester who collects from Georges Bank. In either case, time zero chemical residues will be assesed.

As the field work is planned for late summer during peak metabolic activity of mussels (hence bioaccumulation and growth), the deployment will last for 30 days. This strategy also affords maximum synopticity with other field measurements and greatly reduces risk of sample loss which would accompany longer deployment durations. In addition to chemical analyses and condition indices, mussels collected at these locations will be examined for pathogen concentrations. Data on chlorophyll a, total suspended solids, temperature and salinity will be measured at the beginning, middle and end of the deployment to support interpretation of mussel growth data.

4.1.3. Geophysical/Hydrographic sampling plan

The work described in this section details the approach necessary to characterize sediment distribution spatially and with depth as well as determine the water circulation pattern near Derecktor Shipyard and adjacent Coddington Cove, including the exchange between Coddington Cove and Narragansett Bay.

Geophysical Surveys - The survey will utilize a composite Datasonics Chirp Sub-bottom Sonar and Side-Scan Sonar system that was used for McAllister Point. Side scan sonar will be used for surface characterization; chirp sonar will be used to determine depth of sediment units. The proposed study area is shown in Figure B4-7. This area includes Coddington Cove, and a small area outside the mouth of Coddington Cove up to the Newport Sewage Treatment Plant outfall. The sidescan/chirp probe will be towed behind a vessel along pre-designated survey lines spaced approximately 20-50 m apart. This survey strategy is intended to provide >90% bottom coverage of the survey area. Navigation will be provided at Differential Global Positioning System (DGPS) accuracy (resolution to $\pm$ 3 m).

Hydrographic Surveys. The hydrographic survey plan is shown in Figure B4-8. Data on current velocity vs. depth will be collected in real time using a moving platform. An RD Instruments Broadbeam 1200 acoustic Doppler current profiler (ADCP) will be used, which can vertically profile water currents from a moving platform with $\pm$ 5 cm sec^{-1} accuracy. Factors to be considered in the hydrographic survey include the pattern of water circulation driven by semi-diurnal tides and longer-term, non-tidal net flow driven by winds and density variations. Energetics and flow patterns within Coddington Cove will be determined from data collected over a gridwork of survey lines. The time required to complete the designated line series within the Cove is approximately 15 minutes.

This survey strategy and instrumentation has been used successfully in a previous study of circulation within the Housatonic River Estuary in Connecticut. The use of the ADCP data eliminates inaccuracies in extrapolating three dimensional circulation patterns from point velocity current meters and allows for rapid, accurate and highly cost-effective measurement technique for elucidating circulation patterns into and out of Coddington Cove.

To determine the effect of tidal variation during the survey and remove its effect from the data interpretation, a pressure (tide)/conductivity/temperature gauge will be deployed at the mouth of Coddington Cove. A number of conductivity, temperature, Dissolved Oxygen (CTD) surveys will also be conducted to determine density distributions and salt fluxes across the relevant interfaces.

Three data collection surveys will be conducted to 1) spring or high runoff conditions which will include a Spring tide, 2) late summer or low flow conditions and 3) late fall when seasonal cooling effects become important. The first two sampling sets are most important for characterizing periods of maximum and minimum kinetic/mixing energies, respectively. Finally, information on the kinetic energy of the tidal flow and circulation patterns will be combined with data on sediment size distributions and empirical laws to estimate sediment resuspension and transport patterns in the Coddington Cove - Narragansett Bay system.

4.2. SAMPLE ANALYSIS PLAN

Detailed descriptions of Standard Operating Procedures (SOPs) and Quality Assurance/Quality Control (QA/QC) procedures to be used for chemical and toxicological analyses of sediments and biota are contained in Appendices A and B of the Master Work Plan, respectively. The following section reviews general aspects of these procedures, and describes site-specific modifications/additions where necessary.

4.2.1. Chemical Analyses

Sediments. The concentrations of selected metals, PCB congeners, pesticides, PAHs and butyltins will be determined from surface and core sediment samples (refer to Table 3-2 of Master Work Plan). Two depths per core sample will be analyzed, such that the complete analysis suite will consist of three vertical measurements (surface + 2 depths). These data will serve as the basis from which vertical contamination gradients will be discerned. In addition, the simultaneously extracted metals (SEM) and the acid volatile sulfide (AVS), and the ratio (SEM/AVS) will be determined for sediments.

Tissues. Tissue analyses will include the same suite of analyses as determined in sediments. Shell and exoskeletal material will not be analyzed for any species. Bivalve and fish tissue will be frozen whole after collection and analyzed whole.

Samples of bivalves from the collection will be selected at random and will be shucked at the organic or inorganic lab depending on the analysis. Lobster specimens will be resected live to obtain separate tissue groups; muscle and hepatopancreas. In addition, the lipid content of the tissue will be determined and used in bioaccumulation factor calculations.

Elutriate testing. Elutriate chemical analyses on selected samples will be performed. Measurements will include organics as well as simulataneously extracted metals (SEM) and Acid Volatile Sulfides (AVS) concentration. The elutriate is prepared as a 1:4 dilution of whole sediment., followed by centrifugation (USACE/EPA 1992). Splits of particle-free water are prepared for chemical and toxicological analyses.

Whole water samples. During the sample collection period, and during the hydrographic study, whole water samples will be collected at several stations in Coddington Cove. Water will be collected with a Go-flo or Niskin bottle, preserved and analyzed for dissolved oxygen and free ammonia concentration. The whole water samples will be used to calibrate the CTD profiles and the ammonium sensor incorporated into the CTD profiler. Methods for these analyses are described in Appendix C of the Master Work Plan.

4.2.2. Geotechnical Analyses

Grain size. The grain size distribution and total organic content of the surface and core samples will be determined as described in Appendix B of the Master Work Plan. The grain size data will be used to ground-truth the side-scan sonar map and to normalize the metals data for lithologic variation.

Total organic content. The total organic content data will be used to normalize the organic contaminant data. These measurements are critical because it is otherwise difficult to determine the origin of contaminants by examining concentration gradients without first normalizing for lithologic variation.

4.2.3. Biological Assays

Toxicity Testing. All surface grab samples will be evaluated for bulk sediment and elutriate water toxicity using the amphipod 10-day acute test and the sea urchin embryo development test, respectively. A complete description of the amphipod 10-day test is contained in the Master Work Plan; the elutriate test SOP is provided in Master Work Plan Appendix A. Sea urchins are among the recommended species for the elutriate test, (although the Greenbook lists west coast species), hence testing will use our local species, *Arbacia punctulata*.

Condition Indices. Condition indices on all bivalves collected for this study will be determined from the ratio of dry tissue weight to shell length, weight and volume. Statistical analyses for differences in condition among stations and reference sites will be conducted using station grouping as replicate data, or in the case of deployed mussels, replicate station data (n =4). Indigeneous mussels will be assayed for the presence of hematopoeitic neoplasia, a blood cell disorder correlated with contaminant exposure in soft shell clams (Munns et al., 1991). Fish and lobsters will also be inspected for external evidence of pathological damage (fin rot, gill lesions, shell disease).

Benthic Community Structure Analyses. Quantitative analyses for benthic community structure will employ sample processing and counting techniques closely follow those used in the EPA EMAP program and in the benthic infauna survey of McAllister Point carried out by Menzie - Cura & Associates in August 1993. Organisms will be identified and counted to species. From the data obtained, community structure parameters including species richness, evenness and the number of opportunistic forms present wil be calculated. Diversity analysis will be conducted on both near shore (stations 25-29, 35-36, 40-41) and offshore (stations 32-34, 37-39) sampling locations, as indicated in Figure B4-1.

Community structure data obtained from stations adjacent to Derecktor Shipyard will be compared against reference area results as well as with historical data obtained from sites in lower Narragansett Bay and other estuaries in the region. Information from Remotely Operated Vehicle (ROV) videos, side-scan sonar, and diver observations will be used as presently available to aid in identification of bottom characteristcs from which the taxonomic data was obtained to aid in the interpretation of data.

4.2.4 Geophysical/Hydrographic Studies

Geophysical Surveys Side scan sonar data will be processed to prepare a figure to show areas of debris, changes in sediment lithology which, in conjunction with point estimates of grain size and soft sediment thickness, will allow the construction of maps depicting soft sediment distribution across the harbor and with depth. The results will be produced in a format ammenable to the characterization of sediment distribution and transport potential as well as the estimation of the volume (if any) of contaminated material that should be removed by dredging .

Hydrographic Studies. The CTD and Broadband ADCP survey data will be analyzed to characterize seasonal density and flow patterns adjacent to Derecktor Shipyard in Coddington Cove and from the Cove into neighboring portions of Narragansett Bay. The spring and summer data sets will be used to characterize the maximum and minimum periods of current strength and turbulent mixing, respectively. Event scale perturbations, such as storms, will be documented. Supporting data for locations outside the study area will be used to place this site-specific information into a regional hydrographic context. These data sources will include (i) local wind and tide data from an Office of Naval Research (ONR) funded recording station currently being installed on the Graduate School of Oceanography (GSO) pier and (ii) U.S. Geological Survey (USGS) river runoff data for Providence and Taunton Rivers. Contour maps of water velocities for characterization of sediment transport potential across the cove will be derived as well as the residence time of water masses within various regions of Coddington Cove.

Nutrient Fate and transport Investigations. Water column (BOD/COD) and sediment (SOD) oxygen demand measurements at selected sediment sampling locations (stations 26, 30-33, 35 and reference sites; Table B4-2. Sediment core samples will be taken at each station and incubated with overlying site water at bay temperature (~20-22 °C) and low light (15-30 µE m^{-2} s^{-1}). Time series oxygen measurements are taken to develop a curve of O_2 uptake for the station. Similarly, water samples will be taken at 15 day intervals over a month at each SOD station using Go-flo bottles. Data on oxygen demand as well as salinity distributions and residence time will be entered into the EPA WASP model to calculate/predict water column (surface/bottom) O_2 concentrations. Measurement of tissue pathogen concentrations in deployed mussels will consist of total and fecal coliforms (including *E. coli*),male-specific bacteriophages as well as *Clostridium perfringens* spores will be enumerated in mussel tissues using the most probable number method.
The Newport outfall dye study model and other existing data will be reviewed to assess inputs from the Newport CSO as a potential source of BOD to Coddington Cove.

4.3. SAMPLING LOGISTICS

Sampling will be conducted from three research vessels as well as from shore. For relatively shallow stations (< 3 meters of water), pontoon boats, barges and smaller motorboats will be used for sampling. Accomodation for observers will bemade to the extent possible. During the duration of the sampling the research vessels will be moored at the Navy facilities at Derecktor Shipyard.

5.0 Exposure Assessment

Exposure assessment in the Derecktor Shipyard investigation will involve an evaluation of the site-specific conceptual model with respect to hypothesized exposure pathways. For this assessment, Derecktor Shipyard is considered to be the primary (but not proximal) source of CoCs in nearshore areas. Exposure Assessment will include direct measurement of exposure point concentrations along these pathways. CoCs and other chemical contaminants identified in Section 4.0 will be quantified in environmental media representing proximal sources (including biota). In addition to direct measurement of chemistry, other exposure measures (identified in Table B2-8) will be assessed to aid in the interpretation of chemical exposure conditions. Methods and QA/QC considerations and protocols relevant to analytical chemistry are presented in the master Work Plan and in Section 4.0 above.

Exposure information derived from previous investigations at the site will be evaluated for applicability to this assessment, and will be used as appropriate. Accompanying the use of these data will be a discussion of the comparability of the various data sets. The Exposure Assessment for Derecktor Shipyard will include evaluation of the uncertainty associated with the exposure analyses.

6.0 Ecological Effects Assessment

Ecological effects are quantified by determining the relationships between relevant exposure patterns and resulting responses of ecological systems, put in terms of the measurement endpoints identified during Problem Formulation (Section 2 of this Addendum). Four primary Ecological Effects Assessment activities will occur in the Derecktor Shipyard investigation:

- Toxicity evaluations of bulk sediments using the 10-day amphipod mortality test, and of pore waters using the sea urchin sperm cell test;
- Evaluations of abundance and condition of the receptors identified in Table B2-6;
- Collation of information regarding the known effects of CoCs; and
- Collation of applicable criteria and standards appropriate to the exposure media representing proximal sources along each exposure pathway.

Generally, quantification of measurement endpoints will coincide with quantification of exposure point concentrations of CoCs from a spatial perspective (see Section 4.0 above). An analysis of uncertainties associated with these activities will be included in the Ecological Effects Assessment for Derecktor Shipyard.

7.0 Risk Characterization

A weight-of-evidence approach will be used as the primary method for characterizing offshore ecological risks associated with Derecktor Shipyard. Several lines of evidence will be evaluated in drawing conclusions concerning risk:

1. *Observed adverse effects - comparison with reference stations.* Statistical comparisons can be made of exposure and ecological effects data collected

near Derecktor Shipyard *versus* reference areas, treating sampling stations within an area as replicates.

2. *Analysis of CoC concentration versus observed adverse effects.* Analyses will be conducted to evaluate the relationships observed between measured CoC concentration and the quantified response of the measurement endpoint. For instance, if a particular CoC is causative in ecological impacts to a particular receptor, then a change in the response of measurement endpoints associated with that receptor should be observed with increasing CoC exposure. Interpretation of these patterns will involve a discussion of whether the observed ecological effect is expected to result from elevated exposure to the CoC.

3. *Analysis of bioaccumulation.* Elevated tissue residues in receptor species identified in Table B2-6 will be interpreted as an indication that CoCs are bioavailable and can potentially be transferred in other receptors through trophic interaction. Trophic transfer of CoCs to winter flounder and to avian predators will be calculated as direct measurement ofcontaminants in these species will not be made. Analysis of bioaccumulation in lobster will include two scenarios: one assuming a resident population, and the other assuming a migratory population. Information will be sought from the literature and will be used to estimate ecological risks to receptor species resulting from the presence of CoCs in tissues.

4. *Analysis of toxicity evaluations versus observed ecological effects.* Results of toxicity tests conducted on sediments and porewater collected at field sites will be compared with measurement endpoint response at those sites. Care will be taken to ensure that toxicity endpoint-measurement endpoint comparisons are appropriate for a particular receptor.

5. *Comparison of exposure point concentration with toxicity-based criteria and standards.* This analysis will involve calculation of exposure media-specific Hazard Quotients (HQs) and Hazard Indices (HIs) using NOAA ER-Ls and ER-Ms for sediments, and ambient water quality criteria for pore waters. Crustal weathering models will be employed to evaluate CoC elevation relative to background conditions. SEM/AVS ratios for divalent metals, and pore water equilibrium partitioning for non-ionic organic contaminants will be employed to assess availability of CoCs to ecological receptors.

6. *Comparison of exposure point concentration with toxicity data.* Based on the known adverse effects of CoCs as reported in the literature and in toxicity data bases (*e.g.*, AQUIRE), the concentrations of CoCs measured at critical exposure points will be evaluated against suspected effects levels.

This weight-of-evidence approach will be used to evaluate causal relationships between CoCs (exposure) and the existence or suggestion of adverse ecological effects. For example, the observation of anomalies in benthic community structure in areas with SEM/AVS ratios greater than 1.0, but low organic CoC levels, would suggest divalent metals to be posing ecological risk in those areas. Observation of toxicity of bulk sediments collected in those areas would further support this hypothesis. Conversely, benthic community structure anomalies in the absence of elevated CoCs and sediment toxicity may implicate other types of stress, such as physical disturbance or low near-bottom dissolved oxygen. All available evidence will be utilized in evaluating the lines of evidence relating CoC exposure to potential adverse ecological effects. It should be noted that not all lines of evidence need point to one or more CoCs as causative agents for risk to be presumed in association with that CoC. In this weight-of-evidence approach, it will only be necessary to have the preponderance of evidence suggest a causal relation in CoC-receptor pairings for risk to be concluded.

The uncertainties associated with risk characterization activities, and therefore with the entire site-specific ecological risk assessment, will be discussed and quantified (if possible) when investigation results are reported. These discussions will include identification of assumptions used, any remaining data gaps, and the limitations of the assessment.

8.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Figure B8-1 illustrates the organizational structure and identifies key personnel of this project. This discussion focuses upon the primary responsibilities of individuals directly involved in project planning, management, and execution.

8.1 NAVY REMEDIAL PROJECT MANAGER

Mr. Robert Krivinskas (U.S. Navy, Naval Facilities Engineering Command, Northern Division) is the Remedial Project Manager for NETC Newport. He has general management and technical responsibility for all Remedial Investigation and associated activities at NETC. Supporting Mr. Krivinskas at the U.S. Navy Northern Division is Mr. Todd Bober, (technical lead), and Ms. Shannon Behr (ecorisk).

8.2 PROJECT MANAGER

Stephen S. Parker (Halliburton NUS Corp), is the prime contractor and Project Manager for this study.. He has general management and oversight responsibility of all activities associated with the subcontract team members. In this capacity, he will conduct the following activities:

- Review progress of technical activities towards attainment of project goals
- Review technical products and deliverables for quality and conformance to technical objectives of the project
- Oversee project technical activities to the extent warranted by skills and task requirements
- Communicate with the US Navy on issues relating to definition and conduct of project tasks, inform the Navy Project Manager of project status, and ensure the transmission of all deliverables to the Navy Project Manager
- Ensure that the project is appropriately organized with effective lines of communication, and that project responsibilities and authorities for making critical decisions are clearly understood

8.3 PROJECT QUALITY ASSURANCE OFFICER

The Project Quality Assurance Officer, Ms. Andrea Helmstetter (SAIC), will be responsible for ensuring compliance to all project QA/QC objectives, and for communicating compliance status to the Project Manager. Ms. Helmstetter will perform the following specific tasks:

- Provide guidance in the preparation of the W/QAPjP
- Perform technical review of the W/QAPjP and ensure that project QA/QC procedures are adequate for meeting data quality objectives
- Conduct performance and systems audits to ensure compliance with project QA/QC procedures
- Identify and report QA/QC deficiencies to the Project Manager.
- Recommend appropriate corrective actions when a QA/QC deficiency is identified, and ensure that corrective measures are implemented effectively
- Review and approve all products and deliverables of the project
- Review documentation of all QA/QC activities that occur throughout the period of performance of this project

8.4 PROJECT PRINCIPAL INVESTIGATORS

The Principal Investigators for this project have been subcontracted by HNUS for participation based upon a number of criteria, including technical skill, experience, and existing commitments to other projects. Their responsibilities include oversight of all scientific activities in support of objectives of the project, conformance to all QA/QC requirements, and communication with the HNUS Project Manager and other Principal Investigators on issues of technical effort status, progress, and problems. Principal Investigators also will be responsible for communicating options regarding technical approach within their area of expertise. The Principal Investigators associated with this project are:

- Dr. James Quinn, Professor of Oceanography, University of Rhode Island. Dr Quinn's expertise is the biogeochemistry of organic compounds in the nearshore marine environment. Dr. Quinn will be responsible for the organic contaminant analysis of samples.

- Dr. John King, Associate Professor of Oceanography, University of Rhode Island. Dr King's expertise is the geochemistry of marine and estuarine sediments. Dr. King will be responsible for project planning and reporting, trace metals analyses, and geotechnical characterizations of sediments.

- Dr. Gregory Tracey, Senior Scientist in SAIC's Environmental Assessment Division. Dr. Tracey is the SAIC Program Manager for all ecological risk assessment projects associated with the Narragansett Bay Ecorisk and Monitoring for Navy Sites program, and will be responsible for project planning and reporting, ecological effects investigations, and risk characterization activities.

  Dr. Chris Kincaid, Associate Professor of Oceanography, University of Rhode Island. Dr Kincaid's expertise is thephysical oceanography of marine and estuarine environments. Dr. Kincaid will be responsible for survey planning, conduct and reporting of hydrographic circulation studies for Derecktor Shipyard.

8.5 TECHNICAL COORDINATOR

Mr. Brad Wheeler, NETC Newport, will serve as the NETC Technical Coordinator for this project.

8.6 NARRAGANSETT BAY ECORISK ADVISORY GROUP

Peer review is critical to the success of an ecological risk assessment project. Input from scientific experts, regulatory agencies, resource trustees, special interest groups, and the general public is important to ensure that project activities are designed to meet the scientific, regulatory, and societal needs of the assessment. In recognition of this, the Narragansett Bay Ecorisk Advisory Group will be established to solicit scientific input for conducting the site specific ecological risk assessments. They will meet periodically to provide technical input and assistance to the Navy for development of work plans, review of investigative results, arbitration of technical disputes, assessments of risks, and to evaluate selected remedies in the context of economic benefit and habitat quality. The organizations and members of this group include:

- U.S. EPA Region I - Kymberlee Keckler, Susan Svirsky
- RI Department of Environmental Management - Paul Kulpa, Christopher Deacutis, Bob Richardson
- NOAA - Kenneth Finkelstein
- U.S. Fish and Wildlife - Tim Prior
- Save the Bay - Diana Wilder
- NETC Newport - Brad Wheeler
- Northern Division - Bob Krivinskas, Shannon Behr, Todd Bober
- NCCOSC-MESO - Robert Johnston
- Halliburton NUS - Stephen Parker, Hector Laguette
- University of Rhode Island - James Quinn, John King, Chris Kincaid
- SAIC - Gregory Tracey, Andrea Helmstetter

The Navy has established the Narragansett Bay Ecorisk Advisory Group within a time frame suitable for review and comment upon the approach described in this document. Actual membership may vary over time.

9.0 References

Collier, T.K. & Varanasi, U., 1991. Arch. Environ. Contam. Toxicol.,20: 462-73 .

Collier, T.K., Eberhart, B.-T.L.,Stein, J.E. & Varanasi, U., 1989. *In* Proceedings Oceans '89. IEEE,Washington, DC pp.608-10.

Corbin, J.M., 1989. Recent and historical accumulation of trace metal contaminants in the sediments of Narragansett Bay, Rhode Island, MS Thesis, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI.

ENSR Consulting and Engineering, and Halliburton NUS Corporation, 1993. Preliminary Assessment Report, Derecktor Shipyard, Middletown, RI. Northern Division, NAVFAC Contract No. N62472-90-D-1298. ENSR, Acton, MA.

Goksoyr, A.& Husoy, A., 1992. The Cytochrome P450 1A1 Response in Fish: Application of Immunodection in Environmental Monitoring and Toxicological Testing. Marine Environmental Research, 34, 147-150

Goksoyr, A., Beyer, J., Husoy, A., Larsen, H.E., Westrheim, K., Wilhelmsen, S. & Klungsoyr, J., 1994. Aquatic Toxicology, 29, 21-35.

Halliburton NUS Corporation, 1995. Work Plan for On-shore Site Assessment Screening Evaluation, Former Derecktor Shipyard, Naval Education and Training Center, Newport, Rhode Island. NAVFAC Contract No. N62472-90-D-1298. February .

Haasch, M.L., Quardokus, E.M., Sutherland, L.A., Goodrich, M.S., Prince, R., Cooper, K.R. & Lech, J.J., 1992. Marine Environmental Research, 34, 139-145

Haasch, M.L., Prince, R., Wejksnora, P.J., Cooper, K.R. & Lech, J.J, 1993.. Environmental Toxicology and Chemistry, 12, 885-895

King, J.W., ed., 1994. The Sediments of Narragansett Bay, Report to the Narragansett Bay project, 600 pp.

Kloepper-Sams, P.J. & Benton, E. , 1994. Induction of Hepatic Cytochrome P4501A in Mountain Whitefish (prosopium williamsoni) and other Species. Environmental Toxicology and Chamistry, 13 No. 9, 1483-1496

Lindstrom-Seppa, P., Korytko, P.J., Hahn, M.E. & Stegeman, J.J, 1994. Uptake of waterborn 3,3', 4,4'-tetrachlorobiphenyl an organ and cell-specific induction of cytochrome P4501 adult and larval fathead minnow Pimephales promel. Aquatic Toxicology, 28, 147-167

Monosson, E. & Stegeman , 1991. Environmental Toxicology and Chemistry, 10, 765-774

Pruell, R.J., and J.G. Quinn, 1985. Geochemistry of organic contaminants in Narragansett Bay sediments, Estuarine, Coastal and Shelf Science, 21: 295-312.

Quinn, J.G., J.W. King, R.W. Cairns, P.F. Gingham, and T.L. Wade, 1994a. Chemical Contaminants in Marine Sediments from the Former Derecktor Shipyard Site at Coddington Cove, Newport, Rhode Island, Final Report to the Naval Education and Training Center, Newport, RI, 147 pp.

Quinn, J.G., J.W. King, R.W. Cairns, P.F. Gangemi, and T.L. Wade, 1994b. Chemical Contaminants in Marine Sediments from the Former Derecktor Shipyard Site at Coddington Cove, Newport, Rhode Island, Phase II Draft Final Report to the Naval Education and Training Center, Newport, RI,133 pp.

Ronis, M.J.J., Celander, M., Forlin, L. & Badger, T.M. , 1992. The Use of Polyclonal Antibodies Raised against Rat and Trout Cytochrome P450 CYP1A1 Orthologues to Minitor Environmental Induction in the Channel Catfish (Ictalurus punctatus). Marine

Environmental Research, 34, 181-188.

Stein, J.E., Collier, T.K., Reichert, W.L., Casillas, E., Hom, T. & Varanasi, U. 1992.. Environ. Toxicol. Chem., 11, 701-14

TRC, 1994. Environmental Assessment Report: Derecktor Shipyard- Building 42 Area. Prepared for: Naval Education and Training Center, Newport, RI. TRC Proj. No. 01981-0010. December.

Varanasi, U., Chan, S.-L., Clark, R.C.Jr, Collier, T.K., Gronlund, W.D., Hagen,J.L., Johnson, L.L., Krahn, M.M., Landahl, J.T. & Myers, M.S. 1990. Progress Report for F/S 24, Natural Resources Damage Assessment,

van der Weiden, M.E.J., Celander, M., Seinen, W., van der Berg, M., Goksoyr, A. & Forlin, L. 1993. Induction of Cytochome P450 1A in Fish Treated with 2,3,7,8-tetrachlorodibenzo-p-dioxin or Chemically Contaminated Sediment. Environmental Toxicology and Chemistry, 12, 989-999.

van der Weiden, M.E.J., Celander, M., Seinen, W., van der Berg, M., Goksoyr, A. & Forlin, L. , 1992. Marine Environmental Research, 34, 215-219.

van der Weiden, M.E.J., Hanegraaf, F.H.M., Eggens, M.L., Celander, M., Seinen, W. & van der Berg , 1994. Environmental Toxicology and Chemistry, 13 No. 5, 797-802.

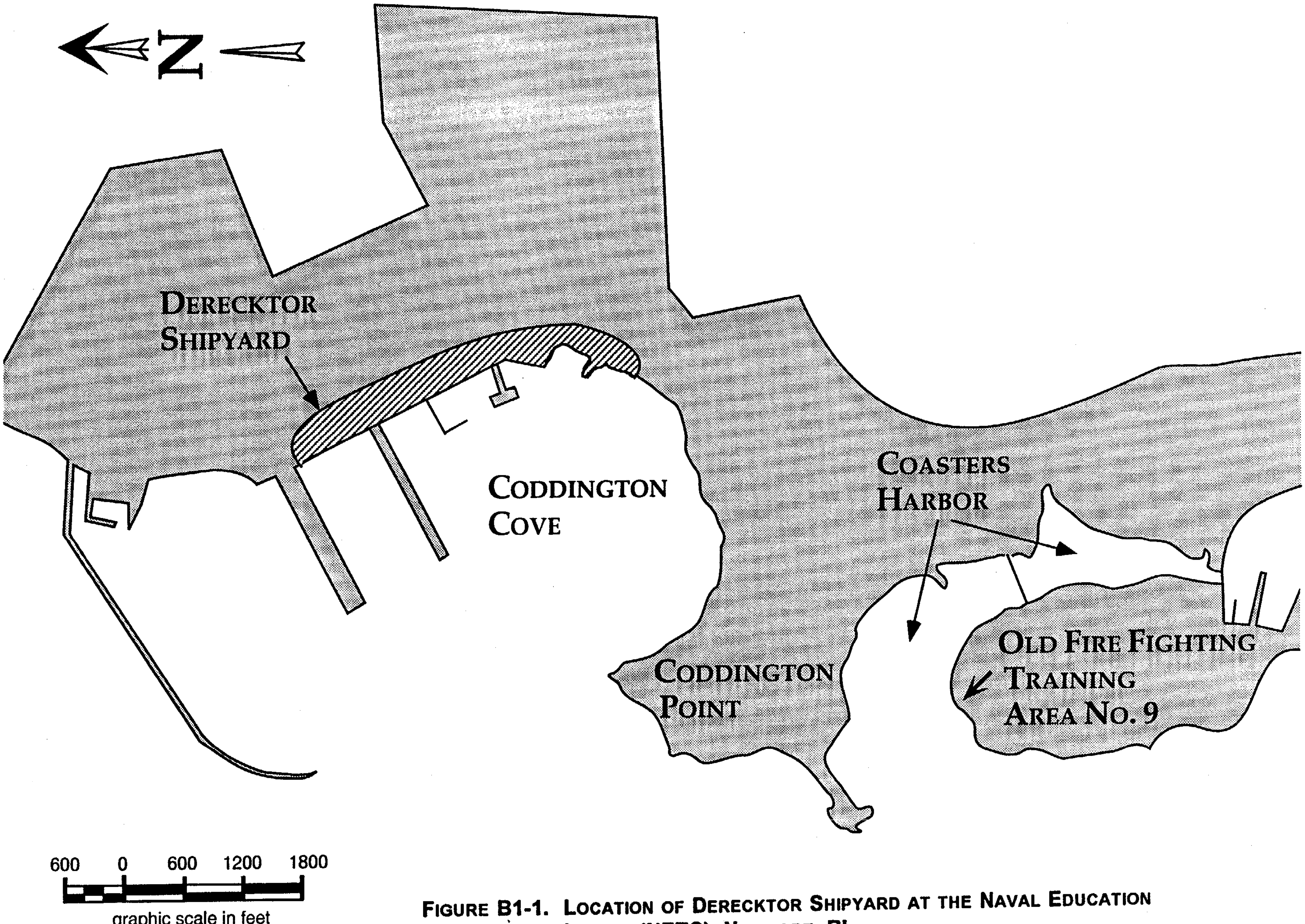


FIGURE B1-1. LOCATION OF DERECKTOR SHIPYARD AT THE NAVAL EDUCATION AND TRAINING CENTER (NETC), NEWPORT, RI.

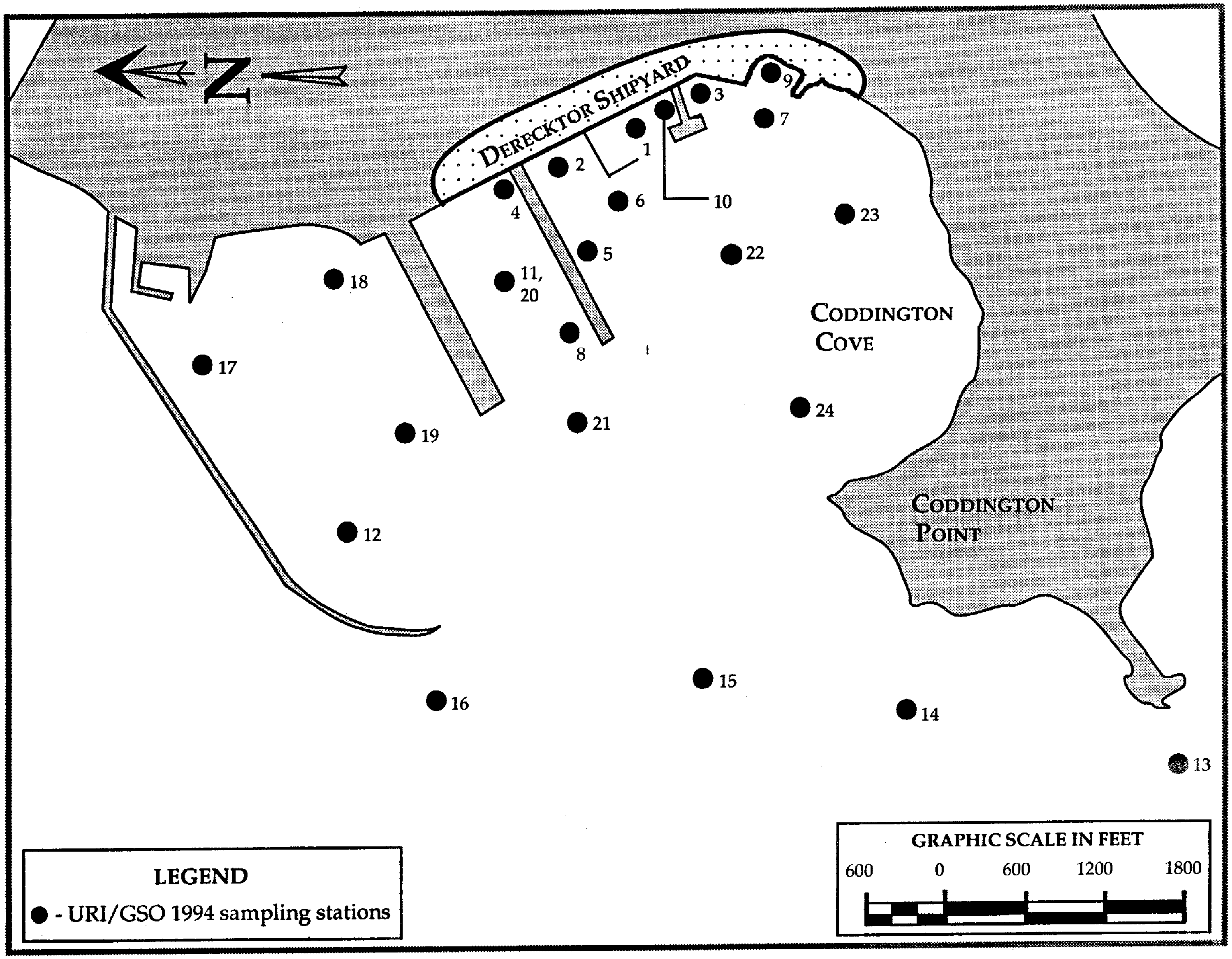


FIGURE B2-1. **STATIONS SAMPLED BY GSO DURING 1993 AND 1994 (QUINN ET AL., 1994B).**

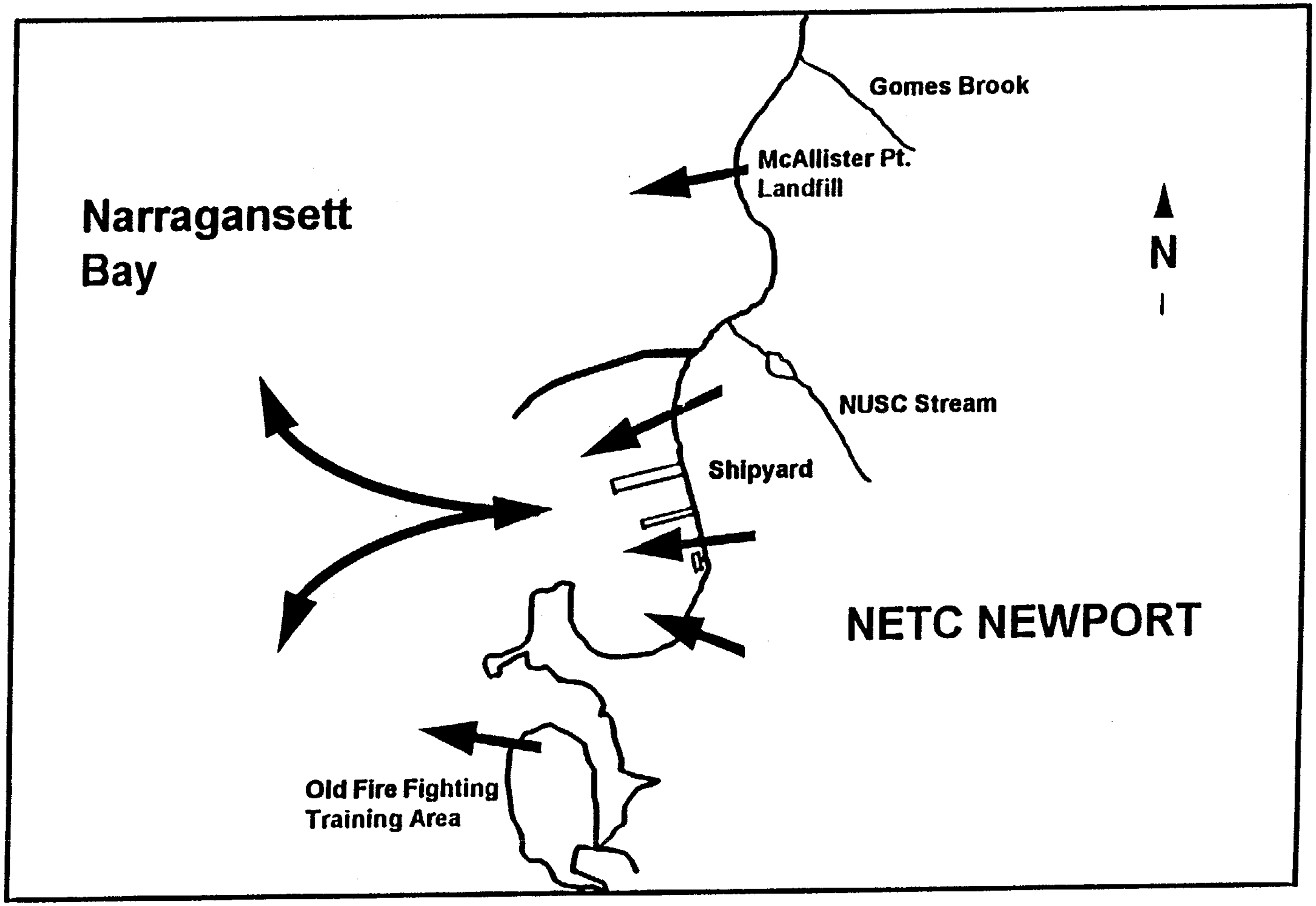


FIGURE B2-2. SECOND TIER CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT FOR DERECKTOR SHIPYARD.

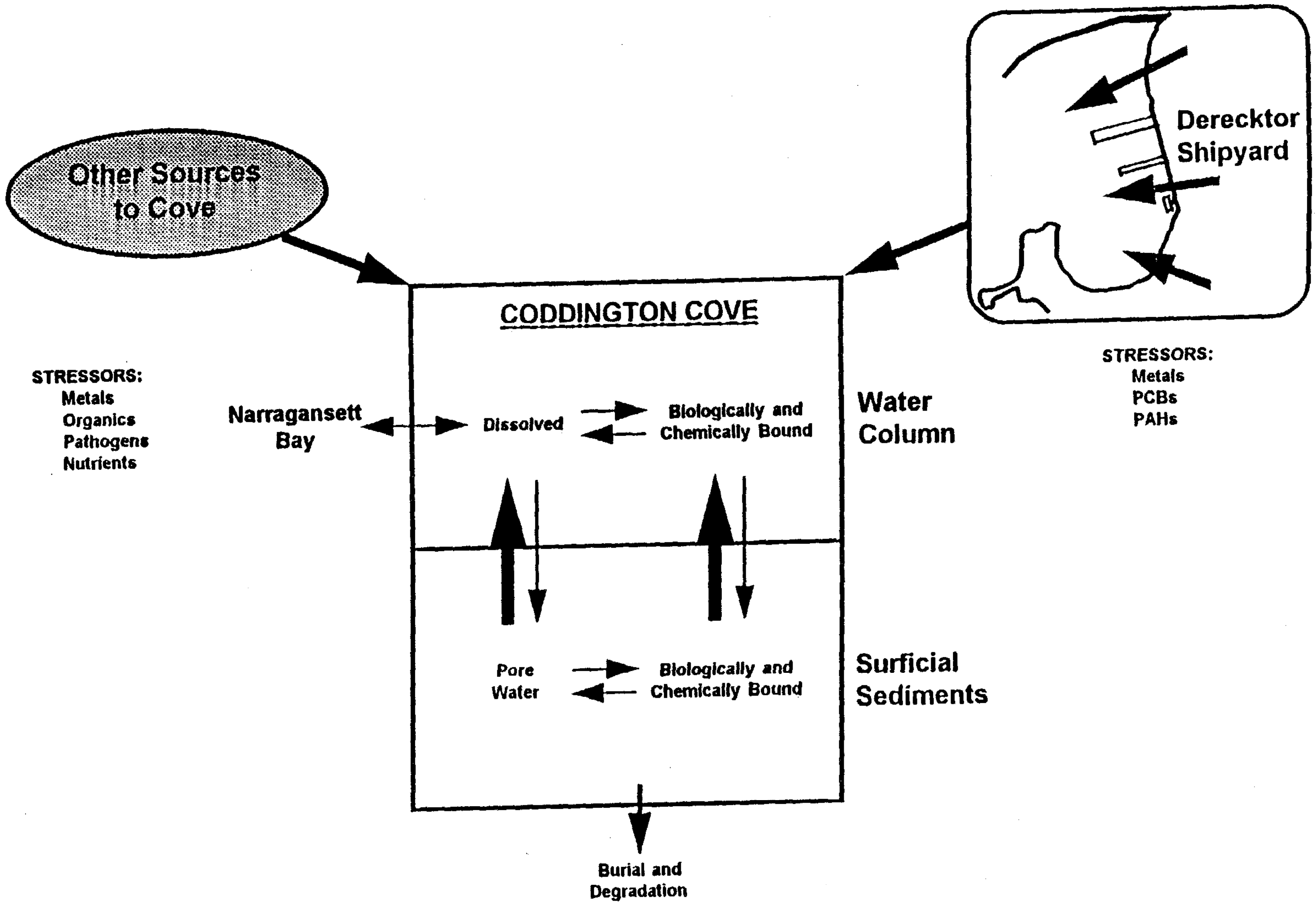


FIGURE B2-3. THIRD TIER CONCEPTUAL MODEL OF CONTAMINANT BEHAVIOR FOR DERECKTOR SHIPYARD.

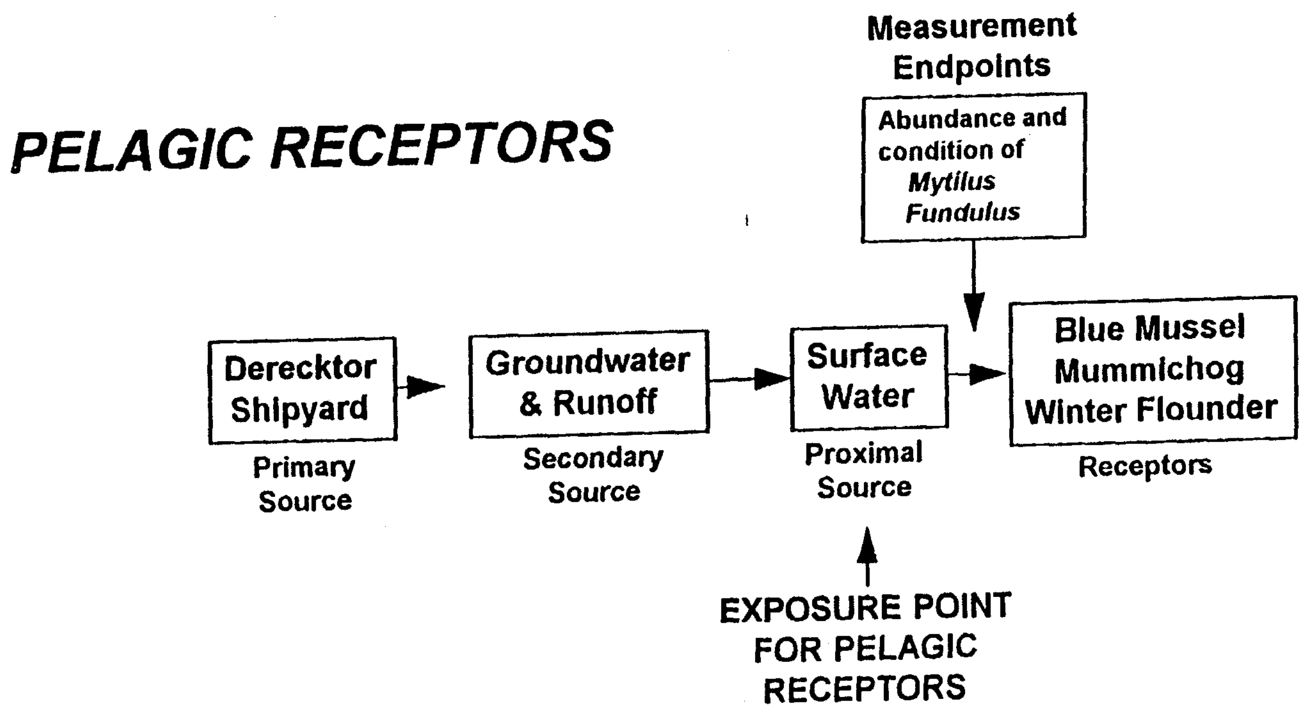


FIGURE B2-4. FOURTH TIER CONCEPTUAL MODEL FOR DERECKTOR SHIPYARD - EXPOSURE PATHWAY TO PELAGIC ORGANISMS.

EPIBENTHIC RECEPTORS

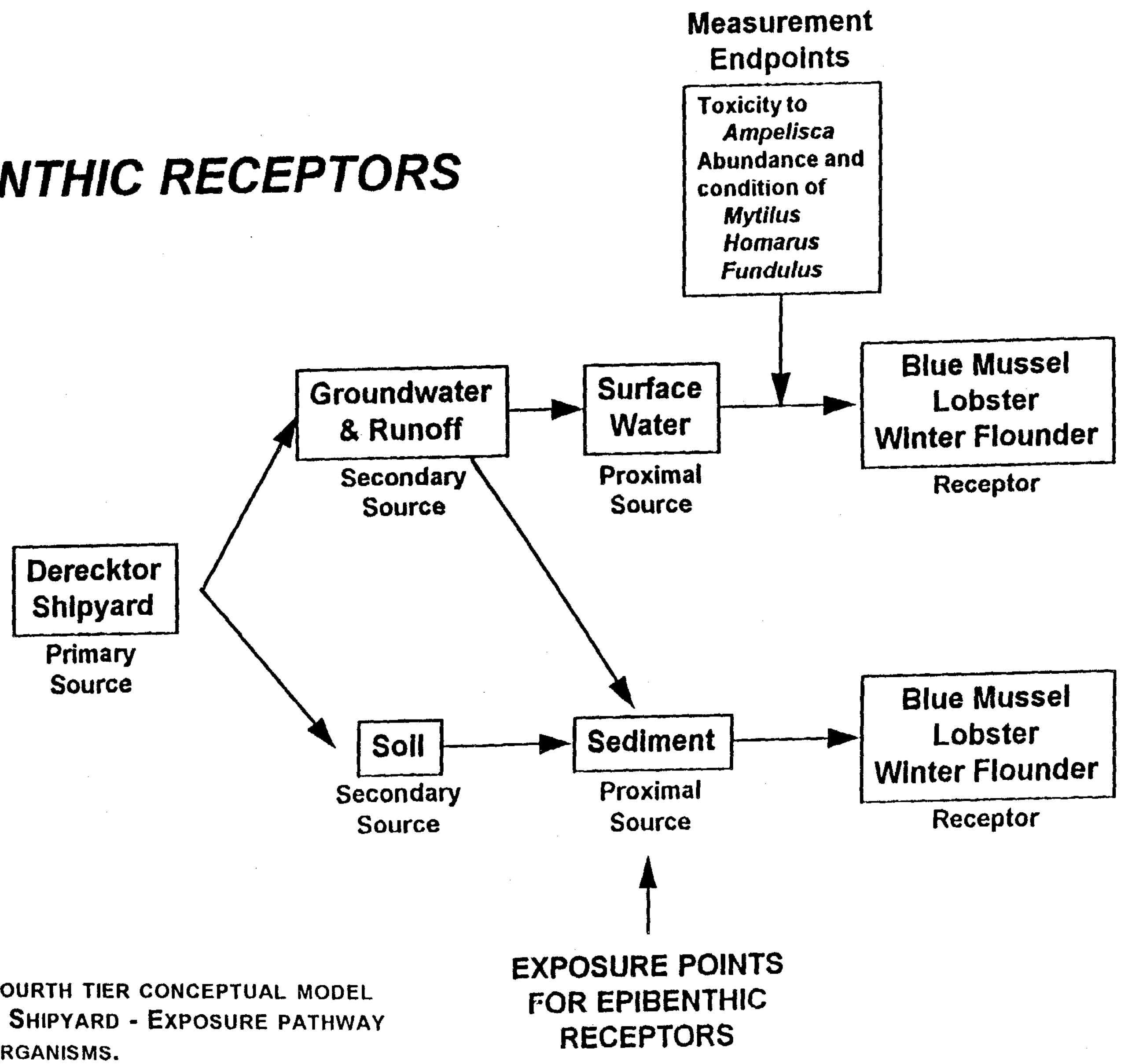


FIGURE B2-5. FOURTH TIER CONCEPTUAL MODEL FOR DERECKTOR SHIPYARD - EXPOSURE PATHWAY TO EPIBENTHIC ORGANISMS.

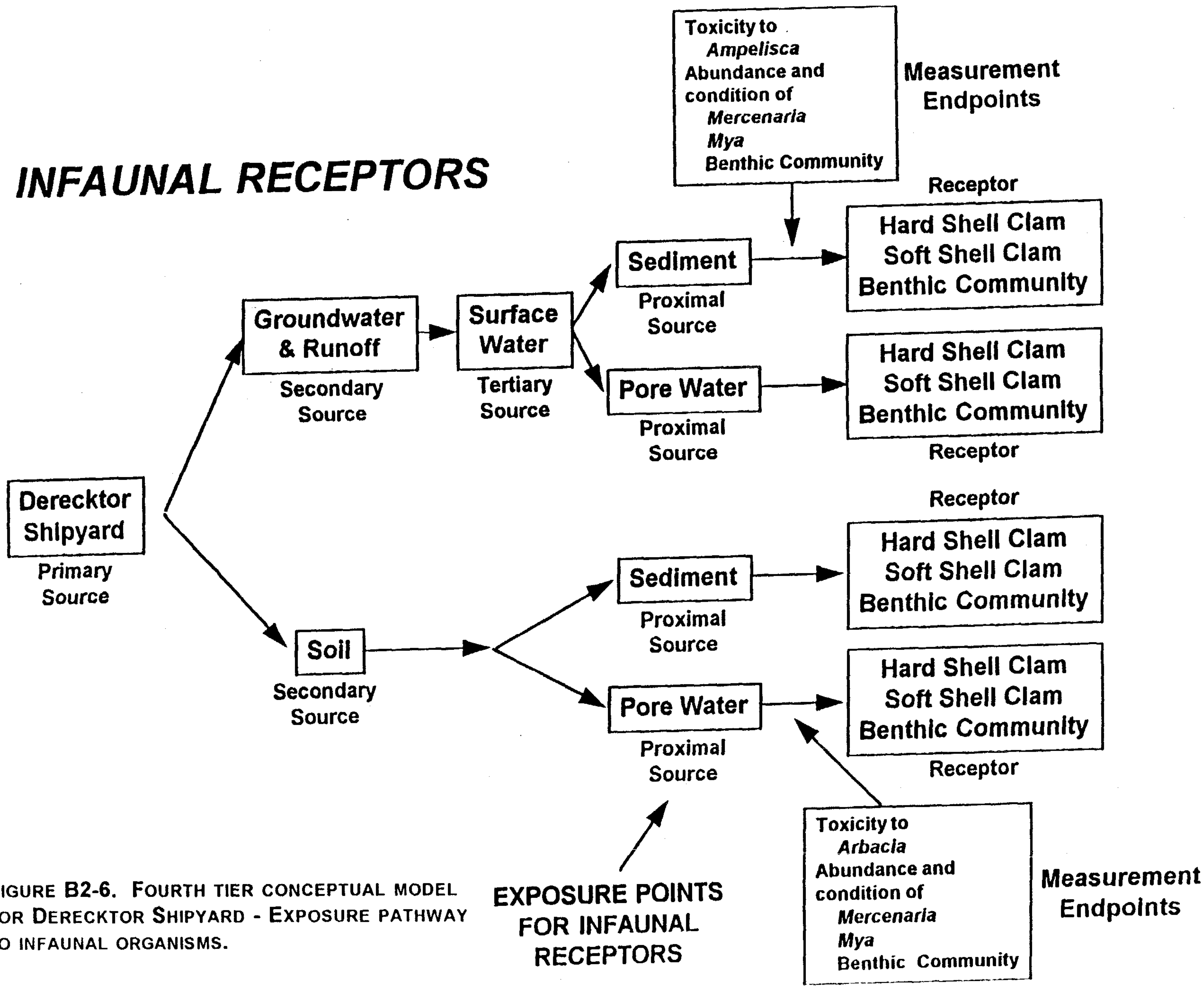


FIGURE B2-6. FOURTH TIER CONCEPTUAL MODEL FOR DERECKTOR SHIPYARD - EXPOSURE PATHWAY TO INFAUNAL ORGANISMS.

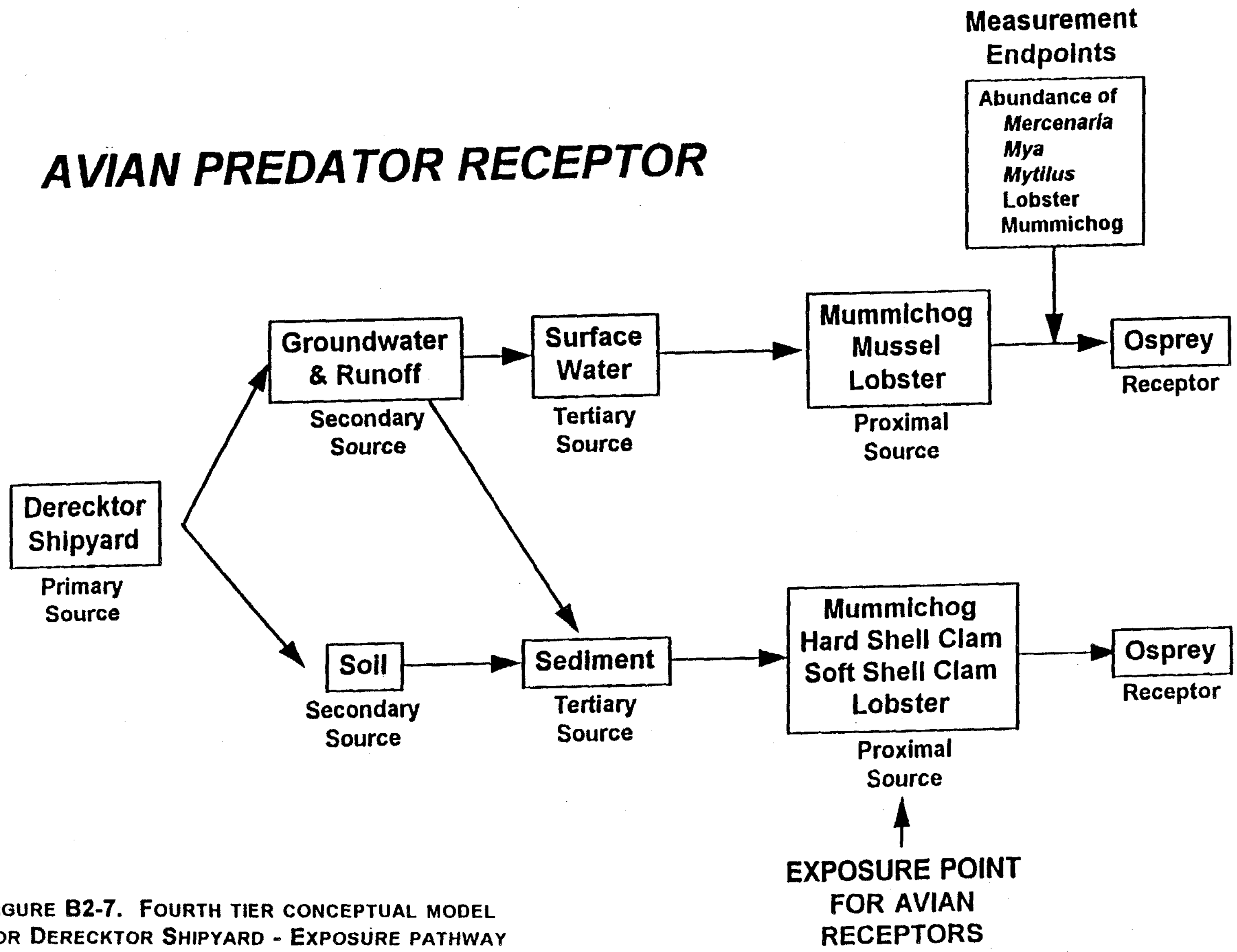


FIGURE B2-7. FOURTH TIER CONCEPTUAL MODEL FOR DERECKTOR SHIPYARD - EXPOSURE PATHWAY TO AVIAN PREDATORS.

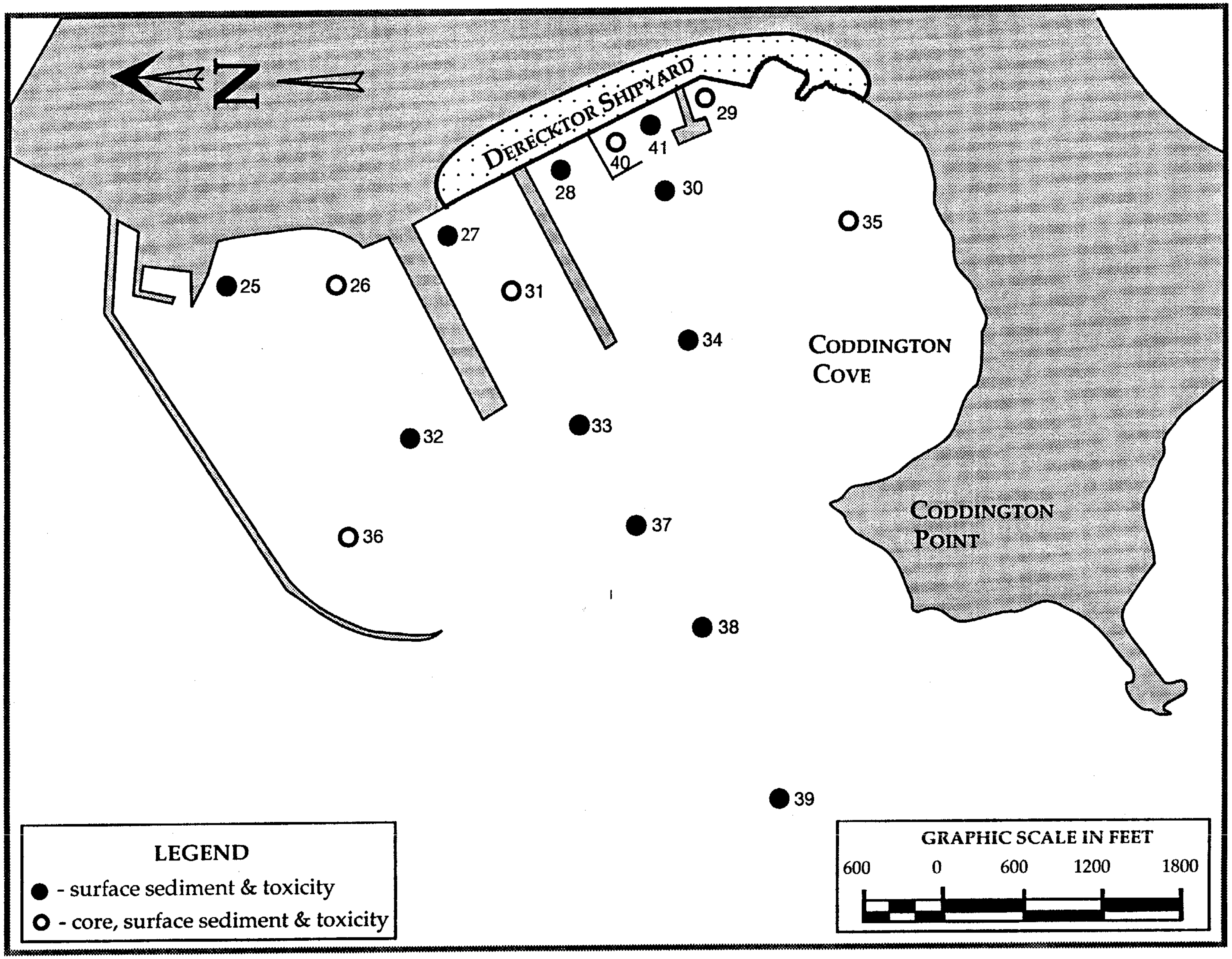


FIGURE B4-1. PROPOSED PHASE II URI/SAIC SEDIMENT SAMPLING LOCATIONS.

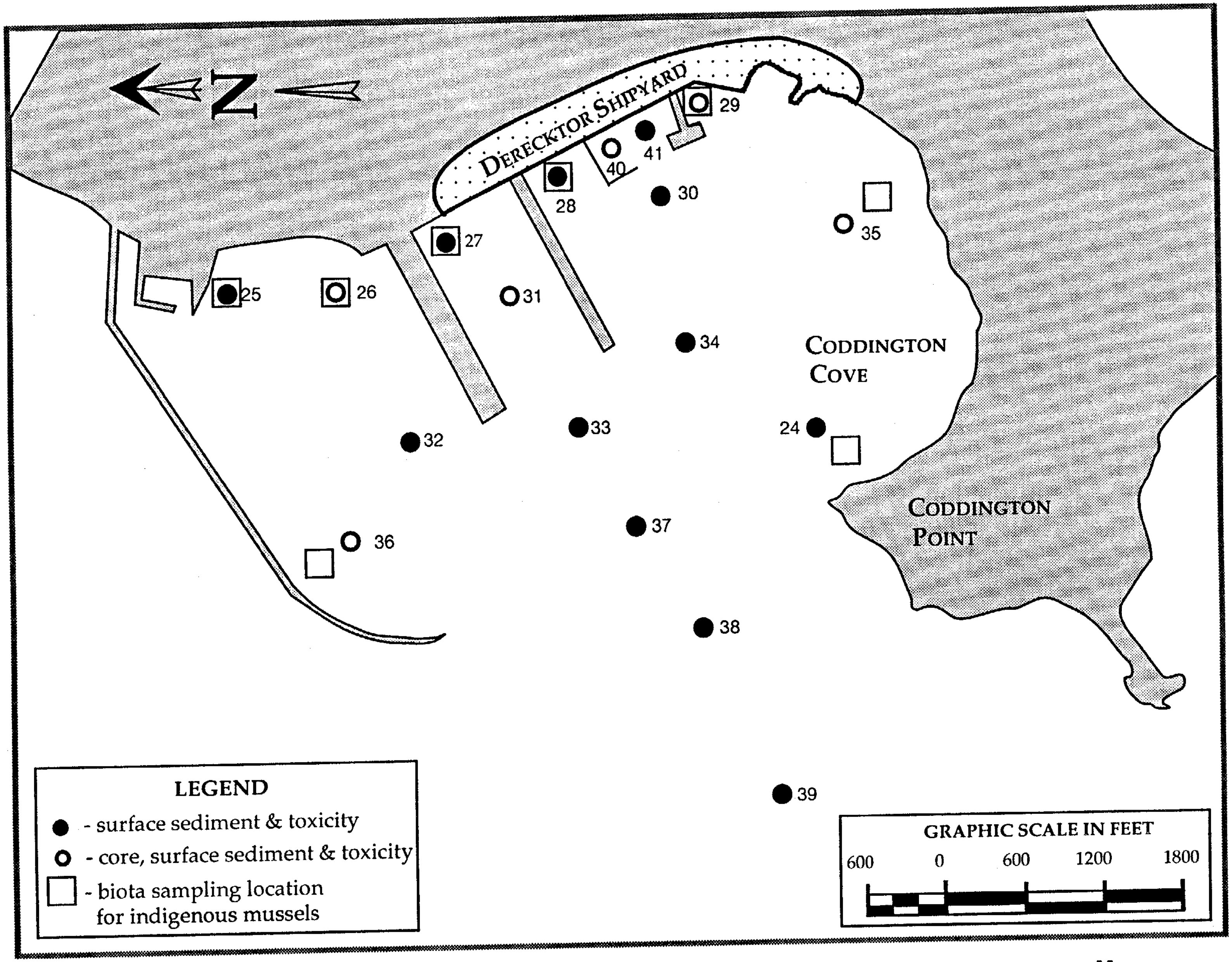


FIGURE B4-2. PROPOSED DERECKTOR SHIPYARD ERA SAMPLING LOCATIONS FOR INDIGENOUS MUSSELS.

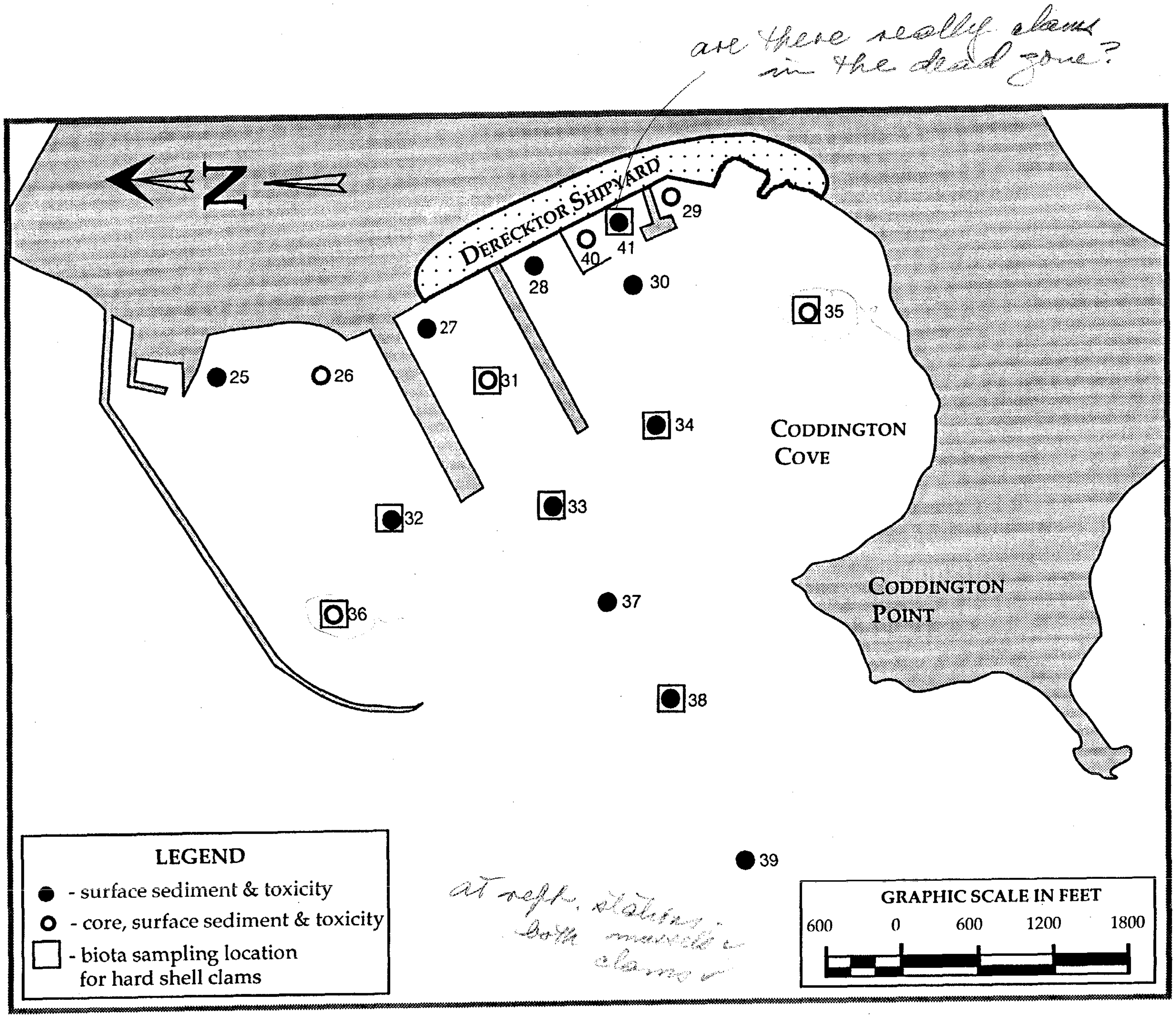


FIGURE B4-3. PROPOSED DERECKTOR SHIPYARD ERA SAMPLING LOCATIONS FOR HARD SHELL CLAMS.

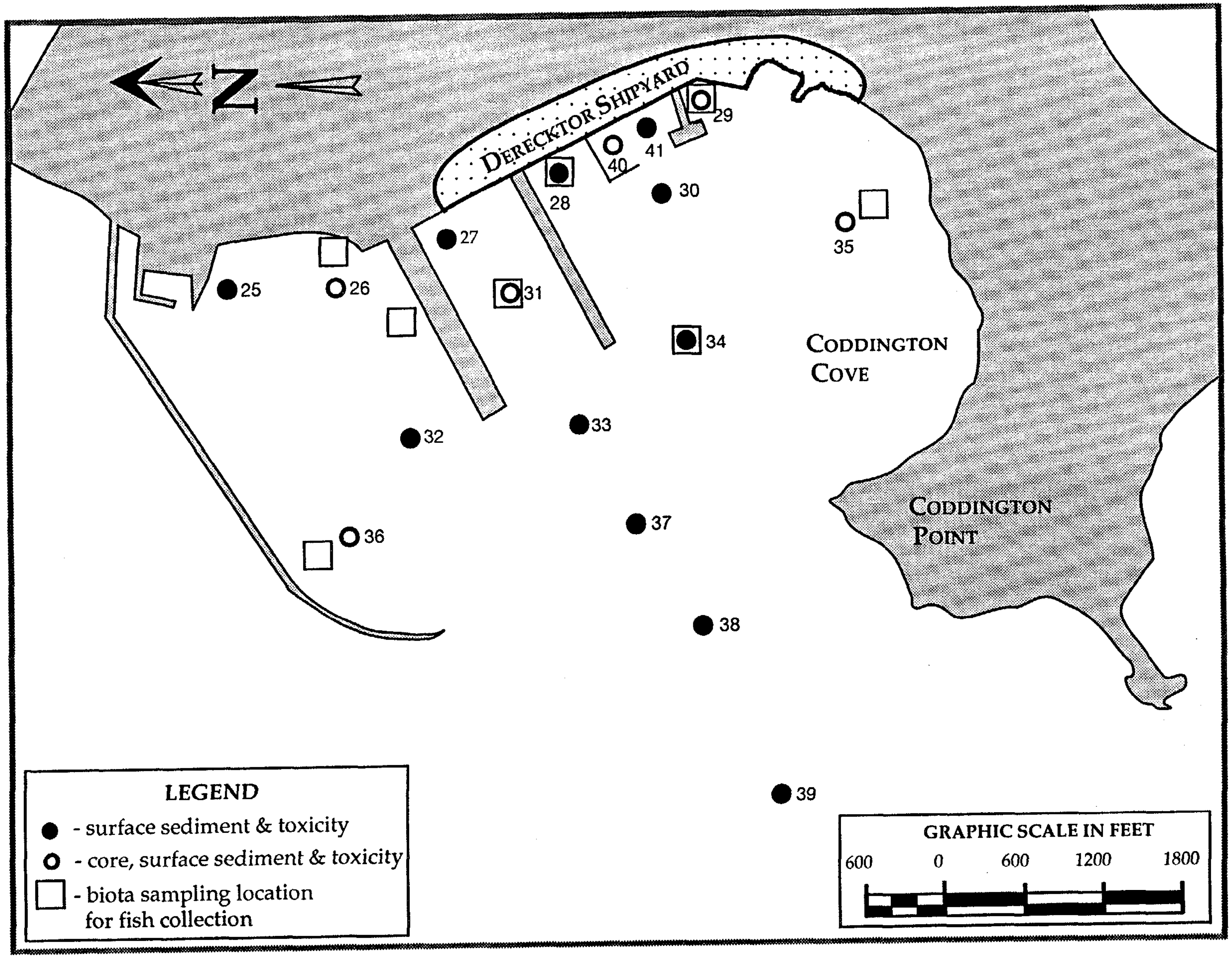


FIGURE B4-4. **PROPOSED DERECKTOR SHIPYARD ERA SAMPLING LOCATIONS FOR DEMERSAL FISH (MUMMICHOGS AND CUNNER).**

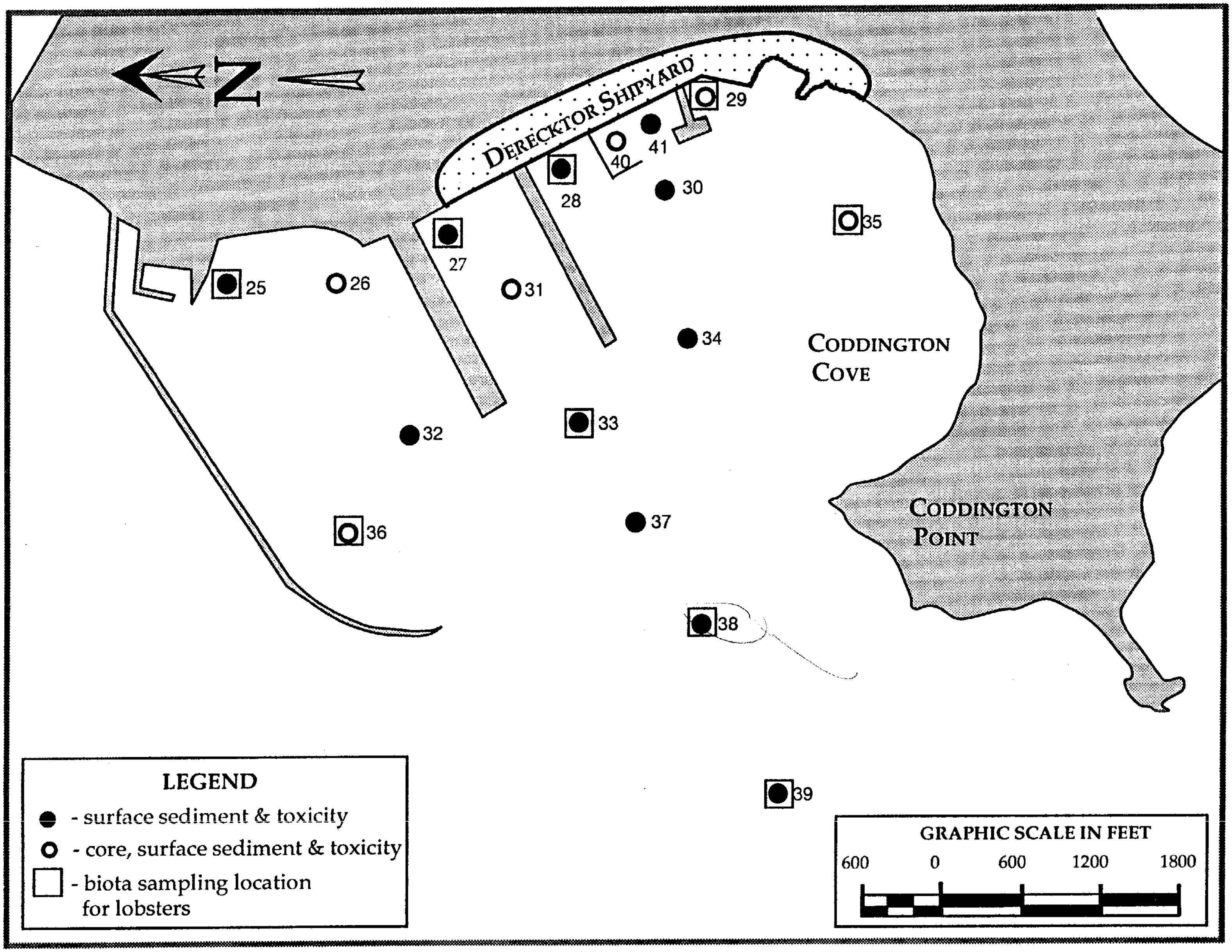


FIGURE B4-5. PROPOSED DERECKTOR SHIPYARD ERA SAMPLING LOCATIONS FOR LOBSTERS.

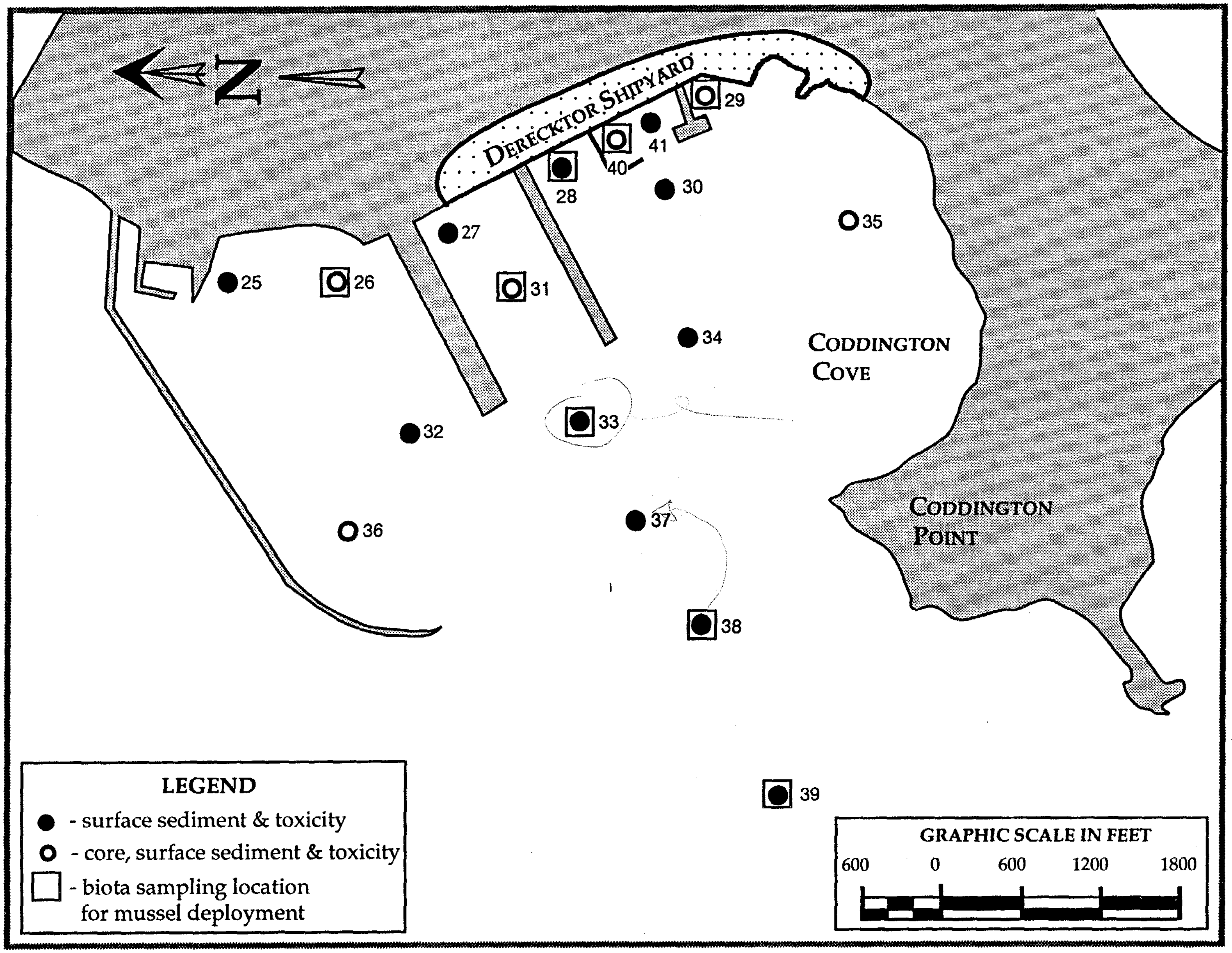


FIGURE B4-6. PROPOSED PHASE II URI/SAIC SAMPLING LOCATIONS FOR DEPLOYED MUSSELS..

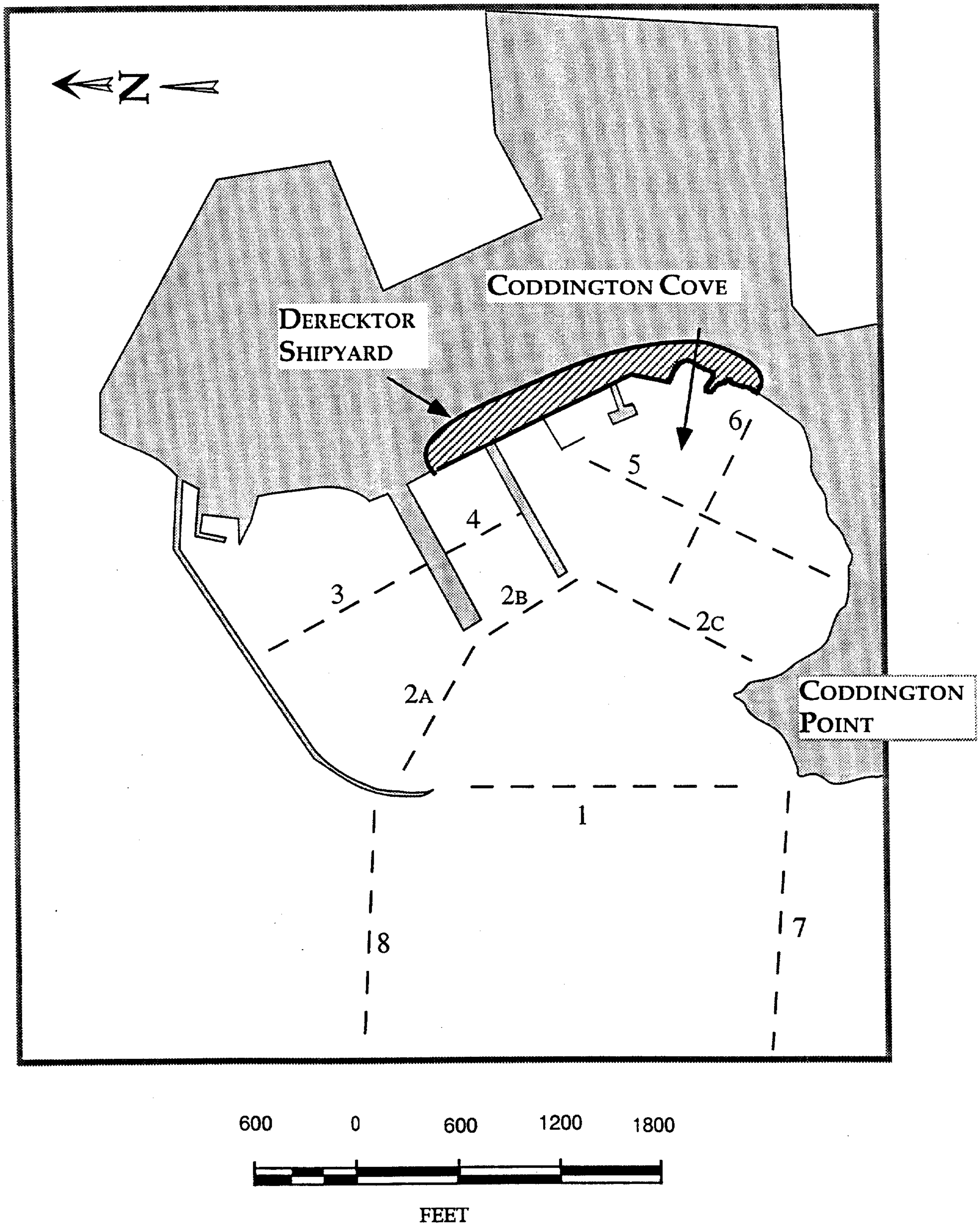


FIGURE B4-7. **PROPOSED DERECKTOR SHIPYARD ERA HYDROGRAPHIC SURVEY LINES.**

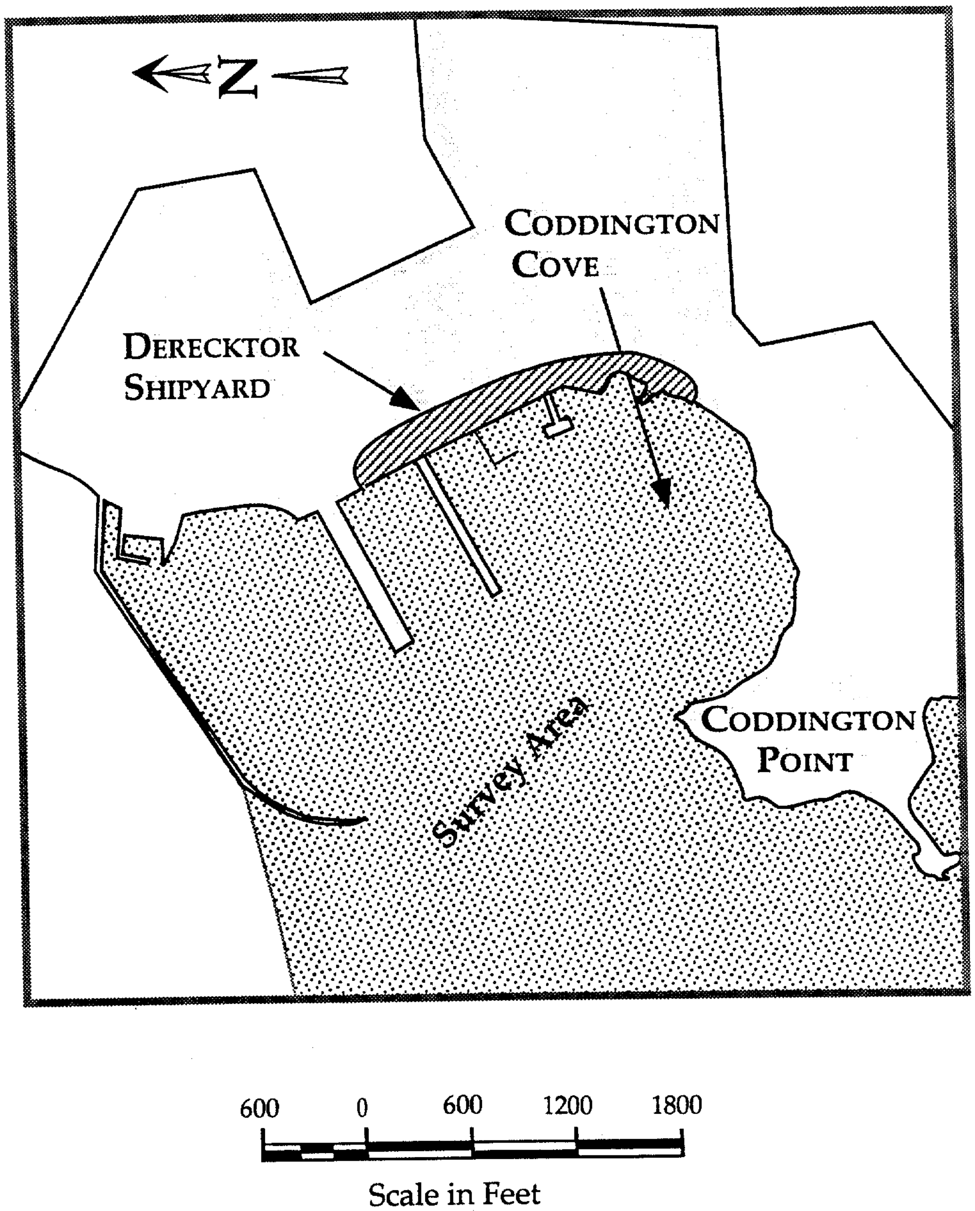
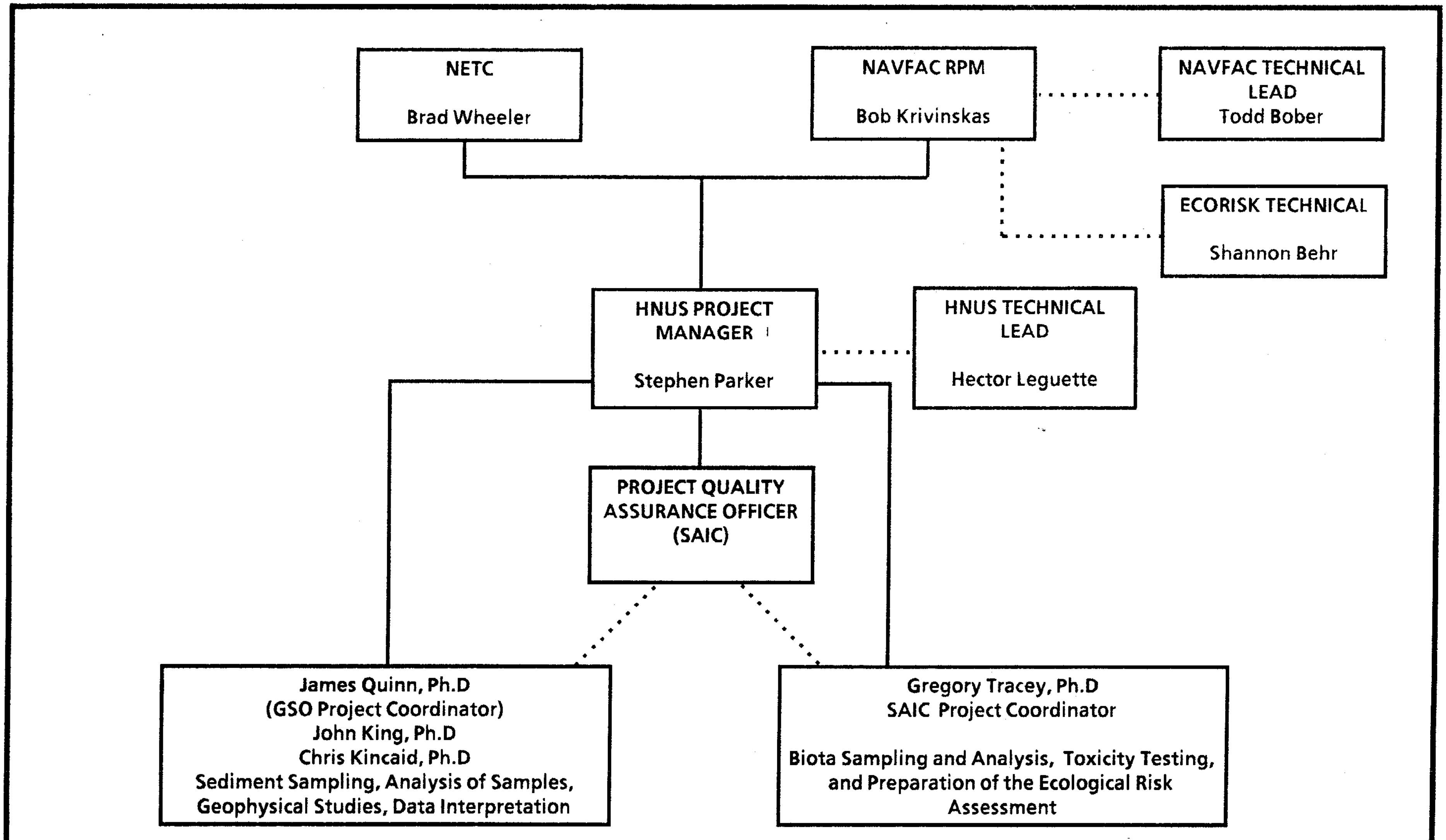


FIGURE B4-8. **PROPOSED DERECKTOR SHIPYARD ERA GEOPHYSICAL SURVEY AREA**



PROJECT ORGANIZATION CHART
DERECKTOR SHIPYARD ECOLOGICAL RISK ASSESSMENT
NAVAL EDUCATION AND TRAINING CENTER (NETC)
NEWPORT, RHODE ISLAND

Halliburton NUS CORPORATION

FIGURE B8-1

Table B2-1. Summary of organic contaminants in sediments of Coddington Cove, Narragansett Bay, RI (Quinn et al., 1994b)[1].

Station	Sum PCBs (ng/g)	Sum PAHs (ng/g)	Organic Carbon (mg/g)	PCBs (ng/mg O.C.)	PAHs (ng/mg O.C.)	TBT (ng Sn/g)
1	67.6	4380.0	20.6	3.3	212.6	31.7
2	209.1	66600.0	13.0	16.1	5120.0	371.7
3	733.3	81700.0	26.3	27.9	3110.0	255.0
4	194.6	6240.0	31.7	6.1	196.8	154.5
5	105.4	5070.0	67.0	1.6	75.7	201.7
6	132.1	5940.0	43.7	3.0	135.9	125.1
7	73.4	4740.0	26.7	2.7	177.5	61.4
8	148.4	6540.0	46.3	3.2	141.3	130.5
9	28.1	690.0	15.1	1.9	45.7	71.5
10	11.7	561.0	15.3	0.8	36.7	63.5
11	658.2	5510.0	61.7	10.7	89.3	139.3
12	176.0	5000.0	53.3	3.3	93.8	115.5
13	22.3	993.0	6.4	3.5	155.2	138.0
14	23.0	500.0	10.1	2.3	49.5	94.3
15	54.8	3560.0	20.6	2.7	172.8	110.0
16	9.4	285.5	2.6	3.6	109.8	82.7
17	243.8	3770.0	10.1	24.1	373.3	81.2
18	292.8	14100.0	29.5	9.9	478.0	167.0
19	216.6	10300.0	42.1	5.1	244.7	220.4
20	367.0	22100.0	32.9	11.2	671.7	197.0
21	92.3	2160.0	11.5	8.0	187.8	109.4
22	178.2	3710.0	29.4	6.1	126.2	244.0
23	150.1	4960.0	28.6	5.2	173.4	219.7
24	25.9	1300.0	14.0	1.8	92.9	119.7

[1]All measurements are dry weight.

TABLE B2-2. PRELIMINARY DERECKTOR SHIPYARD GROUNDWATER COCs[1]

CONSTITUENT	WQC (ug/L) Acute	WQC (ug/L) Chronic	Max. Conc. (ug/L)	Hazard Quotient Acute	Hazard Quotient Chronic
Arsenic	69	36	240	**3.5**	**6.7**
Chromium	1100	50	430	0.4	**8.6**
Copper	2.9	2.9	442	**152.4**	**152.4**
Lead	220	8.5	455	**2.1**	**53.5**
Nickel	75	8.3	540	**7.2**	**65.1**
Zinc	95	86	1190	**12.5**	**13.8**

[1] TRC, 1994

TABLE B2-3. PRELIMINARY DERECKTOR SHIPYARD SOIL COCs[1]

CONSTITUENT	Effects Range[2] Low (ER-L)	Effects Range[2] Median (ER-M)	Max. Conc.	Hazard Quotient Low (ER-L)	Hazard Quotient Median (ER-M)
PAHs (ng/g dry)					
Benzo(a)anthracene	261	1600	830	**3.2**	0.5
Benzo(a)pyrene	430	1600	920	**2.1**	0.6
Chrysene	384	2800	850	**2.2**	0.3
Fluoranthene	600	5100	1100	**1.8**	0.2
Phenanthrene	240	1500	770	**3.2**	0.5
Pyrene	665	2600	2700	**4.1**	1.0
Metals (ug/g dry)					
Arsenic	8.2	70	22.5	**2.7**	0.3
Cadmium	1.2	9.6	0.56	0.5	0.1
Chromium	81	370	31	0.4	0.1
Copper	34	270	550	**16.2**	**2.0**
Lead	46.7	218	380	**8.1**	**1.7**
Mercury	0.15	0.71	0.14	**0.9**	0.2
Nickel	20.9	51.6	68	**3.3**	**1.3**
Silver	1	3.7	0	0.0	0.0
Zinc	150	410	1200	**8.0**	**2.9**

[1] TRC, 1994

[2] Long et al., 1995

Table B2-4. PRELIMINARY OFFSHORE SEDIMENT CoCs

Constituent	Maximum Concentration[1]	ER-L[2]	HQ
Polycyclic Aromatic Hydrocarbons (PAHs) (ng/g dry)			
2-Methylnaphthalene	53.4	70	**0.8**
Acenaphthene	192.9	16	**12.1**
Acenaphthylene	867.2	44	**19.7**
Anthracene	3360.0	85.3	**39.4**
Benzo(a)anthracene	10600.0	261	**40.6**
Benzo(a)pyrene	4710.0	430	**11.0**
Chrysene	6390.0	384	**16.6**
Dibenz(a,h)anthracene	1460.0	63.4	**23.0**
Fluoranthene	13600.0	600	**22.7**
Fluorene	858.8	19	**45.2**
Naphthalene	16.0	160	0.1
Total PCBs (Sum of Congeners x 2)	733.3	22.7	**32.3**
Phenanthrene	4890.0	240	**20.4**
Pyrene	10100.0	665	**15.2**
Total PAHs	81700.0	4022	**20.3**
Pesticides (ng/g dry)			
p,p'-DDE	13.6	2.2	**6.2**
Metals (u g/g dry)			
Arsenic	--	8.2	--
Cadmium	1.0	1.2	**0.8**
Chromium	195.0	81	**2.4**
Copper	262.3	34	**7.7**
Lead	201.1	46.7	**4.3**
Mercury	--	0.15	--
Nickel	167.9	20.9	**8.0**
Silver	13.8	1	**13.8**
Zinc	1231.4	150	**8.2**

[1] Quinn et al., 1994b

[2] Effects Range-Low (Long et al., 1995)

TABLE B2-5. PRELIMINARY LIST OF PROPOSED OFFSHORE COCs* FOR THE DERECKTOR SHIPYARD OFFSHORE ECOLOGICAL RISK ASSESSMENT

CONSTITUENT	Maximum Hazard Quotient	
	Onshore	Offshore
PAHs		
Benzo(a)anthracene	**3.2**	**40.6**
Benzo(a)pyrene	**2.1**	**11.0**
Chrysene	**2.2**	**16.6**
Fluoranthene	**1.8**	**22.7**
Phenanthrene	**3.2**	**20.4**
Pyrene	**4.1**	**15.2**
2-Methylnaphthalene		**0.8**
Acenaphthene		**12.1**
Acenaphthylene		**19.7**
Anthracene		**39.4**
Fluorene		**45.2**
Dibenz(a,h)anthracene		**23.0**
Total Polycyclic Aromatic Hydrocarbons		**20.3**
p,p'-DDE		**6.2**
Total PCBs (Sum of Congeners x 2)		**32.3**
Metals		
Arsenic	**6.7**	--
Cadmium	0.5	**0.8**
Chromium	**8.6**	**2.4**
Copper	**152.4**	**7.7**
Lead	**53.5**	**4.3**
Mercury	**0.9**	--
Nickel	**65.1**	**8.0**
Silver	0.0	**13.8**
Zinc	**13.8**	**8.2**
Total Butyltins	**	

* bolded values = HQ's > 0.7

**special contaminant of concern

TABLE B2-6. TARGET ECOLOGICAL SYSTEMS/SPECIES/RECEPTORS OF CONCERN FOR DERECKTOR SHIPYARD.

Habitat	Ecological System/Species/Receptor of Concern
Pelagic	Blue mussel (*Mytilus edulis*)[1] Mummichog (*Fundulus* spp.) Cunner (*Tautogolabrus adspersus)* Winter flounder (*Pseudopleuronectes americanus*)[2]
Epibenthic	Blue mussel[3] Lobster (*Homarus americanus*)
Infaunal	Hard shell clam (*Mercenaria mercenaria*) benthic community
Avian Aquatic Predator	Osprey (*Pandion haliaetus*) Herring gull (*Larus argentatus*) Red-breasted merganser (*Mergus serrator*) Great blue heron (*Ardea herodias*)

[1]surrogate for pelagic species when deployed in the water column (e.g. mooring floats)
[2]present abundances of this species do not permit their collection for this study.
[3]representative of epibenthic species when collected from bottom substrate.

TABLE B2-7. **ASSESSMENT AND MEASUREMENT ENDPOINTS FOR THE DERECKTOR SHIPYARD ERA**

Assessment Endpoint	Receptor of Concern		Measurement Endpoint
Sediment Quality	Infaunal receptors Epifaunal receptors	o	Bulk sediment toxicity to amphipods (10-day mortality)
		o	Elutriate toxicity to sea urchins (embryo development)
		o	Benthic community structure (diversity, numbers)
		o	Abundance and condition of infaunal target receptors
		o	Tissue residues of infaunal target receptors
Water Quality	Pelagic receptors	o	Abundance and condition of epifaunal/pelagic receptors
		o	Water toxicity to sea urchin gametes (sperm cell test)
		o	Abundance and condition of target receptor species
		o	Tissue residues of epifaunal pelagic target receptors
Status of Natural Resources	Resource species	o	Abundance and condition of target receptor species
		o	Abundance and condition potential prey species
		o	Biomarker (neoplasia, P450) indicators
		o	Tissue residues of infaunal target receptors
		o	Bioaccumulation and trophic transfer potential (avian receptors)

TABLE B2-8. EXPOSURE POINT MEASUREMENTS FOR DERECKTOR SHIPYARD

Exposure Medium/ Receptor		Exposure Point Measurement
Sediment	o	Bulk sediment and pore water chemistry
	o	Redox potential discontinuity
	o	Geotechnical characteristics (*e.g.,* grain size, water content)
	o	Ammonia
	o	Organic carbon
	o	SEM/AVS
Water	o	Water column chemistry (deployed mussel tissue residues)
	o	Dissolved oxygen, ammonia concentration, sediment and water oxygen demand
	o	Hydrographic parameters (temperature, salinity, flushing)
Biota	o	Tissue chemistry
	o	Enzyme activiation (P450 screen)
	o	Tissue abundance of selected pathogen indicators (total/fecal coliforms, *Clostridium perfringens*, male-specific bacteriophage)

TABLE B3-1. FISH SPIECES USED AS ENDPOINTS FOR P450 MEASUREMENTS..

Common Name	Scientific Name	Citation
Starry Flounder	*Platichthys stellatus*	Collier et al., 1989, Stein et al., 1992
Rock Sole	*Lepidopsetta bilineata*	Varanasi et al., 1990, Stein et al., 1992
English Sole	*Parophyrys vetulus*	Collier et al., 1989, 1991; Stein et al., 1992
Winter Flounder	*Pseudopleuronectes americanus*	Collier et al., 1989, Monosson and Stegeman, 1991
White Perch	*Morone americana*	Collier et al., 1989
Atlantic croaker	*Micropogonias undulatus*	Collier et al., 1989
White croaker	*Genyonemus lineatus*	Collier et al., 1989
Yellowfin sole	*Limanda aspera*	Varanasi et al., 1990
Flathead Sole	*Hippoglossus elassodon*	Varanasi et al., 1990
Pacific halibut	*Hippoglossus stenolepis*	Varanasi et al., 1990
Dolly Varden	*Salvelinus malma*	Varanasi et al., 1990
Rainbow trout	*Oncorhynchus mykiss*	Haasch et al., 1992, 1993;
Largemouth bass	*Micropterus salmoides*	Haasch et al., 1992, 1993
Killifish	*Fundulus heteroclitus*	Haasch et al., 1992, 1993
Atlantic cod	*Gadus morhua*	Goksor and Husoy, 1992 Goksoyr et al. 1994
Mirror carp	*Cyprinus carpio*	van der Weiden et al., 1993 van der Weiden, 1992, 1994
Fathead minnow	*Pimephales promelas*	Lindstrom-Seppa et al., 1994
Channel catfish	*Ictalurus punctatus*	Ronis et al., 1992
Rocky Mountain whitefish	*Prospium williamsoni*	Kloepper-Sams and Benton, 1994
Longnose sucker	*Catostomus catostomus*	Kloepper-Sams and Benton, 1994
Burbot	*Lota lota*	Kloepper-Sams and Benton, 1994

TABLE B4-1. **PROPOSED STATIONS AND RATIONALE FOR SELECTION.**

Rationale for Selection	Station[b]
<u>A. SURFACE SAMPLING STATIONS</u>	
1. High metals, high PCBs (GSO)[a]	31
2. High metals, high PCBs and high PAHs (GSO)	26, 28, 29, 32
3. Eliminate data gap near contaminated station (GSO)	25, 27, 30, 34
4. Eliminate data gap (GSO)	35, 36
5. Stations needed to define environmental gradient (GSO)	33, 37, 38, 39
6. Stations needed to characterize potential "dead zone"	40, 41
6. Reference stations ; Jamestown Potter Cove, Castle Hill Cove	JPC1, CHC1
<u>B. DEEP CORE SAMPLING STATIONS</u>	
1. High metals, high organics (GSO)	26, 29, 31
2. Establish historical trends and determine contaminant accumulation (GSO)	35, 36
6. Station needed to characterize potential "dead zone"	40

[a] Quinn et al., 1994b
[b]Refer to Figures B2-1 and B2-2 for station locations.

Table B4-2. Derecktor Shipyard Risk Assessment Sample Collection/Chemical Analysis Summary

Sample ID		Sediment Chemistry*			Tissue Chemistry*					Geotechnical		Water		Bioassay						
	STATION	Bulk Sediment		Elutriate	Indig	Deployed	Hard	Lobster	Fish			BOD/COD	DO/NH4/							
SITE	NO.	SUR	BOT	SUR	Mussel	Mussel	Clam			GS	TOC	SOD	TSS/CHL	HN	DIV	P450	MICRO	AMP	CI	Elutriate
CC	24				1															
CC	25	1		1	1			1		1	1			1	1			1	2	1
CC	26	1	2	1	1	1			1	3	3	1	3	1	1	1	1	1	3	1
CC	27	1		1	1			1		1	1			1	1			1	2	1
CC	28	1		1	1	1		1	1	1	1		3	1	1	1	1	1	4	1
CC	29	1	2	1	1	1		1	1	3	3		3	1	1	1	1	1	4	1
CC	30	1		1						1	1	1			1			1	0	1
CC	31	1	2	1		1	1		1	3	3	1	3		1	1	1	1	3	1
CC	32	1		1			1			1	1	1			1			1	1	1
CC	33	1		1		1	1	1		1	1	1	3		1		1	1	3	1
CC	34	1		1			1		1	1	1				1	1		1	2	1
CC	35	1	2	1	1		1	1	1	3	3	1		1	1	1		1	4	1
CC	36	1	2	1	1		1	1	1	3	3			1	1	1		1	4	1
CC	37	1		1						1	1		3		1		1	1	0	1
CC	38	1		1		1	1	1		1	1		3		1		1	1	3	1
CC	39	1		1		1		1		1	1				1			1	2	1
CC	40	1	2	1		1				3	3		3		1		1	1	1	1
CC	41	1		1			1			1	1				1			1	1	1
JPC	1	1		1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	5	1
CHC	1	1		1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	5	1
T_0						1											1			
TOTAL:		19	12	19	10	11	10	11	9	31	31	8	30	9	19	9	11	19	49	19

Group Totals: 101
QA/QC 20
Total: 121

JPC = Potter Cove, Jamestown
CC = Coddington Cove, NETC
CHC = Castle Hill (So. Aquidneck Island)

GS = Grain Size
TOC = Total organic carbon

*Chemistry analytes described in URI and SAIC, 1994

BOD/COD = Water column biologica/ chemical oxygen demand
SOD = Sediment oxygen demand
DO/NH4 = Dissolved oxygen/ammonia
TSS/CHL = Total suspended solids/ Chlorophyll a

HN = Hematopoietic neoplasia
Micro = Sewage Pathogens in Mussel Tissue
DIV = Community Structure Analysis
P450 = Cytochrome P450 assay
AMP = Amphipod Test
CI = Bivalve Condition Index
Elutriate = Elutriate test with Arbacia