ATTACHMENT 1

Screening-Level Ecological Risk Assessment (SLERA) for the Newark Bay Study Area (Battelle 2008)

FINAL

SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT REPORT

for

Newark Bay Study Area

Submitted to

U.S. Environmental Protection Agency
Region 2

and

U.S. Army Corps of Engineers
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EXECUTIVE SUMMARY

A Remedial Investigation/Feasibility Study (RI/FS) is being conducted within the Newark Bay Study Area (NBSA) to characterize the nature and extent of chemical contamination, develop and evaluate appropriate remedial options, and gather necessary information to select an appropriate remedy for the site. As part of this RI/FS process, a screening-level ecological risk assessment (SLERA), described in this report, was performed. The purpose of the SLERA is to evaluate the potential risks to ecological receptors that are exposed to contaminants of potential ecological concern (COPECs) in environmental media at the site and determine whether additional ecological evaluation is necessary.

This SLERA encompasses Steps 1 and 2 of the U.S. Environmental Protection Agency's (USEPA) eight-step guidance (USEPA, 1997). These steps include developing a conceptual site model (CSM), identifying COPECs, and performing a preliminary exposure assessment using conservative assumptions. Potential risk to ecological receptors was estimated by comparing maximum exposure concentrations to chemical-specific ecotoxicity threshold values to determine whether ecological threats are negligible or substantial enough to warrant continuing with the risk assessment process in a Baseline Ecological Risk Assessment (BERA).

The NBSA consists of Newark Bay and portions of the Hackensack River, the Arthur Kill, and the Kill Van Kull. Urbanization, the expansion of industry, and the release of chemicals into Newark Bay from both point and non-point sources have resulted in elevated levels of chemical contamination in sediments (National Oceanic and Atmospheric Administration [NOAA], 1998). The primary contaminants represent a variety of different contaminant classes, including, but not limited to, metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides/herbicides, and dioxins/furans.

Due to the large area involved, the NBSA was segmented into three regions: north, middle, and south. It is recognized, however, that each of the three regions contains various geomorphological features such as channels, subtidal flats, and intertidal flats that have distinct characteristics, water depth, and depositional rates. The SLERA examines potential exposures of ecological receptors to chemicals within each region using data from previous investigations. Within each of the three regions of the bay are three predominant habitat types: 1) intertidal areas, including the wetlands and mudflats; 2) shallow subtidal areas (1 to 20 feet); and 3) transitional slopes and navigational channels (> 20 feet). The intertidal and shallow subtidal areas are not regularly disturbed by dredging; therefore, there is a high potential for ecological receptors to be exposed to contaminants. Ecological receptors that may be exposed to contaminants in these areas include benthic invertebrates, fish, mammals, and birds. They may be exposed to contaminants via direct contact with, and/or ingestion of contaminated sediment, and by ingesting contaminants that have accumulated in prey tissue.

The maximum concentrations of chemicals in sediment and tissue (fish, benthic invertebrates, crabs, mollusks, and avian embryos) in each region were compared to ecological screening benchmarks to obtain a hazard quotient (HQ). Those chemicals with HQs greater than 1 were retained as COPECs to be further evaluated in a BERA. Ecological screening benchmarks were identified for each distinct environmental media (sediment and biological tissue) and for the relevant exposure pathways. The screening benchmarks for sediment were based on the lowest of various published benchmarks (e.g., New York State Department of Environmental Conservation [NYSDEC], New Jersey Department of Environmental Protection [NJDEP], USEPA). For those contaminants that are considered bioaccumulative (USEPA, 2000), wildlife protective concentration levels (PCLs) were calculated for

sediment and tissue. These wildlife PCLs are back-calculated sediment and tissue concentrations that are derived using conservative exposure assumptions so as to be protective of bioaccumulative hazards to upper trophic level receptors. In addition, a tissue screen was performed by comparing tissue contaminant concentrations with available literature-based critical body residue (CBR) values.

As a result of the screening process, many chemicals were identified as COPECs in sediment, fish tissue, mollusk tissue, crab tissue, and other benthic invertebrates. These include 13 metals plus various forms of mercury; one VOC (ethylbenzene); four non-PAH SVOCs; 25 individual PAHs as well as the sums of high molecular weight (HMW), low molecular weight (LMW), and total PAHs; five individual Aroclors plus total PCBs; 29 pesticides/herbicides as well as the sum concentration of seven compounds; and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) plus its toxic equivalents based on dioxin and dioxin-like PCB components.

There is a degree of uncertainty associated with the results of any SLERA. Several of the uncertainties associated with this SLERA include data limitations, the conservative assumptions of the screening level approach, uncertainties associated with toxicological benchmarks and laboratory data, uncertainties associated with the occurrence of the receptors of concern in the study area, and assumptions regarding the depth exposure for the biologically active zone (BAZ). Despite these uncertainties, the SLERA provides a path forward to further evaluate the identified COPECs in a BERA. Given the complexity and spatial scale of the NBSA, considerable additional information is necessary to develop more realistic estimates of ecological exposure and effects.

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ACRONYMS

AE	assessment endpoint
AOC	Administrative Order on Consent
ATSDR	Agency for Toxic Substances and Disease Registry
AVS	acid volatile sulfides
BAF	bioaccumulation factor
BBL	Blasland, Bouck & Lee, Inc.
BAZ	Biologically Active Zone
BEHP	bis(2-ethylhexyl)phthalate
BERA	baseline ecological risk assessment
BMF	biological magnification factor
BW	body weight
CARP	Contaminant Assessment and Reduction Program
CBR	critical body residue
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CSM	conceptual site model
CSO	combined sewer overflow
COPEC	contaminant of potential ecological concern
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDx	Dichlorodiphenyltrichloroethane (DDT) and its derivatives
DNA	deoxyribonucleic acid
DOC	dissolved organic carbon
DQO	data quality objective
EPC	exposure point concentration
ERA	ecological risk assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERED	Environmental Residue Effects Database
ER-L	effects range-low
ER-M	effects range-median
g	gram
HMW	high molecular weight
HQ	hazard quotient
Kg	kilogram
LMS	Lawler, Matusky, and Skelly Engineers, Inc.
LMW	low molecular weight
LOAEL	lowest observed adverse effect level
LPRRP	Lower Passaic River Restoration Project

MATC	maximum allowable toxicant concentration
MDL	method detection limit
ME	measurement endpoint
mllw	mean lower low water
MMPA	Marine Mammal Protection Act
NBSA	Newark Bay Study Area
NCP	National Contingency Plan
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
NJPDES	New Jersey Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NOAEL	no observed adverse effect level
NPL	National Priorities List
NS&T	National Status and Trends
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OCC	Occidental Chemical Corporation
OSWER	Office of Solid Waste and Emergency Response
PAHs	polycyclic aromatic hydrocarbons
PAR	Pathways Analysis Report
PAS	Princeton Aquatic Sciences
PCBs	polychlorinated biphenyls
PCL	protective concentration level
POTW	publicly-owned treatment works
ppb	parts per billion
PRP	potentially responsible party
QA	quality assurance
RI/FS	Remedial Investigation/Feasibility Study
RIWP	Remedial Investigation Work Plan
RM	river mile
ROC	receptor of concern
SARA	Superfund Amendments and Reauthorization Act
SEM	simultaneously extracted metals
SFF	site foraging frequency
SI	source identification
SLERA	screening-level ecological risk assessment
SPI	sediment profiling imaging
SSO	sanitary sewer overflow
SVOC	semivolatile organic compound
T&E	threatened and endangered
TCDD	tetrachlorodibenzo-*p*-dioxin

TEF	toxic equivalency factor
TEPH	total extractable petroleum hydrocarbons
TEQ	toxic equivalency quotient
THQ	target hazard quotient
TRV	toxicity reference value
µg	microgram
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound
WHO	World Health Organization

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1.0 INTRODUCTION

1.1 Objective and Purpose

Pursuant to the Administrative Order on Consent (AOC) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Index No. CERCLA 02-2004-2010, issued in February 2004 by the United States Environmental Protection Agency (USEPA), a Remedial Investigation/Feasibility Study (RI/FS) is being conducted within the Newark Bay Study Area (NBSA), described as the water column and sediments of Newark Bay and portions of the Hackensack River, the Arthur Kill, and the Kill Van Kull (USEPA, 2004) (Figure 1). The purpose of the RI/FS is to characterize the nature and extent of chemical contamination, develop and evaluate appropriate remedial options, and gather necessary information to select an appropriate remedy for the site. As part of this RI/FS process, a screening-level ecological risk assessment (SLERA), described in this report, was performed for the NBSA to identify the potential for contaminants in environmental media to adversely affect ecological receptor populations.

The ecological risk assessment (ERA) process is conducted to evaluate potential ecological risks, following guidance from USEPA (1992, 1997). It is a tiered process that encompasses eight steps, as summarized in Figure 2. The SLERA encompasses Steps 1 and 2 of USEPA guidance. These steps include developing a conceptual site model (CSM), identifying contaminants of potential ecological concern (COPECs), and performing an exposure assessment using conservative assumptions. Potential risk to ecological receptors is estimated by comparing maximum exposure concentrations to chemical-specific ecotoxicity threshold values to determine whether ecological threats are negligible or if they are substantial enough to warrant continuing with the risk assessment process. If the process continues, a baseline ecological risk assessment (BERA), encompassing Steps 3 through 7 of the USEPA process, is conducted. The BERA uses the output from the SLERA, in concert with new data collection, to refine the problem formulation and further evaluate any COPECs that may adversely affect receptors of concern (ROCs). As the final step in the risk assessment process (Step 8), the findings from the risk assessment are used in the risk-management decision-making process according to the Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-28P *Issuance of Final Guidance, Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (USEPA, 1999) to determine if active risk reduction may be necessary.

Exposure and potential adverse effects are assessed for all endpoints defined in the CSM of the problem formulation step (Step 3) and are used to characterize risks to ecological receptors. Although the CSM is finalized in the BERA, a preliminary CSM of the ecological elements is provided as part of the SLERA. As the RI/FS process moves forward and more data become available, they are incorporated into the BERA.

The goal of this SLERA is to evaluate the potential risks to ecological receptors that are exposed to COPECs in environmental media within the NBSA. SLERA-specific objectives include the following:

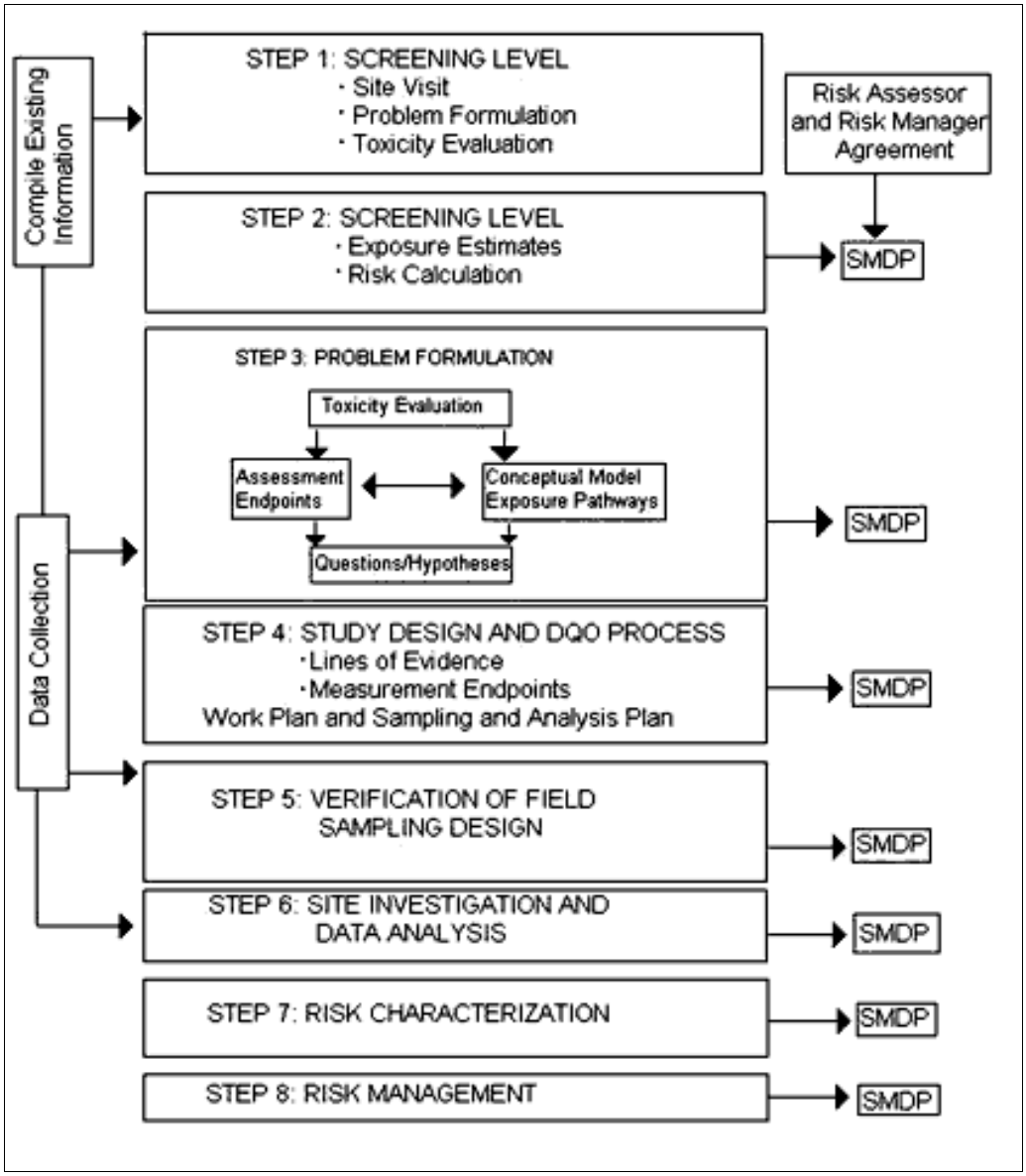
- Describe the physical site conditions and ecological setting.
- Present the screening-level problem formulation.
- Conduct the COPEC screening process based on analytical results from previous investigations.
- Determine if there are area(s) that may pose unacceptable ecological risks and require further evaluation in a BERA.
- Identify major sources of uncertainty associated with the screening level risk estimates.

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Figure 1. The Newark Bay Study Area and Regional Features (Tierra, 2006a)

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SMDP = scientific/management decision point.
DQO = data quality objective.

Figure 2. USEPA's Eight-Step Ecological Risk Assessment Process (USEPA, 1997)

1.2 Report Organization

The SLERA report is organized as follows:

Section 1.0: Introduction. This section presents an overview of the SLERA process.

Section 2.0: Site Description and History. This section provides a site description, including the biological setting, and reviews historical information from previous investigations.

Section 3.0: Screening-Level Problem Formulation. This section includes the CSM, known and suspected sources of chemical contaminants, contaminant fate and transport mechanisms, exposure pathways, and ecological receptors of concern.

Section 4.0: Screening-Level Effects Evaluation and Exposure Estimate. This section describes the contaminant concentrations in each environmental medium and the ecotoxicity threshold that is indicative of potential ecological effects. These elements are combined in the COPEC screening process to characterize the magnitude of exposures.

Section 5.0: Screening-Level Risk Characterization. This section presents the estimates of potential risks to the ecological receptors for each of the COPECs.

Section 6.0: Uncertainty Analysis. This section discusses the uncertainties associated with the screening level risk estimates.

Section 7.0: SLERA Conclusions and Recommendations.

Section 8.0: References.

1.3 Regulatory Framework

The NBSA RI/FS is being conducted by USEPA to address the presence of chemical stressors in Newark Bay. These chemicals were directly released to or transported into Newark Bay from various sources, including groundwater, non-point sources, point sources, and tributaries. The RI/FS is being conducted pursuant to CERCLA, the National Contingency Plan (NCP), and the Superfund Amendments and Reauthorization Act of 1986 (SARA). The work is proceeding under an AOC with one of the potentially responsible parties (PRP), Occidental Chemical Corporation (OCC). Tierra Solutions, Inc. (Tierra) is performing the RI/FS on behalf of OCC.

As a preliminary step in the RI/FS process, a Remedial Investigation Work Plan (RIWP) was prepared by Tierra (2004; 2005). Data were collected (Tierra, 2005), and a Phase II RIWP was subsequently prepared (Tierra, 2006a) with data collected in the fall of 2007. Results from this SLERA will aid and direct subsequent sampling programs intended to support a BERA, if necessary. The overall goals of the risk assessments are to identify areas posing the greatest potential for risks to human health and/or ecological receptors, and develop remedial action objectives in support of the FS.

1.4 SLERA Approach

This SLERA builds on information presented in the Pathways Analysis Report (PAR) (Battelle, 2006), which included preliminary elements of the SLERA, such as suggested receptors and pathways of concern. The PAR was written as a scoping document that allowed an opportunity for stakeholders to provide their input early in the risk assessment process. The SLERA is conducted using these inputs along with existing chemical data from the NBSA to evaluate the potential for adverse effects to ecological receptors from exposure to contaminants. These adverse effects may result from exposure to contaminants in sediments or from the ingestion of contaminated prey. This SLERA is written utilizing data available through 2005. Because the NBSA is a dynamic system, with ongoing anthropogenic activities, data are continually being collected from the area. Additional data collected after 2005 will need to be included in any future risk assessment work (*i.e.*, a BERA).

The SLERA focuses on three habitat types within the bay:

1. Intertidal areas, including wetlands (only those physically connected to the bay) and mudflat habitats.
2. Shallow subtidal areas (1 to 20 feet), which extend from the intertidal areas to the transitional zones or slopes associated with the navigational channels.
3. Navigational channels, which comprise the transitional zones and the dredged channels.

These areas are discussed further in Section 2.3. To evaluate the potential risks to receptors associated with these habitat areas, the first two steps of the eight-step process described in USEPA's *Ecological Risk Assessment Guidance for Superfund* (USEPA, 1997) were followed (Figure 2).

This SLERA describes the screening process to identify COPECs based on available data from the site, literature studies, the fate and transport of those COPECs, ROCs, exposure pathways, and assessment and measurement endpoints. If necessary, additional studies will provide the data necessary to resolve spatial and temporal data gaps in the current data set for contaminant levels in the NBSA. Contaminants that do not occur at concentrations that have a potential to cause adverse effects to ecological populations are screened out in this SLERA. Contaminants that are determined to occur at sufficient concentrations to present a potential for unacceptable risks are further evaluated in a BERA. Following input from stakeholders and other involved parties, the BERA will expand on particular ecological concerns at the site. In accordance with USEPA guidance, conservative assumptions are used in this SLERA (USEPA, 1997), whereas more realistic, site-specific assumptions are considered in the BERA.

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2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Description

The AOC defines the NBSA as "Newark Bay and portions of the Hackensack River, the Arthur Kill and the Kill Van Kull" (USEPA, 2004). Newark Bay itself is part of the New York/New Jersey Harbor Estuary and is located south of the convergence of the Passaic and Hackensack Rivers. To the west are the New Jersey cities of Newark and Elizabeth; to the east are the New Jersey cities of Jersey City and Bayonne; and Staten Island, New York is to the south (Tierra, 2006a). Newark Bay is approximately 6 miles long and 1 mile wide. It is linked to Upper New York Bay by the Kill Van Kull and to Raritan Bay by the Arthur Kill (Figure 1). The upper boundaries of the NBSA include the downstream boundary of the Lower Passaic River Restoration Project (LPRRP) and the Conrail Bridge in the Hackensack River. The lower boundaries (determined for the Phase I and II RIWP) consist of the Bayonne Bridge in the Kill Van Kull and the Goethals Bridge in the Arthur Kill (Tierra, 2006a) (Figure 1).

2.2 Physical Setting

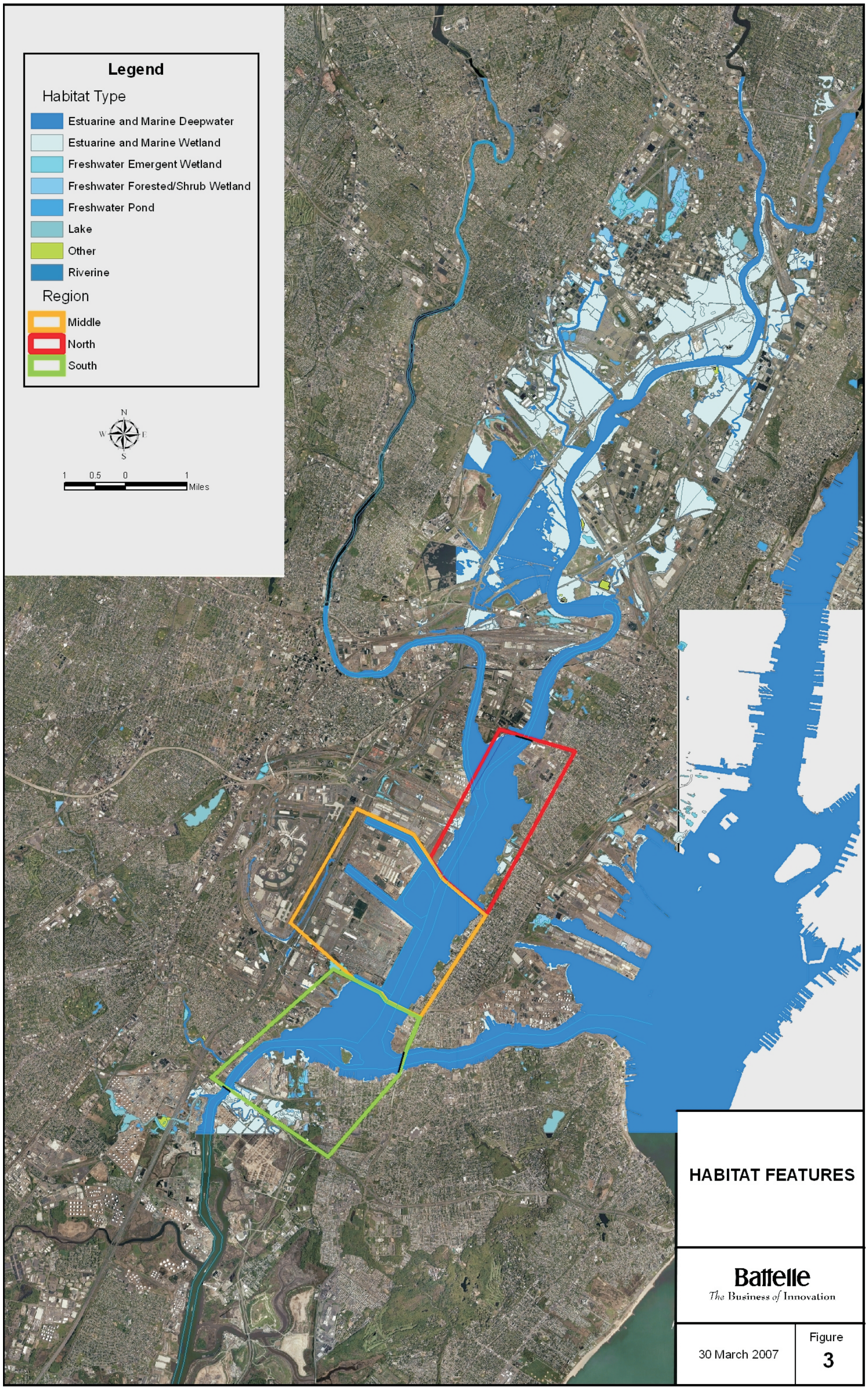
The two major rivers that drain into Newark Bay are the Passaic and Hackensack Rivers. The Passaic River drains a 935-square-mile watershed, encompassing 10 counties from northeastern New Jersey and southeastern New York (HydroQual, 2005). The Hackensack River spans 32 miles from New York to Newark Bay and drains 185 square miles. Each of these rivers has a downstream confluence with Newark Bay, which is connected to Upper New York Bay by the Kill Van Kull and to Raritan Bay by the Arthur Kill. The Kill Van Kull is located along the north side of Staten Island and the Arthur Kill extends along the western side of Staten Island, with both waterways forming the boundary between the States of New York and New Jersey. Together, Newark Bay, its tributaries, and associated wetlands, are one of the world's largest urbanized and industrialized estuarine systems (Gunster *et al.*, 1993a).

Land use in the Newark Bay area has been primarily urban, consisting of a mix of residential, commercial, and industrial uses. During the 1700s, the City of Newark was recognized as a leading manufacturer of leather goods, carriages, and iron and brass products (Urquhart, 1913). Following World War II, Newark became a leading transportation center that included a highly developed infrastructure of highway, railway, and marine services. On the western shore of Newark Bay lies Port Newark, which is part of the port system maintained by the Port Authority of New York and New Jersey. This is one of the nation's largest and busiest ports for containerized cargo, petroleum products, and various hazardous cargo. Both the eastern and western banks of Newark Bay are dominated by numerous active and abandoned commercial and industrial properties. The banks of Newark Bay are extensively developed and consist of miles of hardened, paved shoreline. A highly developed network of combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), and publicly owned treatment works (POTWs) also exists throughout the study area (Mueller *et al.*, 1982).

2.3 Geomorphic Areas

Numerous distinct geomorphic features of Newark Bay are characterized based on water depth, shoreline modifications, and areas affected by dredging and filling. The dominant features are the federal navigation channels and the broad subtidal flats between the navigation channels and the shoreline. Transitional slopes occur between the channels and the subtidal flats. According to the Phase II RIWP Sediment Sampling and Source Identification (SI) Program Report (Tierra, 2006a), the navigational channels (including the port channels) occupy 30% of the study area and the subtidal flats occupy 52% of the study area. Intertidal areas are frequently exposed during low tide and occur in small, localized areas around the bay. Other important features of Newark Bay include extensively developed waterfronts with piers and shipping facilities, as well as the confined disposal facility (CDF) near Port Newark.

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Legend
Habitat Type
Estuarine and Marine Deepwater
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Other
Riverine
Region
Middle
North
South
N
W
E
S
1 0.5 0 1
Miles
HABITAT FEATURES
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30 March 2007
Figure
3

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For the purposes of the SLERA, the NBSA was segmented into three regions. The three regions, identified as south, middle, and north, are illustrated in Figure 3. The channels that pass through each region are clearly depositional in most areas (Tierra, 2006a). The south and north regions consist mostly of shallow subtidal shoal areas that are primarily characterized as minimally depositional or non-depositional. The middle region consists mostly of navigational channels (depositional areas) and a shallow area located on the eastern side that is characterized as moderately depositional. The SLERA examines potential exposures of ecological receptors to chemicals within each region.

Extensive shoreline filling has had an impact on the sedimentation and circulation patterns within Newark Bay. For instance, Suszkowski (1978) concluded that the transition of the southwestern portion of the bay over time from erosional to depositional is significant. The greatest amount of filling occurred prior to 1934; however, a substantial amount of shoreline was also filled between 1934 and 1976 (Tierra, 2006a). Suszkowski (1978) compared National Oceanic and Atmospheric Administration (NOAA) bathymetric charts and reported a 20% reduction in the area of Newark Bay between 1855 and 1976 and noted that until 1969, over 75% of dredged material taken from the bay was deposited in adjacent upland areas as fill for use in coastline development. The western shoreline of the Port Newark area and northward appears to have had the most extensive filling (U.S. Army Corps of Engineers [USACE], 2005). Dredged material removed during bay deepening was used for nearshore fill, which may have resulted in some of the historical contamination being placed in the coastline (Tierra, 2006a). All of these activities have changed sediment transport within the bay. Furthermore, groundwater discharge through the historically contaminated dredged fill material may be a pathway for remobilization of contaminants into the bay (Tierra, 2006a).

2.3.1 Navigation Channels/Port Channels

To maintain the status of Newark Bay and its tributaries as one of the largest commercial ports in the nation, USACE has conducted extensive dredging operations since the 1930s to accommodate the expanding fleet of cargo vessels. Dredging operations are conducted to ensure maneuverability of the increasingly larger ships entering the bay and port system. As mentioned in the previous section, dredged material has historically been used to fill in coastal areas, potentially resulting in the relocation of historical contaminants from navigational channels and waterways to the shoreline or areas outside the navigational channels (Suszkowski, 1978; Tierra, 2006a).

Maintenance dredging of the navigational channels and harbor-deepening projects is currently ongoing throughout the bay. Figure 4 presents a history of both of these dredging activities. Although significant dredging activities have occurred since the time this evaluation was performed, these activities are not considered in this risk assessment but will need to be considered in any future updates. Furthermore, several of the dates listed in Figure 4 reflect maintenance dredging work which, although presented as covering the entire channel length, actually only includes smaller shoal areas within the channels. Figure 5 presents a map of the New York/New Jersey Harbor Deepening Project. The navigation channels shown in these areas have been dredged, are in the process of being dredged, or are scheduled to be dredged to a depth of 50 feet; these operations are expected to continue through 2013.

The navigation channels are unique from the rest of the bay in that, because of deeper water depths, they are not subject to wind-wave resuspension and they accumulate sediments resuspended from the subtidal flats (Suszkowski, 1978). Tierra (2006a) noted that in most areas, the channels have a much higher depositional rate than the rest of the bay. USACE reported a rate of 2 to 10 inches per year (approximately 50 to 250 millimeters per year) in the channel (USACE, 1986). Two other studies (NOAA, 1984; Suszkowski, 1978) reported a rate of 1 to 3 millimeters per year in the subtidal flats. In addition, higher salinities are found in the channels. Consequently, they represent a different habitat than

the rest of the bay (Suszkowski, 1978). Other shoal areas were once historical channels, turning basins, and borrow pits that have accumulated thick beds of legacy sediments due to limited maintenance dredging or abandonment (USACE, 2006).

USACE has identified 11 major navigation channel reaches in Newark Bay (Figure 1); from south to north, these are as follows:

- Gulfport Reach.
- Elizabethport Reach.
- North of Shooters Island Reach.
- South of Shooters Island Reach.
- Bergen Point West Reach.
- Newark Bay South Reach.
- Newark Bay Middle Reach.
- Newark Bay North Reach.
- Turning Basin.
- Kearny Point Reach.
- Droyers Point Reach.

In addition to the 11 reaches, Newark Bay also has three main port channels that are regularly dredged for maintenance: Port Newark Channel, Elizabeth Channel, and South Elizabeth Channel. There is no active maintenance dredging of the channel south of Shooters Island and north of Port Newark. The timing of the various dredging operations in recent years can potentially impact the usability of certain sediment data sets for characterizing sediment contamination in the bay and assessing risks. Sediment samples collected in areas that were subsequently dredged or will be dredged in the upcoming year are not relevant for assessing environmental exposures.

Transitional slopes occur between the deeper dredged channels and the subtidal flats. These slopes cover about 8% of the bay area (Tierra, 2006a). These areas may have been created by cutbacks during dredging, slumping of subtidal flats into the dredged channels, erosion, or some combination of these processes. These areas may act as sediment sinks and storage areas, with periodic resuspension of sediments occurring in response to wind, waves, and tidal currents (Tierra, 2005). Boat traffic could also lead to resuspension of sediments on the transitional slopes. Severe weather events, along with disturbances from waves or propeller wash from passing vessels, could potentially result in the redistribution of sediment from the transitional slopes into the navigation channels/port channels (Tierra, 2006a).

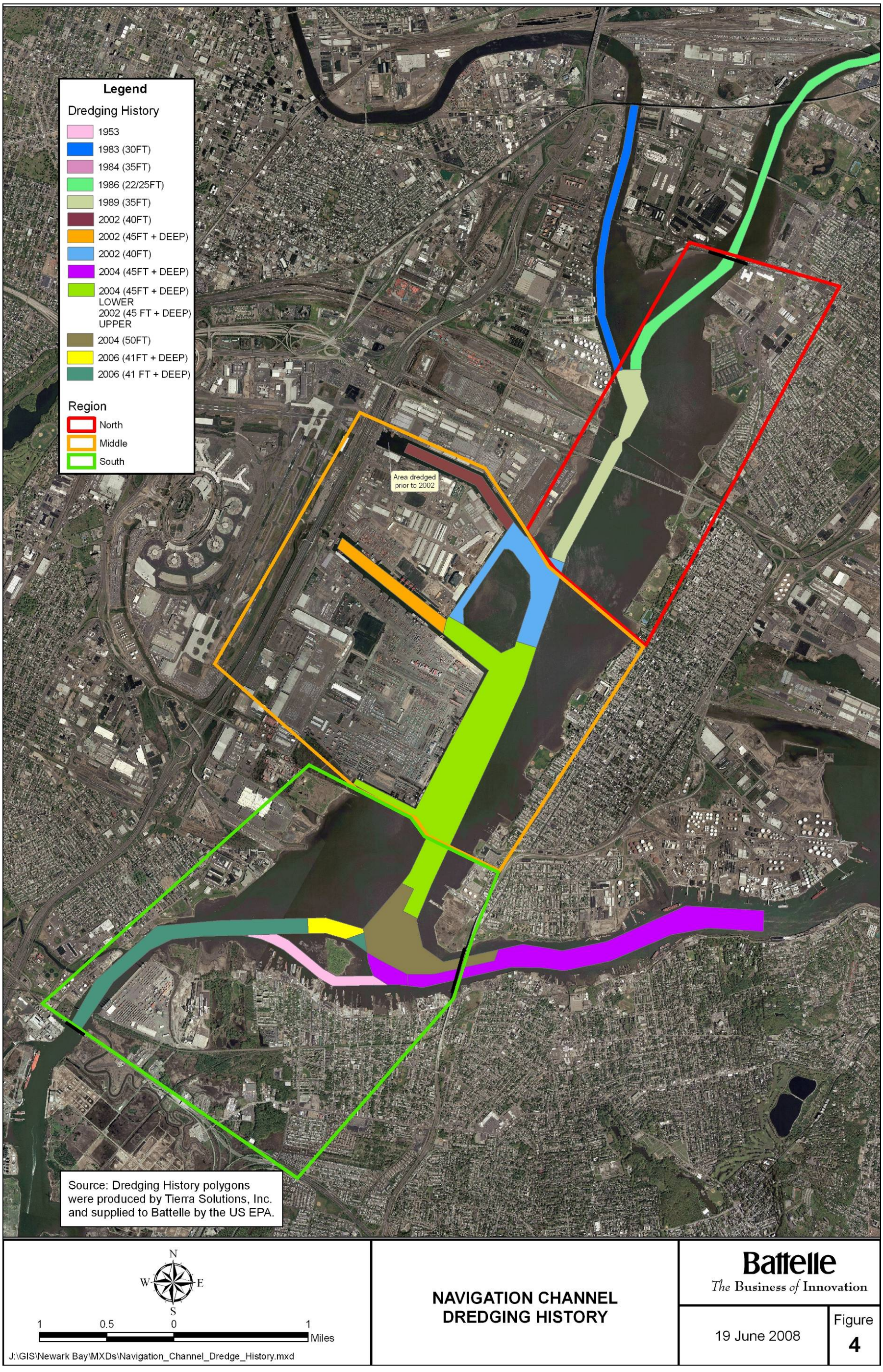


Figure 4. Navigation Channel Dredging History

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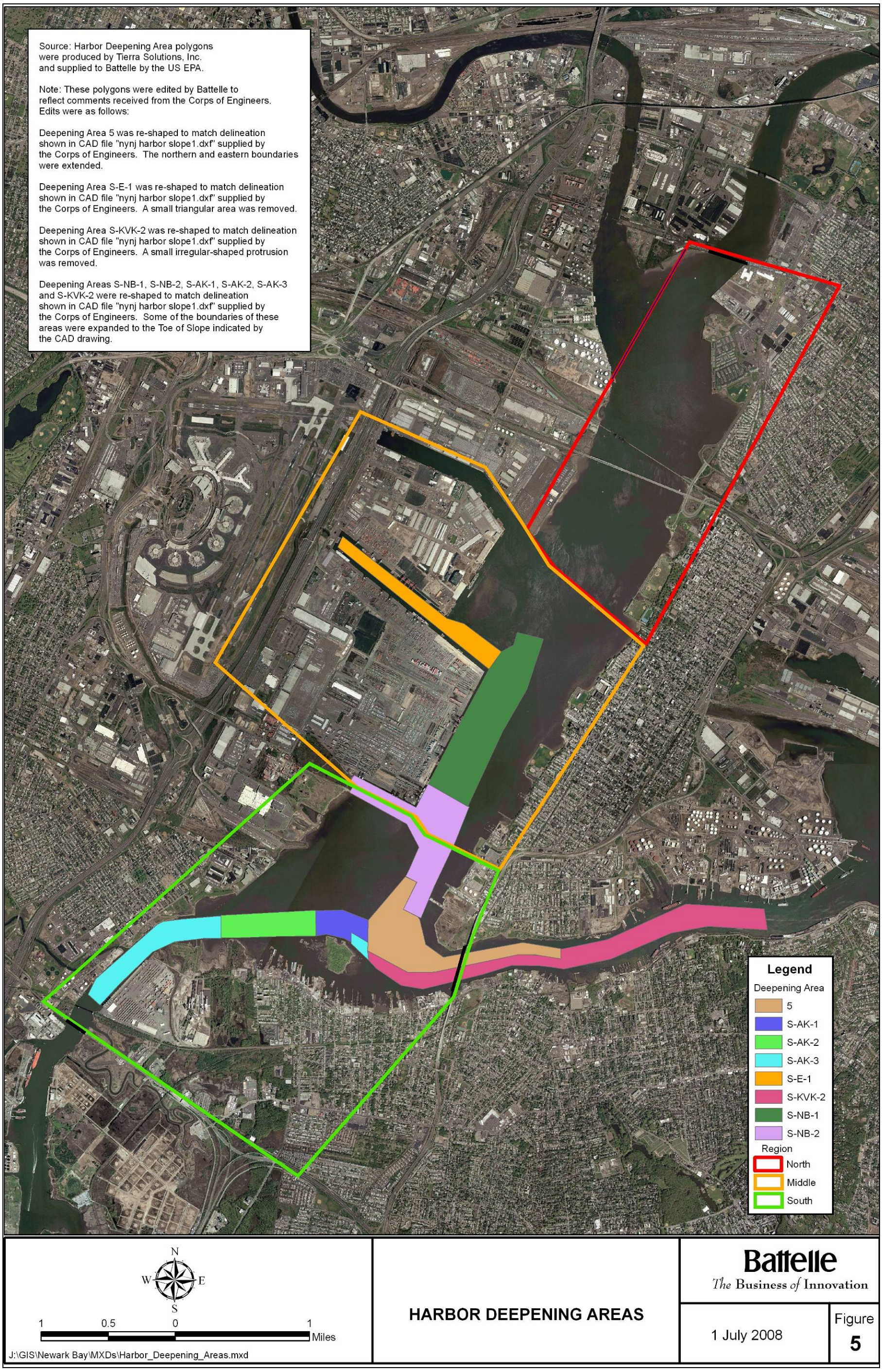


Figure 5. Harbor Deepening Areas

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2.3.2 Subtidal Flats

The broad, shallow subtidal flats located outside of the navigation channels cover the majority of Newark Bay (approximately 52% [Tierra, 2006a]). Water depths range from between 1 to 20 feet below mean lower low water (MLLW) (NOAA, 1997; 2002). These areas are characterized by relatively low sedimentation rates, relatively high bed stability, and limited mixing of buried sediments by resuspension (Tierra, 2005). It is unknown whether ice scouring periodically alters the sediment surface of the subtidal flats.

2.3.3 Intertidal Areas

Intertidal areas in the bay consist mostly of mudflats; however, some wetlands still remain. Most of the wetlands historically present around the fringes of Newark Bay have been filled as a result of development in the area. The small intertidal areas that remain (approximately 2% of the bay [Tierra, 2006a]) are normally exposed during low tide. It is unknown whether ice scouring periodically alters the sediment surface of these exposed areas, although it may be likely.

2.4 Hydrology

Newark Bay is a density-stratified estuary with the dominant freshwater contributions originating from the Passaic and Hackensack Rivers at the north end of the bay and the dominant saltwater contributions originating from tidal exchanges at its southern end through the Arthur Kill and Kill Van Kull. The tidal circulation patterns and influence of wind-driven episodic events, shipping traffic, and dredging activities play a role in the transport of sediments and contaminants within the Bay. The Hackensack River appears to be a sink for suspended sediment and contaminants from the Passaic River and Newark Bay due to estuarine circulation (Pence, 2004). The Arthur Kill and Kill Van Kull appear to be sediment sources to Newark Bay (Suszkowski, 1978; Styles *et al*., 2001; Hunter *et al*., 2002). The flow and circulation patterns within the bay, both long-term cycles and episodic events, impact the transport, deposition, and erosion of sediments by re-suspending sediments and associated contaminants and redistributing them. Suszkowski (1978) indicates that the Kill Van Kull is the largest contributor of inorganic sediment (46%) to Newark Bay, while the Passaic River contributes only 9% of suspended inorganic sediments. The Passaic and Hackensack Rivers, however, are the largest sources of freshwater flow to Newark Bay.

2.5 Ecological Setting

Increased urbanization and shoreline alteration have contributed to extensive habitat loss and degradation, which has greatly reduced the functional and structural integrity of ecosystems within the NBSA. Despite the impacts of urbanization on the bay, existing historical data indicate that the NBSA supports a variety of vegetation, fish, and wildlife species (Tierra, 2006a). Historical surveys and literature indicate that biological organisms are fairly abundant in Newark Bay, but species diversity is generally limited. An overview of the ecological setting of Newark Bay and adjacent waterbodies is presented in the following sections.

2.5.1 Benthic Invertebrates

Macroinvertebrate faunal studies suggest that the benthic invertebrate communities in Newark Bay and adjacent waterbodies have been influenced by the urban and industrial nature of the surrounding area (Tierra, 2004; Adams and Benyi, 2003; Adams *et al.*, 1998). In general, the species composition, diversity, and abundance are characteristic of a degraded estuarine environment. Overall, organism abundance is moderate and species diversity is low. The benthic invertebrate taxa are dominated by generalist and pollution-indicative species that can tolerate environmentally stressful conditions such as low dissolved oxygen. Studies conducted in the NBSA indicate that the invertebrate community is

dominated by polychaete worms (*e.g.*, *Streblospio benedicti*, *Sabellaria vulgaris*, *Scoloplos* sp.), bivalves (*e.g.*, *Mya lateralis* and *M. arenaria*), oligochaetes, and nematode worms (Lawler, Matusky, and Skelly Engineers, Inc. [LMS], 1996, as cited in USACE, 1997). The polychaetes, S. *benedicti* and *Scoloplos* sp., and the soft-shelled clam, *M. arenaria*, often represent over 25% of the total benthic infaunal abundance. Benthic infaunal abundance and species composition increase in the late winter and early spring months and decline in the summer (LMS, 1996, as cited in USACE, 1997). The combination of stressors and controlling factors influencing these seasonal patterns has not been examined sufficiently to differentiate among the possible causes.

Large invertebrates present in the channels and shoals of Newark Bay include crabs (blue, horseshoe, spider, American rock, and lady), soft clams, longfin squid, and shrimp (NOAA, 1994). Blue crab (*Callinectes sapidus*) was the predominant species collected at the channel stations and is present year-round. Blue crabs at shallow water stations appear to be more abundant in the summer and fall (May to November) and are nearly absent during the other months when they migrate into the deeper channels or off-shore (NOAA, 1994; LMS, 1996, as cited in USACE, 1997).

Benthic infauna and epibenthic species are used as a food source by many other species found in the NBSA, including fish, waterfowl, wading birds, and humans. The New York State Department of Health (NYSDOH), New Jersey Department of Environmental Protection (NJDEP), and New Jersey Department of Health and Senior Services (NJDHSS) have prohibited the harvesting, selling, or consumption of blue crabs caught in Newark Bay, the tidal Passaic River, the tidal Hackensack River, the Arthur Kill, the Kill Van Kull, and their tidal tributaries (NYSDOH, 2006; NJDEP and NJDHSS, 2006). These restrictions were issued based on high concentrations of polychlorinated biphenyls (PCBs), cadmium, and dioxin in blue crabs from these areas.

2.5.2 Fish

Fish communities in the NBSA consist of a mixture of marine, estuarine, and anadromous species (Woodhead, 1991). These communities are numerically dominated by a limited number of species, both resident and migratory (USACE, 1997). Several studies identified resident species that may potentially exist throughout the bay as including the mummichog, Atlantic silverside, and bluegill (Princeton Aquatic Sciences [PAS], 1982; USACE, 1987; ChemRisk, 1995a, 1995b). Historically, the most common migratory species observed were the striped bass, blue fish, winter flounder, and American eel (U.S. Fish and Wildlife Service [USFWS], 1981; USACE, 1987; NOAA, 1994). A variety of fish species use the shoal areas of Newark Bay as nursery habitat, as migration corridors, and for feeding and spawning (USACE, 1997). Fish use these shallow water areas from late spring through fall but are present year-round in the deeper navigation channels.

A total of 16 studies, which included characterizations of the fish and crustacean communities associated with Newark Bay and adjacent water bodies, were compiled and reviewed by Tierra (2004). This SLERA does not attempt to reconcile variations in sampling methods, timing, or design as a means of combining or normalizing the various data sets. Simple presence of species, collected in whichever manner proved effective, forms the basis for projecting habitat use. Nonetheless, it is interesting to note the range of biota sampling results reported.

As part of a monthly sampling program conducted in 1995 and 1996, LMS collected a total of 25 species of fish with a bottom trawl from four shoal areas in Newark Bay and a single station each in the Kill Van Kull and Arthur Kill (LMS, 1996). Twenty-three fish species were collected from the shoal areas, with bay anchovy (44-91%) being the predominant species. Atlantic silverside, blue fish, striped bass, and winter flounder accounted for 2% or more of the total number collected during each survey. Trawl catches were abundant from May through October and were low or zero from November through April.

A NOAA study conducted in 1993 and 1994 collected fish and crustaceans at 17 locations in Newark Bay (ten channel and seven shallow water trawls and gillnets). Striped bass, Atlantic tomcod, and blue crab were the most abundant animals collected from the channel trawls. Bay anchovy, Atlantic herring, and Atlantic tomcod were the most abundant animals collected from the shallow water trawl samples (NOAA, 1994). Fish were abundant year-round at the channel stations, but were abundant from May to October on the shoals.

The USACE conducted monthly fish surveys between October 1998 and September 1999 throughout the New York/New Jersey Harbor Estuary. Three stations were located in Newark Bay, two stations were located in the Arthur Kill, and one station was located in the Kill Van Kull (USACE, 1999). A total of 39 species of fish were identified in the survey. The USACE also conducted a number of fish surveys between 2001 and 2003 at eight locations within Newark Bay (five channel and three shallow water stations); these surveys resulted in the collection of 47 species of fish (USACE, 2003a; 2003b; 2003c).

Duffy-Anderson *et al.* (2003) summarized ichthyological studies conducted near man-made structures in the Arthur Kill and Kill Van Kull and also collected a total of 25 fish species, of which silver perch and naked goby were the most abundant. These two species were also present in substantial numbers during the 1993-1994 ichthyoplankton sampling (NOAA, 1994). The results of that survey indicate that both species spawn within Newark Bay, whereas the other species identified in that survey spawn elsewhere, and their larvae are transported by currents into the bay.

The NYSDOH, NJDEP, and NJDHSS have issued health advisories for eating fish caught in the NBSA, including Newark Bay, the tidal Passaic River, the tidal Hackensack River, the Arthur Kill, the Kill Van Kull, and their tidal tributaries (NYSDOH, 2006, NJDEP and NJDHSS, 2006). Fish species affected include striped bass, American eel, white perch, white catfish, gizzard shad, Atlantic needlefish, bluefish, and rainbow smelt. These advisories were issued based on high concentrations of PCBs and dioxin in these fish species.

2.5.3 Birds

The NBSA provides a variety of discontinuous habitats for wading birds, gulls, and waterfowl. The extent of high-quality nesting and foraging areas is limited throughout the NBSA (USACE, 1997; Blasland, Bouck, and Lee, Inc. [BBL], 2002). It is important to note the regionally important rookery habitat on Shooters Island, located at the southern end of Newark Bay, where a significant percentage of the entire New York breeding population of certain wading birds is present. Most of the avian species observed are migratory and have limited breeding activity in the NBSA. However, they do use the area for foraging and a few species use the area for nesting habitat, as well. Food sources in the area include bivalves, benthic worms, crabs, shrimp, and small fish.

A total of 48 avian species (including 28 shorebirds and piscivorous species) were observed from autumn 1999 through spring 2000 along the lower reach of the Passaic River during a four-season avian survey conducted by Tierra (BBL, 2002). Although the majority of aquatic birds observed in the survey were gulls (great black-backed, herring, laughing, and ring-billed), other commonly observed species included wading birds (egrets and herons), pelicanoformes (double-crested cormorants), shorebirds (killdeer, sandpiper, and yellowlegs), osprey, geese, and ducks. The numbers of these latter species were typically greater in spring and summer, as might be expected from their seasonal migratory distribution.

Osprey, northern harriers, and red-tailed hawks are raptors that have nearby nesting areas and are likely to forage in the NBSA (USACE, 1997). Other raptors that may have nearby nesting areas and may forage in the NBSA include falcons (American kestrel and peregrine), hawks (sharp-shinned, Cooper's, red-shouldered, and broad-winged), bald eagles, and merlins.

2.5.4 Mammals

It is relatively unlikely that cetaceans (whales, dolphins, porpoises) would enter the NBSA, although some species of pinnipeds (seals) could possibly be present at any time during the year (USACE, 1997). For example, the harbor seal and harbor porpoise have been noted as visitors to Newark Bay (Schoelkopf, pers. commun., 1996 as cited in USACE, 1997).

Previous ecological surveys conducted by USACE (1987) and ChemRisk (1995a) reported that terrestrial mammal species observed along the Lower Passaic River were limited to human-tolerant species commonly found in urban environments, including raccoon, eastern gray squirrel, eastern cottontail rabbit, and opossum (ChemRisk, 1995c). It is not clear, however, whether this characterization is reflective of current conditions or how applicable it is to the NBSA.

2.5.5 Reptiles

The northern diamondback terrapin has been reported in the Hackensack Meadowlands Complex (USACE, 1997). Individuals may possibly occur in Newark Bay as transients moving through the meadowlands and tidal creeks to the south along the Arthur Kill. Available field survey data are insufficient to determine the presence or absence of the northern diamondback terrapin in Newark Bay.

2.6 Previous Investigations

2.6.1 Historical Investigations

Various historical investigations have been conducted in Newark Bay by several agencies as well as by Tierra, from as early as 1983. These studies collected analytical chemistry data for surface sediment and tissue samples from different locations throughout the bay. Data from these historical investigations are maintained in a database at www.ourNewarkBay.org. Table 1 presents a list of these studies as they were exported from the database. The data were compiled and mapped to identify appropriate samples within the study area. Dredging activities were reviewed, and sediment data collected from dredged areas prior to subsequent dredging were removed from this evaluation. The remaining data suitable for this SLERA were included in the analysis discussed in Section 4.0.

Table 1. Historical Investigations

Organization[a]	Name of Survey	Date Collected	Matrix[b]
NOAA	NS&T Hudson-Raritan Phase I	March, 1991	Surface sediment
	NS&T Hudson-Raritan Phase II	January, 1993	Surface sediment
USEPA	EMAP 90-92	January, 1990	Surface sediment
USEPA	Passaic 1990 Surficial Sediment Investigation	February, 1990	Surface sediment
USEPA	Passaic 1991 Core Sediment Investigation	November/ December, 1991	Surface sediment
USEPA	Passaic 1992 Core Sediment Investigation	December, 1992	Surface sediment
USEPA	Passaic 1993 Core Sediment Investigation-01	March, 1993	Surface sediment
USEPA	Passaic 1993 Core Sediment Investigation-02	July, 1993	Surface sediment
USEPA	Passaic 1996 Newark Bay Reach A Sediment Sampling Program	May, 1996	Surface sediment
USEPA	Passaic 1997 Newark Bay Reach B, C, D Sampling Program	April, 1997	Surface sediment
USEPA	REMAP	August, 1993	Surface sediment
USEPA	REMAP	August/ September, 1994	Surface sediment
USACE	93F64HR: Hackensack River	July, 1993	Surface sediment
USACE	93F64PE: Port Elizabeth	July, 1993	Surface sediment Tissue
USACE	96PPANYNJ: Port Authority of NY/NJ	July, 1996	Surface sediment Tissue
USACE	96PNBCDF: Newark Bay Confined Disposal Facility	July, 1996	Surface sediment
NYSDEC	BSAF: Harbor Worm Sediment Collection	July, 2002	Tissue
NYSDEC	HBIC: Harbor Benthic Invertebrate Collection	June, 1999- May, 2000	Tissue
NYSDEC	HCC: Harbor Crustacean Collection	September, 1999	Tissue
NYSDEC	HCS: Harbor Cormorant Sampling	May, 1999	Tissue
NYSDEC	HFC: Harbor Fish Collection	June, 1999- May, 2000	Tissue
NYSDEC	HRA: Harbor Ambient Sediment Sampling Project	September, 1998- July, 1999	Surface sediment
NYSDEC	HRT: Harbor Sediment Trackdown Sampling Project	August, 2000- November, 2001	Surface sediment
NYSDEC	Unknown	June, 1983	Tissue
NYSDEC	Unknown	November, 1984	Tissue

Table 1. Historical Investigations, continued

Organization[a]	Name of Survey	Date Collected	Matrix[b]
NYSDEC	Unknown	October, 1993	Tissue
NYSDEC	Unknown	October, 1995	Tissue
NYSDEC	Unknown	August/October, 1998	Tissue
Tierra	Remedial Investigation Work Plan, Source Identification (2005)	October - December 2005	Surface sediment

a. The organization responsible was identified from the database output.

b. Although some programs may have collected deeper sediments in addition to the surface sediment (core sampling), only the surface sediment is used in the risk assessment.

2.6.2 RI/FS Investigations

The first phase of investigations for the RI/FS in the NBSA was performed in 2005 according to the Phase I RIWP (Tierra, 2005). These investigations, discussed below, included:

- An investigation of the Biologically Active Zone (BAZ).
- A bathymetric survey.
- Sediment sampling and analysis.
- Source identification activities.

2.6.2.1 BAZ Investigation

Field activities investigating the depth of the BAZ were conducted in October 2005 at 14 sampling locations. These stations were located in the intertidal mudflats, subtidal flats, and navigation channel areas. At each station, sediment profile imaging (SPI) was performed and sediment grab samples were collected for visual characterization. Particular emphasis was given to the subtidal and intertidal samples, because these regions are not regularly disturbed by dredging and are therefore likely to provide the most accurate information on the BAZ.

Results of both the SPI images and visual observations of the surface grab samples indicated that the BAZ was relatively consistent at that time of year across the three different geomorphic areas of Newark Bay (Tierra, 2006a). The reported BAZ depths averaged 5.7 inches in the intertidal areas, 5.4 inches in the subtidal flats, and 6.5 inches in the navigation channels. These results support at least a 6-inch BAZ depth; Tierra recommended that a BAZ depth of 6 inches be used for the Phase I and Phase II sediment sampling and analysis. Therefore, a 6-inch depth was carried forward for the SLERA, pending completion of USEPA's review of the Phase I and Phase II RIWP findings.

2.6.2.2 Bathymetric Survey

A bathymetric survey was conducted to confirm the geomorphic areas (navigation/port channels, transitional slopes, subtidal flats, intertidal flats, and industrial waterfront areas) that were originally delineated in the Phase I RIWP, based on the 2002 NOAA nautical chart. In general, the 2005 bathymetric survey confirmed the position and types of geomorphic areas identified in the Phase I RIWP, with a few refinements. For instance, the navigation/port channels increased in percentage of total study area in the Phase II RIWP by 1% from the Phase I RIWP; the transitional slopes increased in percentage of study area by 2%; the subtidal flats decreased in percentage of study area by 4%; the intertidal areas decreased in percentage by 1%; and the industrial waterfront areas increased by 1%.

2.6.2.3 Sediment Sampling and Analysis

Under the Phase I RIWP, sediment cores were collected from 69 locations from October through December 2005 by Tierra and analyzed for geotechnical properties, radiochemistry, and analytical chemistry. Analytical chemistry results were obtained for a variety of potential contaminants, including semivolatile organic compounds (SVOCs), pesticides, PCB Aroclors, PCB congeners, chlorinated herbicides, dioxin/furan congeners, metals, cyanide, total extractable petroleum hydrocarbons (TEPH), volatile organic compounds (VOCs), and organotins. Results indicate that many chemical constituents are present throughout Newark Bay at elevated concentrations; these data appear consistent with the historical datasets in terms of spatial distribution and concentration levels (Tierra, 2006a). General comparisons of Phase I RIWP data with historical datasets imply that all the various analytical methods used were not entirely comparable.

2.6.2.4 Source Identification Activities

Numerous contaminant sources to Newark Bay and its tributaries have been identified and are described in detail in the Phase II RIWP (Tierra, 2006a). Historical sources include industrial operations throughout the bay. Iannuzzi *et al.* (2002) identified the following types of industries that may have contributed to contaminant releases in the bay: metals refining, dye manufacturing, tanning, soap and candle making, lumber processing, hat manufacturing, carriage building, shoe making, petroleum processing, chemical manufacturing, pesticide and herbicide production, paper and textile manufacturing, copper rolling, wire manufacturing, silver manufacturing, platinum refining, ship building, coke making, decommissioning, and manufactured gas plants. The *Report on the Investigation of Sources of Pollutants and Contaminants* (Tierra, 2006b) also compiled a significant amount of information, via publicly available records (including relevant permits and federal and state databases) and through requests for information from various state and city sources. At the time of the report publication, 177 different waterfront or near-waterfront locations of interest were identified, based on historical or current land use (not including CSOs, SSOs, or POTWs, which are discussed below).

In addition to manufacturing and industrial discharges, Iannuzzi *et al*. (2002) linked contamination of the waterways and surrounding areas of the bay to a number of specific historic occurrences and non-point sources, such as those presented below:

- An oil pipeline crossing Saddle River that burst in the late 1800s, covering miles of the river from shore to shore with oil.
- A tanker spill of carbolic acid (phenol) in the spring of 1880.
- Spreading of lightweight fuel oils for vector control in mosquito-infested wetlands and marshes in the early 1900s.
- Copper fungicide application used on farmlands and watersheds to address mosquito infestation in the 1940s.
- Dichlorodiphenyltrichloroethane (DDT) application on mosquito-infested wetlands, marshes, and stormwater system infrastructure in the 1950s and 1960s.

Examples of more recent accidental releases include the following spills:

- A spill of sodium phosphate to the Arthur Kill in August 1987 (Gunster *et al*., 1993a, b).
- An oil pipeline crossing the Arthur Kill that ruptured in January 1990, releasing thousands of gallons of No. 2 fuel oil (NJDEP, 1991).
- A spill of fuel oil to Newark Bay in October 1991 (Gunster *et al.,* 1993a, b).

Tierra (2006a) also identified the discharge of raw sewage into Newark Bay and its tributaries as a significant input of contaminants and pathogens. Prior to 1960, the City of Elizabeth discharged raw

sewage into the Arthur Kill. In 1960, the city joined with Essex and Union counties to build a POTW. Jersey City, Kearney, and Port Richmond constructed POTWs in the 1950s and 1960s. All of the POTWs noted have CSOs that overflow into Newark Bay or one of its tributaries when capacity is exceeded (usually during a storm event).

The Phase I RIWP (Tierra, 2005) and the Phase II RIWP (Tierra, 2006a) examined several sources that continue to adversely impact the bay. These include POTWs, CSOs, New Jersey Pollutant Discharge Elimination System (NJPDES) permitted discharges, SSOs, and stormwater runoff. As of October 2006, when the Phase II RIWP (Tierra, 2006a) was published, the combined sewerage systems in the communities surrounding the bay still had numerous CSOs that discharge into the bay and its tributaries, including:

- The City of Elizabeth (39 overflow locations)
  - Of these 39 locations, 6 discharge directly to the Arthur Kill or Newark Bay.
  - The others discharge to the Elizabeth River, a tributary of the Arthur Kill.
- The City of Newark (30 overflow locations)
  - Of these 30 overflow locations, 8 CSOs discharge to the Peripheral Ditch – a direct tributary to Newark Bay.
  - The majority of Newark's other 22 CSOs discharge directly to the Passaic River, which is also a tributary to Newark Bay.
- The Town of Kearny (10 overflow locations)
  - All 10 CSOs discharge to the Passaic River and/or its tributaries, which flow to Newark Bay.
- The City of Jersey City (27 overflow locations)
  - Of these 27 CSOs, 2 discharge directly to Newark Bay.
  - 12 discharge to the Hackensack River and its tributaries, which are tributaries to Newark Bay.
- The City of Bayonne (35 overflow locations)
  - Of these 35 CSOs, 28 discharge directly to the Kill Van Kull or Newark Bay.
- The City of New York (through its Port Richmond combined sewer system) (35 overflow locations)
  - Of these 35 CSOs, 20 flow directly to the Kill Van Kull or Newark Bay.

As of 2004, when the Phase I RIWP was released in draft form, there were 417 active NJPDES Permits (issued post-2000) in the NBSA. There are also 11 National Priorities List (NPL) sites and 729 identified Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS), State-Listed and Other Known Hazardous Waste Sites within the NBSA (Tierra, 2004; 2006a; b). A more detailed description of these sources is reported in Newark Bay Study Area Report on Investigation of Sources of Pollutants and Contaminants (Tierra, 2006b).

3.0 SCREENING-LEVEL PROBLEM FORMULATION

The screening-level problem formulation consists of the development of a CSM, which is necessary to relate potential sources of contamination, fate and transport of contaminants, pathways of exposure, and ecological receptors. A CSM is a tool for evaluating the likely connection between ecological receptors and contaminated media, and for determining the number and types of complete exposure pathways that may exist in the system and their relative significance from a risk perspective. The SLERA CSM is also instructive for assessing information gaps and areas where uncertainty levels may warrant further data collection. This section presents a preliminary CSM for Newark Bay, which consists of five main elements: 1) environmental setting and known or suspected sources of contaminants, including an evaluation of the historical contamination, 2) contaminant fate and transport mechanisms, 3) ecotoxicity of contaminants and potentially affected ecological receptors, 4) potentially complete exposure pathways, and 5) ecological endpoints. A graphical representation of the CSM for Newark Bay is presented in Figure 6.

3.1 Environmental Setting and Contaminants at the Site

Newark Bay is part of the NY/NJ Harbor Estuary, which is one of the largest estuaries on the east coast of the United States, encompassing an area of over 42,000 square kilometers. As discussed in Section 2.0, the estuary encompasses several other major water bodies, including the Hudson River, the Raritan River, Upper New York Bay, and Lower New York Bay. Newark Bay is approximately 6 miles long and 1 mile wide. Along its northern boundary, it is formed by the confluence of the Lower Passaic River and the Hackensack River. At its southern boundary, the bay is connected to Upper New York Bay by the Kill Van Kull and to Raritan Bay by the Arthur Kill. Newark Bay is bounded on the west by the New Jersey cities of Newark and Elizabeth and on the east by Jersey City and Bayonne. It is bordered on the south by Staten Island, New York.

Although Newark Bay was originally a relatively shallow tidal estuary, deep navigational channels were created and are maintained in the bay to accommodate ocean-going container ship access to the Port Newark-Elizabeth Marine Terminal along its western shore. Federally authorized navigation channels extend through Newark Bay to the Lower Passaic River and the Hackensack River.

The banks of Newark Bay are home to numerous active and abandoned commercial and industrial properties. The banks are extensively developed and consist of miles of armored shoreline. Expanding urban and industrial development has resulted in the disposal of industrial and municipal waste in the bay and its adjoining water bodies, which in turn has resulted in sediment contamination. Like the rest of the NY/NJ Harbor Estuary, tidal currents cause the reworking of sediments, mixing suspended sediments from the bay with sediments derived from other areas. Consequently, contaminated sediments from Newark Bay may be distributed throughout the NY/NJ Harbor Estuary and contaminated sediments from other parts of the estuary are being re-distributed to the bay.

Urbanization has contributed to extensive habitat loss and degradation, which has reduced the functional and structural integrity of ecosystems within the NBSA. Since 1940, over 88% of wetlands in the Newark Bay estuary have been eliminated (Iannuzzi *et al.*, 2002). Shorelines covered by bulkheads, rip-rap, buildings and other structures, and pavement limit the available wildlife habitat, including nesting and foraging areas for birds along the bay. Increases in the extent of impervious surface within the watershed have decreased stormwater infiltration and shunted concentrated volumes of stormwater runoff directly into the bay. In addition, tidal creeks and marshes that provide critical habitat and ecosystem functions to juvenile and migratory fish have been depleted by loss of habitat, which may have contributed to the resulting decline of avian, fish, and shellfish populations in the estuary.

Despite the impacts of urbanization on the bay, existing historical data indicate that the NBSA supports a variety of vegetation, fish, and wildlife species. Key habitats that remain in the NBSA are the shallow subtidal and intertidal areas, particularly the large marsh/mudflat systems located at the north end of the bay at Kearny Point and at the southern end of the bay adjacent to Staten Island. These habitats provide foraging areas for birds and other wildlife, as well as nursery areas for fish and invertebrates (Tierra, 2006a).

3.1.1 Study Area Boundaries

The NBSA is bounded on the north by the Conrail Bridge that crosses over the Hackensack River and by the southern boundary of the Lower Passaic River Restoration Project Area (Figure 1). The southern boundaries of the NBSA are located at the Goethals Bridge crossing over the Arthur Kill and the Bayonne Bridge over the Kill van Kull. Within these study area boundaries, Newark Bay was segmented into three regions (south, middle, and north) to assist in data evaluation for the SLERA (see Section 2.3).

South Region. The southern area extends from the Goethals and Bayonne Bridges north to the point that transects the bay at the southern boundary of the South Elizabeth Channel. The south region is predominantly minimally depositional or non-depositional, with the exception of the channel areas. There is an extensive shallow-water area within this section of the bay, located west of the Newark Bay South Reach, north of the North of Shooters Island Reach, south of South Elizabeth Channel, and east of the City of Elizabeth. There is a large avian habitat at Shooters Island. Potential metals and PCB sources in the Arthur Kill may be contributing to sediment contamination in the southwestern portion of the bay.

Middle Region. The middle region extends north from the south region to the northern boundary of the Port Newark Channel. There are significant channels and port areas within this region. This area is characterized predominantly as depositional (*i.e.,* navigational channels) and moderately depositional (*i.e.*, shoals on the eastern side of the bay). The Newark Bay CDF is located in this section of the bay on the western side of the Newark Bay Middle Region, between the Port Newark and Port Elizabeth Channels. The CDF is 26 acres in surface area, was excavated to a depth of 70 feet below the bay bottom, and can hold up to 1.5 million cubic yards of dredged material (Tierra, 2004). Local sources of PCBs and mercury in the bay are influencing sediment contaminant concentrations in the vicinity of the port channels.

North Region. The north region comprises the remaining area between the Port Newark Channel and the Conrail Bridge/LPRRP Area. Like the south region, this area is predominantly characterized as minimally depositional or non-depositional, with the exception of the channel areas. There is a large shallow-water/shoal area located along the eastern side of Newark Bay within this section of the study area. Local inputs from the Passaic and Hackensack Rivers include freshwater, solids, and some contaminants to the bay.

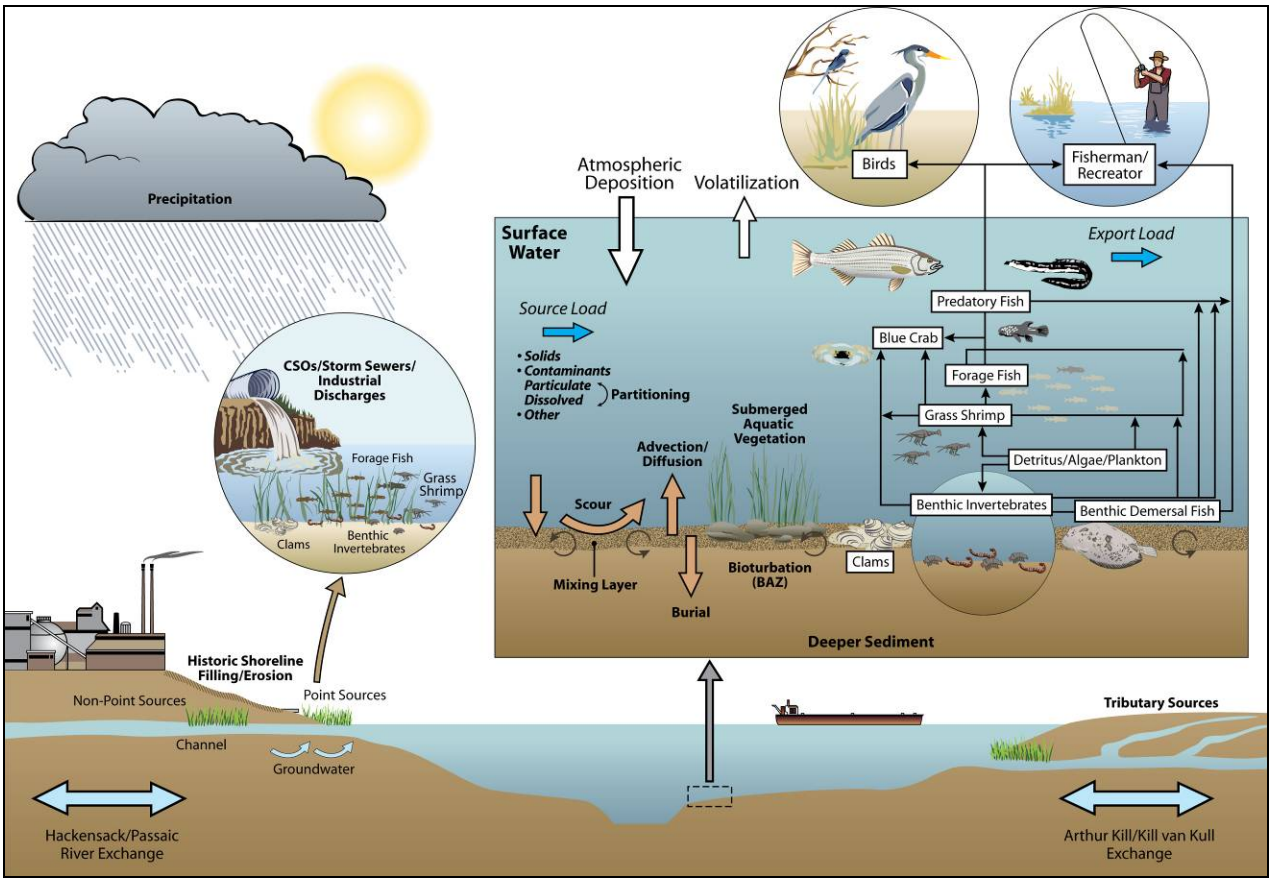


Figure 6. CSM for the NBSA (Tierra, 2004)

3.1.2 Habitat Areas

Within each of the three regions of the bay are three predominant habitat types relevant to the SLERA: 1) the intertidal areas, including the wetlands and mudflats; 2) the shallow subtidal areas; and, 3) the transitional slopes and navigational channels (Figure 7). The intertidal and subtidal areas are not regularly disturbed by dredging. They also likely provide the highest potential for ecological contact with and uptake of contaminants.

The intertidal areas comprise a small portion of the habitat within the bay and are typically characterized by the presence of emergent vegetation, mud flats, and/or historical shoreline filling. In Newark Bay, these areas are generally characterized as minimally depositional or non-depositional areas. These intertidal areas are subjected to municipal and industrial point source discharges, source and non-point source runoff, contaminants transported through tidal exchanges with tributaries such as the Hackensack and Passaic Rivers, and discharge of contaminated groundwater. These areas often provide important habitat for aquatic and piscivorous wildlife. Biological receptors may include benthic invertebrates and macroinvertebrates, such as blue crab, shrimp species, and bivalves, as well as forage fish and smaller predatory fish. Various bird species, such as the blue heron or belted kingfisher, utilize these areas for foraging.

The shallow subtidal areas make up the largest portion of habitat in the bay and are generally characterized by the presence of submerged vegetation, benthic invertebrate communities, forage fish, and predatory fish such as the striped bass. These areas are typically moderately to minimally

depositional and are subjected to various discharges from sources similar to intertidal habitats. These areas can also be subjected to disturbances from shipping traffic, including waves and propeller wash.

The transitional slopes and navigation channels are generally void of any submerged vegetation due to periodic maintenance dredging, deepening-project activities, and limited light conditions due to the increased water depth. Biological communities in the channels include benthic invertebrates, forage fish, and predatory fish. Surveys have shown macroinvertebrates and predatory fish to be especially abundant in the deeper water of the channels in the winter months. The channels have been shown to be depositional areas; contaminant releases to the intertidal and subtidal areas may be transported to the depositional areas of the channels. In addition, shipping activities and storm events can disturb bottom sediments and result in the potential slumping of the channel sidewalls and recontamination of the dredged channel bottoms.

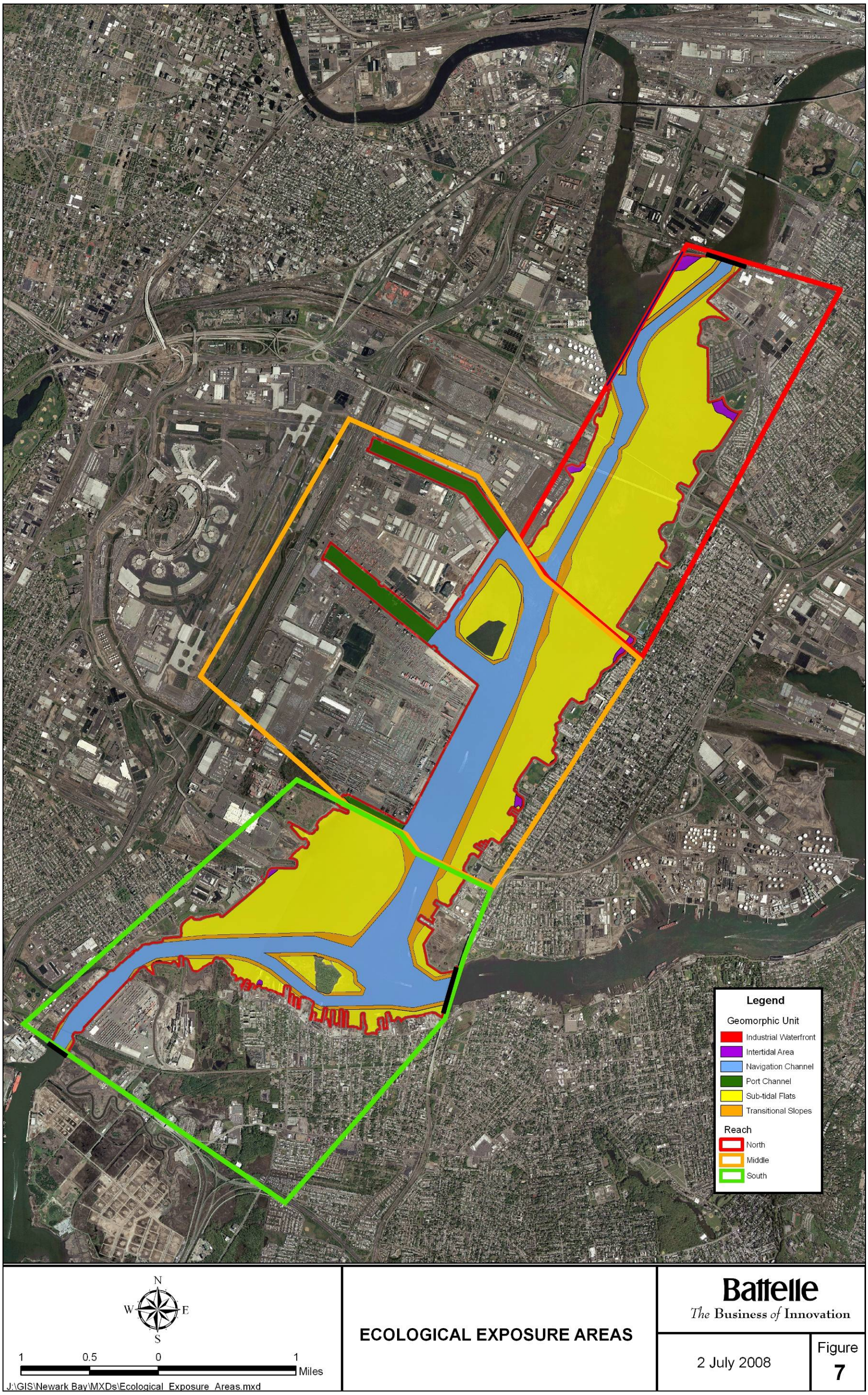


Figure 7. Ecological Exposure Areas of the NBSA

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3.2 Contaminant Fate and Transport

Urbanization, expansion of industry, and the release of chemicals (from both point and non-point sources) into Newark Bay have resulted in elevated levels of chemical contamination in sediments (NOAA, 1998). The primary contaminants represent a variety of different contaminant classes, including but not limited to metals, VOCs, SVOCs, polycyclic aromatic hydrocarbons (PAHs), PCBs, pesticides, and dioxins/furans. The physical, chemical, and biological processes that influence the transport and fate of contaminants in Newark Bay and their availability to ecological receptors are discussed below.

3.2.1 Contaminant Sources and Sinks

As discussed, anthropogenic influences on the natural habitat of the NBSA have included the direct release of large amounts of industrial chemicals and sewage into the NBSA as well as habitat destruction, wetlands drainage, and land alteration. Moreover, numerous historical industrial and manufacturing facilities in the NBSA potentially acted as point and non-point source discharges to the environment. Historic and potentially ongoing sources of biological, inorganic, and organic chemical contaminants include but are not limited to the following:

- Accidental spills.
- Atmospheric deposition.
- CSOs and SSOs.
- Contaminant transport from various waterbodies, including the lower Hudson River, New York Harbor, Raritan Bay, Lower Passaic River, Hackensack River, Arthur Kill, and Kill Van Kull.
- Disturbance of contaminated sediment through dredging and maritime operations.
- Groundwater discharge (both contaminated groundwater from adjacent industrial sites and groundwater infiltration through contaminated sediments that may have historically been placed along the NBSA shoreline).
- Historical direct discharge of industrial waste.
- Illegal disposal and improper handling of chemicals and solvents.
- Marine vessel discharges.
- Contaminated stormwater, potentially transporting eroded soils contaminated by surface spills and chemical product from drum/aboveground tank containment areas.
- Landfills and other hazardous waste sites.

Due to the nature of sediment transport in the bay, particle-bound contaminants are particularly persistent, resulting in a long residence time for these contaminants. Largely because of the extensive set of deep, man-made channels, Newark Bay is a net sink for suspended sediments from both upland and seaward extensions, trapping the contamination delivered by these sources. A solids mass balance performed by Lowe *et al*. (2005) suggested that the net annual accumulation of sediments is roughly offset by the annual removal of sediment by maintenance dredging. Further evaluation conducted by Malcolm Pirnie, Inc. (2006) indicated that approximately 10% of the sediment deposited annually in Newark Bay originates from the Lower Passaic River, 2% originates from the Hackensack River, 85% originates from the Kill Van Kull and Arthur Kill, and the remaining 3% originates from other sources. Consequently, the dominant loads of particle-bound contaminants to Newark Bay likely originate from the Kills and, to a lesser degree, the Lower Passaic River. Relative contributions of contamination are also dependent upon the concentrations of contaminants associated with suspended solids. The Hackensack River and other sources (*e.g*., CSOs, minor tributaries and creeks, atmospheric deposition) do not contribute a significant fraction of the solids load to the bay; therefore the corresponding particle-bound contaminant loads to the bay are also likely to be less than loads from the Kills and the Lower Passaic River. In fact, it is likely

that Newark Bay and the Lower Passaic River are a net source of solids and contamination to the Hackensack River at the current time (Pence, 2004).

3.2.2 Environmental Processes Affecting Contaminant Distribution

As mentioned above, the sediments within Newark Bay act as both a sink and a means for transport of contaminants throughout the bay. Contaminants may be remobilized from the sediments through bioturbation within the BAZ, sediment-porewater exchange, and sediment erosion and scour (Tierra, 2006b). Although groundwater analytical data were not available for consideration in this SLERA, it is possible that the interaction between this medium and sediment (including porewater) may represent a significant migration pathway locally within the bay.

The physical characteristics of the system can also impact the movement of chemicals through sediments. In anoxic environments, metals such as cadmium, lead, copper, and zinc are typically immobilized as sulfides. These metals can be mobilized via a change in redox potential (*i.e.*, oxidation) and/or drop in pH. However, this situation is unlikely in an estuarine environment. Microbial processes can transform elemental mercury into methyl mercury, which is more toxic and more bioavailable than the elemental form. In estuaries, methylation tends to occur at higher rates in coastal wetlands and intertidal mudflats under anaerobic conditions.

Some species of metals, PCBs, PAHs, pesticides, and dioxins/furans are hydrophobic, nonpolar contaminants that tend to tightly adsorb to sediment particles. Therefore, their transport and fate in estuarine systems are controlled by the movement of sediment particles. Surface and subsurface sediments can be mixed by physical processes such as currents, wind and wave resuspension, grounding of ship keels and propellers, dredging, scouring, and liquefaction or slumping. Surface sediment can also be mixed by biological processes (*e.g.*, bioturbation) such as feeding or burrowing. Sediments and their bound contaminants that become resuspended by these processes are likely to be moved around the system by tidal action. Sediment accumulation, vertical mixing, storms, floods, and anthropogenic disturbances (*e.g.*, dredging) control the rate at which contaminants may be buried and removed from receptor pathways.

Many contaminants found in the NBSA are known to bioaccumulate in organisms and move through the food web. This occurs when contaminants are retained within the tissues of primary consumers and are subsequently transferred to other organisms when higher-level consumers feed on them. Certain metals, PCBs, chlorinated pesticides, and dioxins/furans are known to bind to tissue and bioaccumulate in upper-trophic-level organisms. Other contaminants, like PAHs, are not known to bioaccumulate at high rates in tissues (Suedel *et al.*, 1994); the toxic effects of PAHs generally occur via direct ingestion, dermal uptake, or inhalation.

3.2.3 Nature and Extent of Contamination

Geochemical principles provide tools to explain the nature, extent, fate, and transport of contaminants in the bay. These findings can be further supported by a mathematical model, which is designed to emulate geochemical and other principles and is calibrated to field data. A mathematical model was not available at the time that this SLERA was performed; consequently, the following discussion on the fate and transport of contamination in the bay is explained in terms of geochemical principles. Additional modeling may be included in later studies.

As part of the Phase I RI, 69 sediment cores were collected throughout Newark Bay (Tierra, 2006a). Approximately half of the locations (35 of the 69 locations) were characterized as recently depositional,

based on the presence and concentration of beryllium-7 in the top inch of the core[1] (Tierra, 2006a). As expected, these depositional sites were primarily located in the navigation and port channels where the USACE reported depositional rates of 2 to 7 inches/year (reference cited in Tierra, 2006a). Concentration scatter plots for select contaminants at these depositional locations illustrate three general concentration distributions in Newark Bay:

- Decreasing concentration gradients from north to south across Newark Bay (*e.g.*, 2,3,7,8-TCDD) indicative of the impacts of contamination emanating from the Lower Passaic River.
- Uniform concentrations across the main body of Newark Bay, with an increasing gradient in the southwestern area (*e.g.*, arsenic), indicative of a source at the southern end of the bay.
- A distribution with local maxima near the intersection of the Port Newark Channel and the main channel of Newark Bay, as well as at the mouth of the Arthur Kill (*e.g.*, for mercury and total PCBs), indicative of the occurrence of a major source within the bay and the presence of external loads.

The presence of different concentration gradients occurring simultaneously in Newark Bay suggests that the bay is not a very efficient "mixing bowl." In other words, the tidal currents and depositional regimes are not sufficient to completely homogenize and re-distribute contaminated suspended solids evenly throughout the bay, in contrast to the conditions that exist in the Lower Passaic River. It appears that the ongoing external contaminant loads arising from source areas are sufficiently large relative to the tidal fluxes and tidal circulation, and tidal resuspension and redeposition cannot dissipate the local gradients.

Unlike the channels, the shoal areas of Newark Bay are subject to much slower rates of deposition and contain the majority of the non-depositional locations. Typical deposition rates in these areas are estimated at less than 1 inch per year. Slow deposition in these areas has resulted in significant near shore sediment impacts over the long history of contaminant discharge to Newark Bay. For example, surface sediments (defined as 0 to 6 inches for the Newark Bay remedial investigation) on the shoals are likely to be more contaminated than surface sediments from the channels, since 6 inches of sediments in the shoals capture a longer depositional history, and hence, more of the higher historic contaminant loads. This scenario explains most, but not all, of the observations regarding sediment contamination in the shoals. For example, some evidence, including detected contaminant concentrations, suggests that the shoals are impacted by local contaminant sources, particularly in the southwest and northeast corners of the bay. Other shoal areas were once historical channels, turning basins, and borrow pits that have accumulated thick beds of legacy sediments due to limited maintenance dredging or abandonment (USACE, 2006).

Ultimately, the fate of particle-bound contaminants is linked to the movements of sediments in the bay. In this manner, particle-bound contaminants are subject to slow burial in the shoals or to removal from the channels by dredging with subsequent upland disposal due their elevated toxicity. A small portion of the sediments from the bay escape via tidal exchange through the Kills, adding to contamination elsewhere in the NY/NJ Harbor Estuary (Bopp *et al*., 1991). The fate and transport of several more important contaminants are discussed below following geochemical principles for the recent deposition locations.

2,3,7,8-TCDD Source Analysis. The concentration scatter plot for 2,3,7,8-TCDD indicates a general decreasing north-to-south concentration gradient in Newark Bay at depositional locations (Figure 8). This 2,3,7,8-TCDD concentration gradient was suggested by Bopp *et al*. (1991), who also showed that this gradient continued through the Kill Van Kull with the lowest levels of 2,3,7,8-TCDD measured in New York Harbor. Their data indicated that the 2,3,7,8-TCDD contamination likely originated in the Lower Passaic River, using the ratio of 2,3,7,8-TCDD/total TCDD as a chemical tracer. Using data from the RI

[1] Beryllium-7 is a short-lived (54-day half-life) radioactive isotope produced in the upper portions of the earth's atmosphere. Its presence in surficial sediments of a water body is considered indicative of recently deposited sediments.

Phase I dataset (Tierra, 2006a), Malcolm Pirnie, Inc. (2007) observed that the ratio decreased across the bay from approximately 0.6 in the northern reaches to 0.3 in the southern reaches, reflecting the mixing of highly contaminated Lower Passaic River sediments with relatively cleaner sediments originating in Upper and Lower New York Bay (Figure 9). These cleaner sediments have a 2,3,7,8-TCDD/Total TCDD ratio consistent with sewage-based sources, and the 2,3,7,8-TCDD concentrations are orders of magnitude below those concentrations observed in the Lower Passaic River, suggesting that significant transfer of contaminants to the river does not occur, although transfer of some contaminants is possible (Malcolm Pirnie, Inc., 2007; Chaky, 2003). Unlike the maximum loads of other contaminants observed at the heads of the port channels (*e.g.*, total PCBs and metals), elevated concentrations are not observed for 2,3,7,8-TCDD, suggesting that, unlike total PCBs and metals, there are no indications of local sources within Newark Bay.

Metals Source Analysis. Concentration scatter plots for arsenic, cadmium, chromium, lead, and mercury, are presented in Figures 10 through 14. The following dominant features can be inferred from the metals scatter plots:

- A local concentration maximum in the southwestern area of Newark Bay, especially west of Shooters Island near the confluence with the Arthur Kill.
- Elevated concentrations at the head of the Port Newark Channel.
- Generally uniform surface sediment concentrations across the main body of Newark Bay, which are either equal to or lower than 2005 core top concentration measured in the Lower Passaic River (river mile [RM] 1.4).
- Generally higher concentrations in depositional sites located on the shoals versus depositional sites located in the channel.

In general, the plots show a strong concentration gradient near the Arthur Kill, with relatively uniform concentrations across the main body of the bay. This observation suggests that for these metals, concentrations on the suspended sediments delivered by the Kill Van Kull are similar to those sediments delivered by the Lower Passaic River. For several metals, surface concentrations in the middle region of the bay are possibly impacted by another source in the port channels, and surface concentrations in the north region of the bay are likely influenced by the Lower Passaic River and the Hackensack River. Based on these data, an initial fate and transport scenario suggests that several metals source areas exist and are contributing contaminant load to Newark Bay.

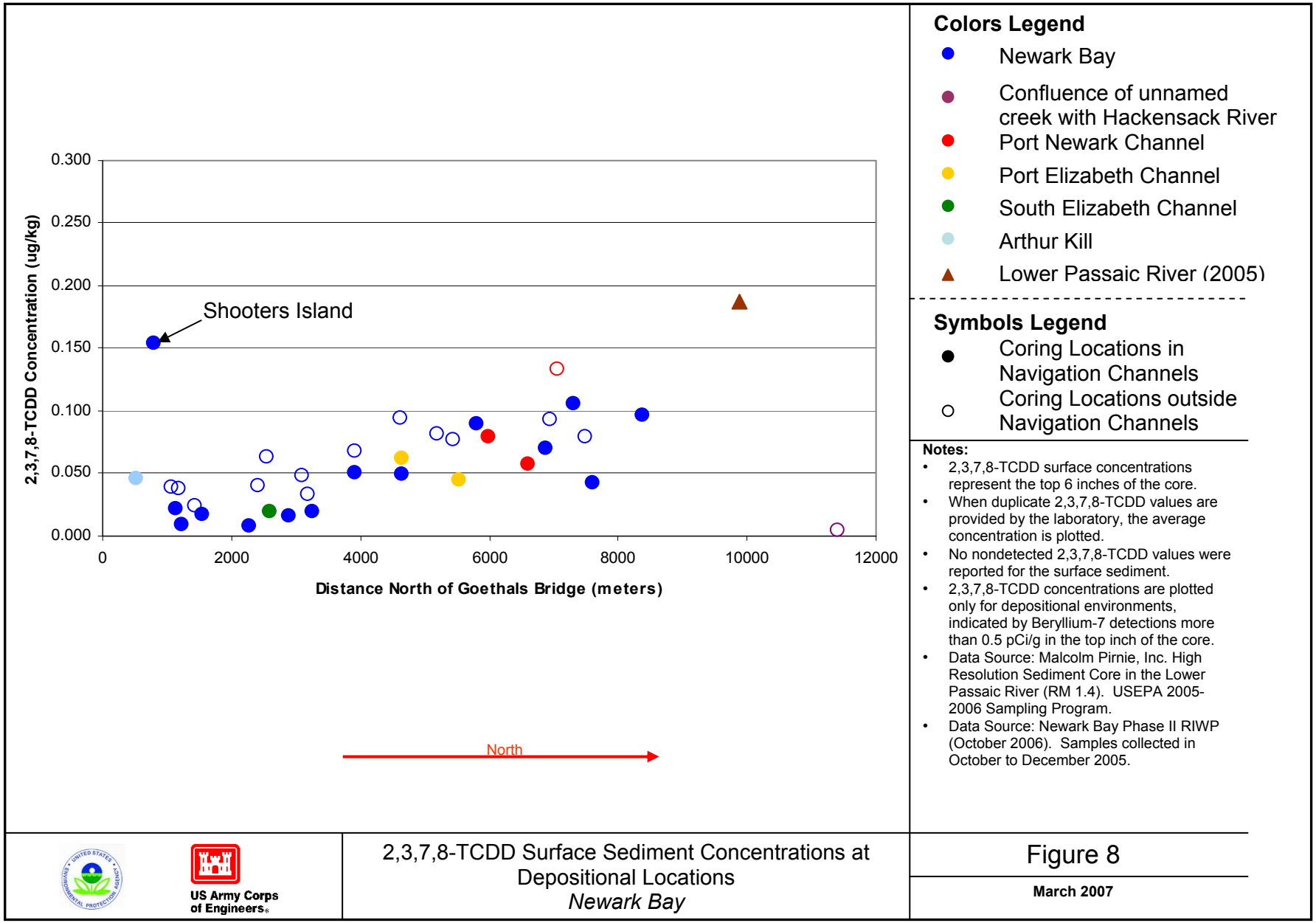
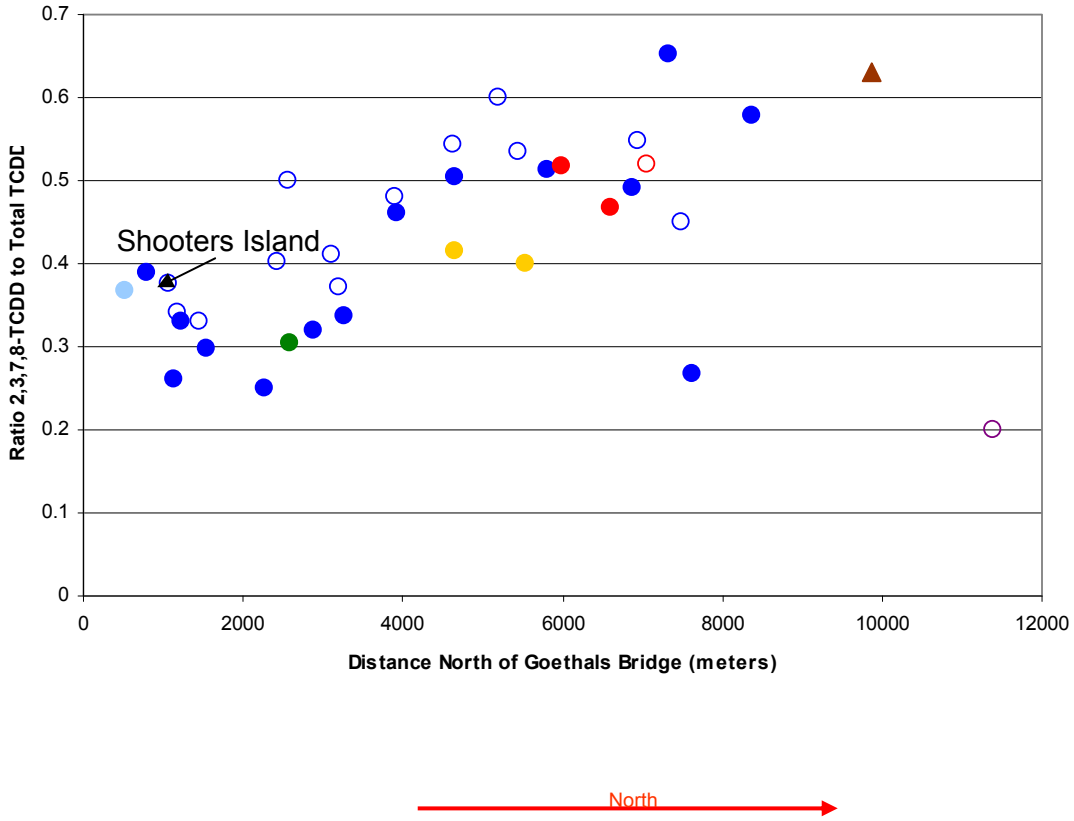


Figure 8. 2,3,7,8-TCDD Surface Sediment Concentrations at Depositional Locations in Newark Bay



Colors Legend

- Newark Bay
- Confluence of unnamed creek with Hackensack River
- Port Newark Channel
- Port Elizabeth Channel
- South Elizabeth Channel
- Arthur Kill
- Lower Passaic River (2005)

Symbols Legend

- Coring Locations in Navigation Channels
- Coring Locations outside Navigation Channels

Notes:

- 2,3,7,8-TCDD and total TCDD surface concentrations represent the top 6 inches of the core.
- When duplicate 2,3,7,8-TCDD or total TCDD values are provided by the laboratory, the average ratio is plotted.
- No nondetected 2,3,7,8-TCDD or total TCDD values were reported for the surface sediment.
- Concentration ratios are plotted only for depositional environments, indicated by Beryllium-7 detections more than 0.5 pCi/g in the top inch of the core.
- Data Source: Malcolm Pirnie, Inc. High Resolution Sediment Core in the Lower Passaic River (RM 1.4). USEPA 2005-2006 Sampling Program.
- Data Source: Newark Bay Phase II RIWP (October 2006). Samples collected in October to December 2005.

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Ratio of 2,3,7,8-TCDD to Total TCDD Surface Sediments Concentrations
Newark Bay

Figure 9

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Figure 9. Ratio of 2,3,7,8-TCDD to Total TCDD Surface Sediment Concentrations in Newark Bay

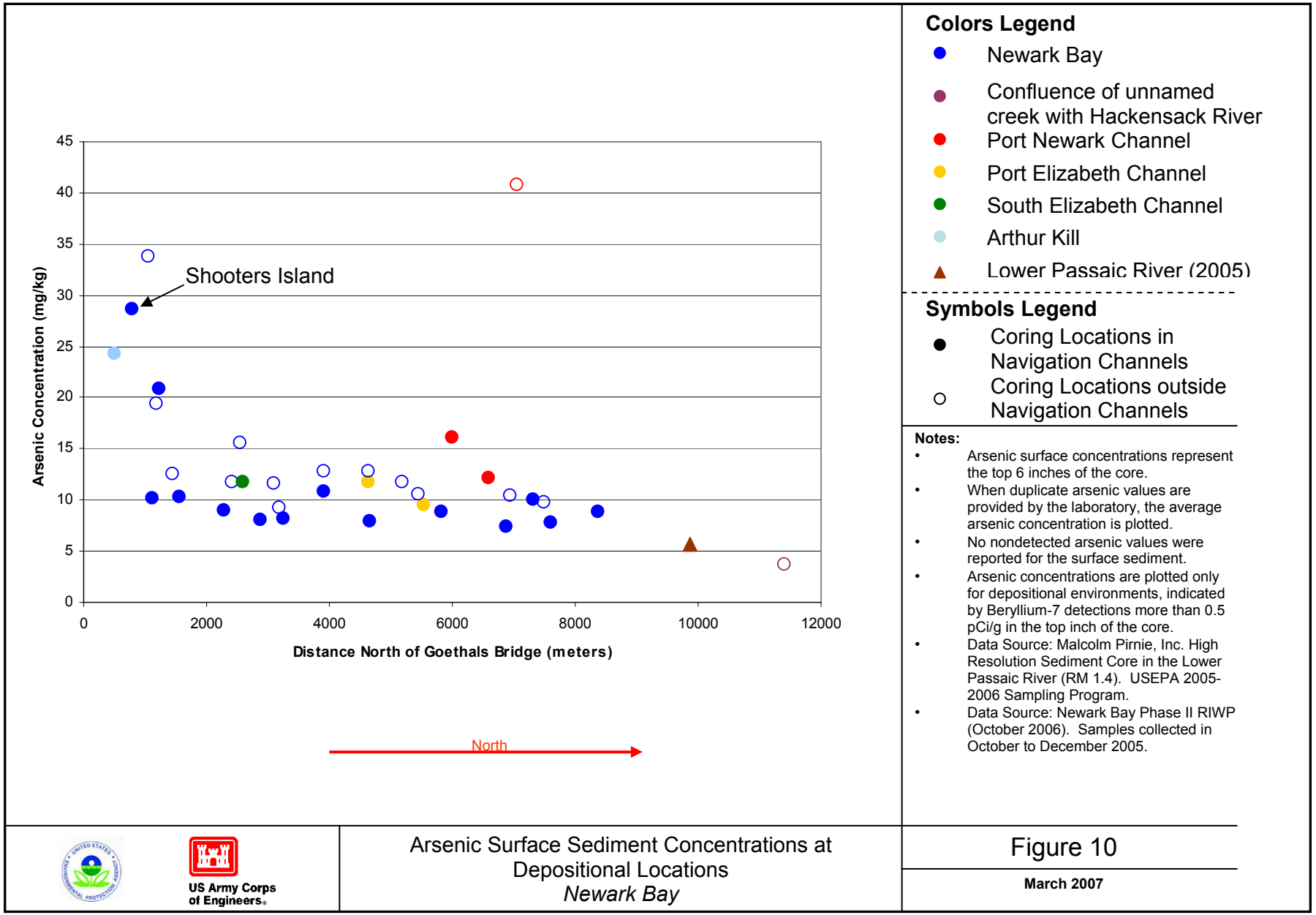
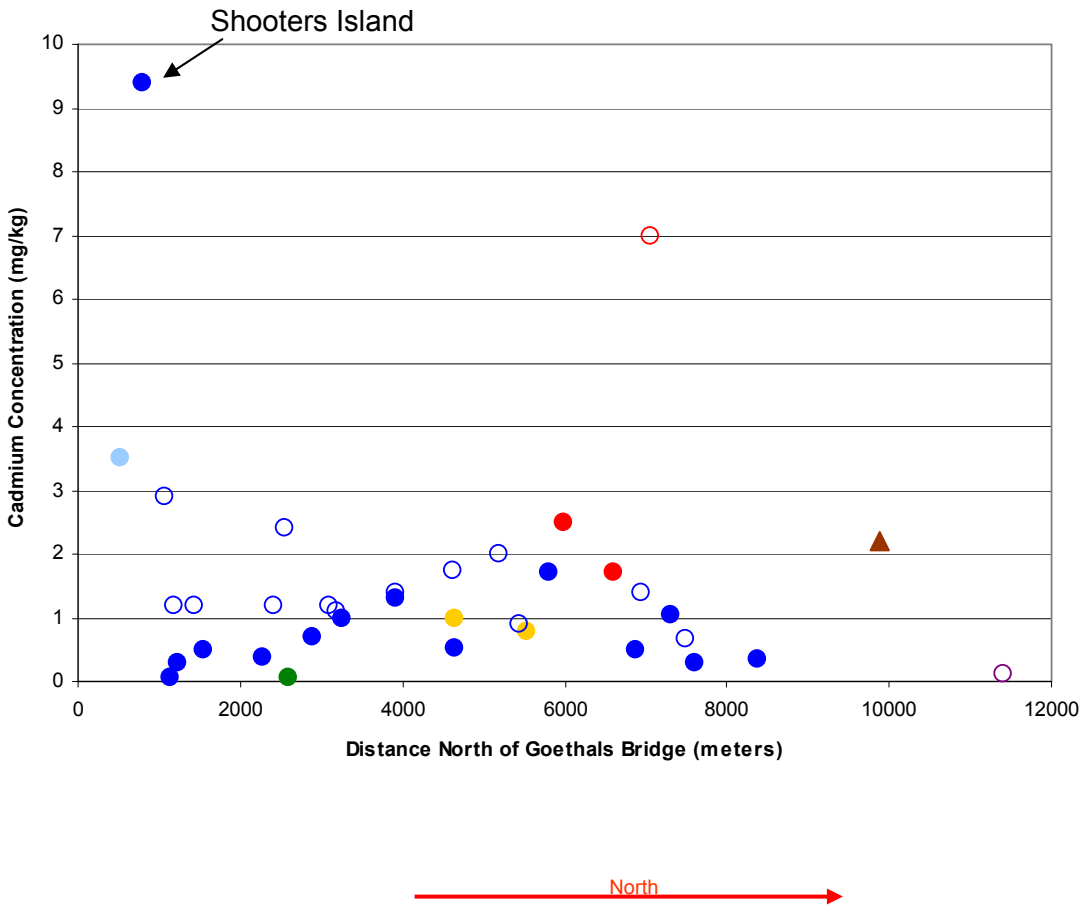


Figure 10. Arsenic Surface Sediment Concentrations at Depositional Locations in Newark Bay



Colors Legend

- Newark Bay
- Confluence of unnamed creek with Hackensack River
- Port Newark Channel
- Port Elizabeth Channel
- South Elizabeth Channel
- Arthur Kill
- Lower Passaic River (2005)

Symbols Legend

- Coring Locations in Navigation Channels
- Coring Locations outside Navigation Channels

Notes:

- Cadmium surface concentrations represent the top 6 inches of the core.
- When duplicate cadmium values are provided by the laboratory, the average cadmium concentration is plotted.
- Nondetected cadmium values were plotted at half the detection limit.
- Cadmium concentrations are plotted only for depositional environments, indicated by Beryllium-7 detections more than 0.5 pCi/g in the top inch of the core.
- Data Source: Malcolm Pirnie, Inc. High Resolution Sediment Core in the Lower Passaic River (RM 1.4). USEPA 2005-2006 Sampling Program.
- Data Source: Newark Bay Phase II RIWP (October 2006). Samples collected in October to December 2005.

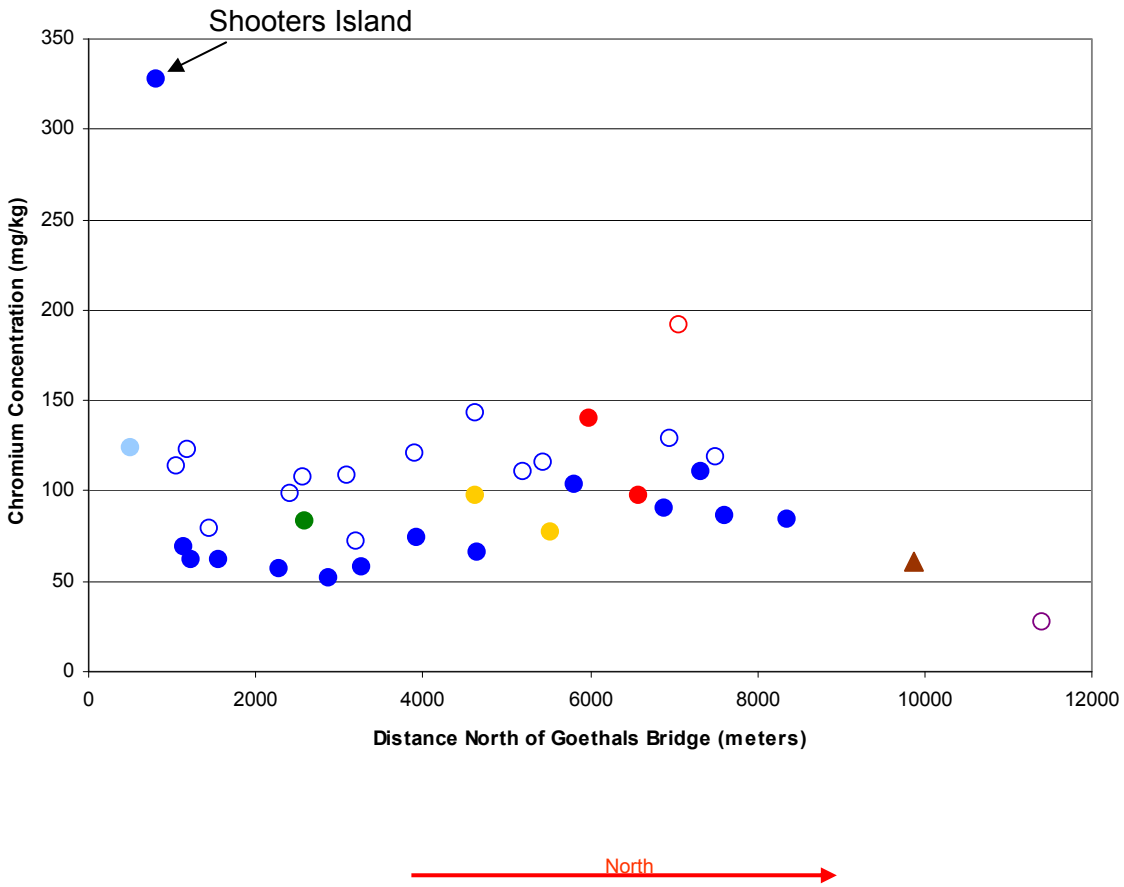
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Cadmium Surface Sediment Concentrations at Depositional Locations
Newark Bay

Figure 11

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Figure 11. Cadmium Surface Sediment Concentrations at Depositional Locations in Newark Bay



Colors Legend

- Newark Bay
- Confluence of unnamed creek with Hackensack River
- Port Newark Channel
- Port Elizabeth Channel
- South Elizabeth Channel
- Arthur Kill
- Lower Passaic River (2005)

Symbols Legend

- Coring Locations in Navigation Channels
- Coring Locations outside Navigation Channels

Notes:

- Chromium surface concentrations represent the top 6 inches of the core.
- When duplicate chromium values are provided by the laboratory, the average chromium concentration is plotted.
- Nondetected chromium values were plotted at half the detection limit.
- Chromium concentrations are plotted only for depositional environments, indicated by Beryllium-7 detections more than 0.5 pCi/g in the top inch of the core.
- Data Source: Malcolm Pirnie, Inc. High Resolution Sediment Core in the Lower Passaic River (RM 1.4). USEPA 2005-2006 Sampling Program.
- Data Source: Newark Bay Phase II RIWP (October 2006). Samples collected in October to December 2005.

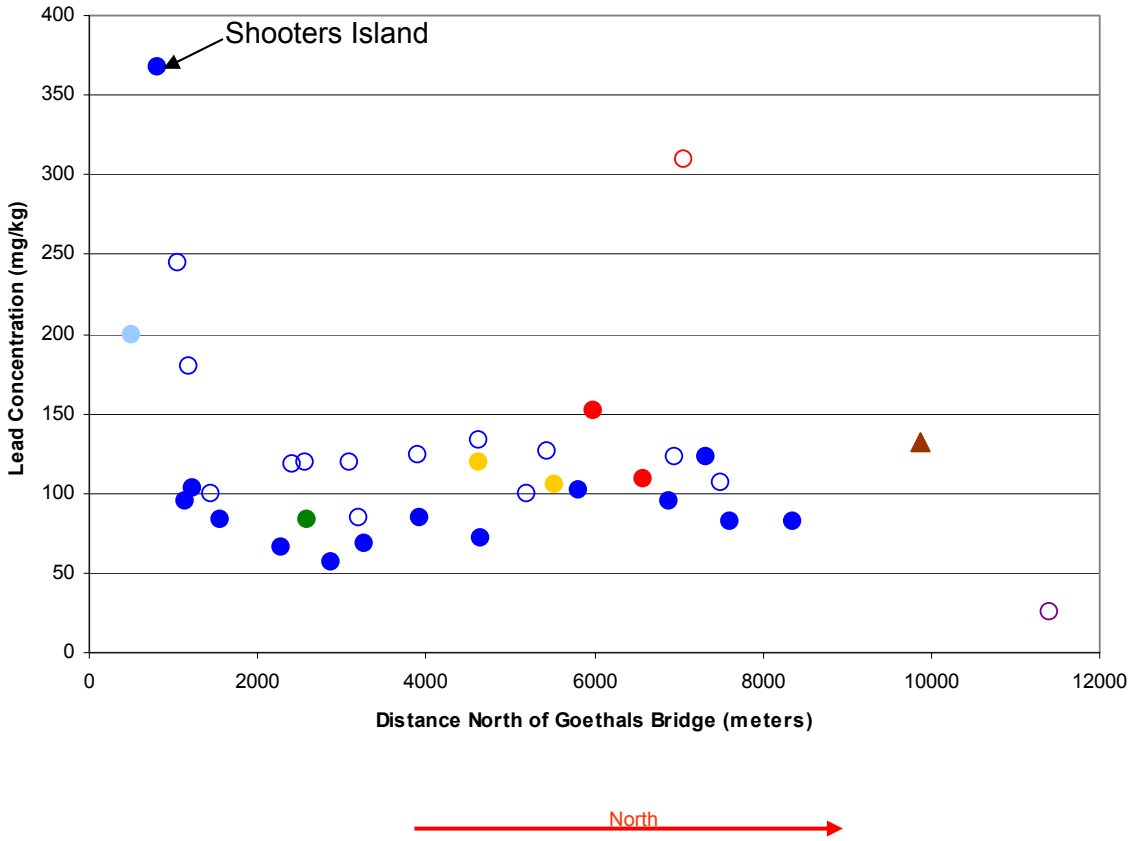
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Chromium Surface Sediment Concentrations at Depositional Locations
Newark Bay

Figure 12

March 2007

Figure 12. Chromium Surface Sediment Concentrations at Depositional Locations in Newark Bay



Colors Legend

- Newark Bay
- Confluence of unnamed creek with Hackensack River
- Port Newark Channel
- Port Elizabeth Channel
- South Elizabeth Channel
- Arthur Kill
- Lower Passaic River (2005)

Symbols Legend

- Coring Locations in Navigation Channels
- Coring Locations outside Navigation Channels

Notes:

- Lead surface concentrations represent the top 6 inches of the core.
- When duplicate lead values are provided by the laboratory, the average lead concentration is plotted.
- No nondetected lead values were reported for the surface sediment.
- Lead concentrations are plotted only for depositional environments, indicated by Beryllium-7 detections more than 0.5 pCi/g in the top inch of the core.
- Data Source: Malcolm Pirnie, Inc. High Resolution Sediment Core in the Lower Passaic River (RM 1.4). USEPA 2005-2006 Sampling Program.
- Data Source: Newark Bay Phase II RIWP (October 2006). Samples collected in October to December 2005.

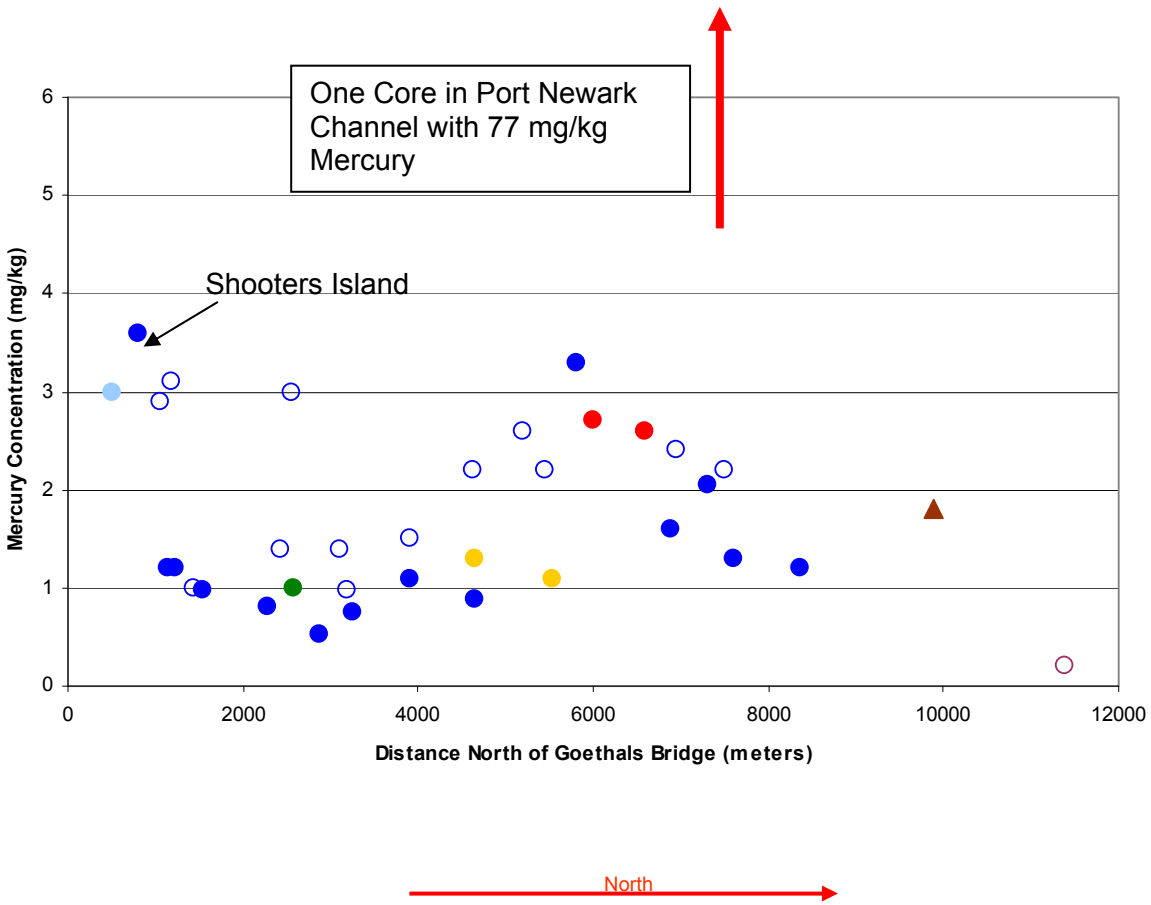
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Lead Surface Sediment Concentrations at Depositional Locations
Newark Bay

Figure 13

March 2007

Figure 13. Lead Surface Sediment Concentrations at Depositional Locations in Newark Bay



Colors Legend

- Newark Bay
- Confluence of unnamed creek with Hackensack River
- Port Newark Channel
- Port Elizabeth Channel
- South Elizabeth Channel
- Arthur Kill
- Lower Passaic River (2005)

Symbols Legend

- Coring Locations in Navigation Channels
- Coring Locations outside Navigation Channels

Notes:

- Mercury surface concentrations represent the top 6 inches of the core.
- When duplicate mercury values are provided by the laboratory, the average mercury concentration is plotted.
- No nondetected mercury values were reported for the surface sediment.
- Mercury concentrations are plotted only for depositional environments, indicated by Beryllium-7 detections more than 0.5 pCi/g in the top inch of the core.
- Data Source: Malcolm Pirnie, Inc. High Resolution Sediment Core in the Lower Passaic River (RM 1.4). USEPA 2005-2006 Sampling Program.
- Data Source: Newark Bay Phase II RIWP (October 2006). Samples collected in October to December 2005.

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Mercury Surface Sediment Concentrations at Depositional Locations
Newark Bay

Figure 14

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Figure 14. Mercury Surface Sediment Concentrations at Depositional Locations in Newark Bay

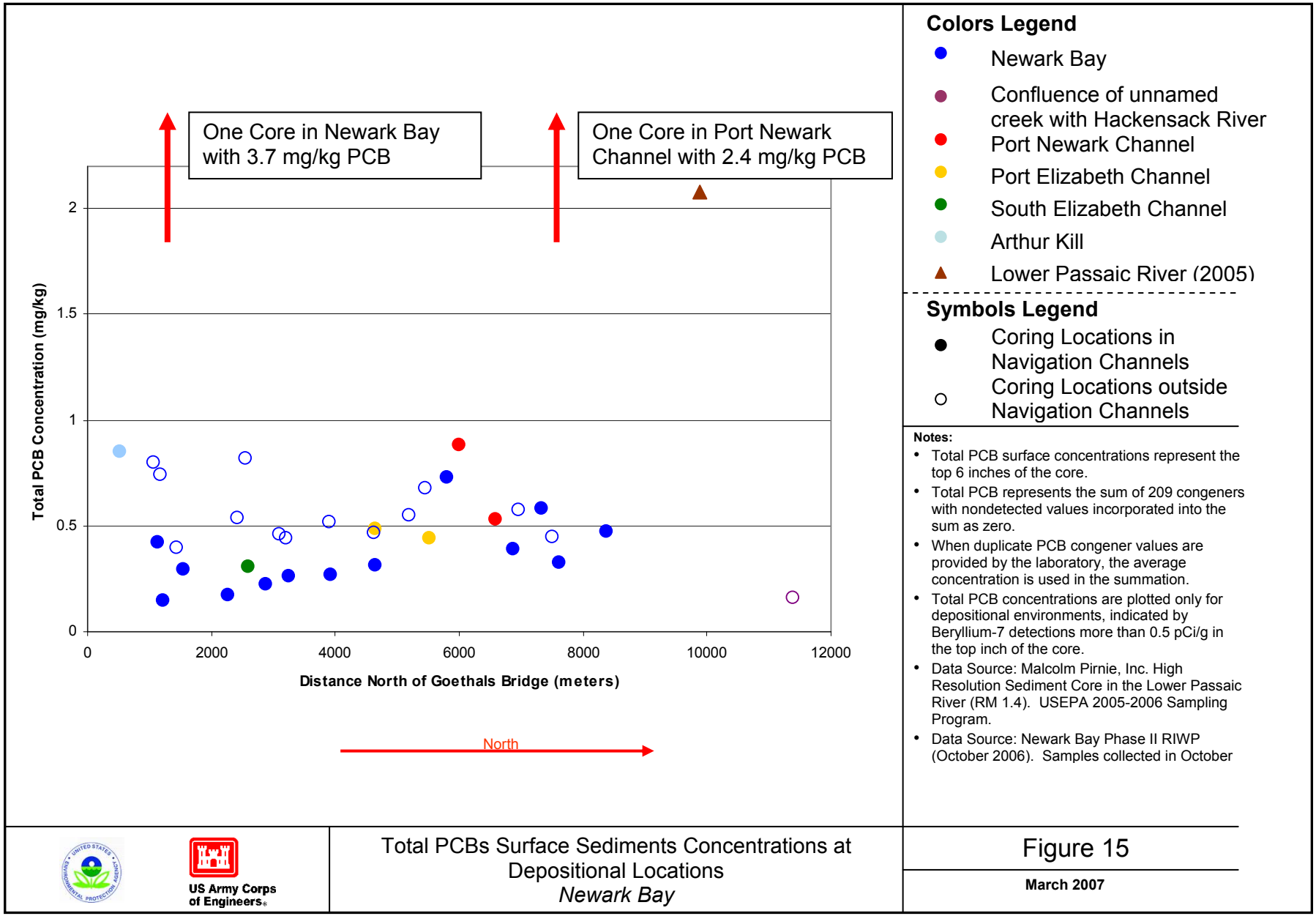


Figure 15. Total PCBs Surface Sediment Concentrations at Depositional Locations in Newark Bay

PCB Source Analysis. The distribution of total PCBs presented in Figure 15 shows the presence of at least two, and possibly several other source areas to and within Newark Bay, which are likely influencing surface sediment concentrations. These source areas include the Lower Passaic River, the port channels, and the southwestern area of Newark Bay near the Arthur Kill. Elevated concentrations of total PCBs continue to drive a concentration gradient in Newark Bay, with contaminant loading from the port channels heavily influencing surface sediment concentrations in the middle of the bay.

To summarize the CSM for Newark Bay:

- The Kill Van Kull and Arthur Kill contribute the largest share of solids to Newark Bay while the Lower Passaic River is the second largest source.
- Data indicate that the metals and PCB sources from the Arthur Kill are contributing to sediment contaminant concentrations in the southwestern portion of the bay.
- The Lower Passaic River contributes substantial loads of 2,3,7,8-TCDD, total PAHs, total PCBs, and mercury to the bay.
- Local sources of mercury and total PCBs in the bay are influencing sediment contaminant concentration in the vicinity of the port channels.
- The contributions from the Hackensack River are not well-characterized, although it is not believed that the river currently contributes a significant solids load to the bay. However, historically, the Hackensack River may have contributed more solids and contamination to the bay.

3.3 Ecotoxicity and Potential Receptors

An understanding of the contaminant mechanism of toxicity is necessary to evaluate the importance of potential exposure pathways (Section 3.4) and to focus the selection of assessment endpoints (Section 3.5). Furthermore, different contaminants have varying toxicological effects on different ecological receptors. Section 3.3.1 provides an ecotoxicological discussion of the major categories of COPECs with a focus on representative contaminants. It should be noted that this is not an all-inclusive discussion; a more expansive and detailed assessment of the COPEC ecotoxicology will be provided in the BERA. Section 3.3.2 discusses the types of ecological receptors likely to be exposed to contaminants in the NBSA.

3.3.1 Ecotoxicity

This section briefly summarizes the ecotoxicological properties of the main contaminant classes associated with NBSA environmental media. In addition, the ecotoxicity of certain individual COPECs is discussed (selected because they likely pose significant hazards to ecological receptors or because they are representative of the contaminant class).

Metals. Key factors that affect the partitioning and speciation, and thus the bioavailability, of sediment-associated metals include redox conditions, pH, porewater hardness, dissolved organic carbon (DOC), sediment organic carbon content and percent fines. These factors influence the oxidation state and the species of dissolved ions present. Metals exhibit a range of binding affinities with both organic and inorganic phases, resulting in varying concentrations of dissolved and particulate fractions. The total concentration of metals in sediments is generally not predictive of the bioavailability of trace metals. Concentrations of certain metals in porewater have been correlated with biological effects (DiToro *et al*., 1991). For several divalent metals, a key partitioning phase controlling cationic metal activity and toxicity in sediments appears to be acid volatile sulfides (AVS) (DiToro *et al*., 1990; 1991; Ankley *et al*., 1996). Simultaneously extracted metals (SEM) and AVS measurements can be made to assess the

potential bioavailability of SEM metals (including cadmium, copper, lead, nickel, and zinc). In general, the bioavailability of metals decreases as conditions become more reducing and pH, hardness, organic carbon, percent fines and AVS increases. Additional information on the ecotoxicity of specific individual metals is presented in the Passaic PAR (Battelle, 2006).

Polycyclic Aromatic Hydrocarbons. PAHs are a group of ubiquitous chemicals that are a major component of petroleum products (*i.e.*, petrogenic) or are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances (*i.e.*, pyrogenic). There are more than 100 different PAHs, which generally occur as complex mixtures. Pyrogenically-derived PAHs mainly enter the environment as releases to air from volcanoes, forest fires, residential wood burning, and exhaust from automobiles and trucks. Petrogenically-derived PAHs are typically released as direct spills to surface water, soils, or sediments.

PAHs include some highly potent carcinogenic compounds that can produce tumors in some organisms at even single doses; however, other, non-cancer-causing effects are not well understood (Eisler, 1987). Their effects are wide-ranging within an organism, and effects have been found in many types of organisms, including non-human mammals, birds, invertebrates, plants, amphibians, fish, and humans. Because their effects are varied, generalizations cannot be readily made. Effects on benthic invertebrates include inhibited reproduction, delayed emergence, sediment avoidance, and mortality. Fish exposed to PAHs in sediment and surface water have exhibited fin erosion, liver abnormalities, cataracts, and immune system impairments leading to increased susceptibility to disease (Fabacher *et al*., 1991; Weeks and Warinner, 1984; 1986; O'Conner and Huggett, 1988; Payne *et al.*, 2003). Early mechanistic models categorized the effects of individual PAHs as either being receptor-mediated, with metabolites forming deoxyribonucleic acid (DNA) adducts, or generally narcotic in nature; however, recent studies suggest that the toxicology is more complicated (Incardona, *et al*., 2006).

Mammals can absorb PAHs by inhalation, dermal contact, or ingestion (Eisler, 1987). The oral toxicity of PAHs ranges from very toxic to moderately toxic in rats. In addition to tumor induction, other effects in mammals include adverse effects on reproduction, development, and immunity (Agency for Toxic Substances and Disease Registry [ATSDR], 1995). Although a large amount of literature on the effects of oil spills on birds is available, toxicity data for birds associated with the ingestion pathway are limited, and no PAH toxicity reference value (TRV) for this receptor group was developed. There are also limited mammalian data available for the 2- and 3-ring PAHs (which are not anticipated to be bioavailable to wildlife).

Polychlorinated biphenyls. PCBs are mixtures of up to 209 individual chlorinated compounds (known as congeners). Some commercial PCB mixtures are known in the United States by their industrial trade name, Aroclor. Because they do not burn easily and are good insulating materials, PCBs were used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in 1977 because there was evidence that PCBs build up in the environment and may cause harmful effects. Once released into the environment, PCBs do not readily break down and therefore may remain for long periods of time, cycling between air, water, and soil. As a consequence, PCBs are found all over the world. The World Health Organization (WHO) has recognized 12 PCB congeners that are structurally similar to dioxins and have similar toxic effects.

In aquatic environments, PCBs are taken up into the bodies of benthic invertebrates and fish. They are also ingested by other animals that feed on these aquatic animals. PCBs bioaccumulate and bioconcentrate in fish and marine mammals (such as seals and whales), reaching levels that may be many thousands of times higher than in water.

Animals exposed to PCBs show various kinds of health effects, including anemia, acne-like skin conditions, as well as liver, stomach, and thyroid gland injuries (ATSDR, 2000). Other effects include reductions in the immune system function, behavioral alterations, and impaired reproduction (ATSDR, 2000). Some PCBs can mimic or block the action of hormones from the thyroid and other endocrine glands. Because hormones influence the normal functioning of many organs, some of the effects of PCBs may result from endocrine changes. While ingestion is the primary exposure pathway, inhalation and dermal exposure to PCBs may cause liver, kidney, and skin damage in animals (ATSDR, 2000).

Pesticides. Organochlorine pesticides include the chlorinated ethane derivatives such as DDT; cyclodiene compounds, which include chlordane, aldrin, dieldrin, heptachlor, endrin, and toxaphene; and hexachlorocyclohexanes, such as lindane. These compounds are very persistent in the environment and possess a strong tendency to accumulate in biological tissue. Organochlorine pesticides exhibit a wide range of acute toxicities. The target loci of primary toxic action of at least some organochlorine pesticides are believed to be sensory and motor neurons and the motor cortex of vertebrates (Klaassen *et al*., 1986). The organochlorine compounds DDT and dieldrin are often detected at environmental concentrations that pose a hazard to ecological receptors.

DDT and its primary metabolites (dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyldichloroethylene [DDE]) are manufactured organochloride pesticides collectively referred to as DDx. DDT use in the United States was banned in 1972, but it was still manufactured for export until the mid-1980s. DDT is a broad-spectrum insecticide that was very popular due its effectiveness, long residual persistence, low acute mammalian toxicity, and low cost. DDT has been widely used to control insects on agricultural crops such as peanuts, soybeans, and cotton; it also was sprayed to decrease the incidence and spread of diseases such as malaria by controlling mosquitoes.

Upon introduction into the environment, DDT enters soil, water, or air. DDT and its metabolites are strongly adsorbed onto particulates in water and settle into sediments, where they become essentially immobile. DDT is highly toxic to aquatic life, including both invertebrates (crustaceans) and vertebrates (fish, shorebirds). Furthermore, DDT and its analogues accumulate in lipid tissues of fish and other organisms, and subsequently bioconcentrate up the food chain.

The best known effect of DDT toxicity is impairment of nerve impulse conduction. Effects of DDT on the nervous system have been observed in animals and can vary from mildly altered sensations to tremors and convulsions. Death in animals following high exposure to DDT is usually caused by respiratory arrest. In addition to being a neurotoxicant, DDT is capable of inducing marked alterations on reproduction and development, which is attributed to hormone-altering actions of DDT isomers and/or its metabolites (ATSDR, 2002a). Eggshell thinning in upper-trophic-level birds is believed to have resulted in population crashes of raptors in the 1960s and 1970s. Due to the ban on the production and use of DDT in the United States and other parts of the world, exposures of wildlife have been declining since the early 1970s, as evidenced by marked decreases in the levels of DDT compounds in fish, shellfish, aquatic mammals, and birds (ATSDR, 2002a).

The well-publicized decline in wild raptor populations, including the bald eagle, during the 1950s and 1960s was attributed partly to reproductive impairment, particularly eggshell thinning. Egg production, fertility, and hatchability were largely unaffected in numerous studies in a variety of bird species. However, increased embryolethality, decreased egg size, delayed oviposition after mating, and increased testicular effects were observed with some regularity among experimental studies in birds. Several authors speculated that the effects were due to DDT-induced hormonal imbalances. In fact, blood hormone levels of estrogen and luteinizing hormone were altered in three of four studies in birds consuming either DDT or DDE in the diet (ATSDR, 2002a).

Dieldrin and aldrin are structurally similar to each other, and aldrin readily converts to dieldrin once it enters the environment or is ingested or inhaled by organisms. These compounds are discussed together because both are COPECs for the LPRRP. Dieldrin is an organochloride pesticide, belonging to the cyclodiene group of pesticides that also includes endrin, endosulfan, and aldrin. Dieldrin is no longer produced or used, but it was once used extensively to kill insects on crops such as corn and cotton and to control termites. Aldrin is a more effective pesticide than dieldrin and therefore was more extensively used as a soil insecticide (ATSDR, 2002b).

Many species of aquatic invertebrates concentrate dieldrin from very low water concentrations, yielding high concentration factors. The bioconcentration of dieldrin in aquatic organisms is principally from water rather than ingestion of contaminated food. Aldrin and dieldrin are both highly toxic to aquatic crustaceans and fish. Effects on mammals include liver damage, central nervous system effects, and suppression of the immune system. Dieldrin and aldrin also disrupt the endocrine and reproductive systems (ATSDR, 2002a).

2,3,7,8-TCDD. 2,3,7,8-TCDD belongs to a class of compounds known as chlorinated dibenzodioxins. These compounds are ubiquitous in the environment as a result of various industrial processes (*e.g.,* solid waste incineration; the production, use, and disposal of pesticides and PCBs; the bleaching process for paper manufacturing; and the production and recycling of metals). Dioxins are usually generated concurrently with other chemicals known as chlorinated dibenzofurans; both of these classes of compounds are highly persistent and have been detected in all environmental media (*i.e*., air, water, soil, animal tissue).

Laboratory toxicity data show that fish are generally more sensitive to TCDD than plants, aquatic invertebrates, and other aquatic vertebrates (*e.g.,* amphibians) (USEPA, 1993). The high lipid content in fish makes them highly susceptible to bioaccumulation of TCDD in their tissues, which can essentially be transferred up the food chain to higher-trophic-level organisms, such as birds and mammals (including humans). Effects of TCDD exposure to mammals and birds are similar to fish and include delayed mortality, a "wasting" syndrome characterized by reduced food intake and reduced body weight, reproductive toxicity, histopathological alterations, developmental abnormalities, and immunosupression (USEPA, 1993).

3.3.2 Receptors of Concern

The selection of ROCs for evaluation in the ecological risk assessment was presented in the PAR (Battelle, 2006) based on a review of available habitat and biota surveys, including those summarized in the NBSA Phase I RIWP (Tierra, 2004). These potential receptors are listed in Table 2. Previous studies (*e.g.,* ChemRisk, 1995c) did not identify any state or federal rare, threatened, or endangered (T&E) species inhabiting the lower portion of the Passaic River. It is also unlikely that there are any T&E species in the NBSA, however, their presence or absence at this point in time is uncertain. In the absence of such data, the receptor groups listed below include a discussion of potential T&E species that may be present.

Benthic Macroinvertebrates. The benthic macroinvertebrate community of the NBSA is dominated by polychaete worms (*e.g.*, *Streblospio benedicti*, *Sabellaria vulgaris*, and *Scoloplos* sp.). Dominant epibenthic species include shrimp species and blue crabs (Tierra, 2004), which are omnivorous benthic crustaceans that consume plankton, invertebrates and small fish and are in direct contact with contaminated sediments. Because of its exposure to contaminated sediment in the NBSA, the blue crab has been identified as a ROC. In addition, bivalve mollusk populations such as the blue mussel (*Mytilus edulis*), soft-shelled clam (*Mya arenaria),* and oyster (*Crassostrea virginica*) that serve as food for upper trophic-level wildlife were also selected as a receptor group.

Fish. Based on studies compiled and reviewed by Tierra (2004), the following fish species have been identified as preliminary ROCs for future evaluations of ecological risk: mummichog (*Fundulus heteroclitus*), American eel (*Anguilla rostrata*), striped bass (*Morone saxatilis*), winter flounder (*Pleuronectes americanus*), white perch (*Morone americana*), and Atlantic menhaden (*Brevoortia tyrannus*). These species represent a variety of habitat preferences and life histories that allow assessment of a wide range of exposure scenarios, including exposures to upper-trophic level consumers such as piscivorous birds and mammals. In addition, many of these pelagic fish (*e.g.,* white perch, mummichog) are in direct contact with bottom sediments during foraging and nesting/egg laying.

Birds. Although high-quality nesting and foraging areas are limited in extent throughout the NBSA, a Tierra study conducted by BBL (2002) confirms the presence of avian species for which complete exposure pathways to sediment contaminants likely exist. Bird species with the greatest potential exposure to site COPECs are sediment probing and wading birds, those with limited foraging ranges (*i.e.*, a large percentage of their foraging time is spent within the NBSA), and those that feed on prey items with small home ranges. The last of these classifications is important because it suggests that even bird species that do not forage within the NBSA for a majority of their food may have significant exposure to site COPECs bioaccumulated by resident prey species. Although the piscivorous bird species identified as ROCs for the NBSA have substantial foraging ranges, biological survey data available for Newark Bay suggest that small fish species with limited home ranges, such as the mummichog, also comprise a significant portion of the prey consumed from Newark Bay (BBL, 2002).

Based on a review of the avian survey data available for the NBSA (BBL, 2002), it is recommended that the following species be included in the list of ROCs for evaluations of ecological risk (Table 2): black-crowned night-heron (*Nycticorax nycticorax*), double-crested cormorant (*Phalacrocorax auritus*), great egret (*Ardea alba*), belted kingfisher (*Megaceryle alcyon*), herring gull (*Larus argentatus*), spotted sandpiper (*Actitis macularia*), and a dabbling duck or goose species (*e.g.*, mallard [*Anas platyrhynchos*] or Canada goose [*Branta Canadensis*]). These species were selected because they are commonly present in the study area and possess life histories (*e.g.*, foraging behavior and prey consumption) that maximize their potential exposure to contaminants in sediment and biota. Specifically, all of these species feed on forage fish and/or sediment invertebrates. Direct and potentially significant exposure to sediment contaminants is another complete exposure pathway, particularly for ducks and geese whose foraging activities include mucking and probing for sediment-dwelling organisms and plants. Although their presence in the NBSA is currently unknown, both the yellow- and black-crowned night-herons are listed as T&E species by the State of New Jersey and are included as ROCs.

Mammals. As with birds, mammals with the greatest potential exposure to site COPECs are those species whose foraging behavior involves direct exposure to surface and subsurface sediments, species with limited foraging ranges (*i.e.*, a large percentage of their foraging time is spent within the site), and species that feed on prey specimens with small home ranges. Mammalian wildlife species that could be exposed to contaminants in the NBSA include both piscivorous (*e.g.*, harbor seal [*Phoca vitulina*], porpoise [*Phocoena phocoena*], river otter [*Lontra canadensis*]) and omnivorous (*e.g.*, raccoon [*Procyon lotor*]) species.

The harbor porpoise, while not listed in the United States as threatened or endangered, is designated as a strategic stock under the U.S. Marine Mammal Protection Act (MMPA) because direct human-caused mortality exceeds the potential biological removal level. Three endangered marine mammals have been identified by the National Marine Fisheries Service (NMFS) as occurring within the project area. These include the northern right whale (*Eubalaena glacialis)*, the humpback whale (*Megaptera novaeangliae*), and the finback whale (*Balaenoptera physalus*) (NMFS, 1999). These migratory species use the harbor in transit to other habitat areas and have been recorded in the Lower New York Bay area, although some

individuals have been documented as far up the Hudson River as the Troy Dam. There is no recent documentation of these species in Newark Bay.

These mammalian species are potential ROCs because their life histories suggest that if present, they will be exposed directly to COPECs via ingestion of prey and sediment. Dermal exposure to site COPECs in estuarine and marshland sediments may also occur, although exposure through this route is expected to be *de minimus* relative to ingestion and is not quantified.

Reptiles. Field survey data are not available at this time to determine the presence of reptiles (*e.g.,* diamondback terrapin) in the study area; however, if present, they are likely to be transient and therefore are not considered in the SLERA. If diamond-backed terrapins are observed more frequently during additional fieldwork, they will be addressed qualitatively in future assessments. An ongoing study of marine turtle occurrence has documented little recent evidence of marine turtle presence in the New York and New Jersey Harbor. Four species of marine turtles—loggerhead (*Caretta caretta*), green (*Chelonias mydas*), leatherback (*Dermochelys coriacea*), and Atlantic (Kemp's) ridley (*Lepidochelys kempii*)—regularly occur in the New York Bight, including the New York/New Jersey Harbor complex. Juveniles of Atlantic ridley and larger age classes of loggerhead have been reported during the summer and fall, with other species of sea turtles occasionally entering the higher-salinity regions.

Table 2. Receptors of Concern

Receptor	Exposure Media	Rationale for Selection of Receptor and Pathway
Benthic Invertebrates		
Blue crab	Sediment/surface water/biota	Epibenthic omnivorous invertebrate that consumes plankton and small fish and comes into direct contact with contaminated sediments.
Benthic macroinvertebrate community	Sediment/surface water/biota	Various benthic invertebrate populations representing different trophic levels that are in intimate contact with contaminated sediments.
Mollusk populations	Sediment/surface water	Residential mollusks that have the potential to accumulate contaminants from the water column and are preyed upon by upper-trophic-level wildlife.
Fish		
Mummichog	Sediment/surface water/biota	Resident planktivorous estuarine forage species.
American eel	Sediment/surface water/biota	Seasonal predatory, catadromous species that consumes small fish.
Winter flounder	Sediment/surface water/biota	Migratory benthic predator species; sport fish.
Striped bass	Surface water/biota	Dominant migrant predatory species that has sensitive early-life stages; sport fish.
White perch	Sediment/surface water/biota	Resident omnivore species; juveniles are important prey to commercially significant species.
Atlantic menhaden	Sediment/surface water/biota	Migratory detritivore/omnivore; important forage fish species.
Piscivorous Birds		
Belted kingfisher	Sediment/surface water/biota	Piscivorous bird potentially present.
Omnivorous Birds		
Ducks/geese (*e.g.*, Mallard duck)	Sediment/surface water/biota	Omnivorous avian species that inhabit wetlands, marshes, and other aquatic sites throughout their lifetime.
Yellow and black-crowned night-heron	Sediment/surface water/biota	NJ State T&E species; wading bird.
Herring gull	Sediment/surface water/biota	Omnivorous, opportunistic bird potentially present in large numbers.
Great egret	Sediment/surface water/biota	Bird potentially present in large numbers.
Benthivorous Birds		
Spotted sandpiper	Sediment/surface water/biota	Wading, benthivorous bird that probes the sediment in search of invertebrates and small fish.
Mammals		
Raccoon	Sediment/surface water/biota	Omnivorous, opportunistic mammal that consumes a variety of food, including benthic invertebrates and fish.
Otter	Surface water/biota	Piscivorous mammal whose diet consists entirely of fish.

3.4 Complete Exposure Pathways

In general, an exposure pathway describes the route(s) a chemical takes from its source to a ROC. An exposure pathway analysis links the source, location, type of environmental release, and media affected with receptor population, location, and activity patterns to determine the primary means of potential exposure. Exposure pathways are completed by one of three exposure routes: ingestion, inhalation or dermal contact. If potentially complete and significant exposure pathways exist between COPECs and ROCs, an assessment of potential exposures and effects is conducted. Only those potentially complete exposure pathways likely to contribute significantly to the total exposure are quantitatively evaluated. All other potentially complete exposure pathways that result in minor exposures or for which there are no exposure models or insufficient toxicity data (*e.g.*, dermal contact with contaminated media) are not quantitatively evaluated in this SLERA.

An exposure pathway is considered complete if all four of the following elements are present (USEPA, 1997):

1. A source and mechanism of chemical release to the environment.
2. An environmental retention or transport medium (*e.g.*, water or sediment) for the released chemical.
3. A point of potential physical contact of a receptor with the contaminated medium (exposure point).
4. An exposure route (*e.g.*, ingestion of contaminated prey, incidental ingestion of sediment).

In the absence of links between each of these elements, a complete exposure pathway cannot exist, and no risk to ecological receptors is possible. A CSM provides the logical framework to identify complete exposure pathways. Thus, a primary function of the CSM is to define the media of concern and the ecological receptors with the greatest risk of exposure at the site.

The ecological CSM for the NBSA is presented in Figure 6. Potential historical sources of contamination include a large number of both point and non-point sources that discharged directly into the surface waters of the NBSA. Following discharge, contaminants can partition by becoming attached to sediment or they can remain suspended (or dissolved) in the water column. Contaminants enter the food web via accumulation in tissues of biota exposed directly to contaminants in the water column, in sediments, and/or in the tissues of prey items. Therefore, the media of concern are surface water, sediment, and the tissues of prey species. For the purpose of this SLERA, the existing sediment and tissue data were deemed adequate to identify chemical stressors to ecological receptors. An assessment of surface water could not be performed, however, due to the lack of reliable surface water data in the database. A range of ecological receptors potentially at risk from exposures to contaminated media was identified, including benthic invertebrates, fish, and a variety of piscivorous or aquatic avian and mammalian predatory species.

Chemical and physical properties of COPECs are important considerations in exposure pathway analysis because they are a primary determinant of whether a COPEC detected in site media is likely to pose a risk to ROCs. For example, the physicochemical properties of PCBs, PAHs, dioxins/furans, most metals, and SVOCs suggest that if these chemicals are detected in site media, receptors exposed to these media will likely be exposed to the chemical (*i.e.*, the exposure pathway is complete). Receptor exposure to VOCs, particularly in aquatic ecosystems, is generally considered *de minimis*, except in cases where extremely high concentrations are present, because VOCs generally dissipate readily. Because detected concentrations of VOCs in the NBSA are generally low (Tierra, 2006a) and these constituents do not bioaccumulate, VOC exposures to ecological receptors are considered minor and are not assessed in this risk assessment.

Dermal exposure to sediment contaminants for birds and mammals, although likely to occur, is considered to be *de minimis* in nature. Although established methods are available to assess dermal exposure to humans, limited data are available to quantitatively assess dermal exposure to wildlife. In addition, the presence of feathers and fur, along with grooming and preening activities, reduces sediment contact with skin.

The inhalation exposure route also will not be addressed in the SLERA. Exposure via inhalation of airborne contaminants is relatively minor and insignificant relative to other exposure routes. Furthermore, toxicity data for this exposure route are limited and the data that are available pertain primarily to human receptors. Based on a review of major exposure pathways, the three significant and complete exposure routes for higher-trophic-level organisms are associated with the ingestion of contaminated prey and direct/incidental ingestion of sediment. For risk assessment purposes, these are considered the primary routes of exposures for mammals and birds in the NBSA.

3.5 Assessment and Measurement Endpoints

The CSM also serves as the basis for identification of risk assessment endpoints (AEs). AEs are defined by USEPA (1997) as formal expressions of the actual environmental values that are to be protected at a site. AEs are required in Step 2 of USEPA Guidance and provide the basis for evaluating the screening-level risk characterization. AEs are defined based on technical considerations, including the significance of exposure pathways, the presence of ROCs, and a COPEC's biotic transfer pathway. Selection of AEs for use in the risk assessment must consider the ecosystems, communities, and species relevant to a particular site. The selection of AEs depends on:

1. The chemicals present and their concentration.
2. Media contaminated as a result of chemical releases.
3. Mechanisms of toxicity of the chemicals to different groups of organisms.
4. Ecologically relevant receptor groups that are potentially sensitive or highly exposed to the chemicals.
5. Potentially complete exposure pathways.

The AEs for quantitative evaluation in this SLERA are based on protection of the most sensitive environmental resources identified at the site (*e.g.,* protection of the benthic-feeding and piscivorous avian and mammalian communities that may use the site) and the primary potentially complete exposure pathways identified. Receptors in other guilds (*e.g.*, sediment-dwelling organisms, fish, reptiles/amphibians) may also come into direct contact with site contaminants and, therefore, are also considered ROCs. The avian benthic-feeding and piscivorous guild is likely to have the highest potential for exposure to site contaminants potentially found in sediment and prey items, and has been selected to provide an upper-bound risk estimate that is protective of other guilds that are less exposed.

At the screening level, risks to these various guilds are evaluated generally and collectively for different levels of biological organization. The AEs for the NBSA SLERA are as follows:

- AE(1): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of benthic invertebrate communities that also serve as a forage base for fish and wildlife populations.
- AE(2): Protection and maintenance (*i.e.,* survival, growth, and reproduction) of healthy populations of crustaceans that also serve as a forage base for fish and wildlife populations.
- AE(3): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of healthy populations of mollusks that also serve as a forage base for fish and wildlife populations.

- AE(4): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of healthy fish populations that also serve as a forage base for fish and wildlife populations.
- AE(5): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of omnivorous wildlife (*i.e.*, birds and mammals).
- AE(6): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of piscivorous wildlife (*i.e.,* birds and mammals).

Assessment endpoints have corresponding measurement endpoints (MEs) that provide a means of determining whether ROCs are at risk from exposure to site-related contaminants. Measurement endpoints are measures of potential effects. Because effects cannot be measured for all ROCs, surrogate receptors are selected to represent the receptor potentially at risk. The MEs that are evaluated in this SLERA for each individual AE are discussed below:

AE(1): Protection and maintenance (*i.e.,* survival, growth, and reproduction) of benthic invertebrate communities that also serve as a forage base for fish and wildlife populations.

- ME(1A): Compare benthic invertebrate COPEC tissue concentrations to relevant toxicity-based critical body residue (CBR) values.
- ME (1B): Compare sediment COPEC concentrations to relevant toxicity-based screening values.

AE(2): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of healthy populations of crustaceans that also serve as a forage base for fish and wildlife populations.

- ME(2A): Compare sediment COPEC concentrations to relevant toxicity-based screening values.
- ME(2B): Compare crustacean COPEC tissue concentrations to relevant toxicity-based CBR values.

AE(3): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of healthy populations of mollusks that also serve as a forage base for fish and wildlife populations.

- ME(3A): Compare sediment COPEC concentrations to relevant toxicity-based screening values.
- ME(3B): Compare mollusk COPEC tissue concentrations to relevant toxicity-based CBR values.

AE(4): Protection and maintenance (*i.e.,* survival, growth, and reproduction) of healthy fish populations that also serve as a forage base for fish and wildlife populations.

- ME(4A): Compare measured concentrations or toxic equivalencies in fish tissue (including eggs) to relevant toxicity-based CBR values.

AE(5): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of omnivorous wildlife (*i.e.*, birds and mammals).

Potential exposure to omnivorous wildlife receptors (*e.g.*, mallard duck and raccoon) is evaluated by modeling the daily dose to these organisms associated with ingestion of COPECs in sediment and prey items. Potential risk is characterized by comparing the species-specific modeled dose estimates to TRVs or similar appropriate descriptors of threshold toxicity. Measurement endpoints include:

- ME(5A): Compare modeled dietary doses of COPECs for the mallard duck with relevant TRVs.
- ME(5B): Compare modeled dietary doses of COPECs for the raccoon with relevant TRVs.

AE(6): Protection and maintenance (*i.e.*, survival, growth, and reproduction) of piscivorous wildlife (*i.e.,* birds and mammals).

Potential exposure to piscivorous wildlife receptors (*e.g.*, belted kingfisher and otter) is evaluated by modeling the daily dose to these organisms associated with ingestion of COPECs in sediment and prey items. Potential risk is characterized by comparing the species-specific modeled dose estimates to TRVs or similar appropriate descriptors of threshold toxicity. Measurement endpoints include:

- ME(6A): Compare modeled dietary doses of COPECs for the belted kingfisher with relevant TRVs.
- ME(6B): Compare modeled dietary doses of COPECs for the river otter with relevant TRVs.

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4.0 SCREENING-LEVEL EFFECTS EVALUATION AND EXPOSURE ESTIMATE

The effects evaluation and exposure analysis of the SLERA are discussed in this section. The effects evaluation of a SLERA focuses on establishing conservative thresholds that are potentially indicative of ecological effects. This is accomplished by compiling existing benchmarks and deriving, where necessary, appropriate screening benchmarks. The exposure analysis consists of determining the maximum documented exposure concentration for each environmental exposure medium (*i.e.*, sediment and biological tissue). The following sections describe this analysis in the context of the COPEC screening process. Through this process, the maximum media concentrations (exposure point concentration [EPC]) is compared to the appropriate ecotoxicity threshold values to evaluate ecological effects and either eliminate COPECs from further evaluation or identify contaminants that may require additional evaluation in a BERA.

4.1 Effects Evaluation (Ecological Screening Benchmarks)

The effects evaluation for a SLERA is generally based on a comparison of EPCs with ecological screening benchmarks. These screening benchmarks represent exposure concentrations above which there is a potential for adverse ecological effects. Because effects concentrations are variable for different receptors, populations and individuals, these are usually conservative values and are used for comparison to reduce the potential for overlooking risks at the early stages of the risk assessment process.

In general, the invertebrate benchmarks employed in the screening analysis are not specific to any one species (although a receptor- and site-specific benchmark for oysters was utilized). As a result, the analytical results are intended to apply to the broad community category of invertebrate organisms that are intimately associated with NBSA sediments. The blue crab is referred to specifically because of the availability of a large tissue dataset for this species.

Ecological screening benchmarks were derived for each distinct environmental media (sediment and biological tissue) and for the relevant exposure pathways as discussed in Section 3.0. For those contaminants that are considered bioaccumulative by USEPA (2000), wildlife protective concentration levels (PCLs) were calculated for sediment and tissue. These wildlife PCLs are back-calculated sediment and tissue concentrations that were derived using conservative exposure assumptions so as to be protective of bioaccumulative hazards to upper trophic level receptors. In addition, for the tissue screen, available critical body residue (CBR) values were also used. The process is discussed in detail below.

4.1.1 Sediment

Both the NJDEP and the NYSDEC provide guidance and recommended benchmarks for conducting ecological screening analysis of sediments (NJDEP, 1998; NYSDEC, 1999) based on direct contact exposures to benthic organisms. NOAA screening values (Long *et al.*, 1995) are key guidelines for screening sediments under both NJDEP and NYSDEC guidance. These benchmarks include Effects Range-Low (ER-L) values that represent a concentration at which adverse benthic effects were observed in approximately 10% of the studies evaluated by Long *et al.* (1995). Effects Range-Median (ER-M) values represent a sediment concentration above which a greater than 50% incidence of adverse effects to sensitive organisms is anticipated. To be as conservative as possible in the SLERA, the ER-L values were selected over the ER-M values for the COPEC screening process. In addition, both NYSDEC and NJDEP recommend saltwater equilibrium-partitioning-based values for non-polar organic compounds lacking ER-Ls, such as benzene, ethylbenzene, tetrachloroethylene, toluene, trichloroethylene, and xylene (NYSDEC, 1999; MacDonald *et al.,* 1992).

Wildlife PCLs were also calculated to ensure that the contaminant screen evaluated the bioaccumulative exposure pathway. Equation 1 was used to estimate PCLs for piscivorous wildlife receptors in the NBSA. The river otter (*Lutra canadensis*) and belted kingfisher (*Ceryle alcyon*) were selected as the model receptors due to their relatively large dietary exposures to sediment-associated chemicals that can bioaccumulate in biological tissue, which ensures that the COPEC process is conservative. Although commonly called a "river otter", *L. canadensis* inhabits marine as well as freshwater environments. Some populations permanently reside in marine shoreline habitats, and are often mistaken for sea otters. The belted kingfisher was selected as a ROC because it is a diving bird that consumes mainly fish tissue. Other avian receptors, such as the great blue heron (used as a receptor for the Lower Passaic River Focused Feasibility Study [Battelle, 2007]), are wading birds and therefore are less likely to forage in Newark Bay than in the Passaic River.

Exposure parameters for the otter and belted kingfisher are summarized in Table 3.

$$PCL_{sed} = \frac{THQ * TRV * BW}{\left(BAF_{fish} * IR_{fish} * P_{fish} * SFF\right)} \qquad \text{Equation 1}$$

where:

PCL_{sed}	=	Protective Concentration Level for sediment (protective of bioaccumulation hazards associated with the fish consumption pathway [µg COPEC/g sediment]).
THQ	=	Target Hazard Quotient for the COPEC based on tissue residue effects (unitless); a THQ of 1.0 was used.
TRV	=	Toxicity Reference Value. Receptor-specific literature-based toxicity threshold value. No- and Lowest-Observed Adverse Effect Level (NOAEL and LOAEL, respectively)-based TRV values are presented in Attachment B. The maximum allowable toxicant concentration (MATC)-based TRV is the geometric mean of the NOAEL- and LOAEL-based values (µg COPEC/g-day).
BW	=	Receptor body weights (kg) (summarized in Attachment B).
BAF_{fish}	=	Bioaccumulation Factor between sediment and fish prey consumed by the receptor (µg COPEC in fish tissue [wet weight]/µg COPEC sediment [dry weight]).
IR_{fish}	=	Daily fish ingestion rate (kg fish consumed per day).
P_{fish}	=	Percentage of fish in the diet.
SFF	=	Site Foraging Frequency (unitless); fraction of time receptor is assumed to forage at the site.

Table 3. Summary of Exposure Parameters Used to Develop PCLs

Parameter	Value	Units	Reference
PCL_{sed}	Calculated using Equation 1	µg COPEC/g sediment	Calculation
PCL_{biota}	Calculated using Equation 2	µg COPEC/g biota	Calculation
THQ	1	unitless	Assumption
TRV	Chemical-specific	µg COPEC/g-day	See Attachments B and C
BW	7.4 (otter)	kg	USEPA, 1993
	0.136 (kingfisher)		USEPA, 1993; Brooks and Davis, 1987
BAF_{fish}	Chemical-specific	µg COPEC fish (wet weight)/µg COPEC sediment (dry weight)	See Attachments B and C
IR_{fish}	0.4 (otter)	kg/day	USEPA, 1993
	0.068 (kingfisher)		USEPA, 1993; Alexander, 1977
P_{fish}	100	%	Assumption
SFF	1	unitless	Assumption

Chemical-specific TRVs and BAFs are presented in Table B-1 (Attachment B), and the calculated PCLs for both receptors are provided in Table B-2. For each chemical, the lower of the two PCL values was identified as the wildlife PCL and used in the screening evaluation. Note that there are relatively few TRVs for avian receptors; consequently, for some COPECs, the wildlife value is based solely on the mammalian PCL.

Table 4 summarizes the available sediment screening values, including both direct contact (*i.e.*, sediment benchmarks) and bioaccumulation hazard-based values (*i.e.*, PCLs) and identifies the sediment benchmarks selected for each analyte to conduct the COPEC for this medium. In many cases, wildlife PCLs are lower than the sediment benchmarks because sediment benchmarks are protective of benthic invertebrates without consideration of bioaccumulation, while PCLs are protective of bioaccumulative hazards to higher trophic level receptors. For all analytes, the lowest of the sediment screening values was used in the assessment, as well as the wildlife PCL.

Table 4. Sediment Screening Values

Chemical[a]	Marine/Estuarine Values						Lowest Sediment Benchmark	Source	USEPA List of Bioaccumulators[e]	Wildlife PCL
	NOAA ER-L[b]	Note	NJDEP[c]	Note	NYSDEC[d]	Note				
Inorganics (ppb)										
Aluminum	-		-		-		-		N	
Antimony	-		-		2,000	4	2,000	NYSDEC	N	
Arsenic	8,200		8,200		8,200		8,200	NOAA ER-L	Y	173,228
Barium	-		-		-		-		N	
Beryllium	-		-		-		-		N	
Cadmium	1,200		1,200		1,200		1,200	NOAA ER-L	Y	3,974
Calcium	-		-		-		-		N	
Chromium	81,000		81,000		81,000		81,000	NOAA ER-L	Y	368
Cobalt	-		-		-		-		N	
Copper	34,000		34,000		34,000		34,000	NOAA ER-L	Y	297
Cyanide	-		-		-		-		N	
Iron	-		-		20,000,000	3	20,000,000	NYSDEC	N	
Lead	46,700		47,000		46,700		46,700	NOAA ER-L	Y	10,606
Magnesium	-		-		-		-		N	
Manganese	-		-		460,000	3	460,000	NYSDEC	N	
Mercury	150		150		150		150	NOAA ER-L	Y	42
Nickel	20,900		21,000		20,900		20,900	NOAA ER-L	Y	3,791
Potassium	-		-		-		-		N	
Selenium	-		-		-		-		Y	925
Silver	1,000		1,000		1,000		1,000	NOAA ER-L	Y	569,210
Silicon	-		-		-		-		N	
Sodium	-		-		-		-		N	
Thallium	-		-		-		-		N	
Tin	-		-		-		-		N	
Titanium	-		-		-		-		N	
Vanadium	-		-		-		-		N	
Zinc	150,000		150,000		150,000		150,000	NOAA ER-L	Y	487
VOCs (ppb)										
1,1,1-Trichloroethane	-		-		-		-		N	
1,1,2,2-Tetrachloroethane	-		-		-		-		N	
1,1,2-Trichloroethane	-		-		-		-		N	
1,1-Dichloroethene	-		-		-		-		N	
1,1-Dichloroethane	-		-		-		-		N	
1,2-Dichloroethane	-		-		-		-		N	
1,2-Dichloroethylene	-		-		-		-		N	
1,2-Dichloropropane	-		-		-		-		N	
2-Hexanone	-		-		-		-		N	
4-Methyl-2-Pentanone	-		-		-		-		N	
Acetone	-		-		-		-		N	
Benzene	-		340	2	260	5	260	NYSDEC	N	
Bromoform	-		-		-		-		N	
Carbon Disulfide	-		-		-		-		N	
Carbon Tetrachloride	-		-		-		-		N	
Chlorobenzene	-		-		35	5	35	NYSDEC	N	

Table 4. Sediment Screening Values, continued

Chemical[a]	Marine/Estuarine Values						Lowest Sediment Benchmark	Source	USEPA List of Bioaccumulators[e]	Wildlife PCL
	NOAA ER-L[b]	Note	NJDEP[c]	Note	NYSDEC[d]	Note				
Chlorodibromomethane	-		-		-		-		N	
Chloroethane	-		-		-		-		N	
Chloroform	-		-		-		-		N	
cis-1,3-Dichloropropene	-		-		-		-		N	
Dichlorobromomethane	-		-		-		-		N	
Ethylbenzene	-		1,400	2	64	5	64	NYSDEC	N	
Methyl Bromide	-		-		-		-		N	
Methyl Chloride	-		-		-		-		N	
Methylene Bromide	-		-		-		-		N	
Methylene Chloride	-		-		-		-		N	
Methyl Ethyl Ketone	-		-		-		-		N	
Styrene	-		-		-		-		N	
Tetrachloroethylene	-		450	2	-		450	NJDEP	N	
Toluene	-		2,500	2	450	5	450	NYSDEC	N	
Total BTEX	-		-		-		-		N	
Trans-1,3-dichloropropene	-		-		-		-		N	
Trichloroethylene	-		1600	2	-		1,600	NJDEP	N	
Vinyl Chloride	-		-		-		-		N	
SVOCs (Non-PAHs) (ppb)										
2,2-oxybis(1-Chloropropane)	-		-		-		-		N	
1,2-Dichlorobenzene	-		-		120	5	120	NYSDEC	Y	2,746,538
1,3-Dichlorobenzene	-		-		120	5	120	NYSDEC	Y	560,635
1,2,4-Trichlorobenzene	-		-		910	5	910	NYSDEC	Y	3,845,153
2,4,5-Trichlorophenol	-		-		-		-		N	
2,4,6-Trichlorophenol	-		-		-		-		N	
2,4-Dichlorophenol	-		-		-		-		N	
2,4-Dimethylphenol	-		-		-		-		N	
2,4-Dinitrophenol	-		-		-		-		N	
2,4-Dinitrotoluene	-		-		-		-		N	
2,6/2,7-Dimethylnaphthalene	-		-		-		-		N	
2,6-Dinitrotoluene	-		-		-		-		N	
2-Chloronaphthalene	-		-		-		-		N	
2-Chlorophenol	-		-		-		-		N	
2-Methylphenol	-		-		-		-		N	
2-Nitroanaline	-		-		-		-		N	
2-Nitrophenol	-		-		-		-		N	
3,3'-Dichlorobenzidine	-		-		-		-		N	
3-Nitroaniline	-		-		-		-		N	
3-Methylphenol/4-methylphenol	-		-		-		-		N	
4-Bromophenyl Phenyl Ether	-		-		-		-		Y	5,850,214
4-Chloroaniline	-		-		-		-		N	
4-Chlorophenyl Phenyl Ether	-		-		-		-		Y	73,676,722
4-Chloro-3-methylphenol	-		-		-		-		N	
4-Methylphenol	-		-		-		-		N	

Table 4. Sediment Screening Values, continued

Chemical[a]	Marine/Estuarine Values						Lowest Sediment Benchmark	Source	USEPA List of Bioaccumulators[e]	Wildlife PCL
	NOAA ER-L[b]	Note	NJDEP[c]	Note	NYSDEC[d]	Note				
4-Nitroaniline	-		-		-		-		N	
4-Nitrophenol	-		-		-		-		N	
4,6-Dinitro-2-Methylphenol	-		-		-		-		N	
Benzo(b)thiophene	-		-		-		-		N	
Bis(2-Chloroethoxy)methane	-		-		-		-		N	
Bis(2-Chloroethyl)ether	-		-		-		-		N	
Bis(2-Ethylhexyl)phthalate	-		-		1,995	5	1,995	NYSDEC	N	
Butyl Benzyl Phthalate	-		-		-		-		N	
Carbazole	-		-		-		-		N	
Dacthal	-		-		-		-		N	
Dibenzofuran	-		-		-		-		N	
Dibenzothiophene	-		-		-		-		N	
Dibutyltin	-		-		-		-		Y	3,583
Diethyl Phthalate	-		-		-		-		N	
Dimethylphthalate	-		-		-		-		N	
Di-n-butyl Phthalate	-		-		-		-		N	
Di-n-Octyl Phthalate	-		-		-		-		N	
Hexachlorobutadiene	-		-		16	5	16	NYSDEC	Y	20,144
Hexachlorocyclopentadiene	-		-		7	5	7	NYSDEC	Y	892,967
Hexachloroethane	-		-		-		-		Y	5,345,828
Isophorone	-		-		-		-		N	
Monobutyltin	-		-		-		-		N	
Nitrobenzene	-		-		-		-		N	
N-nitroso-di-n-propylamine	-		-		-		-		N	
N-Nitrosodiphenylamine	-		-		-		-		N	
Pentachloroanisole	-		-		-				Y	2
Pentachlorophenol	-		-		400	5	400	NYSDEC	Y	415,862
Phenol	-		-		40,000		40,000	NYSDEC	N	
Tetrabutyltin	-		-		-		-		N	
Tributyltin			-		-		-		Y	3,583
SVOCs (PAHs) (ppb)										
1,4-Dichlorobenzene	-		-		120	5	120	NYSDEC	Y	560,635
1-Methylnaphthalene	-		-		-		-		N	
1-Methylphenanthrene	-		-		-		-		N	
2-Methylnaphthalene	70		70		70	5	70	NOAA ER-L	N	
2,3,5-Trimethylnaphthalene	-		-		-		-		N	
2,6-Dimethylnaphthalene	-		-		-		-		N	
Acenaphthene	16		16		16		16	NOAA ER-L	Y	418,164
Acenaphthylene	44		44		44		44	NOAA ER-L	Y	418,164
Anthracene	85.3		85		85.3		85	NJDEP	Y	418,164
Benzo[a]anthracene	261		261		261		261	NOAA ER-L	Y	34
Benzo[a]pyrene	430		430		430		430	NOAA ER-L	Y	87
Benzo[b]fluoranthene	-		-		-		-		Y	6
Benzo[e]pyrene	-		-		-		-		N	
Benzo[g,h,i]perylene	-		170	3	-		170	NJDEP	Y	418,164
Biphenyl	-		-		-		-		N	

Table 4. Sediment Screening Values, continued

Chemical[a]	Marine/Estuarine Values						Lowest Sediment Benchmark	Source	USEPA List of Bioaccumulators[e]	Wildlife PCL
	NOAA ER-L[b]	Note	NJDEP[c]	Note	NYSDEC[d]	Note				
Benzo[k]fluoranthene	-		240	3	-		240	NJDEP	Y	6
Benzofluoranthenes (total)[f]	-		240	3	-		240	NJDEP	Y	6
Chrysene	384		384		384		384	NOAA ER-L	Y	14
Dibenz[a,h]anthracene	63.4		63		63.4		63	NJDEP	Y	17
Fluoranthene	600		600		600		600	NOAA ER-L	Y	418,164
Fluorene	19		19		19		19	NOAA ER-L	Y	418,164
Indeno[1,2,3-c,d]-pyrene	-		200	3	-		200	NJDEP	Y	14
Naphthalene	160		160		160		160	NOAA ER-L	N	
HMW PAHs[g,h]	1,700		-		1,700		1,700	NOAA ER-L	Y	6
LMW PAHs[g,i]	552		-		552		552	NOAA ER-L	Y	418,164
Total PAHs[g,j]	4,022		4,000		4,022		4,000	NJDEP	Y	6
Perylene	-		-		-		-		N	
Phenanthrene	240		240		240		240	NOAA ER-L	Y	418,164
Pyrene	665		665		665		665	NOAA ER-L	Y	418,164
PCBs (ppb)										
Aroclor 1016	-		7	3	-		7	NJDEP	Y	365
Aroclor 1221	-		-		-		-		Y	365
Aroclor 1232	-		-		-		-		Y	365
Aroclor 1242	-		-		-		-		Y	365
Aroclor 1248	-		30	3	-		30	NJDEP	Y	365
Aroclor 1254	-		60	3	-		60	NJDEP	Y	365
Aroclor 1260	-		5	3	-		5	NJDEP	Y	365
Aroclor 1262	-		-		-		-		Y	365
Aroclor-1268	-		-		-		-		Y	365
PCB 18CONGX2	-		-		-		-		Y	365
Total PCBs (Aroclors)[k]	-		-		-		-		Y	365
Total PCBs[l]	22.7		23	3	22.7		22.7	NOAA ER-L	Y	365
Pesticides/Herbicides (ppb)										
2,4,5-T	-		-		-		-		N	
2,4,5-TP	-		-		-		-		N	
2,4-D	-		-		-		-		N	
2,4-DB	-		-		-		-		N	
2,4-DDD[m]	2		-		-		2	NOAA ER-L	Y	830
2,4-DDE[m]	2.2		-		-		2.2	NOAA ER-L	Y	19
2,4-DDT[m]	1		8	3	-		1	NOAA ER-L	Y	30
4,4'-DDD	2		8	3	10	5	2	NOAA ER-L	Y	830
4,4'-DDE	2.2		2.2		2.2		2.2	NOAA ER-L	Y	19
4,4'-DDT	1		8	3	10	5	1	NOAA ER-L	Y	30
Total DDx[n]	1.58		1.6		1.58		1.58	NOAA ER-L	Y	19
Aldrin	-		2	3	7.7	6	2	NJDEP	Y	463
BHC-alpha	-		6	3	-		6	NJDEP	Y	1,247
BHC-beta	-		5	3	-		5	NJDEP	Y	1,247
BHC-gamma (Lindane)	-		3	3	-		3	NJDEP	Y	1,247
BHC-delta[f]	-		3	3	-		3	NJDEP	Y	1,247
Total BHC[o]	-		3	3	-		3	NJDEP	Y	1,247
Chlordane,alpha (cis)[f]	-		7	3	0.02	5	0.02	NYSDEC	Y	2,006

Table 4. Sediment Screening Values, continued

Chemical[a]	Marine/Estuarine Values						Lowest Sediment Benchmark	Source	USEPA List of Bioaccumulators[e]	Wildlife PCL
	NOAA ER-L[b]	Note	NJDEP[c]	Note	NYSDEC[d]	Note				
Chlordane,gamma (trans)[f]	-		7	3	0.02	5	0.02	NYSDEC	Y	2,006
Chlordane,oxy-[f]	-		7	3	0.02	5	0.02	NYSDEC	Y	2,006
Total Chlordane[g,p]	0.5		7	3	0.02	5	0.02	NYSDEC	Y	2,006
Dieldrin	0.02		2	3	170	5	0.02	NOAA ER-L	Y	271
Dieldrin+aldrin, total	-		2	3	7.7	6	2	NJDEP	Y	-
Endosulfan sulfate	-		-		-		-		N	
Endosulfan, alpha	-		-		-		-		Y	4,875
Endosulfan, beta	-		-		-		-		Y	4,875
Total Endosulfan[g,q]	-		-		0.04	5	0.04	NYSDEC	Y	4,875
Endrin aldehyde	-		-		-		-		Y	35
Endrin ketone	-		-		-		-		Y	35
Total Endrin[g,r]	-		3	3	7.3	5	3	NJDEP	Y	35
Heptachlor epoxide	-		5	3	0.9	5	0.9	NYSDEC	Y	9,663
Total Heptachlor[g,s]	-		-		0.9	5	0.9	NYSDEC	Y	2,358
Hexachlorobenzene	-		20	3	120	6	20	NJDEP	Y	92,898
Methoxychlor	-		-		6	5	6	NYSDEC	Y	114,909
Mirex	-		7	3	7	5	7	NJDEP	Y	15,852
Mirex, photo-[f]	-		-		7	5	7	NYSDEC	Y	15,852
Nonachlor, cis-	-		-		-		-		Y	2,006
Nonachlor, trans-	-		-		-		-		Y	2,006
Total Nonachlor[g,t]	-		-		-		-		Y	2,006
Toxaphene	-		-		0.1	5	0.1	NYSDEC	Y	1,398
Dioxins/Furans (ppb)										
2,3,7,8-TCDD	0.0032	1	-		0.002	6	0.002	NYSDEC	Y	2.3
TEQ, sum for PCB congeners	0.0032	1	-		0.002	6	0.002	NYSDEC	Y	2.3
TEQ, sum of dioxin/furan	0.0032	1	-		0.002	6	0.002	NYSDEC	Y	2.3
TEQ, total	0.0032	1	-		0.002	6	0.002	NYSDEC	Y	2.3

a. Chemicals analyzed for and detected in Newark Bay Sediment Samples.
b. ER-L = Effects Range-Low from Long and Morgan, 1991 and Long *et al.*, 1995; except where noted.
c. Values from NJDEP Guidance For Sediment Quality Evaluations, November 1998. References Long *et al*, 1995.
d. Values from NYSDEC, 1999.
e. From USEPA, 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. USEPA-823-R-00-001.
f. Assumed value is the same as total value.
g. Summed compounds not included as an analytical parameter; rather total values were calculated by the database.
h. HMW PAHs is the total sum of >4 ring PAHs.
i. LMW PAHs is the total sum of 2 and 3 ring PAHs including methylates.
j. Total PAHs is the sum of the low and high molecular weight PAHs.
k. Total PCBs Aroclors is the sum of Aroclors.
l. Total PCBs is the sum of all PCB congeners.
m. Value for 4,4' DDT, DDD, DDE was used for 2,4' DDT, DDD, DDE.
n. Total DDx is the sum of six isomers (2,4' and 4,4' DDT, DDD, and DDE).
o. Total BHC is the sum of alpha, beta, delta, and gamma BHC.
p. Total Chlordane is the sum of alpha, beta, delta, and gamma Chlordane.
q. Total endosulfan is the sum of endosulfan sulfate, alpha, and beta.
r. Total Endrin is the sum of Endrin ketone and Endrin aldehyde.
s. Total heptachlor is the sum of heptachlor and heptachlor epoxide.
t. Total nonachlor is the sum of *cis*- and *trans*-nonachlor.

Notes:
1. Derived by USFWS using sediment chemistry for the Arthur Kill and oyster effect data presented in Wintermyer and Cooper (2003).

Table 4. Sediment Screening Values, continued

Chemical[a]	Marine/Estuarine Values							Lowest Sediment Benchmark	Source	USEPA List of Bioaccumulators[e]	Wildlife PCL
	NOAA ER-L[b]	Note	NJDEP[c]	Note	NYSDEC[d]	Note					

2. NJ Volatile Organic Sediment Screening Guidelines derived from MacDonald *et al.,* 1992.
3. Persaud *et al*., 1993.
4. Long and Morgan, 1991.
5. Benthic Aquatic Life Chronic Toxicity Criteria for saltwater used and converted to parts per billion assuming 1% organic carbon.
6. Wildlife Bioaccumulation Criteria used and are expressed in terms of organic carbon (assuming 1%) and converted to ppb.

4.1.2 Biological Tissue

Screening values used in the COPEC screening process for biological tissue were based on tissue concentrations considered protective of either the organism in which the concentration was measured or for consumers of these organisms. For the former approach, CBRs previously summarized for the LPRRP were used. These values were derived and presented in a Problem Formulation Technical Memorandum entitled *Refinement of Toxicity Values and Development of Critical Biota Residues and Biomagnification Factors (BMFs)* (Battelle, March 3, 2006), which is presented in Attachment C. Toxicological data used to develop the CBRs was obtained from the Army Corps of Engineers' Environmental Residue-Effects Database (ERED, available at http://el.erdc.usace.army.mil/ered; queried on 10 January 2006). This information was supplemented with data obtained from other compilations of residue effects data (*e.g.*, USEPA, 2000; Jarvinen and Ankley, 1999) as well as journal articles. The CBRs represent the maximum allowable toxicant concentration (MATC) (i.e., geometric mean) of the most conservative NOAELs and LOAELs for several selected bioaccumulative COPECs.

PCLs based on protecting wildlife consumers of contaminated prey tissue were available from NYSDEC guidance ("fish flesh criteria") for 14 chemicals (Newell *et al*., 1987). PCLs were also calculated for the additional chemicals using a similar approach as described in the previous section for sediment. These values provide a protective tissue screening value based on exposures to higher-trophic-level organisms. Equation 2 was used to estimate tissue PCLs for piscivorous wildlife receptors in the NBSA. The exposure parameters are presented in Table 3.

$$PCL_{biota} = \frac{THQ * TRV * BW}{\left(IR_{fish} * P_{fish} * SFF\right)} \qquad \text{Equation 2}$$

where:

PCL_{biota}	=	Protective Concentration Level for prey tissue (protective of bioaccumulation hazards associated with the fish consumption pathway [µg COPEC/g biota]).
THQ	=	Target Hazard Quotient for the COPEC based on tissue residue effects (unitless); a THQ of 1.0 was used.
TRV	=	Toxicity Reference Value. Receptor-specific literature-based toxicity threshold value. NOAEL and LOAEL-based TRV values are presented in Attachment B. The MATC-based TRV is the geometric mean of the NOAEL- and LOAEL-based values (µg COPEC/g-day).
BW	=	Receptor body weights (kg) are summarized in Attachment B.
IR_{fish}	=	Daily fish ingestion rate (kg fish consumed per day).

P_{fish}	=	Percentage of fish in the diet.
SFF	=	Site Foraging Frequency (unitless); fraction of time receptor is assumed to forage at the site.

Table 5 summarizes the available biological tissue screening values, including both residue-based (*i.e.*, CBRs) and dose-based exposure (*i.e.,* wildlife PCL) values, and, for each chemical, identifies the value selected to conduct the COPEC screening process for this medium.

4.2 Summary of Available Data (Exposure Estimate)

COPECs were identified for sediment and tissue media based on a review of current and historical data that were collected by various groups, including USEPA, USACE, NOAA National Status and Trends (NS&T) program, and Tierra (Table 1). These data are currently stored in an online database at www.ourNewarkBay.org. In addition, data from the NY/NJ Contaminant Assessment and Reduction Program (CARP) were utilized for the risk assessment. Three major datasets (historical data, Phase I RIWP data, and CARP data) were reviewed for quality, comparability, and usability for the risk assessment process and are described in detail below.

Historical data retrieved from the database at www.ourNewarkBay.org include surface sediment (defined as the top 0 to 6 inches) and biological tissue data for a variety of chemicals, including metals, VOCs, SVOCs, PAHs, PCBs, pesticides, herbicides, and dioxins/furans. Historical surface sediment data are from studies dating from 1990-2000, and what was once considered "surface" sediment may no longer be representative of current surface conditions.

Although it is recognized that sediment-associated porewater is a potentially important exposure medium, this SLERA does not evaluate porewater concentrations because insufficient documentation was available regarding historic data quality for the associated investigations. There is considerable complexity associated with the collection of representative porewater samples; therefore, in the absence of the supporting details, these samples were not included in this assessment. In addition, there are too few samples identified in the database as "porewater" to support a definitive analysis. Furthermore, due to the lack of representative surface water samples, no surface water screen was included in this SLERA. A routine water quality monitoring program is anticipated for the Newark Bay Phase III RI field effort, following which, a full surface water screen is expected to be performed for the BERA.

Because the historical data were collected from multiple investigations by various investigators over more than a decade, there are discrepancies with regard to data quality, comparability, and usability. The following assumptions were made to allow for comparisons of data across studies and sampling years:

- All data points qualified with an "R" (rejected) were excluded from the data query outputs.
- Any data point with validation and/or laboratory qualifiers containing a "U" was treated as not detected. Furthermore, it was assumed that the value reported in the database was equivalent to the detection limit.
- Supporting quality assurance (QA) laboratory documentation or metadata defining laboratory qualifiers are not available in the database. With the exceptions noted above, it was assumed that all data meeting screening criteria were appropriate for conducting the SLERA, that the sediment data are reported on a dry-weight basis, and that tissue data are reported on a wet-weight basis.
- Sediment samples collected in areas that were subsequently dredged or will be dredged in the upcoming year will no longer represent relevant environmental exposure conditions. Sediment samples collected prior to known dredging operations were not included in this assessment.

Table 5. Biological Tissue Screening Values

Chemical[a]	List of USEPA Bioaccumulators[b]	Note	NYSDEC[c] Wildlife PCL	Derived Wildlife PCL	Selected Screening Benchmark	Source	Critical Body Residues[d]			
							Fish	Invertebrate	Birds	Note
Inorganics (ppb)										
Aluminum	N		-	-						
Antimony	N		-	-						
Arsenic	Y		-	22,000	22,000	Derived				
Barium	N		-	-						
Beryllium	N		-	-						
Cadmium	Y		-	1,824	1,824	Derived				
Calcium	N		-	-						
Chromium	Y		-	4,472	4,472	Derived				
Cobalt	N		-	-						
Copper	Y		-	21,935	21,935	Derived	6.3	270		
Cyanide	N		-	-						
Iron	N		-	-						
Lead	Y		-	700	700	Derived	88	1,700		
Mercury, elemental	Y		-	168	168	Derived	19	13		
Methyl mercury	Y	1	-	42	42	Derived	3.2			
Total Mercury (Hg(II) + MeHg)	Y	1	-	42	42	Derived	3.2	13		
Magnesium	N		-	-						
Manganese	N		-	-						
Nickel	Y		-	17,629	17,629	Derived	37,000	350		
Potassium	N		-	-						
Selenium	Y		-	925	925	Derived				
Silver	Y		-	569,210	569,210	Derived	76	6		
Sodium	N		-	-						
Thallium	N		-	-						
Titanium	N		-	-						
Vanadium	N		-	-						
Zinc	Y		-	108,782	108,782	Derived	280	410		
SVOCs (Non-PAH) (ppb)										
2,2'-oxybis(1-Chloropropane)	N		-	-						
1,2-Dichlorobenzene	Y		-	2,746,538	2,746,538	Derived				
1,3-Dichlorobenzene	Y		-	560,635	560,635	Derived				
1,2,4-Trichlorobenzene	Y		-	3,845,153	3,845,153	Derived				
2,4,5-Trichlorophenol	N		-	-						
2,4,6-Trichlorophenol	N		-	-						
2,4-Dichlorophenol	N		-	-						
2,4-Dimethylphenol	N		-	-						
2,4-Dinitrophenol	N		-	-						
2,4-Dinitrotoluene	N		-	-						
2,6-Dinitrotoluene	N		-	-						
2-Chloronaphthalene	N		-	-						
2-Chlorophenol	N		-	-						

Table 5. Biological Tissue Screening Values, continued

Chemical[a]	List of USEPA Bioaccumulators[b]	Note	NYSDEC[c] Wildlife PCL	Derived Wildlife PCL	Selected Screening Benchmark	Source	Critical Body Residues[d]			
							Fish	Invertebrate	Birds	Note
2-Methylphenol	N		-	-						
2-Nitroanaline	N		-	-						
2-Nitrophenol	N		-	-						
3,3'-Dichlorobenzidine	N		-	-						
3-Nitroaniline	N		-	-						
4,6-Dinitro-2-methylphenol	N		-	-						
4-Bromophenyl Phenyl Ether	Y		-	5,850,214	5,850,214	Derived				
4-Chloro-3-methylphenol	N	1	-	-						
4-Chloroaniline	N		-	-						
4-Chlorophenyl Phenyl Ether	Y		-	5,850,214	5,850,214	Derived				
4-Methylphenol	N		-	-						
4-Nitroaniline	N		-	-						
4-Nitrophenol	N		-	-						
Benzoic Acid	N	1	-	-						
Benzyl Alcohol	N	1	-	-						
Bis(2-Chloroethoxy)methane	N		-	-						
Bis(2-Chloroethyl)ether	N		-	-						
Bis(2-Ethylhexyl)phthalate	N		-	-						
Butyl Benzyl Phthalate	N		-	-						
Carbazole	N		-	-						
Dibenzofuran	N	1	-	-						
Dibenzothiophene	N		-	-						
Dibutyltin	Y	1	-	35,825	35,825	Derived				
Diethyl Phthalate	N		-	-						
Dimethylphthalate	N		-	-						
Di-n-butylphthalate	N		-	-						
Di-n-Octyl Phthalate	N		-	-						
Hexachlorobutadiene	Y		1,300	20,144	1,300	NYSDEC				
Hexachlorocyclopentadiene	Y		-	35,507	35,507	Derived				
Hexachloroethane	Y		14,100	5,345,828	14,100	NYSDEC				
Isophorone	N		-	-						
Monobutyltin	N		-	-						
Nitrobenzene	N		-	-						
N-Nitrosodiphenylamine	N	1	-	-						
N-Nitrosodipropylamine	N		-	-						
Pentachlorophenol	Y		2,000	14,041	2,000	NYSDEC				
Phenol	N		-	-						
Tetrabutyltin	N		-	-						
Tributyltin	Y		-	35,825	35,825	Derived				
SVOCs (PAHs) (ppb)										
1-Methylnaphthalene	N		-	-						
1-Methylphenanthrene	N		-	-						
1,4-Dichlorobenzene	Y		-	560,635	560,635	Derived				
2-Methylnaphthalene	N		-	-						

Table 5. Biological Tissue Screening Values, continued

Chemical[a]	List of USEPA Bioaccumulators[b]	Note	NYSDEC[c] Wildlife PCL	Derived Wildlife PCL	Selected Screening Benchmark	Source	Critical Body Residues[d]			
							Fish	Invertebrate	Birds	Note
2-Methylphenanthrene	Y	1	-	121,267	121,267	Derived				
2,3,5-Trimethylnaphthalene	N		-	-						
2,6-Dimethylnaphthalene	N		-	-						
3,6-Dimethylphenanthrene	Y	1	-	121,267	121,267	Derived				
Acenaphthene	Y		-	121,267	121,267	Derived				
Acenaphthylene	Y		-	121,267	121,267	Derived				
Anthracene	Y		-	121,267	121,267	Derived				
Benzo(a)anthracene	Y		-	10.0	10.0	Derived				
Benzo(a)pyrene	Y		-	25	25	Derived				
Benzo(b)fluoranthene	Y		-	1.8	1.8	Derived				
Benzo[e]pyrene	N		-	-						
Benzo(g,h,i)perylene	Y		-	121,267	121,267	Derived				
Benzo(k)fluoranthene	Y		-	1.8	1.8	Derived				
Biphenyl	N		-	2,068,363	2,068,363	Derived				
Chrysene	Y		-	4.0	4.0	Derived				
Dibenz(a,h)anthracene	Y		-	4.9	4.9	Derived				
Fluoranthene	Y		-	121,267	121,267	Derived				
Fluorene	Y		-	121,267	121,267	Derived				
Indeno(1,2,3-cd)pyrene	Y		-	4.0	4.0	Derived				
Naphthalene	N		-	-						
Perylene	N		-	-						
Phenanthrene	Y		-	121,267	121,267	Derived				
Pyrene	Y		-	121,267	121,267	Derived				
HMW PAHs[e]	Y	1	-	1.8	1.8	Derived	700	70		
LMW PAH[f]	Y	1	-	121,267	121,267	Derived	700	70		
Total PAHs[g]	Y	1	-	1.8	1.8	Derived	700	70		
PCBs (ppb)										
Aroclor 1016	Y		-	676	676	Derived				
Aroclor 1221	Y		-	676	676	Derived				
Aroclor 1232	Y		-	676	676	Derived				
Aroclor 1242	Y		-	676	676	Derived				
Aroclor 1248	Y		-	676	676	Derived				
Aroclor 1254	Y		-	676	676	Derived				
Aroclor 1260	Y		-	676	676	Derived				
Total PCBs (Aroclors)[h]	Y	1	110	676	110	NYSDEC	7.9	680		
Total PCBs[i]	Y	1	110	676	110	NYSDEC	7.9	680		
Pesticides/Herbicides (ppb)										
2,4'-DDD[j]	Y		200	232	200	NYSDEC				
2,4'-DDE[j]	Y		200	147	147	Derived				
2,4'-DDT[j]	Y		200	232	200	NYSDEC				
4,4'-DDD[j]	Y		200	232	200	NYSDEC				
4,4'-DDE[j]	Y		200	147	147	Derived				
4,4'-DDT[j]	Y		200	232	200	NYSDEC				
Total DDx[k]	Y	1	200	147	147	Derived	0.26	0.58		

Table 5. Biological Tissue Screening Values, continued

Chemical[a]	List of USEPA Bioaccumulators[b]	Note	NYSDEC[c] Wildlife PCL	Derived Wildlife PCL	Selected Screening Benchmark	Source	Critical Body Residues[d]			
							Fish	Invertebrate	Birds	Note
2,4,5-TP	N		-	-						
2,4,5-T	N		-	-						
2,4-D	N		-	-						
2,4-DB	N		-	-						
Aldrin	Y		120	834	120	NYSDEC	35	28		
alpha-BHC	Y		-	2,245	2,245	Derived				
beta-BHC	Y		-	2,245	2,245	Derived				
delta-BHC	Y		-	2,245	2,245	Derived				
gamma-BHC (Lindane)	Y		-	2,245	2,245	Derived				
Total BHC[l]	Y	1	-	2,245	2,245	Derived				
Chlordane,alpha (cis)	Y		500	9,570	500	NYSDEC				
Chlordane,gamma (trans)	Y		500	9,570	500	NYSDEC				
Chlordane,oxy-	Y		500	9,570	500	NYSDEC				
Total Chlordane[m]	Y	1	500	9,570	500	NYSDEC	3.2	6.3		
Dieldrin	Y		120	487	120	NYSDEC	35	28		
Endosulfan sulfate	N		-	8,775	8,775	Derived				
Endosulfan, alpha	Y		-	8,775	8,775	Derived				
Endosulfan, beta	Y		-	8,775	8,775	Derived				
Total Endosulfan[n]	Y	1	-	8,775	8,775	Derived	22	3.2		
Endrin aldehyde	N		-	63	63	Derived				
Endrin ketone	N		-	63	63	Derived				
Endrin	Y		25	63	25	NYSDEC				
Total Endrin	Y	1	25	63	25	NYSDEC	3.6	3.2		
Heptachlor	Y		200	4,245	200	NYSDEC				
Heptachlor epoxide	Y		200	17,394	200	NYSDEC				
Total Heptachlor[o]	Y	1	200	4,245	200	NYSDEC				
Hexachlorobenzene	Y		330	8,361	330	NYSDEC				
Methoxychlor	Y		-	206,836	206,836	Derived				
Mirex	Y		330	20,766	330	NYSDEC				
Mirex, photo-	Y	1	330	20,766	330	NYSDEC				
Nonachlor, cis-	N		-	-						
Nonachlor, trans-	N		-	-						
Total Nonachlor[p]	Y	1	-	9,570	9,570	Derived	3.2			
Toxaphene	Y		-	2,517	2,517	Derived				
Dioxins/Furans(ppb)										
2,3,7,8-TCDD	Y		0.0003	0.059	0.0003	NYSDEC				
TEQ, sum for PCB congeners	Y	1	-	0.089	0.089	Derived	0.043	0.002	0.094	2
TEQ, sum of dioxin/furan	Y	1	-	0.059	0.059	Derived	0.043	0.002	0.094	2
TEQ, total	Y	1	-				0.043	0.002	0.094	2

a. Chemicals analyzed for and detected in Newark Bay tissue samples.
b. USEPA, 2000
c. Values from Newell *et al*., 1987. Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife; Technical Report 87-3, Division of Fish and Wildlife.
d. CBRs are based on MATCs as derived by Battelle (2006).

Table 5. Biological Tissue Screening Values, continued

Chemical[a]	List of USEPA Bioaccumulators[b]	Note	NYSDEC[c] Wildlife PCL	Derived Wildlife PCL	Selected Screening Benchmark	Source	Critical Body Residues[d]			
							Fish	Invertebrate	Birds	Note

e. HMW PAHs is the total sum of >4 ring PAHs.
f. LMW PAHs is the total sum of 2 and 3 ring PAHs including methylates.
g. Total PAHs is the sum of the low and high molecular weight PAHs.
h. Total PCBs Aroclors is the sum of Aroclors.
i. Total PCBs is the sum of all PCB congeners.
j. Values for DDT, DDD, DDE were used for both the 2,4' and 4,4' compounds.
k. Total DDx is the sum of six isomers (2,4 and 4, 4' DDT, DDD & DDE).
l. Total BHC is the sum of alpha, beta, delta, and gamma-BHC.
m. Total Chlordane is the sum of alpha (cis), gamma (trans), and oxy-Chlordane.
n. Total endosulfan is the sum of endosulfan sulfate, alpha, and beta.
o. Total heptachlor is the sum of heptachlor and heptachlor epoxide.
p. Total nonachlor is the sum of cis- and trans-nonachlor.

Notes:
1. Parameter not listed; assumption based on similar compound**.**
2. Based on avian embryo.

- Available tissue data consists of whole-body data for a variety of aquatic organisms, which were grouped into the following categories: benthic invertebrates (including infaunal and epifaunal macroinvertebrates such as polychaetes), mollusks, crab (consisting of blue crab data), fish, and avian embryo data. Tissue data consisting of specific organs (*e.g.,* hepatopancreas) or body fillet data collected for human health exposure assessments were excluded from the database queries used to screen COPECs.
- For various analytes that are chemically related and presumably share toxicological properties, aggregate parameters were estimated as part of the database query process by combining, for each sample, the individual results for each component. Non-detected values were not differentiated during the process. The following aggregate parameters were calculated and incorporated into the screening process:
  - Total PCBs (Aroclors) – Sum of the analyzed Aroclors, including Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, and Aroclor 1268.
  - Low molecular weight (LMW) PAHs – Sum of 2- and 3-ring PAHs including methylated compounds.
  - High molecular weight (HMW) PAHs – Sum of 4-, 5-, and 6-ring PAH compounds.
  - Total PAHs – Sum of all analyzed PAH compounds.
  - Total DDx – Sum of 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
  - Total BHC – Sum of alpha-, beta-, delta- and gamma-BHC.
  - Total chlordane – Sum of alpha, gamma, and oxy-chlordane.
  - Total endosulfan – Sum of endosulfan sulfate and alpha- and beta-endosulfan.

- Total endrin – Sum of endrin, endrin aldehyde, and endrin ketone.
- Total heptachlor – Sum of heptachlor and heptachlor epoxide.
- Total nonachlor – Sum of cis- and trans-nonachlor.

- Toxic Equivalencies Quotients (TEQs) were also calculated for dioxin, furan, and coplanar PCB congeners detected in biological tissue samples. Individual congener concentrations in a sample were multiplied by their respective Toxicity Equivalency Factor (TEF) and the resulting values were summed to derive a sample-specific TEQ (Van den Berg *et al*., 1998). TEF values are available for mammal, bird, and fish receptors, and this process allows the combined toxicological importance of all compounds to be normalized to 2,3,7,8-TCDD (believed to be the most toxic of the dioxin compounds) and quantified in a single value. Due to the uncertainties associated with this process, no TEQs were calculated for sediments; rather only the individual congener of 2,3,7,8-TCDD was evaluated in sediments. TEQs were calculated for tissue samples containing dioxin-like compounds (based separately on mammal, bird, and fish TEFs) for the following contaminant groups:
  - TEQ Dioxin/Furan congeners.
  - TEQ PCB congeners.
  - Total TEQ.

Figure 16 shows the location of all sediment samples selected for the COPEC screening process. The geomorphic units and three main reaches of the bay are also presented so that the reader can better relate the sample locations to the CSM. Figure 17 shows the location of all tissue samples selected for the COPEC screening process. Individual tissue sample types, including benthos, bird egg, crab, mollusks, and fish, are depicted for each region with individual symbols.

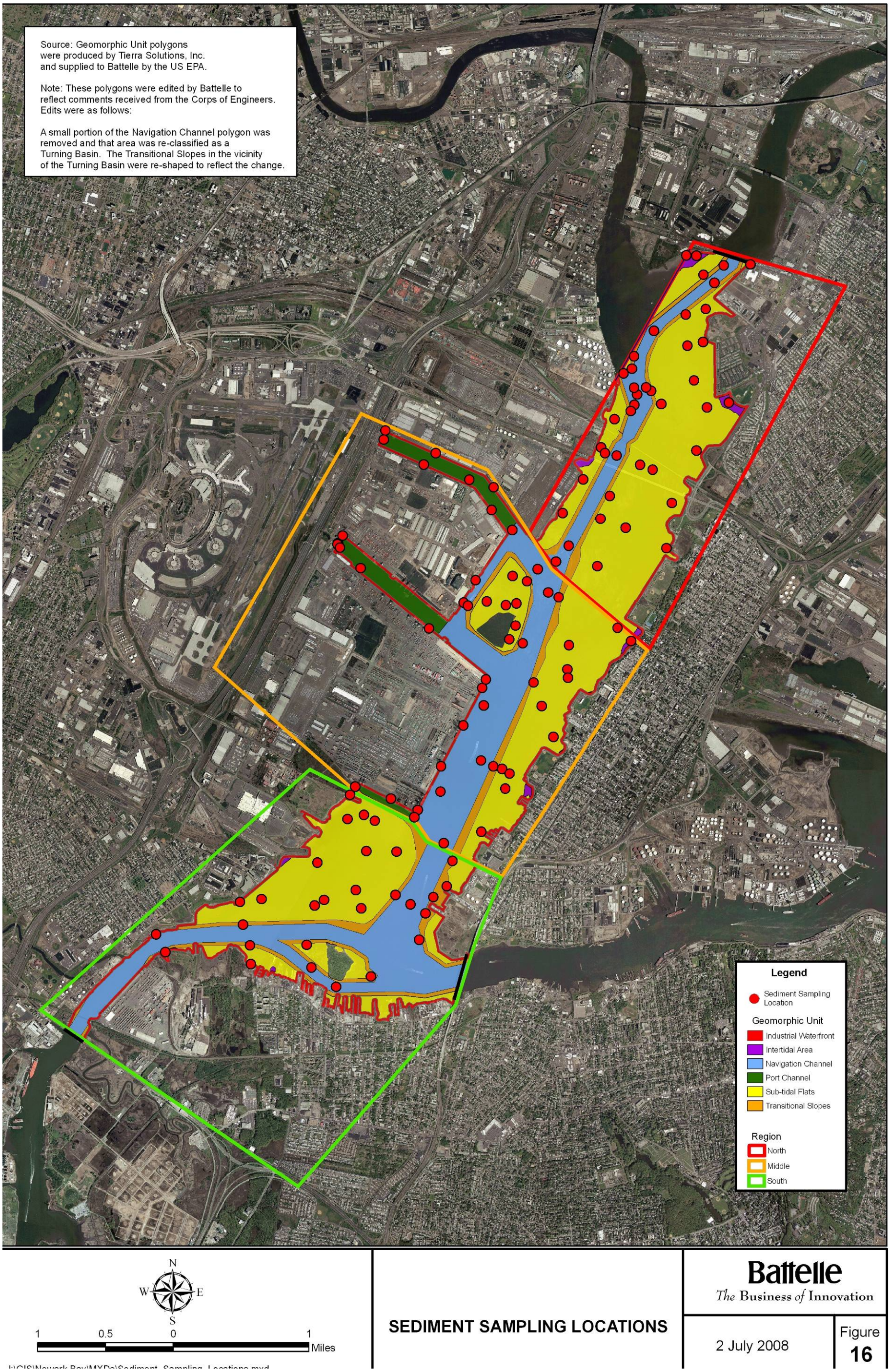


Figure 16. Sediment Sampling Locations

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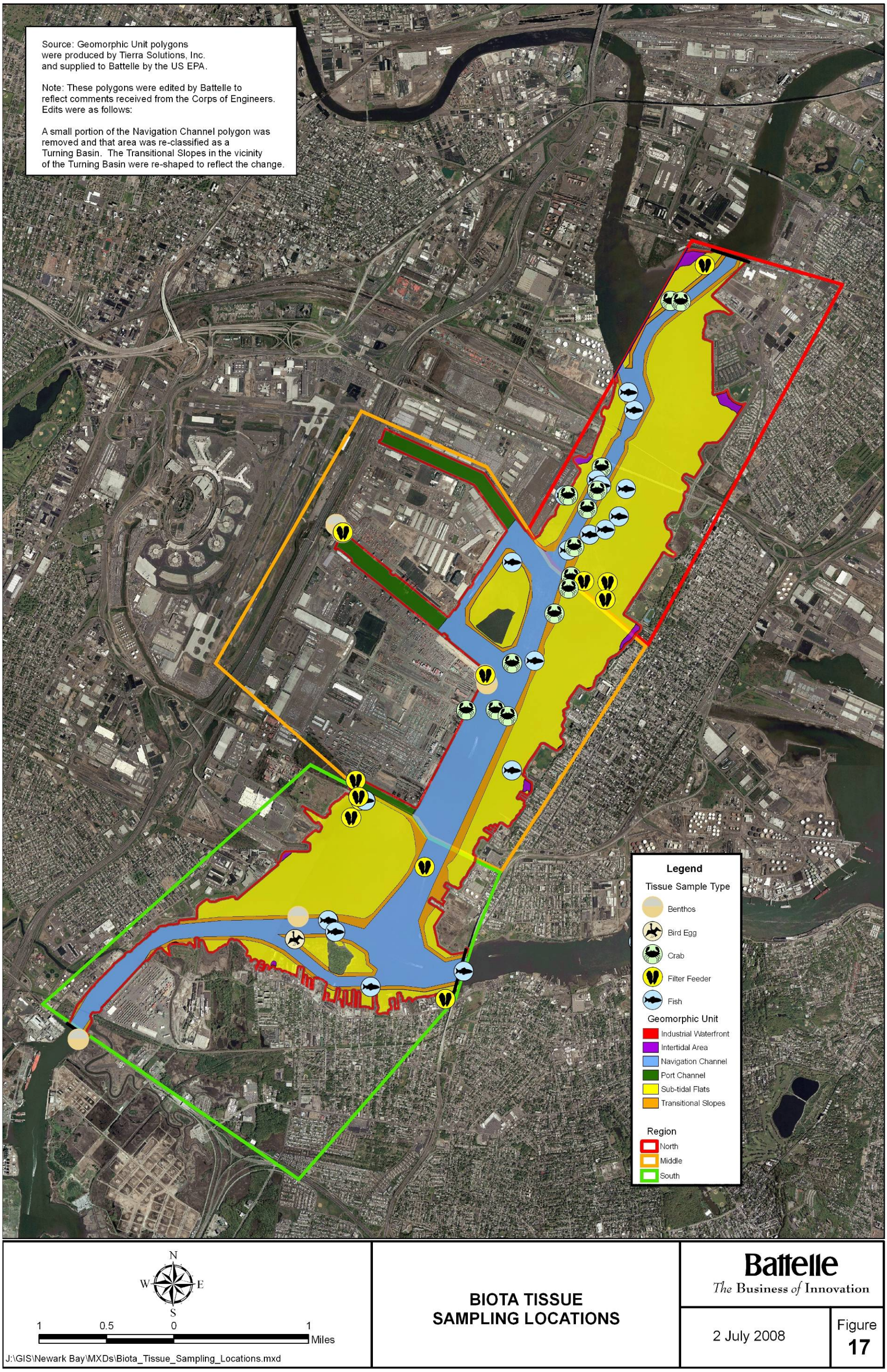


Figure 17. Biota Tissue Sampling Locations

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4.3 COPEC Screening Process (Risk Estimate)

The risk calculation process completes Step 2 of USEPA's Ecological Risk Assessment Guidance for Superfund (ERAGS) (USEPA, 1997). Data from the media-specific datasets described in the previous section were compiled and maximum analyte concentrations were compared to toxicity screening values and PCLs (bioaccumulative contaminants). These comparisons are used to derive hazard quotients (HQs) as described in Equation 3. In general, chemicals with HQs greater than 1 are retained as COPECs for further evaluation in a BERA; those with HQs less than 1 are eliminated from further evaluation. Hazard quotients are calculated using the following equation:

$$HQ = \text{maximum concentration} / \text{screening value} \qquad \text{Equation 3}$$

Hazard quotients were derived for each environmental medium based on the maximum concentration for the NBSA as well as for each of the three regions within the bay (south, middle, and north).

In addition, spatial coverage of the sediment data did not allow further examination of the contaminants associated with each habitat type (*i.e.,* intertidal, subtidal, and channel). Rather, the maximum contaminant concentration from each region (north, south, or middle) was compared to the screening benchmark. It should also be noted that for the SLERA, a conservative approach is recommended (USEPA, 1997); therefore, all chemicals lacking screening benchmarks, even ones that were not detected in any medium, were retained as COPECs because it is possible that data quality objectives were insufficient to detect contaminant concentrations at levels sufficient to compare with effect concentrations. This is addressed further in the uncertainty section (Section 6.0).

The following sections describe the screening process for each media type. The data used in this process are summarized in Attachments A, B, and C. The results of the COPEC screen are provided in Attachments D through I and are summarized by environmental medium in the following sections.

4.3.1 Sediment Screening Process

Sediment COPECs were identified following a screening process that included the following criteria:

1. Bioaccumulation screen.
2. Essential nutrient screen.
3. Availability of a screening benchmark.
4. Comparison to an effects value or screening benchmark.

The sediment screening process is summarized in Figure 18. A conservative screening process was used to ensure that no chemicals were eliminated without going through all steps in the process. For instance, all chemicals considered to be bioaccumulative were carried through and screened against the wildlife PCLs. In addition, all analytes lacking readily available sediment screening benchmarks identified in Table 5 were retained as potential COPECs, as were those where the maximum reported concentration exceeded the selected sediment screening benchmarks (protective of benthic exposures) and/or wildlife PCLs (protective of bioaccumulation hazards). Results are presented in Attachment D.

4.3.2 Biological Tissue Screening Process

A variety of biological tissue data were collected from Newark Bay and are included in the NBSA database. These include chemical concentrations in fish, crabs, mollusks, benthic invertebrates, and bird eggs. COPECs were identified for each tissue category following a screening process that included the following criteria:

1. Wildlife dose assessment bioaccumulation screen.

2. Availability of a screening benchmark.
3. Comparison to a residue-based screening benchmark.

The biological tissue screening process is summarized in Figure 19. Wildlife PCLs were calculated for all bioaccumulative compounds (USEPA, 2000) analyzed for in NBSA biological tissue. To simplify the approach, wildlife PCLs derived for piscivorous receptors were used to evaluate contaminant concentrations in all biological tissue. Table 5 identifies all chemical parameters analyzed in NBSA sediment that are included in the USEPA bioaccumulative compound list and summarizes available CBRs and wildlife PCLs used in the COPEC screening process for this medium.

All analytes lacking readily available tissue residue benchmarks (*i.e.,* CBRs) were retained as potential COPECs, as were those where the maximum reported concentration exceeds the selected CBR (protective of prey organism exposures) and/or wildlife PCLs (protective of bioaccumulation hazards associated with consuming a diet of contaminated prey specimens) Results for benthic invertebrates are presented in Attachment E, mollusks in Attachment F, crabs in Attachment G, fish in Attachment H, and avian embryos in Attachment I.

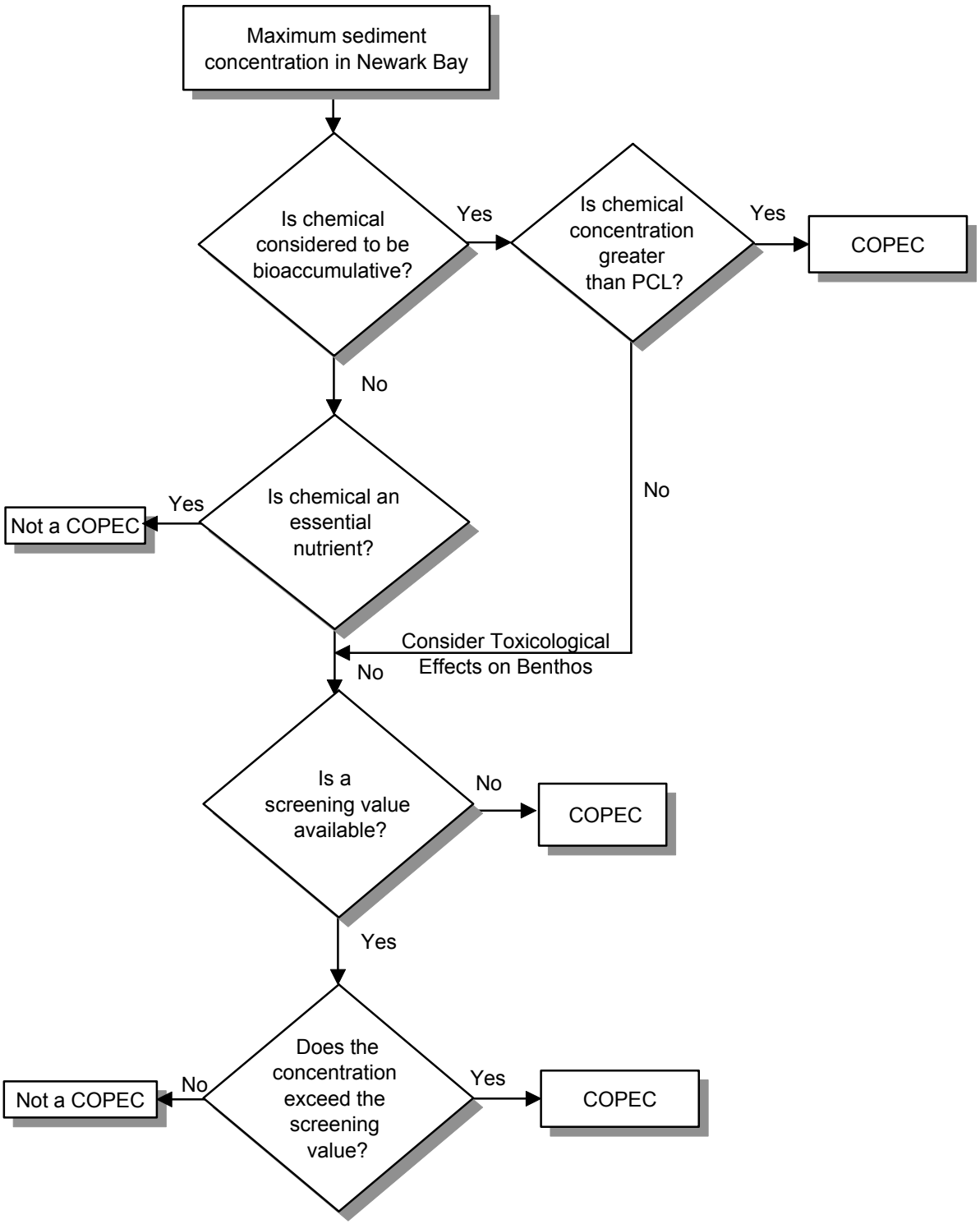


Figure 18. Sediment COPEC Decision Diagram for the Newark Bay SLERA

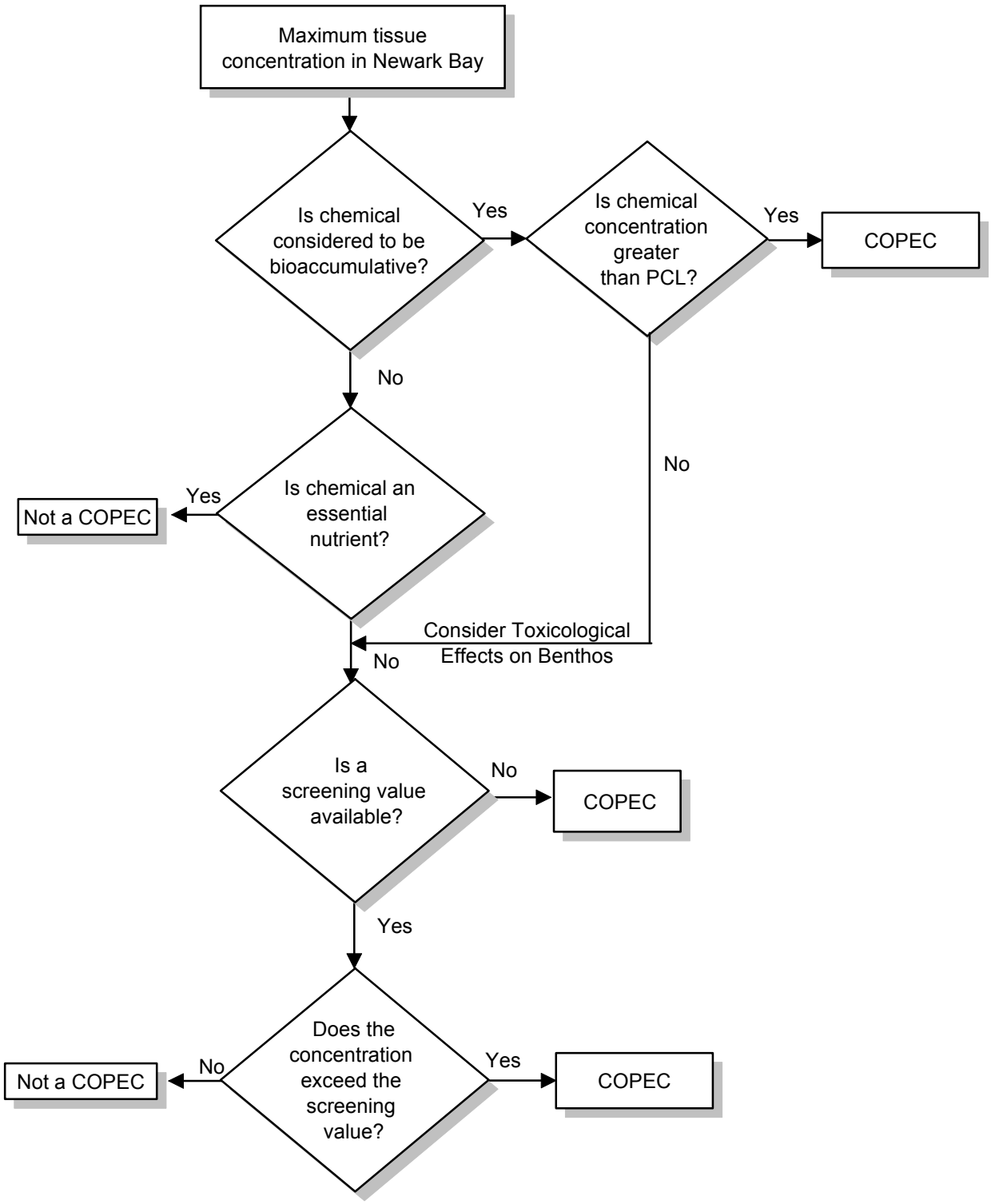


Figure 19. Biological Tissue COPEC Decision Diagram for the Newark Bay SLERA

5.0 SCREENING-LEVEL RISK CHARACTERIZATION

The screening-level risk characterization provides a conservative estimate of the potential for adverse effects to receptors in the NBSA based on the exposure concentrations and effects levels. The results provide a quantitative estimate of the potential for risks to each ecological receptor group. While the HQ is not a measure of the magnitude of effects and HQs are not comparable between chemicals, in general, chemicals with a larger HQ indicate a greater potential for adverse ecological effects. For chemicals with HQs between 1 and 10, there is a low potential for unacceptable risks; for chemicals with HQs between 10 and 100, there is a moderate potential for unacceptable risks; for chemicals with HQs greater than 100, there is a high potential for unacceptable risks. It should be noted, however, that such classifications are arbitrary and an HQ of 99 is not essentially different than an HQ of 100. Rather, the intent of characterizing the risk in this manner establishes order of magnitude differences in potential risk from various COPECs and is intended to facilitate the risk management decision-making process. The results of the COPEC screen and the characterization of the potential risks, based on exposure medium, are discussed in the following sections. Chemicals with HQs exceeding 1 are summarized in Tables 6 through 10; chemicals with HQs greater than 100 and greater than 1000 (*i.e.*, demonstrate the greatest potential for unacceptable ecological risks) are emphasized with bold text.

5.1 Sediment

Sediment results were evaluated for the entire NBSA and for each of the three regions. Results of the sediment screen using the invertebrate screening benchmarks helped identify the potential for adverse effects to invertebrates directly exposed to sediment. Results of the screen to wildlife PCLs identified the potential for adverse effects to upper-trophic wildlife receptors (represented by the otter and belted kingfisher) from bioaccumulative compounds in sediment.

The results of the sediment screen are provided in Attachment D and discussed in detail by contaminant class below. Table 6 presents a summary of the results of the sediment screen by chemical and region within the NBSA. For each region, the magnitude of the HQ above 1 is presented. Only chemicals that were detected in at least one sample at a maximum concentration exceeding a screening value are included. Furthermore, each chemical was screened against two benchmarks within each region: an invertebrate-based benchmark and a wildlife-based benchmark. Bolded values indicate an HQ above 100 or 1000, representing the greatest potential for adverse effects.

Metals

A total of 22 inorganic constituents was retained as COPECs, 13 of which had HQs exceeding 1, for either wildlife or benthic invertebrates. Five constituents were screened out on the basis of being essential nutrients (calcium, magnesium, potassium, silicon, and sodium). Chromium, copper, and zinc had the highest HQs for wildlife (all HQs > 1,000). In general, the highest wildlife PCL exceedances were associated with the middle region of the NBSA, with one notable exception; zinc HQ exceedances were also high in the north and middle regions. The invertebrate HQs for inorganics were all less than 100 throughout the NBSA, and no discernible differences were observed between the three regions.

VOCs

Only 10 VOCs including total BTEX were detected in sediment. One detected VOC (ethylbenzene) exceeded the invertebrate-based benchmark in the middle region and the HQ was less than 10. VOCs do not bioaccumulate through the food web, and, therefore, benchmarks were not derived for wildlife.

Non-PAH SVOCs

A total of 53 non-PAH SVOCs was retained as COPECs in sediment; the majority of which lack sediment benchmarks. Twenty-six non-PAH SVOCs were detected in sediment. Of those with available screening benchmarks, none exceeded their wildlife-based benchmarks. Only four detected non-PAH SVOCs exceeded their respective invertebrate-based benchmarks (1,2,4-trichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and bis(2-ethylhexyl)phthalate [BEHP]). BEHP has the highest potential for adverse effects to benthic invertebrates, with HQs greater than 100 in the north and middle regions.

PAHs

Eighteen detected PAHs, including total benzofluoranthenes, as well as HMW, LMW, and total PAHs, exceeded either the wildlife-based screening benchmarks, invertebrate-based benchmarks, or both. The magnitude of exceedances was consistently higher for HMW PAHs. For invertebrate exposures, the magnitude of exceedances was generally greater than 10 in the north region and higher in the middle and south regions, which frequently were between 100 and 1000. The magnitude of exceedances for wildlife PCLs was generally consistent across all three regions of the NBSA and was almost always greater than 100.

The highest exceedances (HQs > 1,000) of the wildlife PCLs were associated with benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno[1,2,3-c,d]pyrene, the HMW PAHs, and total PAHs. The exceedances of the wildlife PCLs for benzo(b)fluoranthene, HMW PAHs, and total PAHs were consistently high, with wildlife HQs greater than 1,000 in all three regions. Benzo(k)fluoranthene had the highest exceedances in the south region, chrysene in the middle and south regions, and indeno[1,2,3-c,d]pyrene in the north region.

For invertebrate exposures, PAH HQs were almost always greater than 10. The HQs were often greater than 100 in the south region, occasionally greater than 100 in the middle region, and rarely greater than 100 in the north region, with the exception of indeno[1,2,3-c,d]pyrene.

PCBs

Because screening benchmarks and toxicity values for PCBs are based on PCB Aroclors, PCBs are only discussed in terms of Aroclor concentrations. Wildlife-based HQs for Aroclor mixtures were generally less than 10 with the exception of Aroclor 1248, Aroclor 1254, and Total Aroclors, which all had HQs greater than 10 in the south region. Total Aroclors also had an HQ greater than 10 in the middle region.

For invertebrates, HQs for Aroclor 1248 and 1260 were greater than 100. The HQ for Aroclor 1260 was greater than 100 in all three regions, while the invertebrate HQ for Aroclor 1248 was greater than 100 in the south region.

Pesticides/Herbicides

Twenty-one individual detected pesticide/herbicide compounds and five summed total aggregates (*e.g.,* total DDx and total chlordane) exceeded either the wildlife or invertebrate-based benchmarks. Nine compounds (2,4'-DDE, 2,4'-DDT, 4,4'-DDE, 4,4'-DDT, total DDx, dieldrin, endrin, endrin ketone, and total endrin) exceeded their respective wildlife-based PCLs. The greatest exceedances (HQ > 1000) were associated with total DDx, chlordane, dieldrin, and endosulfan. There was an observed increase in the magnitude of exceedances associated with total DDx from north to south for both the wildlife and invertebrate HQs. For all compounds, the exceedances of the invertebrate benchmarks were generally higher than the wildlife exceedances.

Dioxins

2,3,7,8-TCDD exceeded an invertebrate-based benchmark for all the regions. The HQ was highest in the north and middle regions (HQ>100) and lower in the southern region (HQ>10).

Table 6. Summary of Hazard Quotients for Sediment

Chemical	Overall		North		Middle		South	
	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate
Metals								
Antimony		>10		>1		>10		>10
Arsenic	-	>1	-	>1	-	>1	-	>1
Cadmium	>1	>10	>1	>1	>1	>10	>1	>1
Chromium	**>1000**	>1	**>100**	>1	**>1000**	>1	**>100**	>1
Copper	**>1000**	>10	**>100**	>1	**>1000**	>10	**>100**	>1
Iron		>1		>1		>1		>1
Lead	>10	>10	>10	>1	>10	>10	>10	>1
Manganese		>1		>1		>1		>1
Mercury	**>100**	>10	**>100**	>10	**>100**	>10	>10	>10
Nickel	>10	>1	>10	>1	>10	>1	>10	>1
Selenium	>10		>10		>10		>10	
Silver	-	>10	-	>1	-	>10	-	>10
Zinc	**>1000**	>10	**>1000**	>1	**>1000**	>10	**>100**	>1
VOCs								
Ethylbenzene		>1	#N/A	#N/A		>1	#N/D	#N/D
SVOCs (Non-PAHs)								
1,2,4-Trichlorobenzene	-	>1	-	>1	-	>1	#N/D	#N/D
1,3-Dichlorobenzene	-	>10	-	>10	#N/D	#N/D	#N/D	#N/D
1,4-Dichlorobenzene	-	>10	-	>10	-	>10	-	>10
Bis(2-ethylhexyl)phthalate		**>100**		**>100**		**>100**		>10
SVOCs (PAHs)								
2-Methylnaphthalene		**>100**		>10		**>100**		**>100**
Acenaphthene	-	**>100**	-	>10	-	**>100**	-	**>100**
Acenaphthylene	-	**>100**	-	>10	-	**>100**	-	>10
Anthracene	-	>10	-	>10	-	>10	-	>10
Benzo(a)anthracene	**>100**	>10	**>100**	>10	**>100**	>10	**>100**	>10
Benzo(a)pyrene	**>100**	>10	>10	>10	**>100**	>10	>10	>10
Benzo(b)fluoranthene	**>1000**		**>1000**		**>1000**		**>1000**	
Benzo(g,h,i)perylene	-	>10	-	>10	-	>10	-	>10
Benzo(k)fluoranthene	**>1000**	>10	>100	>10	**>100**	>10	**>1000**	>10
Benzofluoranthenes, total		>10		>10		>1		>1
Chrysene	**>1000**	**>100**	**>100**	>10	**>1000**	>10	**>1000**	**>100**
Dibenz(a,h)anthracene	**>100**	>10	>10	>10	**>100**	>10	**>100**	>10
Fluoranthene	-	**>100**	-	>10	-	>10	-	**>100**
Fluorene	-	**>100**	-	>10	-	**>100**	-	**>100**
Indeno[1,2,3-c,d]-pyrene	**>1000**	**>100**	**>1000**	**>100**	**>100**	>10	**>100**	>10
Naphthalene		>10		>1		>10		>10
Phenanthrene	-	**>100**	-	>10	-	>10	-	**>100**
Pyrene	-	**>100**	-	>10	-	>10	-	**>100**
Total PAHs	**>1000**	**>100**	**>1000**	>10	**>1000**	>10	**>1000**	**>100**
High MW PAHs	**>1000**	**>100**	**>1000**	>10	**>1000**	>10	**>1000**	**>100**
Low MW PAHs	-	>10	-	>10	-	>10	-	>10
PCBs								
Aroclor 1242	>1		#N/D	#N/D	>1		#N/D	#N/D

Table 6. Summary of Hazard Quotients for Sediment, continued

Chemical	Overall		North		Middle		South	
	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate
Aroclor 1248	>10	**>100**	>1	>10	>1	>10	>10	**>100**
Aroclor 1254	>10	>10	>1	>1	>1	>10	>10	>10
Aroclor 1260	>1	**>100**	>1	**>100**	>1	**>100**	>1	**>100**
PCB 18CONGX2	>1		>1		>1		>1	
Total Aroclor	>10		>1		>10		>10	
Total PCBs	>1	>10	>1	>10	>1	>10	>1	>10
Pesticides/Herbicides								
2,4'-DDD	-	>10	-	>10	-	>10	-	>10
2,4'-DDE	>1	>10	-	>1	>1	>1	>1	>10
2,4'-DDT	>1	**>100**	-	>1	>1	>10	>1	**>100**
4,4'-DDD	-	**>100**	-	>10	-	>10	-	**>100**
4,4'-DDE	>10	**>100**	>1	>10	>1	>10	>10	**>100**
4,4'-DDT	>10	**>1000**	>1	>10	>10	**>100**	>10	**>1000**
Total DDx	**>100**	**>1000**	>1	>10	>10	**>100**	**>100**	**>1000**
Aldrin	-	**>100**	-	>10	-	>10	-	>100
alpha-BHC	-	>10	-	>1	-	>10	-	>10
beta-BHC	-	>10	-	>1	-	>10	-	>10
delta-BHC	-	>10	-	>1	-	>10	-	>10
gamma-BHC (Lindane)	-	>10	-	>1	-	>10	-	>10
Total BHC	-	**>100**	-	>10	-	>10	-	**>100**
Chlordane	-	**>1000**	-	**>100**	-	**>1000**	-	**>100**
Chlordane,alpha (cis)	-	**>1000**	-	**>1000**	-	**>1000**	-	**>1000**
Chlordane,gamma (trans)	-	**>1000**	-	**>1000**	-	**>1000**	-	**>1000**
Chlordane, oxy	-	>10	-	>10	-	>10	#N/D	#N/D
Total Chlordane	-	**>1000**	-	**>1000**	-	**>1000**	-	**>1000**
Dieldrin	>1	**>1000**	-	**>1000**	-	**>1000**	>1	**>1000**
Endrin	>10	**>100**	>1	>10	>1	>10	>10	**>100**
Total Endrin	>10	**>100**	>1	>10	>1	>10	>10	**>100**
Total Endosulfan	-	**>1000**	#N/D	#N/D	-	**>1000**	#N/D	#N/D
Heptachlor	-	**>100**	-	>10	-	>10	#N/D	#N/D
Heptachlor epoxide	-	**>100**	-	>10	-	>10	-	**>100**
Total Heptachlor	-	**>100**	-	>10	-	**>100**	-	**>100**
Hexachlorobenzene	-	**>100**	-	>10	-	**>100**	-	**>100**
Methoxychlor	-	**>100**	#N/D	#N/D	-	**>100**	#N/D	#N/D
Dioxins/Furans								
2,3,7,8-TCDD	-	**>100**	-	**>100**	-	**>100**	-	>10

Notes:
Refer to Tables D-1 through D-4 in Attachment D for the overall and the north, middle, and south regions, respectively.
Only chemicals detected in at least one sample at a maximum concentration exceeding a screening value are included.
#N/A – parameter not available/.
#N/D - parameter not detected.
A dash indicates that the maximum parameter value used in the screening was less than the benchmark.
Bolded chemicals have HQs greater than 100 and/or 1000.

5.2 Biological Tissue

To assess the risks associated with chemical contaminants in biological tissue, toxicological benchmarks were developed for benthic invertebrates, mollusks, crabs, and fish. These results helped identify the potential for adverse effects to organisms directly exposed to sediment as well as bioaccumulative dietary exposures for wildlife. The results are provided in Attachments E through I and discussed in the following sections. Tables 7 through 10 summarize the results of the tissue screen for benthic invertebrates, mollusks, crabs, fish, and birds, respectively. The tables are organized by chemical and region within the NBSA. For each region, the magnitude of the HQ above 1 is presented. Only chemicals that were detected in at least one sample at a maximum concentration exceeding a screening value are included. Furthermore, each chemical was screened against two benchmarks within each region: a receptor-based benchmark and a wildlife-based benchmark. Receptor-based benchmarks were developed for benthic invertebrates, mollusks, crabs, fish, and bird tissue and represent concentrations that if exceeded could pose an unacceptable risk to that specific receptor (e.g., high body burden in fish tissue resulting in reproductive failure in a bass population). The wildlife-based benchmarks are dietary concentrations (i.e., in prey organisms) that represent a threshold for adverse effects to the wildlife consumer of the contaminated tissue. Bolded values indicate an HQ above 100 or 1000, representing the most potential for adverse effects.

5.2.1 Benthic Invertebrate Tissue

The results of the benthic invertebrate risk characterization (Attachment E) are summarized in Table 7 and are discussed in the following section. There were insufficient data to calculate HQs for the north region of the NBSA.

Metals

Nine detected inorganic compounds had HQs greater than 1 for either the wildlife or invertebrate-based benchmarks. All were located in the middle region of the bay. With the exception of zinc and lead, the wildlife HQs were less than 10, but greater than 1. For the invertebrate HQs, all were greater than 10 with the exception of lead. Zinc had the highest exceedance of the invertebrate CBR, with an HQ greater than 1,000, followed by silver and copper (HQ>100).

PAHs

Seven individual PAHs, in addition to HMW and total PAHs, exceeded their respective wildlife PCLs. Exceedances were generally greater in the middle region than the south region. The highest exceedances (HQs > 1,000) were associated with total PAHs and HMW PAHs.

Although there are no invertebrate CBRs for comparison to individual PAHs; HMW PAHs, LMW PAHs, and total PAHs did exceed their respective invertebrate CBRs. Exceedances were greater than 100 in the middle region and lower in the south region.

PCBs

Total PCBs had an HQ greater than 10 for wildlife and greater than 1 for invertebrates in the middle region of the bay. In the south region of the bay, the wildlife HQ was greater than 1.

Pesticides/Herbicides

Six individual pesticide/herbicide compounds and three summed total aggregates (*e.g.,* total DDx and total chlordane) exceeded the wildlife or invertebrate-based benchmarks. The highest exceedance (HQ >1,000) of the invertebrate CBR was associated with total DDx. Aldrin and dieldrin had HQs less than 10, but greater than 1; total endosulfan and total chlordane had HQs greater than 10.

Dioxins

All of the HQs for the PCB-based TEQs were below 1. The HQs for the dioxin/furan-based TEQs were greater than 1,000. The wildlife HQs were greater than 1,000 in the middle region and decreased substantially in the south region, where all the HQs were less than 1. Dioxin and furan HQs were not calculated for benthic invertebrates due to the lack of both an appropriate toxicological benchmark and TEFs (necessary to calculate TEQs) for this receptor category.

Table 7. Summary of Hazard Quotients for Benthic Invertebrate Critical Body Residues

Chemical	Overall		Middle		South		Representative Species
	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	
Metals							
Arsenic	>1		>1		#N/A	#N/A	
Cadmium	>1		>1		-		
Chromium	>1		>1		#N/A	#N/A	
Copper	>1	**>100**	>1	**>100**	#N/A	#N/A	*Protothaca*
Lead	>10	>1	>10	>1	#N/A	#N/A	*Hyalella*
Mercury (elemental)	>1	>10	>1	>10	-	-	zooplankton
Nickel	>1	>10	>1	>10	#N/A	#N/A	*Hyalella*
Silver	-	**>100**	-	**>100**	#N/A	#N/A	*Acartia*
Zinc	>10	**>1000**	>10	**>1000**	#N/A	#N/A	*Acartia*
SVOCs (PAHs)							
Benzo(a)anthracene	>10		>10		>1		
Benzo(a)pyrene	>10		>10		>1		
Benzo(b)fluoranthene	**>100**		**>100**		#N/A	#N/A	
Benzo(k)fluoranthene	**>100**		**>100**		#N/A	#N/A	
Chrysene	**>100**		**>100**		>10		
Dibenz(a,h)anthracene	>10		>10		>1	`	
Indeno[1,2,3-c,d]-pyrene	>10		>10		>1		
Total PAHs	**>1000**	**>100**	**>1000**	**>100**	**>100**	>10	*Mytilus*
HMW PAHs	**>1000**	**>100**	**>1000**	**>100**	**>100**	>1	*Mytilus*
LMW PAHs	-	>10	-	>10	-	>1	*Mytilus*
PCBs							
Total PCBs	>10	>1	>10	>1	>1	-	*Palaemonetes*
Pesticides/Herbicides							
2,4'-DDD	>1		>1		-		
4,4'-DDD	>1		>1		-		
4,4'-DDE	>1		>1		-		
4,4'-DDT	>1		>1		-		
Total DDx	>1	**>1000**	>1	**>1000**	-	>10	*Hyalella*
Aldrin	-	>1	-	>1	-	-	*Penaeus*
Total Chlordane	-	>10	-	>10	-	-	*Crassostrea*
Dieldrin	-	>1	-	>1	-	-	*Penaeus*
Total Endosulfan	-	>10	-	>10	-	-	*Penaeus*
TEQs (Database)							
DIOX_TEQ_BIRD	**>1000**		**>1000**		-		
DIOX_TEQ_MAMMAL	**>1000**		**>1000**		-		
TOTAL_TEQ_BIRD	**>1000**		**>1000**		-		
TOTAL_TEQ_MAMMAL	**>1000**		**>1000**		-		

Notes:
Refer to Tables E-1 through E-3 in Attachment E for the overall, middle, and south regions, respectively.
Representative species for the invertebrate CBRs as summarized in Table 26 in Attachment C; the wildlife based benchmarks were calculated as described in Section 4.1.3. The wildlife-based benchmarks were developed to be protective of dietary exposures to invertebrate tissue by foraging wildlife.
Only chemicals detected in at least one sample at a maximum concentration exceeding a screening value are included.

#N/A - parameter not available/analyzed; bolded chemicals have HQs greater than 100 and/or 1000.
A dash indicates that the maximum parameter value used in the screening was less than the benchmark.

5.2.2 Mollusk Tissue

The results of the mollusk tissue risk characterizations (Attachment F) are summarized in Table 8 and are discussed in the following section.

Metals

Ten detected inorganic compounds had HQs greater than 1 for either the wildlife or invertebrate-based CBRs. All of the wildlife-based HQs, with the exception of lead, were less than 10. The invertebrate-based HQs were greater than 10 for both lead and nickel and greater than 100 for copper, mercury, and silver. Zinc concentrations showed the highest exceedance, with an HQ greater than 1,000. Overall, the HQs are highest in the middle region of the bay.

PAHs

Seven individual PAHs, as well as HMW PAHs and total PAHs, exceeded wildlife-based PCLs. Benzo(b)fluoranthene, chrysene, HMW PAHs, and total PAHs had the highest magnitude of exceedances, with HQs greater than 1,000 in the middle region and substantially lower in the other two regions (>1 to >10).

For the invertebrate-based HQs, total, LMW, and HMW PAHs were lowest in the north region with HQs greater than 1. They increased in the south region with HQs ranging from >10 to >100 and were highest in the middle region with HQs ranging from >100 to >1000 for the total PAHs.

PCBs

Wildlife-based HQs for Aroclor 1254, total Aroclors, and total PCBs were all greater than 1. Invertebrate-based HQs for total Aroclor and total PCBs were greater than 1. Only wildlife-based HQs for total PCBs exceeded 10 in the middle region; all other HQs were less than 10.

Pesticides/Herbicides

Five individual pesticide/herbicide compounds and three summed total aggregates (*e.g.,* total DDx and total chlordane) exceeded the wildlife or invertebrate-based benchmarks. All the wildlife-based HQs were less than 10 and were associated with DDT compounds (*i.e.*, DDE, DDD, and DDT). The invertebrate-based HQs for aldrin and dieldrin were less than 10. HQs for total chlordane and total endosulfan were greater than 10 in the middle region. The HQ for total DDx exceeded 1,000 in the middle region and 100 in the other two regions. Overall, the middle region had the highest exceedances of both the invertebrate and wildlife benchmarks.

Dioxins

The wildlife-based HQs for dioxin/furan and PCB TEQs were less than 10. These patterns were consistent across all three regions of the NBSA. Mollusk tissue HQs were calculated for 2,3,7,8-TCDD; however, no TEQ could be calculated due to the lack of appropriate TEF values. The mollusk-based HQs for 2,3,7,8-TCDD were greater than 10 in all three regions of the bay.

Table 8. Summary of Hazard Quotients for Mollusk Tissue

Chemical	Overall		North		Middle		South		Representative Species
	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	
Metals									
Arsenic	>1		#N/A	#N/A	>1		-		
Cadmium	>1		-		>1		>1		
Chromium	>1		#N/A	#N/A	>1		#N/A	#N/A	
Copper	>1	**>100**	#N/A	#N/A	>1	**>100**	#N/A	#N/A	*Protothaca*
Lead	>10	>10	>1	-	>10	>10	>1	>1	*Hyalella*
Mercury (elemental)	>1	**>100**	-	>1	>1	**>100**	-	>1	zooplankton
Mercury (total)	>1	>1	-	>1	-	>1	>1	>1	*Hyalella*
Nickel	>1	>10	#N/A	#N/A	>1	>10	#N/A	#N/A	*Acartia*
Silver	-	**>100**	#N/A	#N/A	-	**>100**	#N/A	#N/A	*Acartia*
Zinc	>1	**>1000**	#N/A	#N/A	>1	**>1000**	#N/A	#N/A	*Protothaca*
SVOCs (PAHs)									
Benzo(a)anthracene	**>100**		>1		**>100**		>10		
Benzo(a)pyrene	**>100**		-		**>100**		>10		
Benzo(b)fluoranthene	**>1000**		>10		**>1000**		>10		
Benzo(k)fluoranthene	**>100**		>10		**>100**		>10		
Chrysene	**>1000**		>1		**>1000**		**>100**		
Dibenz(a,h)anthracene	>10		-		>10		>1		
Indeno[1,2,3-c,d]-pyrene	**>100**		>1		**>100**		>10		
Total PAHs	**>1000**	**>1000**	**>100**	>1	**>1000**	**>1000**	**>1000**	**>100**	*Mytilus*
High MW PAHs	**>1000**	**>100**	**>100**	>1	**>1000**	**>100**	**>1000**	**>100**	*Mytilus*
Low MW PAHs	**-**	**>100**	-	>1	-	**>100**	-	>10	*Mytilus*
PCBs									
Aroclor 1254	>1		-		-		>1		
Total Aroclor	>1	>1	>1	-	>1	-	>1	>1	*Palaemonetes*
Total PCBs	>10	>1	>1	-	>10	>1	>1	>1	*Palaemonetes*
Pesticides/Herbicides									
2,4'-DDE	>1		-		>1		-		
4,4'-DDD	>1		-		>1		-		
4,4'-DDE	>1		-		>1		-		
Total DDx	>1	**>1000**	-	**>100**	>1	**>1000**	>1	**>100**	*Hyalella*
Aldrin	-	>1	#N/D	#N/D	-	>1	-	-	*Penaeus*
Total Chlordane	-	>10	-	>1	-	>10	-	>1	*Crassostrea*
Dieldrin	-	>1	-	-	-	>1	-	-	*Penaeus*
Total Endosulfan	-	>10	-	-	-	>10	-	-	*Penaeus*
TEQs (Database)									
2,3,7,8-TCDD		>10		>10		>10		>10	*Crassostrea*
DIOX_TEQ_BIRD	-		-		-		-		
DIOX TEQ_MAMMAL	-		-		-		-		
PCB_TEQ_BIRD	>1		>1		>1		>1		
PCB_TEQ_MAMMAL	>1		-		-		>1		
TOTAL_TEQ_BIRD	>1		>1		>1		>1		
TOTAL_TEQ_MAMMAL	>1		-		-		>1		

Notes:
Refer to Tables F-1 through F-4 in Attachment F for the overall and the north, middle, and south regions, respectively.
Representative species for the invertebrate CBRs as summarized in Table 26 in Attachment C; the wildlife based benchmarks were calculated as described in Section 4.1.3. The wildlife-based benchmarks were developed to be protective of dietary exposures to invertebrate tissue by foraging wildlife.
Only chemicals detected in at least one sample at a maximum concentration exceeding a screening value are included.
#N/A - parameter not available/analyzed.
#N/D - parameter not detected.
A dash indicates that the maximum parameter value used in the screening was less than the benchmark.
Bolded chemicals have HQs greater than 100 and/or 1000.

5.2.3 Crab Tissue

The results of the crab tissue risk characterization (Attachment G) are summarized in Table 9 and discussed in the following section.

Metals

Mercury was the only inorganic compound that had an HQ greater than 1. Data for elemental mercury, methyl mercury, and total mercury were reported for the north and south regions; only data for methyl mercury were reported for the middle region. All the HQs for wildlife were less than 10. Exceedances of the invertebrate-based benchmark were slightly greater, with all HQs greater than 10.

PAHs

Five individual PAHs, as well as HMW PAHs and total PAHs, exceeded wildlife-based PCLs in the northern and middle regions. PAH data were not reported for the south. The HQs were less than 10 for the individual PAHs but exceeded 100 for the HMW and total PAHs. Invertebrate-based HQs were calculated for total PAHs, HMW PAHs, and LMW PAHs; all three compounds had HQs less than 10 but greater than 1. Results were similar for both the north and middle regions.

PCBs

Aroclor 1254 was the only individual Aroclor that exceeded an HQ of 1 and it occurred in the middle region, based on the wildlife PCL. Both total Aroclors and total PCBs exceeded a wildlife-based HQ of 1 in the north and middle regions; the middle region had a higher exceedance for total Aroclor (>10). Invertebrate-based HQs were exceeded for total Aroclors and total PCBs (both >1) in the north and middle regions. PCB data were not reported for the south region.

Pesticides/Herbicides

Total DDx and total chlordane were the only two pesticides that exceeded HQs of 1. Total DDx and total chlordane data were reported for the north and middle regions, but not the south. Total DDx exceeded both the invertebrate and wildlife-based HQs (>100 and >1, respectively) in the middle region and the invertebrate-based HQ in the north region (>100). Total chlordane exceeded the invertebrate-based benchmark in both regions with HQs greater than 1.

Dioxins

Wildlife-based HQs for dioxin/furan, PCB TEQs, and total TEQs were all greater than 1 in the middle region and below 1 in the other regions. Crab tissue HQs were not calculated due to the lack of both an appropriate toxicological benchmark and TEFs (necessary to calculate TEQs) for this receptor category.

Table 9. Summary of Hazard Quotients for Crab Tissue

Chemical	Overall		North		Middle		South		Representative Species
	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	Wildlife	Invertebrate	
Metals									
Mercury (Elemental)	>1	>10	>1	>10	>1	>10	#N/A	#N/A	zooplankton
Mercury (Total)	>1	>10	#N/A	#N/A	>1	>10	#N/A	#N/A	zooplankton
Methyl mercury	>1		#N/A	#N/A	>1		#N/A	#N/A	zooplankton
SVOCs (PAHs)									
Benzo(a)anthracene	>1		>1		>1		#N/A	#N/A	
Benzo(b)fluoranthene	>1		>1		>1		#N/A	#N/A	
Benzo(k)fluoranthene	>1		>1		>1		#N/A	#N/A	
Chrysene	>1		>1		>1		#N/A	#N/A	
Indeno[1,2,3-c,d]-pyrene	>1		>1		>1		#N/A	#N/A	
Total PAHs	**>100**	>1	**>100**	>1	**>100**	>1	#N/A	#N/A	*Mytilus*
HMW PAHs	**>100**	>1	**>100**	>1	>10	>1	#N/A	#N/A	*Mytilus*
LMW PAHs	-	>1	-	>1	-	>1	#N/A	#N/A	*Mytilus*
PCBs									
Aroclor 1254	>1		-		>1		#N/A	#N/A	
Total Aroclor	>10	>1	>1	-	>10	>1	#N/A	#N/A	*Palaemonetes*
Total PCBs	>1	>1	>1	-	>1	>1	#N/A	#N/A	*Palaemonetes*
Pesticides/Herbicides									
Total DDx	>1	**>100**	-	**>100**	>1	**>100**	#N/A	#N/A	*Hyalella*
Total Chlordane	-	>1	-	>1	-	>1	#N/A	#N/A	*Crassostrea*
TEQs (Database)									
DIOX_TEQ_BIRD	>1		-		>1		-		
DIOX_TEQ_MAMMAL	>1		-		>1		-		
PCB_TEQ_BIRD	>1		-		>1		#N/A	#N/A	
PCB_TEQ_MAMMAL	>1		-		>1		#N/A	#N/A	
TOTAL_TEQ_BIRD	>1		-		>1		-		
TOTAL_TEQ_MAMMAL	>1		-		>1		-		

Notes:
Refer to Tables G-1 through G-4 in Attachment G for the overall and the north, middle, and south regions, respectively.
Representative species for the invertebrate CBRs as summarized in Table 26 in Attachment C; the wildlife based benchmarks were calculated as described in Section 4.1.3. The wildlife-based benchmarks were developed to be protective of dietary exposures to invertebrate tissue by foraging wildlife.
Only chemicals detected in at least one sample at a maximum concentration exceeding a screening value are included.
#N/A - parameter not available/analyzed.
A dash indicates that the maximum parameter value used in the screening was less than the benchmark.
Bolded chemicals have HQs greater than 100 and/or 1000.

5.2.4 Fish Tissue

The results of the fish tissue risk characterization (Attachment H) are summarized in Table 10 and are discussed in the following sections.

Metals

Mercury and lead were the only inorganic compounds that had HQs greater than 1. Data for elemental mercury, methyl mercury, and total mercury were analyzed for the north and south regions; only data for elemental mercury were reported for the middle region. There were no data reported for lead in the south region. Lead exceeded the invertebrate CBR in the north and middle regions, with HQs greater than 1. The greatest exceedances for mercury occurred in the north with wildlife-based HQs ranging from greater than 1 to greater than 10 and fish-based HQs ranging from greater than 10 to greater than 100. In the south, the HQs for mercury

were lower, ranging from greater than 1 for the wildlife-based HQ and greater than 10 for the fish-based HQ. This was also the case for elemental mercury (the only species analyzed) in the middle region.

PAHs

Four individual detected PAHs, as well as the HMW PAHs and total PAHs, exceeded wildlife-based PCLs. All of the wildlife-based HQs were less than 10 for the individual PAHs. Total PAHs and HMW PAHs exceeded 1,000 in the north region; total PAHs exceeded 100 in the middle and south regions, while the HMW PAHs were slightly lower (HQ >10) in the middle and south regions. Fish-based HQs only exceeded 1 in the north region for the summed PAHs (HMW, LMW, and total PAHs).

PCBs

Four individual Aroclors (1016, 1242, 1248, and 1254) plus total Aroclors and total PCBs all had HQs greater than 1. The wildlife-based HQs for individual Aroclors were greater than 1 in the north; Aroclor 1254 was greater than 1 in both the middle and south and Aroclor 1016 was greater than 1 in the south. Total Aroclors and total PCBs had fish-based HQs greater than 100 and the wildlife-based HQs greater than 10 in all the regions.

Pesticides/Herbicides

Three individual pesticide/herbicide compounds (4,4'-DDD, 4,4'-DDE, and dieldrin) and four summed totals (total DDx, total endrin, total chlordane, total nonachlor) had HQs greater than 1. In all the regions, exceedances of the wildlife-based HQs were all less than 10. Three pesticides (total DDx, total chlordane, and total nonachlor) exceeded the fish CBR by 10 or more in all regions. Total endrin also exceeded the invertebrate CBR in all regions but had an HQ less than 10.

Dioxins

The wildlife-based HQs for PCB TEQs and total TEQs exceeded 10 in the north and south regions; HQs for dioxin/furan TEQs were less than 10 but greater than 1. The fish-based HQs for all TEQs exceeded 1 in all regions.

5.2.5 Bird Tissue

The results of the bird tissue risk characterization are provided in Attachment I. These tissue values represent egg data collected from the western edge of Shooters Island in the south region of the NBSA. HQs were derived for dioxin TEQs, PCB TEQs, and total TEQs based on the avian TEF values. The resulting HQs were 2.9 for the dioxin TEQ, 11 for the PCB TEQ, and 14 for the total TEQ. The PCBs represent the majority of the risk for this exposure medium.

Table 10. Summary of Hazard Quotients for Fish Tissue

Chemical	Overall		North		Middle		South		Representative Species
	Wildlife	Fish	Wildlife	Fish	Wildlife	Fish	Wildlife	Fish	
Metals									
Lead	-	>1	-	>1	-	>1	#N/A	#N/A	*Oncorhynchus*
Mercury (Elemental)	>1	>10	>1	>10	>1	>10	>1	>10	*Ictalurus*
Mercury (Total)	>10	**>100**	>10	**>100**	#N/A	#N/A	>1	>10	*Fundulus* (eggs)
Methyl mercury	>10	**>100**	>10	**>100**	#N/A	#N/A	>1	>10	*Fundulus* (eggs)
SVOCs (PAHs)									
Benzo(a)anthracene	>1		>1		>1		-		
Chrysene	>1		>1		>1		-		
Dibenz(a,h)anthracene	>1		#N/D	#N/D	-		#N/D	#N/D	
Indeno[1,2,3-c,d]-pyrene	>1		>1		>1		>1		
Total PAHs	**>1000**	>1	**>1000**	>1	**>100**	-	**>100**	-	*Psettichthys*
HMW PAHs	**>1000**	>1	**>1000**	>1	>10	-	>10	-	*Psettichthys*
LMW PAHs	-	>1	-	>1	-	-	-	-	*Psettichthys*
PCBs									
Aroclor 1016	>1		#N/A	#N/A	#N/A	#N/A	>1		
Aroclor 1242	>1		>1		-		-		
Aroclor 1248	>1		>1		-		-		
Aroclor 1254	>1		>1		>1		>1		
Total Aroclor	>10	**>100**	>10	**>100**	>10	**>100**	>10	**>100**	*Oryzias* (eggs)
Total PCBs	>10	**>100**	>10	**>100**	>10	**>100**	>10	**>100**	*Oryzias* (eggs)
Pesticides/Herbicides									
4,4'-DDD	>1		>1		-		>1		
4,4'-DDE	>1		>1		-		>1		
Total DDx	>1	**>1000**	>1	**>1000**	>1	**>100**	>1	**>1000**	*Salvelinus* (eggs)
Total Chlordane	>1	**>100**	>1	**>100**	-	>10	-	>10	*Cyprinodon*
Dieldrin	>1	>1	>1	>1	-	-	-	-	*Oncorhynchus*
Total Endrin	-	>1	-	>1	-	>1	-	>1	*Micropterus*
Total Nonachlor	-	**>1000**	-	>10	-	**>1000**	-	>10	*Cyprinodon*
TEQs (Database)									
DIOX_TEQ_BIRD	>1		>1		-		>1		
DIOX_TEQ_FISH		>1		>1		>1		>1	*Salvelinus* (eggs)
DIOX_TEQ_MAMMAL	>1		>1		>1		>1		
PCB_TEQ_BIRD	>10		>10		>1		>10		
PCB_TEQ_FISH		>1		>1		-		-	*Salvelinus* (eggs)
PCB_TEQ_MAMMAL	>10		>10		-		>10		
TOTAL_TEQ_BIRD	>10		>10		>1		>10		
TOTAL_TEQ_FISH		>1		>1		>1		>1	*Salvelinus* (eggs)
TOTAL_TEQ_MAMMAL	>10		>10		>1		>10		

Notes:
Refer to Tables H-1 through H-4 in Attachment H for the overall and the north, middle, and south regions, respectively.
Representative species for the fish CBRs as summarized in Table 26 in Attachment C; the wildlife based benchmarks were calculated as described in Section 4.1.3. The wildlife-based benchmarks were developed to be protective of dietary exposures to fish tissue by foraging wildlife.

Only chemicals detected in at least one sample at a maximum concentration exceeding a screening value are included.

#N/A - parameter not available/analyzed.

#N/D - parameter not detected.

A dash indicates that the maximum parameter value used in the screening was less than the benchmark.

Bolded chemicals have HQs greater than 100 and/or 1000.

6.0 UNCERTAINTY ANALYSIS

This section discusses major limitations of the SLERA evaluations and sources of uncertainties; it also assesses whether these uncertainties and limitations may have resulted in an over- or under-estimation of risk. Uncertainties associated with the selection of COPECs, exposure assessment, effects assessment, and overall risk characterizations are discussed.

6.1 Problem Formulation Uncertainties

6.1.1 Receptors

Section 2.5 summarizes available knowledge concerning the types of ecological receptors likely to occur within the NBSA. Several regional-scale surveys and various ongoing investigations of dredging-related activities within the NBSA have resulted in a good understanding of the nature, abundance, and seasonal variability of fish and benthic in- and epi-fauna (NOAA, 1994; USACE, 1987, 2003a, b, c; Adams *et al*., 1998; Adams and Benyi, 2003). The avian fauna, both residents and migrants, which may be exposed to NBSA contaminants, are also well-characterized, although the potential presence of several state-listed species warrants greater documentation. The frequency with which fish, reptile, and mammal species utilize these habitats is less understood. The NJ state-listed diamondback terrapin is known to occur regionally, and it is possible that sea turtles could enter the bay seasonally; however, none of this is well-studied or documented. Small piscivorous mammals can potentially receive maximum contaminant doses as a result of their foraging habitats and life-style. There is also the likelihood that the NBSA is occasionally visited by larger marine mammals (as evidenced by a dolphin sighting in the Passaic River). The significance of these exposures, when and if they occur, is an area of uncertainty that will need to be further evaluated.

Aquatic plant species were not considered specifically in this SLERA. The importance of plant species as a component of the forage base of the NBSA ecosystem and in providing subsurface structure is not well understood at this time. Further consideration is warranted to determine whether this receptor group should be the focus of additional assessments. This uncertainty is likely to result in an underestimate of risk.

6.1.2 Identification and Selection of COPECs

The use of conservative screening benchmarks that considered both invertebrate and wildlife protectiveness ensured that the screening process considered all relevant exposures. Concerns regarding the comparability of different sampling programs also resulted in the conservative retention of chemicals that were not reported as detected in the dataset. As a result, the risk may be overestimated.

6.2 Exposure Uncertainties

The major exposure-related uncertainties are associated with uncertainties in the available data, the selection of exposure parameters, using maximum concentrations as exposure concentrations, and estimation of bioaccumulation factors for various environmental media.

6.2.1 Uncertainties in the Available Data

A screening level risk assessment generally relies on the use of historical data to evaluate the potential for adverse effects from ecological exposures to contaminants. In some cases, available data are limited. For this SLERA, surface water data were limited, and spatially inadequate for the purposes of contaminant screening. Therefore, surface water data were not evaluated. The evaluation of the surface water medium in a BERA for Newark Bay will need to rely on additional analytical data that provide a comprehensive understanding of spatial and temporal patterns of all contaminants present in bay waters.

Additional data collected for a BERA will also need to be based on carefully selected Data Quality Objectives. These DQOs should consider effects concentrations to ensure that analytical method detection limits (MDLs) are sensitive enough to detect contaminants at ecologically significant levels. DQOs for the historical data used for the SLERA are uncertain. Therefore, even COPECs with few or no detections were retained for further evaluation if no screening benchmark was identified or if one-half the MDLs exceeded the benchmark. If no screening benchmark is identified, additional laboratory analyses will use the minimum possible MDLs.

The BERA will also need to evaluate porewater exposures as well. Porewater evaluations provide important information on the bioavailable fraction of contaminants in sediments. Some sediment contamination may partition to porewater, while some may be unavailable for uptake because it is bound to sediment particles.

As mentioned in Section 4.2, in some cases, the project database did not have sufficient information to determine whether analytical data from different programs were directly comparable or not. In particular, the reporting basis (*i.e.*, dry weight versus wet weight) and specific chemical method fields were not populated for some sediment and tissue records. Sediment concentrations are usually presented as dry weight while tissue concentrations are presented as wet weight. If sediment data were wet weight, it is possible that risks may be underestimated. Conversely, if tissue data were presented as dry weight, it is possible that risks may be overestimated. If these data are selected for use in the BERA, the original sampling reports should be obtained and reviewed.

6.2.2 Exposure Parameters

The relationship between receptor size and dietary intake is a critical factor in estimating exposure. In addition, dietary composition affects exposure because different food sources contain varying levels of COPECs. Although literature exists for dose calculation inputs such as body weight, ingestion rate, and dietary composition for each receptor evaluated, natural populations may exhibit considerable variability in these parameters. Use of literature-derived exposure parameters increases uncertainty, which could result in an over- or under-estimation of the typical exposures encountered by receptors in the NBSA. The wildlife exposure models were parameterized using available information for adult females for each selected receptor species, and average values were selected for the parameter values where a range of data was provided.

6.2.3 Exposure Concentrations

Consistent with USEPA guidance, maximum detected concentrations of contaminants are used as the exposure point concentrations for risk estimates at the screening level. It is also assumed that concentrations detected in environmental media are 100% available to the exposed receptors. These assumptions are made to ensure that potential risks are not overlooked if the available data are limited. However, average realistic exposure concentrations are likely to be less than the maximum detected concentration in any historical dataset, and it is also likely that are fraction of contaminants is bound to sediment particles and unavailable for uptake by ecological receptors. Therefore, these assumptions likely provide an overestimate of risk.

6.2.4 Contaminant Distribution with Sediment Depth

Consistent with recent information concerning the depth of the BAZ in the NBSA (Tierra, 2005), the evaluation of NBSA sediment analytical data was limited to samples collected from the top 6-inches of sediment only. Some mollusks and segmented worms are known to occur deeper in bed sediments and could be exposed to different contaminants or concentrations. Exposure to deeper sediments may also periodically occur following extreme weather events. Ongoing analysis of sediment core data, along with a better understanding of the benthic ecology and of the hydrodynamic processes within the NBSA, may be necessary to evaluate ecological exposures to deeper strata in subsequent analyses.

The heterogeneous distribution of the sediment contaminants noted in Section 3.2.3 warrants further investigation of the specific exposure concentrations and uptake potential in each geomorphic unit. Where necessary, these exposures will be further refined in the BERA.

6.2.5 Bioaccumulation Factors

Although tissue residue data are available for the NBSA, literature-derived bioaccumulation factors (BAFs) were employed to estimate PCLs. This was necessary due to the absence of consistent tissue datasets for the various receptors and chemicals evaluated. However, no attempt was made to account for the relative importance of carbon and lipid fractions in determining the potential for contaminant uptake of highly hydrophobic organic contaminants in the system. For future risk assessments, it will be necessary to derive site-specific estimates of bioavailability and bioaccumulation in the BERA to reduce the uncertainties associated with using literature-derived uptake factors. Bioaccumulation factors employed in the SLERA were selected to provide conservative estimates of uptake potential and this could have resulted in the unnecessary retention of some chemicals. Therefore, it is likely that risk was overestimated.

6.3 Ecological Effects Uncertainties

The primary effects-related uncertainties are associated with the selection of screening benchmarks and CBRs.

6.3.1 Screening Benchmarks

There are potential uncertainties related to the appropriateness of literature-derived toxicity data. The screening benchmarks used in the SLERA were based on readily available compilations of values from literature sources and have been used in similar screening-level analyses conducted for the NBSA and the Passaic River (Battelle 2006; 2007). Although these compiled values are useful tools in conducting screening analyses, information for some of the COPECs may either be out of date or not necessarily conservative enough (for instance, the TRVs for TCDD have changed).

Chronic toxicological data were selected preferentially in developing screening benchmarks. Chronic NOAELs were the preferred toxicity endpoint for selection of screening benchmarks; however, ecological toxicity data were limited for some COPECs. Therefore, other endpoints (*e.g.*, subchronic NOAELs, or LC_{50} values[2]) were selected for use as benchmarks. When an endpoint other than a chronic NOAEL was selected as a benchmark, an uncertainty factor was applied to the reported value to provide an additional level of conservatism in the risk estimation process. The use of conservative uncertainty factors may result in hazards and risks being over-estimated.

Little or no toxicological data are available for some COPECs. For instance, no avian effects data were available for many of the analyzed parameters, and no information was available to establish CBRs for some of the analytes analyzed for in biota tissue. This resulted in a significant number of chemicals being retained as potential COPECs, although it is unclear whether they do in fact pose an ecological risk.

In general, uncertainty is also associated with the extrapolation of literature-derived toxicity endpoints (especially laboratory-based studies) to equivalent endpoints for measurement endpoint receptors at the site because of differences in exposure conditions. The majority of the toxicity data evaluated and used in the SLERA were derived from laboratory studies. Homogeneous laboratory conditions result in different exposures than experienced by receptors in the environment. Although controlled experiments result in a more valid interpretation of the isolated parameters, uncertainty is associated with the assumption that laboratory exposure conditions are relevant to establishing protective media concentrations under field exposures.

[2] LC_{50} value is the value at which a chemical is lethal to 50% of the organisms tested.

6.3.2 Critical Body Residues

CBRs were generally based on either the lowest bounded or unbounded tissue concentration associated with significant effects on growth, survival, or mortality; in the case of an unbounded LOAEL, a 10 fold extrapolation factor was applied to estimate a NOAEL (Battelle, 2006). The geometric mean (MATC) was calculated for each NOAEL/LOAEL pair and employed in the SLERA to screen tissue concentration data. This is a conservative approach because the CBRs were based on the lowest reported tissue effect concentration for the most sensitive species. However, greater uncertainty regarding the degree of conservatism exists for some COPECs, such as PAHs and dieldrin, for which few residue effect data exists (Battelle, 2006).

6.3.3 Dioxin and Furan Congeners

Wildlife exposures to dioxin and furan congeners were estimated using TRVs similar to those recommended by USEPA (1993) and the consensus-based TEFs from Van den Berg *et al*. (1998; 2005). This approach represents the most recent risk assessment approach for evaluating dioxins and furans. This approach has been employed because there is not adequate toxicity testing for each of the hundreds of dioxin and furan congeners. Although the use of TEFs has a sound scientific basis, there is some uncertainty (including assumption of additivity and methods used to determine relative potency) associated with their use in estimating the ecological effects from exposure to dioxin-like compounds.

The TEQ approach also does not account for toxicity of dioxin/furan and PCB congeners that have a non-AhR-mediated toxicological mechanism[3]. However, risk associated with exposure to compounds that exhibit non-dioxin-like effects was separately considered using toxicological data for PCB mixtures.

[3] The aryl hydrocarbon receptor (AhR) is a protein found in the cytoplasm of somatic cell tissues. The binding of dioxin-like compounds to this receptor has been shown to be the first critical step in expression of toxicological responses in mammals, birds, and fish.

7.0 SLERA CONCLUSIONS AND RECOMMENDATIONS

This SLERA demonstrates that a substantial majority of chemical parameters analyzed to date in relevant environmental media for the NBSA ought to be retained as potential COPECs for further evaluation in a BERA. The COPECs identified for each ecological exposure medium are summarized in Table 12. Moreover, the magnitude by which readily available screening benchmarks were exceeded by contaminants with known ecotoxicological hazards (in some cases, by well over three orders of magnitude) indicates that the potential exists for unacceptable ecological risks to occur within the NBSA. Consequently, a more detailed and site-specific analysis of ecological exposures and potential effects within Newark Bay is warranted to better characterize the risks and identify the relative importance that chemical stressors have for imposing long-term threats to biological populations using this resource.

Given the complexity and spatial scale of this environment, considerable additional information will be necessary to develop more realistic estimates of ecological exposure and effects. It is recommended that planning efforts continue to proceed through USEPA's eight-step ecological risk assessment process so that information necessary to conduct the BERA will be available in a timely fashion.

Table 11. Summary of COPECs for Each Ecological Exposure Medium

Chemical	Sediment	Benthic Invertebrates	Fish	Mollusk	Crab	Avian Embryo
Metals						
Antimony	✓					
Arsenic	✓	✓		✓		
Cadmium	✓	✓		✓		✓
Chromium	✓	✓		✓		
Copper	✓	✓		✓		
Iron	✓					
Lead	✓	✓	✓	✓		
Manganese	✓					
Mercury	✓					
Mercury (Elemental)		✓	✓	✓	✓	✓
Mercury (Total)			✓	✓	✓	✓
Methyl mercury			✓		✓	✓
Nickel	✓	✓		✓		
Selenium	✓					
Silver	✓	✓		✓		
Zinc	✓	✓		✓		
VOCs						
Ethylbenzene	✓					
SVOCs (Non-PAHs)						
1,2,4-Trichlorobenzene	✓					
1,3-Dichlorobenzene	✓					
1,4-Dichlorobenzene	✓					
Bis(2-ethylhexyl)phthalate	✓					
SVOCs (PAHs)						
1-Methylnaphthalene						✓
1-Methylphenanthrene						✓

Table 11. Summary of COPECs for Each Ecological Exposure Medium, continued

Chemical	Sediment	Benthic Invertebrates	Fish	Mollusk	Crab	Avian Embryo
2,3,5-Trimethylnaphthalene						✓
2,6-Dimethylnaphthalene						✓
2-Methylnaphthalene	✓					✓
Acenaphthene	✓					✓
Acenaphthylene	✓					✓
Anthracene	✓					✓
Benzo(a)anthracene	✓	✓	✓	✓	✓	✓
Benzo(a)pyrene	✓	✓		✓		✓
Benzo(b)fluoranthene	✓	✓		✓	✓	
Benzo(g,h,i)perylene	✓					✓
Benzo(k)fluoranthene	✓	✓		✓	✓	
Benzo[e]pyrene						✓
Benzofluoranthenes, total	✓					
Biphenyl						✓
Chrysene	✓	✓	✓	✓	✓	✓
Dibenz(a,h)anthracene	✓	✓	✓	✓		✓
Fluoranthene	✓					✓
Fluorene	✓					✓
Indeno[1,2,3-c,d]-pyrene	✓	✓	✓	✓	✓	✓
Naphthalene	✓					✓
Perylene						✓
Phenanthrene	✓					✓
Pyrene	✓					✓
Total PAHs	✓	✓	✓	✓	✓	✓
High MW PAHs	✓	✓	✓	✓	✓	✓
Low MW PAHs	✓	✓	✓	✓	✓	✓
PCBs						
Aroclor 1016			✓			
Aroclor 1242	✓		✓			✓
Aroclor 1248	✓		✓			✓
Aroclor 1254	✓		✓	✓	✓	✓
Aroclor 1260	✓					✓
PCB 18CONGX2	✓					✓
Total Aroclor	✓		✓	✓	✓	✓
Total PCBs	✓	✓	✓	✓	✓	✓
Pesticides/Herbicides						
2,4'-DDD	✓	✓				✓
2,4'-DDE	✓			✓		✓
2,4'-DDT	✓					✓
4,4'-DDD	✓	✓	✓	✓		✓
4,4'-DDE	✓	✓	✓	✓		✓
4,4'-DDT	✓	✓				✓
Total DDx	✓	✓	✓	✓	✓	✓
Aldrin	✓	✓		✓		✓

Table 11. Summary of COPECs for Each Ecological Exposure Medium, continued

Chemical	Sediment	Benthic Invertebrates	Fish	Mollusk	Crab	Avian Embryo
alpha-BHC	✓					✓
beta-BHC	✓					✓
delta-BHC	✓					✓
gamma-BHC (Lindane)	✓					✓
Total BHC	✓					✓
Chlordane	✓					✓
Chlordane,alpha (cis)	✓					✓
Chlordane,gamma (trans)	✓					✓
Chlordane, oxy	✓					✓
Total chlordane	✓	✓	✓	✓	✓	✓
Dieldrin	✓	✓	✓	✓		✓
Endrin	✓					✓
Endrin aldehyde						✓
Endrin ketone						✓
Total endrin	✓		✓			✓
Endosulfan sulfate						✓
Endosulfan, alpha						✓
Endosulfan, beta						✓
Total endosulfan	✓	✓		✓		✓
Heptachlor	✓					✓
Heptachlor epoxide	✓					✓
Total heptachlor	✓					✓
Hexachlorobenzene	✓					✓
Methoxychlor	✓					✓
Mirex						✓
Nonachlor, cis-						✓
Nonachlor, trans-						✓
Total Nonachlor			✓			✓
TEQs						
2,3,7,8-TCDD	✓					✓
DIOX_TEQ_BIRD		✓	✓		✓	✓
DIOX_TEQ_FISH			✓	✓	✓	✓
DIOX_TEQ_MAMMAL		✓	✓		✓	✓
PCB_TEQ_BIRD			✓	✓	✓	✓
PCB_TEQ_FISH			✓	✓	✓	✓
PCB_TEQ_MAMMAL			✓	✓	✓	✓
TOTAL_TEQ_BIRD		✓	✓	✓	✓	✓
TOTAL_TEQ_FISH			✓	✓	✓	✓
TOTAL_TEQ_MAMMAL	·	✓	✓	✓	✓	✓

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ATTACHMENT 2

Problem Formulation for the Newark Bay Study Area (Tierra 2013a)

FINAL

Newark Bay Study Area
Problem Formulation

Baseline Human Health and
Ecological Risk Assessment

Tierra Solutions, Inc.

East Brunswick, New Jersey

June 2013

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Acronyms and Abbreviations

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
2,3,7,8-TCDF	2,3,7,8-tetrachlorodibenzofuran
AOC	Administrative Order on Consent
AE	assessment endpoint
ATSDR	Agency for Toxic Substances & Disease Registry
AVS	acid volatile sulfides
BAZ	biologically active zone
BEHP	bis(2-ethylhexyl)phthalate
BERA	Baseline Ecological Risk Assessment
BHHERA	Baseline Human Health and Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BSAF	biota-sediment accumulation factor
CARP	Contaminant Assessment and Reduction Project
CBR	critical body residue
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
cm	centimeter(s)
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CPG	Cooperating Parties Group
CSM	conceptual site model
CSO	combined sewer overflow
DDT	dichlorodiphenyltrichloroethane
dioxin	polychlorinated dibenzo-*p*-dioxin (PCDD)
DO	dissolved oxygen
DRA	deterministic risk assessment
EFH	essential fish habitat

ERA	ecological risk assessment
ft	foot/feet
ft/sec	feet per second
furan	polychlorinated dibenzofuran (PCDF)
g/day	gram per day
HDP	Harbor Deepening Project
HHRA	Human Health Risk Assessment
HMW	high-molecular-weight
LMW	low-molecular-weight
LPRRP	Lower Passaic River Restoration Project
m	meter(s)
m/sec	meters per second
ME	measurement endpoint
MLW	mean low water
NBSA	Newark Bay Study Area
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
NOAA	National Oceanic and Atmospheric Administration
NYAS	New York Academy of Sciences
NY/NJ	New York/New Jersey
NYSDEC	New York State Department of Environmental Conservation
OEHHA	Office of Environmental Health Hazard Agency
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PANYNJ	Port Authority of New York and New Jersey
PAR	Pathways Analysis Report
PBB	polybrominated biphenyl
PBDD	polybrominated dibenzo-*p*-dioxin
PBDE	polybrominated diphenyl ether

PBDF	polybrominated dibenzofuran
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-*p*-dioxin (dioxin)
PCDF	polychlorinated dibenzofuran (furan)
PCN	polychlorinated naphthalene
PRA	probabilistic risk assessment
PSE&G	Public Service Electric and Gas Company
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
redox	reduction-oxidation potential
REMAP	Regional Environmental Monitoring and Assessment Program
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIWP	Remedial Investigation Work Plan
SAP	Sampling and Analysis Plan
SEM	simultaneously extracted metals
SI	Sediment Investigation
SLERA	Screening-Level Ecological Risk Assessment
SVOC	semivolatile organic compound
TEF	toxic equivalency factor
Tierra	Tierra Solutions, Inc.
TOC	total organic carbon
TRV	toxicity reference value
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
WHO	World Health Organization
Windward	Windward Environmental, LLC

1. Introduction

Pursuant to the Statement of Work appended to the Administrative Order on Consent (AOC) for the Remedial Investigation and Feasibility Study (RI/FS), Newark Bay Study Area (NBSA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Index No. 02-2004-2010 (U.S. Environmental Protection Agency [USEPA] 2004), one of the goals of the RI/FS is to "Determine the primary human and ecological receptors (endpoints) of PCDDs, PCDFs, PCBs, PAHs, pesticides, and metals contaminated sediments in the NBSA." To accomplish this goal, baseline human health and ecological risk assessments will be conducted in the NBSA, which is identified as Newark Bay (the Bay) and portions of the Hackensack River, Kill van Kull, and Arthur Kill (USEPA 2004a). A regional map showing the NBSA is provided as Figure 1-1.

As part of the risk assessment process, this Problem Formulation was prepared by Tierra Solutions, Inc. (Tierra) on behalf of Occidental Chemical Corporation (the successor to Diamond Shamrock Chemicals Company [formerly known as Diamond Alkali Company]) to establish the overall goals, breadth, and focus of the baseline ecological and human health risk assessments and to define the questions that need to be addressed during these evaluations. This report documents issues that need to be addressed in the human and ecological risk assessments for the NBSA, which are based on the potentially complete exposure pathways and effects identified as part of the conceptual site model (CSM) (Tierra 2011) and decisions that were made during the Baseline Human Health and Ecological Risk Assessment (BHHERA) Workshop held in June 2011 as documented in the BHHERA Workshop Meeting Minutes dated December 1, 2011.

This Problem Formulation was prepared in accordance with guidance from the following USEPA sources, as well as the human health risk assessment (HHRA) guidance documents listed in Section 2.1:

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Interim Final. EPA/540/R-97/OCS. (USEPA 1997a)

- *Considerations for Developing Problem Formulations for Ecological Risk Assessments Conducted at Contaminated Sites under CERCLA: A Discussion Paper*. Prepared for M. Greenberg, Environmental Response Team, USEPA (MacDonald Environmental Sciences Ltd. and Cantox Environmental, Inc. 2004)

Although a problem formulation is not typically performed as part of the HHRA, it is included in this document to provide consistency between the human and ecological risk assessments and to define a roadmap for the implementation of the Baseline Human Health Risk Assessment (BHHRA). For the human health evaluation, the problem formulation primarily describes the CSM, including exposure pathways, potentially exposed populations, available data, and data needs. The *Newark Bay Study Area Pathways Analysis Report* (PAR, USEPA 2006a) will be updated and submitted for USEPA review and approval prior to the development of the BHHRA.

1.1 Summary of Risk Assessment Guidance

1.1.1 Ecological Risk Assessment

The USEPA eight-step Superfund ecological risk assessment process (ERA) (USEPA 1997a) is shown on Figure 1-2. Step 1 (Screening-Level Problem Formulation and Ecological Effects Evaluation) and Step 2 (Screening-Level Exposure Estimate and Risk Calculation) were completed in the NBSA PAR (USEPA 2006a) and *Screening-Level Ecological Risk Assessment* (SLERA) *for the Newark Bay Study Area* (USEPA 2008a), respectively. The results of the SLERA demonstrate that a Baseline Ecological Risk Assessment (BERA), encompassing Steps 3 through 8, is required for the NBSA. In addition, the SLERA contains a compilation of substantial ecological data and information to help guide the BERA process.

The ecological risk sections of this document represent Step 3 (Problem Formulation) of the eight-step ERA process. Specific objectives of Step 3 per USEPA (1997a) are to:

- Refine preliminary constituents of potential ecological concern (COPECs)
- Further characterize ecological effects of COPECs
- Review and refine information on COPEC fate and transport, complete exposure pathways, and ecosystems potentially at risk
- Select assessment endpoints (AEs)
- Develop a CSM with working hypotheses or questions that the site investigation will address

Steps 4 and 5 of the ERA process, which encompass the overall study design and field sampling, are anticipated to be driven by the information contained within this document. Finally, results from Step 6 (Analysis) and Step 7 (Ecological Characterization) will be presented in the BERA report. Results of the BERA will be used to manage ecological risks in the NBSA by informing the remedial action decision-making process (Step 8).

1.1.2 Human Health Risk Assessment

A BHHRA will be conducted for the NBSA pursuant to USEPA's Risk Assessment Guidance for Superfund (RAGS) Human Health Evaluation Manual, Volume I, Parts A through F (USEPA 1989, 1991a, 1991b, 2001a, 2007a, 2009a). Other guidance documents that will be used include, but are not limited to the following (available from www.epa.gov/risk/ and www.epa.gov/oswer/riskassessment/risk_superfund.htm):

- Guidelines for Carcinogen Risk Assessment (USEPA 2005a)
- Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA 2005b)
- Recommended Toxicity Equivalence Factors for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin and Dioxin-Like Compounds (USEPA 2010a)
- Exposure Factors Handbook (USEPA 2011a)
- Child-Specific Exposure Factors Handbook. (USEPA 2008b)
- Highlights of the Child-Specific Exposure Factors Handbook (USEPA 2009b)
- A Framework for Assessing Health Risks of Environmental Exposures to Children (USEPA 2006b)
- Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (USEPA 2005c)
- Soil Screening Guidance (USEPA 1996a,1996b, 2002a)

- Guidance for Conducting Health Risk Assessment of Chemical Mixtures (USEPA 2000a, 1986)
- Guidelines for Exposure Assessment (USEPA 1992a)
- Guidance for Data Usability in Risk Assessment (USEPA 1992b)
- Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites.(USEPA 2002b)
- Supplemental Guidance to RAGS: Calculating the Concentration Term (USEPA 1992c)
- Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA 2002c)
- Land Use in the CERCLA Remedy Selection Process. (USEPA 1995a)
- Role of Background in the CERCLA Cleanup Program (USEPA 2002d)
- Framework for Metals Risk Assessment (USEPA 2007b)
- Polychlorinated biphenyl (PCB) Guidance (USEPA 1996c)
- Polycyclic aromatic hydrocarbon (PAH) Guidance (USEPA 1993a)

Consistent with USEPA guidance (USEPA 1995b, USEPA 2000a), assessments will be conducted for both reasonable maximum exposure and central tendency exposure. The BHHRA will be conducted following an approach designed to support risk management decision-making by initially defining the constituents of potential concern (COPCs) for each medium, based on existing and new data collected during the Remedial Investigation (RI), and using this information to prioritize areas requiring further assessment. The Interim CSM (Tierra 2011) will be updated, as appropriate, and COPCs will be identified using the approach previously approved by USEPA for the Lower Passaic River Restoration Project (LPRRP) (Windward Environmental, LLC [Windward] 2012). Once the updated CSM is reviewed and approved by USEPA, RAGS Part D Tables 1 through 6 will be prepared for review and approval. Following

approval, risk assessment calculations will be conducted in a deterministic risk assessment (DRA).

Depending on the results of the DRA, a probabilistic risk assessment (PRA), consistent with RAGS Volume III Part A Process for Conducting Probabilistic Risk Assessment (USEPA 2001b), Policy for Use of Probabilistic Analysis in Risk Assessment (USEPA 1997b), and Guiding Principles for Monte Carlo Analysis (USEPA 1997c) may be proposed for refining human health risk and hazard estimates in the NBSA. The PRA may also be used to determine risk-based remediation goals. Use of PRA techniques will follow USEPA guidelines (USEPA 2001b, USEPA 1997b, 1997c) and will be conducted with USEPA oversight of all input parameter distributions and modeling approaches. If a PRA is conducted, it will be performed after the work plan is submitted to, and approved by, USEPA. Toxicity factors would not be varied in the PRA, but distributions of exposure point concentrations, toxic equivalency factors for dioxins and dioxin-like compounds, and selected exposure factors would be applied. The goal of the PRA would be to provide more information regarding the range and distribution of risks associated with site contaminants to inform remedial decisions.

1.2 Report Organization

This Problem Formulation is organized into the following sections:

- Section 2: Environmental History and Setting of the NBSA – Provides a concise summary of the site in terms of historical, industrial, and physical setting.

- Section 3: Data Summary – Provides a description of the available qualitative and quantitative data that are currently available for the risk assessments.

- Section 4: Baseline Ecological Risk Assessment – Presents the ecological CSM, including receptors and exposure pathways; discusses assessment and candidate measurement endpoints (MEs) and data needs for the BERA.

- Section 5: Baseline Human Health Risk Assessment – Presents the human health CSM, including receptors and exposure pathways, and data needs for the BHHRA.

- Section 6: Next Steps – Outlines future steps in the risk assessment process that will be conducted following approval of the Problem Formulation.

- Section 7: References – Provides a list of cited literature.

2. Environmental History and Setting of the NBSA

Newark Bay is situated between the cities of Newark and Elizabeth and is bordered by Newark Liberty International Airport to the west, Jersey City and Bayonne to the east, and Staten Island, New York to the south (Figure 2-1). The Passaic and Hackensack Rivers empty into Newark Bay in the north. Two tidal straits in the southern portion of the NBSA, Kill van Kull and Arthur Kill, connect the Bay to Upper New York Harbor and Raritan Bay, respectively. Other tributaries with their confluences in the NBSA include the Elizabeth River, Peripheral Ditch, and Piersons Creek.

2.1 History

As part of the New York/New Jersey (NY/NJ) Harbor Estuary, Newark Bay has evolved into a key shipping port and ideal setting for myriad industries for over two centuries (Brydon 1974; Cunningham 1954, 1966a, 1966b; Meyers 1945). The NBSA is home to major cargo ports, an international airport, numerous industrial properties, and has several bridge crossings for automobile and rail travel between New Jersey and New York. The history of the NBSA is a key factor in understanding the current conditions of the site. As population, industry, and commerce grew during the 1800s and 1900s, significant expansion and development of the NBSA occurred. An historical timeline of major development activities in the NBSA is presented on Figure 2-2.

Situated at the center of one of the most urbanized and industrialized areas in the United States, the NBSA has been subjected to environmental degradation over the past two centuries due to a variety of factors: shoreline and land development (U.S. Army Corps of Engineers [USACE] 2006a), wetlands destruction, habitat degradation, garbage and sewage disposal, and releases of hazardous substances (Iannuzzi et al. 2002). As a result of such practices, the NBSA is known to contain a number of chemical constituents, including but not limited to, PCBs, PAHs, pesticides, herbicides, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated dibenzo-*p*-dioxins (PCDDs, or dioxins), polychlorinated dibenzofurans (PCDFs, or furans), and metals (National Oceanic and Atmospheric Administration [NOAA] 1995; USEPA 1998). These constituents originate from a variety of sources throughout the Newark Bay area (Bonnevie et al. 1994; Crawford et al. 1994, 1995; Gillis et al. 1993, 1995; Gunster et al. 1993a, 1993b; Huntley et al. 1995; Iannuzzi et al. 1995). Industries such as metal refineries, dye manufacturers, tanneries, lumber processors, petroleum processors, chemical manufacturers, and ship builders have produced products using hazardous chemicals that have been discharged into Newark Bay or its tributaries (Iannuzzi et al. 2002). The following paragraphs describe some of the specific sources.

Various waterfront industries have a history of documented discharges to the Lower Passaic River, Newark Bay, and its tributaries. Along the Lower Passaic River, historical discharges of chemicals (primarily dioxins) have occurred from the Diamond Alkali Superfund Site. From 1951 to 1969 the Diamond Alkali Company manufactured chemicals, herbicides, and pesticides (including Agent Orange), of which 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is a byproduct. After hazardous substances were detected at the facility, the USEPA placed the Diamond Alkali Site on the National Priorities List in 1984 (USEPA 1984, 1993b, 2012a).

The entire waterfront area of the Lower Passaic is significantly industrialized, including several other historical operations associated with dioxins, as well as PCBs, PAHs and other chemicals. For instance, the Sherwin-Williams site, adjacent to the Diamond Alkali site, has also been characterized and shown to be similarly contaminated with significant levels of dioxins and other chemicals (Roy F. Weston 2001; Weston Solutions, Inc. 2005, 2008). Present-day and historical discharges from the Bayonne Barrel and Drum Site in Newark have also been documented. This site has been extensively characterized and shown to be contaminated with dioxins, PCBs, metals, and other chemicals (New Jersey Department of Environmental Protection [NJDEP] 1988, 2008; USEPA 2000b, 2004b; Louis Berger & Associates 1986; New York Academy of Sciences [NYAS] 2006).

Documented historical discharges from sites along the south and west lower three miles of the Passaic River, from the vicinity of the Diamond Alkali Site to the river's confluence with Newark Bay, include (but are not limited to) the following: Sherwin-Williams, Chris-Craft (Montrose Chemical site), Hilton-Davis/Thomasett, Benjamin Moore, Atlas Refining, Inc., Fairmount Chemical Company, Essex County Resource Recovery Facility (American Ref-Fuel), Public Service Electric and Gas Company (PSE&G; Essex Generating Station), Newark Boxboard Company, Chemical Leaman Tank Lines (Quala Systems), Getty Newark Terminal (Chevron), Sun Chemical Corporation (Foundry Street), Ashland Chemical, Pitt Consol (Reilly), Alliance Chemical, Elan Chemical Company, Essex Chemical Company, Celanese Chemical Company, Revere Smelting and Refining Co., Reichhold Chemicals (Spencer Kellogg), Vulcan Materials Company (Safety Kleen), and Atlantic Richfield. Documented historical discharges from sites located on the opposite side of the Passaic River have also occurred from the following facilities: Monsanto, SpectraServ, Inc., Alcan Aluminum, Lucent Technologies (Western Electric), and BASF Corp. Some of the more well-documented dischargers (based upon available public information) are documented in Table 2-1.

Along the northern and central portions of Newark Bay, historical and present-day discharges of dioxins and other chemicals have occurred from a number of sites in Newark, Kearny, Jersey City, and Bayonne, including, but not limited to, the following: Central Steel Drum, Prentiss Drug and Chemical Company, Troy Chemical Corporation, Engelhard Corporation, BP Marine Americas, Koppers Inc., Standard Chlorine, PJP Landfill, PSE&G sites, Columbia Terminals, Alpha Metals Inc., Mallinckrodt (MI Holdings), Honeywell, and Pharma Chem (Plant #1 facility). Again, based on publically available records, Table 2-1 highlights those sites that have documented discharges to Newark Bay. Along the southern portions of Newark Bay, historical and present-day discharges of dioxins and other chemicals have occurred from a number of sites in Elizabeth, Linden, Bayonne, and Staten Island, NY. For example, in Elizabeth, discharges occurred to the southern areas of Newark Bay from the Kapkowski Landfill, Allied Signal, Central Railroad/Conrail Site, Nuodex, and Singer Company. Also in Elizabeth, discharges have occurred to the Elizabeth River and Arthur Kill from Elizabethtown Gas Company, Borne Chemical Company, Phelps Dodge, Reichhold Chemicals, Iron Oxide, Apex Chemical Company, and Thomas & Betts Corp.

In Linden, discharges have occurred to the Arthur Kill from the Exxon-Mobil Bayway facility, DuPont, GAF Chemicals Corporation, and American Cyanamid/Cytec. Discharges from Bayonne occurred to the southern areas of Newark Bay from EFKA Plastics (Electric Boat), Texaco, and General Cable. Also in Bayonne, discharges occurred to the Kill van Kull from Pharma Chem (Plant # 2 facility), Dow Chemical, Standard Tank Cleaning, White Chemical, Bayonne Industries, International-Matex Tank Terminal-Bayonne, Exxon-Mobil, and Powell Duffryn. Finally, in Staten Island, discharges occurred to Newark Bay from Procter & Gamble. Table 2-1 provides additional information on those sites located in southern Newark Bay that have well documented evidence of discharge.

Additionally, garbage, sewage, and contaminants have also been released into the waters of the NBSA, adjoining tributaries, and tidal straits through dumping, storm sewers, and combined sewer overflows (CSOs) (Crawford et al. 1994; Gunster et al. 1993b). These include discharges from combined sewer districts that occurred prior to the construction of sewage treatment plants and consisted of the continuous discharge of industrial waste from these outfalls. These releases occurred in Newark, Jersey City, Bayonne, Elizabeth, and Staten Island, NY. Extensive shipping traffic in Newark Bay, as well as pipeline and facility operations, have resulted in numerous oil and chemical spills, also leading to contamination of NBSA sediments.

In addition to contamination of the NBSA, development of the shoreline has led to the destruction of wetlands and a sharp decline in habitats for plants and animals (Iannuzzi et al. 2002). Between 1891 and 1934, a series of navigation channels were constructed by the federal government. In addition, a marine terminal at Port Newark was constructed by the City of Newark and Newark Liberty International Airport opened in 1927. In 1948, the Port Authority of New York and New Jersey (PANYNJ) assumed management of the airport, and the shoreline was filled for expansion activities beginning in the late 1940s through 1970 (PANYNJ 2012a). Development of the Newark Liberty International Airport led to the construction of the Peripheral Ditch, which receives and transports stormwater runoff into the NBSA. Construction of the Port Elizabeth Marine Terminal began in 1958, which also significantly changed the shoreline (PANYNJ 2012a).

Dredging was first initiated in the Newark Bay area in 1874 to accommodate deep-draft vessels (USACE 2007a). Large quantities of dredged material removed during Newark Bay development activities were used as fill for large stretches of Newark Bay's shoreline to facilitate industrial, residential, and recreational development. Over time, several major metropolitan areas were built along the shores. With increases in technological advancements, industry, and trading, the need for transportation into and around Newark Bay grew. In-filling portions of Newark Bay for new construction was not only a necessary practice, but became commonplace. In addition to the growth of port and vessel traffic, various bridges were also built for interstate automobile and train traffic.

2.2 Physical Setting

Tributaries to the NBSA are shown on Figures 1-1 and 2-1. Newark Bay is hydrodynamically influenced by three major forces: tributary flows from the Passaic and Hackensack Rivers and the Kills, astronomical tides, as well as local and regional meteorological events (Herrington et al. 2002; Wakeman 2006). Each of these forces is described in more detail in this section. In addition, Newark Bay's geographic and geomorphic areas are described in Sections 2.2.1 and 2.2.2, respectively.

2.2.1 Geographic Areas

The NBSA has been subdivided by geographic area, as presented on Figure 2-3. The major geographic areas, from north to south, are:

- Passaic River

- Hackensack River
- Newark Bay North
- Newark Bay Central
- Port Channels
- Newark Bay South
- Kill van Kull
- Arthur Kill

The SLERA focused on the three major geographic areas that form Newark Bay proper – Newark Bay North, Central, and South. In addition, a full site-wide evaluation that incorporated all geographic areas was conducted in the SLERA (USEPA 2008a).

As discussed above, the Passaic River is being addressed under separate AOCs that include investigation and clean-up of the lower 17 miles of the river. Contaminated sites along the Hackensack River and the Kills are also being addressed under separate regulatory programs.

The baseline risk assessments will focus on geomorphic areas, habitat types, and area usage of selected receptors. The geomorphic area and habitat discussions are presented below in Sections 2.2.2 and 3.1.1, respectively. Geographic areas of the Bay are important in terms of nature and extent of contamination. Detailed discussions are provided in other RI documents (e.g., Tierra 2008a, 2009, 2011, 2013).

2.2.2 Geomorphic Areas

The NBSA was grouped into seven distinct geomorphic areas based on comparable bathymetry and slopes, hydrodynamic conditions, and historical influences (Figure 2-4). The boundaries/shapes of these areas have evolved with the development of information presented in prior reports (Tierra 2005, 2007, 2011):

· Historically Disturbed Subtidal Flats

· Industrial Waterfront Area

- Intertidal Areas
- Navigation Channels
- Port Channels
- Subtidal Flats
- Transitional Slopes

The Newark Bay Confined Disposal Facility (CDF) is another notable area that comprises less than 1% of the NBSA, but is not considered a geomorphic area due to the use of this area for waste disposal. It was constructed in 1997 within a subtidal flat in the central portion of Newark Bay, between the Port Newark and Elizabeth Channels (Douglas et al. Undated). The CDF reached capacity in 2011 and was closed and capped with at least 3 feet (ft) of sand in June 2012 (Newark Bay Study Area Coordination Team 2012). As a result, the CDF will be excluded from analysis in the baseline risk assessments.

Five of the seven geomorphic areas have unique ecological characteristics and provide important habitat, as discussed below. Exhibit 2-1 provides a breakdown of the percent each geomorphic area contributes to the NBSA.

Exhibit 2-1 Geomorphic Area Percent Contribution to the NBSA

Geomorphic Area	Percent of NBSA
Subtidal Flats	43%
Historically Disturbed Subtidal Flats	6%
Transitional Slopes	10%
Navigation Channels	25%
Port Channels	6%
Intertidal Areas	1%
Industrial Waterfront Area	9%
Total	100%

2.2.2.1 *Subtidal Flats*

The broad, shallow Subtidal Flats located outside of the navigation channels cover approximately 43% of the NBSA (Figure 2-4). Water depth in the Subtidal Flats averages approximately 9 ft based on the bathymetric survey conducted as part of the Phase I Sediment Investigation (Tierra 2005, 2007). Water flow in these areas is largely driven by tidal influence and local winds.

The Historically Disturbed Subtidal Flats geomorphic area was defined for sediment characterization and nature and extent investigational purposes and consists of approximately 6% of the area of the NBSA. These are specific areas located within the Subtidal Flats that were altered by anthropogenic activities, such as dredging or construction. Intermittent natural sedimentation and lack of maintenance has since filled the former depressions to a sediment bed elevation that is comparable with the surrounding Subtidal Flats. The surficial features and habitats of the Historically Disturbed Subtidal Flats are similar to the surrounding Subtidal Flats; only the depositional rates differ. However, both areas will be sampled and sediment chemistry results will be evaluated to determine if there are any differences in risk between these two areas.

USACE catch data indicate the fish community in the Subtidal Flats is dominated by small schooling fish (e.g., bay anchovy [33%] and Atlantic herring [29%]), with fewer larger fish (e.g., white perch [14%] and striped bass [8%]) (USACE 2009).

2.2.2.2 *Transitional Slopes*

Transitional Slopes (Figure 2-4) are located between the deeper dredged channels and the Subtidal Flats. This geomorphic feature covers approximately 10% of the NBSA, with average water depths of approximately 25 ft. The slopes are generally 3 to 1 based on observations from available NOAA bathymetric charts and consistent with the results of the bathymetric survey conducted as part of the Phase I Sediment Investigation (Tierra 2005).

The shallow portions of the Transitional Slopes would be expected to exhibit habitat similar to that of the Subtidal Flats. The deeper portions of the transitional slopes likely lack any vegetation or habitat importance due to periodic maintenance dredging, deepening-project activities, and limited sunlight conditions at depth.

2.2.2.3 *Channels*

Navigation Channels (Figure 2-4) include the main federally-authorized channels within Newark Bay and cover approximately 25% of the NBSA. Other privately dredged channels lead from the navigation channels to various waterfront facilities, particularly along the industrial waterfront on Staten Island and along Bergen Point on the southeast side of Newark Bay. Navigation Channels south of Port Newark, with the exception of the channel south of Shooters Island, have, since 2001, been dredged to maintain water depths of 35 to 50 ft below mean low water (MLW). These areas are also currently part of the Harbor Deepening Project (HDP), which is deepening these channels to 50 ft below MLW South of (and not including) Port Newark; the federally-authorized Navigation Channel was last dredged in 1989, at which time the project depth was 35 ft MLW. Additional information regarding maintenance dredging practices in the NBSA is provided by USACE (2007a).

The Navigation Channels are unique from the rest of Newark Bay due to the depths that are maintained by dredging for vessel traffic that utilizes these areas. Based on a bathymetric survey conducted in 2005, the average depth of the Navigation Channels is approximately 45 ft (Tierra 2005). Since this survey, however, some areas of the southern channels have been deepened to approximately 50 ft as part of the HDP. Due to their deep depths, the Navigation Channels are not subject to wind-wave resuspension and have a tendency to accumulate sediments (Tierra 2005). However, preferential sediment deposition within the Navigation Channels occurs along the sides of the channels where sediments are least subject to navigation-induced resuspension (Wakeman 2006).

Port Channels are located at Port Newark, Elizabeth, and South Elizabeth. Within these ports, large marine vessels maneuver and dock for cargo exchanges, then exit from the piers. The types of forces generated by vessels in these areas create a unique hydrodynamic condition. The Port Channels account for approximately 6% of the NBSA, with average water depths of approximately 48 ft (Tierra 2005). Maintenance dredging occurs on a regular basis within the established Port and Navigation Channels and associated berths for container ships at the larger terminals. Berths associated with privately owned properties along the shoreline of the NBSA are also periodically maintained.

There is little to no difference in the ecology or the biological communities of the Port Channels versus the Navigation Channels. As such, the term Channels will be used to encompass both the Port and Navigation Channels as a whole in the baseline risk assessments. Biological communities in the deep Channels of the NBSA include

benthic invertebrates and predatory fish. Surveys have shown blue crabs and predatory fish (e.g., striped bass) to be abundant in the deeper water of the Channels in the winter months (USACE 1997). USACE community trawl data collected between 2002 and 2009 were separated based on Channel catch vs. non-Channel catch. Overall, 42% more organisms were captured in the Channels than in the non-Channel areas; large fish species, such as white perch, striped bass, and spotted hake, dominated the catch in the Channels (USACE 2009). Due to the sloughing properties of the slopes of the Channels and accumulation of sediments in the Channel bottoms, this geomorphic area will be evaluated as a separate exposure area in the BERA.

2.2.2.4 *Intertidal Areas*

Intertidal Areas (Figure 2-4) are characterized by two main features: wetlands and mudflats (or sand/cobble flats) that are typically exposed during low tide. Figure 2-5 shows the NBSA wetland areas, which are typically characterized by the presence of emergent vegetation, such as common reeds (*Phragmites australis*) and/or saltmarsh cordgrass (*Spartina alterniflora*), as well as soft muddy or organic substrates. Wetlands may provide important foraging and nesting grounds for seasonally abundant waterfowl and other water birds. Mudflats, sand, and cobble flats are characterized by unvegetated expanses of mud, fine sand, or clay. Benthic organisms, such as infaunal invertebrates, crustaceans, bivalves, and forage fish, can be found in these areas. They are also important feeding areas for predatory fish and shorebirds, such as herons, egrets, and sandpipers.

Most of the wetlands historically present around the fringes of the NBSA have been filled, yet small Intertidal Areas remain in various locations around Newark Bay – these represent approximately 1% of the area within the NBSA.

2.2.2.5 *Industrial Waterfront Area*

As previously described, the Newark Bay shoreline has been significantly modified by human activities over time. These modifications include construction of marine facilities, privately dredged channels, publicly owned treatment works, CSOs, stormwater outfalls, rip-rap, and other facilities. The large number of constructed pier and shipping facilities along the waterfront is evidence of extensive historical removal, reworking, and disturbance of sediments. These facilities also present numerous physical obstructions to water currents and may cause highly localized variation in sedimentation patterns.

For purposes of the RI, shoreline areas along the NBSA within 100 ft of the entire shoreline of the NBSA, excluding Intertidal Areas, are considered part of the Industrial Waterfront Area (Figure 2-4). This area covers approximately 9% of the NBSA with average water depths of 17 ft, not including upland areas. While much of the Bay's shoreline is industrial, other non-industrial land uses such as public walkways, piers, and docks are also included in this geomorphic area.

Aquatic and wetland habitat is limited within the Industrial Waterfront Area. Though dilapidated pier structures and submerged wrecks, notably along the southern portion of Newark Bay, Kill van Kull, and Arthur Kill, may provide limited structural habitat for some juvenile and other small pelagic fish species, overall species abundance and diversity is reduced in these areas (Duffy-Anderson et al. 2003). In addition, these areas provide adequate substrate for spawning, egg development, foraging, and sheltering habitat for juvenile/larvae of winter flounder and other essential fish habitat species.

2.2.3 Tributaries

Major freshwater inputs to the NBSA are from the Passaic and Hackensack Rivers. The combined watershed for these two tributaries is approximately 726,700 acres in New Jersey and New York (USEPA 2012b). The Passaic River is roughly 80 miles long with its origin in the center of Mendham, in southern Morris County, New Jersey. It meanders through the swamp lowlands between the ridge hills of rural and suburban northern New Jersey, called the Great Swamp. In the upper reaches of the Passaic River, its tributaries drain much of the northern portion of the state. Upriver of the Dundee Dam in Little Falls, the mean daily flow is approximately 1,200 cubic feet per second (cfs; U.S. Geological Survey [USGS] 2012). In its lower reaches, the Passaic River flows through the most urbanized and industrialized areas of the state, including downtown Newark, and then it enters the upper northwestern corner of Newark Bay. Due to the severe pollution and industrialization in these parts of the river, the lower 17 miles of the Passaic River are identified as the LPRRP, with a separate AOC under the auspices of the CERCLA program.

The Hackensack River originates in Rockland County, New York, just west of the Hudson River and flows for approximately 50 miles into Newark Bay's upper northeast portion. Tributaries of the Hackensack include Sawmill Creek, Berrys Creek, and Overpeck Creek. Just south of the Oradell Dam in New Milford, New Jersey, the Hackensack River has a mean daily flow of approximately 90 cfs. To the south of this dam, an approximately 34 square-mile area known as the Hackensack Meadowlands includes approximately 8,400 acres of wetlands that provide habitat to migratory birds,

serve as a spawning area for fish, filter surface water runoff, and protect the uplands from storm surges. Historically, these barren areas were once considered wastelands and, as a result, were subjected to pollution, alteration, in-filling, and illegal dumping.

The Elizabeth River originates in Hillside, New Jersey, and is approximately 6 miles long. It drains a small, highly urbanized basin and flows into the Arthur Kill. This river has small discharges, typically less than 100 cfs, which are affected by inputs from sewers and other outfalls, several small dams, and wetland areas, all of which affect the hydrologic response (USGS 2010).

Piersons Creek, Peripheral Ditch, and Plum Creek are three small tributaries that flow into central Newark Bay. There are limited data for these tributaries. Piersons Creek and Plum Creek are associated with the area north and east of the Newark Liberty International Airport and are located in a highly industrialized area. The Peripheral Ditch is approximately 4 miles long and varies in width from 100 to 200 ft. It serves as the drainage trench for the airport, commencing along the west side of the facility, wrapping around the southern perimeter, and flowing into the NBSA on the east side of the airport.

The tidally influenced straits of the Kill van Kull and Arthur Kill serve as the main connectors between the NBSA and the Upper Bay of New York Harbor and Raritan Bay, respectively. The Kill van Kull is approximately 3 miles long and 1,000 ft wide. The Arthur Kill is approximately 10 miles long and 600 ft wide. Both are maintained by regular dredging to accommodate cargo vessels travelling to ports and/or various private facilities along the NBSA and Arthur Kill.

Two small tributaries in Staten Island, New Creek, and Old Place Creek flow into the southern NBSA. These small tributaries also have extremely limited data. They are responsible for draining the northwest portion of Staten Island. New Creek is located along the eastern side of the Howland Hook Marine Terminal and is likely associated with the drainage of this facility. It originates just south of General Douglas MacArthur Park and is approximately 1 mile long. Old Place Creek is larger than New Creek and drains the marsh area south of Interstate 278, flowing into the NBSA just north of Goethals Bridge. It originates in the Graniteville Swamp Woods and is just over 1 mile long.

2.2.4 Tides

Newark Bay has a semi-diurnal tide with a tidal period of 12.42 hours (Chant 2006; Pence 2004). The tidal amplitude is similar throughout Newark Bay, with only slight

variations in mean tide levels between the north and south ends of Newark Bay, with the mean tide level at the northern end (Kearny Point) equal to 2.85 ft (0.87 meters [m]) and equal to 2.77 ft (0.84 m) in the southwestern portion of Newark Bay (Pence 2004; Wakeman 2006). Although the tidal amplitude is similar throughout Newark Bay, tidal current velocities vary by location (Pence 2004). According to published tidal charts (NOAA 1998), the maximum ebb tidal current velocity is 2.7 ft per second (ft/sec; 0.8 m per second [m/sec]) towards the southwest near the Elizabeth Channel, and the maximum flood tidal current velocity is 3.0 ft/sec (0.9 m/sec) toward the northeast near the mouth of the Hackensack River. The weakest tidal currents are found south of the South Elizabeth Channel (west side) and in the cove south of Droyers Point (east side) (USACE 1997).

2.2.5 Storm Events

Due to its location along the northeastern coastline of the United States, the NBSA is vulnerable to hurricanes, tropical storms, blizzards, Nor'easters, and other strong storms. Major flooding events have occurred in the region resulting from the combination of significant storm events, as well as the tidal dynamics. Limited information is available on specific events that have caused flooding in Newark Bay; however, there is some information on flooding events caused by storms in the Passaic River. USACE (2006a, 2012a) and NOAA (2011) report a history of significant events that caused "major" flood conditions in the Passaic River, some as recently as 2012. NOAA (2011) also indicates that many of the flooding events (categorized as "minor," "moderate," or "major") along the Passaic River are associated with channelization and regulation/diversion conditions in the river. This implies that not all major floods along the Passaic River resulted in flooding conditions in Newark Bay. Figure 2-2 highlights periods of time when large, flooding storms occurred in the region, including major floods along the Passaic River. It should be noted that these conditions indicate potential flooding in the NBSA, but are not definitive as to whether flooding occurred in the NBSA.

3. Data Summary

To gain a thorough understanding of the ecosystem and current environmental conditions in Newark Bay, various historical and current literature and data/information sources were reviewed. These sources included, but were not limited to, regulatory agency-sponsored reports (e.g., the PAR [USEPA 2006a] and the SLERA [USEPA 2008a]), documents written by Windward (Windward 2011) and Windward/AECOM (2009) on behalf of the Cooperating Parties Group (CPG) for the LPRRP, and Tierra-sponsored reports, including studies summarized in the Inventory and Overview Report of Historical Data (herein referred to as the Inventory Report) in Volume 1 of the NBSA Phase I Remedial Investigation Work Plan (RIWP) (Tierra 2004).

The available data are divided into qualitative and quantitative data. Qualitative data provide an understanding of the physiography and land use, available ecological habitats and species present, as well as the recreational areas along Newark Bay. Quantitative data provide specific concentrations of constituents in biotic and abiotic media and will be used to calculate potential risks in the baseline risk assessments. Depending on the quality of secondary data, these data may supplement data anticipated to be collected under Phase III of the RI for the NBSA. For example these data could be used to support the updated COPEC screen, aid in the development of sampling designs and plans, and/or evaluate potential risk to ecological and human receptors.

The qualitative and quantitative datasets available for the Bay are described below. A full reference list is provided in Section 7.

3.1 Qualitative Data

Iannuzzi et al. (2002) and Crawford et al. (1994) present summaries of the environmental history of Newark Bay and the surrounding lands. Iannuzzi et al. (2002) review the historical ecology of the Passaic River and part of the Newark Bay estuary, showing how anthropogenic activities from the past 150 years have progressively degraded the natural ecology of the region. Crawford et al. (1994) demonstrate how both the abundance and diversity of aquatic species in the Newark Bay estuary have been substantially reduced since the late 1800s due to the intense industrialization and urbanization that occurred throughout the region. This section discusses the land use of the NBSA and describes the various ecological and biological communities that reside within each habitat in Newark Bay.

3.1.1 Land Use and Important Ecological Habitats

As depicted on Figure 3-1, which is based on the Anderson et al. (1976) land-use classification scheme, major land uses in the NBSA are barren land, forest, water, wetlands, and urban. Barren land occupies just over 1%; wetlands and forests each comprise around 2% of the land use in the NBSA. Water encompasses 22%, and the majority of land use (73%) in the NBSA today is classified as urban.

Despite the changing habitat conditions and urbanization of the NBSA during the 20th century, Newark Bay continues to serve as a spawning ground, migratory pathway, and a nursery/foraging area for a variety of aquatic organisms. The following sections describe each land-use category and the predominant organisms residing within these habitats.

3.1.1.1 *Water*

Water depth in Newark Bay ranges from approximately 9 ft in the shallow Subtidal Flats (Tierra 2007) to up to around 50 ft in the dredged channels (USACE 2012b). Salinity in Newark Bay ranges from approximately 14 to 24 parts per thousand, with an average annual salinity of approximately 20 parts per thousand (USACE 2004a). The temperature of Newark Bay is typical of mid-Atlantic waters, ranging from near freezing during the winter months to around 25 degrees Celsius in the summer months. The variable conditions of Newark Bay support a wide range of species that inhabit several of the geomorphic regions: Subtidal Flats, navigation and port channels, and transitional slopes. Newark Bay provides habitat for invertebrates, marine mammals and fish freely swimming within the water column, as well as those residing on or within the sediment, as discussed in this section.

Aquatic Invertebrates

The zooplankton community can be divided into two major categories: permanent holoplankton (which include various forms of small, sometimes microscopic organisms, such as protozoans and copepods) and temporary meroplankton (which include larval stages of shallow-water invertebrates and fish). Among the meroplankton are the ichthyoplankton, consisting of egg, larval, and juvenile stages of fish. A major ichthyoplankton survey conducted in Newark Bay between 1993 and 1994 by the National Marine Fisheries Service collected larvae of 20 different species of fish. Only two species, bay anchovy (*Anchoa mitchilli*) and one unidentified goby (*Gobiosoma* sp.), were collected in substantial numbers at any time during the study year. Both species were present from June through September.

More thorough ichthyoplankton surveys were also conducted by USACE from seven stations within Newark Bay during sampling events for the HDP (USACE 2011). Data collected between 1999 and 2006 (USACE 2003a, 2004b, 2005, 2006b) are presented in Table 3-1. Forty-two species of ichthyoplankton were identified at various life stages (i.e., egg, larvae, or juvenile), including eggs and larvae from one unidentified species. It is unclear why the counts of juveniles are much lower than the other life stages for most species, but could be due to factors such as seasonality, method of capture, or identification procedures. Bay anchovy dominated the catch across all 8 years. All life stages were captured for bay anchovy, winter flounder (*Pleuronectes americanus*), weakfish (*Cynoscion regalls*), and windowpane flounder (*Scophthalmus aquosus*), indicating that these species are spawning and have early life stages in Newark Bay.

Benthic Invertebrates

Fourteen studies have been conducted on the benthic invertebrate communities of Newark Bay and its tributaries; six of which focused solely on Newark Bay (Tierra 2004). These studies consistently indicate that the benthic invertebrate communities throughout Newark Bay are characterized by low abundance and diversity, and that the benthic environment is stressed from various pollutants and anoxic conditions. Species lists in all existing studies are dominated by polychaete worms, oligochaete worms, and small bivalves (clams/mussels). These organisms serve as a forage base for a variety of crustaceans, fish, and wading birds.

A survey of benthic habitats in the NY/NJ Harbor Estuary conducted in June and October 1995 (Iocco et al. 2000) indicates that Newark Bay bottom sediments are predominantly characterized as silt with occasional sand. Grab samples from approximately one-half the stations contained benthic infauna, consisting of predominantly polychaetes (e.g., *Streblospio benedicti*) and bivalves (e.g., *Mulinia lateralis* and *Mya arenaria*). Benthic habitats, such as large clam beds and mats of *Ampelisca abdita* that were seen elsewhere in the NY/NJ Harbor Estuary, were not observed in Newark Bay. At several stations in Newark Bay, the sediment gas content indicated high pollutant or organic content. In 1993-1994 and 1998-1999, USEPA (under the Regional Environmental Monitoring and Assessment Program [REMAP]) collected 56 randomly located benthic invertebrate samples in the area referred to as the Newark Bay sub-basin, which, in addition to Newark Bay, included stations in the Arthur Kill, Lower Passaic River, and Hackensack River (USEPA 2003a). The study concluded that the overall benthic invertebrate community is characterized by low abundance and diversity and is dominated by pollution-indicative species. The Benthic Index of Biotic Integrity, an index calculated based on various structure and abundance metrics, indicated that as much as 90% of the Newark Bay benthos can be classified as moderately to highly impacted (Figure 3-2). All but one station within the NBSA boundaries was considered highly impacted (USEPA 2003a).

Surveys conducted by NOAA in 1993-1994 and USACE in 1995-1996 also found Newark Bay to be dominated by polychaetes and small clams, with a low diversity and abundance of pollution-indicative species (NOAA 1994; USACE 1997). Benthic infaunal abundance and species composition increase in the late winter and early spring months and decline in the summer (USACE 1997). The most abundant species observed in six benthic invertebrate surveys are identified in Table 3-2.

Communities of large invertebrates in the channels and shoals are mainly dominated by blue crabs (*Callinectes sapidus*), which are present year-round in Newark Bay. Blue crabs at shallow water stations (Subtidal Flats) appear to be more abundant in the summer and fall (May to November) and are nearly absent during the other months when they migrate to the deeper channels or offshore (USACE 1997). Bivalve mollusks in Newark Bay were dominated by the dwarf surfclam (*M. lateralis*) and the softshell clam (*M. arenaria*).

Various physical parameters can affect chemical constituents in sediments in the NBSA, making them more or less bioavailable to benthic invertebrates and other organisms. Such factors include, but are not limited to, total organic carbon (TOC), pH, sulfide content, reduction-oxidation potential (redox), and grain size. In addition, various hydrodynamic transport factors, both spatially and temporally, can also influence bioavailability. These include processes such as sedimentation, scouring events, resuspension, and deposition of suspended solids.

A study conducted in October 2005 at 14 stations in Newark Bay utilized sediment profile imagery and supplemental grab samples to determine the biologically active zone (BAZ; Tierra 2008b). Results of the study indicate that the surface sediment is structured by physical (e.g., currents and sediment movement) and biological processes (e.g., movement of infaunal organisms), both of which can affect the bioavailability of chemical constituents. The fauna and biogenic structures observed were sufficient to bioturbate sediment to the estimated total BAZ depths of 13.7 to 16.4 centimeters (cm; average of approximately 6 inches or 0.5 ft). The deepest vertically burrowing species observed were large individuals of *Macoma balthica* and *M. arenaria* clams. The species with the potential to create the deepest convoluted burrow galleries were *Glycera* spp. and *Nereis* spp. Other species found in the grab samples were the burrowing isopod *Cyathura polita* and large-bodied, tube-building polychaetes (*Diopatra cuprea*), maldanids (*Pectinaria gouldii*), and the amphipod *Ampelisca* spp. Most of the stations sampled in this investigation were composed of benthic assemblages in a Stage III (relatively well-developed) successional stage that suggests stability in the sediment structure (Tierra 2008b).

Fish

The finfish assemblage that resides in or is transient to Newark Bay is typical of large coastal estuaries and inshore waterways located along the Mid-Atlantic Bight. Situated in the transition zone between northern coldwater (boreal) and temperate (warm) water with low to moderate salinity, Newark Bay acts as a spawning ground, migratory pathway, and a nursery/foraging area for a variety of estuarine, marine, and anadromous fish species.

Essential fish habitat (EFH) exists for several finfish species, as documented in Environmental Impact Statements required for federal maintenance dredging (USACE 2004a, Undated). The EFH was extracted from NOAA's online EFH data mapper for the Hudson River/Raritan/Sandy Hook Bays area (http://www.nero.noaa.gov/hcd/est.htm). The entire bay is identified as EFH for one or more important life stages (i.e., eggs, larvae, juveniles, adults, and spawning adults) of 21 fish species (Table 3-3).

Many of the seasonally abundant fish species in Newark Bay are transient or migratory, passing through Newark Bay to upstream spawning grounds or entering the area seasonally from nearby ocean waters. These include estuarine migratory species, such as striped bass (*Morone saxatillis*), that depend on the estuary as a nursery and a forage area for juveniles and adults. Species that frequent Newark Bay during similar life history stages include both marine and estuarine predators, such as winter flounder, bluefish (*Pomatomus saltatrix*), and summer flounder (*Paralichthys dentatus*). These fish migrate in and out of Newark Bay seasonally depending on spawning area (estuarine vs. marine) and period (winter vs. summer) (U.S. Fish and Wildlife Service [USFWS] 1997; Woodhead 1991).

A few fish species are year-round residents in Newark Bay; these species generally begin spawning in late spring and continue throughout most of the summer following general onshore and offshore seasonal movement patterns (onshore in spring and summer, offshore to deeper waters in fall and winter). Most life stages of these species may be found in the estuary throughout the year. These species, such as the mummichog (*Fundulus heteroclitus*) and striped killifish (*Fundulus majalis*), provide an important forage base for larger predatory species.

Previous biological investigations have characterized the seasonal distribution and composition of the fish community in various habitats and areas of Newark Bay. The National Marine Fisheries Service conducted a major fish sampling program in Newark Bay as part of an evaluation of a flood control project for the Passaic River Basin (NOAA 1994). This study provides additional information on habitat preference of species (e.g., channel vs. shoal [subtidal] areas). Monthly fish sampling was conducted

from May 1993 through April 1994. Juvenile and adult fish were sampled with bottom trawls and gill nets. A total of 56 species of fish and invertebrates were identified from 299 otter trawl tows, 105 shrimp trawl tows, and 92 gill net sets. The dominant species caught in the channels were striped bass and Atlantic tomcod (*Microgadus tomcod*). The dominant species caught in the shrimp trawl were bay anchovy, Atlantic herring (*Clupea harengus*), and Atlantic tomcod. The dominant species caught in the gill nets were Atlantic menhaden (*Brevooria tyrannus*) and striped bass. From the seven shoal stations on the east side of Newark Bay (relative to the main channel), 28 species of fish were collected with a bottom trawl. Six species – striped bass, winter flounder, bay anchovy, Atlantic herring, Atlantic tomcod, and Atlantic silverside (*Menidia menidia*) – dominated the catch from all shoal stations combined (USACE 2004a). Most species, whether resident or transient, were found throughout the extant range of habitat conditions. The notable exception is white perch (*Morone americana*), which was not collected in waters that had less than 6.23 milligrams per liter of dissolved oxygen (DO) (NOAA 1994).

In order to describe the species composition and relative abundance of fish in shoal areas of Newark Bay, Lawler, Matusky and Skelly Engineers, Inc. conducted sampling trawls from April 1995 to March 1996 (Lawler, Matusky and Skelly Engineers, Inc. 1996). Four shoal areas in Newark Bay were sampled to provide information on the fish community. Species collected from the shoal stations were dominated by relatively few species. Eight species – bay anchovy, striped bass, winter flounder, windowpane flounder, Atlantic silverside, summer flounder, northern pipefish (*Syngnathus fuscus*), and white perch – dominated the catch. Most species occurred infrequently and in very low numbers during the 12-month study. However, there was a consistent seasonal pattern for fish among the shoal stations. Fish were relatively abundant from April through October, but much less abundant from November through March. During the period when fish were most abundant, only four species – striped bass, winter flounder, summer flounder, and bay anchovy – occurred during each month.

Since 1998, USACE has collected fish community data from various stations in Newark Bay with a 30-ft otter trawl as part of the NY/NJ HDP. USACE notes that multi-year sampling programs are essential to establishing the use of channel and non-channel areas within the harbor from year to year. Sampling data can be used to describe annual variability in seasonal movement patterns, in usage and relative abundance, and to expand the temporal coverage of the program database. This sampling has provided a valuable long-term dataset to assess the response of fish communities to changing conditions and anthropogenic alterations in the harbor. In Newark Bay, species abundance has varied from year to year, but is generally dominated by a few species (e.g., white perch, striped bass, and bay anchovy). Data from 5 years of sampling (2005 through 2009) are presented on Figure 3-3.

The available fish community data collected in Newark Bay between 1993 and 2011 are summarized in Table 3-4. Data are presented as catch per unit effort and rounded to the nearest whole number. Direct comparisons of the studies are not possible because different gear types were used (gill nets vs. trawls) in different areas of Newark Bay (shoal vs. channel stations), the sampling efforts were substantially different, and some studies did not provide station information. However, the studies are useful for the identification of species, relative abundance, and seasonal occurrence of fish. Species composition among studies appears to be similar despite gear-type differences. Numbers of some species, such as American eel (*Anquilla rostrata*) and mummichog, may be under-represented in these studies due to the types of fishing methods used. Success rates for capturing such species may be higher with appropriate minnow or eel traps, rather than tow/otter trawls or gill nets.

As shown on Figure 3-4, during 17 years of sampling, the following 12 species dominated the overall composition of Newark Bay finfish community: bay anchovy (31%); white perch (17%); striped bass (16%); Atlantic tomcod (6%); Atlantic herring (5%); alewife (*Alosa pseudoharengus*), winter flounder, and weakfish (4% each); spotted hake (*Urophycis regius*) and blueback herring (*Alosa aestivalis*) (3% each); Atlantic menhaden (2%); and gizzard shad (*Dorosoma cepedianum*) (1%). The remaining species each represented less than 1% of the catch (Figure 3-4). The shortnose sturgeon (*Acipenser brevirostrum*), although federally listed as a protected species in Newark Bay, has not been documented in any of the studies in Newark Bay or adjacent waters (USACE 1997).

The seasonality of the finfish community is plotted on Figure 3-5, which shows the seasonal abundance for several species. For instance, striped bass appears to peak in the late fall (i.e., November). Both weakfish and bay anchovy peak in the late summer/early fall (i.e., September); Atlantic herring peaks around May. White perch is one of the few species that peaks in the winter. Although it appears that Atlantic tomcod peak in the summer, only five fish have been captured since 2005. The cause for the population decline is largely unknown, although investigators have speculated that the cause could be chemical contaminant concentrations (Fernandez et al. 2004; Wirgin 2004; Wirgin and Chambers 2006) and/or rising water temperatures (Daniels et al. 2005).

Marine Mammals

There is limited available aquatic habitat for marine mammals, such as cetaceans, in the NBSA. In addition, the noise and traffic of cargo ships entering and leaving Newark Bay would likely deter these animals from intentionally entering it. As discussed by USEPA (1997a) and in the SLERA (USEPA 2008a), the possibility of cetaceans entering Newark Bay is remote.

There have been recent sightings, however, of harbor seals (*Phoca vitulina*) and harp seals (*Pagophilus groenlandicus*) in the Hackensack River (New Jersey Meadowlands Commission 2010, 2011; Frazier 2011). These seals would have had to traverse Newark Bay to get to foraging grounds in the Meadowlands. Although they are not common in the NBSA, they are a potential visitor.

3.1.1.2 *Wetlands*

The NBSA wetlands shown on Figure 2-5 were classified based on their salinity (e.g., marine, estuarine, and freshwater) according to the USFWS National Wetlands Inventory Program. The dominant wetland type of the NBSA is estuarine/marine. Intertidal wetlands are sporadically observed on the west side of Newark Bay near the Newark Bay Bridge, along Kearny Point, on the southeastern side of Newark Bay just south of the Elizabeth Channel, and near the confluence with the Arthur Kill. A large, contiguous wetland habitat also exists along the eastern side of the Arthur Kill (Figure 2-5). Wetlands dominate the intertidal geomorphic region and provide refuge for a variety of organisms, including aquatic vegetation, which is discussed below.

Aquatic Vegetation

The intertidal wetlands (Intertidal Areas) of the NBSA primarily consist of emergent common reeds and saltmarsh cordgrass, with the cordgrass occupying lower portions of the shoreline, while common reeds are generally located further upland. A vegetation survey along the Lower Passaic River by the USACE in 2008 noted only 20 to 29% of herbaceous plant species and 60 to 80% of shrubs were native (USACE 2004b, 2005, 2006b, 2007b, 2008a, 2009); the remaining were non-native (Windward/AECOM 2009). Similar to the Lower Passaic River, there are likely both native and non-native species along the shoreline of the NBSA, but a vegetation survey has not been performed. In addition to vegetation, the NBSA supports a variety of phytoplankton and algal communities that are periodically surveyed, sampled, and characterized by NJDEP (2009a). In 2005 as in previous years, the Hudson/Raritan estuary was dominated by a diverse assemblage of diatoms in mild to full bloom proportions. Dinoflagellates detected during this season were *Gyrodinium undulans*, *Olisthodiscus luteus*, and *Prorocentrum micans*. In addition, *Pseudonitzschia spp.* and *Dinophysis spp.*, both potentially toxic species, were detected below bloom or toxic concentrations (NJDEP 2008b).

Reptiles and Amphibians

In freshwater wetlands, reptiles and amphibians are typically abundant. However, given the estuarine nature of the water of Newark Bay, amphibians, such as salamanders and frogs, are unlikely to be present (USFWS 1997). However, USACE

(1997) notes the possibility that the diamondback terrapin (*Malaclemys terrapin*) could occur as a transient visitor to the NBSA as it moves between the Hackensack Meadowlands Complex and marshes and tidal creeks along the Arthur Kill. The diamondback terrapin is the only species of turtle in North America that spends its life in brackish water (National Aquarium 2010). No terrapins have been collected to date in bottom trawls, but they appear to be a pollution-tolerant species (Wood 1995, as cited in USACE 1997). USACE (1997) also notes the possibility for three species of marine turtles – loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and the green sea turtle (*Chelonias mydas*) – to utilize the shoal areas (i.e., Subtidal Flats) of Newark Bay. However, there is no documented evidence of these species in the NBSA (Table 3-5).

3.1.1.3 *Forested Areas*

Shooters Island, located in the southern portion of Newark Bay, is one of the major forested areas of Newark Bay. It is partially wooded with species such as black locust (*Robinia pseudoacacia*), tree-of-heaven (*Ailanthus altissima*), and Japanese honeysuckle (*Lonicera japonica*). Small patches of saltmarsh containing common reeds and cordgrass occur around the island's shoreline, including scattered debris, rotting docks, abandoned buildings, shipwrecks, and barges (USFWS 1997). Despite its impacted condition, Shooters Island continues to serve as a bird sanctuary and refuge for migratory birds such as gulls, cormorants, and osprey, which have recently been observed on the island (Bernick and Craig 2008).

Additional forested areas occur along the eastern tip of Kearny Point, just south of the Elizabeth Marine Terminal, along the eastern side of Bayonne Park, and in Richard A. Rutkowski Park. Sporadic forested areas also occur between Veterans and City Parks, in Mariners Marsh, and around the Newark Bay Bridge (Figure 3-1).

Birds

Populations of birds that inhabit or utilize the forested (and other) areas of Newark Bay are mainly water birds, including waterfowl such as ducks and geese; wading birds such as herons and egrets; shorebirds such as sandpipers (*Scolopacidae*), plovers (*Charadrius melodus*), and oystercatchers (*Haematopus*); seabirds such as gulls, terns, and cormorants (*Phalacrocoracidae*); and birds of prey such as osprey (*Pandion haliaetus*). Many of the water bird species found in the Newark Bay region (and NY/NJ Harbor Estuary as a whole) are migratory. The area is part of the Atlantic Flyway, a major north-south migration route that is used by migrant species as a seasonal stopover (Elphick et al. 2001). The birds utilize open waters of Newark Bay and the Intertidal Areas, feeding and resting for a few days to a few weeks en route to northern

breeding grounds or southern wintering areas. Sandpipers, plovers, and their relatives are abundant migrants, and some are winter residents (Walsh et al. 1999).

For those water birds that breed in the NBSA, adequate nesting grounds are limited due to the highly urbanized shoreline of Newark Bay and its tributaries (i.e., the Passaic River, Hackensack River, Arthur Kill, and Kill van Kull). Therefore, most water birds primarily build their nests for breeding offshore on the 17 islands located within the NY/NJ Harbor Estuary. Two of the islands are located in the Arthur Kill/Kill van Kull complex (Prall's Island, and Isle of Meadows), while Shooters Island is located in the southern portion of Newark Bay. These islands and, to a lesser extent, mainland areas of the NY/NJ Harbor Estuary, have been surveyed for decades to quantify and characterize the nesting and trends in water bird populations.

In general, it appears that flight lines occur from colonies on various islands to the Hackensack Meadowlands Complex, which likely provides a variety of foraging habitats (marshes, mudflats, and tidal creeks) (Gelb 2004; USACE 1997). Overall, the breeding populations of water birds in the NY/NJ Harbor Estuary vary in abundance over time (Harbor Herons Subcommittee 2010). The top portion of Figure 3-6 shows the total number of nests for 10 species of water birds documented between 2001 and 2009. Because all 17 islands were not surveyed each year, the bottom portion of Figure 3-6 shows the number of nests normalized to the number of islands surveyed each year, better reflecting the annual variability.

Wading birds can be found foraging in mudflats along the Lower Passaic and Hackensack Rivers and in tidal marshes within the region (Iannuzzi and Ludwig 2004; Ludwig et al. 2010; Windward 2011). They are not expected to be a major component of the bird fauna of the relatively restricted confines of Newark Bay, but they do likely forage on the few intertidal mudflats of Newark Bay. On the other hand, seabirds and birds of prey are able to utilize the entire NY/NJ Harbor Estuary, including Newark Bay, for foraging (USFWS 1997). Several waterfowl species are known or suspected of breeding in the NBSA, including mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), and gadwall (*Anas strepera*) (New York State Department of State 1992; Walsh et al. 1999).

Bird species observed in the NBSA from several bird surveys that have been conducted since 1990 are identified in Table 3-6. The list, originally provided in the Inventory Report (Tierra 2004) and further documented by Ludwig et al. (2010), has been updated to include more recent bird surveys that have been conducted in the region; notably, the Harbor Herons Project survey data collected in 2004, 2007, and 2008, as well as the Hackensack Meadowlands District data collected from 2004 through 2005 (Bernick 2007; Bernick and Craig 2008; Kerlinger 2004; Mizrahi et al. 2007). The majority of bird species were observed in the Hackensack River (248),

including the Meadowlands District; followed by the Arthur Kill (213), including Prall's Island and Isle of Meadows; Newark Bay (81), including Shooters Island; Kill van Kull (59); and the lower 6 miles of the Passaic River (49).

Results of the 2010 summer bird survey of the Lower Passaic River performed by the CPG indicate more aquatic and semi-aquatic bird species observed than during the summer 2000 survey (Ludwig et al. 2010): 21 species were observed in summer 2000, whereas 28 species were observed in summer 2011 (Windward 2011). Similar numbers of species were observed in fall 1999 and fall 2010: 22 species in fall 1999 and 23 species in fall 2010. Gulls were the most commonly observed birds in the fall (1999) and summer (2000), followed by swans, geese, ducks, wading birds, and shorebirds (Ludwig et al. 2010; Windward 2011).

The Natural Heritage Programs of NJDEP and the New York State Department of Environmental Conservation (NYSDEC) have identified and observed 12 rare and protected bird species in the NBSA (refer to Section 3.1.2).

Mammals

Mammals most likely to inhabit the NBSA are human-tolerant species that are commonly found in urban environments, such as squirrels, raccoons, rabbits, bats, and opossum (USACE 1997; USEPA 2008c). The likelihood of any of these animals foraging directly from NBSA waters or the minimal available shoreline is limited, as they would likely remain in the terrestrial habitat.

USACE (1997) identified nine species of bats, a muskrat (*Ondatra zibethica*), and a harbor seal as "possible" mammalian species utilizing the Subtidal Flats of Newark Bay (Table 3-5). In addition, the river otter (*Lontra canadensis*) is a common inhabitant of the Hudson River and the NY/NJ Harbor Estuary. Although commonly called a "river" otter, the name can be misleading, as the animal inhabits marine, as well as freshwater environments, and some populations permanently reside in marine shoreline habitats. The North American river otter is found in a wide variety of aquatic habitats, both freshwater and coastal marine, including lakes, rivers, inland wetlands, coastal shorelines and marshes, and estuaries. The river otter's main requirements are a steady food supply and easy access to a body of water. The North American river otter has been extirpated from much of its historical range due to a number of factors including habitat loss and pollution (Dewey and Ellis 2003).

3.1.1.4 *Urban Landscape*

Urban areas of the NBSA are covered by bulkheads, rip-rap, buildings, and pavement and are shaded gray on Figure 3-1. These areas limit the available wildlife habitat,

such as nesting and foraging areas for birds. The vast extent of impervious surface (i.e., pavement and concrete) decreases stormwater infiltration and shunts stormwater runoff directly into Newark Bay and its tributaries.

Within the urban areas, there are several parklands and public recreational areas for active or passive use (Figure 3-1). The active facilities are designed for activities such as field sports, jogging, and children's play, whereas the passive facilities are intended for activities such as strolling, reading, sunbathing, sitting, bird watching, or dog walking. In many cases, the parklands and public recreation areas can be used for either active or passive recreation.

3.1.1.5 *Barren Land*

Barren land (Figure 3-1) consists of recently cleared or disturbed areas where soils have been disturbed (coal cinders are often a major soil constituent). Vegetation consists of tolerant, often introduced, species. Vegetation is present in scattered patches, offering little cover for wildlife, particularly in winter. Garbage and debris items are present in the vacant lots/fields. Typical plant species include goldenrod (*Solidago canadensis* or *Solidago virgaurea*), mugwort (*Artemisia vulgaris*), raspberry (Rubus), Asian bittersweet (*Celastrus orbiculatus*), pokeweed (*Phytolacca americana*), and saplings of royal paulowina (*Paulownia tomentosa*), mulberry (*Morus* spp.), tree-of-heaven, and black locust. Typical wildlife observed includes terrestrial, urban-tolerant species (United States Coast Guard 2010).

3.1.2 Population Data

3.1.2.1 *Threatened and Endangered Species*

The state and federally listed threatened and endangered species for the NBSA are documented in Appendix A. To identify these species, a request was submitted to the National Heritage Program for the State of New Jersey, and an online search using NYSDEC's Nature Explorer was conducted with a user-defined subject area for the State of New York. The online search area consisted of the southern portion of Newark Bay and portions of the Kills, which are the areas of Newark Bay that fall under New York state jurisdiction. The listed species consist mainly of birds, but also includes three insects, one plant, and one fish species. The State of New York also lists two habitats. The only federally endangered species are the Atlantic and shortnose sturgeon. The species and habitats are identified below.

Exhibit 3-1 Threatened and Endangered Species in the NBSA

Species	Common Name	Federally Listed	State Listed
Birds			
Nycticorax nycticorax	Black-crowned night heron		NJ
Bubulcus ibis	Cattle egret		NJ, NY
Plegadis falcinellus	Glossy ibis		NJ, NY
Sterna antillarum	Least tern		NJ
Egretta caerulea	Little blue heron		NJ, NY
Pandion haliaetus	Osprey		NJ
Falco peregrinus	Peregrine falcon		NJ
Egretta thula	Snowy egret		NJ, NY
Egretta tricolor	Tricolored heron		NJ
Nyctanassa violacea	Yellow-crowned night heron		NJ, NY
Ardea alba	Great egret		NY
Tyto alba	Barn owl		NY
Insects			
Pontia protodice	Checkered white butterfly		NJ
Somatochlora linearis	Mocha emerald dragonfly		NY
Ischnura ramburii	Rambur's forktail damselfly		NY
Plants			
Elocharis quadrangulata	Angled spikerush		NY
Fish			
Acipenser brevirostrum	Shortnose sturgeon	X	NJ
*Acipenser oxyrhynchus**	Atlantic sturgeon	X	
Habitats			
Colonial Waterbird Nesting Area			NY
Gull Colony			NY

Note: Refer to Appendix A.
*Species added based on USEPA comments

3.1.2.2 *Humans*

Human use activities in the NBSA are dictated by a variety of factors, including shoreline type (e.g., bulkhead, bridges, and sheet piling), land use (e.g., industrial, manufacturing, commercial, and residential), public access areas (defined as areas where the public can reasonably reach the edge of the Bay for recreational purposes),

and waterway use (e.g., shipping and fishing). The primary human uses of the NBSA include commercial activities (e.g., shipping, commerce, and industrial and municipal infrastructure and use) and recreational activities (e.g., fishing and shoreline use). Recreational fishing and shellfish collecting are recognized activities that are expected to result in the highest potential for exposure to chemicals in the NBSA (Burger 2002, 2003). Current and future land-use evaluations were performed for the NBSA. A summary of results is presented below. Additional descriptions of the evaluations are provided in Appendix B. Appendix C contains photographs and descriptions that depict additional site reconnaissance in the residential areas near Newark Bay. The photographs in Appendix C show the lack of Newark Bay access at various points near residential areas.

Current Land Use Evaluation

The NBSA is a very large site with mixed human uses. Thus, the entirety of the NBSA shoreline was evaluated for the potential for humans to contact environmental media (i.e., sediment and surface water) under current use conditions. Categories of shoreline accessibility were generally based on current zoning, development plans and physical conditions (i.e., steep elevation changes) and were classified by the type of access as follows:

- Industrial/Manufacturing/Commercial Zoning – No Access – An area of shoreline that is zoned for industrial, manufacturing, or commercial purposes and has no readily available access to sediment and/or surface water by humans.

- Industrial/Manufacturing/Commercial Zoning – With Access – An area of shoreline that is zoned for industrial, manufacturing, or commercial purposes that provides the potential for access to the sediment and/or surface water by humans.

- Residential Zoning – No Access – A residentially zoned area of shoreline that does not provide residential or recreational access to sediment and/or water due to physical conditions/barriers such as steep rocky slopes.

- Residential Zoning -- With Recreational Access – A residentially zoned area of shoreline that provides the possibility of recreational access to sediment and/or surface water by humans. The public could access NBSA sediment and/or surface water during activities such as wading, swimming, boating, canoeing, and fishing or crabbing.

- Residential Zoning – With Residential Access – A residentially zoned area of shoreline that provides the possibility for residential access to sediment and/or

surface water, with residential access defined as exposure 350 days per year for 30 years.

Appendix B contains a detailed description of the current land use and site access evaluation process, and Appendix C provides details regarding on-site reconnaissance activities. Exhibits 3-2a and 3-2b below summarize the results of this evaluation. Exhibit 3-2a contains a summary of the general exposure characterization categories for the NBSA shoreline, and Exhibit 3-2b shows additional detail, including zoning designations. Further site reconnaissance will be conducted to assess areas with potential human access and will be discussed in future documents.

Exhibit 3-2a Summary of Exposure Characterizations – Current Land Use

Characterization	Total Length (miles)	Percentage of Total Perimeter (%)
Industrial/Manufacturing/Commercial Zoning – No Access	15.1	55.3
Industrial/Manufacturing/Commercial – With Access	5.6	20.5
Residential Zoning – No Access	2.9	10.6
Residential Zoning – With Recreational Access	3.7	13.6
Residential Zoning – With Residential Access	0	0
All characterizations	27.3	100

Note: Refer to Appendix B for details.

Exhibit 3-2b Detailed Exposure Characterizations Using Zoning Categories Utilized by Municipalities – Current Land Use

Zoning Category as Listed by Municipalities	Total Length (miles)	Percentage of Total Perimeter (%)
Industrial/Manufacturing Zoning – No Access	13.0	47.6
Industrial/Manufacturing/ Zoning – With Access	4.8	17.6
Bayfront I Redevelopment Area – No Access*	0.2	0.7
Droyers Point Redevelopment Area – No Access*	0.9	3.3
Droyers Point Redevelopment Area – With Recreational Access*	0.1	0.4
Kapkowski Road Redevelopment Area – With Access*	1.1	4.0
Residential Zoning – No Access*	1.8	6.6

Zoning Category as Listed by Municipalities	Total Length (miles)	Percentage of Total Perimeter (%)
Residential Zoning – With Recreational Access*	2.5	9.2
Residential Zoning – With Residential Access	0	0
Commercial Zoning – No Access*	1.1	4.0
Commercial Zoning – With Access*	0.4	1.5
Manufacturing, Research & Commercial Zoning – No Access*	1.0	3.7
Manufacturing, Research & Commercial Zoning – With Access*	0.4	1.5
All characterizations	27.3	100

*Non-industrial area

Future Land Use Evaluation

Four areas along the perimeter of the NBSA have the potential to undergo future residential development. These areas were identified on regional zoning maps and further investigated by reviewing development plans from the respective cities or counties surrounding the NBSA (City of Bayonne 2000, 2001, 2003; City of Elizabeth 2012; City of Kearny 2009; City of Newark 2004; Hudson County 2010; Jersey City 2001, 2008; New York City 2011a, 2011b; Schoor DePalma, Inc. 2005). The objective of this review was to determine if there are any differences between current and future land use with respect to potential exposure to surface water and sediments. A more detailed description of the future residential developments can be found in Appendix B. Figure B8 depicts the locations of these four areas. Exhibit 3-3 below summarizes the areas identified for potential future residential development and shoreline access.

Exhibit 3-3 Areas Slated for Alternative Future Development (Including Residential)

Zone	Length (miles)	Current Shoreline Access Characterization	Potential Future Use (and Shoreline Access Characterization)
Bayfront I Redevelopment Zone	0.2	Industrial/Manufacturing – No Access	Mixed-use residential, retail, parks or recreation, and commercial area which will be bulk-headed, limiting access
Waterfront Development District	0.8	Industrial/Manufacturing – With Access	Mixed-use residential, parks, and commercial area with recreational access
Kapkowski Road Redevelopment Area	1.0	Industrial/Manufacturing – With Access	Mixed-use residential and commercial area with recreational access

Zone	Length (miles)	Current Shoreline Access Characterization	Potential Future Use (and Shoreline Access Characterization)
Staten Island – North Shore	NA	Industrial/Manufacturing – With Access	Mixed-use recreational and commercial with recreational access

Note: NA = not available

In summary, although land uses may change in the future, there appears to be no difference between current and future shoreline access. Some industrial properties and some recreational areas are situated such that humans could have direct access to NBSA environmental media. However, no residential properties were identified under current land use or appear likely in the future that will provide access 350 days per year to environmental media such as sediments. Further site reconnaissance will be conducted to assess areas with potential human access and discussed in future documents.

3.2 Quantitative Data

Apart from sediment data, few other quantitative analytical chemistry data have been collected from the NBSA. Table 3-7 presents a preliminary summary of available data from third-party sources that have been reviewed and are considered relevant and acceptable for quantitative or semi-quantitative use in the risk assessments, as discussed below. Per the June 2011 BHHERA workshop (ARCADIS and ToxStrategies 2011), for the HHRA the Bay will be evaluated as a single exposure unit and the data will be analyzed for the presence of hotspots. For the BERA, exposure areas will be evaluated based on geomorphic area (e.g., Channels, Intertidal Areas, Subtidal Flats), as well as habitat preferences and home ranges of ecological receptors.

3.2.1 Secondary Data Evaluation

An evaluation of all secondary data sources is being conducted to evaluate the quality and usability of data collected by third parties. USEPA identified numerous secondary data sources considered potentially relevant to the NBSA data assessment process (USEPA 2008d, USEPA 2012c). These data sources, and any additionally identified data, are being reviewed as part of the secondary data evaluation. The overall objective of this evaluation is to identify how the data provided in individual source documents can be used to fulfill each of the three RI goals: nature and extent of contamination, risk assessment, and/or source identification.

Data sources being reviewed include government studies, academic theses, peer-reviewed journal articles, and independent studies. Risk assessment-related data generally include biological tissue concentration data and/or bioaccumulation data for

metals, PAHs, PCBs, pesticides, PCDDs, and PCDFs and surficial sediment chemistry, population metrics (e.g., richness and abundance), and toxicity data. The review of each data source involves a step-wise process that ultimately leads to a usability classification:

1. Level 1 (Qualitative) – Data have limitations and should only be used for qualitative purposes in the risk assessments.

2. Level 2 (Semi-Quantitative) – Data have some limitations, but could be used on a semi-quantitative basis in the risk assessments, as appropriate.

3. Level 3 (Quantitative) – Data are considered appropriate for quantitative use in the risk assessments.

Descriptions of major datasets preliminarily deemed reliable for semi-quantitative and quantitative use (i.e., considered Levels 2 or 3) in the baseline risk assessments are provided in the following sections.

3.2.2 Sediment Data

The USEPA (2004a) AOC identified various hazardous substances in NBSA sediments that may pose a risk to human and ecosystem health. These chemicals of interest include, but are not limited to, cadmium, copper, lead, mercury, nickel, zinc, PAHs, PCBs, dichlorodiphenyltrichloroethane (DDT), 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), 2,4-dichlorophenoxy acetic acid, 2,4,5-trichlorophenoxy acetic acid, and 2,4,5-trichlorophenol. As part of the sediment investigations (Phase I and Phase II Sediment Investigations [SIs]) conducted under this AOC and associated RI program, sediment core locations across the NBSA were sampled for various analytes, including pesticides, PCBs (as Aroclors, congeners, and homologues), SVOCs, metals, cyanide, chlorinated herbicides, dioxins/furans, and total petroleum hydrocarbons (Tierra 2005, 2007, 2008a). A limited number of VOCs were also analyzed, including chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, 1,2,4-trichlorobenzene, and 1,2,3-trichlorobenzene (Tierra 2005, 2007, 2008a). Collectively, chemical analyses were performed for 366 individual chemicals or chemical groups in the Phase I and Phase II SIs, providing an abundance of data for these chemicals of interest (Tierra 2008a, 2013).

In addition to the chemicals recognized in the AOC, there are a substantial number of additional chemicals that may be present in the NBSA, including but not limited to, emerging contaminants associated with pharmaceuticals, personal care products, and flame retardants. For example, USEPA has identified the following chemicals as potential emerging chemicals of concern in the environment: bisphenol A; phthalates;

perfluorinated chemicals; penta-, octa-, and decabromodiphenyl ethers; short-chain chlorinated paraffins; benzidine dyes; diisocyantes; nonylphenol and nonylphenol ethoxylates; and siloxanes (USEPA 2010b). Furthermore, van den Berg et al. (2013) has recently proposed toxic equivalency factor (TEF) values for a number of polybrominated dibenzo-*p*-dioxins (PBDDs), polybrominated dibenzofurans (PBDFs) and polybrominated biphenyls (PBBs) but EPA will need to evaluate this report to determine how it will be addressed in the assessment. This is important given the presence of a former PBB manufacturing facility (one of only three facilities in the United States as reported by ATSDR [2004a]) adjacent to the Kill van Kull. Some of these emerging chemicals have already been identified in the NBSA. For example, an SI conducted by the NYSDEC for the Contaminant Assessment and Reduction Project (CARP) detected polybrominated diphenyl ethers (PBDEs; flame retardants) in Newark Bay sediments (NYSDEC 2003). In conjunction with Phase II activities, polychlorinated naphthalenes (PCNs) and PBDEs were also found to be present in sediment throughout the NBSA (Tierra 2013). In an effort to be consistent with USEPA guidance (USEPA 2001a), the RI will include an evaluation of PBDEs and PCNs; those that are identified will be addressed in the BERA and BHHRA either quantitatively or qualitatively based on the available information. It may be necessary to add other chemicals to the RI analyte list in the future (such as PBBs) in order to properly assess human health risks at the site either quantitatively or qualitatively. However, any such addition to the RI analyte list will be done in coordination with USEPA and consideration of available toxicity values to assess the cancer risk or noncancer health hazards.

3.2.2.1 *Sediment Chemistry Data*

Sediment samples have been collected in Newark Bay since 1990 and analyzed for various parameters, including metals, PAHs, PCBs, pesticides, herbicides, VOCs, SVOCs, PCDDs, PCDFs, TOC, grain size, radiochemistry, and acid volatile sulfides/simultaneously extracted metals (AVS/SEM). Sediment core data are available across the NBSA for sediment depths ranging from 0 to 29.5 ft below sediment surface and from surficial sediment grab samples.

The most recent and comprehensive large-scale sediment sampling in the NBSA was conducted by Tierra in 2005 and 2007 under the RI program (the Phase I and Phase II SIs, respectively). Collectively, these sediment sampling events collected and analyzed over 640 surface and subsurface sediment samples from 119 locations in the NBSA, providing data for 366 individual chemicals or chemical groups. These data provide important insight on the horizontal and vertical distribution of COPECs and COPCs throughout the NBSA sediment. These data are available in Tierra 2008a, 2009, and 2013.

The risk assessments will focus on the BAZ, which has been established as the top 15 cm (approximately 6 inches or 0.5 ft) of surface sediment (Tierra 2008b). In order to utilize data that may best represent the current/recent BAZ (i.e., chemistry within the top 6 inches of the sediment bed) and to maintain consistency with other ongoing programs in Newark Bay, only analytical chemistry data collected since 2000 will be quantitatively utilized for risk assessment purposes.

3.2.2.2 *Sediment Toxicity Data*

Fourteen laboratory studies have documented sediment toxicity within Newark Bay and its tributaries (Tierra 2004). Various organisms were used to measure survival and growth, including amphipods (*Ampelisca abdita* and *Rhepoxynius abronius*), polychaetes (*Armandia brevis*), mysids (*Mysidopsis bahi*a), bivalves (*Mulina lateralis*), and sand dollars (*Dendraster excentricus*). In general, the studies showed that, with the exception of *A. abdita*, the organisms were not sufficiently sensitive, from either a growth or survival aspect, to evaluate differences in toxicity of various sediments.

The amphipod *A. abdita* is the most widely used organism in sediment toxicity studies in the NY/NJ Harbor Estuary; the NBSA results are shown in Table 3-8 and on Figure 3-7. Eighty-five individual survival toxicity tests have been conducted using *A. abdita* (Figure 3-7), 55 of which (65%) exhibited toxicity (defined as percent survival significantly less than control). Results from one of the largest programs, USEPA's REMAP, indicated that an estimated 50% of Newark Bay is toxic to amphipods (samples from the Arthur Kill were also included in this estimate) (USEPA 1998, 2003b). NOAA (1995) estimated 85% of the Newark Bay region is toxic (area included the Lower Passaic River, Hackensack River, and Kills). Both the REMAP and NOAA studies used a stratified random design to estimate the areal extent of toxicity.

3.2.3 Tissue Data

3.2.3.1 *Tissue Chemistry Data*

Fish and other biota tissue sampling for contaminant characterization is limited for the NBSA. During the 1980s, NJDEP captured and analyzed fish for PCBs and pesticides from edible fillets (NJDEP 1982, 1983, 1985). Also during the 1980s, Brown et al. (1994) and Rappe et al. (1991) collected dioxin/furan data from various fish and shellfish tissue in Newark Bay. Most recently, CARP captured and analyzed tissue data from one location in the center of Newark Bay (NYSDEC 2004a, 2004b, 2004c, 2005, 2006). Tissue data from CARP are available for the following seven fish species and associated matrices:

- American eel: whole body minus head and viscera

- Blue crab: all edible tissue, hepatopancreas, and muscle tissue
- Mummichog: whole body
- Ribbed mussel (*Geukensia demissa*): all soft parts
- Sevenspine bay shrimp (*Crangon septemspinosa*): whole organism
- Striped bass: liver tissue and standard fillets
- White perch: standard fillets, whole body minus head and viscera, and whole body.

Additional data are available for polychaetes and zooplankton greater than 64 microns. All tissue data were analyzed for metals, PAHs, PCBs, pesticides, PCDDs, and PCDFs (Table 3-7). Length, weight, and percent lipid data were also collected for four fish species, bivalves, and blue crabs (Exhibit 3-4).

Exhibit 3-4 Length, Weight, and Percent Lipid Data for Species Captured Under CARP

Species	Average Length (mm)	Average Weight (g)	Average Percent Lipid (%)
Mummichog	64	64	2
White perch	218	167	5
American eel	544	420	17*
Striped bass	562	2160	3
Bivalves	59	20	1
Blue crab muscle	140	152	5
Blue crab hepatopancreas	140	152	9
Blue crab – all edible	142	149	2

Notes:
mm = millimeter
g = gram
*based on only two samples; additional characterization needed

Tissue data were also collected from Newark Bay for the New Jersey Routine Monitoring Program for Toxics in Fish (Horwitz et al. 2006). Under this program, three samples of blue crab muscle and hepatopancreas tissue were collected from crabs at two stations located in Newark Bay, one at Shooters Island and one at Turnpike Bridge (Table 3-7).

A study by Parsons (2003), also conducted under the CARP program, analyzed samples of double-crested cormorant eggs, blood, and feathers for various chemical parameters (e.g., metals, PAHs, pesticides, PCBs, dioxins/furans) from three islands throughout the NY/NJ Harbor Estuary. The objectives of the study were to determine if concentrations of chemicals were present in the birds at levels of concern, and to determine if there was any correlation between the concentrations of the chemicals and reproductive success in the population. Results indicate that tissue samples collected from birds on Shooters Island, in general, had higher concentrations of chemicals than tissues collected from birds on the other two islands (Swinburne and Gardiners; Parsons 2003). However, no correlation could be made between reproductive success (e.g., egg production, hatching success, and chick survival) and chemical concentrations among the three islands (Parsons 2003).

Additional studies (e.g., Cooper and Buchanan 2007; Bugel 2009, 2011; Gale et al. 2000) have collected biomarker data such as external examinations, blood smears, hematocrit, total and organ weights, histopathology, biochemical endpoints, including endocrine disruption (e.g., ethoxyresorufin-O-deethylase induction), and fluorescent activity. These data attempt to document potential changes in fish at the molecular level; however, it is difficult to scientifically link alterations in biomarkers to particular constituents.

3.2.3.2 *Bioaccumulation Studies*

Four studies documented bioaccumulation in benthic invertebrates within Newark Bay and its tributaries (Tierra 2004). Some studies calculated accumulation factors but did not present the raw data. In addition, two other benthic bioaccumulation studies have been reviewed: one for the CARP program (Hydroqual 2007) and one by USACE (2010a).

As part of the CARP program, co-located sediment and polychaete samples were collected and analyzed from seven locations in the NY/NJ Harbor Estuary, and biota-sediment accumulation factors (BSAFs) were calculated for two subgroups (inner and outer harbor) (Hydroqual 2007). BSAFs for the inner harbor (Upper Bay, Newark Bay, and Arthur Kill) were calculated and range as follows:

- Congener PCBs: 0.16 to 1.38
- PCDD/Fs: 0.05 to 0.27
- Pesticides: 0.15 to 2.82
- PAHs: 0.01 to 0.24.

The dataset used to calculate BSAFs from CARP is small (7 samples) and the limited paired sediment-tissue data do not appear to demonstrate a statistical relationship, based on the large range of BSAFs. According to equilibrium partitioning theory, organic carbon and lipid should account for the variability in the concentrations of COPCs in the tissues. As such, the BSAF values should be similar or at least within the same order of magnitude for each constituent. Because the BSAFs calculated from the CARP differ by an order of magnitude or more, a valid statistical relationship does not appear to exist.

The USACE conducted laboratory bioaccumulation tests and kinetic modeling using Newark Bay and Arthur Kill sediment with the polychaete, *Nereis virens*, and the clam, *Macoma nasuta* (USACE 2010a). The study found that the standard 28-day exposure duration was generally adequate for *N. virens* but not for *M. nasuta,* indicating that clams may require a longer time to reach steady-state conditions with sediment-borne contaminants. As this example suggests, it is important to evaluate and, wherever possible, control the different sources of variability when developing uptake factors.

Bivalves such as the softshell clam (*Mya arenaria*), blue mussel (*Mytilus edulis*), and eastern oyster (*Crassostrea virginica*) have been used to study levels and physiological effects of bioaccumulative constituents (Pruell et al. 1993, Rappe et al. 1991, others, as cited in Wintermyer et al. 2005). The accumulation of constituents in bivalves is influenced by filter feeding while the concentration is influenced by seasonal effects. Bivalves undergo a seasonal increase of percent lipids during gametogenesis and gonadal development, which affects the concentration of constituents in their tissues. For instance, oysters have been shown to accumulate dioxin in gonadal tissue, causing adverse effects on egg and sperm development and fertilization (Wintermyer and Cooper 2003, Wintermyer et al. 2005). While past studies have used eastern oysters as a sentinel species for constituent uptake, the species has not been prevalent in the NBSA for decades (Kurlansky 2006).

3.2.3.3 *Tissue Ingestion Data*

It is expected that the consumption of fish and/or shellfish from the NBSA poses the most significant potential for exposure by humans to chemicals in NBSA environmental media (USEPA 2000c, 2005d); thus accurate characterization of this pathway is important for reducing uncertainty in the BHHRA. A review of existing pertinent information related to human use activities and creel/angler surveys in and around the NBSA is provided below.

Human Activities Related to Crab and Tissue Ingestion

A human use survey of the NBSA was conducted by Burger (2003) as part of a study that documented the public's perception of the most significant environmental concerns in the area and the most important environmental improvements. Different forms of recreational use of Newark Bay were ranked from 1 to 5 (1 being the least important and 5 being the most important). Results indicated that swimming is least important (average ranking of 1.3), fishing/crabbing are moderately important (2.6 to 2.9), and "commune with nature/enjoyment of a place without people" was ranked highest (3.5 to 3.6). With regard to potential restoration opportunities in Newark Bay, the public showed the greatest desire (3.8) for creating more breeding fish habitat.

Additionally, there have been observations of people fishing and crabbing along the Bayonne waterfront, on the eastern side of the NBSA, from piers, exposed rocky shorelines, docks, and pilings, including the pilings of the Central Railroad of New Jersey Newark Bay Bridge that was demolished in the 1980s (Anglerweb.com, accessed August 3, 2010 [Exhibit 3-5]). It is important to note that these activities have been observed despite fishing advisories. Because of the presence of chemicals in NBSA biota, the State of New Jersey advises high risk individuals not to consume blue crab, striped bass, American eel, white perch or white catfish (NJDEP and New Jersey Department of Health and Senior Services [NJDHSS] 2012) while New York advises high risk individuals (women under 50 years of age and children under 15 years of age) not to consume any fish from the NBSA (New York State Department of Health 2013). The general public is currently advised not to eat any blue crab, American eel (*Anguilla rostrata*), or white perch from the NBSA (NJDEP and NJDHSS 2012). Harvest and sale of blue crab and the sale of striped bass and American eel is banned. Current federal regulation requires all anglers to register with their state or the federal government to fish in marine waters. The free saltwater registry for NJ can be found at www.nj.gov/dep/fgw/marinelicenses.htm.

Exhibit 3-5 Observations of Recreational Fishing, Boating, and Crabbing in Newark Bay







Creel/Angler Surveys

There have been four major creel/angler surveys for the area in and around the NBSA: May and Burger (1996), Pflugh et al. (1999), Burger et al. (1999), and Burger (2002). Pflugh et al. (1999) and Burger et al. (1999) are evaluations of the same 1995 survey of the Newark Bay complex. NJDEP also conducted more recent crab/angler surveys in 2002 and 2005, and these data are analyzed in Pflugh et al. (2011). Brief summaries of these studies are provided below, and these data will be considered in the development of site-specific exposure factors for the human health risk assessment. Note that exposure parameters, including fish/crab ingestion rates, will be presented and discussed in the PAR.

May and Burger (1996) interviewed 318 people from May to September 1994 along the shore and on party boats in the Arthur Kill, Raritan Bay, and at two unspecified locations along the New Jersey shore. The survey examined the consumption habits of anglers at these sites, whether the anglers were aware of the fish consumption advisories, how the anglers perceived the risk of eating fish caught from the sites, whether the anglers were exposed to toxic substances in fish, and whether their risk perceptions matched the severity of the hazard. Results showed that the frequency of fishing was highest in the Arthur Kill, averaging over eight times per month. Although 60% of anglers and crabbers in the Arthur Kill reported hearing warnings about consuming fish from these waters, 70% of anglers and 76% of crabbers said that they consumed their catch.

Pflugh et al. (1999) conducted interviews between July and October 1995 with 300 anglers at 26 unspecified fishing and crabbing sites around the NBSA. Data were collected on the six species under a state fish consumption advisory for recreational fishing: blue crab, striped bass, American eel, white catfish (*Ameiurus catus*), white perch, and bluefish. Results provided information regarding anglers' knowledge and belief in fish advisories, perceptions on the safety of consumption, and sources of information about fish and fish consumption advisories. Burger et al. (1999) also published a paper that evaluated the effect of ethnicity on the results of the Pflugh et al. (1999) study. They found that there were ethnic differences in consumption rates and knowledge regarding the safety of ingesting the fish tissue and awareness of fish advisories.

Burger (2002) reported the results from interviews with 267 people observed angling at several locations within the Newark Bay Complex between May and September 1999. Survey locations included Newark Bay, Hackensack and Passaic Rivers, Kill van Kull, and Arthur Kill. The primary objective of the study was to relate the sociological reasons that people fish to their consumption patterns. The survey addressed demographics, consumption behavior (including information regarding serving size), knowledge of advisories, and reasons for angling. Of those interviewed, 111 people reported consuming only fish (44%), 110 people reported consuming only crab (44%), and 33 people (12%) reported consuming both fish and crab. No information was asked regarding species, parts consumed, preparation or cooking practices, or sharing. Based on the meal size and frequency data, Burger (2002) estimated mean consumption rates for fish-only consumers (22 grams per day [g/day]), crab-only consumers (15.6 g/day), and both fish and crab consumers (37 g/day of fish and 17 g/day of crab). More than 30% of anglers interviewed did not eat their catch and were not included in the calculation of consumption rates. There was wide variation in consumption patterns within each ethnic group (White, Black, Hispanic, Asian), but the study found no ethnic differences in reasons for fishing. Most people fished and/or crabbed for recreation; people rated ‘‘angling to obtain food’’ relatively low as a reason

for fishing. Examples of species of finfish commonly caught for human consumption from the NBSA included white perch, striped bass, bay anchovy, Atlantic herring, bluefish, American eel, and various species of flounder.

Pflugh et al. (2011) reviewed and summarized crabbing surveys conducted by the NJDEP in 1995, 2002, and 2005 for the Newark Bay Complex, using the collective data to conclude that crabbing for recreational purposes and for dietary supplementation was occurring despite fishing and crabbing bans. The surveys provided data on the duration, frequency, and amount of crab consumed.

3.2.4 Surface Water Data

Outfalls serve as a continuing source of contaminants into the NBSA surface water and sediments. Chemical contributions from outfalls will be characterized during the RI/FS to understand their impact on the NBSA and their contribution to human health risks.

3.2.4.1 *Surface Water Chemistry Data*

Only a limited amount of chemical contaminant data has been collected for surface water from Newark Bay. For example, analytical chemistry data collected during the 1999-2006 Honeywell International Sampling Program are limited to metals, including hexavalent chromium (Table 3-7). A key difficulty in contaminant characterization sampling for surface water is the ability to achieve detection limits low enough to support risk assessments. Furthermore, because the surface water ingestion pathway is generally considered minor in terms of contaminant uptake, most sampling programs concentrate their efforts on collecting sediment.

Water column samples were collected under the CARP program and analyzed for various analytes, including metals (cadmium, lead, mercury, methylmercury, and silver), at five locations in Newark Bay between 1998 and 2000 (NYSDEC 2003).

Surface water sampling is currently being conducted in Newark Bay and the Lower Passaic River. AECOM's (2011) Small Volume Chemical Water Column Monitoring data were collected in 2011 and 2012 from eight stations within Newark Bay and analyzed for over 200 chemical and physical parameters. In addition, data for the High Volume Chemical Water Column Monitoring program are also anticipated. These data are being collected under a variety of flow conditions and tidal phases to aid in characterizing the variability in fluxes and mixing processes in the NBSA. The data will be evaluated for risk assessment purposes and additional data will be collected, as appropriate, to fulfill risk assessment needs.

3.2.4.2 *Surface Water Quality Data*

Various programs (e.g., NOAA 1994) have collected non-chemistry surface water quality data from the NBSA, including DO, pH, salinity, temperature, conductivity, turbidity, and pathogens. The 2006 Regional Summary of Water Quality in the Newark Bay Area indicated high levels of fecal coliform and low levels of DO in bottom waters of Newark Bay (New Jersey Harbor Dischargers Group 2008). These parameters are also being collected in Newark Bay as part of the surface water monitoring program for the Lower Passaic River.

3.3 NBSA Modeling

Numerical modeling of the Lower Passaic River-Newark Bay system is being performed by the CPG pursuant to the Settlement Agreement and Order on Consent (AOC) effective May 8, 2007 (USEPA 2007d). The work is being conducted according to the Lower Passaic River Restoration Project Modeling Work Plan (Hydroqual 2006a) and the Newark Bay Study Modeling Work Plan Addendum (Hydroqual 2006b). The modeling consists of four sub-models: hydrodynamic, sediment transport, contaminant fate and transport, and bioaccumulation.

The suite of models will be used to inform management decisions, including the development of the baseline risk assessments, which will utilize the results of the physio-chemical models (hydrodynamic, sediment transport, and chemical fate and transport) to estimate the potential for sediment movement and future sediment conditions. The bioaccumulation model will be used to estimate the resulting constituent concentrations in tissue. In addition, the updated CSM will inform the development and/or refinement of the model for Newark Bay.

3.4 Hydrodynamic Model

The Lower Passaic River Study Area hydrodynamic model, based on the ECOM modeling code, was developed by HydroQual, Inc. under contract to Malcolm Pirnie, Inc. for USEPA Region 2 (Hydroqual 2008). The modeling and model performance are documented in the referenced report. As required by the AOC (2007), the CPG has been using this sub-model to develop the sediment transport and contaminant fate and transport models. In addition, the CPG will use the hydrodynamic model to support modeling needs associated with the remedial investigations and feasibility studies for the Lower Passaic River and Newark Bay, inclusive of the associated risk assessments, the latter of which (Newark Bay) is the subject of this Problem Formulation. The model still needs to be calibrated and validated for the NBSA.

3.5 Sediment Transport Model

The sediment transport model, using the code from SEDZLJ, is under development by the CPG, under the oversight of USEPA. Modifications to the model code and the results of model calibration and verification are reviewed by USEPA during regular modeling collaboration meetings. Modeling efforts on the current version of the model, SEDZLJS, have largely focused on the LPR. Work on the model in the NBSA is in the early stages.

3.6 Contaminant Fate and Transport Model

The contaminant fate and transport model, using the code from RCATOX, is under development by the CPG, in coordination with USEPA. Modifications to the model code and the results of model calibration and verification are reviewed by USEPA during regular modeling collaboration meetings. Work on the contaminant fate and transport model was recently initiated for the Lower Passaic River; work on the model in Newark Bay has not yet begun.

3.7 Bioaccumulation Model

The site-specific ecological and chemical characterization data for the NBSA will be used to develop a steady-state bioaccumulation model to help evaluate current and future exposures in the baseline risk assessments. Consideration will be given to the modeling framework currently being developed and tested for the Lower Passaic River by the CPG.

4. Baseline Ecological Risk Assessment

The BERA, consisting of Steps 3 through 7 of USEPA's Eight-Step ERA process (USEPA 1997a), builds on the results of the SLERA to provide a more accurate and realistic estimate of potential ecological risk in the NBSA. To do this, various site-specific data are collected, toxicity tests are conducted, and potential risks to wildlife are estimated using refined food web exposure models. Results of the BERA are then used to manage ecological risks by informing the remedial action decision-making process in Step 8 of the ERA process.

The following activities are conducted as part of the Problem Formulation for the BERA:

- Refine the preliminary list of COPECs
- Characterize the potential ecological effects of COPECs
- Review and refine information on the fate and transport of COPECs, potential exposure pathways, and receptors potentially at risk
- Select assessment and measurement endpoints
- Refine the CSM with testable hypotheses (i.e., risk questions) that the investigation will address

As shown on Figure 1-2, the Problem Formulation concludes with a scientific/management decision point (SMDP) that consists of agreement on the following:

- Assessment endpoints
- Exposure pathways
- Risk questions
- A CSM that integrates the above components

4.1 Refinement of COPECs

The first step in the BERA process is to refine the COPECs that were originally identified in the SLERA based on any new data and any recently updated toxicologically based screening benchmarks.

4.1.1 Summary of COPECs from SLERA

The SLERA utilized data collected between 1990 and 2005 to compare maximum concentrations of constituents in sediment and tissue (i.e., fish, benthic invertebrates, crabs, mollusks, and avian embryos) to conservative ecological screening benchmarks to obtain a hazard quotient. Ecological screening benchmarks were identified for each distinct environmental media (sediment and biological tissue) and for each relevant exposure pathway. The screening benchmarks for sediment were based on the lowest of various published benchmarks (e.g., NYSDEC, NJDEP, and USEPA).

For those constituents considered bioaccumulative (USEPA 2000d), wildlife protective concentration levels were back-calculated for sediment and tissue using conservative exposure assumptions to be protective of bioaccumulative hazards to upper trophic-level receptors. In addition, a tissue screen was performed by comparing tissue concentrations to available literature-based critical body residue (CBR) values. As a result of the screening process, many constituents were identified as COPECs in sediment, fish tissue, mollusk tissue, crab tissue, benthic invertebrates, and avian embryos. Constituents with hazard quotients greater than 1 were retained as COPECs to be further evaluated in the BERA. A summary table of COPECs in each exposure medium is presented in Table 4-1.

4.1.2 Updated COPEC Screen

Additional sediment data have been collected in Newark Bay since the SLERA was conducted in 2008 during the Phase I and II SIs (Tierra 2013). The COPEC screen for surficial sediment (0 to 0.5 ft) has been updated to incorporate these new data (Table 4-2).

Datasets for the updated COPEC screen are limited to the last 12 years (2000 to present) because it is likely that chemical concentrations in surface sediments of older datasets are no longer considered representative of surficial concentrations. Furthermore, only data preliminarily classified as Level 3 by the secondary data evaluation review are incorporated into the COPEC screen. These data are applicable to the study area because they are located within 2 miles of the study area boundaries; were collected under an approved work plan, Quality Assurance Project Plan (QAPP), or were peer-reviewed; have undergone quality assurance/quality control methods;

and have been validated according to USEPA Region 2 standards. As such, they can be utilized quantitatively in the baseline risk assessments.

The complete dataset for the updated surficial sediment COPEC screen consists of data collected from the Honeywell International Sampling Program (1999-2006) and the Newark Bay Phase I and Phase II SIs (Tierra 2013). The dataset consists of over 200 constituents, plus individual congeners of PCBs, PCNs, and PBDEs. The sample size varies for each constituent, from three samples (for pyridine) to 258 samples (for chromium). Additional datasets from CARP (NYSDEC 2003) and USACE (2010a) were identified as Level 2 and were, therefore, not incorporated into the screen.

Ecological screening values for sediment were selected preferentially from values recommended by the Partner Agencies[1], which include those developed for the LPRRP. These values were supplemented with the following, in order of preference: 1) current NJDEP Ecological Screening Criteria for marine sediment (NJDEP 2009b), 2) current NJDEP Ecological Screening Criteria for freshwater sediment (NJDEP 2009b), 3) Region 3 benchmarks for marine sediment (USEPA 2006c), 4) Region 3 benchmarks for freshwater sediment (USEPA 2006d), and 5) Region 5 Ecological Screening Levels for sediment (USEPA 2003c). Constituents without screening values were conservatively retained as COPECs.

The COPEC screen also considered frequency of detection of each constituent. If less than 10% of samples had detected values for a particular constituent, the constituent was eliminated as a COPEC. Non-detect data were incorporated into the dataset at one-half the detection limit. Essential nutrients (calcium, magnesium, potassium, and sodium) were also eliminated as COPECs. Results of the COPEC screen for surficial sediment are discussed in the following section.

A surface water COPEC screen has not been conducted because the most recent surface water datasets are not yet available from the study area. A surface water COPEC screen will be conducted once final validated data from all ongoing surface water sampling events are available. The table below summarizes the availability of the current datasets for the NBSA:

[1] The Partner Agencies include USACE, NJDEP, New Jersey Department of Transportation, NOAA, and USFWS.

Exhibit 4-1 Available Surface Water Datasets for Newark Bay

Date	Sampling Event	Number of Stations	Number of Samples	Number of Analytes	Notes
1999-2006	Honeywell International Sampling Programs	56	92	2 - 8	Number of analytes varies by sample; only analyzed for metals and hexavalent chromium; results for total and filtered samples.
2000-2004	CARP NJ Surface Water Program	4	165	1 - 192	Number of analytes varies by sample.
2000-2004	CARP NY Surface Water Program	1	48	1 - 561	Number of analytes varies by sample.
August 2011	CPG Small Volume Chemical Water Column Monitoring – Routine Event 1	7	106	550	Number of analytes varies by sample.
February 2012	CPG Small Volume Chemical Water Column Monitoring – Routine Event 2	8	101	224	Number of analytes varies by sample.
March 2012	CPG Small Volume Chemical Water Column Monitoring – Routine Event 3	8	64	473	Number of analytes varies by sample.
June 2012	CPG Small Volume Chemical Water Column Monitoring – Routine Event 4	8	~100	~220	Number of analytes varies by sample.
December 2012	CPG Small Volume Chemical Water Column Monitoring – Routine Event 5	8	64	~470	Final validated results not available.
January 2013	CPG High Volume Chemical Water Column Monitoring – Event 1	3	15	~230	Final validated results not available.
February/ March 2013	CPG Small Volume Chemical Water Column Monitoring – High Flow Event 1	8	56	~470	Final validated results not available.

4.1.3 Revised Sediment COPEC Screen Results

Table 4-2 presents the results of the updated surficial sediment COPEC screen. Of the 391 constituents screened, a total of 100 COPECs were identified[2]. These include detected constituents that have maximum concentrations that exceed their respective

[2] Note that individual dioxins/furan and PCB congeners presented, but only included in COPEC count as totals (e.g., Total PCB congeners).

sediment screening values (70 COPECs) and those that lack a screening value (30 COPECs). Of those 70 COPECs with maximum concentrations exceeding their screening values, 60 constituents have mean concentrations that also exceed their screening values. Only five constituents were eliminated because maximum concentrations are lower than screening values.

Thirty-seven constituents were eliminated because they were detected in less than 10% of the samples. Seventy constituents were eliminated because they were not detected in surface sediments; 39 of these have detection limits that exceed their respective screening value. This represents some uncertainty in the COPEC screen.

COPECs are similar to those identified in the SLERA (USEPA 2008a) and include individual constituents from various classes of chemicals (e.g., dioxins/furans, metals, pesticides, PCBs, SVOCs, PAHs, and a few VOCs). For the BERA, all identified COPECs will be evaluated in sediment, benthic invertebrate tissue, and fish tissue. Following analysis, the COPEC list will be refined to evaluate exposure to birds and mammals. Summaries of COPEC fate and transport and ecotoxicity are provided in Sections 4.1.4 and 4.1.5, respectively. Due to the large number of COPECs, the discussions are based on COPEC groups, as opposed to individual COPECs.

4.1.4 Constituent Fate and Transport

The following sections describe general fate and transport processes for the major constituent classes. More specific and detailed discussions of the nature and extent of 18 select COPECs in the NBSA (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, 2,3,7,8-TCDD, bis(2-ethylhexyl)phthalate (BEHP), Total petroleum hydrocarbons, Total DDT, Total Aroclor PCBs, Total Congener PCBs, Total PAHs, Total Chlordane) are provided in the Interim Conceptual Site Model (Tierra 2011), which is anticipated to be updated in 2013, and the Data Evaluation and Analysis Report (Tierra 2013).

4.1.4.1 *Metals*

Metals may be encountered in their singular elemental states but are more commonly found as complexes. Arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc all exist in a variety of oxidative states depending on element loading, microbial activity, nutrient content, pH, redox potential, suspended sediment load, sedimentation rate, salinity, and other variables (Eisler 1987a). When found as compounds, metals are typically bound to other elements, including carbon, oxygen, chlorine, and sulfur atoms. In estuarine environments, metal compounds that include chlorine are regularly encountered. In water, some metals form soluble compounds, while others will precipitate out of solution as insoluble salts; these reactions are largely

dependent on water chemistry. Barium and lead are typically insoluble in water, while silver and zinc are usually found in soluble forms. Metals are also often bound to sediments due to bonding with suspended solids or organic matter in water or due to reactions on the surface of clay minerals.

Some metals are considered essential nutrients in plants and animals and net uptake may be regulated as such over a limited range of concentrations (Agency for Toxic Substances and Disease Registry [ATSDR] 2004b). Plants' tolerance to, and ability to accumulate metals, varies widely by chemical, species, and environmental conditions. Similarly for non-plant aquatic species, the uptake of metals into tissues is highly variable. Some metals are lipophilic (mercury and lead), and concentrations tend to accumulate in fat, liver, brain, egg, and other tissues. Other metals, such as zinc, behave differently with concentrations in organisms not directly related to the concentration in the environment (McGeer et al. 2003). The evidence suggests that fish placed in environments with lower zinc concentrations can sequester zinc in their bodies. The fact that many organisms are capable of regulating internal metals concentrations within certain limits means that, in some instances, organisms can stabilize internal concentrations against perturbations or high concentrations in the external environment (World Health Organization [WHO] 2001). However, this ability is likely to be exceeded at excessively high concentrations.

Consideration of AVS and SEM provides a way to screen out situations where toxicity due to sediment SEMs (copper, cadmium, nickel, lead, silver, zinc) is not expected (USEPA 2005e, 2007c). The difference between the sum of the molar concentrations of SEM (the metal extracted in the AVS extraction procedure) minus the molar concentration of AVS is normalized to the organic carbon fraction in the sediment and can accurately predict which sediments are not toxic because of these metals (USEPA 2005e).

4.1.4.2 *PAHs*

PAHs are a large group of organic chemicals composed of two or more fused benzene rings (USEPA 2003b). PAHs in the environment originate primarily from two sources: petrogenic (i.e., petroleum sources, including different types of oils, coal, and organic shales) and pyrogenic (i.e., combustion), with the majority associated with pyrogenic sources. Petrogenic PAHs are usually associated with local or point sources such as refineries and other petroleum industries, while pyrogenic PAHs tend to occur on a broader scale.

PAHs are considered persistent organic pollutants, but may undergo a variety of degradation processes in abiotic environmental media, including, photolysis, oxidation, biodegradation, binding to solid media, and volatilization. Photolysis of PAHs has been

shown to be dependent on the physical and chemical structure of the substrate the PAH is sorbed to as opposed to the structure of the PAH itself (ATSDR 1995). Similarly, the rate of oxidation is influenced by the nature of the media, as well as PAH structure. Biodegradation of PAHs is influenced by concentration, DO, water temperature, and microorganisms present (ATSDR 1995). Binding of PAHs to organic carbon is controlled by the organic carbon-water partitioning coefficient (K_{oc}). Degradation of PAHs in water depends in part on the temperature and oxygen content of the water (ATSDR 1995). Degradation in soils and sediments depends in part on soil organic content, soil structure, physical factors, the presence of microbes, and the characteristics of the microbes and PAHs (ATSDR 1995).

Physio-chemical properties that affect the fate of individual PAH compounds depend in part on the molecular weight and ring structure of the individual PAH. The rate by which PAHs volatilize from the water column to the atmosphere is dependent on Henry's law constant for the particular PAHs present. Low-molecular-weight (LMW) PAHs volatilize more readily than high-molecular-weight (HMW) PAHs. In general, PAHs have low water solubility and a high K_{oc} value that indicate moderate to high affinity for organic carbon (ATSDR 1995). Thus, in aquatic systems, most of the total amount of PAHs is typically sorbed to suspended particulate matter or sediments rather than being found in the dissolved phase (ATSDR 1995). The presence of dissolved organic carbon has been shown to reduce PAH bioavailability (McCarty and Jimenez 1985; Landrum et al. 1987, as cited in USEPA 2009c).

Photo-oxidation and chemical oxidation are important degradation processes for PAHs in water (ATSDR 1995). PAHs can also be chemically oxidized by chlorination and ozonation. Photolysis, hydrolysis, and chemical oxidation are generally not considered important degradation processes for PAHs in soils and sediments, especially for HMW PAHs (ATSDR 1995). Data suggest that naphthalene and phenanthrene may biodegrade most readily in water; anthracene, benzo(a)anthracene, chrysene, and fluorene may biodegrade in sediment water/slurries; and benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, and other PAHs with five or more rings may not biodegrade readily at all (ATSDR 1995).

PAHs are lipophilic and can rapidly bioaccumulate from water, sediments, soil, and food. Less soluble PAHs are typically taken up more readily in the gastrointestinal tracts of animals (USEPA 2007c). In general, bioconcentration is higher for HMW than LMW PAHs, but can vary by taxa based on the ability of organisms to metabolize parent PAHs to other compounds (ATSDR 1995). Fish can metabolize PAHs in the liver and excrete the metabolites in feces and urine. Most crustaceans also possess the required enzymes for metabolism. Organisms tend to take up PAHs easily from food, although dietary exposure sometimes contributes a limited amount to body burdens compared to water exposure. Due to metabolic ability, PAH concentrations in

fish are typically low. Some data suggest that skin, as well as lipids, may be a temporary site of accumulation and may pose a barrier to the migration of PAHs in tissues. Mollusks and some other invertebrates may be unable to metabolize PAHs efficiently, although they can eliminate them. Studies of marine mollusks have found that while LMW PAHs were bioconcentrated more or less than HMW PAHs, the LMW PAHs were more readily eliminated. Sediment can also be a significant source of body burdens of PAHs for benthic invertebrates and fish. Biomagnification through aquatic food chains has not been observed, likely due to rapid biotransformation and elimination (ATSDR 1995; Eisler 1987b).

4.1.4.3 *PCBs*

PCBs are a group of chemicals that were produced between 1929 and 1978 in the United States for use as industrial coolants, insulators, and lubricants. The term PCBs encompasses 209 individual congeners with one to 10 chlorine atoms attached to a biphenyl molecule. PCBs may be grouped by homologues (defined by the number of chlorines), Aroclors (trade names), coplanar/non-coplanar (positions of chlorines), and as total PCBs (i.e., sum of homologues, sum of Aroclors, or sum of congeners). PCBs are highly lipophilic, semivolatile compounds that bioaccumulate and biomagnify in ecological receptors (USEPA 1999).

Release of PCBs to the environment occurred as the result of industrial discharges, leaks, disposal, landfills, and atmospheric transport of incompletely incinerated PCBs (Eisler 1986). The same chemical properties that made PCBs useful to industry are now responsible for persistent levels of PCBs remaining in the environment. Although the manufacture and use of PCBs was banned in the United States in 1979, they are a ubiquitous contaminant worldwide. This is because PCBs are extremely stable and slow to degrade (Eisler 1986). PCBs are generally ubiquitous in the aquatic environment, particularly in sediments. They may enter aquatic systems from wet and dry deposition, river inflows, groundwater flow, and direct and indirect discharge from industrial facilities. Once in aquatic systems, PCBs quickly partition into the more nonpolar compartments of the ecosystem or are physically adsorbed on particulate matter (Eisler 1986). PCBs are relatively insoluble in water, but are freely soluble in nonpolar organic solvents and in biological lipids (Eisler 1986).

Physical properties of each PCB molecule affect what happens to it over time in the environment. Increasing chlorination causes the solubility of PCBs to decrease and also affects the degree to which a PCB sorbs to organic matter and the ability of biota to excrete the PCB rather than retain it in body tissues. As a result, individual congener PCBs have the potential to bioaccumulate to different extents.

PCB mixtures in environmental media degrade over time, either by processes of weathering or by microbial degradation. These processes can cause dechlorination of PCB molecules, thus affecting the overall bioavailability of individual PCBs. The degree of dechlorination depends on the number and position of chlorine atoms, with lower chlorinated compounds more readily degraded. The degree of chlorination also leads to a wide range of volatility among congeners (Wenning et al. 2011).

PCB molecules are hydrophobic (have low solubility in water), adhere readily to organic matter in soil or sediment, and may bioaccumulate in adipose tissue in fish or other animals. Thus, the highest levels of exposure to PCBs in the environment typically occur through the food chain via ingestion of food items, rather than by direct contact with soil, sediment, air, or water. Many physical, chemical, and biological processes can affect the bioavailability and subsequent uptake of PCBs in the environment, including organic carbon content in sediment or soil and the lipid content in the receptor species. Accumulations are highest in adipose tissue and skin. Accumulation and metabolism are a function of chlorination, with higher chlorinated compounds more difficult to metabolize and more likely to accumulate (Eisler 1986).

4.1.4.4 *Organochlorine Pesticides*

The organochlorine compounds chlordane and DDT are persistent hydrocarbon compounds that were widely used as pesticides in the recent past. Both chlordane and DDT are synthesized chemicals, and their presence in the environment is associated with their production and use as pesticides. These compounds became widely used in agriculture beginning in the 1940s and 1950s. DDT usage in the United States was banned in 1972, while chlordane was banned in 1988 due to increasing evidence regarding their environmental persistence and potential adverse effects on wildlife and human health. Organochlorine pesticides can enter the environment after pesticide applications, disposal of contaminated wastes into landfills, and releases from manufacturing plants.

In general, the organochlorine pesticides have low aqueous solubility and tend to bind strongly to particulates and organic matter in soils and sediments. Chlordane and DDT are very persistent with half lives up to 30 years depending on environmental conditions. It is not known whether much breakdown of chlordane occurs in water or in sediment. Chlordane breaks down in the atmosphere by reacting with light and with some chemicals in the atmosphere; however, it is sufficiently long lived that it can travel long distances and be deposited on land or in water far from its source. Similarly, DDT is highly persistent, but does break down slowly via photolysis and both aerobic and anaerobic degradation. Both chlordane and DDT, and their metabolites, are lipophilic and readily taken up into the aquatic food chain. These chemicals are also known to biomagnify in higher trophic level organisms.

Organochlorine pesticides are highly bioaccumulative, a primary reason they were effective as pesticides. DDT and chlordane bioconcentrate in organisms making up the lower trophic levels of the food chain and accumulate moving up the food chain. Following introduction via the gills or through ingestion of prey items, organochlorines travel through the blood and are then distributed to soft organs and ultimately lipids (USEPA 1999). The individual forms of chlordane vary in their uptake and bioaccumulation (Eisler 1990). After accumulation in tissues, organochlorines may be eliminated over time if exposure is terminated. Little is known about the uptake of DDT and chlordane into aquatic plants.

4.1.4.5 *Dioxins and Furans*

Dioxins and furans are aromatic heterocyclic compounds in the organochlorine group. Dioxins and furans are similar in structure to PCBs with the main difference being the addition of one oxygen atom between rings in furans and two oxygen atoms between rings of the dioxin molecules. Dioxins and furans have no commercial uses and have been introduced to the environment as byproducts of industrial processes including production of Agent Orange and as a byproduct of both natural and anthropogenic combustion. The number of chlorine atoms included in the molecular structure is variable between one and eight resulting in 75 possible dioxin isomers and 135 possible furan isomers. Toxicity of these chemicals is variable based on the position of the chlorine atoms, especially in the “lateral positions” (2,3,7, and 8) with 2,3,7,8-TCDD and 2,3,7,8- tetrachlorodibenzofuran (2,3,7,8-TCDF) having chlorine in all four positions and, as a result, are the most toxic isomers (Hoffman et al. 1995). A group of 12 PCBs are referred to as “dioxin-like compounds” as they behave similarly to dioxin (USEPA 2006e).

Dioxins and furans are commonly detected in air, soil, and sediment around the world. Dioxins and furans are widely distributed at low concentrations with higher concentrations noted in heavily industrialized areas. These compounds enter aquatic environments via soil erosion and stormwater runoff in urban areas and break down very slowly. Like other chlorinated chemicals, dioxins and furans are persistent environmental pollutants ending up in sediments in the aquatic environment due to poor solubility. Increased chlorination of isomers leads to an increase in overall stability and lipophilicity, as well as the slowing of elimination in organisms (USEPA 2008c). Photolysis and volatilization may remove some dioxins and furans from the aquatic environment, but these effects decrease with depth leaving sediments generally unaffected depending on water clarity.

Dioxins and furans are readily taken up into the aquatic food chain; depending on the chemical structure these constituents are known to biomagnify in higher trophic-level organisms in aquatic ecosystems (Hoffman et al. 1995).They are readily biomagnified

in the aquatic food chain, moving from sediments to higher trophic-level organisms. The individual molecular structure of the isomer determines the exact uptake and bioaccumulation due to chemical properties and individual K_{ow} values. After accumulation in tissues, dioxins and furans are not readily eliminated by the organism.

4.1.4.6 *Bis(2-ethylhexyl)phthalate*

Bis(2-ethylhexyl)phthalate (also commonly known as BEHP, di[2-ethylhexyl]phthalate, and DEHP) is the most common phthalate compound and is widely used as a softener in the manufacturing of products made of polyvinyl chloride. Products include packaging film and sheets, wall coverings, floor tiles, upholstery, shower curtains, garden hoses, swimming pool liners, rainwear, shoes, medical tubing, and sheathing for wire and cable (Office of Environmental Health Hazard Agency [OEHHA] 2009). BEHP is ubiquitous in the environment due to the high usage levels in modern society. BEHP can leach out of common products and enter the environment.

In landfills, BEHP has been shown to leach out of products and may enter runoff surface water or groundwater. Once in the water, BEHP has low solubility and tends to disperse slowly. In aquatic systems, BEHP is generally found attached to suspended particles or in the sediment. BEHP is readily degraded with exposure to light. The dominant mechanism for degradation in surface water and sediment is via exposure to bacteria and actinomycetes (OEHHA 2009). Half-lives in surface and marine waters range from under 1 day to more than 2 weeks (OEHHA 2009). BEHP is not considered a persistent pollutant.

BEHP has been shown to bioaccumulate in aquatic plants and invertebrates (OEHHA 2009). Although BEHP is often found in lipid tissues, fish do not readily bioaccumulate BEHP (OEHHA 2009). Specific enzymes in the gills of freshwater fish are thought to be able to break down BEHP, limiting entry into the organism, and thus, limiting bioaccumulation (OEHHA 2009).

4.1.5 Ecotoxicity of COPECs

4.1.5.1 *Metals*

The toxicity of metals in the aquatic environment is dependent on the partitioning and speciation of the given contaminant in the environment, which affect the overall bioavailability of the metal. Examining the total concentration of metal in a medium is not always predictive of the bioavailability of the metal in that environment. In general, metal bioavailability is dependent on redox, pH, hardness, organic carbon, percent fines, AVS, and other factors (ATSDR 2004b; Eisler 1998; Hoffman et al. 1995; USEPA 2007c). For several divalent metals, a key partitioning phase that controls

cationic metal activity and toxicity in sediments appears to be AVS, which is a measure of the amount of sulfides in sediment capable of binding to metals (DiToro et al. 1990, 1991; Ankley et al. 1996). Examining SEM and AVS can successfully estimate the bioavailability of some metals in aquatic environments. It is particularly useful for identifying samples in which toxicity due to SEM metals (i.e., cadmium, copper, nickel, silver, zinc) is not likely to occur (USEPA 2005e).

Some metals can act as essential nutrients to plants (e.g., copper, nickel, zinc, and others) at low to moderate concentrations but can be toxic at higher concentrations. Other metals can adversely affect growth and photosynthesis and may cause lethality depending on the chemical and species present (ATSDR 2004b). In invertebrates, exposure to metals can cause variable effects based on the taxa. Effects due to metals exposure to invertebrates may include decreased survival, growth, reproduction, immobility, gill damage, reduced filtration and feeding rates, and valve closure. In fish, effects from exposure to metals can include alterations to respiration and osmoregulation, gill damage, changes in olfactory and lateral line function, and changes to survival, growth, reproductive and developmental success, and behavior (ATSDR 2004b, 2005; Eisler 1987a, 1998). Some species may be able to develop tolerance to limited concentrations of certain metals, including but not limited to, cadmium and copper, via binding metals to metallothioneins and other proteins as a protective mechanism (Hoffman et al. 1995; International Program on Chemical Safety 1992).

4.1.5.2 *PAHs*

The aquatic toxicity of PAHs may be mitigated by several factors: PAH concentrations in even heavily polluted water are usually far below levels required for acute toxic effects, and PAHs in sediment may be less bioavailable and less toxic than PAHs in solution (Eisler 1987b). The molecular weight of PAHs is also an important factor in aquatic toxicity because toxicity generally increases as molecular weight increases; however, HMW PAHs tend to have low acute toxicity, possibly due to low water solubility (Eisler 1987b). Among aquatic organisms, crustaceans are most sensitive and teleost fish are least sensitive (Eisler 1987b). Toxic effects of PAH exposure in various taxa may include effects on photosynthesis, mobility, blood chemistry, skin, hematopoietic system, organs, immune system, respiratory and cardiovascular systems, reproduction, growth, and survival (Eisler 1987b; USEPA 2007c).

Unsubstituted LMW PAHs are not generally carcinogenic, while many HMW PAHs are known or suspected carcinogens, genotoxins, and mutagens (Eisler 1987b). Neoplasms or related disorders have been observed in connection with high exposure to HMW PAHs in terrestrial and aquatic organisms, including invertebrates and fish. Intraspecies and interspecies differences in response, as well as significant

interactions between HMW PAHs of differing potential carcinogenicity, make characterization of the specific carcinogenic contribution of individual HMW PAHs in the field difficult (Eisler 1987b). HMW PAHs in sediment have been associated with effects on benthic invertebrates, including reproductive effects, delayed emergence, sediment avoidance, and mortality. A variety of carcinogenic (especially in the liver), teratogenic, and other developmental effects have been observed in fish in connection with HMW PAH exposure in water and sediment (Hoffman et al. 1995, USEPA 2009c).

Toxic responses to PAHs have been shown to be induced by ultraviolet radiation. Photo-induced PAH toxicity has been shown to occur in aquatic organisms in petroleum-contaminated habitats (Ireland et al. 1996, Barron et al. 2000) and with specific PAHs such as anthracene (Oris and Giesy 1986) and fluoranthene (Boese et al. 1997).

Although individual PAHs may be toxic to an organism by a compound-specific mode of action, the prevalent mechanism of toxicity in invertebrates is narcosis, which can result in the alteration of cell membrane function (USEPA 2009c). Because narcosis is a non-specific mode of action and the effects are additive, it requires that the toxicity of PAH mixtures be considered (Swartz et al. 1997; DiToro and McGrath 2000; USEPA 2008c). The target lipid model (DiToro et al. 2000, Di Toro and McGrath 2000, McGrath et al. 2009) provides a way to quantify the narcotic effect of PAH mixtures while considering PAH bioavailability as well (USEPA 2003b, 2009c).

4.1.5.3 *PCBs*

Coplanar PCBs have chlorine atoms in non-ortho positions that allow the two benzene rings to lie in the same plane; non-coplanar PCBs have chlorine atoms in the ortho position causing the molecule to twist and the rings are on different planes. The relative toxicities of coplanar PCBs are calculated by expressing their toxicity in relation to 2,3,7,8-TCDD, which also shares the coplanar structure and is the most toxic dioxin (Eisler and Belisle 1996). These fractional potencies are known as toxic equivalency factors (TEFs) and are useful in estimating toxicity in PCBs and PCB mixtures. Toxicity of PCBs is a factor of both the number of chlorine atoms in the molecule and how close the benzene rings are to being coplanar (Loseto and Ross 2011).

PCB toxicity varies among different species of animals, but in general, reproductive effects tend to be the most sensitive endpoint. PCBs may also act as endocrine disruptors. Toxicity is believed to be related to the ability of the congeners to induce cytochrome P450-dependent activity. There are limited data regarding toxicity of PCBs to plant species. PCBs incorporated into phytoplankton exert inhibitory effects on photosynthesis and cell motility (Eisler 1986). PCB toxicity to invertebrates is generally less than that observed in vertebrate species due to limited detoxification systems.

Crustaceans and younger developmental stages appear to be the most sensitive groups, and lower chlorinated compounds appeared to be more toxic. The ability of invertebrates to accumulate PCBs from sediment or the water column makes them good indicator species.

PCB effects may be associated with the survival, growth, and reproduction of individuals within the local populations of fish and wildlife species, with reproduction broadly defined to include egg maturation, spawning, egg hatchability, and survival of fish larvae. The most sensitive endpoint for effects of PCB on fish is found during early life stage survival and recruitment as a result of PCB transfer from maternal tissue to eggs (Berlin et al. 1981). As a group, birds are more resistant to acutely toxic effects of PCBs than mammals, based on literature values (Eisler 1986). Signs of PCB poisoning among birds included morbidity, tremors, beak pointed upwards, and muscular incoordination (Eisler 1986). In mammals, long-term neurobehavioral changes were reported in children, monkeys, and rodents exposed to commercial PCB mixtures during fetal and neonatal development (Eisler 1986). Mink (*Mustela vison*) is among the most sensitive mammals to PCB toxicity, with documented reproductive failure, fetal death, altered blood chemistry, abnormal liver metabolism and histology, raised cortisol excretion, and altered metabolism of Vitamin A (Eisler 1986).

4.1.5.4 *Organochlorine Pesticides*

Organochlorine pesticides are made up of four groups based on chemical structure; these groups include the cyclodienes (e.g., chlordane, endosulfan, and endrin), diphenyl aliphatics (e.g., DDT and its metabolites), hexachlorocyclohexanes (e.g., lindane), and polychloroterpenes (e.g., toxaphene) (Becvar and Lotufo 2011). As a group, the cylcodienes are characterized as the most acutely toxic of the organochlorine pesticides (Elliott and Bishop 2011). There is variation in toxicity between the compounds, likely because of their varying ability to be metabolized. For example, chlordane can be metabolized to form a number of different metabolic products, including heptachlor and heptachlor epoxide, which may be more toxic than chlordane itself. However, all cyclodienes act through a central nervous system mechanism, with dietary exposure considered the most important route (Elliott and Bishop 2011). Acute toxicity of organochlorine pesticides to aquatic organisms has long been studied, oftentimes with rapid death of sensitive organisms at relatively low tissue concentrations and the accumulation of higher residues in the remaining resistant organisms (Becvar and Lotufo 2011). At low concentrations, pink shrimp are similarly susceptible to chlordane as grass shrimp. In contrast, similarly exposed Eastern oysters only showed decreased growth, with no apparent effects on mortality. Signs of chlordane poisoning in fish included hyper excitability, increased respiration rate, erratic swimming, loss of equilibrium, and convulsions; death frequently occurred within 12 hours of exposure (National Research Council Canada 1975).

The diphenyl aliphatics, such as DDT, are highly toxic to aquatic invertebrates with early developmental stages, which make them more susceptible to acute effects of DDT than adults (WHO 1989). Some effects may be reversible prior to lethality setting in, and some invertebrates have also shown resistance to DDT (WHO 1989). DDT is highly toxic to fish, causing effects to behavior, biochemistry, development, growth, histology, reproduction, and mortality (WHO 1989). The bioavailability and effects on benthic organisms of DDT (and other non-ionic chemicals acting by a specific mode of action) may be evaluated using equilibrium partitioning methods (DiToro et al. 1991, 2000).

4.1.5.5 *Dioxins and Furans*

While over 200 dioxin and furan isomers exist, seven dioxins and 10 furans are known by the WHO to be highly toxic (USEPA 2008c), with the most toxic isomers being 2,3,7,8-TCDD and 2,3,7,8-TCDF. In order to more readily assess the toxicity of dioxins and furans as a mixture, the system of TEFs was developed based on the toxicity of 2,3,7,8-TCDD. In this system, each isomer on the WHO list is assigned a factor (i.e., TEF) based on its potency relative to 2,3,7,8-TCDD; the estimated toxicity of all isomers present is summed to come up with an overall estimate of toxicity. Toxicity for these compounds is thought to be broken into three modes of action: 1) irreversible chemical binding to macromolecules inhibiting their function, 2) accumulation to high concentrations in lipids resulting in stress-induced dosing, and 3) irreversible binding to cellular receptors and enzymes inhibiting biochemical communications between cells (McKinney and Walker 1994). In most cases, the toxicity of dioxins and furans is linked to the interruption of function of a specific intracellular protein (AhR).

Invertebrate and vertebrate organisms respond differently to elevated concentrations of dioxins and furans, with invertebrates being relatively tolerant of exposure compared to vertebrate species. This difference may be due to the absence of some receptors in invertebrates that are adversely affected in vertebrate species (Hoffman et al. 1995). Due to their tolerance to exposure, invertebrates may accumulate dioxins and furans into their tissues from sediments, making them more biologically available to vertebrate species in the aquatic environment (Hoffman et al. 1995).

Laboratory toxicity data show that fish are generally more sensitive to 2,3,7,8-TCDD than plants, aquatic invertebrates, and other aquatic vertebrates (e.g., amphibians) (USEPA 2008c). The high lipid content in fish makes them highly susceptible to bioaccumulation of 2,3,7,8-TCDD in their tissues, which can essentially be transferred up the food chain to higher-trophic-level organisms, such as birds and mammals (including humans). Effects of 2,3,7,8-TCDD exposure to mammals and birds are similar to fish and include delayed mortality, a “wasting” syndrome characterized by

reduced food intake and reduced body weight, reproductive toxicity, histopathological alterations, developmental abnormalities, and immunosuppression (USEPA 2008c).

4.1.5.6 *BEHP*

Toxicity to aquatic organisms is variable with arthropods being the most sensitive group that have been studied. Some fish, including the medaka, were sensitive to exposure with sublethal effects noted at low exposure concentrations (OEHHA 2009). However, in most studies toxic effects did not occur until reaching an exposure level above the water solubility of BEHP (OEHHA 2009). Sublethal effects include increased hatching time, reductions in body weight, reduced gonado-somatic index, changes in blood chemistry, developmental difficulty, and changes in sex ratio. Lethality is also possible depending on the concentration and organism (OEHHA 2009).

4.2 Ecological Conceptual Site Model

A preliminary ecological CSM was presented in the Phase I RIWP (Tierra 2005), in the SLERA (USEPA 2008a), and was recently updated in the Draft Interim Conceptual Site Model Report (Tierra 2011). Based on the review of additional data and reports (i.e., the data and information summarized in this document) and decisions from the BHHERA Workshop (ARCADIS and ToxStrategies 2011), the ecological/food web components of the CSM have been updated as displayed on Figure 4-1; the specific ecological exposure pathways are depicted on Figure 4-2. A summary of the key, risk-based components of the CSM is provided below.

4.3 Ecological Exposure Pathways and Receptors

Representative receptor species for evaluation in the BERA were selected based on the available reports, biological surveys, habitat data, and other information from the NBSA, as discussed above. The following factors that were considered for the selection of proposed ecological receptors are the same as those considered in the Problem Formulation Document for the LPRRP (Windward/AECOM 2009):

- **Potential for exposure to sediment-associated chemicals** – Ecological receptors exposed to sediments through direct and incidental ingestion of sediment, ingestion of sediment-exposed prey, or direct contact with sediments have the greatest potential for exposure to sediment-associated chemicals, as opposed to species with less direct sediment contact. In addition, ecological species with small home ranges and whose site use is limited to the NBSA (e.g., mummichog) have a greater potential for exposure to site-related chemicals in sediment than do migratory species (e.g., bluefish), species with large home ranges, or species that do not exclusively use aquatic habitats (e.g., raccoon).

- **Relative ability to bioaccumulate/biomagnify site-related chemicals** – Species from upper-trophic levels (e.g., piscivores) have a greater potential for long-term exposure to bioaccumulative chemicals and a greater potential for the biomagnification of those chemicals.

- **Societal and cultural significance (including species that are highly valued by society)** – Federally and state-listed threatened and endangered species have special consideration in the selection of receptors. Appendix A provides the animal and plant species listed by the states of New Jersey and New York. In addition, the Atlantic sturgeon has a distinct population segment in the New York Bight that is federally-listed as endangered and has been captured once in Newark Bay in 1993 (Table 3-4). Also, those species that are commercially and recreationally important receive greater consideration in the selection of receptors.

- **Ecological significance (including species that serve a unique ecological function)** – Species with unique foraging preferences, such as those that primarily feed in shallow mudflat areas or are bottom-dwellers, receive special consideration.

- **Sensitivity to site-related chemicals** – Species with known sensitivities to particular chemicals (e.g., piscivorous birds sensitive to DDT, mink sensitive to PCBs) receive special consideration in the selection of receptors.

Ecological receptors may be directly exposed to chemicals through contact (e.g., direct contact to sediment and/or surface water), through ingestion of chemicals in water or sediments, or indirectly through the ingestion of contaminated food items. For an exposure pathway to be complete, a chemical must be able to travel from the source to receptors that utilize or inhabit the site and be taken up by the receptors via one or more exposure routes.

The representative receptors that may be exposed to chemical constituents in sediment, surface water, and/or tissue from the NBSA are listed below. Most of these organisms are subject to being exposed to multiple habitats and areas within the NBSA. Aside from plants and infaunal benthic invertebrates, most species are not sessile and will actively move in and out of different habitats/geomorphic areas; thus exposing them to a wide range of chemical constituents within Newark Bay sediments and surface water. For instance, blue crabs inhabit the subtidal flats and intertidal areas in the summer but will overwinter deep in the Channels. Species with known locational (i.e., site) fidelity for all or part of their life history were considered in the selection of receptors. Species were also selected based on feeding guild (e.g., benthic-feeders vs. piscivorous) which reflects differences in exposure.

- Aquatic plants
- Invertebrates
  - Benthic invertebrate community (e.g., amphipods [*Ampelisca abdita* and *Leptocheirus plumulosus*], polychaetes [*Neanthes virens*])
  - Crustaceans (e.g., blue crab,shrimp)
  - Mollusks (e.g., eastern oyster, softshell clam, blue mussel, *Macoma* sp.)
  - Plankton (e.g., zooplankton, ichthyoplankton)
- Reptiles (e.g., diamondback terrapin and sea turtles)
- Fish
  - Forage (e.g., mummichog, bay anchovy, alewife, and herring)
  - Benthic (e.g., Atlantic tomcod, winter/summer flounder, and Atlantic sturgeon)
  - Pelagic (e.g., white perch, striped bass, American eel, weakfish, and bluefish)
- Birds
  - Benthic-feeding (e.g., spotted sandpiper)
  - Insectivorous (e.g., tree swallow, marsh wren, and red-winged blackbird)
  - Omnivorous (e.g., lesser scaup)
  - Piscivorous (e.g., double-crested cormorant, osprey, common tern, and belted kingfisher)
- Mammals
  - Insectivorous (e.g., little brown bat)
  - Omnivorous (e.g., raccoon, muskrat)
  - Piscivorous (e.g., river otter, harbor seal, mink)

4.4 Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

AEs are defined as "an explicit expression of the environmental value that is to be protected" (USEPA 1997a). Because it is not practical or possible to directly evaluate risks to all of the individual components of the ecosystem, AEs focus the risk assessment on particular components of the ecosystem that could be adversely affected by site-related constituents. The AEs were selected based on the June 2011 BHHERA workshop (ARCADIS and ToxStrategies 2011) and are as follows:

- Survival and/or growth of aquatic plants and maintenance of plants as a food resource and habitat for fish and wildlife
- Survival, growth, and/or reproduction of invertebrates
- Survival, growth, and/or reproduction of reptiles
- Survival, growth, and/or reproduction of fish
- Survival, growth, and/or reproduction of birds
- Survival, growth, and/or reproduction of mammals

Following the selection of AEs, testable hypotheses are developed to determine whether or not a potential risk to the AE exists (USEPA 1997a). A testable hypothesis is an operational statement of an investigator's research assumption made to evaluate logical or empirical consequences (USEPA 1997a, 1998). Similar to the LPRRP, the testable hypotheses for the NBSA are presented as a series of risk questions about the relationship between each of the AEs and the responses of the receptors when exposed to chemicals within Newark Bay.

Hypotheses usually postulate that there is no effect or no difference (among groups or measurements), and data are collected to confirm or refute that hypothesis. This document provides a series of risk questions developed based on the June 2011 BHHERA workshop (ARCADIS and ToxStrategies 2011). Table 4-3 presents an overview of the candidate AEs, testable risk hypotheses (phrased as risk questions), representative receptors, MEs, data use objectives, and biological data to be collected based on discussions at the BHHERA Workshop. Also included in Table 4-3 is a general discussion of the data that may be collected and/or compiled based on existing data, as appropriate, from background reference areas to help address the risk questions and MEs. According to USEPA (2002d), the background reference area is an area where background samples are collected for comparison with samples

collected on site. The reference area should have the same physical, chemical, geological, and biological characteristics as the site being investigated, but has not been affected by activities on the site. A regional background approach and stressor evaluation will be developed for use in the risk characterization of the risk assessments, subject to USEPA approval (USEPA 2002d).

An ME is defined as the "measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint" (USEPA 1997a). Final MEs have been selected based on various discussions and document exchanges among Tierra, USEPA, and the Partner Agencies:

- A conference call among all parties on January 22, 2013
- A meeting between Tierra and USEPA on February 22, 2013
- Meeting Minutes from the February 22, 2013 Meeting
- Responses to USEPA Comments on the Draft Problem Formulation document (February 28, 2013)
- EPA Resolution on Comments and Responses to Comments NBSA Problem Formulation Document (provided in an email from E. Naranjo dated March 22, 2013)
- Email from E. Naranjo dated April 4, 2013 (USEPA 2013)

Table 4-4 presents the final selected AEs, MEs, and data to be collected to support the BERA. It also provides the anticipated timeframe for data collection over the next year. Additional dialogue with USEPA and its Partner Agencies as well as future planning documents (i.e., work plans, field sampling plans, QAPPs) will establish final sampling efforts.

4.4.1 Plants

Assessment Endpoint 1: Survival and/or growth of aquatic plants and maintenance of plants as a food resource and habitat for fish and wildlife.

> Plants comprise the base of the food web, serving as food for herbivorous and omnivorous organisms, and create refuge habitat for small, juvenile, and sessile organisms.

Risk Question: *Are COPEC concentrations in surface water and sediments from the NBSA greater than benchmarks for the survival and/or growth of aquatic plants?*

The risk question for plants will be addressed by comparing concentrations of COPECs in surface water (including associated physical parameters) and surficial sediment from intertidal areas to available and relevant toxicological benchmarks. The data use objective for this ME is to estimate the exposure of plants via direct contact and uptake of chemicals in surface water and sediment.

4.4.2 Invertebrates

Assessment Endpoint 2: Survival, growth, and/or reproduction of invertebrates.

Invertebrates form the base of the food web for fish and other upper-trophic level organisms. There are a variety of taxonomic feeding guilds for aquatic and benthic invertebrates including filter-feeders, deposit-feeders, detritivores, and omnivores. Each taxonomic feeding guild has a unique exposure potential to constituents in NBSA media which will be evaluated in the BERA.

Risk Question: *Are invertebrate communities in the NBSA different from those found in similar nearby water bodies with chemical concentrations at regional background levels?*

This question will be addressed by comparing community structure data (e.g., total invertebrate abundance, species richness, and abundance of species or specific taxonomic groups) from Newark Bay to appropriate reference populations using diversity indices, multivariate, and spatial statistical techniques. The data (chemicals and conventional parameters, such as grain size) and results of the benthic community analysis will be used to develop benthic community metrics to be used as an additional line of evidence. This line of evidence will be part of the sediment quality triad approach, which is a sediment assessment technique that incorporates information about sediment chemistry, toxicity, and benthic community metrics. Additional information will be collected on ecosystem characteristics, such as grain size, TOC, and other attributes, to assist in the evaluation of the data in the context of the overall health of the benthic community. The details of the approach for the sediment quality triad and risk characterization using the benthic community data will be presented in the upcoming field sampling plans/work plans.

Risk Question: *Are COPEC residues in invertebrate tissues from the NBSA greater than tissue benchmarks (e.g., critical body residues [CBRs]) for the survival, growth, and/or reproduction of invertebrates?*

This question will be addressed by comparing chemical concentrations in laboratory-exposed and/or site-collected invertebrate tissues to literature-based CBR values. The data use objective for this ME is to assess the adverse effects of chemicals on the invertebrate community. Field-collected tissue data from clams (e.g., *Mya arenaria* or *Macoma* sp.), and/or blue crabs from the NBSA will be analyzed and compared to literature-based CBRs. If sufficient tissue cannot be collected for analysis, a caged bivalve study will be conducted to evaluate COPEC residues in bivalves. In addition, a polychaete worm (e.g., *Nereis virens*) and/or the eastern oyster (*Crassostrea virginica*) may be used to conduct the laboratory and/or field bioaccumulation tests. Whole-body benthic infaunal invertebrate tissue from the tests will be chemically analyzed and then compared to literature-based CBRs.

Risk Question: *Are the COPEC concentrations in sediments from the BAZ greater than benchmarks for the survival, growth, and/or reproduction of invertebrates?*

Chemical concentrations in sediment will be compared to toxicological sediment benchmarks from the literature. The data use objective for this ME is to evaluate the effects of chemical concentrations in sediment on the benthic invertebrate community of the NBSA. Surficial sediment will be collected from the BAZ, which is estimated to be the top 6 inches, and chemically analyzed.

Risk Question: *Is the survival, growth, and/or reproduction of invertebrates exposed to sediments from the BAZ of the NBSA significantly lower than that in reference sediments?*

Laboratory toxicity tests using NBSA surface sediment will be conducted. Proposed tests include a 10-day survival and growth study with *Ampelisca abdita*, a subset of stations are proposed for a 28-day study with *Leptocheirus plumulosus* for survival, growth, and reproduction; and a caged *in-situ* study with eastern oyster for reproduction. The data use objective for this ME is to assess the adverse effects of chemicals (and evaluation of conventional parameters, such as grain size, TOC, sulfide, and ammonia) in sediment to the benthic invertebrate community.

Surface sediment for the bioassays will be collected throughout the NBSA from the BAZ, which is estimated to be the top 6 inches. The results of the bioassays will be statistically compared to bioassays conducted with control sediment for quality assurance/quality control purposes.

The results will also be evaluated using existing regional background comparisons to support risk management decisions, subject to USEPA approval. Amphipods

are considered to be a sensitive biological organism for representing potential risk to the benthic community. Caged bivalve study results will be compared to results obtained at relatively un-impacted reference stations, if practicable.

Risk Question: *Are COPEC concentrations in porewater and surface water from the NBSA greater than toxicological benchmarks for the survival, growth, and/or reproduction of invertebrates?*

This question will be addressed by comparing dissolved chemical concentrations in pore and surface water collected from benthic invertebrate exposure areas to toxicological benchmarks. The data use objective for this ME is to estimate the exposure of the benthic invertebrate community to dissolved COPECs in surface water and in sediment porewater. Surface water will be collected from two depth intervals (one sample from near the sediment-water interface and one sample from 2 ft below the water's surface). This will provide a range of concentrations for different habitats/exposure areas. The water column sample will be representative of pelagic habitat and the sample closer to the sediment-water interface will be representative of epi-benthic habitat.

4.4.3 Reptiles

Assessment Endpoint 3: Survival, growth, and/or reproduction of reptiles.

Risk Question: *Are COPEC concentrations in site surface water and sediment at levels that might adversely affect survival, growth, and/or reproduction of reptiles?*

This question will primarily be addressed qualitatively by discussing the possibility of reptiles inhabiting the NBSA. Information pertaining to any reptiles noted during reconnaissance surveys and/or field work will be recorded. In addition, concentrations of COPECs in surface water and surficial sediment from subtidal and intertidal areas will be compared to available, relevant toxicity-based benchmarks. The data use objective for this ME is to estimate the exposure of reptiles via direct contact and uptake of chemicals in surface water and sediment.

4.4.4 Fish

Assessment Endpoint 4: Survival, growth, and/or reproduction of fish.

Fish in the NBSA serve the middle portions of the food web. They consume invertebrates and other lower-trophic level organisms but, in turn, are fed upon by upper-trophic level birds and mammals. Similar to invertebrates, there are

various taxonomic feeding guilds for fish including benthic-feeding (i.e., benthivores), omnivorous forage fish, and pelagic predatory fish. Each feeding guild has a unique exposure potential to constituents in NBSA media which will be evaluated in the BERA.

Risk Question: *Are COPEC concentrations in fish tissues from the NBSA greater than critical body residue values (i.e., CBRs) for the survival, growth, and/or reproduction of fish?*

Identified fish receptors will be collected throughout the NBSA for whole-body chemical analyses. These data will be compared to literature-based CBRs and/or to whole-body fish tissue chemical concentrations of selected receptors from background reference locations. Specific species of fish will be targeted so that representative species from each of three trophic levels are captured: forage fish, benthic/demersal, and pelagic predatory. Additional physical and biological information will be collected (details to be provided in the upcoming field sampling plans, work plans, and QAPPs) to assist in the interpretation of results in terms of fish population health and include, but are not limited to the following: COPEC concentrations in the tissues (whole body, liver, bile) of fish from the NBSA and reference areas, and associated variables (e.g., percent lipids, fish species, length, weight, age, sex). Species with relatively small home ranges will be targeted. Tissue samples for the BERA should be at sizes relevant to predator preferences and should be whole body composites (e.g., 10 to 20 fish ranging in size from 5 to 20 cm long). Chemical concentrations in a subset of liver and gut tissues will also be collected and compared to relevant CBRs.

External health observations (gross histological analysis) will be made on all fish to provide information on fish population health. The qualitative fish health observation data (e.g., gross histology) will be used to provide general information about the health of NBSA fish populations. Internal histopathology (e.g., of existing tumors, liver, and gonad tissues) of a subset (e.g., 5 to 10 select fish) will also be conducted.

Risk Question: *Are COPEC concentrations in porewater, surface water, and sediment from the NBSA greater than benchmarks for the survival, growth, and/or reproduction of fish?*

Chemical concentrations in dissolved pore water and surface water collected from the NBSA will be compared to toxicological benchmarks. The data use objective for this ME is to estimate the exposure of fish via the surface water exposure pathway to chemicals in surface water. Surface water data, including chemical and physical parameters, such as DO, salinity, pH, and hardness, will be used to

address this risk question. Chemical concentrations in sediment will be compared to toxicological sediment benchmarks from the literature. The data use objective for this ME is to evaluate the effects of chemical concentrations in sediment on fish populations in the NBSA. Surface sediment will be collected from the BAZ, which is estimated to be the top 6 inches, chemically analyzed, and compared to appropriate benchmarks.

To evaluate the potential effects of chemical constituents on reproduction of NBSA fish, a study may be conducted to assess the reproduction of fish species common in the NBSA, such as white perch or mummichog, similar to studies conducted by Cooper and Buchanan (2007). Fish would be collected from both the NBSA and a reference location. Reproductive health will be assessed on individual fish collected via morphology and/or biomarkers (e.g., gonado-somatic index, gonad condition and fecundity estimates, and vitellogenin) (Cooper and Buchanan 2007; Hsiao et al. 1994). Laboratory reproductive bioassays may also be conducted on the mummichog using sediment and/or water collected from various locations in the NBSA, as well as a reference area. Methods for a short-term reproductive bioassay with mummichog have been presented by Peters et al. (2007). In addition, an *in-situ* caged reproduction study may be considered. This would consist of enclosing fish from an appropriate background/reference location in cages in Newark Bay. This may be considered as an additional line of evidence if the primary lines of evidence are insufficient.

Assessing reproductive health of fish species in a large area can be difficult as effects seen in an individual fish may not always correspond to population-level effects. Some species have also been shown to develop adaptive resistance to environmental contamination over time (Cooper and Buchanan 2007; Nacci et al. 1999). It is recommended to use multiple lines of evidence (e.g., community studies, reproductive health of individuals, and bioassays) to estimate overall reproductive health in fish populations in the NBSA. To this effect, ichthyoplankton sampling will also be conducted during the fish trawls to aid in the evaluation of the reproductive health of the fish community and to supplement the existing ichthyoplankton community data.

4.4.5 Birds

Assessment Endpoint 5: Survival, growth, and/or reproduction of birds.

Birds comprise part of the upper trophic levels of the food web. There are four major feeding guilds of birds that will be evaluated in the BERA: benthivores (consume benthic invertebrates), insectivores (consume flying insects), omnivores (consume plant and animal matter), and piscivores (consume fish).

Each feeding guild has a unique exposure potential to constituents in NBSA media which will be evaluated in the BERA.

Risk Question: Does the daily dose of *COPECs received by birds (including piscivorous, benthivorous/sediment probing, omnivorous, and insectivorous) from consumption of tissues of prey species and other media in the NBSA exceed the toxicity reference values (TRVs) for survival, growth, and/or reproduction of birds? If yes, what are the probabilities of effects of differing magnitude for survival, growth and/or reproduction of birds?*

This ME will be evaluated by comparing receptor-specific modeled daily doses associated with the ingestion of chemicals in surface water, sediment, and prey tissue with literature-based dietary dose TRVs. The data use objective for this ME is to estimate exposure of bird receptors via various exposure pathways to chemicals in surface water, sediment, and prey tissue. Four different feeding guilds will be evaluated: piscivorous, benthivorous/sediment-probing, omnivorous, and insectivorous. Surface sediment chemical data (from the BAZ), surface water chemical data (whole water concentrations), and benthic invertebrate and/or fish prey tissue chemical data, depending on receptor-specific diet, will be used to develop the dietary model for each bird receptor. Exposure data used in this ME will be used in the development of a food web model. If potential risks are evident, a Probabilistic Risk Assessment may be conducted to quantify the uncertainty in the food web modeling.

Risks to birds may also be assessed by evaluating field-collected tissue residues of birds (specifically egg tissue) that will be compared to literature-based CBRs for avian eggs. Egg tissue could be collected from the islands within the NBSA (e.g., Shooters Island, Pralls Island) that have historically provided adequate nesting habitat. Final selection of species and specific nesting locations will be determined prior to egg collection during a nest survey. Double-crested cormorant eggs would be the primary target because of their piscivorous diet and their abundance. Caveats to egg tissue collection and analysis include the limited available toxicity thresholds and permitting limitations associated with collecting the eggs. Any egg tissue sampling would likely be an opportunistic event and the targeted number of samples would be dependent upon species, number of nests available, permit requirements, and sample design.

4.4.6 Mammals

Assessment Endpoint 6: Survival, growth, and/or reproduction of mammals.

Mammals comprise another portion of the upper trophic levels of the food web. There are four major feeding guilds of mammals that will be evaluated in the BERA: insectivores (consume flying insects), omnivores (consume plant and animal matter), and piscivores (consume fish). Each feeding guild has a unique exposure potential to constituents in NBSA media which will be evaluated in the BERA.

Risk Question: Does the daily dose of COPECs received by mammals (including omnivorous, piscivorous, and insectivorous mammals) from consumption of the tissues of prey species and from other media at the NBSA exceed the TRVs for survival, growth, and/or reproduction of mammals? If yes, what are the probabilities of effects of differing magnitude for survival, growth, and/or reproduction of mammals?

This ME will be evaluated by comparing receptor-specific modeled daily doses associated with the ingestion of chemicals in surface water, sediment, and prey tissue with literature-based dietary dose TRVs. The data use objective for this ME is to estimate exposure of aquatic and semi-aquatic mammals to chemicals in NBSA surface water, sediment, and prey tissue. Three different feeding guilds will be evaluated: omnivorous, piscivorous, and insectivorous. Surface sediment chemical data (from the BAZ), surface water chemical data (whole water concentrations), and benthic invertebrate and/or fish prey tissue chemical data, depending on receptor-specific diet, will be used to develop the dietary model for each mammal receptor. Exposure data used in this ME will be used in the development of a food web model. If potential risks are evident, a Probabilistic Risk Assessment may be conducted to quantify the uncertainty in the food web modeling.

4.5 Ecological Risk Assessment Data Needs

Sampling/data needs for the BERA are identified in Table 4-4, as well as with their associated data use objective and include the following general needs:

- Co-located surficial sediment chemistry data collected from the top 6 inches (possibly to 12 inches in areas that are likely to experience surface sediment erosion) and porewater analytical data from throughout Newark Bay, including the Intertidal Areas, Subtidal Flats, and Channels

- Surface water analytical data from two distinct depths, one close to the sediment-water interface and one from 2 ft below the water's surface

- Toxicity data (i.e., from laboratory and *in situ* studies)

- Benthic invertebrate community structure data
- Forage fish, benthic fish, and pelagic predatory fish tissue data (including gut contents and bile analysis)
- Ichthyoplankton community data
- Whole body invertebrate chemistry data (e.g., blue crab and softshell clam)
- Blue crab hepatopancreas chemistry data
- Bird (egg) tissue chemistry data
- Mammal population survey
- Regional background reference locations will need to be established for sediment and fish tissue collection

5. Baseline Human Health Risk Assessment

This section discusses the BHHRA framework for the NBSA. The human health CSM includes potential exposure scenarios, populations exposed, and potential exposure pathways. In addition, exposure factors are discussed, and a preliminary summary of environmental data needs for the BHHRA is provided. As discussed in Section 1, although the problem formulation step is formally part of USEPA's Eight-Step ERA process (USEPA 1997a), and as such, is not typically addressed as part of the HHRA, it is included in the BHHRA portion of this document to provide a roadmap for implementing the fieldwork to support the BHHRA for the NBSA.

5.1 Human Health Conceptual Site Model

An interim human health CSM has been developed and is presented in the *Interim Conceptual Site Model* (Tierra 2011). Based on the review of additional data and reports (i.e., the data and information summarized in this document) and decisions from the BHHERA Workshop (ARCADIS and ToxStrategies 2011), the current human health CSM has been revised and updated and is depicted on Figure 5-1. As more information is collected throughout the RI/FS process, the CSM will be further refined as appropriate. For example, soil may be added as a secondary source as more information about historical floodplains is acquired.

As shown in Figure 5-1, primary sources of contamination include industrial point sources, non-point source runoff, sanitary sewer overflows, CSOs, tributaries, and atmospheric deposition. Secondary contamination sources include sediment and surface water. Potential exposure routes resulting from sediment and surface water include ingestion of fish and shellfish, ingestion of waterfowl, dermal contact, incidental ingestion and inhalation (via ambient air). The following pathways will be quantitatively evaluated for the recreational user: dermal contact, incidental ingestion, and inhalation from sediment and surface water. For the angler/sportsman, waterfowl ingestion will be qualitatively evaluated; the remaining pathways will be quantitatively evaluated (fish and shellfish ingestion, dermal contact, incidental ingestion, and inhalation from sediment and surface water). The applicable residential exposure pathways (fish and shellfish ingestion, dermal contact, incidental ingestion, and inhalation from sediment and surface water) will be further considered after additional reconnaissance determines whether a standard residential scenario is applicable for the NBSA. All applicable exposure pathways will be qualitatively evaluated for the transient (fish and shellfish ingestion, dermal contact, incidental ingestion, and inhalation from sediment and surface water). For the port/dock worker, the following pathways will be

quantitatively evaluated: dermal contact, incidental ingestion, and inhalation from sediment and surface water. The need to evaluate a diver for this scenario is currently under review. Additional detail regarding the CSM, associated sources and migration pathways will be documented in the 2013 revision to the *Interim Conceptual Site Model* (Tierra 2011).

5.2 Human Exposure Scenarios – Current and Future Land Use

As discussed above in Section 3.1.2.2, future land use is not expected to differ significantly from current use; as such, the BHHRA will apply a "combined current and future land use" scenario. It is important to note, however, that the concentrations of COPCs in NBSA environmental media are expected to decrease over time. This will need to be accounted for in the Feasibility Study and will be discussed in the revised CSM.

Additionally, USEPA's comments on the Interim Conceptual Site Model (USEPA 2011b) regarding NBSA future use state the following:

> *It is our goal to restore full use of the NBSA as a valuable natural resource for native species and to restore full recreational and commercial use. This would involve improvements in surface water and sediment quality to reduce or remove current fishing and crabbing bans and allow safe wading and swimming. Therefore, future use should be characterized as higher frequency and duration of use.*

Meeting Minutes from the June 2011 BHHERA Workshop (ARCADIS and ToxStrategies 2011) state that future land use will be documented and considered consistent with USEPA's land use and land reuse guidance (Office of Solid Waste and Emergency Response [OSWER] Directive 9355.7-19) entitled *Considering Reasonably Anticipated Future Land Use and Reducing Barriers to Reuse at EPA-lead Superfund Remedial Sites* (USEPA 2010c), which says:

> *Information on surrounding land use may suggest how the site could reasonably be used in the future. Sources and types of information that may aid EPA in determining the reasonably anticipated future land use include: current land use; zoning maps; comprehensive community master plans; accessibility of site to existing infrastructure; recent development patterns; cultural factors; and environmental justice issues. (OSWER Directive No. 9355.7-04, p.5). Discussions with the public, local land use authorities and other appropriate officials should be*

conducted. "By developing realistic assumptions based on information gathered from these sources early in the RI/FS process, EPA may develop remedial alternatives that are consistent with the anticipated future use" (OSWER Directive No. 9355.7-04, pp. 4-5).

5.3 Human Health Exposure Factors

Where appropriate, exposure factors used for the LPRRP HHRA will be used for the NBSA BHHRA. Where alternative values are proposed for the NBSA, these values will be fully documented. Exposure parameters will rely on site-specific data to the extent feasible, USEPA guidance documents, including the Exposure Factors Handbook (USEPA 2011a), and information in published literature. Exposure factors will be documented and discussed in the PAR; the factors will be presented in USEPA RAGS Part D format.

5.4 Potentially Exposed Human Populations

Human use of the NBSA includes commercial (e.g., shipping, commerce, industrial, and municipal infrastructure and use) and recreational (e.g., fishing, boating, swimming, and shoreline use) activities. Characterization of these activities is discussed in this section.

Based on currently available information, a residential scenario will not be evaluated because no properties or shoreline land segments were identified that would be characteristic of a standard residential exposure scenario. While residential properties do border the NBSA, significant obstructions or land-water elevation differences significantly limit human access. These characteristics, as a practical matter, exclude the typical residential exposure scenario for direct contact with NBSA surface water and sediment. As further discussed in Appendix B, to determine that a standard residential scenario was not applicable to the NBSA, Google Earth (imagery date: June 17, 2010) was previously used to determine whether the shoreline and sediments could be easily accessed. Ground-truthing of the Google Earth images, by taking additional photos and documenting the shoreline type, will be conducted during sediment and/or biota sampling. These assessments and findings will be included in later documents.

In addition to ground-truthing the Google Earth images for assessing potential residential land use, a reconnaissance survey will be performed to identify potentially accessible areas for the BHHRA (Section 6). This will also be conducted during

sediment and/or biota sampling activities. Current and future land use scenarios for consideration in the BHHRA will be revisited pending the outcome of these evaluations. Although the currently available information indicates a residential scenario is not applicable, local residents, including those whose properties border the NBSA will be evaluated using the parameters that are applied for the recreational user exposure scenario. The potentially exposed populations and associated site-specific exposure scenarios that will be evaluated are described further below.

5.4.1 Recreational Users

Five recreational areas exist along the eastern shore and one park area borders the western NBSA in the southern portion of the site. Although these parks are along the shore, they primarily offer land-based recreational opportunities, such as baseball diamonds, swing sets, and walking paths (City of Bayonne 2000, 2003) with limited opportunities for direct contact with sediments (Exhibit 5-1). Five recreational areas were identified in the Hackensack River south of Route 7. The Passaic River Yacht Club offers boating. Similar to recreational areas along the NBSA, the other four recreational areas primarily provide land-based recreational opportunities, including baseball diamonds, walking paths, swimming pools and tennis courts (Exhibit 5-2).

A desktop evaluation of potential recreational use of the NBSA was conducted by contacting numerous city and county parks and recreation departments, boating companies, and government agencies to characterize recreational activities, such as boating, sail boating, jet skiing, canoeing, and kayaking activities. Appendix D provides a list of entities contacted. The information collected from these entities indicates that there are occasional recreational activities that occur in the NBSA. For example, recreational boats travel through the NBSA to get to other areas (e.g., Raritan Bay and the Atlantic Ocean). Information also indicates that fishing is much more common in the NBSA than any other recreational activity. Separate from this assessment, a City of Bayonne document indicates that recreational boating in the NBSA appears to be limited due to commercial traffic and industry (City of Bayonne 2000). Marinas and boat ramps in the NBSA were identified using Google Earth imagery of the shoreline and internet searches (Appendix B). The National Park Service is developing a canoe and kayak trail in the Passaic River that will continue into northern Newark Bay, concluding on Kearny Point with a boat ramp and possible picnic area.

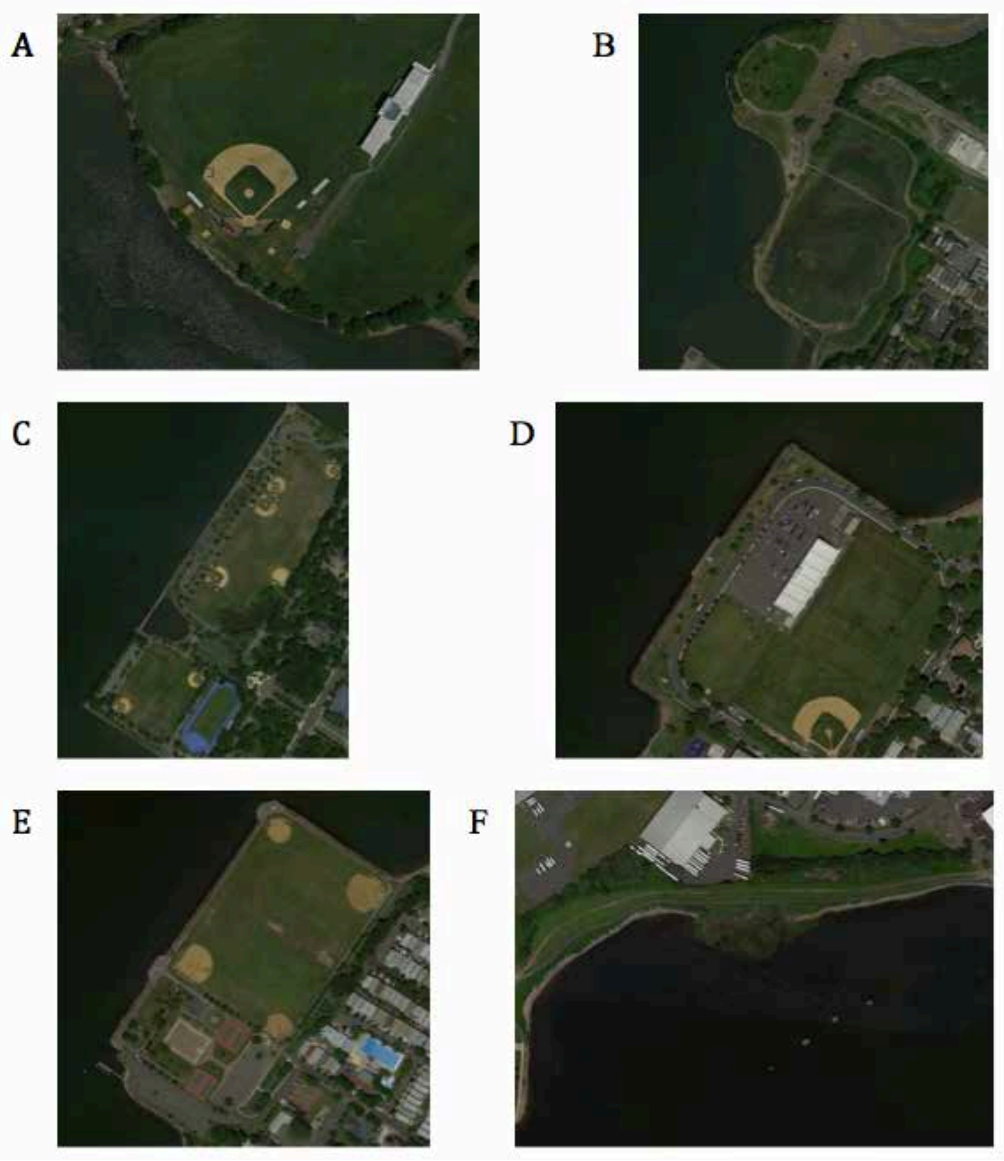


Exhibit 5-1 NBSA Recreational Areas

A) Thomas M. Gerrity Athletic Complex, B) Rutkowski Park, C) Bayonne Park, D) Veterans Park, E) 16th Street Park, F) Arthur Kill Park

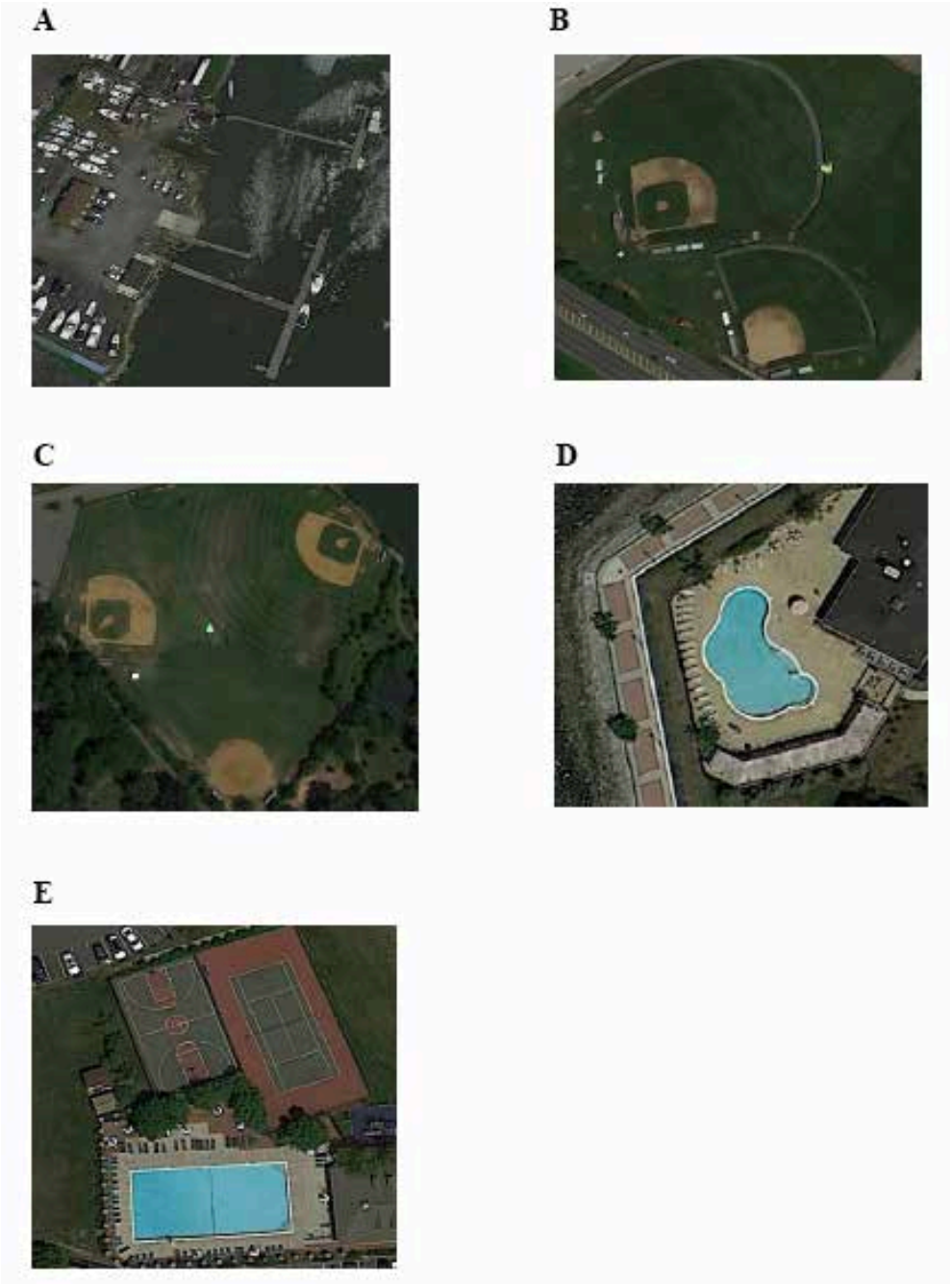


Exhibit 5-2 Hackensack River Recreational Areas

A) Passaic River Yacht Club, B) Joseph J. Jaroschak Field, C) Lincoln Park, D) Society Hill at Droyers Point, E) Society Hill in Jersey City

The possibility of a hunting scenario was also evaluated for the NBSA. Existing hunting regulations were reviewed, and the New Jersey Division of Fish and Wildlife, Bureau of Law Enforcement and the New Jersey State Police were contacted. Research confirmed that hunting is permitted in the NBSA, and there are no Federal Aviation Administration regulations that prevent shooting in the vicinity of Newark Liberty International Airport. State laws govern hunting in the area, including hunting for waterfowl. New Jersey Division of Fish and Wildlife, Bureau of Law Enforcement indicated that they have not observed anyone hunting in the NBSA. Waterfowl hunting is popular in the Hackensack River, and to a lesser extent, in the Passaic River. These data collectively indicate that hunting in the area is not likely to occur, and hunters do not frequent the area. Since hunting is legal in the NBSA, waterfowl hunting will be qualitatively evaluated for the angler/sportsman scenario.

As previously discussed, there are indications that people actively fish and/or crab along several locations of the NBSA shoreline.

5.4.2 Port/Dock Workers

There are several bridges and other structures located in the NBSA. For instance, the piers/foundations that support the Bayonne and Goethals Bridges are located close to or within the water. As such, port/dock workers and commercial divers perform bridge, construction, and repair work in various areas of the NBSA. A number of commercial diving companies, including the U.S. Coast Guard and other entities, were contacted to develop information to characterize potential exposures to industrial workers (Appendix D). Based on the information received to date, commercial divers work on a project-specific basis, with no limit on the number of consecutive days they may dive. Some work 8- to 10-hour days and over 200 days per year. Additional information regarding commercial diving in the area is being collected and will be presented in future documents.

5.4.3 Transient Users

In order to characterize a potential transient population living along the perimeter of the NBSA, a desktop review was conducted using various internet websites, peer-reviewed literature, publicly available documents describing transient activity in the area, and newspaper archives for the cities and counties surrounding the NBSA. Peer-reviewed literature on the transient population of the NBSA was limited to papers and abstracts that characterized the populations along the Lower Passaic River (e.g., Donovan et al. 2008, Proctor et al. 2002) and not the shoreline of the NBSA.

Publically available documents describing long-term plans to address transient individuals and other community involvement plans were reviewed for details or characterizations of potential transient populations associated with the NBSA. These documents included the following:

- The Hudson County 2010-2014 Five Year Consolidated Plan (Hudson County 2010)
- The Road Home: A Ten Year Plan to End Homelessness in Newark and Essex County (2010-2020) (Essex-Newark Task Force to End Homelessness 2010)
- Lower Passaic River Restoration Project and Newark Bay Study – Community Involvement Plan (Malcolm Pirnie, Inc. 2006)

Malcolm Pirnie, Inc. (2006) indicates that homeless populations are living in several places along the Passaic River and around Newark Bay, but does not identify any specific locations along the actual perimeter of Newark Bay. The report notes that areas where transient populations congregate include “Container City” near Port Newark, an area near Minish Park in Newark, and wooded areas near the Dundee Island in the northern portion of the LPRRP area. The other two documents provide city and county homeless population statistics, but no quantitative or qualitative assessments of individuals along the NBSA.

General internet searches for blogs, community websites, and other information on the transient population in the area did not produce any results.

A search of newspaper archives going back to January 2004 yielded two results related to transient individuals in the NBSA. *The Jersey Journal* reported on March 19, 2012, that a man, presumed to be transient, had been found deceased on the shore of Newark Bay in Bayonne (Conte 2012). The article does not describe any other known transient activity in the area and treats the death as an isolated incident. On September 7, 2010, *The Jersey Journal* reported the homicide of a man on a cove near the Tidelands Athletics Complex (Conte 2010). According to the article, investigators determined that the man had been staying with relatives but had been camping on the shore for a couple of days before the murder. Only a single tent was identified on the shore, and the article did not include any additional details about transient persons frequenting that area.

In summary, internet searches, peer-reviewed literature, public studies, and long-term community plans do not describe transient populations living along the NBSA itself. Newspaper archives provide only two individual instances of transient persons along the banks of the NBSA. Therefore, while there are occasional descriptions of transient individuals in the area, the information sources reviewed do not indicate that a significant transient population inhabits the NBSA shoreline. Given the lack of information, the transient population will be evaluated qualitatively in the BHHRA

5.5 Human Health Exposure Pathways

Based on the human use activities discussed above, it is likely that the current and future human users (i.e., the potentially exposed populations) of the NBSA include anglers/sportsmen, port/dock workers, recreational users, and potential transients (Figure 5-1). The human use activity data also indicate that the media of interest relevant to evaluating potential human health exposures for the NBSA include the following:

- Surface water
- Sediment
- Fish tissue
- Shellfish tissue
- Ambient air

Human exposure pathways were identified based on consideration of the source, release, type, and location of chemicals at the site; the likely environmental fate (including persistence, partitioning, transport, and intermedia transfer) of these chemicals; and the location and activities of the potentially exposed populations. Exposure points (points of potential contact with chemicals) and routes of exposure (e.g., ingestion and inhalation) were identified for each exposure pathway consistent with USEPA guidance (USEPA 1989). The most significant pathway by which people may be exposed to chemical constituents in the NBSA is expected to be from consuming fish and/or shellfish (USEPA 2000c, 2005d). These populations may also be exposed to chemicals through direct contact with sediment and/or surface water during recreational activities, such as fishing, boating, or wading. They may also incidentally ingest chemical constituents from sediment and/or surface water during

these activities. Impacts to sediments will be evaluated for fish and shellfish ingestion, dermal contact, incidental ingestion, and inhalation exposures (Figure 5-1).

Each of the above-listed routes of exposures will be evaluated quantitatively using algorithms presented in USEPA guidance (e.g., USEPA 1989, 1991a, 1991b, 2001a, 2007a, 2009a). All pathways of exposure to a transient population that potentially resides or spends considerable time along the shore will be assessed qualitatively.

- Inhalation of chemicals that may volatilize from the exposed sediment or surface water and pose a threat to humans

- Exposures to a transient population that potentially reside or spend considerable time along the shore

5.5.1 Angler/Sportsman

The angler/sportsman exposure scenario considers adults, adolescents, and children catching and consuming a variety of fish (e.g., striped bass, bluefish, and flounder) and shellfish (e.g., blue crab and softshell clams) from the banks of the NBSA and from a boat on the NBSA. The angler/sportsman scenario for the NBSA includes both a reasonable maximum exposure angler/sportsman scenario and a central tendency exposure angler/sportsman scenario. As previously discussed, the collection and consumption of fish and shellfish (e.g., blue crab, softshell clams) from the NBSA has been documented or is expected, and thus, this exposure pathway is considered to be complete. Other potential exposure pathways relevant to the angler/sportsman include direct exposure (i.e., dermal contact and incidental ingestion) of sediment and surface water contacted during these activities. Inhalation of airborne chemicals may also occur if activities occur in intertidal areas, and if VOCs are present in sediments or surface waters. The sediment exposure scenario of an angler/sportsman catching fish from the shoreline will be quantitatively evaluated. The sediment exposure scenario of a person fishing from a boat, who is unlikely to be exposed to sediments, will be described qualitatively. Decreased concentrations of some COPCs in fish/shellfish through cooking loss will be considered and will be discussed in the PAR.

Since hunting is legal in the NBSA, waterfowl hunting will be qualitatively evaluated for the angler/sportsman scenario. Considerations for the decision to evaluate waterfowl on a qualitative instead of quantitative basis include the lack of observed hunting in the area and the type of food waterfowl consume (grass, not fish), which results in lower tissue concentrations. New Jersey state and federal migratory bird regulations discuss

hunting restrictions, permits, and bag limits. Relevant information from these documents, as well as ingestion rates based on bag limits and hunting seasons, will be discussed qualitatively in the BHHRA.

5.5.2 Recreational Users – Boaters, Swimmers, and Waders

In the BHHRA, three primary recreational uses associated with the NBSA will be quantitatively evaluated: boating, wading, and swimming. For these scenarios, exposure is primarily via direct contact (i.e., ingestion and dermal contact) with sediment and surface water. Inhalation exposure to VOCs may also occur if activities occur in intertidal areas or near surface water and/or sediments. Ingestion of fish will not be included as a potential exposure pathway for this scenario. Child, adolescent, and adult recreational exposure age categories will be evaluated for each of these recreational scenarios.

5.5.3 Port/Dock Worker – Including Commercial Diver

Port/dock workers have been identified as potentially exposed populations for activities involving repair of piers and pilings or surveying for subsurface (i.e., underwater) construction projects. These workers could potentially be exposed to sediment and surface waters of the NBSA via ingestion, inhalation, and dermal contact. These workers are governed by Occupational Safety and Health Administration (OSHA) in general and, for divers, the OSHA commercial diving regulations (29 Code of Federal Regulations Part 1910, Subpart T – Commercial Diving Operations). However, a review of applicable OSHA documents did not yield information useful for risk assessment purposes. Additional research regarding exposure to port/dock workers during diving activities will be conducted and discussed in a future document.

5.5.4 Transient

Although transients have been observed in temporary makeshift shelters near the Passaic River (Proctor et al. 2002), it does not appear that transient populations use the NBSA shore in a similar manner. Access to the shore in the industrialized areas of the port is restricted. Other areas, where recreational users have access to the shore, do not appear to support a transient population living along the shore. In addition, the industrialized shoreline of the NBSA limits potential areas for shelter, compared to the Passaic River. Thus, the potential for exposures to transient populations will be evaluated qualitatively, and publically available information will be used to characterize any such population.

5.6 Preliminary Human Health Risk Assessment Data Needs

Currently identified data needs for the HHRA are listed below. As various assessments are ongoing, which may influence the types of data available, the list may be revised over time.

5.6.1 Land Use, Zoning, Future Development Plans, and Hunting

As described above, research regarding current and future zoning, the potential for future development and use of the NBSA for hunting is considered complete. Land-use data indicate that future land use and zoning will not be significantly different from current land use and zoning. Any new residential developments will not likely provide significant access to the NBSA or warrant the need for a residential exposure scenario in any area. Based on this research, exposure by hunting will be qualitatively discussed but not included in the quantitative risk assessment. Additional research regarding access in non-industrial areas will be conducted as part of initial sampling efforts and discussed in future documents.

5.6.2 Environmental Media

Environmental media that need to be collected from the NBSA for the HHRA are: 1) fish and shellfish biological tissue data, and 2) sediment and surface water data from accessible areas. Each is discussed in detail below.

5.6.2.1 *Fish and Shellfish Biological Tissue Data*

Additional measurements of chemical concentrations in fish and shellfish from the NBSA are needed to better characterize the exposures from ingestion from fishing and crabbing. For some species of fish and for some types of chemicals, the data are limited or non-existent. For example, no tissue data are currently available for PCNs or PBDEs, and no data are available for dioxin-like congener PCBs in fish (NJDEP dataset only includes data for these contaminants in crabs). For several chemicals, including dioxins and furans, the data are limited to one white perch fillet, two American eel, and seven striped bass fillet samples. Therefore, future sampling efforts, particularly for fish tissue in the NBSA, representative of multiple edible species and analyzing for all COPCs, including but not limited to, PCNs, PDBEs, dioxins/furans, and dioxin-like PCBs, are necessary. The data needs for specific fish/crab tissue types (e.g., fish fillets, crab muscle/hepatopancreas) and a list of target species will be provided in the sampling work plan.

5.6.2.2 *Sediment Concentrations in Accessible Areas*

In areas where the public may access NBSA sediment, samples of shoreline sediments will be collected to characterize COPC concentrations. Specific sediment sampling areas will be discussed in the sampling work plan after identification during a reconnaissance survey. All areas of accessible sediment will be considered, including areas beyond CSOs and stormwater outfalls.

5.6.2.3 *Surface Water Concentrations in Accessible Areas*

In areas where the public may access NBSA surface water, additional surface water samples will be collected to characterize COPC concentrations in these areas. In addition, COPC concentrations will be evaluated in surface water, sediment, and biological tissue collected from regional “background” locations. However, at this time, an appropriate “background” location has not been identified.

5.6.3 Exposure Factors

Several exposure factors could potentially be refined upon additional data gathering, including exposure frequency, exposure duration, exposure time, and skin surface area for port/dock workers. While some site-specific information has been collected regarding current port/dock workers (specifically commercial divers) and current recreational exposures, additional information may be collected from more commercial diving, recreational boating companies, and government entities. For example, for estimating current exposures for the port/dock worker and the recreational user, additional data to estimate exposure frequency and duration would help delineate these scenarios more accurately. Additional information regarding commercial diving in the area is being collected and will be presented in future documents to assist in evaluating whether a diver will be assessed quantitatively or qualitatively. Lastly, for further assessing potential residential land use and exposures (e.g., exposure frequency), ground-truthing of Google Earth images and a reconnaissance survey will be performed to identify potentially accessible areas.

6. Next Steps

This document presents Step 3 of the eight-step ERA process (Problem Formulation), which includes a CSM with identified exposure pathways and receptors, AEs, as well as the pertinent risk questions to be answered via data collection and analysis. Next, Step 4 will include the development of work plans, field sampling plans, and QAPPs, followed by data collection (Step 5), analysis (Step 6), risk characterization (Step 7), and risk-based decision making (Step 8).

The following work plans are examples of those anticipated to be developed during the next step of the process. However, it should be noted that these are preliminary examples, pending the outcome of the secondary data evaluation:

- **Field Survey/Reconnaissance Work Plan** will discuss how to physically document and characterize the possible ecological habitats in the NBSA, including the shoreline and intertidal areas. In addition, the reconnaissance survey will identify potentially accessible areas for the BHHRA. During this reconnaissance, mammal and bird nest surveys will also be performed.

- **Surface Water, Porewater, and Sediment Sampling and Analysis Plan (SAP)/QAPP** will describe, in detail, the proposed stations and methodology for collecting and analyzing surface water, porewater, and surficial sediment in the NBSA. Information will be provided regarding the collection of sediment and surface water for laboratory analysis.

- **Toxicity/Bioaccumulation Studies Work Plan** will describe, in detail, the proposed toxicity and bioaccumulation studies to evaluate potential adverse effects to fish and invertebrates exposed to media from the NBSA. The methodology for the collection and analysis of benthic invertebrate community metrics will also be provided.

- **Fish and Blue Crab SAP/QAPP** will describe, in detail, the proposed sampling methodology for collecting and analyzing fish and blue crabs from the NBSA.

- **PAR (Updated)** will be prepared. The updated PAR will include the COPC identification for the BHHRA, which was previously approved by the USEPA for the LPRRP HHRA (Windward 2012). Surface water will be screened against both aquatic criteria and human health criteria. The updated PAR will also include methods for calculating exposure point concentrations; an updated CSM; and

detailed discussions of the exposure scenarios, exposure parameters, and assumptions proposed to be used in the baseline risk assessments. Proposed toxicity reference values (TRVs) for the BERA will also be included. Results of the site reconnaissance to "ground-truth" shoreline access assumptions, habitats, and additional research regarding exposure to divers will also be included. The BHHERA will be prepared following USEPA approval of the PAR.

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Tables

Table 2-1
Industrial Sources to Newark Bay and its Tributaries

Site Name	Select On-Site COPCs[1]	Discharges Occurring From Site	References
Lower Passaic River			
Sherwin Williams	1,2,4-Trichlorobenzene	Historic combined sewer overflows (CSOs) and stormwater outfalls (SWOs) allowed for the discharge of process wastes to the Passaic River. Intentional dumping of product occurred to the Passaic River directly or via pipelines. Product spills led to piping network and then to the river.	U.S. Department of the Interior. 1969. Federal Water Pollution Control Administration: *Report on the Quality of the Interstate Waters of the Lower Passaic River and Upper and Lower Bays of the New York Harbor* , November, 1969.
	1,2-Dichlorobenzene		
	1,3 Dichlorobenzene		
	1,4-Dichlorobenzene		
	2,3,7,8-TCDD		PVSC Annual Reports, 1975 - 1976; excerpts concerning Brown Street Storm Sewer.
	2,4,5-Trichlorophenol		
	2,4,6-Trichlorophenol		PVSC. 1986. Memo from Lawrence to D'Ascensio, January 30, 1986.
	2,4-Dichlorophenol		
	2-Chlorophenol		Letter from NJDEP to Various Parties, enclosing *Directive No.1 for Natural Resource Injury Assessment and Interim Compensatory Restoration of Natural Resource Injuries;* September 19, 2003.
	Aroclor PCBs		
	Arsenic		
	BEHP		
	Chlorobenzene		
	Chromium		
	DDT		
	Hexachlorobenzene		
	Mercury		
	PAHs		
	PCDD/Fs (in addition to 2,3,7,8-TCDD)		
	Pentachlorophenol		
Diamond Alkali Superfund Site	2,3,7,8-TCDD	Direct discharges from the site occurred to the Passaic River via pipe.	Diamond Shamrock Chemicals Company; IT Corporation; Woodward- Clyde Consultants; Enviro-Measure, Inc. 1985. Site Evaluation 80 Lister Avenue; February.
	1,2-Dichlorobenzene		
	1,4-Dichlorobenzene		
	2,4,6-Trichlorophenol		Letter from NJDEP to Various Parties, enclosing Directive No.1 for Natural Resource Injury Assessment and Interim Compensatory Restoration of Natural Resource Injuries; September 19, 2003.
	2,4-Dichlorophenol		
	2,4-Dimethylphenol		
	Hexachlorobenzene		
	Chlorobenzene		USEPA 1984 Fact Sheet Diamond Alkali Co. EPA ID # NJD980528996, Region 2, Congressional District 13, NPL Listing History, Proposed Date 9/8/1983, Final Date September 21, 1984.
	Methylene Chloride		
	BEHP		
	DDT		
	DDE		PVSC 1956. Weekly Summary of Inspections by Inspectors, Week of July 16 to July 20, 1956.
	PAHs		
	Acetone		
	Arsenic		
	Chromium		
	Cyanide		
	Copper		
	Lead		
	Mercury		
	Phenol		
Bayonne Barrel & Drum	2,3,7,8-TCDD	Contaminated stormwater runoff from historic operations drained directly to the Passaic River via drainage ditches and storm drains to Harrison Creek. Process wastes discharged directly to the Passaic River via Harrison Creek.	USEPA. 1988. Site Inspection Review Report for Bayonne Barrel & Drum, December 7, 1988.
	2,3,7,8-TCDF		
	PCDD/Fs (in addition to above)		
	2,4-Dimethylphenol		
	Phenol		
	Benzenes		
	Chlorobenzene		
	Aroclor PCBs		
	Arsenic		
	Chromium		
	Mercury		
	Xylenes		
	4,4'-DDD		
	4,4'-DDE		
Chris-Craft (Montrose Chemical Site)	2,4-Dichlorophenol	Former employee stated in signed affidavit that wastes were piped directly to the Passaic River until the mid-1970s.	State of New Jersey, County of Essex 1993. *Affidavit of Oscar Randall* , notarized by Eileen M. Stephens, dated July 21, 1993.
	2,4,5-Trichlorophenol		
	Lindane		
	1,2-Dichlorobenzene		
	1,4-Dichlorobenzene		
	1,2,4-Trichlorobenzene		
	2,4-Dinitrophenol		

Table 2-1
Industrial Sources to Newark Bay and its Tributaries

Site Name	Select On-Site COPCs[1]	Discharges Occurring From Site	References
Lower Passaic River			
Chris-Craft (Montrose Chemical Site) (cont.)	Pentachlorophenol Hexachlorobenzene Chlorobenzene DDT BEHP Aroclor PCB 1248 PAHs Arsenic Chromium Copper Mercury		
Hilton-Davis/ Thomasett	1,2-Dichlorobenzene 1,2,4-Trichlorobenzene Hexachlorobenzene Chlorobenzene 1,4-Dichlorobenzene 1,3-Dichlorobenzene Aroclor PCB 1260 PAHs BEHP Arsenic Chromium Copper Mercury	Site sewers were historically piped directly to the Passaic River.	Letter from NJDEP to Various Parties, enclosing *Directive No.1 for Natural Resource Injury Assessment and Interim Compensatory Restoration of Natural Resource Injuries*, September 19, 2003. PVSC. 1956. *Weekly Summary of Inspections by Inspectors*, re: Hilton Davis site; August. 360 North Pastoria Environmental Corporation 1996. 104(e) Response provided to USEPA by 360 North Pastoria Environmental Corporation on behalf of Thomasset Colors Inc./Hilton Davis Chemical Company – A Division of Sterling Drug Inc.; January.
Alliance Chemical	1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 1,2,4-Trichlorobenzene Chlorobenzene 2,4-Dichlorophenol 2,4-Dinitrophenol	Site contained a landfill and a lagoon. The discharge pathway was from Plum Creek to the Passaic River from the onsite wastewater lagoon; another pathway was through the Roanoke Ave CSO to the river.	NUS Corporation. 1989. *Final Draft Preliminary Assessment Report for Alliance Inc*. prepared for USEPA. June.
	Pentachlorophenol 2-Chlorophenol Aroclor PCBs BEHP PAHs Arsenic Chromium Copper Mercury 4,4-DDE		
Pitt Consol (Reilly)	PAHs BEHP Chlorobenzene Benzene	Direct discharges occurred to the Passaic River via Roanoke Avenue CSO. Other discharges that occurred were from illegal process discharges, spills, and leaks to ground and surface water.	U.S. Department of the Interior. 1969. Federal Water Pollution Control Administration: *Report on the Quality of the Interstate Waters of the Lower Passaic River and Upper and Lower Bays of the New York Harbor*, November, 1969. PVSC. 1973. Annual Report by S. A. Lubetkin, for the Year 1973, excerpts re: Roanoke Avenue Storm Sewer. Clinton Bogert Associates 1979. *City of Newark Feasibility Study Pollution Abatement Program*; January Letter from NJDEP to Various Parties, enclosing *Directive No.1 for Natural Resource Injury Assessment and Interim Compensatory Restoration of Natural Resource Injuries*; September 19, 2003.
Lucent Technologies (Western Electric)	Aroclor PCBs BEHP PAHs Arsenic Benzene Chromium Copper Mercury	Drains were located in the drum storage area with unknown discharge points. Historic untreated discharges occurred to the municipal sanitary system. Process wastes discharged to the Passaic River via storm sewer system.	U.S. Department of the Interior. 1969. Federal Water Pollution Control Administration: *Report on the Quality of the Interstate Waters of the Lower Passaic River and Upper and Lower Bays of the New York Harbor*, November, 1969. Letter from NJDEP to Various Parties, enclosing *Directive No.1 for Natural Resource Injury Assessment and Interim Compensatory Restoration of Natural Resource Injuries;* September 19, 2003.

Table 2-1
Industrial Sources to Newark Bay and its Tributaries

Site Name	Select On-Site COPCs[1]	Discharges Occurring From Site	References
Lower Passaic River			
Vulcan Materials Co. (Safety Kleen)	Aroclor PCBs Chlorobenzene Benzenes Xylenes PAHs Lead Mercury	Historic direct discharges occurred to the Passaic River/Newark Bay via the on-site 36" outfall. Indirect discharges occurred from this facility due to explosions/fires.	U.S. Department of the Interior. 1969.Federal Water Pollution Control Administration: *Report on the Quality of the Interstate Waters of the Lower Passaic River and Upper and Lower Bays of the New York Harbor;* November, 1969. NJDEP. 1993. *Administrative Consent Order* re: Vulcan Materials Site, June. RCRA Facility Assessment Narrative. 1987. Prepared for Vulcan Materials; May. Vulcan Materials Company. 1969. Report to: EPA Region II New York re: Newark, NJ Plant; November. U.S. Department of the Interior, Federal Water Pollution Control Administration. 1969. Proceedings, Conference, In the matter of pollution of the Interstate Waters of the Hudson River and its Tributaries - New York and New Jersey, November. Inland Chemical. 1975. Letter to PVSC, August.
BASF Corp.	Aroclor PCBs BEHP PAHs Arsenic Benzene Chromium Copper Mercury	Stormwater and process water discharges to the Passaic River; spills, leaks and migration to the Passaic River of waste formerly stored on ground surface.	Memorandum For Record re: RCRA and PCB Inspections at the Kearny Works, circa October 27, 1981. BASF. 1994. 104 (e) Response provided to USEPA, January. BASF. 1995. Additional 104 (e) Response provided to USEPA, November. NJDEP. 1990. *Compliance Evaluation Inspection for BASF Kearny Site,* November. NJDEP. 1990. *Inspection Results for BASF Kearny Site* , ECRA case #90537, December.
Hackensack River			
Standard Chlorine	2,3,7,8-TCDD 1,2,4-Trichlorobenzene 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2,4-Dimethylphenol 2,4-Dichlorophenol Aroclor PCBs PAHs DDT Arsenic Chromium Copper Mercury	Overflows from on-site lagoons entered the Hackensack River, a tributary of Newark Bay, during times of heavy water usage or during flooding events. Chlorobenzene distilling operations wastewaters were discharged via a 4-6 inch line to the Hackensack River.	E.C. Jordan. 1985. *Phase II Dioxin Site Investigation Final Report – Standard Chlorine,* prepared for NJDEP, December. New Jersey State Department of Health - FWPCA Hudson Delaware Basins Office. 1969. Industrial Waste Survey for Standard Chlorine, July.
Northern & Central Newark Bay			
Prentiss Drug & Chemical	2,3,7,8- TCDD Aroclor PCBs Chlordane DDT Alpha BHC Beta BHC BEHP PAHs Benzene Arsenic Barium Cadmium Copper Lead Mercury Zinc	Stormwater and runoff discharges to Piersons Creek which eventually discharges to Port Newark Channel.	NJDEP, Prentiss Drug and Chemical Company, *General Information and Site History,* undated.

Table 2-1
Industrial Sources to Newark Bay and its Tributaries

Site Name	Select On-Site COPCs[1]	Discharges Occurring From Site	References
Northern & Central Newark Bay			
Central Steel Drum	2,3,7,8-TCDD	Drainage ditches exist to the east and south. These ditches received wastes from site runoff. Catch basins on the eastern portion of the site reportedly discharged to the drainage ditch along the east side of the site. These drainage ditches discharged into Newark Bay east of the site.	NJ Division of Law, Hazardous Site Litigation Section, SOL Referral, Site Summary report for Central Steel Drum, undated.
	2,3,7,8-TCDF		
	PCDD/Fs (in addition to above)		
	Aroclor PCBs		NJDEP Memorandum 1999. From A. Motter to J. DeNoble re: Central Steel Drum/Newark MOA, *Remedial Investigation Workplan,* September.
	2,4,5-TP		
	2,4,5-Trichlorophenoxyacetic acid		
	2,4-D		
	p,p'-DDT		
	Benzenes		
	PAHs		
	Arsenic		
	Chromium		
	Copper		
	Lead		
	Mercury		
	BEHP		
	VOCs		
	Xylenes		
Troy Chemical Corp.	1,2,4-Trichlorobenzene	Direct discharges have occurred from the site via 15 discharge pipes to Piersons Creek which discharges to Port Newark Channel.	S. McCone. 1977. Inspector Field Notes re: Albert Steel Drum and Related Properties in Newark, June.
	1,2-Dichlorobenzene		
	2,4-Dimethylphenol		
	Benzene		
	Chlorobenzene		
	PAHs		
	Aroclor PCBs		
	BEHP		
	Arsenic		
	Barium		
	Cadmium		
	Lead		
	Mercury		
	Silver		
	Zinc		
	4,4'-DDT		
Honeywell	Chromium	Surface drainage collected in ditches and storm sewer catch basins. Two ditches discharge directly to the Hackensack River/Newark Bay confluence.	United States District Court for the District of New Jersey. 2000. Civil Action – (Docket # 95-2097) *Declaration of William F. Hughes,* February.
	Mercury		
	Cyanide		
	Lead		United States District Court for the District of New Jersey. 2003. *Civil Action (Docket # 95-2097) - Third Progress Report of Special Master Robert G. Torricelli,* December.
	Zinc		
	Phenols		
Southern Newark Bay			
Singer Co.	Aroclor PCBs	Direct discharges occurred to Newark Bay/Arthur Kill via 6 on-site outfalls. Industrial wastes were directed to a wastewater sand pit which discharged to Newark Bay via a 36" line. Spill events occurred, affecting Newark Bay.	NJ State Commissioner of Health 1965. Letter to Singer Co.; March
	Cadmium		
	Chromium		*New Jersey State Health Department and The Interstate Sanitation Commission 1962* . Industrial Waste Preliminary Report
	Copper		
	Lead		
	Mercury		U. S. Coast Guard. 1977. Communication report, December.
	Nickel		
	Zinc		
	PHCs		
Arthur Kill			
Exxon-Mobil Bayway	PAHs	Numerous documented direct discharges occurred on-site to the ground, as well as to Morses Creek leading to the Arthur Kill.	Arthur D. Little. 2000. Bayway Phase 1B Remedial Investigation, Draft Report Volume V, of VI, October.
	Aroclor PCBs		
	4,4'-DDD		TRC Ravix Associates. 2004. *Bayway Refinery Phase 2 Remedial Investigation Report,* April.
	4,4'-DDE		
	BEHP		
	Chlorobenzene		
	Arsenic		

Table 2-1
Industrial Sources to Newark Bay and its Tributaries

Site Name	Select On-Site COPCs[1]	Discharges Occurring From Site	References
Exxon-Mobil Bayway (cont.)	Copper		
	Lead		
	Nickel		
	Zinc		
	PHCs		
	Dieldrin		
	Endrin aldehyde		
	Gamma Chlordane		
Kill Van Kull			
White Chemical Co.	2,4-Dichlorophenol	Documented direct discharges to Platty Kill Canal via onsite pond have been noted.	NJDEP. 1988. *CERCLA Site Investigation Report for White Chemical Corporation,* Volume 1 of 2, October.
	2-Chlorophenol		
	2,4-Dinitrophenol		
	2-Nitrophenol		
	Phenol		
	Pentachlorophenol		
	Monochlorobenzene		
	4, 4'-DDD		

Notes:

1. Not likely a complete list of all COPCs found on-site. The COPCs listed here are for those found on-site and which also match COPCs found in Newark Bay and/or its tributaries in their respective geographic areas.

Table 3-1
Annual Ichthyoplankton Catch in Newark Bay (1999-2006)

Species	Annual Ichthyoplankton Catch								Total Number Caught
	1999	2000	2001	2002	2003	2004	2005	2006	
Acipenser sp.									
Larvae	–	–	–	–	–	–	–	1	1
Alosa sp.									
Egg	–	–	1	–	–	–	–	–	1
Larvae	–	–	2	–	–	–	–	–	2
American sandlance									
Larvae	–	–	9	1	2	1	1	–	14
American shad									
Larvae	–	–	–	–	–	–	39	–	39
Atlantic cod									
Larvae	–	–	–	–	–	1	–	–	1
Atlantic croaker									
Juvenile	–	–	–	–	1	–	1	18	20
Larvae	–	–	–	–	5	1	13	13	32
Atlantic herring									
Juvenile	–	–	–	–	–	1	–	–	1
Larvae	6	–	5	–	9	8	–	2	30
Atlantic mackerel									
Larvae	–	–	–	–	1	–	–	–	1
Atlantic menhaden									
UID	–	–	–	–	–	–	59	2	61
Egg	39	–	9	85	105	469	1311	44	2062
Larvae	257	1	2	7	61	100	172	9	609
Atlantic silverside									
Larvae	–	–	–	2	3	1	1	–	7
Atlantic tomcod									
Juvenile	–	–	5	–	1	3	4	–	13
Larvae	–	–	11	–	1	20	31	–	63
Bay anchovy									
Egg	705	–	144	2431	66	19068	30112	849	53375
Juvenile	–	1	–	–	1	–	1	–	3
Larvae	37	1	2	721	589	1929	525	110	3914
Blennidae									
Larvae	–	–	1	2	–	–	–	–	3
Butterfish									
Larvae	–	–	–	1	–	–	–	–	1
Clupeid unidentified									
Larvae	–	–	16	362	10	–	–	–	388
Conger eel (unidentified)	–	–	1	–	–	–	–	–	1
Cunner									
Larvae	–	–	–	2	–	–	5	–	7
Fourbeard rockling									
Egg	28	–	9	1	1	–	19	5	63

Table 3-1
Annual Ichthyoplankton Catch in Newark Bay (1999-2006)

Species	Annual Ichthyoplankton Catch								Total Number Caught
	1999	2000	2001	2002	2003	2004	2005	2006	
Fourspot flounder									
Egg	73	–	–	–	–	–	–	–	73
Larvae	–	–	–	–	1	–	–	–	1
Gadid unidentified									
Egg	–	–	–	–	–	1	39	3	43
Larvae	–	–	–	–	–	–	2	–	2
Gobiid unidentified									
Larvae	6	–	–	1208	44	29	158	496	1941
Goosefish									
Larvae	–	–	–	1	–	–	–	–	1
Grubby									
UID	–	–	–	–	–	4	3	–	7
Juvenile	–	–	–	–	–	2	–	–	2
Larvae	–	–	478	244	35	430	358	81	1626
Hogchocker									
Larvae	–	–	–	–	–	–	1	–	1
Egg	55	–	2	25	–	–	–	–	82
Labridae									
Egg	350	–	680	391	24	886	1640	90	4061
Longhorn sculpin									
Larvae	–	–	–	–	–	3	–	–	3
Myoxocephalus sp.									
Larvae	68	–	–	–	–	–	–	–	68
Northern pipefish									
Juvenile	2	–	–	6	1	–	–	–	9
Larvae	8	–	8	92	10	13	62	20	213
Northern puffer									
Larvae	–	–	–	–	–	–	1	–	1
Prionotus sp.									
Larvae	–	–	–	–	–	–	1	–	1
Egg	–	–	–	–	6	–	132	10	148
Rock gunnel									
Larvae	–	–	4	11	1	4	5	1	26
Spot									
Larvae	–	–	–	2	–	–	–	–	2
Striped bass									
Larvae	–	–	1	–	1	–	–	–	2
Striped cuskeel									
Larvae	–	–	1	–	–	–	–	–	1
Summer flounder									
Larvae	–	6	6	1	–	–	–	–	13
Tautog									
Larvae	–	–	–	2	–	3	29	0	34

Table 3-1
Annual Ichthyoplankton Catch in Newark Bay (1999-2006)

Species	Annual Ichthyoplankton Catch								Total Number Caught
	1999	2000	2001	2002	2003	2004	2005	2006	
Unidentified									
UID	–	–	–	–	–	1	1	–	2
Egg	–	–	–	1	–	–	–	–	1
Larvae	6	–	–	34	16	350	–	–	406
Walleye									
Larvae	–	–	–	–	–	–	–	2	2
Weakfish									
Egg	870	–	52	108	4	25	5884	2	6945
Juvenile	–	–	1	–	–	–	1	–	2
Larvae	9	9	–	72	7	28	114	–	239
White perch									
Larvae	–	–	–	–	13	–	–	–	13
Windowpane									
Egg	–	–	396	551	77	256	13	–	1293
Juvenile	–	–	1	1	3	–	–	–	5
Larvae	35	–	21	10	6	4	37	5	118
Winter flounder									
UID	–	–	–	–	–	4	13	–	17
Egg	15	–	–	6	1	1	4	–	27
Juvenile	–	–	–	–	2	–	1	–	3
Larvae	34	–	230	537	626	721	198	97	2443

Notes:
2007, 2008, and 2009 data are given in density only and are, therefore, not included.

Acronyms and Abbreviations:
UID = unidentified
USACE = U.S. Army Corps of Engineers

Source:
USACE. 2003. *Aquatic Biological Sampling Program 1998–2003.* Raw data in Access database. New York and New Jersey Harbor Navigation Project. U.S. Army Corps of Engineers, New York District, New York, New York. August.

USACE. 2004, 2005, and 2006. *Aquatic Biological Survey Report. New York and New Jersey Harbor Deepening Project.* U.S. Army Corps of Engineers, New York District, New York, New York.

Table 3-2
Dominant Benthic Invertebrate Species in Newark Bay

Sampling Program	NOAA May 1993 to April 1994[a]	REMAP Summer 1993/94[b]	USACE June 1995[c]	USACE October 1995[c]	USACE Monthly 1995/96[d]	REMAP Summer 1998/99[b]
Number of Stations	25	28	10	10	5	29
Taxa - Scientific Name	**Dominant Species**	**Species Count**				
Polychaeta						
Cirratulidae	–	–	2	–	–	–
Glycera americana	–	–	–	9	–	–
Glycera spp.	–	–	–	–	9	–
Heteromastus filiformis	–	9	6	–	–	–
Leitoscoloplos fragilis	–	–	8	–	–	–
Leitoscoloplos robustus	ü	4	–	7	–	8
Leitoscoloplos sp.	–	5	3	–	–	–
Marenzelleria viridis	–	–	5	–	–	–
Mediomastus sp.	–	–	–	–	–	2
Mediomastus ambiseta	ü	6	4	2	–	–
Paraonidae	–	–	–	–	4	–
Pectinaria gouldii	–	–	–	5	–	–
Phyllodocidae	–	–	10	–	8	–
*Polydora cornuta**	ü	–	–	10	–	3
Polydora ligni	–	–	–		10	–
Sabellaria vulgaris	ü	–	–	6	–	–
Scoloplos sp.	–	–	–	–	1	–
*Streblospio benedicti**	ü	1	1	3	2	1
Tharyx sp. A	ü	7	9	–	–	–
Oligochaeta						
*Oligochaeta**	ü	2	7	8	–	4
Mollusca						
Bivalvia	–	–	–	4	–	–
Odostomia sp.	ü	–	–	–	–	–
*Mulinia lateralis**		10	–	1	3	9
Mya arenaria	ü	–		–	6	–
Mytilus edulis	–	–	–	–	–	6
Rictaxis punctostriatus	–	–	–	–	–	10

Table 3-2
Dominant Benthic Invertebrate Species in Newark Bay

Sampling Program	NOAA May 1993 to April 1994[a]	REMAP Summer 1993/94[b]	USACE June 1995[c]	USACE October 1995[c]	USACE Monthly 1995/96[d]	REMAP Summer 1998/99[b]
Number of Stations	25	28	10	10	5	29
Taxa - Scientific Name	**Dominant Species**	**Species Count**				
Crustacea						
Ampelisca abdita	–	–	–	–	–	7
Corophium tuberculatum	–	–	–	–	–	5
Cyathura polita	–	–	–	–	5	–
Gammarus daiberi	–	3	–	–	–	–
Leucon americanus	ü	8	–	–	–	–
Oxyurostylis smithi	–	–	–	–	7	–

Notes:
* Indicates pollution indicative species (USEPA 2003b).
ü indicates dominant species (NOAA 1994).

Acronyms and Abbreviations:
NOAA = National Oceanic and Atmospheric Administration
REMAP = Regional Environmental Monitoring and Assessment Program
USACE = U.S. Army Corps of Engineers
USEPA = U.S. Environmental Protection Agency
Species count indicates number of organisms of each species found in the study.

Sources:
a. NOAA. 1994. *Results of a Biological and Hydrographical Characterization of Newark Bay, New Jersey, May 1993–April 1994.* Report prepared by U.S. Department of Commerce, National Marine Fisheries, and Northeast Fisheries Service Center, National Oceanic and Atmospheric Administration. Also available online at: http://sh.nefsc.noaa.gov.
b. USEPA. 2003. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures.* EPA-600-R-02-013. Office of Research and Development. November.
c. Iocco, L.E., P. Wilber, R.J. Diaz, D.G. Clarke, and R.J. Will. 2000. *Final Report. Benthic Habitats of New York/New Jersey Harbor: 1995 Survey of Jamaica, Upper, Newark, Bowery, and Flushing Bays.* National Oceanic and Atmospheric Administration, Virginia Institute of Marine Sciences, and U.S. Army Corps of Engineers.
d. USACE. 1997. *Final Environmental Impact Statement on the Newark Bay Confined Disposal Facility.* U.S. Army Corps of Engineers, New York District, New York, New York. April.
USACE. 1999. Draft Feasibility Report for New York and New Jersey Harbor Investigation Study. Draft Environmental Impact Statement (DEIS). U.S. Army Corps of Engineers, New York District, New York, New York.

Table 3-3
Essential Fish Habitat Designations by Life Stage for Newark Bay

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Red hake (*Urophycis chuss*)	ü	ü	ü	ü	–
Winter flounder (*Pseudopluronectes americanus*)	ü	ü	ü	ü	ü
Windowpane flounder (*Scopthalmus aquosus*)	ü	ü	ü	ü	ü
American plaice (*Hippoglossoides platessoides*)	–	ü	ü	ü	–
Atlantic sea herring (*Clupea harengus*)	–	ü	ü	ü	–
Bluefish (*Pomatomus saltatrix*)	ü	ü	ü	ü	–
Atlantic butterfish (*Peprilus triacanthus*)	–	ü	ü	ü	–
Atlantic mackerel (*Scomber scombrus*)	–	–	ü	ü	–
Summer flounder (*Paralichthys dentatus*)	–	ü	ü	ü	–
Scup (*Stenotomus chrysops*)	ü	ü	ü	ü	–
Black sea bass (*Centropristus striata*)	–	–	ü	ü	–
King mackerel (*Scomberomorus cavalla*)	ü	ü	ü	ü	–
Spanish mackerel (*Scomberomorus maculates*)	ü	ü	ü	ü	–
Atlantic mackerel (*Scomber scombrus*)	–	–	ü	ü	–
Cobia (*Rachycentron canadum*)	ü	ü	ü	ü	–
Dusky shark (*Carcharhinus obscurus*)	–	ü	ü	–	–
Sand tiger shark (*Carcharias taurus*)	–	ü	ü	–	–
Sandbar shark (*Carcharhinus plumbeus*)	–	ü	ü		–
Clearnose skate (*Raja eglanteria*)	–	–	ü	ü	–
Little skate (*Raja erinacea*)	–	–	ü	ü	–
Winter skate (*Leucoraja ocellata*)	–	–	ü	ü	–

Notes:
ü indicates habitat is suitable for lifestage.
– indicates habitat is not suitable for lifestage.

Acronyms and Abbreviations:
USACE = U.S. Army Corps of Engineers

Sources:
USACE. 2004. Essential Fish Habitat Assessment. New York and New Jersey Harbor Deepening Project. U.S. Army Corps of Engineers, New York District, New York, New York.

USACE. Undated. Essential Fish Habitat Assessment for Newark Bay Maintenance Dredging: Newark Bay – Port Newark Channel, Port Newark Pierhead Channel, and Port Elizabeth Channel of Newark Bay, Hackensack and Passaic Rivers Federal Navigation Project. Prepared by USACE, New York, New York. 26 pp.

Table 3-4
Monthly Finfish Catch Data from Newark Bay Fish Community Studies (1993-2013)

		January										February											
Common Name	**Scientific Name**	**Jan-94**	**Jan-96**	**Jan-02**	**Jan-03**	**Jan-04**	**Jan-05**	**Jan-06**	**Jan-07**	**Jan-09**	**Average**	**Average % Comp**	**Feb-94**	**Feb-96**	**Feb-99**	**Feb-02**	**Feb-03**	**Feb-04**	**Feb-05**	**Feb-06**	**Feb-07**	**Feb-08**	**Feb-09**	**Average**	**Average % Comp**
Bay anchovy	*Anchoa mitchilli*	0	0	2	5	0	31	0	5	2	5	0.8	0	0	0	0	0	0	0	2	0	1	0	0	0.0
White perch	*Morone americana*	244	0	591	613	119	121	889	743	189	390	61.5	738	0	131	634	55	219	8	648	985	0	6	311	54.7
Striped bass	*Morone saxatillis*	215	0	355	147	69	28	179	35	10	115	18.2	1021	2	24	362	12	281	2	289	169	0	117	207	36.4
Atlantic herring	*Clupea harengus*	0	0	0	0	0	1	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic tomcod	*Microgadus tomcod*	9	0	0	0	1	0	0	0	0	1	0.2	8	0	0	0	0	2	0	0	0	0	0	1	0.2
Alewife	*Alosa pseudoharengus*	9	0	22	6	1	0	0	1	1	4	0.7	0	0	0	22	0	1	0	7	0	0	1	3	0.5
Winter flounder	*Pleuronectes americanus*	52	0	45	37	14	3	11	14	5	20	3.2	33	2	0	38	6	48	1	15	0	0	20	15	2.6
Weakfish	*Cynoscion regalis*	0	0	0	0	0	0	0	1	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Spotted hake	*Urophycis regla*	0	0	10	2	0	2	1	96	0	12	1.9	0	0	0	33	1	0	0	1	0	0	0	3	0.6
Blueback herring	*Alosa aestivalls*	0	0	13	2	0	0	6	10	5	4	0.6	0	0	0	44	0	5	0	27	0	0	0	7	1.2
Atlantic menhaden	*Brevooria tyrannus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Gizzard shad	*Dorosoma cepedianum*	47	1	6	2	8.1	4	7	18	1	10	1.7	1	0	0	1	0	1	0	1	4	0	0	1	0.1
Rainbow smelt	*Osmerus mordax*	313	0		0	0	0	0	0	1	39	6.2	25	0	0	0	0	0	0	0	0	0	0	2	0.4
Atlantic silverside	*Menidia menidia*	1	0	0	21	1	7	0	45	4	9	1.4	0	0	0	12	0	3	2	25	2	18	7	6	1.1
Grubby	*Myoxecephalus aenaeus*	66	0	2	0	1	0	0	0	0	8	1.2	44	0	0	0	0	4	0	0	0	0	17	6	1.0
Summer flounder	*Paralichthys dentatus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Bluefish	*Pomatomus saltatrix*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Butterfish	*Peprillus tracanthus*	0	0	0	0	0	0	0	1	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Red hake	*Urophycis chuss*	3	0	0		4	0	4	25	2	5	0.7	0	0	0	0	1	0	0	3	7	0	0	1	0.2
Windowpane	*Scophthalmus aquosus*	1	0	14	0	2	2	0	2	0	2	0.4	2	0	0	18	1	0	0	0	1	0	0	2	0.4
American shad	*Alosa sapidissima*	0	0	5	0	0	0	0	0	0	1	0.1	0	0	0	6	0	0	0	0	1	0	2	1	0.1
Silver hake	*Merluccius bilinearis*	0	0	0	1	2	0	0	1	0	0	0.1	0	0	0	0	0	2	0	0	1	0	0	0	0.0
Striped searobin	*Prionotus evolans*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic croaker	*Micropogonia undulatus*	0	0	0	1	0	39	1	0	0	5	0.7	0	0	0	0	0	0	0	7	0	0	0	1	0.1
Smallmouth flounder	*Etropus microstomus*	0	0	4	0	0	0	0	1	0	1	0.1	0	0	0	1	0	0	0	0	0	0	0	0	0.0
Northern pipefish	*Syngnathus fuscus*	0	0	1	1	0	0	0	0	1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Silver perch	*Bairdiella chrysura*	0	0	0	0	0	0	19	0	0	2	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern searobin	*Prionotus carollnus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hogchoker	*Trinectes maculatus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Silverside	Atherinidae (unidentified)	0	0	24	0	0	0	0	0	0	3	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic moonfish	*Selene setapinnis*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Threespine stickleback	*Gasterosteus aculeatus*	1	0	0	0	0	1	0	0	0	0	0.0	6	0	0	0	0	0	0	0	0	0	0	1	0.1
American eel	*Anguilla rostrata*	2	0	1	0	0	0	0	1	0	0	0.1	1	0	0	0	0	0	0	0	0	0	0	0	0.0
Scup	*Stenotomus chrysops*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Cunner	*Tautogolabrus adspersus*	1	0	1	1	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Tautog	*Tautoga onitis*	0	0	0	0	0	0	1	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Black sea bass	*Centropristis striata*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern kingfish	*Menticirrhus saxatillis*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Spot	*Leiostomus santhurus*	0	0	0	0	0	0	0	1	0	0	0.0	0	0	0	0	0	0	0	0		0	0	0	0.0
Striped anchovy	*Anchoa hepsetus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Crevalle Jack	*Caranx hippos*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rock gunnel	*Pholis gunnellus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Naked goby	*Gobiosoma bosc*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Little skate	*Raja erinacea*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Oyster toadfish	*Opsanus tau*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Herring	Clupeidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped killifish	*Fundulus majalis*	1	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	1	1	0	0	0	0	0	0	0.0
Lookdown	*Selene vomer*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern puffer	*Sphaeroides maculatus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Fourspot flounder	*Paralichthys oblongus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	1	0	0	0	0	0	0	0	0	0.0
American sandlance	*Ammodytes americanus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Seaboard Goby	*Gobiosoma ginsburgi*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Mummichog	*Fundulus heteroclitus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	1.7	0	0	0	0	0	0	0.0
Lined seahorse	*Hippocampus erectus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic sturgeon	*Acipenser oxyrhynchus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Chub mackerel	*Scomber japonicus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Clearnose skate	*Raja eglanteria*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	1	0	0	0	0	0	0	0	0	0.0
Conger eel	*Conger oceanicus*	1	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Goby	*Gobiidee sp.*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern stargazer	*Astroscopus guttatus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Planehead filefish	*Monacanthus hispidus*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Pollock	*Pollachius sp.*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped cuskeel	*Ophidion marginatum*	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	1	0	0	0	0	0	0	0	0	0.0
	TOTALS	**966**	**1**	**1096**	**839**	**223**	**239**	**1118**	**1000**	**221**			**1880**	**4**	**155**	**1174**	**77**	**569**	**13**	**1025**	**1170**	**19**	**170**		
	Monthly Average									**634**													**569**		

Table 3-4
Monthly Finfish Catch Data from Newark Bay Fish Community Studies (1993-2013)

		March													April												
Common Name	**Scientific Name**	**Mar-94**	**Mar-96**	**Mar-99**	**Mar-02**	**Mar-03**	**Mar-04**	**Mar-05**	**Mar-06**	**Mar-07**	**Mar-08**	**Mar-09**	**Average**	**Average % Comp**	**Apr-94**	**Apr-95**	**Apr-99**	**Apr-02**	**Apr-03**	**Apr-04**	**Apr-05**	**Apr-06**	**Apr-07**	**Apr-08**	**Apr-09**	**Apr-11**	**Average**	**Average % Comp**
Bay anchovy	*Anchoa mitchilli*	0	0	0	1	0	0	0	1	0	0	0	0	0.0	1	0	0	1	0	0	0	1	0	0	0	2	0	0.1
White perch	*Morone americana*	669	0	326	24	6	726	80	172	269	0	248	229	39.1	355	1	0	0	49	191	1	0	1	0	2	0	50	12.5
Striped bass	*Morone saxatillis*	1844	0	234	27	21	866	1	63	18	0	16	281	47.9	1009	17	38	63	57	110	24	1	1	1	31	2	113	28.2
Atlantic herring	*Clupea harengus*	1	0	0	1	0	0	1	0	0	0	0	0	0.0	7	0	0	19	33	12	4	175	0	72	0	1	27	6.7
Atlantic tomcod	*Microgadus tomcod*	7	0	0	0	0	35	0	0	0	0	0	4	0.7	102	0	0	0	0	19	0	0	0	0	0	0	10	2.5
Alewife	*Alosa pseudoharengus*	0	0	0	6	0	17	1	10	6	1	27	6	1.1	9	0	1	3	2	129	10	10	1	0	116	62	29	7.1
Winter flounder	*Pleuronectes americanus*	57	3	242	22	8	20	11	6	5	0	3	34	5.8	72	8	100	27	11	29	5	0	0	1	5	0	22	5.4
Weakfish	*Cynoscion regalis*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Spotted hake	*Urophycis regla*	0	0	14	34	0	5	0	15	0	0	0	6	1.1	26	0	300	211	95	103	1	7	8	0	11	9	64	16.0
Blueback herring	*Alosa aestivalls*	0	0	0	31	0	45	2	0	2	0	1	7	1.3	1	0	0	3	1	62	0	105	1	0	1	660	70	17.4
Atlantic menhaden	*Brevooria tyrannus*	0	0	0	1	0	0	0	0	0	0	0	0	0.0	2	0	0	0	0	0	0	0	0	1	0	0	0	0.1
Gizzard shad	*Dorosoma cepedianum*	0	0	1	1	0	0	0	2	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rainbow smelt	*Osmerus mordax*	28	0	0	0	0	0	0	0	0	0	0	3	0.4	2	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic silverside	*Menidia menidia*	2	0	0	0	0	9	2	13	2	0	0	3	0.4	0	0	0	0	0	2	0	0	0	0	2	2	1	0.1
Grubby	*Myoxecephalus aenaeus*	54	0	7	0	0	1	0	0	0	0	0	6	1.0	13	0	1	2	0	2	0	0	0	0	0	0	2	0.4
Summer flounder	*Paralichthys dentatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	8	0	0	1	2	1	0	0	0	0	0	0	1	0.2
Bluefish	*Pomatomus saltatrix*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Butterfish	*Peprillus tracanthus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Red hake	*Urophycis chuss*	1	0	0	1	0	2	1	4	0	0	1	1	0.2	3	0	0	0	1	9	0	0	0	0	4	0	1	0.4
Windowpane	*Scophthalmus aquosus*	4	0	2	3	0	0	0	0	0	0	0	1	0.1	10	0	1	9	1	4	0	0	0	0	1	0	2	0.5
American shad	*Alosa sapidissima*	0	0	0	0	1	19	1	1	1	0	2	2	0.4	3	0	0	0	0	10	4	3	0	0	0	5	2	0.5
Silver hake	*Merluccius bilinearis*	0	0	4	0	0	0	0	3	0	0	0	1	0.1	0	0	15	0	0	1	0	0	0	0	0	0	1	0.3
Striped searobin	*Prionotus evolans*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic croaker	*Micropogonia undulatus*	0	0	0	0	0	0	0	1	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Smallmouth flounder	*Etropus microstomus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	3	35	0	0	0	0	0	1	1	3	0.9
Northern pipefish	*Syngnathus fuscus*	0	0	0	1	0	0	0	0	0	0	0	0	0.0	2	0	2	1	0	1	1	2	0	0	2	0	1	0.2
Silver perch	*Bairdiella chrysura*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern searobin	*Prionotus carollnus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hogchoker	*Trinectes maculatus*	1	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Silverside	Atherinidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic moonfish	*Selene setapinnis*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Threespine stickleback	*Gasterosteus aculeatus*	13	0	0	0	0	0	0	0	0	0	1	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
American eel	*Anguilla rostrata*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	1	0	0	0	0	0	0	0	0	0.0
Scup	*Stenotomus chrysops*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped anchovy	*Anchoa hepsetus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Crevalle Jack	*Caranx hippos*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rock gunnel	*Pholis gunnellus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	2	0	0	0	0	0	0	0	0	0	0.1
Naked goby	*Gobiosoma bosc*	0	0	0	1	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Little skate	*Raja erinacea*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	1	0	0	0	0	0	0	0	0	0	0	0.0
Oyster toadfish	*Opsanus tau*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Herring	Clupeidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	2	0	0	0	0	0	0	0	0	0	0.0
Striped killifish	*Fundulus majalis*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Lookdown	*Selene vomer*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern puffer	*Sphaeroides maculatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.0
Fourspot flounder	*Paralichthys oblongus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
American sandlance	*Ammodytes americanus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Seaboard Goby	*Gobiosoma ginsburgi*	0	0	0	0	0	0	1	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Mummichog	*Fundulus heteroclitus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Lined seahorse	*Hippocampus erectus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic sturgeon	*Acipenser oxyrhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Chub mackerel	*Scomber japonicus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Clearnose skate	*Raja eglanteria*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Conger eel	*Conger oceanicus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Goby	*Gobiidee sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern stargazer	*Astroscopus guttatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Planehead filefish	*Monacanthus hispidus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Pollock	*Pollachius sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped cuskeel	*Ophidion marginatum*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	TOTALS	**2683**	**3**	**831**	**156**	**36**	**1744**	**101**	**291**	**304**	**1**	**300**			**1633**	**25**	**460**	**349**	**291**	**686**	**50**	**304**	**12**	**76**	**177**	**744**		
	Monthly Average											**586**														**401**		

Table 3-4
Monthly Finfish Catch Data from Newark Bay Fish Community Studies (1993-2013)

		May													June										
Common Name	**Scientific Name**	**May-93**	**May-95**	**May-02**	**May-03**	**May-04**	**May-05**	**May-06**	**May-07**	**May-08**	**May-09**	**May-11**	**Average**	**Average % Comp**	**Jun-93**	**Jun-95**	**Jun-99**	**Jun-02**	**Jun-03**	**Jun-04**	**Jun-05**	**Jun-06**	**Jun-07**	**Jun-11**	**Average**	**Average % Comp**
Bay anchovy	*Anchoa mitchilli*	1	4	34	852	72	3	1385	184	87	789	291	337	34.3	95	24	0	39	35	785	137	558	610	567	285	47.6
White perch	*Morone americana*	4	0	0	2	1	0	0	0	0	0	30	3	0.3	2	0	1	0	0	0	0	0	0	0	0	0.1
Striped bass	*Morone saxatillis*	64	40	13	11	10.7	1	0	8.7	4	0	11	15	1.5	82	64	1	17	7	5	0	0	1.4	0	18	3.0
Atlantic herring	*Clupea harengus*	50	4	1	17	253	213	301	0	25	3356	33	387	39.4	619	0	0	0	1	0	0	0	0	4	62	10.4
Atlantic tomcod	*Microgadus tomcod*	215	1	0	6	74	9	0	1	7	0	6	29	3.0	1098	0	1	0	27	13	0	0	2	0	114	19.1
Alewife	*Alosa pseudoharengus*	17	0	0	3	6	0	19	1	0	25	469	49	5.0	2	0	0	0	0	1	0	0	0	0	0	0.1
Winter flounder	*Pleuronectes americanus*	42	6	13	5	3.7	10	1	0	1	2	0	8	0.8	112	10	19	50	6	5	2	0	3	0	21	3.5
Weakfish	*Cynoscion regalis*	11	1	1	0	0	0	0	0	0	0	1	1	0.1	20	0	0	1	0	1	0	0	0	0	2	0.4
Spotted hake	*Urophycis regla*	288	2	143	198	45	26	150	0	3	16	7	80	8.1	452	0	10	55	88	2	0	17	9	0	63	10.6
Blueback herring	*Alosa aestivalls*	44	0	72	1	4	5	7	5	10	130	61	31	3.1	8	2	0	1	0	0	0	0	0	2	1	0.2
Atlantic menhaden	*Brevooria tyrannus*	252	0	1	0	0	0	1	0	0	0	3	23	2.4	25	0	0	6	1	0	0	0	0	0	3	0.5
Gizzard shad	*Dorosoma cepedianum*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	1	0	0	0.0
Rainbow smelt	*Osmerus mordax*	1	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic silverside	*Menidia menidia*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Grubby	*Myoxecephalus aenaeus*	13	0	0	0	0	0	0	0	0	0	0	1	0.1	28	0	0	2	0	0	0	0	0	0	3	0.5
Summer flounder	*Paralichthys dentatus*	29	5	10	9	0	2	0	0	1	0	0	5	0.5	58	6	8	12	5	4	0	0	2	0	10	1.6
Bluefish	*Pomatomus saltatrix*	8	0	0	0	0	0	0	0	0	0	0	1	0.1	16	0	0	1	0	10	0	0	0	0	3	0.5
Butterfish	*Peprillus tracanthus*	0	0	0	0	0	1	4	0	0	0	2	1	0.1	0	0	1	0	0	0	3	3	1	0	1	0.1
Red hake	*Urophycis chuss*	45	0	0	0	0	0	3	0	0	1	0	4	0.5	33	0	0	0	1	0	0	1	0	0	4	0.6
Windowpane	*Scophthalmus aquosus*	1	0	1	1	1	0	1	0	0	1	2	1	0.1	2	0	3	3	3	0	0	0	0	0	1	0.2
American shad	*Alosa sapidissima*	4	0	0	0	4	1	6	0	0	0	3	2	0.2	1	1	0	0	0	1	0	0	0	0	0	0.1
Silver hake	*Merluccius bilinearis*	0	0	0	0	0	0	0	0	0	0	8	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped searobin	*Prionotus evolans*	2	0	1	1	0	0	0	0	0	0	0	0	0.0	5	0	1	3	0	0	0	0	0	0	1	0.2
Atlantic croaker	*Micropogonia undulatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Smallmouth flounder	*Etropus microstomus*	0	0	2	0	0	0	0	0	1	0	0	0	0.0	0	0	0	4	0	0	0	0	0	0	0	0.1
Northern pipefish	*Syngnathus fuscus*	1	1	0	0	1	0	1	2	0	0	2	1	0.1	3	1	0	3	0	0	0	0	0	0	1	0.1
Silver perch	*Bairdiella chrysura*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern searobin	*Prionotus carollnus*	1	0	8	0	0	0	0	0	1	0	0	1	0.1	9	0	1	10	1	0	0	0	0	0	2	0.4
Hogchoker	*Trinectes maculatus*	1	0	1	0	0	0	1	0	0	0	0	0	0.0	2	0	0	0	0	0	0	4	2	0	1	0.1
Silverside	Atherinidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic moonfish	*Selene setapinnis*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Threespine stickleback	*Gasterosteus aculeatus*	0	0	0	0	1	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
American eel	*Anguilla rostrata*	1	0	1	0	0	0	1	0	0	0	0	0	0.0	1	0	3	1	1	0	0	0	0	0	1	0.1
Scup	*Stenotomus chrysops*	1	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	1	0	0	0	0	0	0	0	0.0
Cunner	*Tautogolabrus adspersus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	1	1	0	0	0	0	0	0	0.1
Tautog	*Tautoga onitis*	0	0	1	1	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Black sea bass	*Centropristis striata*	0	0	1	0	0	0	0	0	0	0	0	0	0.0	0	0	0	2	0	0	0	0	0	0	0	0.0
Northern kingfish	*Menticirrhus saxatillis*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Spot	*Leiostomus santhurus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped anchovy	*Anchoa hepsetus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Crevalle Jack	*Caranx hippos*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rock gunnel	*Pholis gunnellus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	1	0	0	0	0	0.0
Naked goby	*Gobiosoma bosc*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	1	0	0	0	0	0	0	0	0.0
Little skate	*Raja erinacea*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Oyster toadfish	*Opsanus tau*	0	0	1	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	1	0	0	0	0	0	0	0.0
Herring	Clupeidae (unidentified)	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	2	0	0	0	0	0	0	0	0.0
Striped killifish	*Fundulus majalis*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Lookdown	*Selene vomer*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Northern puffer	*Sphaeroides maculatus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Fourspot flounder	*Paralichthys oblongus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	0	0	0	0	0	0	0	0.0
American sandlance	*Ammodytes americanus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Seaboard Goby	*Gobiosoma ginsburgi*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	1	0	0	0	0	0.0
Mummichog	*Fundulus heteroclitus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Lined seahorse	*Hippocampus erectus*	0	0	0	0	0	0	0	0	0	0	1	0	0.0	1	0	0	0	0	0	0	0	0	0	0	0.0
Atlantic sturgeon	*Acipenser oxyrhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	0	0	0	0	0	0	0	0.0
Chub mackerel	*Scomber japonicus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	0	0	0	0	0	0	0	0.0
Clearnose skate	*Raja eglanteria*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Conger eel	*Conger oceanicus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Goby	*Gobiidee sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	1	0	0	0	0	0	0	0	0	0	0	0.0
Northern stargazer	*Astroscopus guttatus*	0	0	0	1	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Planehead filefish	*Monacanthus hispidus*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Pollock	*Pollachius sp.*	0	0	0	0	0	0	0	0	0	0	1	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
Striped cuskeel	*Ophidion marginatum*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0.0
	TOTALS	**1096**	**64**	**305**	**1108**	**476**	**271**	**1881**	**202**	**140**	**4320**	**931**			**2680**	**108**	**49**	**215**	**178**	**827**	**144**	**583**	**632**	**573**		
	Monthly Average											**981**												**599**		

Table 3-4
Monthly Finfish Catch Data from Newark Bay Fish Community Studies (1993-2013)

		July					August							September						October						
Common Name	**Scientific Name**	**Jul-93**	**Jul-95**	**Jul-11**	**Average**	**Average % Comp**	**Aug-93**	**Aug-95**	**Aug-99**	**Aug-06**	**Aug-11**	**Average**	**Average % Comp**	**Sep-93**	**Sep-95**	**Sep-06**	**Sep-11**	**Average**	**Average % Comp**	**Oct-93**	**Oct-95**	**Oct-98**	**Oct-06**	**Oct-11**	**Average**	**Average % Comp**
Bay anchovy	*Anchoa mitchilli*	453	147	1782	794.0	52.7	409	785	1	12636	886	2943.4	83.8	758	1700	1994	830	1320.5	75.1	2	9	100	338	1773	444.4	36.5
White perch	*Morone americana*	0	1	0	0.3	0.0	0	0	0	0	0	0.0	0.0	0	4	0	0	1.0	0.1	1	0	0	0	1	0.4	0.0
Striped bass	*Morone saxatillis*	348	42	0	130.0	8.6	47	0	0	1	0	9.6	0.3	36	1	3	0	10.0	0.6	80	9	0	5	0	18.8	1.5
Atlantic herring	*Clupea harengus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	1	0	0	0	0	0.2	0.0
Atlantic tomcod	*Microgadus tomcod*	1226	1	0	409.0	27.2	684	0	0	0	0	136.8	3.9	15	0	0	0	3.8	0.2	91	0	0	0	0	18.2	1.5
Alewife	*Alosa pseudoharengus*	31	0	1	10.7	0.7	4	0	0	0	0	0.8	0.0	3	0	0	71	18.5	1.1	31	1	1	0	757	158.0	13.0
Winter flounder	*Pleuronectes americanus*	182	7	0	63.0	4.2	285	1	5	2	0	58.6	1.7	54	9	2	0	16.3	0.9	116	5	1	4	0	25.2	2.1
Weakfish	*Cynoscion regalis*	9	4	0	4.3	0.3	808	0	603	2	0	282.6	8.0	1128	1	22	2	288.3	16.4	740	0	173	35	8	191.2	15.7
Spotted hake	*Urophycis regia*	31	4	0	11.7	0.8	0	0	0	1	0	0.2	0.0	0	0	0	0	0.0	0.0	17	0	0	2	0	3.8	0.3
Blueback herring	*Alosa aestivalls*	0	0	6	2.0	0.1	0	0	0	0	0	0.0	0.0	0	0	1	3	1.0	0.1	2	0	0	4	498	100.8	8.3
Atlantic menhaden	*Brevooria tyrannus*	83	0	1	28.0	1.9	22	0	1	80	0	20.6	0.6	2	0	10	3	3.8	0.2	30	0	1	724	7	152.4	12.5
Gizzard shad	*Dorosoma cepedianum*	0	0	0	0.0	0.0	2	0	0	0	0	0.4	0.0	0	0	0	1	0.3	0.0	13	0	0	0	170	36.6	3.0
Rainbow smelt	*Osmerus mordax*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Atlantic silverside	*Menidia menidia*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	78	0	1	19.8	1.1	30	44	0	10	0	16.8	1.4
Grubby	*Myoxecephalus aenaeus*	13	0	0	4.3	0.3	8	0	0	0	0	1.6	0.0	0	0	0	0	0.0	0.0	4	0	0	0	0	0.8	0.1
Summer flounder	*Paralichthys dentatus*	89	3	0	30.7	2.0	46	8	5	0	0	11.8	0.3	10	1	0	0	2.8	0.2	1	6	1	0	0	1.6	0.1
Bluefish	*Pomatomus saltatrix*	3	0	2	1.7	0.1	7	5	0	17	1	6.0	0.2	18	32	61	9	30.0	1.7	3	6	3	22	24	11.6	1.0
Butterfish	*Peprillus tracanthus*	0	0	14	4.7	0.3	42	0	1	55	2	20.0	0.6	18	0	37	3	14.5	0.8	23	0	20	15	5	12.6	1.0
Red hake	*Urophycis chuss*	1	0	0	0.3	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Windowpane	*Scophthalmus aquosus*	13	1	0	4.7	0.3	4	0	0	0	0	0.8	0.0	2	0	0	0	0.5	0.0	19	0	2	0	0	4.2	0.3
American shad	*Alosa sapidissima*	0	0	0	0.0	0.0	3	1	0	0	0	0.8	0.0	2	9	0	1	3.0	0.2	0	3	1	0	9	2.6	0.2
Silver hake	*Merluccius bilinearis*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	3	0.6	0.0
Striped searobin	*Prionotus evolans*	3	0	0	1.0	0.1	9	0	1	2	0	2.4	0.1	45	0	8	0	13.3	0.8	25	0	3	5	0	6.6	0.5
Atlantic croaker	*Micropogonia undulatus*	0	0	0	0.0	0.0	7	0	0	2	0	1.8	0.1	3	0	0	0	0.8	0.0	4	0	0	0	1	1.0	0.1
Smallmouth flounder	*Etropus microstomus*	0	0	0	0.0	0.0	0	0	0	1	0	0.2	0.0	2	0	0	0	0.5	0.0	0	0	0	0	0	0.0	0.0
Northern pipefish	*Syngnathus fuscus*	4	6	0	3.3	0.2	1	0	0	1	0	0.4	0.0	2	0	2	0	1.0	0.1	0	0	0	0	0	0.0	0.0
Silver perch	*Bairdiella chrysura*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	8	0	0	0	5	2.6	0.2
Northern searobin	*Prionotus carollnus*	7	0	0	2.3	0.2	10	0	1	0	0	2.2	0.1	0	0	0	0	0.0	0.0	2	0	0	0	0	0.4	0.0
Hogchoker	*Trinectes maculatus*	1	0	0	0.3	0.0	2	0	0	0	0	0.4	0.0	7	0	0	0	1.8	0.1	0	0	0	1	0	0.2	0.0
Silverside	Atherinidae (unidentified)	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Atlantic moonfish	*Selene setapinnis*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	5	1.3	0.1	0	0	0	0	15	3.0	0.2
Threespine stickleback	*Gasterosteus aculeatus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
American eel	*Anguilla rostrata*	0	0	0	0.0	0.0	1	0	0	0	0	0.2	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Scup	*Stenotomus chrysops*	0	0	0	0.0	0.0	0	0	31	1	0	6.4	0.2	0	0	1	0	0.3	0.0	1	0	0	2	0	0.6	0.0
White perch	*Morone americana*	0	1	0	0.3	0.0	0	0	0	0	0	0.0	0.0	0	4	0	0	1.0	0.1	1	0	0	0	1	0.4	0.0
Striped bass	*Morone saxatillis*	348	42	0	130.0	8.6	47	0	0	1	0	9.6	0.3	36	1	3	0	10.0	0.6	80	9	0	5	0	18.8	1.5
Atlantic herring	*Clupea harengus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	1	0	0	0	0	0.2	0.0
Atlantic tomcod	*Microgadus tomcod*	1226	1	0	409.0	27.2	684	0	0	0	0	136.8	3.9	15	0	0	0	3.8	0.2	91	0	0	0	0	18.2	1.5
Alewife	*Alosa pseudoharengus*	31	0	1	10.7	0.7	4	0	0	0	0	0.8	0.0	3	0	0	71	18.5	1.1	31	1	1	0	757	158.0	13.0
Winter flounder	*Pleuronectes americanus*	182	7	0	63.0	4.2	285	1	5	2	0	58.6	1.7	54	9	2	0	16.3	0.9	116	5	1	4	0	25.2	2.1
Weakfish	*Cynoscion regalis*	9	4	0	4.3	0.3	808	0	603	2	0	282.6	8.0	1128	1	22	2	288.3	16.4	740	0	173	35	8	191.2	15.7
Spotted hake	*Urophycis regia*	31	4	0	11.7	0.8	0	0	0	1	0	0.2	0.0	0	0	0	0	0.0	0.0	17	0	0	2	0	3.8	0.3
Blueback herring	*Alosa aestivalls*	0	0	6	2.0	0.1	0	0	0	0	0	0.0	0.0	0	0	1	3	1.0	0.1	2	0	0	4	498	100.8	8.3
Atlantic menhaden	*Brevooria tyrannus*	83	0	1	28.0	1.9	22	0	1	80	0	20.6	0.6	2	0	10	3	3.8	0.2	30	0	1	724	7	152.4	12.5
Gizzard shad	*Dorosoma cepedianum*	0	0	0	0.0	0.0	2	0	0	0	0	0.4	0.0	0	0	0	1	0.3	0.0	13	0	0	0	170	36.6	3.0
Rainbow smelt	*Osmerus mordax*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Atlantic silverside	*Menidia menidia*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	78	0	1	19.8	1.1	30	44	0	10	0	16.8	1.4
Grubby	*Myoxecephalus aenaeus*	13	0	0	4.3	0.3	8	0	0	0	0	1.6	0.0	0	0	0	0	0.0	0.0	4	0	0	0	0	0.8	0.1
Summer flounder	*Paralichthys dentatus*	89	3	0	30.7	2.0	46	8	5	0	0	11.8	0.3	10	1	0	0	2.8	0.2	1	6	1	0	0	1.6	0.1
Bluefish	*Pomatomus saltatrix*	3	0	2	1.7	0.1	7	5	0	17	1	6.0	0.2	18	32	61	9	30.0	1.7	3	6	3	22	24	11.6	1.0
Butterfish	*Peprillus tracanthus*	0	0	14	4.7	0.3	42	0	1	55	2	20.0	0.6	18	0	37	3	14.5	0.8	23	0	20	15	5	12.6	1.0
Red hake	*Urophycis chuss*	1	0	0	0.3	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Windowpane	*Scophthalmus aquosus*	13	1	0	4.7	0.3	4	0	0	0	0	0.8	0.0	2	0	0	0	0.5	0.0	19	0	2	0	0	4.2	0.3
American shad	*Alosa sapidissima*	0	0	0	0.0	0.0	3	1	0	0	0	0.8	0.0	2	9	0	1	3.0	0.2	0	3	1	0	9	2.6	0.2
Silver hake	*Merluccius bilinearis*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	3	0.6	0.0
Striped searobin	*Prionotus evolans*	3	0	0	1.0	0.1	9	0	1	2	0	2.4	0.1	45	0	8	0	13.3	0.8	25	0	3	5	0	6.6	0.5
Atlantic croaker	*Micropogonia undulatus*	0	0	0	0.0	0.0	7	0	0	2	0	1.8	0.1	3	0	0	0	0.8	0.0	4	0	0	0	1	1.0	0.1
Smallmouth flounder	*Etropus microstomus*	0	0	0	0.0	0.0	0	0	0	1	0	0.2	0.0	2	0	0	0	0.5	0.0	0	0	0	0	0	0.0	0.0
Northern pipefish	*Syngnathus fuscus*	4	6	0	3.3	0.2	1	0	0	1	0	0.4	0.0	2	0	2	0	1.0	0.1	0	0	0	0	0	0.0	0.0
Silver perch	*Bairdiella chrysura*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	8	0	0	0	5	2.6	0.2
Northern searobin	*Prionotus carollnus*	7	0	0	2.3	0.2	10	0	1	0	0	2.2	0.1	0	0	0	0	0.0	0.0	2	0	0	0	0	0.4	0.0
Hogchoker	*Trinectes maculatus*	1	0	0	0.3	0.0	2	0	0	0	0	0.4	0.0	7	0	0	0	1.8	0.1	0	0	0	1	0	0.2	0.0
Silverside	Atherinidae (unidentified)	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Atlantic moonfish	*Selene setapinnis*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	5	1.3	0.1	0	0	0	0	15	3.0	0.2
Threespine stickleback	*Gasterosteus aculeatus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
American eel	*Anguilla rostrata*	0	0	0	0.0	0.0	1	0	0	0	0	0.2	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Scup	*Stenotomus chrysops*	0	0	0	0.0	0.0	0	0	31	1	0	6.4	0.2	0	0	1	0	0.3	0.0	1	0	0	2	0	0.6	0.0
Cunner	*Tautogolabrus adspersus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Tautog	*Tautoga onitis*	0	0	0	0.0	0.0	1	0	0	0	0	0.2	0.0	0	0	0	0	0.0	0.0	0	0	1	0	0	0.2	0.0
Black sea bass	*Centropristis striata*	0	0	0	0.0	0.0	0	0	0	8	0	1.6	0.0	0	0	0	0	0.0	0.0	0	0	0	4	0	0.8	0.1
Northern kingfish	*Menticirrhus saxatillis*	0	0	0	0.0	0.0	3	0	0	0	0	0.6	0.0	0	6	2	0	2.0	0.1	0	0	1	2	0	0.6	0.0
Spot	*Leiostomus santhurus*	0	0	0	0.0	0.0	3	0	0	0	0	0.6	0.0	2	0	1	0	0.8	0.0	1	0	0	0	0	0.2	0.0
Striped anchovy	*Anchoa hepsetus*	0	0	0	0.0	0.0	0	0	0	0	10	2.0	0.1	0	0	0	1	0.3	0.0	0	0	0	0	4	0.8	0.1
Crevalle Jack	*Caranx hippos*	0	0	0	0.0	0.0	0	0	0	1	0	0.2	0.0	2	3	0	0	1.3	0.1	1	0	0	0	0	0.2	0.0
Rock gunnel	*Pholis gunnellus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Naked goby	*Gobiosoma bosc*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	1	0.2	0.0
Little skate	*Raja erinacea*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Oyster toadfish	*Opsanus tau*	0	0	0	0.0	0.0	0	0	0	2	0	0.4	0.0	0	0	0	0	0.0	0.0	0	0	0	1	0	0.2	0.0
Herring	Clupeidae (unidentified)	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Striped killifish	*Fundulus majalis*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Lookdown	*Selene vomer*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	1	0	0.3	0.0	0	0	2	0	0	0.4	0.0
Northern puffer	*Sphaeroldes maculatus*	0	0	0	0.0	0.0	1	1	0	0	0	0.4	0.0	1	0	0	0	0.3	0.0	0	0	0	0	0	0.0	0.0
Fourspot flounder	*Paralichthys oblongus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
American sandlance	*Ammodytes americanus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Seaboard Goby	*Gobiosoma ginsburgi*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Mummichog	*Fundulus heteroclitus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Lined seahorse	*Hippocampus erectus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Atlantic sturgeon	*Acipenser oxyrhynchus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Chub mackerel	*Scomber japonicus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Clearnose skate	*Raja eglanteria*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Conger eel	*Conger oceanicus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Goby	*Gobiidee sp.*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Northern stargazer	*Astroscopus guttatus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Planehead filefish	*Monacanthus hispidus*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	1	0	0	0	0	0.2	0.0
Pollock	*Pollachius sp.*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
Striped cuskeel	*Ophidion marginatum*	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0
	TOTALS	**2497**	**216**	**1806**			**2409**	**801**	**649**	**12812**	**899**			**2110**	**1844**	**2145**	**930**			**1247**	**83**	**310**	**1174**	**3281**		
	Monthly Average			**1506**							**3514**						**1757**							**1219**		

Table 3-4
Monthly Finfish Catch Data from Newark Bay Fish Community Studies (1993-2013)

		November						December									Overall	
Common Name	**Scientific Name**	**Nov-93**	**Nov-95**	**Nov-06**	**Nov-11**	**Average**	**Average % Comp**	**Dec-93**	**Dec-95**	**Dec-98**	**Dec-01**	**Dec-02**	**Dec-09**	**Dec-11**	**Average**	**Average % Comp**	**Species Avg**	**Avg Percent Comp (%)**
Bay anchovy	*Anchoa mitchilli*	5	0	195	839	259.8	19.5	9	0	7	0	1	71	637	103.6	26.8	541.10	31.436
White perch	*Morone americana*	507	1	23	8	134.8	10.1	272	0	77	0	459	15	0	117.5	30.4	103.16	17.404
Striped bass	*Morone saxatillis*	1748	0	41	0	447.3	33.6	205	0	70	0	135	1	0	58.8	15.2	118.60	16.246
Atlantic herring	*Clupea harengus*	17	0	0	0	4.3	0.3	0	0	0	0	0	0	2	0.3	0.1	40.10	4.752
Atlantic tomcod	*Microgadus tomcod*	277	0	0	0	69.3	5.2	110	0	0	0	0	0	0	15.7	4.1	67.64	5.627
Alewife	*Alosa pseudoharengus*	161	0	18	318	124.3	9.3	4	0	15	0	42	4	102	23.9	6.2	35.62	3.723
Winter flounder	*Pleuronectes americanus*	371	1	5	0	94.3	7.1	169	3	8	0	16	4	0	28.5	7.4	33.74	3.710
Weakfish	*Cynoscion regalis*	104	0	12	1	29.3	2.2	4	1	9	0	0	0	0	2.0	0.5	66.77	3.637
Spotted hake	*Urophycis regla*	20	0	9	0	7.3	0.5	15	0	2	0	3	0	0	2.9	0.7	21.23	3.389
Blueback herring	*Alosa aestivalls*	2	0	157	44	50.8	3.8	8	0	0	3	5	46	29	13.0	3.4	23.95	3.286
Atlantic menhaden	*Brevooria tyrannus*	4	0	6	2	3.0	0.2	0	0	0	0	7	0	0	1.0	0.3	19.64	1.554
Gizzard shad	*Dorosoma cepedianum*	196	0	4	40	60.0	4.5	18	0	3	0	7	3	8	5.6	1.4	9.54	0.902
Rainbow smelt	*Osmerus mordax*	0	0	0	0	0.0	0.0	5	0	0	0	0	0	0	0.7	0.2	3.76	0.606
Atlantic silverside	*Menidia menidia*	3	4	22	1	7.5	0.6	8	0	1	0	0	2	0	1.6	0.4	5.32	0.545
Grubby	*Myoxecephalus aenaeus*	6	0	0	0	1.5	0.1	23	0	0	0	0	0	0	3.3	0.9	3.04	0.465
Summer flounder	*Paralichthys dentatus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	5.20	0.418
Bluefish	*Pomatomus saltatrix*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	4.39	0.289
Butterfish	*Peprillus tracanthus*	1	0	3	3	1.8	0.1	0	0	1	0	0	0	0	0.1	0.0	4.60	0.260
Red hake	*Urophycis chuss*	0	0	0	0	0.0	0.0	13	0	0	0	0	0	0	1.9	0.5	1.52	0.248
Windowpane	*Scophthalmus aquosus*	19	0	0	0	4.8	0.4	5	0	1	0	0	1	0	1.0	0.3	2.09	0.248
American shad	*Alosa sapidissima*	5	0	7	18	7.5	0.6	2	0	10	0	0	0	0	1.7	0.4	1.94	0.231
Silver hake	*Merluccius bilinearis*	0	0	2	55	14.3	1.1	0	0	0	0	1	0	2	0.4	0.1	1.56	0.155
Striped searobin	*Prionotus evolans*	7	0	1	0	2.0	0.2	0	0	1	0	0	0	0	0.1	0.0	2.23	0.152
Atlantic croaker	*Micropogonia undulatus*	5	0	1	0	1.5	0.1	3	0	0	0	0	0	4	1.0	0.3	0.94	0.116
Smallmouth flounder	*Etropus microstomus*	3	0	3	0	1.5	0.1	2	0	2	0	0	1	0	0.8	0.2	0.64	0.116
Northern pipefish	*Syngnathus fuscus*	0	0	0	0	0.0	0.0	0	0	0	0	0	1	0	0.1	0.0	0.63	0.068
Silver perch	*Bairdiella chrysura*	13	0	0	0	3.3	0.2	0	0	0	0	0	0	0	0.0	0.0	0.66	0.066
Northern searobin	*Prionotus carollnus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.66	0.058
Hogchoker	*Trinectes maculatus*	0	0	0	0	0.0	0.0	2	0	0	0	0	0	0	0.3	0.1	0.35	0.035
Silverside	Atherinidae (unidentified)	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.22	0.035
Atlantic moonfish	*Selene setapinnis*	0	0	0	3	0.8	0.1	0	0	0	0	0	0	0	0.0	0.0	0.42	0.031
Threespine stickleback	*Gasterosteus aculeatus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.18	0.030
American eel	*Anguilla rostrata*	2	0	1	0	0.8	0.1	1	0	0	0	0	0	0	0.1	0.0	0.22	0.030
Scup	*Stenotomus chrysops*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.63	0.024
Cunner	*Tautogolabrus adspersus*	0	0	0	0	0.0	0.0	0	0	0	0	0	1	0	0.2	0.0	0.13	0.024
Tautog	*Tautoga onitis*	3	0	0	0	0.8	0.1	1	0	0	0	0	0	0	0.1	0.0	0.15	0.017
Black sea bass	*Centropristis striata*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.24	0.016
Northern kingfish	*Menticirrhus saxatillis*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.27	0.015
Spot	*Leiostomus santhurus*	0	0	2	0	0.5	0.0	0	0	0	0	0	0	0	0.0	0.0	0.18	0.011
Striped anchovy	*Anchoa hepsetus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.25	0.011
Crevalle Jack	*Caranx hippos*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.14	0.008
Rock gunnel	*Pholis gunnellus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.03	0.007
Naked goby	*Gobiosoma bosc*	0	0	0	0	0.0	0.0	0	0	0	0	1	0	0	0.1	0.0	0.04	0.007
Little skate	*Raja erinacea*	1	0	1	0	0.5	0.0	0	0	0	0	0	0	0	0.0	0.0	0.06	0.007
Oyster toadfish	*Opsanus tau*	0	0	1	0	0.3	0.0	0	0	0	0	0	0	0	0.0	0.0	0.09	0.006
Herring	Clupeidae (unidentified)	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.03	0.006
Striped killifish	*Fundulus majalis*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.03	0.005
Lookdown	*Selene vomer*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.05	0.004
Northern puffer	*Sphaeroldes maculatus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.06	0.004
Fourspot flounder	*Paralichthys oblongus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.02	0.003
American sandlance	*Ammodytes americanus*	0	0	0	0	0.0	0.0	0	0	0	0	1	0	0	0.1	0.0	0.01	0.003
Seaboard Goby	*Gobiosoma ginsburgi*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.02	0.003
Mummichog	*Fundulus heteroclitus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.002
Lined seahorse	*Hippocampus erectus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.02	0.002
Atlantic sturgeon	*Acipenser oxyrhynchus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Chub mackerel	*Scomber japonicus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Clearnose skate	*Raja eglanteria*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Conger eel	*Conger oceanicus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Goby	*Gobiidee sp.*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Northern stargazer	*Astroscopus guttatus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Planehead filefish	*Monacanthus hispidus*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.02	0.001
Pollock	*Pollachius sp.*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
Striped cuskeel	*Ophidion marginatum*	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0.0	0.0	0.01	0.001
	TOTALS	**3480**	**6**	**514**	**1332**			**879**	**4**	**207**	**3**	**678**	**150**	**784**				
	Monthly Average				**1333**									**386**				**905**

Table 3-4
Monthly Finfish Catch Data from Newark Bay Fish Community Studies (1993-2013)

Table 3-4 Notes:
Based on catch per unit effort (CPUE).

Acronyms and Abbreviations:
LMS = Lawler, Matusky and Skelly Engineers, Inc.
NOAA = National Oceanic and Atmospheric Administration
USACE = U.S. Army Corps of Engineers

Sources:
LMS. 1996. *Biological Survey of Newark Bay Shoal Areas and Adjacent Kill Van Kull and Arthur Kill Channels.* Lawler, Matusky and Skelly Engineers, Inc. Prepared for the Port Authority of New York and New Jersey.

NOAA. 1994. *Results of a Biological and Hydrographical Characterization of Newark Bay, New Jersey, May 1993–April 1994.* Report prepared by U.S. Department of Commerce, National Marine Fisheries, and Northeast Fisheries Service Center, National Oceanic and Atmospheric Administration. Also available online at: http://sh.nefsc.noaa.gov.

USACE. 2004, 2005, 2006, 2007, 2008, and 2009. *Aquatic Biological Survey Report. New York and New Jersey Harbor Deepening Project.* U.S. Army Corps of Engineers, New York District, New York, New York.

USACE 2013. *Migratory Finfish Report* 2011. New York and New Jersey Harbor Deepening Project. USACE New York District. Final Report. January.

Table 3-5
Mammal and Reptile Species that could Possibly Use the NBSA

Common Name	Scientific Name	Season	Habitat
Mammals			
Eastern pipistrelle	*Pipistrellus subflavus*	Spring to fall	Aerial – over land and water
Big brown bat	*Eptesicus fuscus*	Spring to fall	Aerial – over land and water
Red bat	*Lasiurus borealis*	Spring to fall	Aerial – over land and water
Hoary bat	*Lasiurus cinereus*	Spring to fall	Aerial – over land and water
Evening bat	*Nycticeius humeralis*	Spring to fall	Aerial – over land and water
Silver-haired bat	*Lasionycteris noctivagans*	Spring to fall	Aerial – over land and water
Small-footed bat	*Myotis leibii*	Spring to fall	Aerial – over land and water
Little brown bat	*Myotis lucifugus*	Spring to fall	Aerial – over land and water
Northern long-eared bat	*Myotis septentrionalis*	Spring to fall	Aerial – over land and water
Muskrat	*Ondatra zibethica*	Spring to fall	Marsh – wetland, riverine, small bays, and creeks
River otter	*Lutra canadensis*	Spring to fall	Marsh – wetland, riverine, small bays, and creeks
Harbor seal	*Phoca vitulina*	All year	Marine bays, channels, and coastal waters
Reptiles			
Loggerhead	*Caretta caretta*	Summer	Coastal waters
Kemp's ridley	*Lepidochelys kempii*	Summer	Coastal waters
Green sea turtle	*Chelonias mydas*	Summer	Coastal waters
Diamondback terrapin	*Malaclemys terrapin*	Spring to summer	Marsh – wetland, riverine, small bays, and creeks

Acronyms and Abbreviations:
NBSA = Newark Bay Study Area
USACE = U.S. Army Corps of Engineers

Source:
Adapted from USACE. 1997. *Final Environmental Impact Statement on the Newark Bay Confined Disposal Facility.* U.S. Army Corps of Engineers, New York District, New York, New York. April.

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Loons						
Loon, common	–	P	P	P	–	W
Loon, red-throated	–	P	–	P	–	W
Grebes						
Grebe, eared	–	–	–	P	–	T
Grebe, horned	–	P	–	P	–	W
Grebe, pied-billed	–	P	–	P	–	R
Pelicaniformes						
Cormorant, double-crested	P	P	P	P	P	***R***
Cormorant, great	–	–	–	P	–	W
Pelican, brown	–	–	–	P	–	T
Wading Birds						
Bittern, American	–	P	–	P	–	S
Bittern, least	–	P	–	P	–	S
Egret, cattle	–	P	P	P	P	***R***
Egret, great	P	P	P	P	P	***S***
Egret, snowy	P	P	P	P	P	***S***
Heron, black-crowned night	P	P	P		P	***R***
Heron, great blue	P	P	–	P	–	R
Heron, green	P	P	P	P	P	***S***
Heron, little blue	P	P	P	P	P	***S***
Heron, tricolored	–	P	P	P	P	***S***
Heron, yellow-crowned night	–	P	P	P		***S***
Ibis, glossy	–	P	P	P	P	***S***
Swans, Geese and Ducks						
Brant	–	P	P	P	–	W
Bufflehead	–	P	–	P	–	W
Canvasback		P	P	P	–	W
Duck, American black	P	P		P	P	***R***
Duck, fulvous whistling	–	P	–	–	–	T
Duck, long-tailed	–	P	–	P	–	W
Duck, ring-necked	–	P	–	–	–	W
Duck, ruddy	–	P	–	P	–	W
Duck, wood	P	P	–	P	–	R
Gadwall	–	P	P	P	P	***R***
Goldeneye, common	–	P	–	P	–	W
Goose, Canada	P	P	P	P	P	***R***
Goose, snow	–	P	–	–	–	W
Mallard	P	P	P	P	P	***R***
Merganser, common	P	–	–	P	–	W
Merganser, hooded	–	P	–	P	–	R
Merganser, red-breasted	–	P	–	P	–	W
Northern pintail	–	P	–	P	–	W
Northern shoveler	–	P	–	P	–	W
Redhead	–	P	–	–	–	W
Scaup, greater	–	P	P	P	–	W
Scaup, lesser	–	P	–	P	–	W
Scoter, black	P	–	–	P	–	W
Scoter, surf	–	P	–	P	–	W
Scoter, white-winged	P	P	–	P	–	W

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Swan, mute	–	P	–	P	–	R
Swan, tundra	–	P	–	–	–	M
Teal, blue-winged	–	P	–	P	–	S
Teal, green-winged	–	P	–	P	–	R
Wigeon, American	–	–	–	P	–	W
Diurnal Raptors						
American kestrel	P	P	P	P	–	R
Bald eagle	–	P	P	–	–	W
Falcon, peregrine	P	P	P	P	–	R
Hawk, broad-winged	–	P	P	P	–	S
Hawk, Cooper's	–	P	P	P	–	R
Hawk, red-shouldered	–	P	P	P	–	R
Hawk, red-tailed	P	P	P	P	–	R
Hawk, rough-legged	–	P	–	P	–	W
Hawk, sharp-shinned	–	P	P	P	–	S
Merlin	–	P	P	P	–	W
Northern goshawk	–	P	–	–	–	R
Northern harrier	–	P	P	P	P	W
Osprey	P	P	P	P	–	***S***
Vulture, turkey	–	P	P	P	–	R
Upland Game Birds						
Pheasant, ring-necked	–	P	–	P	P	R
Gruiformes						
American coot	–	P	–	P	–	W
Common moorhen	–	P	–	P	P	S
Rail, clapper	–	P	–	P	–	S
Rail, king	–	P	–	–	–	S
Rail, Virginia	–	P	–	P	P	S
Rail, yellow	–	P	–	–	–	T
Sora	–	P	–	P	–	S
Shorebirds						
American avocet	–	P	–	–	–	T
American oystercatcher	–	–	P	–	–	S
American woodcock	–	P	P	P	–	R
Common snipe	–	P	–	P	–	W
Dunlin	–	P	–	P	–	W
Dowitcher, long-billed	–	P	–	P	–	M
Dowitcher, short-billed	–	P	–	–	–	M
Godwit, Hudsonian	–	P	–	–	–	M
Godwit, marbled	–	P	–	–	–	T
Killdeer	P	P	–	P	–	R
Phalarope, red	–	P	–	–	–	M
Phalarope, Wilson's	–	P	–	–	–	T
Plover, American golden	–	P	P	–	–	M
Plover, black-bellied	–	P	–	P	–	W
Plover, semipalmated	–	P	–	P	–	M
Red knot	–	P	–	P	–	W
Ruff	–	P	–	–	–	T
Sanderling	–	P	–	P	–	W
Sandpiper, Baird's	–	P	–	–	–	T

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Sandpiper, buff-breasted	–	P	–	–	–	T
Sandpiper, curlew	–	P	–	–	–	T
Sandpiper, least	P	P	–	P	–	M
Sandpiper, pectoral	–	P	–	P	–	M
Sandpiper, purple	–	–	–	P	–	W
Sandpiper, semipalmated	–	P	–	P	–	M
Sandpiper, solitary	–	P	–	P	–	M
Sandpiper, spotted	P	P	P	P	P	S
Sandpiper, stilt	–	P	–	–	–	M
Sandpiper, upland	–	P	P	–	–	M
Sandpiper, western	–	P	–	–	–	T
Sandpiper, white-rumped	–	P	–	–	–	M
Stilt, black-necked	–	P	–	–	–	T
Turnstone, ruddy	–	P	–	P	–	W
Whimbrel	–	P	–	P	–	M
Willet	–	P	–	P	–	S
Yellowlegs, greater	P	P	–	P	–	W
Yellowlegs, lesser	P	P	–	–	–	M
Gulls, Terns and Skimmers						
Gull, great black-backed	P	P	P	P	P	***R***
Gull, Bonaparte's	–	P	–	P	–	W
Gull, common black-headed	P	P	–	P	–	T
Gull, glaucus	–	P	–	P	–	W
Gull, herring	P	P	P	P	P	***R***
Gull, Iceland	–	P	–	–	–	T
Gull, laughing	P	P	P	P	–	S
Gull, little	–	–	–	P	–	W
Gull, ring-billed	P	P	P	P	–	W
Skimmer, black	–	P	–	–	–	S
Tern, black	–	P	–	P	–	M
Tern, Caspian	–	P	–	P	–	M
Tern, common	–	P	P	P	–	***S***
Tern, Forster's	–	P	–	P	–	M
Tern, gull-billed	–	P	–	P	–	S
Tern, least	–	P	P	P	–	S
Tern, roseate	–	P	–	P	–	S
Tern, royal	–	P	–	–	–	S
Pigeons and Doves						
Dove, mourning	P	P	P	P	–	R
Dove, rock	P	P	P	P	P	***R***
Cuckoos and their Allies						
Cuckoo, black-billed	–	P	–	P	–	S
Cuckoo, yellow-billed	–	P	P	P	–	S

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Owls						
Owl, barn	–	P	–	P	–	R
Owl, barred	–	–	–	P	–	R
Owl, eastern-screech	–	P	–	–	–	R
Owl, great horned	–	P	–	P	–	R
Owl, long-eared	–	P	–	–	–	W
Owl, short-eared	–	P	–	P	–	W
Owl, snowy	–	P	–	–	–	W
Goatsuckers and Swifts						
Chimney swift	–	P	–	P	–	S
Nighthawk, common	–	P	–	P	–	S
Hummingbirds						
Hummingbird, ruby-throated	–	P	–	P	–	S
Kingfishers						
Kingfisher, belted	P	P	P	P	P	R
Woodpeckers						
Flicker, northern	–	P	–	P	P	R
Sapsucker, yellow-bellied	–	P	–	P	P	W
Woodpecker, hairy	–	P	–	–	–	R
Woodpecker, red-bellied	–	–	–	P	–	R
Woodpecker, downy	–	P	P	P	P	R
Woodpecker, red-headed	–	P	–	–	–	T
Tyrant Flycatchers						
Eastern wood-pewee	–	P	–	P	–	S
Flycatcher, great-crested	–	P	–	P	–	S
Flycatcher, least	–	P	–	P	–	S
Flycatcher, olive-sided	–	–	–	P	–	M
Flycatcher, willow	–	–	–	P	–	S
Flycatcher, yellow-bellied	–	P	–	P	–	M
Kingbird, eastern	P	P	–	P	–	S
Kingbird, western	–	P	P	–	–	T
Phoebe, eastern	–	P	–	P	P	S
Shrikes and Vireos						
Shrike, northern	–	P	–	–	–	T
Vireo, red-eyed	–	P	–	P	P	S
Vireo, solitary	–	P	–	P	–	S
Vireo, warbling	–	P	P	P	–	S
Vireo, white-eyed	–	P	–	–	–	S
Vireo, yellow-throated	–	P	–	–	–	S
Jays, Crows and their Allies						
Crow, American	P	P	P	P	–	R
Crow, fish	P	P	P	P	–	R
Jay, blue	P	P	–	P	–	R
Larks						
Lark, horned	–	P	–	–	–	R

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Swallows						
Purple martin	–	P	P	–	–	S
Swallow, bank	–	P	–	P	–	S
Swallow, barn	P	P	P	P	–	S
Swallow, cliff	–	P	–	–	–	M
Swallow, northern rough-winged	P	P	–	P	–	S
Swallow, tree	–	P	P	P	–	S
Chickadees and their Allies						
Chickadee, black-capped	–	P	–	P	–	R
Titmouse, tufted	–	P	–	P	–	R
Nuthatches and Creepers						
Brown creeper	–	P	–	P	–	R
Nuthatch, red-breasted	–	P	–	P	–	W
Nuthatch, white-breasted	–	P	–	P	–	R
Wrens						
Wren, Carolina	–	P	P	P	–	R
Wren, house	–	P	P	P	P	S
Wren, marsh	–	P	–	P	–	S
Wren, sedge	–	P	–	–	–	T
Wren, winter	–	P	–	P	–	W
Old World Warblers, Thrushes and their Allies						
Robin, American	–	P	–	P	P	R
Gnatcatcher, blue-gray	–	P	–	P	–	S
Kinglet, golden-crowned	–	P	–	P	P	W
Kinglet, ruby-crowned	–	P	–	P	P	W
Thrush, gray-cheeked	–	P	P	P	–	M
Thrush, hermit	–	P	–	P	P	R
Thrush, Swainson's	–	P	P	P	P	M
Thrush, wood	–	P	–	P	–	S
Veery	–	P	–	P	–	S
Mimids						
Brown thrasher	–	P	–	P	P	R
Catbird, gray	P	P	P	P	P	R
Mockingbird, northern	P	P	–	P	–	R
Starlings and Minas						
Starling, European	P	P	P	P	–	***R***
Wagtails and Pipits						
American pipit	–	P	–	–	–	M
Waxwings						
Waxwing, cedar	–	P	–	P	P	R
Wood-Warblers						
American redstart	–	P	P	P	P	S
Chat, yellow-breasted	–	–	P	–	–	S
Northern parula	–	P	–	P	–	M
Ovenbird	–	P	–	P	P	S
Warbler, bay-breasted	–	P	–	P	–	M
Warbler, black-and-white	–	P	P	P	P	S
Warbler, blackburnian	–	P	–	P	–	M
Warbler, blackpoll	–	P	–	P	P	M
Warbler, black-throated blue	–	P	P	P	P	M
Warbler, black-throated green	–	P	–	P	–	S

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Warbler, blue-winged	–	P	–	P	P	S
Warbler, Canada	–	P	–	P	–	M
Warbler, Cape May	–	P	–	P	–	M
Warbler, cerulean	–	–	P	P	–	M
Warbler, chestnut-sided	–	P	–	P	P	S
Warbler, Connecticut	–	P	P	P	P	M
Warbler, golden-winged	–	–	P	–	–	M
Warbler, hooded	–	–	P	P	–	S
Warbler, Kentucky	–	–	–	P	–	S
Warbler, magnolia	–	P	P	P	P	M
Warbler, mourning	–	–	P	P	–	M
Warbler, Nashville	–	P	–	P	P	S
Warbler, orange-crowned	–	P	–	–	–	T
Warbler, palm	–	P	–	P	P	M
Warbler, pine	–	–	P	–	–	S
Warbler, prairie	–	P	–	P	–	S
Warbler, prothonotary	–	–	–	P	–	S
Warbler, Tennessee	–	P	–	P	–	M
Warbler, Wilson's	–	P	–	–	P	M
Warbler, worm-eating	–	–	P	P	–	S
Warbler, yellow	–	P	P	P	–	S
Warbler, yellow-rumped	–	P	–	P	P	W
Warbler, yellow-throated	–	–	P	P	–	S
Waterthrush, Louisiana	–	P	–	P	–	S
Waterthrush, northern	–	P	P	P	P	M
Yellowthroat, common	–	P	–	P	P	S
Tanagers, Cardinals and their Allies						
Bunting, indigo	–	P	–	P	–	S
Dickcissel	–	P	–	–	–	T
Grosbeak, blue	–	P	–	–	–	T
Grosbeak, rose-breasted	–	P	–	P	–	S
Northern cardinal	P	P	–	P	–	R
Tanager, scarlet	–	P	–	P	–	S
Emberizine Sparrows and their Allies						
Bunting, snow	–	P	–	–	–	W
Junco, dark-eyed	–	P	–	P	P	W
Longspur, lapland	–	P	–	–	–	W
Sparrow, American tree	P	P	–	P	–	W
Sparrow, chipping	–	P	–	P	–	S
Sparrow, field	–	P	–	P	P	R
Sparrow, fox	–	P	P	–	–	W
Sparrow, Lincoln's	–	P	P	–	–	M
Sparrow, Savannah	–	P	–	P	–	S
Sparrow, seaside	–	P	–	P	–	R
Sparrow, sharp-tailed	–	P	–	P	–	S
Sparrow, song	P	P	P	P	P	R
Sparrow, swamp	–	P	–	P	P	R
Sparrow, vesper	–	P	–	–	–	S
Sparrow, white-crowned	–	P	–	P	–	W
Sparrow, white-throated	P	P	–	P	P	W
Towhee, eastern	–	P	–	P	P	S

Table 3-6
Inventory of Bird Observations in the Newark Bay Study Area

Species	Observed Locations					Residency
	Passaic River	Hackensack River	Newark Bay	Arthur Kill	Kill van Kull	
Icterids						
Blackbird, red-winged	P	P	–	P	–	R
Blackbird, rusty	–	P	–	–	–	W
Blackbird, yellow-headed	–	P	–	–	–	T
Bobolink	–	P	–	–	–	S
Cowbird, brown-headed	–	P	–	P	–	R
Eastern meadowlark	–	P	–	P	–	R
Grackle, common	P	P	P	P	–	R
Grackle, boat-tailed	–		–	P	–	R
Oriole, Baltimore	–	P	P	P	–	S
Oriole, orchard	–	–	P	–	–	S
Finches and Old World Sparrows						
Common redpoll	–	P	–	–	–	W
Finch, house	P	P	–	P	–	R
Finch, purple	–	P	–	P	–	R
Goldfinch, American	P	P	P	P	P	R
Siskin, pine	–	P	–	P	–	W
Sparrow, house	P	P	–	P	–	***R***
Total Number of Species	**49**	**248**	**81**	**213**	**59**	

Notes:

1. P indicates species was observed during any of the following surveys: Tierra (2004), Ludwig et al. (2010), Kerlinger (2004), Bernick (2007), Bernick and Craig (2008), Mizrahi et al. (2006).
2. The Passaic River Bird Survey was conducted on the lower six miles of the river.
3. The residency column differentiates between year-round residents (R), summer residents (S), winter residents (W), migratory species (M) who may stop-over during migration, or transient/vagrant species (T) that normally do not occur in the NBSA based on the *Birds of North America Online*. Species known, or suspected, to breed in the NBSA are in bold italics.

Sources:

Bernick, A.J. 2007. *NYC Audubon's Harbor Herons Project: 2007 Nesting Survey.* NYC Audubon, New York. 48 pp.

Bernick, A.J. and E. Craig. 2008. *NYC Audubon's Harbor Herons Project: 2008 Interim Nesting Survey.* NYC Audubon, New York. 42 pp.

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Table 3-7
Sediment and Tissue Datasets for Use in Risk Assessments

Date	Author	Title	Media
1980	Ellis et al.	A Comprehensive Monitoring and Assessment Program for Selected Heavy Metals in New Jersey Aquatic Fauna	Tissue
1982	NJDEP	PCBs in Fish: 1975-1980. A Comprehensive Survey	Tissue
1983	NJDEP	PCBs in Selected Finfish Caught Within New Jersey Waters 1981-1982 (With Limited Chlordane Data)	Tissue
1985	NJDEP	A Study of Dioxin (2,3,7,8-Tetrachlorodibenzo-p-Dioxin) Contamination in Select Finfish, Crustaceans and Sediments of New Jersey Waterways	Tissue
1991	Rappe et al.	Levels and Patterns of PCDD and PCDF Contamination in Fish, Crabs, and Lobsters from Newark Bay and the Newark Bight	Tissue
1991	Woodhead, P.M.J.	Module 5.3 Inventory and Characterization of Habitat and Fish Resources and Assessment of Information on Toxic Effects of the New York-New Jersey Harbor Estuary	Tissue
1994	Brown et al.	Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans in Mya arenaria in the Newark/Raritan Bay Estuary	Tissue
1997	NOAA	Fish, Megainvertebrates, and Associated Hydrographic Observations Collected in Newark Bay, New Jersey, during May 1993 – April 1994	Tissue
1999	USACE	New York and New Jersey Harbor Navigation Study. Biological Monitoring Program 1998-1999, Volume I of II	Tissue
1999-2006	Honeywell	Offshore Investigation Results Summary Report	Sediment
2000	Gale et al.	Evaluation of Planar Halogenated and Polycyclic Aromatic Hydrocarbons in Estuarine Sediments using Ethoxyresorufin-O-Deethylase Induction of H4IIE Cells	Tissue
2000	USFWS	Impacts of Dioxins, Furans, and Polychlorinated Biphenyls on Anadromous Fish and Piscivorous Birds in Newark Bay. Pre Assessment Study for the Diamond Alkali Superfund Site, Newark, Essex County, New Jersey	Tissue
2001	Yuan et al.	Is Hepatic Cytochrome P4501A1 Expression Predictive of Hepatic Burdens of Dioxins, Furans, and PCBs in Atlantic Tomcod from the Hudson River Estuary?	Tissue
2002	Horwitz et al.	Environmental Assessment and Risk Analysis Element Research Project Summary: Assessment of Total Mercury Concentrations in Fish from Rivers, Lakes and Reservoirs in New Jersey	Tissue
2003	NYSDEC	Contaminant Assessment and Reduction Project: NY/NJ Harbor Sediment Report, 1998-2001	Sediment
2003	USACE	New York and New Jersey Harbor Navigation Project. Aquatic Biological Sampling Program Survey Report, 2001-2002.	Tissue
2003	USACE	New York/ New Jersey Harbor Navigation Project. Aquatic Biological Survey Report, 2002-2003	Tissue
2003	Wintermyer, M.L. and K.R. Cooper	Dioxin/Furan and Polychlorinated Biphenyl Concentrations in Eastern Oyster (Crassostrea virginica, Gmelin) Tissues and the Effects on Egg Fertilization and Development	Tissue
2004	Fernandez et al.	Spatial Variation in Hepatic Levels and Patterns of PCBs and PCDD/Fs among Young-of-the-Year and Adult Atlantic Tomcod (*Microgadus tomcod*) in the NY/NJ Harbor Estuary	Tissue
2004	NYSDEC	Polychlorinated Biphenyls (PCBs) in Five Fish Species from the New York-New Jersey Harbor Estuary	Tissue
2004	NYSDEC	Dioxins and Furans in Five Fish Species, Blue Crabs, Invertebrates and Zooplankton from the New York-New Jersey Harbor Estuary	Tissue
2004	NYSDEC	Mercury, Methyl Mercury, Cadmium and Lead in Five Fish Species, Blue Crabs, Invertebrates and Zooplankton from the New York-New Jersey Harbor Estuary	Tissue
2004	USACE	New York/New Jersey Harbor Deepening Project. Aquatic Biological Survey Report, 2004	Tissue
2005	NOAA	Benthic Macrofauna and Associated Hydrographic Observations Collected in Newark Bay, New Jersey, between June 1993 and March 1994	Tissue
2005	NYSDEC	Organochlorine Pesticides in Five Fish Species, Blue Crabs, Invertebrates and Zooplankton from the New York-New Jersey Harbor Estuary.	Tissue
2005	USACE	New York and New Jersey Harbor Deepening Project. Aquatic Biological Survey Report, 2005	Tissue
2006	Academy of Natural Sciences	Monitoring Program for Chemical Contaminants in Fish from the State of New Jersey. Second Year of Routine Monitoring Program. Final Report. Report No. 06-04F	Tissue
2006	NYSDEC	Polynuclear Aromatic Hydrocarbons (PAHs) in Five Fish Species, Blue Crabs, Invertebrates and Zooplankton from the New York-New Jersey Harbor Estuary	Tissue
2007	Cooper, K.R. and G.A. Buchanan	Integrated Biomarkers for Assessing the Exposure and Effects of Endocrine Disruptors and Other Contaminants on Marine/Estuarine Fish	Tissue
2007	USACE	New York/New Jersey Harbor Deepening Project. Migratory Finfish Report, 2006	Tissue
2007	USACE	New York and New Jersey Harbor Deepening Project. Aquatic Biological Survey Report, 2007	Tissue

Table 3-7
Sediment and Tissue Datasets for Use in Risk Assessments

Date	Author	Title	Media
2008	Bernick, A.J. and E. Craig.	NYC Audubon's Harbor Herons Project: 2008 Interim Nesting Survey	Tissue
2008	USACE	New York and New Jersey Harbor Deepening Project. Aquatic Biological Survey Report, 2008	Tissue
2008	USACE	Dredging Operations Environmental Research Program. Dredged Material Analysis Tools. Performance of Acute and Chronic Sediment Toxicity Methods	Tissue
2009	Bugel, S.M.	An Integrated Biomarker Approach for Assessing Exposure and Effects of Endocrine Disruptors and other Contaminants in Killifish (Fundulus heteroclitus) from the New York-New Jersey Harbor Estuary	Tissue
2009	USACE	New York and New Jersey Harbor Deepening Project. Aquatic Biological Survey Report, 2009	Tissue
2010	USACE	Dredging Operations and Environmental Research Program. Determining Steady-state Tissue Residues for Invertebrates in Contaminated Sediment.	Tissue
2010	USACE	Stratified Sampling Project Summary Report and Evaluation of Data. New York District. New York, NY	Sediment
2010	Tierra	Phase I and Phase II Data Evaluation and Analysis Report. Newark Bay Study Area Remedial Investigation. Revision 0. Tierra Solutions, Inc., East Brunswick, NJ. April	Sediment
2011	Bugel, S.M.	Decreased Vitellogenin Inducibility and 17β-estradioal Levels Correlated with Reduced Egg Production in Killifish (Fundulus heteroclitus) from Newark Bay, NJ	Tissue
2011	Pflugh et al.	Consumption Patterns and Risk Assessment of Crab Consumers from the Newark Bay Complex, New Jersey, USA	Tissue
2013	USACE	New York/New Jersey Harbor Deepening Project. Migratory Finfish Report, 2011	Tissue

Notes:
Datasets are preliminarily deemed Level 2 or 3 from the ongoing secondary data evaluation.

Table 3-8
Summary of Amphipod Survival Studies in Newark Bay

Reference	Data Collection Date(s)	Data Collection Season(s)	Average or Range of Survival as % of Control
Battelle (1992)	1992	Not provided	37
Battelle (1997a)	1995	Summer	19 - 62
Battelle (1997b)	1995	Summer	67
NOAA (1995)	1991, 1993	Not provided	0 - 87
Rice et al. (1995)	1991	Spring	NA
Tierra (2004)	2000	Summer	35
USACE (1997)	1996	Spring	81 - 97
USEPA (1990)	not provided	Not provided	0 - 89
USEPA (1998)	1990 - 1994	Summer	8 - 94
USEPA (2003)	1998	Summer	0 - 99

Notes:
NA = not available

Sources:
Battelle. 1992. *Sediment Toxicity and Concentrations of Trace Metals in Sediment and Porewater in New York/New Jersey Harbor.* Ocean Sciences, Duxbury, MA. Submitted to New York City Department of Environmental Protection.

Battelle. 1997a. *Evaluation of Dredged Material Proposed for Ocean Disposal from Arthur Kill Project Area, New York.* Battelle, Sequim, WA.

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NOAA. 1995. *Magnitude and Extent of Sediment Toxicity in the Hudson Raritan Estuary.* NOAA Technical Memorandum NOS ORCA 88. National Oceanic and Atmospheric Administration Silver Spring, MD.

Rice, C.A., P.D. Plesha, E. Casillas, D.A. Misitano, and J.P. Meador. 1995. Growth and survival of three marine invertebrate species in sediments from the Hudson-Raritan Estuary, New York. *Environ. Toxicol. Chem.* 14(11): 1931-1940.

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USACE. 1997. *Final Environmental Impact Statement on the Newark Bay Confined Disposal Facility.* U.S. Army Corps of Engineers, New York District, New York, New York. April.

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USEPA. 1998. *Sediment Quality of the NY/NJ Harbor System.* EPA/902/R-98/001. U.S. Environmental Protection Agency, Regional Environmental Monitoring and Assessment Program (REMAP), Edison, NJ.

USEPA. 2003. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures.* EPA-600-R-02-013. Office of Research and Development. November.

Table 4-1
Summary of COPECs from the SLERA

Chemical	Sediment	Benthic Invertebrates	Fish	Mollusk	Crab	Avian Embryo
Metals						
Antimony	ü					
Arsenic	ü	ü		ü		
Cadmium	ü	ü		ü		ü
Chromium	ü	ü		ü		
Copper	ü	ü		ü		
Iron	ü					
Lead	ü	ü	ü	ü		
Manganese	ü					
Mercury	ü					
Mercury (Elemental)		ü	ü	ü	ü	ü
Mercury (Total)			ü	ü	ü	ü
Methyl mercury			ü		ü	ü
Nickel	ü	ü		ü		
Selenium	ü					
Silver	ü	ü		ü		
Zinc	ü	ü		ü		
VOCs						
Ethylbenzene	ü					
SVOCs (Non-PAHs)						
1,2,4-Trichlorobenzene	ü					
1,3-Dichlorobenzene	ü					
1,4-Dichlorobenzene	ü					
Bis(2-ethylhexyl)phthalate	ü					
SVOCs (PAHs)						
1-Methylnaphthalene						ü
1-Methylphenanthrene						ü
2,3,5-Trimethylnaphthalene						ü
2,6-Dimethylnaphthalene						ü
2-Methylnaphthalene	ü					ü
Acenaphthene	ü					ü
Acenaphthylene	ü					ü
Anthracene	ü					ü
Benzo(a)anthracene	ü	ü	ü	ü	ü	ü
Benzo(a)pyrene	ü	ü		ü		ü
Benzo(b)fluoranthene	ü	ü		ü	ü	
Benzo(g,h,i)perylene	ü					ü
Benzo(k)fluoranthene	ü	ü		ü	ü	
Benzo[e]pyrene						ü
Benzofluoranthenes (total)	ü					
Biphenyl						ü
Chrysene	ü	ü	ü	ü	ü	ü
Dibenzo(a,h)anthracene	ü	ü	ü	ü		ü
Fluoranthene	ü					ü
Fluorene	ü					ü
Indeno[1,2,3-cd]-pyrene	ü	ü	ü	ü	ü	ü
Naphthalene	ü					ü
Perylene						ü
Phenanthrene	ü					ü
Pyrene	ü					ü
Total PAHs	ü	ü	ü	ü	ü	ü
HMW PAHs	ü	ü	ü	ü	ü	ü
LMW PAHs	ü	ü	ü	ü	ü	ü

Table 4-1
Summary of COPECs from the SLERA

Chemical	Sediment	Benthic Invertebrates	Fish	Mollusk	Crab	Avian Embryo
PCBs						
Aroclor 1016			ü			
Aroclor 1242	ü		ü			ü
Aroclor 1248	ü		ü			ü
Aroclor 1254	ü		ü	ü	ü	ü
Aroclor 1260	ü					ü
PCB 18CONGX2	ü					ü
Total Aroclor	ü		ü	ü	ü	ü
Total PCBs	ü	ü	ü	ü	ü	ü
Pesticides/Herbicides						
2,4'-DDD	ü	ü				ü
2,4'-DDE	ü			ü		ü
2,4'-DDT	ü					ü
4,4'-DDD	ü	ü	ü	ü		ü
4,4'-DDE	ü	ü	ü	ü		ü
4,4'-DDT	ü	ü				ü
Total DDx	ü	ü	ü	ü	ü	ü
Aldrin	ü	ü		ü		ü
alpha-BHC	ü					ü
beta-BHC	ü					ü
delta-BHC	ü					ü
gamma-BHC (Lindane)	ü					ü
Total BHC	ü					ü
Chlordane	ü					ü
Chlordane alpha (cis)	ü					ü
Chlordane gamma (trans)	ü					ü
Chlordane oxy	ü					ü
Total chlordane	ü	ü	ü	ü	ü	ü
Dieldrin	ü	ü	ü	ü		ü
Endrin	ü					ü
Endrin aldehyde						ü
Endrin ketone						ü
Total endrin	ü		ü			ü
Endosulfan sulfate						ü
Endosulfan alpha						ü
Endosulfan beta						ü
Total endosulfan	ü	ü		ü		ü
Heptachlor	ü					ü
Heptachlor epoxide	ü					ü
Total heptachlor	ü					ü
Hexachlorobenzene	ü					ü
Methoxychlor	ü					ü
Mirex						ü
Nonachlor cis-						ü
Nonachlor trans-						ü
Total Nonachlor			ü			ü

Table 4-1
Summary of COPECs from the SLERA

Chemical	Sediment	Benthic Invertebrates	Fish	Mollusk	Crab	Avian Embryo
Dioxins/Furans						
2,3,7,8-TCDD	ü					ü
DIOX_TEQ_BIRD		ü	ü		ü	ü
DIOX_TEQ_FISH			ü	ü	ü	ü
DIOX_TEQ_MAMMAL		ü	ü		ü	ü
PCB_TEQ_BIRD			ü	ü	ü	ü
PCB_TEQ_FISH			ü	ü	ü	ü
PCB_TEQ_MAMMAL			ü	ü	ü	ü
TOTAL_TEQ_BIRD		ü	ü	ü	ü	ü
TOTAL_TEQ_FISH			ü	ü	ü	ü
TOTAL_TEQ_MAMMAL	ü	ü	ü	ü	ü	ü

Acronyms and Abbreviations:
BHC = benzene hexachloride
COPEC = constituent of potential ecological concern
DDD = dichlorodiphenyldichloroethane
DDE = dichlorodiphenyldichloroethylene
DDT = dichlorodiphenyltrichloroethane
HMW = high molecular weight
LMW = low molecular weight
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyls
SLERA = screening level ecological risk assessment
SVOC = semi-volatile organic compound
TCDD = tetrachlorodibenzo-p-dioxin
TEQ = toxic equivalent
VOC = volatile organic compound
DIOX_TEQ = dioxin TEQ
PCB_TEQ = dioxin-like PCBs TEQ
Total_TEQ = sum of dioxin and dioxin-like PCB TEQ

Notes:
PCB congener data will be collected to obtain data for Total PCBs and to verify Aroclor totals.

The form of mercury specified in the various studies/toxicological sources used to obtain screening benchmarks for the different environmental media (e.g., sediment, tissue types) evaluated in the SLERA differed, leading to the identification of different types of mercury as COPECs for different media.

Source:
USEPA. 2008. *Screening-Level Ecological Risk Assessment for Newark Bay Study Area.* Submitted to USEPA Region 2 and USACE Kansas City District. Prepared by Battelle under contract to Malcolm Pirnie, Inc. December 15.

Table 4-2
Surficial Sediment COPEC Screen

CAS Number	Analyte	Screening Value	Basis	Detects/Total Samples	Frequency of Detects	Mean Concentration	Minimum Concentration	Maximum Concentration	Standard Deviation	Geometric Mean	Median	COPEC?	Rationale
Dioxins/Furans (µg/kg)													
35822-46-9	1,2,3,4,6,7,8-HpCDD		NA	168/169	99%	0.267	0.00254	2.26	0.288	0.155	0.216	YES*	Included in total
67562-39-4	1,2,3,4,6,7,8-HpCDF		NA	169/169	100%	0.458	0.012941	7.82	0.882	0.218	0.242	YES*	Included in total
55673-89-7	1,2,3,4,7,8,9-HpCDF		NA	157/169	93%	0.0153	0.000452	0.165	0.0202	0.00866	0.0102	YES*	Included in total
39227-28-6	1,2,3,4,7,8-HxCDD		NA	142/169	84%	0.00379	0.0001	0.0231	0.00343	0.00264	0.00319	YES*	Included in total
70648-26-9	1,2,3,4,7,8-HxCDF		NA	167/169	99%	0.114	0.00273	2.21	0.247	0.0519	0.058752	YES*	Included in total
57653-85-7	1,2,3,6,7,8-HxCDD		NA	156/169	92%	0.0156	0.000544	0.0983	0.0156	0.00968	0.012991	YES*	Included in total
57117-44-9	1,2,3,6,7,8-HxCDF		NA	163/169	96%	0.0312	0.00075	0.401	0.0456	0.0159	0.0173	YES*	Included in total
19408-74-3	1,2,3,7,8,9-HxCDD		NA	151/169	89%	0.00875	0.000419	0.0505	0.00759	0.00596	0.00783	YES*	Included in total
72918-21-9	1,2,3,7,8,9-HxCDF		NA	116/169	69%	0.00409	0.000213	0.0502	0.00572	0.00226	0.00236	YES*	Included in total
40321-76-4	1,2,3,7,8-PeCDD		NA	144/169	85%	0.00378	0.000116	0.0471	0.00465	0.00249	0.00298	YES*	Included in total
57117-41-6	1,2,3,7,8-PeCDF		NA	161/169	95%	0.0127	0.000443	0.152	0.0181	0.0077	0.00909	YES*	Included in total
60851-34-5	2,3,4,6,7,8-HxCDF		NA	160/169	95%	0.0128	0.000498	0.135	0.0161	0.00775	0.0095	YES*	Included in total
57117-31-4	2,3,4,7,8-PeCDF		NA	161/169	95%	0.0216	0.000827	0.243	0.0285	0.0129	0.016	YES*	Included in total
1746-01-6	2,3,7,8-TCDD	0.0025	Recommended by Partner Agencies	167/169	99%	**0.0752**	0.00091	**1.35**	0.132	0.0371	0.0486	**YES**	AboveScreenValue
51207-31-9	2,3,7,8-TCDF		NA	160/169	95%	0.017	0.000738	0.16	0.0174	0.0111	0.0141	YES*	Included in total
3268-87-9	OCDD		NA	169/169	100%	2.65	0.079604	28.1	3.01	1.64	2.02	YES*	Included in total
39001-02-0	OCDF		NA	169/169	100%	0.744	0.01765	13.1	1.38	0.362	0.402	YES*	Included in total
WHODIOXTEQ(B)	Total WHO Dioxin TEQ(Bird)		NA	169/169	100%	0.142	0.0067	1.59	0.189	0.0836	0.108	**YES**	NSV
WHODIOXTEQ(F)	Total WHO Dioxin TEQ(Fish)		NA	169/169	100%	0.115	0.00528	1.5	0.169	0.0646	0.0818	**YES**	NSV
WHODIOXTEQ(H)	Total WHO Dioxin TEQ(Human/Mammal)		NA	169/169	100%	0.115	0.0053	1.5	0.167	0.0647	0.0822	**YES**	NSV
Inorganics (mg/kg)													
7429-90-5	Aluminum	18000	NJDEP ESC Table - Marine	177/178	99%	12500	0.55	**31500**	5110	10600	13050	**YES**	AboveScreenValue
7440-36-0	Antimony	9.3	NJDEP ESC Table - Marine	21/174	12%	2.56	0.235	**35.8**	4.3	1.37	1.25	**YES**	AboveScreenValue
7440-38-2	Arsenic	8.2	NJDEP ESC Table - Marine	181/181	100%	**14.4**	1.4	**113**	12.9	11.5	11.4	**YES**	AboveScreenValue
7440-39-3	Barium	48	NJDEP ESC Table - Marine	181/181	100%	**146**	9.1	**871**	110	117	123	**YES**	AboveScreenValue
7440-41-7	Beryllium		NA	147/178	83%	0.675	0.036	1.6	0.277	0.603	0.69	**YES**	NSV
7440-43-9	Cadmium	1.2	NJDEP ESC Table - Marine	149/181	82%	**1.84**	0.02	**21.5**	2.54	1.02	1.1	**YES**	AboveScreenValue
7440-70-2	Calcium		NA	173/173	100%	7480	345	37800	5100	6300	6940	NO	Nutrient
7440-47-3	Chromium	81	Recommended by Partner Agencies	258/258	100%	**433**	7	**7430**	877	170	136.5	**YES**	AboveScreenValue
7440-48-4	Cobalt	10	NJDEP ESC Table - Marine	165/178	93%	9.31	2.4	**21.8**	3.42	8.59	9.5	**YES**	AboveScreenValue
7440-50-8	Copper	13.318	Recommended by Partner Agencies	176/176	100%	**145**	6.8	**781**	122	108	118	**YES**	AboveScreenValue
7439-96-5-DIV	Divalent Manganese		NA	20/21	95%	116	12.1	304	72.3	92.6	95.8	**YES**	NSV
18540-29-9	Hexavalent Chromium		NA	50/84	60%	18	0.2415	951	106	1.91	1.275	**YES**	NSV
7439-89-6	Iron	20000	USEPA Reg 3 - Freshwater	178/178	100%	**26600**	5310	**57800**	9480	24300	27950	**YES**	AboveScreenValue
7439-92-1	Lead	10.606	Recommended by Partner Agencies	207/207	100%	**153**	7	**882**	122	115	120	**YES**	AboveScreenValue
7439-95-4	Magnesium		NA	178/178	100%	6800	1250	15400	2610	6130	7230	NO	Nutrient
7439-96-5	Manganese	260	NJDEP ESC Table - Marine	178/178	100%	**364**	51.6	**790**	149	324	369	**YES**	AboveScreenValue
7439-97-6	Mercury	0.037	Recommended by Partner Agencies	203/204	100%	**4.52**	0.04	**77**	9.13	2.18	2.3	**YES**	AboveScreenValue
7440-02-0	Nickel	21	NJDEP ESC Table - Marine	178/178	100%	**35.2**	5.7	**179**	18.8	31	34.825	**YES**	AboveScreenValue
7440-09-7	Potassium		NA	169/169	100%	2890	298	8440	1500	2390	2960	NO	Nutrient
7782-49-2	Selenium	1	NJDEP ESC Table - Marine	83/177	47%	**1.16**	0.14	**4.6**	0.952	0.884	0.81	**YES**	AboveScreenValue
7440-22-4	Silver	1	NJDEP ESC Table - Marine	142/172	83%	**2.22**	0.08	**15.85**	2.01	1.59	1.7	**YES**	AboveScreenValue
7440-23-5	Sodium		NA	178/178	100%	7200	551	25200	4020	5980	6915	NO	Nutrient
7440-28-0	Thallium		NA	48/174	28%	0.988	0.071	9.60	0.987	0.71	0.75	**YES**	NSV
7440-32-6	Titanium		NA	106/106	100%	444	116	896	130	423	454	**YES**	NSV
7440-62-2	Vanadium	57	NJDEP ESC Table - Marine	178/178	100%	35.1	5.8	**98.5**	14.5	31.6	35.975	**YES**	AboveScreenValue
7440-66-6	Zinc	6.62	Recommended by Partner Agencies	178/178	100%	**271**	19.2	**1460**	192	218	222.25	**YES**	AboveScreenValue
1191-48-6	Dibutyltin		NA	64/97	66%	5.19	0.47	46.5	6.62	3.13	3.2	**YES**	NSV
78763-54-9	Monobutyltin		NA	0/95	0%	1.53	0.55	3.55	0.617	1.4	1.55	NO	ND
1461-25-2	Tetrabutyltin		NA	5/97	5%	2.03	0.95	24	2.35	1.76	1.75	NO	Low FOD
688-73-3	Tributyltin		NA	63/97	65%	5.96	0.85	74	9.85	3.42	3.7	**YES**	NSV
REAC-CN	Reactive Cyanide		NA	0/9	0%	14100	10000	20300	3900	13700	14050	NO	ND
57-12-5	Total Cyanide	100	NJDEP ESC Table - Freshwater	25/103	24%	**285**	50	**4150**	447	200	180	**YES**	AboveScreenValue
Pesticides/Herbicides (µg/kg)													
93-76-5	2,4,5-T	12300	USEPA Reg 3 - Freshwater	26/104	25%	273	3.6	3783	449	102	232.5	NO	BelowScreenValue
93-72-1	2,4,5-TP (Silvex)	675	USEPA Reg 3 - Freshwater	24/94	26%	318	1.6	**3783**	462	146	260	**YES**	AboveScreenValue
94-75-7	2,4-D	1273	USEPA Reg 5	18/107	17%	690	5	**9328**	1090	270	600	**YES**	AboveScreenValue
94-82-6	2,4-DB		NA	14/86	16%	639	16	7060	872	378	500	**YES**	NSV
53-19-0	2,4'-DDD		NA	9/37	24%	6.82	2.2	47	9.9	4.75	3.8	**YES**	NSV
3424-82-6	2,4'-DDE		NA	12/36	33%	8.65	2.2	33	8.76	5.93	3.875	**YES**	NSV
789-02-6	2,4'-DDT		NA	9/39	23%	4.77	1.3	56	8.48	3.48	3.6	**YES**	NSV
72-54-8	4,4'-DDD	2	NJDEP ESC Table - Marine	79/196	40%	**23**	1.9	**320**	40	12.8	10.5	**YES**	AboveScreenValue
72-55-9	4,4'-DDE	2.2	NJDEP ESC Table - Marine	127/196	65%	**39**	1.9	**1000**	80.5	20.7	22	**YES**	AboveScreenValue
50-29-3	4,4'-DDT	1	NJDEP ESC Table - Marine	36/193	19%	**23.4**	1.4	**560**	56.1	9.92	8	**YES**	AboveScreenValue
309-00-2	Aldrin	2	Recommended by Partner Agencies	9/195	5%	**7.08**	0.63	**115**	10.4	4.49	4.65	NO	Low FOD
319-84-6	Alpha-BHC	6	NJDEP ESC Table - Freshwater	16/196	8%	**7.49**	0.59	**115**	10.9	4.46	4.525	NO	Low FOD
5103-71-9	Alpha-Chlordane	3.24	Recommended by Partner Agencies	37/152	24%	**7.68**	0.39	**115**	11.7	4.39	4.4	**YES**	AboveScreenValue
319-85-7	Beta-BHC	5	NJDEP ESC Table - Freshwater	13/192	7%	**7.51**	1	**115**	11.6	4.52	4.6	NO	Low FOD
5013-74-2	Beta-Chlordane	3.24	Recommended by Partner Agencies	11/26	42%	**3.33**	1	**12**	2.69	2.55	1.725	**YES**	AboveScreenValue
57-74-9	Chlordane	3.24	Recommended by Partner Agencies	0/47	0%	**55.1**	4.15	**100**	20.8	47.7	55	NO	ND
319-86-8	Delta-BHC	3	NJDEP ESC Table - Freshwater	20/195	10%	**7.13**	1	**115**	10.4	4.58	4.6	**YES**	AboveScreenValue
60-57-1	Dieldrin	271	Recommended by Partner Agencies	27/195	14%	12.9	0.67	230	20.7	7.68	6.75	NO	BelowScreenValue
959-98-8	Endosulfan I	2.9	USEPA Reg 3 - Freshwater	9/196	5%	**7.57**	1	**115**	10.7	4.8	4.725	NO	Low FOD
33213-65-9	Endosulfan II	14	USEPA Reg 3 - Freshwater	1/196	1%	12.4	1.9	**230**	20.7	7.41	6.5	NO	Low FOD

Table 4-2
Surficial Sediment COPEC Screen

CAS Number	Analyte	Screening Value	Basis	Detects/Total Samples	Frequency of Detects	Mean Concentration	Minimum Concentration	Maximum Concentration	Standard Deviation	Geometric Mean	Median	COPEC?	Rationale
1031-07-8	Endosulfan sulfate	34.6	NJDEP ESC Table - Freshwater	14/195	7%	12.5	1.3	**230**	20.8	7.42	6.5	NO	Low FOD
72-20-8	Endrin	3	Recommended by Partner Agencies	9/199	5%	**12.5**	1	**230**	20.6	7.4	6.5	NO	Low FOD
7421-93-4	Endrin Aldehyde	480	NJDEP ESC Table - Freshwater	17/196	9%	13.5	1.2	230	22.6	7.83	6.6	NO	Low FOD
53494-70-5	Endrin Ketone		NA	17/196	9%	14.2	1.4	230	21.7	8.2	7	NO	Low FOD
58-89-9	Gamma-BHC (Lindane)	3	NJDEP ESC Table - Freshwater	5/198	3%	**6.97**	0.41	**115**	10.3	4.33	4.525	NO	Low FOD
5566-34-7	Gamma-Chlordane	3.24	Recommended by Partner Agencies	21/122	17%	**9.58**	1.1	**115**	12.5	6.28	5.5	**YES**	AboveScreenValue
76-44-8	Heptachlor	0.68	Recommended by Partner Agencies	12/197	6%	**7.37**	0.85	**115**	11.1	4.52	4.65	NO	Low FOD
1024-57-3	Heptachlor epoxide	5	NJDEP ESC Table - Freshwater	26/195	13%	**8.25**	0.85	**140**	14.1	4.96	4.75	**YES**	AboveScreenValue
72-43-5	Methoxychlor	13.6	Recommended by Partner Agencies	10/199	5%	**58.3**	3.8	**1150**	107	26.9	20.5	NO	Low FOD
TBHC	Total BHC	3	Recommended by Partner Agencies	48/199	24%	**7.99**	0.61	**115**	12	4.64	4.5	**YES**	AboveScreenValue
TDDT-24-44	Total DDT (2,4 & 4,4)		NA	39/39	100%	72.7	8.5	520	103	40.6	30	**YES**	NSV
TDDT-24	Total DDT (2,4)		NA	17/39	44%	13.6	1.3	78	20.5	6.58	4	**YES**	NSV
TDDT-44	Total DDT (4,4)	1.58	Recommended by Partner Agencies	129/196	66%	**64.9**	1.9	**1100**	134	27.8	28.25	**YES**	AboveScreenValue
8001-35-2	Toxaphene	0.077	NJDEP ESC Table - Freshwater	0/199	0%	**443**	8.5	**11500**	1000	212	195	NO	ND
TOT_AGChlor	Total Alpha + Gamma Chlordane	3.24	Recommended by Partner Agencies	37/126	29%	**10**	0.39	**115**	12.6	6.39	5.5	**YES**	AboveScreenValue
PCBs (µg/kg)													
2051-60-7	PCB-1		NA	105/105	100%	1.16	0.0252	6.43	1.06	0.744	0.946	YES*	Included in total
39485-83-1	PCB-100		NA	105/106	99%	0.309	0.0188	1.72	0.264	0.218	0.2585	YES*	Included in total
60145-21-3	PCB-103		NA	104/106	98%	0.333	0.0172	1.89	0.325	0.221	0.258	YES*	Included in total
56558-16-8	PCB-104		NA	71/106	67%	0.0288	0.003	0.258	0.0298	0.0215	0.0213	YES*	Included in total
32598-14-4	PCB-105		NA	168/169	99%	7.52	0.0244	66.9	9.57	4.1	5.32	YES*	Included in total
PCB-106/118	PCB-106/118		NA	169/169	100%	20.1	0.0629	160	24.1	11.1	14.4	YES*	Included in total
70424-68-9/7447	PCB-107/109		NA	106/106	100%	1.65	0.017	11.9	1.87	1.05	1.1575	YES*	Included in total
70362-41-3/7447	PCB-108/112		NA	105/106	99%	1.31	0.0211	12.1	1.72	0.789	0.8465	YES*	Included in total
2050-67-1	PCB-11		NA	106/106	100%	6.64	0.135	59.1	8.82	3.92	4.1875	YES*	Included in total
38380-03-9	PCB-110		NA	106/106	100%	27.6	0.161	210	33.8	16.7	18.05	YES*	Included in total
PCB-111/115	PCB-111/115		NA	105/106	99%	0.495	0.0201	4.97	0.704	0.286	0.3035	YES*	Included in total
68194-10-5	PCB-113		NA	79/106	75%	0.106	0.003	1.91	0.245	0.0481	0.0508	YES*	Included in total
74472-37-0	PCB-114		NA	161/169	95%	0.474	0.00669	5.71	0.682	0.26	0.317	YES*	Included in total
56558-17-9	PCB-119		NA	105/106	99%	0.696	0.0211	4.44	0.703	0.462	0.5315	YES*	Included in total
PCB-12/13	PCB-12/13		NA	105/106	99%	2.66	0.04225	16.7	2.73	1.73	2.095	YES*	Included in total
68194-12-7	PCB-120		NA	87/106	82%	0.401	0.003	33.2	3.22	0.0495	0.0523	YES*	Included in total
56558-18-0	PCB-121		NA	2/106	2%	0.0216	0.003	0.155	0.0213	0.016	0.020575	NO	Low FOD
76842-07-4	PCB-122		NA	105/106	99%	0.306	0.0139	2.91	0.406	0.187	0.208	YES*	Included in total
65510-44-3	PCB-123		NA	161/169	95%	0.392	0.00728	3.15	0.481	0.228	0.284	YES*	Included in total
70424-70-3	PCB-124		NA	105/106	99%	0.859	0.0211	6.36	1.07	0.521	0.55475	YES*	Included in total
57465-28-8	PCB-126		NA	153/169	91%	0.117	0.002465	0.9	0.125	0.0776	0.0953	YES*	Included in total
39635-33-1	PCB-127		NA	2/106	2%	0.0204	0.003	0.1065	0.0168	0.0158	0.02055	NO	Low FOD
PCB-128/162	PCB-128/162		NA	106/106	100%	3.02	0.018	19.5	3.55	1.83	2.05	YES*	Included in total
55215-18-4	PCB-129		NA	105/106	99%	0.807	0.0211	5.4	1.01	0.482	0.509	YES*	Included in total
52663-66-8	PCB-130		NA	106/106	100%	1.24	0.011	6.72	1.28	0.804	0.89925	YES*	Included in total
61798-70-7	PCB-131		NA	10/106	9%	0.0195	0.003	0.1045	0.0147	0.0155	0.0205	NO	Low FOD
38380-05-1/7447	PCB-132/161		NA	106/106	100%	5.52	0.0306	36.1	6.53	3.34	3.595	YES*	Included in total
PCB-133/142	PCB-133/142		NA	105/106	99%	0.604	0.02015	3.51	0.653	0.385	0.4195	YES*	Included in total
PCB-134/143	PCB-134/143		NA	105/106	99%	1.06	0.0211	6.79	1.22	0.659	0.716	YES*	Included in total
52744-13-5	PCB-135		NA	106/106	100%	2.73	0.0206	17	3.01	1.72	1.875	YES*	Included in total
38411-22-2	PCB-136		NA	106/106	100%	2.72	0.0151	17.6	3.08	1.69	1.93	YES*	Included in total
35694-06-5	PCB-137		NA	105/106	99%	0.917	0.0211	6.57	1.15	0.553	0.583	YES*	Included in total
35065-28-2/7447	PCB-138/163/164		NA	106/106	100%	19.8	0.119	118	21.6	12.5	13.825	YES*	Included in total
PCB-139/149	PCB-139/149		NA	106/106	100%	17.1	0.103	107	18.7	10.8	12.15	YES*	Included in total
34883-41-5	PCB-14		NA	2/106	2%	0.0353	0.00393	0.2135	0.0351	0.0248	0.03675	NO	Low FOD
59291-64-4	PCB-140		NA	101/106	95%	0.129	0.006275	0.594	0.123	0.0878	0.0989	YES*	Included in total
52712-04-6	PCB-141		NA	106/106	100%	3.45	0.0241	24.7	4.31	2.04	2.1675	YES*	Included in total
68194-14-9	PCB-144		NA	105/106	99%	0.941	0.0211	6.76	1.1	0.581	0.63	YES*	Included in total
74472-40-5	PCB-145		NA	27/106	25%	0.0183	0.003	0.071	0.0115	0.0147	0.0201	YES*	Included in total
51908-16-8/7447	PCB-146/165		NA	106/106	100%	2.98	0.0237	17	3.06	1.92	2.15	YES*	Included in total
68194-13-8	PCB-147		NA	105/106	99%	0.615	0.0211	2.41	0.534	0.427	0.496	YES*	Included in total
74472-41-6	PCB-148		NA	91/106	86%	0.054	0.003	0.36	0.0513	0.039	0.0429	YES*	Included in total
2050-68-2	PCB-15		NA	106/106	100%	15.1	0.319	74.8	13.3	10.4	13.05	YES*	Included in total
68194-08-1	PCB-150		NA	98/106	92%	0.0845	0.006275	0.459	0.0761	0.0599	0.0652	YES*	Included in total
52663-63-5	PCB-151		NA	105/106	99%	4.78	0.0211	31.8	5.4	2.97	3.26	YES*	Included in total
68194-09-2	PCB-152		NA	81/106	76%	0.0331	0.003	0.249	0.0334	0.0243	0.022825	YES*	Included in total
35065-27-1	PCB-153		NA	106/106	100%	19.6	0.113	124	21.2	12.4	13.65	YES*	Included in total
60145-22-4	PCB-154		NA	105/106	99%	0.484	0.0211	2.405	0.413	0.338	0.3865	YES*	Included in total
33979-03-2	PCB-155		NA	101/106	95%	0.156	0.006275	2.71	0.352	0.0748	0.074475	YES*	Included in total
38380-08-4	PCB-156		NA	165/169	98%	1.78	0.0211	12.3	2.1	0.999	1.22	YES*	Included in total
69782-90-7	PCB-157		NA	160/169	95%	0.4	0.00924	2.48	0.446	0.239	0.2915	YES*	Included in total
74472-42-7/4141	PCB-158/160		NA	106/106	100%	2.15	0.0145	13.2	2.44	1.32	1.455	YES*	Included in total
39635-35-3	PCB-159		NA	76/106	72%	0.154	0.00393	1.54	0.225	0.0678	0.102125	YES*	Included in total
PCB-16/32	PCB-16/32		NA	106/106	100%	12.5	0.0502	200	22.9	6.2	6.115	YES*	Included in total
41411-63-6	PCB-166		NA	98/106	92%	0.0783	0.003	0.485	0.0875	0.0515	0.054225	YES*	Included in total
52663-72-6	PCB-167		NA	165/169	98%	0.754	0.0078	5.23	0.831	0.443	0.53	YES*	Included in total
59291-65-5	PCB-168		NA	83/106	78%	0.0419	0.003	0.181	0.033	0.0313	0.03015	YES*	Included in total
32774-16-6	PCB-169		NA	28/169	17%	0.0234	0.000745	0.131	0.031	0.0125	0.0142	YES*	Included in total
37680-66-3	PCB-17		NA	106/106	100%	8.93	0.0407	136	16.1	4.41	4.45	YES*	Included in total

Table 4-2
Surficial Sediment COPEC Screen

CAS Number	Analyte	Screening Value	Basis	Detects/Total Samples	Frequency of Detects	Mean Concentration	Minimum Concentration	Maximum Concentration	Standard Deviation	Geometric Mean	Median	COPEC?	Rationale
35065-30-6	PCB-170		NA	144/146	99%	4.71	0.0244	38.1	5.76	2.53	3.215	YES*	Included in total
52663-71-5	PCB-171		NA	106/106	100%	1.39	0.0113	10.8	1.62	0.863	0.96	YES*	Included in total
52663-74-8	PCB-172		NA	105/106	99%	0.854	0.0211	6.86	1	0.534	0.5915	YES*	Included in total
68194-16-1	PCB-173		NA	99/106	93%	0.114	0.0041	0.788	0.13	0.0729	0.08115	YES*	Included in total
38411-25-5	PCB-174		NA	106/106	100%	5.39	0.0343	51.5	7.08	3.19	3.64	YES*	Included in total
40186-70-7	PCB-175		NA	105/106	99%	0.286	0.0138	1.83	0.315	0.184	0.198	YES*	Included in total
52663-65-7	PCB-176		NA	105/106	99%	0.783	0.0211	5.18	0.875	0.494	0.535	YES*	Included in total
52663-70-4	PCB-177		NA	106/106	100%	3.44	0.021	26.7	3.94	2.16	2.4275	YES*	Included in total
52663-67-9	PCB-178		NA	105/106	99%	1.33	0.0211	7.9	1.37	0.865	0.962	YES*	Included in total
52663-64-6	PCB-179		NA	106/106	100%	2.9	0.0185	18.5	3.18	1.84	2.0575	YES*	Included in total
37680-65-2	PCB-18		NA	106/106	100%	18.1	0.0858	342	37.7	8.39	7.82	YES*	Included in total
35065-29-3	PCB-180		NA	145/146	99%	12.7	0.0244	105	15.6	6.8	8.82	YES*	Included in total
74472-47-2	PCB-181		NA	92/106	87%	0.056	0.003	0.488	0.0731	0.0338	0.0353	YES*	Included in total
PCB-182/187	PCB-182/187		NA	105/106	99%	8.6	0.0242	51.8	9.04	5.52	6.365	YES*	Included in total
52663-69-1	PCB-183		NA	106/106	100%	3.47	0.0251	21.9	3.79	2.19	2.4825	YES*	Included in total
74472-48-3	PCB-184		NA	82/106	77%	0.0292	0.003	0.22	0.0257	0.023	0.022975	YES*	Included in total
52712-05-7	PCB-185		NA	105/106	99%	0.629	0.0205	6.1	0.839	0.377	0.4135	YES*	Included in total
74472-49-4	PCB-186		NA	2/106	2%	0.0202	0.003	0.1065	0.0168	0.0156	0.020525	NO	Low FOD
74487-85-7	PCB-188		NA	86/106	81%	0.0342	0.003	0.436	0.0451	0.0248	0.024775	YES*	Included in total
39635-31-9	PCB-189		NA	157/169	93%	0.18	0.002465	1.22	0.191	0.114	0.134	YES*	Included in total
38444-73-4	PCB-19		NA	105/106	99%	1.73	0.0211	31.8	3.53	0.813	0.8155	YES*	Included in total
41411-64-7	PCB-190		NA	105/106	99%	1.01	0.0211	7.24	1.14	0.634	0.6995	YES*	Included in total
74472-50-7	PCB-191		NA	105/106	99%	0.204	0.0106	1.33	0.222	0.132	0.14475	YES*	Included in total
74472-51-8	PCB-192		NA	3/106	3%	0.0201	0.003	0.1065	0.0168	0.0156	0.020525	NO	Low FOD
69782-91-8	PCB-193		NA	105/106	99%	0.619	0.0211	4.18	0.671	0.4	0.4525	YES*	Included in total
35694-08-7	PCB-194		NA	106/106	100%	3.45	0.0269	26.5	4.06	2.16	2.395	YES*	Included in total
52663-78-2	PCB-195		NA	105/106	99%	1.3	0.0211	10.8	1.56	0.809	0.9205	YES*	Included in total
PCB-196/203	PCB-196/203		NA	106/106	100%	4.57	0.0323	30.1	4.79	2.97	3.46	YES*	Included in total
33091-17-7	PCB-197		NA	101/106	95%	0.145	0.00585	1.01	0.159	0.0948	0.101	YES*	Included in total
68194-17-2	PCB-198		NA	104/106	98%	0.249	0.0112	2.14	0.309	0.157	0.16775	YES*	Included in total
52663-75-9	PCB-199		NA	106/106	100%	4.63	0.0276	33.6	5.04	3	3.4725	YES*	Included in total
2051-61-8	PCB-2		NA	105/105	100%	0.328	0.0144	1.3	0.238	0.246	0.29	YES*	Included in total
38444-84-7/5570	PCB-20/21/33		NA	106/106	100%	11.5	0.0361	243	26.1	5.07	4.875	YES*	Included in total
52663-73-7	PCB-200		NA	105/106	99%	0.466	0.0177	3.81	0.574	0.291	0.314	YES*	Included in total
40186-71-8	PCB-201		NA	105/106	99%	0.615	0.0211	4.08	0.659	0.405	0.4675	YES*	Included in total
2136-99-4	PCB-202		NA	106/106	100%	1.32	0.0117	6.95	1.2	0.916	1.07	YES*	Included in total
74472-52-9	PCB-204		NA	12/105	11%	0.0192	0.003	0.1065	0.0153	0.0153	0.0205	YES*	Included in total
74472-53-0	PCB-205		NA	105/106	99%	0.146	0.00633	1.03	0.157	0.0987	0.1065	YES*	Included in total
40186-72-9	PCB-206		NA	106/106	100%	3.94	0.0491	46.7	5.45	2.52	2.87	YES*	Included in total
52663-79-3	PCB-207		NA	105/106	99%	0.346	0.0149	2.51	0.364	0.237	0.2655	YES*	Included in total
52663-77-1	PCB-208		NA	106/106	100%	1.25	0.0198	9.86	1.34	0.853	0.9585	YES*	Included in total
2051-24-3	PCB-209		NA	154/155	99%	4.03	0.0366	93.9	9.87	1.9	2.44	YES*	Included in total
38444-85-8	PCB-22		NA	105/106	99%	9.46	0.0421	158	18.2	4.6	4.51	YES*	Included in total
55720-44-0	PCB-23		NA	55/106	52%	0.0318	0.003	0.42	0.0516	0.0205	0.020475	YES*	Included in total
PCB-24/27	PCB-24/27		NA	105/106	99%	1.97	0.0211	22.6	2.94	1.09	1.19	YES*	Included in total
55712-37-3	PCB-25		NA	106/106	100%	4.33	0.028	37	5.62	2.55	3.11	YES*	Included in total
38444-81-4	PCB-26		NA	106/106	100%	6.47	0.0388	73.4	9.34	3.69	4.3975	YES*	Included in total
7012-37-5	PCB-28		NA	106/106	100%	36.4	0.128	415	53.3	20.6	22.8	YES*	Included in total
15862-07-4	PCB-29		NA	93/106	88%	0.107	0.003	2.09	0.228	0.0542	0.05085	YES*	Included in total
2051-62-9	PCB-3		NA	106/106	100%	0.877	0.0273	4.67	0.777	0.612	0.7755	YES*	Included in total
35693-92-6	PCB-30		NA	17/106	16%	0.0251	0.003	0.205	0.0299	0.0172	0.0207	YES*	Included in total
16606-02-3	PCB-31		NA	106/106	100%	29	0.136	458	52.6	15.1	15.55	YES*	Included in total
37680-68-5	PCB-34		NA	101/106	95%	0.2	0.006275	2.88	0.34	0.112	0.12	YES*	Included in total
37680-69-6	PCB-35		NA	104/106	98%	1.04	0.02055	8.51	1.22	0.626	0.7175	YES*	Included in total
38444-87-0	PCB-36		NA	77/106	73%	0.0381	0.003	0.197	0.028	0.03	0.03335	YES*	Included in total
38444-90-5	PCB-37		NA	106/106	100%	10.4	0.08	94	12.2	6.58	8.005	YES*	Included in total
53555-66-1	PCB-38		NA	98/106	92%	0.191	0.003	1.96	0.238	0.119	0.1315	YES*	Included in total
38444-88-1	PCB-39		NA	93/106	88%	0.0896	0.003	0.456	0.0824	0.0632	0.07345	YES*	Included in total
PCB-4/10	PCB-4/10		NA	104/106	98%	4.02	0.04225	60.1	6.82	2.13	2.595	YES*	Included in total
38444-93-8	PCB-40		NA	100/100	100%	4.5	0.0231	73	8.44	2.17	2.2325	YES*	Included in total
52663-59-9/5266	PCB-41/64/71/72		NA	91/92	99%	23.9	0.02055	318	39.4	12	11.95	YES*	Included in total
36559-22-5/7447	PCB-42/59		NA	106/106	100%	9.71	0.0387	134	16.1	5.12	5.055	YES*	Included in total
PCB-43/49	PCB-43/49		NA	106/106	100%	24.5	0.118	311	38.4	13.4	13.525	YES*	Included in total
41464-39-5	PCB-44		NA	106/106	100%	27.1	0.102	429	49.4	13.4	12.8	YES*	Included in total
70362-45-7	PCB-45		NA	105/106	99%	3.89	0.0211	70.2	7.83	1.78	1.645	YES*	Included in total
41464-47-5	PCB-46		NA	105/106	99%	1.66	0.0211	29.9	3.33	0.778	0.7345	YES*	Included in total
2437-79-8	PCB-47		NA	106/106	100%	10.7	0.0626	144	16.9	6.1	6.655	YES*	Included in total
70362-47-9/3259	PCB-48/75		NA	106/106	100%	5.03	0.019	57.6	7.55	2.64	2.42	YES*	Included in total
PCB-5/8	PCB-5/8		NA	105/106	99%	8.7	0.04225	135	14.7	4.87	5.735	YES*	Included in total
62796-65-0	PCB-50		NA	96/106	91%	0.0941	0.003	1.31	0.161	0.0499	0.0436	YES*	Included in total
68194-04-7	PCB-51		NA	105/106	99%	1.68	0.0211	19.1	2.4	0.953	1.03	YES*	Included in total
35693-99-3/6023	PCB-52/69		NA	106/106	100%	29.5	0.141	386	47.7	15.6	15.4	YES*	Included in total
41464-41-9	PCB-53		NA	106/106	100%	4.15	0.0147	62.1	7.32	2.06	2.0275	YES*	Included in total
15968-05-5	PCB-54		NA	99/106	93%	0.1	0.00448	0.858	0.13	0.0608	0.066	YES*	Included in total
74338-24-2	PCB-55		NA	105/106	99%	0.349	0.0153	3.63	0.488	0.206	0.216	YES*	Included in total

Table 4-2
Surficial Sediment COPEC Screen

CAS Number	Analyte	Screening Value	Basis	Detects/Total Samples	Frequency of Detects	Mean Concentration	Minimum Concentration	Maximum Concentration	Standard Deviation	Geometric Mean	Median	COPEC?	Rationale
PCB-56/60	PCB-56/60		NA	106/106	100%	16.4	0.0751	208	26.6	8.82	8.8775	YES*	Included in total
70424-67-8	PCB-57		NA	103/106	97%	0.183	0.006275	1.59	0.231	0.114	0.125	YES*	Included in total
41464-49-7	PCB-58		NA	100/106	94%	0.0923	0.003	0.49	0.0955	0.0624	0.06945	YES*	Included in total
25569-80-6	PCB-6		NA	104/106	98%	2.26	0.04225	24.2	2.94	1.36	1.7	YES*	Included in total
PCB-61/70	PCB-61/70		NA	106/106	100%	28.9	0.117	383	45.7	15.6	15.95	YES*	Included in total
54230-22-7	PCB-62		NA	0/106	0%	0.0201	0.003	0.1065	0.0166	0.0156	0.02055	NO	ND
74472-34-7	PCB-63		NA	105/106	99%	1.12	0.0169	13.3	1.75	0.609	0.66025	YES*	Included in total
33284-54-7	PCB-65		NA	11/106	10%	0.026	0.003	0.177	0.0289	0.0179	0.020675	YES*	Included in total
73575-53-8	PCB-67		NA	105/106	99%	0.927	0.0141	10.3	1.33	0.525	0.5655	YES*	Included in total
73575-52-7	PCB-68		NA	94/95	99%	0.222	0.00894	3.2	0.354	0.138	0.139	YES*	Included in total
PCB-7/9	PCB-7/9		NA	98/106	92%	0.694	0.01205	11.6	1.33	0.351	0.356	YES*	Included in total
74338-23-1	PCB-73		NA	9/106	8%	0.197	0.003	16.3	1.58	0.0202	0.020725	NO	Low FOD
32690-93-0	PCB-74		NA	106/106	100%	13	0.0556	168	20.3	7.12	7.45	YES*	Included in total
PCB-76/66	PCB-76/66		NA	106/106	100%	27.1	0.126	314	41.1	15.1	16.2	YES*	Included in total
32598-13-3	PCB-77		NA	167/169	99%	3.31	0.0244	28.9	4.14	1.84	2.55	YES*	Included in total
70362-49-1	PCB-78		NA	22/106	21%	0.0367	0.003	0.539	0.0718	0.0191	0.0207	YES*	Included in total
41464-48-6	PCB-79		NA	88/106	83%	0.262	0.0142	2.01	0.307	0.163	0.1735	YES*	Included in total
33284-52-5	PCB-80		NA	0/106	0%	0.0201	0.003	0.1065	0.0166	0.0156	0.02055	NO	Included in total
70362-50-4	PCB-81		NA	158/169	93%	0.193	0.00522	3.42	0.388	0.0861	0.0735	YES*	Included in total
52663-62-4	PCB-82		NA	106/106	100%	3.19	0.0244	28.1	4.43	1.83	1.985	YES*	Included in total
60145-20-2	PCB-83		NA	52/106	49%	0.0257	0.003	0.2	0.0284	0.0181	0.020475	YES*	Included in total
52663-60-2/5266	PCB-84/92		NA	106/106	100%	10.6	0.0651	93.6	14	6.2	6.59	YES*	Included in total
PCB-85/116	PCB-85/116		NA	106/106	100%	4.48	0.0317	41	6.06	2.64	2.965	YES*	Included in total
55312-69-1	PCB-86		NA	101/106	95%	0.195	0.003	2.53	0.334	0.102	0.1065	YES*	Included in total
38380-02-8/6819	PCB-87/117/125		NA	106/106	100%	8.56	0.0561	73.2	11.5	4.97	5.365	YES*	Included in total
PCB-88/91	PCB-88/91		NA	106/106	100%	4.54	0.0274	40.3	5.8	2.73	2.985	YES*	Included in total
73575-57-2	PCB-89		NA	104/106	98%	0.425	0.00765	5.68	0.736	0.225	0.228	YES*	Included in total
PCB-90/101	PCB-90/101		NA	106/106	100%	24.8	0.156	183	30.3	14.9	16.15	YES*	Included in total
73575-56-1	PCB-93		NA	3/106	3%	0.532	0.003	38.9	4.05	0.0178	0.020575	NO	Low FOD
73575-55-0	PCB-94		NA	104/106	98%	0.225	0.006275	1.74	0.26	0.143	0.162	YES*	Included in total
38379-99-6/6023	PCB-95/98/102		NA	106/106	100%	19.2	0.109	154	24.7	11.2	11.95	YES*	Included in total
73575-54-9	PCB-96		NA	103/106	97%	0.243	0.004175	2.93	0.364	0.136	0.1405	YES*	Included in total
41464-51-1	PCB-97		NA	106/106	100%	8.08	0.0513	72.4	10.6	4.75	5.11	YES*	Included in total
38380-01-7	PCB-99		NA	105/106	99%	12.5	0.02055	96.8	14.9	7.41	8.505	YES*	Included in total
12674-11-2	Aroclor-1016	7	NJDEP ESC Table - Freshwater	0/132	0%	**76.4**	19	**750**	87.2	57.2	45.25	NO	ND
11104-28-2	Aroclor-1221		NA	0/132	0%	82.5	21.5	750	84.8	65.8	65	NO	ND
11141-16-5	Aroclor-1232		NA	0/132	0%	76.4	19	750	87.2	57.2	45.25	NO	ND
53469-21-9	Aroclor-1242		NA	39/132	30%	123	19	1000	147	84.9	90	**YES**	NSV
12672-29-6	Aroclor-1248	30	NJDEP ESC Table - Freshwater	74/132	56%	**298**	18	**9100**	899	102	100	**YES**	AboveScreenValue
11097-69-1	Aroclor-1254	60	NJDEP ESC Table - Freshwater	101/132	77%	**272**	19	**4100**	464	139	150	**YES**	AboveScreenValue
11096-82-5	Aroclor-1260	5	NJDEP ESC Table - Freshwater	108/132	82%	**127**	14	**980**	158	83.4	80.5	**YES**	AboveScreenValue
37324-23-5	Aroclor-1262		NA	0/106	0%	87.9	21.5	750	93.9	67.4	72.5	NO	ND
11100-14-4	Aroclor-1268		NA	2/106	2%	87.4	9.8	750	94.2	66.1	72.5	NO	Low FOD
TOT_PCB_ARO(7)	Total Aroclor PCBs (Sum of 7 Aroclors)	22.7	Recommended by Partner Agencies	116/132	88%	**729**	37	**14000**	1450	358	370	**YES**	AboveScreenValue
TOT_PCB_ARO(9)	Total Aroclor PCBs (Sum of 9 Aroclors)	22.7	Recommended by Partner Agencies	104/106	98%	**862**	37	**14000**	1590	472	440	**YES**	AboveScreenValue
TPCB Cong-209	Total PCB Congeners (209)	22.7	Recommended by Partner Agencies	106/106	100%	**762**	4.53	**7700**	1020	446	478.25	**YES**	AboveScreenValue
TPCB CongNOAA89	Total PCB Congeners (NOAA 1989)		NA	106/106	100%	566	3.05	5520	746	332	353	**YES**	NSV
WHOPCBTEQ(B)	Total PCB TEQ (Bird)		NA	169/169	100%	0.198	0.004	1.87	0.254	0.114	0.141	**YES**	NSV
WHOPCBTEQ(F)	Total PCB TEQ (Fish)		NA	169/169	100%	0.00116	0	0.01	0.00141	0.00121	0.001	**YES**	NSV
WHOPCBTEQ(H)	Total PCB TEQ (Human/Mammal)		NA	169/169	100%	0.0137	0	0.096	0.0143	0.00941	0.011	**YES**	NSV
Semivolatile Organic Compounds (µg/kg)													
95-94-3	1,2,4,5-Tetrachlorobenzene	1252	NJDEP ESC Table - Freshwater	0/38	0%	215	115	850	122	199	190	NO	ND
120-82-1	1,2,4-Trichlorobenzene	4.8	NJDEP ESC Table - Marine	20/111	18%	**524**	13	**4450**	824	84.7	54	**YES**	AboveScreenValue
95-50-1	1,2-Dichlorobenzene	13	NJDEP ESC Table - Marine	11/111	10%	**627**	17	**4450**	790	139	250	NO	Low FOD
541-73-1	1,3-Dichlorobenzene	1315	NJDEP ESC Table - Freshwater	14/111	13%	619	19	**4450**	794	133	230	**YES**	AboveScreenValue
106-46-7	1,4-Dichlorobenzene	110	NJDEP ESC Table - Marine	46/114	40%	**504**	8.8	**4450**	789	102	125	**YES**	AboveScreenValue
90-12-0	1-Methylnaphthalene		NA	13/14	93%	46.9	2.5	130	33.6	34.3	42	**YES**	NSV
540-54-5	2,2-oxybis(1-Chloropropane)		NA	0/149	0%	547	110	4450	696	371	325	NO	ND
58-90-2	2,3,4,6-Tetrachlorophenol	284	USEPA Reg 3 - Freshwater	0/38	0%	215	115	**850**	122	199	190	NO	ND
95-95-4	2,4,5-Trichlorophenol	3	NJDEP ESC Table - Marine	0/152	0%	**540**	110	**4450**	691	365	325	NO	ND
88-06-2	2,4,6-Trichlorophenol	6	NJDEP ESC Table - Marine	0/152	0%	**540**	110	**4450**	691	365	325	NO	ND
120-83-2	2,4-Dichlorophenol	5	NJDEP ESC Table - Marine	0/149	0%	**547**	110	**4450**	696	371	325	NO	ND
105-67-9	2,4-Dimethylphenol	304	NJDEP ESC Table - Freshwater	1/149	1%	**545**	100	**4450**	697	367	325	NO	Low FOD
51-28-5	2,4-Dinitrophenol	6.21	NJDEP ESC Table - Freshwater	0/149	0%	**2490**	220	**22500**	3660	1360	1350	NO	ND
121-14-2	2,4-Dinitrotoluene	14.4	NJDEP ESC Table - Freshwater	0/152	0%	**459**	38	**4450**	714	229	195	NO	ND
606-20-2	2,6-Dinitrotoluene	39.8	USEPA Reg 5	0/149	0%	**465**	38	**4450**	720	230	200	NO	ND
91-58-7	2-Chloronaphthalene	417	NJDEP ESC Table - Freshwater	0/149	0%	**547**	110	**4450**	696	371	325	NO	ND
95-57-8	2-Chlorophenol	8	NJDEP ESC Table - Marine	0/149	0%	**547**	110	**4450**	696	371	325	NO	ND
91-57-6	2-Methylnaphthalene	70	NJDEP ESC Table - Marine	111/164	68%	**366**	6.6	**4450**	679	148	105	**YES**	AboveScreenValue
95-48-7	2-Methylphenol	55.4	USEPA Reg 5	0/152	0%	**540**	110	**4450**	691	365	325	NO	ND
88-74-4	2-Nitroaniline		NA	0/149	0%	701	110	4450	700	538	485	NO	ND
88-75-5	2-Nitrophenol		NA	0/149	0%	547	110	4450	696	371	325	NO	ND
108-39-4/106-44	3&4-Methylphenol	670	USEPA Reg 3 - Freshwater	0/3	0%	165	165	165	0	165	165	NO	ND
91-94-1	3,3'-Dichlorobenzidine	127	NJDEP ESC Table - Freshwater	0/149	0%	**1040**	115	**9000**	1430	621	650	NO	ND
99-09-2	3-Nitroaniline		NA	0/149	0%	1090	215	9000	1400	735	650	NO	ND

Table 4-2
Surficial Sediment COPEC Screen

CAS Number	Analyte	Screening Value	Basis	Detects/Total Samples	Frequency of Detects	Mean Concentration	Minimum Concentration	Maximum Concentration	Standard Deviation	Geometric Mean	Median	COPEC?	Rationale
534-52-1	4,6-Dinitro-2-methylphenol	104	USEPA Reg 5	0/149	0%	**1690**	220	**14000**	2140	1080	1150	NO	ND
101-55-3	4-Bromophenyl phenyl ether	1230	USEPA Reg 3 - Freshwater	0/109	0%	616	110	**4450**	790	392	395	NO	ND
59-50-7	4-Chloro-3-Methylphenol	388	USEPA Reg 5	0/149	0%	**547**	110	**4450**	696	371	325	NO	ND
106-47-8	4-Chloroaniline	146	USEPA Reg 5	45/149	30%	**436**	12	**4450**	640	248	225	**YES**	AboveScreenValue
7005-72-3	4-Chlorophenyl phenyl ether		NA	0/149	0%	547	110	4450	696	371	325	NO	ND
106-44-5	4-Methylphenol	670	USEPA Reg 3 - Freshwater	37/149	25%	474	8.8	**4450**	716	235	210	**YES**	AboveScreenValue
100-01-6	4-Nitroaniline		NA	0/149	0%	1090	215	9000	1400	735	650	NO	ND
100-02-7	4-Nitrophenol	13.3	NJDEP ESC Table - Freshwater	0/149	0%	**1690**	220	**14000**	2140	1080	1150	NO	ND
83-32-9	Acenaphthene	16	NJDEP ESC Table - Marine	120/180	67%	**614**	7.9	**11000**	1210	210	180	**YES**	AboveScreenValue
208-96-8	Acenaphthylene	44	NJDEP ESC Table - Marine	164/180	91%	**454**	8.6	**4950**	741	235	230	**YES**	AboveScreenValue
98-86-2	Acetophenone		NA	6/38	16%	211	56	850	138	183	190	**YES**	NSV
120-12-7	Anthracene	85	NJDEP ESC Table - Marine	171/179	96%	**737**	18	**7400**	1130	408	380	**YES**	AboveScreenValue
1912-24-9	Atrazine	6.62	USEPA Reg 3 - Freshwater	0/38	0%	**215**	115	**850**	122	199	190	NO	ND
100-52-7	Benzaldehyde		NA	14/38	37%	166	34	850	133	133	172.5	**YES**	NSV
56-55-3	Benzo(a)anthracene	261	NJDEP ESC Table - Marine	179/179	100%	**1590**	34	**20000**	2320	966	910	**YES**	AboveScreenValue
50-32-8	Benzo(a)pyrene	430	NJDEP ESC Table - Marine	179/179	100%	**1560**	29	**15000**	1820	1060	1000	**YES**	AboveScreenValue
205-99-2	Benzo(b)fluoranthene	1800	NJDEP ESC Table - Marine	179/179	100%	1630	19	**23000**	2320	1050	1000	**YES**	AboveScreenValue
192-97-2	Benzo(e)pyrene		NA	14/14	100%	812	53	1400	393	651	820	**YES**	NSV
191-24-2	Benzo(g,h,i)perylene	170	NJDEP ESC Table - Freshwater	178/179	99%	**754**	16	**7400**	830	519	510	**YES**	AboveScreenValue
207-08-9	Benzo(k)fluoranthene	240	NJDEP ESC Table - Freshwater	176/179	98%	**1230**	27	**16000**	1580	802	770	**YES**	AboveScreenValue
92-52-4	Biphenyl	1220	USEPA Reg 3 - Freshwater	16/52	31%	155	1.7	850	141	86.5	172.5	NO	BelowScreenValue
111-91-1	bis(2-Chloroethoxy)methane		NA	0/149	0%	547	110	4450	696	371	325	NO	ND
111-44-4	bis(2-Chloroethyl)ether	3520	NJDEP ESC Table - Freshwater	1/149	1%	455	19	**4450**	725	190	195	NO	Low FOD
117-81-7	bis(2-ethylhexyl phthalate)	182.16	Recommended by Partner Agencies	144/149	97%	**5830**	80	**71000**	10600	2540	2700	**YES**	AboveScreenValue
85-68-7	Butyl benzyl phthalate	63	NJDEP ESC Table - Marine	38/149	26%	**511**	38	**4450**	697	302	325	**YES**	AboveScreenValue
105-60-2	Caprolactam		NA	1/38	3%	213	115	850	123	197	190	NO	Low FOD
86-74-8	Carbazole		NA	82/149	55%	430	8.7	4450	761	172	170	**YES**	NSV
218-01-9	Chrysene	384	NJDEP ESC Table - Marine	179/179	100%	**1970**	29	**45000**	3930	1130	1035	**YES**	AboveScreenValue
53-70-3	Dibenzo(a,h)anthracene	63	NJDEP ESC Table - Marine	143/179	80%	**389**	9.6	**4950**	706	198	180	**YES**	AboveScreenValue
132-64-9	Dibenzofuran	7300	USEPA Reg 3 - Marine	84/163	52%	426	2.5	4450	719	173	150	NO	BelowScreenValue
132-65-0	Dibenzothiophene		NA	13/14	93%	76.8	2.5	210	67.3	49.3	56	**YES**	NSV
84-66-2	Diethyl phthalate	6	NJDEP ESC Table - Marine	1/149	1%	**547**	110	**4450**	696	371	325	NO	Low FOD
131-11-3	Dimethylphthalate		NA	0/149	0%	547	110	4450	696	371	325	NO	ND
84-74-2	Di-n-Butylphthalate	58	NJDEP ESC Table - Marine	17/149	11%	**634**	37	**5100**	892	379	335	**YES**	AboveScreenValue
117-84-0	Di-n-Octylphthalate	40600	USEPA Reg 5	16/141	11%	580	47	4450	742	376	380	NO	BelowScreenValue
206-44-0	Fluoranthene	600	NJDEP ESC Table - Marine	179/179	100%	**3840**	34	**210000**	16000	1550	1400	**YES**	AboveScreenValue
86-73-7	Fluorene	19	NJDEP ESC Table - Marine	123/180	68%	**453**	5.6	**4950**	813	181	155	**YES**	AboveScreenValue
118-74-1	Hexachlorobenzene	20	Recommended by Partner Agencies	7/153	5%	**396**	1.6	**4450**	736	76.9	55	NO	Low FOD
87-68-3	Hexachlorobutadiene	1.3	NJDEP ESC Table - Marine	0/152	0%	**459**	38	**4450**	714	229	195	NO	ND
77-47-4	Hexachlorocyclopentadiene	901	NJDEP ESC Table - Freshwater	0/118	0%	**1620**	135	**14000**	2390	810	850	NO	ND
67-72-1	Hexachloroethane	73	NJDEP ESC Table - Marine	0/152	0%	**449**	19	**4450**	719	187	192.5	NO	ND
193-39-5	Indeno(1,2,3-cd)pyrene	200	NJDEP ESC Table - Freshwater	174/179	97%	**718**	13	**6300**	787	486	490	**YES**	AboveScreenValue
78-59-1	Isophorone	432	NJDEP ESC Table - Freshwater	0/149	0%	**547**	110	**4450**	696	371	325	NO	ND
91-20-3	Naphthalene	160	NJDEP ESC Table - Marine	141/180	78%	**600**	18	**6400**	1010	272	230	**YES**	AboveScreenValue
98-95-3	Nitrobenzene	145	NJDEP ESC Table - Freshwater	3/152	2%	**451**	19	**4450**	718	191	195	NO	Low FOD
621-64-7	N-Nitroso-di-n-propylamine		NA	0/149	0%	455	19	4450	725	188	195	NO	ND
86-30-6	N-Nitrosodiphenylamine	422000	USEPA Reg 3 - Marine	6/149	4%	519	73	4450	668	355	325	NO	Low FOD
87-86-5	Pentachlorophenol	17	NJDEP ESC Table - Marine	0/153	0%	**1580**	4.7	**14000**	2180	455	1100	NO	ND
198-55-0	Perylene		NA	14/14	100%	322	23	600	149	262	325	**YES**	NSV
85-01-8	Phenanthrene	240	NJDEP ESC Table - Marine	173/179	97%	**1080**	25	**31000**	3090	499	440	**YES**	AboveScreenValue
108-95-2	Phenol	130	NJDEP ESC Table - Marine	5/149	3%	**533**	110	**4450**	694	359	325	NO	Low FOD
129-00-0	Pyrene	665	NJDEP ESC Table - Marine	179/179	100%	**3770**	65	**150000**	11500	1930	1800	**YES**	AboveScreenValue
110-86-1	Pyridine	106	USEPA Reg 5	0/3	0%	**850**	850	**850**	0	850	850	NO	ND
THMW PAHs-SVOC	Total HMW PAHs-SVOC	1700	Recommended by Partner Agencies	179/180	99%	**17100**	0	**470000**	38100	9930	9500	**YES**	AboveScreenValue
TLMW PAHs-SVOC	Total LMW PAHs-SVOC	552	Recommended by Partner Agencies	160/164	98%	**2700**	8.6	**44000**	5460	1380	1325	**YES**	AboveScreenValue
TOT_PAH_SVOC	TOTAL PAHs - SVOC	4000	Recommended by Partner Agencies	164/164	100%	**19300**	290	**520000**	44500	10800	11000	**YES**	AboveScreenValue
TEPH	TEPH		NA	67/67	100%	1340000	67000	9700000	1610000	843000	930000	**YES**	NSV
TPH	Total Petroleum Hydrocarbons		NA	39/39	100%	1220000	280000	5400000	1020000	982000	900000	**YES**	NSV
Volatile Organic Compounds (µg/kg)													
71-55-6	1,1,1-Trichloroethane	213	NJDEP ESC Table - Freshwater	0/67	0%	14	3	**450**	54.2	7.12	7	NO	ND
79-34-5	1,1,2,2-Tetrachloroethane	850	NJDEP ESC Table - Freshwater	0/66	0%	14.1	3	450	54.6	7.13	7	NO	ND
79-00-5	1,1,2-Trichloroethane	518	NJDEP ESC Table - Freshwater	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
75-34-3	1,1-Dichloroethane	0.575	USEPA Reg 5	0/67	0%	**14**	3	**450**	54.2	7.12	7	NO	ND
75-35-4	1,1-Dichloroethene	19.4	NJDEP ESC Table - Freshwater	0/70	0%	13.5	2.5	**450**	53.1	6.8	6.625	NO	ND
87-61-6	1,2,3-Trichlorobenzene	858	USEPA Reg 3 - Freshwater	0/38	0%	9.43	4.85	14.5	2.34	9.14	9.5	NO	ND
120-82-1	1,2,4-Trichlorobenzene	4.8	NJDEP ESC Table - Marine	0/38	0%	**9.43**	4.85	**14.5**	2.34	84.7	54	NO	ND
95-50-1	1,2-Dichlorobenzene	13	NJDEP ESC Table - Marine	0/38	0%	9.43	4.85	**14.5**	2.34	139	250	NO	ND
107-06-2	1,2-Dichloroethane	260	NJDEP ESC Table - Freshwater	0/70	0%	13.5	2.5	**450**	53.1	6.8	6.625	NO	ND
540-59-0	1,2-Dichloroethene (total)	654	NJDEP ESC Table - Freshwater	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
78-87-5	1,2-Dichloropropane	333	NJDEP ESC Table - Freshwater	0/67	0%	14	3	**450**	54.2	7.12	7	NO	ND
541-73-1	1,3-Dichlorobenzene	1315	NJDEP ESC Table - Freshwater	0/38	0%	9.43	4.85	14.5	2.34	133	230	NO	ND
106-46-7	1,4-Dichlorobenzene	110	NJDEP ESC Table - Marine	2/38	5%	9.32	4.85	14.5	2.24	102	125	NO	Low FOD

Table 4-2
Surficial Sediment COPEC Screen

CAS Number	Analyte	Screening Value	Basis	Detects/Total Samples	Frequency of Detects	Mean Concentration	Minimum Concentration	Maximum Concentration	Standard Deviation	Geometric Mean	Median	COPEC?	Rationale
78-93-3	2-Butanone	42.4	USEPA Reg 5	19/35	54%	**51.6**	7	**900**	150	21.9	16	**YES**	AboveScreenValue
591-78-6	2-Hexanone	58.2	USEPA Reg 5	0/67	0%	27.9	5.5	**900**	108	14.2	13.5	NO	ND
108-10-1	4-Methyl-2-pentanone	25.1	USEPA Reg 5	0/67	0%	**27.9**	5.5	**900**	108	14.2	13.5	NO	ND
67-64-1	Acetone	9.9	USEPA Reg 5	66/66	100%	**85.4**	8	**580**	101	54.6	51.5	**YES**	AboveScreenValue
71-43-2	Benzene	340	NJDEP ESC Table - Marine	7/70	10%	13.1	0.67	**450**	53.1	6.32	6.25	NO	Low FOD
75-27-4	Bromodichloromethane		NA	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
75-25-2	Bromoform	492	NJDEP ESC Table - Freshwater	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
74-83-9	Bromomethane	1.37	NJDEP ESC Table - Freshwater	0/67	0%	**14**	3	**450**	54.2	7.12	7	NO	ND
75-15-0	Carbon disulfide	0.851	USEPA Reg 3 - Freshwater	44/67	66%	**19.1**	2	**450**	57.1	8.2	7	**YES**	AboveScreenValue
56-23-5	Carbon tetrachloride	1450	NJDEP ESC Table - Freshwater	0/70	0%	13.5	2.5	450	53.1	6.8	6.625	NO	ND
108-90-7	Chlorobenzene	291	NJDEP ESC Table - Freshwater	24/108	22%	13.5	2.5	**450**	43.2	7.82	7	**YES**	AboveScreenValue
75-00-3	Chloroethane		NA	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
67-66-3	Chloroform	121	NJDEP ESC Table - Freshwater	0/70	0%	13.5	2.5	**450**	53.1	6.8	6.625	NO	ND
74-87-3	Chloromethane		NA	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
10061-01-5	cis-1,3-Dichloropropene		NA	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
124-48-1	Dibromochloromethane		NA	0/67	0%	14	3	450	54.2	7.12	7	NO	ND
100-41-4	Ethylbenzene	1400	NJDEP ESC Table - Marine	2/67	3%	14.3	2	450	54.3	7.14	7	NO	Low FOD
75-09-2	Methylene chloride	159	NJDEP ESC Table - Freshwater	0/67	0%	14	3	**450**	54.2	7.12	7	NO	ND
100-42-5	Styrene	254	NJDEP ESC Table - Freshwater	0/67	0%	14	3	**450**	54.2	7.12	7	NO	ND
127-18-4	Tetrachloroethene	450	NJDEP ESC Table - Marine	1/70	1%	13.4	2.5	450	53.1	6.75	6.625	NO	Low FOD
108-88-3	Toluene	2500	NJDEP ESC Table - Marine	5/67	7%	14.7	3	450	54.6	7.13	6.75	NO	Low FOD
10061-02-6	trans-1,3-Dichloropropene	7.31	USEPA Reg 3 - Marine	0/67	0%	**14**	3	**450**	54.2	7.12	7	NO	ND
79-01-6	Trichloroethene	1600	NJDEP ESC Table - Marine	0/70	0%	13.5	2.5	450	53.1	6.8	6.625	NO	ND
75-01-4	Vinyl chloride	202	NJDEP ESC Table - Freshwater	0/70	0%	13.5	2.5	**450**	53.1	6.8	6.625	NO	ND
1330-20-7	Xylene (Total)	120	NJDEP ESC Table - Marine	3/67	4%	14.7	3	**450**	54.4	7.4	7	NO	Low FOD

Notes:
Data from Phase I and Phase II Sediment Investigations (Tierra 2010) and Honeywell International Sampling Investigation (2006).
Surficial sediment is top 0-0.5 feet.
A value of one-half the detection limit is used for non-detects in the dataset and in the summary statistics above.
Bold and shaded cells indicate detected concentrations exceed screening values.
Bold values indicate non-detected concentrations exceed screening values.
Calcium, magnesium, potassium, and sodium, considered essential nutrients and eliminated as COPECs.

Database totals calculated as follows:
Total WHO Dioxin TEQ (Bird): Sum of WHO Dioxin TEQ (bird)
Total WHO Dioxin TEQ (Fish): Sum of WHO Dioxin TEQ (fish)
Total WHO Dioxin TEQ (Human/Mammal): Sum of WHO Dioxin TEQ (human/mammal)
Total DDT (2,4 & 4,4): Sum of 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
Total DDT (2,4): Sum of 2,4'-DDD, 2,4'-DDE, and 2,4'-DDT.
Total DDT (4,4): Sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
Total Alpha + Gamma Chlordane: Sum of Alpha-Chlordane and Gamma-Chlordane.
Total Aroclor PCBs (Sum of 7 Aroclors): Sum of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260.
Total Aroclor PCBs (Sum of 9 Aroclors): Sum of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, Aroclor-1262, and Aroclor-1268.
Total PCB Congeners (209): Sum of 209 individual congener PCBs. Co-elutions included at full value.
Total PCB Congeners (NOAA 1989): Two times the sum of congener PCB numbers 8, 18, 28, 44, 52, 66, 101, 105, 77, 118, 126, 128, 138, 153, 170, 180, 187, 195, 206, and 209 coelutions included at full value.
Total PCB TEQ (Bird): Sum of WHO PCB TEQ (bird)
Total PCB TEQ (Fish): Sum of WHO PCB TEQ (fish)
Total PCB TEQ (Human/Mammal): Sum of WHO PCB TEQ (human/mammal)
Total HMW PAHs-SVOC: Sum of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
Total LMW PAHs-SVOC: Sum of naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
TOTAL PAHs-SVOC: Sum of LMW PAHs and Total HMW PAHs.

Acronyms and Abbreviations:
COPEC = constituent of potential ecological concern
NJDEP ESC = New Jersey Department of Environmental Protection Ecological Screening Criteria
NA = not available
USEPA = United States Environmental Protection Agency
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
ND = non-detect, eliminated as COPEC
Low FOD = low frequency of detection (<10%), eliminated as COPEC
NSV = no screening value, retained as COPEC
YES = retained as COPEC
YES* = individiual congeners retained as COPEC in sum (i.e., total PCBs)
NO = eliminated as COPEC

Screening values selected, based on the following hierarchy:
1. Recommended by Partner Agencies: Ecological sediment screening levels for saline waters —as recommended by the Partner Agencies for the Lower Passaic River in email correspondence to Scott Kirchner of CDM dated May 26, 2011.
2. NJDEP ESC Table - Marine: NJDEP Ecological Screening Criteria (ESC) for Marine Sediment. March 2009.
3. NJDEP ESC Table - Freshwater: NJDEP Ecological Screening Criteria (ESC) for Freshwater Sediment. March 2009.
4. USEPA Reg 3 - Marine: USEPA Region 3 Marine Sediment Screening Benchmarks. July 2006.
5. USEPA Reg 3 - Freshwater: USEPA Region 3 Freshwater Sediment Screening Benchmarks. August 2006.
6. USEPA Reg 5: USEPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels. August 2003.

Sources:
Honeywell. 1999-2006 . *Offshore Investigation Results Summary Report.*
Tierra. 2013. *Phase I and Phase II Data Evaluation and Analysis Report. Newark Bay Study Area Remedial Investigation.* Revision 1. Tierra Solutions, Inc., East Brunswick, New Jersey. April.

Table 4-3
Candidate Assessment Endpoints, Measurement Endpoints, and Data Needs Based on BHHERA Workshop Discussions

Receptor Group and Assessment Endpoint	Risk Question	Candidate Measurement Endpoint	Data Use Objective	Proposed Biological Data/Media to be Sampled	Background Evaluation?
Assessment Endpoint No. 1 - Survival and/or growth of aquatic plants and maintenance of plants as a food resource and habitat for fish and wildlife	Are COPEC concentrations in site surface water and sediment at levels that might adversely affect survival and growth of aquatic plants?	COPEC concentrations in sediment and surface water collected from the NBSA as compared with available and relevant toxicological benchmarks	Estimating the exposure of plants via direct contact and uptake of COPECs in surface water and sediment	Surface water and surficial sediment chemistry and conventional parameters from the NBSA	None
Assessment Endpoint No. 2 - Survival, growth, and/or reproduction of invertebrates	Are invertebrate communities in the NBSA different from those found in similar nearby water bodies with chemical concentrations at regional background levels?	Community structure data (e.g., total invertebrate abundance, species richness, and abundance of species or specific taxonomic groups) and ecosystem characteristics data (e.g., grain size, TOC, and other attributes) from Newark Bay as compared with appropriate regional reference area background datasets using diversity indices, multivariate, and spatial statistical techniques	Evaluating the data in the context of the overall health of the benthic community using the sediment quality triad (SQT) approach, a sediment assessment technique that incorporates information about sediment chemistry, toxicity, and benthic community metrics	Benthic invertebrate taxonomic survey and identification data	Regional background datasets
	Are COPECs in invertebrate tissues from the NBSA greater than tissue benchmarks (i.e., critical body residues [CBRs]) for the survival, growth, and/or reproduction of invertebrates?	Chemical concentrations in laboratory-exposed and/or site-collected invertebrate tissues (e.g., *Nereis virens, Crassostrea virginica*) as compared with literature-based CBRs	Assessing adverse effects of chemicals on the invertebrate community	Whole-body benthic infaunal invertebrate tissue from 28-day laboratory and/or field bioaccumulation tests using NBSA surface sediment	None
	Are COPEC concentrations in sediments from the BAZ greater than benchmarks for the survival, growth, and/or reproduction of invertebrates?	Chemical concentrations in sediment as compared with toxicological sediment benchmarks from the literature	Evaluating the effects of chemical concentrations in sediment on the benthic invertebrate community of the NBSA	Surficial sediment (from the biologically active zone [BAZ]) chemistry and conventional parameters	None
	Is the survival, growth, and/or reproduction of invertebrates exposed to whole sediments from the BAZ of the NBSA significantly lower than that in reference sediments?	Laboratory toxicity tests (e.g., a 10-day survival and growth study with *Ampelisca abdita,* a 28-day study with *Leptocheirus plumulosus* for survival, growth, and reproduction; and/or a caged *in situ* study with eastern oyster for reproduction) using NBSA surface sediment statistically compared to bioassays conducted with control sediment	Assessing the adverse effects of chemicals (and evaluation of conventional parameters such as grain size, TOC, sulfide, and ammonia) in sediment to the benthic invertebrate community	Surficial sediment (from the BAZ) chemistry and conventional parameters	Regional background datasets
	Are COPEC concentrations in pore water and surface water from the NBSA greater than benchmarks for the survival, growth, and/or reproduction of invertebrates?	Dissolved chemical concentrations in pore and surface water collected from benthic invertebrate exposure areas as compared with toxicological benchmarks	Estimating the exposure of the benthic invertebrate community to COPECs the surface and pore water exposure pathways	Surface water collected from two depth intervals (one sample from near the sediment-water interface and one sample from 2 feet below the water's surface) and pore water samples	None

Table 4-3
Candidate Assessment Endpoints, Measurement Endpoints, and Data Needs Based on BHHERA Workshop Discussions

Receptor Group and Assessment Endpoint	Risk Question	Candidate Measurement Endpoint	Data Use Objective	Proposed Biological Data/Media to be Sampled	Background Evaluation?
Assessment Endpoint No. 3 - Survival, growth, and/or reproduction of reptiles	Are COPEC concentrations in site surface water and sediment at levels that might adversely affect survival, growth, and/or reproduction of reptiles?	COPEC concentrations in sediment and surface water collected from the NBSA as compared with available and relevant toxicological benchmarks	Estimating the exposure of reptiles via direct contact and uptake of COPECs in surface water and sediment	Surface water and surficial sediment chemistry and conventional parameters from the NBSA	None
Assessment Endpoint No. 4 - Survival, growth, and/or reproduction of fish	Are COPEC concentrations in fish tissues from the NBSA greater than critical tissue values (i.e., CBRs) for the survival, growth, and/or reproduction of fish?	Whole-body chemical analyses, liver and other tissue (including bile, gut contents) chemical analyses, and external health observations of identified fish receptors as compared with literature-based critical body residues and/or with whole-body fish tissue chemical concentrations of selected receptors from background locations	Estimating the exposure of fish to COPECs in the NBSA	Whole-body fish tissue chemical concentrations, liver chemical concentrations, gross histological analysis, and gross histology of representative species from each of three trophic levels (forage fish, benthic/demersal, and pelagic predatory)	Representative species from each of three trophic levels (forage fish, benthic/demersal, and pelagic predatory) from background locations
	Are COPEC concentrations in pore water, surface water, and sediment from the NBSA greater than benchmarks for the survival, growth, and/or reproduction of fish?	Chemical concentrations in dissolved pore water and surface water collected from the NBSA as compared with toxicological benchmarks	Estimating the exposure of fish via the surface water exposure pathway to chemicals in surface water	Data (chemical and conventional parameters such as DO, salinity, pH, hardness) collected as part of the surface water monitoring program	None
		Chemical concentrations in sediment as compared with toxicological sediment benchmarks from the literature	Evaluating the effects of chemical concentrations in sediment on fish populations in the NBSA	Surface sediment collected from the BAZ	None
		Reproductive health of fish collected from both the NBSA and a reference location assessed via morphology and/or biomarkers (e.g., GSI, gonad condition and fecundity estimates, and vitellogenin) and/or laboratory reproductive bioassays using mummichog or white perch	Evaluating the potential effects of chemical constituents on reproduction of NBSA fish	Fish collected from the NBSA	Fish collected from a background location

Table 4-3
Candidate Assessment Endpoints, Measurement Endpoints, and Data Needs Based on BHHERA Workshop Discussions

Receptor Group and Assessment Endpoint	Risk Question	Candidate Measurement Endpoint	Data Use Objective	Proposed Biological Data/Media to be Sampled	Background Evaluation?
Assessment Endpoint No. 5 - Survival, growth, and/or reproduction of birds	Does the daily dose of COPECs received by birds (including piscivorous, benthivorous/sediment-probing, omnivorous, insectivorous birds) from consumption of the tissues of prey species and from other media in the NBSA exceed the toxicity reference values (TRVs) for survival, growth, and/or reproduction of birds? If yes, what are the probabilities of effects of differing magnitude for survival, growth, and/or reproduction of birds?	Receptor-specific modeled daily doses associated with the ingestion of chemicals in surface water, sediment, and prey tissue as compared with literature-based dietary dose toxicity reference values (TRVs). COPEC concentrations in bird egg tissues may also be collected and compared to CBRs for bird eggs.	Estimating exposure of bird receptors via various exposure pathways to chemicals in surface water, sediment, and prey tissue. If potential risks are evident, a Probabilistic Risk Assessment may be conducted to quantify the uncertainties in the food web models.	Surface sediment chemistry (from the BAZ) and benthic invertebrate and/or fish prey tissue chemical concentrations, depending on receptor-specific diet. Bird egg tissue from the NBSA.	None
Assessment Endpoint No. 6 - Survival, growth, and/or reproduction of mammals	Does the daily dose of COPECs received by mammals (including piscivorous, omnivorous, and insectivorous) from consumption of the tissues of prey species and from other media in the NBSA exceed the TRVs for survival, growth, and/or reproduction of mammals? If yes, what are the probabilities of effects of differing magnitude for survival, growth, and/or reproduction of mammals?	Receptor-specific modeled daily doses associated with the ingestion of chemicals in surface water, sediment, and prey tissue as compared with literature-based dietary dose TRVs	Estimating exposure of aquatic and semi-aquatic mammals to chemicals in NBSA surface water, sediment, and prey tissue. If potential risks are evident, a Probabilistic Risk Assessment may be conducted to quantify the uncertainties in the food web models.	Surface sediment chemistry (from the BAZ) and benthic invertebrate and/or fish prey tissue chemical concentrations, depending on receptor-specific diet	None

Acronyms and Abbreviations:
BAZ = biologically active zone
COPEC = constituent of potential ecological concern
DO = dissolved oxygen
GSI = gonadosomatic index
NBSA = Newark Bay Study Area
SQT = sediment quality triad
TOC = total organic carbon
TRV = toxicity reference value
USEPA = US Environmental Protection Agency

Table 4-4[a]
Final Selected Assessment Endpoints, Measurement Endpoints, and Data Needs to Support the BERA

Receptor Group and Assessment Endpoint	Risk Question	Final Measurement Endpoint	Data Use Objective	Biological Data/Media to be Sampled	Background Evaluation?	Representative Species	Anticipated Data Collection Timeframe
Assessment Endpoint No. 1 - Survival and/or growth of aquatic plants and maintenance of plants as a food resource and habitat for fish and wildlife	Are COPEC concentrations in site surface water and sediment at levels that might adversely affect survival and growth of aquatic plants?	COPEC concentrations in sediment and surface water collected from the NBSA as compared with available and relevant toxicological benchmarks	Estimating the exposure of plants via direct contact and uptake of COPECs in surface water and sediment	Surface water and surficial sediment chemistry and conventional parameters from the NBSA	None	NA	Spring/Summer 2014
Assessment Endpoint No. 2 - Survival, growth, and/or reproduction of invertebrates	Are invertebrate communities in the NBSA different from those found in similar nearby water bodies with chemical concentrations at regional background levels?	Community structure data (e.g., total invertebrate abundance, species richness, and abundance of species or specific taxonomic groups) and ecosystem characteristics data (e.g., grain size, TOC, and other attributes) from Newark Bay as compared with appropriate regional reference area background datasets using diversity indices, multivariate, and spatial statistical techniques	Evaluating the data in the context of the overall health of the benthic community using the sediment quality triad (SQT) approach, a sediment assessment technique that incorporates information about sediment chemistry, toxicity, and benthic community metrics	Benthic invertebrate taxonomic survey and identification data	Regional background datasets	NA	Spring through Fall 2014
	Are COPECs in invertebrate tissues from the NBSA greater than tissue benchmarks (e.g., critical body residues [CBRs]) for the survival, growth, and/or reproduction of invertebrates?	COPEC concentrations in laboratory-exposed and/or site-collected invertebrate tissues (e.g., *Nereis virens, Mya arenaria*) as compared with literature-based CBRs	Assessing adverse effects of COPECs on the invertebrate community	Site-collected invertebrate tissue from softshell clams (*M. arenaria*) and/or blue crabs; whole-body benthic infaunal invertebrate tissue from 28-day laboratory and/or field bioaccumulation tests using NBSA surface sediment	None	Polychaetes - *Nereis virens* Softshell clam - *Mya arenaria* Hard clam - *Macoma sp.*	Spring through Fall 2014
	Are COPEC concentrations in sediments from the BAZ greater than benchmarks for the survival, growth, and/or reproduction of invertebrates?	COPEC concentrations in sediment as compared with toxicological sediment benchmarks from the literature	Evaluating the effects of COPEC concentrations in sediment on the benthic invertebrate community of the NBSA	Surficial sediment (from the biologically active zone [BAZ]) chemistry and conventional parameters	None	NA	Spring through Fall 2014
	Is the survival, growth, and/or reproduction of invertebrates exposed to whole sediments from the BAZ of the NBSA significantly lower than that in reference sediments?	Laboratory toxicity tests (a 10-day survival and growth study with *Ampelisca abdita* and a 28-day study with *Leptocheirus plumulosus* for survival, growth, and reproduction) using NBSA surface sediment statistically compared to bioassays conducted with control sediment	Assessing the adverse effects of chemicals (and evaluation of conventional parameters such as grain size, TOC, sulfide, and ammonia) in sediment to the benthic invertebrate community	Surficial sediment (from the BAZ) chemistry and conventional parameters	Regional background datasets	*Ampelisca abdita* *Leptocheirus plumulosus*	Spring through Fall 2014
	Are COPEC concentrations in pore water and surface water from the NBSA greater than benchmarks for the survival, growth, and/or reproduction of invertebrates?	Dissolved COPEC concentrations in pore and surface water collected from benthic invertebrate exposure areas as compared with toxicological benchmarks	Estimating the exposure of the benthic invertebrate community to COPECs the surface and pore water exposure pathways	Surface water collected from two depth intervals (one sample from near the sediment-water interface and one sample from 2 feet below the water's surface) and pore water samples	None	NA	Spring through Fall 2014

Table 4-4[a]
Final Selected Assessment Endpoints, Measurement Endpoints, and Data Needs to Support the BERA

Receptor Group and Assessment Endpoint	Risk Question	Final Measurement Endpoint	Data Use Objective	Biological Data/Media to be Sampled	Background Evaluation?	Representative Species	Anticipated Data Collection Timeframe
Assessment Endpoint No. 3 - Survival, growth, and/or reproduction of reptiles	Are COPEC concentrations in site surface water and sediment at levels that might adversely affect survival, growth, and/or reproduction of reptiles?	COPEC concentrations in sediment and surface water collected from the NBSA as compared with available and relevant toxicological benchmarks	Estimating the exposure of reptiles via direct contact and uptake of COPECs in surface water and sediment	Surface water and surficial sediment chemistry and conventional parameters from the NBSA	None	NA	Spring 2014
Assessment Endpoint No. 4 - Survival, growth, and/or reproduction of fish	Are COPEC concentrations in fish tissues from the NBSA greater than CBRs for the survival, growth, and/or reproduction of fish?	Whole-body chemical analyses, liver and other tissue (including bile, gut contents) chemical analyses, and external health observations of identified fish receptors as compared with literature-based critical body residues and/or with whole-body fish tissue chemical concentrations of selected receptors from background locations	Estimating the exposure of fish to COPECs in the NBSA	Whole-body fish tissue chemical concentrations, liver chemical concentrations, gross histological analysis, and gross histology of representative species from each of three trophic levels (forage fish, benthic/demersal, and pelagic predatory) from background locations	Representative species from each of three trophic levels (forage fish, benthic/demersal, and pelagic predatory) from background locations	TBD (Examples include mummichog, flounder, white perch)	One event each season for 1 calendar year: Fall 2013, Winter 2013, Spring 2014, Summer 2014
	Are COPEC concentrations in pore water, surface water, and sediment from the NBSA greater than benchmarks for the survival, growth, and/or reproduction of fish?	COPEC concentrations in dissolved pore water and surface water collected from the NBSA as compared with toxicological benchmarks	Estimating the exposure of fish via the surface water exposure pathway to COPECs in surface water	Data (chemical and conventional parameters such as DO, salinity, pH, hardness) collected as part of the surface water monitoring program	None	NA	Spring through Fall 2014
		COPEC concentrations in sediment as compared with toxicological sediment benchmarks from the literature	Evaluating the effects of COPEC concentrations in sediment on fish populations in the NBSA	Surface sediment collected from the BAZ	None	NA	Spring through Fall 2014
		Reproductive health of fish collected from both the NBSA and a reference location assessed via morphology (e.g., GSI, gonad condition), ichthyoplankton trawls	Evaluating the potential effects of COPECs on reproduction of NBSA fish	Fish and ichthyoplankton collected from the NBSA	Fish collected from background reference locations	NA	Spring through Fall 2014

Table 4-4[a]
Final Selected Assessment Endpoints, Measurement Endpoints, and Data Needs to Support the BERA

Receptor Group and Assessment Endpoint	Risk Question	Final Measurement Endpoint	Data Use Objective	Biological Data/Media to be Sampled	Background Evaluation?	Representative Species	Anticipated Data Collection Timeframe
Assessment Endpoint No. 5 - Survival, growth, and/or reproduction of birds	Does the daily dose of COPECs received by birds (including piscivorous, benthivorous/sediment-probing, omnivorous, insectivorous birds) from consumption of the tissues of prey species and from other media in the NBSA exceed the toxicity reference values (TRVs) for survival, growth, and/or reproduction of birds? If yes, what are the probabilities of effects of differing magnitude for survival, growth, and/or reproduction of birds?	Receptor-specific modeled daily doses associated with the ingestion of COPECs in surface water, sediment, and prey tissue as compared with literature-based dietary dose toxicity reference values (TRVs). COPEC concentrations in bird egg tissues may also be collected and compared to CBRs for bird eggs.	Estimating exposure of bird receptors via various exposure pathways to COPECs in surface water, sediment, and prey tissue. If potential risks are evident, a Probabilistic Risk Assessment may be conducted to quantify the uncertainties in the food web models.	Surface sediment chemistry (from the BAZ) and benthic invertebrate and/or fish prey tissue chemical concentrations, depending on receptor-specific diet. Bird egg tissue from the NBSA.	None	TBD (Examples include spotted sandpiper, marsh wren, lesser scaup, osprey)	Bird egg collection - early Spring 2014; nesting survey could be done Fall 2013
Assessment Endpoint No. 6 - Survival, growth, and/or reproduction of mammals	Does the daily dose of COPECs received by mammals (including piscivorous, omnivorous, and insectivorous) from consumption of the tissues of prey species and from other media in the NBSA exceed the TRVs for survival, growth, and/or reproduction of mammals? If yes, what are the probabilities of effects of differing magnitude for survival, growth, and/or reproduction of mammals?	Receptor-specific modeled daily doses associated with the ingestion of COPECs in surface water, sediment, and prey tissue as compared with literature-based dietary dose TRVs	Estimating exposure of aquatic and semi-aquatic mammals to chemicals in NBSA surface water, sediment, and prey tissue. If potential risks are evident, a Probabilistic Risk Assessment may be conducted to quantify the uncertainties in the food web models.	Surface sediment chemistry (from the BAZ) and benthic invertebrate and/or fish prey tissue chemical concentrations, depending on receptor-specific diet	None	Mink, harbor seal, river otter, little brown bat, raccoon	Mammal survey - Summer 2014

Acronyms and Abbreviations:
BAZ = biologically active zone
COPEC = constituent of potential ecological concern
DO = dissolved oxygen
GSI = gonadosomatic index
NBSA = Newark Bay Study Area
SQT = sediment quality triad
TOC = total organic carbon
TRV = toxicity reference value
USEPA = US Environmental Protection Agency

Notes:
a. Table based on discussions/documentation among Tierra, USEPA, and Partner Agencies, including the following:
A conference call among all parties on January 22, 2013
A meeting between Tierra and USEPA on February 22, 2013
Meeting Minutes from the February 22, 2013 Meeting
Responses to USEPA Comments on the Draft Problem Formulation document (February 28, 2013)
USEPA's Resolution on Comments and Responses to Comments (March 22, 2013)
Email from E. Naranjo dated April 4, 2013 (USEPA 2013)

Figures

City: SYR Div/Group: IM Created By: K. SINSABAUGH Last Saved By: ksinsabaugh
Newark Bay (B0009989.0017.00005)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\NBRegionalMap.mxd 5/30/2013 1:43:35 PM

NEW YORK
FOCUS AREA
NEW JERSEY

LEGEND:
NEWARK BAY STUDY AREA BOUNDARY

PATERSON CITY
ELMWOOD PARK BORO
ROCHELLE PARK TWP
MAYWOOD BORO
SADDLE BROOK TWP
TEANECK TWP
ENGLEWOOD BORO
HACKENSACK CITY
CLIFTON CITY
GARFIELD CITY
LODI BORO
BOGOTA BORO
SOUTH HACKENSACK TWP
HASBROUCK HEIGHTS BORO
TETERBORO BORO
LEONIA BORO
RIDGEFIELD PARK VILLAGE
FORT LEE BORO
PASSAIC COUNTY
PASSAIC CITY
WALLINGTON BORO
WOOD-RIDGE BORO
LITTLE FERRY BORO
PALISADES PARK BORO
MOONACHIE BORO
BERGEN COUNTY
RIDGEFIELD BORO
RUTHERFORD BORO
CARLSTADT BORO
CLIFFSIDE PARK BORO
FAIRVIEW BORO
EAST RUTHERFORD BORO
NUTLEY TWP
LYNDHURST TWP
EDGEWATER BORO
GUTTENBERG TOWN
BELLEVILLE TWP
NORTH ARLINGTON BORO
WEST NEW YORK TOWN
HOBOKEN CITY
LIVINGSTON TWP
WEST ORANGE TWP
CITY OF ORANGE TWP
EAST ORANGE CITY
SOUTH ORANGE VILLAGE TWP
SECAUCUS TOWN
NORTH BERGEN TWP
WEEHAWKEN TWP
KEARNY TOWN
EAST NEWARK BORO
HARRISON TOWN
UNION CITY
MANHATTAN
MILLBURN TWP
ESSEX COUNTY
MAPLEWOOD TWP
IRVINGTON TWP
HUDSON COUNTY
NEWARK CITY
JERSEY CITY
SPRINGFIELD TWP
UNION TWP
HILLSIDE TWP
KENILWORTH BORO
ROSELLE PARK BORO
ROSELLE BORO
CRANFORD TWP
GARWOOD BORO
ELIZABETH CITY
BAYONNE CITY
WESTFIELD TOWN
WINFIELD TWP
LINDEN CITY
UNION COUNTY
CLARK TOWNSHIP
RAHWAY CITY
STATEN ISLAND
CARTERET BORO
WOODBRIDGE TWP
MIDDLESEX COUNTY
EDISON TWP
PERTH AMBOY CITY
SOUTH AMBOY CITY

DUNDEE DAM
SADDLE RIVER
THIRD RIVER
BELLMANS CREEK
BERRYS CREEK CANAL
BERRYS CREEK
CROMAKILL CREEK
KINGSLAND CREEK
SECOND RIVER
SAWMILL CREEK
FRANK'S CREEK
PASSAIC RIVER
HACKENSACK RIVER
LAWYERS CREEK
HARRISON CREEK
PLUM CREEK
PIERSONS CREEK
PORT NEWARK CHANNEL
PORT NEWARK
NEWARK LIBERTY INTERNATIONAL AIRPORT
ELIZABETH CHANNEL
NEWARK BAY
PERIPHERAL DITCH
PORT ELIZABETH
SOUTH ELIZABETH CHANNEL
ELIZABETH RIVER
PLATYKILL CREEK
UPPER NEW YORK BAY
MORSES CREEK
SHOOTERS ISLAND
MARINERS MARSH
ARLINGTON MARSH
KILL VAN KULL
OLD PLACE CREEK
PILES CREEK
PRALLS ISLAND
RAHWAY RIVER
FRESH KILLS
ARTHUR KILL
RARITAN RIVER
RARITAN BAY

HR-19.5 HR-19 HR-18.5 HR-18 HR-17 HR-16.5 HR-16 HR-15.5 HR-15 HR-14.5 HR-14 HR-13.5 HR-13 HR-12.5 HR-12 HR-11.5 HR-11 HR-10.5 HR-10 HR-9.5 HR-9 HR-8.5 HR-8 HR-7.5 HR-7 HR-6.5 HR-6 HR-5.5 HR-5 HR-4.5 HR-4 HR-3.5 HR-3 HR-2.5 HR-2 HR-1.5 HR-1 HR-0.5
PR-17 PR-16.5 PR-16 PR-15.5 PR-15 PR-14.5 PR-14 PR-13.5 PR-13 PR-12.5 PR-11.5 PR-11 PR-10.5 PR-10 PR-9.5 PR-9 PR-8.5 PR-8 PR-7.5 PR-7 PR-6.5 PR-6 PR-5.5 PR-5 PR-4.5 PR-4 PR-3.5 PR-3 PR-2.5 PR-2 PR-1.5 PR-1 PR-0.5
PNC-1.5 PNC-1 PNC-0.5
NB-5 NB-4.5 NB-4 NB-3.5 NB-3 NB-2.5 NB-2 NB-1.5 NB-1 NB-0.5
EC-1.5 EC-1 EC-0.5
SEC-0.5
AK-1.5 AK-1 AK-0.5 AK-2 AK-2.5 AK-3 AK-3.5 AK-4 AK-4.5 AK-5 AK-5.5 AK-6 AK-6.5 AK-7 AK-7.5 AK-8 AK-8.5 AK-9 AK-9.5 AK-10 AK-10.5 AK-11 AK-11.5 AK-12 AK-12.5 AK-13 AK-13.5 AK-14
SI-0.5 SI-1
KVK-0.5 KVK-1 KVK-1.5 KVK-2 KVK-2.5 KVK-3 KVK-3.5 KVK-4 KVK-4.5 KVK-5

LEGEND:
RIVER/BAY MILE
NEWARK BAY STUDY AREA BOUNDARY

NOTES:
1. BASE MAP INFORMATION FROM NOAA CHARTS 12331, 12333, AND 12337, DATED MAY 4, 1995.
2. RIVER/BAY MILES CREATED BY DIVIDING RIVER CENTERLINE PROVIDED BY USEPA INTO 0.01-MILE SEGMENTS. HALF-MILE INCREMENTS ARE DISPLAYED ON THIS FIGURE.
3. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.

0 2 4 Miles
GRAPHIC SCALE

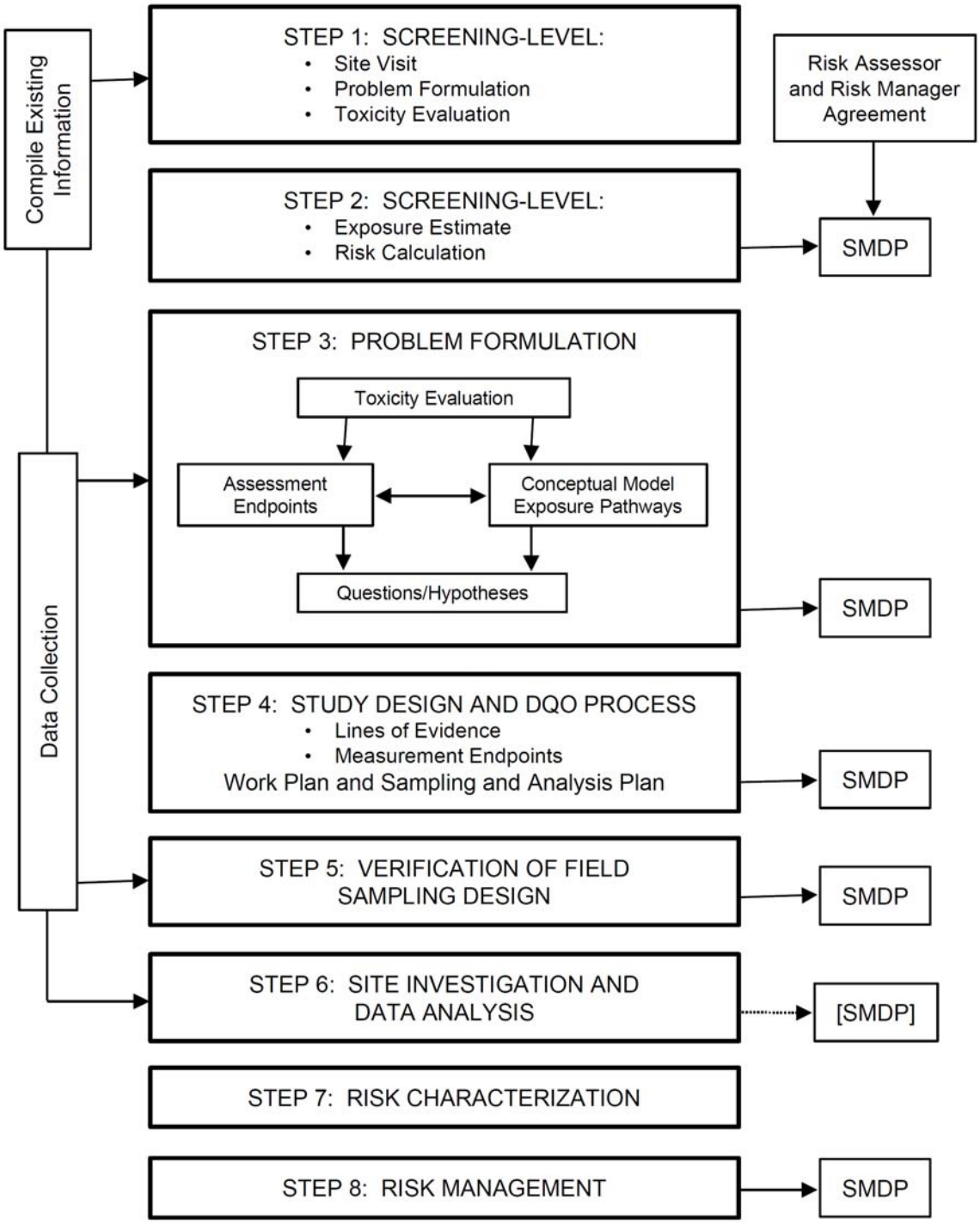
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

PROBLEM FORMULATION

REGIONAL MAP

JUNE 2013

FIGURE 1-1



SMDP = Scientific Management Decision Point

[SMDP] = only if change to the sampling and analysis plan is necessary

DQO = Data Quality Objective

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

EIGHT-STEP ECOLOGICAL RISK ASSESSMENT PROCESS FOR SUPERFUND (USEPA 1997)

JUNE 2013

FIGURE
1-2

05/29/2013 SYRACUSE, NY-ENV/CAD DJHOWES
B0009989/0023/00003/CDR/09989G02.CDR

City: SYR Div/Group: IM Created By: K. SINSABAUGH Last Saved By: ksinsabaugh
Newark Bay (B0009989.0017.00005)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\Current_HistoricalStructures.mxd 5/30/2013 1:46:51 PM

LEGEND:

- SHORELINE
- UNDERGROUND TRIBUTARY
- HISTORICAL FEATURE
- PVSC LINE ("PVSC INTERCEPTOR" NORTH OF NEWARK BAY, "PVSC OUTFALL TUNNEL" IN NEWARK BAY AND SOUTH)
- NEWARK BAY STUDY AREA BOUNDARY

NOTES:

1. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
2. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD 83.
3. DATE FROM NEW YORK CONTAINER TERMINAL HISTORY. www.nycterminal.com/t3/index.php?id=240.
4. DATE FROM USACE (2006b).
5. DATES AND TUNNEL INFORMATION AVAILABLE FROM www.nj.gov/pvsc.
6. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.

HACKENSACK MEADOWLANDS
PASSAIC RIVER
HACKENSACK RIVER
PVSC INTERCEPTOR (NORTH OF NEWARK BAY)
PLUM CREEK
CONRAIL BRIDGE REMNANTS
PIERSONS CREEK
PVSC OUTFALL TUNNEL (CONSTRUCTION COMPLETED 1924[5]) (SOUTH OF NEWARK BAY)
PORT NEWARK CHANNEL
LEHIGH VALLEY RAILROAD BRIDGE
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
NEWARK BAY CDF (CELL 1S)
NEWARK BAY BRIDGE (VINCENT R. CASCIANO I-78 MEMORIAL BRIDGE)
PORT ELIZABETH MARINE TERMINAL
PERIPHERAL DITCH
SOUTH ELIZABETH CHANNEL
OLD BAY DRAW RAILROAD BRIDGE (DEMOLISHED DURING 1980s)
ELIZABETHPORT (1871 - 1940[4])
PORT JOHNSON 1891 - 1940[4]
ELIZABETH RIVER
BAYONNE BRIDGE
KILL VAN KULL
MORSES CREEK
SHOOTERS ISLAND
NEW CREEK
HOWLAND HOOK MARINE TERMINAL (OPENED 1973; STILL IN USE)[3]
GOETHALS BRIDGE
OLD PLACE CREEK
PILES CREEK
ARTHUR KILL
PRALLS ISLAND

0 1 2 Miles
GRAPHIC SCALE

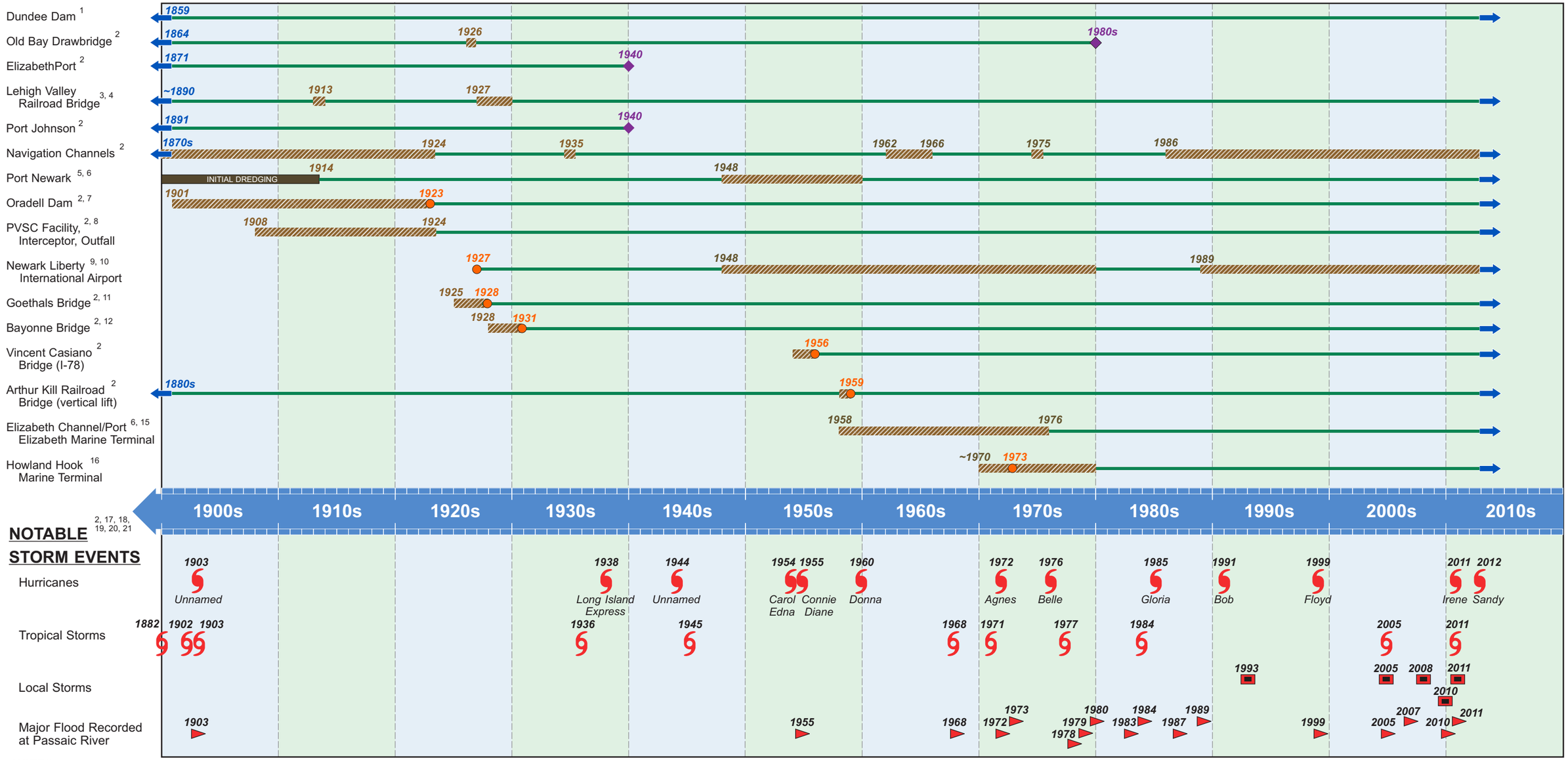
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

SITE MAP INCLUDING CURRENT AND HISTORICAL FEATURES

JUNE 2013

FIGURE 2-1

FACILITIES, STRUCTURES, AND DEVELOPMENT SUMMARY



NOTES:

1. NEW YORK TIMES (NYT). 1999.
2. U.S. ARMY CORPS OF ENGINEERS (USACE). 2006b.
3. NYT. 1891.
4. NYT. 1913a; 1913b; 1927a; 1927b.
5. NYT. 1926.
6. PANYNJ. 2012a.
7. NYT. 2011.
8. PASSAIC VALLEY SEWERAGE COMMISSION (PVSC). 2011.
9. NYT. 1927c; 1927d.
10. PANYNJ. 2012b.
11. PANYNJ. 2012c.
12. PANYNJ. 2012d.
13. NYT. 1955
14. EASTERN ROADS, 2012.
15. NYT. 1972.
16. NEW YORK CONTAINER TERMINAL (NYCT). 2011.
17. USACE. 2012.
18. NOAA. 2011.
19. HURRICANES SHOWN THAT WERE LISTED AS IMPACTING THE STATES OF NEW YORK AND/OR NEW JERSEY IN NOAA 2007.
20. TROPICAL STORMS AND LOCAL STORMS IDENTIFIED IN USACE 2006.
21. PASSAIC RIVER FLOODS LISTED ARE DEFINED AS "MAJOR" FLOODS ACCORDING TO NOAA 2011.

LEGEND:

- Opened
- Construction/Development Activities
- Demolished
- In Use/Maintained
- Hurricane
- Tropical Storm/Extra-Tropical Storm
- Local Storm
- Major Flood

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

TIMELINE SUMMARY OF NBSA ACTIVITIES

JUNE 2013

FIGURE **2-2**

05/29/2013 SYRACUSE, NY-ENV/CAD DJHOWES
B0009989/0023/00003/CDR/09989F01.CDR

CITY: SYR DIV/GROUP: SYE40 DB: K. SINSABAUGH PM:
Newark Bay (B0009989.0011.00001)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\PotentialGeoBounds.mxd - 5/30/2013 @ 1:47:58 PM

LEGEND:

- SHORELINE
- UNDERGROUND TRIBUTARY
- NEWARK BAY STUDY AREA BOUNDARY
- NAVIGATION CHANNEL

GEOGRAPHIC AREAS

- ARTHUR KILL
- KILL VAN KULL
- HACKENSACK RIVER
- NEWARK BAY NORTH
- NEWARK BAY CENTRAL
- NEWARK BAY SOUTH
- PASSAIC RIVER
- PORT CHANNELS

0 0.8 1.6 Miles

GRAPHIC SCALE

PASSAIC RIVER
HACKENSACK RIVER
CONRAIL BRIDGE REMNANTS
PIERSONS CREEK
PORT NEWARK CHANNEL
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
PERIPHERAL DITCH
NEWARK BAY CDF (CELL 1S)
SOUTH ELIZABETH CHANNEL
ELIZABETH RIVER
KILL VAN KULL
MORSES CREEK
GOETHALS BRIDGE
ARTHUR KILL
BAYONNE BRIDGE
SHOOTERS ISLAND
PILES CREEK
PRALLS ISLAND

NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
3. DEPOSITIONAL INFORMATION WAS EXTRACTED FROM FIGURE 2 OF THE USACE GEOMORPHOLOGICAL REPORT DATED DECEMBER 31, 2006.
4. BASE MAP INFORMATION AND NEWARK BAY NAVIGATION CHANNEL FROM NOAA CHARTS 12331, 12333, AND 12337, DATED MAY 4, 1995. PASSAIC NAVIGATION CHANNEL PROVIDED BY THE US ARMY CORPS OF ENGINEERS (USACE).

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

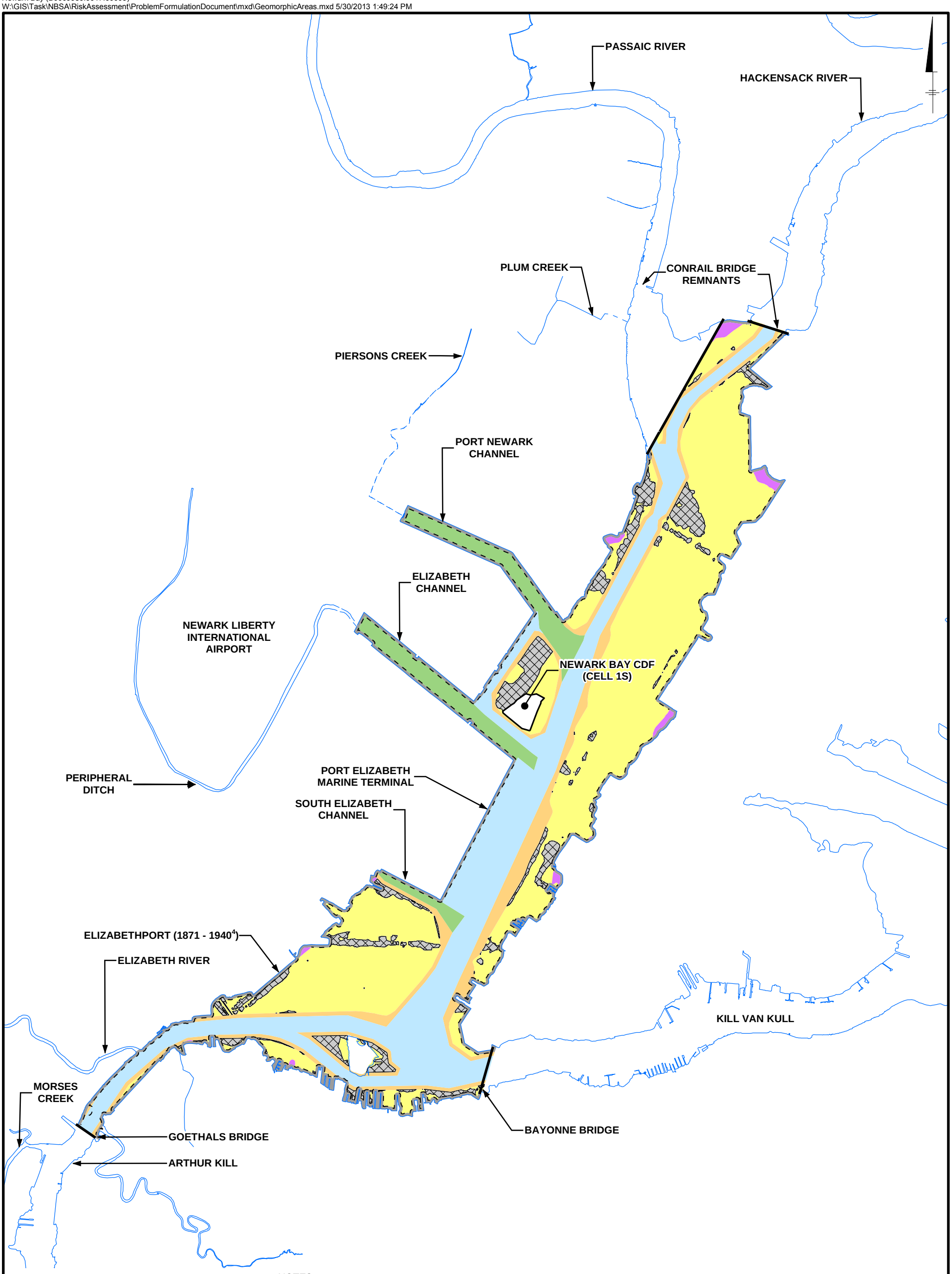
PROBLEM FORMULATION

GEOGRAPHIC AREAS

JUNE 2013

FIGURE 2-3

City: SYR Div/Group: IM Created By: K. SINSABAUGH Last Saved By: ksinsabaugh
Newark Bay (B0009989.0017.00005)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\GeomorphicAreas.mxd 5/30/2013 1:49:24 PM



LEGEND:

- SHORELINE
- NEWARK BAY STUDY AREA BOUNDARY
- HISTORICALLY DISTURBED SUBTIDAL FLATS
- INDUSTRIAL WATERFRONT AREA
- INTERTIDAL AREAS
- NAVIGATION CHANNELS
- PORT CHANNELS
- SUBTIDAL FLATS
- TRANSITIONAL SLOPES

NOTES:

1. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
2. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD 83.
3. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.
4. HISTORICALLY DISTURBED SUBTIDAL FLAT AREAS BASED ON THE USACE GEOMORPHOLOGICAL REPORT DATED DECEMBER 31, 2006.

0 3,500 7,000 Feet

GRAPHIC SCALE

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

PROBLEM FORMULATION

GEOMORPHIC AREAS

JUNE 2013

FIGURE **2-4**

CITY: SYR DIV/GROUP: IT DB: KES LD: PIC: PM: TM: TR:
Newark Bay (B0009989.0003.00001)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\ERA Wetlands.mxd 5/30/2013 1:51:13 PM



LEGEND:

- NEWARK BAY STUDY AREA BOUNDARY
- ESTUARINE & MARINE DEEPWATER
- FRESHWATER FORESTED/SHRUB
- FRESHWATER EMERGENT
- ESTUARINE & MARINE
- FRESHWATER POND
- OTHER
- RIVERINE

NOTES:

1. WETLANDS DATA DOWNLOADED FROM THE U.S. FISH & WILDLIFE SERVICE NATIONAL WETLANDS INVENTORY WEBSITE AT www.fws.gov/wetlands/Data/DataDownload.html.
2. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

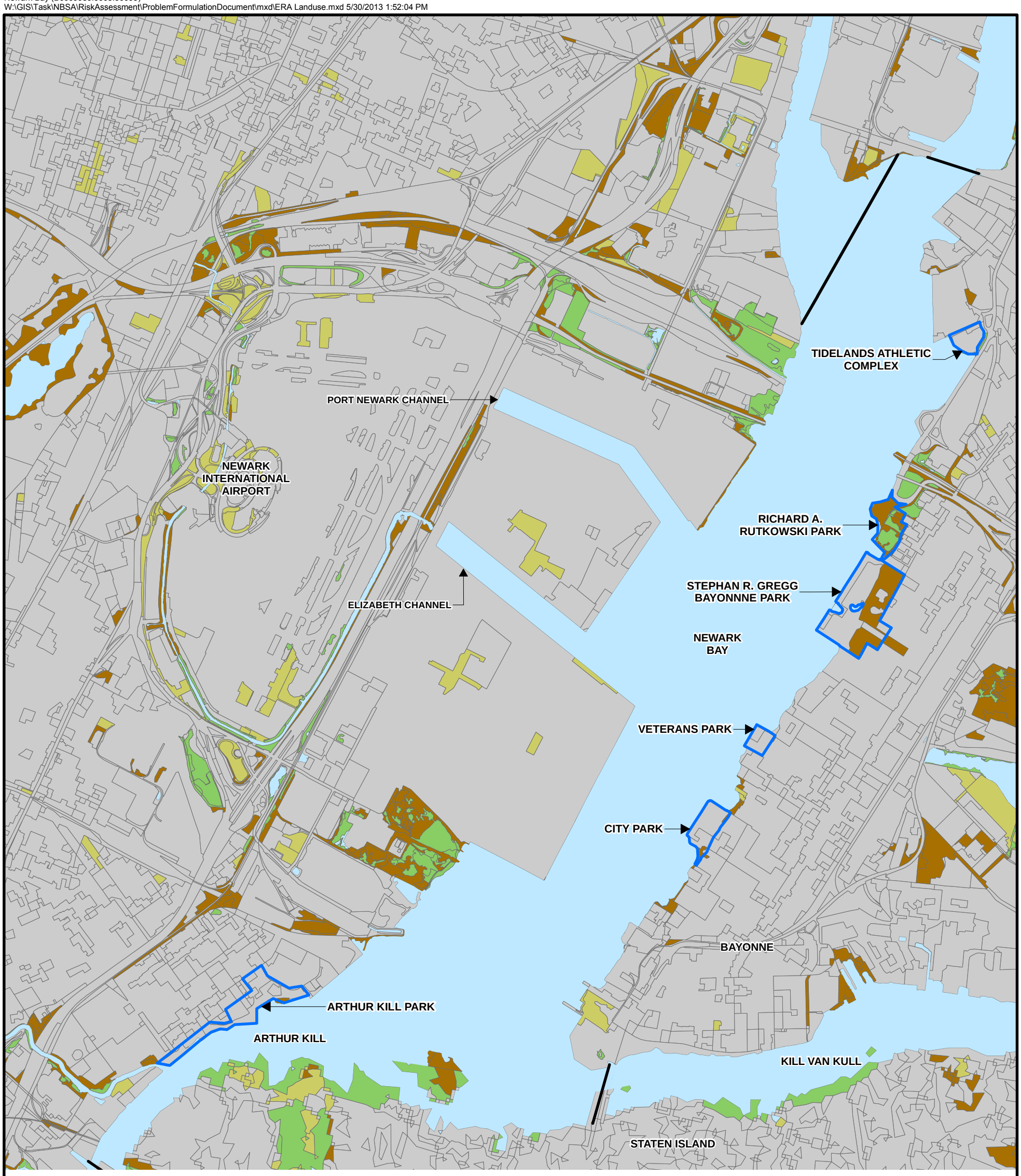
PROBLEM FORMULATION

NATIONAL WETLANDS INVENTORY MAP

JUNE 2013

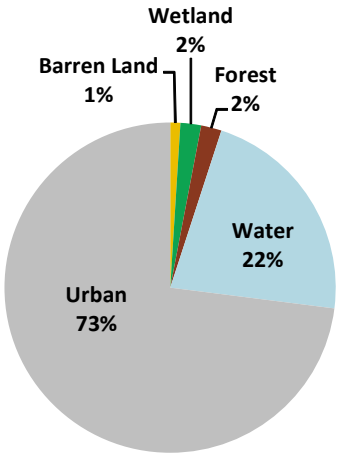
FIGURE 2-5

CITY: SYR DIV/GROUP: IT DB: KES LD: PIC: PM: TM: TR:
Newark Bay (B0009989.0005.00003)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\ERA Landuse.mxd 5/30/2013 1:52:04 PM



LEGEND:

- BARREN LAND
- FOREST
- URBAN
- WATER
- WETLANDS
- PARKS AND RECREATIONAL AREAS
- NEWARK BAY STUDY AREA BOUNDARY



Percentage of Land Cover

NOTES:

1. 2007 NEW JERSEY LAND USE DATA DOWNLOADED FROM THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION GEOGRAPHIC INFORMATION SYSTEM WEBSITE AT www.state.nj.us/dep/gis.
2. 2006 NEW YORK NATIONAL LAND COVER DATA DOWNLOADED FROM THE NEW YORK STATE GEOGRAPHIC INFORMATION SYSTEMS CLEARINGHOUSE AT www.nysgis.state.ny.us.
3. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.

0 3,000 6,000 Feet
GRAPHIC SCALE

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

LAND USE/ECOLOGICAL HABITATS

JUNE 2013

FIGURE 3-1

CITY: SYR DIV/GROUP: IM DB: K. SINSABAUGH PM:
Newark Bay (B0009989.001.00001)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\Biotic Integrity.mxd 5/30/2013 1:52:26 PM

LEGEND:

- UNIMPACTED BENTHOS (B-IBI 3.00 - 5.00)
- MODERATELY IMPACTED BENTHOS (B-IBI 2.00 - 2.90)
- HIGHLY IMPACTED BENTHOS (B-IBI 0.00 - 1.90)
- NEWARK BAY STUDY AREA BOUNDARY
- SHORELINE
- UNDERGROUND TRIBUTARY

0 0.8 1.6 Miles

GRAPHIC SCALE

PASSAIC RIVER
HACKENSACK RIVER
NB205
NB225
CONRAIL BRIDGE REMNANTS
PIERSONS CREEK
NB227
PORT NEWARK CHANNEL
NB217
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
NB216
NB206
NB226
NEWARK BAY CDF (CELL 1S)
NB212
PERIPHERAL DITCH
NB201
SOUTH ELIZABETH CHANNEL
NB231
NB222
ELIZABETH RIVER
NB223
NB207
NB228
NB202
NB218
NB213
KILL VAN KULL
MORSES CREEK
NB211
SHOOTERS ISLAND
BAYONNE BRIDGE
GOETHALS BRIDGE
ARTHUR KILL
PILES CREEK
NB203
PRALLS ISLAND
NB224
NB204

NOTES:

1. B-IBI DATA SHOWN IS FROM USEPA (2003b). ALL LOCATIONS ARE APPROXIMATE.
2. B-IBI = BENTHIC-INDEX OF BIOTIC INTEGRITY
   NB = NEWARK BAY
3. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
4. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
5. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.

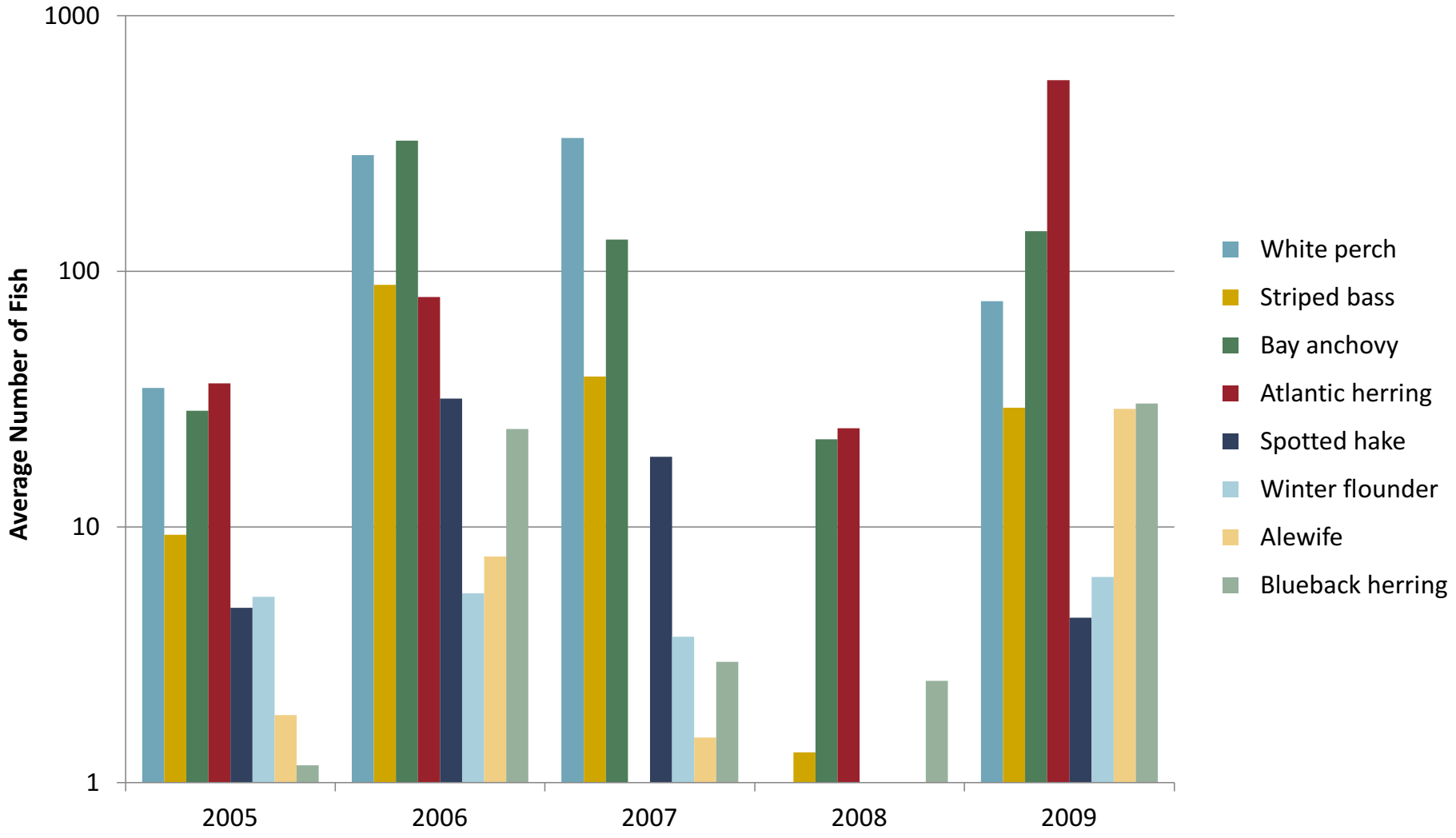
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

PROBLEM FORMULATION

BENTHIC-INDEX OF BIOTIC INTEGRITY

JUNE 2013

FIGURE 3-2



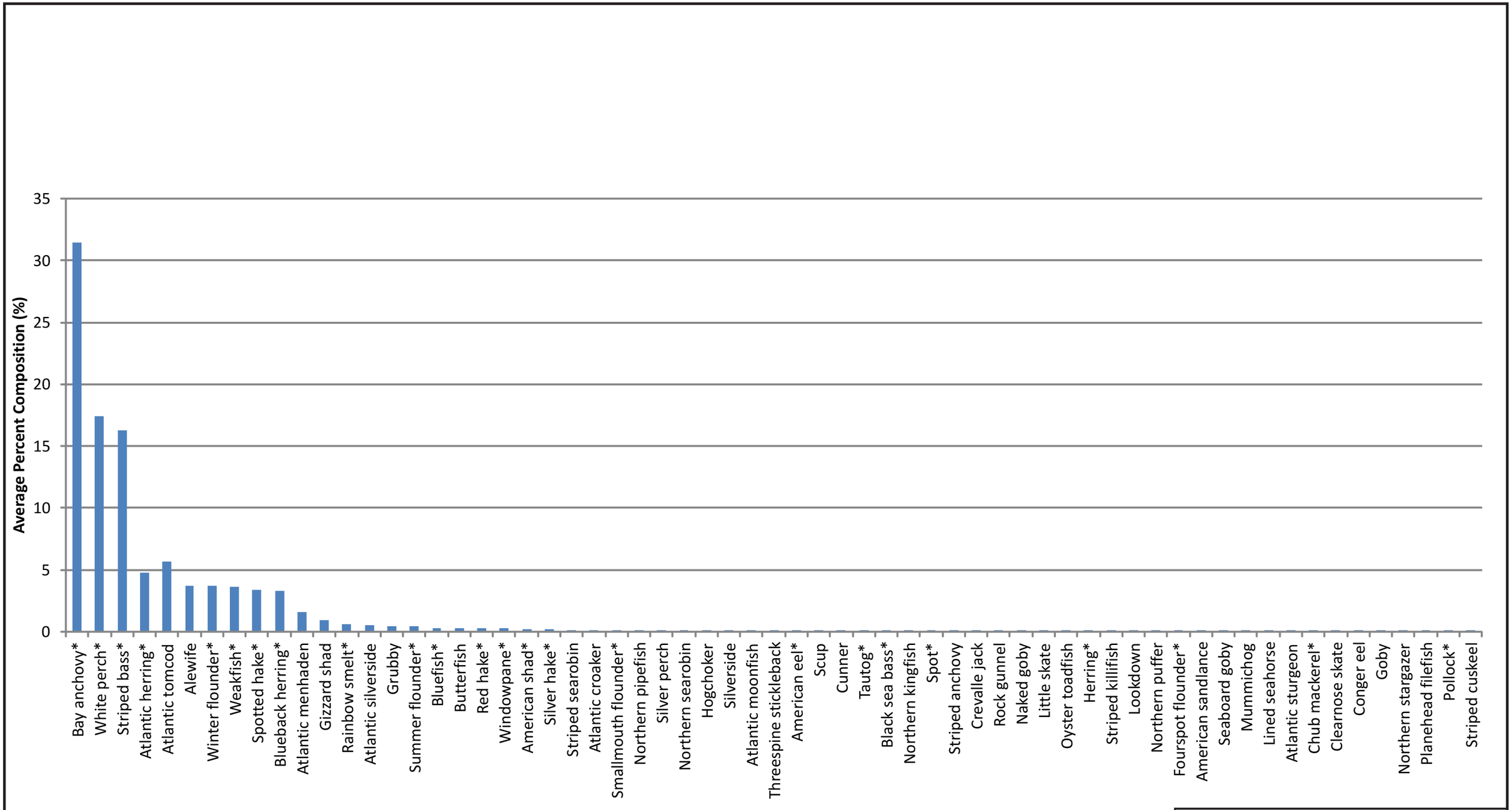
Notes:
From USACE (2005-2009).
Data are log-transformed.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

AVERAGE ANNUAL FINFISH CATCH IN NEWARK BAY (USACE 2005-2009)

JUNE 2013

FIGURE
3-3



Note:
From USACE (2004-2013), NOAA (1994), LMS (1996)

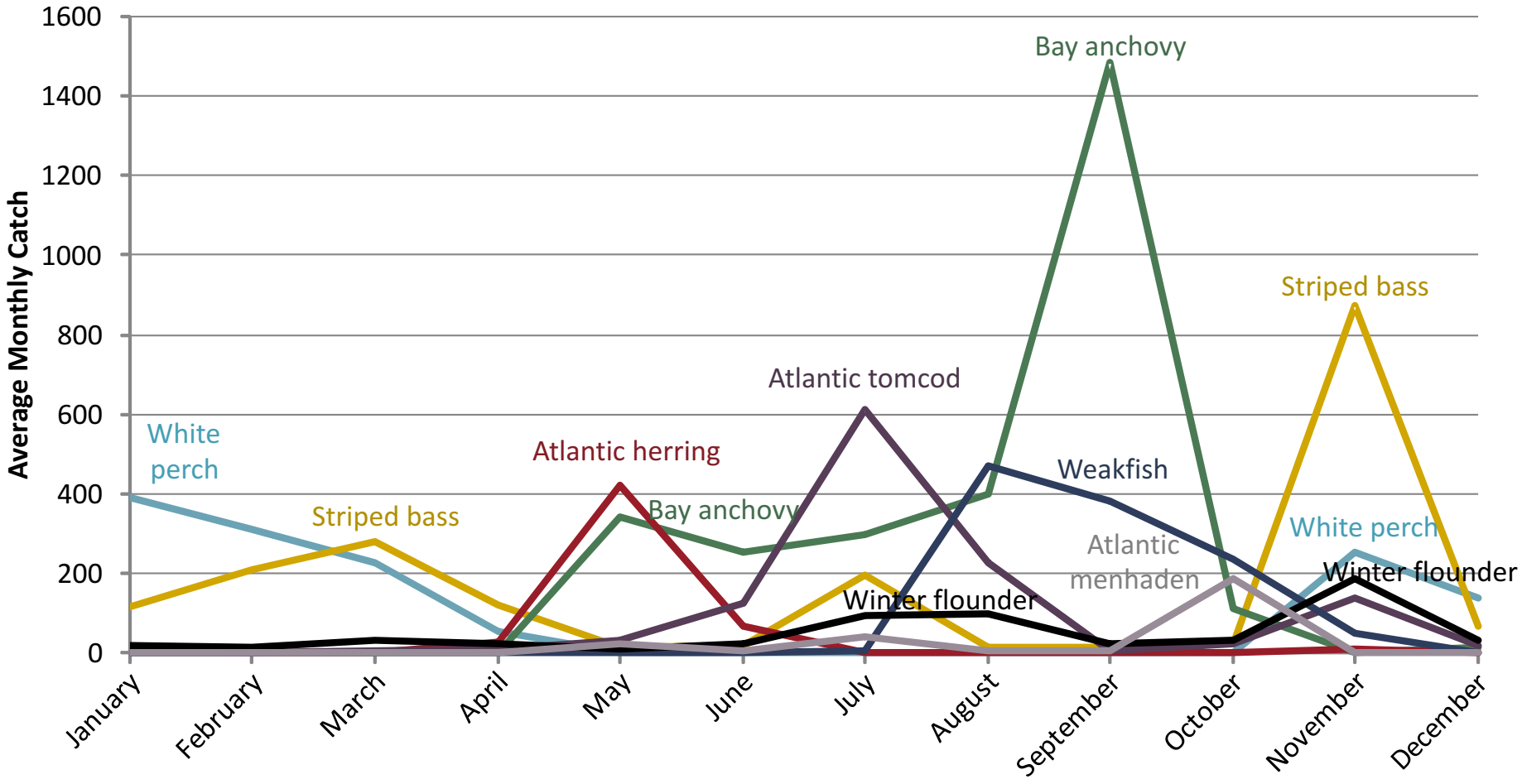
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

AVERAGE PERCENT COMPOSITION OF FINFISH CATCH IN NEWARK BAY (1993-2013)

JUNE 2013

FIGURE
3-4

05/29/2013 SYRACUSE, NY-ENV//CAD DJHOWES
B0009989/0023/00003/CDR/09989G06.CDR



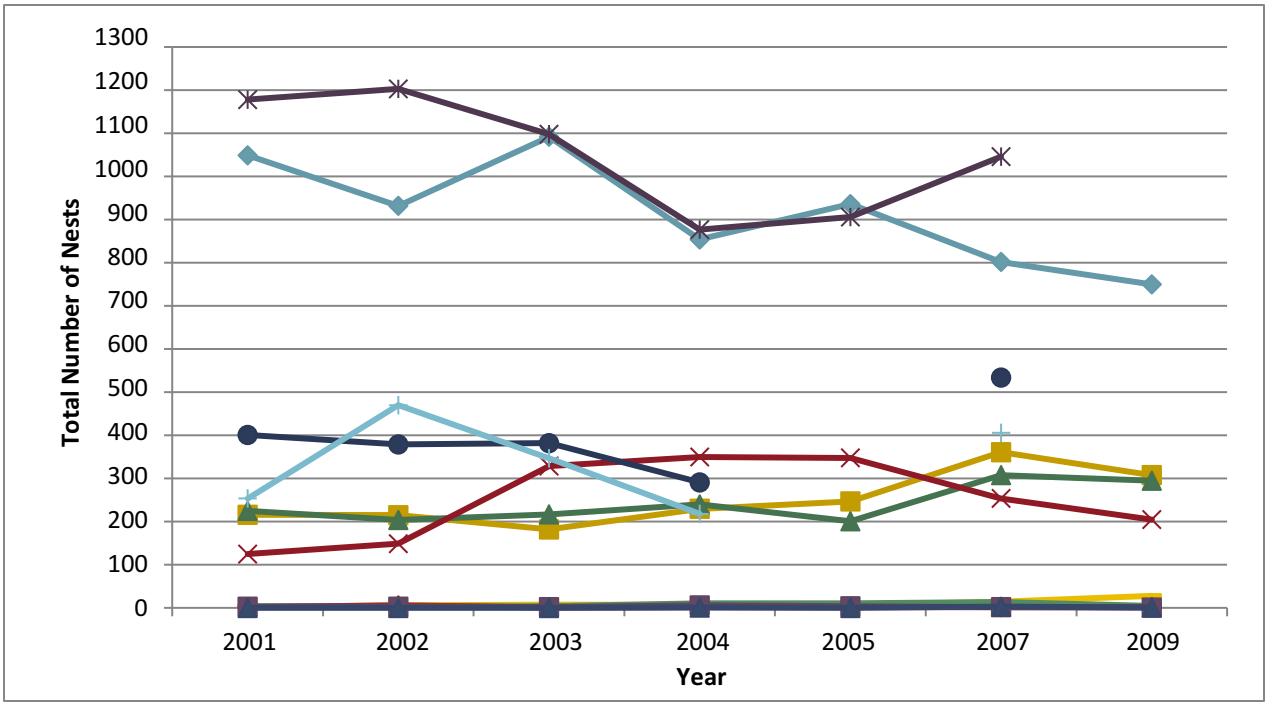
Note:
From USACE (2004-2009), NOAA (1994), LMS (1996).

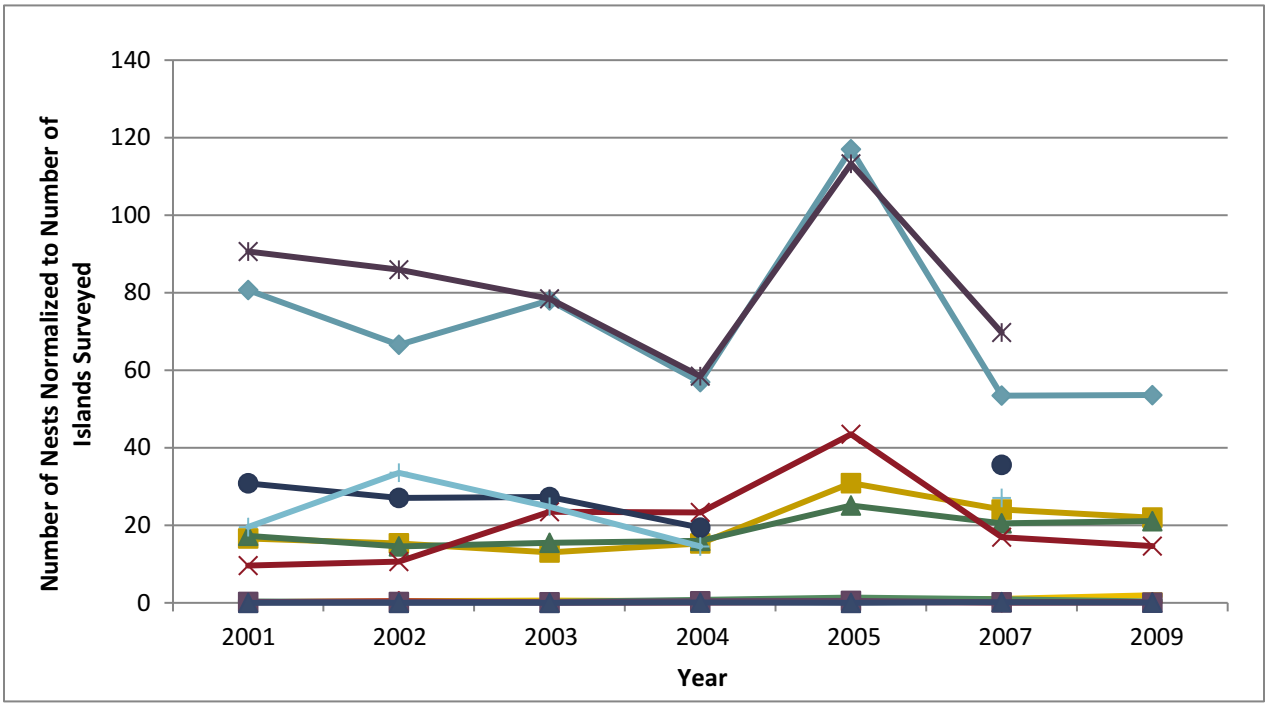
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

AVERAGE MONTHLY COMPOSITION OF FINFISH CATCH IN NEWARK BAY (1993-2009)

JUNE 2013

FIGURE
3-5





Black-crowned night heron
Herring gull
Great egret
Great black-backed gull
Snowy egret
Yellow-crowned night heron
Glossy ibis
Little blue heron
Double-crested cormorant
Tricolored heron

Note:
From Harbor Herons Survey Data:
Bernick (2007), Bernick and Craig (2008),
Gelb (2004), and Harbor Herons Subcommittee (2010).

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

HARBOR HERONS PROJECT DATA (2001-2009)

JUNE 2013

FIGURE
3-6

05/29/2013 SYRACUSE, NY-ENV/CAD DJHOWES
B0009989/0023/00003/CDR/09989G04.CDR

City: SYR Div/Group: IM Created By: K. SINSABAUGH Last Saved By: ksinsabaugh
Newark Bay (B0009989.0017.00005)
W:\GIS\Task\NBSA\RiskAssessment\ProblemFormulationDocument\mxd\Ampelisca Abdita Results.mxd 5/30/2013 1:53:10 PM

LEGEND:

Ampelisca abdita SURVIVAL

REFERENCE

- Battelle (1992)
- Battelle (1997a)
- Battelle (1997b)
- NOAA (1995)
- Rice et al. (1995)
- Tierra (2004)
- USACE (1997)
- USEPA (1990)
- USEPA (1998)
- USEPA (2003)

TOXICITY

- TOXIC/NON-TOXIC

- BAY MILE
- RIVER/BAY MILE

GEOGRAPHIC AREAS

- ARTHUR KILL
- KILL VAN KULL
- HACKENSACK RIVER
- NEWARK BAY NORTH
- NEWARK BAY CENTRAL
- NEWARK BAY SOUTH
- PASSAIC RIVER
- PORT CHANNELS
- SHORELINE
- UNDERGROUND TRIBUTARY

GEOMORPHIC AREAS

- INTERTIDAL AREAS
- NAVIGATION CHANNELS
- PORT CHANNELS
- SUBTIDAL FLATS
- TRANSITIONAL SLOPES
- HISTORICALLY DISTURBED SUBTIDAL FLATS
- INDUSTRIAL WATERFRONT AREA

0 0.8 1.6 Miles

GRAPHIC SCALE

PASSAIC RIVER
HACKENSACK RIVER
CONRAIL BRIDGE REMNANTS
PIERSONS CREEK
PORT NEWARK CHANNEL
ELIZABETH CHANNEL
NEWARK LIBERTY INTERNATIONAL AIRPORT
NEWARK BAY CDF (CELL 1S)
PERIPHERAL DITCH
SOUTH ELIZABETH CHANNEL
ELIZABETH RIVER
MORSES CREEK
SHOOTERS ISLAND
BAYONNE BRIDGE
KILL VAN KULL
GOETHALS BRIDGE
ARTHUR KILL
PILES CREEK
PRALLS ISLAND

NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. SHORELINE IS DIGITIZED FROM AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
3. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.
4. ALL LOCATIONS ARE APPROXIMATE.
5. TOXIC = ALL REPLICATE VALUES WITH LESS THAN 80% OF AVERAGE SURVIVAL/GROWTH OF CONTROLS.
6. NON-TOXIC = ALL REPLICATE VALUES WITH SURVIVAL/GROWTH GREATER THAN OR EQUAL TO 80% OF AVERAGE CONTROL SURVIVAL/GROWTH.
7. RIVER/BAY MILES CREATED BY DIVIDING RIVER CENTERLINE PROVIDED BY USEPA INTO 0.01-MILE SEGMENTS. HALF-MILE INCREMENTS ARE DISPLAYED ON THIS FIGURE.
8. HISTORICALLY DISTURBED SUBTIDAL FLAT AREAS BASED ON THE USACE GEOMORPHOLOGICAL REPORT DATED DECEMBER 31, 2006.
9. ABBREVIATIONS ARE AS FOLLOWS:
   AK = ARTHUR KILL
   EC = ELIZABETH CHANNEL
   HR = HACKENSACK RIVER
   KVK = KILL VAN KULL
   NB = NEWARK BAY
   PNC = PORT NEWARK CHANNEL
   PR = PASSAIC RIVER
   SEC = SOUTH ELIZABETH CHANNEL
   SI = SHOOTERS ISLAND

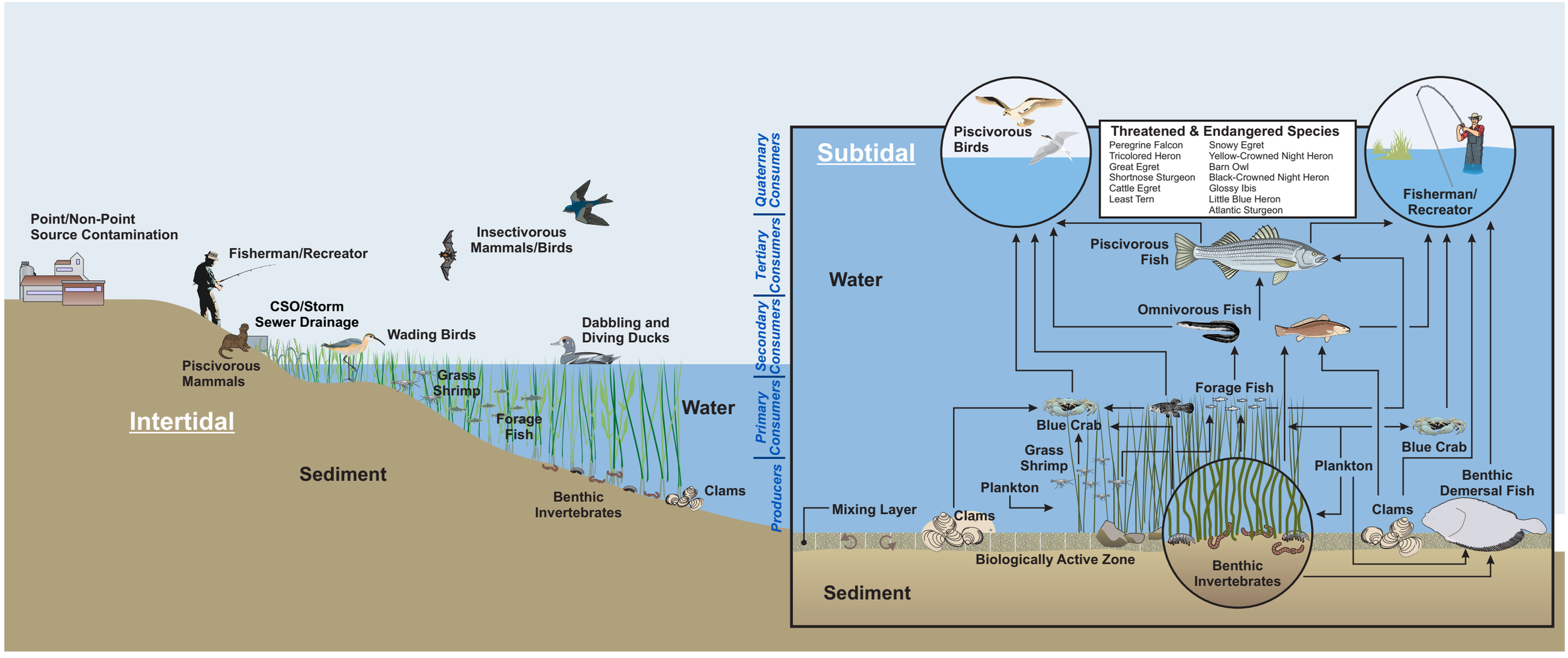
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

PROBLEM FORMULATION

HISTORICAL *AMPELISCA ABDITA* TOXICITY RESULTS

JUNE 2013

FIGURE 3-7



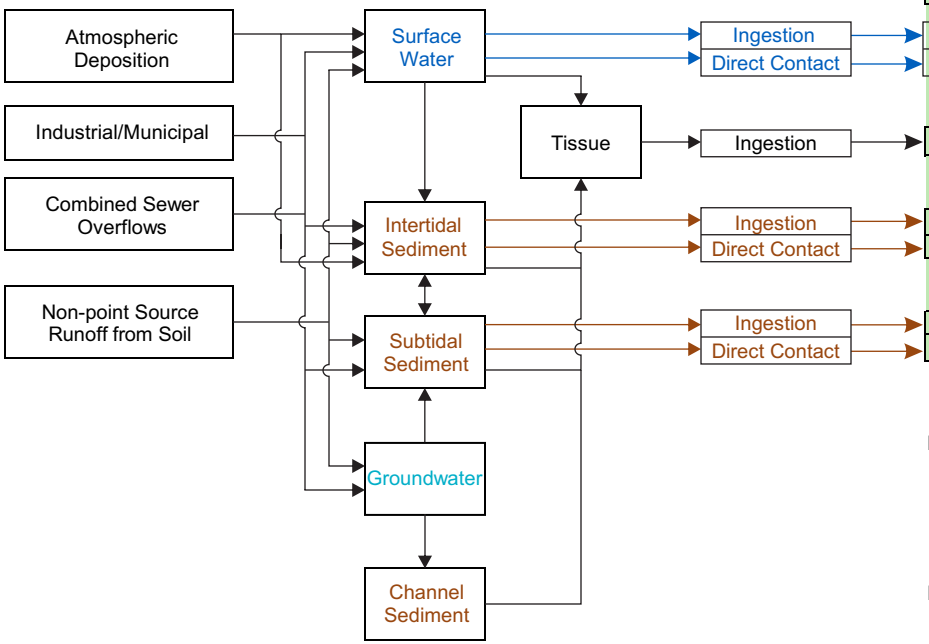
05/30/2013 SYRACUSE, NY-ENV/CAD DJHOWES
B0009989/0023/00003/CDR/09989G12.CDR

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

FOOD WEB DIAGRAM

JUNE 2013

FIGURE
4-1



Ecological Receptors

Exposure Media	Exposure Route	Aquatic Plants	Plankton	Benthic Invertebrate Community	Crustaceans	Mollusks	Reptiles	Forage Fish	Benthic Fish	Pelagic Fish	Omnivorous Birds and Mammals	Benthic-Feeding Birds	Insectivorous Birds and Mammals	Piscivorous Birds and Mammals
Surface Water	Ingestion	NA	X	X	X	X	X	X	X	X	X	X	X	X
	Direct Contact	X	X	X	X	X	X	X	X	X	O	O	O	O
Tissue	Ingestion	NA	NA	NA	O	NA	O	O	O/X [1]	O	X	X	X	X
Intertidal Sediment	Ingestion	NA	NA	X	X	X	X	X	O/X [1]	O	X	X	O	X
	Direct Contact	X	NA	X	X	X	X	X	O/X [1]	O	O	O	O	O
Subtidal Sediment	Ingestion	NA	NA	X	X	X	X	X	X	O	O	O	O	O
	Direct Contact	O	NA	X	X	X	X	X	X	O	O	O	O	O

Legend

NA Pathway not applicable.
X Major, Complete Exposure Pathway, Quantitatively Evaluated
O Minor, Potentially Complete Exposure Pathway, Qualitatively Evaluated

Note

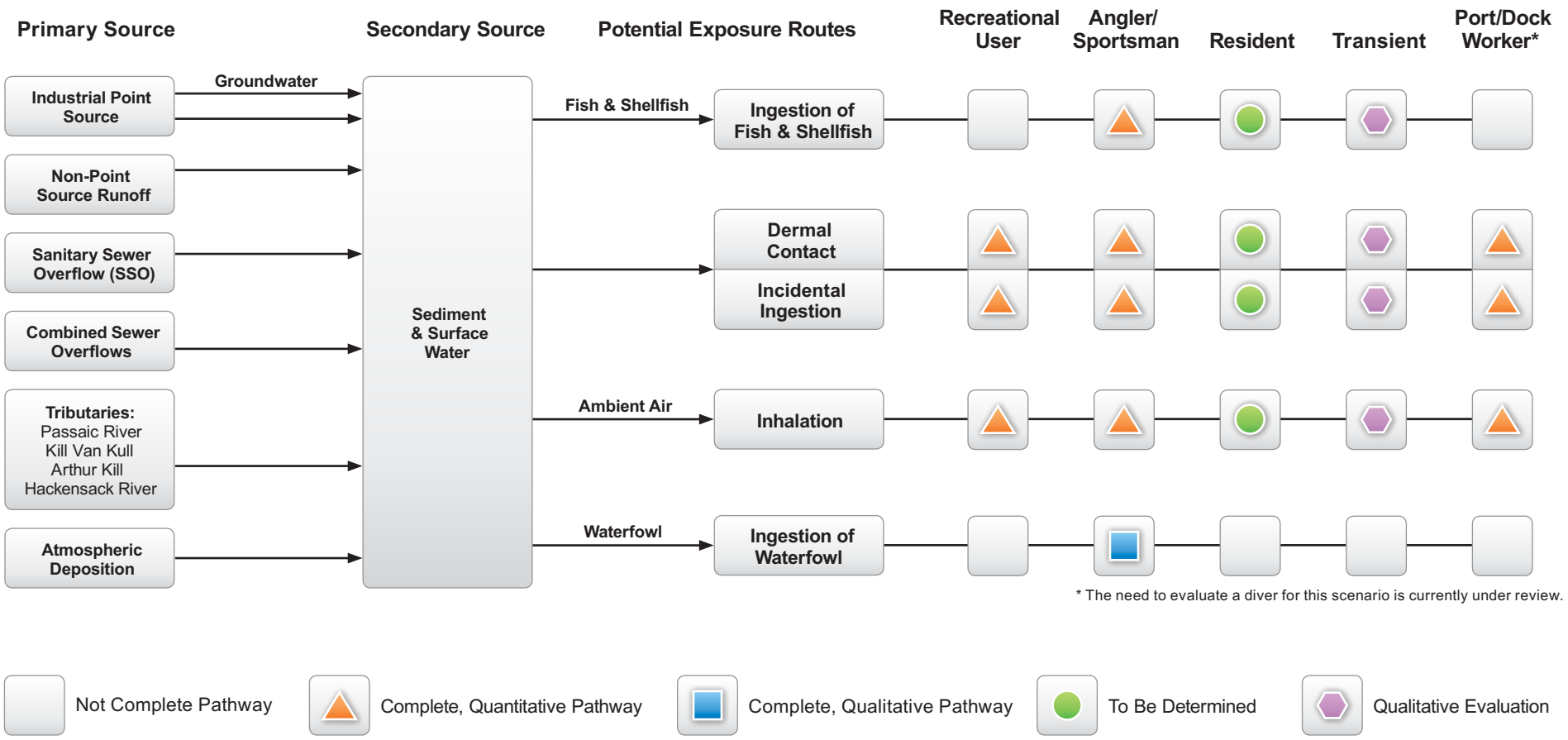
[1] Complete Exposure Pathway but not Determined Whether Major or Minor.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

ECOLOGICAL EXPOSURE PATHWAYS

JUNE 2013

FIGURE
4-2



NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

CONCEPTUAL SITE MODEL: HUMAN HEALTH

JUNE 2013

FIGURE
5-1

Appendix A

Natural Heritage Database Request Results

State of New Jersey

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Parks and Forestry
Mail Code 501-04
ONLM -Natural Heritage Program
P.O. Box 420
Trenton, NJ 08625-0420
Tel. #609-984-1339
Fax. #609-984-1427

BOB MARTIN
Commissioner

April 18, 2012

Melissa Beauchemin
ARCADIS
194 Forbes Road
Braintree, MA 02184

Re: Newark Bay Ecological Risk Assessment

Dear Ms. Beauchemin:

Thank you for your data request regarding rare species information for the above referenced project site in Newark, Elizabeth and Bayonne Cities, Essex, Union and Hudson County.

Searches of the Natural Heritage Database and the Landscape Project (Version 3.1) are based on a representation of the boundaries of your project site in our Geographic Information System (GIS). We make every effort to accurately transfer your project bounds from the topographic map(s) submitted with the Request for Data into our Geographic Information System. We do not typically verify that your project bounds are accurate, or check them against other sources.

We have checked the Landscape Project habitat mapping and the Biotics Database for occurrences of any rare wildlife species or wildlife habitat on the referenced site. The Natural Heritage Database was searched for occurrences of rare plant species or ecological communities that may be on the project site. Please refer to Table 1 (attached) to determine if any rare plant species, ecological communities, or rare wildlife species or wildlife habitat are documented on site. A detailed report is provided for each category coded as 'Yes' in Table 1.

We have also checked the Landscape Project habitat mapping and Biotics Database for occurrences of rare wildlife species or wildlife habitat in the immediate vicinity (within ¼ mile) of the referenced site. Additionally, the Natural Heritage Database was checked for occurrences of rare plant species or ecological communities within ¼ mile of the site. Please refer to Table 2 (attached) to determine if any rare plant species, ecological communities, or rare wildlife species or wildlife habitat are documented within the immediate vicinity of the site. Detailed reports are provided for all categories coded as 'Yes' in Table 2. These reports may include species that have also been documented on the project site.

The Natural Heritage Program reviews its data periodically to identify priority sites for natural diversity in the State. Included as priority sites are some of the State's best habitats for rare and endangered species and ecological communities. Please refer to Tables 1 and 2 (attached) to determine if any priority sites are located on or in the vicinity of the site.

A list of rare plant species and ecological communities that have been documented from Essex, Union and Hudson County can be downloaded from http://www.state.nj.us/dep/parksandforests/natural/heritage/countylist.html. If suitable habitat is present at the project site, the species in that list have potential to be present.

Status and rank codes used in the tables and lists are defined in EXPLANATION OF CODES USED IN NATURAL HERITAGE REPORTS, which can be downloaded from http://www.state.nj.us/dep/parksandforests/natural/heritage/nhpcodes_2010.pdf.

If you have questions concerning the wildlife records or wildlife species mentioned in this response, we recommend that you visit the interactive NJ-GeoWeb website at the following URL, http://www.state.nj.us/dep/gis/geowebsplash.htm or contact the Division of Fish and Wildlife, Endangered and Nongame Species Program at (609) 292-9400.

PLEASE SEE 'CAUTIONS AND RESTRICTIONS ON NHP DATA', which can be downloaded from http://www.state.nj.us/dep/parksandforests/natural/heritage/newcaution2008.pdf.

Thank you for consulting the Natural Heritage Program. The attached invoice details the payment due for processing this data request. Feel free to contact us again regarding any future data requests.

Sincerely,

Robert J. Cartica
Administrator

c: NHP File No. 12-4007462-1182

Table 1: On Site Data Request Search Results (7 Possible Reports)

Rare Plants/Ecological Communities Possibly On Site:	No
Rare Plants/Ecological Communities On Site/Immediate Vicinity:	No
Natural Heritage Priority Sites On Site:	No
Landscape 3.1 Species Based Patches On Site:	Yes
Landscape 3.1 Vernal Pool Habitat On Site:	No
Landscape 3.1 Stream/Mussel Habitat On Site:	No
Other Animals Tracked by ENSP On Site:	No

Rare Wildlife Species or Wildlife Habitat on the Project Site Based on Search of Landscape Project 3.1 Species Based Patches

Class	Common Name	Scientific Name	Feature Type	Rank	Federal Protection	State Protection	Grank	Srank
Aves								
	Black-crowned Night-heron	Nycticorax nycticorax	Foraging	3	NA	State Threatened	G5	S2B,S3N
	Cattle Egret	Bubulcus ibis	Foraging	3	NA	State Threatened	G5	S2B,S3N
	Glossy Ibis	Plegadis falcinellus	Foraging	2	NA	Special Concern	G5	S3B,S4N
	Least Tern	Sternula antillarum	Foraging	4	NA	State Endangered	G4	S1B,S1N
	Little Blue Heron	Egretta caerulea	Foraging	2	NA	Special Concern	G5	S3B,S3N
	Osprey	Pandion haliaetus	Foraging	3	NA	State Threatened	G5	S2B
	Peregrine Falcon	Falco peregrinus	Urban Nest	4	NA	State Endangered	G4	S1B,S3N
	Snowy Egret	Egretta thula	Foraging	2	NA	Special Concern	G5	S3B,S4N
	Tricolored Heron	Egretta tricolor	Foraging	2	NA	Special Concern	G5	S3B,S3N
	Yellow-crowned Night-heron	Nyctanassa violacea	Foraging	3	NA	State Threatened	G5	S2B,S2N
Insecta								
	Checkered White	Pontia protodice	Breeding/Courtship	3	NA	State Threatened	G4	S2
Osteichthyes								
	Shortnose Sturgeon	Acipenser brevirostrum	Migration Corridor - Adult Sighting	5	Federally Listed Endangered	State Endangered	G3	S1

Table 2: Vicinity Data Request Search Results (6 possible reports)

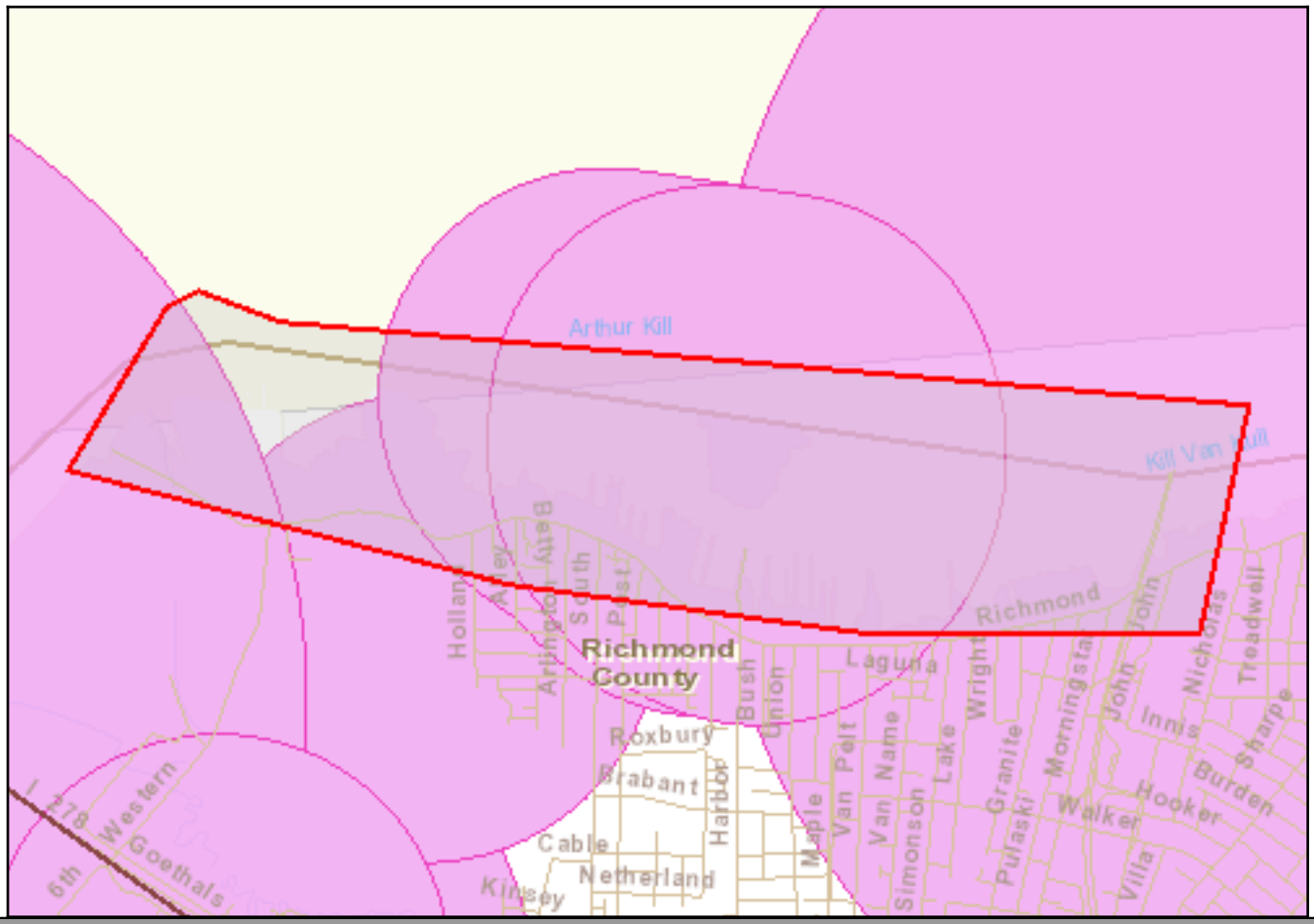
Rare Plants/Ecological Communities within the Vicinity:	No
Natural Heritage Priority Sites within the Vicinity:	No
Landscape 3.1 Species Based Patches within the Vicinity:	Yes
Landscape 3.1 Vernal Pool Habitat within the Vicinity:	No
Landscape 3.1 Stream/Mussel Habitat within the Vicnity:	No
Other Animals Tracked by ENSP within the Vicnity:	No

Rare Wildlife Species or Wildlife Habitat Within the Immediate Vicinity of the Project Site Based on Search of Landscape Project 3.1 Species Based Patches

Class	Common Name	Scientific Name	Feature Type	Rank	Federal Protection	State Protection	Grank	Srank
Aves								
	Black-crowned Night-heron	Nycticorax nycticorax	Foraging	3	NA	State Threatened	G5	S2B,S3N
	Cattle Egret	Bubulcus ibis	Foraging	3	NA	State Threatened	G5	S2B,S3N
	Glossy Ibis	Plegadis falcinellus	Foraging	2	NA	Special Concern	G5	S3B,S4N
	Least Tern	Sternula antillarum	Foraging	4	NA	State Endangered	G4	S1B,S1N
	Little Blue Heron	Egretta caerulea	Foraging	2	NA	Special Concern	G5	S3B,S3N
	Osprey	Pandion haliaetus	Foraging	3	NA	State Threatened	G5	S2B
	Peregrine Falcon	Falco peregrinus	Urban Nest	4	NA	State Endangered	G4	S1B,S3N
	Snowy Egret	Egretta thula	Foraging	2	NA	Special Concern	G5	S3B,S4N
	Tricolored Heron	Egretta tricolor	Foraging	2	NA	Special Concern	G5	S3B,S3N
	Upland Sandpiper	Bartramia longicauda	Breeding Sighting	4	NA	State Endangered	G5	S1B,S1N
	Yellow-crowned Night-heron	Nyctanassa violacea	Foraging	3	NA	State Threatened	G5	S2B,S2N
Insecta								
	Checkered White	Pontia protodice	Breeding/Courtship	3	NA	State Threatened	G4	S2
Osteicht								
	Shortnose Sturgeon	Acipenser brevirostrum	Migration Corridor - Adult Sighting	5	Federally Listed Endangered	State Endangered	G3	S1

New York Nature Explorer
User Defined Results Report

Criteria: Selected Map Area



Animal: Birds

Common Name	Subgroup	Distribution Status	Year Last Documented	Protection Status State	Protection Status Federal	Conservation Rank State	Conservation Rank Global
Barn Owl *Tyto alba*	Owls	Recently Confirmed	2002	Protected Bird		S1S2	G5
Cattle Egret *Bubulcus ibis*	Herons, Bitterns, Egrets, Ibises	Recently Confirmed	2004	Protected Bird		S2	G5
Glossy Ibis *Plegadis falcinellus*	Herons, Bitterns, Egrets, Ibises	Recently Confirmed	2007	Protected Bird		S2	G5
Great Egret *Ardea alba*	Herons, Bitterns, Egrets, Ibises	Recently Confirmed	2007	Protected Bird		S2	G5
Little Blue Heron *Egretta caerulea*	Herons, Bitterns, Egrets, Ibises	Recently Confirmed	2007	Protected Bird		S2	G5

Common Name	Subgroup	Distribution Status	Year Last Documented	Protection Status		Conservation Rank	
				State	Federal	State	Global
Snowy Egret *Egretta thula*	Herons, Bitterns, Egrets, Ibises	Recently Confirmed	2007	Protected Bird		S2S3	G5
Yellow-crowned Night-Heron *Nyctanassa violacea*	Herons, Bitterns, Egrets, Ibises	Recently Confirmed	2007	Protected Bird		S2	G5

Animal: Dragonflies and Damselflies

Mocha Emerald *Somatochlora linearis*	Dragonflies	Historically Confirmed	1926			S2S3	G5
Rambur's Forktail *Ischnura ramburii*	Damselflies	Historically Confirmed	1913			S2	G5

Animal: Animal Assemblages

Colonial Waterbird Nesting Area *Colonial Waterbird Nesting Area*	Animal Assemblages	Recently Confirmed	1998			S3	GNR
Gull Colony *Gull Colony*	Animal Assemblages	Recently Confirmed	1995			SNR	GNR

Plant: Flowering Plants

Angled Spikerush *Eleocharis quadrangulata*	Sedges	Recently Confirmed	1998	Endangered		S1	G4

Note: Restricted plants and animals may also have also been documented in one or more of the Towns or Cities in which your user-defined area is located, but are not listed in these results. This application does not provide information at the level of Town or City on state-listed animals and on other sensitive animals and plants. A list of the restricted animals and plants documented at the corresponding county level can be obtained via the County link(s) on the original User Defined Search Results page. Any individual plant or animal on this county's restricted list may or may not occur in this particular user-defined area.

This list only includes records of rare species and significant natural communities from the databases of the NY Natural Heritage Program. This list is not a definitive statement about the presence or absence of all plants and animals, including rare or state-listed species, or of all significant natural communities. For most areas, comprehensive field surveys have not been conducted, and this list should not be considered a substitute for on-site surveys.

Appendix B

Current and Future Land Use and Access to the Shoreline

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Figure B8 NBSA Future Land Use Characterization End of Document

Appendix B

Current and Future Land Use
and Access to the Shoreline

1. Current Land Use – Zoning and Access

All land with boundaries comprising the shoreline of the Newark Bay Study Area (NBSA) was evaluated for the potential for humans to contact sediments and surface water. Reconnaissance was carried out using a series of approaches to assess every tenth of a mile of the shoreline. First, area zoning maps from Kearny, Jersey City, Bayonne, New York City, Elizabeth, and Newark were studied to determine the current designated land use of all bounding properties (City of Bayonne 2001, City of Elizabeth 2012, City of Newark 2004, Jersey City 2001, Kearny Zoning 2009, New York City 2011a). Second, Google Earth (imagery date: June 17, 2010) was used to determine whether the shoreline and sediments could be easily accessed. For areas in which this determination was not clear from Google Earth imagery, on-site reconnaissance was conducted (Appendix C). Ground-truthing of the Google Earth images by taking additional photos and documenting the shoreline type will be conducted during sampling. These assessments and findings will be included in later documents.

Categories of shoreline accessibility were generally based first on whether the land was zoned industrial/manufacturing/commercial (associated with limited accessibility) or residential (greater potential for accessibility), then further classified by the type of access as follows (representative photographs of each category identified on the NBSA are presented as Figures B1 through B4):

- Industrial/Manufacturing/Commercial Zoning – No Access – An area of shoreline that is zoned for industrial, manufacturing or commercial purposes and has no readily available access to sediment or surface water by humans.

- Industrial/Manufacturing/Commercial Zoning – With Access – An area of shoreline that is zoned for industrial, manufacturing or commercial purposes that provides the potential for access to the sediment and/or surface water by humans.

- Residential Zoning – With Recreational Access – A residentially zoned area of shoreline that provides the possibility of recreational access to sediment and/or surface water by humans. The public could access NBSA sediment and surface water for activities such as wading, swimming, boating, canoeing, and fishing or crabbing.

- Residential Zoning – No Access – A residentially zoned area of shoreline that does not provide for the possibility for residential or recreational land use due to physical conditions/barriers such as steep rocky slopes.

- Residential Zoning – With Residential Access – A residentially zoned area of shoreline that provides the possibility for residential access to sediment, with residential access defined as exposure 350 days per year for 30 years.

Appendix B

Current and Future Land Use
and Access to the Shoreline

Additionally, segment lengths for each category were measured using Google Earth from an altitude of 200 meters.

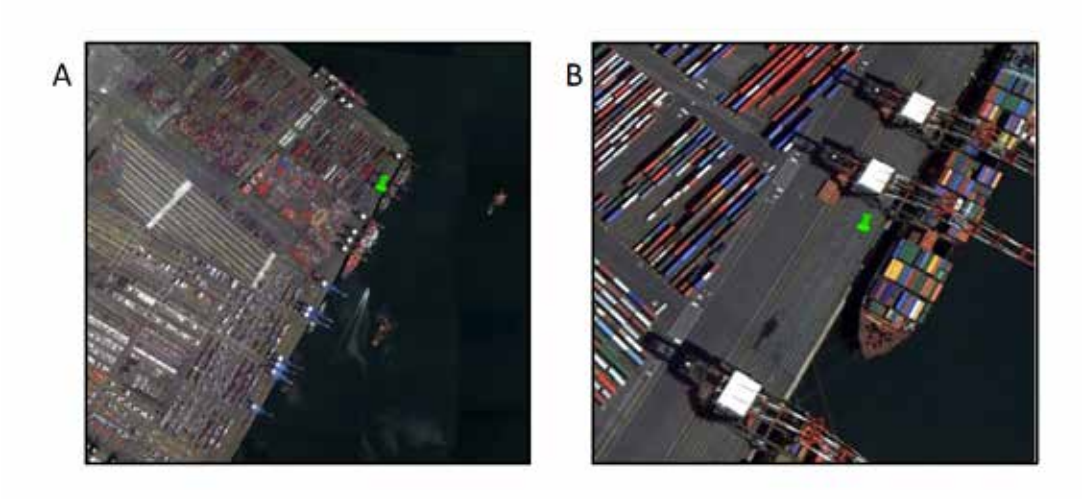


Figure B1 Industrial/Manufacturing/Commercial Zoning – No Access
Representative photos: A) Aerial view. B) Zoomed view.

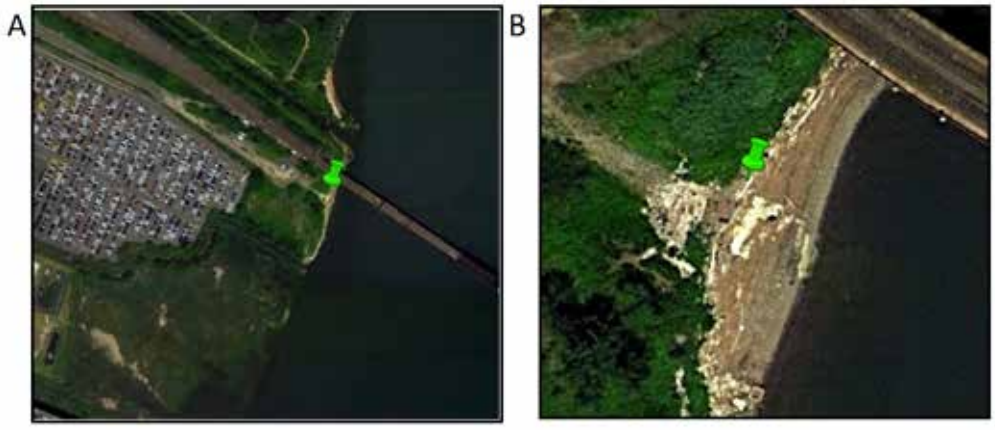


Figure B2 Industrial/Manufacturing/Commercial Zoning – With Access
Representative photos: A) Aerial view. B) Zoomed view.

Based on the findings from this series of evaluations, zoning (land use) and shoreline accessibility were characterized, summarized in Tables B1, B2a and B2b, and shown graphically in Figures B5 and B6. Table B2a contains a summary of the general exposure characterization categories for the Newark Bay shoreline, and Table B2b shows additional detail, including zoning designations. Further site reconnaissance will be

conducted to assess areas with potential human access and will be discussed in future documents. The majority of property around the NBSA was zoned as industrial (76%) – most of which (73%) was determined to have "no access." For the residentially-zoned property, 13% of the total perimeter of the NBSA was found to have access consistent with recreational exposures. Notably, no properties or shoreline land segments were identified that would be characteristic of a standard residential exposure scenario (e.g., exposure to sediments 350 days/year). Specifically, based on current information, there were no areas of residentially zoned land in which there was readily available access to the shoreline, nor was there evidence (e.g., picnic tables along the shoreline, walkways/stairs indicating use of the shoreline area) of a scenario in which residents were interacting with the shoreline in a manner equivalent to the residential exposure scenario. Most residentially zoned properties had significant land elevation differences inhibiting direct contact with NBSA surface water and sediment (Figure B3-D).

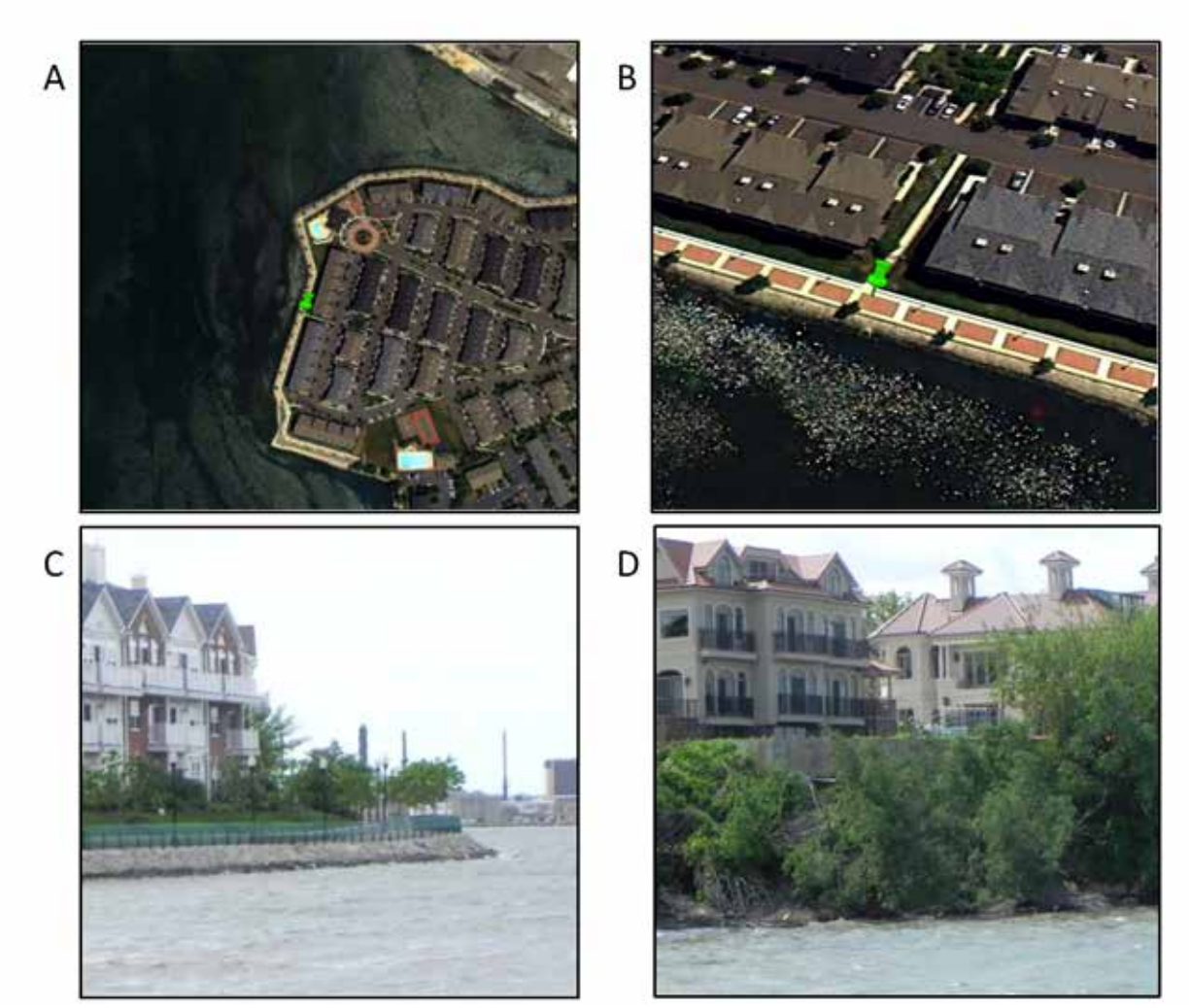


Figure B3 Residential Zoning – No Access
Representative photos: A) Aerial view. B) Zoomed view. C) 2012 photograph of walkway with no access. D) 2012 photograph of residential zoned property with steep slope and no access

Appendix B

Current and Future Land Use
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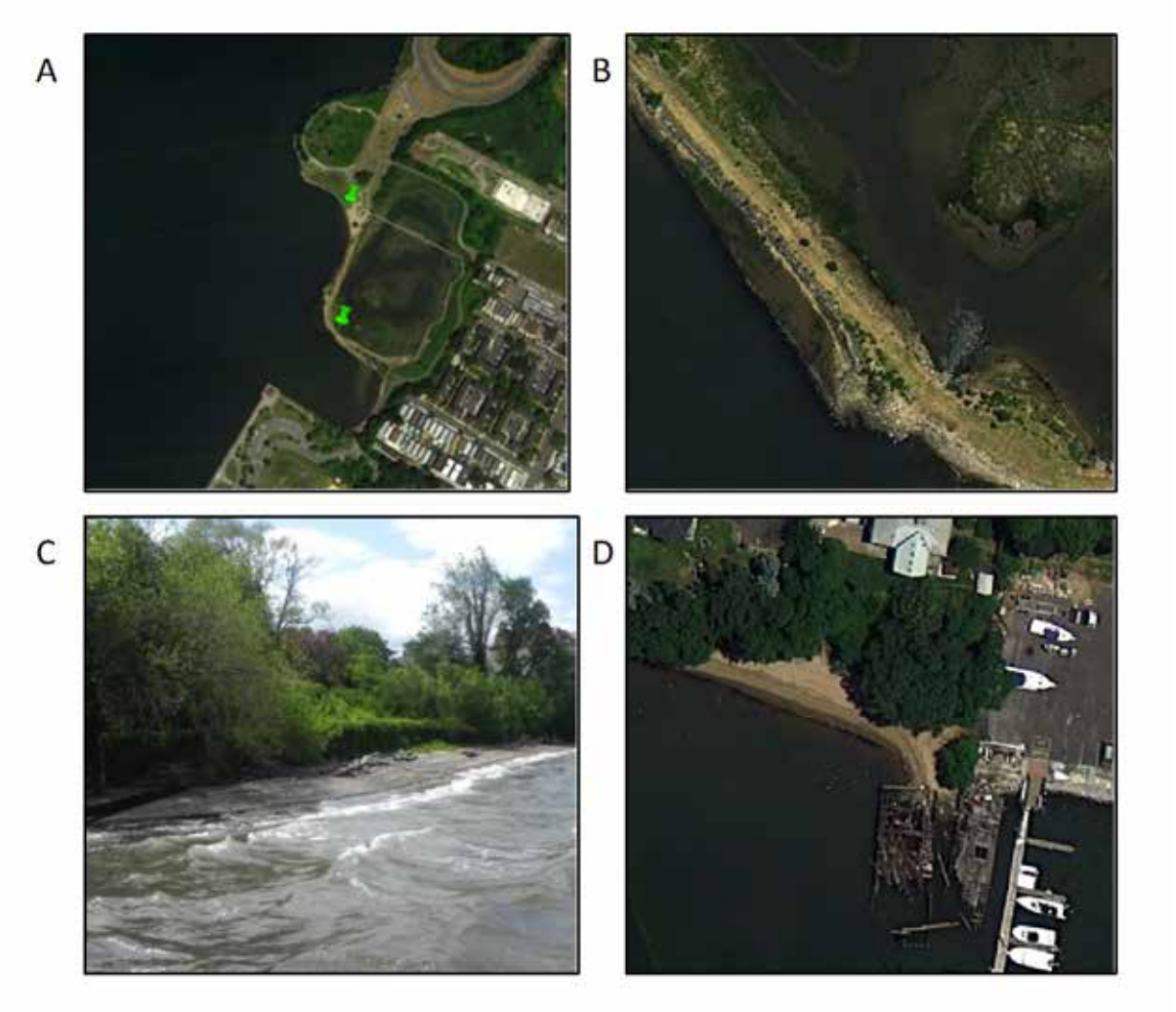


Figure B4 Residential Zoning – With Recreational Access
Representative photos: A) Aerial view. B) Zoomed view. C) Beach area. D) Boating docks.

Appendix B

Current and Future land Use
and Access to the Shoreline

Table B1 NBSA Shoreline Segment Information – Current Land Use

No.	Location	Description	Length (mile[s])	Zoning Category	Shoreline Access Characterization
1	Kearny, NJ	Kearny Point	0.4	Industrial	Industrial/Manufacturing/Commercial Zoning – With Access
2	Jersey City, NJ	Kellogg St	0.2	Redevelopment Area	Industrial/Manufacturing/Commercial Zoning – No Access
3	Jersey City, NJ	Droyers Point (1)	0.1	Redevelopment Area	Residential Zoning – With Recreational Access
4	Jersey City, NJ	Droyers Point (2)	0.9	Redevelopment Area	Residential Zoning – No Access
5	Jersey City, NJ	The Thomas M. Gerrity Athletic Complex	0.2	Residential	Residential Zoning – With Recreational Access
6	Jersey City, NJ; Bayonne, NJ	Route 440	0.9	Community Commercial	Residential Zoning – No Access
7	Bayonne, NJ	Route 440, south of railroad bridge	0.1	Community Commercial	Residential Zoning – With Recreational Access
8	Bayonne, NJ	Route 440 to Rutkowski Park	0.2	Community Commercial	Residential Zoning – No Access
9	Bayonne, NJ	Rutkowski Park	0.6	Residential	Residential Zoning – With Recreational Access
10	Bayonne, NJ	Bayonne Park	0.8	Residential	Residential Zoning – No Access
11	Bayonne, NJ	Park Drive to Benmore Terrace	0.1	Residential	Residential Zoning – With Recreational Access
12	Bayonne, NJ	Benmore Terrace to W 31st Street	0.4	Residential	Residential Zoning – No Access
13	Bayonne, NJ	W 31st Street to W 30th Street	0.1	Residential	Residential Zoning – With Recreational Access
14	Bayonne, NJ	Bayonne High School (North)	0.1	Residential	Residential Zoning – No Access
15	Bayonne, NJ	Bayonne High School to W 24th Street	0.4	Residential	Residential Zoning – With Recreational Access (rocky shoreline; elevation differences between land and water)
16	Bayonne, NJ	W 23rd Street	0.1	Residential	Residential Zoning – No Access
17	Bayonne, NJ	W 22nd Street	0.1	Residential	Residential Zoning – With Recreational Access
18	Bayonne, NJ	Between W 22nd and W 21st Streets	0.1	Residential	Residential Zoning – No Access

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Current and Future land Use
and Access to the Shoreline

No.	Location	Description	Length (mile[s])	Zoning Category	Shoreline Access Characterization
19	Bayonne, NJ	W 21st Street to Marina	0.8	Residential	Residential Zoning – With Recreational Access
20	Bayonne, NJ	Marina to W 8th Street	0.2	Residential	Residential Zoning – No Access
21	Bayonne, NJ	W 8th Street to Marina 2	0.2	Residential	Residential Zoning – With Recreational Access
22	Bayonne, NJ	South of Marina 2	0.1	Residential	Residential Zoning – No Access
23	Bayonne, NJ	Community commercial area	0.3	Community Commercial	Residential Zoning – With Recreational Access
24	Bayonne, NJ	Heavy Industrial area	0.4	Industrial	Industrial/Manufacturing/Commercial Zoning – No Access
25	Bayonne, NJ	Waterfront Development District	0.8	Waterfront Development District	Industrial/Manufacturing/Commercial Zoning – With Access
26	Staten Island, NY	Staten Island (small section by bridge)	0.1	Manufacturing	Industrial/Manufacturing/Commercial Zoning – With Access
27	Staten Island, NY	Staten Island East	3.2	Manufacturing	Industrial/Manufacturing/Commercial Zoning – No Access
28	Staten Island, NY	Staten Island West	1.6	Manufacturing	Industrial/Manufacturing/Commercial Zoning – With Access
29	Staten Island, NY	Shooters Island	0.8	Manufacturing	Industrial/Manufacturing/Commercial Zoning – With Access
30	Elizabeth, NJ	MRC	0.4	Manufacturing, Research, Commercial	Residential Zoning – With Recreational Access
31	Elizabeth, NJ	MRC 2	1.0	Manufacturing, Research, Commercial	Industrial/Manufacturing Commercial Zoning – No Access
32	Elizabeth, NJ	Kapkowski	1.1	Kapkowski Road Redevelopment Area	Industrial/Manufacturing Commercial Zoning – With Access
33	Newark, NJ	Port Newark	8.4	Industrial	Industrial/Manufacturing Commercial Zoning – No Access
34	Newark, NJ	Area near highway and railroad bridges	0.9	Industrial	Industrial/Manufacturing Commercial Zoning – With Access
35	Newark, NJ	North of railroad bridge	0.4	Industrial	Industrial/Manufacturing Commercial Zoning – No Access

Appendix B

Current and Future land Use
and Access to the Shoreline

No.	Location	Description	Length (mile[s])	Zoning Category	Shoreline Access Characterization
36	Newark, NJ	North of Hess Plant	0.2	Industrial	Industrial/Manufacturing Commercial Zoning – With Access
37	Newark, NJ	Final NW Segment	0.6	Industrial	Industrial/Manufacturing Commercial Zoning – No Access

Notes:
MRC = Manufacturing, Research, Commercial
NW = northwest
W = west

Appendix B

Current and Future Land Use
and Access to the Shoreline

Table B2a NBSA Summary of Exposure Characterizations – Current Land Use

Characterization	Total Length (miles)	Percentage of Total Perimeter (%)
Industrial/Manufacturing/Commercial Zoning – No Access	15.1	55.3
Industrial/Manufacturing/Commercial Zoning – With Access	5.6	20.5
Residential Zoning – No Access	2.9	10.6
Residential Zoning – With Recreational Access	3.7	13.6
Residential Zoning – With Residential Access	0	0
All Characterizations	27.3	100

Table B2b Detailed Exposure Characterizations Using Actual Zoning Categories Utilized by Municipalities – Current Land Use

Zoning Category as Listed by Municipalities	Total Length (miles)	Percentage of Total Perimeter (%)
Industrial/Manufacturing Zoning – No Access	13.0	47.6
Industrial/Manufacturing/ Zoning – With Access	4.8	17.6
Bayfront I Redevelopment Area – No Access*	0.2	0.7
Droyers Point Redevelopment Area – No Access*	0.9	3.3
Droyers Point Redevelopment Area – With Recreational Access*	0.1	0.4
Kapkowski Road Redevelopment Area – With Access*	1.1	4.0
Residential Zoning – No Access*	1.8	6.6
Residential Zoning – With Recreational Access*	2.5	9.2
Residential Zoning – With Residential Access*	0	0
Commercial Zoning – No Access*	1.1	4.0
Commercial Zoning – With Access*	0.4	1.5
Industrial/Manufacturing Zoning – No Access	13.0	47.6
All characterizations	27.3	100

*Non-industrial area

Appendix B

Current and Future Land Use
and Access to the Shoreline

2. Current Land Use – Marinas and Boat Ramps

Using Google Earth (imagery date: June 17, 2010)) of the shoreline and internet searches, marinas and boat ramps in the NBSA were identified (Figure B7). Boat/kayak rental businesses were also researched, but none were specifically identified along the perimeter of the NBSA. Marina, boat ramp and boat rental locations will be further researched during the site reconnaissance to be conducted during sampling.

3. Future Land Use

There are four areas (see Table B3 below and Figure B8) along the perimeter of the NBSA that have the potential to undergo future residential development. These areas were identified by regional zoning maps and further investigated by reviewing development plans from the respective cities or counties surrounding the NBSA to determine any potential differences between current and future land use with respect to potential exposures to sediments.

Table B3 NBSA Areas Slated for Alternative Future Development (Including Residential)

Zone	Length (mile[s])	Current Shoreline Access Characterization	Potential Future Use (and Shoreline Access Characterization)
Bayfront I Redevelopment Zone	0.2	Industrial/Manufacturing – No Access	Mixed-use residential, retail, parks or recreation, and commercial area (non-industrial area with no access)
Waterfront Development District	0.8	Industrial/Manufacturing – With Access	Mixed-use residential, parks, and commercial area (non-industrial area with recreational access)
Kapkowski Road Redevelopment Area	1.0	Industrial/Manufacturing – With Access	Mixed-use residential and commercial area (non-industrial area with recreational access)
Staten Island – North Shore	NA	Industrial/Manufacturing – With Access	Mixed-use recreational and commercial (non-industrial area with recreational access)

NA = not available

The Bayfront I Redevelopment Plan involves redeveloping the industrial area to a mixed-use community that will provide “access to an enhanced waterfront to the benefit of the entire Jersey City community.” (Jersey City 2008). Specifically, this area will include (when completed) new housing, retail, office space, parkland, and other amenities. Planning recommendations include a waterfront walkway:

> “the riverfront walkway will be continued from the Droyers Point project along the Hackensack Riverfront to the adjacent property to the north.” (Jersey City 2008).

This plan would change the shoreline access characterization (above section) for the affected 0.2-mile stretch from an industrial area with no access to a non-industrial area with no access, given that the walkway will be continued (and the walkway is constructed so that it borders the shoreline but does not allow access). This change in categorization would not impact how exposure is assessed in the human health risk assessment (i.e., current and future plans involve recreational exposures).

The Waterfront Development District (also referred to as the Texaco Site) is currently zoned for a mix of residential and commercial uses, including one- and two-family dwellings, multi-family housing, retail, offices, restaurants, theaters, commercial recreation, and marinas. It is anticipated that the site will accommodate a mixed-use development with a significant portion earmarked for residential use. Notably, the area is currently being remediated due to contamination, though the plan states that it has the potential to be cleaned to residential site standards. According to the redevelopment plan (City of Bayonne 2000):

> "a remediation plan is being prepared for the remaining contaminated area adjacent to the Bayonne Bridge. The initial evaluation indicates that this small portion of the site may be unsuitable for residential use. This is a condition that should be factored into overall site development."

The plan also states that the District should incorporate a waterfront walkway and that this walkway should conform to New Jersey Department of Environmental Protection (NJDEP) standards and has an inviting public access environment. There is also discussion regarding the existing pier as part of the recreational landscape, with the text stating that "the existing pier may be suitable for recreational use and/or a limited commercial use such as a restaurant." This area is currently considered an industrial/manufacturing location where recreational access is possible, so the future plans would not change how exposure is characterized (i.e., recreational access under current and future scenarios).

The Kapkowski Road Redevelopment Area will be another mixed-use area, although limited information was available from the City of Elizabeth (Construction Journal 2012; Schoor DePalma, Inc. 2005) to specifically characterize future plans. The current shoreline access characterization of this 1-mile zone allows for possible recreational access. This area is currently considered an industrial/manufacturing location where recreational access is possible, so the future plans would not change how exposure is characterized (i.e., recreational access under current and future scenarios).

The North Shore of Staten Island is not currently zoned for redevelopment, but a task force, North Shore 2030, has been initiated as part of a comprehensive planning effort looking at Staten Island's future (New York City 2011b). Literature from the task force indicates that small sections of the shore could become park or mixed-use areas, while others will remain waterfront-manufacturing locations. This change would have minimal impact on the current shoreline characterization of the NBSA as a whole. The North Shore of Staten Island consists of two areas of land, totaling 0.4 mile, which are described in the North Shore 2030 plan as

"New waterfront open space public access," but are currently characterized as industrial/manufacturing – no access. Depending on the final outcome of the redevelopment, this 0.4 mile could become areas with recreational access to the NBSA. With the exception of a 0.4-mile stretch on the North Shore of Staten Island, none of the redevelopment plans indicate that future exposures to sediments and water will be different than current exposures.

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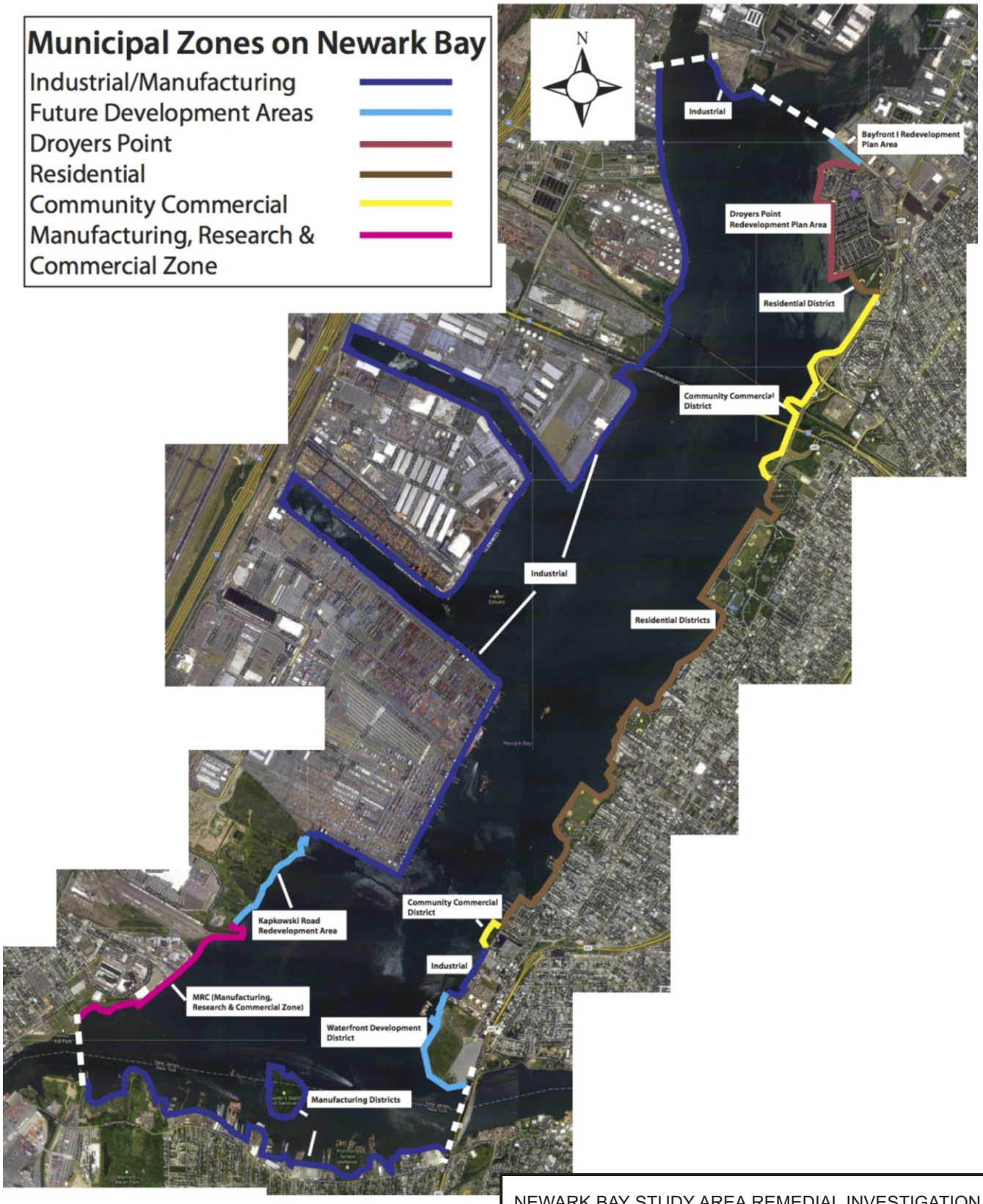
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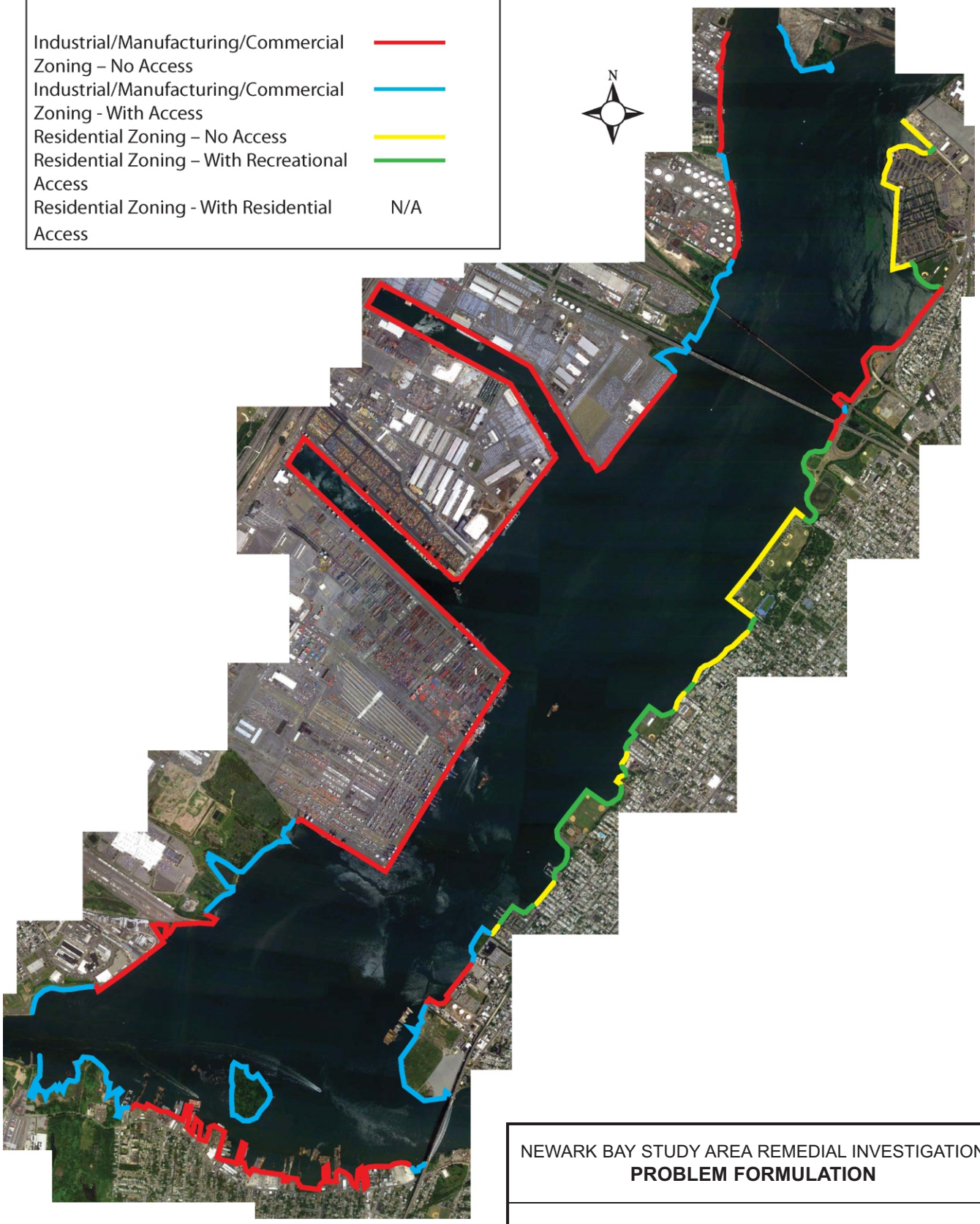
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

NBSA ZONING PERIMETER MAP

JUNE 2013

FIGURE
B5

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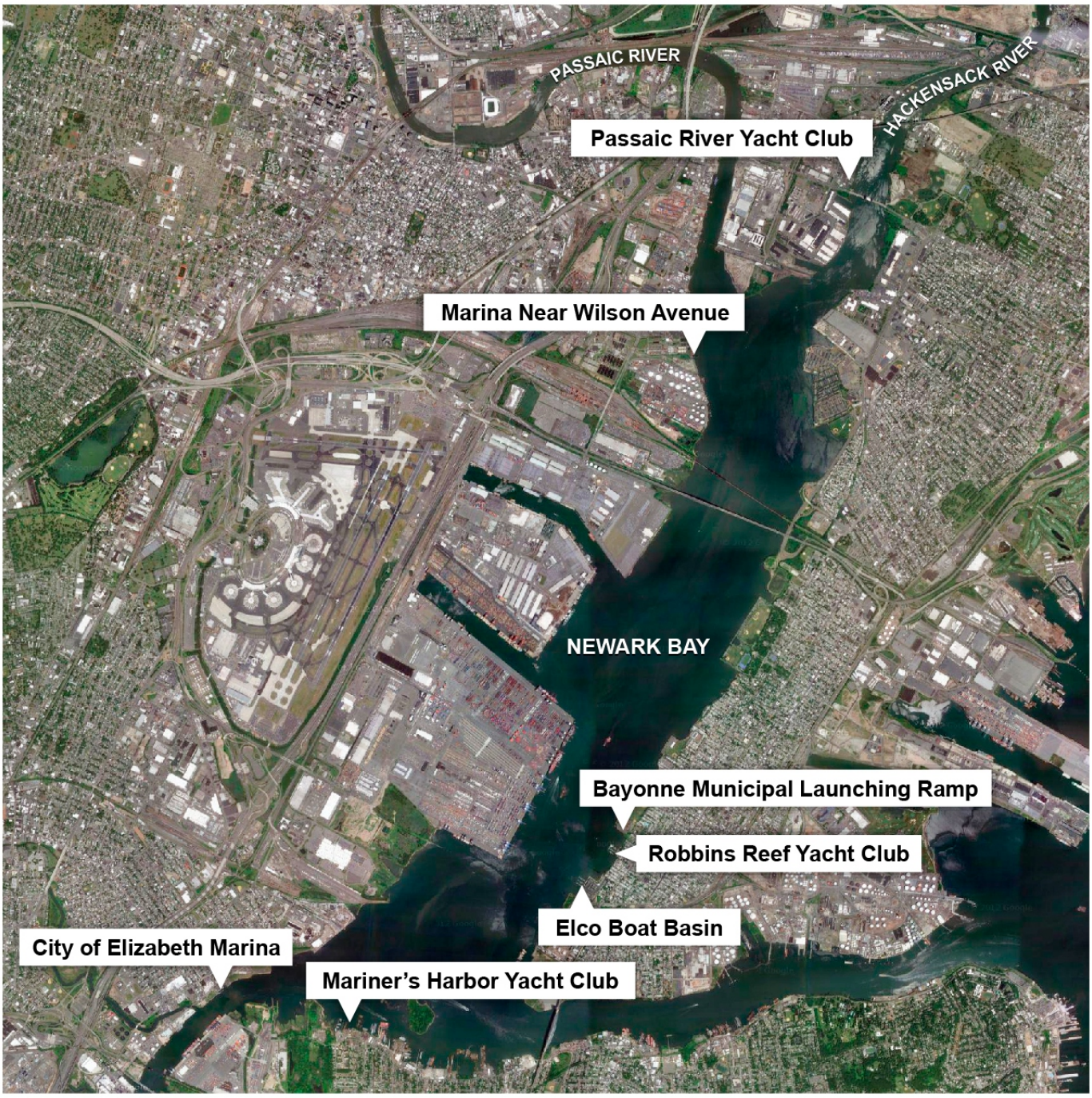
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

NBSA SHORELINE ACCESS CHARACTERIZATION

JUNE 2013

FIGURE
B6

04/26/2013 SYRACUSE, NY-ENV/CAD DJHOWES
B0009989/0023/00003/CDR/09989G09.CDRM



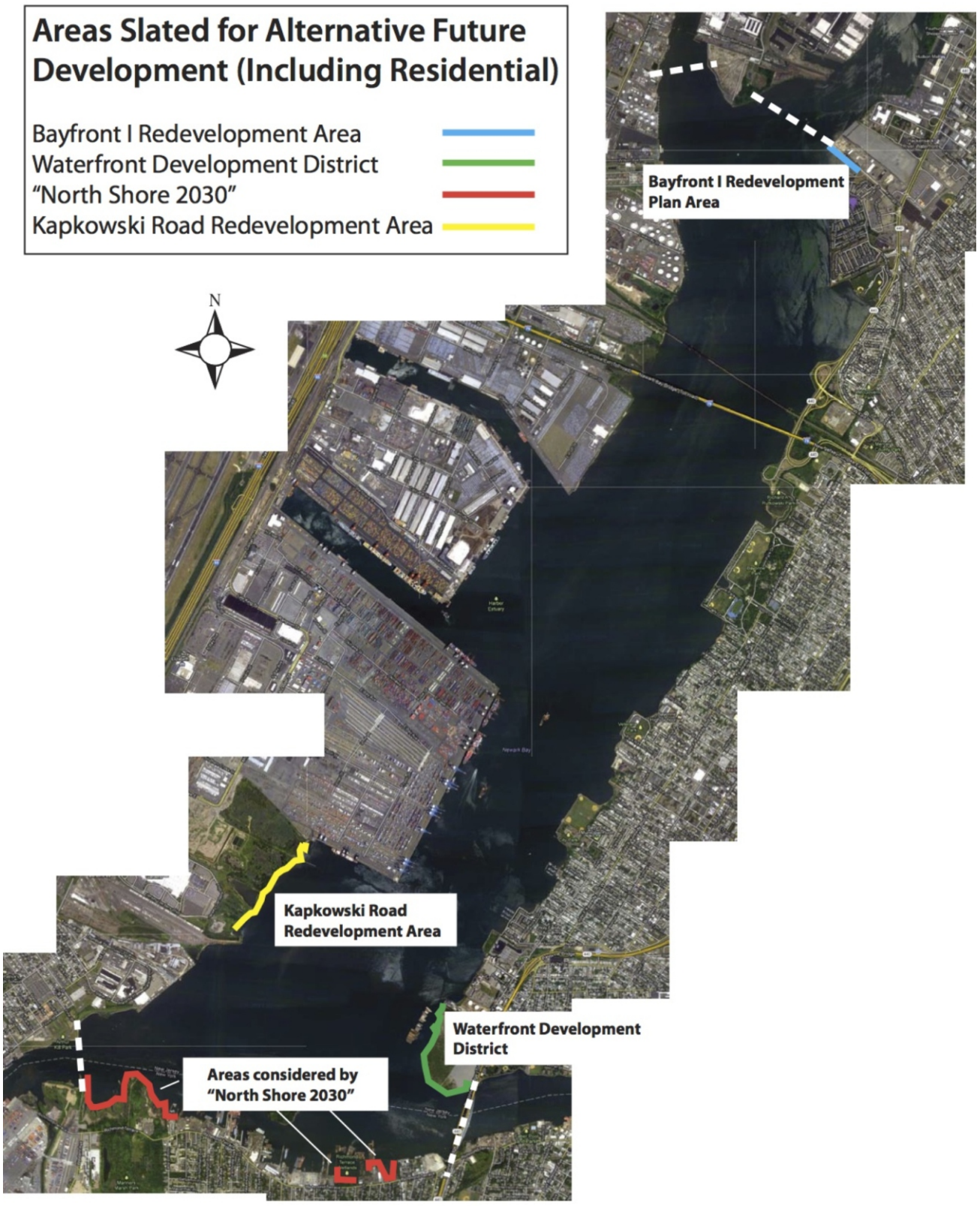
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

MARINAS AND BOAT RAMPS

JUNE 2013

FIGURE
B7

04/10/2013 SYRACUSE, NY-ENV/CAD DJHOWES
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Note:
Only showing potential changes from current use.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
PROBLEM FORMULATION

NBSA FUTURE LAND USE CHARACTERIZATION

JUNE 2013

FIGURE
B8

04/10/2013 SYRACUSE, NY-ENV/CAD DJHOWES
B0009989/0023/00003/CDR/09989G10.CDRM

Appendix C

The Intelligence Group (TIG)
Reconnaissance Survey

Table C1 The Intelligence Group (TIG) Reconnaissance Field Notes

City	General Area	Specific Area	Reason Follow Up Requested	Notes During Reconnaissance	Characterization of Shoreline Access
Jersey City	Droyers Point	Open field area	Need to see if there is access to the sediment in the open field area	Easy access to water by walking across open field; water level appears to be 10 feet or less from ground	Recreational Access
Bayonne	Park Drive	Southeast end of park, where Hackensack Riverwalk ends	Appears to have stairs, but it is unclear if this is the case or where potential stairs lead	Small shoreline area, appears to be inaccessible to public; terrain at end of W37th Street, Wesley Court, Benmore Terrace, etc. from street level down to water very steep, brush covered, rocky; would be very difficult & dangerous for public to navigate; no steps observed from street level down to water; barrier walls seen in backyards of some homes	Recreational Access
Bayonne	W 37th Street	End of Street	Determine if there is access from the house on the end of W 37th	Road dead-ends; no observed pathways down to water; based on vantage point, terrain at end of W37th Street from street level down to water very steep, brush covered, rocky; would be very difficult and dangerous for public to navigate	Recreational Access
Bayonne	Benmore Terrace	End of Street	Determine if there is access from the house on the end of Benmore Terrace	It does not appear as if there is access from the house down to the water; based on observations from Hackensack River Walkway, terrain from house to water would be an extremely steep drop down to water level	No Access
Bayonne	Lincoln Parkway	End of Street	Determine if there is access to the bay off to the left	Locked fence with steep road down to what is believed to be Bayonne Sewage Pumping Station; fence continues along side of residence	No Access
Bayonne	W 24th Street	End of Street	Characterize access from the community of trailers	Mobile home park with Bayfront parking lot for residents' vehicles; certain vehicles appear to be filled to window-level with belongings and/or garbage; easy shoreline access to water via parking lot; some mobile homes are waterfront and have fences	Recreational Access (will be assessed with additional reconnaissance)
Bayonne	W 8th Street	End of Street	Determine if there is access from the house on the end of W 8th St (see photo)	Road dead-ends; no observed pathways down to water; terrain at end of W8th Street from street level down to water very steep, brush covered, rocky; would be very difficult and dangerous for public to navigate	No Access









Jersey City – Droyers Point



Bayonne – Park Drive

Bayonne W 37th Strreet



Bayonne – Benmore Terrace



Bayonne – Lincoln Parkway









Bayonne – West 24th





Bayonne West 8th

Appendix D

Land Use Research Log

Table D1 – Land Use Research Log

Person/Entity Contacted	Contact Info Used	Date of Contact	Response Received?	Date Response Received	Nature of Questions	Summary of Information Provided by Person
NJ State Police, Newark Bay Marine Services Bureau at Port Newark	973-578-8173	4/30/2012	No	--	Commercial diving, recreational activities/boating, hunting	--
NJ State Police, Maritime Questions	lppmsb@gw.njsp.org & roic@gw.njsp.org	5/2/2012	Yes	5/13/2012	Commercial diving, recreational activities/boating, hunting, shooting	Contact NJSP Newark Bay Station personnel (973-578-8189).
Port Authority, NY/NJ	panynj.gov/feedback/ (submitted questions online)	3/30/12 & 4/30/12	Yes	5/18/2012 (from Kathy Kovach, kkovach@panynj.gov)	Commercial diving, recreational activities/boating	The Port Authority regularly inspects its underwater infrastructure. Diving work is subject to OSHA Commercial Diving requirements. Port Authority does not serve as a harbormaster; rather, the U.S Coast Guard is responsible for enforcement of waterway regulations & activities, as well as possibly municipal, county & state agencies having similar jurisdiction. Information on recreational activity can be requested from local jurisdictions.
Port Authority, NY/NJ	212-435-3008	4/2/2012	No	--	Commercial diving, recreational activities/boating	--
US Coast Guard (response from Jeff Yunker)	LNM@d1.uscg.mil	4/2/12 & 4/30/12	Yes	5/3/2012	Commercial diving	Questions regarding bridge work in Newark Bay may be addressed to Joe Arca at 212-668-7069 or Joe.M.Arca@uscg.mil. OSHA diving regulations are published in Title 29 CFR Part 1910 Subpart T and are available at ecfr.gpoaccess.gov.
US Coast Guard (response from Jeff Yunker)	LNM@d1.uscg.mil	4/2/12 & 4/30/12	Yes	5/3/2012	Recreational activities/boating	Recreational boating information is available at New Jersey State Boating Law Administration, Newark Bay, state.nj.us/njsp/maritime/msb-location.html or 973-578-8173. The Marine Trades Association of NJ publishes a Boater's Directory and Boat Ramp Guide. They are available online or to order at mtanj.org in the "Boater Information" section or 732-292-1051.
Randive	randive.com/contact-us.php; divingservices@randive.com	4/30/2012 & 5/1/12	Yes	5/1/2012	Commercial diving	All commercial diving operations are covered by OSHA, USCG and ADC International. We engage in every aspect of commercial diving, including general maintenance and repair work on either a scheduled or emergent basis.
Dryden Diving Company	drydiv@hotmail.com	5/1/2012	Yes	5/1/2012	Commercial diving	Our divers are subject to commercial diving regulations as established in the OSHA regulations. Many divers in the New York area work 200 or more days per year for 6 or more hours per day. There is no limit on the consecutive days worked for a diver.
John Christenson of Pile Test Inc; also listed for Coastal U/W Service M&J Marine	732-899-3034	4/30/2012	Yes	4/30/2012	Commercial diving	Company has commercial diving year-round; does work in Newark Bay. Time spent diving varies greatly with project; no limit on days in a row divers can work. Follow OSHA commercial diving reguations. Work 8-10 hour days. Perform contamination work, piles, on-going work in Bay for Honeywell.
Leah Graziano, ATSDR, NYC	escobar.leah@epa.gov	4/30/2012	No	--	Commercial diving, recreational activities/boating	--
NJDOT	maritime@dot.state.nj.us	5/2/2012	No	--	Commercial diving, recreational activities/boating	--
Manhattan Kayak Company	info@manhattankayak.com	3/30/2012	Yes	4/1/2012	Recreational activities/boating	We do not offer kayak trips on Newark Bay, and we don't have any specific information re: outfitters offering services for that body of water.

Table D1 – Land Use Research Log

Person/Entity Contacted	Contact Info Used	Date of Contact	Response Received?	Date Response Received	Nature of Questions	Summary of Information Provided by Person
Passsaic River Boat Club	passaicriverboatclub.info/PRBC/Joomla/index.php?option=com_contact&view=contact&id=2&Itemid=9 (online request)	5/2/2012	No	--	Recreational activities/boating	--
Bill Sheehan, Hackensack Riverkeekper	info@hackensackriverkeeper.org	5/2/2012	No	--	Recreational activities/boating	--
Essex County Dept of Parks, Rec & Cultural Affaris	joedi@admin.essexcountynj.org	4/2/2012	No	--	Recreational activities/boating	--
Hudson County Div of Parks, Director	bruttler@hcnj.us	4/2/2012	No	--	Recreational activities/boating	--
Union County Parks	nyc.gov/html/mail/html/maildpr.html (online request; response from parksinfo@ucnj.org)	4/2/2012	Yes	4/2/2012	Recreational activities/boating	Passed along contact information for City of Elizabeth's Recreation Department & Union County Police Marine Unit.
New York Commissioner, Dept of Parks & Recreation	nyc.gov/html/mail/html/maildpr.html (online request)	4/2/2012	No	--	Recreational activities/boating	--
City of Elizabeth Parks & Recreation	908-820-4226	4/3/2012	Yes	4/3/2012	Recreational activities/boating	Ashley believes there are no Bay recreational exposures. She has lived in the area 20 years and has never seen anyone go into Bay water; hasn't observed any recreational activities on the Bay.
Union County Department of Emegency Management	908-654-9800	4/3/2012	Yes	4/3/2012	Recreational activities/boating	Kelly believes there are no recreational activities on Newark Bay; has never seen anyone boating, canoeing, etc. in the Bay.
Lynette Lurig, NJDEP	609-633-1314	4/30/2012	Yes (response to later email)	4/30/2012	Recreational activities/boating	Tied up until late week of 5/7/12; will be available to talk then.
Lynette Lurig, NJDEP	Lynette.Lurig@dep.state.nj.us	5/1/2012	Yes	5/1/2012	Recreational activities/boating	Tied up until late week of 5/7/12; will be available to talk then.
Lynette Lurig, NJDEP	609-633-1314	5/18/2012	Yes	5/18/2012	Recreational activities/boating	New park in Newark to open soon; Passaic now has more access points for fishing than did previously. Recreational activity on Bay has increased in the past 6-7 years. Most recreational water activity is on nearby waterbodies, but has also observed it in the Bay. Has observed sailboating; a livery is present on the Bay. Has seen canoes, kayaks & boat ramps in Meadowlands, Woodbridge. Boats go through Arthur Kill to Bay; has observed people putting in kayaks in Elizabeth, above Secaucus behind Meadlowlands. New facilties and jet ski companies in the area; some in the Bay, some closer to the coast. Re: marinas/boat rental facilities on Bay - Robbins Reef Yachtclub in Bayonne; Hackensack Riverkeeper has livery which rents canoes/kayaks. Marinas in Arthur Kill, Perth Amboy. Has observed people bird watching. The Bay is somewhat dangerous for small boats, as large container ships are often present. Condos/townhouses in Bayonne which have moorings. Sailboats are docked in Newark Bay (may go out to ocean).
Debbie Mans (NY/NJ Baykeeper)	debbie@nynjbaykeeper.org	5/1/2012	Yes	5/1/2012	Recreational activities/boating	Passed along websites for Hackensack Riverkeeper, Passaic River Boat Club, & Passaic River Yacht Club.

Table D1 – Land Use Research Log

Person/Entity Contacted	Contact Info Used	Date of Contact	Response Received?	Date Response Received	Nature of Questions	Summary of Information Provided by Person
Tim Ianuzzi & Melissa Beauchmin, ARCADIS	Tim.Iannuzzi@arcadis-us.com, Melissa.Beauchemin@arcadis-us.com	4/30/2012	Yes, from Melissa	4/30/2012	Types of birds that may be hunted in/around Newark Bay, contacts for boating companies, contacts for harbor staff (e.g., for opening bridges)	Provided names of Miller's Launch Marina & Elco Boat Basin; attached draft document from site reconnaissance.
Luxergy (Jet Skiing)	luxergy.com	3/30/2012	No	--	Some info found on website	Website says Luxergy no longer offers jet skiing in Bayonne, Elizabeth, Newark, or Passaic.
Luxergy (Jet Skiing)	888-589-3749	4/30/2012	No	--	Asked why no longer offer jet skiing in the 4 cites listed above	--
Sven VanBatavia, Miller's Launch	sven@millerslaunch.com	4/30/2012	No	--	Recreational activities/boating, contact information for Harbormaster	--
Chief Mark Chicketano, NJ Div of Fish & Wildlife, Bureau of Law Enforcement, Trenton	Mark.Chicketano@dep.state.nj.us	1/20/12 (Response forwarded by E Naranjo)	Yes	1/20/12 (Response forwarded by E Naranjo)	Is hunting legal in Newark Bay?	It is entirely legal to hunt in Newark Bay. All hunting regulations which are applicable elsewhere would of course apply. There is no generalized prohibition against it; it is inherently legal.
Chief Mark Chicketano, NJ Div of Fish & Wildlife, Bureau of Law Enforcement, Trenton	Mark.Chicketano@dep.state.nj.us	4/3/2012	Yes	4/4/2012	Likelihood of fowl and amphibian consumption by people in the vicinity of Newark Bay.	After 28 yrs in law enforcement, I have NEVER heard of anyone hunting waterfowl or collecting amphibians in Newark Bay. There is however, a fairly large group of hunters who hunt waterfowl in the Hackensack River, mostly on the Sawmill Creek Wildlife Management Area located in Lyndhurst, Carlstadt, and Secaucus and a very limited number of waterfowl hunters in the lower Passaic River. I've not heard of anyone in this area (the Hackensack or Passaic Rivers) collecting amphibians.
Reyhan Mehran & Jay Field, NOAA	reyhan.mehran@noaa.gov, jay.field@noaa.gov	4/10/2012	Yes (From R Mehran)	4/12/2012	Commercial diving	In addition to the USCG and the PA, reach out to ATSTDR in NYC (Leah Graziano). For commercial divers, try contacting Dryden Diver Co, K B Commercial Diving, North Atlantic Commerical Diving, and M&J Marine & see if they have any work going on now or know of anything planned. Also see if Marion Olsen at EPA, Anne Hayton at NJDEP, or Tim Kubiak at USFWS have other suggestions (if you haven't checked with them already; I have copied them on this email).
Reyhan Mehran & Jay Field, NOAA	reyhan.mehran@noaa.gov, jay.field@noaa.gov	4/10/2012	Yes (From R Mehran)	4/12/2012	Recreational activities/boating	For recreational activities, contact the NY/NJ Baykeeper (Debbie Mans) & the various boat clubs.
Anne Hayton, NJDEP	Anne.Hayton@dep.state.nj.us	4/12/2012	Yes (Reyhan forwarded Anne my original email)	4/12/2012	Commercial diving	For commercial divers or construction workers, seek information from both private & government agencies which fund marine-related maintenance work, e.g., Port Authority of NY/NJ, dredging companies, USACE (Bryce Wisemiller), NJDOT, & NJ State Police. Eugenia Naranjo (USEPA) may be able to provide contact names/numbers, email addresses for other Bay Agency Coordination participants.
Anne Hayton, NJDEP	Anne.Hayton@dep.state.nj.us	4/12/2012	Yes (Reyhan forwarded Anne my original email)	4/12/2012	Recreational activities/boating	For recreational activities, please contact Lynette Lurig, NJDEP & the NJ State Police.

Table D1 – Land Use Research Log

Person/Entity Contacted	Contact Info Used	Date of Contact	Response Received?	Date Response Received	Nature of Questions	Summary of Information Provided by Person
Bryce Wisemiller, USACE	bryce.w.wisemiller@usace.army.mil	4/10/2012	Yes	4/10/2012	Commercial diving	Would be difficult to estimate any time spent by divers related to our HDP construction. The Corps generally does not allow for any diving in our contracts unless an unexpected occurrence in a contract happens. Contact one of the commercial diving companies that work for the various dredging or marine construction companies (e.g., Randdive) to obtain actual exposure information.
Bryce Wisemiller, USACE	bryce.w.wisemiller@usace.army.mil	4/10/2012	Yes	4/10/2012	Recreational activities/boating	The only information I would have on recreational usage in the Newark Bay would be anecdotal based on my own personal experience in the Bay. The most prevalent recreational usage of the Newark Bay I'm aware of, by far, is recreational fishing, particularly at publically accessible locations such as the Elizabeth Marina. While I would hope that these fishermen do not consume the fish they catch (as the signs everywhere advocate), I know from speaking to several of them over the years, that many do indeed consume the fish that are caught from the Bay.
US Coast Guard	Joe.M.Arca@uscg.mil	5/7/2012	Yes	5/8/2012	Commercial diving, construction	We do not keep a list of divers that work in our area. However, David J. Sheridan, Sr. does a lot work in the area and can probably assist (908-685-0456, southtrader@mindspring.com).
Marine Trades Association of New Jersey	info@mtanj.org	5/7/2012	Yes	5/7/2012	Recreational activities/boating	Forwarded inquiry to staff at NJOT, Coast Guard & Ray Fusco (consultant). Ray Fusco said he could provide information.
Ray Fusco	m: 410-299-1917, o: 845-509-5999	5/7/2012	Yes	5/7/2012	Recreational activities/boating	Mr. Fusco has projects on Port of NY/NJ; has NJDOT Harbor Safety Grant. Some recrational boating on Bay, since is an industrial area with shipping traffic, it seems boating in Bay is mainly to get to other recreational areas (e.g., Hackensack, Passaic, Arthur Kill, Kill Van Kull). Fishing is common. Robbins Reef Marina (in Bayonne) is only marina he's seen on the Bay. Recommended search list of NJ marine boat launches to see proximity; perhaps boat launch in Laurel Hill or Lincoln Park. He doesn't know of any canoe/kayak rentals in the Bay.
7 boating companies/marinas listed on the Marine Trades Association of New Jersey's website	debbie@grassysoundmarina.com, deeluvmm@aol.com, marina@irwinmarinenj.com, lakeviewdocks@comcast.net, info@pier47.com, SShoreMrna@aol.com, emccann@vikingyachts.com	5/7/2012	Yes; from Irwin Marine	5/7/2012	Recreational activities/boating	Recommended contacting the Marine Trades Office directly.
List of New Jersey Marinas	jerseymarinas.com/ramp.htm	6/6/2012	Located marina list on website	6/6/2012	Located marina list on website	One boatramp listed in Newark Bay: Bayonne Municipal Launching Ramp, West Shore Drive & West 16th Street, Bayonne, NJ, 201-858-612.

Table D1 – Land Use Research Log

Person/Entity Contacted	Contact Info Used	Date of Contact	Response Received?	Date Response Received	Nature of Questions	Summary of Information Provided by Person
National Park Service (NPS)	Jill_Hawk@nps.gov, David@patersongreatfalls.org	3/27/2013	Yes; from Darren Boch, Superintendent Paterson Great Falls NHP	3/28/2013	Recreational activities/boating; new canoe/kayak trail along Passaic thru Newark Bay	Recommended contacting Ella Fillipone at the Passaic River Coalition (www.passaicriver.org) and Jerry Willis with Rivers Trails Conservation Assoc. (jerry_willis@nps.gov, 908-461-7596)
Ella Fillipone, Passaic River Coalition	prcwater@aol.com	3/28/13 & 4/3/13	No	--	Recreational activities/boating; new canoe/kayak trail along Passaic thru Newark Bay	--
Jerry Willis with Rivers Trails Conservation Assoc. (NPS)	jerry_willis@nps.gov; 908-461-7596	3/28/13, 4/3/13; 4/4/13	Yes	4/5/2013	Recreational activities/boating; new canoe/kayak trail along Passaic thru Newark Bay	Mr. Willis is more familiar with recreational activities on the Lower Passaic and Hackensack than the Bay. He provided a draft plan for a proposed canoe/kayak trail along the Passaic ending at Kearny Point, but the trail has not been developed. The Lower Passaic is heavily used for kayaking and by rowing clubs. Regarding recreational activities on the Bay, Mr. Willis indicated that it is likely that only very experienced paddlers would kayak/canoe there, due to the tanker traffic. Also the large sewage treatment plant in the area may be a deterrent.

Abbreviations

ADC - Association of Diving Contractors
Assoc - Association
ATSDR - Agency for Toxic Substances and Disease Registry
CFR - Code of Federal Regulations
Dept - Department
Div - Division
HDP - Harbor Deepening Project
NJ - New Jersey
NJ - New Jersey
NJDEP - New Jersey Department of Environmental Protection
NJDOT - New Jersey Department of Transportation
NJSP - New Jersey State Police
NOAA - National Oceanic and Atmospheric Administration
NPS - National Park Service
NY - New York
NY/NJ - New York/New Jersey
NYC - New York City
OHSA - Occupational Safety and Health Administration
PA - Port Authority
Rec - Recreation
USACE - US Army Corps of Engineers
USCG - United States Coast Guard
USEPA - US Environmental Protection Agency
USFWS - US Fish and Wildlife Service

ATTACHMENT 3

Newark Bay Study Area Reconnaissance Report (Tierra 2015a)

Newark Bay Study Area
Reconnaissance Survey Report

Baseline Human Health and
Ecological Risk Assessment

Tierra Solutions, Inc.

East Brunswick, New Jersey

April 2015

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Appendices

A Field Data Forms

B Photo Log

C Shoreline Characterization Video (available on DVD)

1. Introduction

This Reconnaissance Survey Report (report) has been prepared by Tierra Solutions, Inc. (Tierra) on behalf of Occidental Chemical Corporation (the successor to Diamond Shamrock Chemicals Company [formerly known as Diamond Alkali Company]) under the Newark Bay Study Area (NBSA) Administrative Order on Consent, entered pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act Index No. 02-2004-2010 (U.S. Environmental Protection Agency [USEPA] 2004). The Reconnaissance Survey was conducted under the USEPA-approved NBSA Reconnaissance Survey Work Plan (Work Plan, Tierra 2013a) (via September 5, 2013 email from Ms. Eugenia Naranjo [USEPA] to Ms. Carlie Thompson [Tierra]).

This report presents the results of the Reconnaissance Survey that was conducted in the NBSA from September 11 to September 15, 2013. The survey was performed by ARCADIS on behalf of Tierra as part of the Baseline Human Health and Ecological Risk Assessment (BHHERA) for the Remedial Investigation/Feasibility Study (RI/FS) for the NBSA. The NBSA is defined as Newark Bay and portions of the Hackensack River, Kill van Kull, and Arthur Kill (USEPA 2004; Figure 1-1).

1.1 Objectives

One of the main objectives of the Reconnaissance Survey was to provide qualitative observations of shoreline features and characteristics. As part of the survey, the shoreline was divided into segments based on land use and/or habitat type. For each segment, the presence and extent of shoreline features, vegetation, and other characteristics were documented on field data forms, and a video and still camera were used to record shoreline conditions. Observations of human access points (e.g., parks, boat launches) and human activities in the NBSA were also documented. Areas with sufficient habitat to potentially support bird nests and terrestrial mammals were surveyed on foot. Collectively, information regarding shoreline features from the Reconnaissance Survey will be used to characterize human and ecological usage in the BHHERA.

Another objective of the Reconnaissance Survey was to gather information that may be used to support future sediment and biological tissue sampling that will be conducted for the upcoming BHHERA. The existing information that was reviewed prior to conducting the survey included historic site information (Problem Formulation [Tierra 2013b] and Phase I and II Sediment Investigations [Tierra 2014]), data from past studies performed within the NBSA (USEPA's Regional Estuary Monitoring Program

[REMAP] data [USEPA 1998], U.S. Army Corps of Engineers [USACE] aquatic biological surveys [USACE 2003; 2004a,b; 2005; 2006a,b; 2007a,b,c; 2008a,b; 2009; 2013]), navigational charts, and current satellite imagery from Google Earth. The information was reviewed to identify Intertidal Areas and associated Subtidal Flats that would potentially be suitable for collecting bivalves (clams) and crabs. The Reconnaissance Survey ground-truthed these areas to identify any potential obvious physical changes that would limit the accessibility or effectiveness of performing clam and crab sampling within targeted areas. Ground-truthing did not include detailed mapping of all Intertidal Areas and Subtidal Flats, as this was beyond the effort of this survey and would require bathymetric surveys. In addition to the visual ground-truthing, reviews of literature pertaining to sampling methodologies, seasonality, regulations, and typical tissue masses of live clam and crabs were conducted.

Specific ground-truthing that was conducted as part of the Reconnaissance Survey was as follows:

- **Target Organisms**: Existing data indicate that populations of bivalves (softshell clams [*Mya arenaria*] and ribbed mussels [*Geukensia demissa*]) and crabs (blue crab [*Callinectes sapidus*]) occur within the NBSA. Field reconnaissance was conducted to determine general abundance and ability to collect target species.

- **Tissue Mass**: Tissue mass of approximately 194 grams per sample is required to analyze the full target constituent list. This sample mass would require approximately 15 to 20 clams (based on tissue estimates from Beal [2002] and minimum legal size of 1.5 inches) and 25 to 30 hard shell crabs (based on tissue estimates from Tierra [2002] and Windward [2009] and minimum legal size of 4.5 inches [carapace width]). Field reconnaissance was conducted to determine the availability of appropriately sized individuals for the proposed target species.

- **Target Areas**: Water depths and tide changes cause varying conditions within the proposed sampling areas. Also, aerial imagery indicates some potential changes to shoreline areas. Field reconnaissance was conducted to evaluate habitat, accessibility, and safety (e.g., in-water obstructions or land/water use changes) under various tidal conditions.

Results of the survey include the identification and documentation of human and ecological uses of the shoreline, identification of sampling areas for subsequent field efforts, optimization of sampling methodology, and identification of wildlife species inhabiting the NBSA, all of which will further support the BHHERA. It should be noted

that because the Reconnaissance Survey was conducted as a singular event during a brief one-week period, the absence or limited sightings of a species during the survey will not be used to exclude potential receptors from the BHHERA.

The specific tasks completed as part of the Reconnaissance Survey are as follows:

- **Task 1 – Shoreline Habitat Characterization**: This task identified the shoreline habitat types found within the NBSA (e.g., vegetation, riprap, bulkhead).

- **Task 2 – Shoreline Human Use Characterization**: This task identified human use areas (e.g., industrial/commercial, residential, recreational) along the NBSA shoreline and documented observations of human activities (e.g., port/dock work, fishing).

- **Task 3 – Identification of Sampling Areas and Evaluation of Sampling Approaches**: This task identified preliminary locations in the Intertidal Areas for subsequent sampling activities and verified that the sampling equipment proposed for the investigation is suitable to collect the desired biota and sediment samples.

- **Task 4 – Bird Nest Survey**: This task identified possible bird nesting areas.

- **Task 5 – Mammal Survey**: This task documented signs of mammal species that may utilize habitats within the NBSA.

1.2 Document Overview

This report summarizes the results of the 2013 Reconnaissance Survey in the NBSA. An overview of the general scope of reconnaissance survey activities is provided in Section 2. A description of each task (shoreline habitat characterization, shoreline human use characterization, identification of sampling areas and evaluation of sampling approaches, and bird nest and mammal surveys) and a summary of the results are presented in Sections 3 through 6, respectively. References are provided in Section 7.

The text is supported by relevant tables and figures, as well as the following appendices:

- Appendix A – Field Data Forms
- Appendix B – Photo Log
- Appendix C – Shoreline Characterization Video (on DVD)

2. General Methodology

Reconnaissance of the NBSA was performed consistent with the Work Plan (Tierra 2013) and appropriate health and safety protocols in the NBSA Remedial Investigation Work Plan (RIWP), Volume 3 of 3, Health and Safety/Contingency Plan (HASP), Revision 1 (Tierra 2005). Sampling gear was decontaminated, as needed, between sampling areas and before leaving the study area. The procedures for equipment decontamination are described in both the HASP and field Standard Operating Procedure 1 – Decontamination in the Newark Bay Study Area Phase II RIWP, Volume 1a of 2, Addendum 1, Appendix F (Tierra 2007).

Small work boats were used to access NBSA shoreline areas, Intertidal Areas, and Subtidal Flats. Observation activities included shoreline habitat characterization, shoreline human use characterization, bird nest survey, mammal survey, and determination of potential biota collection areas. Bird nest surveys and mammal surveys were not required for all portions of the shoreline. Although artificial structures may provide unnatural habitat for some wildlife (e.g., nesting birds), industrial areas generally do not provide natural habitat for populations of birds and mammals. Therefore, a bird nest survey and mammal survey was not conducted on foot in the commercial/residential land use areas (Segments 2, 5, 6, 8,10-14,18,19, 21, 23, 24, 26, 28-31, 33, 34, and 35). Human use characterization was done throughout the NBSA, regardless of land use or habitat type.

The field effort for the Reconnaissance Survey included one or two two-person crews, who conducted multiple tasks simultaneously to evaluate current conditions within the NBSA and identify possible sampling areas for future data collection. Shoreline habitat and general human use characterization were performed for the NBSA with both a video survey and visual observations. In addition, bird nest remnants and any mammal activity within the NBSA were documented. Clam rakes, guns, and shovels were used to evaluate potential efficacy of collecting clams for tissue analysis within Intertidal Areas. Three types of crab traps (also referred to as pots) were used within Intertidal Areas and associated Subtidal Flats to evaluate potential efficacy of collecting blue crabs for tissue analysis within the NBSA (the types of traps are further described in Section 5.1.1). Field notes, global positioning system (GPS) points, and field forms were used to document observations. Throughout the survey, a USEPA contractor provided oversight of the tasks being conducted.

2.1 Deviations

The field work conducted was consistent with the Work Plan (Tierra 2013), with some minor deviations. For instance, while attempts were made to photograph and videotape the entire shoreline area, some video clips and/or still photos are missing from the Arthur Kill area due to equipment malfunctions (e.g., poor quality of video clips). These include areas around the Elizabeth Marina, Elizabeth River, Arthur Kill Shipping Terminal, and the Linden Terminal. In addition, while the survey documented general human, bird, and mammal usage of the NBSA, not every observation was captured in photographs.

Although the targeted areas outlined in the Work Plan were investigated, some of the specific locations where crabs and clams were collected were located outside of the targeted areas. This includes an area near Rutkowski Park and an additional area across the Bay near the industrial parking lot. In addition, areas located outside of the NBSA (e.g., Pralls Island) were not investigated because these areas will not be the focus of future sampling efforts. The final sampling locations are identified in subsequent sections and depicted on Figure 3-2.

It should also be noted that in the early morning hours of Friday, September 13, 2013, an oil spill occurred at Mariners Harbor Shipyard on Staten Island in the southern portion of the NBSA. While the spill did not affect or hinder the crew's ability to conduct the Reconnaissance Survey, oil slicks were observed in several areas along the coast and prevented additional sampling attempts at Intertidal Area 124. Oiled wildlife was also observed. Photographs documenting the impact on the area of the survey are available in the photo log (Appendices B-2, B-4, B-5, and B-17). Additional information regarding the spill has been reported by news sources, including NJ.com: http://www.nj.com/hudson/index.ssf/2013/09/post_375.html.

3. Shoreline Habitat Characterization

This section presents the methods that were used to conduct the shoreline habitat characterization and includes a summary of the results.

3.1 Methodology

In accordance with the Work Plan (Tierra 2013), the shoreline habitat survey was conducted by boat. The boat traveled as close to the shore as possible (usually less than 100 meters), and video and still cameras were used to record the shoreline characteristics. The shoreline includes the area immediately adjacent to the water that is visible by boat (Tierra 2013), and may also include an adjacent portion of the upland floodplain. Most land use along the shoreline of the NBSA (i.e., residential and industrial properties, parks, and roads) generally extends to the water's edge, and the width of the actual shoreline varies. For example, bulkheads create an abrupt shoreline that is relatively narrow (e.g., 10 meters or less from the waterline), while a vegetated shoreline may extend inland for several hundred meters. Binoculars were used as necessary to view vegetation and identify plant species along the shoreline.

The shoreline of the NBSA was segmented based on the dominant land use/habitat type of that particular stretch of shoreline. Tierra recognizes that a heterogeneous mixture of habitat and human use areas is present throughout the NBSA and each segment may or may not include multiple human use and/or habitat categories. As a result, the shoreline of the NBSA was divided into 35 segments (Table 3-1, Figure 3-1). Each segment was classified into one of four shoreline habitat categories that are similar to those utilized in the Lower Passaic River Study Area for the 2010 Habitat Characterization Survey (Windward 2013):

- **Bulkhead** – Extent of shoreline where the majority of the vertical face consists of wood timbers, metal sheet pile, or large stone/cement blocks.

- **Mixed Intertidal** – Extent of shoreline where a combination of riprap, sand, and/or emergent vegetation is present.

- **Riprap** – Extent of shoreline dominated by sloped banks that are covered by cobble- to boulder-sized stones and/or concrete rubble.

- **Vegetation** – Extent of shoreline with greater than 50% emergent vegetation (e.g., smooth cordgrass [*Spartina alterniflora*], common reed [*Phragmites australis*]).

Dominant vegetation species were recorded, as well as any wildlife observed. The presence of outfalls, discharge pipes, and/or combined sewer overflows was also documented. Field data forms, a photo log, and shoreline characterization video are presented in Appendices A through C, respectively.

3.2 Results

The shoreline of the NBSA was videotaped and divided into segments on September 11, 2013. The video is provided on DVD in Appendix C. During return trips to each segment from September 12 to 15, 2013, additional still photographs were taken and each segment was further characterized. Table 3-1 provides the results of the shoreline habitat characterization for each of the 35 identified segments. Figure 3-2 depicts the shoreline habitat characterization results. The percentage of each shoreline habitat category in the NBSA is as follows:

- **Bulkhead** – 40%
- **Mixed Intertidal** – 10%
- **Riprap** – 30%
- **Vegetation** – 20%

The NBSA shoreline has been industrially developed with approximately two-thirds of the shoreline consisting of riprap and bulkhead. The remnant plant community (upland and wetland) reflects such development, consisting of species that are representative of disturbed conditions.

Upland vegetation along the NBSA generally consisted of a patchy mixture of early successional and ruderal plant species, indicative of the high level of shoreline disturbance. Dominant canopy species included eastern cottonwood (*Populus deltoides*), locust trees (*Gleditsia spp.* or *Robinia spp.*), and catalpa (*Catalpa speciosa*) with an understory of honeysuckle (*Lonicera spp.*) and sumac (*Rhus spp.*). Additional species observed are included in Table 3-2. As indicated in Table 3-2, and characteristic of the disturbed upland habitats, species diversity was low and dominated by fast-growing invasive and/or short-lived vegetation. These upland habitats were small in size, lacked a consistent canopy and understory, and were surrounded by a mixture of commercial, industrial, and residential areas. Due to the limited size and complexity of these habitats, upland areas adjacent to the NBSA do not provide much in the way of suitable habitat for ecological receptors beyond cover, resting, or minimal foraging.

Sporadic, Intertidal Areas that were dominated by emergent wetland vegetation consisted of smooth cordgrass (*Spartina alterniflora*) and/or common reed (*Phragmites australis*). Areas with less than 50% emergent vegetation were classified based on visual estimations of shoreline habitat segments, and were incorporated into the "mixed intertidal" area. A total of 22 common plant and tree species were identified during the survey, and a list of the species is provided in Table 3-2. While this list is not comprehensive, it provides a good representation of the types of plant and tree species observed along the shoreline.

Despite the highly developed shoreline, the NBSA provides habitat for some wildlife, primarily birds. A total of 34 different species of wildlife were observed during the reconnaissance survey. While the majority of observations were birds, several mammals (primarily urban opportunistic species, such as rats and coyotes) were observed throughout the NBSA. Also, one turtle was observed along an area of emergent vegetation. The complete list of species observed is provided in Table 3-3; additional information regarding the results of the bird nest and mammal surveys is provided in Section 6.2.

During the survey, potential sources of contamination were noted. The documentation of these sources was not intended to be a comprehensive assessment, but is only a compilation of visible sources identified during the survey. These included sewer/stormwater pipes, combined sewer overflows and other visible discharge pipes, and tributaries. These features are documented in Table 3-4 and in some photos in Appendix B. Almost 30 discharge pipes and an unnamed tributary were observed. Also, one backwater restoration area was observed, which included marsh grass plantings and bird exclusion controls. Note that this list does not likely include all discharge pipes along the NBSA shoreline because pipes may have been covered during high tide and a complete evaluation/identification was beyond the scope of the survey. Rather, any discharge pipes noted incidentally during the survey were documented.

4. Shoreline Human Use Characterization

This section presents the methods that were used to conduct the shoreline human use characterization and includes a summary of the results.

4.1 Methodology

The human use characterization survey documented observations of human use along the NBSA shoreline. This survey was conducted by boat and occurred simultaneously with the habitat characterization survey on September 11, 2013. Subsequent visits to segments identified as possible human use areas (e.g., parks, fishing spots) occurred on the remaining days of the survey (September 12 to 15, 2013) to take still photographs and record additional observations. Potential public access points (e.g., boat launches, docks, marinas; as shown on Figure 4-1), residential areas, recreational areas, and evidence of human use of the NBSA were documented. Photographs and video recordings were taken of people using the NBSA at the time of the survey (Appendices B and C, respectively).

Five major shoreline human use categories were established for each segment, based on the definitions below:

- **Disturbed Uplands** – Open space areas that have been abandoned and overgrown with terrestrial vegetation (e.g., trees, scrub/shrub).

- **Undisturbed Uplands** – Areas consisting of natural vegetation that provides habitat for wildlife species (natural vegetation does not include landscaped vegetation which is part of the Residential category described below).

- **Industrial/Commercial** – Areas consisting of industrial/commercial use, such as, but not limited to, manufacturing facilities, ports, and shipyards.

- **Recreational –** Areas where recreational activities are dominant (e.g., parks, fishing spots, walking trails).

- **Residential** – Areas consisting of, but not limited to, residential homes, apartment complexes, and schools.

4.2 Results

This section summarizes the observations related to land use, human use, and activities recorded during the survey (e.g., fishing) and relevant shoreline features, including boat launches, boat docks, marinas, fences, and parks. Table 4-1 presents a summary of observations for all days by segment and corresponding photographs are provided in the photo log (Appendix B).

The shoreline of the NBSA was videotaped and divided into segments on September 11, 2013 (provided in Appendix C). Subsequently, during return trips to each segment from September 12 to 15, 2013, additional still photographs were taken and each segment was further characterized. Table 4-1 presents the human activity observations, and Figure 4-1 presents the results of the shoreline human use characterization. The percentage of the dominant shoreline human use category in the NBSA is as follows:

- **Disturbed Uplands** – 18%
- **Undisturbed Uplands** – 26%
- **Industrial/Commercial** – 36%
- **Recreational** – 12%
- **Residential** – 11%

Over 200 individuals were observed using the shoreline in 19 different segments between September 11 and 15, 2013 (Table 4-1). The most popular recreational activity was fishing, which occurred mainly along the banks/piers of the parks. No one was observed crabbing, and crab lines were not observed (even through binoculars). Other recreational activities included jogging and walking along the shoreline. Several individuals were observed with dogs, including playing fetch and letting the dogs swim, or walking/jogging with them. In the industrial/commercial areas, the most common activities were port/dock workers, such as welders or boat workers. No rowing clubs or rowers were identified during the survey; this activity is likely confined to the rivers. The majority of individuals observed were adults, although a few children were also observed.

The results of this five-day survey are intended to serve as an overview of potential human usage within the NBSA, and are not a full quantitative survey of all possible human uses. For example, it is possible that the same individual returned for more than one day, or individuals may have been using the shoreline but were not observed by field staff. Two limitations of the survey are that it was only conducted during daylight

hours and only during a single season. Also, the survey was conducted at the end of the summer and there is a general cyclic trend in human outdoor activity during a calendar year. Usage is expected to be lower in cooler months, moderate in spring and fall months, and higher during summer months when children are not in school. Few children were observed during the survey, which may have been because school was back in session. For these reasons, this five-day survey may underestimate potential human usage of the NBSA.

Limited residential areas exist along the eastern shoreline of the Bay that have either natural or man-made barriers to prevent people from accessing the Bay. Such barriers include steep, heavily vegetated slopes, rip-rap, and fences. Examples are provided in photos in Appendix B (B-7, B-8). One small make-shift shelter was observed along the riprap/cobble shoreline in Segment 25 (Appendix B-15, photo 25b). This area consists of intertidal habitat interspersed with small cobble riprap. Three fishermen were observed in the vicinity of the structure during the latter part of the survey. Additionally, a tent was observed along the sandy portion of the shoreline in Segment 15 (Appendix B-10, photo 15d) but the tent was not present on the day the video was taken.

Segments were categorized based on the dominant shoreline habitat and human use categories identified above. Although multiple habitat and human use categories may be present in the segments to a lesser degree, each segment was characterized by the dominant types observed.

5. Identification of Sampling Areas and Evaluation of Sampling Approaches

This section discusses the methodology and results for the identification of sampling areas and evaluation of sampling approaches for the collection of blue crabs, clams, and surficial sediment.

5.1 Methodology

Intertidal Areas targeted for experimental sampling were initially selected based on a review of aerial imagery, geomorphic areas mapped during the Phase I and II Sediment Investigations, and observations during a site visit that occurred in October 2010. These areas were plotted on maps and identified as possible sampling areas prior to the Reconnaissance Survey.

Potential sampling areas were identified in the field using maps and a hand-held GPS unit loaded with the target area coordinates. A low-draft fiberglass skiff was used to access each of the proposed NBSA sampling areas to evaluate the feasibility of collecting blue crab, clams (various species), and co-located sediment samples. Areas were accessed during various tidal stages to determine the extent of inundation and the accessibility of the areas during phases of the tide. At each area, an assessment was conducted of accessibility, visual observations and probing to characterize intertidal substrates, collection techniques and availability of target species (crabs and clams), and ability to collect sediment using various methods (e.g., Lexan® tubing and petite Ponar dredge).

Field data forms documenting the collection of clams and crabs are provided in Appendix A. Information recorded for each clam and crab survey area included general notes (e.g., location, date, time, crew, weather conditions), sample method(s) used, target species (number and sizes observed), and photos of the target species. Potential safety concerns were also documented. Results are described in Section 5.2.

5.1.1 Crab Survey Methods

Several crab traps were used to identify the most appropriate style for collecting enough blue crabs to meet tissue mass requirements—approximately 25 to 30 hard shell crabs per sample, per references detailed in Section 1.1. Blue crabs were collected using three different style crab traps: a small, two-funnel collapsible oval style trap (32 inches long by 15 inches wide by 15 inches high); a small, four-funnel rectangular trap (24 inches long by 24 inches wide by 18 inches high); and a larger,

four-funnel rectangular trap (24 inches long by 24 inches wide by 12 inches high) (Appendix B-19). The three types of traps contain similar size/shape openings and were capable of capturing crabs of the same size. All crab traps met the New Jersey Department of Environmental Protection recreational fishing requirements of cube or rectangular shape no larger than 30 inches on a side consisting of mesh not less than 1 inch across and oval inward openings no larger than 7 inches wide and 4 inches high.

Crab traps were placed in several different water depths to evaluate whether crabs in the NBSA are more abundant in shallow, Intertidal Areas or deeper, Subtidal Flats. At each targeted area, one of each style of crab trap was deployed. Each trap was weighted and baited with bunker (frozen menhaden). Additionally, for extra scent attraction for the crabs, menhaden oil was applied to the bunker. Sinking rope and a marked buoy were attached to each trap for retrieval. Crab traps were experimentally set for different times, from 2 hours to 43 hours, with an average set time of 18 hours.

5.1.2 Clam Survey Methods

Several techniques were used at each Intertidal Area to document the presence of clams and identify the most appropriate method for collecting enough clams to meet tissue mass requirements—approximately 15 to 20 clams per sample (see Section 1.1). The crew waded along each targeted Intertidal Area in search of clams. Several methods were attempted, including the use of clam rakes, shovels, and a clam gun. A description of each technique is provided below. Associated photographs are provided in Appendix B-20.

- **Clam Rakes** – Clam rakes are long handles with a wire basket on one end (Appendix B-20). The rake is used by dragging it through the sediment, and the sediment passes through the wire basket while larger items (including clams) are collected in the basket. The clam rake is most useful in areas submerged by water and is most effective for hard-shelled clams.

- **Shovel** – A clam shovel has a curved narrow blade and is made specifically for digging softshell clams (Appendix B-20). The shovel is used by first identifying areas with potential clams by the presence of their siphon, or shallow impressions (i.e., small holes) in the sediment. The shovel is then used to gently dig down and uncover the clam.

- **Clam gun** – A clam gun is a 6-inch-diameter metal tube mounted on a steel T-shaped handle (Appendix B-20). The clam gun is pressed into the sediment on top of the potential clam. A vent hole on the side of the handle is covered to cause suction when the tool is pulled from the sediment. The sediment within the tube is then dumped out, including the clam.

5.2 Results

5.2.1 Identification of Sampling Areas

Each targeted Intertidal Area was visited multiple times during the survey. Specific sampling locations within the larger intertidal sampling area were used to evaluate sampling equipment and to experimentally collect blue crabs and clams. Intertidal Area 124 within Segments 7 and 8 was explored. No clams were found, and two crabs were collected. Segment 12/13 was also explored, but the substrate was too coarse for softshell clams and none were found. Areas within Segments 29, 30, 31 and 1 (west of 126) are not classified as the geomorphic category “Intertidal Area” and therefore were not targeted areas. The proposed Intertidal Areas appear suitable for the collection of clams (at low tide) and blue crabs. The survey was intended to evaluate the suitability of the larger sampling areas rather than identifying exact sampling locations. However, the locations where crabs and clams were collected are depicted on Figure 3-2.

5.2.2 Experimental Blue Crab Collection

A total of 48 blue crabs were collected during the Reconnaissance Survey, ranging in size from 2 to 7 inches (51 to 178 millimeters) (Table 5-1). Crabs were identified to species, sexed, and measured from point to point across their carapace to determine if they met the minimum legal size of 4.5 inches. The most efficient trap style was the collapsible style trap (21 crabs), followed by the small rectangular trap (18 crabs) and the large rectangular trap (9 crabs). Crabs were captured from all areas. The largest number of crabs (n=15) was captured at Intertidal Area 125 (Figure 3-2). Crab trap efficiency was not normalized by exposure period; more crabs were captured from traps set for at least 16 hours in deep water where traps remained continuously inundated, even at low tide. Some traps were inadvertently placed in areas where the tops of the traps were partially exposed during low tide, but no traps were placed in areas where they could become completely dry at any time. The highest number of crabs were collected from Area 125 (15 crabs) and Area 126 (11 crabs) (Table 5-1).

Based on these observations, blue crab abundance appears to be adequate for collecting sufficient numbers of crabs to meet the tissue mass requirements. The collapsible crab traps and smaller rectangular crab traps appear to be the most suitable for future collection efforts, and the traps should be set in areas where they will be submerged even during low tide. During this Reconnaissance Survey, three crab traps were deployed at each Intertidal Area. It is recommended that, in order to obtain the required tissue mass of approximately 25 to 30 crabs per area, more than three traps are deployed and traps are set for at least 16 hours to obtain sufficient numbers of crabs.

5.2.3 Experimental Clam Collection

Each of the various techniques described above in Section 5.1.2 were performed in the proposed sampling areas, and shoveling proved to be the most successful method. The clam rakes did not penetrate the sediment deep enough to collect softshell clams, and hard-shelled clams, such as *Macoma* sp. (for which these clam rakes are ideal), were not abundant in the NBSA. The clam gun required much more effort than the other methods and produced limited results, and therefore this method was not used at all targeted areas. A summary of the results of clam collection is provided in Table 5-2.

The softshell clam (*Mya arenaria*) was the most abundant bivalve collected. The clams ranged in size from approximately 1 to 3 inches in length. Other bivalves that were observed included ribbed mussels (*Geukensia demissa*), Atlantic oysters (*Crassostrea virginica*), and Baltic clam (*Macoma balthica*). Based on these observations, the overall abundance of softshell clams observed in the Intertidal Areas indicates that sufficient quantities exist for tissue analysis, and the most effective method for collection is with a clam shovel.

5.2.4 Experimental Sediment Sampling

A sediment probing rod was used in the targeted areas to test the substrate in shallow areas (i.e., water depths less than 2 feet) that were also explored for clam abundance. Humans could be exposed to sediments in these areas only if they were specifically digging for clams. Sediment along the shoreline, both exposed sediment and sediment in shallow water areas, was visually observed and probed with a hand trowel and Lexan® tubing (3-inch-diameter; pushed by hand) to evaluate potential sediment sampling methods. A petite Ponar dredge was tested in several deep water areas to verify its effectiveness (Appendix B-21).

Substrate within the Intertidal Areas consists of a range of inorganic and organic materials. In general, inorganic substrates consisted of a range of fine sand and silt to coarse sand and gravel. Pieces of brick, glass, pottery, and other anthropogenic debris were also present in many areas. Organic substrates included woody debris, algae, and relic shells from various bivalves (e.g., softshell clam, Atlantic oyster, hard-shelled clam, ribbed mussel). Consolidated, coarse-grained, firm sediments occur in shallow areas along the shoreline, while softer, finer-grained sediments occur farther offshore in deeper areas.

The soft substrate is suitable for sampling with a hand-held dredge to collect surficial sediments. Hand-pushing the core into the sediment was effective to recover the top six inches of sediment. Although either method is suitable for future sediment sampling activities, the Ponar dredge is more practical for use in deeper submerged sediments, while the Lexan® core is preferable for sampling in the shallower water areas (4-feet of water or less). Additionally, hand-sampling with a stainless steel spoon may be an alternative if substrates are sampled in exposed areas.

6. Bird Nest and Mammal Surveys

This section describes the methodology and results of the bird nest and mammal surveys.

6.1 Methodology

Bird nest and mammal survey areas were identified based on the habitat characterization and segments identified as "habitat" during the video survey on September 11, 2013. Where feasible, the boat was brought to shore in these habitat areas and field staff surveyed the shoreline on foot looking for remnants of bird nests and signs of mammals (e.g., scat, tracks). Areas for bird and mammal surveys included the southern portion of the NBSA, such as on Shooters Island (Segment 32), in Segment 1, and in the Arthur Kill Wetlands Complex near the Goethals Bridge (Segment 33). Additional areas for surveying included Kearny Point (Segment 20), the large intertidal area in Segment 22, and along various sandy shoreline areas.

6.2 Results

Results of the bird nest and mammal surveys are provided in Tables 6-1 and 6-2, respectively. Locations of observations are shown on Figure 3-2, and direct and indirect wildlife observations are provided in Table 3-3. Associated photographs are provided in the photo log in Appendix B (B-22 through B-24).

No bird nests were observed along any portions of the shoreline; rather, they were observed located on structures in the water (e.g., mile markers, abandoned/dilapidated wooden and metal pier structures; Table 6-1, Appendix B-22). Both large and small nests were observed. The large nests consisting of hard sticks are likely to be osprey (*Pandion haliaetus*) nests. The smaller nests consisting of softer grasses and seaweed that are also located on structures in the NBSA are likely to be double-crested cormorant (*Phalacrocorax auritus*) nests.

Direct mammal sightings were documented, as well as any signs of mammals present along the shoreline (e.g., tracks, scat). Results are provided in Table 6-2 and in associated photographs in Appendix B (B-23 and B-24). The majority of mammals are human-tolerant species that are frequently found in urban areas, including Norway rat (*Rattus norvegicus*), skunk (e.g., *Mephitis mephitis*), coyote (*Canis latrans*), deer (e.g., *Odocoileus virginianus*), rabbit (e.g., *Sylvilagus* spp.), and cat (*Felis catus*). A muskrat (*Ondatra zibethicus*) was seen swimming in the large intertidal area in Segment 22.

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Tables

Table 3-1
Shoreline Characterization Results

Shoreline Segment[1]	Location	Dominant[2] Habitat Characterization	Dominant[2] Land Use Characterization	Appendix	Photo ID	Linear Shoreline Length (feet)	USGS Land Use
1	Arthur Kill to Mariners Harbor Yacht Club	Vegetation	Habitat	B-1	1a-1e	10261	Emergent Herbaceuous Wetlands
2a / 2b	Mariners Harbor Yacht Club to Bayonne Bridge	Bulkhead	Industrial/Commercial	B-2	2-2e	9441	Developed, Medium Intensity
3	Intertidal area west of Bayonne Bridge	Mixed Intertidal	Habitat	B-3	3	395	Developed, Medium Intensity
4	Abandoned uplands west of Bayonne Bridge	Riprap	Disturbed Uplands	B-3	4	5523	Developed, High Intensity
5	Industrial area south of Elco Boat Basin	Riprap	Industrial/Commercial	B-3	5	2937	Developed, Low Intensity
6	Elco Boat Basin, marina, and residences	Bulkhead	Residential	B-4	6-6d	1069	Developed, Low Intensity
7	Between Elco Boat Basin and Robbin's Reef Yacht Club	Mixed Intertidal	Habitat	B-5	7a-7d	2302	Developed, Low Intensity
8	City Park	Bulkhead	Recreational	B-6	8a-8e	3189	Developed, Low Intensity
9	Between City Park and residential properties	Mixed Intertidal	Habitat	-	-	1320	Developed, Low Intensity
10	Apartments and trailer park south of Veteran's Park	Riprap	Residential	B-7	10a-10f	832	Developed, Low Intensity
11	Veteran's Park	Bulkhead	Recreational	B-8	11a-11b	1505	Developed, Low Intensity
12	Residential area north of Veteran's Park	Bulkhead/Riprap	Residential	B-8	12	3369	Developed, Low Intensity
13				B-8	13a-13b		
14	Bayonne Park	Bulkhead	Recreational	B-9	14a-14e	4121	Developed, Low Intensity
15	Rutkowski Park	Vegetation	Habitat/Recreational	B-10	15-15e	3029	Herbaceuous
16	Vegetated area north of Rutkowski Park	Riprap	Disturbed Uplands	B-11	16-16a	5377	Developed, Medium Intensity
17	Intertidal area in front of Tidelands Athletic Complex	Mixed Intertidal	Habitat	B-11	17	1982	Developed, Medium Intensity
18	Condominium area north of Tidelands Athletic Complex	Riprap	Residential	B-11	18-18a	4277	Developed, Medium Intensity
19	Former Honeywell Site downstream of Conrail bridge remnants	Riprap	Disturbed Uplands	-	-	3239	Developed, Medium Intensity
20	Kearny Point	Mixed Intertidal	Habitat	B-12	20a-20b	2209	Developed, High Intensity
21	Hess Plant, PVSC at confluence with Passaic River	Riprap	Industrial/Commercial	B-12	21-21a	2473	Developed, Low Intensity
22	Intertidal area below highway bridges	Vegetation	Habitat	B-13	22a-22f	4768	Deciduous Forest
23	Car lot south of highway bridges	Riprap	Industrial/Commercial	B-14	23a-23e	3175	Developed, Medium Intensity
24	Port Elizabeth marine terminal	Bulkhead	Industrial/Commercial	B-14	24a-24b	17368	Developed, Medium to High Intensity
25	Intertidal area south of Port Elizabeth marine terminal	Vegetation	Habitat	B-15	25a-25b	2636	Developed, Medium Intensity
26	Former industrial area south of Port Elizabeth marine terminal	Riprap	Disturbed Uplands	B-15	26a-26b	1572	Woody Wetlands
27	Backwater restoration area north of Singer factory	Vegetation	Habitat	B-15	27	3413	Developed, Low Intensity
28	Singer factory north of Arthur Kill Park	Bulkhead	Industrial/Commercial	B-16	28a-28c	1956	Developed, Medium Intensity
29	Arthur Kill Park	Mixed Intertidal	Recreational/Residential	B-16	30a-30d	4489	Developed, Medium Intensity
30							
31	Elizabeth Marina	Bulkhead	Industrial/Commercial	-	-	641	Developed, Medium Intensity
32	Shooters Island	Riprap	Disturbed Uplands	B-17	32-32d	7480	Developed, Medium Intensity
33	Arthur Kill wetlands complex near Goethals Bridge	Vegetation	Habitat	B-18	33a-33b	1465	Developed, Medium Intensity
34	Linden Terminal north of Goethals Bridge	Bulkhead	Industrial/Commercial	-	-	4609	Developed, High Intensity
35	Arthur Kill Shipping Terminal north of Goethals Bridge	Bulkhead	Industrial/Commercial	B-18	35	3661	Developed, Medium Intensity

Notes:

1. Shoreline segment locations are shown on Figure 3-1.

2. The shoreline of the NBSA was segmented based on the dominant land use/habitat type of that particular stretch of shoreline. Tierra recognizes that a heterogeneous mixture of habitat and human use areas is present thoughout the NBSA and each segment may or may not include multiple human use and/or habitat categories.

Table 3-2
Vegetation Species Observed

Common Name	Scientific Name
Aspen	*Populus spp.*
Birch	*Betula spp.*
Black locust	*Robinia pseudoacacia*
Boneset (unidentified)	*Eupatorium spp.*
Catalpa	*Catalpa speciosa*
Chokecherry	*Prunus virginiana*
Common reed	*Phragmites australis*
Eastern cottonwood	*Populus deltoides*
Goldenrod (unidentified)	*Solidago spp.*
Groundsel tree	*Baccharis halimifolia*
Honeysuckle	*Lonicera spp.*
Jewelweed (unidentified)	*Impatiens spp.*
Locust (unidentified)	*Gleditsia spp. or Robinia spp.*
Pokeweed	*Phytolacca americana*
Princess trees	*Paulownia tomentosa*
Ragwort	*Jacobaea vulgaris, syn. Senecio jacobaea*
Red maple	*Acer rubrum*
Smooth cordgrass	*Spartina alterniflora*
Sumac	*Rhus spp.*
Sunflower	*Helianthus annuus*
Sycamore	*Platanus occidentalis*
Willow	*Salix spp.*

Notes:
Vegetation was observed in intertidal areas and along the shoreline.

Table 3-3
Wildlife Species Observed

Common Name	Scientific Name
Birds	
American crow	*Corvus brachyrhynchos*
Belted kingfisher	*Megaceryle alcyon*
Black duck	*Anas rubripes*
Blue-winged teal	*Anas discors*
Brant	*Branta bernicla*
Canada goose	*Branta canadensis*
Catbird	*Dumetella carolinensis*
Common sandpiper	*Actitis hypoleucos*
Common tern	*Sterna hirundo*
Double-crested cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodias*
Herring gull	*Larus argentatus*
House wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferus*
Laughing gull	*Leucophaeus atricilla*
Little green heron	*Butorides virescens*
Mallard	*Anas platyrhynchos*
Mockingbird	*Mimus polyglottos*
Mourning dove	*Zenaida macroura*
Osprey	*Pandion haliaetus*
Pied-billed grebe	*Podilymbus podiceps*
Red-winged blackbird	*Agelaius phoeniceus*
Ring-billed gull	*Larus delawarensis*
White egret	*Ardea alba*
Mammals	
Cottontail rabbit	*Lepus sylvaticus*
Domestic cat	*Felis catus*
Domestic dog	*Canis lupus familiaris*
Eastern coyote	*Canis latrans*
Muskrat	*Ondatra zibethicus*
Norway rat	*Rattus norvegicus*
Raccoon	*Procyon lotus*
Striped skunk	*Mephitis mephitis*
White-tailed deer	*Odocoileus virginianus*
Reptiles	
Diamondback terrapin	*Malaclemys terrapin*

Notes:
Wildlife noted were direct (i.e., visual, audible) observations, as well as observations of scat and/or tracks.

Table 3-4
Observed Potential Contaminant Migration Pathways

Shoreline Segment[1]	Description[2]	Visible Discharge[3]	Appendix	Photo ID[4]	Coordinates (DD.MM.SSSS)[5]	
					Latitude	Longitude
6	24-inch pipe with black cover	No	B-4	6d	40.39.9451	74.08.2680
7	CSO outfall #13	Unknown	B-5	7c	40.39.5718	74.08.0471
8	18-inch pipe, partially submerged	Unknown	-	-	40.39.9655	74.07.9129
	24-inch pipe, partially submerged	Unknown	-	-	40.39.8996	74.07.9723
10	CSO outfall #26	No	B-7	10d, 10f	40.40.0569	74.07.6631
	CSO outfall	Unknown	B-7	10e	40.40.0978	74.07.6774
11	Partially submerged pipe	Unknown	B-8	11a	40.40.2452	74.07.6302
12/13	CSO outfall, covered and submerged	Unknown	-	-	40.40.6048	74.07.1510
	CSO outfall	Unknown	B-8	13a	40.40.4167	74.07.3672
15	36-inch pipe	Yes	B-10	15	40.41.2194	74.06.7675
16	CSO outfall, closed	No	B-11	16a	40.41.9827	74.06.3000
18	36-inch pipe	No	B-11	18	40.42.3804	74.06.4140
	36-inch pipe	No	-	-	40.42.6280	74.06.4752
	36-inch pipe	No	-	-	40.42.5417	74.06.4036
	24-inch pipe	No	-	-	40.42.4717	74.06.4075
	Two 24-inch pipes, with screens	Unknown	-	-	40.42.3092	74.06.4024
	Box culvert, partially submerged	Unknown	B-11	18a	40.42.2340	74.06.3720
21	12-inch pipe with baffle	Yes	B-12	21a	40.42.4119	74.07.2403
	Closed pipe	No	-	-	40.42.4119	74.07.2403
22	Unnamed Tributary	Unknown	B-13	22b	40.42.6557	74.07.3458
23	24-inch concrete pipe	No	B-14	23b	40.41.6435	74.07.5684
	24-inch concrete pipe	Unknown	B-14	23c	40.41.5763	74.07.6284
	6-inch metal pipe	Unknown	B-14	23d	40.41.5243	74.07.6785
	24-inch concrete pipe	Unknown	B-14	23e	40.41.4363	74.07.7440
26	Three 36-inch concrete pipes	Unknown	B-15	26a, 26b	40.39.3547	74.09.7991
27	Channel from backwater restoration area	Unknown	B-15	27	40.39.7039	74.09.4670
28	12-inch pipe	Yes	B-16	28a	40.39.1717	74.10.1479
	Two 24-inch pipes, partially submerged	Unknown	B-16	28c	40.39.0940	74.10.2598
29/30	48-inch concrete pipe	Unknown	B-16	30d	40.38.8199	74.11.0596
	48-inch concrete pipe	Unknown	-	-	40.38.8462	74.10.8805

Notes:

1. Shoreline segments are shown on Figure 3-1. Discharge pipe observations are shown on Figures 3-2 and 4-1.

2. Descriptions of pipe size and discharge are approximate, based on visual observations during the survey; some CSOs are identified with numbers, as depicted on the pipes.

3. Discharge descriptions are frequently unknown because the pipes were often partially submerged and/or the water was too shallow to approach close enough with the boat for visual confirmation.

4. This survey was not intended to fully capture all discharge pipes; therefore, it is unlikely that all pipes were observed/documente

5. Coordinates are approximate.

CSO = combined sewer overflow

Table 4-1
Human Activity Observations

Shoreline Segment[1]	Land Use[2]	Date	Activities Observed	Potential Direct Contact with Surface Water or Sediment (Y,N)[3]	Total Number of People Observed		Appendix	Photo ID[4]
					Adults	Children		
2	Industrial/Commercial	11-Sep	Shipyard workers, welders	N	5	0	B-2	2-2e
6	Residential	11-Sep	Fishing	N	1	0	B-4	6, 6a
		13-Sep	Fishing	N	1	0		
		14-Sep	Cleaning up oil spill	N	6	0		
8	Recreational	11-Sep	Fishing	N	1	0	B-6	8d, 8e
		13-Sep	Fishing	N	2	0		
		14-Sep	Biking	N	1	0		
		15-Sep	Fishing	N	3	0		
10	Residential	15-Sep	Dog walking	N	2	0	-	-
11	Recreational	11-Sep	Fishing	N	8	0	B-8	11b
		12-Sep	Fishing	N	5	0		
		14-Sep	Fishing	N	11	0		
		15-Sep	Walking	N	2	0		
		15-Sep	Fishing	N	3	0		
14	Recreational	11-Sep	Fishing	N	4	0	B-9	14a-14e
		12-Sep	Fishing	N	9	0		
		14-Sep	Fishing	N	4	2		
		14-Sep	Walking	N	11	0		
		14-Sep	Photographing	N	5	0		
		15-Sep	Fishing	N	11	1		
		15-Sep	Sitting	N	3	0		
		15-Sep	Walking	N	3	0		
		15-Sep	Jogging	N	4	0		
		13-Sep	Walking	Y	1	0		
15	Habitat/Recreational	14-Sep	Fishing	N	1	0	B-10	15d
		14-Sep	Fishing	N	7	1		
		14-Sep	Playing with dog	Y	2	0		
		15-Sep	Fishing	N	1	0		
		15-Sep	Biking	N	1	0		
		15-Sep	Playing with dog	Y	1	0		
		15-Sep	Temporary Residence[5]	Y	0	0		
16	Disturbed Uplands	13-Sep	Fishing	N	5	0	B-11	16
		13-Sep	Sunbathing	N	1	0		
18	Residential	14-Sep	Running, dog walking	N	13	1	B-11	18
		15-Sep	Jogging, walking	N	5	0		
19	Disturbed Uplands	11-Sep	Construction work	N	NC	0	-	-
20	Habitat	14-Sep	Jetskiing	Y	13	0	-	-
22	Habitat	14-Sep	Industrial workers	Y	2	0	B-13	22c, 22d
		14-Sep	Jetskiing	Y	2	0		
23	Industrial/Commercial	11-Sep	Construction work	N	3	0	B-14	23a
24	Industrial/Commercial	11-Sep	Port work	N	2	0	B-14	24b
		12-Sep	Port work	N	NC	0		
		15-Sep	Boating/fishing	Y	2	0		
25	Habitat	15-Sep	Temporary Residence[6]	Y	0	0	B-15	25b
		15-Sep	Fishing	N	3	0		
28	Industrial/Commercial	15-Sep	Fishing	N	5	0	-	-
		15-Sep	Weedwacking	N	2	0		
		15-Sep	Exercising	N	1	0		
29/30	Recreational/Residential	11-Sep	Fishing	N	15	0	B-16	30c
		12-Sep	Walking/sitting on riprap	Y	6	2		
		14-Sep	Fishing	N	3	4		
		14-Sep	Sitting	N	4	0		
31	Industrial/Commercial	14-Sep	Cleaning fish	N	4	0	-	-
		15-Sep	Fishing	N	2	0		
		14-Sep	Boating	Y	3	3		

Notes:

1. Shoreline segments are shown on Figure 3-1.

2. Segment 12 was not included in the table because no humans were observed using this area, but an upland sports complex (Tideland Athletic Complex) is present and recreationalists were present around the complex.

3. N = no potential for direct contact with surface water and/or sediment because activities were occurring upland, on piers, jetties, docks, sidewalks, and other surfaces well above the water line; Y = potential direct contact with surface water and/or sediment.

4. Photos are representative of human activities associated with the segment; not all activities were photographed.

5. The temporary residence observed was a temporary tent north of Bayonne Park.

6. Temporary residence observed was a bungalow camp.

NC = not counted; heavy machinery and large equipment in use but no direct observations of individuals by the shoreline and no contact with surface water or sedment.

Table 5-1
Blue Crab Collection Results

Intertidal Location	Set[1]		Retreival[1]		Approximate Total Set Time (hours)	Number of Crabs Caught Per Trap Type			Total Number of Crabs per Location	Size Range[2] (inches)
	Date	Time Set	Date	Time		Collapsible	Small Rectangular	Large Rectangular		
122	14-Sep	15:20	15-Sep	11:40	21	3	0	2	5	4.25 - 6.25
123	12-Sep	10:20	13-Sep	10:25	24	1	0	0	4	3.75 - 6.25
	13-Sep	10:30	13-Sep	13:50	3	0	0	0		
	13-Sep	14:10	14-Sep	14:40	24	1	1	0		
	14-Sep	15:00	15-Sep	12:10	21	0	1	0		
124	11-Sep	16:15	12-Sep	8:35	17	2	0	0	2	3.50 - 4.50
125	11-Sep	14:35	11-Sep	16:04	2	0	0	0	15	3.75 - 6.25
	11-Sep	16:06	13-Sep	11:00	43	4	2	0		
	12-Sep	11:15	13-Sep	14:45	27	0	2	0		
	13-Sep	12:25	14-Sep	16:00	28	2	3	2		
126	11-Sep	16:50	12-Sep	12:05	19	2	1	2	11	3.50 - 6.25
	13-Sep	8:20	13-Sep	11:55	4	0	1	0		
	13-Sep	11:55	13-Sep	15:00	3	0	0	0		
	13-Sep	15:00	14-Sep	16:30	25	1	3	1		
127	11-Sep	16:00	12-Sep	7:55	16	1	0	1	2	2.00 - 6.00
128/129	12-Sep	11:30	13-Sep	10:00	25	2	1	0	9	3.25 - 7.00
	13-Sep	10:10	13-Sep	13:35	3	0	0	0		
	13-Sep	13:40	14-Sep	15:10	25	2	3	1		
TOTAL NUMBER OF CRABS:						21	18	9	48	2.00 - 7.00

Notes:

1. Set and retrieval times are approximate and represent the average set times for all three traps at each location. These times represent the overall deployment; traps were checked periodically and re-deployed during deployment.
2. Harvesting blue crabs is prohibited in Newark Bay; however, the minimum size for harvesting hard-shell blue crabs in New Jersey is 4.5 inches (NJDEP, Division of Fish and Wildlife).
3. The sex of crabs caught was recorded but is not documented above.
4. During deployment other species, such as fish, that were inadvertently trapped were recorded, but not documented above.

Table 5-2
Bivalve Clam Collection Results

Intertidal Location	Bivalve Occurrence				Softshell Clam Size Range (inches)[2]
	Softshell Clam	Ribbed Mussel	Atlantic Oyster	Other[1]	
122	19	XX	X	-	0.9 - 2.4
123	2	XX	X	XX	1.1 - 1.2
124[3]	-	X	X	-	-
125	1	XX	-	X	0.87
126	6	XX	-	-	2.0 - 2.7
127	4	XX	X	-	2.1 - 2.7
128	3	XX	-	X	1.1 - 2.5
129	2	XX	X	-	1.3 - 2.0
Total	37				

Notes:

1. Other bivalve species were relatively small (less than 0.5 inch) clams, assumed to be Baltic clams (*Macoma balthica*).

2. Only measurements of softshell clams are reported because they represent the target species for future sampling efforts.

3. Access to this area was not possible during the latter part of the survey because absorbent booms were in place due to a recent oil spill.

- = Not observed.

X = Observed infrequently (four or less individuals).

XX = Observed frequently (more than four individuals).

Table 6-1
Bird Nest Observations

Shoreline Segment[1]	Possible Species	Description	Appendix	Coordinates (DD.MM.SSSS)[2]	
				Longitude	Latitude
1	Osprey	Single nest on old rusty boiler	B-22	40.38.6217	74.10.0793
4	Cormorant	~ 8 nests on mile marker in channel near Bayonne Bridge		40.38.6363*	74.08.7421*
24	Cormorant	~ 9 nests on mile marker #15		40.40.6110	74.08.0855
25	Osprey	Single nest on piling		40.39.6314	74.09.3917
29/30	Gull/cormorant	~ 8 nests on mile marker #22		40.38.8688	74.10.2905
32	Osprey/cormorant	~15 nests on abandoned wooden structures		40.38.6657	74.09.8760

Notes:
1. Shoreline segments are shown on Figure 3-1.
2. Bird nest observation locations are shown on Figure 3-2.
*Coordinates are estimates.

Table 6-2
Mammal Observations

Shoreline Segment[1]	Observation	Likely Species	Appendix	Coordinates (DD.MM.SSSS)[2]	
				Longitude	Latitude
1	Tracks, scat	deer (tracks), rabbit (scat), coyote (scat)	B-23	40.38.6964	74.10.4423
7	Tracks	cat, raccoon, rat	-	40.39.5178*	74.08.1180*
15	Tracks	rat, muskrat	-	40.41.2112	74.06.7362
18	Tracks	cat, raccoon, rat	-	40.42.2433	74.06.3013
20	Tracks, scat	raccoon (tracks), rat (scat)	-	40.43.0633*	74.06.6088*
20	Tracks	unidentified animal tracks [3]	B-23	40.43.0633*	74.06.6088*
22	Tracks, scat, direct	raccoon (tracks), skunk (tracks), coyote (tracks), rat (tracks), rabbit (scat), muskrat (direct), dog (tracks)	B-23, B-24	40.41.7841*	74.07.4657*
27	Direct, tracks	rat (direct), raccoon (tracks)	B-24	40.39.2781	74.10.1110
29/30	Direct, tracks	rat	B-24	40.38.8206	74.11.0604

Notes:

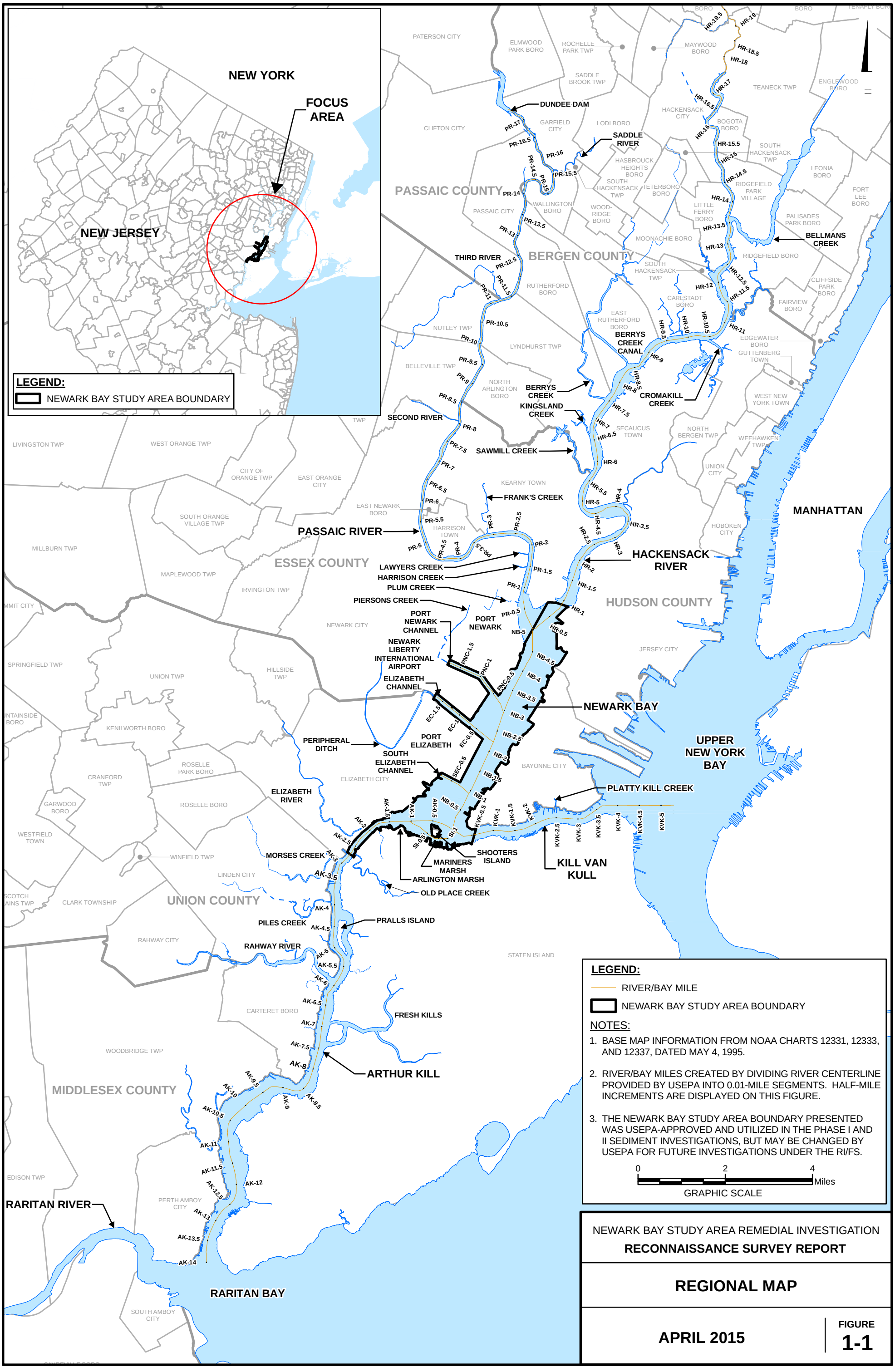
1. Shoreline segments are shown on Figure 3-1.

2. Mammal observation locations are shown on Figure 3-2.

3. During the field reconnaissance there was discussion between ARCADIS and Battelle field personnel regarding whether observed mammal tracks could be mink. It was agreed that photos would be taken and the tracks identified following the field work. Subsequent review of track photos by several ARCADIS biologists/ecologists positively identifed the tracks as muskrat.

Figures

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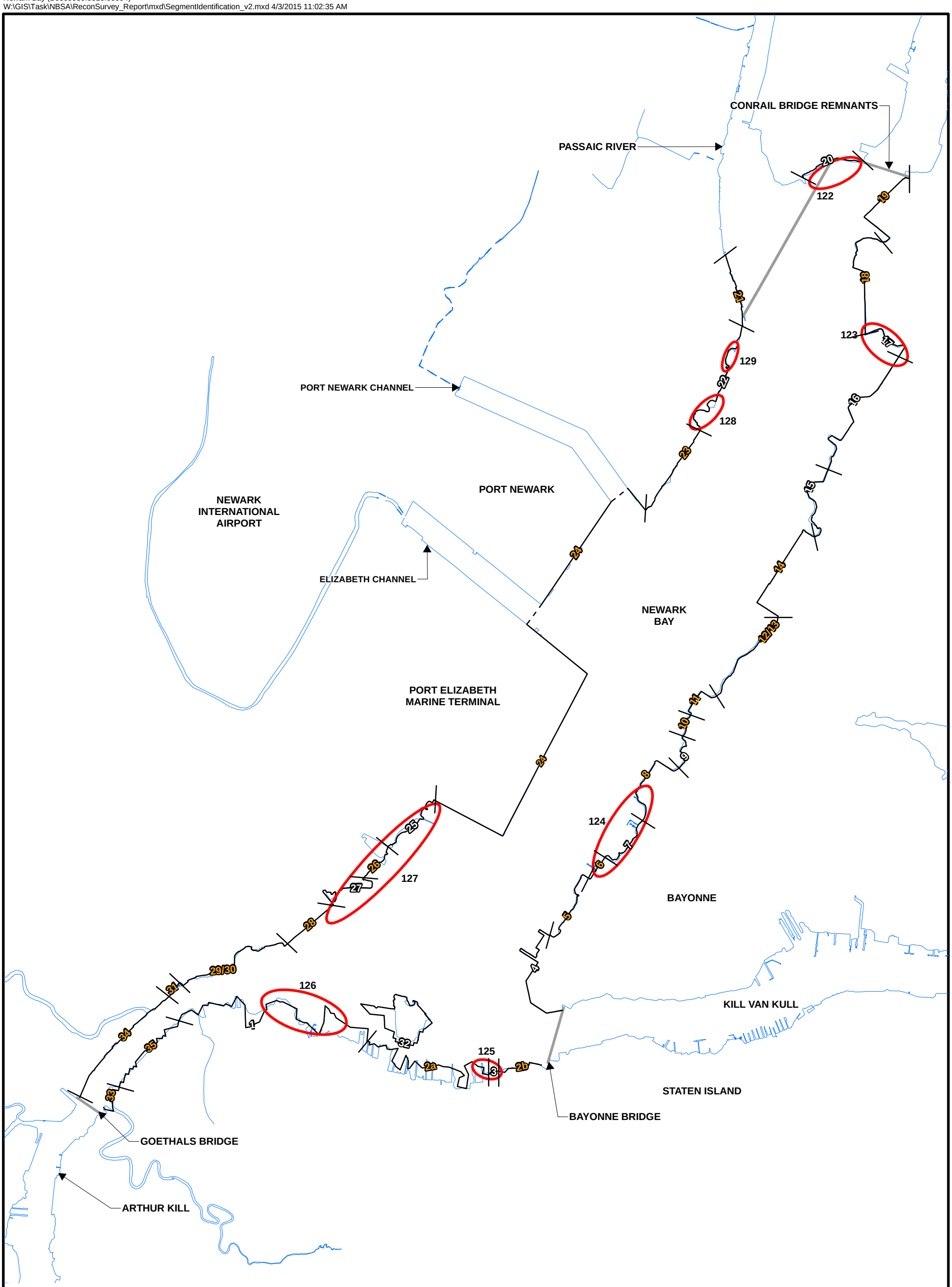
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
RECONNAISSANCE SURVEY REPORT

REGIONAL MAP

APRIL 2015

FIGURE 1-1

CITY: SYR DIV/GROUP: IT DB: KES LD: PIC: PM: TM: TR:
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LEGEND:

- TARGETED CRAB AND CLAM SAMPLING AREA
- SEGMENT ID
- NEWARK BAY STUDY AREA BOUNDARY
- SHORELINE
- UNDERGROUND TRIBUTARY

0 3,000 6,000 Feet
GRAPHIC SCALE

NOTE:

1. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.
2. BIRD NEST AND MAMMAL SURVEYS WERE NOT CONDUCTED ON FOOT IN SEGMENT IDS (IN ORANGE) 2, 5, 6, 8, 10, 11, 12, 13, 14, 18, 19, 21, 23, 24, 26, 28, 29, 30, 31, 33, 34, AND 35 BECAUSE THEY ARE COMMERCIAL OR RESIDENTIAL LAND USE AREAS.

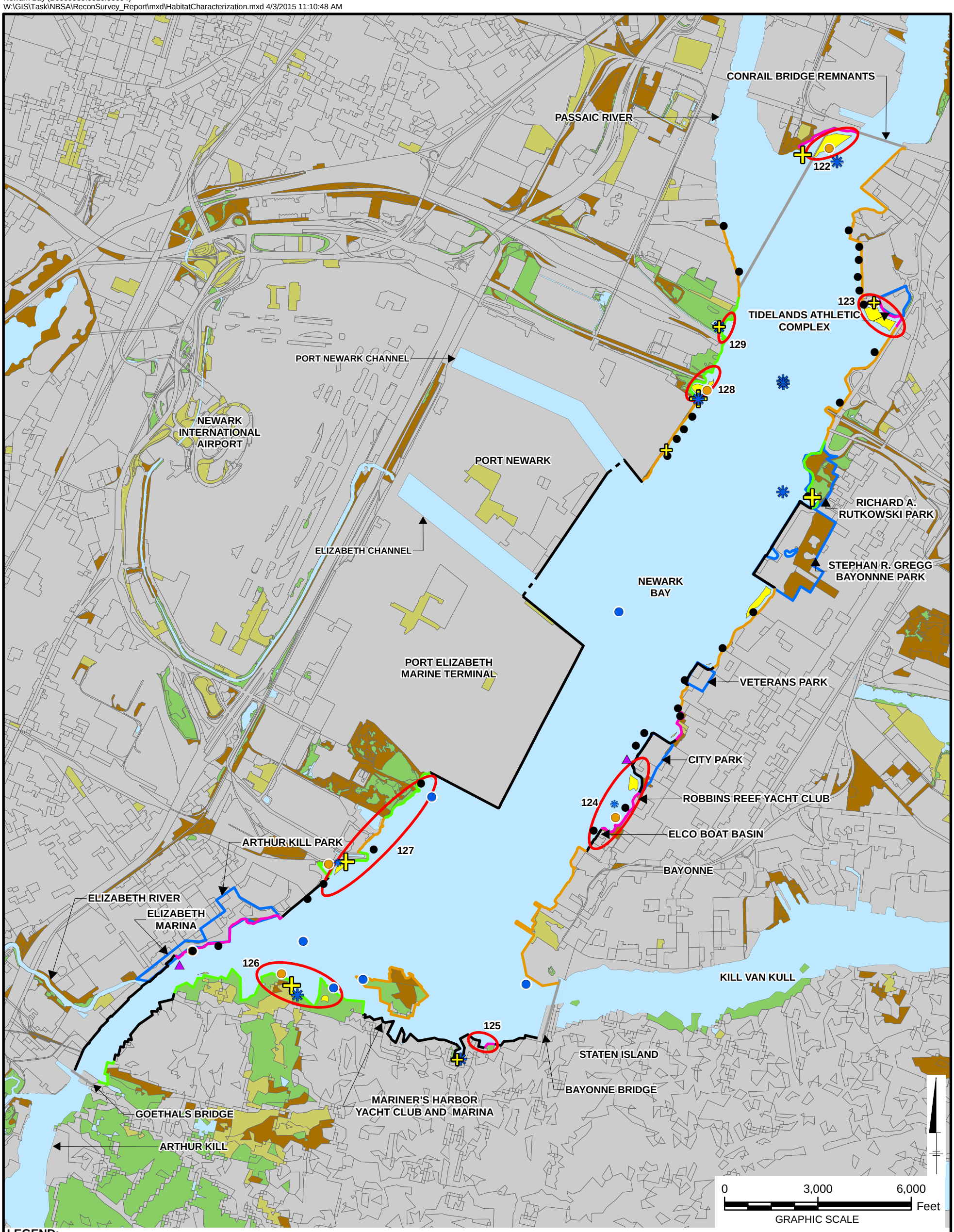
NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
RECONNAISSANCE SURVEY REPORT

SHORELINE SEGMENT IDENTIFICATION

APRIL 2015

FIGURE 3-1

CITY: SYR DIV/GROUP: IT DB: KES LD: PIC: PM: TM: TR:
Newark Bay (B0009989.0016.00004)
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LEGEND:

- CLAM STATION (< 4 SAMPLES)
- CLAM STATION (> 4 SAMPLES)
- CRAB STATION (< 4 SAMPLES)
- CRAB STATION (> 4 SAMPLES)
- TARGETED CRAB AND CLAM SAMPLING AREA
- BIRD NEST LOCATION
- MAMMAL OBSERVATION
- DISCHARGE PIPE OBSERVATION
- BOAT RAMP
- NEWARK BAY STUDY AREA BOUNDARY
- INTERTIDAL AREA
- PARKS AND RECREATIONAL AREAS

OBSERVED SHORELINE HABITAT:

- BULKHEAD
- MIXED INTERTIDAL
- RIPRAP
- VEGETATION

LANDCOVER:

- BARREN LAND
- FOREST
- URBAN
- WATER
- WETLANDS

NOTES:

1. 2007 NEW JERSEY LAND USE DATA DOWNLOADED FROM THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION GEOGRAPHIC INFORMATION SYSTEM WEBSITE AT www.state.nj.us/dep/gis.
2. 2006 NEW YORK NATIONAL LAND COVER DATA DOWNLOADED FROM THE NEW YORK STATE GEOGRAPHIC INFORMATION SYSTEMS CLEARINGHOUSE AT www.nysgis.state.ny.us.
3. THE INTERTIDAL AREAS SHOWN ARE CONSISTENT WITH THOSE PRESENTED IN THE PROBLEM FORMULATION (TIERRA 2013) AND WERE VERIFIED DURING THE RECONNAISSANCE SURVEY.
4. THE NEWARK BAY STUDY AREA BOUNDARY WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.
5. BIRD NEST OBSERVATIONS ARE DESCRIBED IN TABLE 6-1.
6. MAMMAL OBSERVATIONS ARE DESCRIBED IN TABLE 6-2.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

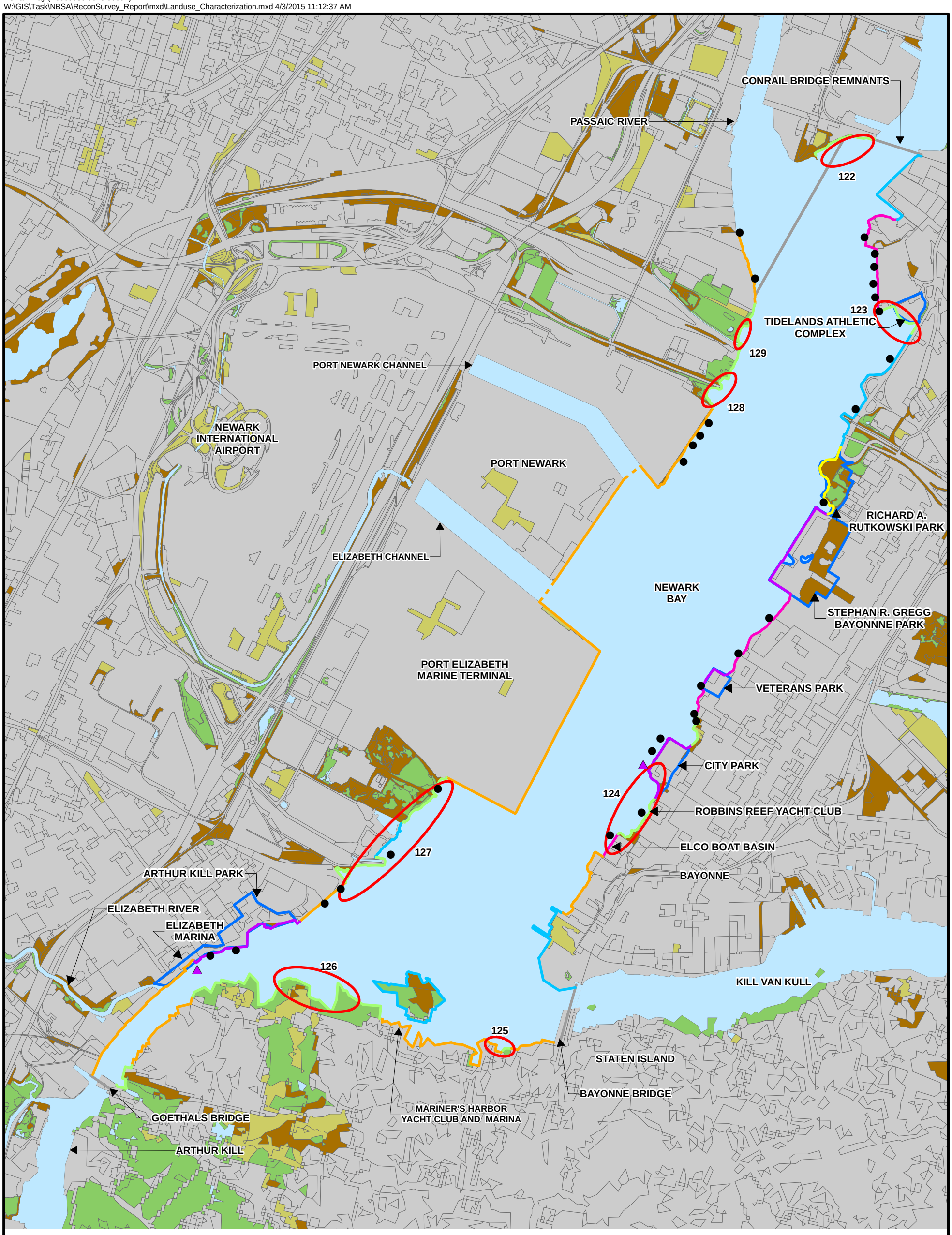
RECONNAISSANCE SURVEY REPORT

SHORELINE HABITAT CHARACTERIZATION AND SAMPLING STATIONS

APRIL 2015

FIGURE
3-2

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LEGEND:

- SAMPLING LOCATION
- DISCHARGE PIPE OBSERVATION
- BOAT RAMP
- NEWARK BAY STUDY AREA BOUNDARY
- PARKS AND RECREATIONAL AREAS

OBSERVED SHORELINE USE:
- DISTURBED UPLANDS
- HABITAT
- HABITAT/RECREATIONAL
- INDUSTRIAL/COMMERCIAL
- RECREATIONAL
- RESIDENTIAL

LANDCOVER:
- BARREN LAND
- FOREST
- URBAN
- WATER
- WETLANDS

0 3,000 6,000 Feet
GRAPHIC SCALE

NOTES:

1. 2007 NEW JERSEY LAND USE DATA DOWNLOADED FROM THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION GEOGRAPHIC INFORMATION SYSTEM WEBSITE AT www.state.nj.us/dep/gis.
2. 2006 NEW YORK NATIONAL LAND COVER DATA DOWNLOADED FROM THE NEW YORK STATE GEOGRAPHIC INFORMATION SYSTEMS CLEARINGHOUSE AT www.nysgis.state.ny.us.
3. THE NEWARK BAY STUDY AREA BOUNDARY PRESENTED WAS USEPA-APPROVED AND UTILIZED IN THE PHASE I AND II SEDIMENT INVESTIGATIONS, BUT MAY BE CHANGED BY USEPA FOR FUTURE INVESTIGATIONS UNDER THE RI/FS.
4. DISCHARGE PIPE OBSERVATIONS SHOWN DO NOT REPRESENT COMPREHENSIVE INVENTORY OF DISCHARGE PIPES LOCATED ALONG THE SHORELINE.

NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION
RECONNAISSANCE SURVEY REPORT

SHORELINE LAND/HUMAN USE CHARACTERIZATION

APRIL 2015

FIGURE 4-1

Appendix A

Field Data Forms

Segment (1)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Southern Bay ① mixed intertidal - AK confluence

Date: 9/11/13 **Time:** 11am, 3pm (9/13)

Crew: Melissa + Dave DKR, MB

Weather Conditions: Hot/sunny **Tide:** coming in

Habitat Type: marsh/wetland/intertidal

Habitat Description: Area between Arthurkill + Mariner's Harbor Yacht Club

Plant Community/Dominant Plant Species:

Spartina, phragmites, Birch, upland trees
Cottonwood, Aspen, Locusts, sumac

Wildlife Observed:

osprey + nest — little green heron
cormorants — mallard
herring gulls — Canada goose
tern

Photolog: Video

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Arthur Kill
Mariner's Harbor Yacht Club

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: Shoreline for intertidal areas combination of soft sediment, rip-rap, and some bulkheads

Signature: DTKA

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Segment 1

Date: 9/11 - 9/14 **Time:**

Crew: DKR, MB

Weather Conditions: Sunny, 70°F **Tide:** NA

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):
~~Adult dock workers~~ NA

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog: - video along entire shoreline

Additional Notes:

Signature: Melissa Beaulieu

(1)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Arthur Kill Intertidal / confluence to Bay

Date: 9/13 **Time:** 3pm

Crew: Dave + Melissa

Weather Conditions: Sunny

Bird Nest Survey Observations None Ø

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

N/A

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature Melissa A Bencin

(1)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Segment 1

Date: 9/13 **Time:** 3pm

Crew: DKR MB

Weather Conditions: sunny

Mammal Survey Observations

Observation Type: Tracks, Scat, Scat Species: Deer, Rabbit, Coyote

GPS Coordinates: 40° 38.81864 74° 10.4423

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat: NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: Melissa A Beaudin

Segment (2)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Southern Bay (2) industrial/commercial

Date: 9/11/13 **Time:** 11:15

Crew: Melissa/Dave DKR, MB

Weather Conditions: Sunny **Tide:**

Habitat Type: Industrial / Commercial

Habitat Description: Mariners Harbor Yacht Club → Beyond Shooters ~~Island~~ Island → Bayonne Bridge

Plant Community/Dominant Plant Species:

~~NONE~~ NA

Wildlife Observed:

canada geese
Dock/Boat workers/welders
cormorant
gulls
Common ~~least~~ tern

Photolog: #

Buy marker 22 - Bird nests

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

N/A

Signature: Melissa A Beaulieu

(2)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Industrial/southern bay

Date: 9/11/13 **Time:** 11:30

Crew: Dave + Melissa

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 5 Activity: workers/welding/portworkers

Estimated Age: Adult men

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: Melissa A Benkert

(2)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: (2) Industrial / Southern portion of Bay

Date: 9/11 **Time:** 11:30

Crew: DR + MAB

Weather Conditions: sunny

Bird Nest Survey Observations

Species (Potential or Known): Osprey Nest Description: Large on old boiler

Habitat:

GPS Coordinates: 40°38.6217 74°10.0793 Number of Nests: 1

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature Melissa A Beaulieu

(2)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Industrial/Southern Bay

Date: 9/11 **Time:** 11:30

Crew: DR+MAB

Weather Conditions: sunny

Mammal Survey Observations None observed/Industrial Area

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species: N/A MAB

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: Melissa A Beaulieu

Segment (3)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Southern Bay (3) mixed intertidal

Date: 9/13 **Time:** 1:50

Crew: Melissa/Dave

Weather Conditions: sunny **Tide:** high

Habitat Type: small Intertidal Area near Bayonne Bridge

Habitat Description:
Spartina
trees
surrounded by industrial area

Plant Community/Dominant Plant Species:

Wildlife Observed: gulls

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Commercial/Industrial

Habitat Features:

Type:	GPS Coordinates: N/A
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature:

(3)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Mixed Intertidal area in Southern Bay

Date: 9/13 **Time:** 1:50

Crew: MAB+DR

Weather Conditions: sunny **Tide:** high

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: Ø Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog: NA

Additional Notes:

Signature: Melissa A Beuth

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Mixed intertidal area in Southern Bay

Date: 9/13 **Time:** 1:50

Crew: MAB+DR

Weather Conditions: Sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature Melissa A Beech

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Mixed Intertidal Area in Southern Bay

Date: 9/13 **Time:** 1:30

Crew: MAB+DR

Weather Conditions: Sunny

Mammal Survey Observations None observed

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: Melissa A Beaven

Segment (4)

9/14

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: KVK → Bay (4)

Date: 9/11-9/15 **Time:** 11:30

Crew: MAB+DR

Weather Conditions: sunny **Tide:**

Habitat Type: disturbed/upland

Habitat Description: Disturbed/upland

Plant Community/Dominant Plant Species:

scrub/shrub/disturbed/rocky shore - manmade riprap
phragmites
small trees
upland grass

Wildlife Observed:

Canada Geese
Nests on Markers (osprey or cormorant)
mourningdoves

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature:

(4)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: (4) Abandoned riprap, scrub shrub, vacant land

Date: 9/13 **Time:** 4pm

Crew: DR+MAB

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: vacant land

Number of People Observed: Ø Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

NT

Additional Notes:

Signature: Melissa A Baird

(4)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Abandoned, vacant land, scrub/shrub

Date: 9/13 **Time:** 4pm

Crew: MAB+DR

Weather Conditions: sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): NA Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature Melissa A Beaulieu

(4)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Abandoned, vacant land, scrub/shrub

Date: 9/13 **Time:** 4pm

Crew: MMBTDR

Weather Conditions: sunny

Mammal Survey Observations None observed

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: Melissa A Beaute

Segment (5)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (5) Industrial / Abandoned

Date: 9/11-9/15 **Time:** 11:50

Crew: MAB / DR

Weather Conditions: sunny **Tide:**

Habitat Type: industrial / abandoned

Habitat Description: Rip Rap / Industrial / Abandoned
more open space

Plant Community/Dominant Plant Species:
trees

Wildlife Observed:
Mallard herring gull
Kingfish
Ring-billed gull
Canada geese

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

NJ

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Industrial / Abandoned

Date: 9/14/13 **Time:** 755

Crew: DR / JEB

Weather Conditions: **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: none observed

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog: 1447 - 1454

Additional Notes: 9/14 - cleaning up oil spill - 3 smaller boats ~ 2 people on each and 6 on shoreline
1420
9/15 - 845 - empty - nothing - no clean up - both boats out

Signature: JEB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Industrial/Abandoned

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions:

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature Melissa A Beaulieu

(5)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Industrial/Abandoned

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: Sunny

Mammal Survey Observations None observed

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: Melissa A Beaudin

Segment (6)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (6) Residential/Commercial / Elco Boat Basin Marina

Date: 9/11-9/15 **Time:** 12:00

Crew: MAB/DR

Weather Conditions: Sunny **Tide:**

Habitat Type: Residential/Commercial

Habitat Description:
Bulkheaded

Plant Community/Dominant Plant Species:

Wildlife Observed:
(9/11) 1 Fisherman at point near Elco Boat Basin (Adult male)
~~Robin~~ edge tide

Photolog: CSO photo #25

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 24" pipe/Blackover	GPS Coordinates: 40° 38.5481 74° 9.4983 No discharge
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature: MAB

(6)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Elco Boat Basin (6)

Date: 9/13 **Time:** 12:00

Crew: MAB/DR

Weather Conditions: Sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 1 (9/13) Activity: Fishing

Estimated Age: Adult Male

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Elco Boat Basin Marina

Date: 9/11-9/13 **Time:** 12

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(6)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Elco Boat Basin Marina

Date: 9/11-9/13 **Time:** 12

Crew: BMAB/DR

Weather Conditions: sunny

Mammal Survey Observations None observed

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (7)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (7) Intertidal Area near residences @ Elco Bot Basin → Robins Reef YC → Beyond

Date: 9/11-9/15 **Time:** 1200

Crew: MAB/DR

Weather Conditions: Sunny **Tide:** ~~EBB~~

Habitat Type: Mixed intertidal, including RRYC - residential/commercial

Habitat Description: Mixed intertidal - residential behind
Spartina on ½, riprap/trees other half, sandy shoreline

Plant Community/Dominant Plant Species:
Spartina in front of bulkhead
trees to edge in Rocks
RipRap/MudFlat/sandy shoreline on other side of RRYC

Wildlife Observed:

Brant	GBH
Herring Gull	sandpiper
Mallard	oiled mallard
2 shorebirds	blue winged-teal

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: ~~industrial~~

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: CSO #13 on sandy beach	GPS Coordinates: 40° 38.5481 74° 9.4983 Locked, No daylight
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: Lots of oil washed onshore - 9/13
Heavy petroleum smell
Oiled mallard

Signature: Melissa A Bianchin

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Intertidal Area w RRYC

Date: 9/11-9/15 **Time:** 12

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]): NA

Zone: Industrial/Commercial/Residential/Recreational/Other: Houses w fences, no access

Number of People Observed: Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Intertidal Area @ RRYC

Date: 9/11-9/15 **Time:** 12

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): NA Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(7)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Intertidal Area @ RRYC

Date: 9/11-9/15 **Time:** 12:00

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: ~~Feral~~ tracks Species: cat, raccoon, rat

GPS Coordinates: 40.38.5481 74°9.4983

Habitat: sandy shore

Photolog:

Additional Notes:

Signature: MAB

Segment (8)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (8) City Park

Date: 9/11-9/15 **Time:** 12:00

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Habitat Type: Recreational

Habitat Description: Rip Rap
~~Residential~~ Park - Recreational
Soccer fields/tennis courts/Baseball fields

Plant Community/Dominant Plant Species:

Wildlife Observed:
3 Recreational Fishers (adult men)
2 (9/3)

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 2 pipes (18" + 24")	GPS Coordinates: 40° 38.5481 74° 9.4983 partially submerged
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

NA

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: City Park

Date: 9/11-9/15 **Time:** 12:00

Crew: MAB | DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 1 Activity: Fishing

Estimated Age: Adult man

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: Boat launch
9/14 755 – NONE
1425 – None fishing ~~fatpic~~ 1 adult biking
9/15 ~~845~~ 850 – 3 adults fishing

Signature: MAB

(8)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: City Park

Date: 9/11-9/15 **Time:**

Crew: MAB|DR

Weather Conditions: sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: City Park

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: Sunny

Mammal Survey Observations None observed

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (9)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (9) Intertidal Area – Beyond City Park

Date: 9/13 **Time:** 12:00

Crew: MAB/DR

Weather Conditions: cloudy **Tide:**

Habitat Type: mixed intertidal

Habitat Description:
small marsh, sandy beach, upland trees

Plant Community/Dominant Plant Species:
~~Canada geese~~
spartina, willow trees, chokecherry, locust, sumac phragmites

Wildlife Observed:
Canada geese

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

NA

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

N/A

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Intertidal Area Beyond City Park

Date: 9/13 **Time:** 12:00

Crew: MAB/DR

Weather Conditions: cloudy **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]): NA

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 0 NA Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: Signs of humans on sandy shore area, none observed

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Intertidal Area Beyond City Park

Date: 9/13 **Time:** 12

Crew: MAB/DR

Weather Conditions: Cloudy

Bird Nest Survey Observations No signs of nests

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Intertidal Area Beyond City Park

Date: 9/13 **Time:** 12

Crew: MAB/DR

Weather Conditions: cloudy

Mammal Survey Observations No signs

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (10)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (10) Residential CSO Area Beyond intertidal area/Beyond city Park - Assisted Living home Trailer Park

Date: 9/13 **Time:** 12:20

Crew: MAB/DR

Weather Conditions: cloudy **Tide:**

Habitat Type: Residential

Habitat Description: CSOs, bulkhead, fence

Plant Community/Dominant Plant Species:
scrub shrub, ornamental landscape

Wildlife Observed:

Photolog: #26 - CSO end of street

(10)

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

40.40.0569 740 [illegible] 6631

Type: CSO partially submerge	GPS Coordinates: ~~40°38.5481 74°9.4983~~
Type: Assisted living home (?)	GPS Coordinates: ~~40°38.5481 74°9.4983~~ No discharge
Type:	GPS Coordinates: 40.40.0978 74°7.6774
Type:	GPS Coordinates:
Type:	GPS Coordinates:

wrong coordinates

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

(10)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Assisted Living Home / Residential Area Beyond city Park, Trailer Park

Date: 9/15 **Time:** 9:15

Crew: ~~MA~~JEB/DR

Weather Conditions: Sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 2 Activity: Walking Dogs

Estimated Age: Adults

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: Trailer Park + 2 Large Apt Bldgs

9/15 900 - 2 Adults walking dogs

Signature: MAB

(10)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Assisted Living Home, Trailer Park

Date: 9/13 **Time:** 12:20

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(10)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Assisted Living Home, Trailer Park

Date: 9/13 **Time:** 12:20

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations None observed

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (11)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (11) Veterans Park

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Habitat Type: Recreational

Habitat Description: Recreational

Plant Community/Dominant Plant Species:

30 Fishermen (adult men)
5 Fishermen (adult men)

Wildlife Observed:

Photolog: CSO pipes #28

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 2 partially submerged	GPS Coordinates: 40°40.2452 74°7.6302
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

NA

Signature: MAB

(11)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Veteran's Park (11)

Date: 9/11-9/15 **Time:**

Crew: JEB/DR/MAB

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 5 Activity: Fishing

Estimated Age: adult men

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: 9/14 - 800 - none
1425 2 Adult walking,
1 ~~0~~ Adult fishing
9/15 905 3 ~~2~~ Adult fishing - photos 1461 - 1463

Signature: MAB

(11)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Veterans Park

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None observed

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(11)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Veterans Park

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: None observed

Mammal Survey Observations

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (12)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (12) Muddy shore beyond Veterans Park

Date: 2/11-2/15 **Time:** 3:30

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Habitat Type:

Habitat Description: Muddy shore → Bulkhead cement Riprap
Residential/commercial

Plant Community/Dominant Plant Species:

Wildlife Observed: Egret

Photolog: #29 CSO

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: N/A

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: covered submerged CSO	GPS Coordinates: 40° 40.6048 74° 7.1510
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

N/A

Signature:

MAB

(12)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Muddy Shore Beyond Veterans Park

Date: 9/11-9/15 **Time:** 3:30

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: None Ø Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(12)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Muddy Shore Beyond Veterans Park

Date: 9/11-9/15 **Time:** 3:30

Crew: MAB/DR

Weather Conditions: Sunny

Bird Nest Survey Observations No observations NA

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Muddy shore Beyond Veterans Park

Date: 9/11-9/15 **Time:** 3:30

Crew: MAB/DR

Weather Conditions: Sunny

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (13)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (13) Residential / Fenced

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: Sunny **Tide:**

Habitat Type: Residential

Habitat Description: Trees to shoreline, riprap
No res. access
muddy shoreline along both edges of residential segment (combine 12/13)

Plant Community/Dominant Plant Species:

Wildlife Observed:
Shorebird

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: CSO	GPS Coordinates: 40° 40.4167 74° 7.3672
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Residential / Fenced

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: muddy shoreline along edge of segment, runs into Segment 12

Signature: MAB

(13)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Residential / Fenced

Date: 9/11-9/15 **Time:**

Crew: MAB / DR

Weather Conditions: Sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(13)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Residential Fenced

Date: 9/11-9/15 **Time:**

Crew: MAB/DR.

Weather Conditions: Sunny

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (14)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Bayonne Park / ~~Rutkowski Park~~

Date: 9/13-9/15 **Time:** 1230

Crew: Dave/Melissa

Weather Conditions: Sunny **Tide:** High

Habitat Type: Bulkheaded

Habitat Description: recreational, 4 fishing (9/11)

Plant Community/Dominant Plant Species:

Wildlife Observed: NA

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

NA

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: N/A

Signature: MAB

(14)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Bayonne Park (14)

Date: 9/12 **Time:** 930

Crew: Melissa, Dave, Norm, Carlie | DR+JEB

Weather Conditions: Hot/sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: Recreational

Number of People Observed: 23, 5, 1 Activity: Fishing

Estimated Age: Adult men

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: 9/14 800 4 Adults fishing
~~8~~ 20 Adults Total: most walking, 5 taking photo shoot
4 fishing - 1 caught fish,
2 child fishing
9/15 910 6 fishing - 11 Adult - 1 child
3 sitting, 3 walking, 4 joggers Adults

Signature:
MAB | JEB

(14)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Bayonne Park

Date: 9/13-9/15 **Time:** 1230

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Bayonne Park

Date: 9/13-9/15 **Time:** 12:30

Crew: DB+MAB

Weather Conditions:

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (15)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Rutkowski Park (15)

Date: 9/13 - 9/15 **Time:** 1:40

Crew: Melissa / Dave

Weather Conditions: Sunny **Tide:** high

Habitat Type: Intertidal, parkland

Habitat Description: walking path

Plant Community/Dominant Plant Species:
Spartina

Wildlife Observed: mallards

Photolog:

(15)

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Photo 1 – Type: 36" pipe w/ visible discharge	GPS Coordinates: N40 41.2194 W74 10.7675
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature:

(15)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Rutkowski Park

Date: 9/13-9/15 **Time:** 1:40

Crew: MAB/DR

Weather Conditions: sunny **Tide:** high

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 1 Activity: walking

Estimated Age: Adult man

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: 9/14 835 1 Adult male fishing - tent on beach
1430 2 Adults - 2 dogs swimming (male + female) GPS: N 40 41.3297
W 74 0.7567
7 Adults - 1 child fishing

Signature: 9/15 910 1 Adult w/ dog swimming tent still set up
1 Adult biking, 1 Adult fishing
photos 1964-1965 (JEB)

(15)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Rutkowski Park

Date: 9/13-9/15 **Time:** 1:40

Crew: MAB/DR

Weather Conditions:

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(15)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Ruthkowski Park

Date: 9/14/13 **Time:** 820

Crew: JEB/DR

Weather Conditions:

Mammal Survey Observations

Observation Type: tracks Species: rat, muskrat

GPS Coordinates: N40 41.2117 W74 6.7367

Habitat: sand flat adj. to spartina marsh

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAG/JEB/DR

Segment (16)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Rip/Rap Rocky shore upland vegetation, continues under + past bridges

Date: 9/13 - 9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Habitat Type: Rocky, upland shoreline - guardrail - highway

Habitat Description: Rocky upland scrub/shrub, sumac

Plant Community/Dominant Plant Species:
Trees

Wildlife Observed:
NA

Photolog: 1350-1353 (JEB)

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: residential / commercial

Habitat Features: r.prap, rocky shoreline, guardrail

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: closed door CSO, no discharge	GPS Coordinates: 40°41.9827 74°63.000
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

(16)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Riprap, upland veg, highway, under Bridges

Date: 9/13-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 5, 1 Activity: Fishing, sunbathing

Estimated Age: adult males, 1 female

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature:
MAB

(16)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Rip Rap, upland veg, highway, under bridges

Date: 9/13-9/15 **Time:**

Crew: MAB-DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes Checked for swallow nests under bridges - none

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Rip Rap upland veg, along highway, under bridges

Date: 9/13-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (17)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Tidelands Athletic Complex – (17)

Date: 9/14/13 **Time:** 840

Crew: JEB, DKR

Weather Conditions: sunny, 60s **Tide:** heading to low

Habitat Type: mudflat / rocky shoreline - athletic field beyond fence

Habitat Description:
primarily riprap shoreline, spartina line, sandy beach near low tide

Plant Community/Dominant Plant Species:
spartina

Wildlife Observed:
teal, mallard, black duck

Photolog: Note: same as station 129 for crab/clam sampling
1354-1355 JEB

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

NA

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature:

(17)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Irvelands Athletic Complex

Date: 9/14/13 **Time:** 8:40

Crew: JEB/DKR

Weather Conditions: sunny **Tide:** going out

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]): NR

Zone: Industrial/Commercial/~~Residential~~/~~Recreational~~/Other: none

Number of People Observed: Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:
riprap shoreline

Signature: MMB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Tidelands Athletic Complex

Date: 9/14/13 **Time:** 8:40

Crew: JEB DKR

Weather Conditions: Sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature JEB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Tidelands Athletic Complex

Date: 9/14/13 **Time:** 8:40

Crew: JEB, DKR

Weather Conditions: sunny

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (18)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Residential Condos north of Athletic complex - (18)

Date: 9/14 - 9/15 **Time:** BSD - 920

Crew: D. Riggs, J. Burnett, C. Thompson, N. Richardson

Weather Conditions: SUNNY 60s **Tide:** ~~to~~ heading towards low

Habitat Type: riprap shoreline - guard rail - residential, bulkhead

Habitat Description:
- rocky shoreline
- new st spartina
- concrete wall / guard rail
- sycamores - planted
- residential

Plant Community/Dominant Plant Species:
Spartina, line of sycamores

Wildlife Observed: wren, gulls, crow

Photolog: 1356 - 1354 (60) JEB

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: residential

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: box culvert, part submerged	GPS Coordinates: N 40 42.2433 W 74 6.3013
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

photo 13e8-1370 JEB

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MB

(18)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Residential Condos N. of Athletic Complex

Date: 9/14/13 **Time:** 850 - 920

Crew: D. Rigg, J. Burns, C. Thorsen, N. Richardson

Weather Conditions: Sunny low **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/~~Residential~~/Recreational/Other:

Number of People Observed: ~~8 9~~ 13 Activity: running | walking | walking dog

Estimated Age: ~~25-50 2 5 60s~~ Adults ~~X~~ 1 child ~6

GPS Coordinates and/or Approximate Location:

Photolog: 1360

Additional Notes: 9/15 · 920 5 Adults jogging/walking

Signature: MPB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Condo Complex, North of Athletic Complex

Date: 9/14-9/15 **Time:** 8:50-9:20

Crew: DLR, JEB

Weather Conditions:

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(18)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Athletic Field 18

Date: 7/14 **Time:** 920

Crew:

Weather Conditions: Sunny 60s

Mammal Survey Observations

Observation Type: tracks Species: feral cat, raccoon, rat (Norway)

GPS Coordinates: N. 40 42.2433 W 74 6.3613

Habitat: mudflat adj to Sporting

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

MAB

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: After Condo Complexes, NE corner of Bay (19)

Date: 9/11-9/15 **Time:**

Crew: MAB, DR

Weather Conditions: Sunny **Tide:**

Habitat Type: Construction/Abandoned Land - former Honeywell site

Habitat Description: Bulkhead, disturbed abandoned area

Plant Community/Dominant Plant Species: None

Wildlife Observed: None

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

NA

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: NE corner of Bay, Former Honeywell Site

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: machinery/equipment

Number of People Observed: 0 Activity: Construction work

Estimated Age: Adult

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: All people were inside vehicles + none were directly observed counted or construction work not ongoing during survey

Signature:

MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: After Condo Complex, NE Corner of Bay

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: After Condo Complex, NE Corner of Bay

Date: 9/11 9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations

Observation Type: Species: NA

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (20)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: (20) Kearny Point

Date: 9/11, 9/12 **Time:** 4:30, 10am

Crew: Norm, Carlie, Dave, Melissa

Weather Conditions: sunny **Tide:**

Habitat Type: Intertidal

Habitat Description:
spartina, some riprap
phragmites, mudbanks
Cargo containers

Plant Community/Dominant Plant Species:
Spartina → Phrag → Cottonwood, Polonia

Wildlife Observed: Beds of ribbed mussels
Mallards
Canada geese
Herring gull

Photolog: See Norm's *

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature:

(20)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Station 20 / Keary Pt

Date: 9/14 **Time:** 850

Crew: JEB / DR / MAB

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 13 Activity: jet skiing

Estimated Age: Adult

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(20)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Kearny Pt

Date: 9/12 **Time:** 10 am

Crew: Melissa, Dave, Carlie, Norm

Weather Conditions: Hot/sunny

Bird Nest Survey Observations NONE

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MSD

(20)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Kearny Pt (20)

Date: 9/12 **Time:** 10am

Crew: Melissa, Dave, Carlie, Norm

Weather Conditions: Hot/Sunny

Mammal Survey Observations

Observation Type: Scat Species: Rat

GPS Coordinates:

Habitat: Phragmites, Spartina, Cottonwood

Observation Type: Tracks Species: Raccoon

GPS Coordinates:

Habitat:

Observation Type: Tracks Species: unknown

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MB

Segment (21)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: ~~Station~~ segment 21

Date: ~~9/14~~ 9/14-9/15 **Time:** 1010 – 1015

Crew: D Rigg, J Bluvias, C Thomson, N. Richardson

Weather Conditions: Sunny, Lgs **Tide:** low

Habitat Type: Industrial

Habitat Description:
industrial rocky/riprap/hard structure lined shore
near mouth of Passaic
HESS stn, PVSC

Plant Community/Dominant Plant Species:
—

Wildlife Observed: Kingfisher
—

Photolog: 1386 – 1391

(21)

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Industrial

segment 22

Habitat Features:

Type: Military	GPS Coordinates: N 40 42.6557 W 74 E 7.3458
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

(1) Type: 12" cast iron w/ baffle	GPS Coordinates: N 40 42.4119 W 74 7.2403
Type: slight discharge	GPS Coordinates:
(2) Type: additional of same type	GPS Coordinates:
Type: close to just south of outfall	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

photos 1393-1394 seb 1395-1397

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

(21)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: (21) Industrial

Date: ~~MAB/DR~~ 9/11 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(21)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: (21) Industrial

Date: 9/11 **Time:**

Crew: MAB/DR

Weather Conditions:

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(21)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Industrial

Date: 9/11/13 **Time:**

Crew: MAB/DR

Weather Conditions:

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (22)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: segment 7 x

Date: 9/14 - 9/15 **Time:** 1015

Crew: D Riggs, J. Bluvias, C. Thompson, N. Richardson

Weather Conditions: sunny 60s **Tide:** low

Habitat Type: intertidal marsh - large under bridges

Habitat Description: (same as Cobden stations 128-129)
sandy shoreline, rocky shore near bridges

Plant Community/Dominant Plant Species:
~~Phrag~~ shoreline - sand armored no rip cobble
fringe - phrag
tree line - sumac, sumac, cottonwood, sunflower

Wildlife Observed: teal ducks, Great Blue heron
white egret terrapins
mallard sandpipers
RWBB
muskrat

Photolog: 1318 - 1401, 1407 - 1420

~~22~~ 21

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: ~~industrial~~

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 12" cast iron w/ baffle -	GPS Coordinates: N 40 42.4119 W 74 7.2403
Type: slight discharge (permitted)	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

segment ~~22~~ 21

Sketch:

additional outfall located just south - some type but dark & wet

None observed in segment 22

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Station 22

Date: 9/14/13 **Time:** 1540

Crew: D Riggs J Blunas

Weather Conditions: **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 2, 2 Activity: jet skiing, shoreline ind. workers

Estimated Age: Adult

GPS Coordinates and/or Approximate Location:

Photolog: photo #

Additional Notes:

Signature: MAB

(22)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: (22) Intertidal Area Under Bridges

Date: 9/11/13 **Time:**

Crew: MAB/DR

Weather Conditions: Sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(22)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Intertidal Area Under Bridges (22)

Date: 9/12 **Time:** 11:30 am

Crew: Norm, Carlie, Melissa, Dave

Weather Conditions: Hot/Sunny

Mammal Survey Observations

Observation Type: Tracks Species: Raccoon, skunk, coyote, rat

GPS Coordinates:

Habitat: small sandy shoreline

Observation Type: 9/14 rabbit pellets Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog: Photos of tracks

Additional Notes:

Signature: MAB

Segment (23)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: station 23

Date: 9/11-9/15 **Time:** 920 - 950

Crew: JEB/DR

Weather Conditions: sunny (80's) **Tide:** mid - heading to low

Habitat Type: commercial/industrial

Habitat Description: chainlink
rocky/rip rap - fine - parking lot
15-20 sandy intertidal area intact
Whole shore bulkheaded or sea wall

Plant Community/Dominant Plant Species:
Phrag., Spart

Wildlife Observed: gulls, mallards

Photolog: 1466 - ~~1472 - 1479~~ M93

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Industrial - parking lot

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 24" concrete pipe - no discharge	GPS Coordinates: N 40 41.4435 W 74 7.5604
Type:	GPS Coordinates:
Type: 24" concrete pipe - some discharge (tide?)	GPS Coordinates: N 40 41.5763 W 74 7.6284
Type:	GPS Coordinates:
Type: 24" concrete pipe some discharge (tide?)	GPS Coordinates: N 40 41.5743 W 74 7.6705

Sketch:

4) 24" concrete pipe slight trickle - tide or discharge? N 40 41.4363 W 74 7.7440

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature:

(23)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: 23-Carlot

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]): NA

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 3 Activity: const. workers

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog: see photo

Additional Notes:

Signature: MAB

(23)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: 23-Carlot

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions:

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests: N/A

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: 23-CarLot

Date: 9/11-9/15 **Time:** 9:20-9:50

Crew: JEB/DR

Weather Conditions: sunny

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates: NA

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Sesment (24)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Ports Elizabeth + Newark

Date: 9/11-9/15 **Time:** 950

Crew: JEB/DR

Weather Conditions: sunny **Tide:**

Habitat Type: port

Habitat Description: armored shoreline w/ wilkneck industrial

Plant Community/Dominant Plant Species:

Wildlife Observed:

Photolog: 1494 - 1526

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features: NA

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: N/A

Signature:

(24)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Port Terminal

Date: 9/15/13 **Time:** 1125

Crew: JEB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: ~~Industrial~~/Commercial/Residential/Recreational/Other:

Number of People Observed: 2 Activity: boating/fishing

Estimated Age: Adult

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(24)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Port Terminal

Date: 9/15 **Time:** 1030

Crew: JEB/DR

Weather Conditions: sunny

Bird Nest Survey Observations

Species (Potential or Known): Cormorant Nest Description: twigs - 2' diam, shallow

Habitat: channel marker #15

GPS Coordinates: N 40 40 6/10 W 74 8.055 Number of Nests: 9 ~~photos 1512-1517~~

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog 1512-1517

Additional Notes

Signature JEB

(24)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Port Terminal

Date: ~~JEB/DR~~ 9/15 **Time:**

Crew: JEB/DR

Weather Conditions:

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates: NA

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (25)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Mixed Intertidal (25)

Date: 9/13-9/15 **Time:** 9:00

Crew: Melissa, Dave

Weather Conditions: sunny **Tide:** Low

Habitat Type: Mixed intertidal

Habitat Description: small sandy stretch of shore small rocks, marsh grass small backwater area, no water at low tide - restoration activities

Plant Community/Dominant Plant Species: spartina, aspen, cottonwood

Wildlife Observed: turtle
4egrets (white)
cormorant
gulls
kingfisher
flock of sandpipers
ribbed mussels
common qube

Photolog: Restoration area x2
Shanty
shoreline

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Commercial

Habitat Features:

Type: ~~tributary~~ restoration area	GPS Coordinates: N 40 39 7039 W 74 9.4670
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Intertidal

Date: 9/15 **Time:** 840

Crew: MAB/DR

Weather Conditions: **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]): NA

Zone: Industrial/Commercial/Residential/Recreational/Other: Intertidal marsh

Number of People Observed: 3 Activity: fishing

Estimated Age: Adult

GPS Coordinates and/or Approximate Location:

Photolog: Shanty - photo

Additional Notes: at 1225 2 Adults on small boat fishing

Signature: JEB

(25)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Station 25

Date: 9/14 **Time:** 1200

Crew:

Weather Conditions: 60s partly cloudy

Bird Nest Survey Observations

Species (Potential or Known): osprey Nest Description: Nest on top of piling

Habitat: Nest

GPS Coordinates: N40 39.6314 W74 9.3917 Number of Nests: 1

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MJB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Intertidal Area

Date: 9/13-9/15 **Time:** 9:00

Crew: MAB/DR

Weather Conditions:

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat: NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (26)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Riprap/Upland vegetation (26)

Date: 9/13/13 **Time:** 8:40

Crew: Melissa, Dave

Weather Conditions: Sunny **Tide:** Low

Habitat Type: Rocky shore, riprap, abandoned upland

Habitat Description: mixed scrub shrub, fence small trees
small rocks → Larger rocks
small sandy shoreline area

Plant Community/Dominant Plant Species: scrub shrub, sycamore, cottonwood

Wildlife Observed: 4 egrets (white) see segment (25)
~~cormorant~~
~~gulls~~

Photolog: #10, #12 (double CSD)

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 3 - all in similiarea	GPS Coordinates: 40° 39.3547 74°9.7991
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Riprap / Upland Veg

Date: 9/13 **Time:** 8:40

Crew: MAB/DR

Weather Conditions: sunny **Tide:** Low

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Riprap / Upland Veg

Date: 9/13 **Time:** 8:40

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Riprap / Upland Veg

Date: 9/13 **Time:** 8:40

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (27)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Intertidal (27)

Date: 9/11-9/15 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Habitat Type: Intertidal, mixed veg, restoration area

Habitat Description:

Plant Community/Dominant Plant Species:
Spartina, scrub shrub, sumac, cottonwood, sycamore

Wildlife Observed: Rat, raccon tracks, killdeer, catbird, mocking bird, mourning dove, GBH tracks, gulls, RWBB

Photolog: Restoration area

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

(27)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Intertidal

Date: 9/11-9/15 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: Ø Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog: 27a - small shanty on shoreline

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Intertidal

Date: 9/11-9/15 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: Sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Intertidal

Date: 9/11-9/15 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations

Observation Type: Direct Species: Rat

GPS Coordinates:

Habitat:

Observation Type: Tracks Species: Raccoon

GPS Coordinates: 40°39.278' 74° 10.111

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (28)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Singu factory / Industrial

Date: 9/13/13 - 9/15/13 **Time:** 8:30

Crew: Melissa, Dave

Weather Conditions: sunny **Tide:** Low

Habitat Type: Industrial

Habitat Description: Bulkhead / riprap, algae covering lower rocks

Plant Community/Dominant Plant Species:

Wildlife Observed:

Photolog: CSOs #5

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: Large, industrial, (2) submerged	GPS Coordinates: 40° 39.0940 74° 10.2598
Type: small diameter, riprap	GPS Coordinates: 40° 39.1717 74° 10.1479 trickling
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes:

NA

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Singa Factory/Industrial

Date: 9/15 **Time:** 840

Crew: JEB/DR

Weather Conditions: SUNNY 60s **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 3 Activity: 2 head walking 1 exercising

Estimated Age: Adult

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(28)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Singer Factory

Date: 9/13 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: Sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests: N/A

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Singer Factory

Date: 9/13 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations None NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (29)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: ~~BASF Factory Industrial~~ Part of Arthur Kill Park (see segment 30)

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: **Tide:**

Habitat Type:

Habitat Description:

Plant Community/Dominant Plant Species:

Wildlife Observed:

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: N/A

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Arthur Kill Confluence (29)

Date: 9/11/13 **Time:** ~~5:30~~ 2:30

Crew: Melissa, Dave

Weather Conditions: Hot/sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: ~15 Activity: Fishing

Estimated Age: Adult Men

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: 9/14 1415 1 Adult fishing
4 Adults sitting
1430 2 Adults/4 Children fishing

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Part of Arthur Kill Park (see seg 30)

Date: 9/11-9/15 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations

Species (Potential or Known): Nest Description:

Habitat: N/A

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Part of Arthur Kill Park (see Seg 30)

Date: 9/11-9/15 **Time:**

Crew: DR/MAB

Weather Conditions:

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat: NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (30)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Arthur Kill Park (30)

Date: 9/~~30~~ 13-9/15 **Time:** 7:30am

Crew: Melissa, Dave

Weather Conditions: sunny **Tide:**

Habitat Type: recreational, residential, intertidal

Habitat Description: Rocky/sandy shore, relic pilings, seawall

Plant Community/Dominant Plant Species: some Spartina, mowed lawn, ornamental trees

Wildlife Observed: Rat (N40° 33.8206 W 74° 11.0604)
Direct Observations
Killdeer

Photolog: Photo #1, 2, 3

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Elizabeth Marina - commerical

Habitat Features: Rocky/sandy shore

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type: 48" concrete pipe	GPS Coordinates: N 40° 38.8199 W 74° 11.0596
Type: 48" concrete pipe	GPS Coordinates: N 40° 38.8462 W 74° 10.8805
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: Gull/Cormorant(?) Nests on Buoy markers - #22
N 40° 38.8688 W 74° 0.2905

Signature: MAB

(30)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Arthur Kill (30) Park

Date: 9/12/13 **Time:** 1pm

Crew: Melissa, Norm, Dave, Carlie

Weather Conditions: Cloudy **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 4|2 Activity: child swimming | men on rocks

Estimated Age: 2 children, 2 Adults (women)

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Arthur Kill Park

Date: 9/13 **Time:** 7:30

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat: NA MB 9/13/13

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(30)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Arthur Kill Park (30)

Date: 9/13 **Time:**

Crew: Melissa Dave

Weather Conditions: sunny

Mammal Survey Observations

Observation Type: Direct Species: Rat

GPS Coordinates: N 40°.38.8206 W 74°11.0604

Habitat: Rocky shore

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Segment (31)

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Elizabeth Marina (31)

Date: 9/13/13 **Time:** 8:30

Crew: Melissa, Dave

Weather Conditions: Sunny **Tide:**

Habitat Type: NA

Habitat Description: Commercial - Marina

Plant Community/Dominant Plant Species: None

Wildlife Observed: None

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: NA

Signature: MAB

(31)

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Elizabeth Marina

Date: 9/14/13 **Time:** 1410

Crew: JEB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: Activity: Boating, cleaning fish

Estimated Age: 7 adults, 3 children

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:
cleaning fish 4 adults
on boat in marina 3 adults 3 children

Signature: MAD

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Elizabeth Marina

Date: 9/13 **Time:** 8:30

Crew: MAB|DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description: NA

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

(31)

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Elizabeth Marina

Date: 9/13 **Time:** 8:30

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations none NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Shooters Island

Date: 9/13 **Time:** 9:40

Crew: Dave Melissa

Weather Conditions: Sunny **Tide:**

Habitat Type: Upland

Habitat Description: Sheen on water - oil spill in Mariners Marina

Plant Community/Dominant Plant Species: Honeysuckle, dead/dying trees

Wildlife Observed:

shorebirds	catbird
osprey	GBH
Cormorants	oiled Canada Goose
gulls	perching birds/song/land birds
tern	

Photolog: oiled goose

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

NA

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: petrolkum smell in air

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Shooters Island

Date: 9/13 **Time:** 9:40

Crew: MAB/DR

Weather Conditions: **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]): NA

Zone: Industrial/Commercial/Residential/Recreational/Other: No one allowed on Shooters Island

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(32)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: Shooters Island

Date: 9/13 **Time:** 10am

Crew: Dave/Melissa

Weather Conditions: Sunny

Bird Nest Survey Observations

Species (Potential or (Known)): Osprey Nest Description: Large twigs/sticks ~~Abandoned Structures~~

Habitat: Abandoned structures

GPS Coordinates: see below Number of Nests: #3

Species (Potential or (Known)): Cormorant Nest Description: smaller, marsh grass

Habitat:

GPS Coordinates: 40°38.6657 74°9.8760 Number of Nests: 12

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Shooters Island

Date: 9/13 **Time:** 9:40

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations None N/A

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Wetlands Complex near Goethals Bridge

Date: 9/13 **Time:**

Crew: Melissa, Dave

Weather Conditions: Sunny **Tide:** high

Habitat Type: wetlands - phrag, spartina

Habitat Description: large wetlands complex

Plant Community/Dominant Plant Species:
phrag/spartina

Wildlife Observed:
little green heron

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: Shipping terminal

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type: NA	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: N/A

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: 33 - Wetlands Complex near Goethals Bridge

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: 33 - Wetlands Complex Near Goethals

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: High tide - did not enter marsh/swamp

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes green heron directly observed

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: Wetlands Complex near Goethals Bridge

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: High Tide - Didn't enter wetlands

Mammal Survey Observations None

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: Linden Terminal

Date: 9/13 **Time:**

Crew: Melissa + Dave

Weather Conditions: Sunny **Tide:**

Habitat Type: None

Habitat Description: industrial/commercial

Plant Community/Dominant Plant Species:

NA

Wildlife Observed:

NA

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use: NA

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: Elizabeth River nearby

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: Linden Terminal

Date: 9/13 **Time:**

Crew: Melissa + Dave

Weather Conditions: **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other:

Number of People Observed: 0 Activity: None

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes:

Signature: MAB

(34)

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: 34 - Linden Terminal

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None

Species (Potential or Known): Nest Description: NA

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: 34 - Linden Terminal

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions:

Mammal Survey Observations None NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment A-1

Field Data Sheet – Shoreline Habitat Characterization [pg 1/3]
(completed approximately every ½-mile, or whenever shoreline attributes change substantially)

Location: AK Shipping Terminal

Date: 9/13 **Time:**

Crew: Melissa/Dave

Weather Conditions: sunny **Tide:**

Habitat Type: indus/commercial

Habitat Description: None

Plant Community/Dominant Plant Species:

Wildlife Observed:

Photolog:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 2/3]

Adjacent Land Use:

Habitat Features:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Outfalls and Tributaries:

Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:
Type:	GPS Coordinates:

Sketch:

Newark Bay Study Area
Reconnaissance Survey

Field Data Sheet – Shoreline Habitat Characterization [pg 3/3]

Additional Notes: Active shipping port/ terminal
Dredging sediments in front (9/12)

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment B-1

Field Data Sheet – Shoreline Human Use Characterization [pg 1/1]

Location: AK Shipping Terminal

Date: 9/13 **Time:**

Crew: Dave/Melissa

Weather Conditions: sunny **Tide:**

Human Use Observations (number of people, types of activities, description of individuals engaged in the activities [e.g., adults, adolescents, children]):

Zone: Industrial/Commercial/Residential/Recreational/Other: None

Number of People Observed: 0 Activity:

Estimated Age:

GPS Coordinates and/or Approximate Location:

Photolog:

Additional Notes: Active terminal, No workers visible on shoreline

Signature: MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment E-1

Field Data Sheet – Bird Nest Survey [pg 1/1]

Location: AK Shipping Terminal

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Bird Nest Survey Observations None NA

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Species (Potential or Known): Nest Description:

Habitat:

GPS Coordinates: Number of Nests:

Photolog

Additional Notes

Signature MAB

Newark Bay Study Area
Reconnaissance Survey
Attachment F-1

Field Data Sheet – Mammal Survey [pg 1/1]

Location: AK Shipping Terminal

Date: 9/13 **Time:**

Crew: MAB/DR

Weather Conditions: sunny

Mammal Survey Observations none NA

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Observation Type: Species:

GPS Coordinates:

Habitat:

Photolog:

Additional Notes:

MAB

Signature:

Appendix A

Sampling Field Data Forms

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: Station 124

Date: 9/13/13 **Time:** 910 -935

Crew: Jason Vogel, Jessie Blivins, Carlie Thompson (Tetra) Nat Richardson

Weather Conditions: mostly sunny, 70s **Tide:** low

Identify Sampling Locations:

Safety Hazards Present: some underwater obstructions (rocks) along rockpile, oilsheen along mudflat

Accessibility of Intertidal Area:
flat

Additional Notes (Benthic Organisms/Substrate):
3.5' water at deep intertidal 200-250 yards from spartina line
soft shell relic, oyster relic, ribbed mussel relic,
substrate - some silt, sand, rock - sheen along exposed mudflat near rock jetty & all along muddle
crab, short claw crab, juvenile,
Multiple dead blue crabs

GPS Coordinates: pt 55

Photolog 1315 - 1329 - habitat at bar

Signature

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: Station B4

Date: 9/11/13 **Time:** 1605

Crew:

Weather Conditions: **Tide:**

Identify Sampling Locations:

Safety Hazards Present:

Accessibility of Intertidal Area:

Additional Notes (Benthic Organisms/Substrate):

GPS Coordinates:

Photolog ~~021~~ 208 - 216 (1293 - 1301)

Signature

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Station 124

Date: 9/11/13 **Time:** 1605

Crew: **Tide:**

Weather Conditions:

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
Crab pots deployed 3.5-4' at 1615 24x24x10, 24x24x10, collapsible along rock jetty	9/12/13 835 collapsible - 4.5" and 3.5" blue crabs

Photolog: 217 – 221 (1300 - 1306)

Additional Notes:

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: mudflat north of station 124

Date: 9/11/13 **Time:** 1650

Crew: Jason Vogel Jesse Burgis, AmyMarie Allard-Dey (LBG) **Tide:** high

Weather Conditions: sunny 100s

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake	softshell clam relic

Photolog:

Additional Notes:

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Station 124

Date: 9/13/13 **Time:** 910 – 935

Crew: Jason Rosel, Jesse Bluvias, Carla Thomas (Tierra), Norm Richardson **Tide:** low

Weather Conditions: SUNNY, 70s

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake	- soft shell clam rake, common oyster, oyster drill juv. blue crab ~ 3", ribbed mussel
	-

Photolog: pt 55 clam rake off boat
1330-1331 clam rake along rock jetty
pt 56 – 2 common oyster on rocky substrate
pt 57 2 common oyster, juvenile 1-2" ribbed mussels (2 indiv.)

Additional Notes: oil sheen when exposed mudflat

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: #035 (GPS) – Southeast of Shooters Island (Station 125,

Date: 9/11/2013 **Time:** 1020 – 1050

Crew: Jason Vogel, Jessie Bluvias, Chuck Nace (USEPA)

Weather Conditions: Sunny mid 80's **Tide:** Low tide – rising limb

Identify Sampling Locations:

Safety Hazards Present: Rock piles, sunken timber, old piers

Accessibility of Intertidal Area:
At low tide may have trouble navigating rock piles on entry.

Additional Notes (Benthic Organisms/Substrate):
Firm substrate
organisms – unknown whelk/snail, relic oysters, ribbed mussel relic, ribbed mussel along spartina roots, blue crab
bed of oyster relics with firm sediment make sed sampling difficult
small to med rock, good hiding places for crabs, also rocks

GPS Coordinates: #35 – N 40.63734° W 074.15331°

Photolog #138 – 145 (1223 – 1230)
SNAIL 146 – 150 (~~1225~~ 1231) – 1235

Signature Jason C. Vogel

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: #035 (GPS) - Southeast of Shooter's Island station 185

Date: 9/11/2013 **Time:** 1020

Crew: Jason Vigel, Jessie Bluvias **Tide:** Low tide - rising limb

Weather Conditions: Chuck Nace (VSEPA) Sunny mid 80's

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake	ribbed mussel and oyster relics, live ribbed mussels
trawl pairing/trawl*	ribbed mussels - 1.5-2"
*Sediment would be trawled out from root mats.	large pot retrieved 1604 - empty
crab pots 24x24x18, 24x24x12 and collapsible	collapsible trap 1600 - some snails
deployed at 1435, ~6' depth, 3' depth, near shoreline	small pot 1608 - on land - empty

Photolog: 151 - 152 (1234 - 1237)

Additional Notes: ribbed mussels not as abundant as location #32
would be easier to composite ribbed mussels with sediment -
SM pot dragged during ride to shallow flat

Signature:

9/13/13: retrieval 1100
small pot - 2 → 5.25", 5" - redeployed pt 58 at 1125 6-8'
large pot - nothing → 5.5' water redeployed at 1130 pt 59
collapsible - 4 → 2 at 4.5, 1 at 4.25, 1 at 5" - redeployed 1135 at 7' pt 60
note: at 840 inaccessible - lots of old dock pieces, rocks, etc

9/13/13 1445 small trap retrieval 2 crabs – 6.25" and 5"
redeployed same location (near structure) 1450
1450 Lg trap empty – redeploy same location
1455 collapsible trap – empty – redeploy same location

9/14/13 1225 – 1245
40 38 2360 soft shell 23mm
74 9.2225 percnus #3 – 20, 17, 10mm
photos 1443-1446

retrieve crab pots at 1600
sm – 3 crabs (F, 4.5"; M 5 3/4"; F 5 1/2") northern stargazer 9 1/2"
Lg – 2 crabs (M 5 1/4"; F 5")
collapsible – 2 crabs (M 3 3/4"; M 5 1/4")

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
Station # 126 **(completed for each intertidal sampling area)**

Location: #032 (GPS) - South shore; southwest of Shooter's Island

Date: 9/11/2013 **Time:** 0915 - 1000

Crew: Jason Vogel, Jessie Blunias, Chuck Nace (USEPA)

Weather Conditions: Sunny 80s **Tide:** Low tide - rising limb

Identify Sampling Locations:

Safety Hazards Present: Old wooden piers submerged

Accessibility of Intertidal Area:

Some old wooded piers to entry of cove.

Small tributary at southern portion of cove.

Additional Notes (Benthic Organisms/Substrate):

Substrate - mainly fines/silt
- small mussel relic shells

Organisms - ribbed mussels, remnants of soft shell clams
ribbed mussels along roots of spartina with/around ties
some fiddler crabs along tributary

GPS Coordinates: #032 N 40.64309°, W 074.17220°
#033

Photolog #113 - 124 - Sampling location
(196-1198 - 196-1209)
ribbed mussel 131-134 (217-218)
ribbed mussel along root of spartina w/ties 135-136 (1220-1221)

Signature Jason C. Vogel

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: #832 (COPS) – South shore, southwest of Shooter's Island (station 126)

Date: 9/11/2013 **Time:** 0915 – 1000

Crew: Jason Vogel, Jessie Blavias **Tide:** Low tide – rising limb

Weather Conditions: Chuck Nace (USEPA)

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
Clam rake	some soft shell clam remnants
Sediment probing rod	Adequate silt layer > 2'
power check	
travel, hand picking bar trks	ribbed mussels
crab pots 24x24x18, 24x24x12	1600 large pot – 1 blue crab 4"
deployed 1345 collapsible – depth ~ 6'	1650 oil apxille – lots of small snails
	1655 small pot 1 blue crab (spat below natural line)

Photolog: ~~pt 83 ribbed mussel photos 1216 (1216–1219)~~ (82) 131–134)
~~ribbed mussels in trees photos 135–136 (1220–1221)~~ (82)
clam rake 125–130 (1210–1215), 135–136 (1220–1221)

Additional Notes: ~~ribbed mussels within roots of spartina in trees~~, some (83) of the soft shell clams power check likely best bet – soft, firmer as closer to tributary

Signature: Jason C. Vogel

12:05 – 9/12/13 Results

Small trap 1 @ 4 3/8"
Collapsable 2 (4 1/4", 3 1/2")
Large trap 2 (4 3/8", 3 3/8")

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Station # 126

Date: 9/13/2013 **Time:** 0800

Crew: Jason Vogel, Jessie Bluvias **Tide:** incoming low tide

Weather Conditions: Partly cloudy high 60's

Oversight: Norm Carlie

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
crab ~~pots~~	
· water depth:	

B20 - Collapsible ; 8' water depth ~~pt 53~~ retrieved 1155 - empty - redeployed 12w

B10 - Small 4-funnel ; 8' water depth, ~~pt 52~~ retrieved 1145 1-5" blue, redeployed 1151

B30 - Large 4-funnel ; ~~8'~~ 8.5' water depth retrieved 1200 - empty - redeploy 12w

9/13/13 - retrieved and redeployed between 1500-1510 - all traps empty

Photolog: GPS: pt 52 small trap, pt 53 collapsible trap, pt 54 large trap

Additional Notes: Re-deploy pots out from cove towards channel. North of old wooden pilings depths:

Signature: Jason C. Vogel

- see back for more

9/14/13 1630 retrieval

SM 3 (M 6½"; M 6¼"; M 4")
LG 1 (M 5")
Collapsible 1 (M 6¼")

9/15/13 clamming w/ clamshovel 1025 - 1100

GPS 40 38.6338
74 10.3713

6 softshell clams (4 fell in water) 69, 51 (MM)
- other 4 broken or dropped in water ± 55 mm each

Substrate - fill - rocks / bricks
70% rocks / fill
20% sand
10% silt
better closer to spartina

photos 1535 - 1537

* for access - better to go in by sandy beach near DONUT anchor or rocks

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: #036 (GPS) - station 127

Date: 9/11/2013 **Time:** 11:10

Crew: Jason Vogel, Jessie Bluvias, Chuck Nace

Weather Conditions: Sunny 80's **Tide:** low - incoming high tide

Identify Sampling Locations:

Safety Hazards Present: none

Accessibility of Intertidal Area: Habitat looks relatively unsuitable for clamming in the intertidal zone.
steep sand slope and no tidal marsh habitat present.
** Going to look further north along western shore.

Additional Notes (Benthic Organisms/Substrate):
0-20' towards shores - fine gravel to firm sand
>20 - silt layer

GPS Coordinates: N 40.65474°, W 074.16747°

Photolog 153-164 (1238-1249)

Signature Jason C. Vogel

Station 127 Continued

9/15 1010 - 1020

clamming w/ shovel/spade (clams stored)

GPS N 40 39.2892

W 74 9.9913

Note - lots of watter spouting observed along shore line - (clams)

Soft shell clams 4 →

in(mm) 54, 60, 59, 65

photos

1527 - 1531 habitat

1532 - 1534 clams

substrate:

70% rock 30% sand

Note - all clams from same hole.

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: #037 (GPS) North of #127 along west shore, just south of Port.

Date: 9/11/2013 **Time:** 11:30 –

Crew: Jason Vogel, Jessie Bluvias, Chuck Nace (USEPA)

Weather Conditions: Sunny 80's **Tide:** Low on rising limb

Identify Sampling Locations:

Safety Hazards Present: None - clear shoreline, minimal underwater obstructions

Accessibility of Intertidal Area:
Slope is still moderate, but some exposed flat present.

Additional Notes (Benthic Organisms/Substrate):
Relics of clams moderately abundant
- ribbed mussel relics, oyster, dead horseshoe crab
- coarser sand – slope different than location 32+35, more ribbed mussels different mud flats perpetina
- lots of schools of fish (mummichogs + silversides)

GPS Coordinates: #037 N 40.66012° W 074.16032°

Photolog 165 – 180 (1250 – 1265)
oyster 185 – 189 (1270 – 1274)

Signature Jason C. Vogel

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: #037 - mudflat area North of station 127

Date: 9/11/2013 **Time:** 11:30 - 12:00

Crew: Jason Vogel, Jessie Bluvias, **Tide:** Low on rising limb

Weather Conditions: Chuck Nace (USEPA) - Sunny 80's

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake 1ex4 w 3" diam.	soft shell clam + hybrid mussel remnants depth 6" - soft shell clam relics oyster
* substrate out deeper looks conducive to clam dredge or using longer-handled rakes	
station 127 - relocated to north - dropped 3 type Crab pots start 1600 (1) 24x24x10, 24x24x12 + collapsible depth ~ 6' ~~3'~~	
Photolog: (1266 - 1269) 183 - 185	

Additional Notes: lots of soft shell clam relics - but no live clams
we not much change at species different - no mussels

Signature:

4/12/13 750 Large pot / male blue crab 6"
755 collapsible / 2" blue crab

Mudflat North of 127 Continued

9/14/13 1205 ~~1210~~ N 40 39.6413
W 74 9.5239

Clamming w/ shovel (shootrspade)

3 softshells in 2 scoops 64, 69, 67 (mm)

photos 1437 1440

50% rock/gravel
~~50~~ 40% sand
10% silt

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: Station 128

Date: **Time:** 1050

Crew:

Weather Conditions: Sunny, low 80s **Tide:** Midway btw low and high - going towards high

Identify Sampling Locations:

Safety Hazards Present:
No obstructions;

Accessibility of Intertidal Area:
Long flat intertidal area

Additional Notes (Benthic Organisms/Substrate):
soft

GPS Coordinates: Pt 47 GPS

Photolog 1147 - 1154

Signature

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Station 128

Date: 9/12/13 **Time:** 1055

Crew: **Tide:** Mid between low and high - heading to high

Weather Conditions: SUNNY, low 80s

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake - offshore transect	clam rake
9/14 1115-1130	3 soft shell clams in NM 49, 48, 29
shoot-n-spade	3 per clams 22, 22, 20
	substrate: 60% sand 40% silt

Photolog: GPS pt 47 - clam rake from boat
pt 48 clam rake

1419 - 1420 1421-1422 — shoot-n-spade/shovel for clams
1423-1426 GPS pt N 40 41.7377
W 74 7.5264

Additional Notes:

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: Station 129

Date: 9/12/13 **Time:** 1020

Crew: Jason Boyd, Jessie Bhuiyan

Weather Conditions: Sunny low 80s **Tide:** low - going to high

Identify Sampling Locations:

Safety Hazards Present: steep slope - ~~not good~~

Accessibility of Intertidal Area:

~~sand, silt, rocks~~
steep slope, likely soft material further out - quick drop off to 10'

Additional Notes (Benthic Organisms/Substrate):

pt 4 to
sandy, from fill material - rocks, bricks
etc oyster and ribbed mussel relics

GPS Coordinates: pt 4 to

Photolog 1141 - 1146

Signature

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Station 129

Date: 9/12/13 **Time:** 1020

Crew: Jason Hyek, Jesse Burks **Tide:** Mid low towards high

Weather Conditions: SUNNY, low 80s

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake	—
deploy crab pots 1130 – 1135	9/12/13
lg 24x24x18 – pt 49 10'	1005 – nothing – redeployed at 1010
sm 24x24x12 10'	– 955 (9/13/13) 1 10.5" blue crab redeployed 955
collapsible 10'	– 1000 1-7", 1.5.75" blue crab – redeployed at 1001

Photolog:

Additional Notes: fill material, steep slope at about drop off

Signature:

9/13/13 M trapped at 1335 all empty except 4 spot fish in collapsible trap redeployed at 1340 at same locations/bottom as last time

9/14/13 1025-1105

clam w/ shoot spade — oysters and ribbed mussels near rocky point just North of 95 Bridge

Not as easy to get clams - near silty portion adj. to bulkhead at North end

some soft shell clams

per clam 17

2 soft shell 50, 32

N 40 43.0971
W 71 7.3531

No clams in rocks or sand

Combo of silt/rock/sand = clams

50% sand
30% rock/cobble
20% silt

photos 1404-1407

9/14/13 1510 retrieval

small trap - 3 (M 5¾"; F 5¾", M 5½")

collapsible - 2 (M 6½", F 3¼")

Large trap - 1 (M 5½")

pull out

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: GPS Pt 038 station 122

Date: 9/12/13 **Time:** 855 - 925

Crew: Jason Vogel, Jessie Blurias

Weather Conditions: ~~mostly sunny~~ hazy, mid-high 70s **Tide:** low - incoming high

Identify Sampling Locations:

Safety Hazards Present: None - clear shoreline, minimal underwater obstructions

Accessibility of Intertidal Area:

~~mostly steep~~ some exposed mudflat - near spartina live steep slope, otherwise relatively flat

Additional Notes (Benthic Organisms/Substrate):

- soft silt, lots of relic clamshells, 1 soft shell clam - 40 yards from spartina. IRVAN or dredge should be fine to use in sediment

GPS Coordinates: N 40.71850 W 074.10953

Photolog 1111-1117
1120 - 1125 - softshell clam and whelks (dog winkle?)

Signature Jason C Vogel

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: GPS Point 028 Station 122

Date: 9/12/13 **Time:** 855

Crew: Jason Royal, Jesse Hanley **Tide:** low; incoming high

Weather Conditions: ~~mostly~~ hazy, sunny, mid-high 70s

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
clam rake trawl/hand picking	all softshell clams: juv(MM) 61, 60, 58, 60, 47, 43, 50, 44, 44, 31, 31, 30, 28, 30, 26, 23, 26, 27, 29
9/14 shooter spade for clams 945-950	
clam gun (only for softsed)	GPS pt - N. 40 43.0311
primarily shooter spade	W. 74 6.7920
	oyster 50/1 mat/cobble, 2ft silt, 3ft sand

rocky pt adj to mud bank + S part of marsh

Photolog: 1118-1119, 1371-1385

Additional Notes: Not dropping crab pots due to close proximity to channel/confluence of both Hackensack and Passaic Rivers

Signature: Joann C. Royal

Station 122 Continued

9/14 1530 deploy crab pots

		depth
~~Lg~~	N 40° 42. 9934 W ~~74° 06. 5546~~	14'
collapsible -	N 40° 43. 00 25 W 74° 06. 5598	11'
Small	N 40° 42. 9920 W 74° 06. 5510	16'

9/15 1140 retrieval

Lg - 2 crabs (m 6"; F 4¼")

SM - empty

collapsible - sea bass, 3 crabs F 5¾; F 5¾; m 6¼)
6½"

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: station 123 Cuts pt #29

Date: 9/12/13 **Time:** 935-1025

Crew: Jason Vogel, Jesse Blumes

Weather Conditions: Sunny, high 70s/low 80s **Tide:** low-heading towards high

Identify Sampling Locations:

Safety Hazards Present: open, clear shoreline

Accessibility of Intertidal Area:
open - flat mudflat

Additional Notes (Benthic Organisms/Substrate):
firm, softshell relics
oyster, ribbed mussels, ~~softshell clam~~ hardshell clam

GPS Coordinates: N
pt 39 ribbed mussel
pt 41 ribbed mussel
pt 40 clam - hardshell
pt 42 oyster and lots of ribbed mussels

Photolog benthic assessment: 1130 - 1140
habitat pt 26 - 1132

Signature

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Station 123

Date: 9/12/13 **Time:** 935 - 1025

Crew: Jason Vogel, Jesse Bruno **Tide:** low - heading to high

Weather Conditions: Sunny, high 70s/low 80s

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
dan rake	
hand trawl	retrieved 9/13/13
deploy crab pots 1020 ~~80~~	
collapsible at 5.5' depth	1030 - 1 - 5.5" blue crab - ~~blue~~ redeployed at 10:
small pot 24x24x18 at 6.5' depth	1025 - NOTHING - redeployed at 1030
lg pot 24x24x18 at 7' depth	- 1020 blue in trap - but 2 entry - 1 inshore 1 offshore redeployed at 1025

Photolog: dan rake 1133 - 1135
habitat 1126 - 1132

Additional Notes: pts 43-45 = crab pots 43 collapsible 44 small pot
45 lg pot

Signature:

3/13
retrieved high tide - 1350 - all empty - redeployed at 1400 closer to 95 Bridge in deeper water depths between 13-20 feet
Collapsible CPS pt 61 at 1405
sm. trap pt 60 at 1416
lg. trap CPS pt 63 at 1420

Station 123 Continued

9/14/13 840-920 clam w/ shoterspade
2 ~~0~~ softshell clams - more of an effort
6 per clam

softshells 31 MM
29 MM

per clams 10 mm
18
20
28
18
17

GPS at boat N 40 41.2433
W 74 6.3013

9/14/13 1440 small trap 1 — 6.25
collapsible trap 1 — 3.75
Leg trap ~~empty~~ 8 all male
~~redeploy~~ redeploy at 1500
small trap —
collapsible trap —
Leg trap —

9/15 12:10 pm
small: 1 crab: M 5¼
large: ∅
collapsible: ∅

N 40.41.8417] Big trap
W 74 06.9409]

N 40°41.8330] med trap
W 74°06.9370]

N 40° 41.8163] collapsible trap
W 74° 06.9349]

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: mudflat area north of station 124, adjacent to north of Robbins Reef yacht club

Date: 9/11/13 **Time:** ~~1650~~ 1550

Crew: Jason Vogel, Jessie Blevins, AmyMarie Accardi - Day (LBG)

Weather Conditions: sunny, 80s **Tide:** high

Identify Sampling Locations:

Safety Hazards Present:

Accessibility of Intertidal Area:

Additional Notes (Benthic Organisms/Substrate):
- layer of silt, sand, some rock; mudflat ~ 5' at high tide
- saw shell clam relic

GPS Coordinates:

Photolog 203 - 207 (196 - 1292)

Signature

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Sixth Elizabeth Channel mudflat

Date: 9/14/13 **Time:** 1150–1155

Crew: Rigg, Blum(s), Thompson, Richard **Tide:** low

Weather Conditions: 60s partly sunny

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
shot r spade / shovel	soft shell clam: (mm)
	55, 33, 36, 37

Photolog: ~~1150-1~~ 1429-1432

Additional Notes: 90% sand 10% silt
GPS N 40 39.7043 W 74 9.4674

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment D-1

Field Data Sheet – Evaluation of Sampling Approaches [pg 1/1]

Location: Intertidal area North of Bayonne Park

Date: 9/14/13 **Time:** 815 - 825

Crew: Ryf, Burns, C. Thomson, N. Richardson **Tide:** Low

Weather Conditions: Cool, partly sunny

Sampling Feasibility Survey:

Sampling Method	Target Species/# of Individuals Caught
shoto spade/shovel	soft shell clams: 43(mm)
	31
	28
	25

Photolog: 1344 - 1349

Additional Notes: 80% sand 20% silt Mushy/oder
GPS N. 40 41.2112 W. 74 06.7362

Signature:

Newark Bay Study Area
Reconnaissance Survey
Attachment C-1

Field Data Sheet – Identification of Sampling Locations [pg 1/1]
(completed for each intertidal sampling area)

Location: Intertidal overbay and City Park to North

Date: 9/15/13 **Time:** 0955 -

Crew: Russ, Blumai, Thompson,

Weather Conditions: sunny, less **Tide:** past MHL heading towards LW

Identify Sampling Locations:

Safety Hazards Present:

Accessibility of Intertidal Area:

Additional Notes (Benthic Organisms/Substrate):

GPS Coordinates:

Photolog

Signature

Additional Areas

Extra area 9/15 855 - ~~855~~ 900

clamming w/ shovel – no clams – too sandy

rock/cobble shoreline

habitat photos - 1457 - 1460

GPS - N 40 39 9664 W 74 07. 7252

Intertidal flat adj. to industrial area parking lot

9/15 930 - 940 sandy rock/cobble shoreline adj to riprap wall, chain link fence + parking lot for industrial area

Substrate: 90% sand 5% gravel 5% silt

GPS N 40 41 4664
W 74 7. 7516

photos 1478 - 1481

3 soft shell clams - in(mm) 47, 40, 64

1484 - 1487 photos

Shoot + spade/clam shovel - photos 1482 - 1483

Appendix B

Photo Log



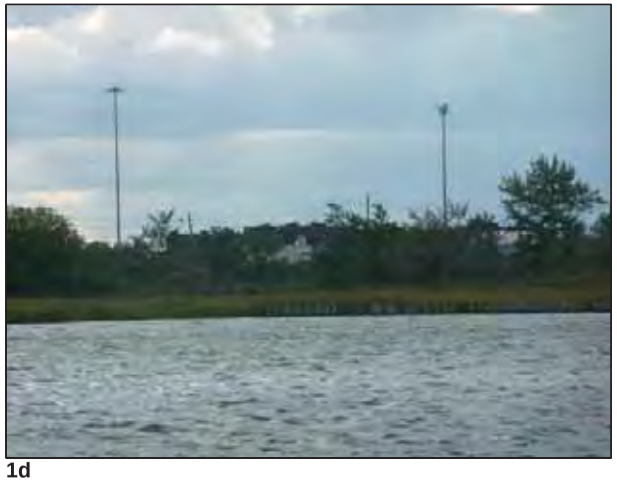
1a



1b



1c



1d



1e

Note: Refer to Figure 3−1 for segment identification.

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RECONNAISSANCE SURVEY REPORT

SHORELINE CHARACTERIZATION: SEGMENT 1

APRIL 2015

FIGURE B−1

Recon_Survey_Segments_20131230.m



2. Post Spill Clean Up



2a



2b



2c



2d



2e

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 2

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FIGURE
B−2

Recon_Survey_Segments_20131230.m



3



4



5

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENTS 3, 4, AND 5

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FIGURE B−3

Recon_Survey_Segments_20131230.m



6. Post−Spill Boom Elco Boat Basin



6a



6b



6c



6d

Note: Refer to Figure 3−1 for segment identification.

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**SHORELINE CHARACTERIZATION:
SEGMENT 6**

APRIL 2015

**FIGURE
B−4**

Recon_Survey_Segments_20131230.m



7a



7b Oil Spill



7c



7d

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 7

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FIGURE B–5

Recon_Survey_Segments_20131230.m



8a



8b



8c



8d



8e

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 8

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FIGURE B−6

Recon_Survey_Segments_20131230.m



10a



10b



10c



10d



10e



10f

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 10

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FIGURE B−7

Recon_Survey_Segments_20131230.m



11a



11b



12



13a



13b

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENTS 11, 12, AND 13

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FIGURE B−8

Recon_Survey_Segments_20131230.m



14a



14b



14c



14d



14e

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 14

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FIGURE B−9

Recon_Survey_Segments_20131230.m



15



15a



15b



15c



15d



15e

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 15

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FIGURE
B−10

Recon_Survey_Segments_20131230.m



16



16a



17



18



18a

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENTS 16, 17, and 18

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FIGURE
B−11

Recon_Survey_Segments_20131230.m



20a



20b



21



21a

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION:
SEGMENTS 20 and 21

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FIGURE
B−12

Recon_Survey_Segments_20131230.m



22a



22b



22c



22d



22e



22f

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 22

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FIGURE B−13

Recon_Survey_Segments_20131230.m



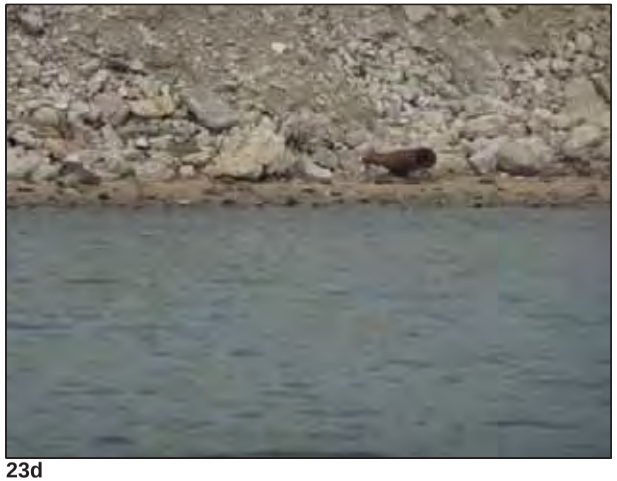
23a



23b



23c



23d



23e



24a



24b

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 23 AND 24

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FIGURE B−14

Recon_Survey_Segments_20131230.m



25a



25b



26a



26b



27

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENTS 25, 26, AND 27

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FIGURE
B−15

Recon_Survey_Segments_20131230.m



28a



28b



28c



30a



30b



30c



30d

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENTS 28 AND 30

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FIGURE
B−16

Recon_Survey_Segments_20131230.m



32. Oiled Bird



32a



32b



32c



32d

Note: Refer to Figure 3−1 for segment identification.

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SHORELINE CHARACTERIZATION: SEGMENT 32

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FIGURE B−17

Recon_Survey_Segments_20131230.m



33a



33b



35

Note: Refer to Figure 3−1 for segment identification.

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**SHORELINE CHARACTERIZATION:
SEGMENTS 33 AND 35**

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**FIGURE
B−18**

Recon_Survey_Segments_20131230.m



Lowering Baited Crab Pot



Crab Pot Buoy



Crab Pots 1



Crab Pots 2



Crabs in Pot

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RECONNAISSANCE SURVEY REPORT

EVALUATION OF SAMPLING APPROACHES: CRAB SAMPLING

APRIL 2015

FIGURE
B–19

Recon_Survey_Segments_20131230.m



Clam Gun



Clam Gun in Use



Clam Rake



Clam Shovel



Clam Shovel in Use



Clam Shovel with Clams



Softshell Clams Measurement

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EVALUATION OF SAMPLING APPROACHES: CLAM SAMPLING

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FIGURE
B–20

Recon_Survey_Segments_20131230.m



Lexan Tube



Ponar Grab

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EVALUATION OF SAMPLING APPROACHES: SEDIMENT SAMPLING

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FIGURE
B–21



Mariners Marina



Mile Marker 15



Mile Marker 22



Segment 25



Shooters Island

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RECONNAISSANCE SURVEY REPORT

BIRD NEST SURVEY: BIRD NEST OBSERVATIONS

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FIGURE
B–22

Recon_Survey_Segments_20131230.m



Deer Tracks Segment 1



Rabbit Scat Segment 1



Unidentified Animal Tracks Segment 20



Unidentified Animal Tracks Segment 20



Muskrat Segment 22



Coyote Tracks Segment 22



Dog Tracks Segment 22

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RECONNAISSANCE SURVEY REPORT

MAMMAL SURVEY: MAMMAL OBSERVATIONS

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FIGURE
B–23



Skunk Tracks Segment 22



Rat Tracks Segment 22



Raccoon Tracks Segment 22



Raccoon Tracks Segment 27



Rat Tracks Segment 30

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NEWARK BAY STUDY AREA REMEDIAL INVESTIGATION

RECONNAISSANCE SURVEY REPORT

MAMMAL SURVEY: MAMMAL OBSERVATIONS

APRIL 2015

FIGURE B–24

Appendix C

Shoreline Habitat Characterization
Video (available on DVD)