Appendix G:

Dredged Material Management Assessments

LOWER EIGHT MILES OF THE LOWER PASSAIC RIVER
DREDGED MATERIAL MANAGEMENT ASSESSMENTS

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1 SEDIMENT REMOVAL VOLUME ESTIMATE METHODOLOGY

This section outlines the methodology and results of the calculation for the sediment removal volumes from river mile (RM) 0 to RM8.3 for the alternatives evaluated in the Focused Feasibility Study (FFS). The alternatives are as follows:

- 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

Sediment removal volumes are estimated to evaluate the feasibility of each active alternative (*i.e.*, not including No Action) with respect to the remedial action duration, dredged material management options, costs, and other considerations. This section describes the data used for the calculations, methods used to calculate sediment volumes, and the results of the calculations for each active remedial alternative.

1.1 Data

1.1.1 Bathymetric Survey

Data obtained from a bathymetric survey conducted in 2004 by Rogers Surveying, Inc. for the United States Army Corps of Engineers (USACE) were used to approximate the current sediment surface. The bathymetric data are relative to the National Geodetic Vertical Datum of 1929 which is 2.4 feet above mean low water (MLW) from RM0 to RM7.1 and 2.3 feet above MLW from RM7.1 to RM8.3[1]. The tidal datum conversion is different in the two regions (RM0 to RM7.1 and RM7.1 to RM8.3) because tidal datum elevations vary with horizontal (geographic) distance.

[1] In this document MLW is based on USACE tidal datum. Geodetic to tidal datum conversion was provided by the surveyor in the original bathymetry drawings.

At the time the volume estimates were finalized the most current bathymetric survey was conducted in 2010 by Gahagan & Bryant Associates for the Cooperative Parties Group (CPG). A comparison of the surveys (2004 and 2010) is described in Section 1.2.6.

1.1.2 Geotechnical Borings and Chemical Core Data

Data from sediment cores collected in 1991, 1993, 1995 and 2008 were used to estimate the depth of contamination (see the Methodology section discussion below). The sediment core dataset is described in detail in Appendix A.

Geotechnical borings were performed in 2005. The borings were logged and the depth of the fine-grained sediment (primarily silt) was estimated by a geologist evaluating the boring logs. Since the contaminants of potential concern are persistent and particle reactive (see Remedial Investigation Chapter 5), the depth of fine-grained sediment was used to approximate the depth of contamination. Geotechnical boring logs are provided in the *Technical Report: Geophysical Survey* (Aqua Survey, Inc., 2006).

1.2 Methodology

1.2.1 Transect Locations

For Alternatives 2 and 3, eighteen transects (A through R) were drawn across the river between RM0 and RM8.3 (from bank to bank), dividing the river into segments (a river segment is formed by two transects; refer to Figure 1-1a). Transects were drawn at the upper and lower limits of the lower eight miles of the Lower Passaic River (FFS Study Area) to define the limits of dredging (one at each end); seven additional transects were drawn to account for changes in depth and width in the federal navigation channel; and, nine additional transects were drawn to refine the volume calculations in areas where the distance between transects was greater than approximately one-half mile. Table 1-1a summarizes data on transect locations with respect to river miles for Alternatives 2 and 3.

For Alternative 4, ten[2] transects (AA through JJ) were drawn across the river between RM1.09 and RM8.13 (from bank to bank), dividing the river into segments (refer to Figure 1-1b). Transects were drawn at the upper and lower limits of dredging (one at each end) with eight intermediate transects drawn to account for changes in width of the footprint. Table 1-1b summarizes data on transect locations with respect to river miles for Alternative 4.

1.2.2 Average-End Area Calculation

Sediment removal volumes for the majority of the river were estimated using average-end area calculations. This method involved determining the cross-sectional area for sediment removal for each remedial alternative along each transect based on the sediment depth and channel configuration (refer to Section 1.3). The cross-sectional areas for the transects comprising each end of the river section were averaged and multiplied by the length of the river section to estimate the sediment removal volume in that section. This calculation assumes that the change in the sediment surface between the two transects is linear. The greater the distance between adjacent transects, the greater the uncertainty in the average-end area calculation due to irregularities in the sediment surface and the width of the river.

1.2.3 Depth of Contamination in Shoals for Alternative 2

For Alternative 2, which involves the removal of fine-grained sediment from the federal navigation channel and shoals[3], the depth of sediment to be removed from the shoals was determined using geotechnical and chemical core data (see Figure 1-1a for core locations).

The 2005 geotechnical and CPG2008 cores provided data on the depth of fine-grained sediment associated with the presence of contamination in the sediments. Mercury and 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) were used as indicators for identifying the depth of contamination in the sediment. Mercury was used as a surrogate because mercury contamination occurs deeper in the sediment bed relative to 2,3,7,8-TCDD and polychlorinated biphenyls

[2] Transects were specifically developed for Alternative 4 in order to account for the non-continuity in the areas and changes in the width of the footprint. Ten transects were considered appropriate to represent changes in the footprint because Alternative 4 has a constant dredging depth and spacing transects approximately every half-mile was not deemed necessary.

[3] The term “shoals” is used to describe areas outside of the navigation channel.

(PCBs); 2,3,7,8-TCDD was used because it is one of the primary risk drivers for the FFS Study Area (see Appendix D). For the historical datasets (*i.e.*, 1991, 1993, and 1995) only the mercury data were used because the cores generally did not reach the native sediment layer and mercury contamination occurs at greater depths than 2,3,7,8-TCDD.

The depth of contamination indicated by each chemical core was determined as follows:

- CPG2008 Cores: Analyte-specific thresholds were selected to represent the contaminant concentrations in uncontaminated sediment as described in Attachment A of Data Evaluation Report No. 5 (Appendix A). The threshold values used were 2 parts per trillion for 2,3,7,8-TCDD and 200 parts per billion (ppb) for mercury. Core profiles were evaluated to identify segments where the concentrations exceeded the threshold values. In some cases the depth of contamination was selected by evaluating concentration trends in the core profiles[4].
- Historical Cores: The chemical cores included both complete cores (where mercury concentrations peaked and declined to the analyte-specific threshold values) and incomplete cores (where a rising mercury concentration gradient or a mercury concentration above the analyte-specific threshold value exists at the core bottom). Incomplete cores were compared to complete core data and depth of silt to estimate the depth of contamination.

The core locations were plotted to determine which cores fell closest to each transect. The cores were assigned to the different transects and the average depth of contamination was estimated for each dataset (*i.e.*, historical, CPG2008, and geotechnical cores) for each transect. The average depths of contamination indicated by the different datasets were compared and professional judgment was used to select the depth of contamination for the associated transect. For example, if multiple cores indicated a significant variability in the depth of contamination, the depth of fine-grained sediment was used as an indicator of the depth of contamination. Because dredging can be more precise at shallower depths, six inches were added to the depth of contamination

[4] For a few cores, thin contaminated segments (less than six inches) were bounded by thick segments (greater than two feet) of clean sediment. For these cases, the core concentration profile was evaluated and compared to nearby cores to determine whether the thin core segment was representative of the depth of the contamination.

where the estimated depth was fifteen feet or less and one foot was added where the estimated depth was greater than fifteen feet to account for dredging inaccuracy (*i.e.*, overdredge allowance). Table 1-2 presents the average depth of sediment removal under Alternative 2 for the shoals at each transect.

The excavation side slopes in the cross-sectional areas were constrained to be no greater than a 3 horizontal to 1 vertical (3H:1V) slope. In areas where the existing bathymetry had a slope of 3H:1V or greater, the slopes for the areas to be excavated were designed at 3H:1V; in areas where the existing bathymetry had a slope less than 3H:1V, dredge cuts were designed such that the slope was equal to that of the existing bathymetry. The resulting transect cross-sections were used to calculate sediment removal volumes using the average-end area calculation method described above.

1.2.4 Removal Depth in Capping Areas for Alternative 3

For Alternative 3, which requires the placement of capping material over the shoals, the shoals would be pre-dredged prior to cap placement. Hydrodynamic modeling of the top of the cap (refer to Appendix B) determined that pre-dredging to a depth of 2.5 feet below existing bathymetry would be necessary to accommodate a two-foot-thick engineered sand cap (including 6 inches of overdredge allowance) and to prevent additional flooding as compared to baseline conditions (*i.e.*, no net increase in flooding is predicted). The area within the horizontal limits of the federally authorized navigation channel from RM2.2 to RM8.3 would be pre-dredged 2.5 feet prior to cap placement; the dredging depths in RM0 to RM2.2 are as described in Section 1.3.2 below. The results of hydrodynamic modeling indicated that pre-dredging would not be necessary to accommodate an engineered cap in the Kearny Point shoal area (*i.e.*, the shoals on the left descending bank between RM0.7 and RM1.1). However, the mudflat[5] areas within the Kearny Point shoal area would need to be reconstructed to restore the mudflat areas to the correct mudflat elevation; therefore, pre-dredging would be necessary within the mudflat areas. Figure 2-1 in Appendix F presents the cap concepts for the engineered and mudflat reconstruction caps.

[5] The term "mudflat" is used to describe areas which are intermittently exposed and submerged based on tidal action.

As with Alternative 2, the excavation side slopes in the cross-sectional areas were constrained to be no greater than a 3H:1V slope as described in Section 1.2.3. For Alternative 3, a 6-inch armor layer would be placed over the engineered cap in select areas as described in Appendix F. The areas to be armored were selected to be conservative for cost estimation purposes. The thickness of the armored cap was estimated at 2.5 feet (refer to Figure 2-1 in Appendix F). An additional 6 inches of pre-dredging to account for the overdredge allowance (for a total of 3.0 feet) was added to the average-end area calculation in armored areas to account for the additional volume to make room for the armor layer.

1.2.5 Removal Depth in Capping Areas for Alternative 4

Alternative 4 requires the placement of cap material over shoals and mudflats with higher levels of contaminant flux as shown in Figure 1-1b (refer to Chapter 4 of the FFS for additional details), with these areas being pre-dredged prior to cap placement. As with Alternative 3, modeling results indicate that pre-dredging to a depth of 2.5 feet below existing bathymetry would be necessary to accommodate the cap thickness and over dredge allowance, and to prevent flooding. Following pre-dredging, disturbed mudflat areas would need to be reconstructed to restore the mudflat areas to the previous mudflat elevation.

The excavation side slopes in the cross sectional areas were constrained to be no greater than a 3H:1V slope as described in Section 1.2.3. For Alternative 4, an armor layer would be placed over the cap material in select areas as described in Appendix F. The size of the areas to be armored was selected to be conservative for cost estimation purposes. The thickness of the armored cap was estimated at 2.5 feet (refer to Figure 2-1 in Appendix F). An additional 6 inches of pre-dredging to account for the overdredge allowance for a total pre-dredging depth of 3.0 feet was added to the average-end area calculation in armored areas to account for the additional volume required for the armor layer.

1.2.6 2004 and 2010 Bathymetry Surveys Comparison

The 2004 bathymetric survey conducted by Rogers Surveying was used to represent the existing sediment surface in estimating the sediment removal volumes. At the time the volume estimates were finalized, the most current bathymetric survey was the 2010 survey by Gahagan & Bryant Associates. As a result, in order to account for the differences between the two bathymetric surveys (erosion and deposition between 2004 and 2010), the 2004 and 2010 bathymetric surveys were compared using Geographic Information Systems (GIS).

The 2004 bathymetric survey was developed using a single-beam sonar system with transect measurements taken at 200-foot intervals. Soundings (elevation data points) were taken at 10-foot intervals along each transect. For the 2010 bathymetric survey, a multi-beam sonar system was used which generated high resolution bathymetry (1x1 grids).

In order to accurately compare the two types of data sets, elevations from the 2010 bathymetric survey were extracted at the locations where each sounding was collected for the 2004 bathymetric survey. The survey results were compared at each location to determine the depth of erosion or deposition that had occurred. Figures 1-2a through 1-2d depicts the data point locations and associated depth of erosion or deposition between the 2004 and 2010 bathymetric surveys.

For Alternative 2, the estimated sediment removal volume is dependent on the targeted elevation to be dredged for contaminant removal. Therefore, erosion and deposition that occurred between the periods of the two bathymetric surveys would result in changes in the volume estimates (*e.g.*, deposition would increase the depth of removal, erosion would decrease it). In order to account for this, a net change in depth was determined based on the survey comparisons. As shown on Figures 1-2a through 1-2d, the majority of deposition occurred in the downstream areas of the FFS Study Area, specifically between RM0 to RM2.2. Based on these results, the area of dredging was divided into two segments: RM0 to RM2.2 and RM2.2 to RM8.3. The net change in depth in each segment was determined and multiplied by the associated area to determine the overall net volumes of additional sediment to be removed between RM0 to RM8.3.

Alternative 3 involves dredging the existing federally-authorized navigation channel to targeted elevations between RM0 to RM2.2, and pre-dredging 2.5 feet below the existing bathymetry in the shoal areas between RM0 to RM2.2 and bank-to-bank between RM2.2 to RM8.3 (refer to Section 1.3.2). Areas that require pre-dredging 2.5 feet below the existing bathymetry are not dependent on a targeted elevation and deposition and erosion that occurred between the two bathymetric surveys would not significantly affect the volume estimates. Therefore, deposition and erosion comparison calculations were not performed between RM2.2 and RM8.3. However, between RM0 and RM2.2, deposition and erosion was considered for the navigation channel and the areas between the top and toe of the channel slopes (see Figure 1-3) because these areas are dependent on the targeted navigation channel elevation. The areas between the top of slope and the shoreline from RM0 to RM2.2, where pre-dredging is required for the engineered cap, were not considered as these areas are not dependent on a targeted elevation rather they are dependent on the existing bathymetry.

For Alternative 4, the top 2.5 feet of sediment would be removed during pre-dredging for the selected areas based on the existing bathymetry. Because the sediment removal volumes are not based on a targeted elevation, historical deposition and erosion volumes are not a concern and comparison calculations were not performed.

The net volume of additional sediment removal computed for each alternative was included in the sediment removal volume estimates calculated based on the 2004 bathymetric survey. For Alternative 2, the total depositional volume occurring within the FFS Study Area between 2004 and 2010 was estimated at 396,000 cubic yards (cy) and the overall erosion volume was estimated at 245,000 cy. Therefore, an additional 151,000 cy were added to the sediment removal volume estimate for Alternative 2. For Alternative 3, the net volume (depositional volume minus erosional volume) computed for the shoals and federal navigation channel was estimated at 263,000 cy. Table -1-3 shows a summary of the bathymetric volume comparison.

1.2.7 Tidal Mudflat Estimation

Tidal mudflats (*i.e.,* areas which are intermittently exposed and submerged based on tidal action), would be reconstructed if disturbed by dredging or backfill/capping operations related to the remedial alternatives. Since tidal mudflats are located within the shoal areas (*i.e.*, areas outside the navigation channel), dredging depths would generally equal that of the shoal areas.

- Tidal mudflats in Alternative 2 would be dredged to the depth of contamination in the shoal areas as described in Section 1.2.3. The mudflats would be backfilled to one foot below original grade (to restore hydrologic conditions) followed by a one foot layer of mudflat reconstruction material.
- Tidal mudflats in Alternative 3 would be dredged to a depth of 2.5 feet to accommodate an engineered cap consisting of one foot of capping material and one foot of mudflat reconstruction material with a 0.5 foot overdredge allowance.
- Tidal mudflats in Alternative 4 would be dredged to a depth of 2.5 feet in areas where the mudflats coincide with the selected areas of high contaminant flux. Following dredging, an engineering cap consisting of one foot thick sand cap and one foot of mudflat reconstruction material would be constructed with a 0.5 foot overdredge allowance.

GIS shapefiles were provided by the National Oceanic and Atmospheric Administration (NOAA) for the tidal mudflat areas (defined as the areas between the MLW elevation and the shoreline). The total disturbed mudflat area is approximately 101 acres for Alternatives 2 and 3 and 51 acres for Alternative 4. Table 1-4 presents the disturbed mudflat areas by river mile. As discussed in Section 1.2.1, transects were developed using river bathymetry in order to estimate sediment removal volumes. Because of the shallow water depths within mudflat areas, river bathymetry did not always extend to the shoreline; therefore, in some areas, the sediment volume within some of the disturbed mudflats was not accounted for by the average-end area estimate (see Figure 1-4). An estimate of the volume not accounted for by the average-end area estimate was prepared by multiplying the depth of dredging times the area not accounted for. For Alternative 2, the sediment volume to be removed from the mudflat areas is 29,000 cy, for Alternative 3, the volume is 171,000 cy, and for Alternative 4, the volume is 152,000 cy.

1.2.8 Removal Volumes for Highly Contaminated Sediment

An Administrative Order on Consent between United States Environmental Protection Agency (USEPA) and Occidental Chemical Corporation signed in June 2008 required 200,000 cy of highly contaminated sediment be removed as a separate action (Phase 1 and Phase 2). For Alternative 2, the average end area calculation accounted for this volume by subtracting 200,000 cy from the sediment removal volume calculation. For Alternative 3, the average-end area calculation accounted for this volume by subtracting the portion of the 200,000 cy that was present in the top 2.5 feet of sediment. The Phase 1 and Phase 2 footprints were outside of the Alternative 4 footprint, therefore, the 200,000 cy was not incorporated into the average-end area calculation for Alternative 4.

1.3 Discussion

1.3.1 Alternative 2 (Deep Dredging with Backfill)

Alternative 2 would involve the removal of fine-grained sediment from within the horizontal limits of the federally authorized navigation channel as well as from the adjacent shoals. Within the navigation channel, the depth of fine-grained sediment has been shown to correspond well with the depth of historical dredging (see Remedial Investigation Chapter 3). For this reason, the depth of dredging was assumed to be the historically constructed channel depth plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot). For this alternative, the resulting sediment removal depth would be as follows:

- 33 feet MLW for RM0.0 to RM2.6
- 23 feet MLW for RM2.6 to RM4.6[6]
- 19 feet MLW for RM4.6 to RM7.1
- 19 feet MLW for RM7.1 to RM8.1
- 13 feet MLW for RM8.1 to RM8.3.

In areas where bulkheads are present, dredging would extend to within approximately two feet of the wall and the resulting side slopes would be essentially vertical. In areas where riprap is present, the side slope of the cut would be parallel to the face of the riprap at an approximate 2H:1V slope. The cut would be offset about four feet from the face of the riprap to avoid

[6] The 20-foot deep section of the authorized channel stops at RM4.1. However, historical dredging records show that the channel was sometimes maintained to a 20-foot depth up to RM4.6 (refer to FFS Table 1-1).

undercutting the toe of the stone. Note that volume estimates conservatively assume bank to bank dredging (*i.e.*, do not include offsets from dredging near shorelines) and would need to be refined during the design phase of the selected remedial alternative.

Following removal of the sediment, it is assumed that a minimal amount of fine-grained sediment would remain in the channel. Therefore, a two foot backfill layer would be placed to mitigate the impacts of the remaining fine-grained sediment and/or dredging residuals (Figures 1-5a through 1-5d).

The average-end area calculations were not appropriate for estimating the sediment removal volume for the Kearny Point shoals at the mouth of the river because the width of the river changes dramatically in this segment (see Figure 1-1a). For this portion of the river, the sediment removal volume was calculated by multiplying the area of the Kearny Point shoals by the depth of contamination, estimated to be 3.5 feet based on the core data collected at the mouth of the river.

The conceptual design for Alternative 2 shows the cross sections of sediment removal for each transect and is presented in Figure 4-5 of the FFS. Table 1-5 presents the calculated volumes of sediment to be removed from each river section under Alternative 2.

1.3.2 Alternative 3 (Capping with Dredging for Flooding and Navigation)

Alternative 3 would involve the removal of fine-grained sediment from within the horizontal limits of the federally authorized navigation channel to accommodate the reasonably-anticipated future navigation use of the river (refer to Chapter 4 of the FFS for additional details). For this alternative, the resulting sediment removal depths would be as follows:

- 33 feet MLW from RM0 to RM1.2
- 30.5 feet MLW from RM1.2 to RM1.7
- 25.5 feet MLW from RM1.7 to RM2.2

In areas where bulkheads are present, dredging would extend to within approximately two feet of the wall and the resulting side slopes would be essentially vertical. In areas where riprap is present, the side slope of the cut would be parallel to the face of the riprap at an approximate 2H:1V slope. The cut would be offset about four feet from the face of the riprap to avoid undercutting the toe of the stone. Note that volume estimates conservatively assume bank to bank dredging (*i.e.*, do not include offsets from dredging near shorelines) and would need to be refined during the design phase of the selected remedial alternative.

An engineered cap (or backfill where appropriate, as described below) would be placed over RM0 to RM8.3 bank-to-bank. The dredging depths under Alternative 3 do not always correspond with the depth of historical dredging in the navigation channel; therefore, additional dredging is required in order to protect the integrity of the cap (Figures 1-5a through 1-5d).

From RM0 to RM1.2, the depth of dredging within the horizontal limits of the federally authorized navigation channel is assumed to be the historically constructed channel depth plus an additional three feet to account for historical overdredging (two feet) and dredging accuracy (one foot). The side slope would be constructed at a slope of 3H:1V. After sediments are removed from the federally authorized navigation channel to the depth specified above (*i.e.*, 33 feet MLW), it is assumed that minimal fine-grained sediment would remain in the channel. Therefore, a two foot backfill layer would be placed within the channel to mitigate for remaining fine-grained sediment and/or dredging residuals (Figure 1-5a).

From RM1.2 to RM1.7 and RM 1.7 to 2.2, the currently authorized channel extends to a depth of 30 feet MLW. Following sediment removal, it is possible that additional, un-targeted contaminant inventory would remain in place. Therefore, it is assumed that an engineered cap would be placed on the channel bottom. To configure a 25-foot deep and 20-foot deep channel, dredging would occur to the depth required to accommodate navigation (*i.e.*, 25 feet and 20 feet), plus the depth to accommodate the necessary cap components that would be placed (an additional 5.5 feet), for a total dredging depth of 30.5 feet and 25.5 feet, respectively (Figures 1-5b and 1-5c). The side slope would be constructed at a slope of 3H:1V.

Alternative 3 also involves the placement of an engineered cap in the side slope and shoals of RM0 to RM2.2 and throughout RM2.2 to RM8.3 bank-to-bank. An additional minimal amount of sediment removal would also 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.

The conceptual design for Alternative 3 is shown on Figure 4-6 of the FFS. Table 1-6 presents the volume of sediment to be removed from each river section for this alternative.

1.3.3 Alternative 4 (Focused Capping with Dredging for Flooding)

Alternative 4 does not incorporate dredging for navigation; dredging is limited to that necessary to accommodate the engineered caps in selected areas to prevent additional flooding as described in Section 1.2.5. The engineered caps would be placed over selected riverbed areas from RM1.09 to RM8.13 and selected mudflat areas from RM0 to RM1 and RM4 to RM5 as shown in Figure 1-1b. Capping locations would be based on modeling results showing the highest gross or net contaminant flux in the sediment. The side slopes of the riverbed areas would be capped and graded to a slope of 3H:1V. The mudflats would be re-graded to the original bathymetry when capped.

The conceptual design for Alternative 4 is shown on Figure 4-7 of the FFS. Table 1-7 presents the volume of sediment to be removed from each river section for this alternative.

1.4 Summary

Table 1-8 summarizes estimated sediment removal volumes for the remedial alternatives considered in the FFS. The values have been rounded to the nearest thousand cubic yard. The volume estimates presented have uncertainties related to the datasets chosen as well as in the methodology used, which are discussed below. Note that the effect of significant variations in volume for each remedial alternative was evaluated in a cost sensitivity analysis presented in Chapter 5 of the FFS.

- Average-End Area Method: Volume estimates were calculated using an average-end area method, which uses discrete transects spaced approximately a half mile apart to estimate sediment removal. Discrete transects are unlikely to capture variations in the sediment bed and hence may introduce some error in the volume estimate. The greater the distance between adjacent transects, the greater the uncertainty in the average-end area calculation due to irregularities in the sediment surface and the width of the river. However, this error is not likely to be significant because available bathymetry data were evaluated to assess the placement of transect locations in an effort to capture changes in bed elevation and river width.

- Bathymetry: Single beam bathymetry data collected in 2004 were used to estimate the elevation of the river bottom. Bathymetry data inherently has some uncertainty associated with the elevation measurements. Interpolation techniques add to the uncertainty in the estimated elevation of the river bottom. The uncertainty associated with the bathymetry data is not expected to introduce a significant error in the volume estimates (single beam equipment accuracy is typically around ±3 inches). Moreover, uncertainty introduced by bathymetric data would have an even smaller effect on alternatives whose dredging volumes are not dependent on a targeted elevation but rather remove a predetermined depth below the existing sediment surface to make room for the engineering cap (*i.e.*, Alternative 3 and Alternative 4). During the design phase of the selected remedial alternative, multibeam bathymetry datasets can minimize uncertainty associated with volume estimates.

- Depth of Contamination in Shoal Areas: For Alternative 2, the depth of contamination was estimated in the shoal areas using CPG2008 and historical data as well as available 2005 geotechnical data (refer to Figure 1-1a and Section 1.2.3). The CPG2008 data included complete cores (*i.e.*, the cores were advanced into the native material); however, the density of these cores by themselves was not considered appropriate to characterize the depth of contamination in the shoal areas. While the historical data included cores at a higher density, the core data had fewer cores that were advanced into the native material.

The density of the geotechnical data was also limited. The highest uncertainty in the volumes estimate for Alternative 2 is related to the available core data density. This type of uncertainty would be addressed with data collected during the design phase of a remediation project. Note that for the purposes of a feasibility level evaluation, it is assumed that the available data provides a reasonable estimate of depth of the contamination in the shoal areas. The effect of significant changes to the volume estimates was evaluated in the cost sensitivity analysis presented in Chapter 5 of the FFS.

2 WASTE CHARACTERIZATION ASSESSMENT

This section presents the methodology used for determining the dredged material classification for the FFS Study Area. This analysis was performed for FFS cost estimating purposes only; a waste characterization program would have to be implemented during the design phase of the selected remedial alternative for treatment and disposal purposes.

The USEPA has determined that the sediments from the Lower Passaic River do not contain a listed hazardous waste (USEPA, 2008). Management and disposal of dredged material would comply with the requirements of the Resource Conservation and Recovery Act (RCRA), the Toxic Substance Control Act (TSCA), and with the Off-Site Rule, which requires that Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) wastes be placed in a facility operating in compliance with RCRA or other applicable Federal or State requirements. Dredged material as described in this section is defined as contaminated sediments and debris associated with the FFS Study Area dredging activities.

Three dredged material management (DMM) scenarios are developed in the FFS (refer to Chapter 4 of the FFS for additional detail on the DMM options):

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

Material classification procedures for DMM Scenarios B and C are discussed in this section. Under DMM Scenario A, the dredged material is placed directly into a CAD and waste classification is not required[7]. Under DMM Scenario B, dredged material from the FFS Study

[7] RCRA regulations exclude dredged material that is subject to the requirements of a Clean Water Action Section 404 permit, which would govern the disposal of the sediment in a disposal area within the navigable waters of the United States, from the definition of hazardous waste. 40 C.F.R. 261.4(g). Because the Lower Passaic River is being remediated as part of a Superfund site, a permit is not required, but the remedial action will comply with substantive requirements of Section 404. Further, If dredged contaminated sediment is consolidated within the Area of Contamination, which includes the Lower Passaic River and the areal extent of contamination within Newark Bay, RCRA land disposal restrictions would not be triggered.

Area would be transported, treated if necessary, and disposed in approved facilities as described in Section 4. Under DMM Scenario C, dredged material would be treated using a decontamination technology at a local upland processing facility, to a quality that would allow the treated sediment to be used beneficially, in accordance with state and local regulations as described in Section 5.

2.1 Dredged Material Classifications for DMM Scenario B: Off-Site Disposal

Dredged material for off-site disposal (*i.e.*, DMM Scenario B) would be classified as either a non-hazardous or hazardous material based on RCRA regulations. Dredged material must be managed as a hazardous waste if the material exhibits a RCRA hazardous characteristic (toxicity, reactivity, ignitability, corrosivity) pursuant to 40 CFR Part 261, Subpart C. Non-hazardous materials may be eligible for direct landfill disposal at a RCRA Subtitle D facility, depending on the facility's permit. It is not expected that dredged material would be regulated as a TSCA waste because sampling to date for Total PCBs in the Lower Passaic River generally has not detected concentrations above 50 parts per million (ppm)[8].

Dredged material that is being managed as a hazardous waste must comply with RCRA land disposal restrictions for characteristic hazardous wastes requiring examination for underlying hazardous constituents (UHCs). Based on RCRA regulations (40 CFR 268.48), environmental media that are being managed as hazardous waste are eligible for direct disposal at a RCRA Subtitle C landfill as long as the UHCs in the waste do not exceed the alternative treatment standard (ten times the universal treatment standard [UTS]) for soil or sediment.

Dredged material containing hazardous constituents not suitable for direct land disposal (UHCs exceeding ten times the UTS) must be treated prior to disposal to achieve either a 90 percent reduction in UHCs, or a reduction in UHCs to no more than 10 times the UTS. This requirement is in addition to meeting the individual acceptance criteria of the receiving facility (*i.e.*, facility permit requirements). Material not suitable for direct land disposal must be sent to an approved treatment facility. The non-wastewater standards listed in the UTS (40 CFR Section 268.48) are

[8] To date, only one sediment sample has shown Total PCB concentrations in excess of 50 ppm out of more than 1,000 samples.

numerical limits, not technology based limits. Currently, thermal treatment is the only technology known to be able to treat sediments that contain dioxin as a UHC to the applicable standards (Congress, 1991). The ash generated by this treatment system can be disposed at a RCRA Subtitle C landfill.

Figure 2-1 presents a flow chart for handling procedures of the dredged material for disposal of Passaic River sediments.

The following disposal profiles apply for dredged material:

- **Non-Hazardous Material:** Non-Hazardous materials are dredged materials that do not exhibit a RCRA characteristic. As described above, dredged materials that do not exhibit a RCRA characteristic are not considered to contain hazardous waste and are therefore, not subject to identification of UHCs. Non-Hazardous materials are eligible for direct landfill disposal at a RCRA Subtitle C or D facility if in compliance with the individual acceptance criteria of the receiving facility. For FFS cost estimation purposes, placement in a RCRA Subtitle C landfill was conservatively assumed since that was the method of disposal for both the Phase 1 Tierra Removal and RM10.9 Removal.

- **Hazardous Material:** Hazardous materials are dredged materials that exhibit a RCRA hazardous characteristic pursuant to Subpart C of 40 CFR Part 261.
    - Hazardous materials that contain UHCs exceeding the UTS, but do not contain UHCs exceeding ten times the UTS for soil or sediment are eligible for direct landfill disposal at a RCRA Subtitle C facility if the material is in compliance with the individual acceptance criteria of the receiving facility.
    - Hazardous materials that contain UHCs exceeding ten times the UTS for soil or sediment must be treated prior to disposal to achieve either a 90 percent reduction in UHCs, or a reduction in UHCs to no more than 10 times the UTS. If thermally treated, the resulting ash generated by the treatment process would be disposed at a RCRA Subtitle C facility.

2.2 Dredged Material Classifications for DMM Scenario C: Local Decontamination and Beneficial Use

The total cost of a remedial alternative that involves decontamination of contaminated sediment depends heavily on the processes required to achieve acceptable levels of contaminant reduction so that contaminant concentrations in the end products comply with state and local regulations. For this analysis, the term “beneficial use product” is used to denote the products of the decontamination process that are capable of achieving applicable regulatory limits. In order to determine the cost of decontaminating sediment to these levels, assumptions have been made regarding the efficiency of two decontamination processes based on conversations with equipment vendors and decontamination program administrators.

- Sediment washing has been assumed to be capable of reducing contaminant concentrations by less than 80 percent of the original contaminant concentrations, depending on the contaminant (refer to Section 5.2).
- Thermal treatment has been assumed to be capable of reducing organic contaminant concentrations by more than 99 percent of original concentration (refer to Section 5.3).

The beneficial use of dredged materials is regulated on the state level and requirements vary from state to state. For dredged material being treated for beneficial use in New Jersey, the Acceptable Use Determination (AUD) process assesses whether the end-product of a sediment treatment process is environmentally safe to use within the State of New Jersey for purposes such as fill or landscaping material. This review process takes into account whether the project where the end product would be used is in compliance with other State environmental laws applicable to the project such as New Jersey Water Pollution Control Act, N.J.S.A. 58:10A-1 et seq., Spill Compensation and Control Act, N.J.S.C. 58:10-23.11 and Solid Waste Management Act, N.J.S.A. 13:1E-1. Under the AUD process, contaminant concentrations in the final product must comply with current New Jersey Department of Environmental Protection (NJDEP) Soil Cleanup Criteria (NJDEP, 1997). In New Jersey, current soil cleanup criteria are specified in the New Jersey Non-Residential Direct Contact Soil Remediation Standards (NRDCSRS) under the New Jersey Administrative Code (N.J.A.C.) 7:26D. Dredged materials or products that ultimately cannot be used as a beneficial product in accordance with the AUD (because of lack of market or market disruptions) would be treated as solid waste and handled in accordance with RCRA and New Jersey solid waste regulations. For purposes of this FFS evaluation, New Jersey AUD regulations and standards will be used to assess compliance of potential beneficial use materials with regulatory standards.

Figure 2-2 presents a flow chart for handling procedures of dredged material for decontamination of Passaic River sediments that was assumed for cost estimation purposes.

Non-Hazardous Materials

- Non-hazardous dredged materials that do not contain constituents that exceed the NRDCSRS may be solidified/stabilized (*e.g.* Portland cement amendment) with the final product classified as a beneficial use end product.
- Non-hazardous materials that contain constituents exceeding the NRDCSRS may be decontaminated by the sediment washing technology to meet the NRDCSRS requirements with the final product classified as a beneficial use end product. Because the availability of beneficial uses for dredged materials could not be assessed three or more years in the future, for cost estimation purposes, a conservative assumption was made that the beneficial use facility would have a tipping fee associated with its use, equivalent to a Subtitle D landfill tipping fee.

Hazardous Materials

- Hazardous materials that contain UHCs exceeding the UTS but less than ten times the UTS for soil or sediment can be treated to meet the NRDCSRS requirements at which time the final product can then be classified as a beneficial use end product. For cost estimating purposes, it has been assumed that the dredged material under this classification would be decontaminated by a sediment washing technology. Because the availability of beneficial uses for dredged materials could not be assessed three or more years out, for cost estimation purposes, a conservative assumption was made that the beneficial use facility would have a tipping fee associated with its use, equivalent to a Subtitle D landfill tipping fee.

- Hazardous materials that contain UHCs exceeding ten times the UTS for sediment would likely require thermal treatment to achieve either a 90 percent reduction in UHCs or a reduction in UHCs to no more than 10 times the UTS. Under specific applications, the final product may then be classified as a beneficial use end product (see Section 5.3). Ash generated by thermal treatment would be disposed at a RCRA Subtitle C facility.

2.3 Methodology

FFS Study Area dredged materials were evaluated with respect to whether they would be characterized as non-hazardous or hazardous based on the RCRA characteristic of toxicity; past experience has shown that the sediment is not reactive, ignitable, or corrosive. The data used in this analysis included samples from the historical sediment cores collected by Tierra Solutions, Inc. (TSI) in 1995 as well as sediment cores collected by USEPA in 2006 and by the CPG in 2008 (see Data Evaluation Report No.2 in Appendix A for more details on the sampling programs). Toxicity characteristic leaching procedure (TCLP) data were not available for the sediment core samples collected in the FFS Study Area. However, waste characterization data collected from the TSI Phase 1 Removal near 80-120 Lister Avenue, Newark, New Jersey included TCLP results. In order to classify the sediment samples collected in 1995, 2006, and 2008, Phase 1 waste characterization data were used to estimate bulk sediment concentrations that could potentially fail the RCRA screening criteria.

A correlation was developed between bulk sediment concentrations (totals) and TCLP concentrations for the analytes of concern using Phase 1 samples. Figures 2-3a, b and c show examples of the correlation plots used to determine the estimated bulk sediment concentration that could potentially fail the TCLP RCRA regulatory limit for a given analyte (referred to in this section as “RCRA standard threshold for bulk sediment”). The RCRA standard threshold values for bulk sediment were determined based on the following approach:

- For Phase 1 analytes with a correlation between bulk sediment concentration and TCLP concentration, the bulk sediment concentration before exceeding the TCLP RCRA standard was conservatively reduced by 25 percent. See Figure 2-3a for an example correlation for 2,4-Dinitrotoluene.

- For analytes with bulk sediment concentrations significantly below the TCLP RCRA standard, the maximum bulk sediment concentration value was chosen as shown on Figure 2-3b for Lead correlation.
- For analytes with a weak correlation between bulk sediment concentration and TCLP concentration, the bulk sediment concentration for the data point just before exceeding the TCLP RCRA standard for the first time was chosen. See Figure 2-3c for an example correlation for Endrin.

The RCRA standard threshold for bulk sediments chosen for the analytes of concern based on the Phase 1 data were then compared with the sediment core data (sediment concentrations) collected in the FFS Study Area (1995, 1996, and 2008) to characterize the material and determine the contaminants that could potentially fail the RCRA criteria. As a conservative approach, samples failing the RCRA limits were assumed to be hazardous materials containing UHCs exceeding ten times the UTS requiring thermal treatment as described in Section 2.1. This conservative approach is consistent with the results presented in the Phase 1 Removal Action Design Analysis Report (TSI 2010).

The sediment concentrations for the FFS Study Area were also compared with the NRDCSRS to determine the applicability of beneficial use for the dredged material (*i.e.,* DMM Scenario C). Tables 2-1a and 2-1b show the RCRA and NRDCSRS criteria for the list of contaminants evaluated. For the NRDCSRS, although no regulatory criterion has been established, 2,3,7,8-TCDD was added to the list of contaminants to be evaluated using a cleanup criterion of 1 microgram per kilogram from the UTS.

2.4 Analytical Results

Table 2-1a presents a list of contaminants and a count (frequency) of exceedances for samples collected in 1995, 1996 and 2008 based on the criteria in Sections 2.1. Of the 39 contaminants evaluated, nine could be assumed to exceed the TCLP RCRA standard based on this analysis. For these nine contaminants, the frequencies were low with Silver and Selenium having the highest number of exceedances at 6 percent and 4 percent, respectively.

As presented in Table 2-1b, the frequency of exceedances when compared to the NRDCSRS was generally higher than when compared to the RCRA standard threshold. Of the 110 contaminants evaluated, 23 contaminants from the 1995, 1996 and 2008 data set exceeded the NRDCSRS. For example, the frequency of exceedance of Lead when compared to the RCRA standard threshold was less than 1 percent, while the frequency of exceedance when compared to the NRDCSRS was 3 percent. For the NRDCSRS, the highest frequencies of exceedance occurred for Acetone and Benzo(a)pyrene at 100 percent and 91 percent, respectively.

2.5 Classification of Dredged Materials in the FFS Study Area

To calculate the percent of each type of disposal for sediments in different alternatives, each core was assigned a volume of influence in the river using statistical polygons to estimate the volume of sediment in the FFS study Area with contaminant concentrations that could exceed TCLP criteria. Table 2-2 shows on a volume basis the percentage breakdown for each DMM Scenario by alternative. For Alternative 2, 10 percent of the dredged material is estimated to require thermal treatment; for Alternative 3, 7 percent; and for Alternative 4, 4 percent. Under DMM Scenario B, the estimated amount of dredged material that could go directly to a Subtitle C landfill is 90 percent for Alternative 2, 93 percent for Alternative 3, and 96 percent for Alternative 4. Under DMM Scenario C, the estimated amount of material anticipated to meet criteria for industrial beneficial use with only stabilization is approximately 2 percent for Alternative 2, 1 percent for Alternative 3, and 2 percent for Alternative 4. The remaining material under DMM Scenario C is estimated to require sediment washing and thermal treatment.

3 UPLAND PROCESSING OPTIONS

3.1 Data Collection Process

Contractor/vendor input was requested for the development of this section. If requested, a fact sheet with a compilation of chemical and geotechnical data for FFS Study Area sediments was provided to the contractors/vendor (see Attachment A). The data provided had been previously presented in various submittals prepared for the FFS. The data in Attachment A does not include the most recent data collected from the Lower Passaic River, which was not available when the contractors and vendors were surveyed; it includes only readily available, previously tabulated data that was sufficient to provide the contractors/vendors with a sense of the general characteristics of the FFS Study Area sediments.

3.2 Upland Processing Facility Logistics

For each of the active remedial alternatives, three DMM Scenarios are being evaluated:

- DMM Scenario A: CAD
- DMM Scenario B: Off-Site Disposal
- DMM Scenario C: Local Decontamination and Beneficial Use

DMM Scenarios B and C require dredged material be dewatered at an upland processing facility before treatment and disposal (either on- or off-site). Under DMM Scenario A, the dredged material would be placed in a CAD and not require dewatering. Refer to Chapter 4 of the FFS for additional details on each of the Scenarios.

The upland processing facility associated with DMM Scenario B or C would have to handle up to approximately 0.96 million cy per year of dredged material (measured on an *in situ* basis) with the following total volumes dredged:

- Alternative 2 would have a total dredged material volume of approximately 9.7 million cy.
- Alternative 3 would have a total dredged material volume of approximately 4.3 million cy.
- Alternative 4 would have a total dredged material volume of approximately 1.0 million cy.

During preparation of the FFS, a preliminary siting analysis was conducted to assess the availability of potential properties of various sizes in the general area of the Lower Passaic River. A conceptual design of an upland processing facility is discussed in this section.

3.3 Desirable Characteristics and Siting Considerations for Potential Sites

The FFS includes remedial alternatives that incorporate a regional upland processing facility (*i.e.*, dredged material treatment facility). Siting a processing facility in an urban, highly industrialized, densely populated area in the vicinity of the Lower Passaic River requires the consideration of numerous desirable site characteristics each of which contributes to the feasibility of constructing such a facility with respect to implementability and logistical challenges. Additional siting considerations, such as administrative issues must also be taken into account. This section describes siting considerations for an upland processing facility. Remedial alternatives presented in the FFS may incorporate these factors, depending on the alternative.

3.3.1 Siting Consideration for an Upland Processing Facility

(A) Desirable Site Characteristics for the Land-Based Site Location and Adjacent Properties

- Proximity to the FFS Study Area.
- Available acreage to accommodate the required footprint of the proposed facility
- Suitable current land usage (*e.g.*, presence of vacant lots and abandoned spaces, low level of development [low density of buildings and structures], existing development, if any, is generally industrial in nature)

- Sufficient distance from residential development and sensitive populations (*e.g.*, schools, hospitals)
- Sufficient distance from recreational areas, historic areas and potential restoration projects[9]
- Suitable property zoning (*i.e.*, not zoned as residential or public use/parkland)
- Limited topographic relief (*i.e.*, relatively flat)
- Limited presence of floodplains
- Minimal presence of wetlands
- Absence of sensitive wildlife habitat and wildlife management areas
- Waterfront access (*e.g.*, sufficient shoreline frontage to support barge operations, presence of piers/bulkheads, presence of loading/docking facilities)
- Road access (*e.g.*, presence of paved roadways capable of supporting trucks, condition of existing roadways, proximity to major highways, available routes to/from the facility that do not pass through residential areas)
- Rail access (*e.g.*, proximity to rail lines or spurs, presence of rail infrastructure on-site)
- Proximity of shoreline to a navigable channel
- Soil characteristics suitable to support heavy loads (*e.g.*, construction equipment, processing and treatment operations)
- Suitable depth to bedrock to minimize additional facility construction costs associated with bedrock at or near the surface.

(B) Desirable Site Characteristics for the Water Area Adjacent to the Site Location

- Sufficient water depth for scow, barge, and tug maneuverability
- Sufficient horizontal and vertical clearance of nearby bridges.

(C) Other Siting Considerations for an Upland Processing Facility

- Quality of life issues associated with the constructed facility (*e.g.*, noise, odor)

[9] Potential restoration projects are evaluated by USACE under the Water Resources Development Act (WRDA) in the *Draft Final Restoration Opportunities Report* (Earth Tech, Inc. and Malcolm Pirnie, Inc., 2006a) and *Draft Restoring Vision: Balancing Ecosystem and Human Use* Map (Earth Tech Inc., and Malcolm Pirnie, Inc, 2006b).

- Ability to obtain applicable permits, permit equivalencies or other administrative approvals.
- Potential impact of air emissions to adjacent populations
- Environmental justice community impacts and alternatives.

3.3.2 Findings of Siting Studies

USACE Study: A study was conducted by the USACE to investigate the feasibility of developing a dredged material upland public processing facility in the Port of New York and New Jersey (USACE, 2007). The purpose of the public processing and storage facilities that were discussed in the study is to handle dredged material derived from regular maintenance dredging activities in the NY/NJ Harbor. Although the processing facilities included in the FFS remedial alternatives may or may not be public and would be used primarily to handle dredged material derived from remedial dredging activities, siting considerations would be very similar to those presented for public facilities. As such, the site evaluation conducted by the USACE for public facilities can be used to aid in assessing the availability of processing facility sites presented in the FFS.

The USACE study included shoreline and nearshore areas in the NY/NJ Harbor, including Upper and Lower New York Bay, Newark Bay, the Arthur Kill, the Kill Van Kull, and portions of the Hudson River and the East River. The study consisted of predominantly desktop evaluations and consultation with Port stakeholders. Separate siting evaluations were conducted for processing and disposal facilities (see Section 4 for site evaluations conducted for disposal facilities).

A total of 192 potential properties in New York and New Jersey were evaluated for the development of an upland processing facility. Sites were evaluated based on many of the desirable site characteristics listed earlier in this section and were assigned a rank of “high,” “medium,” or “low” with respect to the presence of these characteristics. A total of 17 properties were ranked “high”, of which 14 were ranked “high” for an upland processing facility and eight were ranked “high” for a storage facility (of these 17 properties, 5 were ranked “high” for both an upland processing facility and storage facility). The attributes of the “high”-ranking properties for an upland processing facility are summarized in Table 3-1. Note that “high”-ranked sites located too far from the Lower Passaic River were omitted from the summary table since they are not considered to be realistic options; therefore, only 12 of the 17 properties are presented in Table 3-1.

Based on the results of the study, it is anticipated that the NY/NJ Harbor contains several sites for potential development of an upland processing facility. Note that this screening survey did not extend to confirmation of future development plans.

NJDEP Study: A screening survey was conducted by NJDEP to evaluate the feasibility of finding a suitable property in the region for the development of either a processing facility or placement site to handle dredged material from the Lower Passaic River (The Louis Berger Group, Inc., 2007). The survey covered a 15-mile radius around the Harrison Reach (approximately RM2.5 to RM4.6) of the Lower Passaic River. The survey area included heavily industrialized inland and waterfront areas around Newark Bay, the Lower Passaic River, the Hackensack River, the Arthur Kill, and the Kill Van Kull. Sites were evaluated based on many of the desirable site characteristics listed earlier in this section.

A total of 87 potential placement or processing locations were identified within the extent of the survey. Table 3-2 summarizes the survey results based on access characteristics and parcel size; Table 3-3 summarizes the survey results with waterfront access based on access characteristics, parcel size and distance in river miles from the Diamond Alkali plant at 80-120 Lister Avenue, Newark, New Jersey, which is located at RM3.1.

The majority of identified properties were under 30 acres in size and less than 10 river miles from the Diamond Alkali plant. Sixty-seven percent (58 out of a total of 87 properties) have waterfront access to allow for barges or scows, although bulkheading or dredging activities would likely be required at many locations. Rail and road access were identified at 34 and 91 percent of the sites, respectively. Of the 58 properties with waterfront access , 16 properties have rail access and 55 properties have road access as well.

According to the study results, several potential properties were suitable for a processing or treatment facility, based on adequate size and acceptable distance from the Lower Passaic River. Note that this screening survey did not extend to identification of land ownership or confirmation of future development plans.

3.3.3 Review of Siting Studies

Based on the results of the siting studies and in light of the desirable characteristics of potential properties, developing an upland processing facility for dredged material associated with the FFS Study Area in the NY/NJ Harbor is technically feasible. However, none of the properties identified would be selected without further detailed analysis. Future screening assessments and extensive public outreach will be required to further evaluate potential properties and select the most appropriate for the development of a processing facility. Future screening would be conducted during the design phase of a remedial alternative in the FFS Study Area.

3.4 Facility Processes

3.4.1 Sediment Delivery

For this analysis, it was assumed that dredged material would be transported to the upland processing facility by scow and offloaded hydraulically. The dredged material in the dredge scow would be slurried with additional water to facilitate hydraulic offloading of the dredged material, thereby lowering the solids content. Alternatively, the dredged material could be pumped directly to the processing facility from the dredge site.

3.4.2 Dewatering

For FFS cost estimation purposes, dewatering was assumed to be necessary to remove excess water from the dredged material. Current estimates indicate the *in-situ* sediments are approximately 40 to 50 percent solids by weight; following dredging, dredged materials in the scow would be approximately 30 to 35 percent solids by weight. Off-site shipment of dredged material (for disposal) requires that the dredged material be dewatered to approximately 55 to 60 percent solids by weight. On-site treatment would also require dewatering before or after treatment depending on the selected decontamination technology. Several approaches to dewatering are available, as described below.

Mechanical Systems: Mechanical dewatering systems (*e.g.*, filter press, belt press, screw press) involve the use of large equipment to compress the dredged material and force the release of porewater. Depending on the material characteristics, multiple dewatering stages may be required to reach a condition where treatment or off-site shipment is feasible. Due to the relative operational complexity, these systems are typically more capital and labor intensive than passive dewatering, resulting in a relatively high cost per cubic yard. However, the footprint of a mechanical dewatering operation (and, therefore, the land requirement) is smaller than with passive dewatering systems. In addition, passing dredged material through mechanical filter presses results in a much drier material and less volume compared to passive dewatering systems, which can be advantageous in terms of off-site shipment efficiency and costs.

Passive Systems: Passive dewatering systems such as filter beds and sand beds involve placing the dredged material on some form of filter media and allowing the gradual release of porewater. The filter beds can be located out of doors, eliminating the need for, and cost of, buildings and related mechanical systems (ventilation, electrical, *etc.*). However, the process is relatively slow and can be very land-intensive for large volumes of material. In addition, because the beds would be outdoors, there is the potential for odors and wind-related dispersion of fine-grained particles from the beds as the surface layer dries. Preliminary siting analyses indicate that there are a limited number of large parcels available in the vicinity of the FFS Study Area capable of handling a large installation of sand filters. This, combined with the anticipated large annual volume of dredged material requiring dewatering, generally makes the use of filter beds for passive dewatering infeasible.

Geotextile Bags: Geotextile bags (*e.g.*, Geotubes®) are a form of passive dewatering technology. Dredged material, in slurry form, is pumped into geotextile bags and allowed to dewater by gravity. The bags can be stacked on top of each other adding a compressive force to speed up the dewatering process and reducing the amount of land required. In addition, the bag acts as a filter medium, removing most of the suspended solids from the supernatant. However, as with other passive systems, geotextile bags require time to dewater solids to an optimal percent solids producing less efficient and timely results compared to mechanical systems. In addition, although geotextile bags have smaller footprint requirements compared to other passive filter systems, areas large enough to accommodate what are still large footprint requirements may not be available at facilities with limited space such as facilities located in urban settings.

For the FFS evaluation, mechanical filter presses were selected as the method for dewatering, because of the smaller footprint requirements compared to other dewatering alternatives and the potential for efficient and timely results compared to passive dewatering techniques. A typical mechanical filter press dewatering operation would involve the following steps:

- Dredged material would be offloaded from the dredge scow hydraulically. Water would be added to the stream as needed to reduce the solids content to approximately 10 to 15 percent (by weight) to facilitate pumping.
- The slurry would be pumped into a series of screens to remove debris and particles that could damage the filter press membranes. In addition, sand separation units could be added to the system to remove coarse grained materials that are typically clean, dewater readily, and would not require further processing.
- Chemicals would be added to the slurry prior to being discharged to prethickening tanks. The chemicals assist in flocculation and settling during the prethickening stage.
- From the prethickening tanks, additional chemicals could be added to aid in the dewatering process as the thickened slurry is pumped into the mechanical filter press. The filter press consists of a number of plates which are used to compress the slurry forcing out the entrained water.
- Solids would accumulate on the filter media with filtrate forced through the plates.
- After each cycle, plates would be separated and the cake removed.
- Wastewater generated during the process would be diverted to the wastewater treatment plant through filtrate piping.

3.4.3 Solids Handling

Following dewatering, dredged material would either be shipped off-site for disposal or decontaminated on-site. For local decontamination (DMM Scenario C), refer to Section 5.

Off-Site Disposal: Under DMM Scenario B, dewatered dredged material would be removed from the dewatering containment area and placed in a temporary storage structure. Dewatered sediment requiring thermal treatment would be loaded onto dedicated rail cars for transport to a facility licensed for the treatment and disposal of dioxins and the other contaminants in the dredged material. Transportation alternatives, as well as a review of off-site facilities permitted for the treatment of waste streams similar to the FFS Study Area sediment are discussed in Section 4.

This DMM Scenario is based on the use of treatment and disposal facilities owned and operated by private companies. As discussed in Section 2, hazardous dredged material would be treated at an incineration facility and the ash and byproducts disposed in a Subtitle C Landfill; non-hazardous material would be transported directly to a Subtitle C landfill. There are currently four incineration facilities in the United States that can potentially accept Lower Passaic River sediment in addition to two facilities located in Canada (see Section 4). Based on the waste characterization evaluation (see Section 2), approximately 4 to 10 percent of the dewatered sediments would require treatment prior to disposal (approximately 52,000 cy of dewatered sediment per year for 11 years for Alternative 2, 28,000 cy per year of dewatered sediment for 5 years for Alternative 3, and 10,000 cy per year of dewatered sediment for 2 years for Alternative 4). The total domestic thermal treatment capacity for the four incineration facilities within the United States is approximately 357,000 tons per year. If additional treatment capacity is required, the two thermal treatment facilities located in Canada could provide an additional annual capacity of approximately 436,000 tons per year. For non-hazardous dredged materials, there are several Subtitle C Hazardous Waste landfills in the United States that could accept wastes from the Lower Passaic River.

For this analysis, it was assumed that temporary storage would need to be provided at the processing facility to store materials waiting processing at the off-site treatment and disposal facilities. The volume of storage would depend on the selected remedial alternative; a 6-month storage capacity was assumed for hazardous wastes and 3-month (for DMM Scenario B) or 6-month (for DMM Scenario C) storage capacity was assumed for non-hazardous wastes. Storage requirements would vary from approximately 0.6 to 0.8 acres for hazardous wastes and 3.6 to 7.3 acres for non-hazardous wastes.

3.4.4 Water Handling and Disposal

The dewatering process would generate a large volume of water that would need to be captured and treated. In general, water-handling requirements can be broken down into two broad categories: non-contact water and contact water.

Non-contact water is primarily stormwater that has fallen onto the upland processing facility property, but has not come into contact with contaminated materials. Non-contact water runoff would be diverted to on-site sedimentation basins for treatment and discharged according to regulatory requirements or, if a new facility is sited at the Superfund site, according to applicable or relevant and appropriate requirements (ARARs). Facility design would include measures such as perimeter ditches and berms to control run-on from adjacent parcels as well as to collect and control runoff from disturbed areas within the property.

Contact water is water that has incidentally come into contact with contaminated dredged material or effluent generated in the processing facility. Examples of contact water include porewater released through dewatering operations, stormwater that has fallen on processing areas or other areas that may contain contaminated dredged material, decontamination water (*e.g.*, truck wash water), and condensate or other process water from on-site operations. Portions of the facility where contaminated dredged material are handled would be sloped and paved to contain contact water and divert it to a collection system. Collected water would flow to the contact water storage tank prior to treatment.

There are three options for handling contact water, as described below:

Direct use: It may be feasible to use all or a portion of the contact water as makeup water in slurry production. Water released during dewatering could be recycled if the material is mechanically dredged and then hydraulically off-loaded from the scow. Additional evaluation would be required to determine if this approach concentrates contaminants in the water to a point where it is detrimental to the overall process or poses other technical problems.

Treatment and discharge: If direct use is not feasible, treatment of the water to remove contaminants and discharge of this water back to the Lower Passaic River may be feasible.

Treatment and use/discharge: Some combination of treatment, reuse, and discharge may provide the greatest flexibility for water management at the upland processing facility.

3.4.5 Debris and Waste Management

Large items encountered during dredging operations would be removed from the sediment and segregated from the barge contents. These items would be transported on the dredge scow to the upland facility for disposal. The debris that remains in the scow following offloading would also be removed for proper disposal.

Debris removed from the sediment and other hazardous waste generated by facility operations would be stored on-site in an area designated for hazardous waste storage. It may be feasible to decontaminate and recycle some of this debris (*e.g.*, metal waste). Several recycling facilities are located in the vicinity of the site which could handle the debris. Material that cannot be recycled would be hauled to a hazardous waste disposal facility.

3.4.6 Ancillary Facilities and Systems

There are a number of ancillary facilities that would be required at the upland processing facility for DMM scenarios incorporating either off-site disposal, or local decontamination and beneficial use. These facilities are described below:

Administrative/support systems: An administrative office/support building would be required to house administrative offices, locker rooms and sanitary facilities for workers, lunchroom, and other support facilities.

Site security: Because of the nature of contaminants at the facility, security would be important for protection of the public. Security measures would include fencing at the property boundary, a manned security post and locked gates on other access points, warning signs, and lighting system. Additional fencing would be provided around the exclusion zone (*i.e.*, dredged material handling areas). Security alarms and other controls may be included in the remedial design.

Access roads: Paved access roads and work surfaces would be provided throughout the portions of the upland processing facility where contaminated dredged material would be handled. Paved surfaces would allow routine cleaning to control the spread of contaminants and prevent the formation of fugitive dust.

Rail spur: To reduce the impact of truck traffic on surface roads surrounding the facility, access to a rail spur on the property (either existing or new) would be provided for DMM Scenario B.

Truck wash: Vehicles exiting the exclusion zone would be required to pass through a truck wash to remove potential contaminants from the tires, undercarriage, and body of the vehicle. Water from the truck wash would be processed through the contact water collection and treatment system.

Lighting: It is assumed for FFS evaluation purposes that the facility would be operated 24 hours per day, necessitating operational lighting across the facility.

Site utilities: Electrical, natural gas, potable water, and sanitary sewer service would be required.

Stormwater and erosion controls: As mentioned above, stormwater would be collected and diverted to containment structures. Where feasible, contact water would be used at the facility or treated prior to release. Non-contact water would be controlled, monitored, and discharged in accordance with the facility's regulatory requirements (or substantive requirements, if the facility is at the Superfund site). Other stormwater and erosion controls may be established at the facility based on site-specific conditions.

The conceptual layout for DMM Scenario B is shown in Figure 3-1. The conceptual layout for DMM Scenario C is shown in Figure 3-2.

3.5 Potential Facility Impacts

Health and safety: Because of the nature of the contaminants in the sediments, health and safety would be a primary concern for workers and the general public. To minimize potential impacts, the following steps are assumed to be taken, for FFS evaluation purposes:

- A site-specific health and safety plan would be prepared, identifying potential risks, procedures for addressing the risk, and required training for employees.
- Contaminated dredged material would be stored in a covered storage structure constructed on a concrete pad. Exterior contact water piping systems would be constructed of double-walled pipe to prevent contaminants from leaking into area soils. These containment systems would be removed at the end of the remediation process.
- Contingency plans and emergency response plans would be prepared to address conditions that may arise during facility operations.

Air quality and odor: Odors are primarily a concern if the sediment is found to contain high concentrations of organic material or other constituents such as petroleum hydrocarbons. If long-term storage is required due to limited treatment capacity, the potential for odors could increase depending on the volume of storage required and the length of time on-site. An air treatment system would be provided for the structures containing the dewatered sediment to minimize the odor potential.

For DMM Scenario B and C, one of the primary air quality impacts is related to the formation of fugitive dust. Fugitive dust emissions are a potential concern due to the nature of the dredged material being handled at the facility, but can be controlled by site design and good housekeeping practices, which could include the following:

- Paving access roads and other high traffic areas.
- Controlling traffic patterns within the facility to minimize the distances over which contaminated dredged material is transported.
- Covering stockpiles of reclaimed sand.
- Covering loads exiting the property (*e.g.*, rail cars or vehicles).
- Regular sweeping and washing of roads to remove fine particles.
- Moisture conditioning to control dust during dry periods.

In addition, under DMM Scenario C, a thermal treatment facility could be constructed at the processing facility to deal with hazardous materials requiring treatment. The facility would be required to meet applicable state, and federal emission limits.

Nuisance Conditions: Unless the sediments are found to contain high concentrations of organic material, the upland processing facility is unlikely to pose an attractive nuisance condition for area wildlife. The facility would be fenced to control access and lighted to allow 24 hour-per-day operations, which is likely to deter most forms of wildlife. Good housekeeping (controlling waste generation, timely disposal of waste and debris, proper materials management, cleanliness) would also prevent the formation of other nuisance conditions. Noise for decontamination operations is expected to be consistent with other industrial activities in the general area.

3.6 Feasibility Review for an Upland Processing Facility

Overall, the use of an upland processing facility for handling contaminated dredged material appears technically feasible. Both types of upland processing facilities (*i.e.*, for off-site disposal, or local decontamination and beneficial use) rely on the same basic approach to dewatering dredged material. The use of mechanical dewatering through filter presses has been shown to be effective at a number of other sediment remediation projects and has been proven successful in accommodating large volumes of dredged materials and at facilities with limited space such as in urban areas. Facilities could require approximately 26 to 39.5 acres of land or more to construct. Storage requirements for dewatered dredged material waiting processing or transport would vary depending on the remedial alternative. There are several locations near the FFS Study Area meeting the siting criteria, as outlined in Section 3.1.

Table 3-4 summarizes the anticipated upland processing facility acreage requirements. Upland processing facility acreages have been estimated for DMM Scenarios B and C for each of the active remedial alternatives.

4 OFF-SITE DISPOSAL FACILITIES

This section evaluates the feasibility of transporting and disposing of dredged material in off-site disposal facilities, based on published information and personal communication and information provided by the off-site disposal facilities.

4.1 Facility Evaluation Process

As mentioned in Section 2, the USEPA has determined that the sediments from the Lower Passaic River do not contain a listed hazardous waste. Under DMM Scenario B, sediments eligible for direct landfill disposal would be disposed at a RCRA Subtitle C landfill. Sediments that exhibit a RCRA characteristic and exceed the alternative treatment standard as described in Section 2 would be thermally treated at an off-site facility and the resulting ash disposed in a RCRA Subtitle C landfill.

In this evaluation of off-site facilities, no attempt was made to review the facility design or operations, operating history, regulatory compliance record, enforcement or other legal actions that may have been taken against the facility, owners, or operators, or other performance-related issues. This review was limited to the questions presented below and is only intended to determine the availability of potential facilities for this conceptual level review. No attempt was made to independently verify the information provided by the facility owners or operators. During the design phase, additional due diligence evaluations would be needed to assess the suitability for actual disposal purposes.

The facilities were evaluated focusing on the following questions (See Attachment B):

1. What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?
2. What is the available capacity remaining of the facility to receive RCRA and TSCA waste (*i.e.* what percentage of the capacity is not committed to clients)?
3. Is the facility in compliance with the Off-Site Rule?

4. What are the acceptance criteria for waste, *e.g.*, chemical concentration/threshold level, physical properties, etc.?
5. Does the facility accept non-listed dioxin waste?
6. Is rail service available to the facility? If yes, who is the rail service provider?
7. Are there other viable transportation alternatives to the facility?
8. What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?
9. What is the cost per ton for acceptance and disposal?
10. What is the cost per ton for rail interface, offloading and/or material handling?
11. Limitations, if any, of the facility?

4.2 Off-Site Thermal Destruction Facilities

A number of thermal destruction/incineration facilities accepting hazardous waste were contacted to determine their potential suitability for treatment of FFS Study Area sediments. The majority of the facilities contacted was inactive/discontinued or only accepted specific categories of wastes such as bulk liquids, explosive materials, *etc*. Four were identified that process material on a commercial basis within the Unites States. In addition to these facilities, there are two thermal treatment facilities located in Canada. These facilities were evaluated along with the U.S. facilities in order to have a wider range of options. The facilities evaluated are as follows:

- Veolia Environmental Services' Gulf Coast Incineration Facility, Port Arthur, Texas
- Clean Harbors' Aragonite Incineration Facility, Salt Lake City, Utah
- Clean Harbors' Deer Park Incineration Facility, La Porte, Texas
- Clean Harbors' Kimball Incineration Facility, Kimball, Nebraska
- Clean Harbors' Ontario Thermal Desorption Unit, Lambton, Ontario, Canada
- Bennett Environmental Inc.'s Thermal Oxidizer Facility, Quebec, Canada

Table 4-1 provides a summary of the capacity of the six facilities. Additional information on each facility is provided below.

Veolia Environmental Services' Port Arthur Facility located on Highway 73 in Port Arthur, Texas, is a permitted RCRA, TSCA, and CERCLA incineration facility. The permitted maximum throughput rate of the incinerator is 57,198 pounds (lbs) per hour of RCRA and TSCA waste with hourly constraints on individual feed devices feed concentrations and heat releases. According to information obtained in personal communications with the facility (see Attachment B), the typical annual throughput rate capacity is greater than 120 million lbs per year (greater than 60,000 tons per year), which is dependent on the waste characteristics received. While the maximum permitted rate is 57,198 lbs per hour, the practical daily throughput rate (dependent on waste characteristics) is 400,000 lbs per day (200 tons per day). The facility operates approximately 330 days a year with down time for planned maintenance outages. The facility is permitted for solids, liquids, and gases in both bulk and drums with the exception of radioactive waste, municipal garbage, Class I explosives, and listed dioxin-containing wastes (*i.e.,* F020-F023, and F026 – F028). The facility does accept non-listed dioxin waste. There is no direct rail service to the facility and a transfer facility does not exist for solid waste. In addition, there is no on-site landfill for disposal of ashes generated from the incinerator. Overall cost for accepted materials ranges from $400-$700 per ton and is dependent on the physical and chemical properties of the material.

Clean Harbors Inc.'s Deer Park Incineration Facility is located on 2027 Independence Parkway South, LaPorte, Texas. The 145-acre facility is permitted to receive most non-dioxin waste codes and non-listed dioxin waste. The facility has an on-site RCRA landfill for ash disposal. The landfill has a remaining permitted airspace of 452,000 cy based on information available from Clean Harbors' 2010 Annual Report (Clean Harbors, Inc., 2011). The Deer Park Incineration Facility operates three incinerators with a combined practical annual throughput rate capacity of 165,500 tons (Clean Harbors Deer Park, L.P., 2011). According to information obtained in personal communications with the facility (see Attachment B), the facility is typically down 2 weeks per year and operates on a 24/7 schedule. Given that the facility can operate 50 weeks per year, the daily throughput rate capacity is estimated at 473 tons. The approximate cost for Clean Harbors' RCRA incineration and RCRA/TSCA incineration are $0.20 per lb and $0.26 per lb ($400 and $520 per ton), respectively. The Deer Park facility has rail service available (waste-to-rail capabilities) to the facility using Union Pacific.

Clean Harbors Inc.'s Aragonite Incineration Facility is located on 1600 North Aptus Road in Aragonite, Utah, approximately 75 miles west of Salt Lake City, Utah. This incineration facility is permitted under RCRA and TSCA with rail service available by both Union Pacific and Burlington Northern Railways. The facility is able to treat a wide range of waste codes. According to information obtained in personal communications with the facility (see Attachment B), the approximate cost for Clean Harbors' RCRA incineration and RCRA/TSCA incineration are $0.20 per lb and $0.26 per lb ($400 per ton and $520 per ton), respectively. The practical annual throughput rate capacity according to information provided by the Clean Harbors' 2010 Annual Report is 66,815 tons (Clean Harbors, Inc., 2011). The facility is typically down 2 weeks per year and operates on a 24/7 schedule. Daily practical throughput rate capacity is approximately 191 tons given that the facility operates 24/7, 50 weeks per year.

Clean Harbors Inc.'s Kimball Incineration Facility is located on 2247 South Highway 71 in Kimball, Nebraska, approximately 5 miles south of Kimball. The Kimball facility is a RCRA-permitted, commercial facility for the treatment, storage and disposal of hazardous waste. Based on personal communication (see Attachment B), the facility is able to accept non-listed dioxin waste. The practical annual throughput rate capacity according to information provided by the Clean Harbors' 2010 Annual Report is 58,808 tons (Clean Harbors, Inc., 2011). The facility consists of a fluidized-bed incinerator for thermal destruction (as compared to traditional rotary kilns). The facility also has an on-site monofill dedicated for disposal of residual ash, which has been built to RCRA Subtitle C standards (Clean Harbors Kimball, 2011). Based on personal communication, the approximate cost for Clean Harbors' RCRA incineration is $0.20 per lb ($400/ton). The facility is typically down 2 weeks per year and operates on a 24/7 schedule. Daily practical throughput rate capacity is approximately 168 tons based on a 24/7, 50 weeks per year operating schedule.

Clean Harbors' Ontario Thermal Desorption Unit Facility is located in St. Clair Township, County of Lambton, Ontario, Canada. This facility uses an indirect thermal desorption unit that consists of the thermal processor, vapor condenser and an air pollution control (APC) system. Because temperatures are less in thermal desorption units, this facility may not be able to handle dioxin-containing waste. The facility services organic wastes in Canada and the United States.

Typical waste streams include organic solid and semi-solid waste containing listed and characteristic hazardous waste. The thermal desorption system operates 24 hours a day and 7 days per week and also has an on-site hazardous waste landfill to dispose of residual solids (Clean Harbors Canada, Inc., 2010). The system can treat up to 36 tonnes (metric tons) per hour (approximately 40 tons per hour) of hazardous wastes (Ministry of the Environment, 2010). The annual throughput rate capacity is estimated to be 336,000 tons per year based on an operation schedule of 50 weeks per year.

Bennett Environmental Inc.'s Recupere Sol Thermal Treatment Facility is located in Saint Ambroise, Quebec, Canada. This facility is a permitted RCRA and TSCA thermal treatment facility (permitted only for TSCA wastes from Canadian provinces) with nearby rail service available through the Canadian National Rail Company. According to information obtained in personal communications with the facility, Bennett's Thermal Treatment Facility does not have any restrictions on RCRA wastes/contaminant concentrations or waste codes and can accept unlisted dioxin sediments regardless of its concentration. Although the facility is not directly rail-served, the facility has two offloading locations available in Quebec less than 20 miles away. The facility can process up to 100,000 tons of RCRA soil/sediments per year and greater than 300 tons of soil/sediments per day in addition to having the ability to accept up to 2,200 tons of sediment/soil in a day via truck, rail or ship. The facility also has the capability to accept sediments via ships, which are offloaded at a deep water port located in LaBaie, Quebec. The facility does not have a landfill on-site; two nearby landfills in Quebec (built to Subtitle C standards) are used for ash disposal. The average cost per ton for acceptance and disposal is approximately $325 per ton. The actual range is $190-$525 per ton depending on levels of metal, moisture and sulphur contents and debris type and percentages. The approximate costs per ton for rail interface/offloading and material handling is approximately $45 per ton.

4.3 RCRA Subtitle C Landfills

Subtitle C landfill facilities were reviewed to assess their suitability for direct landfill of the sediments generated from the FFS Study Area.

Fifteen Subtitle C landfills were evaluated, as listed in Table 4-2. The listed Subtitle C landfill facilities were evaluated focusing on the same questions as used for the thermal treatment/incineration facilities (see Section 4.1 for questions and Attachment B for detailed information provided by the facilities**).**

Based on information obtained from personal communications and provided by the facilities, the Subtitle C facilities listed in Table 4-2 would meet the requirements of the Off-Site Rule. In addition, except for the Roachdale Facility located in Roachdale, Indiana, the facilities listed in Table 4-2 accept non-listed dioxin-containing waste. Although most of the Subtitle C facilities listed in Table 4-2 accept non-listed dioxin-containing waste, each facility has specific criteria for waste acceptance and requires a waste profile for further evaluation. Disposal costs were provided by the facilities for feasibility level planning and are based on limited waste profile information provided to the facilities and typical rates used for other projects. Costs can vary on a case-by-case basis depending on material volumes, timing, processing requires (*e.g.*, stabilization or other treatment), etc. Therefore, a detailed consultation with the facility/facilities of preference would be required before decisions can be made on disposal sites. For this review, Subtitle C landfill facilities were evaluated based on available capacity, location and direct or nearby rail accessibility.

Alternative 2 would generate the greatest volume of sediment of the three active remedial alternatives and a combination of Subtitle C landfill facilities may be required to accommodate the large amount of sediment generated for disposal. With the lower Subtitle C disposal capacity requirements for Alternatives 3 and 4, it is possible that only one or two facilities would be needed to accommodate the contaminated sediment. Based on information provided by the facilities, the following Subtitle C landfills have the largest available capacities with rail service to accommodate the volume of sediments generated.

Chemical Waste Management, Inc.'s Lake Charles Facility. The Lake Charles Facility is located at 7170 John Brannon Road in Sulphur, Louisiana and currently has an available capacity of approximately 5,730,000 cy. Although this facility alone would not be able to handle the entire volume of sediment generated under Alternative 2, it can potentially accommodate the entire volume of material generated under Alternatives 3 or 4. The facility operates a rail transfer facility in nearby Beaumont, Texas and its own transportation group located at the 10-Day Transfer Facility immediately adjacent to the facility.

Clean Harbors' Lone Mountain Subtitle C Landfill. The 560 acre facility is located at Route 2 Box 170 in Waynoka, Oklahoma and has an estimated remaining capacity of approximately 3,822,000 cy according to Clean Harbors' 2010 Annual Report (Clean Harbors, Inc., 2011). At the time of this questionnaire, Clean Harbors was not able to provide information on whether the facility can accept non-listed dioxin waste. However, according to the Lone Mountain Fact Sheet, the facility accepts hazardous soil for treatment of organics on a case-by-case basis. The facility operates a 35-acre rail transfer site in Avard, Oklahoma approximately 20 miles north of the landfill .

U.S. Ecology's Grandview Facility. The facility, located in Grandview, Idaho, currently has approximately 3,200,000 cy of available capacity and has no limit on the daily disposal rate. The facility is able to accept non-listed dioxin waste. The facility is serviced by the Union Pacific Railroad and has its own Rail Transfer Facility including over two miles of railroad tracks with indoor offloading.

The current combined available capacity at the Lake Charles, Lone Mountain, and Grandview Subtitle C Landfills is approximately 12.7 million cy. To accommodate the approximately 5.1 million cy of dewatered sediment requiring Subtitle C landfill disposal under Alternative 2, a combination of the Subtitle C landfills cited above is likely to be required. The 1.9 million cy of dewatered sediment requiring disposal under Alternative 3, or the 0.5 million cy of dewatered sediment requiring disposal under Alternative 4 may be accommodated by a single facility. The majority of the other facilities reviewed as part of this study (see Attachment B) were not considered feasible due to capacity limitations and/or location.

4.4 Conclusion

Off-site treatment and disposal of dredged sediments (DMM Scenario B) from the FFS Study Area is a feasible option. There are several suitable Subtitle C facilities available within the

United States that could accept non-hazardous materials from the FFS Study Area. The Lake Charles, Lone Mountain and Grandview Subtitle C facilities have a combined total of approximately 12.7 million cy in available capacity, which would be sufficient for disposal of the dewatered sediment from any of the alternatives. Alternative 2 would likely require the use of multiple facilities while Alternatives 3 or 4 may be accommodated by a single facility with the Lake Charles Facility having the largest available capacity of approximately 5.7 million cy.

For hazardous materials requiring treatment, four incineration facilities are available domestically with a combined total thermal treatment capacity of approximately 357,000 tons per year. Since only approximately 4 to 10 percent (depending on the alternative) of the dredged material would require treatment at an off-site incinerator (15,000 to 67,000 tons per year, or 5 to 19 percent of the permitted capacity of the four facilities), off-site treatment is a feasible option. If more capacity is required to meet the demands, two additional off-site thermal treatment facilities are available in Canada (*i.e.,* Clean Harbors' Ontario Thermal Desorption Unit Facility and Bennett Environmental's Thermal Oxidizer Facility) that could accept FFS Study Area sediments with a combined total thermal treatment capacity of approximately 436,000 tons per year, although it would be necessary that the facilities accept and treat dioxin-containing waste.

5 SEDIMENT TREATMENT TECHNOLOGIES

This section evaluates the feasibility of using different treatment technologies for dredged material management. Under DMM Scenario C, *ex-situ* on-site treatment technologies would be used at a local upland processing facility to treat dredged material for beneficial use. Three types of treatment technologies were evaluated:

- Solidification/Stabilization
- Sediment Washing
- Thermal Treatment

Under DMM Scenario C, treatment technologies would be implemented at an upland processing facility to treat the dredged material depending on the waste characteristics described in Section 2. Refer to Section 3 for desirable characteristics and siting considerations for potential upland processing facility locations.

5.1 Solidification/Stabilization Technology

Solidification/stabilization (S/S) technologies consist of processes used to treat a variety of wastes for reuse or disposal.

- Solidification consists of processes that encapsulate a waste to form a solid material restricting contaminant migration. The process decreases the surface area exposed to leaching by coating the waste with low-permeability materials through chemical reactions between the waste and binding reagents or mechanical processes.
- Stabilization consists of processes that involve chemical reactions to reduce the leachability by chemically immobilizing hazardous materials or by reducing its solubility. Reagents used during stabilization processes include Portland cement and lime/pozzolans such as fly ash and cement kiln dust. Stabilization processes have been used at Superfund sites to "render a RCRA hazardous waste non-hazardous prior to disposal" (USEPA, 2000).

5.1.1 Applications

Under DMM Scenario C, the FFS Study Area sediments that are classified as non-hazardous and meeting the NRDCSRS as described in Section 2, may be treated using S/S technology with the end product slated for beneficial use purposes.

Ex-situ S/S is a commonly used process to treat contaminated dredged material in which the treated end product can be used for landfill closure and Brownfield remediation projects (Krause, 2000; USEPA 2009). S/S technology has been proven effective in treating a variety of media including soils, sludges, or slurries contaminated with inorganics; however, highly contaminated sediments may require pre-cleaning or treatment with another process prior to S/S applications to produce a beneficial use product (Krause, 2000). While S/S technology reduces contaminant mobility, the contaminant toxicity is not reduced (NJDEP, 1998). Therefore, S/S processes are considered non-destructive methods as they do not reduce or remove the quantities of the constituents, and instead produce less leachable products.

For S/S technology, the binder material is critical in effective treatment and is material-specific depending on the waste characteristics. Binders should be prescreened with the contaminated media to assess interferences and chemical incompatibilities; metal chemistry considerations; disposal or reuse environment compatibility. Laboratory bench-scale screening tests are generally necessary to assess binder suitability and formulation (binder-to-weight wet sediment ratios)[USEPA, 1993a]. In a study evaluating S/S applications on NY/NJ Harbor sediments, the optimal binder formulation for sediments from the NY/NJ Harbor was 0.4 cement and 0.3/0.6 lime/fly ash to effectively solidify/stabilize (USACE, 1997a). Performance of the solidified and cured end product material is based on physical tests for strength and durability (*e.g.*, unconfined compressive strength) and chemical tests for leaching (TCLP, Synthetic Precipitation Leaching Procedure [SPLP])[USEPA, 2000].

Portland cement is the most common inorganic binder material due to its effectiveness, availability, and low costs compared to other types of binder materials (USEPA, 2009). Other binders include the following materials:

Inorganic Binder

- Portland cement
- Lime/fly ash
- Kiln dust (lime and cement)
- Portland cement/fly ash
- Portland cement/lime
- Portland cement/sodium silicate

Organic Binders,

- Asphalt
- Polyethylene
- Polyester
- Polybutadiene
- Epoxide
- Urea formaldehyde
- Acrylamide gel
- Polyolefin encapsulations

5.1.2 Facility Processes

Prior to mixing, the dredged sediments would be dewatered to reduce moisture content lowering waste leachability and the amount of reagents required (USEPA, 1986; USEPA, 2009).

Readily available construction equipment is commonly used for S/S mixing operations. Under DMM Scenario C, a mixing plant would include chemical feed storage and feed systems, mixing equipment (such as a pug mill), and treated sediment handling equipment. An alternative to land-based operations is barge mixing using an excavator-mounted mixing head. A binder is added to the sediments in the barge avoiding the need for dewatering operations prior to amendment. While on-site barge mixing has relatively low capital costs, it is hard to control or monitor mixing quality and can result in the need for a dock (Douglas, 2010). Additionally, uncontrolled hydration of cement or cement kiln dust can result in leaching of high pH liquids, which can potentially mobilize metals.

Throughput capacity is dependent on the equipment size and typically ranges between 1 and 200 tons per hour (USEPA, 1996b). The cost per unit of sediment treated would vary based on a number of parameters including the mixing equipment and reagent used; initial contaminant concentrations (if being stabilized to control potential leaching); initial water content; proposed end use (if being stabilized for geotechnical use). Typical costs range from $10 to $25 per cy..

5.1.3 Beneficial Use Options

The S/S process produces a solid aggregate with low moisture content and improved geotechnical/structural properties (compared to untreated sediment) that can be used as landfill cover, and structural and non-structural fill for various construction applications (Adriaens et al., 2002). A USEPA study found that out of 245 *ex-situ* S/S projects evaluated, 122 projects used the end product as capping material, 88 projects disposed of the products on-site, and 35 projects disposed of the products off-site (USEPA, 2000; USEPA, 2009).

Studies have indicated that cement-based S/S products have the potential to disintegrate over a period of 50 to 100 years as the end-products have the same physical and chemical degradation processes as concrete and other cement-based materials (USEPA, 2000). In a study prepared by Rutgers University's Center for Advanced Infrastructure and Transportation in cooperation with the New Jersey Department of Transportation Office of Maritime Resources (NJDOT-OMR) and U.S Department of Transportation Federal Highway Administration, stabilized dredged material from the NY/NJ Harbor satisfied most of the geotechnical criteria used for construction of fills and embankments; however, a soil cover was needed to address durability concerns due to freeze-thaw and wet-dry cycles. It was concluded that stabilized dredged sediments should be placed below the frost line and a proper soil cover maintained to minimize strength loss due to erosion. In addition, the study determined that temperature had a strong effect on curing processes at temperatures below 40°F and recommended that the stabilized dredged sediments be placed during warm seasons for optimal moisture content reduction (Maher et al., 2003).

In the NY/NJ Harbor, several projects have used S/S-treated dredged sediments for beneficial use purposes.

- The Jersey Gardens Mall in Elizabeth, New Jersey was constructed on a 126-acre former landfill using approximately 600,000 cy of S/S treated dredged material (Maher et al., 2003). The Portland cement amended sediments were used for grading, filling and capping required for the remediation of a former landfill at the property, in addition to serving as structural fill for the construction of parking areas. Dredged sediments and cement were mixed using an excavator-mounted mixing head in a barge.

- The Koppers Seaboard Site in Kearny, New Jersey, a former coal gasification facility/wood preservation facility, used more than 1.5 million cy of S/S treated sediments as part of a brownfield redevelopment project.

- The Bayonne National Golf Course project in Bayonne, New Jersey was constructed on a former landfill. Over 1 million cy of Portland cement treated dredged sediments were used as engineering fill for the golf course. Dredged sediments were processed using a large-scale stationary pug mill mixing sediments with Portland cement to generate structural fill (Wilk, 2008).

5.2 Sediment Washing Technology

Sediment washing technologies (*ex-situ* separation processes) are water-based processes used to separate contaminants from sediments. Water (typically) is used in combination with chemical additives and a mechanical process to “scrub” the sediments of hazardous contaminants. Contaminated fine sediments (*e.g.*, silt and clay) are separated from the coarser sediments (*e.g.*, sand and gravel), which generally have lower contaminant concentrations. The sand and gravel may be used for beneficial use purposes without additional treatment; however, contaminated fine sediments may require further treatment prior to beneficial use (USEPA, 1996a). A number of vendors have worked on the development of sediment washing technologies and four firms (Bergmann USA, BESCORP, Biotrol and BioGenesis™) have demonstrated their sediment washing technology under USEPA’s Superfund Innovative Technology Evaluation (SITE) program through pilot-scale testing conducted in 1993, 1989, 1992 and 1992, respectively. CETCO & Pear Technologies have developed a sediment washing process, although pilot studies have not been completed.

- Bergmann USA demonstrated their technology using dredged sediments from the Saginaw River contaminated with low levels of PCBs and heavy metals. The technology achieved an 82 percent reduction in PCB concentrations (overall average initial concentrations at 1.35 milligram per kilogram) and reductions between 60 and 90 percent for metals (USEPA, 1994; USEPA, 1995a).

- BESCORP's demonstration was conducted at the Alaskan Battery Enterprise site in Fairbanks, Alaska using 46 tons of soil contaminated with broken lead batteries. The technology was evaluated for its effectiveness in meeting EPA's redeposit cleanup goals for total lead (less than 1,000 milligram per kilogram and TCLP lead less than 5 milligram per liter). Three runs with varying adjustments were conducted in which the lead removal efficiency ranged from 61 to 85 percent. However, the washed sand did not achieve the cleanup goals due to the presence of contaminated fines that the system did not separate from the sand fraction (USEPA, 1995b).

- Biotrol's demonstration testing was conducted at the MacGillis and Gibbs Company wood preserving site in New Brighton, Minnesota. The primary contaminants of concern were pentachlorophenol and polycyclic aromatic hydrocarbons (PAHs). The demonstration testing used sandy soil, consisting of less than 10 percent fines (silts and clays). Two test runs were performed in which pentachlorophenol concentrations were reduced from 130 ppm to 14 ppm (89 percent removal efficiency) and 680 ppm to 87 ppm (87 percent removal efficiency), respectively. Concentrations of total PAHs were reduced from 247 ppm to 42 ppm (83 percent removal efficiency) and 404 ppm to 48 ppm (88 percent removal efficiency), respectively, in the two tests (Stinson, 1991). Removal efficiencies ranged between 50 percent and 70 percent for copper, chromium and arsenic (USEPA, 1992).

While Bergmann USA, BESCORP and Biotrol have demonstrated their technologies under the SITE program, the vendors do not appear to be active in the market. Therefore, Bergmann USA, BESCORP and Biotrol were not evaluated in detail in this FFS. Additionally, while CETCO & Pear Technologies have a sediment washing process, no data or evidence of a demonstration study was available at the time of this FFS. Therefore, the CETCO & Pear Technologies sediment washing process was not evaluated further. Because of BioGenesis™' work with the Lower Passaic River sediments and their active status in the market, BioGenesis™ has been selected as being representative for this type of technology for the purposes of the FFS evaluations. Final selection of a treatment vendor would be done during the final design phase.

The BioGenesis™ Sediment Decontamination Technology is a patented sediment washing process which uses impact forces and proprietary chemicals to remove organic and inorganic contamination from coarse and fine-grained sediments. The technology was evaluated in 1992 under USEPA's SITE program (USEPA, 1993b). In 2008, the BioGenesis™ technology was tested on NY/NJ Harbor sediments, including Lower Passaic River sediments (USACE, 2011).

5.2.1 Applications

According to the vendor, the BioGenesis™ Sediment Washing Technology has been tested on sediments containing a broad range of chlorinated hydrocarbons, pesticides, PCBs, metals and other organic and inorganic contaminants in a variety of bench scale and pilot scale studies in and outside of the United States since the 1992 USEPA SITE program bench testing (BioGenesis, 2001). The studies have led to several system improvements throughout the process chain leading up to a demonstration project, which tested approximately 15,000 cy of dredged material from the NY/NJ Harbor, including 2,655 cy of Lower Passaic River sediments (BioGenesis, 2009).

In 2005-2006, BioGenesis™ conducted a demonstration program in Keasbey, New Jersey for sediments dredged from the Lower Passaic River, the Raritan River and the Arthur Kill, operating at a treatment rate of approximately 40 cy per hour (250,000 cy per year). The sediments from the Lower Passaic River contained PCBs, PAHs and lead at concentrations above the New Jersey Residential Direct Contact Soil Remediation Standard (RDCSRS), other heavy metals at concentrations generally below the RDCSRS, and dioxins and furans that do not have established RDCSRS.

The results of the 2005-2006 demonstration on the Lower Passaic River sediments are summarized below. Contaminant concentration reduction percentages were calculated based on a limited number of samples analyzed as presented in the 2009 BioGenesis™ report.

- Concentrations of lead, arsenic and mercury decreased by 45 percent, 40 percent and 33 percent, respectively, following treatment. For the select metals evaluated, wastewater sludge concentrations were higher than concentrations in the untreated material, suggesting that the contaminants were transferred from the sediment particles into the sludge. Initial concentrations of arsenic and mercury in untreated materials were below the RDCSRS while the concentration of lead was slightly above the RDCSRS. Following treatment, concentrations of lead, arsenic and mercury were below the RDCSRS.

- For select PAHs, the sediment washing technology did not significantly decrease the concentrations in the sediment. On average, concentrations of these select PAHs were reduced less than 10 percent following treatment. As a result, concentrations of select PAHs (*i.e.*, benzo(a)anthracene, benzo(a)pyrene) in treated samples remained above the RDCSRS. Biogenesis™ attributed this to the presence of fine organic materials saturated with PAHs which the solid/liquid separation processes could not effectively separate and has made modifications to its design to address concerns with treatment of PAHs. These modifications are discussed later in this section.

- The average reduction in the concentrations for select pesticides was 37 percent. The concentration of dieldrin in untreated materials was slightly above the RDCSRS while the concentration after treatment was reduced by 23 percent, to below the RDCSRS.

- Concentrations of PCBs in the treated sediment were lower than initial concentrations in the untreated sediment. PCB concentrations in the wastewater sludge were higher than concentrations in the untreated material. Based on the one sample provided, the PCB concentration decreased by 26 percent after treatment. However, the concentration of PCBs in untreated material, treated material, and in wastewater treatment sludge all exceeded the RDCSRS.

- Concentrations of dioxin and furans were reduced following treatment. Based on the one sample provided, the concentration of 2,3,7,8-TCDD decreased by 83 percent following treatment.

Based on the results of the 2005-2006 demonstration project, Biogenesis™ conducted additional bench-scale tests to investigate the variations among the organic contaminant removal efficiencies. On the basis of this testing, it was hypothesized that the fine organic matter containing PAHs was not being removed during the solid/liquid separation process. A micro-floatation unit, a common technology used in water and wastewater treatment to remove non-aqueous organic material, was added toward the beginning of the process chain to remove the PAH contaminated organic fibers. It was concluded that micro-floatation would be added as part of the liquid/solid separation phase for sediments with significant fractions of organic material and where PAHs are of concern (BioGenesis, 2011). The BioGenesis™ process with the micro-floatation unit incorporated has not been tested in the field. Additionally, BioGenesis™ mentioned in their report that the use of a micro-floatation unit would require off-gas treatment to control Volatile Organic Compounds (VOC) and Semi Volatile Organic Compounds (SVOC) and is anticipating that this would require a discharge permit approval from NJDEP (BioGenesis, 2011).

5.2.2 Facility Processes

A typical sediment washing system consists of several processes including:

- Screening to remove small and medium sized particles (rocks and debris)
- Chemical addition and agitation to remove chemical constituents
- Physical separation units to remove sand and coarse grained inorganic materials
- Clarification and settling
- Dewatering of sediment
- Wastewater treatment

Under DMM Scenario C, the dredged material would be hydraulically offloaded from the barge and screened for oversized materials such as rocks and debris. The sediment slurry would then be mixed with washing chemicals (*e.g.*, surfactants, chelating agents, defoamers) to decrease affinity among contaminants, sediment solids and naturally occurring organic materials. Following mixing, the slurry would be pumped into the collision chamber where high pressure water would be used to strip the biofilm layer and adsorbed contaminants from the sediment particles. From the collision chamber, a micro-floatation unit would be used to remove floatable organic material. The remaining the slurry would be pumped to a cavitation/oxidation unit for destruction of organic contaminants followed by a hydrocyclone/screen and centrifuge to remove coarse grained particles such as sand and small gravel. The material would then be dewatered using a filter press, prior to processing for beneficial use.

Wastewater generated during the process would be either reused to slurry the sediment for hydraulic offloading or treated at an on-site wastewater treatment system along with stormwater collected within the exclusion zone. Treated wastewater would be discharged to the river in accordance with regulatory requirements.

The treatment facility would need to be located on the river to minimize transport costs with access for deep water barge offloading. Treatment facility land requirements vary depending on the alternative selected and the dredging method used (see Section 3). The projected cost for the commercial scale facility was estimated at $55 to $65 per *in-situ* cy based on one round of decontamination (updated to 2014 dollars)[BioGenesis™, 2011]. These costs will vary based on the size of the facility and the anticipated years of operations (amortization period).

5.2.3 Beneficial Use Options

Dredged material treated with a sediment washing technology could qualify as a beneficial use product. The beneficial use of the material would depend on the chemical and geotechnical characteristics of the end product. While chemical concentrations in the treated material may be below NRDCSRS, making it suitable for use as landfill covers, the geotechnical properties may not be adequate for use as general or structural fill on construction projects. Geotechnical properties may be improved by S/S (such as addition of Portland cement).

Washed sediment could be used to generate manufactured topsoil as shown by BioGenesis™ in their 2005-2006 demonstration project. Approximately 20 cy of decontaminated sediments from the Lower Passaic River were used as part of the demonstration. The decontaminated sediments were blended as follows: 39 percent decontaminated sediment (by dry weight), 43 percent sand, 12 percent organics (peat moss) and 6 percent red clay. The objective of the BioGenesis™ demonstration was to generate topsoil for residential applications and while the concentrations of potential contaminants in the manufactured topsoil were found to be below the RDCSRS, it is important to note that the soil mixture only dilutes the concentration of the remaining contaminants in the washed sediment.

More recently, in mid-2012, bench scale studies by two sediment washing technology vendors (Biogenesis and Pear Technology) showed that their technologies were unable to reduce Lower Passaic River sediment contamination to levels low enough for beneficial use of the final product (de maximis inc., 2012). It remains to be seen whether the beneficial use products produced through the sediment washing process can receive regulatory approval. If the manufactured topsoil does not receive regulatory approval, an option is to couple the BioGenesis™ technology with S/S to further reduce the contaminant mobility and use the material for industrial applications such as daily landfill covers.

In the FFS evaluations, for DMM Scenario C, it was assumed that material would be treated with a sediment washing technology coupled with a S/S technology to generate beneficial use material for industrial applications such as daily landfill covers.

5.3 Thermal Treatment Technology

Thermal treatment/destruction technologies involve high temperature heat to remove contaminants from the sediment matrix, typically in a rotary kiln. A rotary kiln consists of a large (10 to 20 feet in diameter), long (50 to 100 feet or longer) tube. The tube is rotated to mix the sediments while the material is heated to high temperatures to destroy contaminants. Thermal treatment processes have proven effective in reducing contaminant concentrations with the level of decontamination dependent on temperature and time the contaminated sediments remain in the kiln. The decontaminated sediments can be used for beneficial use purposes such as construction fill and habitat restoration. Hazardous materials in the form of ash generated by the treatment process require disposal at a hazardous waste treatment facility (Krause, 2000). Other thermal treatment technologies include thermal vitrification and gasification processes.

The following thermal treatment technologies were evaluated based on available information:

- Cement-Lock® Technology
- JCI/Upcycle Associates, LLC's Rotary Kiln
- Minergy's Glass Furnace Technology
- Westinghouse Plasma Corporation (WPC)'s Vitrification Technology

The Cement-Lock® Technology, a thermal treatment process for managing dredged material from the NY/NJ Harbor, has been pilot-tested on Lower Passaic River sediments. The Cement-Lock® Technology process involves mixing dewatered dredged material with limestone and other additives in a cement kiln (*i.e.,* a rotary kiln). During processing, the organic fraction is burned off and the metals are bound into a chemically-stable, solid, slag-like material produced as a byproduct of the treatment process. This material can be processed to produce an aggregate for use in construction projects (Gas Technology Institute [GTI], 2008a).

The Cement-Lock® Technology has been pilot-tested in both non-slagging and slagging operation modes. When operated on non-slagging mode, the material is sintered (*i.e.*, formed into a coherent mass by heating without melting) and not melted, which results in construction aggregate form called EcoAggMat. For continuous slagging operations, the end product is Ecomelt®, which is a pozzolanic material that, when dried and finely ground, can be blended with Portland cement to generate blended concrete (GTI, 2008a). The optimized Cement-Lock® operations would be configured to produce Ecomelt® (USACE, 2011). Therefore, this section will focus on continuous slagging operations for the Cement-Lock® Technology.

JCI/Upcycle Associates, LLC (JCI/Upcycle)'s thermal treatment technology also uses a rotary kiln to process contaminated sediments converting dredged sediments into lightweight aggregate products. In 2000, JCI/Upcycle worked with NJDOT as part of a comparative technology demonstration on sediment from the Stratus Petroleum site in Newark, New Jersey. The JCI/Upcycle process involves two main phases: the solid-liquid separation/dewatering phase and the rotary kiln processing phase. The first phase consists of screening (*e.g.* debris removal) and mechanical dewatering with the addition of polymers to form dewatered filter cakes. Following dewatering, the filter cake is further dried, ground, and milled to produce a powder that is extruded as pellets. The pelletized feed is then sent to the rotary kiln producing lightweight aggregates for beneficial use (JCI/Upcycle, 2002). A 2011 USACE study on available technologies indicated that there have been no further activities since the 2000 pilot demonstration for NJDOT, although there is reportedly a group interested in the use of JCI/Upcycle's thermal treatment technology. While it is not known if there is still an interest in pursuing this sediment processing technology, JCI/Upcycle's thermal treatment will be included as part of the technology evaluations in this Appendix.

Minergy Corporation Limited (Minergy)'s glass furnace technology is a thermal vitrification process for treating contaminated sediments. Minergy's technology was demonstrated at pilot scale for the USEPA under the SITE program in 2001 using sediments dredged from the Fox River in Green Bay, Wisconsin. The process involves thermal drying to remove water in the sediment and then high temperature melting of the solids in a refractory-lined smelter to produce glass aggregates. The glass aggregates encapsulate metals and the high temperatures destroy the organic contaminants. The glass aggregates can be used for beneficial use products such as hot mix asphalt (HMA), construction fill, cement substitutes and ceramic floor tiles. Based on a USACE study, the technology is not being actively marketed for sediment decontamination; however, there may be future interests (USACE, 2011). Minergy has indicated in personal communications that the firm would be interested in participating in the FFS Study Area sediment decontamination; however, they will not pursue it unless under a paid consulting arrangement (personal communications, August 30, 2011).

Westinghouse Plasma Corporation's plasma technology is a plasma vitrification process that can be applied to contaminated sediments. WPC's technology is based on their plasma torch technology in which the sediment is burned at high temperatures generated by the plasma arc torch (Westinghouse Marc-11 plasma torch). Dewatered sediments are injected into the plume of the torch combusting and destroying organics. The minerals in the sediment are heated to the melting point and fused into a homogenous glassy liquid. The molten glass is then quenched encapsulating the heavy metals. The glass product can be suitable for a wide variety of applications such as road aggregates, sandblasting grit, glass fibers and architectural floor tiles. WPC's plasma vitrification technology was demonstrated over a 2.5 year period on NY/NJ Harbor sediments beginning in late 1996 through bench-scale and pilot-scale studies. WPC's plasma torch technology has been implemented on a wide variety of commercial applications such as converting hazardous and industrial wastes into a source of energy termed "syngas". However, in personal communications, WPC has indicated that it has not embarked in commercial or large-scale operations for dredged sediments. The company would be interested in exploring future opportunities for the FFS Study Area remediation (personal communications, August 17, 2011).

5.3.1 Applications

Under DMM Scenario C, the FFS Study Area sediments that are classified as hazardous materials (UHCs exceeding ten times the UTS, as described in Section 2), would be treated using thermal treatment technology with the end product slated for beneficial use purposes. Ash or other hazardous byproducts would be disposed in a Subtitle C landfill.

The Cement-Lock® Technology

The Cement-Lock® Technology has been tested on several bench scale and pilot studies, including a demonstration pilot scale testing performed at the International Matex Tank Terminal site in Bayonne, New Jersey. Sediment sources during the testing periods (2003-2007) included sediments from the upper Newark Bay and the Passaic River (conducted in December 2006 and May 2007). Approximately 32 tons of Passaic River sediments (including modifiers) were processed at throughput rates exceeding 1 cy per hour (approximately 1 ton per hour). The quantity was equivalent to an *in-situ* volume of 44 cy of contaminated sediment. The process generated approximately 27 tons of Ecomelt® products.

Treatment efficiencies were very high for selected contaminants:

- 99.991 percent for PCBs
- 99.947 percent for 2,3,7,8-TCDD
- 99.968 percent for benzo(a)pyrene
- 99.625 percent for naphthalene
- 99.685 percent for mercury.

TCLP testing results on the Ecomelt® indicated that none of the Ecomelt® samples exceeded the regulatory limits for priority metals. SPLP results for priority metals (three samples tested) were below detection limits for most analytes. One sample exceeded the New Jersey Ground Water Quality Criteria limit for manganese and all samples exceeded the limit for lead.

Flue gas samples were collected and analyzed for metals, PCBs, dioxin/furans, and SVOCs to characterize air emissions and to determine the efficiency of activated carbon beds as part of the APC system. The APC system was aimed at capturing volatile heavy metals, particularly mercury due to its high volatility. Capture efficiencies for mercury were greater than 88.8 percent for the December 2006 testing event and greater than 98.9 percent for the May 2007 testing event. The APC system was less efficient for total metals (*i.e.*, the sum of heavy metals evaluated) removal indicating that metals were particle-bound.

Average capture efficiencies for dioxins and furans were generally high at 99.1 percent; destruction and removal efficiency were also high at 99.949 (December 2006 testing) and 99.886 percent (May 2007 testing). For PCBs, the capture efficiency was high for the December 2006 testing 92.1 percent but fell off substantially during the May 2007 testing resulting in 45.7 percent capture efficiency. For PCBs, destruction and removal efficiency rates were 99.987 (December 2006 testing) and 99.957 percent (May 2007 testing).

Ecomelt® generated from the treatment process was mixed with Portland cement at 40:60 ratio and tested to evaluate its performance compared to standard concrete. Samples were tested for compressive strength, flexural strength, drying shrinkage, freeze-thaw testing deicing-scaling and chloride permeability. Test results indicated that Ecomelt® when mixed with Portland cement is comparable to standard concrete and can be used for construction purposes. However, the Ecomelt®/Portland cement mix may require an accelerator for high early strength applications as it took 56 days to achieve the same compressive strength as standard concrete (GTI, 2008b).

JCI/Upcycle's Rotary Kiln Technology

JCI/Upcycle's Rotary Kiln process was selected for a pilot study project in July 2000 under contract with NJDOT-OMR. The pilot project consisted of two phases: the pre-kiln/dewatering phase and the rotary kiln processing phase. The pre-kiln/dewatering phase was conducted at Stratus Petroleum in Newark, New Jersey and the rotary kiln processing phase was conducted in Catasauqua, PA using approximately 4 cy of dewatered dredged material filter cakes from the Stratus Petroleum site. Based on data presented in the 2002 report, it is estimated that this is equivalent to an *in situ* volume of approximately 8 to 10 cy of sediment. Testing was conducted during the 2000-2001 period (JCI/Upcycle, 2002). This discussion focuses on the thermal treatment process.

During the pilot study, the feed ratio was 70 percent dewatered sediment to 30 percent shale (by weight) added to the rotary kiln to enhance the properties of the lightweight aggregate byproduct.

Treatment efficiencies were high for the select organics evaluated:

- Greater than 99.99 percent for 2,3,7,8-TCDD
- Greater than 98.31 percent for 2,3,7,8-tetrachlorodibenzofuran
- Greater than 99.99 percent for total pentachlorodibenzo-p-dioxin
- 99.32 percent for total pentachlorodibenzofurans.

Treatment efficiencies for various metals evaluated:

- 32 percent for arsenic
- 66 percent for barium

- Greater than 79 percent for cadmium
- 93 percent for chromium
- 94 percent for lead
- Greater than 97 percent for mercury (JCI/Upcycle, 2002).

The decontamination efficiency ranged from 97 to 100 percent for TCLP metals. While TCLP results for metals in samples of the light weight aggregate were below the TCLP RCRA regulatory limits, the TCLP results from the filter cake (pre-kiln) were also below the regulatory limits making it difficult to draw conclusions on performance.

The available TCLP results for individual metals removal efficiencies were mixed. For arsenic, the extractable fraction in the light weight aggregate was an order of magnitude lower than in the filter cake; cadmium and chromium was not detected in the fraction extractable in the light weight aggregate; and for barium and lead, the fraction extractable in the light weight aggregate was significantly higher than in the filter cake.

Measurable concentrations of mercury, sulfur dioxide, nitrous oxides, carbon monoxides and VOCs were detected in the dryer offgases in addition to low concentrations of dioxins and furans. Contaminant releases to atmosphere from the offgas stream include measurable concentrations of several metals, VOCs, some SVOCs, PCBs, chlorine, sulfur dioxide, nitrous oxides and carbon monoxide (USACE, 2011).

Minergy's Glass Furnace Technology

Minergy's technology was demonstrated for the USEPA SITE program in 2001 on river sediments dredged from the Lower Fox River in Green Bay, Wisconsin. During the demonstration pilot study, a total of 12,400 kilogram (kg; 27,000 lbs) of sediment was treated resulting in the generation of approximately 4,900 kg (11,000 lbs) of glass aggregate. The pilot study treated mechanically dewatered sediments at a processing rate of approximately 200 lbs per hour (approximately 2.4 ton per day).

Treatment efficiencies were high for the select organics evaluated:

- 99.9995 percent for Total PCB
- Greater than 99.9995 percent for dioxins and furans.

Glass aggregate samples had detectable concentrations of barium, chromium, lead, and selenium. However, in the TCLP analytical results for the glass aggregate leachates, the metals and PCBs were below the detection limits.

The air sample probe and the flue of the pilot-scale furnace were clogged by dust during furnace operations, which frequently interrupted air sample collections during the pilot study. Evaluation of dust material indicated the presence of metals such as lead and chromium. Dioxin and furans were detected in very small concentrations at 1.0×10^{-5} ppm in the dust samples. Samples were not analyzed for PCBs, SVOCs or VOCs (USEPA, 2004).

WPC's Plasma Vitrification Technology

WPC's plasma vitrification technology was demonstrated on NY/NJ Harbor sediments in a three-phase implementation process in late 1996. Phase I bench testing was conducted to characterize the sediments and to verify whether high quality glass could be prepared with the addition of less than 15 percent fluxing agents. Phase II pilot testing included large-scale pre-treatment and included a full-sized plasma melting reactor powered by WPC's plasma torch (Marc-11 plasma torch). Four metric tonnes (4.4 tons) of pretreated NY/NJ Harbor sediments were treated at an approximate rate of 0.8 metric tonnes per hour (0.9 tons per hour). Phase III testing demonstrated the beneficial use aspect of the technology with conversion of sediments into commercial architectural tiles.

Treatment efficiencies were high for the select organics evaluated:

- 99.8 percent for all organic categories
- 99.9999 percent overall for total organics
- Greater than 99.99 percent for dioxin.

Only lead was detected in the TCLP leachate on the glass byproduct at a concentration that was 2 to 5 percent of the USEPA regulatory limits. Most RCRA metals were captured in the glass matrix with fraction retained values ranging from 61.3 to 99.8 percent. Metals that were not captured (partially escaped the smelter) will be found in the calcium sulfate/sulfite stream (offgas treatment), which would be sent to a landfill.

Pretreatment results indicated that the approximately one percent of the original sediment volume would require disposal in a landfill. This material consisted primarily of debris and gravel (inorganics) rinsed of surface contamination (McLaughlin et al., 1999).

5.3.2 Facility Processes

Cement-Lock® Technology

The Cement-Lock® technology consists of five primary steps:

- Prior to treatment, debris and solids are removed or separated and the sediment dewatered.
- Modifiers are added to the dewatered sediments and the mixture fed into the rotary kiln (Ecomelt® Generator), which is maintained at a temperature of 2400° to 2600° F. The reaction with high temperature (thermo-chemically) transforms the mixture into a lava-like melt, in which non-volatile metals are encapsulated.
- The mixture is fed into the granulation and drying system, in which the quenched and granulated material (Ecomelt®) is removed by way of a drag conveyor.
- The Ecomelt® is then processed with additives to generate construction grade cement.
- Flue gas resulting from the rotary kiln discharges to a secondary combustion chamber to ensure destruction of organic compounds. Flue gas exiting the secondary combustion chamber is rapidly cooled with water injections to prevent the formation of dioxin or furan precursors. Powdered lime is then injected into the cooled gas to capture sulfur oxides and hydrogen chloride. The treated gases are run through a fixed bed of activated carbon pellets to remove heavy metals before the flue gas is vented to the atmosphere (GTI, 2008a).

At this time, the Cement-Lock® Technology is estimated to achieve an average throughput rate of approximately 50,000 tons per year using a 4.4 meter rotary kiln operating at 6 to 9 tons per hour. The processing fee for this plant is estimated at $350.00 for each *in-situ* ton of sediment and could be designed to accommodate additional capacity expansion as needed. Temporary storage requirements for the dewatered dredged material would vary. It was assumed that up six months of storage would be provided for the alternatives to allow for operating flexibility, or approximately 0.6 acres for Alternatives 3 and 4 and 0.8 acres for Alternative 2.

JCI/Upcycle's Rotary Kiln Technology

The JCI/Upcycle Rotary Kiln process involves two main phases: the pre-kiln or solid-liquid separation/dewatering phase and the rotary kiln processing phase.

- The pre-kiln phase involves debris removal and dewatering of the dredged material
- Once debris screening and dewatering (in addition to polymer addition and blending) is complete, the dewatered filter cakes are fed to the hammermill drying/grinder system.
- The hammermill drying/grinder system would further dry the filter cake producing a fine, free-flowing material that could be homogenized with ground shale (if part of feed mixture) and extruded.
- Dust from the hammermill is collected in a baghouse.
- Pug milling and extrusion of the dried and ground filter cake with raw shale (if part of the feed mixture) then produce the feed pellets for the rotary kiln. The feed pellets are then fed into the rotary kiln with temperatures exceeding 1400°C.
- APC systems for the process consist of an afterburner, ceramic filter collector and recirculating wet scrubber (JCI/Upcycle, 2002).

During pilot operations, the kiln feed rate was approximately 43 lbs per hour (approximately 0.5 tons per day). Based on pilot study results, JCI/Upcycle prepared commercial scale estimates for a facility able to handle 500,000 cy (*in-situ*) per year with a supply term of 30 years. The projected cost for the commercial scale facility was estimated at $42.43 per *in-situ* cy (based on 2002 dollars). The size of the facility was estimated at 10 acres, which would include storage capacity for both the unprocessed dredged material and the dewatered filter cake product as well as building for administrative, laboratory and dewatering operations (JCI/Upcycle, 2002).

Minergy's Glass Furnace Technology (GFT)

Minergy's GFT system process involves the following:

- Sediment is dewatered to approximately 45 to 55 percent solids by weight.
- Dewatered sediment is further dried in a thermal dryer to increase the overall efficiency of the process by limiting the amount of moisture in the smelter (reducing the physical volume of the feed and maintaining high processing temperatures).
- Gas from the drying step is directed into the glass furnace or another destructive device to control emissions.

The core process consists of a smelter (glass furnace technology), quench tank, off-gas collection/treatment system and material handling equipment. The glass furnace is a refractory-lined, rectangular smelter. The refractory in the Minergy system is a special type of brick that is resistant to both chemical and physical abrasion, has a high melting point, and provides a high degree of insulating value. The glass furnace (configured with oxygen and natural gas delivery systems) requires an internal temperature of approximately 1,600°C for sediments to melt and flow out of the furnace as molten glass. The quench tank system then allows the molten material to quickly cool (harden) to form the glass aggregate product.

According to the USEPA SITE program evaluation document, Minergy has designed (not constructed) a full-scale GFT system to support large river-sediment dredging operations (USEPA, 2004). The treatment facility would need to be located near dredging and dewatering operations to minimize transportation and handling costs. The full-scale system is designed to melt 600 tons per day of dewatered sediment and produce 250 tons per day of glass aggregate. The Minergy technology is currently being used to recycle wastewater solids from 12 paper mills. Minergy's Fox Valley glass aggregate plant in Neenah, Wisconsin recycles approximately 350,000 tons of wastewater solids annually, producing process steam for an adjacent paper mill and glass aggregates for resale.

Minergy has evaluated several scaled-up scenarios for dredged sediment opportunities and has estimated (for a facility operating 24 hours per day, 350 days per year over a 15-year project period) that a mid-sized stand-alone facility with a dredged sediment processing rate of 1,200 tons per day (glass aggregate production of 500 tons per day) would cost approximately $30 per ton. For a large, stand-alone facility with a dredged sediment processing rate of 1,800 tons per day (glass aggregate production of 750 tons per day), the unit price would be approximately $27 per ton. Projected costs were estimated in 2004 based on an operating life of 15-years (USEPA, 2004).

WPC's Plasma Vitrification Technology

WPC's plasma vitrification technology process involves the following steps:

- The sediments are washed with freshwater to remove large debris that can clog the sediment injection nozzle into the plasma smelter (particle sizes typically larger than one millimeter and debris such as sticks, leaves, etc.).
- The washed sediments are partially dewatered (upper practical limit is 50 to 55 percent solids for slurry pumping). Various chemical feeds are involved in the plant process such as lime and flocculating agents.
- The plasma smelter consists of a cylindrical furnace with refractory lining. Sediment slurry is injected through the injection ports (referred to as "tuyere") with the outer end mounted with the Westinghouse plasma torch.
- Sediment and flux mixtures are pumped through the injection nozzle directly into the plume of the plasma torch combusting the organic surface deposits. Air is passed through the electrodes of the torch superheating it to temperatures approaching 5000°C or higher.
- The molten byproduct can be cast into large masses, roll quenched into thin sheets or water quenched to form a fine aggregate. It is noted that pumping the slurry mix into the injection nozzle caused difficulties when the slurry solids content was higher than optimal.

WPC's demonstration study included a full-scale plant design (not-constructed). WPC's full scale production design was based on a 500,000 cy per year treatment capacity facility. It was estimated that for this plant capacity, approximately 8.2 acres of land would be required (12 acres with glass product plant). The net cost of processing without accounting for product credits was estimated to be approximately $42.5 per metric tonnes to $72.0 per metric tonnes (estimated costs were reported in 1999)[McLaughlin et al., 1999].

5.3.3 Beneficial Use Options

Cement-Lock® Technology

Cement-Lock® technology produces a pozzolonic Ecomelt® product, which can be used for beneficial use purposes such as the production of blended concrete. During the pilot testing in 2006 and 2007, approximately one ton of Ecomelt® was shipped to Montclair State University where it was used in the production of concrete for a portion of a sidewalk (approximately 165 feet long and 6 feet wide) for beneficial use. In addition, during its early non-slagging pilot test operations, an EcoAggMat® product was produced (approximately 53 tons), which was used as clean geotechnical fill at a remediation project in South Kearny, New Jersey (GTI, 2008b).

Ecomelt® can be used for various construction purposes such as aggregates for geotechnical fills (*e.g.*, surrounding underground pipes to absorb stresses); construction of gravel walkways and production of floor tiles with a combination of crushed glass (USEPA, 2011). Since Ecomelt® can be used as geotechnical fill, it can potentially be suitable for mine reclamation projects.

JCI/Upcycle's Rotary Kiln Technology

The light-weight aggregates generated from JCI/Upcycle's rotary kiln technology can be used in a variety of construction applications.

During the pilot study, total production from the entire rotary kiln program was approximately 3,100 lbs of light weight aggregate with an overall product bulk density of 37.59 lbs per cubic foot. Crushing strengths for the light weight aggregate averaged over 214 lbs, which is comparable to or exceeds the crushing strengths of many commercially available light weight aggregates in the market.

Minergy's Glass Furnace Technology

Glass aggregate products can meet industrial requirements for the manufacture of asphalt pavement, construction backfill, roadbed construction, ceramic tiles, roofing shingles, granules, and cement/concrete products, mine reclamation, blasting grit, blended cement and utility trench backfill.

Minergy, in partnership with OMNNII Associates and Northeast Asphalt, Inc. has developed a HMA mix using glass aggregates produced from paper mill sludge at the Fox Valley Glass Aggregate Plant and sediments containing PCBs dredged from the Lower Fox River. The HMA mix has been used on Wisconsin Department of Transportation and private projects, where the glass aggregate was used as a substitute in the HMA mix for washed manufactured sand. In addition, Minergy's glass aggregate customers have successfully used the glass aggregates from the Fox Valley Glass Aggregate Plant for structural fill purposes such as building footings and foundations, backfill, pipe bedding and drainage applications (Minergy, 2011).

WPC's Plasma Vitrification Technology

Similar to Minergy's GFT technology, WPC's Plasma Vitrification technology produces glass products that can be used in a wide variety of construction applications such as road aggregates, sandblasting grit, glass fibers and even architectural floor tiles. Other high end value products that may be applicable include roofing granules, glass cullet replacements, and additives to brown bottle glass, filler materials for artificial onyx bathtubs and similar fixtures, and rock wool insulating fibers.

During Phase III demonstrations, approximately 1,000 kg of sediment glass were converted into 2,200 kg of tiles. WPC collaborated with Futuristic Tile LLC for the conversion process. It was concluded that sediment glass can produce good quality tiles and can provide significant processing advantages compared to recycled glass.

5.4 Summary of Decontamination Technologies

DMM Scenario C relies on sediment decontamination technologies to treat the contaminated dredged sediments from the FFS Study Area while generating beneficial use end products. Currently, there are several technologies available, although, except for S/S, none of the technologies have been used at a commercial-scale for an extended period of time. Sediment decontamination technologies with potential to treat the FFS Study Area sediments include the following:

- Solidification/Stabilization
- Sediment Washing
- Thermal Treatment

S/S technology is full-scale immobilization technology for non-volatile heavy metals using a relatively simple process with readily available equipment at a high throughput rates. S/S technology is commonly used on a variety of waste materials and has a number of well-developed non-proprietary options. End products can be used for landfill cover material, and structural and non-structural fill for various construction applications and projects including brownfield remediation. While S/S technology can be highly effective in immobilizing non-volatile heavy metals, the technology is not effective in treating organics, especially with the use of standard binding/stabilizing agents. Environmental conditions may affect the long-term immobilization of contaminants although limited post-treatment/long term performance data are available.

Sediment washing technology is a process used to separate contaminants from sediments. As an example, BioGenesis™ Sediment Washing is a proprietary technology that not only physically separates, but chemically oxidizes organic chemicals providing some treatment of the finer fractions. BioGenesis™ has conducted several bench scale and pilot scale studies in addition to a demonstration project testing dredged sediments from the Lower Passaic River. Several improvements and design modifications have been made since the last demonstration project; however, the technology has yet to be tested on a commercial scale level able to meet normal production rates of commercial dredging operations in addition to field testing with design modifications such as the micro-floatation unit. In addition, the market capacity for the beneficial use product is untested in terms of the ability to gain regulatory approval.

Thermal treatment technologies have the potential for being effective in treating most organics and metals at a wide range of contaminant concentrations. Based on bench scale/pilot scale studies results, thermal technologies are effective at achieving the destruction of organic contaminants and the immobilization of metals. However, thermal treatment technologies are energy intensive and have high capital costs. Thermal treatment technologies potentially suitable for FFS Study Area sediments include the following proprietary technologies:

- Cement-Lock® Technology
- JCI/Upcycle Associates, LLC's Rotary Kiln
- Minergy's Glass Furnace Technology
- WPC's Vitrification Technology

These proprietary technologies have developed near-commercial-scale potential with the Cement-Lock® technology being most active with the latest pilot-scale testing conducted for the Passaic River sediments in 2007. The other three technologies have not been active in the dredged sediment market although all three firms expressed potential interest in pursuing the development of a facility for the Passaic River project. The end products of the thermal technologies can be used for a variety of beneficial use purposes with each technology producing different types of products (Minergy's and WPC's end products are similar):

- Cement-Lock® Technology – Ecomelt®
- JCI/Upcycle Associates, LLC's Rotary Kiln – lightweight aggregates
- Minergy's Glass Furnace Technology – glass aggregates
- WPC's Vitrification Technology – glass products

While several design modifications have resulted from the bench-scale and pilot-scale studies, the thermal treatment technologies have operated at a limited scale and have had persistent logistical issues that have yet to be tested at a commercial-scale level using contaminated sediment. Several key factors affecting the feasibility of thermal treatment have yet to be evaluated during a full scale operation including the throughput rate and operating history, air emissions, and the market capacity/acceptance for byproducts of the treatment process.

The sediment treatment technologies evaluated in this section show potential to treat the dredged sediments from the FFS Study Area in addition to generating end products for beneficial use purposes, thereby reducing the volume to be disposed at an off-site disposal facility. DMM Scenario C relies on the construction and operation of a self-contained treatment facility. S/S technology has been used on sediment at a commercial-scale while sediment washing and thermal treatment technologies have shown potential at near-commercial-scale operations. The innovative technologies evaluated would need to demonstrate their ability to be expanded to full scale commercial operations that can meet site-specific project needs. Process design would need to be flexible to account for variability and uncertainties during the scale up process. Persistent logistical issues would need to be addressed including consistent quality controls and air emissions. Pre-treatment (*e.g.*, screening, dewatering, etc.) would be critical for all technologies and would play a large role in the performance of the commercial-scale facilities and siting areas and requirements. Lastly, cost uncertainty would be a concern (*e.g.*, market uncertainty for beneficial use products) since commercial-scale facilities for these technologies have not been tested.

6 CAD CONCEPT DESIGN

This section evaluates the use of CAD to dispose of dredged sediment associated with a remedial action in the FFS Study Area. Evaluations and studies necessary for constructing a CAD are described, including siting considerations and studies, as well as the assumptions associated with a feasibility-level conceptual design. This section also includes analysis of eight CAD projects at other sites in the United States. The analyses in this section were performed for FFS alternative evaluation purposes (such as cost estimation); if CAD were to be selected as part of the final remedy, detailed studies to support siting and construction would be done during the remedial design.

CAD is a form of dredged material disposal involving the placement of dredged material in a laterally confined subaqueous site. Disposal takes place below the water surface either on the river bottom or in a depression or excavated pit. The contaminated material is capped, usually with clean sediment, to separate it from the surrounding water. CADs are used to provide long-term storage capacity, control contaminant release, and retain solids (USACE, 2001).

One of the DMM scenarios (DMM Scenario A) includes placing dredged sediment into CADs. Refer to Chapter 4 of the FFS for additional information on the CAD scenarios.

A preliminary siting analysis was performed to assess desirable characteristics and siting considerations for potential CAD sites in the vicinity of the Lower Passaic River. A detailed siting evaluation and extensive public outreach would be required during the design phase if the selected remedial alternative were to incorporate disposal of dredged material in a CAD.

6.1 Siting Considerations

The desirable characteristics and siting considerations for potential sites at which a CAD could be constructed are presented below.

(A) Desirable Site Characteristics

- Proximity to the FFS Study Area
- Distance of at least 100 feet from the nearest navigable channel (USACE, 2007) Distance from the shoreline not greater than 2,000 feet (USACE, 2007)
- Sufficient water depth for scow, barge, and tug maneuverability; water depth at least 20 feet MLW (USACE, 2007)
- Sufficient depth to bedrock to accommodate the required storage volume
- Low permeability subgrade formation (*i.e.*, glacial till or red brown clay)
- Sufficient depth to groundwater aquifers or impermeable layer isolating aquifers to minimize water quality impacts
- Sufficient horizontal and vertical clearance from nearby bridges
- Minimal impacts on waterway (*e.g.*, disruption of circulation patterns, increased channel sedimentation)
- Minimal flooding impacts
- Minimal amount of contaminated sediments at the CAD site that would need to be managed during facility construction
- Sediment characteristics (at and adjacent to the site) suitable to support heavy loads (*e.g.*, anchoring construction equipment, supporting pilings for ancillary structures)
- Avoidance of buried cables and pipelines.

(B) Other Siting Considerations

- Quality of life issues associated with the constructed facility (*e.g.*, noise, odor, lights)
- Ability to obtain applicable permits, permit equivalencies or other administrative approvals
- Minimal adverse environmental impacts (*i.e.* temporary loss of benthic and aquatic habitat) and compliance with New Jersey's Rules on coastal zone management, as applicable.

6.1.1 Previous Siting Studies

USACE Study

As part of the USACE siting study discussed in Section 3.3.2, the USACE also investigated the feasibility of developing an in-water public storage facility in the Port of New York and New Jersey (USACE, 2007).

The USACE study evaluated locations for developing a commercial disposal facility for material derived from regular navigation maintenance dredging activities in NY/NJ Harbor. Although the disposal facilities evaluated in the FFS would be used to handle material derived from remedial dredging activities, siting considerations would be very similar to those presented for public facilities. As such, the USACE evaluation can be used in assessing the availability of disposal sites presented in the FFS.

The USACE study included shoreline and nearshore areas in the NY/NJ Harbor, including Upper and Lower New York Bay, Newark Bay, the Arthur Kill, the Kill Van Kull, and portions of the Hudson River and the East River. The study consisted of desktop evaluations including a review of previous studies in the vicinity of the NY/NJ Harbor, online research and data review (focusing on GIS data and aerial photographs), and consultation with Harbor stakeholders.

Eighty-one potential sites in New York and New Jersey were identified for the development of a storage facility. Sites were ranked as “high,” “medium,” or “low” with respect to siting characteristics discussed in Section 6.1. Eight sites were ranked “high” for a water-based storage facility. The attributes of the “high”-ranked sites for a storage facility are summarized in Table 6-1.

Although the USACE did not evaluate potential locations for the construction of a CAD, the study identified four potential locations with the highest potential suitability for an in-water pit storage facility. Further research will be required to determine if these locations would be suitable for the construction of a CAD.

Newark Bay EIS

At the request of the Port Authority of the New York and New Jersey, USACE prepared an Environmental Impact Statement (EIS) for several confined disposal facility (CDF[10]) locations in Newark Bay in April 1997 (USACE 1997b). The EIS evaluated three potential areas as described below:

- Area 1 (Area 1S) – Area 1 is located on the western side of Newark Bay between the Port Elizabeth Channel and the Port Newark Channel. This location was ultimately selected, used as a CAD, and recently closed.
- Area 2 (Areas 2N and 2S) – Area 2 is also located on the west side of Newark Bay north of the Port Newark Channel. Area 2 was permitted but never constructed. The EIS indicated that short-term adverse impacts from construction of a disposal facility at this location were offset by potential beneficial impacts and no long-term adverse impacts were expected.
- Area 3 – Area 3 is located in Newark Bay east of the main Federal Navigation Channel opposite Port Newark. The EIS indicated that Area 3 warrants further studies as it would have the advantage of being able to accommodate large volumes of material.

Other potential areas identified were screened out due to the extensive number of buried cables and pipelines.

6.1.2 Preliminary CAD Siting Analysis

Previous evaluations were limited to nearshore disposal facilities. The USACE study identified four potentially suitable locations for an in-water disposal facility and the Newark Bay EIS identified three potential locations (one of which was ultimately constructed). The construction of a CAD further away from the shoreline would potentially avoid modifications to the existing shoreline near the CAD.

[10] The Newark Bay CDF sites evaluated in the EIS are technically CADs as defined in this document.

For the FFS alternative evaluation purposes, potentially suitable locations for a CAD were identified and evaluated based on the criteria listed in Section 6.1. Sites were identified in Newark Bay and the immediately surrounding waterways; additional locations could be evaluated during the design phase, if the selected remedial alternative were to include DMM Scenario A. To identify potential locations, the following databases and information sources were used:

- Bathymetry survey data was used to assess the depth in Newark Bay.
- Land surface elevation data was taken from United States Geological Survey (USGS) maps and databases.
- NOAA navigation charts were used in conjunction with aerial imagery to identify areas with navigation uses.
- Aerial imagery was used to determine land uses adjacent to potential sites and to confirm information on navigation areas (*e.g.*, locations where boats were seen docked in the images were confirmed as marinas when noted as "Special Anchorage Areas" in the NOAA charts).
- Limited core data available were used to approximate depth of contamination (2005 Newark Bay Phase I Investigation; 2007 Newark Bay Phase II Sediment Investigation; and CPG2008 low-resolution cores).
- USACE 2005 Top of Rock Contours were used to determine approximate bed rock information.
- Previous studies as described in Section 6.1.1.

A visual inspection of the aerial imagery and NOAA navigation charts identified several possible sites in Newark Bay for a CAD. Potential locations were located away from the shoreline and in areas that were adjacent to commercial, industrial, unused or open space property along the shoreline (nearshore). Site configuration was based on the shape of the existing shoreline, the location of the Federal navigation channel and engineering judgment.

Five potential CAD sites were identified (Figure 6-1) and then screened based on site specific criteria. For each of the five sites, the maximum disposal capacities were estimated assuming a side slope of 2H:1V for the contaminated sediment layer and 1.5H:1V for the underlying clay layer. Excavation depth is limited at some locations due to the depth to bedrock or other conditions. The disposal facility capacity estimates are shown in Table 6-2. These numbers represent the maximum available capacity based on existing information. Note that dredged material placement at a CAD would not extend above the existing mudline.

The five potential sites are located in Newark Bay which, along with the FFS Study Area, is part of the Diamond Alkali Superfund Site, and in the general proximity of the FFS Study Area where dredging activities would occur and are subject to the same physical constraints (*e.g.*, bridges). Site boundaries were established to maintain a setback of at least 100 feet from the navigation channel. Additional screening results for the various sites are presented in Table 6-2. These criteria include adjacent land use (e.g., proximity to residential development, sensitive human populations, and environmentally sensitive areas); depth to bedrock; depth of approach waters; the shortest distance to the navigation channel; the presence of offshore utilities or vessel traffic services areas; and the availability of adjacent property.

As shown on Figure 6-1, potential CAD Areas 3, 4 and 5 are located away from the shoreline, avoiding the need for modifications to the existing shoreline, while CAD Areas 1 and 2 are located along the existing shoreline. Limited information is available on the depth of unconsolidated sediments and the underlying clay confining layer. Available data for CAD Area 2 indicate that unconsolidated sediments extend to a depth of 7 feet below the mudline. Bedrock is located at an estimated depth of 60 to 80 feet below the MLW, limiting the depth of CAD in the area. CAD Area 2 is within the general proximity of the dredging work. There are no tidal mudflats in the area although a wetland abuts the property to the north of the site and could be impacted during construction. The Newark Bay EIS indicated that short-term adverse impacts from construction of a disposal facility at this location were balanced by potential beneficial impacts and that no long-term adverse impacts were expected (USACE, 1997b).

CAD Area 3 is located on the eastern side of the Navigation Channel in Newark Bay and can provide the largest surface area of the five areas under consideration. In addition, the average depth to bedrock is estimated to range between 70 to 100 feet below the MLW providing large volume capacities. Depth of unconsolidated sediment is estimated at approximately 4 feet below the mudline. CAD Area 3 is within the general proximity of the dredging work, far from tidal mudflats, avoiding the potential for disturbance to mudflat areas and is located away from the shoreline avoiding impacts to the existing shoreline. CAD Area 3 was also evaluated as a potential site in the EIS for the Newark Bay CDF (designated as Alternative 3, Area 3). The EIS indicated that Area 3 warrants further studies as it would have the advantage of being able to accommodate large volumes of material.

Less information is available on Areas 1, 4 and 5. Based on desktop review of the sources and databases listed above, there are underwater utilities located within Areas 1, 4 and 5 while Areas 2 and 3 are clear of underwater utilities. Available data indicate that Area 1 has a significantly greater depth of unconsolidated sediments compared to the other potential locations, estimated at approximately 15 feet below the mudline. While the depth of the unconsolidated sediments at Area 4 is approximately 5 feet below the mudline, the depth to bedrock ranges between 20 to 60 feet below MLW limiting the available capacity available at this location. Area 5 can provide the largest capacity based on a depth of bedrock of approximately 70 to 120 feet MLW; however, there are underwater utilities located at the location.

Given the available information based on potential capacity, location, depth of contaminants, and other relevant factors as discussed in this section and outlined in Table 6-2, Area 3 was used as the CAD location for evaluating the alternatives for cost estimation purposes in the FFS (see Figures 6-2a through 6-2c for Plan View Schematic). A detailed siting study and extensive public outreach would be conducted during the design phase, should the selected remedial alternative include a CAD for disposal.

6.1.3 Conclusions

The results of the USACE siting study, the Newark Bay CDF EIS study, and additional screening (as outlined in Section 6.1.2) conducted for the FFS indicate developing a CAD site in the Newark Bay is a technically feasible option for dredged material management associated with the FFS alternatives.

6.2 Pre-Design Field Investigations and Laboratory Testing for CAD Design

Various field investigations and laboratory studies are required to support the design of CAD facility. These investigations and studies would take place during the design phase of the remedial alternative, should a CAD cell be included as a disposal option.

6.2.1 Field Investigations

Should a CAD site be selected, a variety of field investigations would be performed to define site-specific conditions . These could include geologic and geotechnical analyses to determine if the underlying soils can handle the weight of the dredged sediment; bathymetric and topographic surveys to assess contours in the area of the CAD cell; collection of sediment to characterize the material for disposal purposes; air and water quality samples to establish baseline conditions in the area; biological testing including habitat surveys and toxicity testing.

Information regarding sampling techniques, collection, and equipment as well as development of field sampling programs for dredged material deposition applicable to CAD siting is provided in the USEPA/USACE Inland Testing Manual (USEPA/USACE, 1998) and NJDEP Dredging Technical Manual (NJDEP, 1997). Additional information on costs for a pre-design investigation is included in Appendix H.

6.2.2 Laboratory Testing and Desktop Studies

Samples collected during the pre-design field investigation would be analyzed in the laboratory to determine design factors for the CAD.

CADs require particular attention to cap design and bearing capacity. Testing and computational analysis procedures for structural elements of the CAD, including shear strength testing, bulking, consolidation analysis and slope stability, are described in Geotechnical Design Considerations for Contained Aquatic Disposal (Rollings, 2000).

The Inland Testing Manual (USEPA/USACE, 1998) provides detailed testing procedures for evaluating potential contaminant migration from dredged material deposition which can be applied to CAD cells prior to implementation. Migration pathways include dispersion to surface water during filling operations, leachate (seepage) into groundwater or surface water, volatilization to the atmosphere, direct uptake by aquatic organisms and subsequent cycling through food webs, erosion via waves and currents, and soluble diffusion convection. Refer to Figure 6-3 for a schematic on contaminant migration pathways for in-placed sediments in CADs. Additional discussion of contaminant pathways for CADs including appropriate testing protocols and evaluation procedures are summarized in the following paragraphs (This text was taken from the following references: USEPA/USACE, 1998; USACE, 2003; and USEPA/USACE, 2004.)

Dispersion to Water Column

During operation, CAD discharges may contain both dissolved and suspended contaminants. In the case of the Lower Passaic River, a large portion of the contaminant load is bound to the particulates. Contaminants released to the water column during sediment placement can be predicted by an elutriate test; depending on the elutriate test results; additional acute water-column toxicity bioassays (considering initial mixing) may also be necessary. Procedures to perform these tests are provided in the Marine Protection, Research, and Sanctuaries Act and Clean Water Act testing manuals (USACE/USEPA, 1991; Palermo, et al., 1998). Computerized programs are available to compare predicted effluent concentrations with water quality criteria (Palermo and Schroeder, 1991) for CAD cells.

Leachate

Water released from the contaminated sediment (*i.e.*, leachate), along with associated dissolved and colloidal materials, can seep through foundation or capping material releasing contaminants to ground or surface water. The process can be facilitated by groundwater migrating vertically or horizontally through the dredged material. During the design phase, models would be used to assess the leachate seepage rate and the impact on water quality.

The Reible Cap model, a model used to predict the long-term movement of contaminants in or through caps due to advection and diffusion, was developed by the USEPA and is described in *Guidance for Subaqueous Dredged Material Capping* (Palermo et al., 1998) and in Appendix F. This model may be applicable to determine leachate migration through final CAD cap layer.

Volatilization to Air

Contaminant transport from *in-situ* sediment to air is a relatively slow process because contaminants must first be released to the water and then to the atmosphere. The potential for volatilization would be evaluated in accordance with regulatory requirements of the Clean Air Act.

Emission rates are primarily dependent on the chemical concentration of the source (*i.e.*, the dredged material), the exposed surface area, and the degree to which the dredged material is in direct contact with the air. Volatilization may occur from exposed dredged material prior to placement; however, this is of limited duration. Since the water depth is anticipated to be relatively deep, volatilization may be less of a concern. Potential, impacts associated with volatilization of contaminants would be evaluated during the design phase, based on the estimated exposure to selected receptors and appropriate inhalation reference doses.

Aquatic Organisms

Aquatic organisms have the potential for exposure to contaminated sediments in the water column and sediment during dredged material placement and post-disposal operations. Biological effects testing including acute and chronic toxicity evaluations and bioaccumulation would be performed in accordance with the USEPA/USACE Inland Testing Manual. In addition, benthic communities may be affected by the mobility of contaminants through the cap, and the cap thickness would be required to account for the effects of bioturbation taking into account the known behavior and depth distribution of infaunal organisms likely to colonize the area.

Erosion

Long-term continuous processes (*i.e.*, tidal currents and normal wave activity) and periodic events such as storms have the potential to erode CAD cap material exposing contaminated sediment to surface water and infaunal organisms. Cap thickness required to account for the effects of erosion would be calculated based on the acceptable level of risk, cap maintenance time period and hydrology. Erosion magnitude and rate can be estimated using hydrodynamic and sediment transport modeling (refer to Appendix B) and models such as Long-Term FATE and empirical simulation techniques. More detail on modeling and calculation procedures can be found in *Guidance for Subaqueous Dredged Material Capping* (Palermo et al., 1998).

6.3 Conceptual Design

A conceptual design for a CAD for the active remedial alternatives was prepared for FFS cost estimating purposes, based on Area 3 as the CAD location.

The conceptual design was based on the following assumption:

- A multi-cell concept in which CADs would be constructed as capacity in existing CAD(s) is exhausted.
    - For Alternative 2, three cells would be constructed with a total footprint of approximately 165 acres (plus 6 additional acres for the construction of entrance channels from the main navigation channel), an estimated effective capacity of approximately 11.4 million cy, and an excavation depth of 60 feet below MLW.
    - For Alternative 3, two cells would be constructed with a total footprint of approximately 76 acres (plus 4 additional acres for the construction of entrance channels from the main navigation channel), an estimated effective capacity of approximately 5.2 million cy, and an excavation depth of 60 feet below MLW.
    - For Alternative 4, one cell would be constructed with a total footprint of approximately 17 acres (plus 2 additional acres for the construction of entrance channels from the main navigation channel), an estimated effective capacity of approximately 1.1 million cy, and an excavation depth of 60 feet below MLW.
- The contaminated unconsolidated sediment layer of the first cell being constructed would be disposed in an off-site, upland facility. The contaminated unconsolidated sediment layer of successive CADs would be disposed in existing cells.
- The underlying clay layer would be disposed in the Historic Area Remediation Site (HARS) disposal area.
- The final grade of the capped cells would be similar to existing bathymetry.

The individual design elements are discussed in further detail below.

6.3.1 Facility Design

The following is a brief summary of the conceptual design of each cell used for sediment disposal at CAD Area 3 developed for FFS cost estimating purposes. Figure 6-4 depicts the conceptual CAD construction sequencing for Area 3. Figure 6-5 illustrates the major design components for a CAD.

- The CAD site would be surrounded by a sheetpile containment system designed to control the migration of solids released during sediment placement. The top of the sheetpile would extend approximately 5 feet above the Mean Higher High Water to provide freeboard during material placement and during storm events.
- The edge of the sheetpile containment system would be placed approximately 100 feet from the main navigation channel. A small channel (approximately 150-foot bottom width and 25-foot depth below MLW with 3H:1V side slopes) would be excavated between the main channel and each CAD.
- A silt curtain would be installed across the entrance channel for use during material placement. The curtain would be permanently attached to the containment system on one side and temporarily attached on the other. Workers on support vessels would open and close the silt curtain as necessary to allow barges to enter and exit the CAD site during offloading operations. To allow flexibility in movement, the bottom of the curtain would be weighted but not anchored to the floor of the entrance channel. A similar silt curtain door design is being implemented as part of the New Bed Harbor CAD (see Section 6.3).
- The contaminated unconsolidated sediment layer of the first CAD to be constructed would be dredged and transported to an off-site, upland facility for processing and disposal. In successive CADs, this contaminated unconsolidated sediment layer would be disposed in the existing cells. The remainder of non-contaminated material would be disposed at HARS or used as capping material.
- Soft sediments and clay would be removed to a depth of approximately 60 feet MLW.
- Each remedial alternative considered in the FFS would result in a different volume of sediment that would need to be placed in CADs. The size of each CAD cell would vary

for each alternative. In order to minimize the amount of disturbed bay bottom area, CADs would be constructed to the maximum depth possible (*i.e.* 10 feet above bedrock). Subsequent cells would be constructed as capacity in the previously constructed cell is reached.

- The CAD dimensions for each alternative are shown in Figures 6-2a through 6-2c. The cells would be constructed with a side slope of approximately 2H:1V in the upper unconsolidated sediment layer and 1.5H:1V in the underlying clay layer.
- A small upland support facility would be developed under the dredging alternatives. The support facility would allow space for parking for workers, storage for equipment and supplies, offices and warehouse space, access to the river and a small area for equipment decontamination.

6.3.2 Dredged Material Placement

It was assumed that sediments would be mechanically dredged and placed in a split hull or bottom dump scow for transport to the CAD site. Dredged material would be placed in the CAD using selective placement. Selective placement of dredged material involves a strategy for placing contaminated sediment within the CAD to minimize the water quality impacts of the CAD. These strategies include:

- Discharging sediment where contaminants remain relatively immobile.
- Placing relatively cleaner dredged material in areas to intercept or attenuate contaminant migration from more contaminated material.
- Discharging sediment below the surface water elevation and keeping portions of the CAD anaerobic, which reduces the potential for release of some classes of contaminants (*e.g.*, metals) to the dissolved phase.
- Configuring the CAD with a greater depth and a smaller footprint which reduces the area subject to erosion, plant and animal uptake, and surface runoff (Palermo and Averett, 2000).

The conceptual sequencing for dredged material placement in a CAD at Area 3 would dictate the dredging sequence.

- For Alternative 2, the majority of the contaminant inventory would be removed and much of the dredged material would be heavily contaminated, so the sequencing for dredging would be dictated by considerations other than placement for contaminant management. For the purposes of the FFS, it has been assumed that dredging for Alternative 2 would occur from RM8.3 downstream to RM0.
- For Alternative 3, the lower 2.2 miles of the FFS Study Area (the deepest material to be dredged and the most heavily contaminated) would be dredged first followed by dredging the remainder of the river to accommodate construction of an engineered cap over remaining contaminated sediments without increasing flooding.
- For Alternative 4, selected areas would be dredged prior to constructing an engineered cap. Because capping activities would be focused on areas that have the highest contaminant flux (gross or net), it is anticipated that the dredged material would all be similarly contaminated. Therefore, similar to Alternative 2, dredging would start upstream and progress downstream.

Section 7 presents modeling results of dredged material placement operations at the CAD site (Area 3).

6.3.3 Closure

Following the completion of dredging operations, the cells would be capped. Prior to capping, the sheetpile containment system would be dismantled. An engineered cap would then be constructed and the original bathymetry reestablished (see Figure 6-4). After closure, vertical migration of contaminants is likely to be of more concern than lateral migration within the cells. Since the geology in the areas where the CAD site would most likely be located (*i.e.*, in the vicinity of Newark Bay) is such that competent clays are commonly encountered at approximately 20 to 30 feet below the mudline, natural conditions would be expected to attenuate lateral contaminant migration. However, groundwater upflow, erosion, bioturbation, and contaminant flux are potential concerns for vertical migration. Appropriate modeling for these conditions would be performed during design in order to calculate final cap thickness.

CAD cap/cover design would account for bioturbation (including root penetration), erosion, consolidation, and long term chemical isolation. For the FFS conceptual design, it was assumed that a three-foot thick sand cap would be placed over the CAD at final grades similar to existing bathymetry. Use of active capping material would be considered during design. If determined to be necessary through hydrodynamic and sediment transport monitoring, armor material could be placed on top of the sand cap to prevent erosion of the cap (also an issue to be considered during design).

6.3.4 Long-term CAD Management

The major considerations for long-term management of a CAD include the following:

- Long-term monitoring
- Cap maintenance
- Reporting and recordkeeping

Long-term monitoring associated with CAD includes turbidity and total suspended solids (TSS) measurements, surface sediment sampling and analysis, biological monitoring and habitat recolonization, and bathymetric surveys. A site-specific long-term monitoring plan would be developed, outlining the types of samples to be collected, required analyses and frequency of sampling. The monitoring requirements are anticipated to be similar to the methods described in the Inland Testing Manual (USEPA/USACE, 1998) and *Contained Aquatic Disposal of Contaminated Sediments in Subaqueous Borrow Pits* (Palermo, 1997). The US Navy (Apitz et al., 2002) has recommended a three-pronged approach to monitoring that can be applied to CADs:

1. Monitor to assess the effectiveness of the remedial action in achieving the ultimate goal, (*i.e.,* protection or recovery of the resource at risk).
2. Identify interim goals and monitor to evaluate the effectiveness of the remedial action in achieving those interim goals.
3. Monitor implementation of the remedial action.

For FFS cost estimation purposes, the following assumptions were made about long-term monitoring requirements:

Water Quality Monitoring

Water samples would be collected annually to assess the impact of the site on water quality. Samples would be analyzed for turbidity, TSS, and potentially other parameters based on design modeling results.

Sediment Monitoring

Sediment samples would be collected annually to assess potential contaminant migration through the surficial deposits from the underlying contaminated sediments as well as the redeposition of sediments in the disturbed areas.

Biological Monitoring

Construction of a CAD system temporarily disrupts the aquatic ecosystem at the site. A Clean Water Act Section 404(b)(1) analysis was conducted to assess the impacts associated with CADs (refer to Appendix F for additional details). The analysis concluded that the CAD would result in temporary losses of shallow bay habitat but over time, the ecosystem would be reestablished in the area. As part of the long-term monitoring program, biological monitoring would be conducted to evaluate the progress associated with the reestablishment of ecosystem and to determine if additional measures are required.

CAD Cap Monitoring

The thickness of the cap would be monitored over time to ensure that adequate material remains in place over the dredged materials. Pre- and post-closure bathymetric surveys would take place to monitor the placement and thickness of the cap over time. As necessary, maintenance (*i.e.*, replenishment) of the cap would also be performed.

Cap Maintenance

Periodic maintenance of the cap is expected to be required. Damage to the cap can be caused by natural events (*e.g.*, erosion, scour due to storm events) and manmade events (*e.g.*, boat anchors, propellers). In addition, if water quality or sediment samples indicate unacceptable levels of leakage through the cap materials, additional or alternative capping materials may be required to be placed in the area.

Reporting and Recordkeeping

Long-term monitoring at the CAD site would include the collection and maintenance of information documenting performance as well as periodic reporting to regulatory agencies on the facility performance.

6.4 CAD Characteristics at Other Sites

Eight CAD projects were selected for evaluation based on the relative similarity of conditions to those in the FFS Study Area. Information on the CAD projects was gathered through a literature review focused on facility construction and consolidation techniques, capping material, water treatment, and contaminant fate and transport. The results of the literature reviews are summarized in Table 6-3.

The CAD projects selected for evaluation include the following:

- Newark Bay,[11] New Jersey
- Boston Harbor, Massachusetts.[12]
- Puget Sound Naval Shipyard, Washington
- Lower Duwamish Waterway, Washington
- Providence River and Harbor Maintenance Dredging Project, Rhode Island
- Ross Island Lagoon, Oregon
- Port of Los Angeles, California
- New Bedford Harbor Superfund Site (NBHSS), Massachusetts

Of the eight CAD projects, seven were constructed and one is currently being constructed (NBHSS). The CAD footprints range from 1.7 to 94 acres in size with CAD capacities ranging

[11] Although referred to as a CDF, the Newark Bay facility is technically a CAD cell as defined in this FFS.

[12] Nine CAD cells were constructed in association with the Boston Harbor Navigation Improvement Project.

from 5,100 cy to 2.3 million cy. Contaminants of concern at the CAD sites include heavy metals, PCBs, PAHs, dioxin, pesticides and other contaminants. In addition, the Newark Bay CAD received material unsuitable for unrestricted ocean disposal (*i.e.,* material with no significant toxicity but potential for bioaccumulation).

The majority of the project excavations were conducted using conventional mechanical dredging techniques (*i.e.,* environmental clamshell buckets) with disposal operations consisting of split hull (bottom dump) barges equipped with global positioning systems. Conventional means of placement (*i.e.,* bottom dumping) have generally been effective, especially when the placement procedures were adequately engineered. Disposal in conjunction with a tremie tube can potentially reduce the effects of potential loss of contaminated material during placement; however, it can significantly increase project costs (Palmerton, 2001). For the Ross Island Lagoon project, split-hull barge and tremie tube disposal methods were used. For the Boston Harbor CAD project, excavation was conducted using level cut/environmental clamshell buckets for surface silts and open-toothed buckets for native clay.

Side slopes and depths varied depending on specific project capacity requirements. The Newark Bay CAD was designed to have a bulking factor of 1.2, slopes of 3:1 and 1.5:1 with a depth of 70 feet below MLW. For the NBHSS, the proposed depth below existing sediment surface is approximately 50 feet and side slopes are 6:1 for the top 7 feet and 3:1 for the remainder. In general, CADs were constructed below the mudline of the adjacent sediment.

Water quality was monitored during placement of dredged material in the CADs. In Newark Bay, turbidity and TSS sampling were conducted during dredged material placement, and bathymetric surveys were performed periodically and after each 10-foot lift of disposed material. Sediment migration during dredged material placement was observed to be minimal at the Newark Bay CAD site. During the Boston Harbor CAD operations, monitoring was extensive and included fisheries observation, turbidity tests and real-time tracing of turbidity, and bioassay tests. Water quality and TSS monitoring were conducted adjacent to dredging operations during placement of dredged material.

Some CADs also included containment structures to prevent dredged material from escaping the CAD during placement. The Port of Los Angeles project, a subaqueous berm was constructed around the unit before disposal. Although still under construction, the NBHSS CAD design includes silt curtains along the perimeter of the CAD (Apex, 2013). The silt curtains are to be used during placement of dredged material from January through June of every year the CAD is in operation. The design includes a silt curtain “door” to allow for barges to enter and exit the CAD. The NBHSS CAD has a proposed footprint of approximately 10 acres and a capacity of approximately 350,000 cy.

Capping of the dredged material is a primary design component of CAD and is a primary means for effective chemical and physical isolation of the contaminated sediments. Typical caps ranged from 2 to 6 feet in thickness and were constructed of clean cap material (*e.g.,* clean sand). The Newark Bay CAD was capped with approximately 3 feet of sand after the cell was filled to capacity with dredged material. For the NBHSS, a proposed cap thickness of 3 feet was established based on modeling results. For the Puget Sound Naval Shipyard, the capping process included an intermediate cap placement prior to final capping.

The cap integrity was evaluated through monitoring programs. For example, monitoring of the eight Boston Harbor CAD caps included bathymetric, sub-bottom, and side-scan sonar surveys, core collection for chemical data, and video logs during cap placement. After closure of each cell, ten-foot sediment cores, surface samples, and sediment profile images were collected. Cap erosion predictions from both tidal currents and ship propeller wash were developed to characterize the anticipated amount of cap damage to be expected from either source. Monitoring efforts showed no significant changes to the cap, and the capped area was recolonized with benthic communities similar to those in the surrounding harbor bottom (Palmerton, 2003). The time frame to achieve benthic recolonization was not available.

The original tipping fee at the Newark Bay CAD was approximately $29 per cy, based on a capacity of approximately 1,500,000 cy. The CAD was permitted for 10 years but was anticipated to be filled in 1 to 2 years. Assuming the tipping fee accounts for significant cost items, the initial estimated construction and operating cost was approximately $44 million. The

CAD remained open longer than originally anticipated and the tipping fee was increased to $36 per cy after several years. Assuming that the disposal capacity remained unchanged, the increased tipping fee suggests construction and operating costs of approximately $50 million (average $33 per cy). For the Boston Harbor project, the total cost for the CAD project was approximately $2 million ($87 per cy).

In general, CADs can provide significant cost savings compared to upland disposal. For example, the Puget Sound Naval Shipyard project reported $30 million savings in transportation costs when compared with upland disposal options (Palmerton, 2001).

The conceptual design for CADs for the FFS Study Area incorporates many of the features incorporated into the construction and closure of the Newark Bay and Boston Harbor CADs, as well as components from the other projects reviewed. These features and procedures include pre-design investigation sampling (including geotechnical and chemical sediment sampling, and geophysical and bathymetric surveys), sampling and monitoring throughout CAD construction and material placement, and an engineered cap as a final cover material for the cell. Since highly contaminated FFS Study Area sediments may be disposed in the CAD, the CAD would potentially require comprehensive environmental controls to limit the mobility of contaminants during construction and operation, as well as after closure of the cell. For example, the CAD site would be enclosed within a sheetpile containment system to minimize particle migration outside the CAD area during disposal operations.

Cost estimates for CAD construction, operation, and maintenance for the FFS Study Area remediation vary for the active remedial alternatives, depending on the volume of material to be dredged and disposed. The tipping fee for the Newark Bay CAD ($29 - $36 per cy) is significantly less than the estimated dredged material disposal cost for a FFS Study Area remediation CAD (approximately $70 or $80, depending on the alternative [see Appendix H]) although the costs are not directly comparable. The increased costs associated with the highly contaminated nature of the FFS Study Area sediments (*e.g.*, a more extensive pre-design investigation and more extensive environmental controls and monitoring) substantially increase the overall disposal cost compared to projects that receive navigation dredged material only.

The CAD projects described in this Section were constructed such that contaminated sediments are contained within the cells. Lessons learned from these projects can be incorporated into a CAD for the FFS Study Area remediation to achieve similar results in an environmentally protective manner.

Lessons learned from the Newark Bay Project include the following:

- CAD is feasible and successful in containing dredged material in Newark Bay.
- Sediment disposal should be performed under favorable hydrodynamic conditions to minimize potential environmental impacts, including resuspension and contaminant release (USACE, 1997b).

Lessons learned from the Boston Harbor CAD project include the following (text abstracted from Bottin, 2002):

- The natural cohesion and strength of sediments were altered by the dredging process, resulting in dredged material in the CADs that was unstable due to high water content and low shear strength. Observations indicated that extending the dredged material consolidation period prior to capping would allow the sediment shear strength to increase sufficiently to adequately resist the superimposed cap weight.
- From analytical modeling results, an undrained shear strength of approximately 957 Pascal (Pa; 20 pounds per square foot [psf]) was determined to be a reasonable criterion for dredged material strength prior to capping. Physical modeling of consolidation within the CAD when a cap is placed on dredged material with an undrained shear strength between 957 Pa (20 psf) and 1,436. Pa (30 psf) indicated that the sand cap would remain stable, although settlement was observed in the sand surface.
- Monitoring indicated that dredged material or capping material was temporarily resuspended during the passage of large vessels; however, the volume of capping material or dredged material resuspended from both capped and uncapped CADs was very small. The resuspended sediments settled to the seafloor with one hour of

suspension. It was also determined that tidal currents within Boston Harbor were insufficient to induce “major” erosion of dredged material or capping material within the CAD.

Lessons learned from the other projects listed include the following:

- Capping can provide effective chemical and biological isolation of the contaminants. Choice of capping material, thickness and method used to place the cap are critical design components that must factor in site-specific conditions.
- A comprehensive, site-specific sampling and monitoring program before, during and after CAD placement is critical to the success of the project. Site specific factors include water depth, distance from dredging areas, hydrodynamics, sediment characteristics, water quality, biological resources, etc. (Palmerton, 2003).
- The potential for bottom surges needs to be accounted for as was the case for the Boston Harbor, Puget Sound Naval Shipyard and Lower Duwamish Waterway projects. “Recognition of the potential for bottom surge and the use of real-time monitoring designed to identify surges could have provided early information about placement techniques and the potential need to remove contaminated surge deposits”. In the case of the Boston Harbor CAD project, denser material placed on top of lighter material caused a small amount of disposed material to be pushed outside the cell. (Palmerton, 2003).
- Sequencing of dredging operations allows for a project to continue in a cost effective manner and minimizes interruptions. This sequencing includes the methods used to dredge sediments, the length of time that consolidation would be allowed prior to capping, methods used to place the cap, length of time to fill the cell, etc. Considerations for environmental windows during sequencing are also a factor that must be incorporated.

Table 6-3 provides additional lessons learned during CAD operations for the projects selected for evaluation based on literature review.

7 MODELING ANALYSIS OF CAD PLACEMENT OPERATIONS

This section discusses the modeling analyses and results conducted to evaluate the use of a CAD in Newark Bay as a sediment management alternative for contaminated dredged sediments from the FFS Study Area.

Recent modeling of the fate of dredged material during disposal in a proposed Newark Bay CAD without any particulate and dissolved phase controls indicated that engineering controls may be needed to limit releases of contaminants contained in dredged materials (see Attachment C). The results indicated that contaminant losses from the CAD cells were approximately one percent of the mass placed, assuming placement of a relatively small amount of dredged materials in the CAD site (approximately 38,400 cy) over a seven day period. This loss could cause contaminant concentrations in Newark Bay surface sediments to increase by up to 220 percent for dioxin, 10 percent for PAHs and 35 percent for PCBs at small scattered areas in the bay. Because of the concern for solids and contaminant releases from the CAD, a sheetpile containment system around the CAD was proposed as an engineering control, with an entrance channel through which the disposal barges would enter and exit the CAD (refer to Section 6.3.2). The conceptual design for facility operations is that a silt curtain would be installed across the entrance channel to the operating cell; 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.

The modeling focused on estimating the short-term contaminant release during placement in the middle CAD for FFS Alternative 2, at various fill levels. This condition was taken as representative of conditions that are likely to exist during operations under any of the alternatives. Figure 6-2a shows the proposed locations of CAD cells within Newark Bay for Alternative 2 as described in the FFS. While there are multiple cells associated with this alternative, only the middle cell was modeled in this evaluation as representative of CAD operations in general (and since only one cell is planned to be operational at any given time).

The objective of this modeling was to quantify the short-term losses of solids and contaminants (represented by 2,3,7,8-TCDD and Phenanthrene) during the placement of dredge materials from the FFS Study Area at different fill levels. Specifically, solids and contaminant losses were evaluated at 0 percent, 50 percent and 90 percent fill levels, and a linear combination was used to estimate the overall losses expected during the filling operations. In addition, a literature search on the effectiveness of silt curtains in further reducing the estimated losses was conducted. Dredging contractors verbally expressed some doubts about the feasibility of installing silt curtains over an opening that allows for barge traffic and would have to be regularly opened and closed. However, recent CAD design bidding documents for NBHSS include the use of a silt curtain "door" (Apex, 2013) similar to that included in the conceptual design.

7.1 Approach

The dimensions of the Alternative 2 CAD cell configuration are approximately 1500 feet x 1600 feet. The area within the containment system is about 279 acres (Figure 7-1). The approach used in this evaluation includes the following:

- Performing hydrodynamic simulations to understand the estuarine circulation in the vicinity of the CAD
- Applying the Short-Term FATE of dredged material (STFATE) model to simulate the dynamics of dredge material placement in the middle CAD
- Calculating total solids loss from the CAD
- Calculating of total contaminant loss from the CAD.

These steps are described in more detail below.

7.1.1 Hydrodynamics

Water circulation in the vicinity of the CAD was simulated using the Lower Passaic River-Newark Bay hydrodynamic model developed for the FFS (see Appendix B). This model was modified with refined spatial resolution in the area of the proposed CAD (Figure 7-1). The containment system proposed for controlling solid phase releases from the CAD was represented in the model by the thin-dam feature. This feature allowed interfaces between grid cells to be specified as barriers, so that no transport occurs across those interfaces. The operation of the silt curtain was not represented explicitly in the hydrodynamic simulations; however, bounding simulations were performed to evaluate the effect of the silt curtain on currents in the CAD. In one simulation, the silt curtain was represented as a thin dam, which represented a complete elimination of currents through the entrance channel. The opposite representation of the effect of the silt curtain was simulated by leaving the entrance channel completely open. Fill levels of 0, 50, and 90 percent full were simulated for the open entrance channel configuration, to represent the influence of CAD cell depth on the vertical structure of the currents. The depths of the CAD for these levels were 62, 36 and 16 feet mean sea level, respectively. Each of the four hydrodynamic conditions (the three fill levels with open entrances and the closed entrance scenario) was simulated for a one-year time period. The high flow water year in 2005, during which a 1 in 10-year flow event occurred, was used as the base flow condition in the modeling. The discharges during the 2005 storm event measured at Little Falls USGS gauging station, upstream of Dundee Dam are presented in Figure 7-2.

7.1.2 Barge Placement (STFATE Model)

Sediment dynamics during barge placement in the middle CAD were estimated with the STFATE model (Johnson and Fong, 1995). STFATE mathematically models the physical processes that determine the short-term fate of dredge materials disposed at open-water locations following the placement of a single load of dredged material. The physics of dredged material released from a barge can be categorized into three general phases: convective descent, dynamic collapse, and passive transport and dispersion. These processes are described in detail in Attachment C. The model was run for 1 to 1.5 hours after disposal. The model outputs of interest in this evaluation included: the mass of dredged material suspended in the water column, the horizontal and vertical distribution of the Gaussian clouds of suspended materials in the water column, and the suspended solids concentration in the water column.

STFATE model simulations were developed to represent the anticipated operations for the Newark Bay CAD. Placement was assumed to occur at the center of the CAD during these model runs. Barge dimensions, material characteristics, and water column properties were made consistent with values specified in Attachment C as follows:

- Placement site conditions were represented as a uniform, flat bottom with water depth represented as the depth to the bottom of the CAD at fill levels corresponding to the hydrodynamic simulation.

- Water densities at the dredging site and the placement site were assumed to be 1.002 and 1.010 grams per cubic centimeter, respectively.

- Barge placement was assumed to be accomplished with a 4,000 cy bottom-release scow. Dimensions of the 4,000 cy Sterling Mighty Quinn were used as a representative barge of this class. The dimensions include: length - 240 feet; beam - 54 feet; bin length – 150 feet; bin width - 40 feet; pre-disposal draft - 14 feet; light draft - 3 feet.

- A conservative approach was used when defining the physical properties of the dredged material (*i.e.*, a material with a high percentage of silt was used in the model). Based on grain size data obtained during the Low Resolution Coring Program conducted in 2006 for the FFS Study Area, the sample with the highest percent silt had the following grain size distribution: 83 percent silt, 11 percent clay, and 6 percent sand. The *in-situ* moisture content was 55 percent.

- Applying a bulking factor of 25 percent (Bray et al, 1997) to account for additional water entrainment during mechanical dredging, and for clumping, the inputs for the material to STFATE were specified as: 12.3 percent clumps, 0.87 percent sand, 13.6 percent fines, and 73.3 percent water, with a bulk density of 1.32 grams per cubic centimeter. Given these characteristics, the total mass of sediment in a 4,000 cy barge is approximately 2,200,000 kg.

The average difference between high and low tide water elevation in Newark Bay is about 5 feet. However, the depth of the CAD cell entrance is about 25 feet at the entrance channel. In this analysis, it was assumed that all suspended solids clouds from STFATE in the top 25 feet of the water column have the potential to be transported outside the CAD through the entrance channel. The mass of solids within the top 25 feet of the water column in the CAD was used as the basis of estimating particulate contaminant losses from the placement operations.

For each fill level, a single barge placement was simulated. STFATE does not have the capability to track multiple plumes during consecutive barge placements. It was observed from New Bedford Harbor that the single barge placement at different fill levels can be linearly combined to determine overall losses from the placement operations (Schroeder et al., 2010). That approach was used here as well by simulating single barge placement at the different fill levels, and estimating the overall placement loss using a linear weighting scheme described in Attachment C.

7.1.3 Water Column Solids and Contaminant Concentrations

During filling, dredged material would be stripped and resuspended from the discharge, releasing both particulates with their associated contaminants and porewater with its dissolved contaminants. Calculation of contaminant mass in the water column above the CAD was based on the following:

- Total contaminant mass – In the water column above the CAD, contaminant masses were estimated using the suspended sediment cloud in the top 25 feet of the water column from STFATE and the bulk sediment contaminant concentrations of the dredged material. The bulk sediment concentration of the dredged material was conservatively represented by the 95 percent upper confidence limit (UCL) of the average concentration of the dredge material in the FFS Study Area, outside the TSI Phase 1 Removal area. These 95 percent UCL concentrations are 9 ppb for 2,3,7,8-TCDD and 17,000 ppb for Phenanthrene.
- Dissolved Phase Fraction – The dissolved phase fraction of the contaminant mass in the top 25 feet above the CAD was estimated using an equilibrium partitioning approach with the following parameters: the 95 percent UCL bulk sediment concentrations discussed above for the dredge sediments, an organic carbon content of 4 percent for the Lower Passaic River sediments, and site-specific organic carbon partitioning coefficient of 6.81 for 2,3,7,8-TCDD and 5.98 for Phenanthrene used in the FFS fate and transport model.

7.1.4 Solids and Contaminant Loss in Outgoing Tide

After running STFATE for 1 to 1.5 hours, it was assumed that the simulated solids and associated contaminant mass in the 25 feet water column would be maintained as the water exits the entrance during the outgoing tide. This is conservative because additional settling would occur that would further reduce the resuspended mass in the water column.

7.2 Results

7.2.1 Hydrodynamics

Flow movement within the CAD is dependent on the level of in-place material and tidal phase. Figures 7-3 through 7-6 present the hydrodynamic results of speed (velocity magnitude) at a position 70 percent of the water depth below the surface for selected model grid cells in the main channel, the CAD entrance channel and inside the CAD. Directional velocity profiles with depth are plotted for the main channel, entrance, and center of the CAD for two selected time periods corresponding to pre-storm event and two days after the peak discharge recorded at Little Falls (Figures 7-7a, 7-7b, 7-8a, 7-8b, 7-9a, and 7-9b). The velocity along the channel (V) is positive towards the Passaic River, and the cross channel velocity (U) is positive to the east. The overall observations from the hydrodynamics are:

- Speeds within the CAD are considerably less than velocities in the navigation channel.
- Directional velocities are small and fluctuate with depth within the CAD. Unlike the main channel where V dominates the speed, both the U and V velocities are of similar magnitudes and ranges within the CAD. There were also no significant differences in the U and V values simulated for the different fill scenarios. Based on these observations, the U, and V velocities were set between 0.1 to 0.2 feet per second (fps) in STFATE model simulations for the 0 percent, 50 percent and 90 percent fill scenarios.
- During the high flow event, the influence of freshwater discharged from the Lower Passaic River into Newark Bay affected the salinity (not shown here) and circulation in the vicinity of the CAD. During high river flow conditions there are substantial salinity differences between the channel and inside of the CAD. Water salinity inside of the CAD

remains high while the water in the channel is quickly flushed out by the freshwater and this promotes horizontally mixing across the channel and within the CAD.

7.2.2 Solids and Contaminants in Suspension and Losses

Table 7-1 provides the predicted mass of fine-grained dredge material that remains in suspension in the entire water column of the CAD during a single barge disposal event and indicates that about 2 to 3 percent of the placement materials remain in the water column 1 to 1.5 hours after disposal. The solids would extend from the surface to the bottom depth of the CAD. This result is consistent with model results obtained for CAD simulation at New Bedford Harbor (Schroeder et al., 2010) where 3 to 4 percent were estimated to remain in the water column during that period. Schroeder et al. (2010) indicated that these solids mass and the associated TSS concentrations are a generalization and cites field monitoring study by Dragos (2009) in the New Bedford Harbor, which showed TSS concentrations returning to background levels typically within two hours.

Assuming these clouds (*i.e.*, suspended material in the water column from TSS) from STFATE are uniformly distributed vertically, the potential water column solids mass lost through the CAD cell entrance is given as the mass in the top 25 feet of the water column (Table 7-2). Using the water column solids mass in the top 25 feet of the water column and the bulk sediment concentrations, the predicted total contaminant mass that could be potentially be lost from the CAD for the single disposal event are given in Table 7-2. The mass of dissolved phased contaminants lost to resuspension (notes in Table 7-2) during offloading operations is small compared to the estimated total mass of contaminant lost when the tide goes out.

The total mass lost from the water column on the outgoing tide ranged from 0.06 to 0.5 percent of the mass of material placed in the CAD. The overall average mass lost for the various fill levels was estimated as 0.23 percent (Table 7-3). For Alternative 2, the inventory of 2,3,7,8-TCDD targeted for removal is approximately 38 kg. If that inventory is placed into CADs, the losses during disposal would be approximately 87 grams from 2018 to 2029 or an average of 8.7 grams per year. This flux is less than half the average annual flux of 2,3,7,8-TCDD discharged into Newark Bay from the Lower Passaic River (refer to Remedial Investigation Chapter 5 for additional details).

7.2.3 Effect of Silt Curtain at CAD Entrance

Silt curtains are devices that control suspended solids and turbidity in the water column generated by dredging and disposal of dredged material. It has been reported that under ideal conditions, turbidity levels in the water column outside the curtain can be as much as 80 to 90 percent lower than levels inside or upstream of the curtain. Such ideal conditions include: low turbulence, low currents (less than 1.5 fps), and appropriate construction and deployment of the silt curtains. During a capping demonstration study in the Grasse River, it was observed that water column TSS and turbidity were elevated inside the cell undergoing capping. However, TSS and turbidity were not significantly elevated outside of the silt curtains, with levels returning to baseline a short distance outside of the silt curtain (Alcoa, Inc., 2002).

Review of the directional velocities on the western side of the entrance grid cell (U velocities) from Figures 7-3 through 7-9 indicates that values are typically lower than 1.5 fps. There is potential for bottom U velocities to be relatively higher than values at the top because of salinity driven circulation associated with the storm event simulated by the model. The model predicted U velocities are within the range that is suitable for utilization of silt curtains. When the entrance channel is assumed as completely closed, hydrodynamic model results shows little circulation driven by the effect of wind. Assuming zero currents in the CAD and performing STFATE simulation for three hours for the 50 percent fill depth level, the relative distribution of the suspended solids differs from results obtained above, with more than two-thirds of the solids located below the lip of the CAD. This result suggests that any containment that reduces the circulation would result in more solids sinking downwards over time. When currents are directed to the west of the CAD, suspended particles may migrate towards the entrance, and so care must be taken when opening the silt curtain to ensure that the suspended solids are contained as the barge moves in and out of the CAD entrance. A two curtain lock system at the entrance would minimize the escape of solids during opening and closure.

7.3 Conclusions

Simulations were performed for dredge sediment disposal in the middle CAD for FFS Alternative 2 remedial option at 0, 50, and 90 percent CAD fill levels. Three-dimensional hydrodynamic model was used to determine circulation patterns and STFATE model used to simulate solids dynamics during and after barge disposal. The results of the modeling are:

- Constructing a containment system around the CAD reduces water currents in the CAD.
- Approximately 2 to 3 percent of the fine-grained solids remain in suspension 1 to 1.5 hours after disposal.
- The overall mass lost estimated from the single disposal event was 0.25 percent of the mass placed.

8 ACRONYMS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzodioxin
APC	air pollution control
ARARs	applicable or relevant and appropriate requirements
AUD	Acceptable Use Determination
CAD	Confined Aquatic Disposal (Contained Aquatic Disposal)
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPG	Cooperative Parties Group
cy	cubic yards
DMM	Dredged Material Management
EIS	Environmental Impact Statement
FFS	Focused Feasibility Study
fps	feet per second
GFT	Glass Furnace Technology
GIS	Geographical Information System
GTI	Gas Technology Institute
H:V	horizontal to vertical
HARS	Historic Area Remediation Site
HMA	hot mix asphalt
kg	kilogram
lbs	pounds
MLW	mean low water
NBHSS	New Bedford Harbor Superfund Site
N.J.A.C	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJDOT-OMR	New Jersey Department of Transportation Office of Maritime Resources
NOAA	National Oceanic and Atmospheric Administration

NRDCSRS	New Jersey Non-Residential Direct Contact Soil Remediation Standards
Pa	Pascal
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
ppb	parts per billion
ppm	parts per million
psf	pounds per square foot
RCRA	Resource Conservation and Recovery Act
RDCSRS	New Jersey Residential Direct Contact Soil Remediation Standards
RM	river mile
SITE	Superfund Innovative Technology Evaluation
SPLP	Synthetic Precipitation Leaching Procedure
S/S	solidification/stabilization
STFATE	Short-Term FATE of dredged material
SVOC	semi volatile organic compounds
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
TSI	Tierra Solutions, Inc.
TSS	total suspended solids
UCL	upper confidence limit
UHC	underlying hazardous constituents
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTS	universal treatment standard
VOC	volatile organic compounds
WPC	Westinghouse Plasma Corporation
WRDA	Water Resources Development Act

Acronyms Presented in Tables

BHNIP	Boston Harbor Navigation Improvement Project
CWM	Chemical Waste Management
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality
GPS	Global Positioning System
μg/kg	micrograms per kilogram
μg/L	microgram per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MCY	million cubic yards
NBCDF	Newark Bay Confined Disposal Facility;
PANY/NJ	Port Authority of New York & New Jersey
PRHMDP	Providence River and Harbor Maintenance Dredging Project;
ROD	Record of Decision
TBT	Tributyltin

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TABLES

Table 1-1a River Transects Used for Sediment Removal Volume Estimates – Alternatives 2 and 3

Transect	River Mile
A	0
B	0.6
C	1.2
D	1.7
E	2.2
F	2.6
G	3.1
H	3.6
I	4.1
J	4.6
K	5.1
L	5.6
M	6.1
N	6.6
O	7.1
P	7.6
Q	8.1
R	8.3

Table 1-1b River Transects Used for Sediment Removal Volume Estimates - Alternative 4

Transect	River Mile
AA	1.09
BB	1.73
CC	2.65
DD	3.58
EE	3.78
FF	4.69
GG	5.49
HH	6.73
II	7.59
JJ	8.13

Table 1-2 Depth for Sediment Removal from Shoals for Alternative 2

Transect	Removal Depth in Shoal Areas (Feet)
Kearny Shoals	3.5
A	19.5
B	17
C	17
D	11
E	10
F	8.5
G	11.5
H	11
I	7
J	12.5
K	12.5
L	12.5
M	9.5
N	6
O	8.5
P	3
Q	3
R	3

Table 1-3 Bathymetric Comparison

River Section	Deposition			Erosion			Net Volume (CY)
	Average Difference (Feet)	Area (Acres)	Volume (CY)	Average Difference (Feet)	Area (Acres)	Volume (CY)	
Alternative 2							
RM0 to RM8.3	1.38	178	396,255	-0.80	189	-245,435	150,820
Additional Dredging Volume for Alternative 2							151,000
Alternative 3							
RM0 to RM2.2 - Left Shoal	0.18	13.71	3,872	For Alternative 3 only the net change was calculated over the area of interest.			
RM0 to RM2.2 - Right Shoal	1.56	13.68	34,543				
RM0 to RM2.2 - Nav Channel	1.77	78.58	224,566				
Additional Dredging Volume for Alternative 3							263,000

Notes:

cy = cubic yards; RM = river mile.

The depth difference between the bathymetric surveys was calculated by comparing the 2004 single beam points to the 2010 average depth of 2010 survey within 3 feet of the 2004 sounding location. The extent of depositional and erosional areas were estimated by a comparison between the 2004 and 2010 bathymetric surfaces (TINs). Areas provided above correspond to areas where both surveys had data points.

Bathymetric comparisons were not performed for Alternative 4 because sediment removal volumes are based on a specific dredging depth below the existing bathymetry to accomodate an engineered cap; therefore, historical deposition and erosion would not significantly effect removed volumes.

Table 1-4 Mudflat Areas and Sediment Removal Volumes by River Mile

River Miles	Mudflats (Acres)	
	Alternatives 2 & 3	Alternative 4
0 - 1	35.2	31.2
1 - 2	0.9	0.0
2 - 3	12.3	0.4
3 - 4	11.7	0.5
4 - 5	11.5	4.6
5 - 6	1.4	0.1
6 - 7	6.3	0.5
7 - 8.3	21.7	14
Total	101.2	51.4

Table 1-5 Volume of Sediment to be Removed for Alternative 2

Alternative 2 Deep Dredging with Backfill				
Inventory Removal Component				
Section		**Average Surface Area (Square Feet)**	**Average Depth of Section (Feet)**	**Volume of Section (CY)**
Kearny Point Shoal Area		7,214,146	3.5	*935,167*
Section		**Average Cross Sectional Area (Square Feet)**	**Length of Section (Feet)**	**Volume of Section (CY)**
A - B	Left	1,267	3,168	148,688
	Center	3,516		412,505
	Right	2,359		276,832
B -C	Left	1,014	3,168	118,997
	Center	4,510		529,116
	Right	3,904		458,117
C - D	Left	1,226	2,640	119,862
	Center	5,383		526,383
	Right	3,459		338,256
D - E	Left	1,671	2,640	163,384
	Center	5,608		548,319
	Right	1,669		163,239
E -F	Left	1,912	2,112	149,575
	Center	5,541		433,399
	Right	1,324		103,571
F -G	Left	2,103	2,640	205,634
	Center	3,150		308,027
	Right	891		87,118
G - H	Left	1,581	2,640	154,604
	Center	3,728		364,561
	Right	1,095		107,055
H - I	Left	529	2,640	51,684
	Center	3,516		343,749
	Right	1,445		141,240
I - J	Left	474	2,640	46,348
	Center	3,104		303,466
	Right	1,747		170,792
J - K	Left	264	2,640	25,834
	Center	2,159		211,145
	Right	1,820		177,911
K - L	Left	236	2,640	23,103
	Center	2,016		197,134
	Right	1,064		104,046
L - M	Left	195	2,640	19,019
	Center	1,201		117,399
	Right	197		19,243

Table 1-5 Volume of Sediment to be Removed for Alternative 2

Section		Average Cross Sectional Area (Square Feet)	Length of Section (Feet)	Volume of Section (CY)
M - N	Left	150	2,640	14,687
	Center	1,681		164,346
	Right	385		37,626
N - O	Left	422	2,640	41,246
	Center	2,468		241,278
	Right	558		54,582
O - P	Left	626	2,640	61,191
	Center	1,191		116,444
	Right	886		86,597
P - Q	Left	298	2,640	29,126
	Center	1,517		148,328
	Right	734		71,773
Q - R	Left	261	1,056	10,209
	Center	588		23,008
	Right	115		4,492
Subtotal Inventory Removal Component				9,709,454
Plus Delta 2004-2010 Volume				151,000
Minus Phase 1 and Phase 2 Inventory Removal				-200,000
Total Inventory Removal Component				9,660,454
Armor and Mudflats				
Section		**Area (Square Feet)**	**Depth (Feet)**	**Volume of Section (CY)**
Armor/Wearing Layer		0	-	0
Additional Mudflat Volume		161,172	3.5	20,893
Total Volume (CY)				*9,681,347*

Notes:

cy = cubic yards.

The left area refers to the left shoal area (looking upriver), the center area refers to the area within the horizontal limits of the authorized navigational channel, and the right area refers to the right shoal area (looking upriver).

Table 1-6 Volume of Sediment to be Removed for Alternative 3

Alternative 3 Capping with Dredging for Flooding and Navigation			
Navigation Component			
Section	**Avg. Cross Sectional Area (Square Feet)**	**Length of Section (Feet)**	**Volume of Section (CY)**
A - B	4,270	3,168	501,032
B - C	6,222	3,168	730,044
C - D	6,381	2,640	623,920
D - E	4,673	2,640	456,879
Flooding Component			
Section	**Avg. Cross Sectional Area (Square Feet)**	**Length of Section (Feet)**	**Volume of Section (CY)**
E - F	1,461	2,112	114,316
F - G	1,480	2,640	144,684
G - H	1,381	2,640	135,051
H - I	1,436	2,640	140,431
I - J	1,436	2,640	140,442
J - K	1,234	2,640	120,630
K - L	1,057	2,640	103,377
L - M	1,057	2,640	103,377
M - N	973	2,640	95,113
N - O	1,123	2,640	109,837
O - P	1,431	2,640	139,895
P - Q	1,303	2,640	127,388
Q - R	1,107	1,056	43,307
Subtotal Inventory Removal Component			3,829,724
Plus Delta 2004-2010 Volume			263,000
Minus Phase 1 and Phase 2 Inventory Removal (top 2.5 feet)			-41,664
Total Inventory Removal Component			4,051,060
Armor and Mudflats			
Section	**Area (Square Feet)**	**Depth (Feet)**	**Volume of Section (CY)**
Armor/Wearing Layer	5,170,572	0.5	95,751
Additional Mudflat Volume	1,694,484	2.5	156,897
Total Volume (CY)			*4,303,708*

Notes:

cy = cubic yards.

Table 1-7 Volume of Sediment to be Removed for Alternative 4

Alternative 4 Focused Capping with Dredging for Flooding			
Flooding Component			
Section	**Avg. Cross Sectional Area (Square Feet)**	**Length of Section (Feet)**	**Volume of Section (CY)**
AA - BB	881	3,377	110,192
BB - CC	672	4,873	121,201
CC - DD	385	4,910	69,966
EE - FF	730	4,780	129,322
FF - GG	286	4,267	45,199
GG - HH	493	6,555	119,714
HH - II	899	4,528	150,848
II - JJ	874	2,824	91,412
Subtotal Inventory Removal Component			837,854
Plus Delta 2004-2010 Volume			0
Minus Phase 1 and Phase 2 Inventory Removal (top 2.5 feet)			0
Total Inventory Removal Component			837,854
Armor and Mudflats			
Section	**Area of Dredging (Square Feet)**	**Depth (Feet)**	**Volume of Section (CY)**
Armor/Wearing Layer	2,564,240	0.5	47,486
Additional Mudflat Volume	1,467,972	2.5	135,923
Total Volume (CY)			*1,021,263*

Notes:

cy = cubic yards.

Table 1-8 Volume of Sediment to be Removed for Each Remedial Action Alternative

Alternative	Alternative 1 – No Action	Alternative 2 – Deep Dredging with Backfill [a]	Alternative 3 – Capping with Dredging for Flooding and Navigation [a]	Alternative 4 – Focused Capping with Dredging for Flooding [a]
Navigation Channel + Shoals/Side Slopes (CY)	0	9,709,000	3,830,000	838,000
Delta 2004 – 2010 Bathymetry	0	151,000	263,000	0
Minus Phase 1 and 2 Inventory Removal	0	-200,000	-42,000	0
Room for Armor and Wearing Layer (CY)	0	0	96,000	48,000
Mudflats (CY)	0	21,000	157,000	136,000
Total Volume (CY)	0	9,681,000	4,304,000	1,021,000

Notes:

cy = cubic yards.

a: Volumes are rounded to the nearest thousand cubic yards.

Table 2-1a Frequency of RCRA Exceedances

Contaminant	Bulk Sediment Concentration (X) Limit	Bulk Sediment Concentration Units	RCRA TCLP Screening Value	TCLP Units	Number of Cores	Number of Samples	Number of Samples that Exceeded the Standards	Percentage of Samples that Exceeded the Standards
1,1-Dichloroethene	5,900	µg/kg	700	µg/L	148	674	0	0.00%
1,2-Dichloroethane	4,400	µg/kg	500	µg/L	148	674	0	0.00%
1,4-Dichlorobenzene	4,500	µg/kg	7,500	µg/L	147	653	0	0.00%
2,4,5-TP (Silvex)	90,000	µg/kg	1,000	µg/L	148	921	0	0.00%
2,4,5-Trichlorophenol	130,000	µg/kg	400,000	µg/L	150	937	0	0.00%
2,4,6-Trichlorophenol	75,000	µg/kg	2,000	µg/L	150	937	0	0.00%
2,4-D	100,000	µg/kg	10,000	µg/L	148	922	0	0.00%
2,4-Dinitrotoluene	27,000	µg/kg	130	µg/L	150	935	0	0.00%
2-Butanone	100,000	µg/kg	200,000	µg/L	141	612	0	0.00%
2-Methylphenol	40,000	µg/kg	200,000	µg/L	149	936	0	0.00%
4-Methylphenol	34,000	µg/kg	200,000	µg/L	149	936	**1**	**0.11%**
Alpha-Chlordane	550,000	µg/kg	30	µg/L	147	837	0	0.00%
Arsenic	183	mg/kg	5	mg/L	149	931	0	0.00%
Barium	661	mg/kg	100	mg/L	60	433	2	0.46%
Benzene	10,500	µg/kg	500	µg/L	148	675	0	0.00%
Cadmium	33	mg/kg	1	mg/L	146	922	**15**	**1.63%**
Carbon Tetrachloride	3,300	µg/kg	500	µg/L	148	673	0	0.00%
Chlorobenzene	6,000,000	µg/kg	100,000	µg/L	148	673	0	0.00%
Chloroform	3,300	µg/kg	6,000	µg/L	148	674	0	0.00%
Chromium	1,650	mg/kg	5	mg/L	146	922	**1**	**0.11%**
Endrin	18,000	µg/kg	20	µg/L	149	886	0	0.00%
Gamma-BHC (Lindane)	93,000	µg/kg	400	µg/L	148	849	0	0.00%
Heptachlor	9,000	µg/kg	8	µg/L	147	866	0	0.00%
Heptachlor Epoxide	300,000	µg/kg	8	µg/L	149	888	0	0.00%
Hexachlorobenzene	375,000	µg/kg	130	µg/L	149	973	0	0.00%
Hexachlorobutadiene	40,000	µg/kg	500	µg/L	61	445	0	0.00%
Hexachloroethane	40,000	µg/kg	3,000	µg/L	149	933	0	0.00%
Lead	1,650	mg/kg	5	mg/L	143	888	**1**	**0.11%**
Mercury	27	mg/kg	0	mg/L	144	930	**2**	**0.22%**

Table 2-1a Frequency of RCRA Exceedances

Contaminant	Bulk Sediment Concentration (X) Limit	Bulk Sediment Concentration Units	RCRA TCLP Screening Value	TCLP Units	Number of Cores	Number of Samples	Number of Samples that Exceeded the Standards	Percentage of Samples that Exceeded the Standards
Methoxychlor	550,000	µg/kg	10,000	µg/L	149	876	0	0.00%
Nitrobenzene	40,000	µg/kg	2,000	µg/L	149	933	0	0.00%
Pentachlorophenol	66,000	µg/kg	100,000	µg/L	61	445	0	0.00%
Pyridine	40,000	µg/kg	5,000	µg/L	0	0	0	0.00%
Selenium	3	mg/kg	1	mg/L	140	864	**34**	**3.94%**
Silver	14	mg/kg	5	mg/L	144	873	**53**	**6.07%**
Tetrachloroethene	3,300	µg/kg	700	µg/L	147	672	0	0.00%
Toxaphene	6,500,000	µg/kg	500	µg/L	149	886	0	0.00%
Trichloroethene	3,300	µg/kg	500	µg/L	148	673	1	0.15%
Vinyl Chloride	3,300	µg/kg	200	µg/L	148	674	0	0.00%

Note:

µg/kg = micrograms per kilogram; µg/L = micrograms per liter; mg/kg = milligrams per kilogram; mg/L = milligrams per liter;

RCRA = Resource Conservation and Recovery Act; TCLP = Toxicity Characteristic Leaching Procedure.

Table 2-1b Frequency of NRDCSRS Exceedances

Contaminant	Non-Residential Direct Contact Soil Remediation Standard	Units	Number of Cores	Number of Samples	Number of Samples that Exceeded the Standards	Percentage of Samples that Exceeded the Standards
Acenaphthene	10,000,000	µg/kg	150	939	0	0.00%
Acetone	1,000,000	µg/kg	73	192	**192**	**100.00%**
Acrylonitrile	5,000	µg/kg	--	--	--	--
Aldrin	170	µg/kg	150	875	0	0.00%
Anthracene	10,000,000	µg/kg	150	941	0	0.00%
Antimony	340	mg/kg	146	909	**1**	**0.11%**
Arsenic	20	mg/kg	149	931	**299**	**32.12%**
Barium	47,000	mg/kg	60	433	0	0.00%
Benzene	13,000	µg/kg	148	675	0	0.00%
Benzo(b)fluoranthene	4,000	µg/kg	150	942	**478**	**50.74%**
Benzo(a)anthracene	4,000	µg/kg	150	942	**464**	**49.26%**
Benzo(a)pyrene	660	µg/kg	150	943	**856**	**90.77%**
Benzo(k)fluoranthene	4,000	µg/kg	150	943	**4**	**0.42%**
Benzyl Alcohol	10,000,000	µg/kg	--	--	--	--
Beryllium	1	mg/kg	59	432	0	0.00%
bis(2-Chloroethyl)ether	3,000	µg/kg	150	934	**29**	**3.10%**
bis(2-Chloroisopropyl)ether	10,000,000	µg/kg	150	934	0	0.00%
bis(2-Ethylhexyl)phthalate	210,000	µg/kg	150	939	**38**	**4.05%**
Bromodichloromethane	46,000	µg/kg	148	673	0	0.00%
Bromoform	370,000	µg/kg	148	673	0	0.00%
Bromomethane	1,000,000	µg/kg	148	673	0	0.00%
2-Butanone	1,000,000	µg/kg	141	612	0	0.00%
Butyl benzyl phthalate	10,000,000	µg/kg	150	935	0	0.00%
Cadmium	100	mg/kg	146	922	0	0.00%
Carbon Tetrachloride	4,000	µg/kg	148	673	0	0.00%
4-Chloroaniline	4,200,000	µg/kg	150	928	0	0.00%
Chlorobenzene	680,000	µg/kg	148	673	0	0.00%
Chloroform	28,000	µg/kg	148	674	0	0.00%
4-Chloro-3-methyl phenol	10,000,000	µg/kg	150	932	0	0.00%
Chloromethane	1,000,000	µg/kg	148	675	0	0.00%

Table 2-1b Frequency of NRDCSRS Exceedances

Contaminant	Non-Residential Direct Contact Soil Remediation Standard	Units	Number of Cores	Number of Samples	Number of Samples that Exceeded the Standards	Percentage of Samples that Exceeded the Standards
2-Chlorophenol	5,200,000	µg/kg	150	937	0	0.00%
Chromium – hexavalent (VI)	6,100	mg/kg	4	4	0	0.00%
Chromium – trivalent (III)	--	mg/kg	--	--	--	--
Chrysene	40,000	µg/kg	150	943	0	0.00%
Copper	600	mg/kg	56	449	0	0.00%
Cyanide	21,000	mg/kg	140	830	0	0.00%
4,4'-DDD	12,000	µg/kg	148	911	**1**	**0.11%**
4,4'-DDE	9,000	µg/kg	149	852	0	0.00%
4,4'-DDT	9,000	µg/kg	146	891	**2**	**0.22%**
Dibenzo(a,h)anthracene	660	µg/kg	150	939	**733**	**78.06%**
Dibromochloromethane	1,000,000	µg/kg	148	673	0	0.00%
Di-n-Butylphthalate	10,000,000	µg/kg	150	935	0	0.00%
Di-n-Octylphthalate	10,000,000	µg/kg	150	937	0	0.00%
1,2-Dichlorobenzene	10,000,000	µg/kg	147	652	0	0.00%
1,3-Dichlorobenzene	10,000,000	µg/kg	147	653	0	0.00%
1,4-Dichlorobenzene	10,000,000	µg/kg	147	653	0	0.00%
3,3'-Dichlorobenzidine	6,000	µg/kg	150	928	**27**	**2.91%**
1,1-Dichloroethane	1,000,000	µg/kg	148	674	0	0.00%
1,2-Dichloroethane	24,000	µg/kg	148	674	0	0.00%
1,1-Dichloroethene	150,000	µg/kg	148	674	0	0.00%
trans-1,2-Dichloroethylene	1,000,000	µg/kg	60	178	0	0.00%
cis-1,2-Dichloroethylene	1,000,000	µg/kg	60	178	0	0.00%
2,4-Dichlorophenol	3,100,000	µg/kg	150	937	0	0.00%
1,2-Dichloropropane	43,000	µg/kg	148	673	0	0.00%
1,3-Dichloropropene(cis and trans)	5,000	µg/kg	--	--	--	--
Dieldrin	180	µg/kg	150	898	**13**	**1.45%**
Diethyl phthalate	10,000,000	µg/kg	150	934	0	0.00%
2,4-Dimethylphenol	10,000,000	µg/kg	150	937	0	0.00%
Dimethyl phthalate	10,000,000	µg/kg	150	929	0	0.00%
2,4-Dinitrophenol	2,100,000	µg/kg	150	937	0	0.00%

Table 2-1b Frequency of NRDCSRS Exceedances

Contaminant	Non-Residential Direct Contact Soil Remediation Standard	Units	Number of Cores	Number of Samples	Number of Samples that Exceeded the Standards	Percentage of Samples that Exceeded the Standards
Dinitrotoluene(2,4-/2,6-mixture)	4,000	µg/kg	--	--	--	--
Endosulfan	6,200,000	µg/kg	--	--	--	--
Endrin	310,000	µg/kg	149	886	0	0.00%
Ethylbenzene	1,000,000	µg/kg	148	674	0	0.00%
Fluoranthene	10,000,000	µg/kg	150	943	0	0.00%
Fluorene	10,000,000	µg/kg	150	939	0	0.00%
Heptachlor	650	µg/kg	147	866	0	0.00%
Hexachlorobenzene	2,000	µg/kg	149	973	**63**	**6.47%**
Hexachlorobutadiene	21,000	µg/kg	61	445	0	0.00%
Hexachlorocyclopentadiene	7,300,000	µg/kg	150	925	0	0.00%
Hexachloroethane	100,000	µg/kg	149	933	0	0.00%
Indeno(1,2,3-cd)pyrene	4,000	µg/kg	150	941	**225**	**23.91%**
Isophorone	10,000,000	µg/kg	150	934	0	0.00%
Lead	600	mg/kg	143	888	**28**	**3.15%**
Gamma-BHC (Lindane)	2,200	µg/kg	148	849	0	0.00%
2-Methylphenol	10,000,000	µg/kg	149	936	0	0.00%
4-Methylphenol	10,000,000	µg/kg	149	936	0	0.00%
Methoxychlor	5,200,000	µg/kg	149	876	0	0.00%
Mercury	270	mg/kg	144	930	0	0.00%
Phenol	1,000,000	µg/kg	146	659	0	0.00%
Methylene Chloride	210,000	µg/kg	148	675	0	0.00%
Naphthalene	4,200,000	µg/kg	150	939	**20**	**2.13%**
Nickel	2,400	mg/kg	148	958	0	0.00%
Nitrobenzene	520,000	µg/kg	149	933	0	0.00%
N-Nitrosodiphenylamine	600,000	µg/kg	95	513	0	0.00%
N-Nitroso-di-n-propylamine	660	µg/kg	150	934	**525**	**56.21%**
Total PCB	2,000	µg/kg	10	55	**41**	**74.55%**
Pentachlorophenol	24,000	µg/kg	61	445	**2**	**0.45%**
Phenol	10,000,000	µg/kg	150	937	0	0.00%
Pyrene	10,000,000	µg/kg	150	943	0	0.00%

Table 2-1b Frequency of NRDCSRS Exceedances

Contaminant	Non-Residential Direct Contact Soil Remediation Standard	Units	Number of Cores	Number of Samples	Number of Samples that Exceeded the Standards	Percentage of Samples that Exceeded the Standards
Selenium	3,100	mg/kg	140	864	0	0.00%
Silver	4,100	mg/kg	144	873	0	0.00%
Styrene	97,000	µg/kg	148	674	0	0.00%
2,3,7,8-TCDD	1	µg/kg	151	938	**263**	**28.04%**
1,1,1,2-Tetrachloroethane	310,000	µg/kg	--	--	--	--
1,1,2,2-Tetrachloroethane	70,000	µg/kg	148	673	0	0.00%
Tetrachloroethene	6,000	µg/kg	147	672	0	0.00%
Thallium	2	mg/kg	148	926	0	0.00%
Toluene	1,000,000	µg/kg	148	675	0	0.00%
Toxaphene	200	µg/kg	149	886	**2**	**0.23%**
1,2,4-Trichlorobenzene	1,200,000	µg/kg	147	652	0	0.00%
1,1,1-Trichloroethane	1,000,000	µg/kg	148	673	0	0.00%
1,1,2-Trichloroethane	420,000	µg/kg	148	673	0	0.00%
Trichloroethene	54,000	µg/kg	148	673	0	0.00%
2,4,5-Trichlorophenol	10,000,000	µg/kg	150	937	0	0.00%
2,4,6-Trichlorophenol	270,000	µg/kg	150	937	0	0.00%
Vanadium	7,100	mg/kg	59	432	0	0.00%
Vinyl Chloride	7,000	µg/kg	148	674	0	0.00%
Xylenes (Total)	1,000,000	µg/kg	--	--	--	--
Zinc	1,500	mg/kg	56	417	0	0.00%

Notes:

2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzodioxin; DDD = dichlorodiphenyldichloroethane; DDE = dichlorodiphenyldichloroethylene; DDT = dichlorodiphenyltrichloroethane;

µg/kg = micrograms per kilogram; mg/kg = milligrams per kilogram.

There was no criterion for 2,3,7,8-TCDD, therefore, it was added using cleanup criteria from the Universal Treatment Standards (UTS).

Table 2-2 Percent Volume by DMM Scenario and Alternative

DMM Scenario	DMM Scenario Type	Scenario Description	Alternative 2 Percent Volume	Alternative 3 Percent Volume	Alternative 4 Percent Volume
DMM Scenario A	Type A-I	CAD Disposal	100%	100%	100%
DMM Scenario B	Type B-I	Off Site Disposal - Thermal Treatment	10%	7%	4%
	Type B-II	Off Site Disposal - Subtitle C Landfill	90%	93%	96%
DMM Scenario C	Type C-I	Local Decontamination and Reuse - Thermal Treatment	10%	7%	4%
	Type C-II	Local Decontamination and Reuse - Sediment Washing	88%	92%	94%
	Type C-III	Local Decontamination and Reuse - Stabilization/Solidification	2%	1%	2%

Notes:

CAD = Confined Aquatic Disposal; DMM = Dredged Material Management.

Table 3-1 Summary of “High”-Ranked Sites for a Processing Facility (USACE, 2007)

Site Name	Site Location	Site Acreage	Potential Site for Processing Facility
Bergen Point	Bayonne, NJ	43	Yes
Chelsea	Staten Island, NY	31	Yes
Kearny Point	Kearny, NJ	25	Yes
Keasbey/ Bayshore	Woodbridge, NJ	100	Yes
Military Ocean Terminal	Bayonne, NJ	672	Yes
National Lead	Sayerville, NJ	302	Yes
Newtown Creek	Queens, NY	27	Yes
Port Newark	Newark, NJ	211	Yes
Pralls Island Reach	Linden, NJ	92	Yes
South Amboy (north)	South Amboy, NJ	44	Yes
South Amboy (south)	South Amboy, NJ	25	Yes
Tremley Point	Linden, NJ	32	Yes

Notes:

USACE = United States Army Corps of Engineers.

Cortlandt, NY sites presented in USACE study were omitted as they are too far from the Lower Passaic River to be realistic options.

Table 3-2 Summary of Potential Placement/Processing Sites by Acreage

Sites		Access [a]		
Area (Land acres)	Total Number of Sites	Sites with Waterfront Access	Sites with Rail Access	Sites with Road Access
<10	18	13	3	16
10 – 20	17	11	6	17
20 – 30	17	9	7	16
30 – 50	16	9	5	13
50 – 100	6	4	1	6
100 – 200	11	10	7	9
>200	2	2	1	2
Total	87	58	30	79

Note:

a: Sites can be grouped into more than one category.

Table 3-3 Summary of Potential Placement/Processing Sites with Waterfront Access by Distance

Sites		Access [a]	
Distance (RM)[b]	Sites with Waterfront Access	Sites with Rail Access	Sites with Road Access
<2	14	2	13
2 – 5	15	2	15
5 – 10	11	4	10
>10	18	8	17
Total	58	16	55

Notes:

RM = river mile.

a: Sites can be grouped into more than one category.

b: Approximate distance measured from the Diamond Alkali plant at 80-120 Lister Avenue, Newark, NJ.

Table 3-4 Upland Processing Facility Acreages for DMM Scenario B and C

Upland Processing Facility Acres[a]	DMM Scenario B: Off-Site Disposal			DMM Scenario C: Local Decontamination and Beneficial Use		
	Alternative 2: Deep Dredging with Backfill	Alternative 3: Capping with Dredging for Flooding and Navigation	Alternative 4: Focused Capping with Dredging for Flooding[b]	Alternative 2: Deep Dredging with Backfill	Alternative 3: Capping with Dredging for Flooding and Navigation	Alternative 4: Focused Capping with Dredging for Flooding[b]
Total Uplands Area	27.5	26.0	26.0	39.5	36.0	36.0
Ancillary Area	2.5	2.5	2.5	2.5	2.5	2.5
Exclusion Zone Area	25.0	23.5	23.5	37.0	33.5	33.5
Thermal Treatment Area	0.0	0.0	0.0	5.0	5.0	5.0
Processing Buildings	5.5	5.5	5.5	8.5	8.0	8.0
Processed Material Storage Area	5.5	4.5	4.5	8.0	6.5	6.5
Reclaimed Sand Storage	1.0	1.0	1.0	1.0	1.0	1.0
Debris Processing	1.0	1.0	1.0	1.0	1.0	1.0
Roads and Loadout Area	11.0	10.5	10.5	11.5	10.5	10.5
Contact Water and Recycle Water Storage Tank	1.0	1.0	1.0	2.0	1.5	1.5

Note:

DMM = Dredged Material Management.

a: Acres were estimated for cost estimating purposes. In this table areas have been rounded to the nearest 0.5 acre, values presented in Appendix H may vary.

Table 4-1 Summary of Throughput Rates for Incineration Facilities

Facility Name	Owner	Location	On-Site Landfill	Operating Days per Year	Throughput Rate Capacity (Tons)	
					Yearly	Daily
Deer Park Facility	Clean Harbors	Texas	Yes	350	165,500	473
Aragonite Facility	Clean Harbors	Utah	No*	350	66,815	191
Kimball Facility	Clean Harbors	Nebraska	Yes	350	58,808	168
Port Arthur Facility	Veolia	Texas	No*	330	66,000	200
Ontario Thermal Desoprtion Unit Facilty	Clean Harbors	Ontario, Canada	Yes	350	336,000	960
Bennett Facility	Bennett Environmental	Quebec, Canada	No*	330	100,000	300**

Notes:

Sources are provided in the Appendix G Narrative.

* Ash generated managed internally by Owner/Operator

** Bennett has the capability to accept up to 2200 tons of soil in a day via truck, rail or ship

Table 4-2 Summary of Subtitle C Landfill Facilities

Subtitle C Landfills	Location	Capacity	Cost for Disposal	Rail Service (Direct or within 60 mile radius)
*Roachdale Facility	Roachdale, IN	14,500,000 cy	Not provided	Yes
Lake Charles Facility	Sulphur, LA	5,730,000 cy	Non-hazardous dioxin impacted material $98 per ton	Yes
Lone Mountain Landfill	Waynoka, OK	3,822,000 cy	$120 per ton	Yes
Grand View Landfill	Grand View, ID	3,200,000 cy	$200 per ton including transportation services	Yes
Envirosafe Services Otter Creek Road	Oregon, OH	Estimated 6-8 years operating life based on current receipts (235,000 tons per year annually)	$59.90 per ton for direct disposal (no treatment required), $75.00 per hour (labor), $130.00 per ton (reagent) for incidental free liquid stabilization	Yes
Emmelle Landfill	Emmelle, AL	480,000 tons per year	Non-hazardous dioxin impacted material $98 per ton	Yes
Grassy Mountain Landfill	Salt Lake City, UT	938,000 cy	$120 per ton for RCRA; $200 per ton for TSCA	Yes
Deer Trail Landfill	Deer Trail, CO	759,000 cy	$120 per ton for RCRA; $200 per ton for RCRA/TSCA	Yes
CWM of the Northwest	Arlington, OR	600,000 cy	RCRA waste for direct landfill $112 per ton. RCRA waste requiring stabilization $225 per ton	Yes
Model City Facility	Model City, NY	364,000 cy	Non-hazardous dioxin impacted material $75 per ton	No
Site #2 Landfill	Belleville, MI	Not provided. Currently, constructing subcell expected to last until 2015	$80-$150 per ton	Yes
Westmorland Landfill	Westmorland, CA	2,000,000 cy	$120 per ton	Not provided
Buttonwillow Landfill	Buttonwillow, CA	>9,000,000 cy	$120 per ton	No
Kettleman Landfill	Kettleman City, CA	Pending new permit	RCRA waste for direct landfill $65 per ton. RCRA waste requiring treatment/stabilization $300 per ton	No
PDC #1	Peoria, IL	Little capacity remaining	n/a	n/a

Notes:

CWM = Chemical Waste Management; cy = cubic yards; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substance Control Act.

*Facility does not accept non-listed dioxin waste.

Table 6-1 Summary of "High"-Ranked Sites for a Storage Facility (USACE, 2007)

Site Name	Site Location	Site Acreage	Potential Site for Storage Facility	Storage Facility Type and Maximum Size (MCY)[a]			
				Upland Pit CDF	Upland Bermed CDF	In-Water Pit CDF	Near-shore Bermed CDF
Bergen Point	Bayonne, NJ	43	Yes	1.0	0.25	0.50	
Caven Point	Jersey City, NJ	10	Yes			1.0	
Kearny Point	Kearny, NJ	25	Yes	1.0	0.25	1.5	
Newark Bay	Newark, NJ	15	Yes	0.25			
Newtown Creek	Queens, NY	27	Yes	0.5	0.25		
Port Reading Reach	Woodbridge, NJ	120	Yes	1.5	1.5	0.25	
Pralls Island Reach	Linden, NJ	92	Yes	1.5	1.0		
Tremley Point	Linden, NJ	32	Yes	0.5	0.25		

Note:

CDF = Confined Disposal Facility; MCY = million cubic yards; USACE = United States Army Corps of Engineers.

a. Data retrieved from Table 16 (USACE, 2007). The "Near-shore Bermed CDF" column is blank in the original table.

Table 6-2 Preliminary Screening Results for Potential Confined Aquatic Disposal Sites

Site ID	Area (Acres)	Depth to Bedrock (Feet MLW)	Depth of Approach (Feet MLW)	Shortest Distance to Navigation Channel (Feet)	Depth of Sediment Contamination (Feet)	Presence of Under Water Utilities	Adjacent Property Use	Included in 1997 USACE EIS?	Capacity (MCY)
Area 1	112	40-110	4	300	15	Yes	Undeveloped Industrial	No	11
Area 2	106	60-80	22	100	7	No	Developed Industrial	Yes	7
Area 3	278	70-100	9	550	4	No	Recreational and Residential	Yes	18
Area 4	249	20-60	14	175	5	Yes	Industrial - Developed and Undeveloped	Yes	9
Area 5	193	70-120	7	100	4	Yes	Residential	Partial	25

Note:

2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzodioxin; EIS = Environmental Impact Statement; H:V = horizontal to vertical; MCY = million cubic yards; MLW = Mean Low Water; NOAA = National Oceanic and Atmospheric Administration; USACE = United States Army Corps of Engineers.

Sources:

Depth of Bedrock - 2005 USACE bedrock contour map from harbor deepening project. Depth of Approach - 2005 Newark Bay Bathymetry Sounding Data

Distance to Navigation Channel - Distance from navigation channel defined by NOAA to CAD site.

Depth of Sediment Contamination - 2005 Phase I and 2007 Phase II Newark Bay Investigation and 2008 CPG low resolution cores. Depth of contamination is defined as thickness of where detectable levels of Mercury and 2,3,7,8-TCDD were measured. Under Water Utilities - USACE Newark Bay EIS and utilities identified by NOAA.

Property Use - 2002 and 2007 aerial images from NJ State.

Capacity - Estimated using volume of a rectangular prism volume using a 2H:1V slope in the contaminated sediment layer and 1.5H:1V slope in the clay layer.

Table 6-3 Summary of Selected CAD Projects

Category	Project Features	Newark Bay, New Jersey	Boston Harbor, Massachusetts	Puget Sound Naval Shipyard, Washington	Lower Duwamish Waterway, Washington
General	Project location	Newark Bay, NJ	Boston Harbor, MA	Puget Sound, WA	Duwamish Waterway, WA
	Project classification	USACE-New York	Joint Project between the USACE and MassPort	CERCLA	CERCLA
	General project description	In 1997, the PANY/NJ received a permit to construct three CAD cells in a shoal area of Newark Bay. In November 1997, the PANY/NJ completed the construction of the first cell, the NBCDF, with a remaining capacity of 1.1 MCY (711,000 cy dredged material, 400,000 cy cap material), of which 830,000 cy of capacity remains. Disposal is restricted to dredged material excavated within the NBCDF draw area, which includes Newark Bay, Kill Van Kull, Arthur Kill and the New Jersey side of the Upper Bay to Liberty State Park. The NBCDF is 70 feet deep and constructed in a water depth of about 3 feet.	The BHNIP was run in conjunction between the USACE and the Massachusetts Port Authority. The goal was to deepen specific areas of Boston's Inner Harbor, tributary channels, and its berths. Three million cubic yards of material was the amount to be dredged. This project was conducted in two phases, with Phase I having been completed in July 1997, with a little less than 5% of the total dredging volume. After monitoring Phase I, many corrections were made to have Phase II produce a better outcome. Nine CAD cells were constructed beneath the navigable channel as part of the BHNIP carried out between 1997 and 2000. Under the BHNIP, the CAD cells received dredged harbor sediments that were identified as unsuitable for unconfined open water disposal. Following completion of disposal into the CAD cells, they were capped with a layer of sand to further isolate the dredged material from the overlying waters.	This site involves the remedial action for the marine area, called Operable Unit B, which is one of the four operable units at the Bremerton Naval Complex Superfund site, located in Bremerton, WA. This remedial action was implemented to protect the public health and welfare of the environment from the threat of the release of hazardous materials into the environment. The risks identified would be the consumption of seafood and erosion of fill material into the marine environment. The Bremerton Naval Complex consists of the Naval Station Bremerton and the Puget Sound Naval Shipyard. They are a home port for aircraft carriers and supply ships. Puget Sound Naval Shipyard provides overhaul, maintenance, conversion, refueling, defueling, and repair services to the naval fleet.	Known as the first CAD project in Puget Sound. Described as a shoal that limited navigation through the waterway and was found to contain contaminated sediments in the 5.5 miles stretch of the Duwamish River that flows into the Elliot Bay in Seattle. The waterway is surrounded by an industrial population and years of industrial use has left the water contaminated with many different chemicals.
	Primary contaminants	Category 2 Material (material with no significant toxicity, but has the potential to be dangerous.)	Heavy metals, PCBs, and PAHs	PCBs, PAHs, metals, and other contaminants	Heavy metals, PCBs, Arsenic, Dioxin, PAHs, Aldrin, and others.
Construction/ Consolidation	CAD Area	Entrance channel: 20 ft deep x 200 ft wide. Triangular shaped pit with a depth of approximately 70 ft. 3H:1V side slopes in top 15 ft; thereafter, 1:5H:1V in clayey material. Approximately 26 acres of water surface.	200 ft x 500 ft x (14 to 29 ft) Vertical Walls	10 acres surface area	Approx. 100 ft x 750 ft x 7 to 8 ft. Side slopes of 3H:1V to 5H:1V
	CAD Capacity	1.5 MCY	23,000 cy	377,000 cy	1,100 cy of contaminated fine, sandy, clayey silt plus 4,000 cy of cap material
	Dredging volume	Approximately 2 MCY (0.6 MCY of Category 2 silts and 1.4 MCY of clean clay)	142,500 cy	200,000 cy of CERCLA sediments and 100,000 cy of unsuitable navigational sediments	1,100 cy of contaminated fine, sandy, clayey silt plus 4,000 cy of cap material
	Containment / construction approach	A closed environmental bucket was used for dredging and a split-hull scow was used for placement. During the placement period, TSS samples were taken beyond the perimeter and after disposal had taken place. Bathymetric surveys were performed and samples were collected 6 inches from the surface at a 20 ft depth, using controlled samples. Operation at the facility included visual observations during every disposal events, water quality monitoring, and periodic bathymetric surveys.	A split-hull scow was used. Sub aqueous berms were constructed for containment along the east and west ends of the site. Level cut environmental clamshell was used for surface silts and the open-toothed bucket for native clay. During the construction of the cell, there were limitations due to the fishery observations and limited turbidity tests were also performed. No significant suspended solid impacts were found. During the placement period, real-time tracking of turbidity was performed. Bioaccumulation, dissolved oxygen, and bioassay tests were performed, showing no impact. During the capping process, bathymetric and side-scan sonar surveys were taken in core collections to find the chemical concentration. Also, a video done for Phase 1, showed that there was significant cap thickness variability and insufficient consolidation prior to capping. Phase II showed that with complete cap coverage, there was no significant mixing of the contents with the cap.	Sediments were being delivered by split-hull bottom-dump haul barges that were controlled by GPS positioning. TSS and turbidity testing were used during placement of the contaminants. During the dredging procedure, a pre-dredge side-scan sonar was used, as well as water quality monitoring. For the capping process, an intermediate cap was placed first, so there was no monitoring needed for the clean cap placement. Daily bathymetric surveys were performed and extensive water quality monitoring, along with pre-dredge side scans for debris. Sediment sample chemical analysis were done for assessment of downstream deposition to surface sediments. Bathymetric surveys were used to see if the mass removal met the design specifications. Acoustic sub-bottom profiling, sediment coring, and sediment surface photography was used to gauge the lateral extent, thickness, and the uniformity of the cap.	A conventional clamshell dredge was used and placement with a split-hull bottom dump barge. The contaminated material exited the bottom dump as slurry. Three barges using survey positioning systems were used to place the sand cap by "sprinkling" sand at an average rate of 21 m^3/min. The contaminated material was placed into a subaqueous depression. During construction of the baseline, bathymetry and tidal current monitoring were performed. Sediment samples were also analyzed.

Table 6-3 Summary of Selected CAD Projects

Category	Project Features	Newark Bay, New Jersey	Boston Harbor, Massachusetts	Puget Sound Naval Shipyard, Washington	Lower Duwamish Waterway, Washington
Construction/ Consolidation	Final cover material	Three-foot-layer sand cap.	Approximately 20,000 tons of coarse-grained sand, about 1 to 4 feet thick was used as a cap.	Consisted of a thick and thin layer caps. Thin layer caps used at the site had a thickness of at least 20 centimeter. The 3 feet thick cap was implemented on an as-needed basis to isolate the sediment, and to withstand erosional forces. A 4-6 feet thick layer of clean import material was used to cap the CAD cell on an overall basis.	Consisted of a 4,200 cy sand dredged from the upper Duwamish River, with an average thickness of 2 ft.
	Long-term Issues		A bottom surge was created due to denser material being placed on the top of lighter material, which caused to deposition of a small amount of contained contaminated material to be pushed outside the cell.	Post construction, bottom surge deposits were found after capping, needing more attention.	Monitoring showed that a bottom surge displaced some contaminated material outside of the cell. Clay balls of contaminants were also found in the capping material.
Hydraulic Controls	Monitoring System in Place	A sediment sampling program was implemented to better understand how material behaves once it is deposited.	Monitoring showed that transport of suspended solids were limited and the water quality criteria was not exceeded. After construction, 10-foot core surface samples were collected along with sediment profile imaging, showing no significant changes in the cap of Phase II. A biological assessment was performed, showing a recolonization of stage 2 organisms as a community at the bottom of the harbor.		Five years after disposal, samples were taken with three vibracores along the length of the project at the thickest part of the cap. No migration of contaminants were found. After monitoring for 18 months and the 11-year post-cap monitoring period, there was no mixing of contaminated sediment with cap material and a "moderate to fair" sediment quality for benthic communities. The last time monitoring was done was in 1996, showing that the cap was still stable and effective.
Other Controls		Post construction, bathymetric surveys were done periodically and after each 10-foot lift of disposed material. Vibracore sediment samples were collected for geotechnical data.			
Lessons Learned		Environmental sampling results led to the conclusion that proper disposal of sediments could take place at the NBCDF with no adverse effects to the immediate aquatic environment. Also, sediment disposal should be performed under favorable hydrodynamic conditions to minimize potential environmental impacts.	Lessons learned were to allow the contaminated materials to consolidate for several months or before capping. The longest consolidation period from phase I and II was over 200 days. Also, "slop out" could be caused if the cells were overfilled. Real-time turbidity monitoring gave a good indication of the possible transport of material away from the disposal site. In terms of affecting the water column, the operational aspects (scow washing, operators) outweighed the equipment aspect of dredging. Also, periodic monitoring of the different aspects, focusing on real-time measurements estimating suspended solids, sampling and analysis focused on significant suspended solids, plume occurrences, or dissolved constituent concerns, could be a more effective way of monitoring.	Lessons learned were that the area selected protected from prop wash. Due to this use of a CAD cell, there was a $30 million savings that was reported in transportation costs, in comparison to upland sites. Water quality monitoring could have had a better location and could have been better timed in terms of measurements.	Some lessons learned were that conventional dredging equipment and disposal techniques were effective in placing of the cap and disposed material. The cohesive fine grained material emptied rapidly form the barge with a high flow velocity. Slow barge-dump placement of the sand cap was not as accurate as with specialized equipment. Steep side slopes of the CAD cell reduced the outward surge of the dumped material. Slow release of capping sand limits the displacement of the material that is being capped. There was no need to delay the capping for consolidation. High levels of acoustic background makes application of SSS more difficult and more time consuming. A standard hydrographic survey depth sounder is seen as the best in finding sediment thickness.
Comments				Over 85,000 cy of clean sediment was approved for cap natural recovery enhancement and beneficial use.	SSS was used successfully to monitor disposal, and also to find the limits of the cap, but the use of a sub-bottom profiler was a little more successful at finding the cap thickness.
References					Seattle Daily Journal 2003 Consent Decree - Ecology vs FWDA 2003

Table 6-3 Summary of Selected CAD Projects

Category	Project Features		Ross Island Lagoon, Oregon	Port of Los Angeles, California	New Bedford Harbor Superfund Site (NBHSS), Massachusetts
General	Project location	Providence River, RI	Ross Island, OR	Port of Los Angeles, CA	New Bedford Harbor, MA
	Project classification		Mandated for clean-up by the DEQ in Oregon		Superfund Program, USACE New England District
	General project description	The PRHMDP was an extensive dredging project designed and implemented to address the increasing navigational constraints within the principal commercial waterway in Rhode Island. The Providence River is located by the junction of the Woonasatucket and Moshassuck Rivers. It flows south for a mile to the head of Providence Harbor, where it is joined by the Seekonk River. This harbor makes up the principal commercial waterway in Rhode Island. A total of 6 CAD cells were constructed between May 2003 and January 2004. Part of the A37 goal is to restore navigation and get rid of the unsuitable material. These CAD cells were constructed beneath the Federal channel at the head of the main channel in the Providence River.	Ross Island Lagoon is located in the Willamette River at Portland, Oregon. The lagoon was created in the late 1920s, when Ross and Hardtack Islands were joined with an earthen dike that closed a former channel in the Willamette River. The lagoon is known to be used for mining of sand and gravel by Ross Island Sand and Gravel (RIS&G), which is the owner and operator. In 1980, RIS&G needed to reclaim the mining area, so they started to import fill to the site. Some of the fill turned out to be contaminated and therefore needed to be capped with clean material. A ROD was signed in 2005, identifying long term confinement, monitoring, and management approaches that RIS&G needed to follow. Four CAD cells accepted material from navigational dredging and one cell contained material from Portland's Pencil Pitch Spill.	Not used for Navigation: the depth of this site was reduced from 40 feet to 15 feet to create a habitat. This was known as the first CAD project in California for contaminated sediments.	The project is classified as a Federal Superfund Site. Two CAD cells are currently being used as a sediment management area for PCB and copper contaminated sediments, and a third cell was approved in March, 2011. Industrial and municipal waste releases into the Acushnet River Estuary and harbor areas adjacent to New Bedford have contaminated the bottom sediments with organic chemicals, principally chlorinated hydrocarbons with heavy metals.
	Primary contaminants		Metals, TBT, PAHs, PCBs	Heavy Metals, PAHs, DDT, PCBs, Storm drain discharges	PCBs and Heavy Metals
Construction/ Consolidation	CAD Area	2.07 acres to 27.8 acres; depths of 70 ft to 100 ft, side slopes ranging from 1H:2V	Five CAD cells were constructed.	94 acres CAD within a 192 acres site	A 650 ft x 650 ft (~10 acres) square surface footprint with 6H:1V side slopes for the top 7 ft of depth and 3H:1V for the remaining 47 ft of depth below existing sediment surface.
	CAD Capacity	CAD capacity is 2.3 MCY			Approximately 379,000 cy
	Dredging volume	The dredging volume was 1.2 MCY of 5.8 MCY dredged material.	Approximate dredged material was 160,000 cy	Dredging volume was 5 MCY	Approximately 300,000 cy
Construction/ Consolidation (cont'd)	Containment / construction approach	Disposal into CAD cells involved using split-hull scows. The smaller CAD cells were filled with material that was generated from construction of the other CAD cells. The larger CAD cells were reserved for unsuitable material.	Four disposal cells were created by excavating older non-Port fill or other materials using clamshell dredge mining methods. One cell was created using an existing depression in non-Port fill. Following disposal of dredged material from either a split-hull barge or tremie tube, each cell was capped with a confining layer of fine-grained material derived from on-site sand and gravel washing and processing.	A perimeter subaqueous berm was placed in before placement of the contaminated material.	The disposal operation consists of mechanical dredging of sediment into 500 cy split hull (bottom dump) barges. After placement is completed and dredged material and suspended solids have been allowed to settle and densify, a cap will be placed to close the CAD. A perimeter silt curtain is proposed to minimize potential contaminant loss during placement.
	Final cover material	The sites were left uncapped for many years.	Fine-grained material from on-site sand and gravel washing and processing operations. This material came from Ross Island rock crushing settling pond.	13 ft of clean harbor material; 2 ft of clean sand	Based on modeling results, a 3-foot cap would be highly effective in isolating the contaminated dredged material
	Long-term Issues	None mentioned	None. CAD cells are working well. A barge tipped over in 1998, but the spilled material was covered with a 1-foot cap. A part of the cell 5 cap was breach and repaired in 1998.		It is expected that diffusion of contaminants will occur from the expulsion of contaminated pore water from sediment consolidation.
Hydraulic Controls	Monitoring System in Place	Required monitoring were real-time measurements of turbidity, backscatter, current, temperature, salinity, and dissolved oxygen to track plume movement and assess water mass movement and water quality. During the monitoring of benthic conditions after disposal, bathymetry surveys were taken, side-scan sonars, sediment profile imaging, and benthic grabs were performed. Biological monitoring performed during dredging did not find any significant impacts to the hatching success of water flounder eggs. An extensive water column monitoring program was needed for the PRHMDP, described in the Water Quality Certification. After completion of the first couple monitoring events, it was seen that there were no significant impacts involving disposal.	No long term monitoring of the dredging site seemed to be needed. A monitoring program for the disposal area was started in 1999 because of concerns in the Willamette River and disposal area.	No long-term monitoring was needed. 1998/94 monitoring showed that the cap was still in place.	Monitoring includes fish migration, air, water quality, and sediment. Sediment monitoring in the upper harbor north of Wood Street. is performed annually and groundwater monitoring in the Sawyer Street area is performed biannually.
Category	**Project Features**		**Ross Island Lagoon, Oregon**	**Port of Los Angeles, California**	**New Bedford Harbor Superfund Site (NBHSS), Massachusetts**
		The CAD cells proved to be stable structures, providing sufficient space for placement of dredged material unsuitable for open water disposal. The size, depth, and side slopes made successful disposal		Overall effective cap was greater than 15 ft. The thick cap was used	Extending the dredged material sediment consolidation period prior to capping would allow the sediment shear strength to increase sufficiently to adequately

Lessons Learned		disposal. The size, depth, and side slopes made successful disposal possible, with no transport of material out of the cell during or after placement. Real- time and analytical measurements showed that disposal operations did not result in significant negative environmental impacts. Sequencing of dredging operations made it possible for the project to continue in a cost effective manner and with no interruptions.		Overall effective cap was greater than 15 ft. The thick cap was used because of the geometry of the site and dredging volumes. It was not needed to prevent containment migration. The cap had also covered a designated "hot spot."	resist the superimposed cap weight. Turbidity was observed to be lowest for an enclosed CableArm bucket compared to other types. Resuspended sediments settle to the sea floor within 1 hour of suspension. Tidal currents within the harbor were insufficient to induce major erosion of bottom sediments within the CAD cells.
References					

Note:

BHNIP = Boston Harbor Navigation Improvement Project; CAD = Confined Aquatic Disposal; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; cy = cubic yards; DDT = dichlorodiphenyltrichloroethane; DEQ = Department of Environmental Quality; ft = feet;

GPS = Global Positioning System; H:V = horizontal to vertical; MCY = million cubic yards; m3/min = cubic meters per minute; NBCDF = Newark Bay Confined Disposal Facility; PAHs = Polycyclic aromatic hydrocarbons; PANY/NJ = Port Authority of New York & New Jersey; PCBs = Polychlorinated biphenyls;

TSS = Total Suspended Solid; PRHMDP = Providence River and Harbor Maintenance Dredging Project; TBT = Tributyltin; USACE = United States Army Corps of Engineers; ROD = Record of Decision.

References: See reference list in Appendix G.

Table 7-1 Predicted Resuspension During Single Barge Disposal Event 1 to 2 Hours After Discharge

Fill Level	Mass of Total Suspended Solids (TSS) (kg)	Mass of TSS / Mass Placed
0 percent	66,000	3%
50 Percent	50,000	2%
90 Percent	55,000	3%
Overall	55,500	3%

Notes:

kg = kilograms.

Table 7-2 CAD Cell Solids and Contaminant Mass Losses (Mass in Top 25 Feet)

Fill Level	Solids (kg)	2,3,7,8-TCDD (mg)[a]	Phenanthrene (g)[b]
0 percent	1,403	13	24
50 Percent	2,954	27	50
90 Percent	11,317	102	192
Overall	5,075	46	86

Notes:

2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzodioxin; kg = kilograms; mg = milligrams; g = grams.

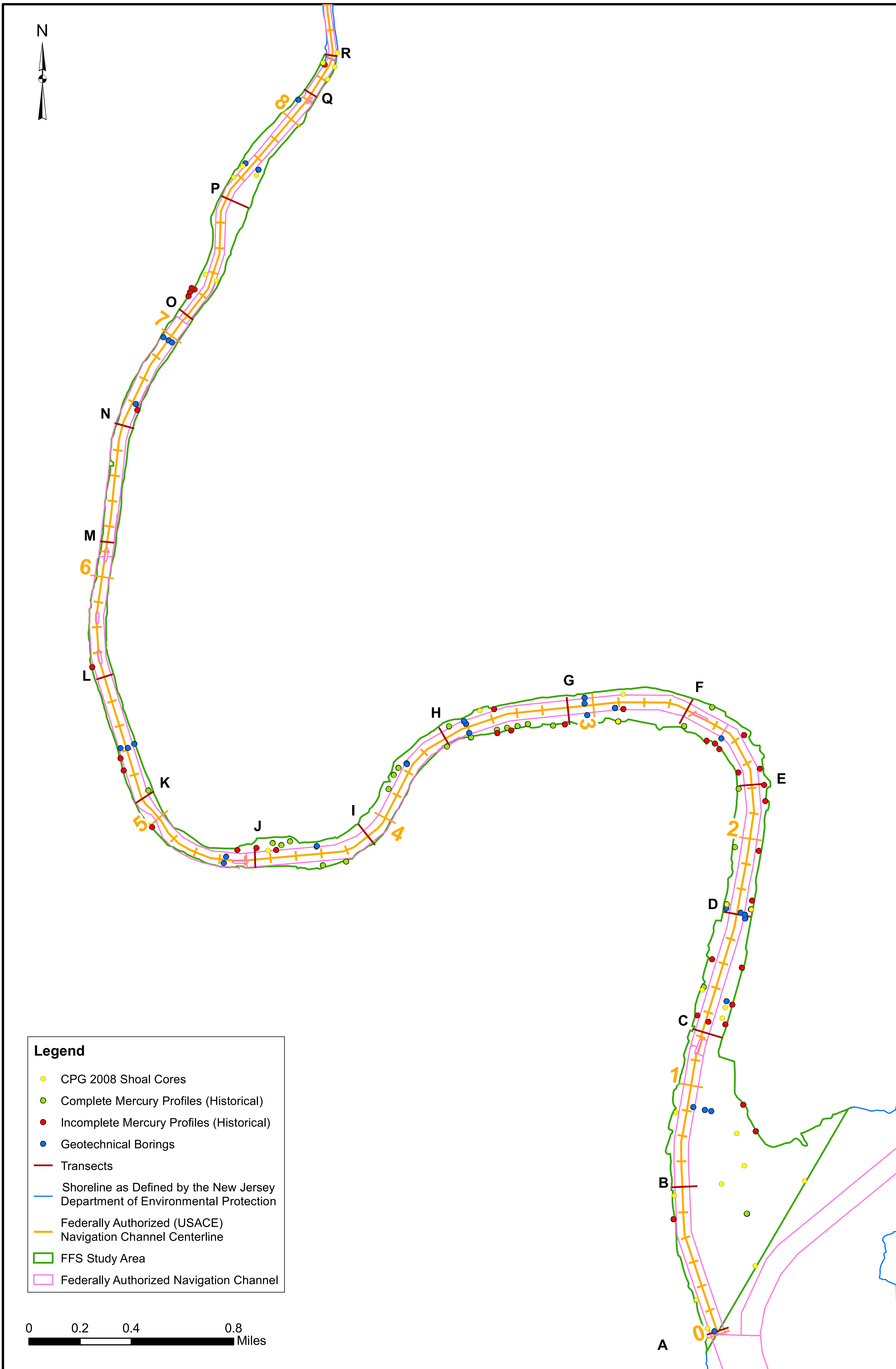
a. Dissolved 2,3,7,8-TCDD loss is about 0.08 milligram, which is 0.2 percent of total mass lost

b. Dissolved Phenanthrene loss is about 1 gram which is 1 percent of total mass lost

Table 7-3 CAD Cell Percent Mass Losses From Tidal Flow

Fill Level	Total Loss / Mass Placed
0 percent	0.06%
50 Percent	0.14%
90 Percent	0.52%
Overall	0.23%

FIGURES



Sediment Cores and Transect Locations RM0 to RM8.3

for Alternatives 2 and 3

Lower Eight Miles of the Lower Passaic River

Figure 1-1a

2014

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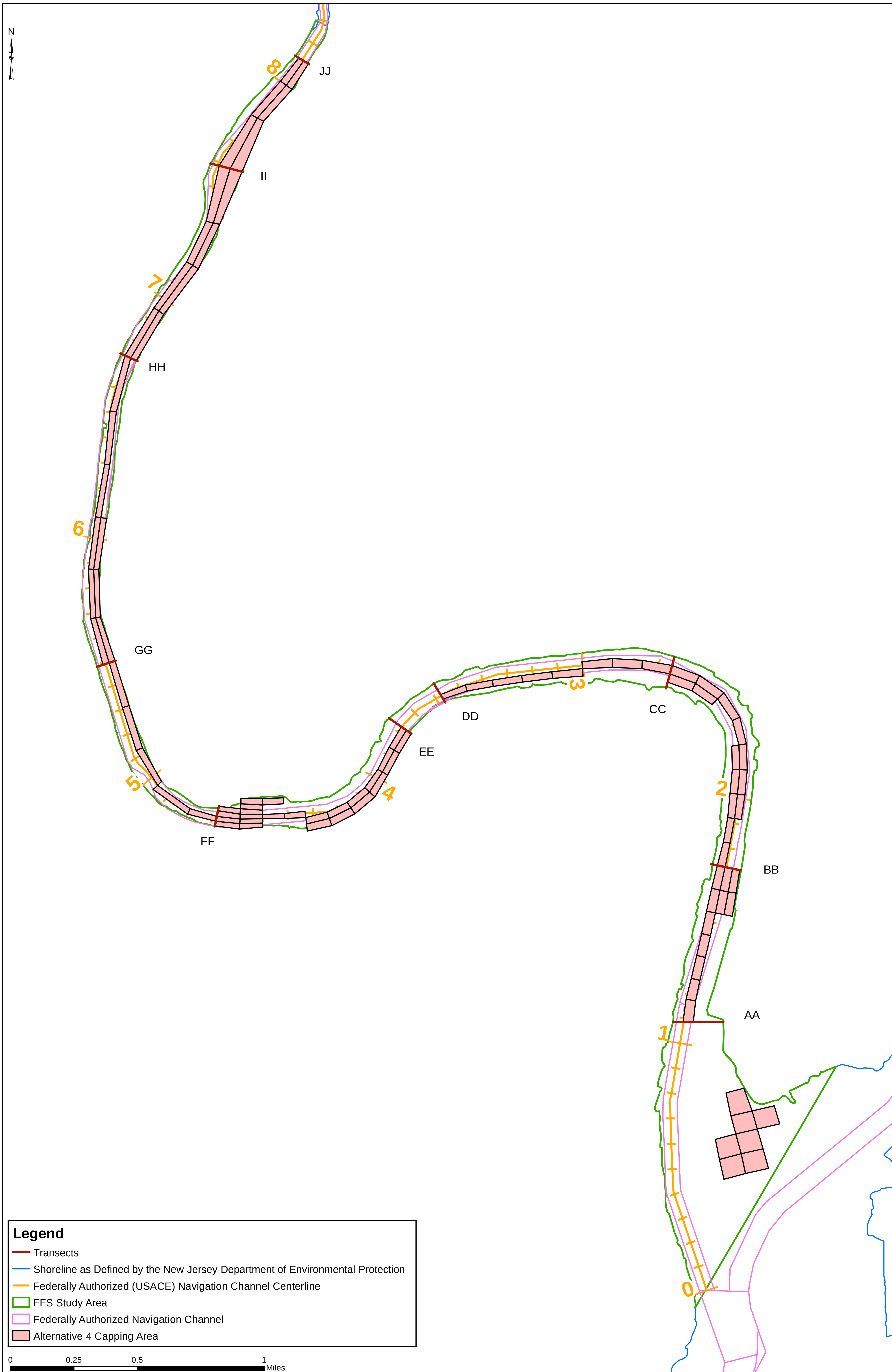

Transect Locations RM0 to RM8.3 for Alternative 4 *Lower Eight Miles of the Lower Passaic River*	Figure 1-1b
	2014

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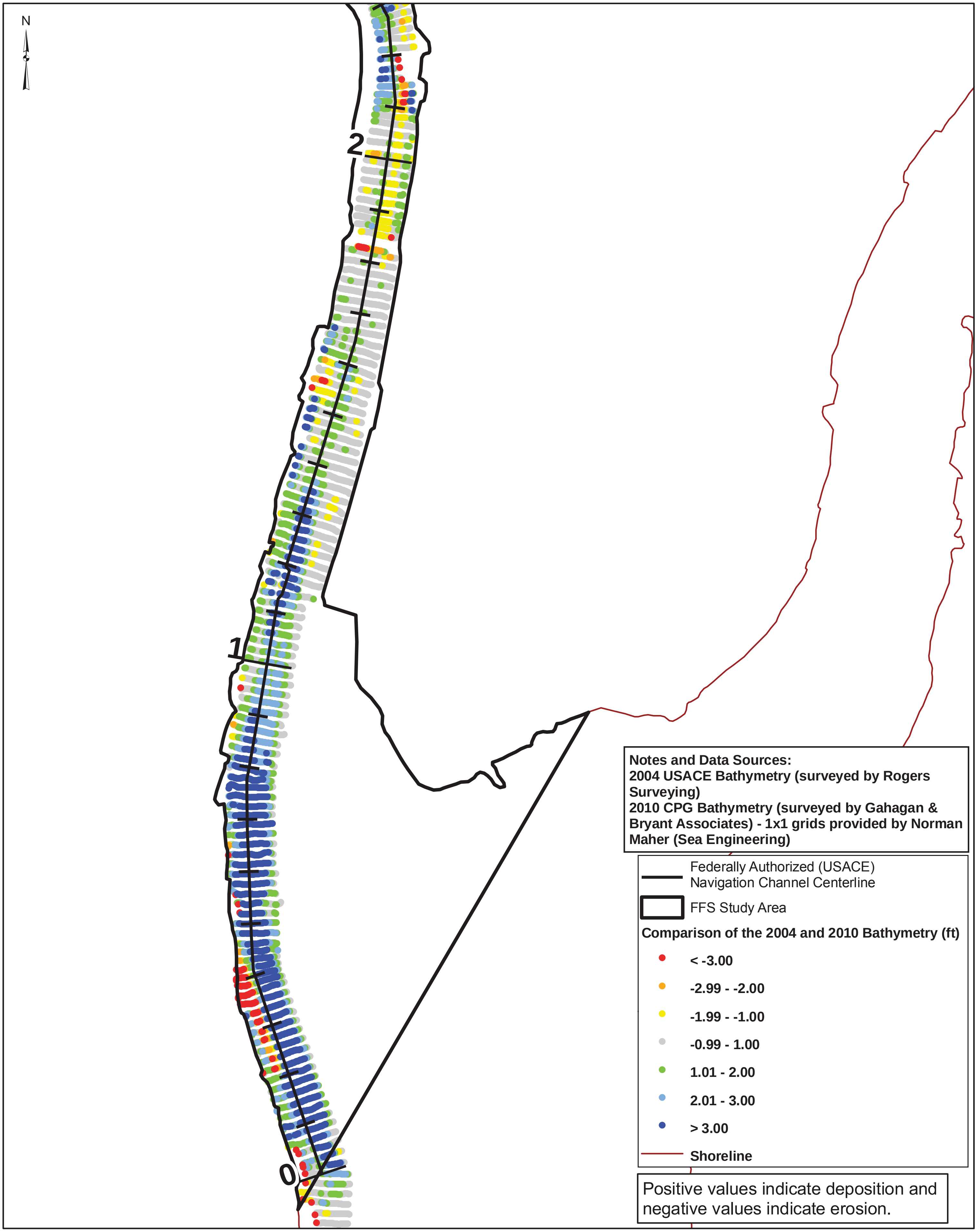
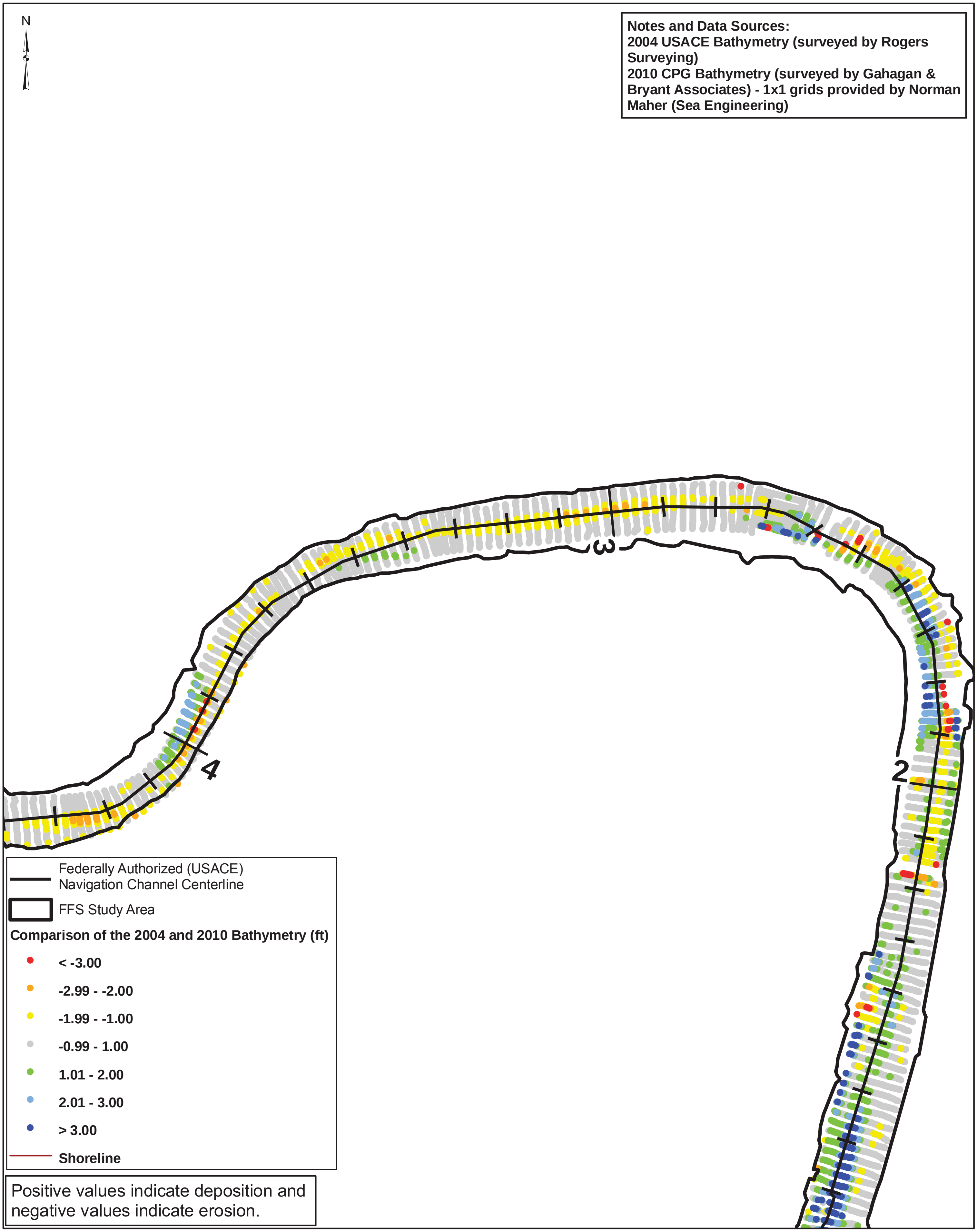


Comparison of the 2004 and 2010 Bathymetry - RM0 to RM2

Lower Eight Miles of the Lower Passaic River

Figure 1-2a

2014



Notes and Data Sources:
2004 USACE Bathymetry (surveyed by Rogers Surveying)
2010 CPG Bathymetry (surveyed by Gahagan & Bryant Associates) - 1x1 grids provided by Norman Maher (Sea Engineering)

Federally Authorized (USACE) Navigation Channel Centerline

FFS Study Area

Comparison of the 2004 and 2010 Bathymetry (ft)

- **< -3.00**
- **-2.99 - -2.00**
- **-1.99 - -1.00**
- **-0.99 - 1.00**
- **1.01 - 2.00**
- **2.01 - 3.00**
- **> 3.00**

Shoreline

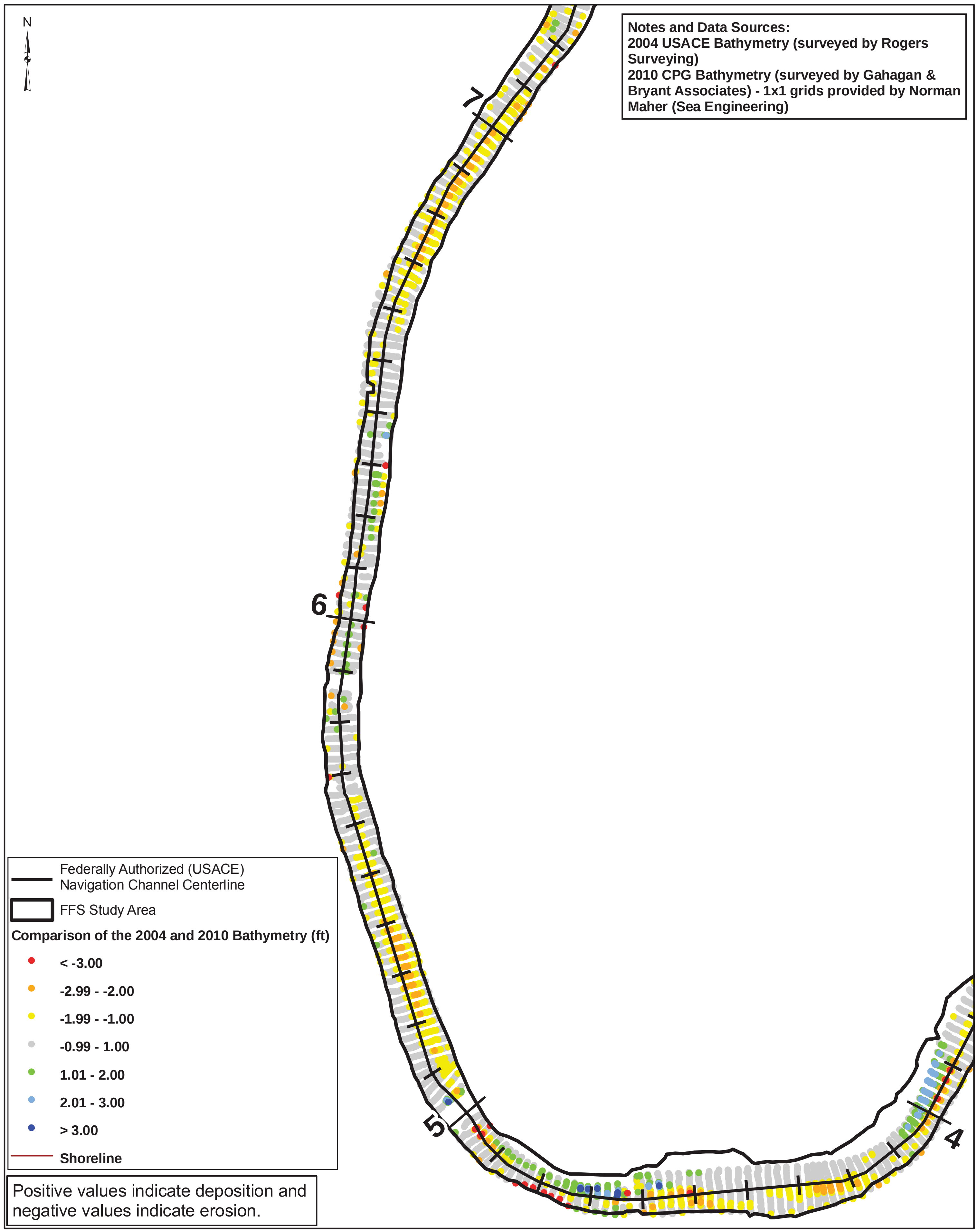
Positive values indicate deposition and negative values indicate erosion.

Comparison of the 2004 and 2010 Bathymetry - RM2 to RM4

Lower Eight Miles of the Lower Passaic River

Figure 1-2b

2014

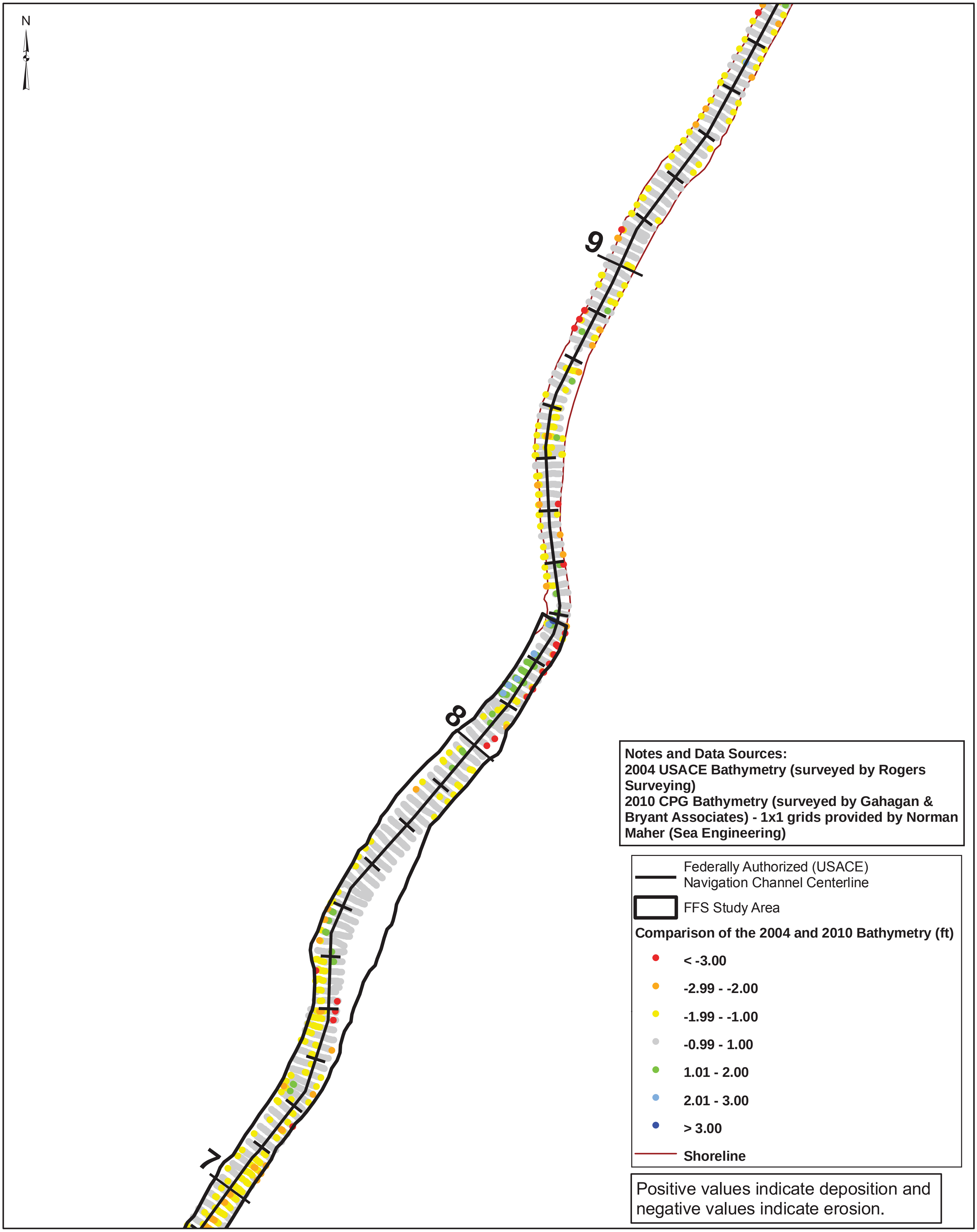


Comparison of the 2004 and 2010 Bathymetry RM4 to RM7

Lower Eight Miles of the Lower Passaic River

Figure 1-2c

2014

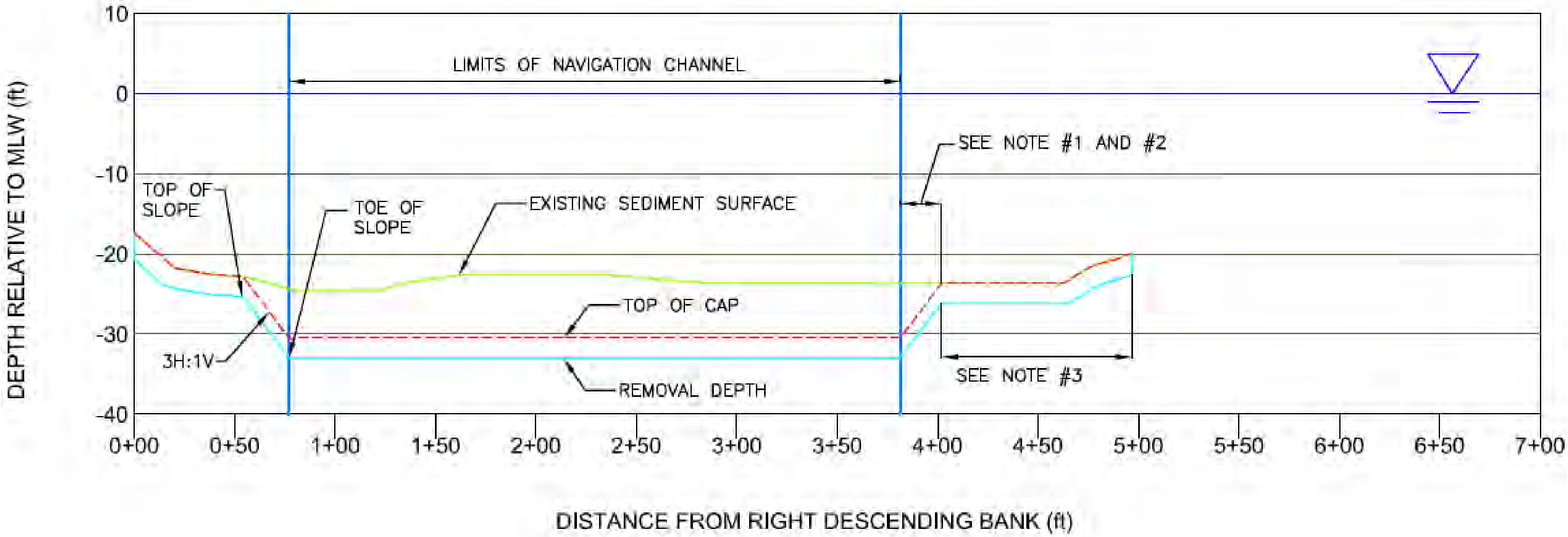


Comparison of the 2004 and 2010 Bathymetry RM7 to RM8.3

Lower Eight Miles of the Lower Passaic River

Figure 1-2d

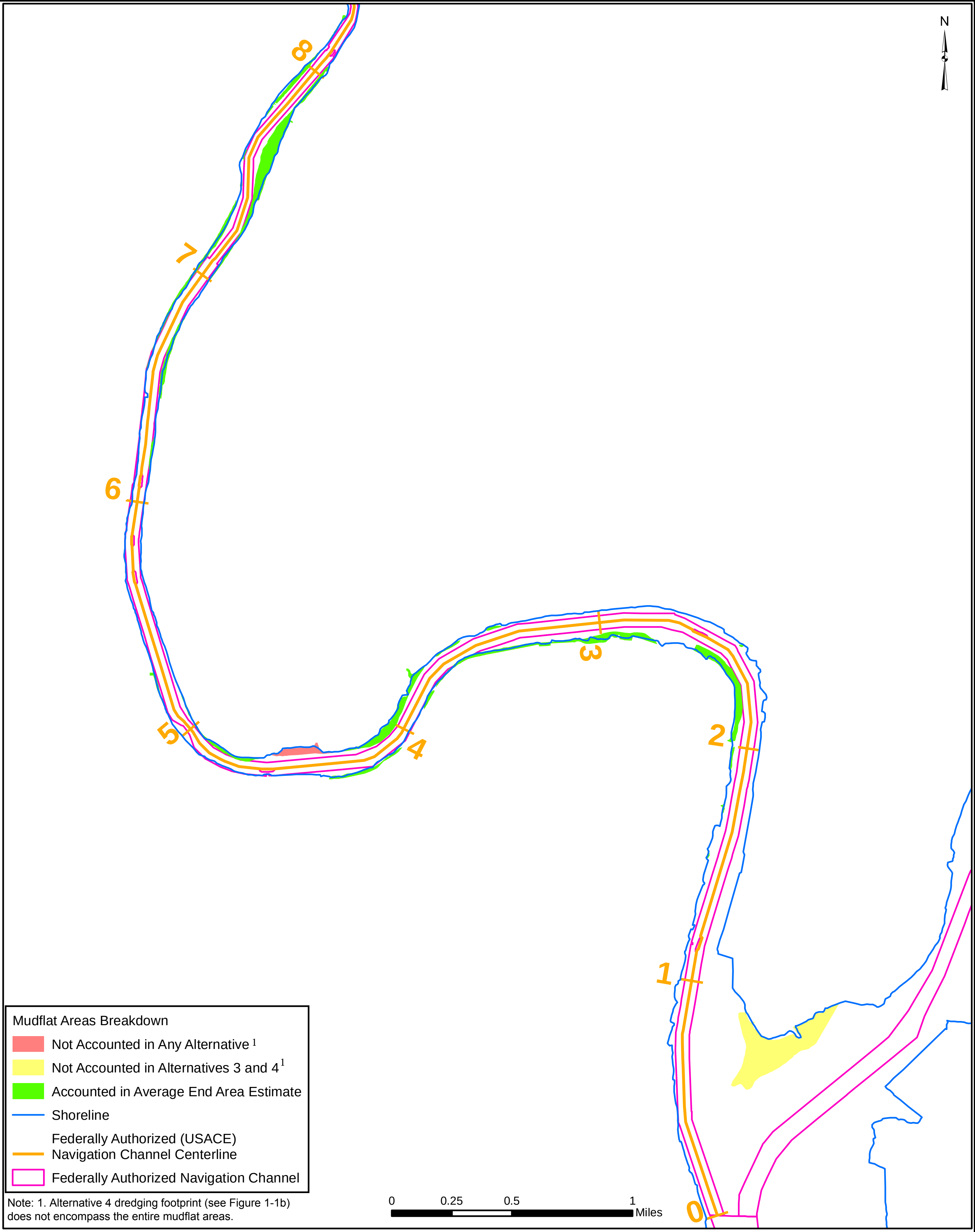
2014



NOTES:

1. MEASURED HORIZONTAL DISTANCE BETWEEN CHANNEL AND TOP OF SLOPE USING CAD SOFTWARE.
2. USED GIS SOFTWARE TO SELECT BATHYMETRIC COMPARISON WITHIN AREA TO CALCULATE DELTA VOLUME.
3. A DELTA VOLUME WAS NOT CALCULATED BETWEEN TOP OF SLOPE AND SHORELINE BECAUSE THIS AREA WOULD BE DREDGED TO CREATE SPACE FOR THE CAP (2.5 FEET THICK), WHICH WOULD REMAIN RELATIVELY THE SAME WITH CHANGES IN BATHYMETRY.

Methodology for Left and Right Shoal Volumes	Figure 1-3
Lower Eight Miles of the Lower Passaic River	2014



Note: 1. Alternative 4 dredging footprint (see Figure 1-1b) does not encompass the entire mudflat areas.

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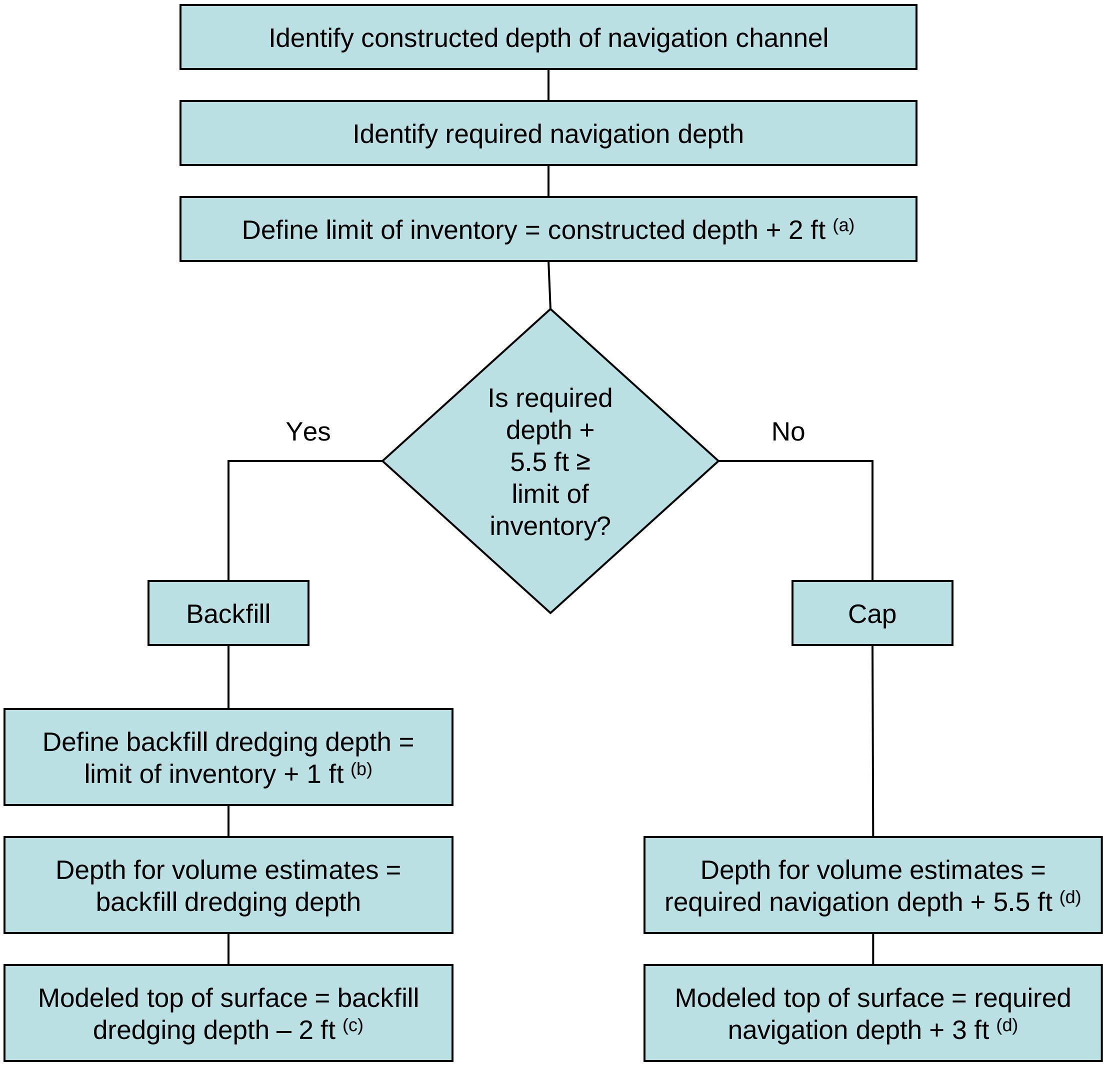
Mudflat Areas Breakdown

Lower Eight Miles of the Lower Passaic River

Figure 1-4

2014



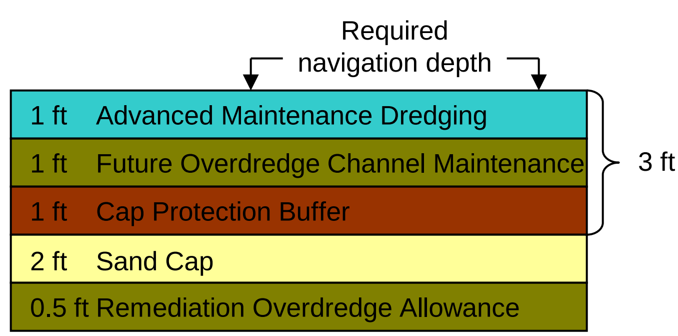
Assumptions:

(a) 2 ft = historical overdredge allowance

(b) 1 ft = remediation overdredge allowance

(c) 2 ft = nominal backfill thickness

(d) 5.5 ft Criteria (refer to FFS Table 4-1 for additional details)

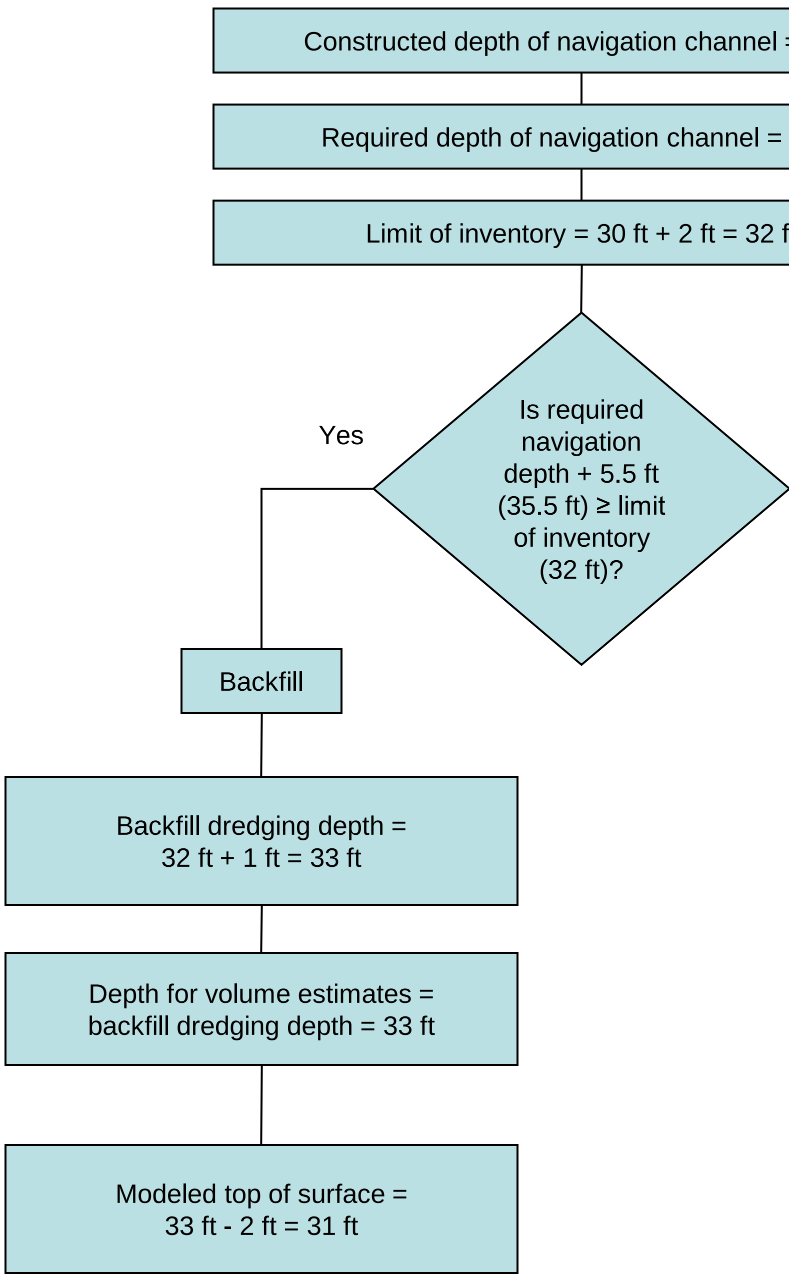


Flowchart for Determining Depth for Volume Estimates and Modeled Top of Surface

Lower Eight Miles of the Lower Passaic River

Figure 1-5a

2014



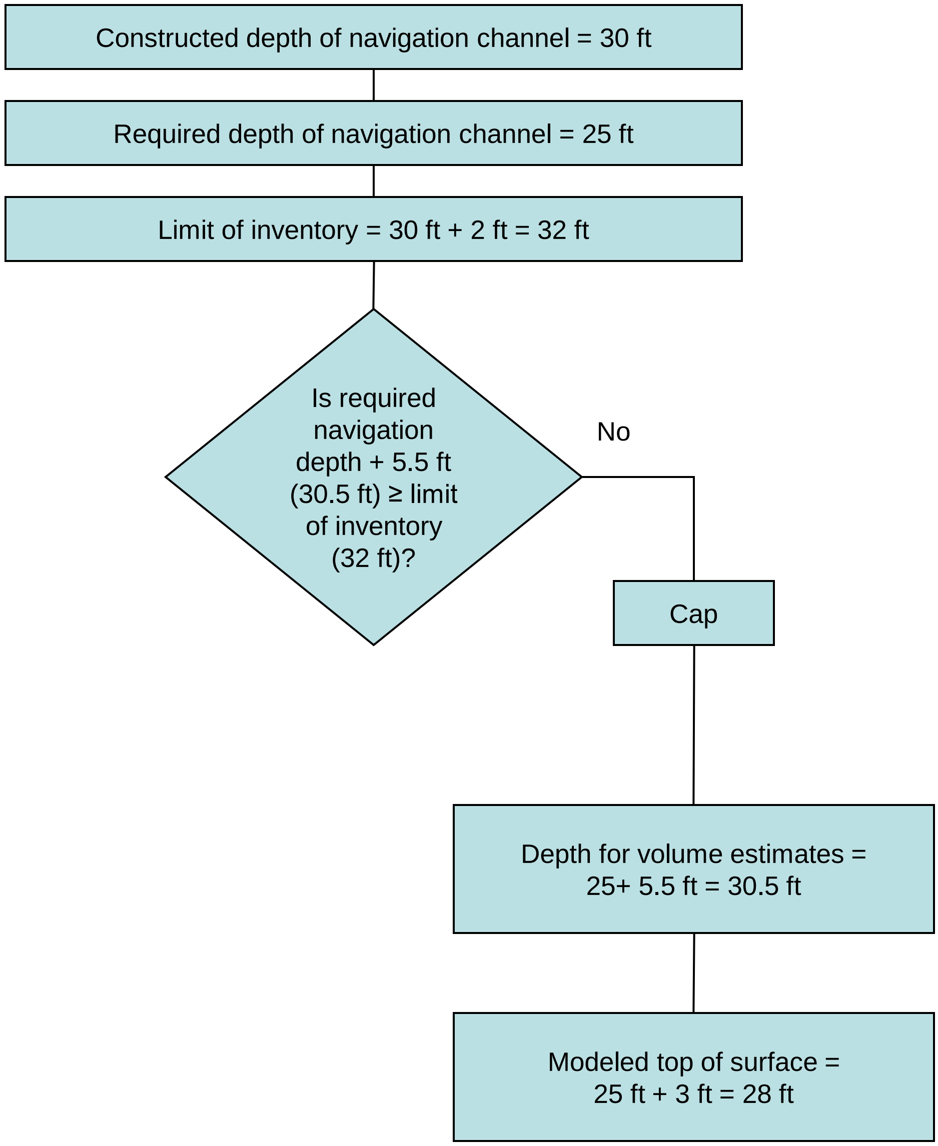
Flowchart for Determining Depth for Volume Estimates and Modeled Top of Surface

30 ft MLW Navigation Channel from RM0 to RM1.2

Lower Eight Miles of the Lower Passaic River

Figure 1-5b

2014



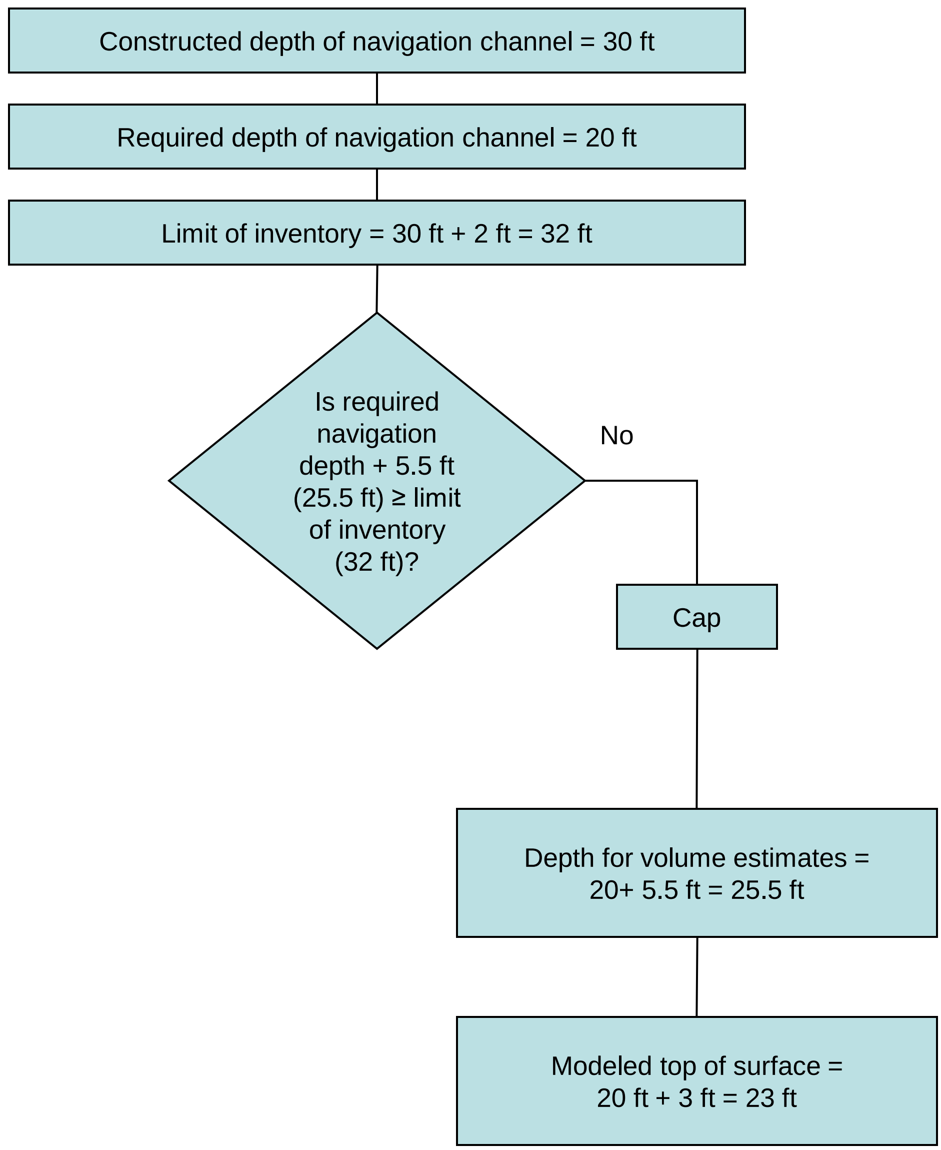
Flowchart for Determining Depth for Volume Estimates and Modeled Top of Surface

25 ft MLW Navigation Channel from RM1.2 to RM1.7

Lower Eight Miles of the Lower Passaic River

Figure 1-5c

2014



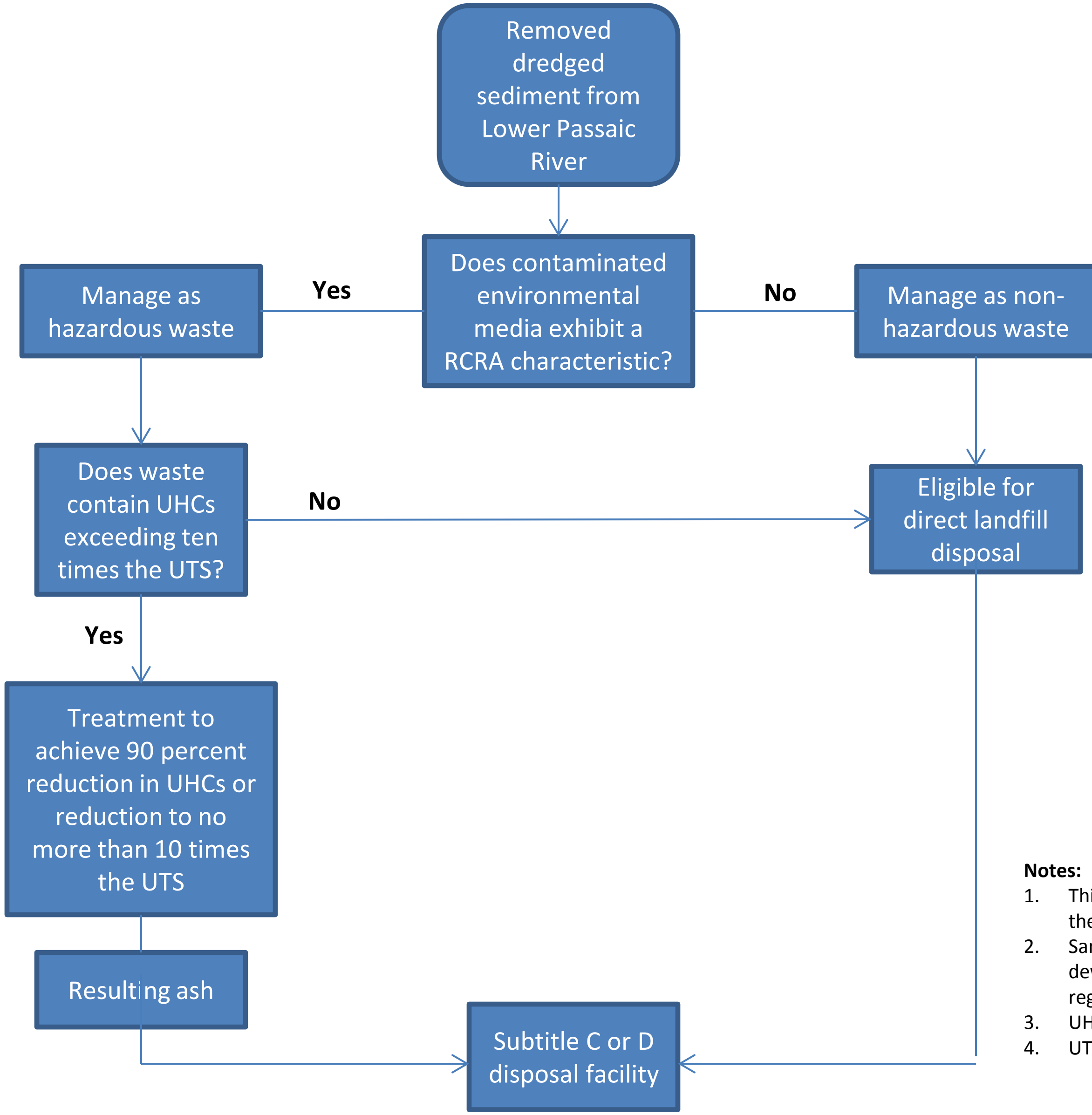
Flowchart for Determining Depth for Volume Estimates and Modeled Top of Surface

16 ft MLW Navigation Channel from RM1.7 to RM2.2

Lower Eight Miles of the Lower Passaic River

Figure 1-5d

2014



Notes:

1. This flow chart assumes that all removed material meets the individual acceptance criteria of the receiving facility.
2. Sand and rock may be separated during system dewatering. Their sale/reuse is subject to applicable regulations.
3. UHCs – Underlying Hazardous Constituents
4. UTS – Universal Treatment Standards

Flow Chart for DMM Scenario B – Off-Site Disposal

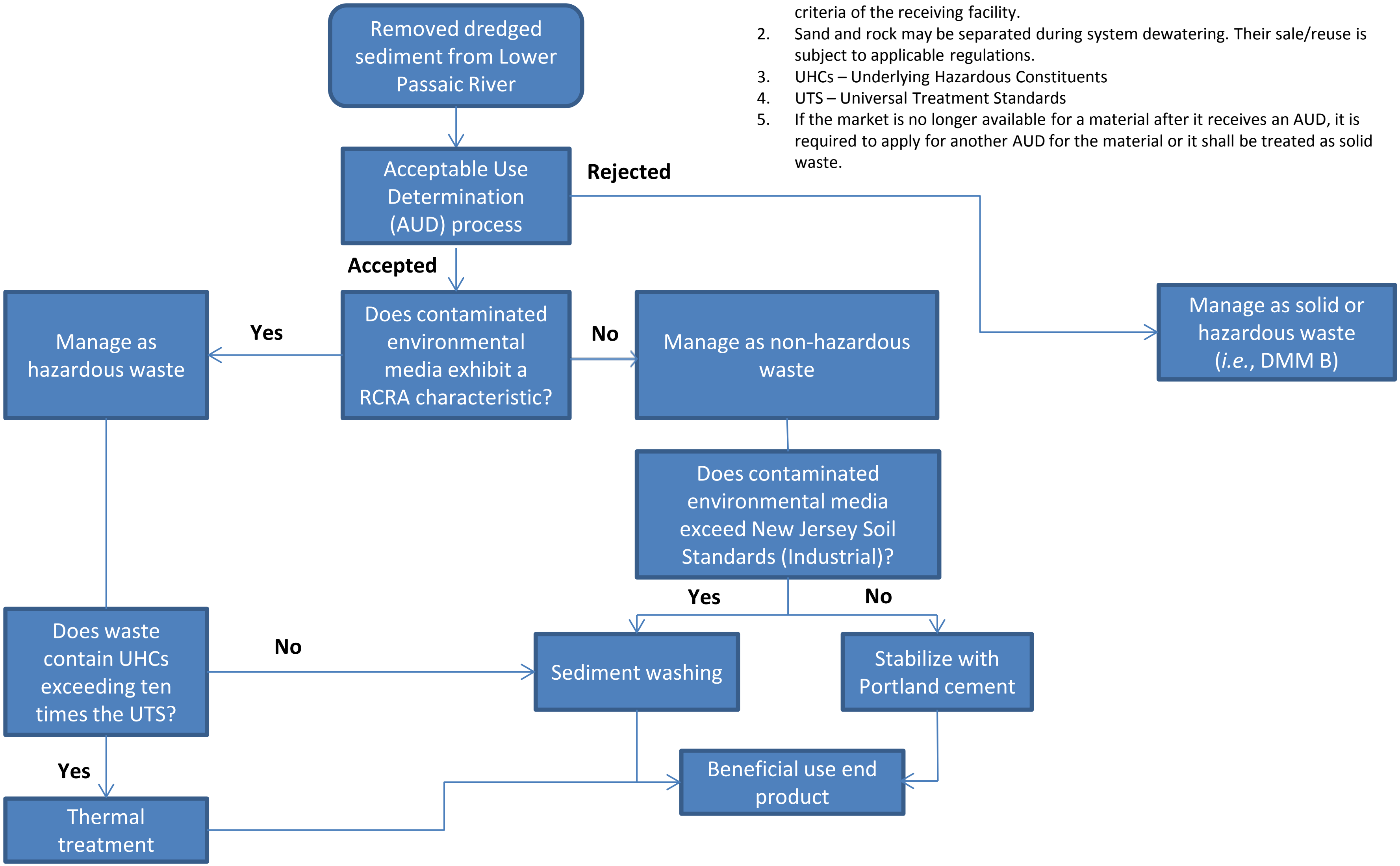
Lower Eight Miles of the Lower Passaic River

Figure 2-1

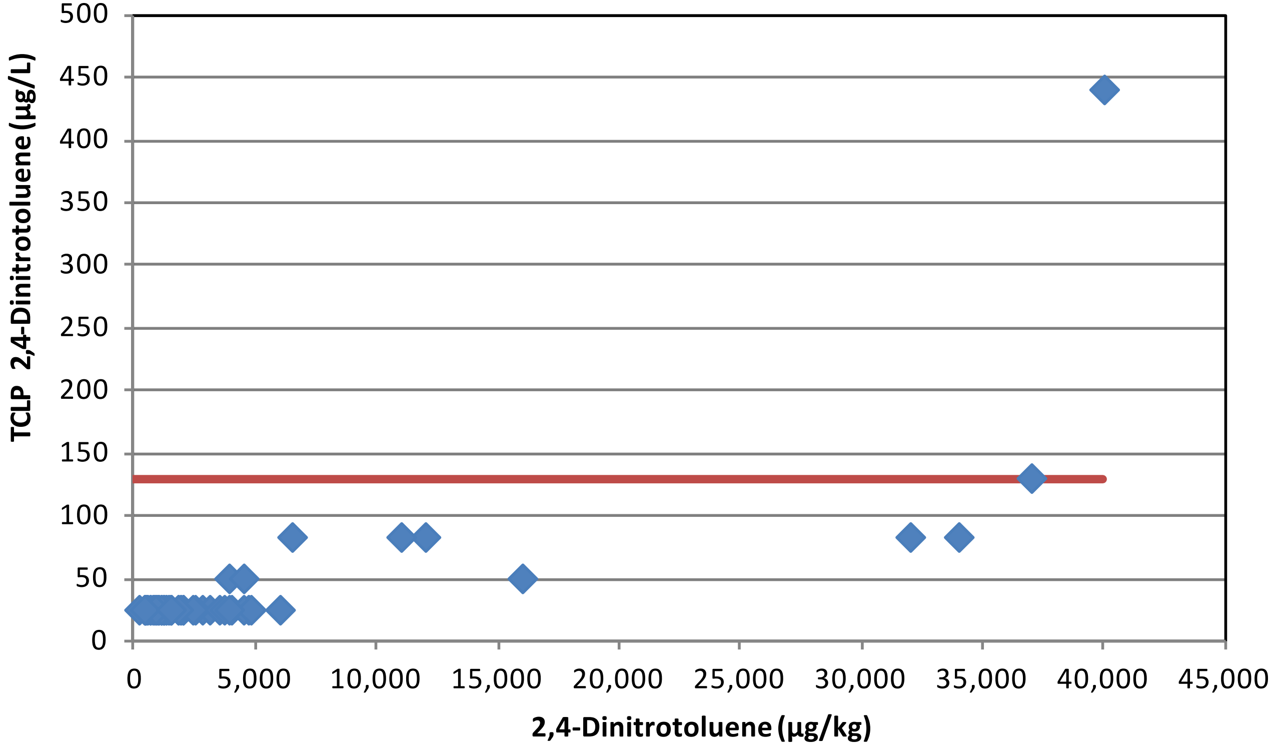
2014

Notes:

1. This flow chart assumes that all removed material meets the individual acceptance criteria of the receiving facility.
2. Sand and rock may be separated during system dewatering. Their sale/reuse is subject to applicable regulations.
3. UHCs – Underlying Hazardous Constituents
4. UTS – Universal Treatment Standards
5. If the market is no longer available for a material after it receives an AUD, it is required to apply for another AUD for the material or it shall be treated as solid waste.



Flow Chart for DMM Scenario C - Local Decontamination and Beneficial Use	Figure 2-2
Lower Eight Miles of the Lower Passaic River	2014



Legend

2,4-Dinitrotoluene Data

TCLP RCRA Standard

Notes

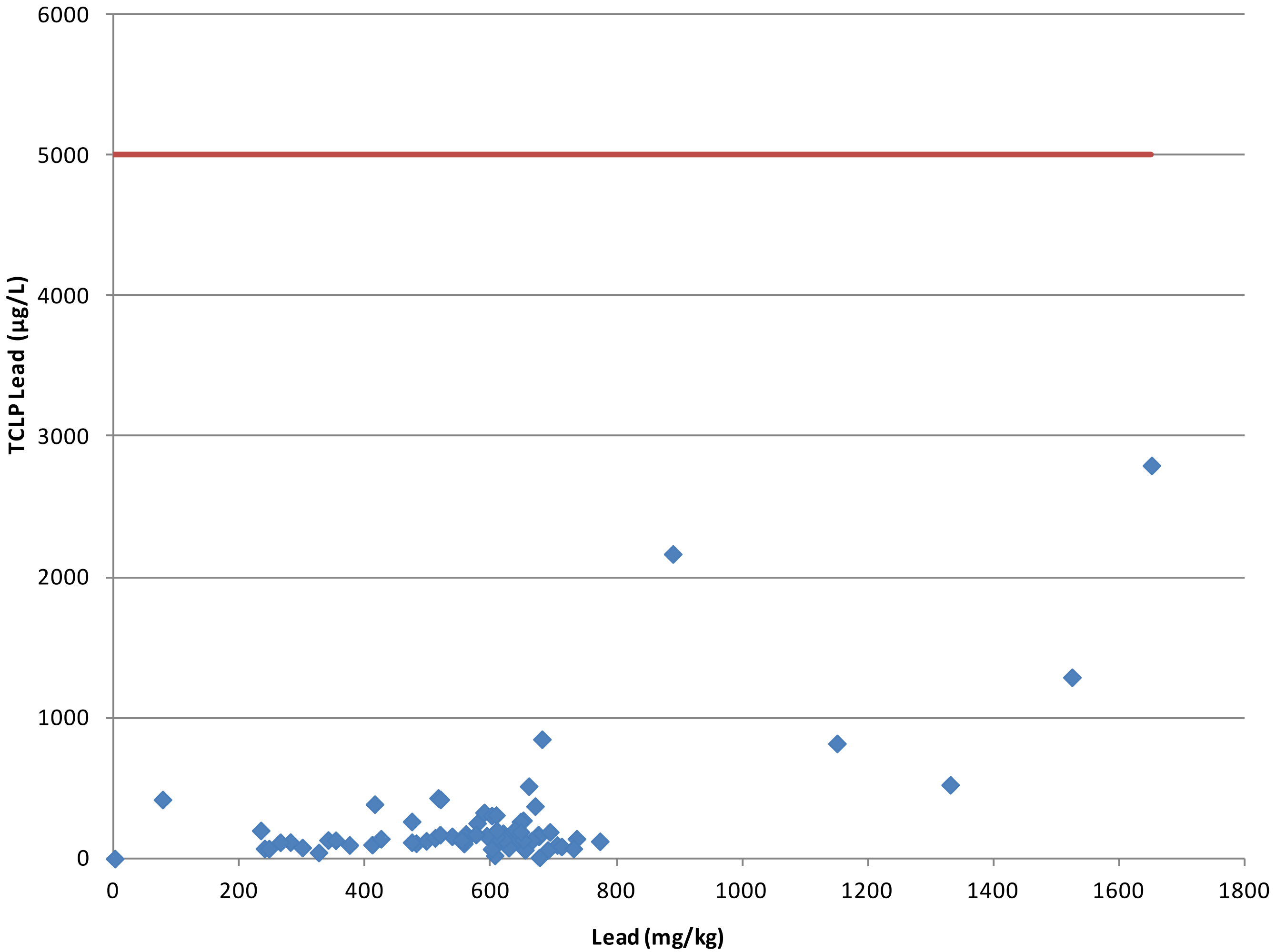
The RCRA Standard threshold chosen for 2,4-Dinitrotoluene was 27,000 µg/kg (after being reduced by 25 percent to be conservative).

2,4-Dinitrotoluene Correlation to Determine
the RCRA Standard Threshold for Bulk Sediment

Lower Eight Miles of the Lower Passaic River

Figure 2-3a

2014



Legend

- Lead Data
- TCLP RCRA Standard

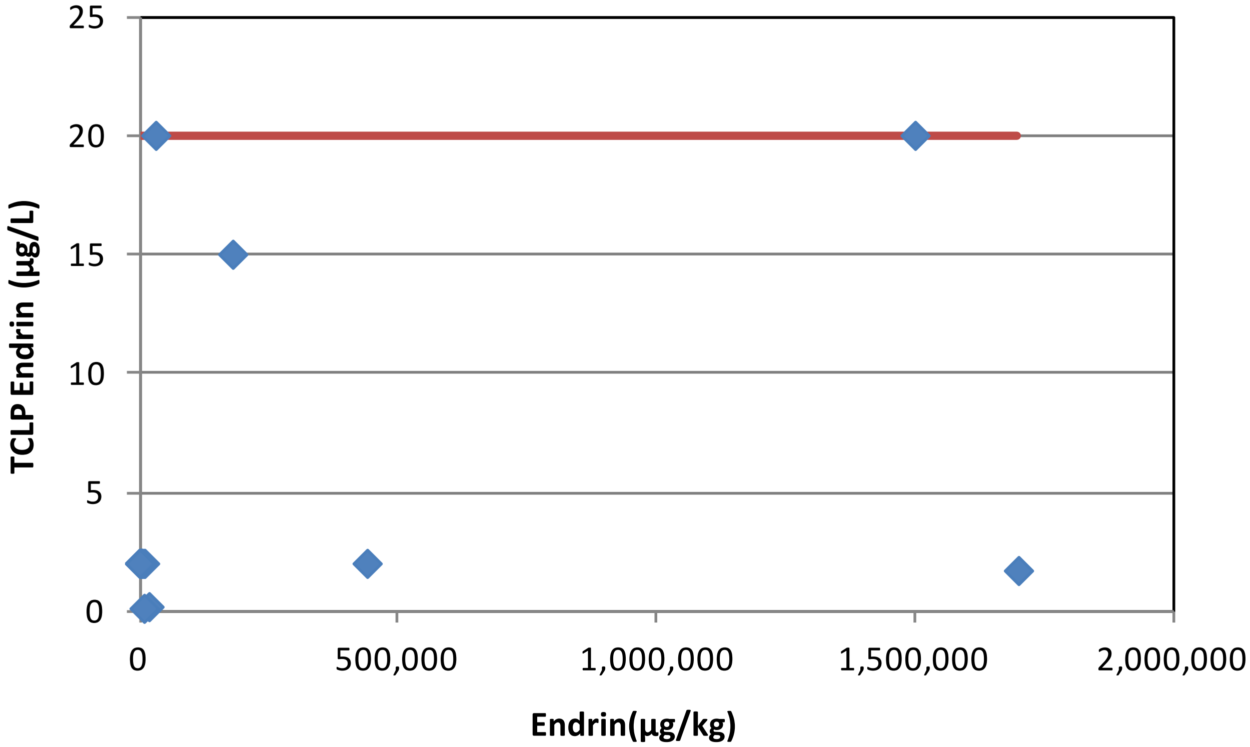
Notes

The RCRA Standard threshold chosen for Lead was 1,650 mg/kg (the maximum bulk sediment concentration).

Lead Correlation to Determine
the RCRA Standard Threshold for Bulk Sediment
Lower Eight Miles of the Lower Passaic River

Figure 2-3b

2014



Legend

- Endrin Data
- TCLP RCRA Standard

Notes

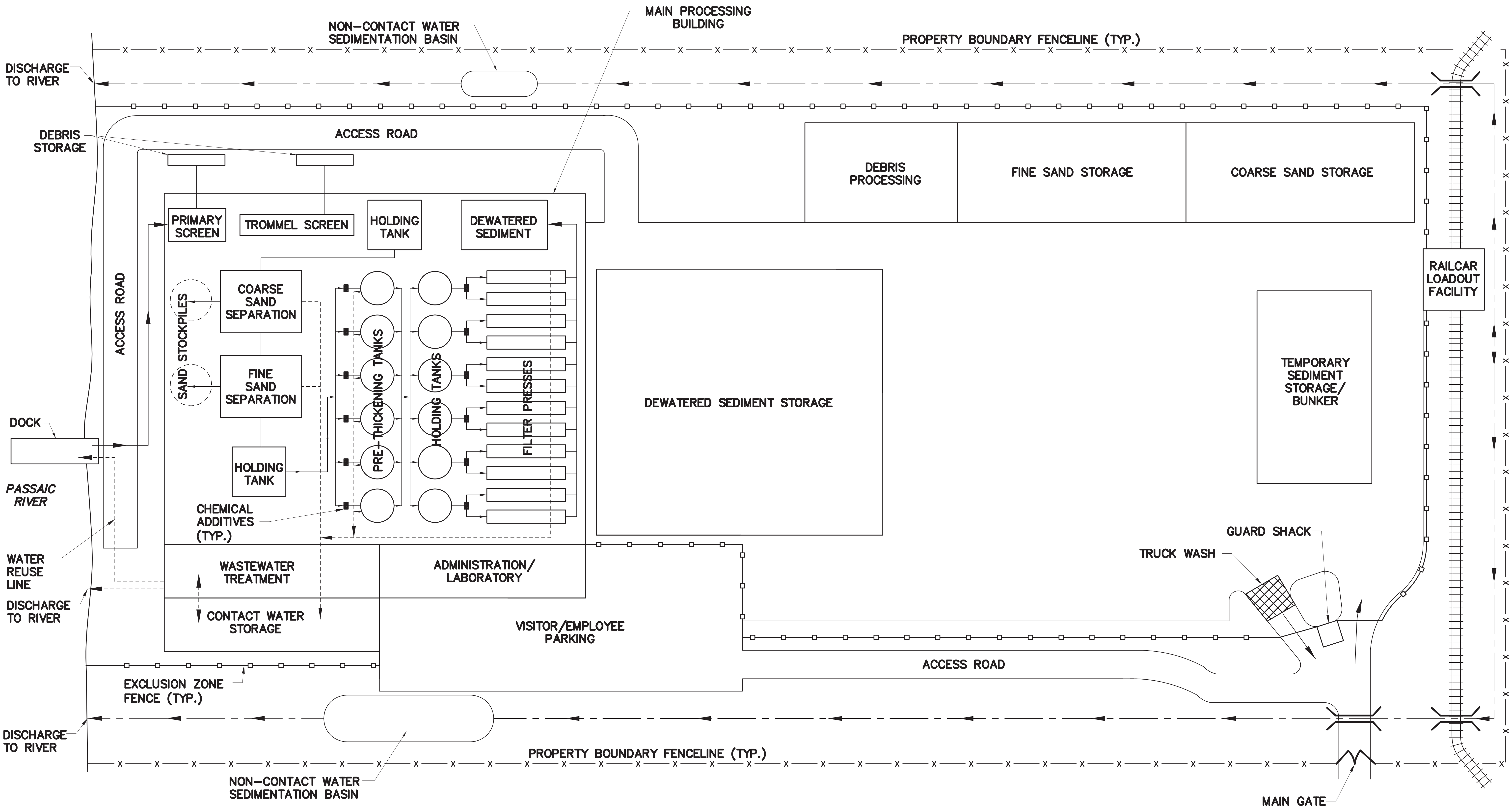
The RCRA Standard threshold chosen for Endrin was 18,000 µg/kg (the bulk sediment concentration just before exceeding the standard for TCLP).

Endrin Correlation to Determine
the RCRA Standard Threshold for Bulk Sediment

Lower Eight Miles of the Lower Passaic River

Figure 2-3c

2014



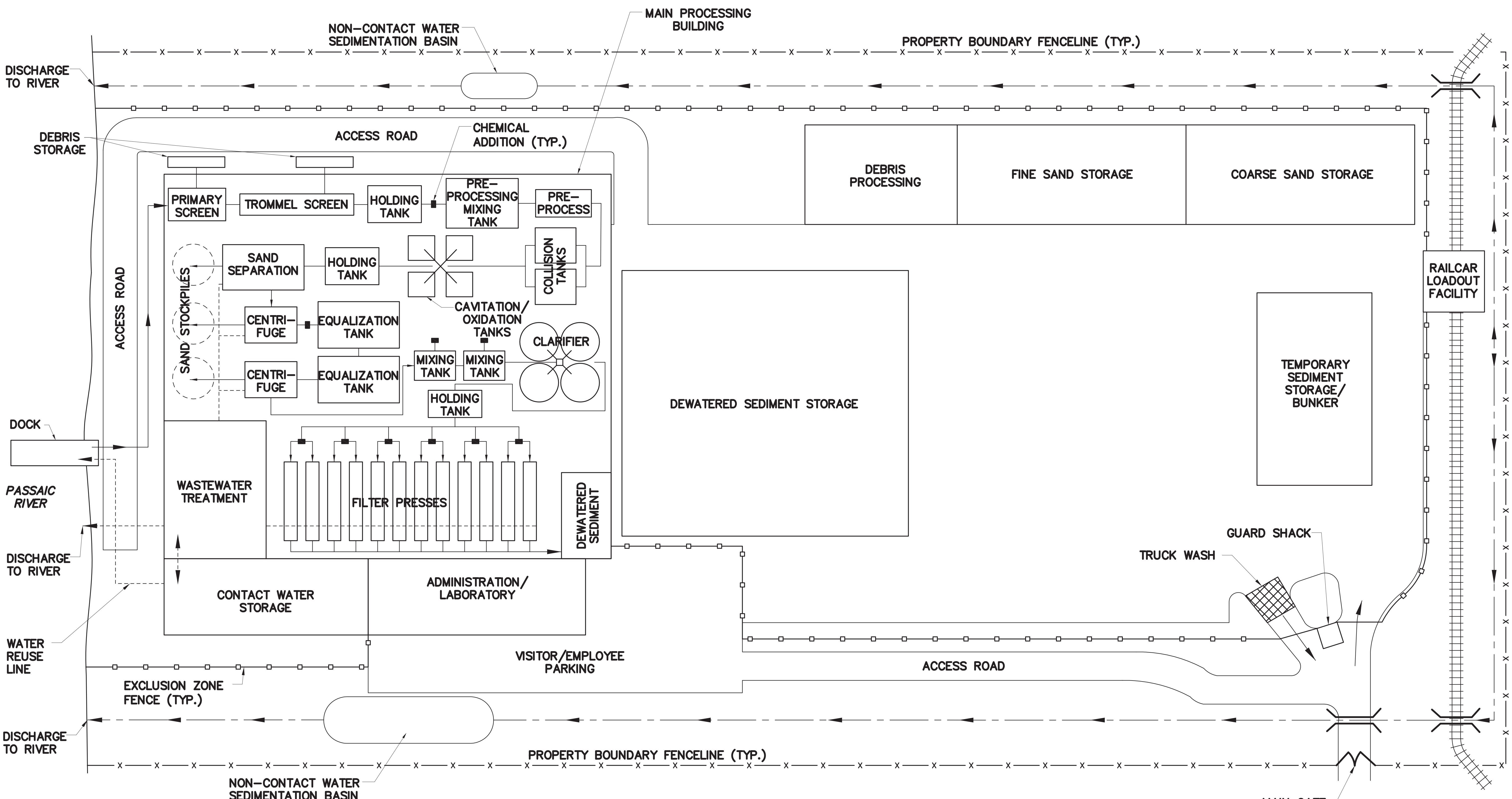
Note: Not to scale

Upland Processing Facility Schematic DMM Scenario B

Lower Eight Miles of the Lower Passaic River

Figure 3-1

2014



Note: Not to scale.

Thermal treatment area is not shown in schematic. A thermal treatment facility could be constructed within the upland processing facility or at a separate site as a dedicated or regional facility.

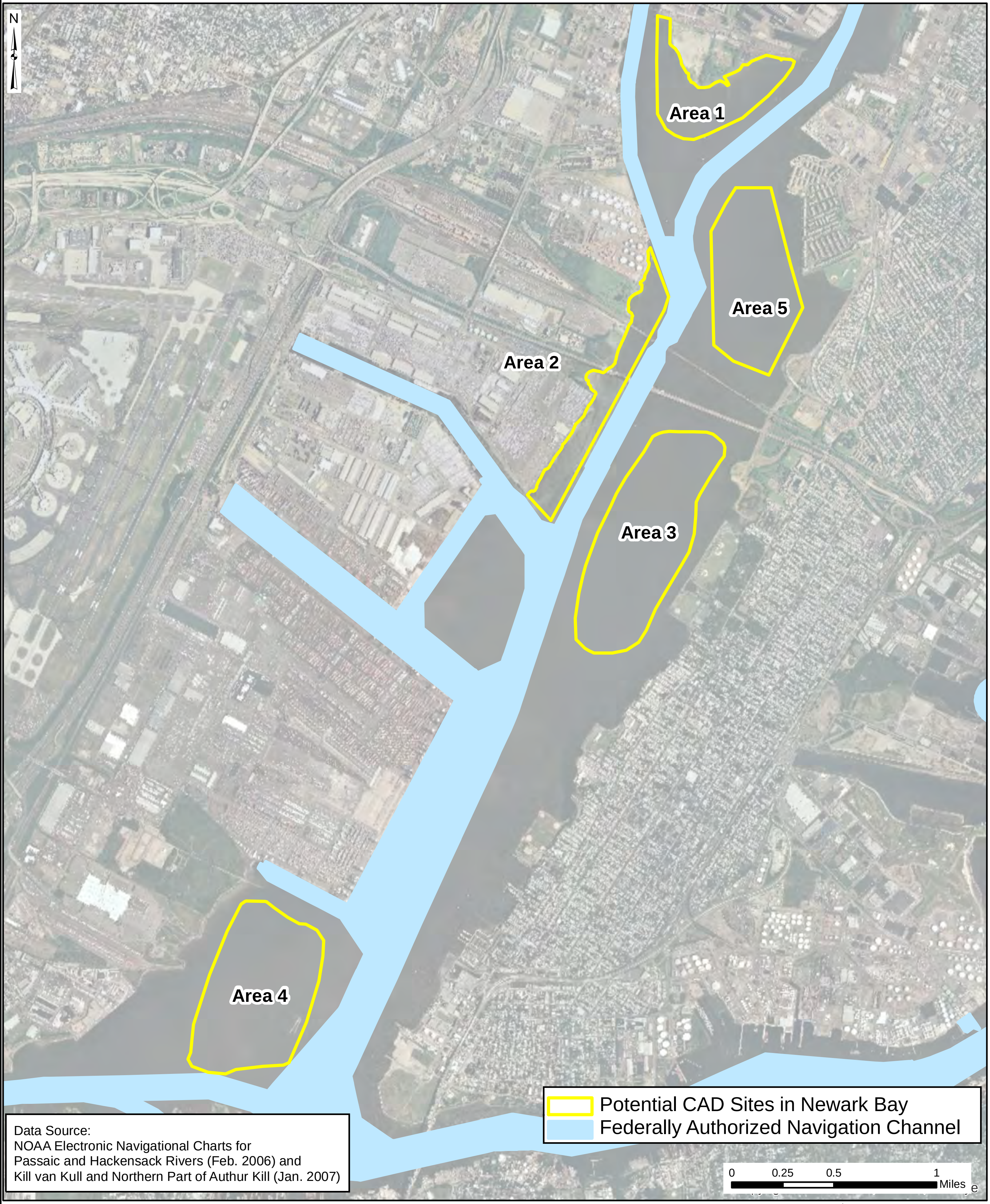
Note that for the purposes of the FFS, 5 acres were assumed for the thermal treatment area (refer to Table 3-4).

Upland Processing Facility Schematic DMM Scenario C

Lower Eight Miles of the Lower Passaic River

Figure 3-2

2014

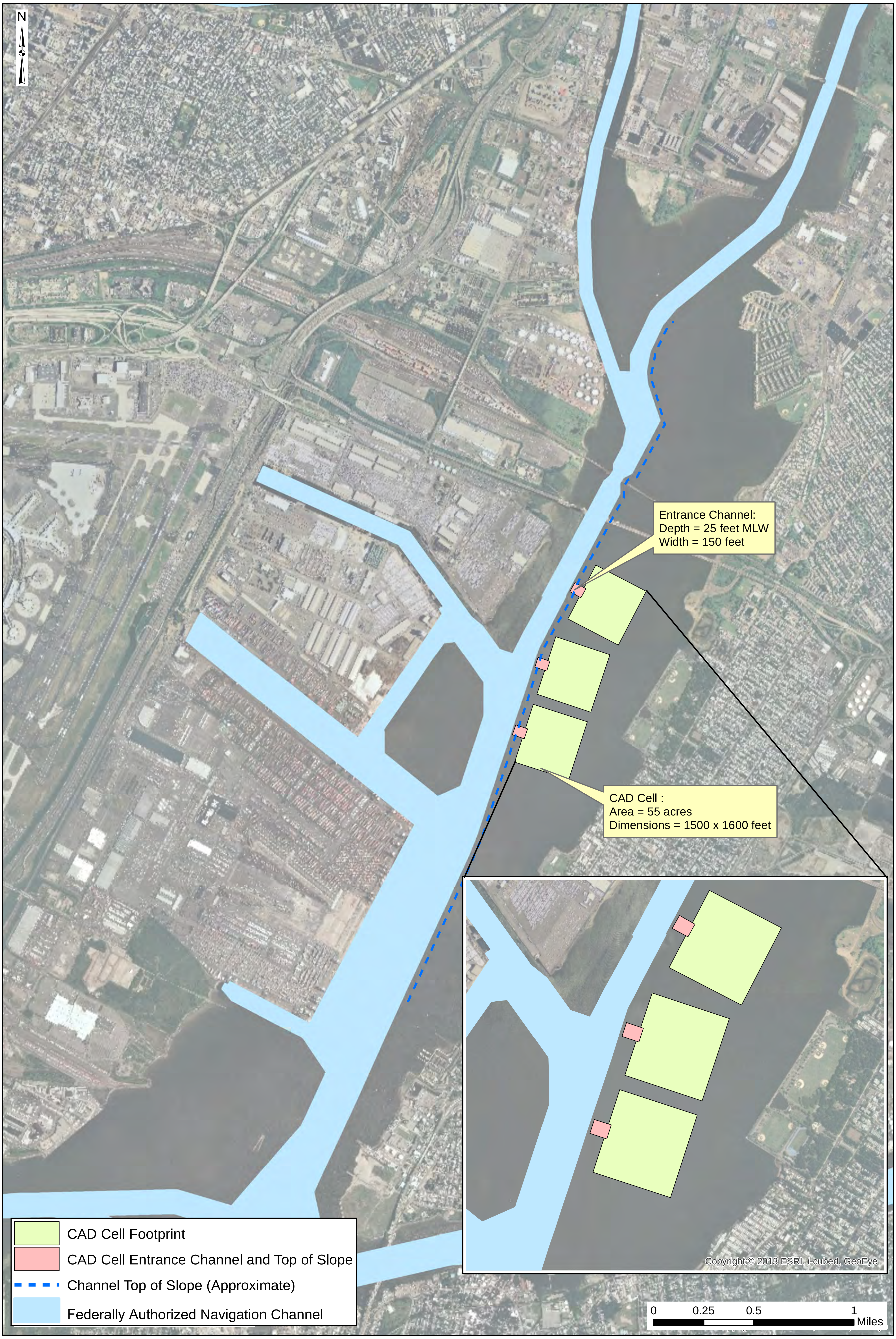


Potential CAD Sites in Newark Bay

Lower Eight Miles of the Lower Passaic River

Figure 6-1

2014



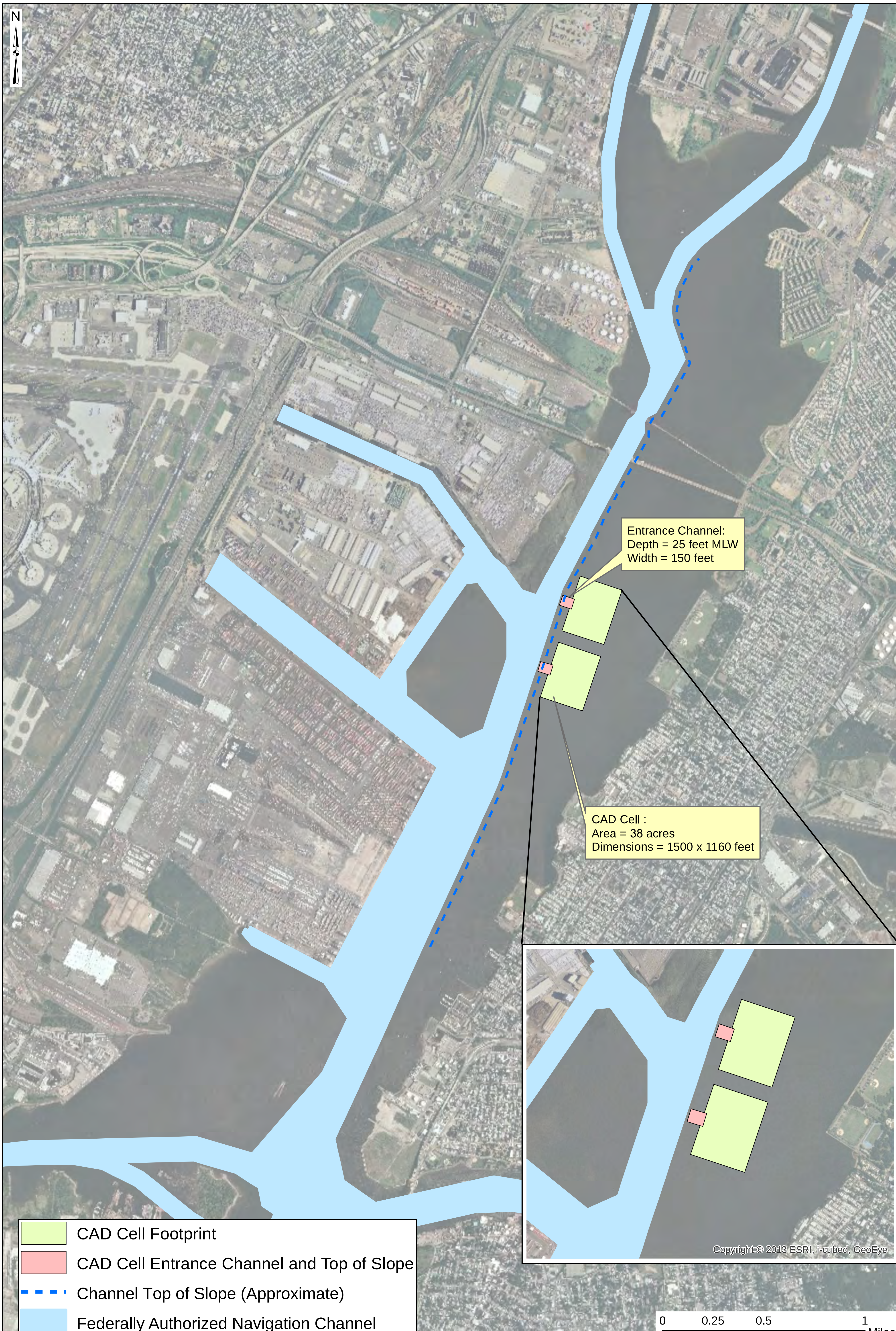
CAD Footprint for Alternative 2
Deep Dredging with Backfill

Lower Eight Miles of the Lower Passaic River

Data Source:
NOAA Electronic Navigational Charts for
Passaic and Hackensack Rivers (Feb. 2006) and
Kill Van Kull and Northern Part of Authur Kill (Jan. 2007)

Figure 6-2a

2014



CAD Footprint for Alternative 3

Capping with Dredging for Flooding & Navigation

Lower Eight Miles of the Lower Passaic River

Data Source:
NOAA Electronic Navigational Charts for
Passaic and Hackensack Rivers (Feb. 2006) and
Kill van Kull and Northern Part of Authur Kill (Jan. 2007)

Figure 6-2b

2014

S:\Projects\passaic\MapDocuments\Final_FFS_Figures_2014\Figure G 6-2b_CADFootprint_Alt_3.mxd

CAD Footprint for Alternative 4

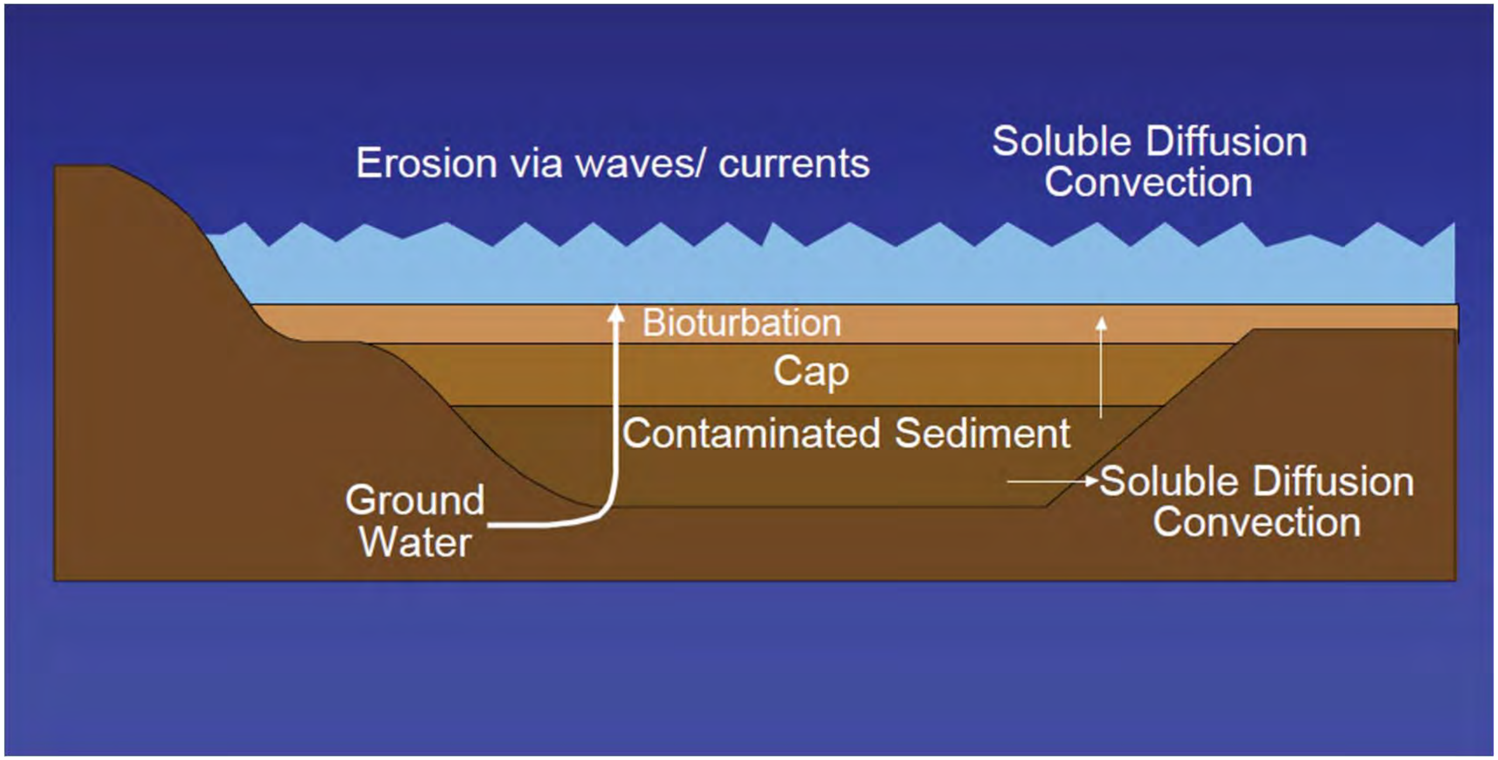
Focused Capping with Dredging for Flooding

Lower Eight Miles of the Lower Passaic River

Data Source:
NOAA Electronic Navigational Charts for
Passaic and Hackensack Rivers (Feb. 2006) and
Kill Van Kull and Northern Part of Authur Kill (Jan. 2007)

Figure 6-2c

2014

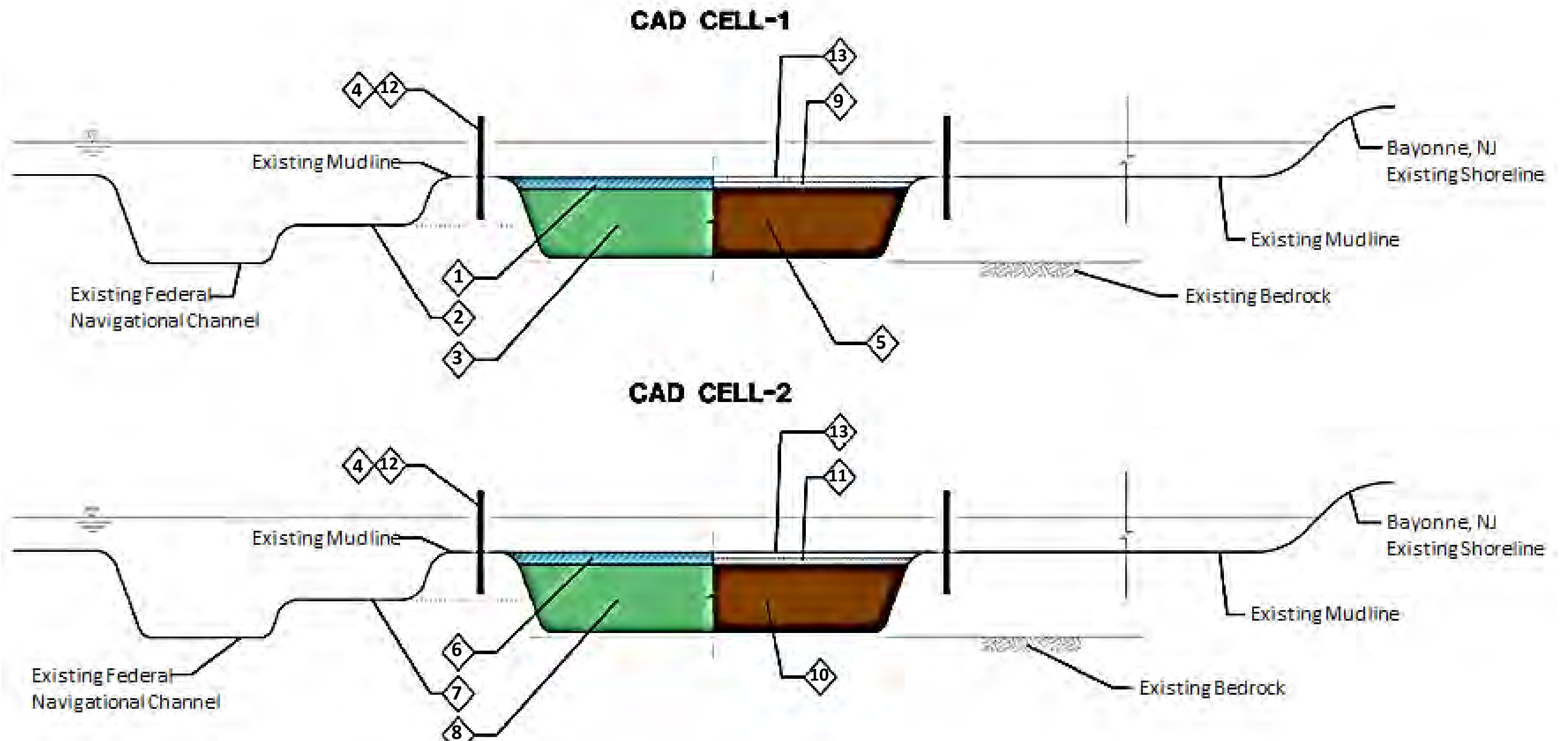


Source: (Palermo, 2001)

Contaminant Migration Pathways for In-Placed Sediment in CAD	Figure 6-3
Lower Eight Miles of the Lower Passaic River	2014

CAD Construction Sequence:

1. Excavate unconsolidated sediment (upland disposal).
2. Dredge navigational approach channel.
3. Excavate underlying clay (HARS) CAD Cell-1.
4. Construct sheetpile containment system around entire CAD site perimeter during steps 1-3.
5. Place contaminated river sediments in CAD cell-1.
6. Excavate unconsolidated sediment in CAD cell-2 (place in CAD Cell-1). Once CAD cell-1 has reached approximately one year of remaining design capacity, construction of CAD Cell-2 will begin.
7. Dredge navigational approach channel.
8. Excavate underlying clay (HARS) in CAD cell 2.
9. Construct interim cap for CAD-cell 1 once cell has reached design capacity.
10. Place contaminated river sediments in CAD cell-2.
11. Construct interim cap once CAD cell-2 has reached design capacity.
12. Remove sheetpile containment system once all CAD cells have reached design capacity and interim caps have been constructed.
13. Construct final cap and habitat layer. Final cap will be constructed to match existing mudline.
14. Comprehensive long-term monitoring.



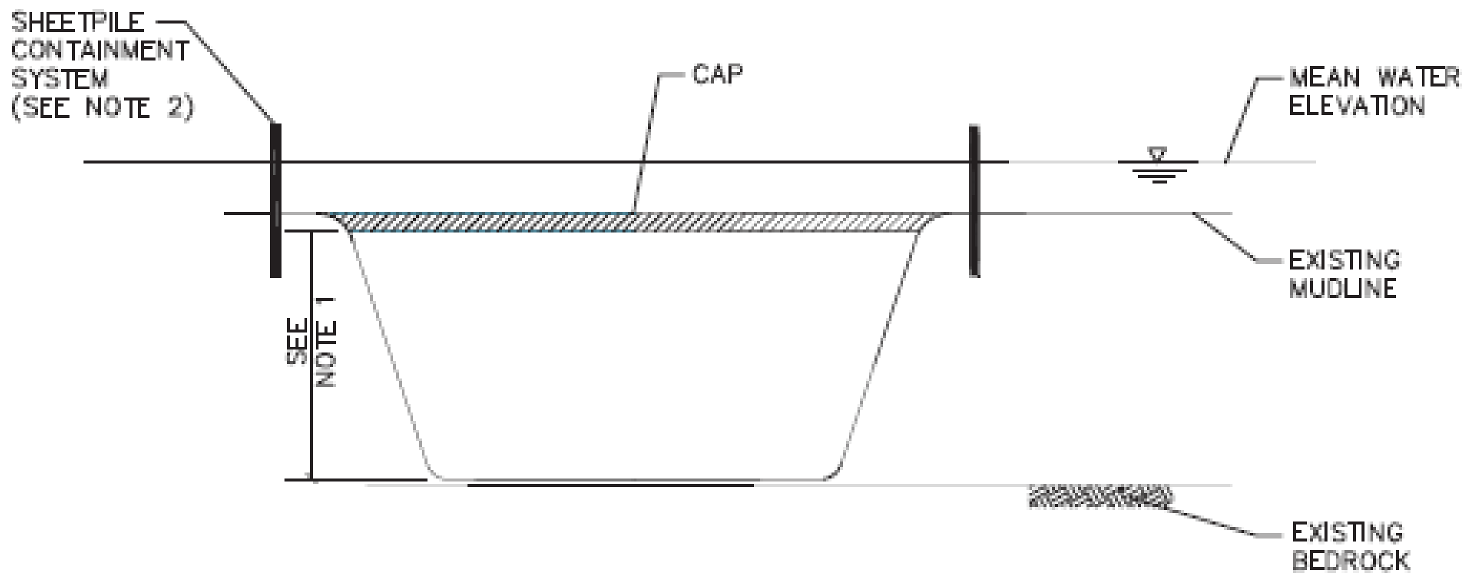
Notes:
Construction and Disposal Sequence (Steps 6-13) apply to any additional CAD Cells.
NOT TO SCALE

CAD Construction Sequencing: CAD Area 3

Lower Eight Miles of the Lower Passaic River

Figure 6-4

2014

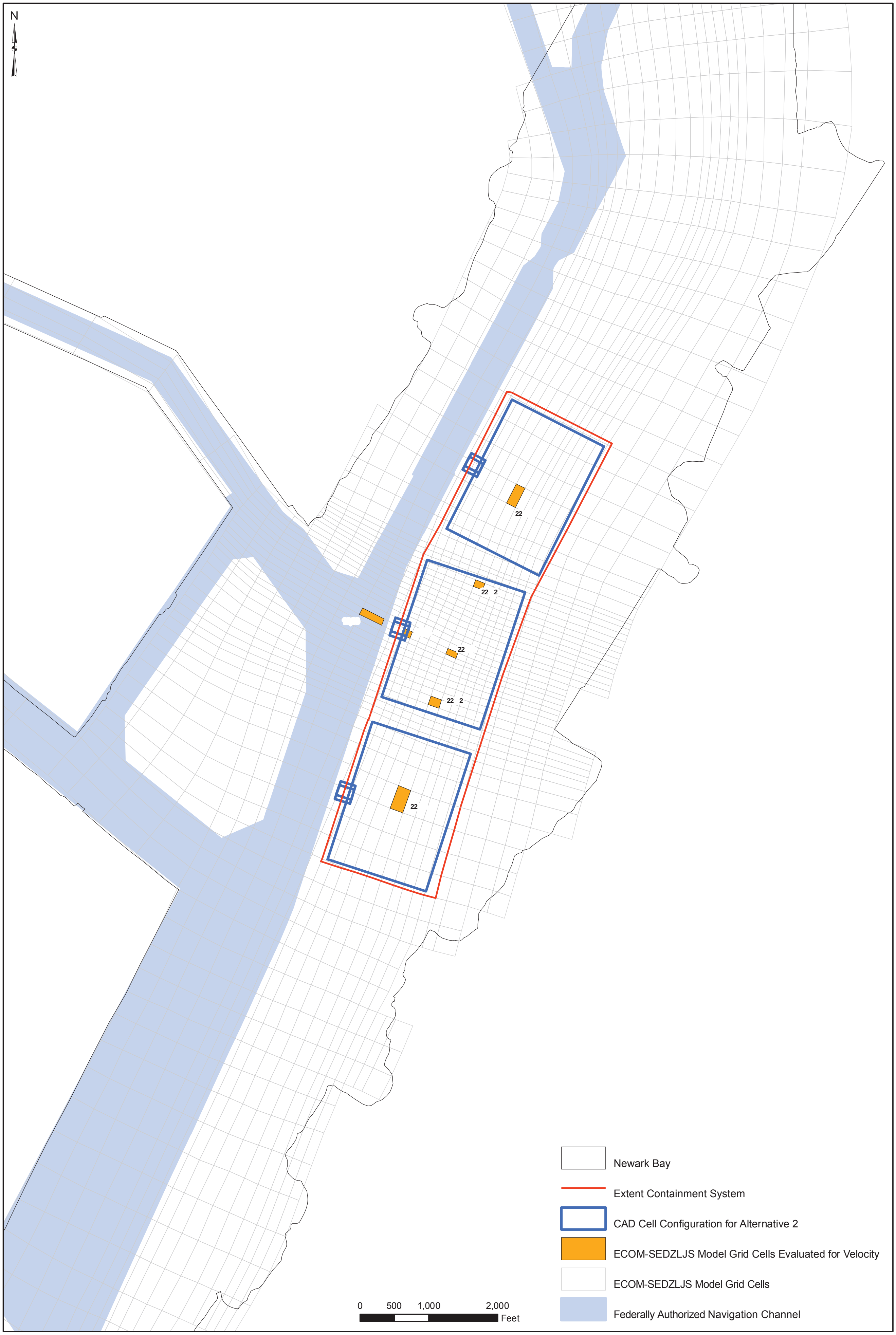


Notes:

1. Depth of excavation varies – maintain a 10 ft separation to bedrock.
2. Sheet pile containment system consists of king piles as structural supports and sheet piles as intermediary elements.
3. Refer to Figure 6-4 for CAD construction sequencing.

NOT TO SCALE

Confined Aquatic Disposal Typical Cross Section	Figure 6-5
Lower Eight Miles of the Lower Passaic River	2014

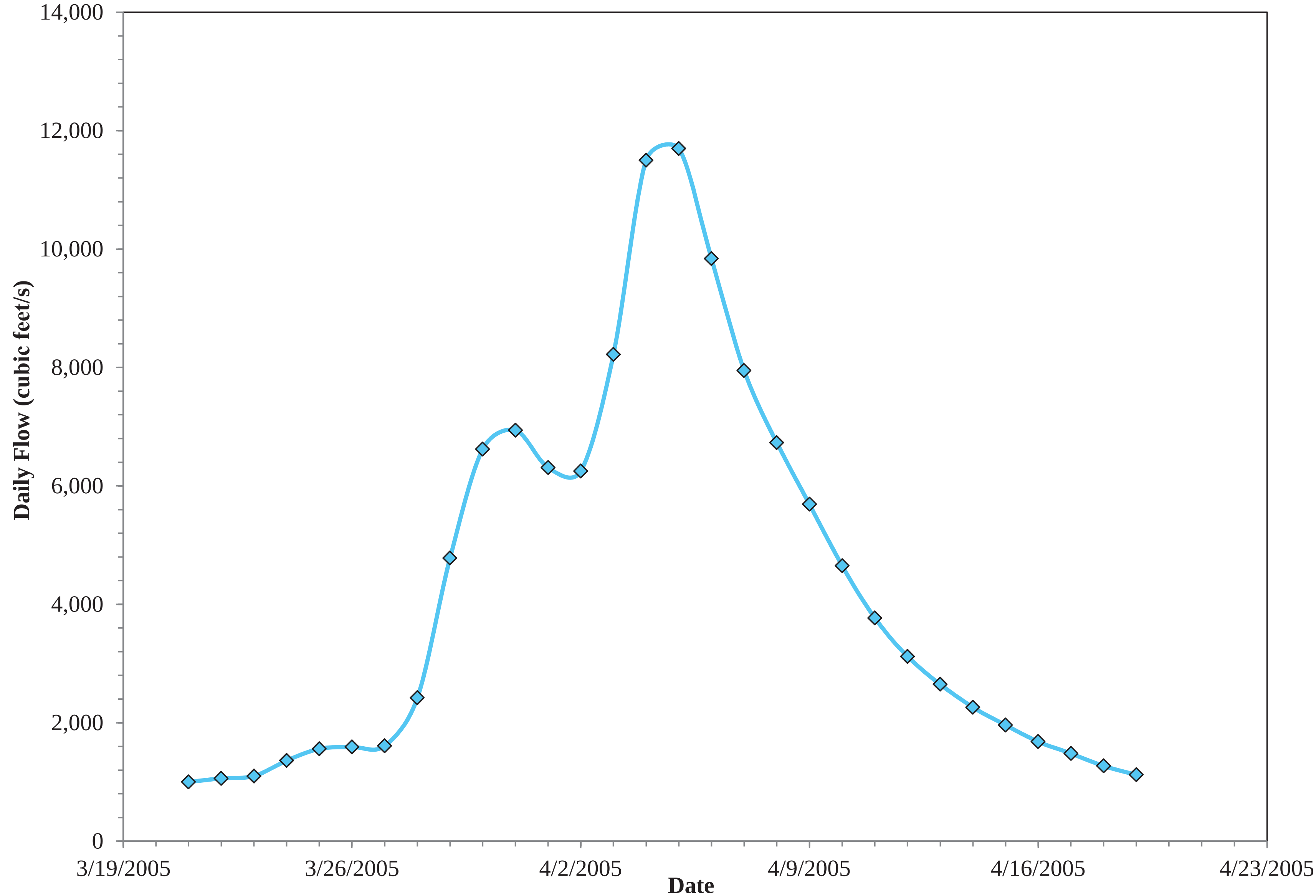


Representation of CAD Cell and Containment System on ECOM-SEDZLJS Model Grid

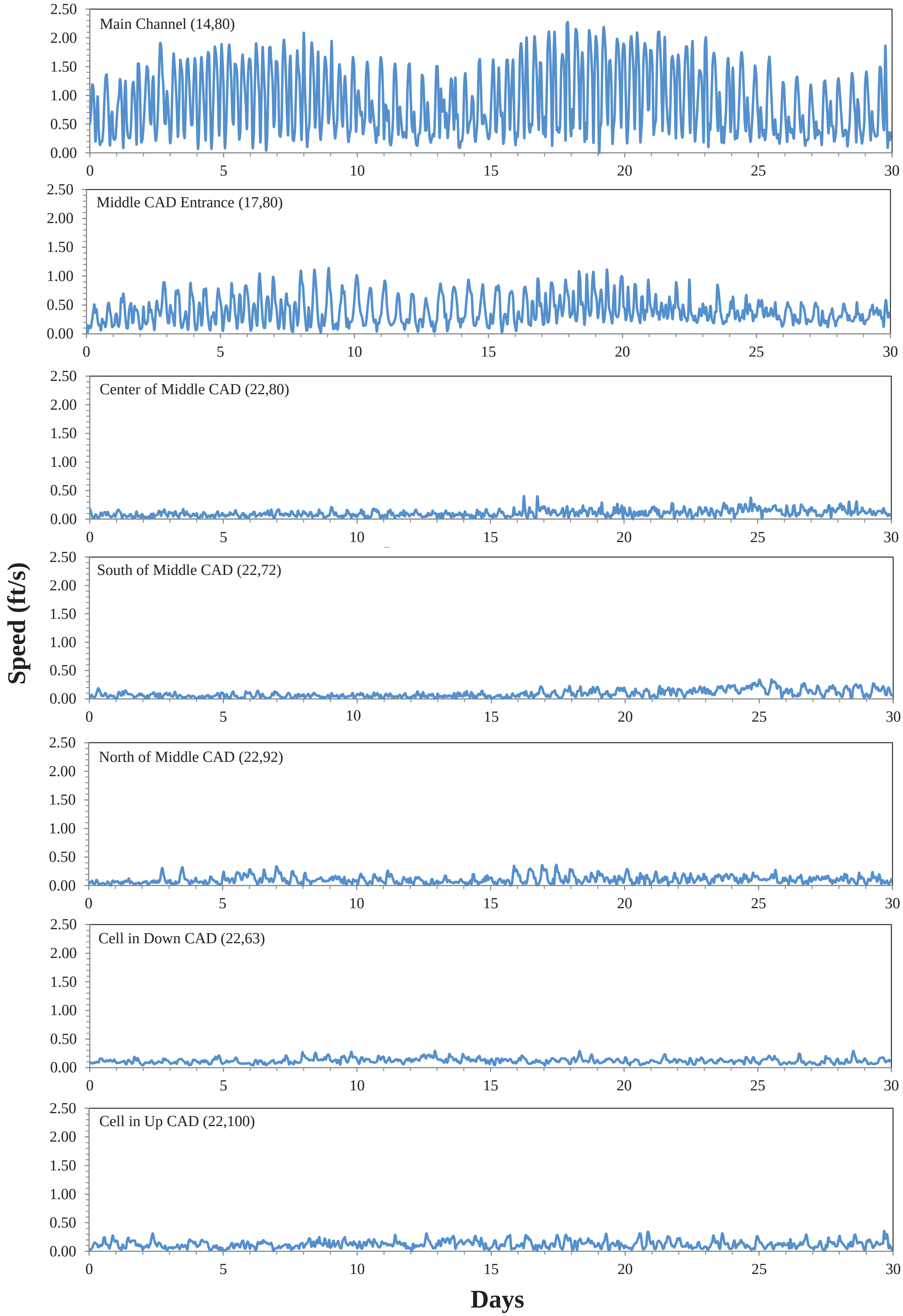
Lower Eight Miles of the Lower Passaic River

Figure 7-1

2014



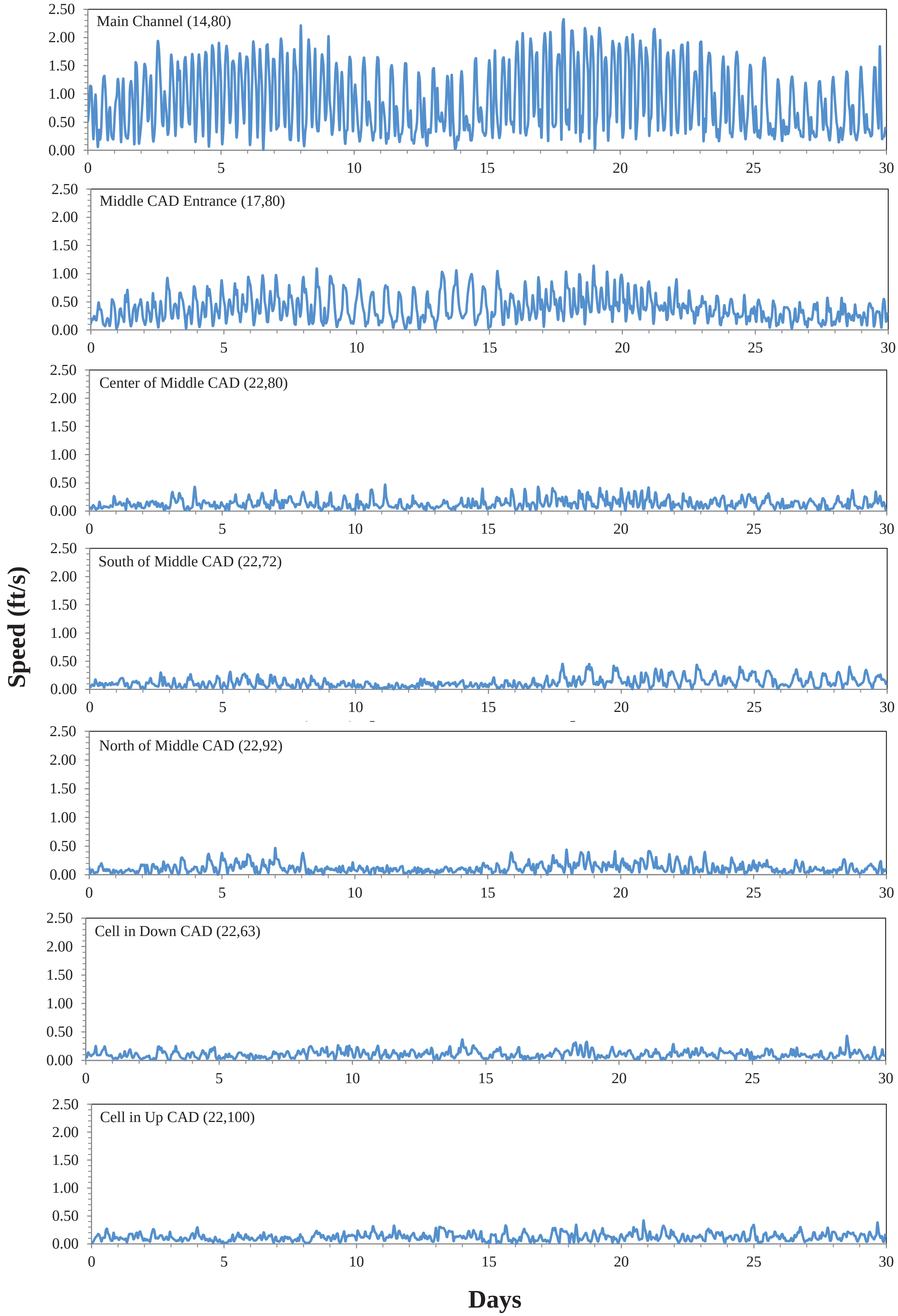
Little Fall Daily Flow for 1 in 10-year Flow Event in March - April 2005 *Lower Eight Miles of the Lower Passaic River*	Figure 7-2
	2014



Velocity Magnitude for Alternative 2
0% Fill Level at Various Locations
Lower Eight Miles of the Lower Passaic River

Figure 7-3

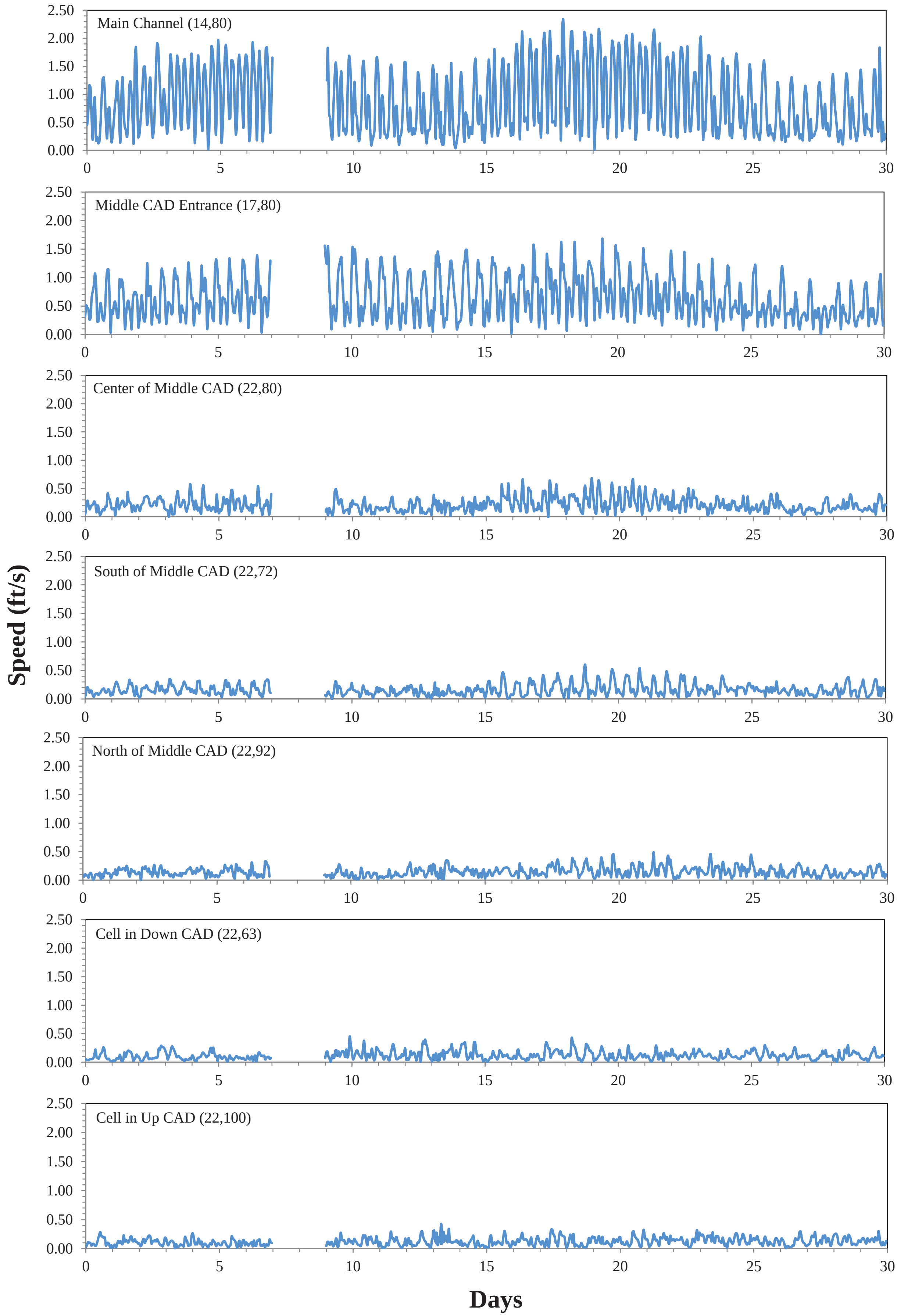
2014



Velocity Magnitude for Alternative 2
50% Fill Level at Various Locations
Lower Eight Miles of the Lower Passaic River

Figure 7-4

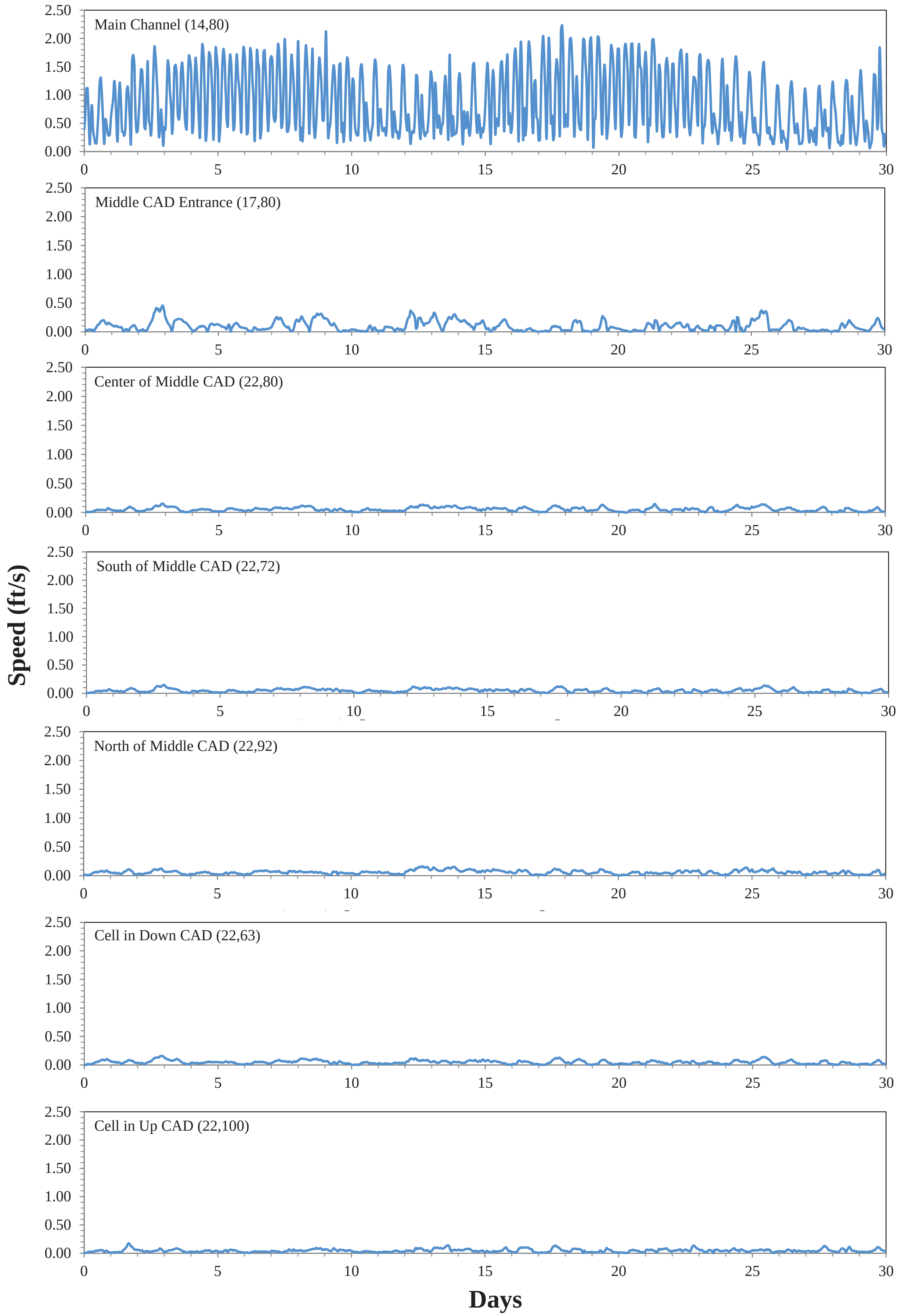
2014



Velocity Magnitude for Alternative 2
90% Fill Level at Various Locations
Lower Eight Miles of the Lower Passaic River

Figure 7-5

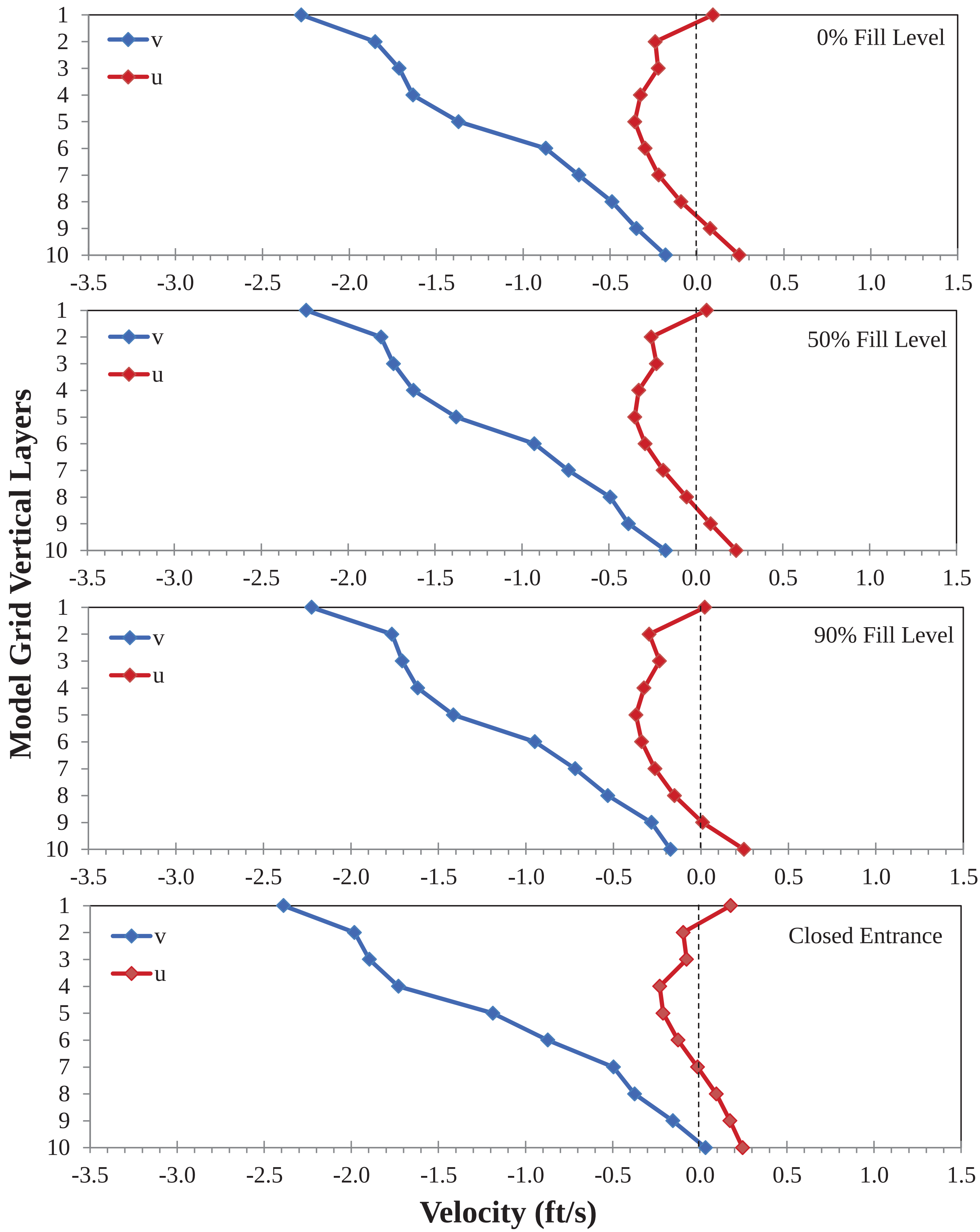
2014



Velocity Magnitude for Alternative 2
Closed Entrance at Various Locations
Lower Eight Miles of the Lower Passaic River

Figure 7-6

2014



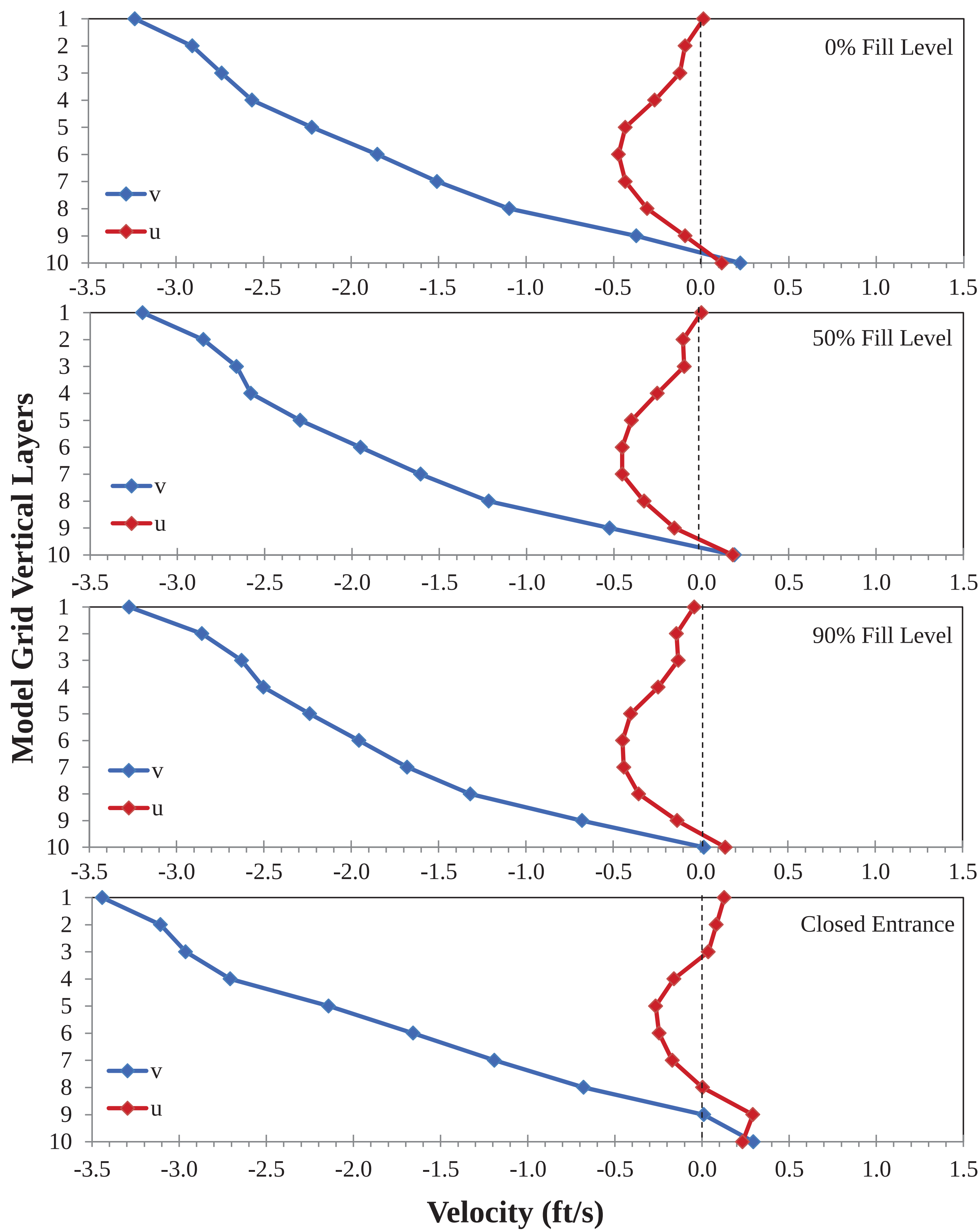
Model Simulated Vertical Profiles of Directional Velocities in the Main Channel Grid 14,80

3/21/2005 20:30 (Pre-Storm Event)

Lower Eight Miles of the Lower Passaic River

Figure 7-7a

2014



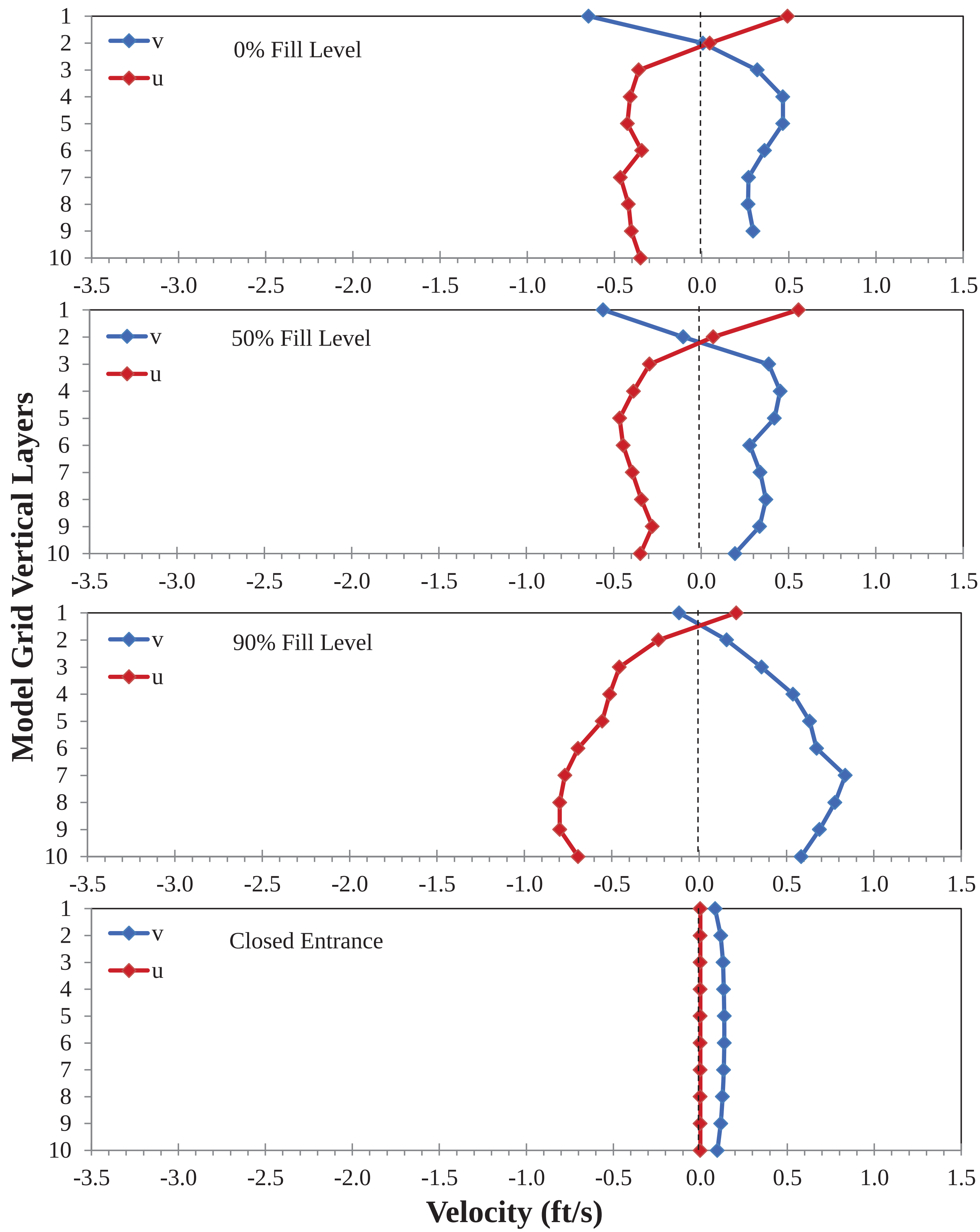
Model Simulated Vertical Profiles of Directional Velocities in the Main Channel Grid 14,80

4/6/2005 20:30 (Storm Event)

Lower Eight Miles of the Lower Passaic River

Figure 7-7b

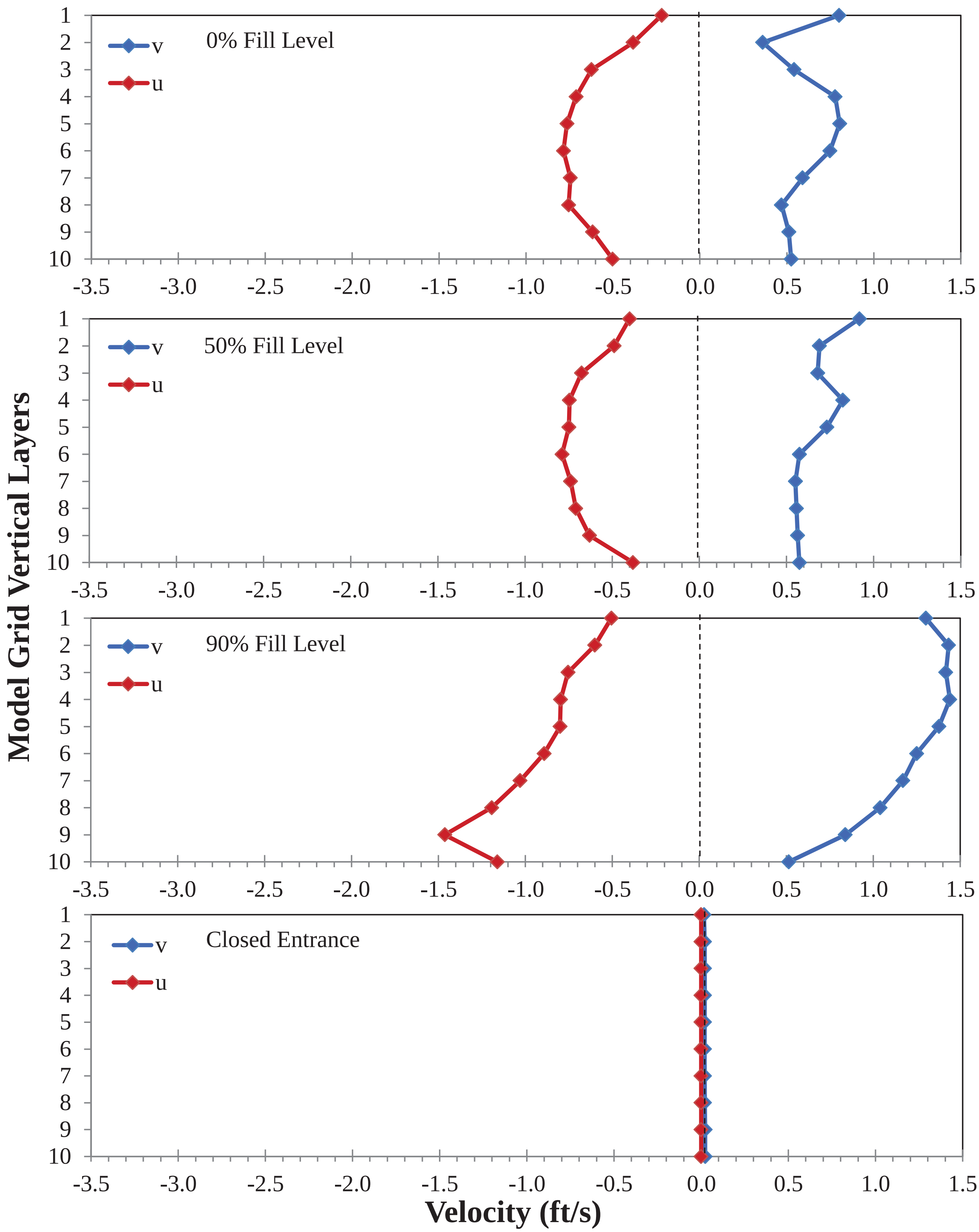
2014



Model Simulated Vertical Profiles of Directional Velocities in the Entrance Grid 17,80
3/21/2005 20:30 (Pre-Storm Event)
Lower Eight Miles of the Lower Passaic River

Figure 7-8a

2014



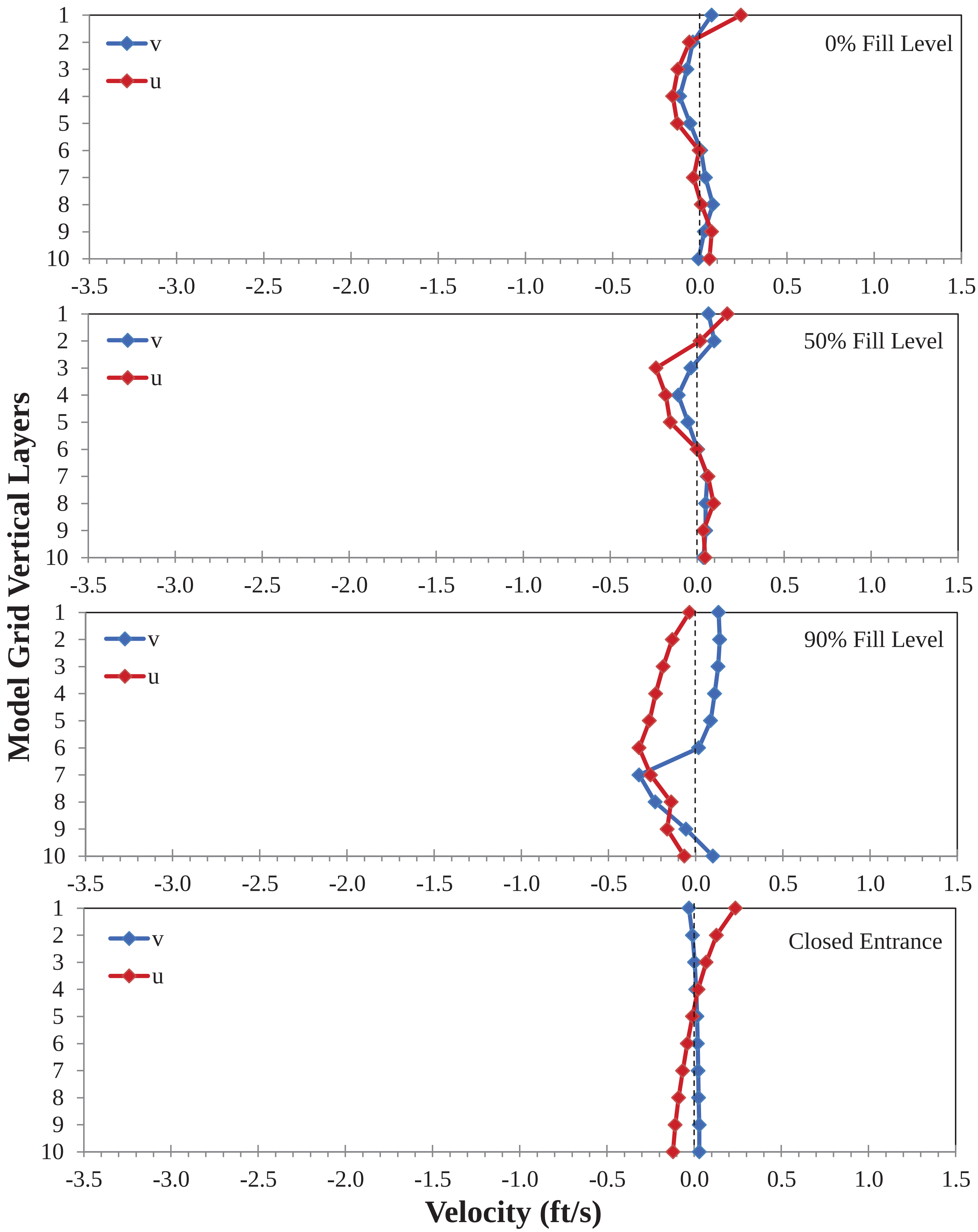
Model Simulated Vertical Profiles of Directional Velocities in the Entrance Grid 17,80

4/6/2005 20:30 (Storm Event)

Lower Eight Miles of the Lower Passaic River

Figure 7-8b

2014



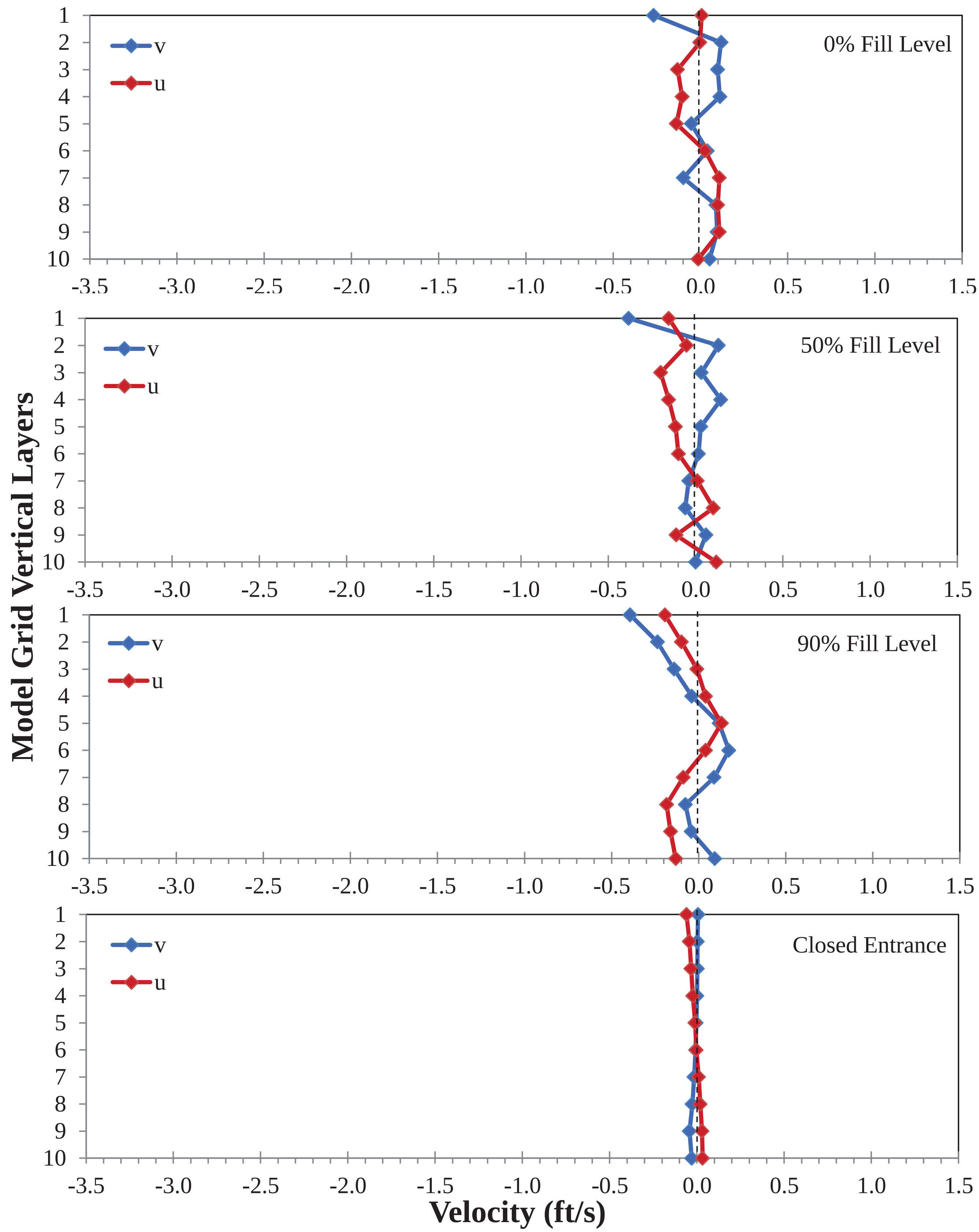
Model Simulated Vertical Profiles of Directional Velocities in the Center of Middle CAD Grid 22,80

3/21/2005 20:30 (Pre-Storm Event)

Lower Eight Miles of the Lower Passaic River

Figure 7-9a

2014



Model Simulated Vertical Profiles of Directional Velocities in the Center of Middle CAD Grid 22,80 4/6/2005 20:30 (Storm Event) *Lower Eight Miles of the Lower Passaic River*	Figure 7-9b 2014

Attachments

Attachment A

Passaic River Fact Sheets for Vendors

Benchmark Chemical Concentrations in Surface Sediment

(Source: Malcolm Pirnie, Inc., Battelle and HydroQual, Inc. August 2005. Work Plan, Lower Passaic River Restoration Project)

Chemical	Min. Conc.	Max. Conc.	Average Conc. (Arithmetic Mean)	Detection Frequency	SQG Conc.	Exceedance Frequency	Units
Lead	< 0.01	2200	252	337 / 344	218	225/344	ppm
Mercury	< 0.01	12.4	3.0	261 / 344	0.71	242/344	ppm
Silver	< 0.01	39.5	4.5	227 / 341	3.7	127/341	ppm
Cobalt	< 0.01	41.1	8.9	299 / 321	NA[1]	NA	ppm
Zinc	< 0.01	1900	425	332 / 344	410	213/344	ppm
Total DDT	6.0	5980	231	238 / 261	46	216/261	ppb
Total Chlordane	3.0	210	49	130 / 232	6.0	126/232	ppb
Dieldrin	3.0	270	27	119 / 261	8.0	110/261	ppb
Mirex	8.0	135	26	12 / 13	7.0	12/13	ppb
Total Xylenes	2.0	440	108	13 / 142	25	9/142	ppb
Methyl ethyl ketone	9.0	83	36	29 / 142	43	9/142	ppb
HMW PAHs (total)	1,500	1,400,000	30,062	326 / 330	9,600	288/330	ppb
LMW PAHs (total)	210	1,410,000	10,603	299 / 330	3,160	158/330	ppb
Total PCBs	230	2,482	1,219	16/16	Not calculated	Not calculated	ppb
2,3,7,8-TCDD	2	13,500	518	260 / 266	NA	NA	ppt

(1): "NA" = None Available

Benchmark Chemical Concentrations in Subsurface Sediment

(Source: Malcolm Pirnie, Inc., Battelle and HydroQual, Inc. August 2005. Work Plan, Lower Passaic River Restoration Project)

Chemical	Min. Conc.	Max. Conc.	Average Conc. (Arithmetic Mean)	Detection Frequency	SQG Conc.	Exceedance Frequency	Units
Lead	1.0	22,000	527	573/619	218	443/619	ppm
Mercury	0.01	29.6	7.7	511/618	0.71	472/618	ppm
Silver	0.63	26.7	9.1	413/616	3.7	363/616	ppm
Cobalt	2.6	42.9	12.8	570/616	NA[1]	NA	ppm
Zinc	10.8	3,110	789	592/619	410	432/619	ppm
Total DDT	4.1	18,600,000[2]	61,250[2]	471/606	46	417/606	ppb
Total Chlordane	3.0	791	72	328/578	6.0	311/578	ppb
Dieldrin	1.3	580	63	313/615	2.0	312/615	ppb
Mirex	No subsurface samples						
Total Xylenes	3.0	150,000	1,130	233/526	25	216/526	ppb
Methyl ethyl ketone	10.0	7,200	109	315/526	43	196/526	ppb
HMW PAHs (total)	220	2,290,000	43,500	517/611	9,600	451/611	ppb
LMW PAHs (total)	280	5,460,000	39,700	474/610	3,160	322/610	ppb
Total PCBs	180	27,560	2,774	351/580	Not calculated	Not calculated	ppb
2,3,7,8-TCDD	0.072	5,300,000	22,000	524/598	NA	NA	ppt

1 – None Available

2 – It should be noted that this sample concentration is anomalous when compared to all of the other Total DDT sample results. Therefore, it is possible that this value is unreliable.

Statistical Data Analysis of Total Organic Carbon Concentrations (Historical Data) (Source: Malcolm Pirnie, Inc. and EarthTech, Inc. September 2007. Draft Environmental Dredging Pilot Study Report)

Depth Interval	0 to ≤ 3 feet				3 to ≤ 5 feet				> 5 feet			
	Det /n	Min	Max	Avg	Det /n	Min	Max	Avg	Det /n	Min	Max	Avg
Total Organic Carbon (mg/kg)	269/ 271	0.238	409	73.0	117/ 117	0.324	563	76.7	117/ 118	0.691	272	76.6

"Det" is number of detections; "n" is total number of data points (includes duplicates and validated and unvalidated data)

Geotechnical Data – Passaic River July 2004 Core Samples (0-3 feet) Collected for Pilot Dredging Study (Harrison Reach only)

(Source: TAMS and Malcolm Pirnie, Inc. May 2005. Final Data Summary and Evaluation Report)

	Solids, Percent IN623	Moisture Content D2216	Liquid Limit D4318 LL	Plasticity Index D4318 PI	Plastic Limit D4318 PL	Specific Gravity D854
Average (15 cores, 3 samples per core)	42.5%	134.3%	71.2	27.3	44.2	2.35
Median	41.5%	137.8%	66.0	24.0	43.0	2.34

Grain Size Data – Passaic River July 2004 Core Samples (0-4 feet) Collected for Pilot Dredging Study (Harrison Reach only)

(Source: TAMS and Malcolm Pirnie, Inc. May 2005. Final Data Summary and Evaluation Report)

	Granule >2 mm, %	Sand %	Silt %	Clay and Colloids, %	SUM, %
Average 0-1 ft interval (15 cores)	0.0%	26.5%	65.9%	7.7%	100.1%
Average 1-2 ft interval (15 cores)	0.0%	31.3%	61.3%	7.4%	100.0%
Average 2-3 ft interval (15 cores)	0.4%	27.5%	66.5%	5.6%	100.0%
Average 3-4 ft interval (15 cores)	0.0%	9.6%	83.6%	6.3%	99.8%
AVERAGE (ALL INTERVALS)	0.1%	23.4%	70.2%	6.3%	100.0%

Surface Sediment Grain Size Data –Number of Shallow Cores Classified by Sediment Type per River Mile

(Source: AquaSurvey, Inc. June 2006. Technical Report, Geophysical Survey, Lower Passaic River Restoration Project)

River Mile	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt
0 to 1	1						7
1 to 2						1	4
2 to 3				1			3
3 to 4					1	1	2
4 to 5					1	1	
5 to 6				2		1	1
6 to 7	1				4	1	1
7 to 8	1			2		1	2
8 to 9			1	2	1		1
9 to 10				3	3		
10 to 11		1		4	1		1
11 to 12	1			3	2		
12 to 13			2	2	1		1
13 to 14		1	1	4	3	1	
14 to 15		1		3	2		1
15 to 16	1		3	1	1		
16 to 17		1			1		

Attachment B

Records of Landfill and Incineration Facility Information (Literature Reviews and Telephone Interviews)

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Alcoa Gum Facility (Arkadelphia Facility)		**FACILITY CLASSIFICATION:** n/a
ADDRESS: 500 E. Reynolds Rd., Arkadelphia, AR 71923		**DATE OF CONTACT:** 4/15/2011
PHONE: (870) 245-2720	**FAX:**	**CONTACT PERSON:** Lin Sheperd, Environmental Manager

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	This facility only accepts K088 waste streams.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Only accepts K088 waste streams.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: El Dorado Incineration facility			**FACILITY CLASSIFICATION:** n/a
ADDRESS: 309 American Circle El Dorado, AR 71730			**DATE OF CONTACT:** 5/20/2011
PHONE: (201) 538-0109		**FAX:** (973) 643-6050	**CONTACT PERSON:** John McNally
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?		This facility only accepts drums.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?		n/a
3	Does the facility meet the requirements of the OSR?		n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		n/a
5	Does your facility accept non-listed dioxin waste?		n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?		n/a
7	Are there other viable transportation alternatives to the facility?		n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		n/a
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	Only accepts drums.		

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Braintree facility			**FACILITY CLASSIFICATION:** n/a
ADDRESS: 1 Hill Avenue Braintree, Massachusetts, 02184			**DATE OF CONTACT:** 5/20/2011
PHONE: (201) 538-0109		**FAX:** (973) 643-6050	**CONTACT PERSON:** John McNally
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?		Based on Braintree facility Fact Sheet available on the Clean Harbors website, this facility provides services for fuels blending, stabilization, container storage, consolidation and transfer.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?		n/a
3	Does the facility meet the requirements of the OSR?		n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		n/a
5	Does your facility accept non-listed dioxin waste?		n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?		n/a
7	Are there other viable transportation alternatives to the facility?		n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		n/a
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	Based on Braintree facility Fact Sheet available on the Clean Harbors website, this facility provides services for fuels blending, stabilization, container storage, consolidation and transfer.		

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Kimball facility		**FACILITY CLASSIFICATION:** RCRA permitted-Incinerator
ADDRESS: 5 Miles South of Kimball on Highway 71 Kimball, NE 69145		**DATE OF CONTACT:** 5/20/2011
PHONE: (201) 538-0109	**FAX:** (973) 643-6050	**CONTACT PERSON:** John McNally

QUESTION NO.	**QUESTION**	**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	Does not receive TSCA waste. The facility size is 640 acres. Based on the Kimball facility fact sheet available on the Clean Harbors website, the Feed Capacity is 17,925 pounds per hour (solids, liquids, sludge).
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	Practical Capacity = 58,808 tons
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	This incineration is a RCRA permitted Hazardous Waste Incinerator.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Kingston Incinerator		**FACILITY CLASSIFICATION:** n/a	
ADDRESS: 657 Gallaher Road, Kingston, TN 37763		**DATE OF CONTACT:** 5/4/2011	
PHONE: 865-376-8706	**FAX:**	**CONTACT PERSON:** Rich Devin	

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	Based on phone conversation with Rich Devin of Perma-Fix, the facility does not exist.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: EBV Explosive Environmental Co. Incinerator			**FACILITY CLASSIFICATION:** RCRA Part B Treatment, Storage, Disposal
ADDRESS: 3078 County Road 180, Joplin, Missouri 64802			**DATE OF CONTACT:** 4/14/2011
PHONE: (610) 298-3085		**FAX:** (610) 298-4652	**CONTACT PERSON:** Dave Zoghby, Senior Director
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?		The facility is specifically designed for the incineration of explosive hazardous wastes. The facility is only economical for explosive contaminated soils over 500 ppm or for explosive residuals such as ammunition that was buried.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?		n/a
3	Does the facility meet the requirements of the OSR?		n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		n/a
5	Does your facility accept non-listed dioxin waste?		n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?		n/a
7	Are there other viable transportation alternatives to the facility?		n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		n/a
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:			

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Dalton Incinerator		**FACILITY CLASSIFICATION:** n/a
ADDRESS: Dalton, GA		**DATE OF CONTACT:** 4/15/2011
PHONE: (870) 863-7173	**FAX:**	**CONTACT PERSON:** n/a

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: The incinerator no longer exists based on phone conversation with representative.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Bridgeport Incinerator		**FACILITY CLASSIFICATION:** n/a
ADDRESS: Bridgeport, NJ		**DATE OF CONTACT:** n/a
PHONE: n/a	**FAX:**	**CONTACT PERSON:** n/a

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Based on the document "Closure of Safety-Kleen's Bridgeport Hazardous Waste Incinerator" available on EPA's RCRA Online webpage, the incinerator has been closed since 2001.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Clarence Incinerator		**FACILITY CLASSIFICATION:** n/a	
ADDRESS: Clarence, NY		**DATE OF CONTACT:** 5/3/2011	
PHONE: (201) 538-0109	**FAX:**	**CONTACT PERSON:** John McNally	

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	The facility is inactive.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: The facility is inactive based on phone conversation with John McNally of Clean Harbors.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Roebuck Incinerator		**FACILITY CLASSIFICATION:** n/a
ADDRESS: Spartanburg County, Roebuck, SC		**DATE OF CONTACT:** n/a
PHONE: (803) 576-1085	**FAX:**	**CONTACT PERSON:** n/a

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: The contact phone number is not valid. Based on online research (www.scelp.org), laidlaw's hazardous waste incinerator at Roebuck has been closed since 1999.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Calvert Incinerator		**FACILITY CLASSIFICATION:** n/a
ADDRESS: 2475 Industrial Parkway Calvert City, KY 42029		**DATE OF CONTACT:** n/a
PHONE: n/a	**FAX:**	**CONTACT PERSON:** n/a

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Based on online research (www.epaosc.org), the incineration facility ceased in January 2004, and the last owner, Blue Grass Incineration Services, LLC, abandoned the site in October 2005.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Veolia ES Technical Solution Trade Waste Incineration (Veolia, TWI)			**FACILITY CLASSIFICATION:** n/a
ADDRESS: 7 Mobile Avenue, Sauget Illinois 62201			**DATE OF CONTACT:** 5/5/2011
PHONE: (201) 392-6714		**FAX:**	**CONTACT PERSON:** Patrick O'Shea CHMM
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?		n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?		n/a
3	Does the facility meet the requirements of the OSR?		n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		n/a
5	Does your facility accept non-listed dioxin waste?		n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?		n/a
7	Are there other viable transportation alternatives to the facility?		n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		n/a
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	Based on email conversation with Patrick O'Shea of Veolia ES, this facility is not a candidate as it is not a TSCA incinerator. Patrick O'Shea mentioned that there are only 3 TSCA incinerators in the United States: 1) Veolia's Port Arthur, TX facility; 2) Clean Harbors in Deer Park, TX; 3) Clean Harbors in Aragonite, UT.		

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: 1. Hammon Facility; 2. Baton Rouge Incinerator; 3. Houston Facility		**FACILITY CLASSIFICATION:** n/a
ADDRESS: 1. Hammon IN 46320; 2. Baton Rouge, LA 70821 3. Houston, TX 77012		**DATE OF CONTACT:** 4/18/2011
PHONE: (972) 712-5257	**FAX:**	**CONTACT PERSON:** Armond Johnson

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	All three Rhodia's Incinerators only accept bulk liquids.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Based on phone conversation with Armond Johnson of Rhodia, Inc., all three incinerators operated by Rhodia, Inc. accepts bulk liquids only.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Coffeyville Incinerator		**FACILITY CLASSIFICATION:** n/a	
ADDRESS: Highway 169 North, PO Box 428 Coffeyville, KS 67377		**DATE OF CONTACT:** n/a	
PHONE: (316) 251-6380	**FAX:**	**CONTACT PERSON:** n/a	

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	Could not reach a representative. Based on online research (www.ehso.com), the Coffeyville facility is a PCB Transformer Decommissioning facility.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Rock Hill Incinerator			**FACILITY CLASSIFICATION:** n/a
ADDRESS: Rock Hill, SC			**DATE OF CONTACT:** n/a
PHONE: (803) 329-1891		**FAX:**	**CONTACT PERSON:** n/a
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?		n/a
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?		n/a
3	Does the facility meet the requirements of the OSR?		n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		n/a
5	Does your facility accept non-listed dioxin waste?		n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?		n/a
7	Are there other viable transportation alternatives to the facility?		n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		n/a
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	Contact phone number is disconnected.		

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Veolia ES Technical Solutions, L.L.C. Gulf Coast Treatment Center		**FACILITY CLASSIFICATION:** Subpart O Incinerator
ADDRESS: Highway 73, 3.5 miles West of Taylor Bayou Port Arthur, TX 77640		**DATE OF CONTACT:** 5/5/2011; 4/15/2011; 2/2/2012
PHONE: (409) 736-4154; (219) 392-6714	**FAX:**	**CONTACT PERSON:** Rean Swanson; Patrick O'Shea

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	In a typical year, yearly throughput rate capacity is greater than 120 million pounds/year. The max daily permit rate is 57,198 pounds per hour (not the practical rate). With maintenance outages, Port Arthur operates approximately 330 days a year. Throughput rates can vary greatly depending on waste characteristics. In a reasonable day, 400,000 pounds/day.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	No fixed commitments to customers. There are no on-site landfills.
3	Does the facility meet the requirements of the OSR?	Permitted RCRA, TSCA and CERCLA facility
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	With the exception of Rad waste, municpal garbage, Class 1 explosives and F020's series of dioxins codes, permitted for solids and liquids and gases in both bulk and drums. Physical and chemical properties will have impact on pricing not acceptance.
5	Does your facility accept non-listed dioxin waste?	Yes
6	Is rail service available to the facility? If yes, who is the rail service provider?	Not directly. We have a RR siding transfer used for certain bulk liquids - but not solid. KSC
7	Are there other viable transportation alternatives to the facility?	Trucks all types
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	$400-700/ton
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Patrick O'Shea mentioned that there are only 3 TSCA incinerators in the United States: 1) Veolia's Port Arthur, TX facility; 2) Clean Harbors in Deer Park, TX; 3) Clean Harbors in Aragonite, UT.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Eau Claire Incinerator		**FACILITY CLASSIFICATION:** n/a
ADDRESS: Eau Claire, WI		**DATE OF CONTACT:** 4/15/2011
PHONE: (715) 559-0745	**FAX:**	**CONTACT PERSON:** David Barton, VP

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	WRR Environmental Services discontinued incinerators years go due to the lack of inbound continuous feedstock and the increasing regulations that would demand volume to justify the purpose to maintain the permit requirements.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	n/a
3	Does the facility meet the requirements of the OSR?	n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	n/a
5	Does your facility accept non-listed dioxin waste?	n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?	n/a
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	n/a
9	What is the cost per ton for acceptance and disposal?	n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	n/a

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Based on phone conversation with David Barton of WRR Environmental Services Co, Inc., WRR has discontinued its incinerators years ago.

Incineration Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Bennett/Recupere Sol Treatment Facility			**FACILITY CLASSIFICATION:** Subpart O Incinerator equivalent Rotary Kiln Incinerator
ADDRESS: Saint Ambroise, Quebec, Canada			**DATE OF CONTACT:** 2/3/2012
PHONE: 978-692-9990		**FAX:**	**CONTACT PERSON:** William C. Eaton

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily) to receive RCRA and TSCA waste?	Facility can process up to 100,000 tons of RCRA soil per year and 300+ tons of soil per day. The facility has the ability to accept up to 2,200 tons of soil in a day via truck, rail or ship.
2	What is the available capacity remaining of the facility to receive RCRA and TSCA waste (i.e. what percentage of the capacity is not committed to clients)?	See Answer from Question No. 1
3	Does the facility meet the requirements of the OSR?	N/A
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Prior to acceptance, the proposed material is sampled and tested at an independent laboratory in Canada using Canadian Standards which are similar to the SW-846 in the U.S. All waste streams must contain at least 50% soil or "soil-like" (silt, sediment, clay, misc. earthen materials) material in order to accept it for treatment. Waste can contain up to 49% debris provided the debris was part of the excavated material and not mixed into the soil post-construction. All waste must not contain any free liquids (i.e. pass paint filter analysis). Facility does not have any restrictions on RCRA waste/contaminant concentrations or waste codes. The USEPA does not allow for the export of TSCA waste to Canada. The facility does handle PCB waste from the Canadian provinces only.
5	Does your facility accept non-listed dioxin waste?	The facility can accept unlisted dioxin soil regardless of concentration. The facility can also accept any level of RCRA listed (i.e. any F listing) dioxin waste provided the requirements are met.
6	Is rail service available to the facility? If yes, who is the rail service provider?	Facility is not directly rail served. However, Facility has two offloading locations available in Quebec. Both locations are less than 20 miles from the facility.
7	Are there other viable transportation alternatives to the facility?	Facility has the ability to accept soil by ship via a deep water port located in LaBaie, Quebec.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	Facility has the ability to off-load intermodal containers, gondola cars utilizing lift bags as well as gondola cars directly loaded. Facility suggests keep shipments using directly loaded gondola cars to non-winter months (April - November) to avoid bulk soil freezing. Other rail services are not weather dependent. Rail cars must comply with AAR weight regulations. Facility has the ability to off-load a maximum of 3650 tons per week when rail is utilized.
9	What is the cost per ton for acceptance and disposal?	The average price would be around $325 per ton at the gate of RSI. The actual range of pricing is $190-$525 per ton due to RCRA metal levels, moisture and sulphur content and debris type and percentage.
10	What is the cost per ton for rail interface, offloading and/or material handling?	Approximately $45 per ton which includes off-loading and transportation to the facility.
11	Limitations, if any, of the facility?	Only restriction is that the facility is not allowed to accept TSCA or radioactive waste.

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Facility does not have a landfill on the property. The facility uses two landfills in Quebec that are built to a Subtitle C standard. Both of these landfills are less than 50 miles from the facility.

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Kettlman Hills Facility		**FACILITY CLASSIFICATION:** Subtitle C Hazardous Waste Landfill
ADDRESS: 35251 Old Skyline Road, P.O. Box 471 Kettleman City, CA 93239		**DATE OF CONTACT:** 4/1/2011
PHONE: (559) 318-6086	**FAX:**	**CONTACT PERSON:** Chris Brady
QUESTION NO.	**QUESTION**	**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?	No capacity left unless expansion permit is approved (been in works for 2.5 years). Likely 18 months out to construct new landfill. If the landfill is built, 25 million cubic yards. Right now, less than 100,000 cubic yards (not accepting). Normally, it was unrestricted. With new potential permit, don't know.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	Pending new permit.
3	Does the facility meet the requirements of the OSR?	Yes. CERCLA approved.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Can't Provide. In California, regulates 17 metals, etc. Basically, cannot accept explosives, bioinfectious. Can accept heavy metals, certain levels of organics. Facility can treat and stabilize.
5	Does your facility accept non-listed dioxin waste?	Yes. The only issue is in California, regulates dioxin so it depends on how material is classified.
6	Is rail service available to the facility? If yes, who is the rail service provider?	No.
7	Are there other viable transportation alternatives to the facility?	Trucks.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	No Rail Service available.
9	What is the cost per ton for acceptance and disposal?	RCRA waste that needs to be treated/stabilized, $300 per ton. RCRA waste for direct landfill $65 per ton.
10	What is the cost per ton for rail interface, offloading and/or material handling?	See costs from above. No rail service available.
11	Limitations, if any, of the facility?	No, except for the current permitting issue.
Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426	
Notes:		

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Lake Charles Facility			**FACILITY CLASSIFICATION:** Subtitle C Hazardous Waste Landfill
ADDRESS: 7170 John Brannon Road, Sulphur, LA 70665			**DATE OF CONTACT:** 4/1/2011; 6/3/2011
PHONE: (908) 387-1476 (337) 583-3613		**FAX:** (908) 387-0784 (337) 583-4615	**CONTACT PERSON:** Simone Heinke, Waste Management Sales; Ken Anderson, Senior Engineer
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		Total Permitted Facility = 440 acres.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		Closed cells (cells 5,6,7 and 14) = 77.5 acres. Active cells (cell 8) = 53 acres. Cell 8 has a disposal capacity for the next 25-30 years. Remaining landfill capacity at the site is 5,730,000 CY. Facility consumes around 20,000 CY per month, or around 1,000 CY per day.
3	Does the facility meet the requirements of the OSR?		Yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		All industrial hazardous and non-hazardous waste types except for explosives regulated by ATF, etiologic agents, and radioactive material (specifically NRC regulated or non-exempt Naturally Occuring Radioactive Material at 150 piC/g or greater). The facility will make every effort to resolve and process the waste in accordance with all regulations prior to rejection. In the past, wastes would be rejected if: 1) it is non-conforming to the profile and cannot be managed at the facility or transhipped to an alternative facility for treatment, or 2) the generator requests that the facility rejects it.
5	Does your facility accept non-listed dioxin waste?		Facility is authorized to receive Hazardous Waste Codes F020, F021, F022, F023, F026, F027, and F-028 as well as F039. All ash with dioxin codes will have been treated by incineration in an approved incinerator meeting requirements of 40 CFR 264.343(a)(2) and LAC33:V.3111.A.2 and treated to meet the standards of 40 CFR 268.41 Table CCWE and LAC33:V.Chapter 22 Table 2.
6	Is rail service available to the facility? If yes, who is the rail service provider?		The facility operates a rail transfer facility in nearby Beaumont, Texas that can provide cost effective transportation nationwide.
7	Are there other viable transportation alternatives to the facility?		The facility has its own transportation group located at the 10-Day Transfer Facility immediately adjacent to the disposal facility.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		End dumps and roll-off boxes are readily available. All other types upon request by using the Chemical Waste Management's qualified sub-haulers.
9	What is the cost per ton for acceptance and disposal?		A rough estimate on disposal pricing for non-hazardous dioxin containing waste is $98.00 per ton.
10	What is the cost per ton for rail interface, offloading and/or material handling?		Disposal fuel surcharge and environmental fees are currently running 14-15%.
11	Limitations, if any, of the facility?		
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:			

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Model City Facility			**FACILITY CLASSIFICATION:** Subtitle C Landfill TSCA, PCBs
ADDRESS: 1550 Balmer Road, Youngstown, NY 14107			**DATE OF CONTACT:** 4/1/2011, 5/18/2011
PHONE: (716) 754-8231 (908) 387-1476		**FAX:** (908) 387-0784	**CONTACT PERSON:** Jonathon Rizzo, Permitting Manager Simone Heinke, Sales
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		3.6 MCY Overall Capacity of Active Facility; 364,000 CY is the remaining. Annual maximum gate receipts is 450,000 tons per year and 100,000 to 250,000 tons per year annual (past 5 years).
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		Approximately 500,000 tons of airspace currently available in the existing cell of the landfill. There is an application submitted to NY State DEC for an expansion to the facility in the future.
3	Does the facility meet the requirements of the OSR?		Yes, operates under EPA RCRA and NYDEC requirements.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		Waste analysis plan; on-site stabilization facility meet land disposal restrictions; strength requirement (ex. Soft sludge).
5	Does your facility accept non-listed dioxin waste?		By permit, facility is able to accept non listed dioxin material for disposal at the site. However, profile specific review is required.
6	Is rail service available to the facility? If yes, who is the rail service provider?		No.
7	Are there other viable transportation alternatives to the facility?		Trucking.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		Not Applicable.
9	What is the cost per ton for acceptance and disposal?		Budgetary disposal pricing for non hazardous (dioxin impacted) material is estimated at ~$75.00 per ton which would include the current applicable fees.
10	What is the cost per ton for rail interface, offloading and/or material handling?		Transportation via end dumps to MDC typically run in the $64 - $65 per ton range (22 ton per load minimum) plus the applicable fuel surcharges which is currently running at ~40% (adjusted weekly). For non hazardous material leaving the State of NJ, there is also a NJ Solid Waste Fee of $3.00 per ton.
11	Limitations, if any, of the facility?		
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	Facility is currently investigating a rail unloading facility in the Buffalo/Niagara area, which could potentially be available for this project.		

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Chemical Waste Management of the Northwest		**FACILITY CLASSIFICATION:** RCRA/TSCA Subtitle C Landfill
ADDRESS: 17629 Cedar Springs Lane, Arlington, OR 97812		**DATE OF CONTACT:** 4/1/2011
PHONE: (541) 454-2030; (425) 864-1527	**FAX:** (541) 454-3247	**CONTACT PERSON:** Gary Fisher, District Manager; Jim Beck, Sales

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	No capacity constraints in terms of yearly and daily.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	Building cells as necessary. 600,000 CY. No setup for specific clients, but can arrange if needed.
3	Does the facility meet the requirements of the OSR?	Yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Codes that are applicable to the material. Show analytical data demonstrating that it meets the requirements for direct landfill.
5	Does your facility accept non-listed dioxin waste?	Will accept FO-20 to FO-28 if it meets LDR standards and requires special packaging. If it is dioxins just in the waste and not by a code particularly, it is not a concern.
6	Is rail service available to the facility? If yes, who is the rail service provider?	Yes, Union Pacific.
7	Are there other viable transportation alternatives to the facility?	Rail and truck. Rail is preferred from New Jersey.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	via Rail, unload gondolas from overhead bridge with excavators and then offload to dump trucks. Also do intermodal containers are available.
9	What is the cost per ton for acceptance and disposal?	For RCRA waste (direct landfill), $112/ton. For RCRA waste requiring stabilization, $225/ton.
10	What is the cost per ton for rail interface, offloading and/or material handling?	All inclusive of the costs stated above.
11	Limitations, if any, of the facility?	No.

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	No volume constraints (yearly and daily). It's a matter of preparing for the particular job to prepare space and additional cells.

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Emelle Landfill		**FACILITY CLASSIFICATION:** Subtitle C Hazardous Waste Landfill
ADDRESS: 36964 Hwy, 17 North Emelle, AL 35459		**DATE OF CONTACT:** 6/3/2011
PHONE: (908) 387-1476	**FAX:** (908) 387-0784	**CONTACT PERSON:** Simone Heinke, Waste Management Sales

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	600,000 tons per year. There is no daily limit.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	480,000 tons per year.
3	Does the facility meet the requirements of the OSR?	Yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Not provided.
5	Does your facility accept non-listed dioxin waste?	Yes.
6	Is rail service available to the facility? If yes, who is the rail service provider?	The facility is not directly rail served, however there is a transfer facility that is used in Mt. Hebron, AL where rail is offloaded and then trucked to the facility. The rail is serviced by Alabama Gulf Coast Rail.
7	Are there other viable transportation alternatives to the facility?	Road - truck.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	Depends on the type of rail equipment.
9	What is the cost per ton for acceptance and disposal?	A general idea regarding pricing for non haz, dioxin containing waste is $98.00 per ton plus applicable fees which are right now ~14 – 15%
10	What is the cost per ton for rail interface, offloading and/or material handling?	Rough estimate on off loading and drey to the facility is ~$35.00 per ton.
11	Limitations, if any, of the facility?	No infectious, NRC regulated radioactive materials, explosives.

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes:

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Westmorland Landfill			**FACILITY CLASSIFICATION:** Subtitle C Landfill
ADDRESS: 5295 South Garvey Road Westmorland, CA 92281 US			**DATE OF CONTACT:** 5/20/2011
PHONE: (201) 538-0109		**FAX:** (973) 643-6050	**CONTACT PERSON:** John McNally

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	Not available. Facility Size is 640 acres.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	Estimated at 2 MCY. See Notes.
3	Does the facility meet the requirements of the OSR?	In compliance with RCRA and California and County permits.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Typical waste streams include RCRA hazardous waste, NORM waste from geothermal operations, APHIS soils, and California-regulated waste materials.
5	Does your facility accept non-listed dioxin waste?	Not provided.
6	Is rail service available to the facility? If yes, who is the rail service provider?	Not provided.
7	Are there other viable transportation alternatives to the facility?	Not provided.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	Not provided.
9	What is the cost per ton for acceptance and disposal?	$120 per ton
10	What is the cost per ton for rail interface, offloading and/or material handling?	Not provided.
11	Limitations, if any, of the facility?	Not provided.

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Clean Harbors operates two landfills in California. Based on the 2010 Annual Report for Investors, the two facilities have a combined remaining highly probable airspace of 11,345,000 CY. Buttonwillow (one of the two facilities) has an available capacity of approximately 9 MCY based on information provided by Marianna Buoni, General Manager. Therefore, Westmorland facility is estimated to have approximately 2 MCY of available capacity.

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Sawyer (a.k.a. Echo Mountain) Landfill			**FACILITY CLASSIFICATION:** Subtitle D Non-Hazardous Industrial Landfil
ADDRESS: P.O. Box 168 Sawyer, ND 58781 US			**DATE OF CONTACT:** 5/20/2011
PHONE: (201) 538-0109		**FAX:** (973) 643-6050	**CONTACT PERSON:** John McNally
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		This facility is not applicable as it only accepts non-hazardous material.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		n/a
3	Does the facility meet the requirements of the OSR?		n/a
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		n/a
5	Does your facility accept non-listed dioxin waste?		n/a
6	Is rail service available to the facility? If yes, who is the rail service provider?		n/a
7	Are there other viable transportation alternatives to the facility?		n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		n/a
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		n/a
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	As informed by John McNally of Clean Harbors, this facility is not applicable since it only accepts non-hazardous materials.		

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Buttonwillow Landfill			**FACILITY CLASSIFICATION:** Class I Facility Subtitle C Landfill
ADDRESS: 2500 West Lokern Road Buttonwillow, CA 93206 US			**DATE OF CONTACT:** 4/5/2011; 5/20/2011
PHONE: (661) 762-6200 Ext 6236 (201) 538-0109		**FAX:** (661) 762-7681 (973) 643-6050	**CONTACT PERSON:** Marianna Buoni, General Manager John McNally, Clean Harbors

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	351,150 tons annually. 4,050 tons daily.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	More than 9 million cubic yards are available.
3	Does the facility meet the requirements of the OSR?	Yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Follows the permitted waste analysis plan - which can be obtained via public records act upon request.
5	Does your facility accept non-listed dioxin waste?	Yes, if they are not land disposal restricted.
6	Is rail service available to the facility? If yes, who is the rail service provider?	No.
7	Are there other viable transportation alternatives to the facility?	All truck transport, drums, flobins, etc. The site is off Insterstate 5, one of the largest in the nation.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	No rail cars.
9	What is the cost per ton for acceptance and disposal?	$120 per ton
10	What is the cost per ton for rail interface, offloading and/or material handling?	No rail.
11	Limitations, if any, of the facility?	None.

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Deer Trail Landfill			**FACILITY CLASSIFICATION:** Subtitle C
ADDRESS: 108555 East Highway 36 Deer Trail, CO 80105 US			**DATE OF CONTACT:** 4/6/2011; 5/20/11
PHONE: (970) 386-2293 (201) 538-0109		**FAX:** (970) 386-2262 (973) 643-6050	**CONTACT PERSON:** George Cebula, Sales Specialist John McNally
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		How much they can bring in to the facility. Limited to current super cell.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		Remaining Highly Probable Airspace = 759,000 CY. Remaining Life = 20 years.
3	Does the facility meet the requirements of the OSR?		yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		Look at packages. Use your common sense threshold level. Not going to take organics. Threshold level is profile specific.
5	Does your facility accept non-listed dioxin waste?		Yes, need a profile to see what it is.
6	Is rail service available to the facility? If yes, who is the rail service provider?		NO. several spurs located 50 - 60 miles away. One in sterling, CO.
7	Are there other viable transportation alternatives to the facility?		Trucks.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		Fully enclosed treatment building. Typically goes directly in and dumped. Typical landfill, basins, treatment building. Drum docks.
9	What is the cost per ton for acceptance and disposal?		$120 per ton for RCRA; $200 per ton for RCRA/TSCA.
10	What is the cost per ton for rail interface, offloading and/or material handling?		Depends on how it arrives. Included in costs above.
11	Limitations, if any, of the facility?		Typical landfill facility.
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	For Available Capacity, used information available on Clean Harbors 2010 Annual Report as referred to by John McNally of Clean Harbors.		

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Lone Mountain Landfill		**FACILITY CLASSIFICATION:** Subtitle C Landfill
ADDRESS: Route 2 Box 170 Waynoka, OK 73860 US		**DATE OF CONTACT:** 5/20/2011
PHONE: (201) 538-0109	**FAX:** (973) 643-6050	**CONTACT PERSON:** John McNally

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	Not available. Facility Size = 560 acres
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	Remaining Highly Probable Airspace = 3,822,000 CY
3	Does the facility meet the requirements of the OSR?	In compliance with RCRA.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Typical waste streams include PCB soil and debris (Mega Rule), non-hazardous soil, hazardous soil for direct landfill, hazardous soil for treatment of metals and organics on a case-by-case basis, debris for microencapsulation, plating waste, acidic waste, caustic waste, cyanide and sulfide bearing waste, and hazardous and non-hazardous liquid.
5	Does your facility accept non-listed dioxin waste?	Not provided.
6	Is rail service available to the facility? If yes, who is the rail service provider?	Yes, this facility operates a 35 acre rail transfer site located in Avard, OK about 20 miles north of the landfill site.
7	Are there other viable transportation alternatives to the facility?	n/a
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	Not provided.
9	What is the cost per ton for acceptance and disposal?	$120 per ton.
10	What is the cost per ton for rail interface, offloading and/or material handling?	n/a
11	Limitations, if any, of the facility?	

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Grassy Mountain Landfill			**FACILITY CLASSIFICATION:** Subtitle C Landfill
ADDRESS: 3 Mile East 7 Miles North of Knolls, Exist 41 off I-80 Grantsville, UT 84029 US			**DATE OF CONTACT:** 4/6/2011; 5/20/2011
PHONE: (435) 884-8900 (201) 538-0109		**FAX:** (435) 884-8990 (973) 643-6050	**CONTACT PERSON:** Les Ashwood John McNally
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		RCRA Landfill Capacity = 710,768 CY. TSCA Landfill Capacity = 773,712 CY.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		3 Open landfill cells. 1 is TSCA-PCB only cell. One cell is RCRA only. 1 is Landfill cell is for mixed. Three cells combined: 938,000 CY remaining.
3	Does the facility meet the requirements of the OSR?		Yes
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		Accepts all kinds of different hazardous wastes. Don't accept radioactive, explosives, flammables. Link to permit - no organics that don't meet treatment standards, flammables.
5	Does your facility accept non-listed dioxin waste?		Case by case basis. What it is, levels, how it is handled.
6	Is rail service available to the facility? If yes, who is the rail service provider?		Not directly to the facility. Clean Harbors does operate a facility less than 15 miles away, Clean Harbors Clydes Facility.
7	Are there other viable transportation alternatives to the facility?		Trucks.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		n/a
9	What is the cost per ton for acceptance and disposal?		$120 per ton for RCRA; $200 per ton for RCRA/TSCA.
10	What is the cost per ton for rail interface, offloading and/or material handling?		n/a
11	Limitations, if any, of the facility?		No municipal type waste.
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:	Permit link is available at: *http://www.hazardouswaste.utah.gov/CFF_Section/CleanHarborsGrassyMountainPermit.htm*		

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Envirosafe Services Otter Creek Road		**FACILITY CLASSIFICATION:** RCRA Subtitle C Treatment, Storage, and Disposal Facility – Part B Permitted.
ADDRESS: 876 Otter Creek Road, Oregon, OH 43616		**DATE OF CONTACT:** 4/15/2011
PHONE: (419) 698-3500 ext 226	**FAX:** (419) 698-8663	**CONTACT PERSON:** Lisa A. Humphrey, Director

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	Yearly- 235,000 tons per year hazardous waste with unlimited volumes for non-hazardous waste; Daily- 150 tons per hour Stabilization treatment plant, 100 tons per hour treatment in Cell M, unlimited direct disposal between 6:00 AM and 6PM.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	Envirosafe Services of Ohio, Inc. (ESOI)'s current operating cell has an estimated 6-8 years operating life based on current receipts. 94% of the capacity is not committed to clients (94% of remaining landfill capacity is available)
3	Does the facility meet the requirements of the OSR?	Yes, see attachment (CERCLA Letter.06.22.2009).
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Envirosafe is permitted to treat heavy metal and sulfides, all organic constituents subject to LDR treatment standards must meet the applicable standards prior to Envirosafe's acceptance. Generator must complete a Waste Product Questionnaire and provide analysis that is less than one year old on a representative sample of the waste material.
5	Does your facility accept non-listed dioxin waste?	Yes.
6	Is rail service available to the facility? If yes, who is the rail service provider?	Yes, we are direct rail served by Norfolk Southern's Toledo Homestead Yard.
7	Are there other viable transportation alternatives to the facility?	An alternate rail service provider would be Midwest Terminals, which is CSX served. If using Midwest Terminals, material will have to be transshipped to Envirosafe via highway carrier. Midwest Terminals is less than 1 mile from Envirosafe's facility. Envirosafe also accepts material shipped in various highway containers, i.e. dump trailers, roll-offs, vacuum trucks, pneumatic, van trailers, flatbeds, etc. ESOI also receives material in drums, boxes, bags, etc.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	In addition to gondolas, Midwest Terminals has the ability to off-load intermodal railcars.
9	What is the cost per ton for acceptance and disposal?	$59.90 per ton for direct disposal (no treatment required), $75.00 per hour (labor), $130.00 per ton (reagent) for incidental free liquid stabilization. Disposal price is applicable to waste shipped in gondola railcars or by highway transportation, i.e., dump trailers, roll-off containers.
10	What is the cost per ton for rail interface, offloading and/or material handling?	Off-loading and material handling costs for waste shipped in gondolas that are off-loaded at ESOI are included in disposal price (rail transportation/movement costs are not included). Intermodal off-loading at ESOI and material handling costs is assessed on a case by case basis and is based on volume and frequency.
11	Limitations, if any, of the facility?	ESOI does not have the necessary equipment to off-load intermodal containers on-site; however, if necessary, equipment can be rented.

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Heritage Hazardous Waste Landfill			**FACILITY CLASSIFICATION:** Subtitle C Landfill
ADDRESS: 4370 W CR 1275N Roachdale, Indiana 46172			**DATE OF CONTACT:** 4/11/2011
PHONE: (765) 435-2704; (317) 432-3872		**FAX:**	**CONTACT PERSON:** Brian Walker

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	There are no daily or yearly limits on the waste volume the landfill can receive. The landfill is permitted to operate 7 days a week. Normal operations are 5 days per week during daylight hours. The landfill can operate at night if necessary.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	14.5 million cubic yards of permitted capacity and no capacity has been reserved for specific clients.
3	Does the facility meet the requirements of the OSR?	Yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	The Heritage Landfill provides no treatment or solidification. Hazardous waste must comply with LDR upon receipt at the facility. Heritage is also permitted to accept PCB Remediation Waste under certain conditions.
5	Does your facility accept non-listed dioxin waste?	No.
6	Is rail service available to the facility? If yes, who is the rail service provider?	The Heritage landfill is not directly rail served. Heritage operates a Part B permitted treatment facility in Indianapolis which has a gondola railcar offloading facility. Waste material that requires treatment prior to final disposal will be treated at the Indianapolis facility. Wastes that are received in gondola cars that are eligible for direct landfill are transferred to dump trucks and transported 45 miles to the Heritage landfill. Heritage also utilizes the Indiana Railroad yard located in Indianapolis for receiving our company owned ABC intermodal flatcars. CSX & The Indiana Railroad
7	Are there other viable transportation alternatives to the facility?	Dump Truck or Roll off
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	Heritage currently does not utilize a railcar tipper for gondola cars. The cars are emptied using excavation equipment. Heritage owns specialized tipper trucks for unloading intermodal rail containers. Standard Gondola cars have a capacity of 100 tons. Heritage can accept any size gondola. Intermodal container can haul up to 22 tons of material.
9	What is the cost per ton for acceptance and disposal?	Not provided.
10	What is the cost per ton for rail interface, offloading and/or material handling?	Not provided.
11	Limitations, if any, of the facility?	Not provided.

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426
Notes:	

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Mill Service Landfill			**FACILITY CLASSIFICATION:**
ADDRESS: 1815 Washington Road, Pittsburgh, PA 15241-1498			**DATE OF CONTACT:** 4/1/2011
PHONE: (724) 722-3500		**FAX:**	**CONTACT PERSON:**
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		
3	Does the facility meet the requirements of the OSR?		
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		
5	Does your facility accept non-listed dioxin waste?		
6	Is rail service available to the facility? If yes, who is the rail service provider?		
7	Are there other viable transportation alternatives to the facility?		
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		
9	What is the cost per ton for acceptance and disposal?		
10	What is the cost per ton for rail interface, offloading and/or material handling?		
11	Limitations, if any, of the facility?		
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:			

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: PDC # 1 Landfill		**FACILITY CLASSIFICATION:** RCRA Part B
ADDRESS: 4349 Southport Road Peoria, Illinois 61615		**DATE OF CONTACT:** 4/5/2011 to 4/7/2011
PHONE: (309) 676-4893	**FAX:**	**CONTACT PERSON:** Linda Kocher, LKocher@pdcarea.com

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	See Notes.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	There is very little capacity left at PDC # 1.
3	Does the facility meet the requirements of the OSR?	See Notes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	See Notes.
5	Does your facility accept non-listed dioxin waste?	See Notes.
6	Is rail service available to the facility? If yes, who is the rail service provider?	See Notes.
7	Are there other viable transportation alternatives to the facility?	See Notes.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	See Notes.
9	What is the cost per ton for acceptance and disposal?	See Notes.
10	What is the cost per ton for rail interface, offloading and/or material handling?	See Notes.
11	Limitations, if any, of the facility?	See Notes.

Phone Questionnaire Initiator: Ellis Byeon (973) 407 - 1426

Notes: Based on conversations with Linda Kocher of PDC, there is very little capacity left at PDC#1.

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Perma-Fix of Maryland Landfill		**FACILITY CLASSIFICATION:** N/A
ADDRESS: Baltimore, MD 21226		**DATE OF CONTACT:** 4/1/2011
PHONE: (770) 587-9898	**FAX:**	**CONTACT PERSON:** Perma-Fix Environmental Services

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	Not Available (See Notes)
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	Not Available (See Notes)
3	Does the facility meet the requirements of the OSR?	Not Available (See Notes)
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	Not Available (See Notes)
5	Does your facility accept non-listed dioxin waste?	Not Available (See Notes)
6	Is rail service available to the facility? If yes, who is the rail service provider?	Not Available (See Notes)
7	Are there other viable transportation alternatives to the facility?	Not Available (See Notes)
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	Not Available (See Notes)
9	What is the cost per ton for acceptance and disposal?	Not Available (See Notes)
10	What is the cost per ton for rail interface, offloading and/or material handling?	Not Available (See Notes)
11	Limitations, if any, of the facility?	Not Available (See Notes)

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426

Notes:
Contacted Perma-Fix corporate office and was informed that the Perma-Fix of Maryland Landfill is not in their database anymore. Based on online research, Perma-Fix has discontinued operations at Perma-Fix of Maryland.

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Wayne Disposal Landfill			**FACILITY CLASSIFICATION:** RCRA Hazardous waste, TSCA/PCB waste
ADDRESS: 49350 North I-94 Service Drive Belleville, Michigan 48111			**DATE OF CONTACT:** 4/7/2011
PHONE: 734-699-6239		**FAX:** 734-697-9886	**CONTACT PERSON:** Michael L. Porath, Operations Manager
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		Does not provide information to outside contractors/consultants.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		Information is confidential. Currently, there is no capacity committed. Currently constructing a subcell to the existing footprint and expects the cell to last until 2015 based upon current airspace consumption rates.
3	Does the facility meet the requirements of the OSR?		Yes.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		No limit for concentration on PCB waste. Land Disposal Restrictions for RCRA wastes. There are requirements for strength criteria.
5	Does your facility accept non-listed dioxin waste?		In the past, the facility has accepted, but very low level concentrations of dioxin.
6	Is rail service available to the facility? If yes, who is the rail service provider?		No direct rail service. Separate entity for transfer is EQ RTF. Rail transfer point is 10-12 miles away. Service provider is Norfolk Souther, CSX, and Canadian national.
7	Are there other viable transportation alternatives to the facility?		Trucking.
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		Open top gondola carts. Ramp set up at top and dig up into cars (michigan gravel trains) Hold 50 tons with one tractor. Most cars weigh 100 tons. Currently, looking into other rail transfer entity with intermodal.
9	What is the cost per ton for acceptance and disposal?		80 to 150 dollars per ton. Huge Range.
10	What is the cost per ton for rail interface, offloading and/or material handling?		18 to 75 dollars per ton. Huge Range depending on how its handled, who pays for freight and bills, etc.
11	Limitations, if any, of the facility?		Landfill, no limitations on operating hours, volumes. Whatever they can get in a day they will take. Will run 24 hours a day.
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	
Notes:			

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: Grand View Facility			**FACILITY CLASSIFICATION:** Subtitle C Facility
ADDRESS: US Ecology of Idaho Inc., P.O. Box 400, Grand View, Idaho P.O. Box 400, Grand View, Idaho 83624			**DATE OF CONTACT:** 4/27/2011; 5/2/2011
PHONE: 1 (800) 274-1516		**FAX:** (208) 834-2919	**CONTACT PERSON:** Tim Curtain
QUESTION NO.	**QUESTION**		**ANSWER/COMMENT**
1	What is the total capacity of the facility (yearly and daily)?		No limit on daily capacity has been reached. We averaged > 1,350 tons per day from the Honeywell project over a 4 year period.
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?		We have ~ 3.2 M CY of capacity at our US Ecology ID facility
3	Does the facility meet the requirements of the OSR?		Yes, we are a fully permitted subtitle C RCRA, TSCA facility that is CERCLA approved.
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?		This varies from project to project but we do have every RCRA code that exists on our sub title C permit. We also can accept mixed wastes and perform various treatment prior to disposal as well as transportation via truck and or rail.
5	Does your facility accept non-listed dioxin waste?		Yes
6	Is rail service available to the facility? If yes, who is the rail service provider?		We are serviced by the UP RR and prefer to be involved in the transportation to assure your client gets the best service and price available for the transportation aspects. When US Ecology performs the transportation under our contract we also take ownership of the waste at the time it is shipped from the project site in NJ.
7	Are there other viable transportation alternatives to the facility?		Yes
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?		We have over 2 miles of RR track and INDOOR offloading with Level C APC capabilities at our own rail transfer facility (RTF). There are size and weight limitations which vary depending on the material and mode of transportation selected.
9	What is the cost per ton for acceptance and disposal?		using the assumption that a RR spur is not available for direct loading of this material at the project site, US Ecology will using our proven truck to rail option for a complete "door to door" transportation service proposes using a budgetary price of $200/ton for BOTH transportation and disposal (including the ID tax/fee) to US Ecology for this 900,000 tons/year of material.
10	What is the cost per ton for rail interface, offloading and/or material handling?		See above.
11	Limitations, if any, of the facility?		We do have several large proposal out to clients so timing and volume again may play a part in pricing or transportation options available at a particular time.
Phone Questionnaire Initiator:		Ellis Byeon (973) 407 - 1426	

Notes:
Tim Curtain of US Ecology recommended Grandview ID facility as the most appropriate option for US Ecology support for the Passaic River project. Therefore, other US Ecology facilities were not evaluated.

Landfill Facility Data Sheet
PHONE QUESTIONNAIRE FORM

FACILITY NAME: WCS Texas		**FACILITY CLASSIFICATION:**
ADDRESS: PO Box 1129 Andrews, TX 79714		**DATE OF CONTACT:** 4/5/2011
PHONE: (432) 525-8500	**FAX:**	**CONTACT PERSON:** David Henderson

QUESTION NO.	QUESTION	ANSWER/COMMENT
1	What is the total capacity of the facility (yearly and daily)?	
2	What is the available capacity remaining of the facility (i.e. what percentage of the capacity is not committed to clients)?	
3	Does the facility meet the requirements of the OSR?	
4	What are the acceptance criteria for waste, e.g., chemical concentration/threshold level, physical properties, etc.?	
5	Does your facility accept non-listed dioxin waste?	
6	Is rail service available to the facility? If yes, who is the rail service provider?	
7	Are there other viable transportation alternatives to the facility?	
8	What types of off-loading/tipping facility are available? Are there any weight/size limitations of the rail cars?	
9	What is the cost per ton for acceptance and disposal?	
10	What is the cost per ton for rail interface, offloading and/or material handling?	
11	Limitations, if any, of the facility?	

Phone Questionnaire Initiator:	Ellis Byeon (973) 407 - 1426

Notes:

Attachment C

Fate of Dredged Material Placed in Potential Network Bay CAD Cells

17 May 2012

FATE OF DREDGED MATERIAL PLACED IN POTENTIAL NEWARK BAY CAD CELLS

Tahirih Lackey, Jarrell Smith, Ian Floyd, and Sung-Chan Kim

1 BACKGROUND

The Environmental Protection Agency (EPA) is developing a Focused Feasibility Study (FFS) to evaluate alternatives for remediating the sediments of the lower eight miles of the Passaic River. In addition to a "No Action" alternative, two "active" alternatives are being evaluated:

- Alternative 2 ("Deep Dredging"): Dredging to remove all fine-grained sediment in the lower eight miles
- Alternative 3 ("Capping with Some Dredging"): Capping of all sediment in lower eight miles, with some dredging so that the cap does not cause additional flooding and to accommodate continued use of the federal navigation channel in the lower two miles of the river.

Each of the active alternatives includes three dredged material management options:

- Placement in Confined Aquatic Disposal (CAD) cells in Newark Bay (three cells for Alternative 2 [Fig 1-1c], two cells for Alternative 3 [Fig 1-1d]). Conceptual design follows operational practices at the existing Newark Bay CDF, which is for placement to occur during slack tides (within an hour on either side), with no night placement and only one cell open at a time.
- Dewatering and transportation off-site for disposal.
- Treatment at an on-site or regional sediment decontamination facility with beneficial use end-products.

The EPA requested assistance from the U.S. Army Engineer Research and Development Center (ERDC) in estimating contaminant losses during placement of contaminated dredged material into potential CAD cells within Newark Bay. Newark Bay is a tidal embayment at the confluence of the Passaic and Hackensack Rivers within the New York Harbor complex (Figure 1-1b). Newark Bay is part of the New York/New Jersey Harbor Estuary, in one of the most industrialized regions of the nation. The geomorphology and bathymetry of Newark Bay are complex with several tributaries, the Passaic River to the northwest and the Hackensack River to the northeast, and connections to the sea; east to the Upper New York Harbor through the Kill van Kull Waterway and to the southwest through the Arthur Kill Waterway to Raritan Bay. Figure 1-1 c and Figure 1-1 d indicate the proposed locations of CAD cells within Newark Bay, for Alternative 2 and Alternative 3 respectively. While the figures show multiple CAD cells associated with each alternative, only one CAD cell per alternative was modeled for this work because it is expected that only one CAD cell will be operational at any given time.

During placement operations within the CAD cell, a portion of the contaminants (both dissolved and particulate phases) will be transported outside the CAD cell and will be considered losses to the estuary. These losses depend on placement method, sediment characteristics, CAD cell fill level, and local hydrodynamic conditions. For this study, two CAD cell alternatives are evaluated, which differ primarily in size and shape. The CAD cell alternatives are displayed in Figure 1-2. In these figures, the vertical scale has been exaggerated by a factor of 50 for visualization purposes. The figures also illustrate the variation in CAD cell fill level. The depths of the CAD cell were 19 m (62 ft), 11 m (36 ft), and 5 m (16 ft) Mean Sea Level for 0 percent, 50 percent, and 90 percent fill levels, respectively. The dimension of the Alternative 2 CAD cell configuration was approximately 358 m x 583 m (1175 ft x 1913 ft), and the Alternative 3 configuration is approximately 364m x 308m (1194 ft x 1010 ft). The CAD cell dimensions and fill levels influence hydrodynamics within the CAD and consequently transport and loss of contaminants. Alternative 2 provided a larger basin with reduced currents (favorable for suspended sediment deposition), but also allows deeper mixing of surface currents and enhanced losses of fines. The smaller CAD configuration, Alternative 3, permits less time for suspended sediments to settle, but also reduces bottom shear stresses given the shorter length over which surface currents may be mixed deeper into the basin. Therefore each configuration and fill level requires a separate hydrodynamic solution. It should also be noted that there is an access channel on the northwest CAD cell boundary.

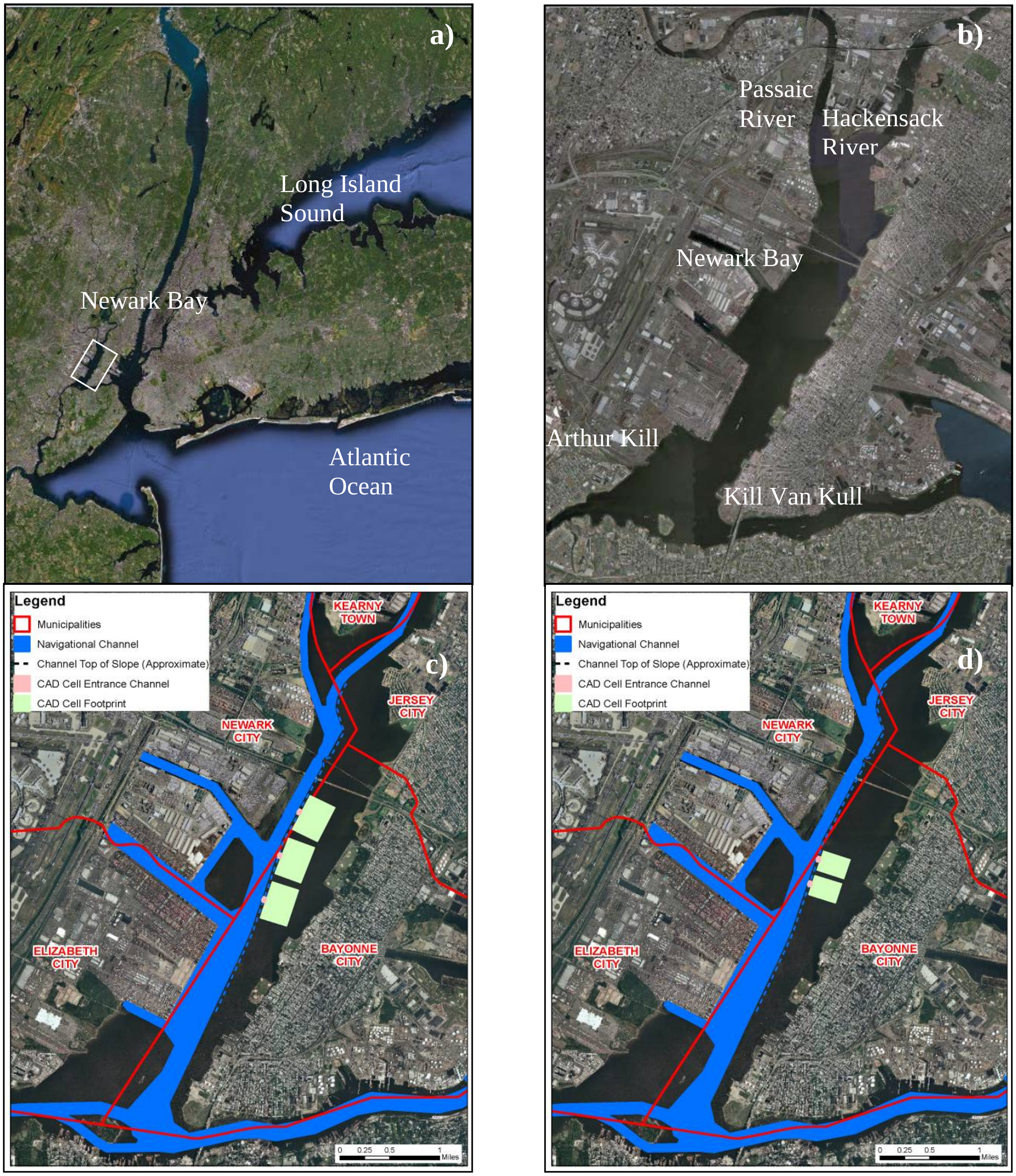


Figure 1-1. a) New York/New Jersey Region b) Newark Bay, c) Alternative 2 CAD cell configuration map (CAD cell model dimensions (1175 ft x 1913 ft), d) Alternative 3 CAD cells configuration map (CAD cell model dimensions (1194 ft x 1010 ft).

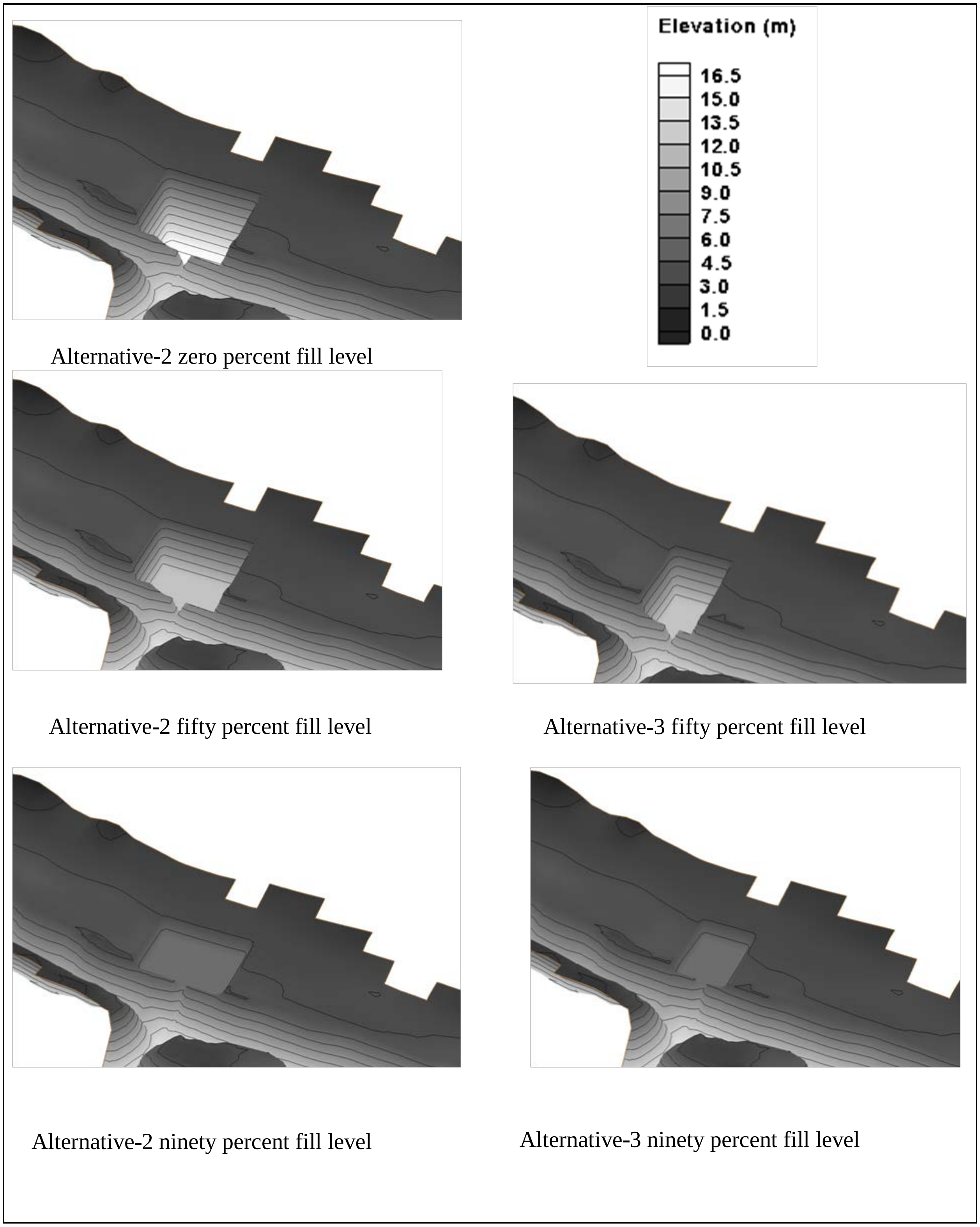


Figure 1-2 Alternative 2 and 3 configuration with variation in CAD cell fill level

Contaminant losses were estimated through simulations of dredged material placement and transport, accounting for variations in CAD cell configuration, CAD cell fill level, and hydrodynamic conditions. A simulation matrix is shown in Table 1-1. The contaminant loss evaluation proceeded in two phases. During phase one, a comparison of two proposed CAD cell configurations was performed to determine the worst case alternative. That is, the alternative which produced the largest sediment loss from the CAD cell during and immediately following placement. During phase two, the worst case alternative was investigated at three fill levels (0%, 50%, and 90%) to determine contaminant losses due to dredged material placement at each fill level and under varying hydrodynamic conditions. The total estimated contaminant loss for the entire fill time of the CAD was predicted from these results. As a precursor to this work, 30-day hydrodynamic simulations with each of the two CAD cell configurations and three fill levels were performed by HydroQual using the Lower Passaic River-Newark Bay hydrodynamic model (HydroQual, 2008). The results of these hydrodynamic simulations (water surface elevation and 3D velocity components) were provided by HydroQual as input to the Particle Tracking Model (PTM). The hydrodynamic simulations were based on average flows (annual mean flows for both Lower Passaic and Hackensack Rivers), with normal (not stormy) wind speeds from August 2006. These were used to represent typical conditions for CAD operations, since disposal is not expected to occur in stormy weather. The layer of deposition from the rest of Newark Bay that an open CAD would be expected to receive during stormy weather is not modeled here.

PTM is an ERDC-developed, Lagrangian numerical model designed specifically to track the fate of constituents (sediment, dissolved constituents, etc) released from point or localized sources (dredging operations, placement operations, combined sewer outfalls, surface runoff, etc) in complex hydrodynamic and wave environments (McDonald et al 2006, Gailani et al 2007, Lackey and Smith 2008). In this work, PTM was applied to estimate transport of dredged material outside the CAD cell for each hydrodynamic condition and CAD fill level. Dredge source definition is based on 1) placement type, 2) sediment type, and 3) hydrodynamic conditions. Dredge sources are time-varying and can include multiple constituents (sediment classes, chemicals). Therefore, model results include the fate of each constituent from each placement source.

Suspended sediment mass resulting from barge placement (Figure 1-3) of dredged material was estimated with STFATE (Johnson and Fong 1993). The suspended sediment distribution estimated by STFATE immediately following placement was provided to PTM for transport modeling.

Table 1-1. Simulation Matrix

Simulation Variable	Details	Number of Alternatives
CAD cell configuration	Alternative 2 and 3	2
CAD fill levels	0, 50, and 90%	3
Hydrodynamic conditions	Neap and spring	2

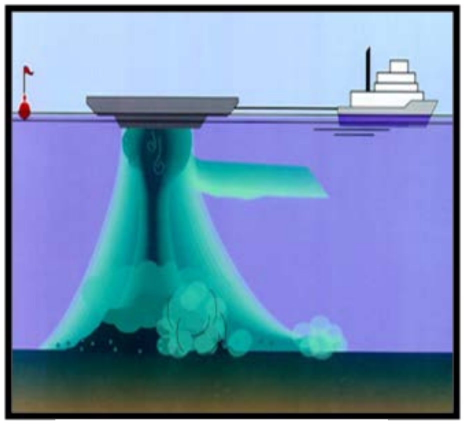


Figure 1-3 Schematic illustrating sediment suspension during barge placement.

This report is presented in four sections. Section 1 contains the background information and site description. Section 2 describes methods applied for estimating suspended sediment releases from barge placement operations, numerical transport modeling of these releases within the CAD cell, and analysis of the simulation results. Section 3 presents simulation results, followed by summary and conclusions in Section 4.

2 METHODS

Bathymetry and Hydrodynamics

Estuarine, Coastal and Ocean Model (ECOM) bathymetry and a thirty day hydrodynamic solution (three-dimensional velocity and water surface elevation) were provided by HydroQual. The hydrodynamic simulation was based on average flows (annual mean flows for both Lower Passaic and Hackensack Rivers), with normal (not stormy) wind speeds from August 2006. These were used to represent typical conditions for CAD operations, since disposal is not expected to occur in stormy weather. This hydrodynamic solution was converted to PTM format. The Hydroqual developed grid bathymetry, water surface elevation, and velocity data were interpolated onto the nodes of the PTM grid using an ERDC-developed conversion code. The code read in the ECOM grid and solution which consisted of quadrilateral cells and interpolated the velocities and water levels from the ECOM solution to each grid node using a linear interpolation algorithm. Each ECOM grid quad was bisected to form two triangular elements for the PTM grid. The bathymetry in the CAD cell region for Alternative 3 can be seen in Figure 2-1.

Three-dimensional hydrodynamics and sediment transport modeling was required for this project. The hydrodynamics within the CAD cell are complex and significantly three-dimensional. Flow movement within the CAD cell is dependent on the fill level and tidal phase.

Maximum velocity magnitude within the CAD cell is considerably less than velocities in the navigation channel. Hydrodynamic values of velocity magnitude, for Alternative 2, 50% fill level are shown in Figure 2-2. Values for speed (at a position 70% of the depth) within the main channel, the northeast end, middle, and southwest end of the CAD cell, as well as south of the CAD cell are displayed over a thirty day period. Also visible are the change in velocity magnitude over the spring and neap cycles. Neap (day 1-7) and spring (day 7-14) periods were extracted for the transport simulations.

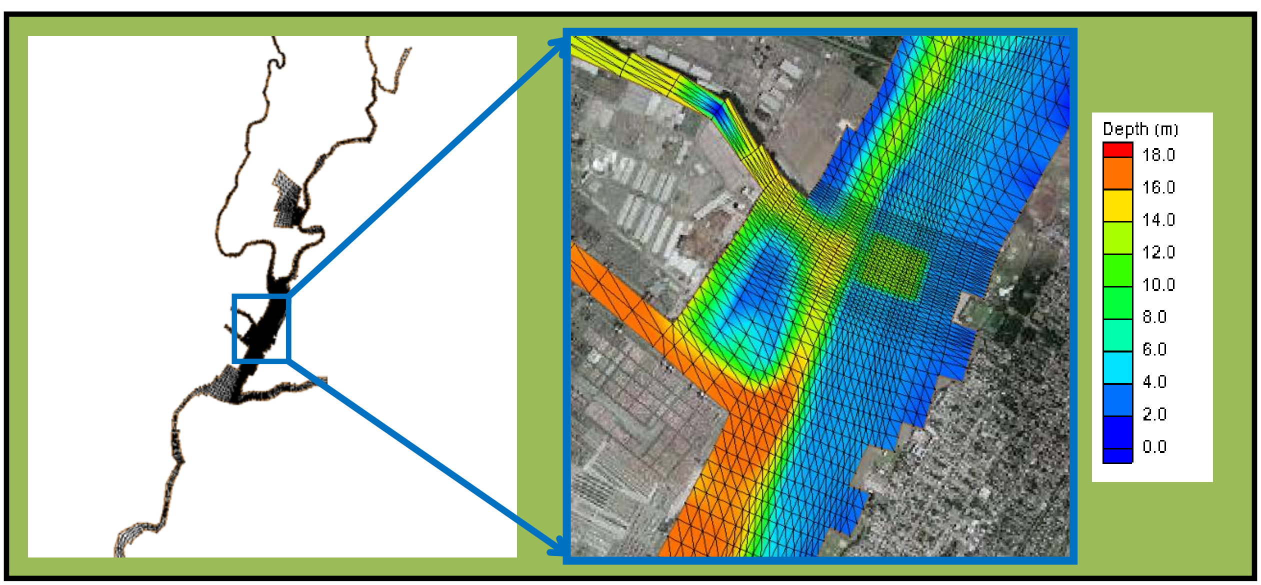


Figure 2-1 Newark Bay PTM computational mesh converted from ECOM grid

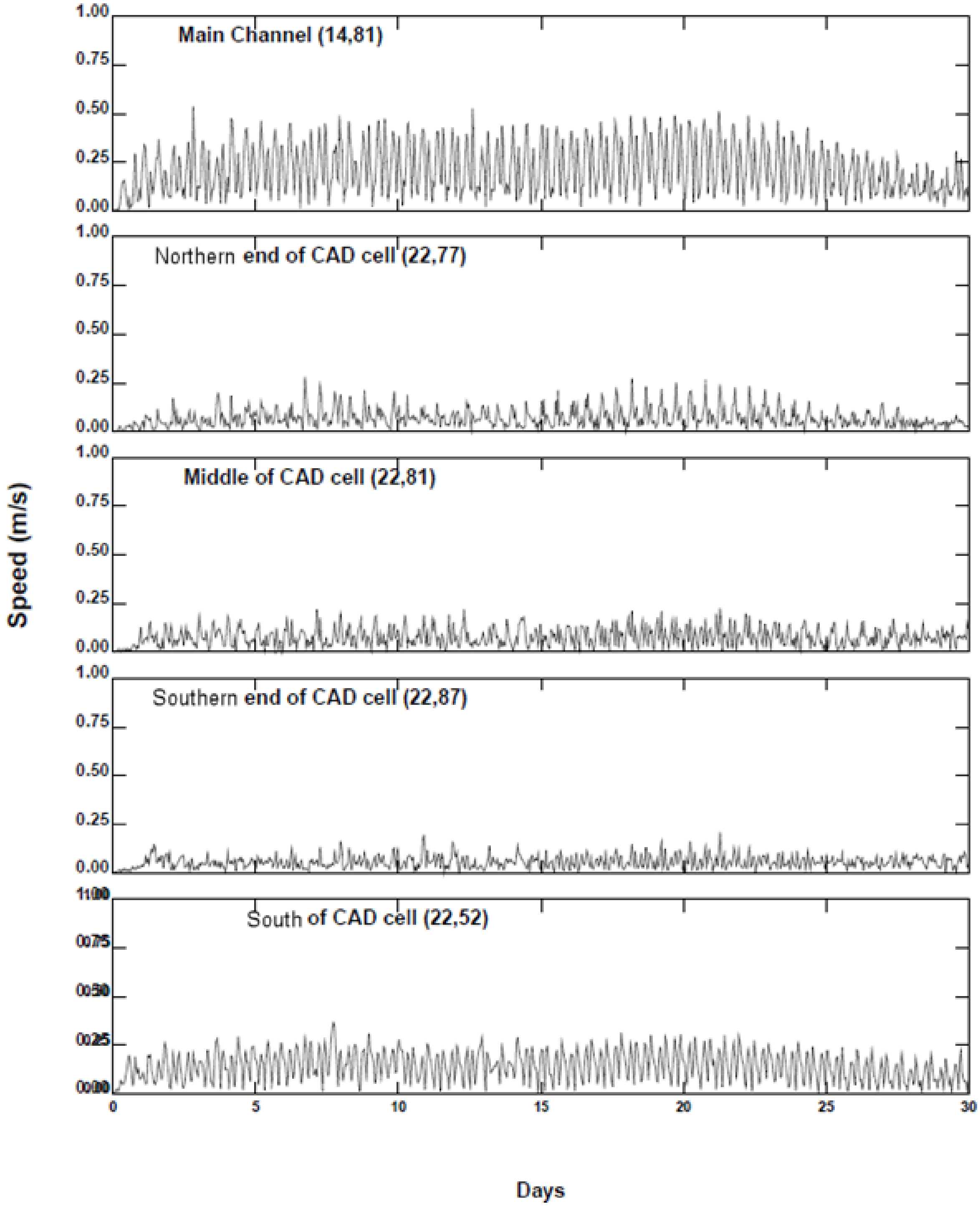


Figure 2-2 Velocity magnitude for Alternative 2, 50% fill level at various locations.

Sources

Estimates of sediment suspension during placement operations are required to evaluate contaminated sediment transport from the CAD. This section describes the application of the numerical model, STFATE, to estimate suspended sediments immediately following barge placement of dredged material.

Barge Placement

Sediment suspension during barge placement was estimated with the Short-Term FATE of dredged material model (STFATE). STFATE (Johnson and Fong 1993) simulates the placement of a single load of dredged material. The physics of dredged material released from a barge can be categorized into three general phases (Figure 2-3): convective descent, dynamic collapse, and passive transport and dispersion. The passive transport and dispersion stage of STFATE does not appropriately represent the complex, 3-D hydrodynamic conditions and mixing within the CAD and was not applied in this study. Transport and mixing of the suspended sediments was modeled with PTM.

Convective Descent. During convective descent, dredged material rapidly travels to the bottom as a high-density plume. Descent velocity is governed by negative plume buoyancy, drag, and momentum. Nearly all sediment mass is contained within the dense plume, but a portion of the sediment mass is entrained to the water column. The proportion and vertical position of sediment entrained is influenced by sediment type, plume density, descent velocity, and distance from the barge to the sediment bed.

Dynamic Collapse. Dynamic collapse describes plume impact with the sediment bed, transfer of vertical momentum to horizontal momentum, and flow of the dense plume across the bottom. Impact and spreading of the dense plume across the sediment bed results in momentum losses (through turbulent mixing and friction). As the radially spreading plume's surge front slows and eventually stops, sediments are deposited to the bed. During dynamic collapse, sediments may also be entrained to the water column by ambient currents and turbulence produced by the surge front.

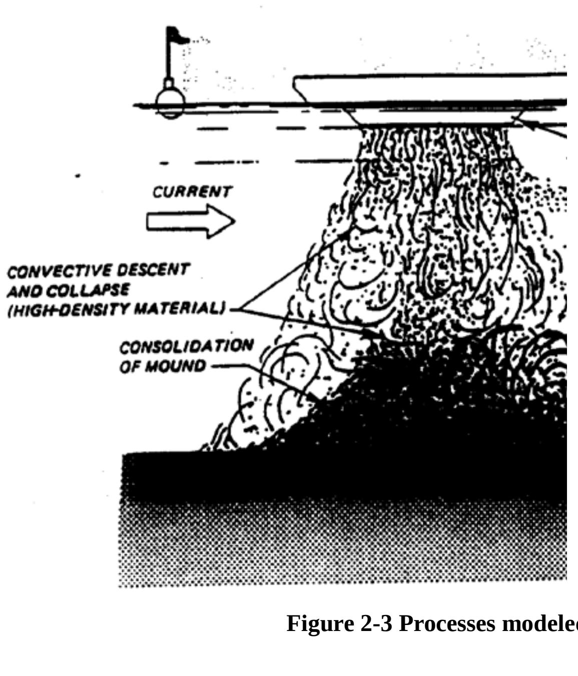


Figure 2-3 Processes modeled in STFATE

At the end of the descent and collapse phases, a series of clouds containing sediment mass are represented in suspension along the descent and bottom spreading path of released material. Ordinarily, the clouds containing stripped sediments are passed to the passive transport phase of STFATE. For the present study, the cloud positions, sizes, and sediment masses are output to create source terms for PTM. The sediment mass contained in these clouds is discretized into multiple PTM parcels, and the vertical and horizontal distributions of these parcels are approximated to represent the corresponding dimensions of the stripped clouds in STFATE.

It should be noted that resuspension by subsequent placements is not addressed directly in the model. Once dredged sediments are deposited in the cell, the CAD floor becomes composed of softer, consolidating sediment. During subsequent placements, some of this deposited material will be eroded by the surge front of the material released from the barge. However, laboratory experiments and physics of dense plumes suggest that the eroded material from a surge front is incorporated into the dense plume, and little of this eroded material from the bed is suspended to the water column.

Simulated Barge Placement

STFATE model simulations were developed to represent the anticipated operations for the Newark Bay CAD. Barge dimensions, material characteristics, and water column properties were estimated and specified based on engineering judgment and available data.

Placement site conditions were represented as a uniform, flat bottom with water depth represented as the depth to the bottom of the CAD at fill levels corresponding to the hydrodynamic simulation. Effects of the steeply sloping side walls were neglected. (None of the simulations indicated a bottom surge that would interact with the side-slopes.) Currents within the CAD were assumed to be zero, consistent with the management constraint of placement near slack water built into the FFS remedial alternatives, and the negligible effects of small currents on stripping of the descending and collapsing dredged material release. Water densities at the dredging and placement sites were assumed to be 1.002 and 1.010 $g \cdot cm^{-3}$, respectively. These water densities correspond to 15°C water at 4 ppt salinity at the dredging site and 14 ppt salinity at the placement site.

Barge placement is anticipated to be accomplished with a 4000 yd^3 bottom-release scow. Dimensions of the 4000 yd^3 Sterling *Mighty Quinn* were used as a representative barge of this class. The corresponding input to STFATE is provided in Table 2-1. The loaded draft of the barge is approximately 14 ft, determined from the barge dimensions, the barge light draft, and the estimated density of the dredged material (next paragraph). At the 90% CAD fill level (16 ft deep MSL), the bottom of the barge will be near the CAD bottom, but placements of full loads is still feasible with split hull barges. The clearance between the barge and CAD bottom could be increased with operational constraints such as light loading of barges or restricting placement to high tide. For the purposes of this scoping-level study, the barges are assumed to be fully loaded at the 90% CAD fill level.

Table 2-1. Barge dimensions represented in STFATE. (based on Sterling, *Mighty Quinn*)

Parameter	Value
Capacity	4000 yd^3
Length	240 ft
Beam	54 ft
Bin Length	150 ft
Bin Width	40 ft
Light Draft	3 ft

Sediments at the dredging site were represented as 6 percent sand and 94 percent fines (silt and clay), with 55 percent water content. This description was based Louis Berger Group information from 2007-2008 coring program in the Passaic River (LBG 2010 pers. comm.) and a conservative selection of the sample with the highest silt content. Composition of dredged material within the barge was estimated from these material properties, factoring in bulking of the dredged material (and entrainment of dredging site water) and clumping of the mechanically dredged sediment. A bulking factor (ratio of dredged material volume to in-situ volume) of 1.25 was applied based on Bray et al. (1997) for silt and clay, resulting in a bulk density (mass of sediment and water per unit volume) of the dredged material 1.32 g·cm^{-3}. Clump fraction (fraction of sediment mass bound in clumps) was assigned a modest value of 25%, considering the relatively low water content of the bed sediment. With a bulk density of 1.32 g·cm^{-3}, the volume fraction of sediment in the barge is 19.3% and the volume fractions of individual constituents modeled by STFATE are 12.3% clumps (sediment and water), 0.87% sand, 13.6% fines, and 73.3% water.

Recently collected data at hopper and mechanical dredging sites suggest that very little fine-grained dredged material is completely disaggregated into individual silt and clay particles (Smith and Friedrichs, 2010; unpublished data from Boston Harbor (Smith and Friedrichs)). Instead, the fine-grained portion released to the water column is composed of a wide range of aggregated sediments, some of which are fragments of the dredged sediment bed, and therefore have relatively large densities. Based on these recent data, two fine classes were represented in STFATE, one with settling velocity of 1.5 mm/s (4.9 x 10^{-3} ft/s) and the other with 0.5 mm/s (1.6 x 10^{-3} ft/s). The fine-grained sediment mass was distributed equally between these two classes. Settling velocity of the sand fraction was set to 10.5 mm/s (3.4 x 10^{-2} ft/s), consistent with fine, quartz sand (125 μm).

Dredged material releases were simulated at slack tide (one release per slack tide) from stationary barges. Based on operational practices (Thompson per. Communication) the barge was positioned at the CAD cell center. The placed material flows to develop a uniform surface across the CAD cell. Releases occurred at each slack tide for 3 days during both spring and neap tidal conditions, resulting in a total of 12 barge releases for each PTM simulation period. For the 0, 50, and 90% full CAD cell, the sediment mass stripped from the plume (but still within the CAD cell) was 14.8%, 14.6%, and 4.1% of the total sediment mass placed, respectively. (The dramatic reduction in suspended sediment for the 90% full case is associated with reduced stripping to the water column by the small distance between the barge and the sediment bed.) The temporal and spatial distributions of stripped sediments estimated by STFATE (for each of the three sediment classes) were converted to PTM sources for each simulation.

Sediment Transport Model

PTM is an ERDC-developed model designed specifically to track the fate of point-source constituents (sediment, chemicals, debris, etc…) released from local sources such as dredges, placement sites, and outfalls in complex hydrodynamic and wave environments. Each local source is defined independently and may have multiple constituents. Therefore, model results include the fate of each constituent from each local source. PTM is a three-dimensional Lagrangian transport model which simulates transport using pre-calculated, periodically saved hydrodynamic (and wave) model output. The hydrodynamic model is not coupled to the sediment transport model and therefore can be run once for multiple PTM simulations. Each particle in PTM represents a specific mass (or number of particulates) of one constituent. Total mass is conserved because particles are conserved. PTM also requires hydrodynamic mesh geometry and bathymetry, as well as descriptions of particulate releases at sediment sources.

One of the primary benefits of PTM is that it allows the user to model only the constituents of concern. Eulerian models simulate the transport and fate of all sediment (including bed sediments) in the domain. By treating only the sediments or constituents of interest, PTM requires much less computational time and therefore permits rapid simulation of multiple long-term scenarios.

The particle velocity is described using the three-dimensional velocity vector $\vec{\mathbf{U}}$:

$$\vec{\mathbf{U}} = \vec{\mathbf{U}}_A + \vec{\mathbf{U}}_D - \vec{\mathbf{U}}_S$$

where *A* indicates advective forcing from the hydrodynamics and *D* indicates diffusion. The subscript *S* indicates the settling velocity. The settling term is zero for the horizontal components; the vertical component is defined by the settling velocity values provided in the Simulated Barge Placement section.

The random walk representation of the horizontal dispersive velocity is computed as:

$$\mathbf{U}_D = 2(\Pi - 0.5)\sqrt{\frac{6E_t}{dt}}$$

where Π is a random number uniformly distributed between 0 and 1. E_t is the horizontal turbulent diffusion coefficient. The vertical diffusion is described similarly in terms of E_v. The turbulent diffusion coefficients in these equations are estimated as presented in Fischer et al. (1979) and as applied by Shen et al. (1993) amongst others. In each case E_t and E_y are dependent on coefficients K_{Et} and K_{Ev} respectively. For this work K_{Et} is 0.5 and K_{Ev} is 0.00859. These values are typical coefficients taken from the literature. A more detailed description of these terms can be found in McDonald et al. (2006).

Particle deposition and resuspension are based on the critical shear stress, τ_{cr} . For the two fine-sediment classes represented, the critical shear stress for initiation was set to 0.1 N/m^2 (consistent with numerous laboratory experiments measuring critical stress for recently deposited dredged material, e.g. Demirbilek et al. 2010). Critical erosion stress for the sand class was set to 0.14 N/m^2 (based on Shields curve (Graf 1971, Soulsby 1997, and Dean and Dalrymple 2002). The critical shear stress of deposition was set to 0.05 N/m^2 and 0.03 N/m^2 for the two fine classes, and 0.12 N/m^2 for the sand class.

Model output includes time-dependent, three-dimensional particle positions throughout the domain. Various other attributes such as mass, density, and suspension status are also assigned to each of the output parcels.

Burial

In CAD cells, deposited sediment is frequently buried by continuing placement of dredged material within the CAD. PTM does not currently support parcel burial by dredged material placement. To account for this process, parcel burial was incorporated into post processing of the PTM simulation results. A parcel is considered buried if it resided long enough on the CAD bottom to be covered by dredged material placement to a depth greater than a prescribed threshold.

The burial rate of the placement operation is defined as:

$$\frac{dz}{dt} = \frac{\dot{m}}{A\rho_b}$$

where dz/dt is the burial rate (length/time), $\dot{m}$ is the mass rate of sediment delivery by the placement operation, A is the area of the CAD bottom, and ρ_b is the dry bulk density of the deposited bed. The mass rate of sediment placement within the CAD was defined by the placement method and rate. CAD bottom area was determined from the CAD representation in the hydrodynamic grid. Dry bulk density (mass of sediment per unit volume) was estimated based on a wet bulk density of 1.2 g·cm^{-3} (a value based on the authors' laboratory experience with the thin surface layer of dredged material slurries and consolidation experiments). Burial thresholds were estimated based on laboratory experience with dredged material erosion experiments, which suggest that critical stresses of fine-grained sediments increase rapidly from 0.1 Pa at the surface to greater than 0.4 Pa at depths of 0.25 to 1.0 cm (0.1 to 0.4 inches) beneath the sediment surface. The sensitivity of model results to burial thresholds is tested using three values (0.25, 0.5, 1.0 cm), as discussed in the Results section.

Simulation Details

For this work, each PTM simulation is run for seven days. During the first three days placement occurs, with one barge placement (simulated by STFATE) at each slack tide during the period. The following four days are allotted for the placed material to either settle within the CAD cell or become transported out of the CAD cell into other areas of the system. Simulation periods correspond to spring and neap cycles as described in the bathymetry and hydrodynamic section.

Analysis of Sediment Mass Lost

PTM simulations were analyzed to determine the fraction of placed sediment mass that was transported outside the CAD boundaries (or lost). PTM parcel positions were evaluated at the end of the 7-day simulation period. A rectangular polygon was defined around the outer edge of the CAD. Parcels located outside this polygon at the end of the simulation were considered losses from the CAD. PTM simulations were conducted with critical stress for erosion of 0.1 Pa, representative of fine sediments resting on the sediment surface. To account for parcel burial, the time-history of each parcel transported outside the polygonal CAD boundary was evaluated to determine if the parcel had deposited within the CAD for a sufficient period of time to be considered buried. All parcels that meet the burial criterion are excluded from the set of parcels transported outside the CAD. Finally, the mass of non-buried parcels transported outside the CAD boundary are summed to determine the total mass lost.

Contaminant Loss and Transport Calculations

Contaminant losses from the CAD placements are quantified in three ways:

1. Percent of total contaminant mass placed in the CAD (by particulate and dissolved phases)
2. Total contaminant mass loss
3. Increase in contaminant bed concentrations outside the CAD.

This section describes the methods for each of these calculations. Results are provided in Section 3.

Contaminant Partitioning

Contaminant transport estimates require an estimate of contaminant partitioning between the particulate and dissolved phases. For the screening-level estimates provided by this study, the following assumptions were applied: (1) the residence time in the barge was assumed to be sufficiently long to achieve equilibrium partitioning of contaminants between the dredged sediment and water (bed pore water and dredging-entrained water) within the barge, (2) the descent and settling time of sediments during placement was assumed sufficiently short to neglect kinetic reactions, (3) all dissolved phase contaminants were assumed to be transported outside the CAD (even though some of this contaminant mass would likely be retained in the sediment bed within the CAD), and (4) repartitioning of sediment parcels during passive transport simulation with PTM was not considered . A two-phase partitioning approach was used, which means that the estimated dissolved phase includes both the pure water phase and the macromolecule/colloidal phase.

Equilibrium partitioning was estimated by the K_d method, $S = K_d C_{eq}$, where S is the equilibrium contaminant concentration in particulate phase (kg contaminant/ kg solids), K_d is the equilibrium partitioning coefficient, and C_{eq} is the equilibrium contaminant concentration in dissolved phase (kg/L). For hydrophobic sorption of organic compounds, K_d can be estimated by $K_d = K_{oc} f_{oc}$, where K_{oc} is the partitioning coefficient of a compound between organic carbon and water and f_{oc} is the mass fraction of organic carbon in sediment. Equilibrium partitioning coefficients for dioxin (2,3,7,8 TCDD), PAH (Phenanthrene), and PCB-77 are presented in Table 2-2. These coefficients were determined from the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles (http://www.atsdr.cdc.gov/toxprofiles/index.asp) as well as the Lower Passaic River-Newark Bay Fate and Transport Model, HydroQual 2012. For compounds with a defined K_{oc}, a representative f_{oc} of 4% (Gbondo-Tugbawa, pers. comm.) was applied to estimate K_d.

Table 2-2 Equilibrium Partitioning Coefficients			
Compound	**K_d**	**Details**	**Reference**
2,3,7,8 TCDD	258262	from log(K_{oc})=6.81 assuming f_{oc}=4%	Lower Passaic River-Newark Bay Fate and Transport Model, HydroQual 2012
Phenanthrene	565	from log(K_{oc})=4.15, assuming f_{oc}=4%	(ATSDR ToxProfile)
PCB-77	120226	from mean(log(K_d)) for PCB-77	Midpoint of ATSDR Range

Contaminant Loss

Contaminant loss estimates were prepared by assuming 100% loss of the dissolved phase and a fraction of the particulate phase loss (which was determined from PTM simulations). Partitioning of contaminant mass in the barge was estimated from the mass of sediment and water in the barge and the partitioning coefficients provided in Table 2-2. For a 4000 yd^3 barge filled with dredged material from a bed at 55% water content and a bulking factor of 1.25, the masses of sediment and water in the barge are 2.6 x 10^6 kg and 2.1x 10^6 kg, respectively. Contaminant mass concentrations in the barge are estimated as follows:

$$M_{aq} = \frac{S_{bed}}{K_d} V_w$$

$$M_p = S_{bed} M_s - M_{aq}$$

where,

M_{aq} = Contaminant mass in aqueous phase
M_p = Contaminant mass in particulate phase
S_{bed} = Contaminant concentration in the bed
V_w = Volume of water in the barge
M_s = Mass of sediment in the barge

Contaminant mass lost from the CAD was computed as:

$$L_{aq} = n M_{aq}$$

$$L_p = n \ f \ M_p$$

$$L_{total} = L_{aq} + L_s$$

where L_{aq} is the mass lost in aqueous phase, L_p is the mass lost in particulate phase, L_{total} is the total mass lost, n is the number of barge loads considered, and f is the fraction of sediment mass that exited the CAD boundaries. Expression of the contaminant losses in percent is simply

$$\%Loss_x = 100\% * \frac{L_x}{M_{aq} + M_p},$$

where the x subscript denotes *aq* (aqueous phase), *p* (particulate phase), or *total*.

It should be noted that contaminant concentrations in the suspended sediment transported out of the CAD will probably be higher (on a mass contaminant/mass suspended sediment basis) than that in the source dredged material. This is the result of the coarser grained (and relatively less contaminated) sand fraction and "clumps" being retained in the CAD, while finer grained (and relatively more contaminated) particles are suspended and transported out of the CAD. However, because the sediment grain size distribution is only 6% sand, the increased contaminant concentration is 6.3% which is relatively small compared to the overall level of uncertainty.

Increase in Bed Concentration

PTM computes transport, deposition, and resuspension of sediment beyond the CAD boundaries. The distribution of PTM sediment parcels at the end of the simulation allows an estimate of changes in contaminant concentrations within the surface layer associated with operation of the CAD. The change in bed concentration resulting from deposition of dredged material leaving the CAD is expressed as:

$$\Delta C = C_{new} - C_{Bed}$$

$$C_{new} = \frac{C_{Bed} M_{Bed} + C_{Dredge} M_{Dredge}}{M_{Bed} + M_{Dredge}}$$

$$M_{Bed} = A d \rho_{bed}$$

where ΔC is change in bed concentration, C_{new} is the concentration of the surface layer after deposition of CAD-associated sediment, C_{Bed} is obtained from data from contaminant maps (Appendix A) which have been interpolated with the Surface Water Modeling System (SMS) software using a weighted distance average technique onto the computational Cartesian grid (Figure 2-4), C_{Dredge} is the contaminant concentration associated with dredged solids, M_{Dredge} is the mass of deposited dredged solids, A is the area of the computational Cartesian grid cell, d is the depth of the surface mixed layer, and ρ_{bed} is the dry bed density. All calculations of the above equations are performed on a 50 m x 100 m (164 ft x 328 ft) computational Cartesian grid (not the PTM hydrodynamic mesh). The values applied in these calculations are provided in Table 2-3. The dredging site contaminant concentrations evaluated included the Tierra Removal area[1].

For completeness, analysis was performed for bed contaminant increase using both the mean concentration of the dredge material and the 95% UCL concentration. The 95% UCL for the dredge material placed in the CAD cell was estimated as follows:

- The total mass of each contaminant within the lower 8 miles was calculated using all available data from 1990-2010. Because the sediments in the Tierra Phase 1 area will be disposed of at an upland site, this area was excluded from the mass calculation.

[1] For this CAD cell analysis, the Tierra Removal area includes Phase 1 (40,000 cubic yards) and Phase 2 (160,000 cubic yards) of a removal of highly contaminated sediments adjacent to the former Diamond Alkali plant in Newark, NJ being conducted under an Administrative Order between EPA and Occidental Chemical Corporation; and another 150,000 cubic yards on either side of the Phase 2 area which EPA had considered separating from the rest of the sediment evaluated in the FFS. Subsequent to the completion of this CAD cell analysis, EPA decided not to treat the 150,000 cubic yards differently than the rest of the sediment in the lower 8.3 miles of the Lower Passaic River.

- 95% UCL for the total mass for each contaminant was determined.
- The 95% UCL for the contaminant concentrations were estimated using the 95% UCL mass, the total sediment volume, and the volume-weighted bulk density.

2-1 Computational Cartesian Grid for Concentration Data Analysis

Table 2-3 Dredge site parameters and characteristics

Parameter	Value	Units
water content, bed	0.55	unitless
density, bed (wet)	1.65	g/cm3
density, bed (dry)	1.06	g/cm3
Mean Concentration		
Concentration, 2,3,7,8 TCDD	4.5	ppb
Concentration, Phenanthrene	8,500	ppb
Concentration, PCB-77	45	ppb
95% UCL Concentration		
Concentration, 2,3,7,8 TCDD	9	ppb
Concentration, Phenanthrene	17,000	ppb
Concentration, PCB-77	90	ppb

The mixing of sediment released from the CAD cell operations with the top 10 cm of sediment bed, is expected to occur within a year. This rapid recycle between the water column and the sediment bed is consistent with Berryllium-7 activities observed by Sommerfield and Chant (2010) in Newark Bay. Note that the resulting estimated concentrations presented in this report are conservative estimates because they do not incorporate the effect of 140,000 metric tons (Sommerfield and Chant, 2010) of relatively less contaminated sediments (in terms of the contaminants evaluated in this report) that enter the bay each year from Kill Van Kull.

Model Uncertainty

It is difficult to state a single uncertainty for the modeling results. The analysis and results given in this report are based on hydrodynamic modeling, source term modeling, and sediment transport modeling. Each of these models has uncertainty. These results are then analyzed with techniques which require various assumptions stated within the methods section. A rigorous treatment of uncertainty, therefore, requires sensitivity analysis on key parameters (sediment composition, settling velocities, accuracy of the hydrodynamics, shear thresholds for erosion and deposition, clumping factor, partitioning coefficients etc…) Many of these parameters are interrelated, making uncertainty even more difficult to determine.

The approach of this work has therefore been to make conservative assumptions for crucial aspects of the study, including: sediment composition, neglect of natural deposition, clumping factor, critical shear for erosion, and dissolved phase losses. In addition sensitivity was addressed for burial depth, and contaminant concentrations. Utilizing this approach, the results should show conservative estimates for the fraction of contaminants released from the CAD and the change of bed contaminants in the surrounding areas.

3 RESULTS

This section provides results for Phase 1 and 2 PTM simulations and estimates of contaminant losses from the CAD cell.

Phase 1: Comparison of Alternative 2 and 3 for the Worst Case Scenario

Within Phase 1 of this work, we determine the worst-case CAD configuration by comparing sediment losses from the Alternative 2 and Alternative 3 CAD configurations. For barge placement, the greatest transport of solids from the CAD is associated with the 50% fill level. Although the resuspended sediment is susceptible to higher shear stresses in the 90% fill level case, the source term (percentage of sediment resuspended) in the 50% fill level case is decreased by 70% due to reduced stripping to the water column associated with the shorter descent path from the barge to the sediment surface.

For the Phase 1 evaluation, the ratio of sediment mass lost to sediment mass placed ("Percent Mass Lost") is used as the criterion for selecting the worst-case scenario. The term sediment mass lost refers to the mass of sediment that exits the CAD cell and the term sediment mass placed refers to the mass of sediment that is contained in the barge and subsequently placed in the CAD. Additionally, the ratio of sediment initially suspended during placement (but still within the CAD) to the sediment mass placed ("Source Percentage") is reported to illustrate relationships between transport potential and suspended sediment available.

$$Source\ Percentage = \frac{Mass_{Source}}{Mass_{Placed}} \times 100\%$$

$$Percent\ Mass\ Lost = \frac{Mass_{Loss}}{Mass_{Placed}} \times 100\%$$

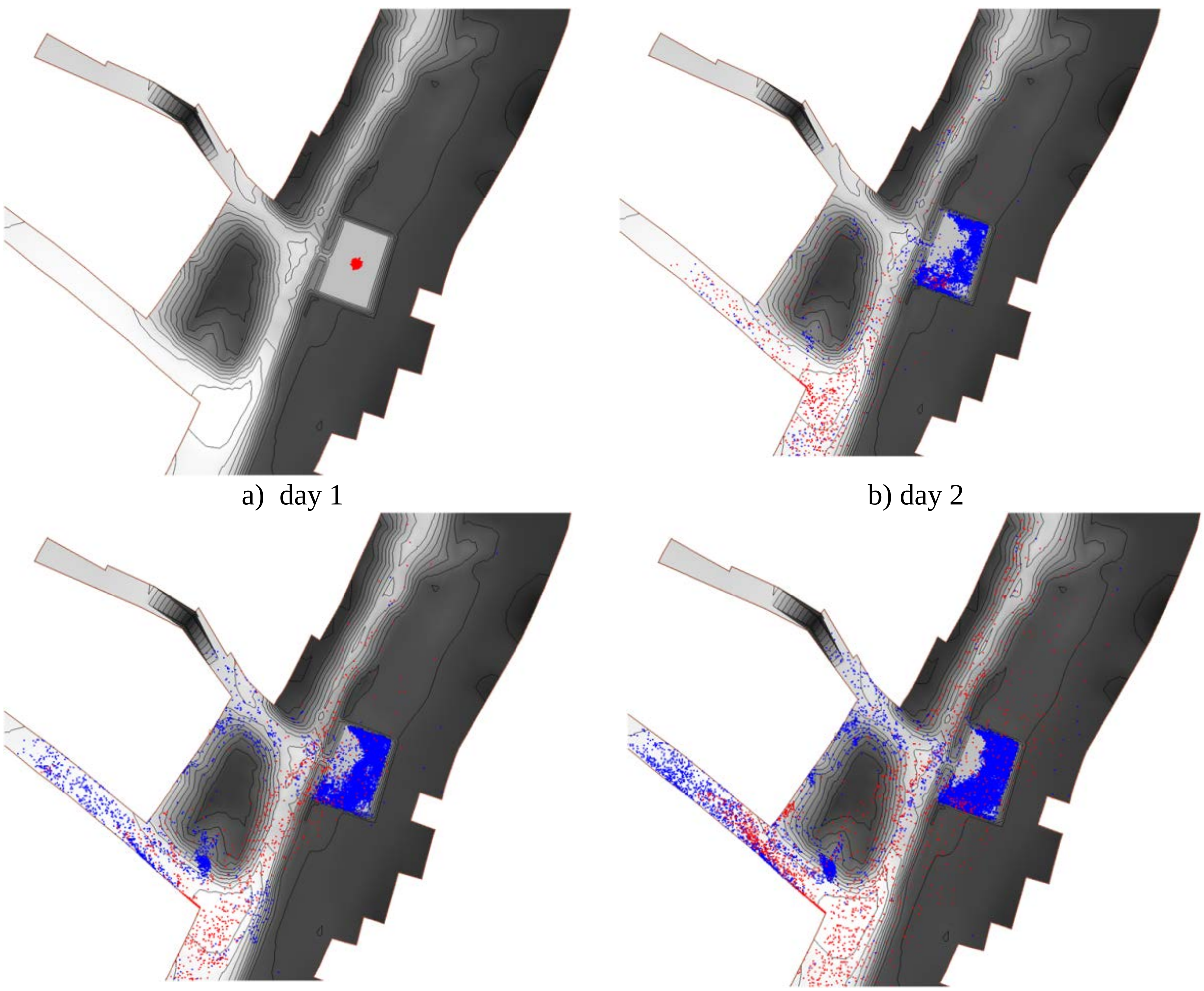
A summary for the results for the Phase 1 evaluation is provided in Table 3-1. The table shows outcome for both spring and neap hydrodynamic conditions for CAD cell Alternatives 2 and 3. For each of these simulations, 14.6% of the sediment placed is initially in suspension. For both spring and neap conditions, Alternative 2 simulations are 10-25% greater than that for Alternative 3.

Table 3-1 Barge Placement for 50% CAD cell fill level

Hydrodynamic Conditions	CAD Cell Configuration	Mass Source/Total Mass placed (%)	Mass Lost/Total Mass Placed (%)
Spring	2	14.6	3.2
Spring	3	14.6	2.9
Neap	2	14.6	0.8
Neap	3	14.6	0.6

Phase 2: Evaluation of Sediment and Contaminant Losses for Alternative 2

Phase 1 results showed that Alternative 2 results in greater sediment losses than Alternative 3. In Phase 2, sediment and contaminant losses from Alternative 2 are examined in greater detail. PTM particle positions give indications of sediment transport pathways out of the CAD cell. In Figure 3-1, simulation snapshots are shown for barge placement within the Alternative 2 CAD at 50% fill level. Snapshots are taken at the beginning of day 1, 2, 3 and 4. Particles are colored based on state of deposition (blue) or suspension (red). The particle positions provided in Figure 3-1 indicate that the particles released at the center of the CAD are initially suspended and in close proximity to the release point. At the beginning of day 2, three placements have occurred and some sediment has been transported out of the CAD cell. At this point in the simulation, some sediment transported out of the CAD has deposited in the nearby channels or transported outside the figure area. By day 3, more sediment has been placed, and the majority of released sediment is within the CAD cell. At Day 4 barge placements for this simulation have concluded. Most of the suspended sediment released during placement has deposited within the CAD boundaries; however some deposition within the navigation channels and berthing areas is evident.



a) day 1 b) day 2

c) day 3 d) day 4

Figure 3-1 PTM snapshots from 50% CAD fill level and spring tidal hydrodynamics simulation. Blue particles are deposited, red particles are in suspension.

Table 3-2 provides the percent of sediment mass placed that was transported outside the CAD boundaries for all simulations. Values range from 0.0% loss (neap tidal conditions and 0% fill level) to approximately 3% loss (50% fill level and spring tidal conditions). Sensitivity of sediment mass loss to burial depth (described in the Methods section) is also provided in Table 3-2.

Table 3-2 Sediment Mass Loss Estimated from PTM Simulations of Alternative 2

Hydrodynamic Conditions	CAD Cell Fill Level (%)	Mass Source/Total Mass Placed (%)	Mass Loss/Total Mass Placed (%) (burial depth thresholds shaded)		
			0.25 cm	0.5 cm	1.0 cm
Spring	0	14.8	**0.1**	**0.1**	**0.2**
Spring	50	14.6	**2.3**	**2.8**	**3.1**
Spring	90	4.1	**0.3**	**0.5**	**0.6**
Neap	0	14.8	**0.0**	**0.0**	**0.0**
Neap	50	14.6	**0.7**	**0.8**	**0.8**
Neap	90	4.1	**0.1**	**0.1**	**0.1**

Percent mass lost over the complete filling cycle is estimated from the discrete values in Table 3-2 using a weighted averaging approach. Loss values are weighted as follows based on the CAD fill level.

- 0-25% fill level = 0% fill level value
- 25-70% fill level = 50% fill level value
- 70-100% fill level= 90% fill level value

Table 3-3 presents the project-averaged results using the 0.5-cm burial depth criterion, which is a reasonable average as shown by the sensitivity results. For the spring tide hydrodynamics, average mass loss is 1.44% and for the neap cycle, mass loss is 0.39%. If placement occurs evenly between spring and neap conditions, total predicted percent mass loss is 0.92%.

Table 3-3 Sediment Mass Loss Averaged over CAD Filling Cycle

Hydrodynamic Conditions	Mass Loss/Total Mass Placed during fill of CAD cell (%)
Spring	**1.44**
Neap	**0.39**

Contaminant Loss and Transport Results

Contaminant losses from the CAD cell were estimated for three contaminants: 2,3,7,8 TCDD (dioxin), Phenanthrene (PAH), and PCB-77. Tables 3-4 through 3-11 provide the estimated losses for aqueous phase, particulate phase, and total for each contaminant for both the mean concentration and the 95% UCL Concentration. The losses are expressed as percent of total contaminant mass placed for the three simulated CAD fill levels (0%, 50%, and 90% full) and as an average of the complete filling cycle of the CAD. This project average is defined similarly to the project average described in the previous section, as a weighted average based on the fill level. The results indicate that contaminant losses from the CAD are predominantly in the particulate phase. Consequently, the contaminant loss rates closely follow the estimated sediment loss rates presented earlier, with project-averaged contaminant losses of approximately 1.5% during spring conditions and 0.4% during neap conditions. Assuming equal distribution of placements during spring and neap tidal conditions, contaminant loss rates for the full filling cycle of the CAD is approximately 1.0% of the total contaminant mass placed for all contaminants.

Table 3-4 Contaminant Loss from CAD (Aqueous Phase)
(Calculated using Mean Dredge Material Contaminant Concentration)

Compound	Hydro	Contaminant Loss (percent)			
		0% full	50% full	90% full	Project average
2,3,7,8 TCDD (dioxin)	Spring	0.000	0.000	0.000	0.000
	Neap	0.000	0.000	0.000	0.000
Phenanthrene (PAH)	Spring	0.141	0.141	0.141	0.141
	Neap	0.141	0.141	0.141	0.141
PCB-77	Spring	0.001	0.001	0.001	0.001
	Neap	0.001	0.001	0.001	0.001

Table 3-5 Contaminant Loss from CAD (Aqueous Phase)
(Calculated using 95% UCL Dredge Material Contaminant Concentration)

Compound	Hydro	Contaminant Loss (percent)			
		0% full	50% full	90% full	Project average
2,3,7,8 TCDD (dioxin)	Spring	0.000	0.000	0.000	0.000
	Neap	0.000	0.000	0.000	0.000
Phenanthrene (PAH)	Spring	0.141	0.141	0.141	0.141
	Neap	0.141	0.141	0.141	0.141
PCB-77	Spring	0.001	0.001	0.001	0.001
	Neap	0.001	0.001	0.001	0.001

Table 3-6 Contaminant Loss from CAD (Particulate Phase)
(Calculated using Mean Dredge Material Contaminant Concentration)

Compound	Hydro	Contaminant Loss (percent)			
		0% full	50% full	90% full	Project average
2,3,7,8 TCDD (dioxin)	Spring	0.100	2.800	0.500	1.440
	Neap	0.000	0.800	0.100	0.390

Phenanthrene (PAH)	Spring	0.100	2.796	0.499	1.438
	Neap	0.000	0.799	0.100	0.389
PCB-77	Spring	0.100	2.800	0.500	1.440
	Neap	0.000	0.800	0.100	0.390

Table 3-7 Contaminant Loss from CAD (Particulate Phase)
(Calculated using 95% UCL Dredge Material Contaminant Concentration)

		Contaminant Loss (percent)			
Compound	**Hydro**	**0% full**	**50% full**	**90% full**	**Project average**
2,3,7,8 TCDD (dioxin)	Spring	0.100	2.800	0.500	1.440
	Neap	0.000	0.800	0.100	0.390
Phenanthrene (PAH)	Spring	0.100	2.796	0.499	1.438
	Neap	0.000	0.799	0.100	0.389
PCB-77	Spring	0.100	2.800	0.500	1.440
	Neap	0.000	0.800	0.100	0.390

Table 3-8 Contaminant Loss from CAD (Total)
(Calculated using Mean Dredge Material Contaminant Concentration)

		Contaminant Loss (percent)			
Compound	**Hydro**	**0% full**	**50% full**	**90% full**	**Project average**
2,3,7,8 TCDD (dioxin)	Spring	0.100	2.800	0.500	1.440
	Neap	0.000	0.800	0.100	0.390
Phenanthrene (PAH)	Spring	0.241	2.937	0.641	1.579
	Neap	0.141	0.940	0.241	0.531
PCB-77	Spring	0.101	2.801	0.501	1.441
	Neap	0.001	0.801	0.101	0.391

Table 3-9 Contaminant Loss from CAD (Total)
(Calculated using 95% UCL Dredge Material Contaminant Concentration)

		Contaminant Loss (percent)			
Compound	**Hydro**	**0% full**	**50% full**	**90% full**	**Project average**
2,3,7,8 TCDD (dioxin)	Spring	0.100	2.800	0.500	1.440
	Neap	0.000	0.800	0.100	0.390
Phenanthrene (PAH)	Spring	0.241	2.937	0.641	1.579
	Neap	0.141	0.940	0.241	0.531
PCB-77	Spring	0.101	2.801	0.501	1.441
	Neap	0.001	0.801	0.101	0.391

Tables 3-10 and 3-11 provide the estimated total contaminant mass losses per 4000 yd^3 barge. Table 3-10 uses the mean contaminant bed concentration and Table 3-11 uses the 95% UCL concentration.

Table 3-10 Contaminant Mass Loss
(Calculated using Mean Dredge Material Contaminant Concentration)

Compound	Hydro	Contaminant Loss (kg/4000 yd^3 barge)			
		0% full	50% full	90% full	Project average
2,3,7,8 TCDD (dioxin)	Spring	1.18E-05	3.28E-04	5.86E-05	1.69E-04
	Neap	3.62E-08	9.38E-05	1.18E-05	4.57E-05
Phenanthrene (PAH)	Spring	5.34E-02	6.50E-01	1.42E-01	3.50E-01
	Neap	3.13E-02	2.08E-01	5.34E-02	1.17E-01
PCB-77	Spring	1.18E-04	3.28E-03	5.87E-04	1.69E-03
	Neap	7.78E-07	9.38E-04	1.18E-04	4.58E-04

Table 3-11 Contaminant Mass Loss
(Calculated using 95% UCL Dredge Material Contaminant Concentration)

Compound	Hydro	Contaminant Loss (kg/4000 yd^3 barge)			
		0% full	50% full	90% full	Project average
2,3,7,8 TCDD (dioxin)	Spring	2.35E-05	6.56E-04	1.17E-04	3.38E-04
	Neap	7.25E-08	1.88E-04	2.35E-05	9.15E-05
Phenanthrene (PAH)	Spring	1.07E-01	1.30E+00	2.84E-01	6.99E-01
	Neap	6.26E-02	4.16E-01	1.07E-01	2.35E-01
PCB-77	Spring	2.36E-04	6.56E-03	1.17E-03	3.38E-03
	Neap	1.56E-06	1.88E-03	2.36E-04	9.16E-04

Increase in bed concentration

Sediment-sorbed contaminants transported outside the CAD boundaries will ultimately settle to the bed, and can potentially increase bed concentrations in the surrounding areas. The increase in surface contaminant concentrations is dependent upon the mass of sediment deposited, the concentration of contaminants sorbed to these sediments, the surface mixing depth, and the existing contaminant concentrations in the bed. The increase in bed concentration was computed for 2,3,7,8-TCDD, Phenanthrene, and PCB-77, based on existing near-surface contaminant concentrations, contaminant concentrations from the dredging area, and CAD-placed sediments transported and deposited to the surrounding area (estimated by PTM). Increases in surface contaminant concentrations were estimated from the PTM simulations of 0%, 50%, and 90% CAD fill levels during spring and neap hydrodynamic conditions, applying contaminant concentrations using the parameters from Table 2-3.

Figures 3-2 through 3-13 present the estimated increases in surface concentrations (using both mean and 95% UCL contaminant concentrations for the dredge material) for 12 barge placements (48,000 yd^3 of placed dredged material or 38,400 yd^3 of removal from the dredging site). In each figure, the CAD cell is masked to exclude sediments deposited in the CAD. The largest increases in bed concentration are associated with the conditions of greatest sediment loss from the CAD (spring tidal hydrodynamics and 50% CAD fill level). The largest increases in surface concentrations are generally in the Port Elizabeth channel. Maximum increases outside the CAD (for 12 barge placements) are 150 pg/g for 2,3,7,8 TCDD, 50 µg/kg for Phenanthrene, and 1500 pg/g for PCB-77.

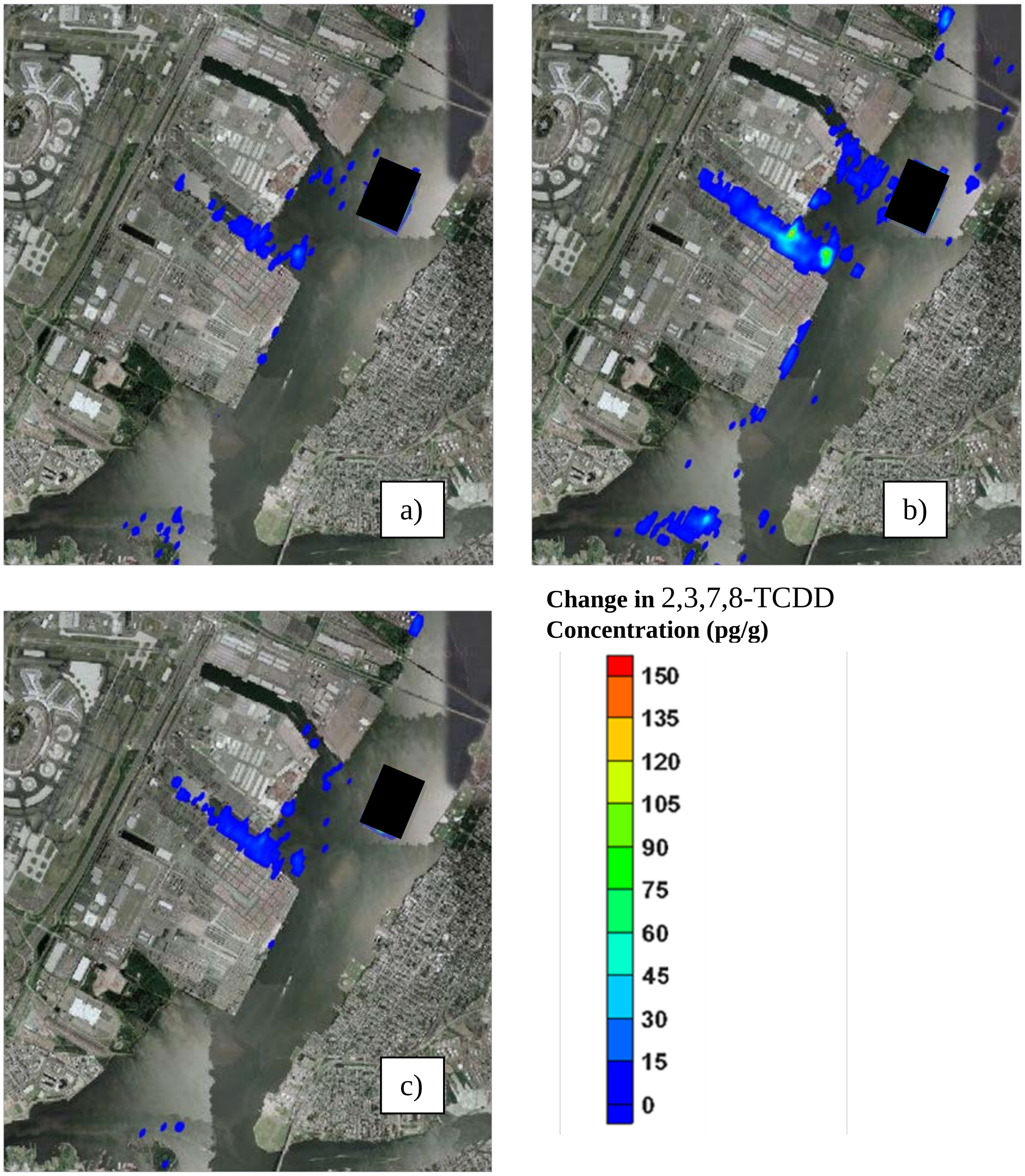


Figure 3-2 Neap Conditions, 95% UCL concentration, 2,3,7,8 TCDD Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

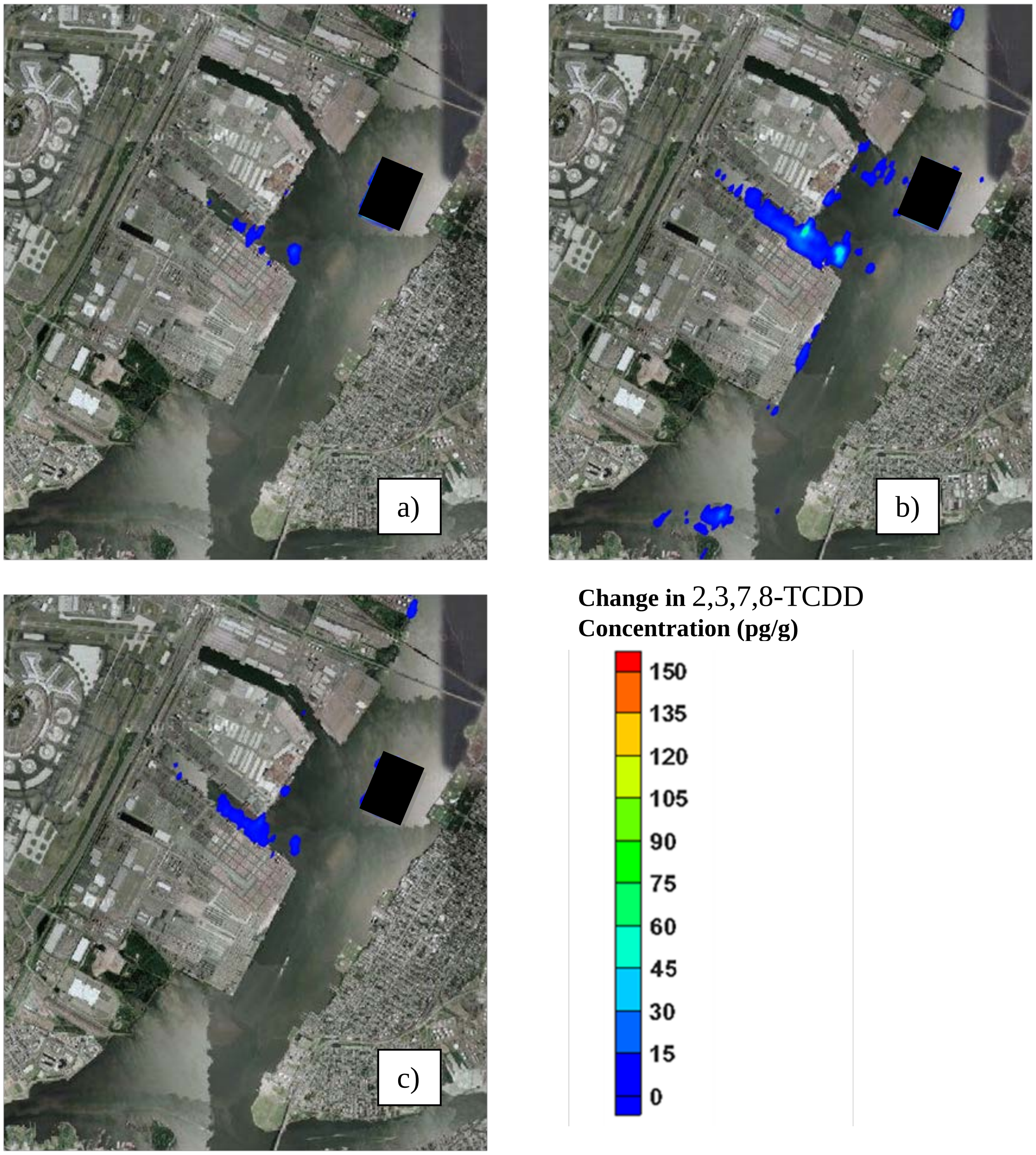


Figure 3-3 Neap Conditions, mean concentration,, 2,3,7,8 TCDD Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

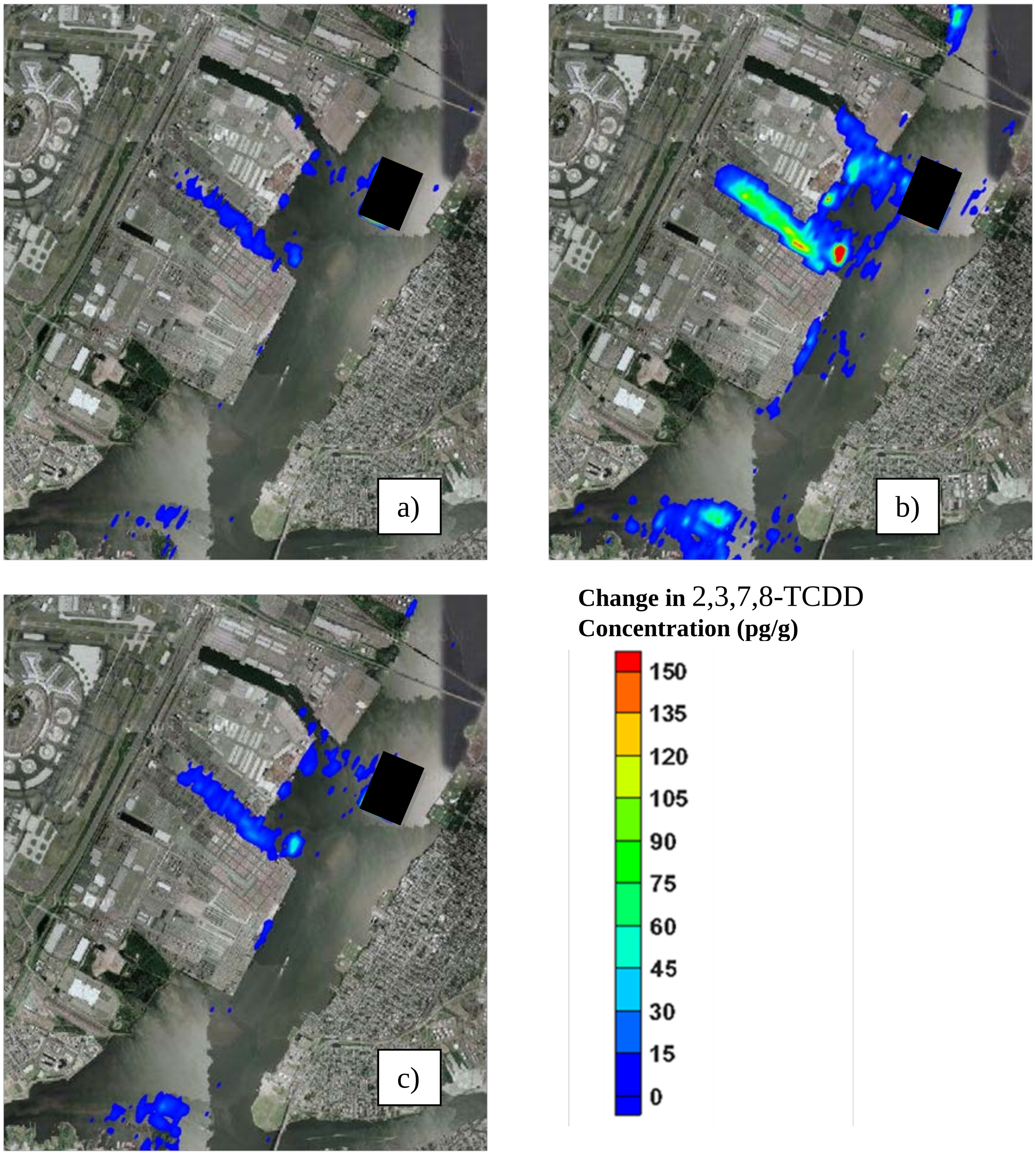


Figure 3-4Spring Conditions, 95% UCL concentration , 2,3,7,8 TCDD Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

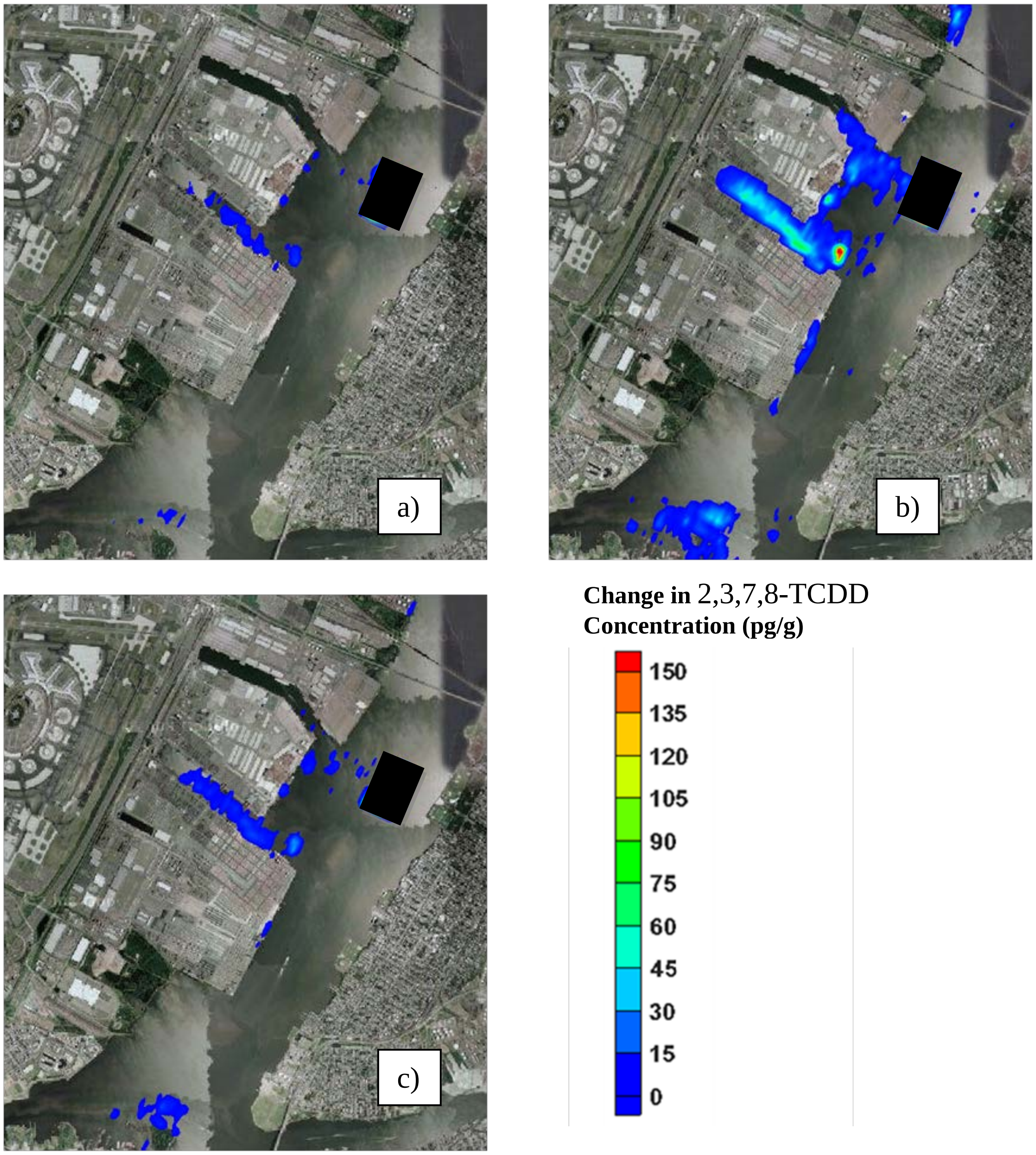


Figure 3-5 Spring Conditions, mean concentration, 2,3,7,8 TCDD Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

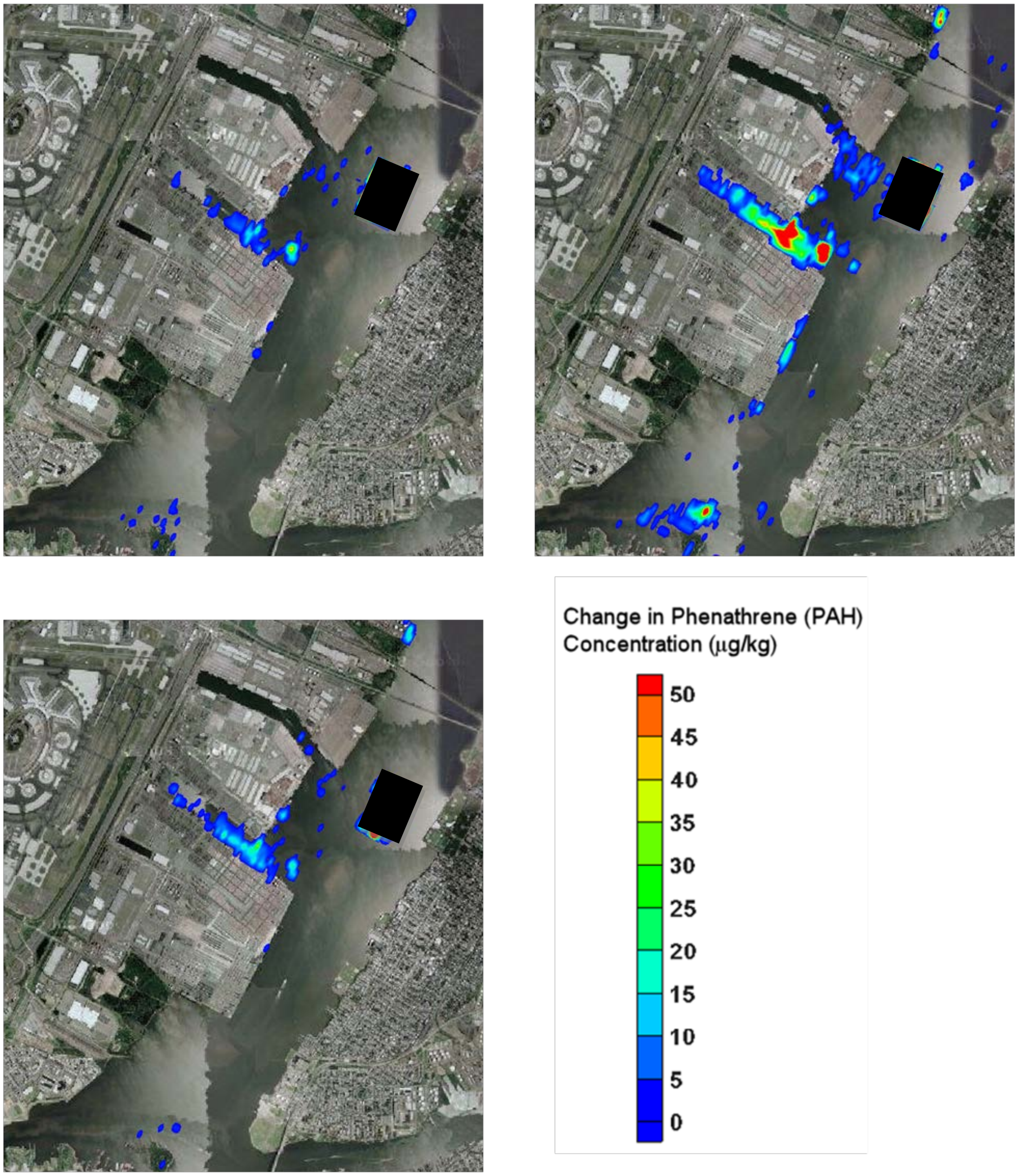


Figure 3-6Neap Condition, 95% UCL concentration, Phenanthrene Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

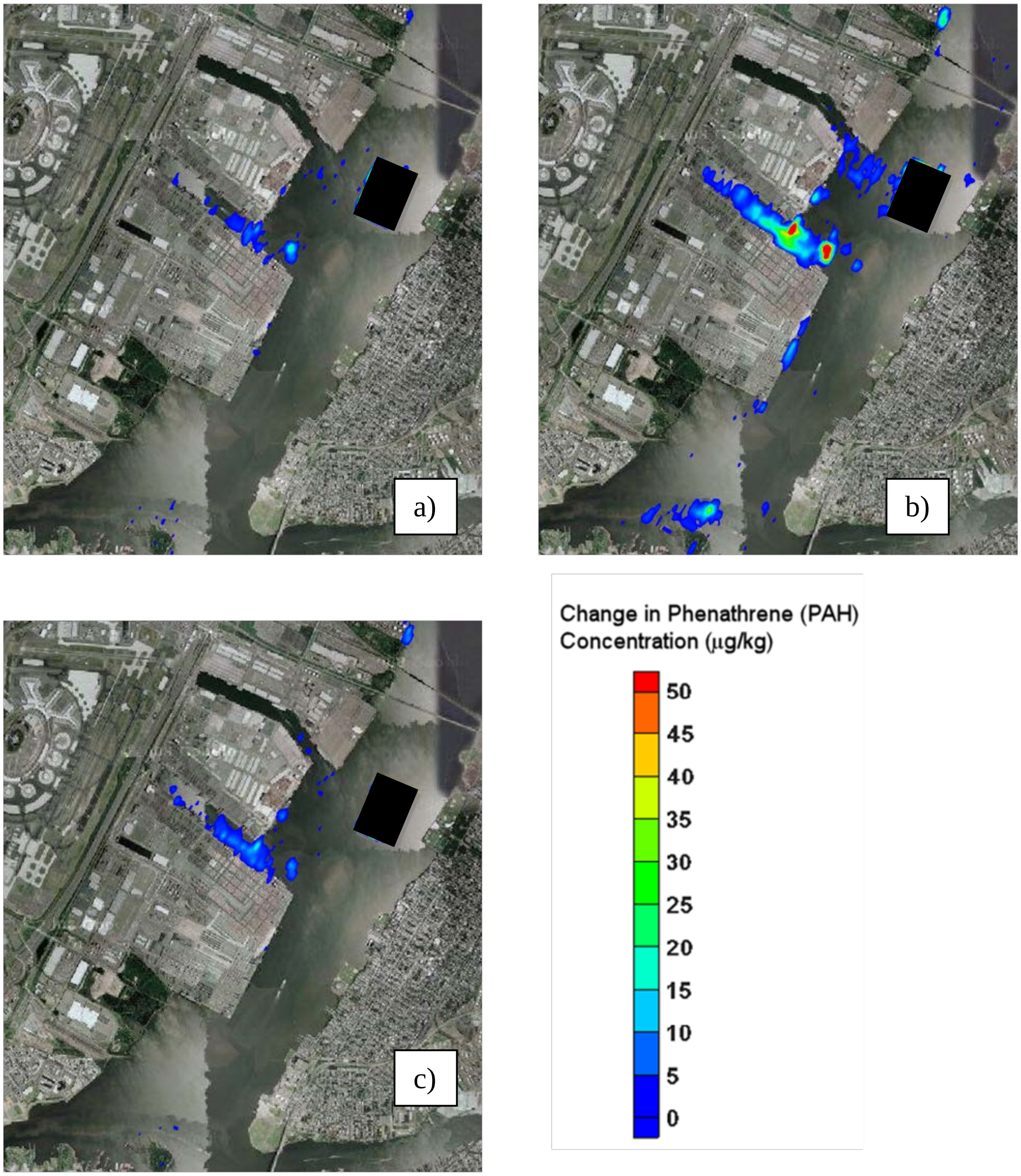


Figure 3-7 Neap Condition, mean concentration, Phenanthrene Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

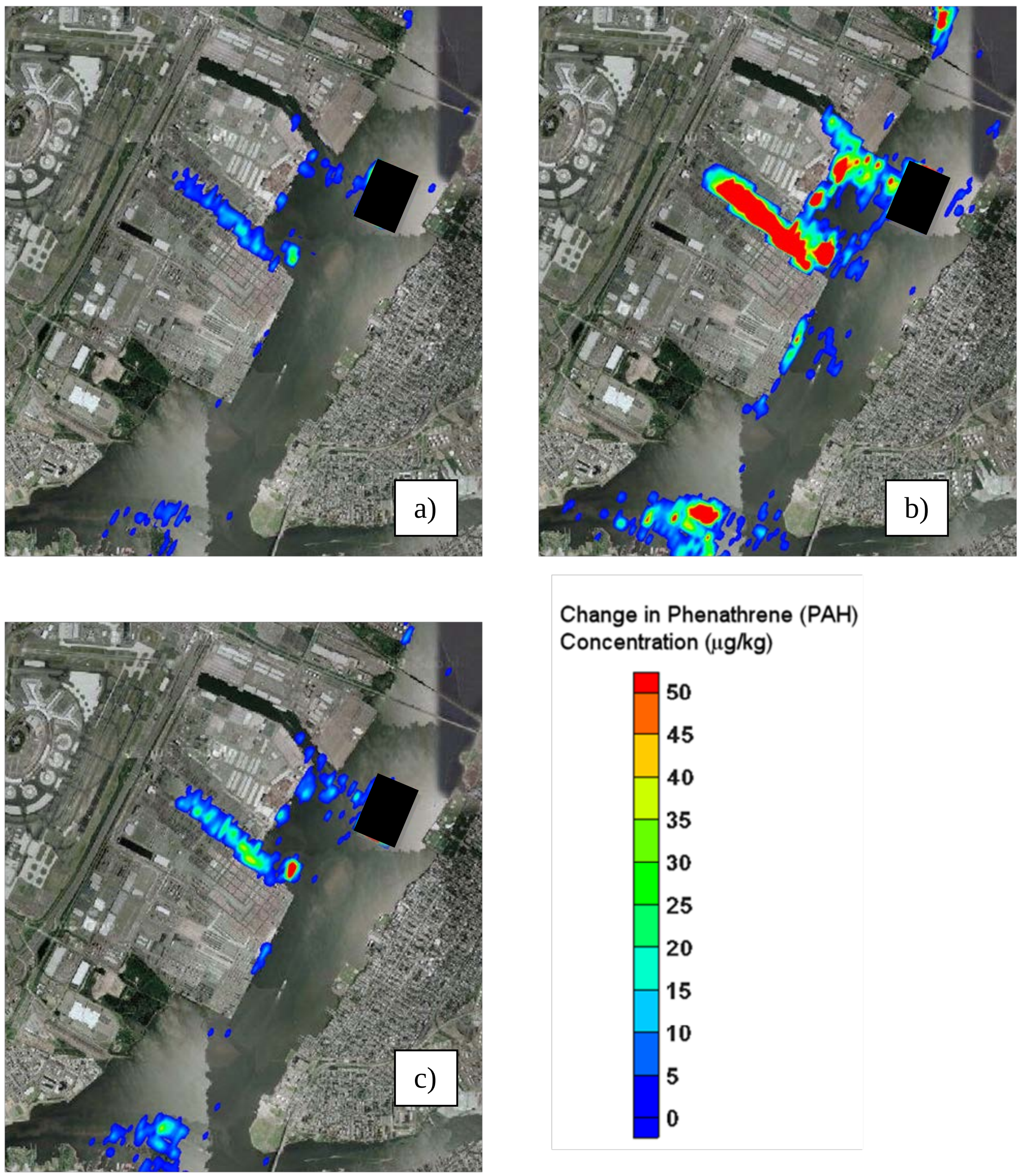


Figure 3-8 Spring Condition, 95% UCL concentration, Phenanthrene Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

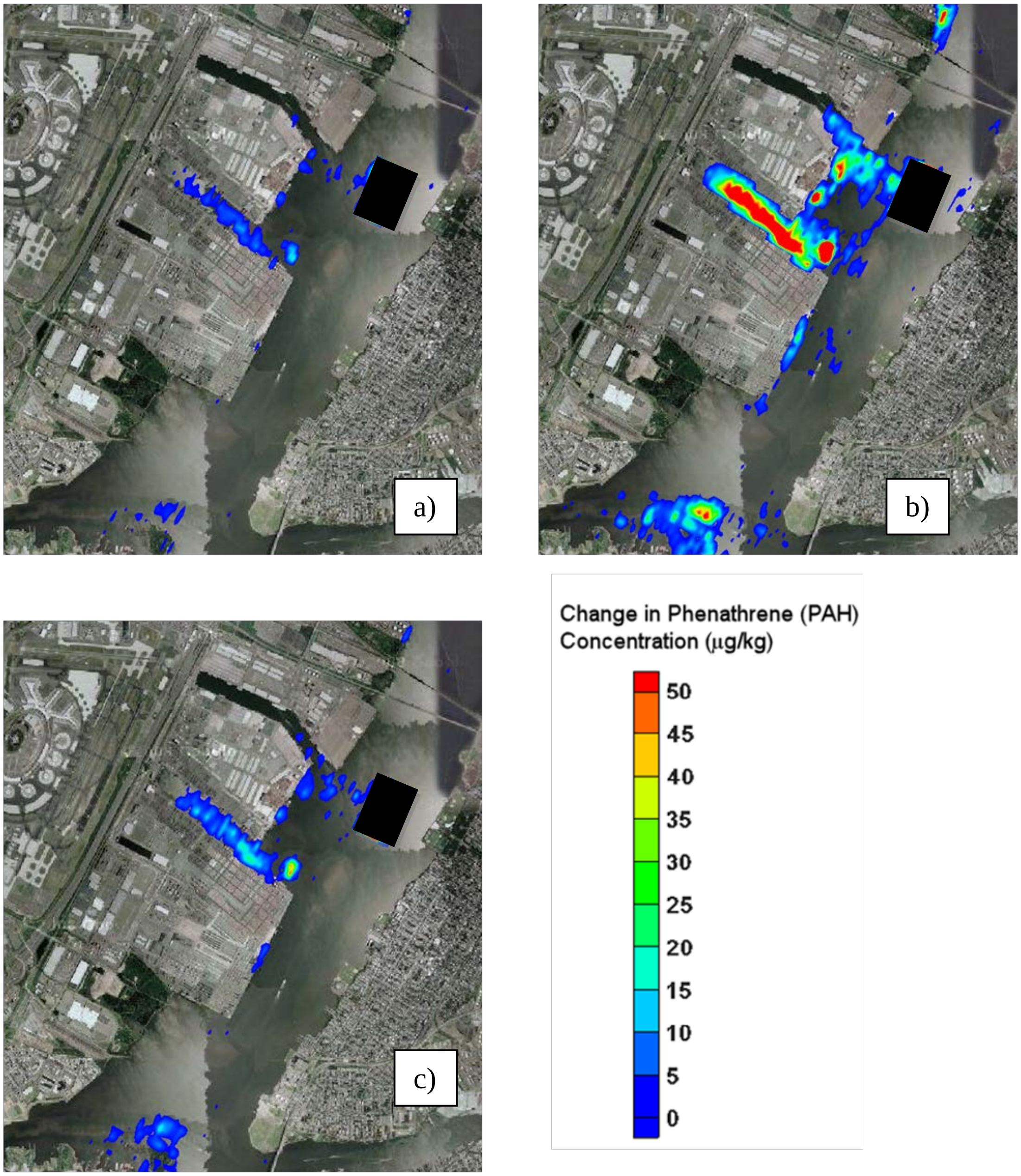


Figure 3-9 Spring Condition, mean concentration, Phenanthrene Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

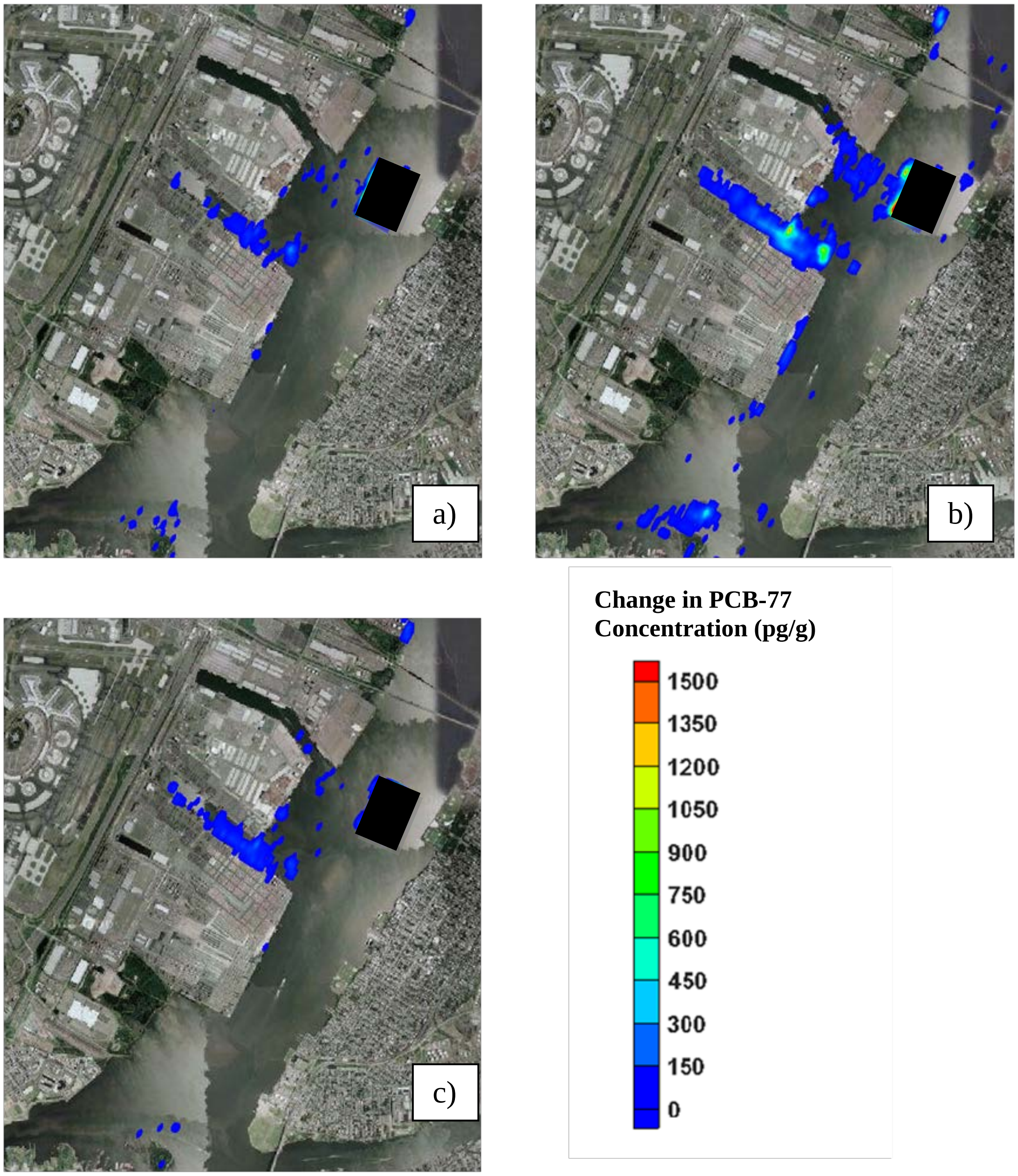


Figure 3-10 Neap Condition, 95% UCL concentration, PCB-77 Concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

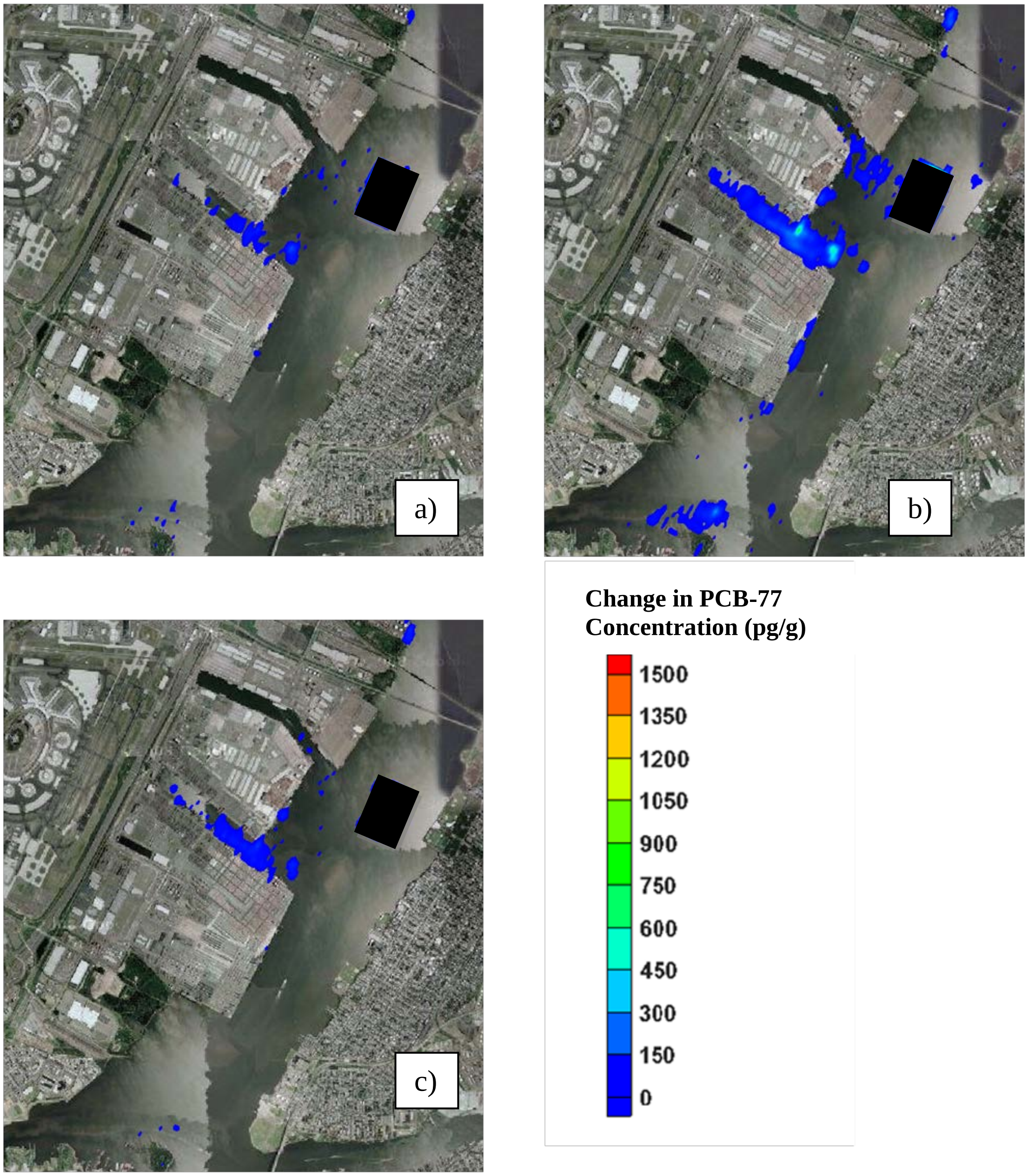


Figure 3-11 Neap Condition, mean concentration, PCB-77 concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

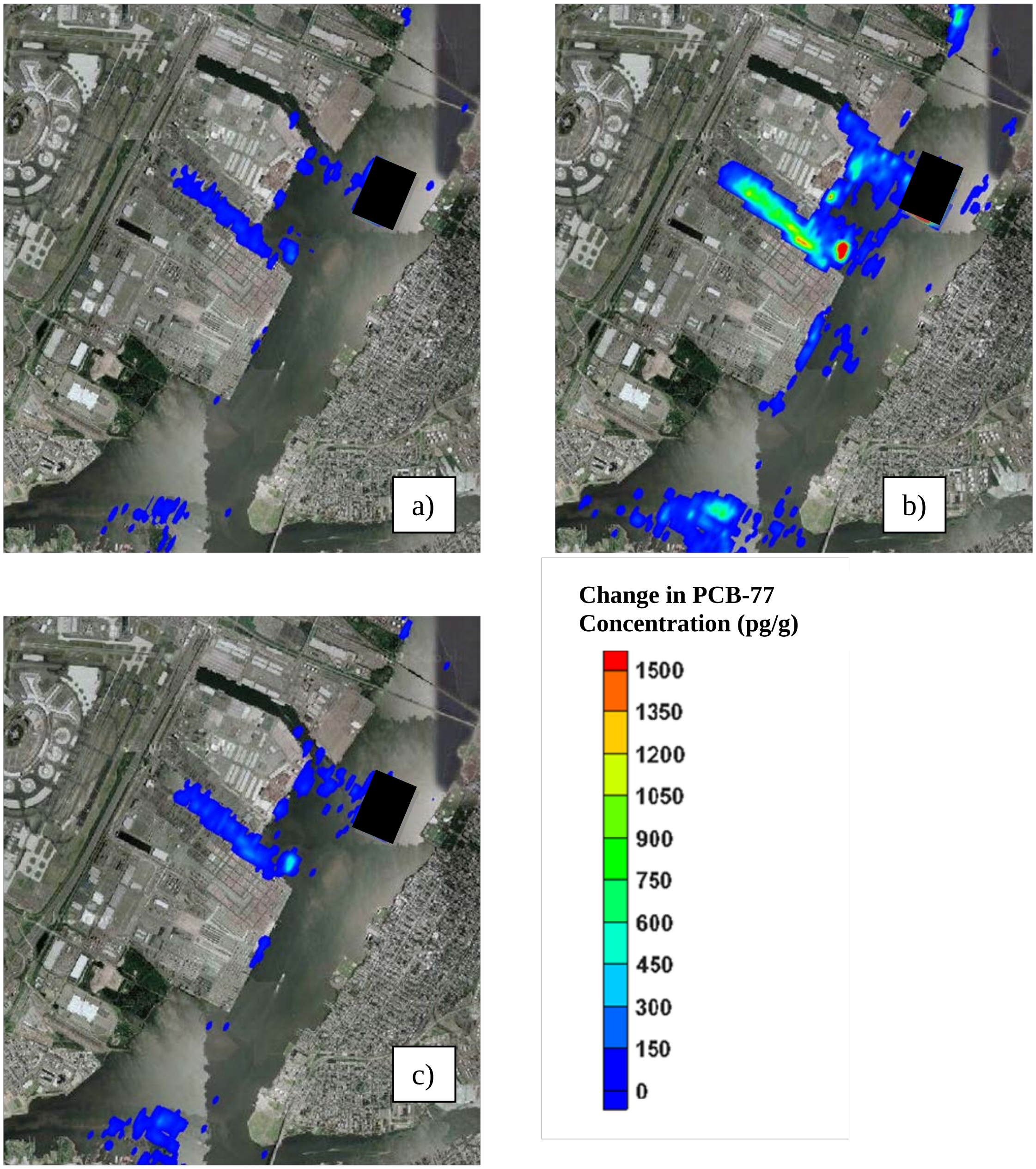


Figure 3-12 Spring Condition, 95% UCL concentration, PCB-77 surface concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

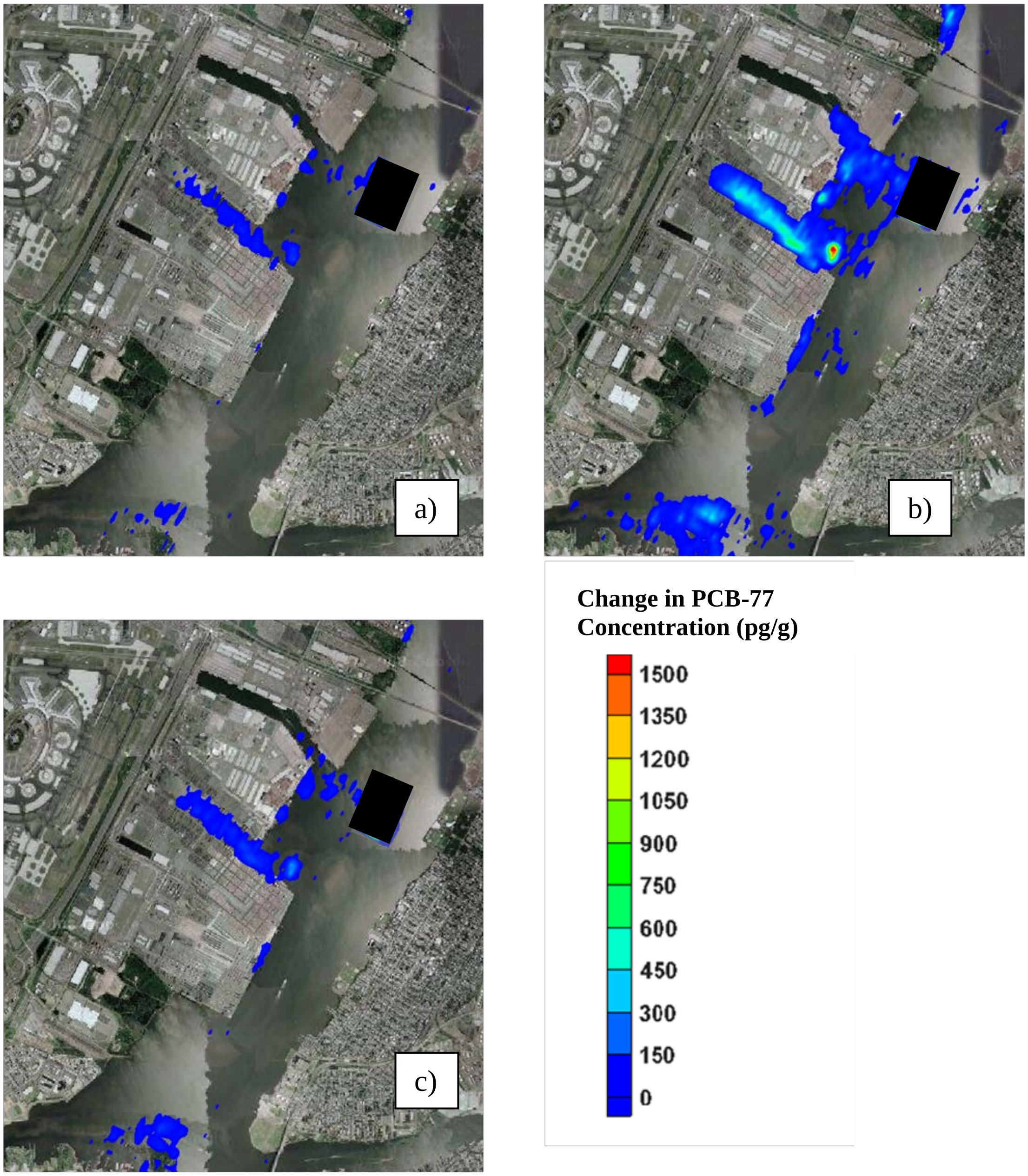


Figure 3-13 Spring Condition, mean concentration, PCB-77 concentration change (12 barge placements) for a) 0% fill, b) 50% fill, c) 90% fill level.

4 SUMMARY AND CONCLUSIONS

This report describes the investigation of the fate of contaminated dredged material placed in potential Newark Harbor CAD cells. Simulations were performed for two CAD cell configurations with spring and neap hydrodynamic conditions and 0%, 50%, and 90% CAD fill levels. Placement sources were modeled using STFATE for barge placement. Three dimensional hydrodynamics for the system were provided by HydroQual as input to the Particle Tracking Model (PTM). PTM is a Lagrangian particle tracker that can model sediment transport fate in complex hydrodynamic systems given user specified source, bathymetry, and hydrodynamic data.

Work was performed in two phases. During Phase 1 of this study, Alternative 2 was identified as the worst case CAD cell configuration. Alternative 2 resulted in 10-25% higher sediment loss than Alternative 3.

In Phase 2, a more detailed examination of Alternative 2 was performed, including evaluation of sediment and contaminant loss from the CAD. The PTM simulations indicate that during spring hydrodynamic conditions approximately 1.4% of the total sediment mass placed is transported outside of the CAD cell (or lost). During neap hydrodynamic conditions (weaker currents), the sediment losses were approximately 0.39%. Assuming an equal distribution of placements between neap and spring tidal conditions, the project-averaged sediment losses are approximately 0.9% of the total sediment mass placed.

Contaminant losses were estimated for 2,3,7,8 TCDD (dioxin), Phenanthrene (PAH), and PCB-77, factoring contaminant partitioning between particulate and dissolved phases. Contaminant losses were estimated to be primarily in the particulate phase, and the contaminant losses for all contaminants considered was approximately 1% of the total contaminant mass placed. Transport and deposition of particulate-phase contaminants leaving the CAD were modeled with PTM. At the end of a seven-day simulation of 12 barge placements (48,000 yd^3 of placed dredged material or 38,400 yd^3 of removal from the dredging site), maximum increase in the upper 10 cm of the surrounding Newark Bay sediment bed was 150 pg/g for 2,3,7,8 TCDD, 50 μg/kg for PAH, and 1500 pg/g for PCB-77.

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Appendix A: Bed Concentration Maps

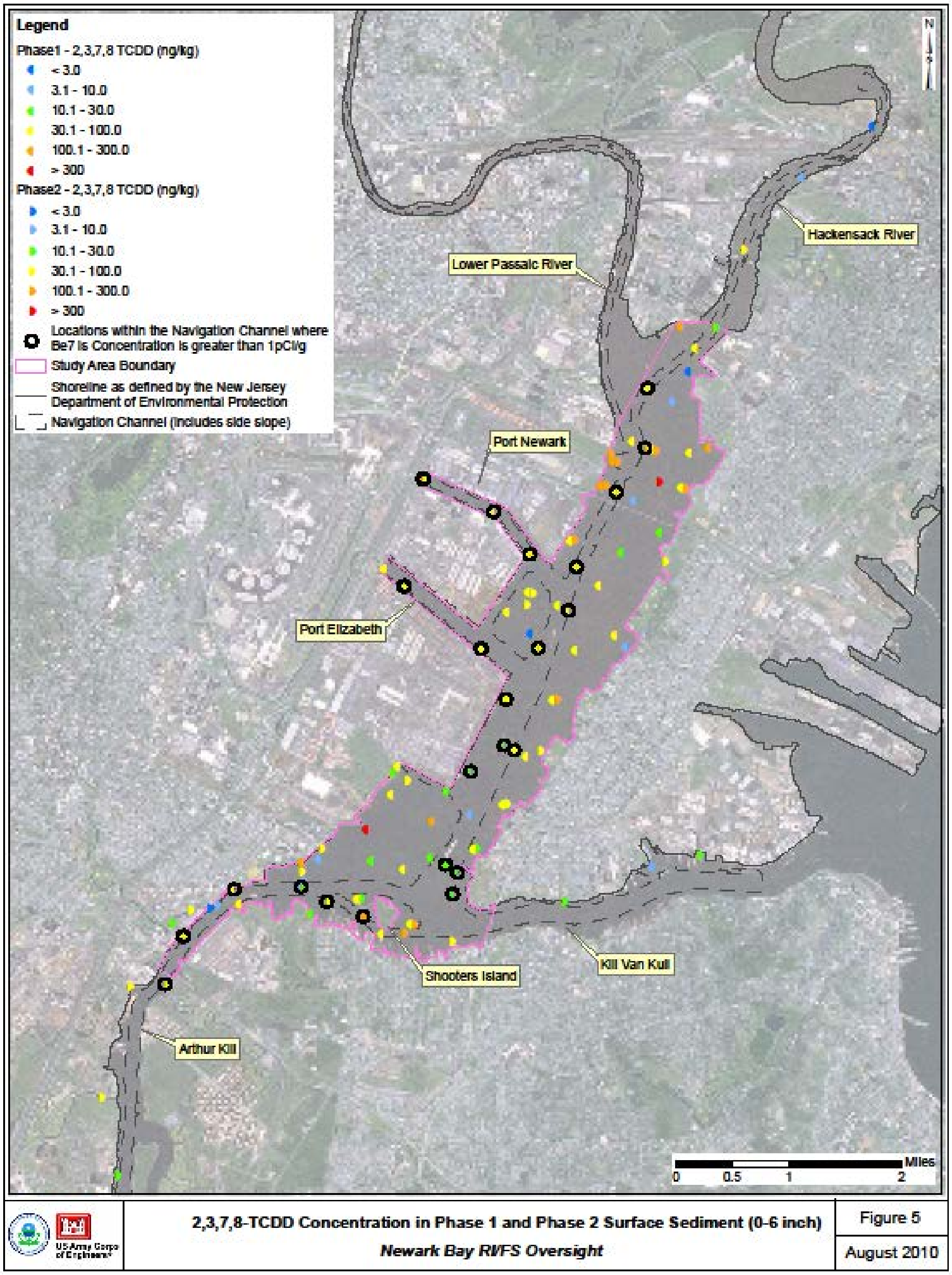

Figure A-1 Dixon Bed Concentration Map

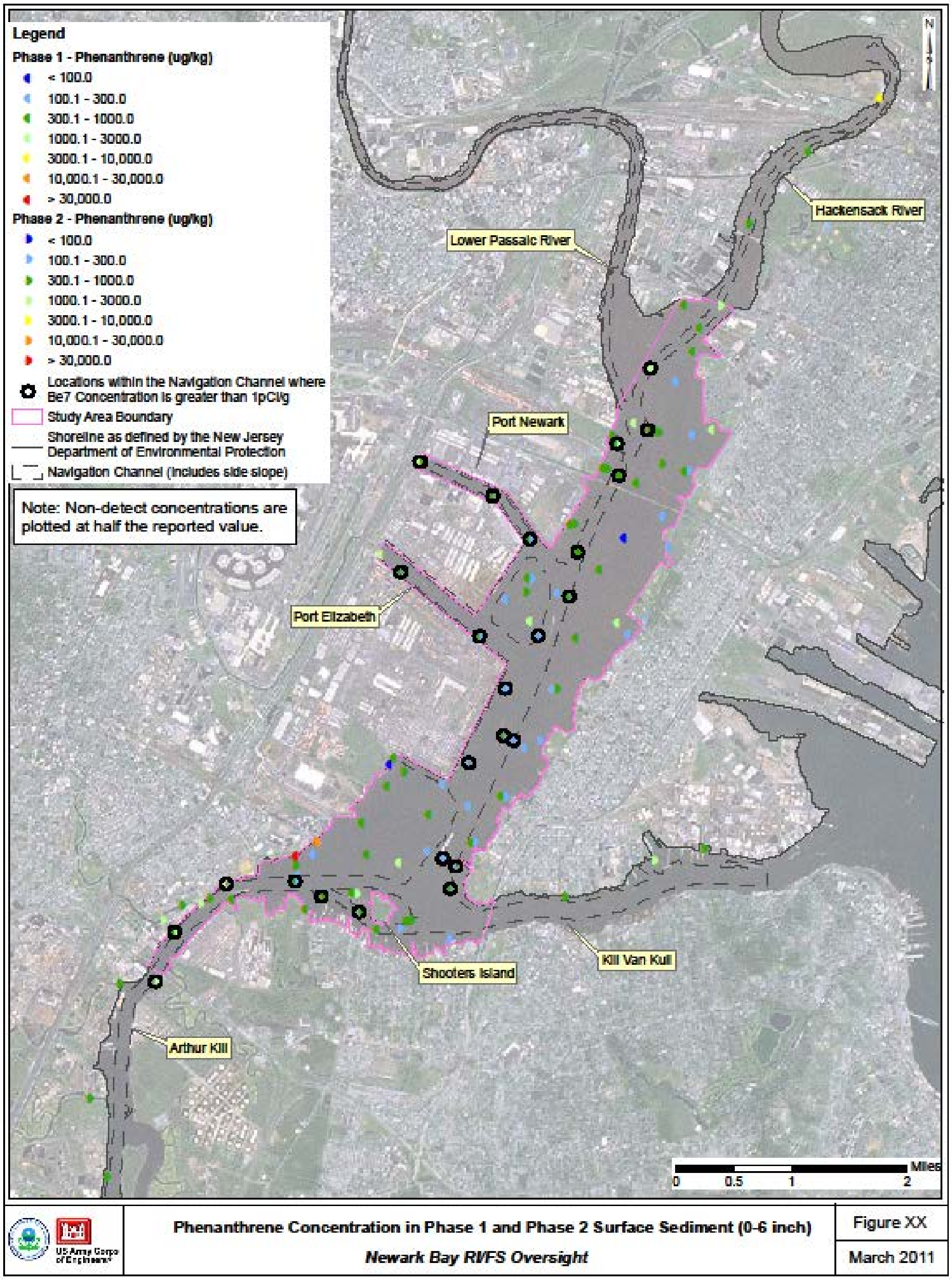

Figure A-2 PAH Bed Concentration Map

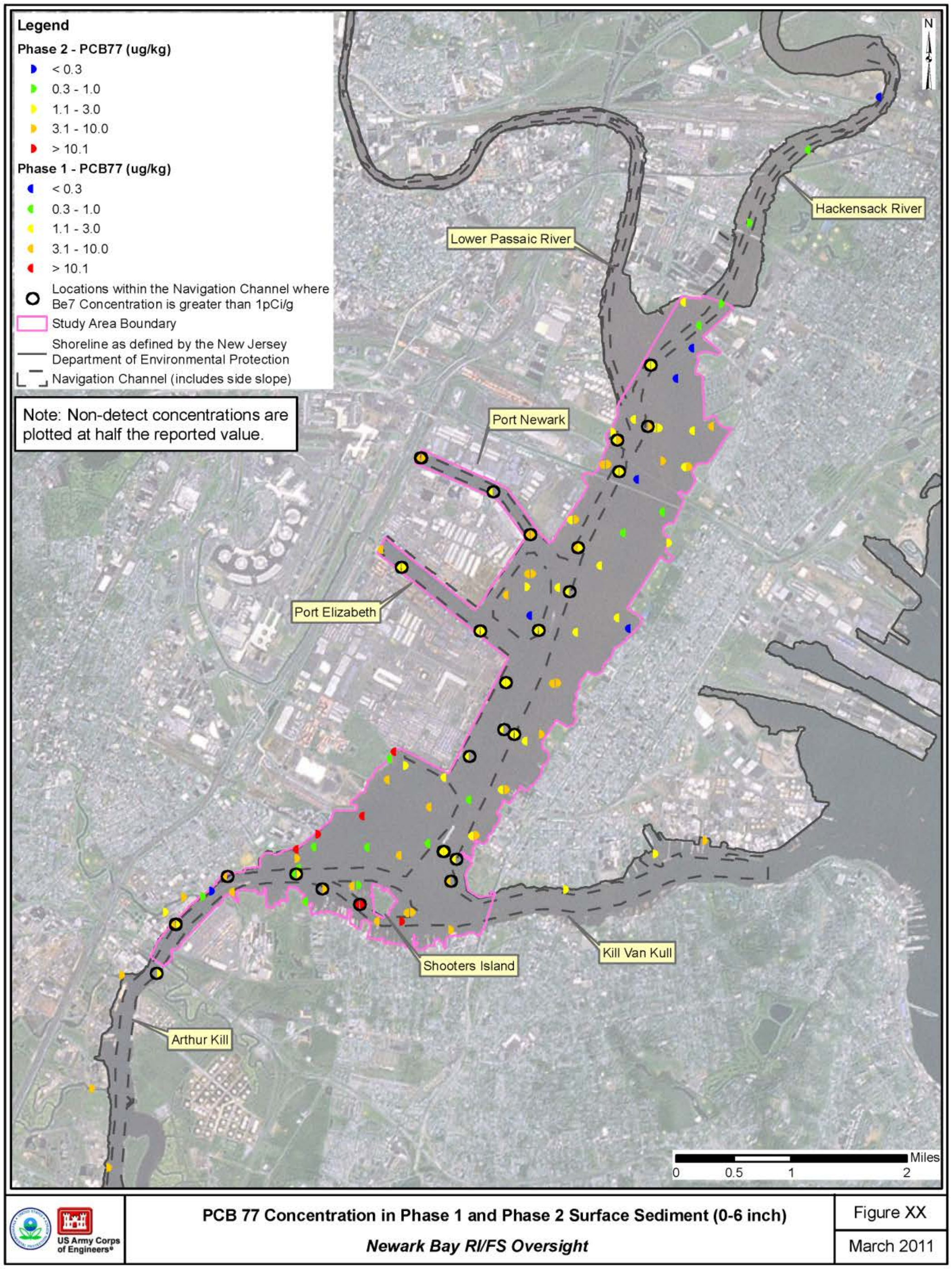

Figure A-3 PCB-77 bed concentration map.