# Appendix F:

# Engineering Evaluations

**LOWER EIGHT MILES OF THE LOWER PASSAIC RIVER**
**ENGINEERING EVALUATIONS**

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# 1 EVALUATION PROCESS SINCE DRAFT FFS

## 1.1 Draft FFS Issued in 2007

As part of the Focused Feasibility Study (FFS) for the lower eight miles of the Lower Passaic River (FFS Study Area), the United States Environmental Protection Agency (USEPA) is evaluating alternatives that include dredging and capping to remove or permanently sequester fine-grained sediments containing high concentrations of persistent, bioaccumulative, particle-reactive contaminants, a major source of contamination to the rest of the river and Newark Bay. Work on the FFS has been ongoing since 2006, with the first draft of the FFS completed in June 2007.

The draft FFS evaluated six active remedial alternatives along with a No Action alternative. The active remedial alternatives evaluated were as follows:

- **Alternative 1- Removal of Fine-Grained Sediment from Area of Focus[1].** This alternative consisted of using mechanical dredges to remove contaminated sediment down to underlying material for placement into a confined disposal facility (CDF). Dredged areas would be backfilled. Sediment removal depths within the area of the federally-authorized navigation channel were the depths of historical dredging; removal depths outside of the navigation channel varied and were determined by geotechnical and chemical cores.
- **Alternative 2 - Engineered Capping of Area of Focus.** This alternative consisted of sequestering contaminated sediment in the Area of Focus under an engineered cap, with removal of contaminated sediments for mudflat reconstruction and armor placement only. No dredging for flood control or to allow for use of the federally authorized navigation channel was included in this alternative. Dredged material would be placed in a near-shore CDF.
- **Alternative 3 - Engineered Capping of Area of Focus Following Reconstruction of Navigation Channel.** This alternative consisted of restoring the current federally

[1] The draft FFS included an analysis of the nature and extent of contamination in the 17-mile Lower Passaic River Study Area, which defined an Area of Focus for the FFS as the area containing contaminated sediments present in River Mile (RM) 0 to RM8.3.

authorized navigation channel to historical depths while sequestering contaminated sediment on the side slopes of the channel and shoals on either side under an engineered cap. Backfill would be placed within the dredged channel. Dredged material would be placed in a near-shore CDF.

- **Alternative 4 - Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Current Usage.** This alternative consisted of dredging the navigation channel up to River Mile (RM) 2.5 with an engineered cap placed throughout the rest of the Area of Focus. The navigation channel would be dredged to accommodate the authorized depths up to RM1.2 with backfill placed in the channel and capping on the side slopes. From RM1.2 to 2.5 the navigation channel would be dredged to the depth required by the design vessel (13 feet) with an additional 12 feet for underkeel clearance and necessary cap components for possible underlying contaminated sediment. Dredged material would be placed in a near-shore CDF.
- **Alternative 5 - Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage.** This alternative consisted of dredging the federally-authorized navigation channel to accommodate future use of the river based on estimates by the State of New Jersey. An engineered cap would be constructed over the remainder of the Area of Focus. The navigation channel would be dredged although the depth would vary along its length. Backfill would be placed in the channel with capping on the sideslopes of the navigation channel as well as in the shoals. This alternative would include pre-dredging to control flooding. Dredged material would be placed in a near -shore CDF.
- **Alternative 6 - Engineered Capping of Area of Focus Following Construction of Navigation Channel to Accommodate Future Usage and Removal of Fine-Grained Sediment from Primary Inventory Zone and Primary Erosional Zone.** This alternative is identical to Alternative 5, with the exception that in areas of higher potential for erosion and areas with higher levels of contamination, the depth of dredging was the estimated depth of fine-grained sediment plus an additional one foot to account for dredging accuracy.

The primary method for disposal of dredged materials in the draft FFS was placement in a nearshore CDF for either long-term disposal or short-term storage with the material to be excavated, thermally treated, and the byproducts beneficially used in the long term.

## 1.2 History of FFS Process Since 2007

Since the issuance of the draft report in 2007, a number of different approaches have been evaluated based on public input into the planning process and additional evaluation of the FFS Study Area. This has resulted in the elimination or alteration of the original six alternatives and two dredged material management (DMM) scenarios. The following is a summary of some of the major changes in the planning process between 2007 and 2014 that have had an impact on the development and evaluation of alternatives and DMM scenarios.

### 1.2.1 Waste Characterization

At the time the draft FFS was prepared, EPA had not reached a conclusion about whether the contaminated sediment contained a listed hazardous waste. This was a factor considered in evaluation of disposal options in the 2007 draft FFS. In 2008, USEPA reviewed historical information and concluded that on balance, and in consideration of a weight-of-the-evidence approach, it did not have sufficient evidence to conclude that the Lower Passaic River sediment contain a listed hazardous waste (USEPA, 2008).

### 1.2.2 Revisions to Volume Estimates

The contaminated sediment inventory estimate was revised based on data[2] collected since the 2007 draft was issued. This data allowed modifications to the placement of transects to more accurately reflect the changes in site conditions across the FFS Study Area. Additional chemistry data incorporated into the site conceptual model allowed a more accurate estimate of the depths of contamination based on mercury and dioxin concentrations. Updated bathymetric survey data allowed a comparison to identify more recent areas of deposition and erosion which impacted target elevations for dredging.

[2] Data collected since 2007 incorporated into the volume estimates includes 2010 bathymetric survey, hydrodynamic surveys from 2008 to 2011, a sediment transport study in 2008, low resolution coring in 2008, and surface sediment sampling in early 2008. See Appendix G for more details.

### 1.2.3 Navigation Channel

Four of the six alternatives in the 2007 FFS involved dredging the federally-authorized navigation channel to varying depths and lengths based on the depth of contamination and anticipated use of the channel. Studies conducted by the United States Army Corps of Engineers (USACE), the State of New Jersey and other interested parties (see Appendix G) on the navigational use and needs along the Lower Passaic River in the FFS Study Area were reviewed and used to evaluate ongoing navigation and reasonably-anticipated future use. Studies released after the 2007 Draft FFS were incorporated into an updated future use determination.

The following is a summary of the parameters that were used in developing alternatives for the final FFS in order to accommodate continued and reasonably anticipated future use of the federally-authorized navigation channel.

| Reach | Depth (MLW) | Basis | References |
|---|---|---|---|
| RM0 - RM1.2 | 30 feet | Current authorized navigation depth. Future use for numerous users currently operating with restrictions, with greatest depth needed by Darling International. Designation as City of Newark Port District. | Darling International permit application, USACE, 2010. City of Newark Master Plan |
| RM1.2 - RM1.7 | 25 feet | Future use for Harms Construction (RM1.4) and Getty Petroleum (RM1.7), both currently operating with restrictions. | Navigation user survey, USACE, 2010. |
| RM1.7 - RM2.2 | 20 feet | Future use for Clean Earth NJ (RM2.2). | Navigation user survey, USACE, 2010. |
| RM2.2 – RM8.3 | 10 feet | In select areas, for future recreational use and commercial uses consistent with recreation. | New Jersey’s Position on the Future Navigational Use on the Lower Passaic River, River Miles 0 - 8, NJDOT, 2007. |

Note:

Under Alternative 3, sediment removal would occur in select areas of the river between RM2.2 to RM8.3 so that the final top of cap elevation is at least 10 feet below MLW over a 200-foot width to accommodate recreational uses and commercial uses consistent with recreation (e.g., a water taxi), except between RM8.1 and RM8.3 where the width would be limited to 150 feet.

### 1.2.4 Dredged Material Management Scenarios

Approaches to DMM have changed since the issuance of the draft FFS. In the original draft FFS, technology options were constrained by the possibility that the sediment might be managed as a listed waste. Since the determination that the sediment would not be managed as a listed hazardous waste, a number of other options have been considered. During preparation of the final FFS, a range of potential technologies for DMM were screened to identify those that were potentially feasible and to identify technological changes that may have occurred since the draft report was prepared. This process is summarized below:

*In Water Disposal*

Disposal in a CDF (either as a long-term option or as a short-term option with later excavation and treatment) was the primary DMM approach in the 2007 draft FFS. Since 2007, the following in-water disposal options have been evaluated:

- Disposal in a CDF - A CDF is an engineered structure consisting of dikes or other structures extending above the water surface enclosing a disposal area for dredged material. Over time, as the CDF is filled and the material consolidates, the open water is converted to solid land which can be developed by adjacent land owners.
- Disposal in a CAD site - A CAD site involves placing material in a subaqueous excavated pit in which native soil [*e.g.,* clay in Newark Bay] provides lateral containment. The contaminated material is capped with clean soil to physically separate the material from the overlying water. The final grade of a capped CAD cell would be similar to the adjacent subaqueous land surface. A CAD cell may be constructed under a CDF to increase the disposal capacity. Further details on CAD site construction and operation can be found in Appendix G.

For both CDFs and CAD cells, multiple sites and design configurations have been evaluated.

*Off-Site Thermal Treatment*

Off-site thermal treatment was considered for the long-term disposal of the contaminated sediment. This option entailed dewatering and transporting the sediment to one of the licensed commercial incinerators located in the United States (U.S). See Appendix G for more information on off-site thermal treatment.

*Land Disposal*

Land disposal of the contaminated sediment was evaluated based on disposal in a landfill (Subtitle C or Subtitle D), or disposal in a dedicated upland CDF. Use of an upland CDF would entail site selection and construction of the facility as well as long-term care of the facility following closure. Disposal in a landfill assumed use of a commercial landfill permitted to accept material with the contaminants identified during the Remedial Investigation (RI).

*Decontamination Technologies*

Several local decontamination technologies have been evaluated with the intent of producing a product that could be used beneficially and not disposed of in a landfill. Under the USEPA Superfund Innovative Technology Evaluation program, pilot studies were conducted on several technologies including thermal treatment and sediment washing. Sediment washing *(e.g.*, Biogenesis®) was retained in the 2007 FFS, however was not considered a viable DMM scenario. Thermal treatment (*e.g.*, Cement Lock®) was also retained as a potential treatment option. Both technologies have been retained as potentially viable in the final FFS.

*Sediment Processing*

A variety of approaches to sediment processing have been evaluated, particularly options for dewatering sediment. Sediment dewatering would be required for most of the *ex-situ* treatment options considered. Dewatering options evaluated included both passive and mechanical dewatering systems. Passive dewatering included the use of geotextile bags and dewatering beds; mechanical dewatering included both belt and filter presses.

*Transportation*

A range of transportation options were reviewed including barge transport, over the road vehicles, or rail. In evaluating potential off-site facilities, consideration was given to available modes of transport.

## 1.3 Conclusion

In the Final FFS, the number of active remedial alternatives has been reduced from six to three, while the number of DMM scenarios has increased from two to three. In addition to the No Action Alternative (Alternative 1), the three new active remedial alternatives are as follows:

- Alternative 2: Deep Dredging with Backfill
- Alternative 3: Capping with Dredging for Flooding and Navigation
- Alternative 4: Focused Capping with Dredging for Flooding

The new DMM scenarios are as follows:

- DMM Scenario A – In Water Disposal - Confined Aquatic Disposal
- DMM Scenario B - Off-Site Treatment and Disposal
- DMM Scenario C - Local Decontamination and Beneficial Use

# 2 ALTERNATIVE CONCEPTUAL DESIGNS

## 2.1 Introduction

Conceptual designs for each of the active remedial alternatives in the FFS were developed to support the preparation of cost estimates and a comparative analysis of alternatives. This chapter describes the assumptions used to support the design concepts for backfill depth, sediment removal productivity, and an engineered cap.

## 2.2 Backfill

Following sediment removal activities, dredging residuals would be either covered with backfill or an engineered cap (see Section 2.3). Backfill would be placed in areas where all sediment inventory was removed; an engineered cap would be constructed in areas where contaminated fine-grained sediments were left in place. Unlike the engineered cap, the backfill layer would not be maintained after installation. Under Alternative 2, the entire dredged area would be backfilled; under Alternative 3, limited portions of the FFS Study Area would be backfilled with the remainder receiving an engineered cap. Backfilling is not a component of the Alternative 4 conceptual design.

Backfilling following dredging serves two primary purposes:

- Controlling sediment resuspension and protecting water quality
- Returning river bathymetry to pre-dredge grades in mudflats.

The backfill material would consist of a well graded granular soil (*e.g.*, sand) from nearby borrow sources.

Under Alternative 2, to control the resuspension of contaminants following dredging, a 2-foot backfill layer would be placed bank-to bank. It was assumed that the backfill would be placed in two lifts, with the first lift being placed immediately after dredging is completed in a given area to sequester residuals; the remainder of the material was assumed to be placed after dredging has been completed for the entire FFS Study Area to mitigate recontamination from resuspension during dredging. In addition, backfill material would be used to reconstruct mudflats. In mudflat areas, all contamination would be removed and a sand backfill material would be used to regrade and restore hydrologic conditions in the area. The mudflats would be backfilled to one foot below the original grade to allow for one foot of mudflat reconstruction material to be placed on top of the sand backfill.

Under Alternative 3, backfill is limited to portions of the navigation channel where it would be placed to control the resuspension of contaminants following dredging. For FFS cost estimation purposes, it was assumed that the backfill would be placed in one lift, placed immediately after dredging is completed in a given area to sequester residuals.

For cost estimating purposes, conservative assumptions on the depth of backfill were used (2 feet on average) based on similar environmental dredging projects such as the Fox River Superfund Site and the United Heckathorn Superfund Site (Malcolm Pirnie, Inc. and TAMS Consultants, Inc. 2004) where backfill depths ranged from 6 to 18 inches. The actual thickness of the backfill layer in the FFS Study Area would be established during the design phase and may vary in thickness depending on the location. During the design process, consideration would be given to a number of factors including location, habitat, potential erosion, consolidation, site reconstruction, grading, and future use of the area.

## 2.3 Engineered Cap

The construction of an engineered cap was evaluated as one of several potential remedial technologies in the FFS. The cap would involve placing sand, or other suitable cover material, over the top of the contaminated sediment to physically isolate the remaining contaminant inventory from benthic and aquatic organisms; to stabilize the sediments to limit resuspension and transport of contaminated sediment to other sites; and to minimize the flux of contaminants into the water column. Under Alternative 3, the entire FFS Study Area would be capped except for a portion of the federally-authorized navigation channel which, as discussed in Section 2.2, would be backfilled. Under Alternative 4, an engineered cap would be constructed in areas that exhibit the highest contaminant flux. Alternative 2 does not incorporate an engineered cap. Three conceptual engineered caps were developed to address different requirements in FFS Study Area:

- Engineered cap: This cap would be constructed over the majority of the Alternative 3 or 4 footprint.
- Armored cap: This cap would be constructed in areas which have a high potential for erosion.
- Mudflat reconstruction cap: This cap would be constructed in mudflat areas to provide suitable habitat for benthic organisms.

Figure 2-1 presents conceptual schematics of the three different cap configurations described above. These conceptual designs were developed in accordance with USACE (1998) and USEPA recommendations and guidelines (Palermo et al, 1998), and are intended for cost estimation purposes only. A detailed design analysis would be required if capping were implemented as part of a remedial action.

### 2.3.1 Cap Components

The cap composition and thickness would be designed to address bioturbation, erosion, consolidation and settlement, and chemical isolation (*i.e.*, advective/diffusive contaminant flux). The thickness of the cap may vary depending on the characteristics of the cap location. These elements are discussed in the following subsections.

### 2.3.2 Bioturbation

Bioturbation is the displacement and mixing of sediment by burrowing or boring organisms. The extent bioturbation would impact the integrity of the cap would be considered during the design phase. For the FFS Study Area, a bioturbation component is necessary to prevent benthic organisms from disturbing the chemical isolation component of the cap (see Section 2.3.4).

Benthic invertebrate surveys were conducted in the Lower Passaic River in the fall of 2009 and the spring and summer of 2010. The data collected showed that, in general, the benthic community structure was similar during the three surveys, with *polychaetes* and *oligochaetes* being the two most dominant groups. A literature review was conducted to identify the burrowing depths of the dominant taxa identified during the surveys; findings are shown in Table 2-1. Based on this analysis, organisms commonly found in the FFS Study Area generally have burrowing depths of approximately 4 to 6 inches (10 to 15 centimeters [cm]). Therefore, a 6-inch-thickness has been assumed for the bioturbation component in the conceptual design of the engineered cap. In mudflat areas the top layer of the cap would be composed of a suitable reconstruction material.

### 2.3.3 Erosion

An erosion component is necessary to protect the integrity of the bioturbation and chemical isolation components (Section 2.3.4) from scour. Two different erosion components are considered in this FFS to provide this function: additional sand thickness and an armor layer.

In areas not selected to be armored, an erosion layer was built into the cap design to protect the cap integrity against losses in the cover material due to erosion, and to minimize the frequency of cap maintenance. Cap maintenance is usually performed when the integrity of the cap has been compromised over a significant area. For example, in the Hudson River Phase 2 Year 1 Operation, Maintenance, and Monitoring Plan, the cap would be repaired if there were a measurable loss of the cap, which is defined as a loss of more than 3 inches of cap material over a contiguous 4,000 square foot area or an area representing 20 percent of the cap (Parsons, 2012). The maintenance plan developed for the cap installed for the Fox River Superfund Site requires action if more than 5 percent of the area does not meet design specifications (Anchor QEA, 2009). For this FFS, it was assumed that the thickness of the sand erosion component would be 6 inches.

Hydrodynamic and sediment transport modeling showed that capped areas in the FFS Study Area would be subject to less than 3 inches of erosion during a 100-year flow storm event (refer to Appendix B). Based on these modeling results, it is unlikely that the integrity of the cap would be compromised during a storm event. However, to be conservative for cost estimating purposes, some areas were selected for armoring based on an analysis of bottom velocities generated from the hydrodynamic model of the 100-year storm event.

The 100-year storm event bottom velocities ranged from 0.6 to 8.7 feet per second (fps) with an average velocity of 2.3 fps. For the purposes of the FFS, the 75th percentile (3.4 fps) was selected as the threshold value beyond which capped areas would be armored. Using this threshold value, approximately 119 acres of the FFS Study Area would be armored. Figure 2-2 shows the areas that were selected for armoring.

The Isbach equation was used to calculate the median stone size diameter in areas selected for armoring:

$$V = C\left[2g\left\{\left(\frac{\gamma s}{\gamma w}\right) - 1\right\}\right]^{0.5} (D_{50})^{0.5}$$

Where:

V is the bottom velocity (fps)

C is the turbulence constant

g is the gravitational constant (32.2 feet per second squared)

$\gamma$s is the stone density (pounds per cubic foot [pcf])

$\gamma$w is the water density (pcf)

$D_{50}$ is the median stone diameter (feet)

A turbulence constant of 1.2 (conservative estimate), stone density of 120 pcf (similar to wet sand), and water density of 62.5 pcf were assumed for each grid cell. Figure 2-2 presents a summary of the results. For cost estimation purposes, it was assumed that stone with a $D_{50}$ of 2 inches would be used in areas requiring armor.

The armor would be composed of a poorly-graded stone, with a gradation such that a filter layer between the cap and armor would not be necessary. Stone would be placed with a minimum thickness of three times the $D_{50}$ size when a filter layer is not used (as per New Jersey Soil Erosion and Sediment Control Standards [NJDOT, 2008]). Therefore, the thickness of the armor layer was assumed to be 6 inches.

Due to the potential flooding impacts in the FFS Study Area, a sand “smoothing layer” was incorporated into the armored cap concept design. The “smoothing layer” would be placed on top of the armor to reduce the roughness of the cap surface by filling in void space, thereby mitigating the potential for additional flooding impacts. The “smoothing layer” was assumed to be 6 inches and would be regularly monitored and maintained. Note that the “smoothing layer” and the armor may serve as a bioturbation layer to protect the chemical isolation layer.

### 2.3.4 Chemical Isolation

The overall goal of the chemical isolation layer is to reduce the flux of dissolved contaminants from the sediment into the upper layers of the cap. This is important because the intent of this layer is to physically and chemically isolate aquatic plants, benthic organisms, animals, and humans from the underlying contaminated sediment. Processes that must be considered in the design of a sediment cap for chemical isolation include advection (groundwater upwelling), diffusion, sorption and reaction. Deposition of fresh sediment at the cap/water interface may also be an important process.

The Reible Steady-State Cap Analytical Model (Version 1.18) (Reible, 2011) was used to estimate the required thickness of the chemical isolation layer. The steady-state model was used to predict concentrations that would exist after contaminants have traveled upwards into the cap and an equilibrium condition becomes established between advective and diffusive transport, and exchange with the overlying water column.

For this FFS, the thickness of the chemical isolation layer was estimated such that the concentration in the biologically active zone (BAZ) remained below the sediment preliminary remediation goals (PRGs) for contaminants that are risk drivers. It was assumed that the cap chemical isolation material was composed of a granular material such as sand with minimal organic carbon.

The model was run for the following contaminants: 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD), total polychlorinated biphenyl (Total PCB), Total DDx, and mercury. These contaminants were selected to represent the range of sediment-pore water partitioning in the river. Table 2-2 summarizes the model inputs and assumptions.

Site-specific model input parameters include:

- Initial contaminant pore water concentration
- Fraction of organic carbon in the isolation layer and bioturbation layer
- Groundwater upwelling velocity
- Organic carbon partitioning coefficient for the isolation and habitat layers (as well as the underlying sediments).

The FFS Study Area was divided into 2-mile reaches, and the chemical concentrations of each contaminant in the sediments below the cap material was conservatively estimated as the upper confidence interval of the mean for each reach. The modeled cap thickness was set at 12 inches for the isolation layer. Table 2-3 shows a summary of the model results.

For the modeled contaminants, the steady state concentrations in the bioturbation layer were generally less than their corresponding sediment PRG concentrations except for Total DDx in RM2 to RM4. It is anticipated that during the design phase, adjustments such as the addition of organic carbon to the cap and changes in cap thickness would be evaluated for localized areas where data indicate that a 12 inch cap thickness would not sufficiently isolate contaminants.

### 2.3.5 Consolidation and Settlement

Over time, some settlement of the cap material is possible, reducing the overall thickness of the cap. In addition, the underlying sediments may consolidate, lowering the surface elevation of the cap. In designing the cap, factoring in potential consolidation/settlement is necessary to maintain cap thickness and to be able to monitor that thickness after the underlying sediments consolidate.

Based on the use of a poorly-graded sand as the main capping material, significant settlement of the cap material itself is not likely to occur. However, it is likely that some consolidation of the underlying fine-grained sediment would occur. The consolidation can be calculated as follows:

$$\Delta H = \frac{C_c\, H}{1 + e_0} log \frac{p_0' + \Delta p}{p_0'}$$

Where:

$C_c$ is the coefficient of consolidation

H is stratum thickness

ΔH is the settlement

$e_0$ is the initial void ratio where $C_c$ was obtained

$p_0'$ is the effective overburden stress at center of H

Δp is the stress increases induced by the loading in at center of H.

Soil conditions underlying the Lower Passaic River were determined based on the results of several vibracore boring logs taken during site investigations (Aqua Survey, Inc., 2006). Using information obtained from these investigations, a general profile of area soils was developed. The following is a general soil profile (top to bottom) for the area.

- Silt layer approximately 7 feet thick
- Peat layer approximately 1 foot thick
- Clayey silt layer approximately 1 foot thick
- Coarse to fine-medium sand layer approximately 8 feet thick
- Sandy lean clay encountered at a depth of approximately 17 feet below ground surface.

The total consolidation associated with the proposed cap system is the sum of the consolidation settlement in the silt, peat, clayey-silt layers, and sandy lean clay. Because the subgrade consists mainly of non-plastic silty material, consolidation from the placement of the proposed sand cap and armor layer was estimated by computing elastic deformations. The results of the consolidation calculations are included in Table 2-4. It is anticipated that the sand cap would not be affected by significant consolidation of the underlying sediments while the armored sand cap would settle approximately 2 inches due to consolidation in the silty subgrade. For the purposes of the FFS, a consolidation component of 6 inches was only included for the armored sand cap.

### 2.3.6 Conceptual Cap Thickness

For FFS cost estimation purposes, the final cap thickness was determined by adding the different cap component thicknesses. The overall cap thickness for a sand cap or mudflat reconstruction cap was estimated to be 2 feet. In areas targeted for armor the cap was estimated to be 2.5 feet (see Figure 2-1).

## 2.4 Dredging Operations

Under the FFS, the conceptual designs for the active remedial alternatives assume mechanical dredging of sediments, using a dredge fitted with an environmental clamshell bucket (comparative costs for hydraulic dredging were also prepared). For FFS cost estimation purposes, the production rate for each of the two primary dredges was conservatively estimated to be 2,000 cubic yards per 24-hour day. This production rate was based on the following:

- Site specific data from the Environmental Dredging Pilot Study (The Louis Berger Group, Inc. (LBG), 2012).
- Data from several large environmental dredging projects including projects on the Hudson River and the Fox River.
- Reach by reach analysis.

The actual type and number of dredges would be determined during design.

### 2.4.1 Site Specific Data

Previous operations were evaluated to establish an average dredge productivity rate for FFS cost estimation purposes. In 2005, the Environmental Dredging Pilot Study (LBG, 2012) was conducted to assess how site specific conditions in the Lower Passaic River would impact dredging operations. In the study, an environmental dredge equipped with an 8 cubic yard Cable Arm® clamshell bucket was able to dredge approximately 4,150 cubic yards over a 5 day period. Data collected during the pilot study (field oversight and bathymetric surveys) was used to evaluate the productivity of the dredging operations and estimate dredge production rates.

Production rates were compared to rates observed in the field on other environmental dredging projects.

For FFS cost estimation purposes, the production rate was conservatively assumed to be 2,000 cubic yards per 24-hour day. This rate accounts for periods where a smaller secondary dredge would operate at a lower production rate around obstructions such as bridge abutments and bulkheads. Dredging was assumed to occur for 40 weeks per year to account for equipment maintenance, weather, and some degree of fish window restrictions.

### 2.4.2 Accuracy

During the Environmental Dredging Pilot Study, over 90 percent of the targeted area (1.2 acres) was dredged within twelve inches and over 70 percent of the targeted area was dredged to within six inches of the target elevation using single pass production dredging, which is typical of modern dredging practices. The Pilot Study targeted dredging was based on dredging three feet of contaminated sediment at three different elevations. Dredging depth accuracy can be attributed to several factors such as the experience of the equipment operator, positioning system accuracy, site conditions (*e.g.,* water depths), and dredging bucket design. The Pilot Study was performed using a clamshell bucket designed to achieve level cuts with ±3 inch tolerances, by allowing the bucket sides to draw together while the pivot point lifts, leaving a nearly level footprint, and allowing for overlap of subsequent dredge 'bites'. The bucket was also equipped with pressure sensors that allowed for the positioning system to detect bucket closure and estimate the depth of the dredge.

Given the specifications of the dredging equipment, the targeted dredging depths, and its performance during the Pilot Study, a vertical accuracy of six inches was assumed for estimated depths of fifteen feet or less and a vertical accuracy of one foot for depths greater than fifteen feet; hence a six-inch or one-foot over-dredging allowance (depending on the dredging depth) was assumed for volume estimates (refer to Appendix G).

### 2.4.3 Reach by Reach Analysis

In assessing the overall project productivity, the time to transport and handle (primarily unload) the contaminated sediments at the processing or disposal site was also considered, as summarized below.

- There are 15 active bridges and one inactive bridge in the FFS Study Area (USACE, 2010). Bridges can restrict the size of barges and tug boats used to transport sediment, both vertically and in the width of the vessel. Based on this information the FFS Study Area was divided into three reaches.

| Reach | Maximum Sediment Volume (Cubic Yards) | Minimum (Bridge Closed) Vertical Clearance (Feet) | Beam Limitation (Feet) |
|---|---|---|---|
| RM0 to RM4.6 | 7,680,000 | unrestricted | |
| RM4.6 to RM8.1 | 1,960,000 | 12 | 24 |
| RM8.1 to RM8.3 | 40,000 | 40 | 16 |

- For this analysis, it was assumed that where the vertical clearance is less than approximately 40 feet (measured from mean low water [MLW]), it would be necessary to open the bridge to allow passage of tug boats and barges. While this may not restrict the size of the vessels used, it may slow down passage and increase the amount of planning and coordination required to ensure that the bridges are operational and opened at the right times.

- Table 2-5 provides a reach by reach assessment of the impact of bridges on the potential project productivity. The majority of the material to be dredged is located within Reach 1 where equipment sizing is unlimited. Increasing the equipment size to increase productivity could be accommodated within the site constraints. The greatest access restrictions are in Reach 3 but because this area has the least volume of material to be removed, the access restrictions have a limited impact on the overall project schedule. The greatest potential for schedule impacts would occur in Reach 2. Although the volume of material to be dredged is approximately 25 percent of the volume in Reach 1, it will take approximately 50 to 60 percent of the time required to complete Reach 1 to complete dredging operations in Reach 2.  Because of this, there is the greatest potential for schedule slippage in this area.

- At the processing or disposal site, sediment would be offloaded from the barges.  Under DMM A (CAD), split bottom barges can offload relatively quickly and cycle time would be controlled by water quality to limit impact to the Bay, and the time it takes to open the silt curtain to allow barge(s) to exit.  Under DMM B and C, the sediment in the barges would be mixed with water to form a slurry to allow for hydraulic offloading.  The geotechnical characteristics of the sediment would impact offloading time and this issue would need to be addressed during the design phase.
- Based on the results of this analysis, the optimum location for an upland processing facility would be within the first reach (RM0 to RM4.6) to minimize the impact of river constraints.

The reach by reach analysis supports the use of the conservative production rate of 2,000 cubic yards per dredge in the feasibility analysis and cost estimating process. It should be recognized that the data from the pilot study and this evaluation may not fully represent all the large scale physical and environmental conditions applicable to the FFS Study Area dredging remedies and that the assumptions developed for the FFS warrant further evaluation during the design phase. The FFS cost estimates (refer to Appendix H) account for the resulting uncertainty through the use of conservative assumptions.

# 3 IN-WATER DISPOSAL SITE MITIGATION

## 3.1 Introduction

The FFS evaluates potential dredging and capping alternatives to remove or permanently sequester contaminated sediments, a major source of contamination to the rest of the river and Newark Bay. One of the DMM scenarios being evaluated for the FFS Study Area involves in-water disposal of sediment. Possible in-water disposal areas include sites located within Newark Bay. Together, the FFS Study Area and the upper portion of Newark Bay form the project area for this 404(b)(1) analysis (see Figure 3-1 for a map of the project area).

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), remedial actions must meet all applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws and regulations, unless a waiver is justified. For actions that include discharges to the waters of the U.S., Section 404(b)(1) of the federal Clean Water Act (CWA) is an ARAR. Guidelines developed by USEPA and the USACE under Section 404(b)(1) establish a sequence by which proposed projects involving discharges of dredged or fill materials into wetlands or waters of the U.S. are to be evaluated. Under this process, potential impacts are to be avoided to the maximum extent practicable. Impacts that cannot be avoided are to be minimized through appropriate and practicable steps including project modifications, followed by compensatory mitigation of impacts.

A Section 404(b)(1) analysis was conducted for the remedial alternatives involving in-water disposal evaluated in the FFS. This analysis, prepared in accordance with the Section 404(b)(1) guidelines, describes existing habitat, potential impacts of the remediation activities, and avoidance, minimization and mitigation measures. This analysis supplements, and does not displace, USEPA's analysis of the remedial alternatives under the criteria set forth in CERCLA, the National Contingency Plan (NCP) and USEPA guidance documents.

## 3.2 Purpose and Need

A CWA Section 404(b)(1) analysis was conducted for the remedial alternatives evaluated in the FFS, including in-water disposal scenarios within Newark Bay. This section describes existing habitat, potential impacts of remedial alternatives, and avoidance, minimization and mitigation measures in accordance with the Section 404(b)(1) guidelines.

### 3.2.1 Section 404(b)(1) Guidelines

USEPA developed criteria for evaluating discharges of dredged or fill material into waters of the U.S. under Section 404 of the CWA. *The Guidelines for Specification of Disposal Sites for Dredged or Fill Material* (40 CFR Part 230, December 24, 1980) are commonly known as the Section 404(b)(1) Guidelines. The guidelines state that dredged or fill material should not be discharged into the aquatic system unless it can be demonstrated that such a discharge would not have an unacceptable adverse impact. Compliance with the guidelines requires an analysis of alternatives. Specifically, the guidelines state that the discharge of dredged or fill material is not permitted if there is a practicable alternative to the proposed discharge that would have less of an adverse impact on the aquatic ecosystem, so long as the alternative itself does not have other significant adverse environmental consequences. An alternative is defined as practicable if it is available and capable of being implemented after taking into consideration cost, existing technology, logistics, and the overall project purpose.

The USACE regulates the issuance of Section 404 of the CWA permits. Permit applications are evaluated based on the USEPA guidelines described above unless the USACE concludes that the economics of navigation and anchorage warrant permit issuance.

The Section 404(b)(1) Guidelines are discussed in a Memorandum of Agreement between USEPA and USACE (55 FR 9211, February 6, 1990). This memorandum indicates that USEPA and USACE will strive to achieve a goal of no overall net loss of functions and services for aquatic ecosystems. To achieve this goal, USEPA and USACE have established a process by which proposed projects in wetlands are to be evaluated[3]. Impacts that cannot be avoided are to be minimized through appropriate and practicable steps including project modifications, followed by compensatory mitigation of impacts.

CERCLA Section 121(d)(2) requires that remedial actions meet all ARARs of federal and state environmental laws or regulations, unless a waiver is justified. Under CERCLA Section 121(e)(1), it is not necessary to obtain federal, state or local permits for remedial actions performed on-site in compliance with CERCLA. Accordingly, any remedy selected by USEPA for the Lower Passaic River would have to meet the substantive requirements of Section 404(b)(1), but not the administrative or procedural requirements. Thus, USEPA would not engage in a formal permitting process under the CWA; but the analysis set forth in this report would guide USEPA in complying with the substantive requirements of Section 404(b)(1).

### 3.2.2 Project Background

The Passaic River was one of the major centers of the American industrial revolution with early manufacturing, particularly cotton mills, developing in the area around Great Falls in the city of Paterson located eight miles upriver of the Dundee Dam. In subsequent years, a multitude of industrial operations sprang up along the river's banks as the cities of Newark and Paterson grew. These industrial developments, which included manufactured gas plants, paper manufacturing and recycling facilities, and chemical manufacturing facilities, used the river for wastewater disposal. The Lower Passaic River was also used to convey municipal wastewater discharges. Together, these waste streams (industrial and municipal) have delivered to the river a number of contaminants including, but not limited to, 2,3,7,8-TCDD, PCB compounds, polycyclic aromatic hydrocarbon (PAH) compounds, dichlorodiphenyltrichloroethane (DDT), other pesticides, mercury, lead, and other metals.

[3] This CWA Section 404(b)(1) analysis is separate and distinct from Natural Resource Damage Assessments performed using Habitat Equivalency Analysis for calculating habitat injury in terms of discounted service acre years, or other techniques, under CERCLA by the Natural Resource Trustee agencies (National Oceanographic and Atmospheric Agency and United States Fish and Wildlife Service). Under CERCLA, these assessments provide an estimate of the potential amount to claim from a Responsible Party for damages to the environment due to unpermitted past or on-going activities. A CWA 404(b)(1) analysis, performed under the Section 404(b)(1) Guidelines (55 FR 9211, March 12, 1990), evaluates mitigation for impacts of activities that have not yet occurred to enable USACE to issue CWA 404 permits.

### 3.2.3 Project Area

The FFS evaluates conditions in the FFS Study Area, which is in the 17-mile, tidally-influenced portion of the Passaic River located in northeastern New Jersey. The Lower Passaic River comprises the portion of the river from the Dundee Dam (located at RM17.4) to the confluence with Newark Bay at RM0 along with the associated watershed for this portion of the river, including the Saddle River, Second River, and Third River. The Upper Passaic River watershed (the portion of the Passaic River located above the Dundee Dam) contributes solids, water, and contaminants that cross over the head-of-tide (*i.e.,* the Dundee Dam) into the Lower Passaic River. USEPA is evaluating potential dredging and capping remedial alternatives for the FFS Study Area to remove or permanently sequester the contaminated sediments that are a major source of contamination to the rest of the river and Newark Bay. Possible in-water disposal locations for the dredged material include a CAD site or CDF located within Newark Bay or the surrounding waterways. Other alternatives involve upland treatment/decontamination and landfill disposal or beneficial use of the dredged materials. Together, the FFS Study Area and the upper portion of Newark Bay form the project area for this 404(b)(1) analysis (see Figure 3-1 for a map of the project area).

## 3.3 Existing Environment

Section 3.3.1 describes the habitat and wildlife present within the Lower Passaic River and Section 3.3.2 describes conditions in Newark Bay.

### 3.3.1 Lower Passaic River – River Mile 8.3 to River Mile 0

Biological literature reviews, field sampling programs, and environmental impact assessments conducted from 1987 to present were compiled and reviewed to develop a description of the environmental conditions in the FFS Study Area and Newark Bay. Sensitive habitat types (*i.e.*, wetlands, mudflats, and submerged aquatic vegetation [SAV]) are described and their locations are illustrated in Figures 3-2a, 3-2b, 3-2c, and 3-2d. A discussion of the wildlife that utilizes these habitats is also provided.

#### 3.3.1.1 Background

The Lower Passaic River, which drains into Newark Bay, is part of the New York/New Jersey (NY/NJ) Harbor estuary system. The river is part of a highly urbanized ecosystem that has been severely degraded by more than 200 years of urbanization and industrialization. As part of the area's development, the river channel was dredged to permit commercial vessels to travel up the estuary to the city of Newark and beyond. Several large dredging projects were undertaken at the end of the nineteenth century to create a federally-authorized navigation channel from RM0 to RM15.4. Maintenance dredging to maintain the navigation channel greatly enhanced the rate of sediment accumulation in the dredged areas. Maintenance dredging above RM2 ceased in the 1950s and below RM2 in the 1980s. The lack of maintenance dredging combined with industrial discharges to the river allowed thick beds of contaminated sediments to accumulate. Since industries were most active in the decades when the navigation channel was first filling in, contaminant concentrations tend to be higher deeper down into the sediment bed.

Below RM8.3 historically high rates of deposition (4 inches per year and then gradually declining in the latter 20$^{th}$ century, particularly below RM2) have resulted in sediment beds over 15 feet thick (see RI Chapter 3). Since the 1990s, the channel has filled in and the river has begun to approach a quasi-steady state condition with the overall pattern of infilling slowing considerably and alternating with some scouring during high flow events.

The river bed below RM8.3 is dominated bank to bank by silty material with pockets of silt and sand. Above RM8.3 the bed is dominated by coarser sediments with smaller areas of silt often in areas outside the channel. By volume, about 90 percent of silts in the Lower Passaic River are located below RM8.3 (see RI Chapter 3).

#### 3.3.1.2 Current Setting

Between RM0 and RM8.3, the river flows though industrial and urban environments, typically with hardened shorelines, as described below.

- From RM0 to RM4 (RM5 for east bank), both banks of the river have a mix of infrastructure (bridges and rail), industrial and commercial facilities, and vacant industrial or commercial land, except for the east bank near the confluence of Newark Bay, which is predominantly open space (Kearny Point) and a small tidal emergent marsh located adjacent to the Port Authority facility across the river from Minish Park.

- From RM4 to RM5.5, the west bank has narrow bands of park (Riverbank Park and Minish Park) and open space surrounded by commercial and dense urban residential development (Ironbound and other Newark neighborhoods).
- From RM5.5 to RM8, the west bank is dominated by the elevated Route 21 structure, although there is a marina and boat launch at RM7.
- From RM5 to RM6.5, on the east bank, land use is commercial (hotel, shopping, car wash), with new developments of multi-family condominiums.
- From RM6.5 to RM8.3 the east bank turns into park land (Kearny Park with a boat launch, Riverbank Park, Rapp's Boat Yard and Marina) surrounded by suburban residential neighborhoods of Kearny and North Arlington.

Tierra Solutions, Inc. (TSI) conducted a habitat characterization survey between RM1 to RM7 in the fall of 1999 and spring of 2000 (Tierra Solutions Inc., 2003). The Cooperating Parties Group (CPG) conducted a survey with similar methodologies on the 17-miles of the river in the fall of 2010 (Windward Environmental, 2011b). Between RM1 to RM7 (overlapping area), both the TSI and CPG surveys reported that the riverbanks consisted of 70 to 80 percent bulkhead and riprap, 10 to 30 percent riprap or bulkhead with overhanging vegetation, and 5 percent aquatic vegetation. The CPG survey found that in the lowest portions of the river that had been industrially developed, the plant community was less diverse and mostly composed of scrub-shrub vegetation with individual or small stands of trees present less frequently. Sites with emergent vegetation were primarily found below RM3.5 and were associated with intertidal mudflats and occupied by common reed (*Phragmites australis*) and to a lesser degree smooth cordgrass (*Spartina alterniflora*). Further upriver (above RM4) where the shoreline had urban green spaces and parks, mixed forest became more dominant and diverse.

#### 3.3.1.3 Special Resource Value Habitats

Although the Lower Passaic River flows through a highly urbanized area and river habitats have been severely degraded due to development, some habitat exists that can provide special value to local wildlife. The presence and extent of these habitats (*i.e.*, wetlands, mudflats, and SAV) is described in the sections below.

### *Wetlands*

Figures 3-2a and 3-2b present the New Jersey Department of Environmental Protection (NJDEP) tidal water, National Oceanic and Atmospheric Administration (NOAA) mudflat, and National Wetland Inventory (NWI) mapping for the FFS Study Area. NJDEP maps the entire stretch of the Lower Passaic River as Tidal Water and does not include any intertidal wetlands in the area; NWI mapping shows two "estuarine and marine" wetlands near RM3.5 and RM4, totaling approximately 2.4 acres.

The USACE (New York District) conducted a vegetation survey in the riparian zone of the Lower Passaic River in the fall of 2007 and spring/summer of 2008 (USACE, 2008b). Baseline vegetation data for potential restoration sites along the Lower Passaic from RM0 to the Dundee Dam (RM17.4) were collected under leaf-on conditions. Formal wetland delineations were conducted at two locations below RM8.3 to RM7.7 (Kearny Riverbank Park) and RM4 (Harrison Wetland which is NWI mapped) per Federal Wetland Delineation procedures. The USACE study also included bio-benchmark surveys.

The Harrison wetland on the east bank of the Lower Passaic River near RM4 was identified as estuarine intertidal emergent. Persistent emergent vegetation is primarily common reed (*Phragmites australis*), smooth cordgrass (*Spartina alterrniflora*), and chairmaker's bulrush (*Scirpus americanus*), and the scrub-shrub vegetation is primarily marsh elder (*Iva frutescens*) and desert false indigo (*Amorpha fruticosa*). The location is tidal and it is expected the wetland would be inundated at high tide.

The wetlands delineated along the shoreline at Kearny Riverbank Park are identified as estuarine intertidal wetlands. They are sparsely vegetated; the most common emergent vegetation present is swamp smartweed (*Polygonum hydropiperoides*) and swamp dock (*Rumex verticillatus*). The site has a steep, filled shoreline and extensive mudflats are exposed at low tide. Results of the bio-benchmark studies for the sampling area show that swamp smartweed is present at elevations from 2.1 to 2.3 feet National Geodetic Vertical Datum 1929. The southern sampling area exhibited similar vegetation presence with respect to elevation.  Swamp smartweed was present between 2.1 and 3.8 feet, with Japanese knotweed (*Polygonum cuspidatum*) dominant above 3.8 feet.

Results of the bio-benchmark studies conducted at the proposed Minish Park Tidal Wetland Restoration site (RM4 to RM3) and the associated Harrison Reference site (RM4) indicated that smooth cordgrass was present at elevations from 0.9 to 2.4 feet and at elevations from 1.3 to 3.6 feet at the Harrison Reference site (RM4) (LBG, 2004).  The lower limits of smooth cordgrass at the Minish site and the Harrison site were similar (0.9 feet and 1.2 feet, respectively) however the upper limit of this species at Minish was considerably lower than at Harrison (2.4 feet and 3.6 feet, respectively).  These apparent upper edge elevation differences are likely due to the very small amount of smooth cordgrass which was present and available for sampling at the Minish site in 2002; no smooth cordgrass remained there by 2008.  The Harrison site had much more smooth cordgrass present than observed at the Minish site in 2002.  The Harrison site is a functioning tidal fringe wetland and supports other brackish species such as chairmaker's bulrush, water hemp (*Amaranthus cannabinus*), seaside goldenrod (*Solidago sempervirens*), and common reed.

### *Mudflats*

Intertidal mudflats are unvegetated silt/clay to fine sand substrate in river habitats that support a variety of benthic and epibenthic communities which are important food sources for fish and birds.  Mudflats have a relatively shallow grade (less than two percent) and fine sediments are generally up to one foot thick.  Intertidal mudflats and the associated shallow-water subtidal areas are important habitats for estuarine organisms, providing valuable foraging habitat for fish, blue crab, and waterbirds.  The locations of mudflats in the FFS Study Area are shown in Figures 3-2a and 3-2b and cover an area of approximately 101 acres.

### *Submerged Aquatic Vegetation*

There are no data on the presence of SAV communities and associated species that utilize this habitat type.  A 2004 biological literature review conducted by Earth Tech, Inc. and Malcolm Pirnie, Inc. confirmed the lack of data on SAV for the entire 17 miles of the Lower Passaic

River. No SAV species were observed during the 2007/2008 shoreline vegetation sampling events conducted by USACE New York District (USACE, 2008b).

#### 3.3.1.4 Wildlife

*Threatened Endangered and Rare Species and Critical Habitat*

The shortnose sturgeon (*Acipenser brevirostrum*) is federally listed as endangered. This species was not collected in any of the studies conducted in Newark Bay or adjacent waters. The Atlantic sturgeon (*Acipenser oxyrhynchus*), federally listed as endangered in 2012, formerly inhabited the Passaic River but urbanization, industrialization, and pollution in the late $19^{th}$ century became a barrier to the upstream spawning (USACE, Undated).

Very limited areas exist with suitable habitat to support endangered and threatened species. These habitats were characterized using datasets developed by the NJDEP Division of Fish and Wildlife, Endangered Non-game Species program.

According to the 2012 NJDEP Natural Heritage Database and Landscape Project Habitat mapping, six rare bird species have historically been observed, although generally not within the FFS Study Area. These species are black crowned night-heron (*Nycticorax nycticorax)*, glossy ibis (*Plegadis falcinellus*), least tern (*Sternula antillarum*), little blue heron (*Egretta caerulea*), snowy egret (*Egretta thula*), and peregrine falcon (*Falco peregrinus*). Some of these species could potentially utilize this section of the river or its tributaries at some stage in their lives.

United States Fish and Wildlife Service (USFWS) documents indicate that the federally endangered peregrine falcon (*Falco peregrinus*) and occasional transient bald eagle (*Haliaeetus leucocephalus*) (de-listed in 2007) are known to occur in the Lower Passaic River and both species were observed in the FFS Study Area during the CPG habitat surveys conducted in 2010. The bald eagle is protected by the Bald and Golden Eagle Protection Act of 1940 and the Migratory Bird Treaty of 1918.

*Fish Community*

A number of surveys have been conducted to characterize the fish community of the Lower Passaic River. The major reports and surveys are summarized below.

- A 1987 USACE survey of fish in the lower 12.3 miles of the river characterized the fish community as being comprised of pollution-tolerant fish with a smaller component of "persistent" game fish (USACE, 1997). The report stated that the presence of juvenile anadromous fish in the river indicated successful spawning by these species. Finfish observed included Atlantic tomcod (*Microgadus tomcod*), red and silver hake (*Urophycis* species), northern pipefish (*Syngnathus fuscus*), mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), striped bass (*Morone saxatilis*), and white perch (*Morone americana*) (USACE, 1987 as cited in Earth Tech, Inc. and Malcolm Pirnie, Inc., 2004).

- TSI conducted a survey in the fall 1999 and spring 2000 which found that mummichog was the most abundant fish species and accounted for 32 percent of sampled organisms in 1999 and 63 percent in 2000. Other fish species observed in 1999 and 2000 included Atlantic menhaden (*Brevoorita tyrannus*), gizzard shad (*Dorosoma epedianum*), striped bass, and white perch. A large number of blue crabs (*Callinectes sapidus*) were also collected during this study. Blue crab was found to account for 36 percent of sampled organisms in 1999 and 14 percent in 2000; however, additional blue crabs were purposely collected in 1999 to support the laboratory analytical mass requirements.

Data available from the USEPA National Coastal Assessment Program (USEPA, 2000) indicate that the dominant fish species captured near the mouth of the Lower Passaic River consists of Atlantic menhaden, white perch, Atlantic tomcod, and striped bass.

A 2010 fish community survey was conducted in the winter and spring/summer seasons (Windward Environmental, 2011a). The winter catch was very low with only 13 fish collected in a two week period. The species collected consisted of spottail shiner (*Notropis hudsonius*), white perch, American eel, and white catfish (*Ameiurus catus*). The late spring/early summer sampling effort yielded results consistent with previous sampling events with the catch being dominated by white perch, Atlantic menhaden, and blue crab. Anecdotal observations from the field crew reported that sampling efforts during the spring/summer 2010 survey appeared to be most successful in areas of aquatic vegetation and along shorelines with rocks, riprap, debris, or overhanging vegetation. These types of shorelines may offer greater habitat structure for refuge and foraging than do shorelines associated with bulkheads or open mudflats, which are devoid of aquatic vegetation (Windward Environmental, 2011a).

National Marine Fisheries Service (NMFS) has designated the Lower Passaic River as Essential Fish Habitat (EFH) for the following species and life stages:

- Atlantic sea herring (*Clupea herengus*) - larvae, juveniles, and adult
- red hake (*Urophycis chuss*) - larvae, juveniles, and adults
- winter flounder (*Psuedopleuronectes americanus*) – all life stages
- windowpane (*Scophthalmus aquosus*) - all life stages
- bluefish (*Pomatomus saltatrix*) - juveniles and adults
- butterfish - (*Peprilus triacanthus*) - larvae, juveniles, and adults
- Atlantic mackerel (*Scomber scombrus*) - juveniles, and adults
- summer flounder (*Paralichthys dentatus*) - larvae, juveniles, and adults
- black sea bass (*Centropristis striata*) - juveniles and adults
- scup (*Stenotomus chrysops*) – eggs, larvae and juveniles
- king mackerel (*Scomberomorus cavella*) - all life stages
- Spanish mackerel (*Scomberomorus maculatus*) - all life stages; and
- cobia (*Rachycentron canadum*) - all life stages

An abbreviated EFH assessment was prepared by TSI in August 2010 for the Phase 1 Removal adjacent to the former Diamond Alkali plant (TSI, 2010). This assessment indicated that adverse effects on EFH from the removal action performed by TSI near RM3 would not be substantial, since dredging would be confined to the sediment enclosure constructed with sheet piles; no in-water work would be permitted within the Passaic River from March 1 to June 30 to minimize impacts to anadromous fish; and the removal of contaminated sediments would have a long-term benefit to EFH.

An EFH assessment was completed in 2004 for Newark Bay related to maintenance dredging of Port Newark (USACE, 2004). A complete list of the species for which Newark Bay has been designated as EFH can be found in Section 3.3.2.4. If the habitat exists, it is expected these species would migrate from Newark Bay into the Lower Passaic River. Two summer flounder were collected between RM2 and RM4 during the 2010 summer sampling event. There is also evidence of anadromous fish passage from Newark Bay to the Lower Passaic River as five alewife were caught in May 2010 (Windward Environmental, 2011a).

The fish community is dominated by relatively few migratory species. The two resident species found in the highest abundance are the mummichog and white perch. Compared to other estuaries in the greater NY/NJ area, the diversity and abundance of fish in the FFS Study Area is low.

*Benthic Invertebrate Community*

Several benthic community surveys were conducted along the Lower Passaic River to characterize and catalog the communities in RM1 to RM7. A 1994 survey characterized the local benthic invertebrate community as being heavily influenced by the urban and industrial surroundings and typical of a "degraded estuarine environment" (Battelle, 2005). The dominant species observed included polychaete and oligochaete worms, amphipods, grass shrimp (*Palaemonetes pugio*), and blue crabs. Similar results were found in a benthic survey conducted by TSI in the fall 1999 and spring 2000, which showed that the intertidal mudflat benthic community for RM1 to RM7 represented a stressed community largely comprised of pollution tolerant organisms, such as oligochaete and polychaete worms. A 2001 survey which focused specifically on the benthic macroinvertebrate community for RM0 to RM1, found the benthic community to have low diversity, while exhibiting moderate abundance, which was "fairly representative" of other estuaries in the region.

A benthic community survey and sediment profile imaging study of the Lower Passaic River conducted in 2005 included stations from RM0 to the Dundee Dam (RM17.4) (Aqua Survey, Inc., 2005). The survey showed a transition of benthic invertebrates in the Lower Passaic River from taxa typically observed in polyhaline waters [salinity of 18 to 30 parts per thousand] at the mouth of the river to organisms more commonly found in oligohaline waters (salinity of 0.5 to

5 parts per thousand) north towards the Dundee Dam. Typical species observed near the mouth of the river include polychaetes, such as *Scoloplos* sp., *Steblospio benedicti*, and oligochaetes. The sampled benthic community from RM1 to RM7 was comprised of a mix of organisms that are tolerant of a wide range of salinities (euryhaline), although some organisms (*e.g.*, naididae oligochaetes, sphaeriidae [fingernail clams]) that were present in this area are typically more abundant in oligohaline or freshwater habitats. Other benthic organisms commonly observed between RM1 and RM7 included the polychaete *Marenzelleria viridis*, which can tolerate relatively low salinities, and amphipods belonging to the genus *Gammarus*.

A 2011 Benthic Invertebrate Community Survey identified the dominant taxon below RM8.3 as either a polychaete (*Leitoscoloplos fragilis* or *Marenzellaria viridis),* an oligochaete (*Tubificoides heterochaetus* or *Limnodrilus hoffmeisteri),* or a crustacean (*Cyathura polita*). It is worthwhile to note that nine eastern oysters (*Crassostrea virginica*) were collected between RM3 and RM4 during the summer 2010 sampling. The benthic invertebrate community in the FFS Study Area generally consisted of species commonly found in the brackish water zone of northeastern U.S. estuaries (Windward Environmental, 2011b).

#### *Avian Community*

An avian survey conducted from fall 1999 to summer 2000 documented a total of 48 avian species (including 28 aquatic and piscivorous bird species) below RM8.3 (BBL, 2002 as cited in Battelle, 2005). Various species of gulls, wading birds (egrets and herons), and waterfowl species accounted for most of the sighting of aquatic birds. The majority of birds that were observed included common terrestrial birds such as sparrows, pigeons, crows, and hawks, waterfowl such as ducks and geese; wading birds such as herons and egrets; and diving birds such as gulls and cormorants. The most commonly observed bird species were herring gull (*Larus argentatus*), laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), mallard (*Anas platyrynchos*), and double-crested cormorant (*Phalacrocorax auritus*).

An avian survey was conducted during the summer and fall of 2010 at 24 survey locations from the mouth of the Lower Passaic River (RM0) to the Dundee Dam (RM17.4) (Windward Environmental, 2011c). Approximately 5,898 aquatic and semi-aquatic individuals were identified during the summer 2010 survey. Of the 32 aquatic and semi-aquatic bird species identified, the following species were observed frequently (*i.e.*, at least once per day, typically several times per day) throughout the study area:

- Double-crested cormorant
- Belted kingfisher
- Osprey
- Five gull species
- Mallard
- Canada goose
- Spotted sandpiper
- Least sandpiper
- Killdeer
- Great blue heron
- Peregrine falcon
- Bald Eagle
- Great egret.

The most abundant species observed were mallard, Canada goose, ring-billed gull, and various sandpipers. During the fall 2010 survey, approximately 16,034 aquatic and semi-aquatic individuals (28 different species) were identified (Windward Environmental, 2011c). Of these, the same species as those in the spring, plus American duck, were observed at high frequency. The most abundant species observed were ring-billed gull and Canada goose, followed by mallard.

#### 3.3.1.5 Resource Condition/Function

Overall the condition of the habitat that exists within FFS Study Area is one that is influenced by the many years of industrial and urban development in the surrounding area. The shoreline consists primarily of riprap, bulkheads, and upland scrub-shrub, with a few small, scattered emergent wetlands and mudflats. The intertidal mudflats support a benthic invertebrate community that provides forage areas for migratory and resident birds; however, it is a low diversity community dominated by pollution-tolerant organisms. The river supports a migratory fish population, including some anadromous species, a few resident species, and a population of blue crabs. A diverse community of aquatic and semi-aquatic birds has been observed below RM8.3.

### 3.3.2 Newark Bay

#### 3.3.2.1 Historical Setting

Newark Bay is part of the Hudson-Raritan Estuary and lies below the confluence of the Hackensack and Lower Passaic Rivers. It is rectangular, approximately 5.5 miles long, and varying in width from 0.6 to 1.2 miles. It has been modified extensively by dredging, filling, and commercial port operations for more than 100 years.

The western edge of Newark Bay was originally shallow tidal wetlands covering approximately 12 square miles. Around 1910, the City of Newark began excavating an angled shipping channel in the northeastern quadrant of the wetland which formed the basis of Port Newark. Work on the channel and terminal facilities on its north side accelerated during World War I when the federal government took control of Port Newark. The Port Authority of New York and New Jersey (PANYNJ) took over the operations of Port Newark in 1948 and began modernizing and expanding both facilities southward. In 1958, the Port Authority dredged another shipping channel which straightened the course of Bound Brook, the tidal inlet forming the boundary between the cities of Newark and Elizabeth. Dredged material was used to create new upland areas south of the new Elizabeth Channel, where the Port Authority constructed the Elizabeth Marine Terminal (USACE, 1997). This series of dredging projects shaped the current environment of Newark Bay.

#### 3.3.2.2 Current Setting

The Newark Bay complex exists within one of the most densely populated areas in the country. The land surface surrounding the Bay has been developed to serve human needs including residential and industrial developments, transportation routes, shopping malls, office complexes, airports, refineries, and other commercial and industrial sites. The western shore of Newark Bay is dominated by Port Newark and Port Elizabeth. The eastern side of Newark Bay is characterized by light industry, residential areas, schools, and park land. To the south is Staten

Island and to the north are Kearny Point and Droyer's Point, which marks the mouth of the Hackensack River.

Despite extensive habitat alterations within and surrounding Newark Bay, a study by the NMFS Northeast Fisheries Science Center conducted between 1993 and 1994 identified 56 species of fish and macroinvertebrates in Newark Bay. In addition, Newark Bay has been designated as EFH under the Magnuson-Stevens Fishery Conservation and Management Act for 13 federally managed species. Intertidal and subtidal shallow waters of Newark Bay, where potential CDFs or CAD sites have been identified for FFS cost estimation purposes, provide refuge and forage for a number of commercially and recreationally important species, including winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), and bluefish (*Pomatomus saltatrix*) as well as adult spawning and egg development habitat for some of these species.

Newark Bay is a spawning ground, migratory pathway, nursery, and foraging habitat for a diverse group of aquatic organisms. A number of different biological communities are present in the various geomorphic habitats described above. The following subsections provide a detailed description of the biological communities that inhabit and/or use Newark Bay.

#### 3.3.2.3 Special Resource Value Habitats

The land surrounding Newark Bay is densely populated and highly urbanized, however, some habitat exists within the Bay that can provide special value to local wildlife. The presence and extent of these habitats (*i.e.,* wetlands, mudflats, and SAV) is described in the following sections.

*Wetlands*

Figures 3-2c and 3-2d present the NJDEP tidal water, NOAA mudflat, and NWI mapped wetlands within Newark Bay. NWI mapping shows intertidal estuarine wetlands along the eastern face of Kearny Point, as well as under and around the western end of the Route 78 Bridge.

The intertidal wetlands of the Newark Bay system primarily consist of common reed and smooth cordgrass, with cordgrass occupying lower elevations of the shoreline. Similar to the Lower

Passaic River, there are both native and nonnative plant species along the shoreline of Newark Bay, though a comprehensive vegetation survey has not been performed.

*Mudflats and Subtidal Flats*

The intertidal areas within Newark Bay consist of mudflats (fine sediments and sand) that are typically exposed during low tide. Mudflats 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 the mudflats. Mudflats are also important feeding areas for predatory fish and shorebirds such as herons, egrets, and sandpipers. Based on data available from NOAA, there are approximately 31 acres of intertidal mudflats present in Newark Bay. NWI mapping shows intertidal unconsolidated shore in Newark Bay, including along the bulkhead between Route 78 and the Port Newark Channel.

The broad, shallow subtidal flats located outside of the navigation channels cover approximately 40 percent of Newark Bay (Figures 3-2c and 3-2d). Water depths in the subtidal flats average approximately 9 feet based on the bathymetric survey conducted as part of the Phase I sediment investigation (Tierra Solutions Inc., 2004). Subtidal flats are important ecological areas that can support SAV communities, diverse benthic communities, and a variety of fish and shellfish.

*Submerged Aquatic Vegetation*

There are no data on the presence of SAV communities and associated species that utilize this habitat type in Newark Bay, as confirmed by a biological literature review conducted by Earth Tech, Inc. and Malcolm Pirnie, Inc. in 2004.

#### 3.3.2.4 Wildlife

*Threatened and Endangered Species*

The shortnose sturgeon is federally listed as endangered. This species was not collected in any of the studies conducted in Newark Bay or adjacent waters. The Atlantic sturgeon, federally listed as endangered in 2012, formerly inhabited the Passaic River, but urbanization, industrialization, and pollution in the late 19$^{th}$ century became a barrier to the upstream spawning of American shad and sturgeon (USACE, Undated). The NMFS caught an Atlantic sturgeon in Newark Bay during 1993/1994 sampling (NMFS, Undated), though this species was not collected in any other fish studies of Newark Bay or adjacent waters conducted from 1986 to 1999 (USACE, 2004).

Kemp's ridley (*Lepidochelys kempii*; federally endangered), loggerhead (*Caretta caretta;* federally threatened), and green (*Chelonia mydas*; federally threatened) sea turtles migrate through the New York Bight in late May and can be present until November. Although sea turtles do not nest as far north as New Jersey, juvenile turtles seasonally inhabit estuaries and bays and are known to occur in the NY/NJ harbor. However, sea turtles are not likely to venture into Newark Bay except as occasional seasonal transient individuals.

Several species of small marine mammals have been reported in the Arthur Kill and may occasionally be present in Newark Bay. All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972 (16 USC Chapter 31). The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, as well as the importation of marine mammals and marine mammal products into the U.S. "Take", as defined under the MMPA means to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect". The bottlenose dolphin, (*Tursiops truncatus*; MMPA depleted) harbor porpoise (*Phocoena phocoena*), harbor seal (*Phoca vitulina*), and West Indian manatee (*Trichechus manatus*; federally endangered) have been sighted in the Arthur Kill in recent years (USCG, 2010). A harp seal (*Pagophilus groenlandicus*) was documented at the Kane wetland mitigation bank along the Hackensack River during the winter of 2011. Based on these sightings, it appears that these species are most likely to be present in the area during the winter. The harbor seal and harbor porpoise are reported as uncommon visitors to Newark Bay (USACE, 1997).

The USFWS documentation states that the peregrine falcon and occasional transient bald eagle are known to occur in Newark Bay. Newark Bay is within the historic range of the peregrine falcon, which is federally listed as endangered, and the bald eagle, which was de-listed in 2007 and is now protected by the Bald and Golden Eagle Protection Act of 1940 and the Migratory Bird Treaty of 1918. Peregrine falcons have been known to nest on the Bayonne Bridge, which spans the Kill Van Kull, and on the Goethals Bridge over the Arthur Kill, both of which are located at the southern tip of Newark Bay. Both species were observed in the FFS Study Area during the CPG habitat surveys conducted in 2010.

*Fish Community*

The USACE New York District conducted supplemental biological sampling to obtain information on distribution patterns of the eggs and larvae of demersal fish species within the navigation channels and shoals of Upper New York Bay, Newark Bay and the Arthur Kill (USACE, 2001). Samples from the shallow water stations in Newark Bay contained eggs from a variety of species including tautog (*Tautoga onitis*), weakfish (*Cynoscion regalis*), Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy (*Anchoa mitchilli*), and windowpane (*Scopthalmus aquosus*). Post yolk-sac larvae of windowpane, summer flounder, and winter flounder were also collected in the sampling.

Sediments in the intertidal portions of Newark Bay support a wide variety of organisms. Shallow sandy flats support infaunal and epifaunal benthic organisms that are prey for small or juvenile fish. A survey of an intertidal flat in Newark Bay conducted in 1985 found that several stations had 1,500 to 3,700 individual benthic invertebrates per square meter.

The intertidal and subtidal shallow environments are of special value to small fish that find refuge in these areas from larger fish. Subtidal shallows are within the photic zone most of the time and thus support macroalgae even though the water frequently may be turbid. Algae and other structures in subtidal shallows such as exposed rocks, oyster shell, and man-made debris, are important habitat for young-of-the-year tautog (*Tautoga onitis*), black sea bass (*Centropristis striata*), striped bass, blue crab, American eel, and other fish species.

Available fish data indicate that Newark Bay has a diverse fish community dominated by relatively few species. Dominant species in recent fish studies include striped bass, winter flounder, bay anchovy, and Atlantic tomcod. A number of other species also occur, but are present in smaller numbers, or are present for only short periods of time. Newark Bay provides nursery habitat for winter flounder and acts as a passageway for anadromous fish species. Most of the anadromous species that travel through Newark Bay continue on to the Hackensack River.

Several alewife were caught in the Lower Passaic River during the May 2010 small forage fish reconnaissance (Windward Environmental, 2011a).

### *Essential Fish Habitat*

EFH was defined by Congress as "those waters and substrates necessary for fish spawning, breeding, feeding, or growth to maturity." EFH and the associated federally managed species are considered aquatic resources of national importance. Newark Bay has been designated as EFH for the following species:

- Atlantic sea herring (*Clupea herengus*) - larvae, juveniles, and adult
- red hake (*Urophycis chuss*) - larvae, juveniles, and adults
- winter flounder (*Psuedopleuronectes americanus*) - all life stages
- windowpane (*Scophthalmus aquosus*) - all life stages
- bluefish (*Pomatomus saltatrix*) - juveniles and adults
- butterfish - (*Peprilus triacanthus*) - larvae, juveniles, and adults
- Atlantic mackerel (*Scomber scombrus*) - juveniles, and adults
- summer flounder (*Paralichthys dentatus*) - larvae, juveniles, and adults
- black sea bass (*Centropristis striata*) - juveniles and adults
- scup (*Stenotomus chrysops*) - eggs, larvae, and juveniles
- king mackerel (*Scomberomorus cavella*) - all life stages
- Spanish mackerel (*Scomberomorus maculatus*) - all life stages
- cobia (*Rachycentron canadum*) - all life stages.

While Newark Bay is EFH for a number of species, the habitat it provides for winter flounder is particularly valuable. The southern New England and Mid Atlantic winter flounder stock is considered depleted and is currently at record lows (NEFSC, 2008). Winter flounder use habitats of Newark Bay throughout all stages of their life cycle including the subtidal shallow water for adult spawning, egg development, juvenile foraging, and juvenile sheltering habitat. Adult winter flounder migrate inshore in the fall and early winter and spawn in their subtidal shallow water natal spawning grounds (the locations where they were born) in the late winter and early spring. Winter flounder eggs are demersal and adhesive. Spawning behavior causes resuspension of fine-grained sediment that acts to separate, coat, and distribute eggs along the sediment surface. Ideal spawning habitats are shallow, unvegetated, and composed of fine-grained silt or sand.

*Benthic Invertebrate Community*

The Newark Bay benthic community is dominated by polychaetes worms which are habitat generalists and exhibit high tolerance to environmentally stressful conditions. Two polychaete worms – *Streblospio benedicti*, *Sabellaria vulgaris*, and the soft clam *Mya arenaria* are dominant during spring and summer months. There is a high variability of individual species abundance levels between shallow and deepwater environments. The moderate organism abundance and generally low species diversity in the benthos suggests that Newark Bay is a stressed environment that restricts the development of the benthic community (USACE, 1997).

The polychaetes found in these shallow areas of Newark Bay may be grazed upon by small decapod crustaceans such as crabs and shrimp as well as fish, including killifish, silversides, Atlantic tomcod, young-of-the-year or older winter flounder, scup, kingfish (*Menticirrhus saxatilis*), and sea robin (*Prionotus carolinus*), species that were reported as inhabiting Newark Bay. Many of the benthic invertebrates also are prey for wading or intertidal feeding shore birds.

The benthic community of Newark Bay is similar to the soft sediment benthic communities found throughout the NY/NJ harbor complex. Seasonal patterns in species composition and species abundance follow expected patterns related to growth, maturation, and reproduction. The Newark Bay benthic community exhibits relatively low species diversity, moderate to low abundance levels, and dominance by polychaete worms capable of tolerating marginal environmental conditions.

*Avian Community*

Three species of rails (Virginia, clapper, and sora) and the American coot (*Fulica Americana*) may breed in the general area of Newark Bay. The rail species occur in marshes while the American coot is the more aquatic member of the rail family. The American kestrel (*Falco sparverius*) and peregrine falcon nest near Newark Bay. Other raptors, including Cooper's (*Accipiter cooperii*), red-shouldered (*Buteo lineatus*), and broad-winged (*Buteo platypterus*) hawks are present during migratory periods. Osprey (*Pandion haliaetus*), northern harriers (*Circus cyaneus*), and red-tailed hawks (*Buteo jamaicensis*) are more likely to forage in Newark Bay as they nest in the NY/NJ estuary. Several species of gulls, including herring (*Larus smithsonianus*), black-backed (*Larus marinus, L. fuscus*), ring-billed (*Larus delawarensis*) and laughing (*Leucophaeus atricilla*), are known to forage and nest in Newark Bay. A variety of shorebirds including plovers (Family: Charadriidae), snipe (Family: Scolopacidae), turnstones (*Arenaria* spp.), sandpipers (Family: Scolopacidae), yellowlegs (*Tringa* spp.), dunlin (*Calidris alpine*), and sanderling (*Calidris alba*) migrate through the Newark Bay/New York Harbor area. The shoreline of Newark Bay where undisturbed intertidal mudflat is present provides marginal habitat for foraging and resting shorebirds.

Shooters Island, at the south end of the Bay, is an important breeding area for long-legged wading birds, seabirds, and waterfowl. In 1996, the following species were reported nesting on Shooters Island: great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), tricolored heron (*Egretta tricolor*), cattle egret (*Bubulcus ibis*), black-crowned night heron (*Nycticorax nycticorax*), glossy ibis (*Plegadis falcinellus*), green heron (*Butrorides striatus*), double-crested cormorant (*Phalacrocorax auritus*), herring gull (*Larus argentatus*), and great black-backed gull (*Larus marinus*). Newark Bay and Arthur Kill provide important nesting areas for long-legged coastal wading birds of New Jersey, New York, and Connecticut; mudflats and near shore shallows in Newark Bay provide valuable foraging habitat for these species (USACE, 1997).

#### 3.3.2.5 Resource Condition/Function

Overall, the condition of the habitat that exists within Newark Bay is one that is influenced by the many years of industry and urban development in the surrounding area. The shoreline is severely altered and is characterized by riprap, bulkheads, upland scrub-shrub, and a large commercial container port. Some small, scattered emergent wetlands and mudflats are still present. The intertidal mudflats support a benthic invertebrate community that provides forage areas for migratory and resident birds; however it is a low diversity community dominated by pollution-tolerant organisms. Newark Bay supports a limited migratory fish population, provides passage to freshwater habitats for anadromous fish species, provides foraging grounds for resident fish species, and is nursery grounds for winter flounder.

## 3.4 Remedial Alternatives and Impacts Assessment

### 3.4.1 Remedial Alternatives

The purpose of the FFS is to evaluate alternatives for remediating sediment in the Lower Passaic River from RM0 to RM8.3 (Figure 3-1). In addition to the No Action alternative that CERCLA and CWA 404(b)(1) regulations require to be evaluated, the following three active remedial alternatives were evaluated.

- Alternative 2: Deep Dredging with Backfill
- Alternative 3: Capping with Dredging for Flooding and Navigation
- Alternative 4: Focused Capping with Dredging for Flooding

Following completion, each of these alternatives relies on monitored natural recovery with institutional controls to achieve protectiveness. In addition, separate studies are on-going in the river above RM8.3 and in Newark Bay that are expected to result in remedial actions; if implemented, those actions may shorten the time frame within which the FFS remedial alternatives achieve protectiveness.

#### 3.4.1.1 Alternative 1: No Action

Alternative 1 does not include any containment, removal, disposal, or treatment of contaminated sediment in RM0 to RM8.3. NJDEP fish and shellfish consumption advisories would continue. Alternative 1 assumes that contaminated sediment in the FFS Study Area would be addressed under the on-going Remedial Investigation/Feasibility Study (RI/FS) for the entire 17-mile Lower Passaic River Study Area, being conducted by the CPG under USEPA oversight.

#### 3.4.1.2 Alternative 2: Deep Dredging with Backfill

Alternative 2 would use mechanical or hydraulic dredging to remove as much contaminated fine-grained sediment from the river bank to bank as practicable resulting in the exposure of the underlying native material. As soon as practicable after dredging in an area, backfill would be placed bank to bank in two, one-foot lifts, with the first lift being placed soon after dredging is completed in a given area to sequester residuals.  The second lift would be placed after dredging is complete.  The backfill thickness would not be maintained following installation.

For FFS cost estimation purposes, backfilling was assumed to be conducted using conventional methods, which would be capable of minimizing the amount of settlement of the sand material into the underlying native material. Existing mudflats would be reconstructed by placing clean sand backfill material covered by one foot of mudflat reconstruction (habitat) substrate restoring the area to the original mudflat elevation.  Due to the proximity to shore, mudflat reconstruction material could be placed via shore-based mechanical equipment.

The dredging would result in the restoration of the federal navigation channel to its currently authorized depth between RM0 and RM8.3.  Dredging would be conducted in accordance with *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA, 2005); *Technical Guidelines for the Environmental Dredging of Contaminated Sediments* (USACE, 2008c); and "*The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters,"* (NJDEP, 1997), to the extent practical. Dredging and backfilling operations are estimated to take 11 years.

#### 3.4.1.3 Alternative 3: Capping with Dredging for Flooding and Navigation

Alternative 3 would entail placing an engineered cap (or backfill where appropriate) bank to bank over the FFS Study Area.  Before placement of the cap, enough fine-grained sediment would be dredged (mechanically or hydraulically) so that the cap could be placed without causing additional flooding and to accommodate continued use of the 300-foot wide federally-authorized navigation channel with the resulting sediment removal depth of 33 feet MLW from RM0 to RM1.2, 30.5 feet MLW from RM1.2 to RM1.7, and 25.5 feet MLW from RM1.7 to RM2.2.  Some additional dredging may also be required in small areas between RM2.2 and RM8.3 to ensure a water depth of at least 10 feet below MLW over an area that is 200 feet wide (and 150 feet wide in RM8.1 to RM8.3), to accommodate current and future recreational uses of the river.  In portions of the river where scour is likely, the cap would be armored with riprap to control erosion.  The cap thickness would be monitored and maintained following construction. Existing mudflats would be reconstructed by removing 2.5 feet of contaminated sediment, placing one foot of a granular soil as capping material, and placing 1 foot of mudflat reconstruction (habitat) substrate.

For FFS cost estimation purposes, cap placement was assumed to be conducted using conventional methods, which would be capable of minimizing the amount of settlement of the sand material into the existing silt. Placement of armor material would be achieved using mechanical methods, typically from water-borne vessels. Due to the proximity to shore, mudflat reconstruction material could be placed via shore-based mechanical equipment. Dredging would be conducted in accordance with "*The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters,"* (NJDEP, 1997), to the extent practical. In-water operations are estimated to take 4.5 years.

#### 3.4.1.4 Alternative 4: Focused Capping with Dredging for Flooding

Alternative 4 involves placing an engineered cap over select areas of the FFS Study Area sediments that release the most contaminants into the water column (the areas total about one third of the FFS Study Area, or approximately 220 acres). Before placement of the cap, enough fine-grained sediment would be dredged (mechanically or hydraulically) so that the cap could be placed without causing additional flooding. The mudflat areas would be reconstructed as described in Alternatives 2 and 3. In the capped portions of the river where scour is likely, the cap would be armored with riprap to control erosion. The dredged mudflat areas would be reconstructed by removing 2.5 feet of contaminated sediment, placing 1 foot of sand as capping material, and placing 1 foot of mudflat reconstruction (habitat) material . The cap thickness would be monitored and maintained following implementation.

For FFS cost estimation purposes, cap placement was assumed to be conducted using conventional methods, which would be capable of minimizing the amount of settlement of the sand material into the existing silt. Placement of armor material would be achieved using mechanical methods, typically from water-borne vessels. Due to the proximity to shore, mudflat reconstruction material could be placed via shore-based mechanical equipment. Dredging would be conducted in accordance with "*The Management and Regulation of Dredging Activities and*

*Dredged Material Disposal in New Jersey's Tidal Waters,"* (NJDEP, 1997), to the extent practical. In-water operations are estimated to take 1.5 years.

### 3.4.2 Dredged Material Management Scenarios

The dredged material removed during implementation of the active remedial alternatives would be managed in accordance with one of three DMM scenarios:

- DMM Scenario A – In Water Disposal in a CAD or CDF
- DMM Scenario B - Off-Site Treatment and Disposal
- DMM Scenario C - Local Decontamination and Beneficial Use

Descriptions of these disposal scenarios can be found in FFS Chapter 4. Only DMM Scenario A (CAD or CDF) would involve the discharge of dredged material into waters of the U.S. Under DMM Scenarios B and C, the sediment would be dewatered and treated prior to on-land disposal. An upland sediment processing site would be identified during the design phase. Impacts to aquatic resources associated with the upland processing site (*e.g.* wetlands), if any, would be evaluated at that time.

Under DMM Scenario A (CAD), the existing surface layer of contaminated sediment would be dredged and disposed in an upland landfill and the non-contaminated underlying material would be excavated to create a pit (CAD cell). The excavated material from the CAD cell would be taken to an ocean disposal site. Under DMM Scenario A (CAD), the pit would be surrounded by sheetpiles to control the spread of contaminants during filling operations with access on the side closest to the navigation channel. The final grade of the capped CAD cell would be similar to the surrounding floor of the Bay.

Under DMM Scenario A (CDF), a CDF would be constructed on top of a CAD cell (constructed as before), totally enclosed in sheetpiles or another structural containment system. The final grade of the capped CDF would be similar to the adjacent upland surface elevation and the final use of the CDF would be consistent with adjacent upland use. For FFS cost estimation purposes, both Site 1 and Site 7 are considered potential CDF sites (Figures 3-2c and 3-2d).

Under Alternative 2, DMM Scenario A (CAD), the dredged material would be placed in three CAD cells in Newark Bay totaling 171 acres (165 acres for the CAD cell and 6 acres for the access channel), with an estimated capacity of 11.4 million cubic yards. Under DMM Scenario A (CDF), the dredged material would be placed in a CDF in Newark Bay at Site 1, totaling 112 acres. It is expected that an additional 3 acres of emergent wetlands immediately landward of the CDF footprint would also be filled for construction access. Therefore, the Alternative 2 CDF would impact approximately 115 acres of intertidal/subtidal habitat (Figures 3-2c and 3-2d).

Under Alternative 3, DMM Scenario A (CAD), the dredged material would be placed in two CAD cells in Newark Bay, totaling 80 acres (76 acres for the CAD cell and 4 acres for the access channel) with an estimated capacity of 5.2 million cubic yards. Under DMM Scenario A (CDF), the dredged material would be placed in a CDF at Site 7 in Newark Bay, totaling 40 acres. An additional 5 acres of estuarine unconsolidated bottom (mudflat) immediately landward of the CDF would also be filled for construction access. Thus, the Alternative 3 CDF would impact approximately 45 acres of intertidal/subtidal habitat (Figures 3-2c and 3-2d).

Under Alternative 4, DMM Scenario A (CAD), the dredged material would be placed in one CAD cell in Newark Bay, totaling 19 acres (17 acres for the CAD cell and 2 acres for the access channel) with an estimated capacity of 1.1 million cubic yards. Under DMM Scenario A (CDF), the dredged material would be placed in a CDF in Newark Bay in the southern portion of Site 7, totaling 33 acres. An additional 3 acres classified as estuarine unconsolidated bottom (mudflat) immediately landward of the CDF would be filled for construction access. Thus, the Alternative 4 CDF would impact approximately 36 acres of intertidal/subtidal habitat (Figures 3-2c and 3-2d).

A comparison of the alternatives is provided in Table 3-1.

### 3.4.3 Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem

#### 3.4.3.1 Substrate

Under Alternative 2, contaminated sediments in the FFS Study Area would be dredged to the depth of underlying native material, resulting in the loss of existing substrate over the approximate 650 acre area (RM0 to RM8.3 bank to bank). Following dredging, 2 feet of backfill material would be placed over the river bottom to contain residual contamination. Under Alternative 3, the dredging footprint is also approximately 650 acres; an engineered cap will be installed bank-to-bank and armored in spots to control erosion, except within the federal navigation channel between RM0 to RM1.2 which will be backfilled. Under Alternative 4, the dredging footprint is approximately 220 acres, with about one third of the river and mudflats being dredged and an engineered cap installed. For all alternatives, disturbed mudflats would be restored with one foot of suitable reconstruction material on top of sand. Over time, silty sediments would likely be deposited over the sand.

Temporary impacts to substrate in Newark Bay would be similar for all CAD scenarios except for the overall acreage and duration of impacts (171 acres for 11 years under Alternative 2; 80 acres for 5 years under Alternative 3; and, 19 acres for 2 years under Alternative 4). The natural silty bottom would temporarily be lost during the CAD cell construction. The CAD cell would be surrounded by a temporary sheetpile wall which would be removed following filling of the CAD cell. An engineered cap would be placed over the CAD cell and the original bathymetry would be reestablished.

Permanent impacts to substrate in Newark Bay would be similar for CDF scenarios except for the overall acreage of impacts (115 acres under Alternative 2; 45 acres under Alternative 3; and, 36 acres under Alternative 4). The natural silty bottom would be replaced by CDFs and, ultimately, uplands.

#### 3.4.3.2 Suspended Particulates/Turbidity

Under Alternatives 2, 3, and 4, sediment resuspension in the Lower Passaic River is expected to increase during river dredging. Sediment resuspension was estimated by simulations of sediment transport/contaminant fate during dredging (refer to Appendix B). High turbidity levels generated during dredging would likely impact fish and benthos. Resuspended sediment would be carried upstream (above RM8.3) and downstream to Newark Bay resulting in widespread sediment suspension and subsequent redeposition. Impacts from Alternative 3 would be less severe than from Alternative 2, and impacts from Alternative 4 would be less severe than from Alternative 3 owing to the smaller volume of material to be dredged in each case.

Dredging for the creation of a CAD cell or CDF in Newark Bay would occur within CAD/CDF containment structures, so sediment resuspension would be confined to the CAD cell or CDF area. Placement of dredged material into the CAD cell or CDF would result in the resuspension of sediment but it is expected that most effects would be confined to the CAD cell or CDF; a small fraction of the total discharged mass is estimated to escape the containment system (see Attachment C of Appendix G). For the CAD cell, the edge of the sheetpile containment system would be placed approximately 100 feet from the main navigation channel. A small channel would be excavated between the main channel and each CAD cell. A silt curtain would be installed in the navigation channel for use during material placement. The silt curtain would be opened to allow a loaded barge to enter and closed before dredged materials are released. After some settling time is allowed, the silt curtain would then be opened again for the empty barge to exit the CAD cell. Although still under construction, the New Bedford Harbor Superfund Site CAD cell design includes silt curtains along the perimeter of the CAD cell (Apex, 2013). The design incorporates a silt curtain "door" to allow for barges to enter and exit the CAD cell. Best management practices described in "*The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters"* (NJDEP, 1997) would be followed to the extent practical.

#### 3.4.3.3 Water Quality

Dredging operations could result in degradation of water quality throughout the project area, depending on how many of the actions to minimize adverse effects described in Section 3.4.5 are implemented.  Resuspension of contaminants in dredged material would make contaminants available for uptake by fish and benthic organisms.  Additionally, high levels of resuspended sediment may reduce dissolved oxygen levels, potentially stressing aquatic biota.  Impacts from Alternative 2 would be more severe than those of Alternatives 3 or 4, owing to the greater volume to be dredged and the deeper dredging depths (since contaminant concentrations tend to increase with depth).  Placement of dredged material in the CAD cell or CDF would result in similar water quality impacts, but these effects would be largely confined to the CAD cell or CDF because a small fraction of the total discharged mass is estimated to escape the containment system (see Attachment C of Appendix G). However, it is unknown how much dissolved phase contamination would escape through the containment system during placement. Dredging would be conducted in accordance with "*The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters,"* (NJDEP, 1997), to the extent practical.

#### 3.4.3.4 Normal Water Level Fluctuations

The proposed Lower Passaic River dredging would not have a significant impact on normal water level fluctuations in the river.  Short- and long-term changes to river bathymetry would result from the proposed dredging alternatives but because the river is tidal, and no portion of the river would be cut off from the tide during dredging or capping, normal water level fluctuations would prevail (see Appendix B).

For Alternative 2, changes in the river bathymetry (including restoring the navigation channel to RM8.3) would result in a greater volume of tidal water exchange in the Lower Passaic River. However, because the river is currently brackish up to RM6 and tidal up to RM17.4, no long-term effects on water level fluctuations are expected.  For Alternative 3, changes in the river bathymetry (including dredging the federal navigation channel to RM2.2) and restoration of the current bathymetric contours following capping would not lead to long-term changes in normal water level fluctuations.  For Alternative 4, restoration of the current bathymetric contours following capping would ensure no long-term changes in normal water level fluctuations.

The presence of a CAD cell or CDF would not affect normal water level fluctuations in Newark Bay.

#### 3.4.3.5 Salinity Gradients

Increases in water depths between RM0 and 8.3 would affect salinity conditions in the Lower Passaic River in several ways. With deeper water depths, salinity would intrude farther upstream with change, relative to existing conditions, of up to several miles, depending on river flow and tidal conditions. Increases in water depth would also decrease the tidal excursion (movement of the salt from high to low tide) and decrease the longitudinal salinity gradient (*i.e.*, salinity concentrations would change more gradually with distance along the river).

In Newark Bay, following construction of the CAD cell, velocities will be significantly reduced within the containment system, creating a condition that favors settling of dredge disposal materials and reduction in contaminant release to the bay. The CAD cell or CDF would have little effect on salinity distribution within Newark Bay.

### 3.4.4 Potential Impacts on Biological Characteristics of the Aquatic Ecosystem

#### 3.4.4.1 Threatened and Endangered Species

The federally-endangered shortnose sturgeon has not been collected in any of the studies in the Passaic River, Newark Bay or adjacent waters. The federally-endangered Atlantic sturgeon has been absent from the Lower Passaic River in the 20$^{th}$ century but has been infrequently caught in Newark Bay in recent years.

Threatened and endangered species that may occasionally be found in the Lower Passaic River include black crowned night-heron, cattle egret, glossy ibis, least tern, little blue heron, snowy egret, and peregrine falcon (see Section 3.3.1.4 for more details). These species are highly mobile and would likely avoid areas of dredging activity and noise. There would be a temporary loss of foraging habitat in areas of active dredging although areas of the river where dredging is not active would provide alternate habitat for displaced individuals.

The federally endangered Kemp's ridley, loggerhead, and green sea turtles are occasionally present as transients in the NY/NJ Harbor in the warmer months (see Section 3.3.2.4 for more details). These species are unlikely to venture into Newark Bay, therefore impacts from the CAD cell or CDF construction and operation on these sea turtles are not expected. Several species of marine mammals are occasionally sighted in Newark Bay, primarily harbor seals and harbor porpoise. If present, these species would likely avoid noise generated by the CAD cell or CDF construction and filling, therefore impacts are not expected.

#### 3.4.4.2 Fish Community

The fish communities of the FFS Study Area are not very diverse, as discussed in Section 3.3.1.4.

Impacts of dredging operations on the existing fish community would include exclusion of the fish species from suitable habitat due to increased turbidity, water disturbance, noise, and vibration. These effects would locally reduce the available water column and benthic habitat and would cause fish and crabs to move to other habitat or experience mortality. Turbidity increases in the surrounding waters may directly impact some fish species that are sensitive to water quality fluctuations or rely on sight for feeding (*i.e.*, winter flounder, bluefish). Overall, demersal (river or harbor bottom) species are likely to experience more impacts than more mobile pelagic (open water, far from shore) species, especially species which are only present on a seasonal basis.

Dredging operations under the different alternatives are scheduled to span several years and it is estimated that approximately 15 acres in open water and 5 to 10 acres near the shoreline would be disturbed at any point in time. Juvenile and adult fish are highly mobile and would likely avoid high levels of turbidity generated by dredging, opting for less disturbed suitable habitat elsewhere in the river. Mudflats, once backfilled to pre-existing elevations with habitat-specific material, would be quickly colonized by pioneer prey species. Habitat loss would be temporary, as the natural silty substrate of mudflats and the subtidal river bottom and associated benthic food base would become reestablished.

Potential long-term impacts from dredging in the Lower Passaic River may include the alteration of shallow-water bathymetry and hydrodynamics, but these areas would still provide suitable depth and habitat substrate for the fish community. Upon completion of dredging/capping, the local habitats would again be available to fish species, though habitat recovery times for the alternatives may differ, owing to the differing dredging volumes and durations. Under the different alternatives, the surficial river bottom sediments would be temporarily converted to sand and it would take approximately one to five years (Newell et al, 1998) before the previously existing silty character of the substrate becomes reestablished.

The special concern species, alewife and blueback herring ("river herring") appear to be seasonal visitors to Newark Bay which may serve as nursery habitat for these species. Newark Bay provides anadromous fish passage to the Hackensack River, while the Lower Passaic River appears to support only small numbers of river herring. Potential direct impacts to anadromous species would be limited to a few months in spring, primarily April and May. Adult migrating river herring are highly mobile fish that can avoid most in-water construction activities. River herring do not feed while moving upriver to spawn; however, because adult river herring are largely planktivorous (feed on plankton), elevated levels of suspended silt and clay could reduce available planktonic food resources in the vicinity of construction and may impair feeding by post-spawning adults moving out of the Lower Passaic River and Hackensack River through Newark Bay. Therefore, sediment resuspension, either from dredging in the FFS Study Area or from construction/operation of the CDF or CAD cell, could impact river herring. NMFS has previously recommended that no in-water work be conducted from March 1 to June 30 for other projects in the Newark Bay region, including in the Substantive Requirements Compliance Action Plan (SRCAP) for the Phase 1 Removal Action, in order to protect anadromous species, including river herring (TSI, 2010, Appendix D).

Winter flounder have not been caught during fisheries studies of the Lower Passaic River. However, winter flounder use habitats of Newark Bay throughout all stages of their life cycle including the subtidal shallow water habitats of Newark Bay for adult spawning, egg development, juvenile foraging, and juvenile sheltering habitat (USACE, 2004). Shallow water, nearshore habitats are of critical importance to winter flounder. The fine-grained substrate in these areas is required for egg development and the hydrodynamics of these areas are essential for preventing dispersion of the larvae. Fine-grained sediment in subtidal shallow waters is also critical for juvenile foraging and sheltering habitat.

Temporary increases in suspended sediment entering Newark Bay resulting from FFS Study Area dredging operations and, to a much lesser extent, from CAD cell or CDF construction and operation could adversely affect the ability of winter flounder to feed because of its dependence on sight and light. Eggs, post-settled larvae, juveniles, and adults are demersal and could be subjected to increased turbidity. Potential direct impacts to winter flounder EFH would most likely include temporary disturbance of habitat for spawning adults, demersal eggs, and newly-metamorphosed larvae through increased turbidity, and the burial of eggs and larvae through sediment deposition. Disturbance of the benthic and pelagic habitats occupied by prey organisms are the primary indirect impact to winter flounder. Temporary loss or relocation of benthic prey species resulting from physical removal of substrate and burial due to settlement of resuspended sediments would cause winter flounder to move to other feeding habitats within the harbor. These effects would be more severe from Alternative 2 than from Alternatives 3 or 4, due to the larger dredge volume and longer project schedule. While these impacts would occur over a number of years, they are ultimately temporary with no permanent habitat loss. Additionally, turbidity in the NY/NJ Harbor is naturally highly variable depending on freshwater inflow, tidal resuspension, storms, and other factors. Demersal species such as winter flounder occur in the often turbid conditions of estuaries and can avoid temporary increases in suspended sediments. The containment of the CAD cell or CDF would minimize sediment resuspension during dredged material placement operations, thereby minimizing impacts to winter flounder and other demersal and benthic species.

Following the closure of the CAD cell, the site would be capped with sand and the original bathymetry would be restored. The life history strategies of winter flounder preclude substantial use of newly created or re-created shallow water habitat for adult spawning and egg development. Juvenile use of newly created or re-created shallow water areas for seasonal foraging habitat is likely to occur soon after the benthic food base within these areas has been reestablished (one to five years [Newell et al, 1998]). These areas are also expected to be used as seasonal foraging and sheltering habitat for juveniles.  Over time, the natural silty substrate would become reestablished at the CAD site, and suitable substrate should be available to all life stages of winter flounder.

Construction of the Alternative 2 CDF would result in the permanent loss of approximately 5 acres of emergent wetlands, 43 acres of mudflats, and 67 acres of subtidal shallows currently available to fish.  Construction of the Alternative 3 CDF would result in the permanent loss of 7 acres of intertidal habitat and 38 acres of subtidal shallows currently available to fish. Construction of the Alternative 4 CDF would result in the permanent loss of 5 acres of intertidal habitat and 31 acres of subtidal shallows currently available to fish.

#### 3.4.4.3 Benthic Invertebrate Community

The primary indirect dredging impact to aquatic biota is the effect on nearby benthic habitat resulting from increased sediment resuspension and redeposition.  Many of the fish species in the Project Area are demersal or benthic feeders, and may experience a reduction in feeding efficiency during dredging operations.  Excess silt would cause burial of some benthic organisms in the surrounding area.  Filter feeders would have difficulty locating and capturing food due to an increase in suspended non-edible particulates.  The impacts under Alternative 2 would be more severe than under Alternatives 3 or 4 due to the greater duration and volume of material to be dredged for Alternative 2. It is estimated that dredged material placement in Newark Bay, whether for a CAD cell or CDF, would result in minimal sediment resuspension and related impacts to benthic habitat because of containment structures. Without the use of silt curtains, sediment resuspension may have negative impacts on benthic habitat in Newark Bay and possibly beyond.

Recovery times vary depending on resulting substrate properties, bathymetry and hydrodynamics.  "Recovery" is generally defined as a return of the benthic assemblage to baseline, or pre-dredging, conditions of abundance, biomass, and community composition.  In some cases, opportunistic taxa achieve densities many times higher than that reported prior to dredging.  If the dredged area is not impacted by continued dredging, unusually high sedimentation rates, or some other disturbance, natural succession should occur, restoring the original benthic community within one to five years (Newell et al., 1998). However, if the characteristics of the area are changed such that it fills in with a different type of sediment, or if local hydrodynamics are affected by topographic changes (such as for Alternative 2, where a deeper lower eight miles would exist post-remedy), different species may re-colonize the area. Sites that experience changes in sediment texture typically exhibit much longer recovery times. Dredging down to underlying native material and backfilling with sand under Alternative 2 and placement of an engineered cap of sand under Alternatives 3 and 4 would initially favor a different benthic community, but over time, natural silty substrates would become reestablished, allowing restoration of the pre-existing benthic community.

Migration of adult benthos from adjacent areas that have not yet been dredged would provide recently dredged/backfilled areas with adult colonists, in addition to larval recruits from the water column. It is expected that dredged areas would be initially colonized by opportunistic species. Initial larval recruits likely would be dominated by deposit feeding, opportunistic taxa, such as the polychaetes and oligochaetes that were dominant in Lower Passaic River benthic surveys. These species are well adapted to environmental stress and can exploit suitable habitat when it becomes available. Immigration of motile annelids and crustaceans into impacted areas also would begin soon after dredging. Later stages of benthic recolonization would be more gradual and involve taxa that generally are less opportunistic and longer-lived, such as bivalves.

Since the CAD sites evaluated in the FFS for cost estimation and other comparative purposes are in the same region of Newark Bay, the types of impacts to aquatic biota are expected to be similar. However, because of the differences in acreage of bay bottom temporarily lost to CAD cell construction and the duration of this loss for the alternatives, there is a difference in the scale of impacts to aquatic biota. The area and duration of impacts required for the Alternative 2 CAD cells would be greater than those for Alternatives 3 or 4 CAD cell(s).

Construction of the CDF under Alternative 2 would result in the permanent loss of approximately 5 acres of emergent wetland benthic habitat, 43 acres of mudflat benthic habitat, and 67 acres of subtidal benthic habitat. Construction of the Alternative 3 CDF would result in the permanent loss of approximately 7 acres of intertidal benthic habitat and 38 acres of subtidal benthic habitat.  Construction of the Alternative 4 CDF would result in the permanent loss of approximately 5 acres of intertidal benthic habitat and 31 acres of subtidal benthic habitat.

#### 3.4.4.4 Avian Community

A temporary loss of bird foraging habitat, particularly the mudflats along the shoreline within the FFS Study Area, would occur during dredging and backfilling operations.  Once backfilled with mudflat reconstruction materials, pioneer prey species would quickly recolonize mudflats.  It is important to note that approximately 5 to 10 acres would be disturbed at any given point in time during nearshore construction, so suitable shorebird habitat would likely always be available somewhere in the Project Area over the 1.5 to 11 years of in-water operations.

Temporary loss of fish and benthic habitat associated with construction and operation of CAD cellss would marginally reduce the forage base for waterbirds.  Impacts would be more severe for Alternative 2 because of the greater volume to be dredged, larger CAD site footprint, and longer project duration.  If a CDF is used for dredged materials management, the loss to waterbird forage base would be permanent.  The Alternative 2 CDF would result in a permanent loss of approximately 5 acres of emergent wetlands, 43 acres of mudflat habitat, and 67 acres of subtidal habitat currently available to the avian community.  The Alternative 3 CDF would result in a permanent loss of approximately 7 acres of intertidal habitat and 38 acres of subtidal habitat currently available to the avian community.  Construction of the Alternative 4 CDF would result in the permanent loss of approximately 5 acres of intertidal benthic habitat and 31 acres of subtidal benthic habitat.

### 3.4.5 Potential Impacts on Special Aquatic Sites

#### 3.4.5.1 Sanctuaries and Refuges

No sanctuaries or refuges are located in the Lower Passaic River or in the vicinity of the proposed CAD cells or CDFs in Newark Bay.  Therefore, none of the proposed alternatives would impact sanctuaries or refuges.

#### 3.4.5.2 Wetlands (Intertidal Shallows)

Alternatives 2, 3, and 4 would each cause short-term loss of several acres of emergent wetlands along the limited areas of natural shoreline of the FFS Study Area (USACE and NWI mapped wetlands at RM3.5, RM3.8, and RM7.7, and unmapped wetlands). Natural shorelines would be stabilized with coir rolls, biodegradable erosion control matting and revegetated with wetland plants.

The CAD site option would likely not impact wetlands depending on the effectiveness of the CAD cell containment structures. The CDF option at Site 7 and 7S would not impact wetlands but the CDF option at Site 1 would result in the permanent loss of 5 acres of emergent wetlands (refer to Figure 3-2c and 3-2d).

#### 3.4.5.3 Mudflats (Intertidal Shallows)

Both Alternatives 2 and 3 would remove contaminated sediments from approximately 101 acres of mudflat; Alternative 4 would remove sediment from approximately 51 acres of mudflat. The mudflats would be replaced through backfilling with no net loss of mudflats. It is likely that the construction of a CAD cell would not directly impact mudflats although the cumulative adverse environmental impacts of any discharge during disposal into a CAD cell may extend beyond the immediate footprint of that cell into Newark Bay and possibly beyond.

Construction of the CDF at Site 1 would result in the permanent loss of approximately 43 acres of mudflat (Figures 3-2c and 3-2d) and construction of the CDF at Site 7 would impact approximately 7 acres of intertidal habitat, characterized in NWI mapping as estuarine unconsolidated shore. Construction of the CDF at Site 7S would impact approximately 5 acres of intertidal habitat.

#### 3.4.5.4 Subtidal Shallows

As previously described, backfilling with sand as proposed under Alternative 2 would result in a coarser-grained substrate in the FFS Study Area. Likewise, the capping and armoring under Alternatives 3 and 4 would result in a different substrate affecting subtidal shallows until such time as the naturally occurring silty substrate is reestablished (one to five years Newell et al., 1998). The sediment transport modeling results indicate that infilling would occur in remediated areas especially for Alternative 2. Higher infilling rates are also expected under Alternative 3 in the portion of the river downstream of RM2.2 where the deepening for the navigation channel creates a zone of preferential deposition. The model further indicated that the rate of infilling by silty substrate would be limited by the supply of solids from freshwater inputs and Newark Bay (Appendix B).

CAD cell construction and filling would create a temporary loss of subtidal shallows in Newark Bay. As CAD cells are scheduled to remain open for the duration of the dredging operations, the use of CAD cells for Alternative 2 would cause the loss of 171 acres of subtidal shallows for 11 years. Use of CAD cells for Alternative 3 would cause the loss of 80 acres of subtidal shallows for 5 years. Use of a CAD cell for Alternative 4 would cause the loss of 19 acres of subtidal shallows for 2 years. Construction of the CDF under Alternative 2 would result in the permanent loss of 67 acres of subtidal shallows. Construction of the CDF under Alternative 3 would result in the permanent loss of 38 acres of subtidal shallows. Construction of the CDF under Alternative 4 would result in the permanent loss of 31 acres of subtidal shallows.

A summary of the impacts from Alternatives 2, 3, and 4 and aquatic DMM scenarios is provided in Table 3-2. Based on this assessment, in terms of CWA Section 404(b)(1), Alternative 4 would have less impact than Alternatives 2 and 3 as a remedial action. Based on the suspended sediments modeling performed for the FFS, the CAD site option would have the least impact of the two aquatic DMM scenarios evaluated. As noted previously, DMM Scenario B - Off-Site Treatment and Disposal and DMM Scenario C - Local Treatment and Beneficial Use would involve upland sites and would be likely to avoid impacts to the aquatic ecosystem. The practicability of DMM Scenarios B and C in terms of cost, existing technology and logistics are evaluated in the FFS under the NCP's nine criteria.

### 3.4.6 Actions to Minimize Adverse Effects

Due to the large extent of area to be dredged (approximately 650 acres for Alternatives 2 and 3 and approximately 220 acres for Alternative 4), dredging of the FFS Study Area has the potential to cause adverse effects, both within the River and in Newark Bay. Dredged material disposal within a CAD cell or CDF in Newark Bay also has the potential to cause adverse effects. To the extent practicable, dredging would be conducted in accordance with *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA, 2005); *Technical Guidelines for the Environmental Dredging of Contaminated Sediments* (USACE, 2008c); and *The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters* (NJDEP, 1997). The following discussion of minimization of adverse effects focuses on dredging and aquatic dredged material disposal options. In accordance with CWA Section 404(b)(1) guidance, the discussion describes Actions Concerning the Location of the Discharge and the Material to be Discharged, Actions Controlling the Material after Discharge, Actions Affecting the Method of Dispersion, Actions Related to Technology and Actions Affecting Plant and Animal Populations.

#### 3.4.6.1 Dredging Operations

Dredging operations would result in some sediment resuspension which may be redeposited within the Lower Passaic River or transported to other locations in the water body. Contaminants may also dissolve into the water column and become available for uptake by biota. Adverse environmental impacts due to dredging may be minimized using engineering and operational controls such as:

- Optimizing the design of the clamshell bucket or auger head for the anticipated depth of cut.
- The use of a closed, watertight clamshell dredge or hydraulic dredge with appropriate controls.
- Appropriate maintenance and operation on equipment or machinery, including adequate training, staffing, and working procedures.
- Designing access structures that would accommodate fluctuating water levels, and maintain circulation and faunal movement.
- Employing appropriate machinery and methods of transport of the material for discharge.
- Minimizing the number of passes needed to dredge a particular volume of sediment.
- Slowly withdrawing the clamshell through the water column.
- Minimizing vessel movement within the dredging area.

- Not allowing water to overflow barge (Note that the Lower Passaic River and Newark Bay are subjected to “No Barge Overflow” dredging conditions [NJDEP, 1997]).
- Not hosing down or rinsing sediment down the sides of the barge gunwales.

#### 3.4.6.2 CAD and CDF

The effects of the dredged material disposal would be minimized as much as possible by the selection of the potential disposal sites. The size and location of proposed CAD and CDF sites would be designed to minimize loss of Newark Bay habitat and to avoid a disruption of water inundation patterns. Should CAD cells or a CDF be selected for dredged material disposal, the actual impact on Newark By would need to be evaluated based on final designs.

To minimize the effects, the discharge of dredged material would be conducted such that physiochemical conditions are maintained. The availability of pollutants would ultimately be reduced through burial of contaminated sediment in a CAD cell or CDF, which would minimize contaminant movement.

The effects of the dredged material after discharge would be controlled by selecting discharge methods to reduce the potential for erosion, slumping or leaching of materials into the surrounding aquatic ecosystem. These methods could include, but are not limited to:

- CAD cell or CDF containment structures to minimize resuspended contaminant escape during filling operations, with the exception of losses through an entrance channel for the CAD cell.
- Capping contaminated material in a CAD cell or CDF with clean material.
- Monitoring and maintaining CAD cell or CDF to prevent contaminant release.
- Timing the dredging and dredged material placement to minimize impact, for instance avoiding in-water work during periods of unusual high water flows, wind, wave, and tidal actions.
- Strategic placement within the cell (*e.g.*, deep burial of the most highly contaminated sediment).
- Maintaining appropriate water depth during placement.

- Selecting the appropriate discharge equipment. (*e.g.* NJDEP guidance recommends split hull barges for projects which would use CAD cells [NJDEP, 1997]).
- Establishing limitations on the amount of material to be discharged per unit of time or volume of receiving water.

Minimization of adverse effects on populations of plants and animals would be achieved by the construction of CAD cell or CDF containment structures outside of the likely period of winter flounder spawning and early life stage presence and anadromous species passage through Newark Bay (see Section 3.5 for more details).

Dredged material placement within a CAD cell would not result in losses of mudflats or wetlands in Newark Bay and impacts to water column and subtidal fish and benthic habitat would be limited to the period of CAD cell filling. Original bathymetry would be restored as part of the CAD cell closure, and the natural silty sediments would become reestablished over time. Water currents and circulation patterns altered due to CAD cell construction and operation would be restored upon CAD cell closure.

## 3.5 Avoidance, Minimization, and Mitigation

The Section 404(b)(1) guidelines provide an outline for an analysis of alternatives to assist USEPA in meeting the substantive requirements of Section 404(b)(1). This analysis will assist USEPA in evaluating how impacts could be avoided or mitigated for each remedial alternative under consideration, and would provide a basis for estimating the costs of mitigation that may be associated with each alternative.

### 3.5.1 Avoidance

The following four alternatives are being evaluated:

- Alternative 1: No Action
- Alternative 2: Deep Dredging with Backfill
- Alternative 3: Capping with Dredging for Flooding and Navigation

- Alternative 4: Focused Capping with Dredging for Flooding

While the No Action alternative would completely avoid the discharge of dredged material to the aquatic ecosystem, this alternative has significant adverse environmental consequences. Under the No Action alternative, the contaminated sediments in the FFS Study Area would remain in place, continuing as a potential source of harm to human, aquatic and wildlife health for the foreseeable future because of the persistence of the contaminants. Therefore, in terms of CWA Section 404(b)(1), Alternatives 2, 3, or 4 would have fewer adverse impacts in the long term compared to the No Action alternative. During implementation of Alternatives 2, 3, and 4, best management practices would be employed to minimize adverse impacts of the dredging and capping activities. Based on the comparison of alternatives in Section 3.4, Alternative 4 would have fewer adverse impacts on aquatic resources than Alternatives 2 or 3, in terms of CWA Section 404(b)(1) criteria. However, Alternative 4 would also have significant adverse environmental consequences in that only one third of the contaminated sediments in the FFS Study Area would be dredged and capped, leaving the majority of contaminated sediments in place and continuing as a potential source of harm to human, aquatic and wildlife health for the foreseeable future.

For each of the active remedial alternatives, three DMM scenarios are being considered: DMM Scenario A – In-Water Disposal in a CAD cell or CDF in Newark Bay; DMM Scenario B - Off-Site Treatment and Disposal; and DMM Scenario C - Local Decontamination and Beneficial Use. DMM Scenarios B and C would not include in-water disposal. The practicability of DMM Scenarios B and C in terms of cost, existing technology and logistics are evaluated in the FFS under the NCP's nine criteria. Both the CAD cell and CDF options under DMM Scenario A would involve the discharge of dredged material into waters of the U.S. If DMM Scenario A is incorporated into the selected remedy, in accordance with CWA Section 404(b)(1), mitigation of the impacts from the aquatic disposal sites would be necessary.

### 3.5.2 Minimization

For the three active remedial alternatives, turbidity during dredging and dredged material disposal would be controlled using best management practices, including practices presented in

"*The Management and Regulation of Dredging Activities and Dredged Material Disposal in New Jersey's Tidal Waters,"* (NJDEP, 1997). Because of the large dredging footprint and the speed of currents in the Lower Passaic River, in-river silt curtains or cofferdams were assumed not be used in this FFS evaluation. Biostabilization of natural shorelines would be included in the three active remedial alternatives. Additionally, best management practices for soil erosion and sediment control would be used to minimize sediment entering waterways.

The discharge of litter and debris into the river from construction activities would be minimized by employing a pollution prevention and control plan, which would include restricting the location of refueling activities and requiring immediate cleanup of spills and leaks of hazardous materials; storing potentially hazardous materials on-site in clearly marked tanks with secondary containment structures; and regularly maintaining construction equipment to identify and repair leaks.

Within the USACE New York District, in-water work may be restricted to protect overwintering or spawning habitat for fish, including striped bass, American shad, Atlantic tomcod, and winter flounder. By limiting in-water work to periods where sensitive life stages of these species are unlikely to occur, impacts to these species and their habitats would be minimized. In particular, efforts could be made to build the CAD cell or CDF containment structures between July 1 and December 31 to avoid sediment resuspension and noise impacts to winter flounder and anadromous species. It should be noted that NOAA recommended for the Phase 1 Removal SRCAP that no in-water work be conducted within the Passaic River from March 1 to June 30 to minimize impacts to anadromous fish. NOAA did not object to work within cofferdams during this time frame, provided the cofferdams were installed and removed outside of this time. During the design of the selected remedy, USEPA would consult and coordinate with NJDEP, USACE, NMFS, and USFWS to identify appropriate procedures to minimize aquatic habitat impacts. Fish migration studies will be conducted during the design phase to assess appropriate in-water work windows.

### 3.5.3 Compensatory Mitigation Requirements

Notwithstanding efforts to avoid and minimize impacts to jurisdictional areas consistent with the Section 404(b)(1) guidelines, the potential remedial alternatives would still result in impacts to mudflats, intertidal wetlands, and open water (subtidal waters). Possible options and costs associated with mitigating these impacts are described in the following sections.

#### 3.5.3.1 Remediation of Lower Passaic River

The purpose of the dredging and capping remedial alternatives in the FFS Study Area is to either remove or permanently sequester contaminated sediments, which are a major source of contamination to the rest of the river and Newark Bay. Due to past industrial and municipal uses, the sediments of the FFS Study Area are severely degraded and impacted by contamination. This contamination has the potential of passing through the food chain and rendering many species unfit for consumption by anglers (*e.g.,* fish and crabs) and wildlife. Restrictions on consumption of fish and crabs are already in place. The remedial alternatives being considered (except for No Action) would improve sediment and water quality, restore degraded shorelines, replace existing habitats and enhance human and ecological use in the FFS Study Area. Compensatory mitigation would be obtained through the following actions:

- After implementation of the selected remedial alternative, the degraded FFS Study Area would be replaced with a healthier ecosystem, improved habitat, and the federal navigation channel would be appropriately accessible(under Alternatives 2 or 3). The quantity of open water, mudflat and intertidal wetlands that currently exist would be replaced with open water, mudflat and intertidal wetlands of similar size and location, but significantly improved quality.
- Upon remediation of the sediments in the existing wetlands in the FFS Study Area, the wetlands would be reestablished to the original marsh elevation and revegetated with native herbaceous vegetation. The mudflats would be reestablished to the original mudflat elevations.
- Remediation of contaminated sediments, along with improving water quality, would minimize potential adverse health effects to individual organisms, communities, and populations. Since the water-dependent remedial action would re-create, replace and

improve existing open water, mudflat and intertidal habitat, no additional compensatory mitigation measures would be necessary.

New Jersey regulations state that mitigation is not required for maintenance dredging in accordance with NJAC 7:7E-4.6 or for new dredging (to a depth not to exceed four feet below MLW) in accordance with NJAC 7:7E-4.7. Federal mitigation regulations indicate that the proposed remedial alternatives would be considered "rehabilitation." Rehabilitation is defined as "the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function but does not result in a gain in aquatic resource area" (40 CFR Part 230 Subpart J and 33 CFR Part 332). Therefore, the proposed remediation of the FFS Study Area under Alternatives 2, 3, and 4 would not require any additional compensatory mitigation. This is consistent with the Hudson River PCBs Superfund Site dredging project.

#### 3.5.3.2 Dredged Material Management

The conceptual design of the potential DMM scenarios (DMM Scenario A) has been guided by the Section 404(b)(1) three-step process used by the USACE, USEPA and NJDEP for projects involving activities in wetlands, open waters of the U.S., and mudflats. This process requires that the proponents:

- Avoid wetlands, open waters and mudflats to the extent practicable.
- Minimize impacts to wetlands, open waters and mudflats to the extent practicable.
- Compensate for impacts to wetlands, open waters and mudflats.

DMM Scenario A (CAD) – The CAD site would temporarily impact the subtidal habitat of Newark Bay. These impacts cannot be avoided as the potential disposal sites would be located in the subtidal zone of Newark Bay. However, the disposal sites would be selected to avoid impacts to wetlands and mudflats. The open water impacts from the CAD cell in Newark Bay would be temporary as the bottom bathymetry would be restored once the CAD cell is closed and the re-establishment of natural silty sediments would occur over time. The CAD cell(s) could be open for 2 to 11 years, depending on the alternative. Typically, USACE and NJDEP consider temporary impacts to be impacts that last less than 6 months. Therefore, the CAD cell option would require mitigation for its temporal impacts.

DMM Scenario A (CDF) - A CDF would permanently impact intertidal and subtidal habitats of Newark Bay. These impacts cannot be avoided as the potential disposal sites would be located in intertidal and subtidal portions of Newark Bay. Subtidal shallows and mudflats in Newark Bay would be permanently lost if a CDF were used under Alternative 2. Additionally, estuarine intertidal shore would also be lost under the Alternative 3 and 4 CDFs. The CDF would be converted to uplands after closure. Federal and state mitigation regulations require mitigation for the CDF permanent impacts.

In keeping with the three-step Section 404 (b)(1) process, impacts to open waters that cannot be avoided are minimized and then mitigated with newly-created, restored, enhanced and/or preserved areas, that include open waters, to achieve no net loss of functions of the aquatic system. As noted above in Section 3.4, the total direct impacts to open waters from the CAD cell(s) would be approximately 171 acres if remedial Alternative 2 is implemented, approximately 80 acres if remedial Alternative 3 is implemented, and approximately 19 acres if remedial Alternative 4 is implemented.

Federal mitigation regulations (40 CFR Section 230.93(f)(1)) state that "*a minimum one-to-one acreage or linear foot compensation ratio must be used*" for compensatory mitigation. New Jersey regulations (NJAC 7:7E-3.15(h), Coastal Zone Management Rules, March 3, 2011) specifically state that "*Mitigation shall be required for the destruction of intertidal and subtidal shallows at a creation to lost ratio of 1:1 through the creation of intertidal and subtidal shallows on the site of the destruction. For the purposes of this section, creation means excavating upland to establish the characteristics, habitat and functions of an intertidal and subtidal shallow.*"

Where on-site creation is not feasible, New Jersey regulations direct that mitigation shall be accomplished in accordance with the following hierarchy (NJAC 7:7E-3.15 (h) 2):

i. Creation of intertidal and subtidal shallows within the same 11-digit hydrologic unit code area as the destruction at a creation to loss ratio of 1:1.
ii. Creation of intertidal and subtidal shallows within an adjacent 11-digit hydrologic unit code area within the same WMA as the destruction at a creation to loss ratio of 1:1.
iii. Enhancement of a wetland which was previously more ecologically valuable but has become degraded due to factors such as siltation, impaired tidal circulation, or contamination with hazardous substances on the site of the destruction at an enhancement to loss ratio of 2:1.
iv. Enhancement of a degraded wetland system within the same 11-digit hydrologic unit code area as the destruction at an enhancement to loss ratio of 2:1.
v. Enhancement of a degraded wetland system within an adjacent 11-digit hydrologic unit code area within the same WMA as the destruction at an enhancement to loss ratio of 2:1.
vi. If none of the above is feasible, then mitigation shall be required in accordance with either of the following:
    (1) Creation of intertidal and subtidal shallows at a creation to lost ratio of 1:1 within the same WMA.
    (2) Enhancement of degraded wetlands at an enhancement to loss ratio of 2:1 within the same WMA.

Federal mitigation regulations (40 CFR Section 230.93(f)(2)) state that " *The district engineer must require a mitigation ratio greater than one-to-one where necessary to account for the method of compensatory mitigation (e.g., preservation), the likelihood of success, differences between the functions lost at the impact site and the functions expected to be produced by the compensatory mitigation project, temporal losses of aquatic resource functions, the difficulty of restoring or establishing the desired aquatic resource type and functions, and/or the distance between the affected aquatic resource and the compensation site. The rationale for the required replacement ratio must be documented in the administrative record for the permit action*."

As described above, if DMM Scenario A were selected, the acres of bay bottom and associated open water impacted would be restored in kind upon completion of the remedy. However, construction of CAD cells would require compensatory mitigation at a separate location to offset temporary losses to the impacted area (*i.e*., the footprint of the CAD cells) arising from the fact that the bay bottom would be uninhabitable by aquatic species during the construction period. Based on a review of other area projects with long-term temporary impacts to open water, a ratio of one acre mitigated for each acre impacted (1:1 ratio) could be considered appropriate. This compensatory mitigation could be funded in several ways, one of which is the purchase of credits from an approved mitigation bank (see Section 3.5.4.1). Credits are generated by the banks by the restoration of nearby lands to natural conditions. The "value" in terms of the mitigation acres each credit provides to the purchaser is bank-specific and will vary depending on the location of the bank, the ecological value of the restored lands, and other regulatory restrictions. While impacts to aquatic habitat resulting from CAD cells are temporary, because the construction period for all active remedial alternatives is greater than 6 months, for FFS cost estimation purposes it is conservatively assumed that each credit purchased from a mitigation bank would compensate for one impacted acre from a CAD cell. This is a conservative assumption because mitigation banks credits generally incorporate a higher ratio to address the greater mitigation ratio required for permanent impacts (e.g, one credit compensates for multiple acres of permanent impact). The actual mitigation ratio used, and the number of credits purchased, would be determined by USEPA in consultation with other regulatory agencies if CAD cell disposal is selected as part of the remedial action. For any compensatory mitigation acres not covered by the purchase of credits from a mitigation bank, in-lieu fee or permittee responsible (see Sections 3.5.4.2 and 3.5.4.3) mitigation would be required.

Construction of the CDF option would require compensatory mitigation at a separate site to offset permanent loss of habitat (*i.e.*, the footprint of the CDF and associated areas) since the bay bottom habitat would no longer be available to aquatic species following construction. Based on recent projects in the Hudson/Raritan estuary, it is expected that the permanent loss of mudflats, wetlands, and subtidal habitats would be compensated for at a ratio of 3 mitigation acres for each impacted acre (3:1 ratio). Similar to the CAD option, compensatory mitigation could involve the purchase of credits from approved mitigation banks. For FFS cost estimation purposes, it is assumed that each mitigation credit purchased from a mitigation bank would compensate for one impacted acre from a CDF [see Section 3.5.4.1]; actual credit exchange rates may vary. For any additional compensatory mitigation acres not covered by the purchase of credits from the mitigation banks, in-lieu fee or permittee responsible (see Sections 3.5.4.2 and 3.5.4.3) mitigation would be required.

### 3.5.4 Compensatory Mitigation Options

Unavoidable impacts to aquatic resources from the potential CAD site require mitigation to offset temporal ecological losses to habitat and their functional value to the local and regional environment. In 2008, USEPA and USACE published regulations to promote no net loss of wetlands by improving wetland restoration and protection policies, increasing the effective use of wetland mitigation banks and strengthening the requirements for the use of in-lieu fee mitigation. These wetlands compensatory mitigation rules follow the recommendations of the National Research Council by establishing equivalent, effective standards for wetland replacement projects under the CWA. These federal regulations set forth the process for selecting appropriate mitigation options (*Compensatory Mitigation for Losses of Aquatic Resources*, 40 CFR Part 230 Subpart J and 33 CFR Part 332). The regulations establish a preference for using credits from a mitigation bank over other compensation mechanisms. If a mitigation bank is not available, the next preference is in-lieu fee mitigation. The final option is known as “permittee-responsible” mitigation.

#### 3.5.4.1 Wetland Mitigation Bank

A wetland mitigation bank is a wetland area that has been restored, established, enhanced or preserved, which is then set aside to compensate for future conversions of wetlands for development activities. Permittees, upon approval of regulatory agencies, can purchase credits from a mitigation bank to meet their compensatory mitigation requirements. The value of the “credits” is determined by quantifying the wetland functions or acres restored or created. The bank sponsor is responsible for the success of the project. Mitigation banking is performed "off-site," meaning it is at a location not on or immediately adjacent to the site of impacts, but within the same WMA (USEPA, Undated). According to NJDEP, the following three wetland mitigation banks may be able to provide tidal mitigation credits to compensate for the temporal CAD cell impacts in Newark Bay (NJDEP, 2013).

### *ProLogis / Port Reading Wetland Bank Wetland Mitigation Bank*

The Port Reading Bank is operated by ProLogis and is located on a 11.26-acre property in the Township of Woodbridge, Middlesex County. The bank received a total of 8.47 credits for creation and enhancement of intertidal and subtidal shallows and tidal wetlands on 11.13 acres of the parcel (mitigation acres). The service area for the bank includes the tidal portions of WMA 7 (Arthur Kill) as depicted in Figure 3-3. In 2009, each credit from this bank was priced at approximately $600,000. For purposes of this assessment, it is assumed that credits are currently valued at $650,000. At this point in time, and pursuant to its release of credits, Port Reading is expected to have about 7 credits available over the next 3 years. Since DMM Scenario A – CAD would involve temporal impacts to open water, it is possible that 1 credit could compensate for more than 1 acre of temporary open water impact. However, there is currently no precedent for this approach as temporary impacts have not previously been mitigated by wetland bank credits. Therefore, as explained above, it is conservatively assumed that 1 credit would be purchased for 1 acre of either temporary or permanent impacts. Therefore, the bank could potentially compensate for 7 acres of CAD cell or CDF impacts at an approximate cost of $4,600,000.

### *Richard P. Kane Wetland Mitigation Bank*

The Kane Wetland Mitigation Bank is operated by Kane Mitigation, LLC and is located in the Boroughs of Carlstadt and South Hackensack, Bergen County, New Jersey. By restoring and enhancing 217.5 mitigation acres of intertidal and subtidal shallows, tidal wetlands and mudflats, the Kane Bank is expected to generate approximately 70 mitigation credits. The Service Area for the tidal bank includes the Hackensack River and the Lower Passaic River of WMA 5, primarily within Bergen and Hudson Counties. These two watersheds surround and encompass the Hackensack Meadowlands District so that projects with a component in the District are included in the Service Area. The bank is set up exclusively for transportation projects. The following transportation agencies may use this bank: New Jersey Transit, PANYNJ, New Jersey Department of Transportation (NJDOT), and New Jersey Transit Authority. Since the PANYNJ and NJDOT are involved in the Lower Passaic River Restoration Project, of which the CERCLA remedial action is a part, and the project includes an component that will affect the federal navigation channel (transportation component), it is possible that Kane credits could be used to off-set the CAD cell or CDF impacts (USEPA would expect to consult with the PANYNJ and NJDOT before contemplating the purchase of any Kane credits). The FFS Study Area could be argued to have a component in the Hackensack Meadowlands District as the confluence of the Lower Passaic River and the Hackensack River is located in Newark Bay. Also a portion of the remedial action near RM3, is located on the boundary of the Hackensack Meadowlands District. However, the proposed CAD cell and CDF locations appear to be located just outside of the service area for the Kane Bank. For purposes of this analysis, it is assumed that Kane Bank credits could be used to compensate for the CAD cell or CDF impacts.

This bank is currently able to sell a portion of its mitigation credits. At this point in time, and pursuant to a full release of credits, Kane is expected to have about 66 credits available over the next five years. Based on recent sales to the New Jersey Turnpike Authority and NJDOT, the price for each credit is approximately $795,000. Since DMM Scenario A – CAD would involve temporal impacts to open water, it is possible that 1 credit could compensate for more than 1 acre of temporary open water impact. However there is currently no precedent for this as temporary impacts have not previously been mitigated by wetland bank credits. Therefore, as explained above, it is conservatively assumed that 1 credit would be purchased for 1 acre of either temporary or permanent impacts. Therefore, the bank could potentially compensate for 66 acres of CAD cell or CDF impacts at an approximate cost of $52,500,000.

*Marsh Resources Incorporated Phase 3 Wetland Mitigation Bank*

The 51-acre Marsh Resources Incorporated Phase 3 (MRI3) Bank is operated by Evergreen and is located in the Borough of Carlstadt. The MRI3 Bank is expected to provide approximately 21 tidal wetland credits over the next five years. The MRI3 mitigation bank, once fully approved, would sell mitigation credits that translate into 1 credit for 1 acre of permanent impacts to wetlands/open water. Since the CAD cell option involves temporal impacts to open water, it is possible that 1 credit could compensate for more than 1 acre of temporary open water impact, however, as explained above, there is currently no precedent for this. Therefore, it is conservatively assumed that the bank could potentially compensate for 21 acres of CAD cell or CDF impacts. The credit price is unknown but it is likely to be similar to the Port Reading and Kane Bank credit prices. Assuming a cost per credit of $700,000, this bank could potentially compensate for 21 acres of CAD cell or CDF impacts at a cost of $14,700,000.

Assuming that all credits from the Port Reading, Kane and MRI3 Banks could be purchased to compensate for the CAD cell temporary impacts at a credit “value” of one credit equal to one acre of mitigation, the banks could compensate for 94 acres of impacts. It is possible that 1 credit could compensate for more than 1 acre of temporary open water impact but there is currently no precedent for this approach as temporary impacts have not previously been mitigated by wetland bank credits (Table 3-3).

- Existing mitigation banks could only compensate for 94 acres of the 171 acres of impacts from the Alternative 2 CAD cells at a price of approximately $72,000,000. Based on a mitigation to impact ratio of 1:1, an additional 77 acres of mitigation would be required for the Alternative 2 CAD cells. Therefore, additional mitigation sites would need to be selected to supplement the available bank credits (refer to Table 3-3 for the cost tabulation).
- Existing mitigation banks could compensate for the entire 80 acres of impacts from the Alternative 3 CAD cells at an approximate price of $61,000,000.
- Existing mitigation banks could compensate for the entire 19 acres of impacts from the Alternative 4 CAD cell at an approximate price of $13,000,000.

Assuming that all credits from the Port Reading, Kane and MRI3 Banks could be purchased to compensate for the CDF permanent impacts at a credit “value’ of one credit equal to one acre of mitigation, the banks could compensate for 94 acres of impacts.

- Existing mitigation banks could only mitigate for 94 acres of the total 115 acres of permanent losses of wetlands, mudflat and subtidal habitat under Alternative 2 CDF, at a cost of approximately $72,000,000. At a mitigation to permanent loss ratio of 3:1, an additional 63 acres of mitigation area would be required for the Alternative 2 CDF[4]. Therefore, additional mitigation sites would need to be selected to supplement the available bank credits for the Alternative 2 CDF (refer to Table 3-3 for the cost tabulation).

[4] Additional impacts not covered by available mitigation banks would need to be mitigated at an off-site mitigation site. Permanent impacts are typically compensated at mitigation to loss ratio of 3 to 1 while temporary impacts are compensated at a 1 to 1 mitigation to loss ratio.

- Existing mitigation banks could provide the entire mitigation necessary to offset the 45 acres of permanent impacts associated with the Alternative 3 CDF, at a cost of approximately $33,000,000.
- Existing mitigation banks could also provide the entire mitigation necessary to offset the 36 acres of permanent impacts associated with the Alternative 4 CDF, at a cost of approximately $26,000,000.

#### 3.5.4.2 In-Lieu Fee Mitigation

In-lieu fee mitigation occurs when a permittee provides funds to an in-lieu-fee sponsor (a public agency or non-profit organization). Usually, the sponsor collects funds from multiple permittees in order to pool the financial resources necessary to build and maintain the mitigation site. The in-lieu fee sponsor is responsible for the success of the mitigation. Like banking, in-lieu fee mitigation is also "off-site", but unlike mitigation banking, it typically occurs after the permitted impacts. Based on precedence, in-lieu fee mitigation is not a likely mitigation option. Presently, an in-lieu Fee program has not been established within the watershed.

#### 3.5.4.3 Permittee Responsible Mitigation

Permittee responsible mitigation is defined as the restoration, establishment, enhancement or preservation of wetlands undertaken by a permittee in order to compensate for wetland impacts resulting from specific project regulations (40 CFR Part 230 Subpart J and 33 CFR Part 332). The permittee performs the mitigation after the permit is issued and concurrently with project construction. The permittee is ultimately responsible for implementation and success of the mitigation. Permittee-responsible mitigation may occur at the site of the permitted impacts or at an off-site location within the same watershed. Since the project is a Superfund remedial action, proceeding under CERCLA authority, permits are not required for on-site activities, so there would be no “permittee” as such, but the substantive requirements would apply to the party implementing the action.

Mitigation could include restoration, creation, enhancement, and/or preservation. The goal of restoration is to return natural or historic functions and characteristics to a former or degraded wetland or other aquatic resource. Restoration may result in a gain in wetland function or wetland acres, or both. Creation involves the development of a wetland or other aquatic resource where one did not previously exist through manipulation of the physical, chemical and/or biological characteristics of the site. Successful creation results in a net gain in wetland acres and function. Enhancement consists of activities conducted within existing wetlands that heighten, intensify, or improve one or more wetland functions. Enhancement is often undertaken for a specific purpose such as to improve water quality, flood water retention or wildlife habitat. Enhancement results in a gain in wetland function, but does not result in a net gain in wetland acres. Preservation is the permanent protection of ecologically important wetlands or other aquatic resources through the implementation of appropriate legal and physical mechanisms (*i.e.*, conservation easements, title transfers). Preservation may include protection of upland areas adjacent to wetlands as necessary to ensure protection or enhancement of the aquatic ecosystem. Preservation does not result in a net gain of wetland acres and may only be used in certain circumstances, including when the resources to be preserved contribute significantly to the ecological sustainability of the watershed.

There is precedent for restoring, enhancing, or creating wetland sites to compensate for impacts to intertidal and subtidal shallows. Typically, tidal wetland mitigation sites include subtidal open water and intertidal mudflats and vegetated marsh. For example, USACE restored the KeySpan site on Staten Island, New York, in 2006/2007 to mitigate for unavoidable impacts resulting from the dredging and deepening of the Arthur Kill Channel in the NY/NJ Harbor. The 9-acre restoration effort included: the removal and grading of approximately 36,200 cubic yards of materials to create tidal channels and marshland; the removal of *Phragmites* and debris; re-grading the marsh surface to promote the growth of *Spartina* grass; the limited placement of clean soil; and planting native wetland vegetation. The $5,400,000 project was constructed to mitigate shallow water impacts resulting from the deepening of the Arthur Kill Channel (USACE, 2009).

Similarly, USACE restored the Medwick Wetland in Carteret, New Jersey to mitigate for unavoidable impacts from the dredging and deepening of the Arthur Kill Channel. The $3,300,000 mitigation project restored approximately 14-acres of tidal wetlands by removing invasive *Phragmites* and approximately 30,000 cubic yards of soil, re-contouring the site to elevations suitable for native plant and planting 270,000 native wetland plants. The connection of the wetland to the adjacent Rahway River was restored, improving water and soil quality and promoting the return of native fish and wildlife (USACE, 2009).

*Identification of Potential Mitigation Sites*

The Restoration Opportunities Report (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2006), developed as part of the Lower Passaic River Restoration Project, of which the CERCLA remediation is a part, presents and describes potential restoration opportunities in the Lower Passaic River. The report was developed to facilitate the coordination of restoration-related actions among regional stakeholders and the public. Potential restoration opportunity sites were initially identified through an open nomination process, a computer-based screening process, and field reconnaissance efforts. A Restoration Work Group composed of federal and state agencies, local environmental and business groups, and potentially responsible parties met periodically to discuss restoration visions and goals for the Lower Passaic River. The group also discussed potential restoration opportunities. Habitats were delineated into the following categories: "subtidal" defined as habitats located below MLW; "intertidal" defined as habitats located between MLW and mean high water (including wetland and mudflat areas); "riparian" defined as habitats located above mean high water to the top of the river bank; and "upland" defined as the adjacent terrestrial habitats located on and above the river bank. The following six restoration goals were identified:

- Create, enhance, and restore habitat;
- Enhance plant communities;
- Enhance animal communities;
- Improve water quality;
- Improve sediment quality; and
- Support human use.

More than 50 potential restoration sites were identified during the open nomination process. These sites are located along the Lower Passaic River from RM0 to RM17.4 in the river, adjacent to the river, and in upland areas. Based on geographical location and habitat similarities, the sites were grouped into the following eight restoration areas: Freshwater River Section of the Lower Passaic River; Transitional River Section of the Lower Passaic River; Brackish River Section of the Lower Passaic River; Saddle River; Third River; Second River; Kearny Point; and Oak Island Yards. The following five areas are best suited to mitigate for impacts to the tidal waters and bottom of Newark Bay.

*Transitional River Section* represents the portion of the Lower Passaic River between the Freshwater River Section and Brackish River Section, where the salt front typically advances under high-tide conditions (approximately RM6.0 to RM9.0). Hence, this river section is continuously influenced by saltwater intrusion and mixing, resulting in changing water chemistry. The habitat in the Transitional River Section reflects a mixture of freshwater and salt-tolerant ecosystems, resulting in a high diversity of plants and animals (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2006).

*Brackish River Section* encompasses approximately RM0 to RM6.0 where the water conditions are defined as "almost always" moderately saline. The water elevations are heavily influenced by tides. The Brackish Section reflects a salt-tolerant ecosystem and likely provides suitable habitat for estuarine aquatic plants (vascular and algae), macroinvertebrates (polychaetes, blue mussel, blue crab), fish (white perch), and wildlife species that forage on these prey types (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2006).

*Second River* is a major tributary (3.1 miles) of the Lower Passaic River with its confluence located at RM8.1. The Second River is an urban river that flows through the New Jersey municipalities of Newark, Bloomfield, and Belleville. Near the confluence, Second River is approximately 40 feet wide. Restoration opportunities encompass the lower 2.0 miles of Second River (approximately 49 acres, which includes a 100-foot buffer).

*Kearny Point* (Figure 3-3) is located at the confluences of the Lower Passaic River, Hackensack River, and Newark Bay. This large contiguous property, which borders the Passaic River, is listed in the *Project Management Plan* (USACE *et al*, 2003) as a restoration area. It is anticipated that restoration opportunities at Kearny Point would encompass approximate

73 acres. The "Kearny Point" restoration site does not include Kearny Marsh since this marsh area is a candidate restoration site under the Hackensack Meadowland study. However, Kearny Marsh would be an appropriate mitigation site for impacts to Newark Bay.

*Oak Island Yards* is a large contiguous former industrial site of approximately 39 acres located just south of the mouth of the Lower Passaic River. Oak Island Yards, which borders the Passaic River, is listed in the *Project Management Plan* (USACE *et al*, 2003) as a restoration area. Restoration opportunities at Oak Island Yards would include property adjacent to an existing tidal creek (approximately 90 acres) and 2 nearby wetland areas (approximately 1.6 acres).

In 2008, USACE further identified possible restoration sites along tributaries of the Lower Passaic River including Saddle River, Third River; and Second River. Figures 3-4a and 3-4b depict the locations of these potential restoration sites (LBG, 2008). The Tier 1 sites on Figures 3-4a and 3-4b are likely to maximize wetland functions and services, when restored. The functions and services on the restored Tier 2 sites would be more limited. In addition, the USACE has drafted detailed fact sheets for many of these potential restoration sites, including Kearny Point, Oak Island Yards, Kearny Marsh, Harrison Marsh, Minish Park Wetland, Frank Vincent Park and Boat Ramp and Kearny Riverbank Park.

The Hudson Raritan Estuary Comprehensive Restoration Plan (HRE-CRP) (USACE, 2009) includes a list of restoration opportunities in the Passaic River and Newark Bay. In addition to the wetland restoration sites discussed previously, the HRE-CRP noted that the incorporation of a fish passage structure into the restoration plans for Dundee Dam would open more than 47,000 feet of the Passaic River. In addition, the Third River, a tributary to the lower Passaic River, was identified as an opportunity to construct a fish ladder. The HRE-CRP identified additional habitat restoration opportunities including softening shorelines and re-contouring shallow water habitat along the Passaic and Hackensack Rivers and along Newark Bay. In addition, mitigation could also include the creation of artificial reefs outside of navigation channels to enhance fisheries habitat.

A recent supplemental restoration site search by The Louis Berger Group (LBG, 2011), performed for the PANYNJ, identified six additional possible restoration sites, as depicted on Figure 3-3. Sites were identified based upon desktop investigations and additional investigations are warranted to screen sites for potential mitigation use. During the Site identification process, each individual site was screened using Geographic Information Systems geospatial data for information pertaining to existing landscape characteristics including soils, topography, land use, vegetative communities, wetlands, threatened and endangered species, utilities and existing easements. Review of existing and historic aerial photography also provided background on site use and alterations.

All of these restoration studies indicate that mitigation sites are available, but limited, in the densely developed areas of the Passaic River Watershed. In addition to using the abovementioned mitigation banks, several sites may need to be restored to provide the additional 77 acres to compensate for the temporal losses associated with the Alternative 2 CAD cells and the additional 63 acres for the permanent losses associated with the Alternative 2 CDF.

*Mitigation Site Development*

Once primary candidate mitigation sites are identified, the following steps typically must be completed to obtain approval of the site as mitigation for the proposed impacts. The typical costs for planning, designing, constructing, monitoring and maintaining a mitigation project are provided in a subsequent section of this report.

<u>Baseline Studies</u>: Information is gathered on the vegetation, soils, hydrology and topography of the proposed mitigation sites, as well as adjacent wetlands, to assess various design components. This information is also compared to the characteristics of the open water proposed for impact in Newark Bay. The baseline information is used to set design features that can realistically be implemented and serve to replace wetland/open water attributes lost as a result of project construction. The baseline studies include a detailed wetland delineation, vegetation bio-benchmarks, topographic survey, contamination studies, geotechnical studies, and hydrologic/hydraulic analysis and modeling.

Site Design and Acquisition: Based on the baseline data, a conceptual restoration design is completed. The Conceptual Design Plans are revised based on comments received from the regulatory agencies. If the restoration sites/designs seem acceptable, it would be necessary to coordinate and negotiate the purchase fee for the property or a conservation easement with the land owner, utilize a New Jersey licensed surveyor to prepare a legal boundary description, and prepare closing documentation. Subsequently, final design plans, specifications, reports and cost estimates are developed.

Site Construction: Construction typically requires a design/build approach to allow an adaptive management strategy and close coordination with the regulatory officials as the dynamics of the natural site may require revisions during construction to improve the success of the design. After earthwork is completed, planting and seeding of desirable native species would be undertaken as per the approved planting plans. Planting and seeding would occur within recommended planting windows, which would minimize plant loss due to freezing and would provide a complete growing cycle for production of viable seed for the next growing season.

Monitoring and Maintenance (3 to 5 years): Once construction and planting is completed, it is necessary to conduct monitoring to assess site conditions and performance standards. Monitoring involves various standardized vegetation, soil and hydrology sampling methods. It is also necessary to note any increase of invasive species so that appropriate management measures can be taken. Annual Monitoring reports are prepared and are submitted to regulatory agencies as required.

### *Mitigation Development Costs*

The 2006-2007 construction cost for the USACE's 43-acre Elders Point East Wetland Project, with 248,500 cubic yards of material movement and installation of 750,000 plants, was $16 million ($372,000 per acre) (USACE, 2008a).

To mitigate shallow water impacts from the deepening of the Arthur Kill Channel, the USACE restored the 9-acre KeySpan Marsh in Staten Island, New York in 2005 for $5,400,000 and the 14-acre Medwick Wetland in Carteret, New Jersey in 2006/2007 for $3,300,00 (USACE et al, 2009). The per acre mitigation costs were $600,000 and $236,000, respectively.

These three projects demonstrate the wide range of costs associated with mitigation sites. The average cost per acre for these three sites was $403,000. For purposes of this analysis, it is assumed that mitigation costs would be $403,000 per acre. At this rate, the cost for 77 acres of additional mitigation for the Alternative 2 CAD cells would be approximately $31,000,000. The cost for an additional 63 acres of mitigation under Alternative 2 CDF would be approximately $25,400,000.

### 3.5.5 Avoidance, Minimization and Mitigation Summary

Table 3-4 compares the CWA impacts associated with each alternative and provides the preliminary costs for each alternative, including mitigation costs.

# 4 PASSAIC RIVER SHORT-TERM REMEDIATION IMPACTS

## 4.1 Introduction

The purpose of this chapter is to discuss the potential short term adverse impacts on human and ecological receptors in the FFS Study Area due to the remedial construction activities. This chapter presents the following information:

- Brief description of the remedial alternatives evaluated in the FFS.
- Description of potential short-term impacts associated with the three active remedial alternatives (*i.e.,* alternatives other than "No Action"). Remedial construction activities include dredging, capping, and in-process transportation activities.
- Description of potential short-term impacts associated with the three DMM scenarios. DMM activities relate to facility construction, processing/treatment operations, off-site transportation, and disposal activities.
- Short-term remediation impacts include water quality, air quality, accidents, biota and habitat, and quality of life such as noise, lighting, odor, and navigation.

### 4.1.1 Summary of Remedial Alternatives and DMM Scenarios

In addition to the No Action Alternative (Alternative 1), which serves as a baseline against which the performance of other remedial alternatives may be compared, the three active remedial alternatives being evaluated for the FFS are as follows:

- Alternative 2 – Deep Dredging with Backfill
- Alternative 3 – Capping with Dredging for Flooding and Navigation
- Alternative 4 – Focused Capping with Dredging for Flooding

The active remedial alternatives target the fine-grained sediment present in the FFS Study Area by dredging (Alternative 2) or a combination of dredging and capping (Alternatives 3 and 4). The dredging volumes for Alternatives 2, 3, and 4 are 9.7, 4.3, and 1.0 million cubic yards, respectively. Additional information on the three active remedial alternatives is presented in Chapter 4 of the FFS.

Dredged materials from each of the active remedial alternatives would be managed through the following potential DMM scenarios:

- DMM Scenario A - Confined Aquatic Disposal
- DMM Scenario B - Off-Site Disposal
- DMM Scenario C - Local Decontamination and Beneficial Use

Additional information on the three DMM scenarios is presented in Chapter 4 of the FFS.

### 4.1.2 Short-term Effectiveness Criterion

The short-term effectiveness criterion guides the evaluation of each dredging alternative or each DMM scenario for its effects on human health and the environment during the construction and implementation phases (USEPA, 1988). Each alternative (where appropriate) addresses the protection of the local community and site workers during remedial actions, as well as potential environmental impacts.

Evaluation considerations in feasibility studies involving contaminated sediment sites are also addressed in the *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA, 2005). Section 3.4 of this guidance discusses short-term impacts specifically associated with capping and remedial alternatives, including:

- Contaminant releases during dredging and/or capping
- Contaminant releases during transportation, treatment, and/or disposal of dredged sediments
- Accidents during dredging and/or transport or placement of cap material
- Accidents during construction and operation of sediment handling and treatment facilities
- Impacts to the benthic community.

For this assessment short-term impacts were broken into two categories: remedial alternatives (Section 4.2) and DMM scenarios (Section 4.3). The short-term impacts that were considered during the comparative evaluation of remedial alternatives are as follows:

- Sediment resuspension and contaminant releases
- Residuals
- Impacts to biota and habitat
- Accidents
- Air quality
- Quality of life impacts.

The short-term impacts that were considered during the comparative evaluation of DMM scenarios are as follows:

- Sediment resuspension and contaminant releases (Scenario A – CAD only)
- Residuals (Scenario A – CAD only)
- Accidents and releases
- Impacts to biota and habitat
- Air quality
- Quality of life impacts.

## 4.2 Detailed Characterization of Short-Term Impacts Related to Remedial Alternatives

In assessing remedial action impacts, it was assumed that mechanical dredging would be used in the implementation of the three active remedial alternatives. The primary factors that affect the short-term impacts for remedial alternatives include:

- Sediment inventory
- Project duration
- Disturbed area
- Depth of dredging operations.

A discussion of the comparative evaluation of the remedial alternatives is presented below.

### 4.2.1 Sediment Resuspension and Contaminant Release

Water quality and ecological concerns may result when sediment particles are dislodged and dispersed into the water column during dredging and capping operations. Debris removal operations, although limited in the overall scope of the project, are particularly disruptive. Two important processes that affect water quality during dredging and related operations include the resuspension of sediments and the release of contaminants.

**Resuspension** is the process by which a dredge and attendant operations dislodge bedded sediment particles and disperse them into the water column (USACE, 2008d). Dredge-head movements associated with normal dredging operations dislodge some bed sediment that is not captured as part of the dredging operation. Sediment resuspension also results from other activities directly associated with dredging (*e.g.*, spillage, propeller wash from tug boats and attendant vessels, spuds, dredge movement, and anchoring systems) and ancillary activities associated with environmental dredging operations (*e.g.*, debris removal and management of silt curtains). Resuspended sediments can include native bed sediments and "fall-back," (*i.e.*, sediments loosened by previous dredge actions, but not captured). Resuspension rates for environmental dredging[5] projects are reported to range from less than 0.1 percent to over 5 percent of the mass removed (USACE, 2008d). Factors affecting the amount of sediment resuspension include:

- Sediment properties such as bulk density, particle size distribution, and mineralogy
- Site conditions such as water depth, currents, and waves, and the presence of hardpan, bedrock, loose cobbles or boulders
- Nature and extent of debris and obstructions
- Dredging operational considerations such as production rate, thickness of dredge cuts, dredging equipment type, method of operation, and skill of the operator

[5] No quantitative estimates are available for the amount of resuspension caused by cap placement, but USEPA assumes that less resuspension is caused by capping than by dredging (USEPA, 2005).

- Other construction-related ship traffic (tenders, scows, etc.).

**Contaminant release** is the process by which contaminants are transferred from sediment pore water and sediment particles into the water column or air during dredging operations (USACE, 2008d). Contaminants adsorbed to resuspended particles may partition to the water column and be transported great distances downstream in dissolved form along with dissolved contaminants in the released pore water. As the released particles are transported, they can settle out of the water column and release contaminants into the dissolved phase. Ultimately, resuspended sediment particles would settle and become part of the dredging residuals.

Contaminant releases may also be related to consolidation, diffusion, and bioturbation in the sediment layer. Although these releases might be assumed to involve a short-term exposure, in reality, there are significant implications for the long-term flux of sediment-associated contaminants into the water column. Possible release sources include:

- Resuspension and dispersion of bedded sediment particles and pore water
- Erosion/resuspension of dredging or capping residuals and other high solids concentration layers on the sediment surface
- Molecular diffusion from the dredging cut face and residuals
- Groundwater advection
- Pore water expulsion from sediment and dredged material
- Non-aqueous phase liquid exposure.

The Lower Passaic River-Newark Bay model[6] developed for the FFS (see Appendix B) evaluated the impact of sediment resuspension and contaminant release during dredging to assess the short term impact of the remediation operations. One of the model inputs was the resuspension rate at the dredge head, expressed as a percentage of the sediment resuspended during each dredging lift. For dredging, a resuspension rate of three percent of the mass removed (solids, carbon, and chemical) was assumed. This rate is based on the Environmental

[6] The Lower Passaic River-Newark Bay model includes linked hydrodynamic, sediment transport, organic carbon and contaminant fate and transport models. See Appendix B "Modeling" for specific information on models used in the analysis.

Dredging Pilot Study (LBG, 2012) results and similar measurements from other dredging projects. It was added directly to the water column above the model grid cell where dredging was simulated. Pore water associated with dredging operations was also released to the water column but this mass is a very small percentage (less than 0.2 percent) of the sediment inventory targeted for removal.

The modeling simulation of dredging and capping are based on the following assumptions:

- Dredging starts in 2018 for the three active remedial alternatives[7]
- Dredging is completed between 2019 and 2029 (Alternative 4 – 2019; Alternative 3 - 2022; Alternative 2 – 2029)
- All of the contaminated fine-grained sediments, to the extent practical, are removed from the FFS Study Area under Alternative 2. Under Alternative 3, over half of the contaminated sediment remains in place but is sequestered under an engineered cap bank-to-bank. Under Alternative 4, discrete areas of the FFS Study Area (totaling approximately 220 acres or about one third of the FFS Study Area) are dredged and capped.
- The hydrograph and other tidal forces for the period October 1995 to September 2010 were repeated in 15-year cycles to simulate future conditions through September 2059.

Because the river is tidal, it was necessary to assess the dredging impacts both upriver and downriver of the FFS Study Area as contaminants may be distributed in either direction. The short term impacts of resuspension and release were assessed by analyzing the contaminant model results for 2,3,7,8-TCDD net monthly flux in the downstream direction (Figure 4-1) at the following locations:

- RM0.88, which is just upstream of the boundary of the FFS Study Area with Newark Bay
- RM8.6, which is just upstream of the FFS Study Area boundary
- RM-1.95, which is 2 miles into Newark Bay from the confluence with the Passaic River.

[7] Schedule dates are based on a water year which runs from October 1 through September 30.

2,3,7,8-TCDD was used to represent the behavior of all of the sediment-bound contaminants released during dredging. In Figure 4-1, there are breaks in the lines plotted for RM8.6, which correspond to periods when the net transport is upriver, which can occur under low flow conditions. The results from Figure 4-1 indicate that Alternative 2, which would require dredging the largest volume of material at the greatest depth with the highest contaminant concentrations, would result in the greatest short-term impact from resuspension and releases. The short-term impacts due to Alternative 2 are not limited to the FFS Study Area but would occur throughout Newark Bay. Alternative 3, which requires less dredging, at shallower depths, and in sediments with lower contaminant concentrations, has fewer potential short-term impacts from resuspension and releases compared to Alternative 2. Similarly, because Alternative 4 requires even less dredging in sediments, with similar contaminant concentrations as would be dredged in Alternative 3, it would result in the fewest potential short term impacts from resuspension and releases of the three alternatives.

The 2,3,7,8-TCDD impact is much greater downstream compared to upstream of dredging operations. One reason for this is that the tidal influence upstream is less than it is downstream with greater net flow in the downstream direction.

Overall, the short-term impacts to the water column resulting from resuspension are limited to the construction period, as water column flux rates are predicted to drop below the baseline (Alternative 1) immediately after dredging is completed. It is therefore anticipated that the impact on fish tissue concentrations would be limited to the period during active dredging (GW Partners, 2013). Given the impact of contaminant release and transport during dredging activities, it is important to implement best management practices to limit resuspension impacts during remediation. Resuspension can be controlled using the results of near-field (within 1,000 feet) and far-field (greater than 1 mile) water quality monitoring programs designed to provide feedback to the dredge operator. Operational controls include limiting the swing speed for cutterhead dredges and cycle times for bucket dredges (USACE, 2008d). While a minimal level of resuspension cannot be avoided, it is important to monitor and control dredging productivity and optimize the dredging process so that the overall project mass loss (including on-going releases due to natural forces) is minimized. If operator adjustments are not sufficient, additional controls such as silt curtains or silt barriers could be considered.

### 4.2.2 Residuals

Environmental dredging or capping residuals refer to contaminated sediment found at the post-construction sediment surface, either within or adjacent to the construction footprint. Residuals are grouped into two categories: undisturbed residuals and generated residuals.

**Undisturbed residuals** are contaminated sediments uncovered by dredging but not removed. Undisturbed residuals are generally due to difficult bottom characteristics (*e.g.*, shallow depth to bedrock) or inadequate characterization (*i.e.*, missed inventory) but may result when dredging is purposely designed to proceed to a depth less than the depth of contamination such as would occur under Alternatives 3 and 4 where the depth of sediment removed is determined by the required navigation depths or the depth required to construct a cap without raising the elevation of the river bed.

**Generated residuals** are post-construction surface sediments that are dislodged or suspended by the dredging or capping operation and subsequently redeposited on the bottom of the water body. This category includes sediment left behind by the dredge head or by debris-removal operations, sediment from adjacent areas sliding into dredged areas, slope failures, and resuspended sediment that has quickly resettled (USACE, 2008d).

One of the more significant limitations associated with predicting the effectiveness of environmental dredging is the uncertainty associated with estimating the nature and extent of residual contamination following removal operations. No removal technology can capture every particle of contaminated sediment and field results to date for completed environmental dredging pilots and full-scale projects suggest that post-dredging residual contamination levels have often not met desired cleanup levels. This is not surprising given the limitations of even the most modern dredging equipment and the variable distribution of contamination found in many sites – where typically higher concentrations occur in deeper sediments. It is logical that the nature and extent of post-dredging sediment residuals are related to dredging equipment, dredging methods, sediment geotechnical and geophysical characteristics, the variability in contaminant distributions, and physical site conditions (including hydrodynamics). Depending on site-specific conditions and the methods used, cap placement may also disturb underlying sediment which could resettle on top of the cap.

The level of concern surrounding residuals is dependent on:

- Concentration and toxicity of contaminants of potential concern (COPCs) and contaminants of potential ecological concern (COPECs)
- Residence time of the residual sediment layer and its associated exposure and risk
- Residual sediment layer thickness
- Dry density, as a measure of stability
- Concentration variability of COPCs and COPECs
- Geochemical availability (*e.g.*, contaminant bioavailability in present form)
- Mobility and fate of residuals.

There is little research on the bioavailability of generated residuals and relatively little experimental data on which to base conclusions about how a layer of residuals contributes to exposure or risks in the short- or long-term (USACE, 2008d).

Residuals can be controlled using appropriate environmental dredging techniques and placing backfill or engineered cap materials over the residuals soon after the dredging in a particular area has been completed. Placing the material in a series of lifts, the first lift soon after dredging, allows the backfill or engineered cap materials to sequester residuals thereby minimizing the time the remaining inventory is exposed to resuspension and limiting their availability to biota and other receptors. If missed inventory is encountered, it can be addressed by additional dredging passes. The quantity of generated residuals can be minimized by selecting an appropriate dredge type for the site and using good dredging techniques assisted by feedback from the post-dredging sampling.

In the FFS Study Area, the anticipated dredging activities would involve the removal of sediments above either the unconsolidated fine-grained material or the underlying sandy layer/red-brown clay. Dredging into these types of materials is anticipated to generate fewer residuals than, for example, dredging into uneven bedrock or hardpan surfaces. For Alternative 2, where the intent is to remove the entire fine-grained sediment contaminant inventory, backfilling is planned to cover residuals. For Alternatives 3 and 4, dredge cuts would generally end in unconsolidated materials and in sediment layers expected to contain higher contamination than present at the surface. However, the engineered cap would sequester residuals present at the disturbed sediment surface. The engineered cap and backfill materials would reduce residuals that may be created when the cap or backfill material hits the fine-grained material.

Since contaminant concentrations tend to increase with depth in the FFS Study Area, alternatives that require deeper dredging are anticipated to result in more highly contaminated residuals. For this reason, Alternative 2, which involves the deepest dredging depths, is anticipated to have the greatest short-term impacts. Both Alternatives 3 and 4 are anticipated to have a fewer short-term impacts associated with residuals because dredging depths are shallower. Alternative 4 is anticipated to have fewer short-term impacts than Alternative 3 because of the lower volume of material to be dredged.

### 4.2.3 Impacts to Biota and Habitat

Dredging and capping activities, including debris removal, have the potential to disturb habitat and injure biota during the construction period. The impacts may include removal or disturbance of mudflat areas and the BAZ. Significant site features with respect to ecological receptors (mudflats, wetlands, benthic community, fish species, endangered and threatened species, critical habitat) were described in Sections 3.3.1 (Lower Passaic River) and 3.3.2 (Newark Bay). The construction-related impacts that they are expected to experience are described in detail in Sections 3.4.3 (physical and chemical effects), 3.4.4 (biological effects) and 3.4.5 (special aquatic sites). These impacts are summarized below.

### *Mudflat Areas*

During dredging, approximately 101 acres of mudflats (see Figures 3-2a and 3-2b) under Alternatives 2 and 3 would be disturbed. Under both alternatives, the mudflats would be reconstructed through backfilling/capping with no net loss in acreage although under Alternative 2, reconstruction would also include regrading activities to restore hydrologic conditions disturbed by the larger dredging program. Under Alternative 4, approximately 51 acres of disturbed mudflats would be reconstructed. The extent of mudflat impacts would be the least for Alternative 4 and the same for Alternatives 2 and 3, although the duration of the impact would be longer with Alternative 2.

### *Wetlands*

There would be a short-term loss of several acres of emergent wetlands along the limited areas of natural shoreline of the Lower Passaic River (USACE and NWI mapped wetlands at RM3.5, RM3.8, and RM7.7, and unmapped wetlands). The same amount of wetlands would be impacted under Alternatives 2 and 3 while Alternative 4 would impact fewer acres of wetlands due to the smaller dredging footprint. The natural shorelines would be stabilized with coir rolls, biodegradable erosion control matting and revegetated with wetland plants following dredging and the habitat restored.

### *Biologically Active Zone*

A BAZ is defined as the area between the sediment surface and the deepest subsurface biogenic structures. The Lower Passaic River Sediment Profiling Imagery report (Germano and Associates, Inc., 2005) identified the average depth of the 'maximum feeding void depth' for brackish water stations where voids were present as 6 inches (~15.2 cm). A feeding void is created when an organism ingests sediment as it feeds, similar to a mining tunnel. Because the dredging depths are deeper than the maximum feeding void depths, the entire BAZ would be disrupted by dredging and capping activities. Once the engineered cap / backfill surface (Alternatives 3 and 4) is constructed or the backfill is placed (Alternative 2), it is anticipated that the area would be recolonized by biota. The final cap design may include substrates that are favorable to biota.

The short-term impacts of dredging and backfilling/capping for Alternatives 2 and 3 would be similar with fewer impacts for Alternative 4 because of the smaller disturbed footprint.

### *Fish Spawning Periods*

Construction activities, including dredging or capping and their associated effects on water quality, may have adverse impacts on fish spawning (refer to Section 3 for more information). NOAA recommended during the Phase 1 Removal SRCAP that no in-water work be conducted within the Passaic River from March 1 to June 30 to minimize impacts to anadromous fish (Tierra Solutions Inc., 2010, Appendix D). NOAA did not object to work within cofferdams during this time frame, provided the cofferdams were installed and removed outside of this period. During the remedy design for the FFS Study Area, a fish migration study would be conducted to better define the fish window. On the basis of the fish migration study results, USEPA would consult with NJDEP, USACE, NMFS and USFWS to establish appropriate timing constraints for FFS Study Area remediation. Overall, Alternative 2 is anticipated to have the greater potential for impacts on fish spawning periods because of the length of the in-water operations (11 years) compared to Alternatives 3 and 4 (4.5 and 1.5 years, respectively)[8].

### *Endangered and Threatened Species and Critical Habitat*

While the threatened and endangered species identified in Section 3 are generally highly mobile and would likely avoid areas of dredging activity, there would be a temporary loss of foraging habitat in areas of active dredging. Areas of the river where dredging is not active would provide alternate habitat for displaced individuals. The potential impacts for the alternatives are comparable on an annual basis; however, due to the longer project duration, Alternative 2 is anticipated to have the greatest potential for short-term impacts.

### *Waterways*

The various alternatives would remove or smother biota and habitat in the FFS Study Area during sediment dredging or backfilling/capping operations. Alternatives 2 and 3 would disrupt approximately the same amount of the river through their operations, with Alternative 4 disrupting approximately one third of that amount. The longer period of operations under

[8] Durations refer to in-water work only; actual project duration may be longer.

Alternative 2 (11 years) would extend the disruption to the waterways for an additional 6 to 9 years compared to Alternatives 3 and 4, respectively.

*Conclusions*

Short-term impacts related to biota and habitat would be the greatest under Alternative 2 primarily due to the greater duration of the project and would be the least for Alternative 4 due to the smaller extent of the dredging program.  Alternative 3 would disturb a similar footprint compared to Alternative 2, but the smaller volume and shorter duration would result in less overall impact than Alternative 2 and more than Alternative 4.

### 4.2.4 Accidents

Accidents can result in injuries to people or property and may also cause the release of contaminants during transport and placement of capping materials; transportation, treatment, and disposal of dredged sediment; and mobilization, operation, and demobilization of treatment facilities. Steps can be taken to minimize the potential for, and the impact of, accidents during operations by health and safety planning and follow through, ongoing training for on-site workers, use of the appropriate equipment and proper equipment maintenance, and other steps, but the potential for accidents during the remediation project should be acknowledged.

Activities associated with the three active remedial alternatives would be similar on a day to day basis, with the primary difference being the duration of the project.  Alternative 2 has the longest project duration and therefore would be expected to have the greatest number of accidents; Alternatives 3 and 4 would be anticipated to have fewer accidents because of the shorter duration.

### 4.2.5 Air Quality

Dredging activities may adversely impact the air quality in the local communities on a temporary basis due to the following:

- Volatilization of contaminants in dredged materials
- Air emissions from equipment during dredging and capping operations

- Emissions from transport vessels during the transportation of sediment to a processing or disposal site
- Workers commuting to the job site inpersonal vehicles.

During remedial design, existing emission sources should be considered when assessing short term impacts on the resident population which may already be stressed by current emission levels. For example, the City of Newark is in a heavily industrialized area with former and existing chemical plants, a garbage incinerator, and heavy truck traffic. Children living in the area are reported to have elevated levels of asthma. Because dredging and capping operations would be spread over a large section of the river and the time spent in any one location would be relatively short, the impact on any particular area should be limited. Mitigative measures that could be implemented to reduce impacts include the use of low sulphur fuels, air pollution controls on high emission equipment, restrictions on work in some areas during temperature inversions or conditions that trap contaminants close to the ground surface, changes to signaling or traffic flow patterns to limit idling.

Alternative 2 is anticipated to have the greatest short-term impact to air quality because a greater volume of sediment would be dredged compared to Alternative 3, which similarly would have greater impacts than Alternative 4.

### 4.2.6 Quality of Life Concerns

The quality of life concerns include odor, noise, construction lighting, traffic, and impacts to navigation, aesthetics, and recreation. For the purposes of cost and schedule estimation in the FFS, remedial activities are assumed to occur 24 hours per day, 6 days per week for 40 weeks each year. The short-term impacts of these concerns would be managed by performance standards established for the selected remedial action. It is expected that the local communities would be involved in the design of the selected remedy so that they may take an active role in minimizing impacts to their neighborhoods.

The following impacts may be experienced during remedial activities:

- In-water construction activities may adversely impact in-water recreational and commercial navigation in the FFS Study Area and Newark Bay by potentially impeding vessel passage and precluding in-water recreation in some locations.
- The construction operations may impair the views of the river for residents who live along the riverbanks and near Newark Bay. Residential areas in the FFS Study Area are located along the west bank between RM4 and RM5 and along both banks of the river between RM5.5 and RM8.3.
- Waterfront festivals and parks may be disrupted by project activities.
- Increased vehicular traffic in the area of the upland processing facility due to remedial activities (*i.e.*, additional commuting workers, delivery of supplies, off-site shipment of waste and byproducts) could result in stress on local roadways in terms of congestion and increased roadway deterioration.
- An increase in in-water vessel traffic (*e.g.*, dredges, capping supply barges, scows) transporting material to and from the construction may impact the number and timing of bridge openings adding to road congestion and impacting the local communities.
- Potential odors including exhaust generated by equipment and petroleum-like odors associated with dredged material from the river, may impact recreational activities on the river and the use of adjacent property.
- Elevated noise levels from increased traffic and equipment use on the river from dredging and capping operations may impact surrounding properties. Elevated noise levels, particularly during evening and night hours, may be disruptive to local communities and to the local wildlife, especially territorial species.
- Artificial lighting systems may be used to illuminate nighttime dredging, capping, and in-river transport operations. Project lighting may be disruptive for local communities and could adversely affect local wildlife.

Mitigations measures may reduce but are not likely to eliminate the quality of life impacts associated with remedial alternatives. Potential mitigation measures could include:

- Maintaining frequent communication with commercial entities and communities adjacent to the project area would be essential during any remedial action. The commercial entities and communities would be informed of the project activities, road closures, river access restrictions, and other institutional controls via mailing lists, newsletters, and media. Commercial navigation and in-water recreational activities would need to be carefully timed and coordinated with remedial activities, using notifications, project websites, and community meetings.

- Odor control measures including covering loads and using masking sprays may be evaluated during the design phase of the project.
- Use of directional lighting to focus the illuminated area may be evaluated during the design phase of the project.

Alternative 2 is anticipated to have the greatest short-term impact related to quality of life issues because of the longer project duration compared to Alternative 3, which similarly would have greater impacts than Alternative 4.

### 4.2.7 Conclusion for Remedial Alternatives Comparison

In general, the longer the project duration and the greater the volume of dredged materials that must be handled, the greater the potential for short-term impacts to human health and the environment, including the local quality of life. Alternative 2 would be anticipated to have the greatest short-term impacts because it removes the greatest volume of material over the longest project duration. Alternative 3 would be anticipated to have fewer short-term impacts than Alternative 2 because of the smaller volume of contaminated sediments dredged. Alternative 4 would be anticipated to have the fewest short-term impacts.

## 4.3 Detailed Characterization of Short-term Impacts Related to DMM Scenarios

### 4.3.1 Sediment Resuspension and Contaminant Release

Water quality and ecological impacts may result when sediment particles are dislodged and dispersed into the water column during dredging (particularly during debris removal) and capping operations. Two important processes that affect water quality during dredging and related operations are the resuspension of sediments and the release of contaminants. The definition and causes of resuspension and contaminant releases are discussed in Section 4.2.1.

Because DMM Scenario B – Off-site Disposal and DMM Scenario C – Local Decontamination and Beneficial Use would not involve in-water work, resuspension and contaminant release would not be an issue. However, the construction and operation of the CAD site (DMM Scenario A) in Newark Bay has the potential for resuspension and contaminant release.

During CAD cell construction, resuspension is the primary concern. Any active remedial alternative that incorporates DMM Scenario A would require deep dredging operations in Newark Bay to build a CAD cell handling a similar volume of material to be dredged from the FFS Study Area. However, because contaminant concentrations in the deeper clay soils in Newark Bay are much less than in the sediment removed during river sediment dredging and the excavation operations required to construct the CAD cells would take less time, the impacts associated with CAD cell construction are anticipated to be less than those associated with construction of the active remedial alternatives.

CAD cell operations have the potential for contaminant releases during barge unloading. This becomes a concern as the CAD cell fills and material is released closer to the ground surface. The sheetpile wall would retain most of the sediment released to the water column during offloading but the entrance channel has the potential to allow the flow of solids in the water column to areas outside of the containment system. A silt curtain could be installed in the navigation channel for use during material placement to minimize the release of contaminants. The silt curtain would be opened to allow a loaded barge to enter and closed before dredged materials are released. After some settling time is allowed, the silt curtain would then be opened again for the empty barge to exit the CAD cell.

As noted in Section 4.2.1, resuspension can be controlled by using the results of near-field (within 1,000 feet) and far-field (greater than 1 mile) water quality monitoring programs to optimize dredging operations.

### 4.3.2 Residuals

CAD cell construction has the potential to generate dredging residuals similar to the three active remedial alternatives based on the depth and volume of the material removed. However, because the contaminant levels in the deeper sediments in the Bay are orders of magnitude lower than those to be dredged from the river, and the CAD cell construction duration is shorter, the overall impact would be much less than during in-river dredging activities.

Because DMM Scenario B – Off-site Disposal and DMM Scenario C – Local Decontamination and Beneficial Use would not involve in-water work, residuals would not be an issue.

The primary concerns with CAD cell construction and operations are generated residuals (see Section 4.2.2), which are post-construction surface sediments that are dislodged or suspended by dredging during CAD cell construction or capping to close the CAD cells, and subsequently redeposited on the bottom of the bay. During offloading operations, these residuals could exit the CAD cell area through the entrance channel.

Residuals can be controlled by placing the engineered cap materials as soon as possible after the CAD cell fill operations are completed. Depending on site-specific conditions and methods used, cap placement may disturb underlying sediment which could resettle on top of the cap. Placing the cap soon after dredging allows the engineered cap materials to sequester residuals thereby minimizing the time the remaining inventory is exposed to resuspension, and limiting the availability to biota and other receptors.

### 4.3.3 Impacts to Biota and Habitat

DMM Scenario A – CAD has the potential to disturb aquatic habitat and injure biota, primarily during the construction period. Those impacts are summarized below.

Because DMM Scenario B – Off-site Disposal and DMM Scenario C – Local Decontamination and Beneficial Use would not involve in-water work, the impact to biota and habitat would be limited to the upland sediment processing facility which is likely to be located in an area that has been developed previously.  Impacts under DMM Scenarios B and C are generally limited to urban and industrial neighborhoods with much less likelihood of habitat disturbance.

*Biologically Active Zone*

The BAZ identified in the Lower Passaic River was approximately 6 inches (~15.2 cm, [Germano and Associates, Inc., 2005]).  Assuming the BAZ in Newark Bay is similar in depth, the BAZ would be disrupted by dredging and capping activities for the CAD cell.  Once constructed and capped, it is assumed that surface would be recolonized by biota.  The final cap design may include substrates that are favorable to biota.

Under DMM Scenario A, between 19 and 171 acres of CAD cell area (see Section 3.4.2 ) would be operational at any point in time during the duration of the dredging operations (acreage will vary depending on the remedial alternative selected and the number of cells operational) preventing recolonization of biota until the active CAD cell(s) are closed.  DMM Scenarios B and C would not have any short-term impact on the BAZ in Newark Bay.

*Fish Spawning Periods*

In-water construction activities related to CAD cell(s) (Scenario A) may have adverse impacts on fish spawning (refer to Section 3).  NOAA has recommended on other related projects that no in-water work be conducted within the Passaic River from March 1 to June 30 to minimize impacts to anadromous fish (Tierra Solutions Inc., 2010, Appendix D).  Work within cofferdams, such as CAD cell construction, was acceptable during this time frame provided the cofferdams were installed and removed outside of this time.  During the remedy design, a fish migration study would be conducted to better define the fish window. On the basis of the fish migration study results, USEPA would consult with NJDEP, USACE, NMFS and USFWS to establish appropriate timing constraints for any FFS Study Area remediation.

DMM Scenario A is anticipated to have the greater potential for impacts to biota and habitats because of its operation in Newark Bay, as compared to either DMM Scenario B or C whose operations are land-based.

### *Endangered and Threatened Species and Critical Habitat*

While the threatened and endangered species identified in Section 3 are highly mobile and would likely avoid areas of dredging activity and noise, there would be a temporary loss of foraging habitat during construction and operations. Areas of the Bay (DMM Scenario A) or surrounding property (DMM Scenarios B and C) would provide alternate habitat for displaced individuals.

The impacts to endangered and threatened species would be similar for DMM Scenarios B and C because similar amounts of land would be disturbed. Because of the differences in size, habitat, and species impacted, it is not possible to draw a suitable comparison between Scenario A and Scenarios B and C in terms of short-term impacts. DMM Scenario A would impact aquatic habitat while DMM Scenarios B and C would impact upland habitat. Impacts under DMM Scenarios B and C would likely be limited to urban and industrial neighborhoods with much less likelihood of native habitat disturbance because of previous site development activities.

### *Waterways*

DMM Scenario A would remove or smother biota and habitat in the Newark Bay during construction and filling operations. DMM Scenarios B and C both rely on an upland location for processing of dredged sediments which could potentially impact terrestrial habitat, but would have limited impact on the waterways. As noted previously, the upland sediment processing facilities under DMM Scenarios B and C would likely be located in urban and industrial neighborhoods with much less potential for native habitat disruption because of previous site development activities. The additional volume of barge traffic to and from the processing/disposal site would depend on the relative locations of the upland processing facility and the CAD cell. This is not anticipated to impact habitat and biota significantly.

### *Conclusions*

Of the three DMM Scenarios, DMM Scenario A – CAD, has the greatest potential to disrupt habitat in Newark Bay and would require the mitigation of impacts of 19 to 171 acres of Newark Bay used for CAD cell disposal. Both DMM Scenarios B and C involve the construction of upland sediment processing facilities ranging in size from approximately 25 to 40 acres with either off-site disposal of sediment or beneficial use of the processed sediment, avoiding the disposal of dredged materials in the aquatic ecosystem. The construction of the upland processing facilities would disrupt land that would potentially serve as local habitat to upland birds and wildlife although the impacts would depend on the selected site (*i.e.*, disruption would be minimal if the upland site is already developed or partially developed). As noted previously, DMM B and C upland processing facilities would likely be located in urban and industrial neighborhoods with much less potential for native habitat disruption because of previous site development activities.

### 4.3.4 Accidents and Releases

Accidents may cause injury to people, property or the environment including the release of contaminants. Steps can be taken to minimize the potential for and the impact of accidents by careful planning and follow through, ongoing training for on-site workers, use of the appropriate equipment and proper equipment maintenance, and other steps, but the potential for accidents remains (see Section 4.2.4).

In-water accidents associated with the construction and operation of DMM Scenario A would be anticipated to be similar, both in type of accident and frequency, to the in-water accidents discussed in Section 4.2.4 related to the remedial alternatives.

On-land accidents associated with DMM Scenarios B and C could occur either during construction or operation of the upland processing facility. In general, the extent of the on-site operations and their complexity is an indicator of the potential for accidents in the workplace.

Accidents associated with construction of the DMM upland processing facilities would be typical of accidents related to the construction of similarly-sized industrial facilities involving a range of hazards including mechanical, electrical, chemical, material and equipment handling, falls, etc. DMM Scenario C would have the greatest potential for accidents due to the size and complexity of the on-site systems that would need to be constructed. DMM Scenario B would have fewer on-site systems requiring less construction and a lower potential for accidents.

During operations, one of the primary factors in accidents is the number of non-automated (manual) material handling operations. Manual material handling operations typically involve large pieces of equipment operating in tight spaces with other workers in the area, leading to the potential for accidents. DMM Scenario B involves offloading the material at an upland processing facility for dewatering, transfer of the dewatered material to storage, and loading material on a rail car for transport to either an off-site landfill or incinerator for thermal treatment prior to land disposal. DMM Scenario C involves offloading the material at the upland processing facility and segregating the material into three groups. Material requiring thermal treatment would be dewatered and transferred to the thermal treatment plant, then to storage prior to shipment of byproducts off-site. Material requiring sediment washing would be decontaminated using sediment washing, transferred to the dewatering facility, and then to storage prior to shipment of byproducts off-site. Material requiring only stabilization would be dewatered, stabilized, and transferred to storage prior to shipment of byproducts off-site. DMM Scenario C involves much more manual material handling, increasing the potential for accidents.

DMM Scenario C – Local Decontamination and Beneficial Use is anticipated have the greatest potential for short-term impact from accidents due to the number and complexity of the material handling operations. DMM Scenario B – Off-site Disposal has fewer on-site operations and involves the use of rail transfer to the off-site thermal treatment or disposal sites. DMM Scenario A – CAD is anticipated to have the least potential for accidents due to the limited site operations and people involved in the process.

### 4.3.5 Air Quality

Diesel fumes and exhaust from equipment and vehicles and fugitive dust and other particulates from site operations would have an impact on local air quality. As noted in Section 4.2.5, existing emission sources in the area should be considered during remedial design when assessing short term impacts on the resident population which may already be stressed by current emission levels.

DMM Scenario A would have the least potential impact on air quality from both construction and site operations. The likely location of a CAD cell (further away from residential areas than an upland sediment processing facility), the wet condition of the sediment on the barge, the under water disposal process, and the limited equipment required for offloading would reduce the potential for emissions generated at a CAD cell site.

Construction activities associated with the upland sediment processing facilities under DMM Scenarios B and C would be anticipated to have a 12 to 24 month impact on air quality, related primarily to construction equipment and work crews commuting to the job site. Because of the more extensive on-site operations with DMM Scenario C, related construction activities would be anticipated to have a greater short-term impact compared to DMM Scenario B.

Operational activities associated with the upland processing facilities would have a greater potential to impact air quality. DMM Scenario C would have the greatest potential for air emissions due to the more extensive local operations and larger work force. In addition, where feasible, materials would be converted to products that have a beneficial use and would be transported (typically by truck) to local markets. Construction of a new emission source in an industrial area (DMM Scenario C) would increase the emission loading in an urban area and be subject to USEPA's New Source Review/Prevention of Significant Deterioration national priority strategy (USEPA, 2012) and other requirements under the Clean Air Act. Although most of the sediment processing and material storage is assumed to occur indoors, outdoor stockpiles of processed materials (sand, rock) could potentially result in fugitive dust emissions. While these stockpiles would be managed in accordance with applicable regulations to control fugitive emissions (covering stockpiles, watering, sweeping roads, etc.), the potential for short-term impacts to air quality from facility operations exists.

DMM Scenario B would have less potential to impact air quality because there would be fewer on-site operations and a smaller work force. Material would be dewatered and transported by rail to either an off-site treatment and/or disposal facility. DMM Scenario B has a similar potential for the generation of fugitive dust emissions from exterior stockpiles of sand and rock as with DMM Scenario C.

### 4.3.6 Quality of Life Concerns

The quality of life concerns for the DMM scenarios are similar to the quality of life impacts discussed in Section 4.2.6 for the remedial alternatives both in scope and duration. The following impacts may be experienced from the DMM Scenarios:

DMM Scenario A only:

- In-water construction activities may adversely impact recreational and commercial navigation in Newark Bay by potentially limiting vessel passage and precluding in-water recreation.
- The construction operations may impair the views of the river for residents who live near Newark Bay. Waterfront festivals and parks may be disrupted by project activities as well.
- Vessel traffic transporting sediment to the CAD cell in Newark Bay may disrupt the community and existing vessel traffic on the river and in Newark Bay. Vessels using the commercial port facilities in Newark Bay would need to navigate around the barges and the dredge equipment. (Note: a CAD cell constructed as part of DMM Scenario A would be located outside the Federal navigation channel.)

DMM Scenarios B and C only:

- Increased road traffic on local roadways, primarily due to construction activities and processing site operations, could result in increased traffic congestion on local roadways and heavy loads increasing roadway deterioration. The most significant impact would be during construction of the upland processing facility (12 to 24 months) from large work crews, equipment mobilization/demobilization, and construction material deliveries. The traffic loads would decrease during site operations due to a smaller work force and less truck traffic. For a map of the major transportation routes in the vicinity of the Lower Passaic River and Newark Bay, refer to Figure 4-2. The short-term impacts associated with DMM Scenario C would be expected to be greater than for DMM Scenario B due to the more extensive construction projects, larger work force and anticipated use of trucks to transport processed materials to beneficial use sites.  DMM Scenario B anticipates that dewatered sediment would be shipped by rail for off-site for treatment and/or disposal (see Appendix G).

- Elevated noise levels are likely to result from increased traffic and equipment usage during construction and operation of the sediment processing/transfer facilities. Elevated noise levels, particularly during evening and night working hours, may be disruptive to local communities and to the local wildlife, especially territorial species.  DMM Scenario C is anticipated to have a greater short-term impact compared to DMM Scenario B due to the more extensive construction activities and on-site treatment processes.

All Scenarios:

- Potential sources of odor from the project include exhaust generated by construction equipment and the petroleum-like odors associated with dredged material from the river as well as near the upland sediment processing facility.  The two DMM Scenarios involving an upland processing facility would be anticipated to have a greater impact than the CAD cell(s) due to the proximity of the facility to residential areas.
- Because work would be conducted overnight and on weekends, noise and light from construction activities may disturb communities in the vicinity of the project area. Residential areas in the FFS Study Area are located along the west bank between RM4 and RM5 and along both banks of the river between RM5.5 and RM8.3. Artificial lighting systems may be used to illuminate nighttime construction and in-river transport operations as well as land-based sediment processing/transfer facility operations and CAD cell operations.  Project lighting may be disruptive for local communities and could adversely affect local wildlife.

Mitigation measures may reduce but not likely eliminate the quality of life impacts associated with dredging activities.  Potential mitigation measures associated with quality of life impacts are discussed in Section 4.2.6.

DMM Scenario A – CAD is anticipated to have the least potential for quality of life impacts because the disposal site is likely to be located further from residential areas as compared to the other two scenarios; material handling would be limited to offloading of barges; and the dredged material would be submerged during the majority of the CAD cell operational period. Similar dredging and disposal operations have been conducted in Newark Bay for navigational dredging projects.

DMM Scenario C – Local Decontamination and Beneficial Use is anticipated to have the most potential for impacts due to the extensive construction required for the numerous processing facilities (dewatering, sediment washing, material stabilization, thermal treatment), the complexity of operations, and the potential proximity of the site to residential areas.

The potential short term impacts associated with DMM Scenario B - Off-site Disposal would be between the other two alternatives.

### 4.3.7 Conclusion for DMM Scenarios Comparison

The different DMM processes result in a range of impacts. DMM Scenario A - CAD has the greatest potential for impacts on in-water conditions but has relatively fewer impacts on upland conditions. DMM Scenario C – Local Decontamination and Beneficial Use has the greatest potential for impacts to upland conditions such as air quality and quality of life factors due to the large local upland processing facility potentially located in a congested urban area as well as the greatest potential for releases and accidents due to the complexity of the on-site processing operations. DMM Scenario B – Off-site Disposal is ranked between the other two scenarios in potential short-term impacts.

# 5 ACRONYMS

| | |
|---|---|
| 2,3,7,8-TCDD | 2,3,7,8-tetrachlorodibenzodioxin |
| ARAR | applicable or relevant and appropriate requirements |
| BAZ | biologically active zone |
| CAD | Confined Aquatic Disposal |
| CDF | Confined Disposal Facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| cm | centimeters |
| COPCs | contaminants of potential concern |
| COPECs | contaminants of potential ecological concern |
| CPG | Cooperating Party Group |
| CWA | Clean Water Act |
| $D_{50}$ | median diameter of material |
| DDT | dichlorodiphenyltrichloroethane |
| DMM | Dredged Material Management |
| EFH | Essential Fish Habitat |
| FFS | Focused Feasibility Study |
| fps | feet per second |
| HRE-CRP | Hudson Raritan Estuary Comprehensive Restoration Plan |
| LBG | The Louis Berger Group, Inc. |
| MLW | Mean Low Water |
| MMPA | Marine Mammal Protection Act |
| MRI3 | Marsh Resources Incorporated Phase 3 |
| NCP | National Contingency Plan |
| NJDEP | New Jersey Department of Environmental Protection |
| NJDOT | New Jersey Department of Transportation |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NWI | National Wetland Inventory |

| | |
|---|---|
| NY/NJ | New York/New Jersey |
| PAH | polycyclic aromatic hydrocarbon |
| PANYNJ | Port Authority of New York and New Jersey |
| PCB | polychlorinated biphenyls |
| pcf | pounds per cubic foot |
| PRG | Preliminary Remediation Goals |
| RI | Remedial Investigation |
| RI/FS | Remedial Investigation/Feasibility Study |
| RM | river mile |
| SAV | submerged aquatic vegetation |
| SRCAP | Substantive Requirements Compliance Action Plan |
| TSI | Tierra Solutions, Inc. |
| U.S. | United States |
| USACE | United States Army Corps of Engineers |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| WMA | Watershed Management Area |

**Acronyms Presented in Tables**

| | |
|---|---|
| cy | cubic yards |
| MCY | million cubic yards |
| NA | not applicable |
| ρg/g | picograms per gram |
| µg/g | micrograms per gram |

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# TABLES

**Table 2-1 Dominant Taxa Collected During Seasonal Benthic Invertebrate Community Surveys**

| Class | Genus | Species | River Mile | Burrowing Depth | Notes | References |
|---|---|---|---|---|---|---|
| Polychaeta | *Leitoscoloplos* | *fragilis* | RM0 to RM2 | Inhabits upper 15 cm of sediments | Alternate representation = *Scoloplos fragilis*, reference refers to *Scoloplos* | Bianchi, 1998<br>Brown, 1982<br>Rice *et al.*, 1986 |
| Polychaeta | *Marenzelleria* | *viridis* | RM2 to RM7 | Vertical mucus lined burrows up to 40 cm in depth | | Granberg *et al*., 2008<br>Josefson, 2010<br>Olenin, 2006 |
| Oligochaeta | *Tubificoides* | *heterochaetus* | RM2 to RM4 | Majority found within upper 10 cm (90%); few burrow to 20 cm | No reference for *Tubificoides* was found, burrowing depth is for similar species in the same family *Tubifex tubifex* | Mermillod-Blondin *et al*., 2001 |
| Oligochaeta | *Limnodrilus* | *hoffmeisteri* | RM5 to RM8.3 | Majority found within upper 10 cm (90%); few burrow to 20 cm | Burrowing depths measured under laboratory conditions | Cunningham, P.B. *et al*., 1999<br>Mermillod-Blondin, 2001 |
| Crustacea | *Cyathura* | *polita* | RM3 to RM5 | 5 to 8 cm | Believed to be only burrowing isopod in the northeast | Burbanck, 1959<br>Burbanck, 1962 |

Note:

cm = centimeter; RM = river mile.

Benthic invertebrate surveys were conducted in the Lower Passaic River in the fall of 2009 and the spring and summer of 2010 in accordance with the CPG QAPP (Windward Environmental, LLC, 2011b).

**Table 2-2 Reible Model Input Assumptions**

| Model Input | Assumptions |
|---|---|
| Contaminant Properties | |
| Organic Carbon Partition Coefficient, log $K_{oc}$ | Site specific organic partitioning coefficients developed by HDR\|HQI for the contaminant model were used for most contaminants. For PCBs and metals, site specific coefficients were not available. For PCBs, partitioning coefficients of Dichlorobiphenyl from HQI model inputs were used. For metals, partitioning coefficients developed for the EPA (EPA/600/R-05/074, July 2005) were used. For mercury, it was assumed that Kd=Koc (*i.e.* , foc ~ 1) in the bioturbation layer. |
| Colloidal Organic Carbon Partition Coefficient, log $K_{DOC}$ | This parameter is estimated using the equation provided in the Reible Model (log $K_{DOC}$ = Log $K_{OC}$ – 0.37). This will be updated using the $K_{DOC}$ values developed by HDR\|HQI. |
| Water Diffusivity, $D_w$ | Water diffusivity was derived from literature for different chemicals. |
| Cap Decay Rate, $l_1$ | No decay was assumed. |
| Bioturbation Layer Decay Rate, $l_2$ | No decay was assumed. |
| Sediment Properties | |
| Contaminant Pore Water Concentration, $C_0$ | This parameter was calculated using equilibrium partitioning (Koc*foc = Csediment/Cwater). For each chemical, the initial pore water concentration was estimated by using the Koc and the upper confidence limit at 2 mile intervals (2.5 to 3.5 feet horizon). |
| Biological Active Zone Fraction Organic Carbon, $(f_{oc})_{bio}$ | Sediments in the Lower Passaic River contain an average of 4 percent organic carbon. |
| Colloidal Organic Carbon Concentration, $\rho_{DOC}$ | This parameter was approximated at 14 milligrams per liter using 2009 DOC water column values. |
| Darcy Velocity, $V$ (Positive is Upwelling) | A conservative value of 21 cm/year was assumed based on estimates from a previous pore water analysis. |
| Depositional Velocity, $V_{dep}$ | A conservative value of 0.002 cm/year was assumed. |
| Bioturbation Layer Thickness, $h_{bio}$ | A conservative value of 10 cm was selected for this analysis. |
| Pore Water Biodiffusion Coefficient, $D_{bio}^{pw}$ | Assume 100 $cm^2$/year (same input used for Fox River and Hudson River cap design). |
| Particle Biodiffusion Coefficient, $D_{bio}^{p}$ | Assume 10 $cm^2$/year for estuarine conditions (based on communications with Dr. Reible). |
| Cap Properties | |
| Depth of Interest, $z$ | The depth of interest was set at the bioturbation layer interface (*i.e.* , 10 cm). |
| Fraction Organic Carbon at Depth of Interest, $f_{oc}(z)$ | Typical value for quarry sand = 0.001. |
| Conventional Cap Placed Depth | See output results. |
| Cap Materials - Granular (G) or Consolidated Silty/Clay (C) | Granular. |
| Cap Consolidation Depth | Assumed 1 cm of consolidation of cap material. |
| Underlying Sediment Consolidation Due to Cap Placement | Assumed 15 cm consolidation of underlying sediment due to weight of sand cap. |
| Porosity, e | Typical porosity of placed sand = 0.4. |
| Particle Density, $\rho_P$ | Sand specific gravity = 2.6 grams/$cm^3$. |
| Fraction Organic Carbon, $(f_{oc})_{eff}$ | Typical value for quarry sand = 0.001. |
| Boundary Layer Mass Transfer Coefficient, $k_{bl}$ | Assume 0.75 cm/hour (Fox River assumes 1 cm/hour and Hudson River assumes 0.75 cm/hour). |
| Cap Thickness, $h_{cap}$ | Same as conventional cap placed thickness. |

Notes:

cm = centimeter; DOC = Dissolved Organic Carbon; PCB = polychlorinated biphenyl.

## Table 2-3 Summary of Reible Model Results

| Parameter | RM Grouping | Units | Upper Confidence Limit | Target Bioturbation Layer Loading Concentration[1] | Average Bioturbation Layer Loading Concentration |
|---|---|---|---|---|---|
| 2,3,7,8-TCDD | 0-2 | ρg/g | 1,167 | 7.1 | 0.005 |
| 2,3,7,8-TCDD | 2-4 | ρg/g | 266,195 | 7.1 | 1.17 |
| 2,3,7,8-TCDD | 4-6 | ρg/g | 38,312 | 7.1 | 0.169 |
| 2,3,7,8-TCDD | 6-8 | ρg/g | 17,166 | 7.1 | 0.076 |
| Hg | 0-2 | µg/kg | 7,187 | 74 | 23 |
| Hg | 2-4 | µg/kg | 10,323 | 74 | 34 |
| Hg | 4-6 | µg/kg | 8,327 | 74 | 27 |
| Hg | 6-8 | µg/kg | 12,132 | 74 | 40 |
| Total DDx | 0-2 | µg/kg | 988 | 0.30 | 0.21 |
| Total DDx | 2-4 | µg/kg | 2,494 | 0.30 | 0.52 |
| Total DDx | 4-6 | µg/kg | 776 | 0.30 | 0.16 |
| Total DDx | 6-8 | µg/kg | 1,114 | 0.30 | 0.23 |
| Total PCB | 0-2 | µg/kg | 5,470 | 44 | 15.5 |
| Total PCB | 2-4 | µg/kg | 8,077 | 44 | 22.9 |
| Total PCB | 4-6 | µg/kg | 6,867 | 44 | 19.5 |
| Total PCB | 6-8 | µg/kg | 15,319 | 44 | 43.4 |

Notes:

2,3,7,8- TCDD = 2,3,7,8-Tetrachlorodibenzo-p-dioxin; DDx = dichlorodiphenyltrichloroethane; Hg = mercury;
µg/kg = micrograms per kilogram; ρg/g = picograms per gram; PCB = polychlorinated biphenyl.

1. Target concentration based on contaminant selected PRGs (Table 2-10 of FSS).

**Table 2-4 Summary of Consolidation Calculation Results**

| Depth (Feet) | Material After Construction | Layer Thickness After Construction($\Delta H$) (Feet) | Material Before Construction | Layer Thickness Before Construction (Feet) | Layer Center Depth After Construction (Feet) | Saturation Unit Weight $\gamma_{Saturation}$ (pcf) | Effective Unit Weight $\gamma_{effective}$ (pcf) | Coefficient of Consolidation $c_c$ | Initial Void Ratio $e_0$ | $c_c/(1+e_0)$ | Effective Overburden Stress $p_0$ | Total Stress $p_0+\Delta p$ | Consolidation Depth (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Smoothing Layer | 0.5 | Silt | 6.7 | | 119.4 | 57 | NA | | | | | |
| 0.5 | | | | | | | | | | | | | |
| 1 | Armor | 0.5 | | | | 165 | 102.6 | | | | | | |
| 3.5 | Sand Cap | 2.5 | | | | 119.4 | 57 | | | | | | |
| 6.7 | Silt | 3.2 | | | 4.6 | 113.4 | 51 | 1.265 | 1.45 | 0.52 | 234.6 | 275.4 | 1.4 |
| 8 | Peat | 1.3 | Peat | 1.3 | 6.85 | 77.5 | 15.1 | | | 0.4 | 351.515 | 366.815 | 0.1 |
| 9.25 | Clayey Silt | 1.25 | Clayey | 1.25 | 8.125 | 113.4 | 51 | 1.265 | 1.45 | 0.52 | 393.205 | 408.505 | 0.1 |
| 16.9 | F- M Sand | 7.65 | Sand | 7.65 | 12.575 | 119.4 | 57 | NA | | | | | |
| 18.8 | Sandy Lean Clay | 1.9 | Sandy Lean Clay | 1.9 | 17.35 | 113.4 | 51 | 1.265 | 1.45 | 0.52 | 909.58 | 924.88 | 0.1 |
| | | | | | | | | | | | | Total Consolidation | 1.7 |

Notes:

pcf = pounds per cubic foot; NA = Not Available.

## Table 2-5 Reach by Reach Analysis - Impacts on Productivity

| River Miles | Nominal Barge Capacity / *in situ* Sediment Capacity (CY) | Dredge Production Rates (CY) | Number of Dredges | Daily Production Rate (CY) | Yearly Dredging Production Rate (CY) | Alterantive 2 Deep Dredging with Backfill | | Alternative 3 Capping with Dredging for Flooding and Navigation | | Alterantive 4 Capping with Focused Dredging | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Volume (CY) | Duration (Years) | Volume (CY) | Duration (Years) | Volume (CY) | Duration (Years) |
| RM0 to RM4.6 | 3000/1800 | 3300 | 2 | 6600 | 1,584,000 | 7,680,000 | 4.8 | 3,360,000 | 2.1 | 588,000 | 0.4 |
| RM4.6 to RM8.1 | 1500/900 | 1350 | 2 | 2700 | 648,000 | 1,960,000 | 3.0 | 900,000 | 1.4 | 430,000 | 0.7 |
| RM8.1 to RM8.3 | small capacity barge | 500 | 1 | 500 | 120,000 | 40,000 | 0.3 | 40,000 | 0.3 | 3,000 | 0.10 |
| Average | | 1960 | 2 | 4929 | 1,182,927 | 9,680,000 | 8.2 | 4,300,000 | 3.9 | 1,021,000 | 1.1 |

Notes:

cy = cubic yards; RM = river mile.

Assume loaded capacity approximately 50 percent nominal capacity.

Assume small barge used to transport material above RM8.1, with a capacity of 500 cubic yards.

Duration shown is for dredging only; does not include backfilling or capping or other site reconstruction activities.

Alternative volumes may vary slightly from volumes listed in Appendix G due to rounding.

**Table 3-1 Summary of Action Remedial Alternatives and Associated CAD or CDF**

| Remedial Alternative | Volume Dredged (MCY) | Years of In-River Dredging/ Capping/ Backfillling | Navigation Channel | Long Term Management | Temporary Impacts to Subaqueous Land Needed for CAD | Permanent Impacts to Subaqueous Land Needed for CDF |
|---|---|---|---|---|---|---|
| Alternative 2: Deep Dredging with Backfill | 9.7 | 11 years | Dredge to federally authorized navigation depth | Monitoring | 171 acres for 11 years | 115 acres |
| Alternative 3: Capping with Dredging for Flooding and Navigation | 4.3 | 4.5 years | Accommodate use of federal navigation channel in the lower 2.2 miles | Monitoring & Maintenance | 80 acres for 5 years | 45 acres |
| Alternative 4: Focused Capping with Dredging for Flooding | 1 | 1.5 years | No Restoration | Monitoring & Maintenance | 19 acres for 2 years | 36 acres |

Notes:

CAD = Confined Aquatic Disposal;

CDF = Confined Disposal Facility;

MCY = million cubic yards.

**Table 3-2 Impacts to the Aquatic Ecosystem from Remedial Alternatives 2, 3, and 4 and Dredged Material Management Scenarios**

| | **Alternative 2: Deep Dredging with Backfill** | | | **Alternative 3: Capping with Dredging for Flooding and Navigation** | | | **Alternative 4: Focused Capping with Dredging for Flooding** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **In-River Dredging and Backfilling** | **DMM Scenario A (CAD)** | **DMM Scenario A (CDF)** | **In-River Capping with Dredging** | **DMM Scenario A (CAD)** | **DMM Scenario A (CDF)** | **In-River Capping with Dredging** | **DMM Scenario A (CAD)** | **DMM Scenario A (CDF)** |
| Acres | Approximately 650 dredged (to various depths) and backfilled (2 feet). | Temporary loss of 171 acres of shallow bay habitat. CAD would be capped with clean sand to restore natural bathymetry. | Permanent loss of 5 acres of wetlands, 43 acres of mudflat and 67 acres of shallow bay habitat. | Approximately 650 acres dredged (to various depths) and capped (2 feet). | Temporary loss of 80 acres of shallow bay habitat. CAD would be capped with clean sand to restore natural bathymetry. | Permanent loss of 7 acres of intertidal habitat and 38 acres of shallow bay habitat. | Approximately 220 acres dredged (to various depths) and capped (2 feet). | Temporary loss of 19 acres of shallow bay habitat. CAD would be capped with clean sand to restore natural bathymetry. | Permanent loss of 5 acres of intertidal habitat and 31 acres of shallow bay habitat. |
| Duration | 11 years | 11 years | Permanent | 4.5 years | 5 years | Permanent | 1.5 years | 2 years | Permanent |
| Suspended Particles / Turbidity | Sediment resuspension. | Placement of dredged material would cause resuspension but effects would be confined to the CAD/CDF (See Attachment C, Appendix G). | | Sediment resuspension. | Placement of dredged material would cause resuspension but effects would be confined to the CAD/CDF (See Attachment C, Appendix G). | | Sediment resuspension. | Placement of dredged material would cause resuspension but effects would be confined to the CAD/CDF (See Attachment C, Appendix G). | |
| Fish and Benthos | Backfilling with sand may initially favor colonization by a different benthic community until silty sediments become re-established. | Subsequent deposition of fine, silty sediments and re-establishment of stable, low-diversity benthic community. | Permanent loss of 5 acres of wetlands, 43 acres of mudflat and 67 acres of shallow bay habitat. | Capping subtidal depths with sand may initially favor colonization by a different benthic community until silty sediments become re-established. | Subsequent deposition of fine, silty sediments and re-establishment of stable, low-diversity community. | Permanent loss of 7 acres of intertidal habitat and 38 acres of shallow subtidal bay habitat. | Capping subtidal depths with sand may initially favor colonization by a different benthic community until silty sediments become re-established. | Subsequent deposition of fine, silty sediments and re-establishment of stable, low-diversity community. | Permanent loss of 5 acres of intertidal habitat and 31 acres of shallow bay habitat. |
| Wetlands | Short-term loss of several acres of emergent wetlands. Shoreline would be biostabilized and replanted. | No impacts to wetlands. | Permanent loss of 5 acres of estuarine emergent wetlands. | Short-term loss of several acres of emergent wetlands. Shoreline would be biostabilized and replanted. | No impacts to wetlands. | No impacts to wetlands. | Short-term loss of several acres of emergent wetlands. Shoreline would be biostabilized and replanted. | No impacts to wetlands. | No impacts to wetlands. |
| Mudflats | Remove contaminated sediments from 101 acres. Would be replaced through backfilling for no net loss. | No impacts to mudflats. | Permanent loss of 43 acres of intertidal unconsolidated shore. | Remove contaminated sediments from 101 acres. Would be replaced through backfilling for no net loss. | No impacts to mudflats. | Permanent loss of 7 acres of intertidal unconsolidated shore. | Remove contaminated sediments from 51.4 acres. Would be replaced through backfilling for no net loss. | No impacts to mudflats. | Permanent loss of 5 acres of intertidal unconsolidated shore. |

Notes:

CAD = Confined Aquatic Disposal;

CDF = Confined Disposal Facility.

## Table 3-3 Mitigation Options and Costs for DMM Scenario A (CAD or CDF in Newark Bay)

| Remedial Alternative | DMM Scenario | DMM Impacts to Waters of the U.S. | | Impact Area That Could Be Mitigated By Existing Banks (Acres)[a] | | | | Mitigation Bank Cost ($000)[b] | Remaining Unmitigated Impact Area (Acres) | Additional Mitigation Required[c] | | Total Mitigation Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Temporary (Acres) | Permanent (Acres) | Port Reading | Kane | MRI3 | Total | | | (Acres) | Cost ($000)[d] | |
| Alternative 2 - Deep Dredging with Backfill | CAD | 171 | 0 | 7 | 66 | 21 | 94 | $71,720 | 77 | 77 | $31,031 | $102,751,000 |
| | CDF | 0 | 115 | 7 | 66 | 21 | 94 | $71,720 | 21 | 63 | $25,389 | $97,109,000 |
| Alternative 3 - Capping with Dredging for Flooding and Navigation | CAD | 80 | 0 | 7 | 52 | 21 | 80 | $60,590 | 0 | 0 | 0 | $60,590,000 |
| | CDF | 0 | 45 | 7 | 17 | 21 | 45 | $32,765 | 0 | 0 | 0 | $32,765,000 |
| Alternative 4 - Focused Capping with Dredging for Flooding | CAD | 19 | 0 | 7 | 0 | 12 | 19 | $12,950 | 0 | 0 | 0 | $12,950,000 |
| | CDF | 0 | 36 | 7 | 8 | 21 | 36 | $25,610 | 0 | 0 | 0 | $25,610,000 |

Notes:

CAD = Confined Aquatic Disposal; CDF = Confined Disposal Facility; DMM = Dredged Material Management; MRI3 = Marsh Resources Incorporated Phase 3.

a: The mitigation banks provide 1 mitigation credit (representing multiple mitigation acres) for each acre of permanent impact, such as the CDF permanent impacts. It is likely that 1 mitigation credit could compensate for more than 1 acre of temporary open water impact, but there is currently no precedent for this. Therefore, it is conservatively assumed that 1 mitigation credit would be required for each acre of temporary CAD impact.

b: The following Bank Credit Prices were used:

$650,000 Approximate Port Reading Credit Price

$795,000 Approximate Kane Credit Price

$700,000 Approximate MRI3 Credit Price

c: At an off-site mitigation site, permanent impacts are typically compensated at mitigation to loss ratio of 3 to 1 while temporary impacts are compensated at a 1 to 1 mitigation to loss ratio.

d: Three recent restoration projects demonstrate that mitigation costs could be $403,000 per acre (based on USACE's 43-acre Elders Point East Wetland Project, KeySpan Marsh, and Medwick Wetland).

**Table 3-4 Comparison of Mitigation Costs under CWA 404 for Remedial Alternatives and Dredged Material Management Scenarios**

| Remedial Alternative | Volume Dredged (MCY) | Years of In-River Dredging/ Capping (Year) | Navigation Channel | Resuspension Due to Dredging | Long Term | Preliminary Estimated PV (Billion $) | Upland Needed (Acres & Time) | Subaqueous Land Needed (Acres & Time) | Mitigation Costs (Billion $) |
|---|---|---|---|---|---|---|---|---|---|
| Alternative 1 - No Action | 0 | N/A | No change | No change | N/A | N/A | N/A | N/A | 0 |
| Alternative 2 - Deep Dredging with Backfill Placement | 9.7 | 11 | Dredge to federally authorized navigation depth | 6 times current | Monitoring | CAD: $1.3 | Support Facility 5 acres | CAD: 171 acres for 11 years | $0.10 |
| | | | | | | Off-site Disposal: $3.2 | Off-site Disposal: 23.5 acres for 11 years | Off-site Disposal: none | 0 |
| | | | | | | Local Decon: $2.6 | Local Decon: 35.5 acres for 11 years | Local Decon: none | 0 |
| Alternative 3 - Capping with Dredging for Flooding and Navigation | 4.3 | 4.5 | Accommodate use of federal navigation channel in the lower 2.2 miles | 2 times current | Monitoring & Maintenance | CAD: $1.0 | Support Facility 5 acres | CAD: 80 acres for 5 years | $0.06 |
| | | | | | | Off-site Disposal: $1.7 | Off-site Disposal: 22 acres for 5 years | Off-site Disposal: none | 0 |
| | | | | | | Local Decon: $1.6 | Local Decon: 33 acres for 5 years | Local Decon: none | 0 |
| Alternative 4 - Focused Capping with Dredging for Flooding | 1.0 | 1.5 | No change | 2 times current | Monitoring & Maintenance | CAD: $0.4 | Support Facility 5 acres | CAD: 19 acres for 2 years | $0.01 |
| | | | | | | Off-site Disposal: $0.6 | Off-site Disposal: 17 acres for 2 years | Off-site Disposal: none | 0 |
| | | | | | | Local Decon: $0.6 | Local Decon: 25.5 acres for 2 years | Local Decon: none | 0 |

Notes:

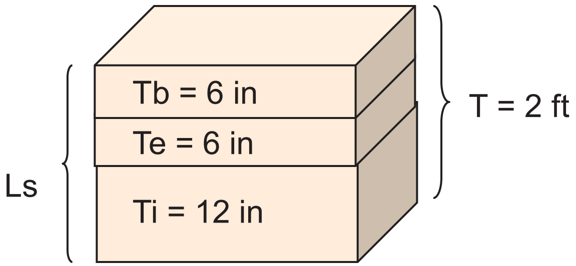
CAD = Confined Aquatic Disposal; MCY = million cubic yards.

Mitigation costs included in calculation of Present Value.

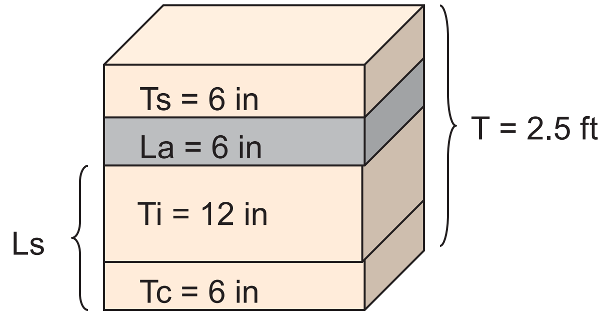
PV- Present value based on 7 percent discount rate. See Appendix H for detailed cost information.

# FIGURES

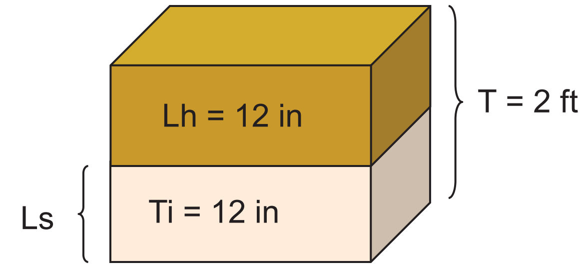
## Sand Cap




## Armored Sand Cap




## Mudflat Reconstruction Cap




<u>Sand Cap</u> – The thickness of the sand cap is formed by different components. A bioturbation component is necessary to prevent benthic organisms from disturbing the chemical isolation component. An erosion component is necessary to protect the bioturbation and chemical isolation components from erosion. A chemical isolation component is necessary to prevent contaminant flux. No consolidation of the underlying sediments is expected.

<u>Armored Sand Cap</u> – A sand "smoothing layer" is placed on top of the armor to reduce the roughness of the cap surface, thereby mitigating additional flooding impacts. The armor layer protects the cap against erosion. A chemical isolation component is necessary to prevent contaminant flux. A consolidation component is necessary to maintain cap thickness after the underlying sediments consolidate.

<u>Mudflat Reconstruction Cap</u> – The sand layer of the cap would be a mixture of sand and organic carbon. It is assumed that the chemical isolation and the consolidation component of this layer would be the same as that of a sand cap. The habitat layer encompasses the thickness of the biological active zone (bioturbation component thickness).

<u>Legend</u>
La – Armor Layer
Lh – Habitat Layer
T – Total Thickness

Sand Layer (Ls) Components:
Tb – Bioturbation Component
Te – Erosion Component
Tc – Consolidation Component
Ti – Chemical Isolation Component
Ts – Smoothing Component

Refer to Appendix F Section 2.3 for discussion on thickness of cap components.

Schematic of Cap Concepts

*Lower Eight Miles of the Lower Passaic River*

Figure 2-1

2014


Notes: The armor area was selected using the bottom velocities in the river during a 100-year flow event. Total armor area is approximately 119 acres. Stone size (D50) for the armor was selected using the Isbach equation. For cost estimation purposes, a D50 of 2 inches was selected.

Armored Areas with Stone Size

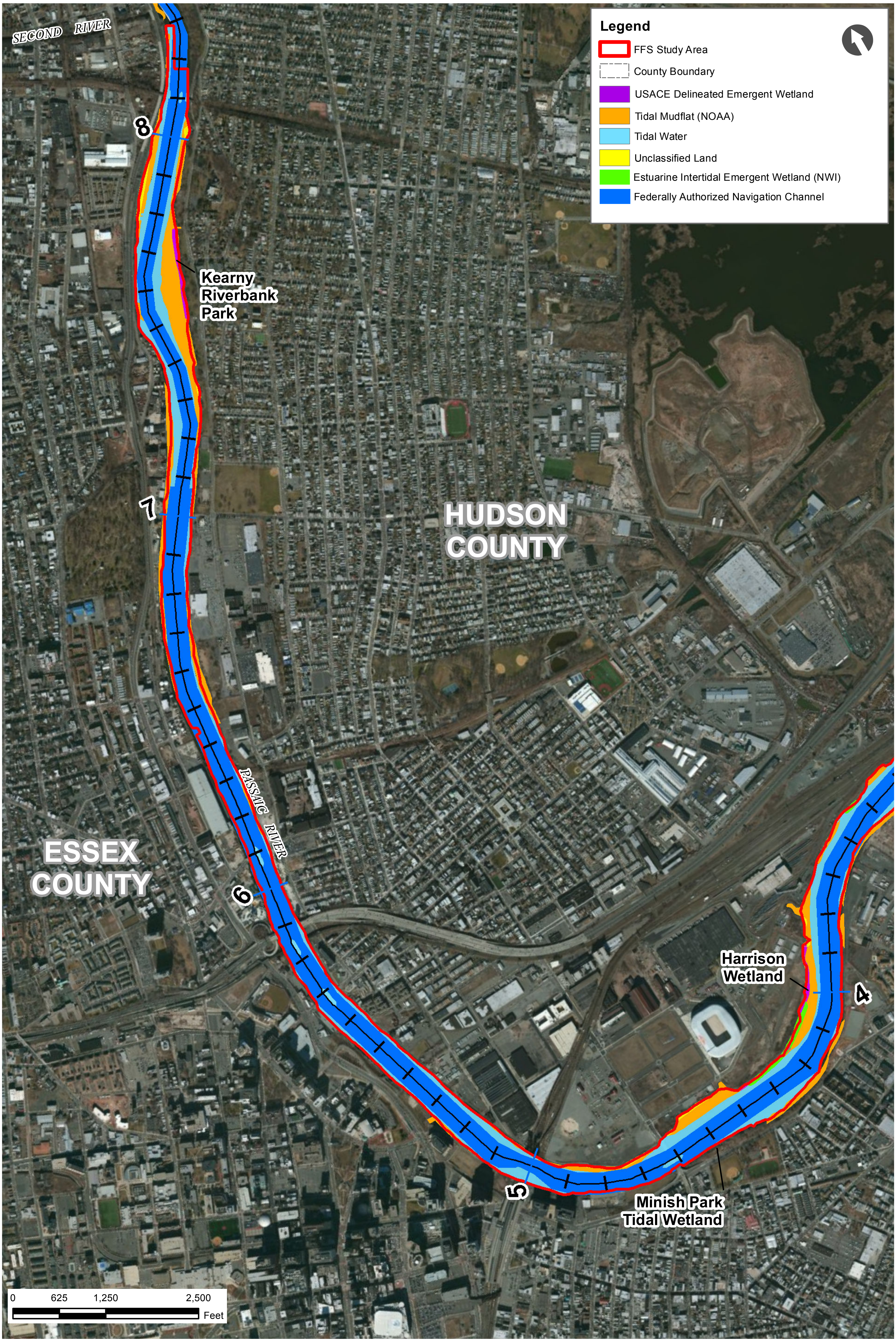
*Lower Eight Miles of the Lower Passaic River*

Figure 2-2

2014

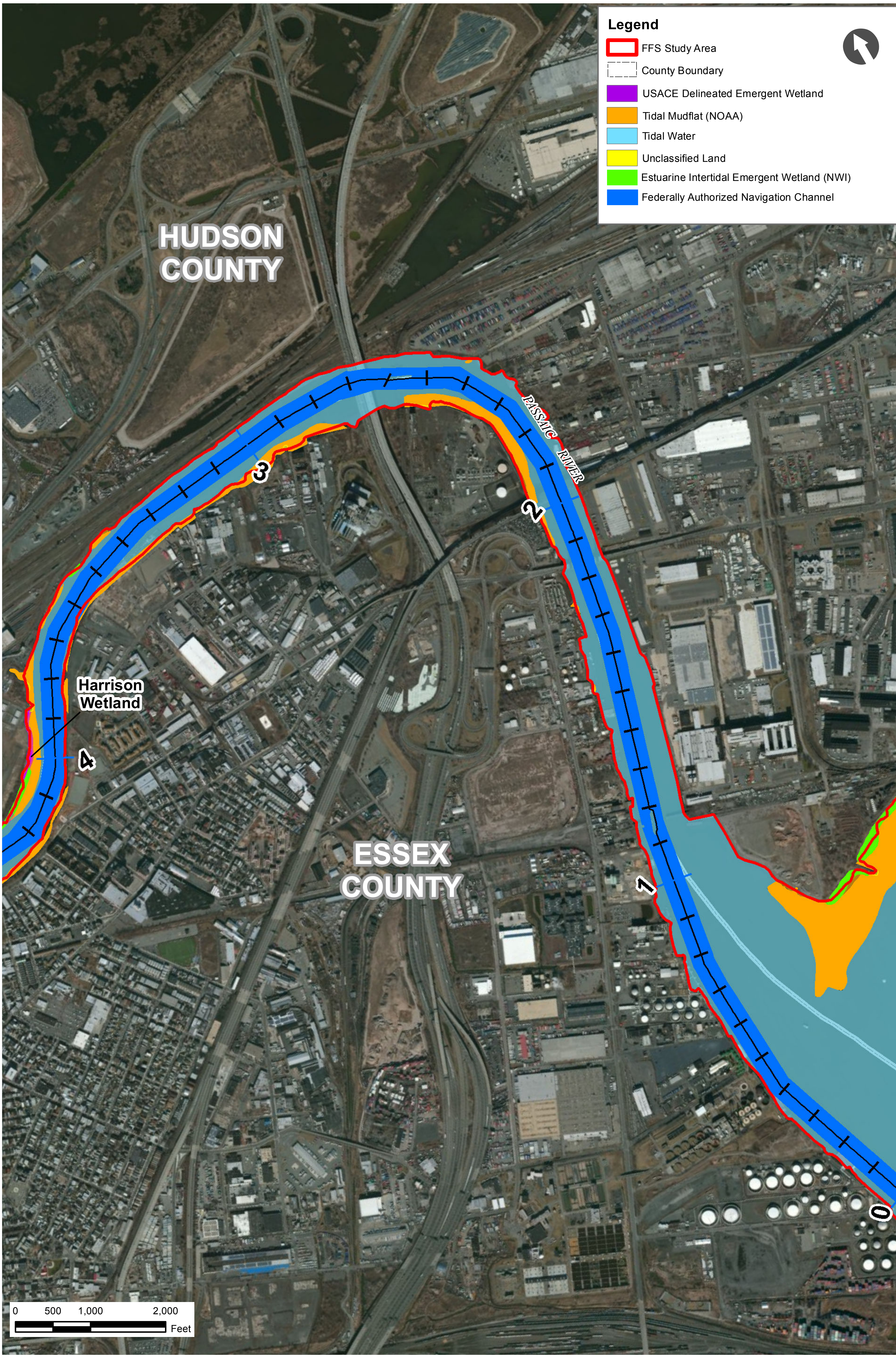

Base Map - ESRI Map Service, Microsoft 2008.

| Regional View<br>*Lower Eight Miles of the Lower Passaic River* | Figure 3-1 |
| --- | --- |
| | 2014 |



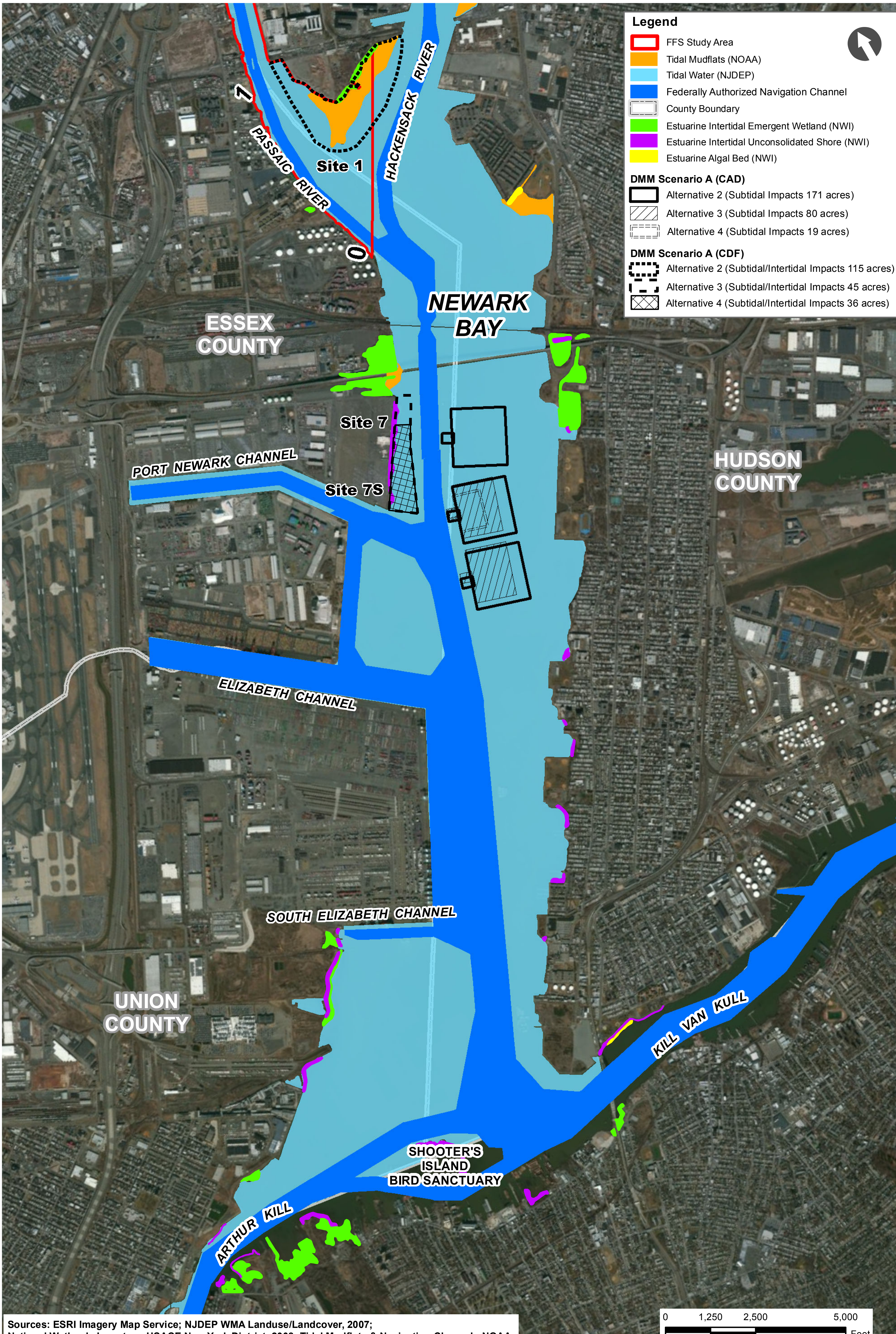

Sources: ESRI Imagery Map Service; NJDEP WMA Landuse/Landcover, 2007; National Wetlands Inventory, USACE New York District. 2008; Tidal Mudflats & Navigation Channel - NOAA.

| | |
|---|---|
| Habitat Impact Areas<br>(RM8 to RM4)<br>*Lower Eight Miles of the Lower Passaic River* | Figure 3-2a<br>2014 |




SourcesL ESRI Imagery Map Service; NJDEP WMA Landuse/Landcover, 2007;
National Wetlands Inventory, USACE New York District. 2008; Tidal Mudflats & Navigation Channel - NOAA.

| Habitat Impact Areas<br>(RM4 to RM0)<br>*Lower Eight Miles of the Lower Passaic River* | Figure 3-2b<br>2014 |
|---|---|

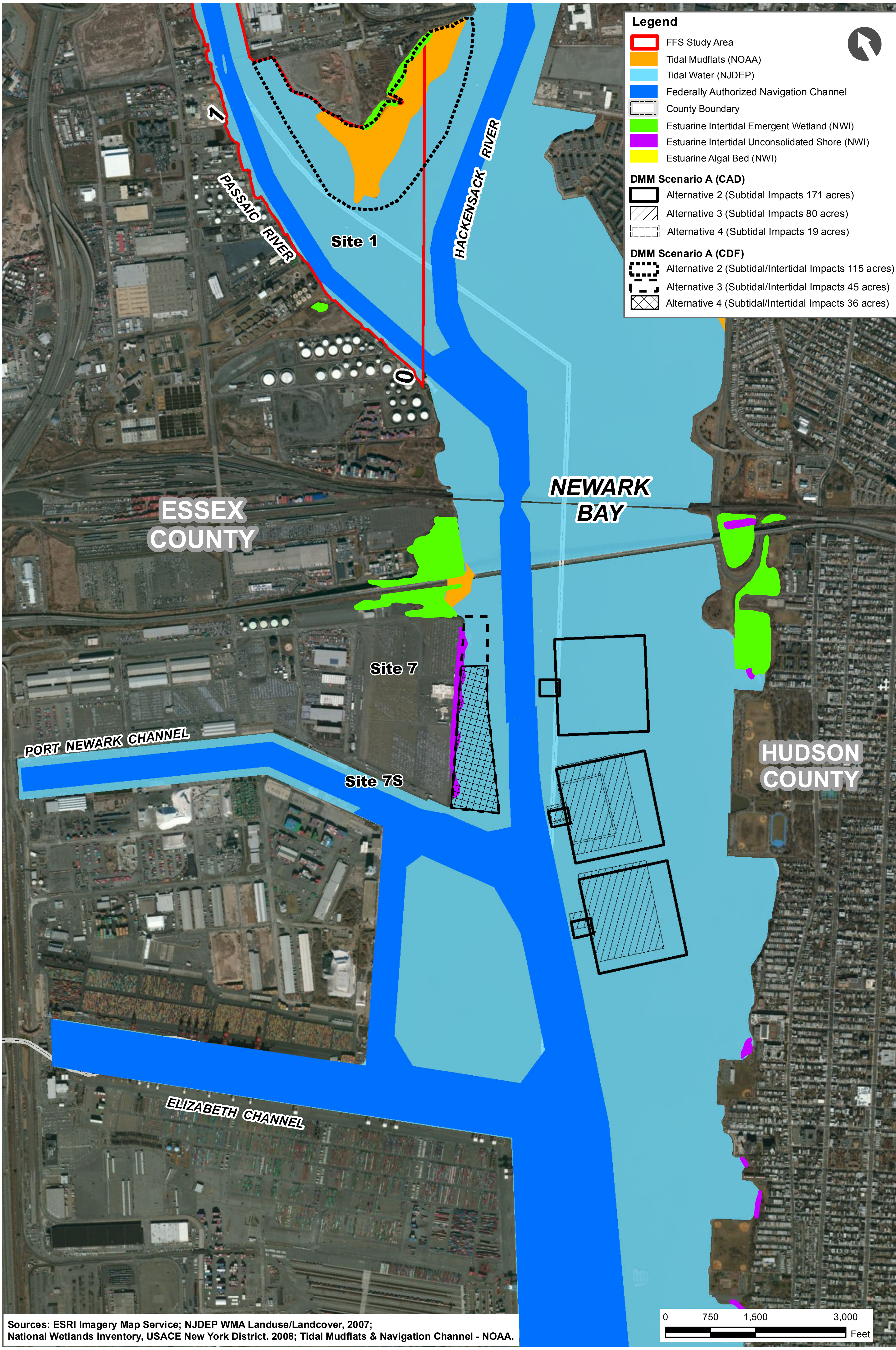



Habitat Impact Areas
(Newark Bay)

*Lower Eight Miles of the Lower Passaic River*

Figure 3-2c

2014



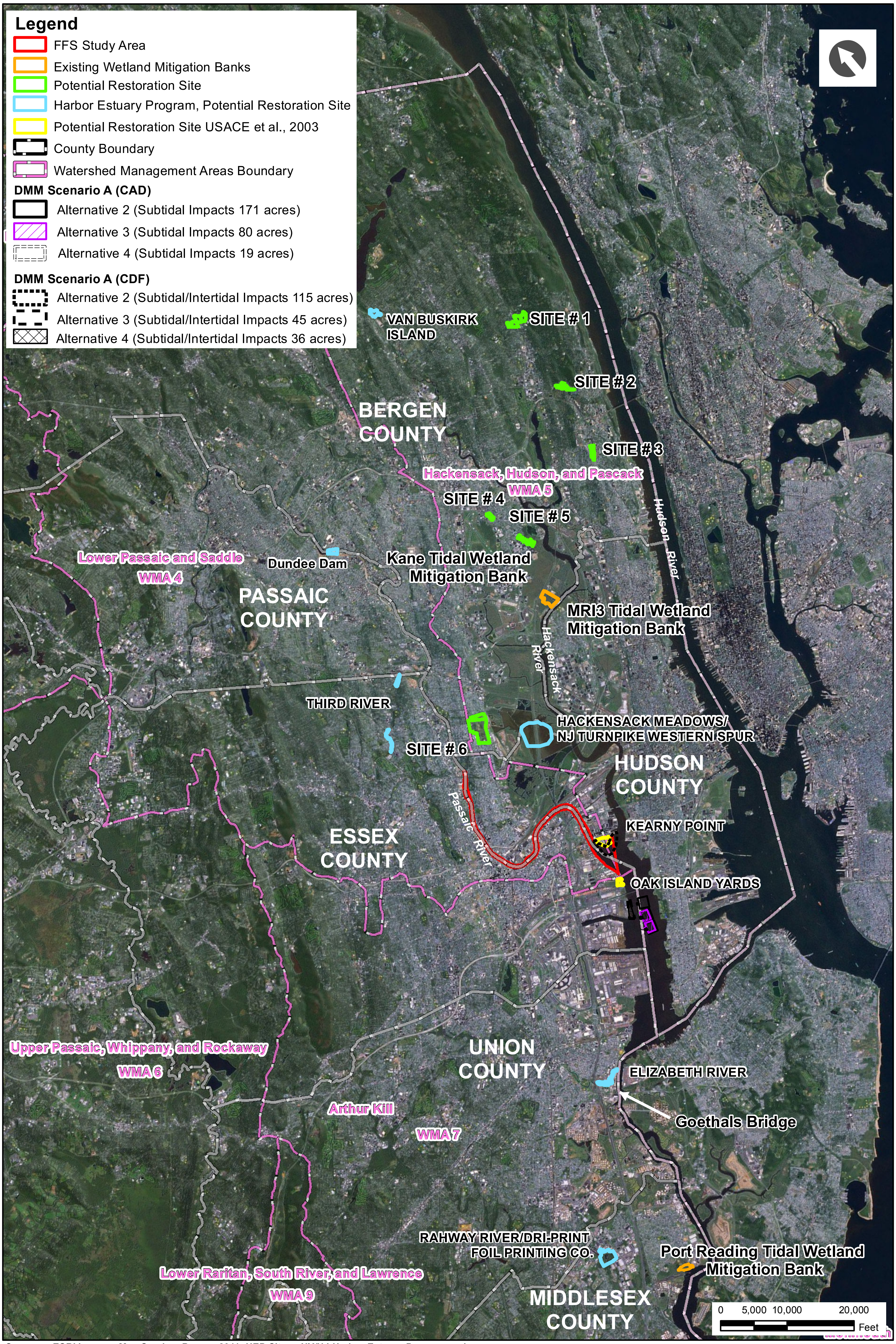

Sources: ESRI Imagery Map Service; NJDEP WMA Landuse/Landcover, 2007; National Wetlands Inventory, USACE New York District. 2008; Tidal Mudflats & Navigation Channel - NOAA.

Habitat Impact Areas
(North Newark Bay)

*Lower Eight Miles of the Lower Passaic River*

Figure 3-2d

2014

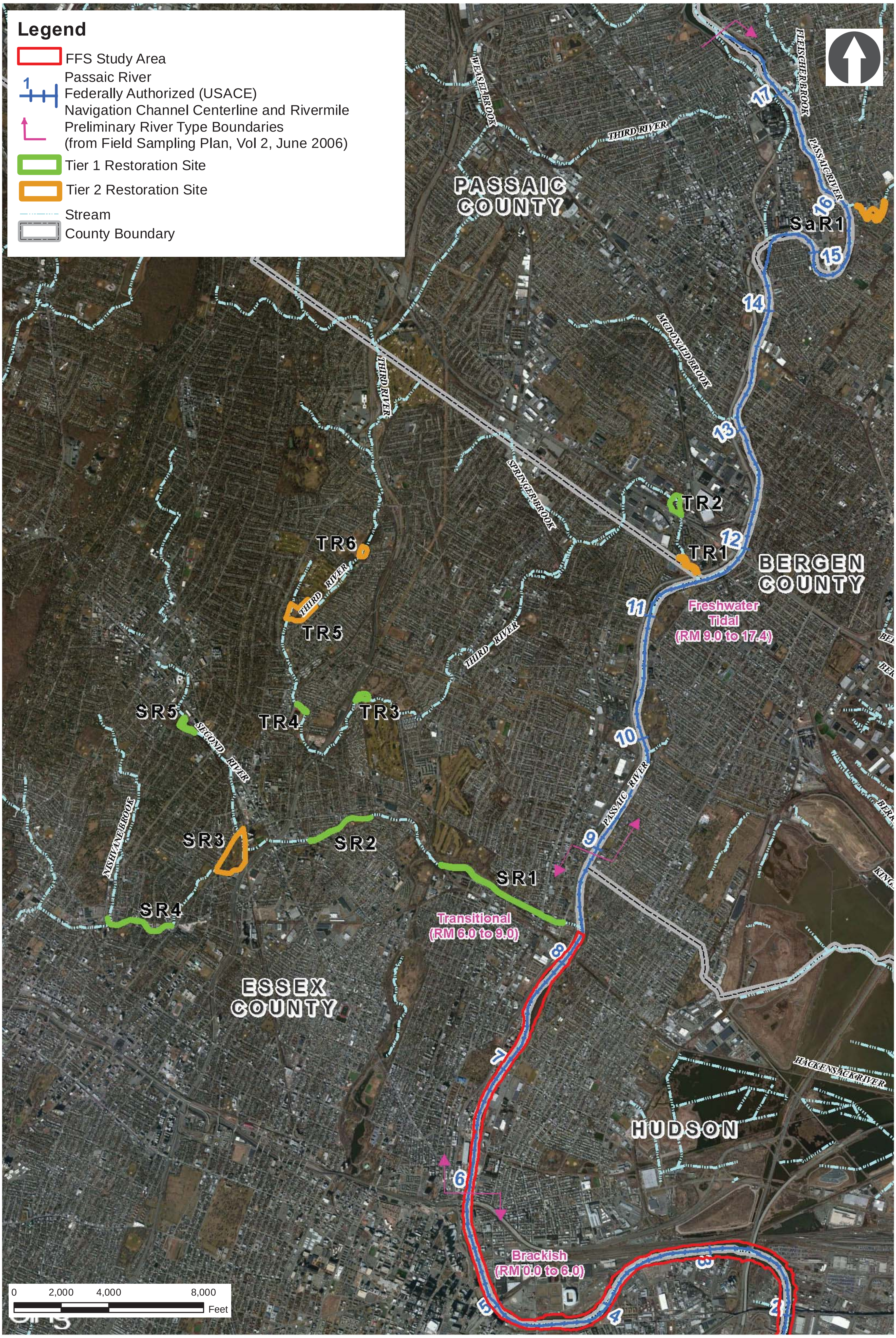



Sources - ESRI Imagery Map Service; Berger, 2011; HEP Sites - NY/NJ Harbor Estuary Program and U.S. Army Corps of Engineers, New York District. Maintained for OASIS by the Center for Urban Research, CUNY Graduate Center., 2008

| Additional Potential Wetland Restoration Sites<br>*Lower Eight Miles of the Lower Passaic River* | Figure 3-3 |
|---|---|
| | 2014 |

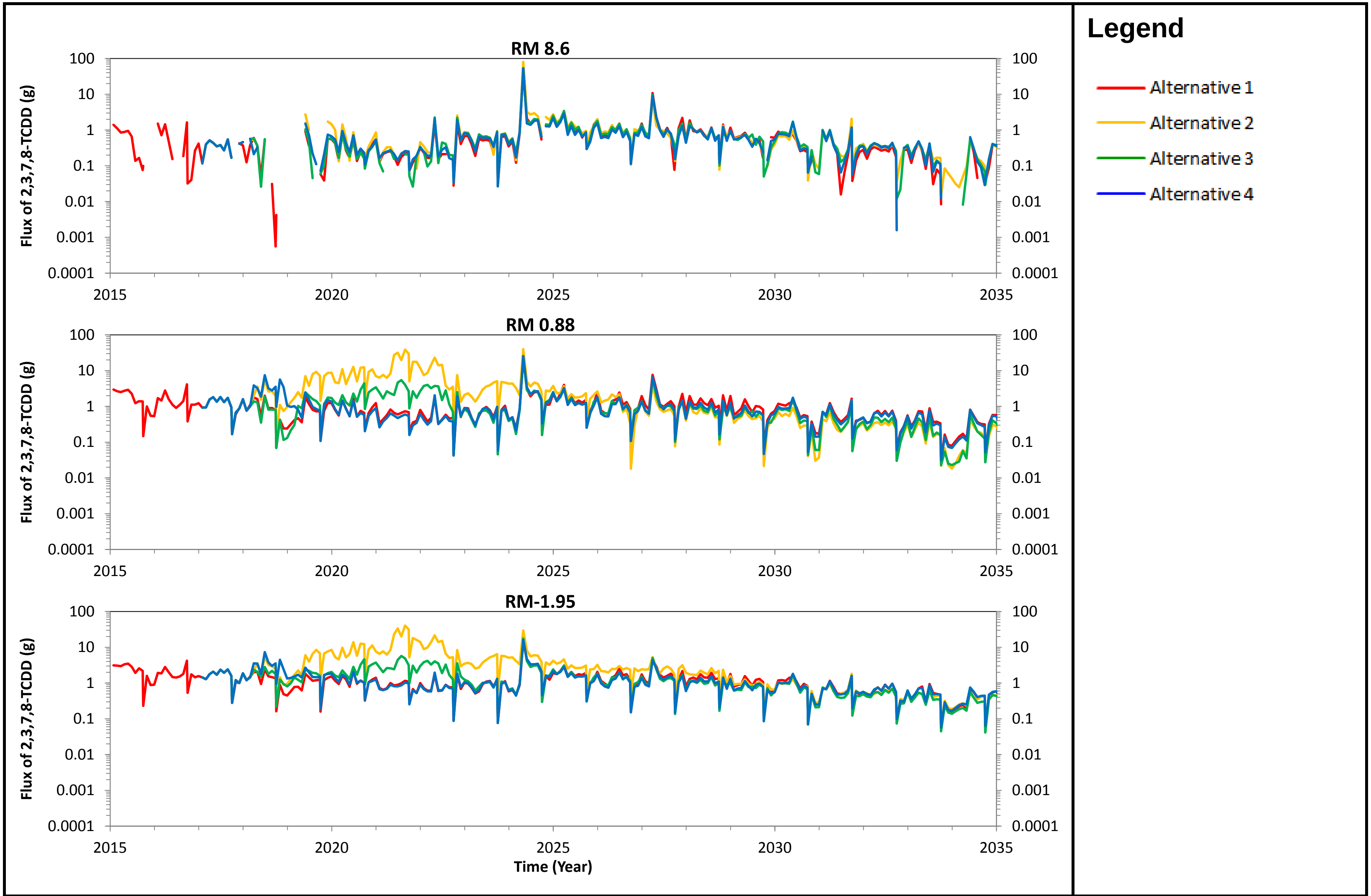

Base Map - ESRI Map Service, Microsoft 2008.
USACE, Draft in Preparation, PASSAIC RIVER TRIBUTARIES – POTENTIAL RESTORATION SITES

| | |
|---|---|
| Previously Identified Potential Wetland Restoration Sites<br>(Bergen and Passsaic County)<br>*Lower Eight Miles of the Lower Passaic River* | Figure 3-4a<br>2014 |




Base Map - ESRI Map Service, Microsoft 2008.; Berger, 2009.
USACE, Draft in Preparation, PASSAIC RIVER TRIBUTARIES – POTENTIAL RESTORATION SITES

| Previously Identified Potential Wetland Restoration Sites (Essex County) *Lower Eight Miles of the Lower Passaic River* | Figure 3-4b |
|---|---|
| | 2014 |




Model Simulated Monthly Flux of 2,3,7,8-TCDD by River Mile in the Lower Passaic River and Newark Bay from 2015 to 2035

*Lower Eight Miles of the Lower Passaic River*

Figure 4-1

2014


Major Roadway Location Map

*Lower Eight Miles of the Lower Passaic River*

Figure 4-2

2014