Phase I
Engineering Evaluation/Cost Analysis

CERCLA Non-Time-Critical Removal Action –

Lower Passaic River Study Area

Tierra Solutions, Inc.

East Brunswick, New Jersey

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Revision 3

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A Preliminary Cost Estimates

Acronyms and Abbreviations

°F	degrees Fahrenheit
2,3,7,8-TCDD	2,3,7,8-tetrachloro-dibenzo-*p*-dioxin
ADCP	Acoustic Doppler Current Profiles
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirement
BBL	Blasland, Bouck & Lee, Inc.
bss	below sediment surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHASP	Community Health and Safety Plan
CIP	Community Involvement Plan
CLH	Chemical Land Holdings, Inc.
CPG	Cooperating Parties Group
CWA	Clean Water Act
cy	cubic yard
DASS	Diamond Alkali Superfund Site
EE/CA	Engineering Evaluation/Cost Analysis
EFH	essential fish habitat
EST	effluent storage tank
fps	feet per second
FS	feasibility study
FFS	Focused Feasibility Study
ft	foot/feet

GWTS	groundwater treatment system
GWWS	groundwater withdrawal system
in/hr	inch per hour
LDR	Land Disposal Restriction
LI	liquidity index
LPRSA	Lower Passaic River Study Area
MHW	mean high water
MLW	mean low water
mph	miles per hour
MSL	mean sea level
MTLC	maximum theoretical leachate concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGVD29	National Geodetic Vertical Datum 1929
N.J.A.C.	New Jersey Administration Code
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
N.J.S.A.	New Jersey State Archives
NOAA	National Oceanic and Atmospheric Administration
NTCRA	Non-Time-Critical Removal Action
NWP	Nationwide Permit
OCC	Occidental Chemical Corporation
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDDs	polychlorinated dibenzo-*p*-dioxins (dioxins)
PCDFs	polychlorinated dibenzofurans (furans)
POTW	publicly owned treatment works

ppm	parts per million
RAO	removal action objective
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	Record of Decision
SPT	standard penetration test
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
Tierra	Tierra Solutions, Inc.
TWA	Treatment Works Approval
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Codes
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTS	universal treatment standard
WRDA	Water Resources Development Act

Executive Summary

Tierra Solutions, Inc. (Tierra) has agreed to fund and perform the removal and disposal of 200,000 cubic yards (cy) of sediment located adjacent to Operable Unit 1 (OU-1) of the Diamond Alkali Superfund Site located in Newark, New Jersey. The primary purpose of this action is to remove the highest 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (2,3,7,8-TCDD) concentrations and, thereby, reduce the overall dioxin mass in the Lower Passaic River Study Area (LPRSA). It is recognized that this work will be considered accordingly as part of the 17-mile LPRSA Remedial Investigation/Feasibility Study (RI/FS), as well as with the associated Focused Feasibility Study (Malcolm Pirnie, Inc. 2007).

The sediment removal activities will be performed in two distinct phases (Figure 1-2):

- Phase I, targeting approximately 40,000 cy
- Phase II, targeting approximately 160,000 cy.

As per the Administrative Settlement Agreement and Order on Consent Docket No. 02-2008-2020 (2008 AOC; U.S. Environmental Protection Agency [USEPA] 2008a), the work is being performed as a Non-Time-Critical Removal Action (NTCRA), necessitating development of an Engineering Evaluation/Cost Analysis (EE/CA). The purpose of this Phase I EE/CA is to address Phase I activities only. A Phase II EE/CA will follow in a future deliverable.

Together with the 2008 AOC (USEPA 2008a), this Phase I EE/CA was developed using USEPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (USEPA 1993). In accordance with USEPA guidance (1993), an EE/CA (including this Phase I EE/CA) is not intended to provide design-level information, but instead reflects more of a typical feasibility study.

As indicated above, the Phase I Work will remove approximately 40,000 cy of sediment from within a sheet pile enclosure, with subsequent treatment and off-site disposal. The Phase I Work Area, located immediately adjacent to OU-1, measures 750 feet (ft) by 135 ft and consists of the upper 12 ft of sediment. Tierra recognizes the importance of protecting the surrounding community during a project such as this, and will work together with USEPA, New Jersey Department of Environmental Protection, and community members to ensure that quality of life issues are accounted for during design. As part of this, both a Community Involvement Plan (CIP) and Community

Health and Safety Plan (CHASP) will be developed as part of the overall project implementation.

Given the conceptual nature of this EE/CA, it is possible that certain elements may be altered during the design process. The CIP will describe measures to coordinate with the public as the design and removal action progress, while the CHASP will address the protection of community health and safety during removal activities.

Site Information

The Phase I Work Area is located within the Harrison Reach of the LPRSA; the LPRSA is approximately 17 miles long and extends from the Dundee Dam near Garfield, New Jersey, to Newark Bay. In 1983, USEPA sampling confirmed detections of dioxin at the 80 Lister Avenue property (part of OU-1), which is situated adjacent to the Phase I Work Area. A Record of Decision was finalized by USEPA in 1987, documenting the selection of a remedial action plan for the cleanup of OU-1, which is subject to USEPA review every two years. Implemented between April 2000 and June 2004, this OU-1 selected remedy (with biennial evaluation) included: constructing a slurry trench cutoff wall, a floodwall, and an environmental cap to isolate/contain the soils and materials consolidated on OU-1; installing a groundwater withdrawal system and groundwater treatment system within the contained area of the property; and implementing groundwater level monitoring and stormwater management programs.

The region surrounding the Phase I Work Area consists predominately of industrial facilities involved (either currently or historically) in various manufacturing activities, including but not limited to, paint and chemical manufacturing. To support and protect these facilities, many portions of the river have been filled and the banks either bulkheaded or armored. Residences are also located within 0.25 miles of the Phase I Work Area.

Sediment data indicate that relatively elevated levels of various chemicals (including 2,3,7,8-TCDD, metals, and organic compounds) are present in the Phase I Work Area. It appears that at least some of the sediment is characteristic hazardous waste and exceeds the universal treatment standard for dioxins. Generally, the Phase I Work Area sediment is fine-grained, cohesive material classified as moderate to high plasticity organic silt and clay. Based on the gauged and ungauged flow information, the average flow near the Phase I Work Area is approximately 1,450 cubic feet per second.

The EE/CA Process

To complete the Phase I EE/CA, several activities were conducted: estimating the risk from chemicals of concern at the site, establishing removal action objectives (RAOs), identifying applicable regulations and requirements that are necessary to consider when evaluating remedial alternatives, identifying and screening applicable technologies for implementing the Phase I Work, and developing and evaluating remedial alternatives. These steps are briefly discussed below.

Streamlined Risk Evaluation: The streamlined risk evaluation documents the apparent exposure risks that are present in the Phase I Work Area and qualitatively summarizes how the Phase I Work may reduce such risks. The reduction in mass resulting from the Phase I Work may lead to a reduction of chemical concentrations in the food web.

Removal Action Objectives: RAOs were established and help to determine the relative success of the Phase I Work. Protection of community health and safety is implicit in these objectives. The RAOs for the Phase I Work include:

- *RAO #1*: Remove a portion of the most concentrated inventory of 2,3,7,8-TCDD, as well as other hazardous substances, to minimize the possibility of migration due to extreme weather events.

- *RAO #2*: Prevent, to the extent practicable, the migration of resuspended sediment during removal operations.

- *RAO #3*: Prevent, to the extent practicable, the potential for spillage or leakage of sediment and contaminants during transport to the disposal facility.

- *RAO #4*: Restore habitat. (Note that restoration of the Phase I Work Area will need to consider the activities of the bordering Phase II Work efforts. As such, restoration of the Phase I Work Area may not occur until Phase II is completed.)

Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Factors: ARARs are those requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the site. For this Phase I Work, the potential chemical-, action-, and location-specific ARARs have been initially identified.

TBCs are the non-promulgated criteria, guidance, and proposed standards issued by federal or state governments. TBCs are not enforceable, and identification of and compliance with TBCs are not mandatory in the same way they are for ARARs. Nonetheless, TBCs are essential considerations when evaluating potential remedial alternatives and have been identified for this Phase I Work. The ARARs and TBCs are listed in Table 6-1. USEPA's Action Memorandum will ultimately determine which ARARs and TBCs will be met during the Phase I Work.

Technology Screening: In the technology screening step, seven elements (referred to as general technology screening groups) were identified as being applicable for implementing the Phase I Work and meeting the RAOs. Under each technology screening group, associated process options were then screened based on effectiveness, implementability, and relative cost. The results of the screening step are presented in Table 7-1 and summarized briefly herein.

General Technology Screening Group	Retained Process Options
Containment and shoreline stability	Removal in the wet
Sediment removal	Mechanical Hydraulic High-solids pump Caisson (potential specialized option for removing sediment adjacent to shoreline structures)
Sediment processing	Solids separation Geotextile tubes Mechanical dewatering
Water treatment and discharge	On-site water treatment plant
Off-site transport of sediment	Truck transport Rail transport Barge transport
Off-site treatment and disposal	Incineration (other potential treatment methods will be evaluated during design, such as

General Technology Screening Group	Retained Process Options
	oxidation of the dioxins and other organics) and Subtitle C or D landfills
Backfilling	The backfilling process option does not affect the alternatives developed because most sediment removal technologies can be used to backfill the Phase I Work Area. As such, backfilling process options were not developed.

Identification of Alternatives: Retained process options under each technology screening group were combined to develop the Phase I Work Alternatives. As outlined in Section 8, the Phase I Work Alternatives include:

- *Alternative A*: Hydraulic removal with geotextile tube processing
- *Alternative B*: Hydraulic removal with mechanical processing
- *Alternative C*: Mechanical removal with mechanical processing
- *Alternative D*: High-solids pump removal with mechanical processing.

Figures 8-1 through 8-4 provide depictions of the Phase I Work Alternatives, as well as miscellaneous conceptual details relating to the associated process options. These alternatives were then evaluated based on the NTCRA criteria of effectiveness, implementability, and relative cost (USEPA 1993). Following this evaluation, the alternatives were compared against each other to assess their relative performance using the evaluation criteria.

All of the Phase I Work Alternatives meet the project requirements, namely removal of 40,000 cy of material within a sheet pile enclosure, with subsequent treatment and off-site disposal. The main differences between the Phase I Work Alternatives are the manner in which the sediment is removed and the manner in which the sediment is processed prior to transporting it off site.

Phase I Recommended Alternative

Using the comparative assessment as a guide, Alternative C: Mechanical Removal with Mechanical Dewatering is recommended for the Phase I Work. With this alternative, a sheet pile enclosure will first be constructed around the Phase I Work

Area. The conceptual design anticipates that the sheet piles for this enclosure will be driven into a deep silty clay layer with low permeability. Together with a sealant, which will be applied to the joints to reduce the interlock permeability, such measures will help to contain resuspended material within the Phase I Work Area. The sheeting will also play an important role in maintaining the stability of the existing shoreline structures.

The 40,000 cy of sediment and debris will be removed using a conventional mechanical dredge or a long-reach excavator and placed on barges. The dredges, barges, and other equipment associated with the Phase I Work will be contained within the enclosure. Ambient river water (or treated process water) will be pumped into the enclosure, as needed, to maintain appropriate water depth within the Phase I Work Area during removal. The mechanically dredged material will be passed through a Grizzly™ screen to remove large debris and then slurried by adding water. Alternatively, the sediment may be slurried in the barge and pumped to the sediment processing equipment. The sediment slurry will then pass through hydrocyclones to separate out the sand fraction of the material.

Following the hydrocyclone step, the resulting fine-grained sediment slurry will be mechanically dewatered using a filter press, belt press, or equivalent, and the resulting dewatered sediment will be stockpiled. Water generated during sediment processing will be treated using an on-site water treatment system. Dewatered sediment will be transported off site in sealed intermodal containers via barge or train. Sediment will be transported to an incinerator or a Subtitle C landfill, depending on characterization. Upon completion of the removal, the Phase I Work Area will be backfilled. Debris will be rinsed using pressure washing and transported off site for disposal, most likely at a Subtitle D landfill.

Alternative C is recommended for the following reasons:

- Alternative C ranks highest overall in effectiveness and implementability.

- Alternative C addresses the RAOs for the project. Conducting the removal within an enclosure will prevent (to the extent practicable) the dispersion of resuspended sediment. Dewatering the sediment and the use of sealed intermodal containers for transport to the treatment/disposal facility will prevent (to the extent practicable) spillage, leakage, and the risk of the material being handled in an uncontrolled manner. Backfilling the Phase I Work Area will partially restore the habitat and allow for future restoration.

- Alternative C ranked medium in protectiveness because mechanical dredging will remove sediment out of the water column and transport it to a barge. Comparatively, this process results in greater exposure to on-site workers than the hydraulic alternatives. This issue will be mitigated in design, to the extent practicable, to increase protectiveness.

- Alternative C process options consist of proven technologies that are available, though there are constraints on the availability of off-site treatment and disposal facilities.

- Mechanical removal is well-suited to handle the presence of abundant debris within the Phase I Work Area. Due to the deep removal depth required (12 ft below sediment surface) and the likely presence of debris, geophysical surveys conducted during design are not likely to identify all of the debris present in the Phase I Work Area; therefore, using a removal method that is able to adapt to unidentified debris and other obstructions is advantageous. Mechanical removal has a higher probability for successfully meeting the schedule approved by USEPA, given the lower risk for decreases in dredging production rates than the other removal methods.

- Mechanical removal methods are more effective at removing material in close proximity to the existing shoreline structures

- Mechanical processing is suitable for dewatering high plasticity, fine-grained sediment like that in the Phase I Work Area. Mechanical dewatering using mechanical methods will reduce the potential that additional drying of the sediment through stockpiling is needed to reduce moisture content.

Based on the considerations provided above, Alternative C (Mechanical Removal with Mechanical Dewatering) exhibits the greatest ability to meet the requirements of the evaluation criteria and, for that reason, is the recommended Phase I Work Alternative.

1. Introduction

Presented herein is the Phase I Engineering Evaluation/Cost Analysis (Phase I EE/CA) for sediment removal activities planned within a specified area (i.e., Phase I Work Area) of the Lower Passaic River Study Area (LPRSA). This document has been prepared pursuant to the Administrative Settlement Agreement and Order on Consent Docket No. 02-2008-2020 (2008 AOC; U.S. Environmental Protection Agency [USEPA] 2008a) by Tierra Solutions, Inc. (Tierra), on behalf of Occidental Chemical Corporation (OCC); the successor to Diamond Shamrock Chemicals Company (formerly known as Diamond Alkali Company).

As described in the above-referenced 2008 AOC (USEPA 2008a), Tierra has agreed to fund and perform the removal and disposal of 200,000 cubic yards (cy) of Passaic River sediment located adjacent to Operable Unit 1 (OU-1) of the Diamond Alkali Superfund Site (DASS), 80 and 120 Lister Avenue, Newark, New Jersey. The main objective of the work is to remove the highest concentrations of 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (2,3,7,8-TCDD) and associated dioxin mass. The project is scheduled to be conducted in two distinct phases:

- Phase I, targeting approximately 40,000 cy
- Phase II, targeting approximately 160,000 cy.

Figure 1-1 illustrates the extent of the 17-mile LPRSA (including the surrounding estuary), while both Figures 1-2 and 1-3 delineate the extent of the Phase I and Phase II Work Areas. As per the 2008 AOC (USEPA 2008a), removal activities shall be completed within a sheet pile enclosure and will target the upper-most 12 feet (ft) of sediment. The purpose of this document is to address Phase I activities only; Phase II will be addressed in separate, future reports. The results of both phases are to be considered as part of the larger 17-mile LPRSA Remedial Investigation/Feasibility Study (RI/FS) and the associated Focused Feasibility Study (FFS; Malcolm Pirnie, Inc. 2007).

The sediment removal will be conducted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as a Non-Time-Critical Removal Action (NTCRA). As required under Section 300.415(b)(4) of the NCP, an EE/CA, which analyzes removal action alternatives for a site and provides for public participation, is required for all NTCRAs. Documentation of USEPA's concurrence to

prepare such an EE/CA is provided in the 2008 AOC as Appendix A, also referred to as the EE/CA Approval Memorandum (USEPA 2008a).

Together with the 2008 AOC, this Phase I EE/CA has been developed using USEPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (USEPA 1993). In accordance with the NTCRA guidance, an EE/CA is meant to identify the objectives of the removal action and to analyze various alternatives that may be implemented to satisfy those objectives. The guidance also indicates that while an EE/CA is similar to a typical RI/FS, it is less comprehensive (USEPA 1993). As such, this Phase I EE/CA is not intended to present detailed design information.

Tierra recognizes the importance of protecting the surrounding community during a project such as this. Accordingly, Tierra will work together with USEPA, NJDEP, and community members to ensure that quality of life issues such as noise, odor, road traffic, navigational traffic, water quality, air quality, and light are accounted for during design. Both a Community Involvement Plan (CIP) and Community Health and Safety Plan (CHASP) will be developed as part of the overall project implementation. The CIP will describe measures to coordinate with the public as the design and removal action progress, while the CHASP will address the protection of community health and safety during removal activities.

In accordance with the above, this Phase I EE/CA includes (together with this Introduction) the following sections:

- *Section 2 – Background and Site Description*: provides historical perspective on the LPRSA and the DASS (OU-1), and provides the location and setting of the Phase I Work Area.

- *Section 3 – Summary and Relevance of Existing Data*: encapsulates the previous sediment investigations and relevant chemical, geophysical, geotechnical, hydrodynamic, and groundwater data for the Phase I Work Area.

- *Section 4 – Streamlined Risk Evaluation*: documents the apparent human health and ecological exposures to chemicals that are present in the Phase I Work Area, and qualitatively summarizes how the Phase I Work may reduce such exposures and their associated risks.

- *Section 5 – Removal Action Objectives*: identifies the objectives to be achieved by the Phase I Work.

- *Section 6 – Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements*: identifies the applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) requirements.

- *Section 7 – Technology Screening*: assesses the technology classes identified for implementing the Phase I Work.

- *Section 8 – Identification and Evaluation of Phase I Work Alternatives*: outlines the process used to develop the Phase I Work Alternatives and evaluates each alternative using NTCRA criteria.

- *Section 9 – Comparative Analysis of Phase I Work Alternatives*: comparatively evaluates each of the Phase I Work Removal Alternatives using NTCRA criteria.

- *Section 10 – Recommended Phase I Work Alternative*: provides the rationale for selecting the recommended alternative for the Phase I Work.

- *Section 11 – References*: lists documents and additional references cited in this Phase I EE/CA.

Associated tables, figures, and appendices are provided to supplement the various sections of this document.

2. Background and Site Description

2.1 Background

This section provides background information for both the LPRSA and the DASS. The information and data associated with these areas have been essential in developing this Phase I EE/CA and will play an important role in the subsequent design.

2.1.1 Diamond Alkali Superfund Site

The DASS consists of several units, including the Diamond Alkali plant located at 80 and 120 Lister Avenue (OU-1) in Newark, New Jersey; the LPRSA; and the Newark Bay Study Area. The LPRSA includes the 17-mile tidal portion of the Passaic River, extending from Dundee Dam to Newark Bay, located in Essex, Hudson, Bergen, and Passaic Counties, New Jersey. As indicated in Section 1, the Phase I Work Area is located within the LPRSA and adjacent to OU-1.

Newark Bay, part of the New York/New Jersey Harbor Estuary, is located between the shores of Newark and Elizabeth to the west, Jersey City and Bayonne to the east, the confluence of the Passaic and Hackensack Rivers to the north, and Staten Island to the south. Newark Bay is linked to Upper New York Bay by the Kill van Kull and to Raritan Bay by the Arthur Kill.

A summary of OU-1 is provided first, followed by a brief description of LPRSA and Newark Bay activities.

2.1.1.1 Recent OU-1 History

In May 1983, results of USEPA sampling confirmed detections of dioxin at the 80 Lister Avenue property and, consequently, the NJDEP took steps to control access to the property. On June 2, 1983, the State of New Jersey issued Executive Order No. 40, which guided subsequent control and cleanup activities.

In March 1984, Diamond Shamrock Chemicals Co. entered into an Administrative Consent Order with NJDEP to perform a site evaluation and FS for 80 Lister Avenue (NJDEP 1984a). Under the oversight of USEPA and NJDEP, Diamond Shamrock Chemicals Co. constructed measures to control access to the property and to restrict the potential for dioxin-containing material to migrate from OU-1. The principal measures consisted of:

- Installing a fence around the 80 Lister Avenue property, including the Passaic River frontage
- Placing a 24-hour security guard at the only gate providing access to the property
- Covering the entire property (excluding areas covered by buildings and equipment) with a permeable geotextile fabric, which was anchored by concrete blocks.

In December 1984, following execution of a second Administrative Consent Order with NJDEP (NJDEP 1984b), Diamond Shamrock Chemicals Co. implemented remedial measures to secure the 120 Lister Avenue property, sampled to determine the degree of contamination, and used the property to receive and store shipping containers filled with nearby off-site materials possibly containing dioxin (Blasland, Bouck & Lee, Inc. [BBL] 2006).

A Record of Decision (ROD) was signed by USEPA on September 30, 1987, and was accepted by NJDEP in December 1987. The ROD documented the selection of a remedial action plan for the cleanup of OU-1 and USEPA's reasons for adopting such a plan. The OU-1 selected remedy generally consisted of demolition, decontamination of non-porous materials, construction of a groundwater cutoff wall, construction of a floodwall along the Passaic River, and placement of the remaining OU-1 materials beneath a secure environmental on-site cap. According to the ROD, the selected remedial action is subject to review every two years.

On November 19, 1990, a Judicial Consent Decree was entered by the U.S. District Court for the District of New Jersey between the United States of America/State of New Jersey and OCC/Chemical Land Holdings, Inc. (CLH) to govern the implementation and design of the Remedial Construction Activities (State of New Jersey 1990). The *Final Modified (100%) Remedial Design Report* (Eckenfelder 1999) was prepared in accordance with the ROD and Consent Decree and approved by USEPA on September 23, 1999.

The OU-1 selected remedy (with biennial evaluation) was implemented between April 2000 and June 2004 and included the following major elements:

- Stabilization of drum and tank contents

- Dismantling and demolition of existing OU-1 structures
- Decontamination and off-site disposition of all non-porous materials
- On-site consolidation of secured materials and disposition of shipping containers
- Construction of a slurry trench cutoff wall, a floodwall, and a secure environmental cap to isolate/contain the soils and materials consolidated on OU-1
- Installation of a groundwater withdrawal system (GWWS) and groundwater treatment system (GWTS) within the contained area of the property
- Implementation of a groundwater level (hydraulic control) monitoring program and stormwater management program
- Installation of security measures and landscaping.

Figure 2-1 illustrates the Phase I Work Area with respect to the OU-1 property topography, floodwall, and surficial cap. Site conditions (including applicable historical geotechnical data) are discussed in Section 3 and will be considered in the design of the Phase I Work.

2.1.1.2 Current OU-1 Operations

As indicated previously, a secure environmental cap was installed at OU-1, and a floodwall was constructed along the Passaic River. This floodwall acts as a retaining wall to support the surficial cap and protect the property from a 100-year flood (see Figure 2-1). Additionally, the below-grade component of the floodwall was designed and constructed to function as a groundwater cutoff wall in concert with the slurry trench cutoff wall constructed along the southern, eastern, and western property lines.

Currently, the GWTS, which was installed as part of remediation activities, operates on a weekly cycle. Between Monday morning and Thursday afternoon, the GWTS treats extracted groundwater using a series of well pumps that generally operate in a continuous automatic mode, turning off when the water level in the well has been drawn below the optimum range for extraction and turning on once the water level has recovered sufficiently. When the GWTS is shut down (e.g., on weekends and for maintenance), the pump at each extraction well operates in an automatic mode and

shuts down automatically once the equalization (influent) tank has reached the preset maximum capacity.

Groundwater is treated to remove various chemical constituents and is then batched in a series of on-site, 17,000- to 20,000-gallon aboveground effluent storage tanks (ESTs), also located on OU-1. Once a batch of effluent is available (at this time, a full batch includes four ESTs with a total capacity of approximately 80,000 gallons), the treated water is sampled and analyzed. After the sampling results have been validated and reviewed to verify that the treated water meets the applicable New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water Permit Equivalent (NJDEP 2000) discharge criteria, the water is released to the Passaic River (BBL 2006).

Additional long-term monitoring and maintance at OU-1 includes the following routine activities:

- Inspections of the surface of the surficial cap, asphalt, and granular roadways and parking area
- Inspections of the perimeter and interior drains, floodwall, and perimeter fencing/entrance gate
- Monitoring of methane gas using the 14 OU-1 gas vents
- Measurements of groundwater elevations
- Collection and analysis of periodic GWTS influent and effluent samples
- Collection and analysis of groundwater samples from the OU-1 piezometers, both inside and outside the slurry wall.

2.1.2 Other Diamond Alkali Superfund Site-Related Studies

In addition to the work described as part of OU-1, OCC signed an AOC with USEPA in 1994 to conduct an RI/FS within the lower 6-mile stretch of the Passaic River (including the Harrison Reach; USEPA 1994a). Previous sampling of sediment in the Passaic River revealed hazardous substances, including, but not limited to, polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs, also referred to as dioxins/furans), dichlorodiphenyltrichloroethane, polychlorinated biphenyls (PCBs),

polycyclic aromatic hydrocarbons (PAHs), mercury, cadmium, copper, lead, nickel, and zinc.

The primary objectives of the Passaic River RI were to determine:

- The spatial distribution and concentration of hazardous substances, both vertically and horizontally, in the sediment
- The primary human and ecological receptors of contaminated sediment
- The transport of contaminated sediment.

As part of this RI, Tierra collected a significant amount of data from the lower 6 miles of the river, including data associated with sediment, surface-water, and biological tissue matrices. For sediment alone, more than 1,700 samples were obtained for chemical, radiochemical, and geotechnical characterization. Tierra also undertook a number of other studies as part of this work, including, but not limited to, a bathymetry survey.

In January 2001, USEPA directed Tierra to suspend work under the 1994 AOC (USEPA 1994a). USEPA and a partnership of federal and State of New Jersey agencies then undertook a joint CERCLA-Water Resources Development Act (WRDA) study of the 17-mile tidal LPRSA. In June 2007, a group of 73 potentially responsible parties, named the Cooperating Parties Group (CPG), entered into an AOC with USEPA to complete the CERCLA-WRDA RI/FS for the LPRSA (USEPA 2007). This work is ongoing. Subsequent to the CPG entering into the 2007 AOC, USEPA, NJDEP, and the other partner agencies developed an FFS (Malcolm Pirnie, Inc. 2007) to evaluate the need to undertake an early action in the river. That evaluation process is also ongoing.

In addition to work conducted within the Passaic River, OCC entered into an AOC with USEPA in 2004 (USEPA 2004) to conduct an RI/FS in Newark Bay. To date, Tierra has implemented two phases of sediment collection (i.e., 2005 and 2007), primarily for purposes of characterizing the nature and extent of contamination. Additional RI work is expected in the near future.

2.1.3 Relationship of Phase I Work to Ongoing Activities

As indicated, the Phase I Work will occur within the LPRSA, directly adjacent to the floodwall that forms the northern boundary of OU-1. As part of this project, a sheet pile

containment structure will be installed around the perimeter of the Phase I Work Area to prevent, to the extent practicable, resuspended material losses. Alternatives developed in this Phase I EE/CA recognize that the construction of these containment elements and the subsequent removal of sediment during Phase I could potentially affect Passaic River surface-water currents and flow velocities, the groundwater flow at OU-1, and the integrity of the OU-1 floodwall. Additionally, existing bulkhead located along the shoreline of the adjacent Sherwin-Williams property might also be impacted.

While addressed for the purposes of identifying, evaluating, and comparing alternatives in this Phase I EE/CA, these issues will also be accounted for in greater detail during the design of the project.

This Phase I Work is not anticipated to significantly impact the ongoing LPRSA and Newark Bay RI Programs. The Phase I Work Area will be contained to prevent the migration of resuspended sediment to the extent practicable. However, the potential for sediment scour outside of the sheet pile enclosure exists and has been initially assessed in this Phase I EE/CA for purposes of estimating costs (i.e., scour mitigation/protection). This issue will be further evaluated during design.

2.2 Characteristics of Phase I Work Area

The Phase I Work Area is located within the LPRSA, which is approximately 17 miles long and extends from the Dundee Dam near Garfield, New Jersey, to Newark Bay. As shown on Figure 1-1, the Phase I Work Area is located specifically within the Harrison Reach, which contains a federal navigation channel with an authorized depth of 20 ft below mean low water (MLW; -22.4 ft National Geodetic Vertical Datum 1929 [NGVD29]). No portion of the Phase I Work Area is within this channel; however, there is a potential that a portion of the channel side slopes may fall within the Phase I Work Area.

This section describes the Phase I Work Area characteristics. In instances where there is no information available specific to the Phase I Work Area, regional information is provided instead.

2.2.1 Location and Boundary Description

The Phase I Work Area, measuring approximately 750 by 135 ft, is located adjacent to the southern shoreline of the Passaic River. As shown on Figure 1-3, the Phase I Work Area is bounded to the north by the navigation channel and to the south by portions of

the Sherwin-Williams property and OU-1. The shoreline along the Phase I Work Area consists of a bulkhead along the Sherwin-Williams property and a concrete floodwall that runs along the river frontage of OU-1. The floodwall is an anchored wall structure consisting of steel, wide-flange beams, or master piles, spaced approximately 9 ft apart and driven into deeper soil units for lateral support. The upper portion of the floodwall consists of cast-in-place concrete panels forming a solid wall down to elevation -22 ft NGVD29. The floodwall is anchored to concrete monolith “deadman” structures placed behind the walls, which are connected by steel tierods and provide the necessary additional lateral support. The stability of these structures will be considered during design of the sheet pile enclosure and post-removal backfill.

2.2.2 Land Use and Property Ownership

The area surrounding the Phase I Work Area consists predominately of industrial facilities involved (either currently or historically) in various manufacturing activities, including but not limited to, paint and chemical manufacturing. A commuter rail corridor and rail yard is located along the opposite shore of the Passaic River, north of the Phase I Work Area. To support and protect these facilities, many portions of the river have been filled and the banks either bulkheaded or armored.

Current riverfront property owners on the south bank of the river in the vicinity of the Phase I Work Area, from west to east, include: FRA JA RI Company, 99 Chapel Street LLC, Sherwin-Williams, Singer Realty, Benjamin Moore, Fairmont Chemical, and Blanchard Street Urban Renewal Association (Figure 1-2). The nearest residence is estimated to be approximately 0.25 miles away.

Consultation with NJDEP is currently in progress to determine the ownership of the riparian property within the Phase I Work Area. In cases where it may be needed for purposes of completing the Phase I Work, every effort will be made to secure the appropriate access agreements and/or licenses.

2.2.3 Climate

The climate for the Newark area (including Harrison Reach) is characteristic of the Middle Atlantic Seaboard, where marked changes in weather are frequent, particularly in the spring and fall. Precipitation is moderate and distributed fairly uniformly throughout the year, averaging approximately 43.5 inches annually with 121 days of precipitation per year. Dry years may yield between 25 to 30 inches of precipitation, while wet years may yield up to 60 inches. An analysis of Newark precipitation data

from 1951 to 1997 indicates that monthly precipitation averages range from approximately 3 to 4 inches, but average monthly precipitation intensities vary substantially during the year. Precipitation intensity averages are low from December through April (0.04 inch per hour [in/hr]), increasing to a high of 0.09 in/hr in July and decreasing to 0.05 in/hr in October (National Climatic Data Center Newark Hourly Rainfall Data 1951 to 1997). Seasonal tropical storms, thunderstorms, and hurricanes are more likely to occur between June and November than other months, and nor'easters are more likely to occur from November to April. Winters are moderate, with snowfall averaging approximately 34 inches annually from October through mid-April (U.S. Army Corps of Engineers [USACE] 1987).

The average annual temperature in Newark is 54 degrees Fahrenheit (°F), with recorded extremes from -26°F to +108°F. Prevailing winds in the Newark area are from the southwest with only small seasonal variations in direction. The mean wind direction for the winter months is west-northwest (13 percent of time period), while southwest winds (12 percent of time period) predominate during the summer. Mean wind speeds are generally highest during the winter and spring (10 to 12 miles per hour [mph]) and lower (8 to 9 mph) during the summer, with an average annual speed of approximately 10 mph (USACE 1987).

Climate data will be considered during design of the Phase I Work. More specifically, the design of the sheet pile enclosure, sediment removal, and stormwater management in the sediment processing facility will consider how to accommodate typical precipitation and weather conditions.

2.2.4 Geology

The Passaic River (including the Harrison Reach) is situated within the Newark Basin portion of the Piedmont physiographic province, which is located between the Atlantic Coastal Province and the Appalachian Province. The Newark Basin is underlain by sedimentary rocks (sandstones, shales, limy shales, and conglomerates), igneous rocks (basalt and diabase), and metamorphic rocks (schists and gneiss) (Rogers et al. 1951, 1952).

Bedrock underlying the area includes two members of the mid-Triassic to early Jurassic Period Passaic Formation, which generally consists of interbedded red-brown sandstones and shales (Drake et al. 1996). In the downstream portion of the Passaic River, the bedrock is a red-brown silty to sandy mudstone and siltstone, and the depth to bedrock varies from 0 to 250 ft below mean sea level (MSL) (Stone et al. 1995). In

the vicinity of the Phase I Work Area, MSL was assumed to be about equal to NGVD29 (USACE 2008). Depth to bedrock drops to about 250 ft below MSL in the large meander where Newark and Harrison Reaches meet.

In the upstream portion of the river, the bedrock consists of interbedded grayish-red sandstone with brownish-red siltstone (planar to ripple cross-laminated, fissile, locally calcareous, and contains desiccation cracks and root casts) (Drake et al. 1996). Depth to bedrock in the upstream portion of the LPRSA varies, but is generally encountered at less than 50 ft below MSL (Stone et al. 1995). A bedrock outcropping is present on the east bank of the river in the Kearny Reach, which corresponds with the topographic ridge near Kearny and Harrison.

Almost the entire Passaic River Basin was subjected to glacial erosion and deposition during the last stage of the Wisconsin glaciation (Rogers et al. 1951). Considerable quantities of stratified sand, silt, gravel, and clay were deposited in a glacial lake covering the area. These glacial deposits overlie bedrock and underlie this section of the Newark Basin (Drake et al. 1996). Recent fluvial deposits are present in the Passaic River channel and floodplain.

Sediment layers encountered during various investigations in the vicinity of the Phase I Work Area are as follows, from shallowest to deepest:

- Slightly clayey organic silt
- Silty sand to sand
- Clayey silt to silt
- Sand to sand and gravel.

These layers are further described in Section 3 and are the strata in which the proposed work will occur. Bedrock and glacial deposits are not expected to be encountered during installation of the sheet pile enclosure or during sediment removal.

2.2.5 Potentially Sensitive Ecosystems

The Phase I Work Area contains shallow subtidal and intertidal mudflats with little or no associated vegetation. The species that are supported in this system are limited in terms of diversity and abundance relative to other estuarine rivers in the New

York/New Jersey Harbor Estuary (Iannuzzi et al. 2002). The majority of the adjacent upland shoreline is unsuitable for birds and is dominated by bulkheads, riprap, buildings, parking lots, roads, and other structures (Ludwig and Iannuzzi 2001).

Formal consultations with the U.S. Fish and Wildlife Service (USFWS) and the New Jersey Natural Heritage Program are in progress to confirm the absence of threatened or endangered species in the river near the Phase I Work Area. Additionally, a formal essential fish habitat (EFH) consultation with the National Marine Fisheries Service is in progress. Information gathered from these efforts will be incorporated into the design.

2.2.6 Commercial and Recreational Traffic

Commercial shipping traffic in the Passaic River is tracked by the USACE. In 2006, there were a total of 1,726 vessel trips on the Passaic River (USACE 2006). The majority of the vessels were shallow draft (less than 14 ft). The deepest draft vessels listed for the river in 2006 were 31-ft-draft foreign tankers (USACE 2006). It is unlikely that these tankers made it to the Harrison Reach, as the authorized depth of the federal navigation channel in Harrison Reach is 20 ft below MLW. Current commercial shipping traffic is expected to be similar to that of 2006.

Recreational traffic is not tracked to the same extent as commercial traffic; therefore, data are not readily available. However, given the small number of public boat launch locations and marinas in the vicinity of the Phase I Work Area, coupled with the fishing advisories currently in place for the LPRSA, recreational traffic, even if present, is expected to be minimal and unlikely to impact the Phase I Work.

2.2.7 Bridges

Bridge construction has significantly impacted sedimentation patterns in the Passaic River estuary. The numerous bridge piers and bridge abutments impart localized influences on currents and sedimentation patterns, inducing secondary circulation patterns and increasing peak-flow velocities. Many bridges were built and destroyed through the eighteenth and nineteenth centuries. However, 13 bridges currently cross the LPRSA, according to Table 2-1.

The location of certain bridges, especially those situated between the Newark Bay Study Area and the Harrison Reach, could influence the Phase I Work, particularly the ability to sail marine-based equipment to the Phase I Work Area. The Point-No-Point

Reach includes the abandoned Conrail Bridge, the Lincoln Highway Bridge, and the General Pulaski Skyway Bridge (U.S. Routes 1 and 9). The lower portion of the Harrison Reach includes the Conrail Penn Central freight bridge and the I-95 (New Jersey Turnpike) bridge. Except for the Pulaski Skyway and New Jersey Turnpike bridges, which have clearances over at least 100 ft from mean high water (MHW), all of the bridges listed in Table 2-1 are swing or lift bridges. The impact of bridges on equipment accessibility will be further evaluated during design.

2.2.8 Utilities

An evaluation of utilities located within the Phase I Work Area is in progress. In doing so, the following companies have been contacted to determine whether private utility lines exist in the Phase I Work Area vicinity:

- City of Newark
- Cablevision of Mid New Jersey
- Port Authority of New York & New Jersey
- Sunoco Pipeline, L.P.
- Verizon
- Broadwing Communications
- XO New Jersey, inc.
- Public Service Electric & Gas Company
- Transcontinental Gas Pipe Line Corp.
- Town of Kearney Water Department
- Passaic Valley Water Commission
- Passaic Valley Sewer Commission

- MCI
- AT&T Transmission
- Qwest Communication International
- Town of Harrison/Water & Sewer Department.

Information from these utilities is still being collected and will continue to be evaluated.

2.2.9 Cultural Resources

There are no known cultural resources in, or adjacent to, the Phase I Work Area. To confirm this, the NJDEP State Historic Preservation Office will be contacted during the design stage.

3. Summary and Relevance of Existing Data

A significant amount of sampling data have been collected in the Passaic River since 1990, and these data include many locations within the Phase I Work Area. A summary of the data collected from these locations is provided herein. Much of the existing data for the Passaic River were compiled in the Newark Bay Study Area Database Version 3.0 (as maintained by ARCADIS), which was used to generate the data presented in this Phase I EE/CA. The available data will assist in understanding the chemical concentrations and physical conditions expected to be encountered during the Phase I Work.

The following subsections summarize the pertinent sediment datasets and describe how each is useful for the Phase I Work.

3.1 Sediment Investigations

Recent sediment investigations from within the Phase I Work Area are listed below. Table 3-1 summarizes the number of sediment samples collected by each investigation, and Figure 3-1 shows the sample locations.

- 1991 Core Sediment Investigation (ChemRisk 1991)
- 1995 RI Sampling and Geotechnical Testing Program (USEPA 1994b; CLH 1995a, 1995b, 1995c, 1995d, and 1995e)
- 1999 Late Summer/Early Fall RI-Ecological Sampling Program (CLH 1999a, 1999b, 1999c)
- 1999 Preliminary Toxicity Identification Evaluation Study (Appendix B to Tierra 2007)
- 2000 Toxicity Identification Evaluation Study (Appendix B to Tierra 2007, Kay et al. 2008).

Sediment samples collected during these programs have been analyzed for numerous constituents, including metals, dioxins/furans, herbicides, PAHs, PCBs, pesticides, semivolatile organic compounds, volatile organic compounds, total petroleum hydrocarbons, organotins, acid volatile sulfides/simultaneous extracted metals, cyanide, ammonia, pH, sulfide, total organic carbon, and radioisotopes. Geotechnical

data have also been obtained. To the extent practical, both chemistry and geotechnical data are discussed herein. Biota tissue data are discussed in Section 4.

In addition to this, other surveys/investigations conducted beyond the Phase I Work Area that are considered useful are also presented.

3.2 Chemical Data and Sediment Characterization

A summary of the sediment chemistry data pertinent to the Phase I Work Area is presented in Table 3-2. These data can be used in part to characterize the sediment that will require disposal. Although no toxicity characteristic leaching procedure (TCLP) data exist for samples collected in this area, these data are still useful for purposes of preliminary characterization.

In general, chemical data from the Phase I Work Area indicate that the highest concentrations of 2,3,7,8-TCDD, metals, and other constituents were found deeper than 2 ft below sediment surface (bss), with concentrations tending to decrease to relatively low levels by 12 ft bss. Samples collected closer to shore also tend to exhibit more elevated concentrations as compared to those collected farther from shore.

The existing data also suggest that some of the dredged material will have the potential to be designated as a characteristic hazardous waste. Although TCLP and other characteristic waste tests (ignitability, corrosivity, and reactivity) have not been run on any of the historical samples, the Resource Conservation and Recovery Act (RCRA) allows for the estimation of a maximum theoretical leachate concentration (MTLC) by dividing each result by 20 (or multiplying the regulatory level by 20) and comparing the results. The division factor reflects the 20-to-1 ratio of extraction fluid to solid used in the TCLP analysis (USEPA Method 1311). Therefore, if the total concentration of a chemical in a solid material is less than 20 times the TCLP regulatory limit, then the sample theoretically cannot leach enough of that constituent to fail that TCLP limit even if all of the chemical dissolved into the extraction fluid.

The MTLC was calculated using the maximum concentrations of the samples collected within the Phase I Work Area. In doing so, the calculated MTLC values were determined to be greater than the RCRA regulatory level for five metals (arsenic, cadmium, chromium, lead, and mercury) and 11 organic compounds (hexachlorobenzene, benzene, 1,4-dichlorobenzene, hexachlorobutadiene, 2,4-dinitrotoluene, 2,4,6-trichlorophenol, 2,4-D, 2,4,5-TP, endrin, heptachlor, and toxaphene). The existing samples did not extend through the entire removal depth in

the Phase I Work Area; therefore, these MTLC values correspond to only a portion of the sediment targeted for removal. For the purposes of this Phase I EE/CA, it was assumed that some of the sediment removed will be a characteristic hazardous waste. As such, it is necessary to identify underlying hazardous constituents, which may include, but not be limited to, dioxins. For example, the mean concentration of 2,3,7,8-TCDD, based on the historical sediment sampling results, is 0.244 parts per million (ppm). Because this value is greater than the universal treatment standard (UTS) of 0.001 ppm, it was assumed for the purposes of this Phase I EE/CA that some of the sediment will require treatment (incineration) prior to disposal. The remainder of the sediment will be assumed to be environmental media and will not require treatment prior to land disposal. During design, the percentage of sediment requiring treatment will be further refined. Additional characterization is planned during design to confirm this list and plan for treatment and disposal. It is important to note that for the purposes of this Phase I EE/CA, it was assumed that the sediment does not contain a listed waste.

3.3 Geophysical Surveys

Geophysical data are those data that, together with other in-situ information, describe the physical condition of the sediment bed. Geophysical data available in the vicinity of the Phase I Work Area include information related to both bathymetry and debris. These data are described in more detail below.

3.3.1 Bathymetry

Bathymetric survey data represent important information that will serve as the baseline for designing the Phase I Work. A total of seven bathymetric surveys of the lower 6 miles of the Passaic River (including the Phase I Work Area) have been conducted since 1995 using modern measuring techniques (differential global positioning system integrated with digital sounding equipment). These surveys were conducted to document the elevation of the sediment bed and its changes over time.

Of the seven bathymetric surveys conducted since 1995, the August 2007 survey conducted by Gahagan and Bryant Associates, Inc., on behalf of ENSR (for the CPG), is the most recent and, therefore, most relevant to the Phase I Work. Information from this survey was used during the Phase I EE/CA process to evaluate the sediment bed in the Phase I Work Area. The Gahagan and Bryant Associates, Inc., bathymetry for the Phase I Work Area is depicted on Figure 3-2. As shown, the sediment bed

elevation varies from 3.2 ft below MLW (-5.6 ft NGVD29) at the deepest point of the Phase I Work Area, to 2.0 ft above MLW (-0.4 ft NGVD29) near shore.

The sheet pile enclosure will be designed so that sufficient water elevation can be maintained within the structure for Phase I Work navigation purposes.

3.3.2 Debris Surveys

A series of geophysical surveys were conducted in 2004 to perform a detailed characterization of the dredging area targeted as part of the 2005 Dredge Pilot Study (TAMS/Earth Tech and Malcolm Pirnie, Inc. 2005). Among other things, the work included the following surveys:

- Hydrographic
- Side-scan sonar
- Magnetometer
- Sub-bottom profiler (chirp).

Although these surveys were not conducted in the Phase I Work Area, their proximity to the Phase I Work Area provides an indication of the types and frequency of debris that may be found there. In general, the surveyed area is approximately 500 ft downstream of the Phase I Work Area.

Based on these surveys, a total of 12 magnetic anomalies occurred in their 100-ft wide search area. Of these anomalies, three were classified as large, and several others were described as individual or groups of smaller objects, such as chain, wire, anchors, or pipes. In addition to those objects identified by the magnetometer, two targets were identified using the sub-bottom profiler.

Beyond the formal debris survey described above, observations made during the numerous bathymetric and field surveys conducted in the vicinity of the Phase I Work Area since 1995 also indicate that debris is abundant in the Harrison Reach sediment. These observations indicated that old tires and piles (vertical and horizontal) were the most prevalent objects encountered.

Based on these observations, there is a high likelihood that debris is present in the Phase I Work Area. The likely presence of debris was considered when evaluating removal technologies in this Phase I EE/CA and will also be addressed as part of the design.

3.4 Geotechnical Data

Geotechnical data have been collected as part of previous studies in and near the Phase I Work Area. These data represent conditions both within the river, as well as upland (i.e., the Lister Avenue Site). Both are described below.

3.4.1 Passaic River Sediment Geotechnical Data

Geotechnical data for sediment in the Phase I Work Area consist of sediment physical properties and/or engineering index properties. Sediment sampling to a depth of about 9 ft provided the following data:

- Grain size distribution or fine-grained fraction (10 samples)
- Atterberg limits of plasticity (4 samples)
- Moisture content (5 samples)
- Bulk density (5 samples).

Table 3-3 provides a summary of available physical property data available within the Phase I Work Area. These data were used in this Phase I EE/CA to select the appropriate sediment removal and sediment processing technologies. The following paragraphs describe these results and the anticipated significance for the Phase I Work.

Generally, the Phase I Work Area sediment is fine-grained, cohesive material classified as moderate to high plasticity organic silt and clay. Sediment is also generally soft and the shear strength low. Results of bulk density testing range from 74 to 97 pounds per cubic foot, and Atterberg limits demonstrate the sediment plasticity index is high, with values ranging 64 to 93 percent. (Note: The plasticity index is equal to the plastic limit subtracted from the liquid limit.) Liquid limit results, ranging from 111 to 147 percent, are also high, indicating the sediment will exhibit plastic behavior for a wide range of moisture contents.

Sediment moisture contents are generally at or above the liquid limit and, therefore, have low shear strength and may behave as a fluid. This is also confirmed by the liquidity index (LI) values ranging from 1.6 to 2.1. (Note: values from 0 to 1 generally indicate plastic behavior, and values greater than 1 generally indicate fluid behavior.) The LI is expected to decrease with the depth of removal due to decreasing moisture content and/or increasing bulk density. The alterations in the moisture content during removal and sediment processing implies that the sediment will experience the full range of behavior from fluid to plastic solid. The latter typically involves added difficultly to handle and a longer period of time to dewater and consolidate compared to low plasticity sediment.

Results of the grain size distribution indicate that 86 to 97 percent by weight of sediment is silt and clay-sized. This implies that a range of 3 to 14 percent of surface sediment may be coarse particles and may require solids separation during sediment processing (for proper functioning of the dewatering equipment), assuming similar grain size characteristics within the 12-ft depth of removal.

3.4.2 OU-1 Soil Geotechnical Data

This section discusses the soil geotechnical data for the OU-1 floodwall. Although these data were collected outside of the Phase I Work Area, they are still considered useful for inferring geotechnical properties of the Phase I Work Area. Additional physical properties and/or engineering index properties of subsurface layers below the sediment cut depth are of interest for purposes of the sheet pile enclosure design. These data were obtained during construction of the Lister Avenue remedy, and include grain size, Atterberg limits, moisture content, sediment bulk density, subsurface soil type (density by standard penetration blow counts obtained during drilling), and shear strength. The following text provides a summary of the primary soil layers based on borings collected for the Lister Avenue floodwall (Eckenfelder 1999).

OU-1 consists of a secure environmental cap underlain by fill and peat. These upper layers are not discussed in this section as they only appear in the upland, and they are not present in the Phase I Work Area. The subsurface layers below the fill and peat, from top to bottom, are as follows (Eckenfelder 1999):

- Silty sand to sand ranging in thickness from 12 to 44 ft
- Clayey silt to silt ranging in thickness from 5 to 10 ft

- Sand to sand and gravel.

Thicknesses are anticipated to vary from these ranges (as shown on Figure 3-3) and will be further evaluated during design.

For the layers indicated below, the standard penetration test (SPT) values (in blows per ft) (Eckenfelder 1999) and associated correlation to density are as follows:

- Silty sand to sand SPT, ranging from 8 to greater than 50, which is generally loose to very dense material, and values indicate a high degree of variability in density of the layer.

- Clayey silt to silt SPT, ranging from 6 to greater than 50, which is generally medium stiff to very hard material and values also indicate a high degree of variability in density of the layer.

- Sand to sand and gravel SPT, ranging from 14 to greater than 50, which is generally medium dense to very dense.

Geotechnical data described in this section (both for sediment in the Phase I Work Area and soil conditions from OU-1) provide a sufficient basis for this Phase I EE/CA, but will be further evaluated during design.

3.5 Hydrodynamic Data

The Passaic River exhibits both riverine and estuarine characteristics, depending on whether the upstream flows are high or low. The LPRSA (which includes Harrison Reach) extends from the river's confluence with Newark Bay, approximately 17 miles upstream to Dundee Dam. Estuarine conditions and tidal flow velocities are dominant in the Harrison Reach during the majority of the time when stream flows are at, or lower than, average. When freshwater flows are significantly above average, riverine conditions are dominant.

Hydrodynamic data for the Passaic River include the U.S. Geological Survey (USGS) gauging information to measure river flows and tide gauge information to measure the effects of semidiurnal tides. In addition to this, data were collected as part of the 1995 RI Program to generate water current-velocity profiles across the channel using Acoustic Doppler Current Profiles (ADCP) and moored current meters. Total suspended solids and water velocity data were also obtained through the 1995 RI

Program. These data were obtained from various locations and at various times during the study and were reviewed relative to their potential applicability to the Phase I Work.

Based on data from the USGS (Simons & Associates 1996; USGS 1995), the upstream Passaic River contributes the majority of freshwater inflow (approximately 1,200 cubic feet per second [cfs] on average at the Little Falls gauge just upstream of Dundee Dam) to the estuary. Gauged tributaries between Dundee Dam and the Phase I Work Area contribute another 121 cfs on average (USGS 2002). Additional freshwater inflow is contributed by three ungauged tributaries and urban runoff, including storm sewers and combined sewer overflows. According to Suszkowski (1978), the ungauged flow between Dundee Dam and Newark Bay is less than 10 percent of the total flow at the mouth of the Passaic River. Based on the gauged and ungauged flow information, the average flow near the Phase I Work Area is approximately 1,450 cfs.

High flow events are most prevalent in the spring months, but also occur in the summer/fall as a result of hurricanes and tropical storms, or on occasion, during the winter months when frozen ground in the watershed increases surface-water runoff and river levels. Figure 3-4 depicts the Passaic River daily average flows at Little Falls, New Jersey, from 1983 through 2008.

The area near the Phase I Work Area is influenced by semidiurnal tides. The mean tidal range (difference in height between MHW and MLW) at the New Jersey Turnpike Bridge (approximately 1.5 miles upstream from Newark Bay) is 5.1 ft (National Oceanic and Atmospheric Administration [NOAA] 1972). The mean tide level (midway between MLW and MHW) is 2.5 ft (NOAA 1972). The mean spring tide range (average semidiurnal range occurring during the full and new moon periods) is 6.1 ft.

Stratification of the density profile and residual circulation is common in the lower Passaic River. Hydrodynamics within portions of the LPRSA are complex, with currents near the bed sometimes flowing in the opposite direction of currents near the water surface for portions of the tidal cycle (Simons and Associates 1996). Observations also identified that flow directions are sometimes opposite between the central deeper channel and the shallower zones near the riverbanks (Simons and Associates 1996).

ADCP flow measurements and moored current meter data between June 1995 and May 1996 in the vicinity of the Phase I Work Area were obtained. The ADCP maximum velocity measurements ranged from 3.2 feet per second (fps) in the landward direction to 2.3 fps in the seaward direction, while the maximum velocities from the moored

current meter ranged from 2.2 fps seaward to 1.8 fps. Within the river near the Phase I Work Area, the average cross-sectional velocity due to freshwater flow is approximately 1 fps. Typical maximum tidal velocities in the LPRSA are approximately 3 fps (USACE 1987).

In order to better understand how the river hydrodynamics might change as a result of the sheet pile enclosure, Tierra has begun development of a localized hydrodynamic model. Additional information on this model development is provided in Section 8.

3.6 Groundwater Data

In general, there are limited data regarding groundwater-surface water interactions in the Phase I Work Area. Given the relatively small Phase I Work Area footprint and the upland controls in place (see Section 2.), the impact of groundwater on the Phase I Work Area is expected to be limited. The sections below describe the groundwater and groundwater control structures at OU-1. Groundwater data at the Sherwin-Williams property are also relevant as a portion of the Phase I Work Area is adjacent to this property. Groundwater data from the Sherwin-Williams facility will be evaluated during design.

Groundwater occurs both in the non-indigenous fill and the native materials beneath OU-1, as shown on Figure 3-5. The fill materials are approximately 8 ft thick over most of OU-1 but thicker to the north, adjacent to the Passaic River, to approximately 20 to 25 ft thick (Figure 3-5). The fill materials were placed on native materials to raise the grade of OU-1 during historical operations. The native materials beneath the fill materials consist of an organic silt layer, which overlies glaciofluvial sand (also referred to as silty sand to sand layer in Section 3). The organic silt layer is approximately 10 ft thick over most of OU-1, but thins to the north, adjacent to the Passaic River and is absent in some areas. This layer has low permeability (1.7×10^{-7} centimeters per second; Eckenfelder 1999) and acts as a barrier to vertical groundwater migration. The glaciofluvial sand underlies the organic silt layer and is relatively permeable.

The hydrogeology of OU-1 is controlled by the organic silt layer, the engineered barriers that surround and isolate OU-1, the cap, and the GWWS. As indicated above, the organic silt layer is believed to be a barrier to the vertical groundwater migration between the fill materials above the organic silt layer and the native sand below the silt layer. The barriers that surround OU-1 include a floodwall and slurry trench cutoff walls. The floodwall is on the northern OU-1 boundary, between OU-1 and the Passaic River. It was installed to a depth of minus 18.5 ft MSL or approximately 15.5 ft below

the bottom of the Passaic River, into the glaciofluvial sand, and limits communication between OU-1 groundwater and the Passaic River. Floodwall master piles were driven to the approved "tip depth" of -22 ft MSL (Attachment 5 of Appendix K; BBL 2004). The slurry trench cutoff walls are on the remaining three upland sides of OU-1, surround the fill layer, and were keyed 3 to 4 ft into the organic silt layer. The walls consist of solidified concrete slurry and isolate the groundwater in the fill layer from areas outside OU-1. The surface of OU-1 is a multilayer cap that prevents precipitation from recharging the fill layer.

The GWWS consists of 10 extraction wells that are screened in the fill layer and remove water at a typical rate of approximately 10 gallons per minute (combined). Eight of the extraction wells are located in the northern portion of OU-1, adjacent to the Passaic River, where the fill materials are thickest and the organic silt layer is thinnest. Groundwater is treated in the treatment plant on OU-1 before testing, and then discharged to the Passaic River after results are validated. Operation of the GWWS started in 2001.

Groundwater contained within the slurry wall and floodwall occurs at elevations less than outside the slurry wall and decreases in elevation from approximately 5 ft above MSL (approximately equivalent to NGVD29 in the vicinity of the Phase I Work Area) in the south to 1 to 2 ft above MSL in the north (along the floodwall). Following construction of the walls and cap and groundwater extraction system optimization in 2001 and 2002, groundwater elevations within the slurry wall in the fill declined sharply and have reached a relatively static equilibrium where groundwater elevations within the sand unit and in the fill outside the slurry wall have remained relatively constant.

Based on the historical groundwater measurements, groundwater elevation fluctuations due to external forces (tidal and precipitation) primarily occur within the glaciofluvial unit closest to the Passaic River and non-indigenous fill located outside the slurry wall. Adjacent to the floodwall, groundwater within the fill inside the slurry wall beneath the cap was determined to be slightly impacted by a change in high tide river elevation (BBL 2003a, 2003b). Overall, the engineered barriers and operation of the GWWS meet the remedial objectives of attaining "a hydraulic gradient preventing the migration of groundwater from the volume contained within the slurry wall" in accordance with Section V1.B.9 of the Consent Decree (State of New Jersey 1990).

Groundwater monitoring was performed in August 2008 in accordance with the USEPA-approved May 2008 Final Quality Assurance Project Plan (Environmental Data Services, Inc. 2008). Groundwater samples were collected from 19 gradient control

pair piezometers by low-flow purge and sample methods and analyzed for site chemicals of concern. These data will be evaluated accordingly during design.

4. Streamlined Risk Evaluation

A quantitative baseline risk assessment for chemical constituents in sediment and the food web of the LPRSA (including the Phase I Work Area) is being performed by the CPG as part of the CERCLA-WRDA RI/FS and FFS (Malcolm Pirnie, Inc. 2007). The RI/FS and FFS risk assessments will quantify existing risks to human and ecological receptors and evaluate potential future risks for various large-scale remedial actions that may be undertaken in the LPRSA. It is anticipated that the Phase I Work (and the post-removal conditions) will be considered and evaluated under the CERCLA-WRDA program. As such, and pursuant to USEPA guidance (1993), a quantitative risk assessment will not be conducted as part of this Phase I EE/CA.

Instead, this section briefly identifies and summarizes the human and ecological exposures to chemical constituents in sediment, which will be reduced following the implementation of this work. In accordance with USEPA guidance (1993), this streamlined risk evaluation is being provided to “help justify” the removal action and is focused “on the specific problem that the removal action is intended to address.” In this case, the action is removal of a specific area and mass of LPRSA sediment that has been deemed of particular concern by USEPA relative to its potential for future transport and exposures.

4.1 Pre-Removal Conditions and Exposures

As discussed in detail in Section 2, the area surrounding the Phase I Work Area consists predominantly of industrial facilities/properties, and the substrates and habitats that exist in the river within the Phase I Work Area are limited to relatively degraded intertidal mudflats and shallow subtidal bottom areas (Figure 2-1). The associated shoreline consists of bulkheads and a concrete floodwall.

Figure 4-1 presents a simplified conceptual model of the fate and transport of chemical constituents in the Passaic River and the potential exposure pathways for human and ecological receptors to these chemicals. The available data demonstrate that the sediment in the Phase I Work Area, both at the surface and at depth, is contaminated with a variety of chemical constituents (see Section 3.1), many of which:

- Are present at levels that are of potential concern for risk to both human and ecological receptors.
- Are transferred into the food web.

- May be transported to other areas of the river.

Ecological receptors in the Phase I Work Area include a range of invertebrate and vertebrate organisms that inhabit or utilize the river either year round or on a migratory basis. These primarily include infaunal and epifaunal benthic invertebrates, shellfish (primarily blue crabs), fish, and birds (both shorebirds and passerines). Exposures for all of these groups can include both direct contact with sediment and water, as well as indirect uptake of bioaccumulative chemical constituents through food web (i.e., feeding) interactions.

Potential human exposures to chemical constituents include recreators, such as fisherman, crabbers, and boaters, as well as workers in the area. These exposures are primarily through dermal contact and/or incidental ingestion of sediment and/or water, and ingestion of fish or shellfish from the river. Inhalation of volatile or semivolatile organic compounds from sediment or water is another potential exposure pathway, but this is not likely as significant as the ingestion and contact pathways.

These potential exposure pathways, combined with the elevated concentrations of a variety of chemical constituents, suggest the potential for risk from chemicals to both human and ecological receptors in the Phase I Work Area and associated areas of the Passaic River under the pre-removal conditions.

4.2 Post-Removal Conditions

Because the Phase I Work is area- and mass-based in nature and not focused on attaining criteria-based standards or cleanup goals, the actual impacts on risks and risk reduction in the system cannot be quantified at this time. As previously stated, it is anticipated that this will be done as part of the CERCLA-WRDA RI/FS and FFS process.

Following implementation of the selected Phase I Work Alternative, the conditions in the Phase I Work Area should be different and improved, to some extent, from an exposure potential, because the Phase I Work Area will be less contaminated and backfilled with several feet of clean material. In addition, the potential for chemical transport from the Phase I Work Area to upstream or downstream areas will also be reduced.

The removal of a large sediment/chemical mass in the system could have some small incremental affect on the magnitude of transfer of chemical constituents within the river

itself and the overall food web. Such a reduction in the overall transfer of chemical constituents into the food web, even at a local level, may result in a reduction of chemical concentrations in larger fish and crabs that are available for consumption by humans, which may result in reductions in the magnitude of any consequent health risks.

From an ecological perspective, if recontamination from ongoing sources in the river can be avoided, the sediment in the Phase I Work Area should provide a foundation for an improved and more diverse benthic community. This in turn should provide an improved and more abundant organism base within the food web and a greater selection of prey items for higher order consumers. These prey items should be less contaminated, resulting in less transport of chemical constituents through at least the localized food web in this area.

5. Removal Action Objectives

Developing removal action scope, goals, and objectives is an important step for the EE/CA (USEPA 1993). As outlined in the 2008 AOC (USEPA 2008a), the scope of Phase I involves the excavation of 40,000 cy of sediment within a sheet pile enclosure with the material sent to an off-site treatment and disposal facility. The removal action goal, as described in the 2008 AOC, is to "… excavate a portion of the highest concentrations of 2,3,7,8-TCDD in the area ..." (USEPA 2008a).

To better track the overall success of the project, more specific removal action objectives (RAOs) were developed, based on the 2008 AOC (USEPA 2008a) and USEPA guidance (1993). Protection of community health and safety is implicit in these objectives. The resulting RAOs for the Phase I Work are listed below:

- *RAO #1*: Remove a portion of the most concentrated inventory of 2,3,7,8-TCDD, as well as other hazardous substances, to minimize the possibility of migration due to extreme weather events.

- *RAO #2*: Prevent, to the extent practicable, the migration of resuspended sediment during removal operations.

- *RAO #3*: Prevent, to the extent practicable, the potential for spillage or leakage of sediment and contaminants during transport to the disposal facility.

- *RAO #4*: Restore habitat. (Note that restoration of the Phase I Work Area will need to consider the activities of the bordering Phase II work efforts. As such, restoration of the Phase I Work Area may not occur until Phase II is completed.)

As described in subsequent sections of this Phase I EE/CA, the RAOs (together with the ARARs and TBCs discussed in Section 6) serve as a framework for the screening and selection of a recommended Phase I Work Alternative.

6. Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements

The 2008 AOC (USEPA 2008a) requires that the Phase I Work comply with ARARs. These regulatory requirements are discussed below as they pertain to the removal action represented in this Phase I EE/CA. Requirements that are legally applicable to off-site actions (e.g., material transportation, sediment disposal) are also presented.

TBCs are non-promulgated advisories, criteria, or guidance issued by federal or state government that are not legally binding and do not have the status of ARARs. However, where no promulgated cleanup levels or standards exist, they may be useful in helping to determine the necessary level of cleanup or standard of control that is protective of human health and the environment, or how to carry out certain actions or requirements.

For each ARAR and TBC identified, the applicability to the Phase I Work is discussed herein. Ultimately, USEPA's Action Memorandum will determine which ARARs and TBCs are to be met during the Phase I Work.

For purposes of this Phase I EE/CA, it was assumed that the definition of "site" includes not only the Phase I Work Area but also the Sherwin-Williams property located immediately to the west of OU-1. Tierra is currently in discussions with Sherwin-Williams for the use of their property during the project. For the purposes of this Phase I EE/CA, it was assumed that the Sherwin-Williams property will, in fact, be used. It is envisioned that upland activities, including staging, sediment processing, water treatment, and other related activities will occur at the Sherwin-Williams property (herein referred to as the upland site).

6.1 Applicable or Relevant and Appropriate Requirements Process

For CERCLA sites, such as this one, agency permits or approvals are not required for on-site actions; however, on-site actions must be conducted in a manner that meets the substantive provisions of applicable requirements. Actions that take place off site are subject to all applicable requirements, including administrative (e.g., permit/approval reporting). For the alternatives evaluated in this Phase I EE/CA, only the transportation, treatment, and disposal of the Phase I Work Area sediment will take place off site. The impact of obtaining any federal, state, and local permits for any off-site actions is addressed in the administrative feasibility section for each Phase I Work Alternative (Section 8).

For on-site actions, the legally established ARARs that may govern the Phase I Work must be identified. Legally applicable requirements include those that are promulgated under federal or state law or state facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the site. Examples of legally applicable requirements include cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations. Relevant and appropriate requirements are requirements for environmental protection promulgated under federal or state law that address situations sufficiently similar to the circumstances of the Phase I Work contemplated and are well-suited to the site [40 Code of Federal Regulations {CFR} 300.400(g)(1) and (2)].

In addition, to qualify as an ARAR, a state requirement must be:

- A state law
- Promulgated under a federal or state environmental or facility siting law
- More stringent than the federal requirement
- Identified by the state in a timely manner
- Consistently applied.

Additional coordination with NJDEP to select state ARARs will be performed during the design process. For instance, air permit equivalents may be required to address potential emmissions from sediment once it is processed and stockpiled.

6.2 Applicable or Relevant and Appropriate Requirements

The potential chemical-, action-, and location-specific ARARs for the Phase I Work Area have been identified and are summarized below, as well as in Table 6-1.

6.2.1 Chemical-Specific Applicable or Relevant and Appropriate Requirements

Chemical-specific ARARs are either a numerical concentration limit or an emission or effluent discharge limit. These limits establish the acceptable amount of a particular chemical that can be found in or discharged to the environment. For the Phase I Work Alternatives, chemical-specific ARARs will apply to discharges from water treatment

activities, stormwater discharges, and/or air emissions. The chemical-specific ARARs for the Phase I Work Alternatives are provided below.

6.2.1.1 Federal

Section 112 of the Clean Air Act (CAA) requires USEPA to set standards for pollutants considered harmful to public health and the environment. The standards (i.e., national emissions standards for hazardous air pollutants) are issued to limit releases from specific industrial sectors. Subpart GGGGG of the act (National Emission Standards for Site Remediation) may be applicable to the site based on the type and amount of emissions present during construction. Calculations will be conducted during design to determine if Section 112 of the CAA is an ARAR.

Section 304 of the Clean Water Act (CWA) (33 U.S. Codes [U.S.C.] 1251-1376) requires USEPA to publish Water Quality Criteria, which are developed for the protection of human health and aquatic life. Federal water quality criteria are published as they are developed, and the most recent criteria were published in 2006 (USEPA 2006). New Jersey also has adopted water quality standards for several of the federal criteria (see the next section). While the criteria are not regulations, Sections 301, 302, and 303 of the CWA require states to develop water quality standards that are relevant and appropriate. These sections also require all states to identify water body uses and values. These are presented below.

6.2.1.2 State

Federal CWA, the Federal Regulatory Program (40 CFR Part 131), and pursuant to the New Jersey Water Pollution Control Act (New Jersey State Archives [N.J.S.A.] 58:10A et. seq.) and the New Jersey Water Quality Planning Act (N.J.S.A. 58:11A) requires the development of surface-water quality standards. The surface-water quality standards establish designated uses, classify streams based on uses, designate anti-degradation categories, and develop water quality criteria to protect those uses. The surface-water quality standards are regulated under N.J.A.C. 7:9B. Water quality criteria are developed for individual pollutants to protect aquatic life and human health in both fresh and saline water. New Jersey also establishes water quality-based effluent limitations from all point and non-point sources.

6.2.2 Location-Specific Applicable or Relevant and Appropriate Requirements

The location of a removal action may require essential controls to manage the action's impact on human health and the environment. These controls are identified in location-specific ARARs, which are the same for all of the Phase I Work Alternatives being considered.

6.2.2.1 Federal

Section 10 of the Rivers and Harbors Appropriations Act (33 U.S.C. 403; 33 CFR Part 320, 322) prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. Procedures set forth by USACE in 33 CFR Parts 320 and 322 require an examination of the impact of the action(s), in this case sediment removal, backfill, and installation of the sheet pile enclosure, on the public interest. The requirements of Section 10 are typically addressed by the USACE at the same time it addresses the requirements of Section 404 of the CWA. There is a federally designated navigation channel adjacent to the Phase I Work Area; therefore, the Rivers and Harbors Appropriations Act is considered an ARAR for the Phase I Work.

Section 7 of the Endangered Species Act (16 U.S.C .1531 et seq.; 50 CFR Parts 17, 200, 402) requires that federal agencies consider the effect of proposed actions on federally threatened or endangered species. A formal consultation with the USFWS and the New Jersey Natural Heritage Program is in progress to confirm the absence of threatened or endangered species in the river near the Phase I Work Area.

The Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) establishes criteria to protect fish and wildlife that could be affected by proposed or authorized federal projects involving "impounding, diverting, or controlling waters." Also, the statute requires that adequate provisions be made for the conservation, maintenance, and management of fish and wildlife resources and their habitats. A formal consultation with the USFWS is in progress to confirm the absence of threatened or endangered species in the river near the Phase I Work Area.

Section 307 of the Federal Coastal Zone Management Act (16 U.S.C. Section 1451 et seq.) requires that all federal projects, or non-federal projects that require a federal permit, require a determination of consistency with the State Coastal Zone Management Program. In New Jersey, these consistency determinations are evaluated pursuant to the Rules on Coastal Zone Management (N.J.A.C. 7:7E-l.l et seq.) and are incorporated into the Waterfront Development Permit issued for a project;

therefore, the Federal Coastal Zone Management Act is an ARAR for the Phase I Work.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended and reauthorized by the Sustainable Fisheries Act (16 U.S.C. 1801 et seq.), established a program to promote the protection of EFH. After EFH has been described and identified in fishery management plans by the regional fishery management councils, federal agencies are obligated to consult with NOAA to confirm that the action does not adversely affect any EFH. A formal EFH consultation with the National Marine Fisheries Service is in progress for the Phase I Work.

6.2.2.2 State

New Jersey Soil Erosion and Sediment Control Act (N.J.S.A 4:24-39 et seq.) establishes soil erosion and sediment control standards for land disturbance activities. Land disturbance activities are defined as any activity involving the clearing, excavation, sorting, grading, storing, filling, or transporting of soil of more than 5,000 square ft of surface area for a project. A project is defined as an activity requiring a construction permit, the demolition of one or more structures, the construction of a parking lot, the operation of any mining or quarrying activity, or the clearing or grading of any land other than land for agricultural or horticultural purposes. Meeting the substantive requirements of construction permits may be required for upland structures needed to conduct the Phase I Work; therefore, the Soil Erosion and Sediment Control Act is an ARAR for the Phase I Work.

Tidelands Act (Riparian Lands Leases, Grants and Conveyances [N.J.S.A. 12:3-1 et seq.]) requires a tidelands license for the use of state-owned riparian lands, including for dredging projects or installation of a sheet pile enclosure. The State of New Jersey owns all riparian lands flowed by the mean high tide of a natural waterway, except for those in which it has already conveyed its interest in the form of a riparian grant. Therefore, the Tidelands Act is an ARAR for the Phase I Work. If the project includes a permanent modification to the floodwall, a modification to the existing lease would be required. A license is needed for short-term use of the tidelands, and a lease is needed for long-term use of the tidelands. A consultation with NJDEP is in progress to determine the ownership of the tidelands within the Phase I Work Area.

Waterfront Development Law (N.J.S.A. 12:5-3) regulates any waterfront development at or below MHW and up to 500 ft away from MHW in the Coastal Zone and tidal waters of the state. This applies only to work areas outside of the USEPA-

defined site. Because waterfront developments include the removal or deposition of subaqueous materials (dredging or filling), the Waterfront Development Law is an ARAR for the Phase I Work. Sediment that is not classified as hazardous waste, pursuant to the New Jersey Hazardous Waste Regulations N.J.A.C. 7:26G, will require an Acceptable Use Determination that addresses the transfer, processing, and relocation of dredged materials.

Flood Hazard Area Control Act (N.J.S.A. 58:16A-50 to -101) governs disturbance to land and vegetation in the flood hazard or riparian area of a regulated waterway to control development in flood hazard areas. The goals of the act are to minimize potential on- and off-site damage to public or private property, to protect and enhance the public's health and welfare by minimizing the degradation of water quality from point and non-point pollution sources, and to protect wildlife and fisheries. A permit is required for the construction, installation, or alteration of any structure or permanent fill along, in, or across the channel or flood plain of any watercourse; therefore, the Flood Hazard Control Act is an ARAR for the Phase I Work.

Wetlands Act of 1970 (N.J.S.A. 13:9A-1 to 10) regulates the draining, dredging, excavation, or deposition of material, and the erection of any structure, driving of pilings, or placing of obstructions in any coastal wetlands that have been mapped or delineated pursuant to the Wetlands Act of 1970. A list of these maps and a full list of regulated activities appear in N.J.A.C. 7:7-2.2. The intertidal mudflats in the Phase I Work Area are considered jurisdictional wetlands; therefore, the Wetlands Act of 1970 is an ARAR for the Phase I Work.

6.2.3 Action-Specific Applicable or Relevant and Appropriate Requirements

Action-specific ARARs are identified by determining the details for implementing each removal action alternative. Action-specific ARARs are usually derived from one or more of the following: RCRA, CWA, CAA, Toxic Substances Control Act, and state regulations. Although the additional details about the specific actions associated with the Phase I Work are presented in the technology screening section (Section 7), the general actions used to identify action-specific ARARs include containment and shoreline stability, sediment removal, sediment processing, water treatment and discharge, off-site transport of sediment, and backfilling.

6.2.3.1 Federal

Hazardous Materials Transportation Act (49 CFR, et seq.) are U.S. Department of Transportation (USDOT) regulations that govern the transportation of hazardous materials, including communications and emergency response requirements, shipping, and packaging requirements (40 CFR Part 171 through 180). There is the potential for hazardous materials to be transferred off site; therefore, the USDOT requirements are an ARAR for the Phase I Work.

RCRA (Subtitle D) Nonhazardous Solid Waste Program [42 U.S.C. 6941 through 6949(a)] and Regulations (40 CFR Parts 257, 258) regulates solid waste management throughout the United States. The upland disposal of dredged contaminated sediment is not exempt from these requirements. However, states are typically authorized by RCRA to develop and implement their own waste programs, if the state requirements are as stringent as, or more stringent than, the federal requirements. Sediment or debris that is shown to be nonhazardous will be managed in accordance with these requirements; therefore, RCRA (Subtitle D) is an ARAR for the Phase I Work.

RCRA (Subtitle C) Hazardous Waste Program [42 U.S.C. 6921 through 6939(e)] and Regulation 40 CFR 261.4(g) exempts dredged contaminated sediment subject to CWA Section 404 requirements from regulation as a hazardous waste, in terms of disposal within water or on land where there is discharge back to surface water. The disposal of dredged sediment in an upland facility where there is no connection to surface water is not exempt from regulation. Existing sediment data indicate that some or all of the sediment removed for off-site disposal may be designated as a characteristic hazardous waste; therefore, RCRA (Subtitle C) is an ARAR for the Phase I Work.

Sections 401 and 404 of the Federal CWA – Water Quality Certification and Dredge and Fill Requirements (33 U.S.C. 1340, 1344; 33 CFR Parts 320 through 330 and 40 CFR Parts 230 and 231) set forth requirements for water quality certification and for dredging and placing fill materials into the waters of the United States, respectively, and are applicable to all potential Phase I Work Alternatives. Therefore, Sections 401 and 404 of the CWA are ARARs for the Phase I Work.

Section 401 requires that a certification of water quality be issued by the responsible government authority to state that removal actions will not violate applicable water quality standards. A Section 404(b)(1) evaluation is typically completed to confirm that

the in-water work complies with the requirements of CWA Section 404. Specifically, the selected alternative will need to comply with the substantive requirements of USACE Nationwide Permit (NWP) No. 38, Cleanup of Hazardous and Toxic Wastes. The general conditions of the NWP No. 38 pertinent to the removal action are summarized as follows:

- *Navigation* – Activity cannot cause more than a minimal adverse impact on navigation.
- *Fills within 100-Year Floodplains* – The removal action construction must comply with Federal Emergency Management Agency or local floodplain management requirements.
- *Proper Maintenance* – Any structure or fill must be properly maintained.
- *Erosion and Sediment Controls* – Appropriate erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.
- *Aquatic Life Movements* – Activity may not substantially disrupt the necessary lifecycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water.
- Heavy Equipment – Measures must be taken to minimize soil disturbance.
- Water Quality – No activity may result in more than minimal degradation of water quality.

Off-Site Disposal Rule (40 CFR 300.440) applies to wastes generated from CERCLA-authorized cleanup activities that are sent off site for disposal. The receiving disposal unit must meet minimum technology standards and have not had any releases or, if a release has occurred, a corrective action agreement needs to be in place to clean up the release. Therefore, the off-site disposal rule is an ARAR for the Phase I Work.

Land Disposal Restrictions (40 CFR 268) are USEPA-promulgated criteria specific to the land disposal of hazardous wastes. The criteria require that soil or sediment that

contains hazardous wastes and are planned for land disposal meet the Land Disposal Restrictions (LDRs). The alternative treatment standards in the LDRs allow soil (or sediment) to be land disposed if the hazardous constituents are reduced by 90 percent or meet 10 times the UTS. These treatment standards also apply to all underlying hazardous constituents when they are found at concentrations greater than 10 times the UTS. Because it is possible that sediment removed from the Phase I Work Area may be considered hazardous; therefore, the LDRs are an ARAR for the Phase I Work.

6.2.3.2 State

New Jersey Solid Waste Management Act (N.J.S.A. 13:1E-1 et seq.) does not apply to dredged material; however, materials transported off site for disposal must be transported via a registered solid waste carrier; therefore, the New Jersey Solid Waste Management Act is an ARAR for the Phase I Work.

New Jersey Water Pollution Control Act (N.J.S.A. 58:10A et seq. 58:10A- 1 et seq., 58:11A- 1 et seq., 58:11-49 et seq., 58:10-23.11 et seq., 58:11-18.10 et seq., 13:1D-1 et seq., 13:1E-1 et seq., 58:4A-5, 58:4A-4.1, 58:12A-1 et seq.) – NJPDES Rules set forth the rules concerning implementation and operation of the NJPDES permit and Treatment Works Approval (TWA) program. An NJPDES permit is required to discharge any pollutant to surface and groundwater of the state. A TWA is required to build, modify, install, or operate any facility for the collection, treatment, or discharge of any pollutant. The need for a treatment plant triggers the need for a General Industrial Treatment Works Permit equivalency. Treated water will likely be discharged to surface water, which will require a NJPDES Surface Water Discharge Permit equivalency from the Bureau of Point Source Permitting; therefore, the New Jersey Water Pollution Control Act is an ARAR for the Phase I Work.

New Jersey Technical Requirements for Site Remediation (N.J.A.C. 7:26E-1.13, -2.1, -2.2, -3.4, -3.8, -3.11, -4.5 and -4.7) The NJDEP has developed a detailed process for the technical aspects of investigating and remediating contaminated sites known as the “New Jersey Technical Requirements for Site Remediation.” The process is presented in N.J.A.C. 7:26E-1et seq. These rules constitute the minimum technical requirements to investigate and remediate contamination at any site in New Jersey. The concepts in the rules are similar to requirements in USEPA rules and guidance with instructions on the investigation and remediation process. The New Jersey Technical Requirements for Site Remediation is an ARAR for the Phase I Work.

6.3 To Be Considered

The USEPA has developed another category of requirements called TBCs, which includes non-promulgated criteria, guidance, and proposed standards issued by federal or state governments. TBCs are not promulgated or enforceable, and identification of and compliance with TBCs are not mandatory in the same way they are for ARARs. Other than USEPA's Guidance on Green Remediation (USEPA 2008b) and local applicable standards (specifically by the City of Newark), there do not appear to be any TBCs that would apply to the Phase I Work Area. It is possible that the City may require construction permits for temporary structures required to complete the Phase I Work. Other local regulations will be reviewed and considered for applicability.

7. Technology Screening

In accordance with USEPA guidance (1993), "only the most qualified technologies that apply to the media or source of contamination" need to be considered for the development, comparative evaluation, and selection of removal action alternatives. For purposes of this Phase I EE/CA, the following seven elements (referred to as general technology screening groups) have been identified for use in implementing the Phase I Work and in meeting the established Phase I RAOs:

- Containment and shoreline stability
- Sediment removal
- Sediment processing
- Water treatment and discharge
- Off-site transport of sediment
- Off-site treatment and disposal
- Backfilling.

Process options were identified for each technology screening group and are discussed in subsequent sections. These process options are then subsequently screened for use based on effectiveness, implementability, and relative cost (USEPA 1993). Table 7-1 provides the evaluation of each process option. The remaining portions of Section 7 provide a summary of the evaluation from Table 7-1.

7.1 Containment and Shoreline Stability

A sheet pile enclosure surrounding the Phase I Work Area is required per the 2008 AOC (USEPA 2008a). Such containment not only provides control of sediment resuspension that occurs during sediment removal, but it also provides excavation support. Finally, this structure will serve to stabilize existing shoreline structures during the removal.

Once the sheet pile enclosure is built, and prior to sediment removal, the enclosed surface water can be pumped out (removal in the dry) or remain (removal in the wet)

within the Phase I Work Area. As shown in Table 7-1, removal in the wet has been retained because it is considered more effective and implementable than removal in the dry. Factors accounted for included:

- Removal in the dry would limit sediment removal process options, which are discussed in Section 7-.2, and may result in vertical groundwater seepage that could destabilize the bottom of the excavation.

- Removal in the dry would likely produce much more water for treatment than removal in the wet because all of the surface water within the Phase I Work Area enclosure would be pumped out prior to removal and treated prior to discharge. In addition, it is likely that additional pumping/treatment would be required throughout the project to maintain "dry" conditions in the excavation area due to potential inflows such as groundwater infiltration.

- Removal in the dry would likely produce air quality impacts from the exposed sediment that may affect workers and the surrounding community.

- Removal in the dry may result in increased ecological risks as birds that forage on mudflats may forage on the exposed sediment.

- Removal in the dry production rates would be lower than equivalent mechanical dredge excavator used for removal in the wet because river stage and tide may limit dredging time.

7.2 Sediment Removal

Sediment removal is a fundamental component of the 2008 AOC (USEPA 2008a). Sediment removal process options that were screened include:

- Mechanical

- Hydraulic

- High-solids pump

- Caisson.

As shown in Table 7-1, all four sediment removal process options have been retained. However, mechanical, hydraulic, and high-solids pump removal are the process options of primary choice. Caisson dredging has also been retained, but only as a specialized option for purposes of removing sediment adjacent to shoreline structures. As such, this particular process option could ultimately be used in combination with one or more of the primary options; however, it is not considered further in this Phase I EE/CA.

In addition to the sediment, abundant debris (including timber piles, woody debris, and metal objects) is expected to be encountered during removal. As this debris is not expected to be confined to the top of the sediment bed, it will have to be managed throughout the sediment removal operation. Debris is likely to consist of both over-sized and smaller materials. Unlike smaller debris, over-sized debris, such as cars or logs or other large objects, will be removed mechanically and handled separately from the sediment. Such handling could require a dedicated (and different) removal process option. For example, if a hydraulic dredge was selected as the primary removal process option, a mechanical dredge might also be needed to remove the over-sized debris.

A debris survey will be conducted during design to identify debris that may be present in the Phase I Work Area. However, the debris survey would only identify materials that may be present in the upper portion of the sediment bed or, with some technologies, metallic objects at depth.

7.3 Sediment Processing

Sediment processing (assumed to occur at the Sherwin-Williams property) may include solids separation and/or sediment dewatering. Dewatering is necessary to meet treatment or disposal facility requirements for no free standing water on the sediment (i.e., the sediment must pass the paint filter test to be accepted by the treatment or disposal facility). The RAOs and ARARs also require measures to prevent, to the extent practicable, the potential for spillage or leakage of free water during transport, either by on-site processing or by transportation in water-tight containers. The Phase I Work will use both of these methods.

Solids separation is needed to remove debris and other over-sized solids from the sediment so that the dewatering process option can function properly. Both solids separation and dewatering are described further below. Discussion of oxidation, polymerization, and stabilization is presented in Section 7.6.

7.3.1 Solids Separation

Solids separation based on particle size was screened in Table 7-1 as a stand-alone process option for sediment processing (that is, it was not compared to dewatering as the objectives of solids separation and dewatering are different and, therefore, not comparable). Solids separation would likely include the removal of large solids, including smaller debris, via Grizzly™ or equivalent equipment. This step is needed to remove larger solids that may damage the dewatering equipment and minimize functionality. Solids separation may also include the removal of sand-sized solids via hydrocyclone or similar equipment. This step is needed for mechanical dewatering. If the sand is not removed, it can settle in the slurry pipe and clog the pipe. Sand can also damage mechanical dewatering equipment. During design, the percentage of sand present in the sediment and the need for solids separation (including an assessment of the optimum amount of sand needed to operate the dewatering equipment) will be evaluated.

As indicated in Section 7.2, over-sized debris will likely be encountered during the Phase I Work. However, over-sized debris processing was not screened in Table 7-1 as it is not considered a sediment processing process option. Instead, it is discussed here to describe how such debris will be handled.

Once removed and stockpiled, over-sized debris will be pressure washed. The rinse water will be collected for subsequent treatment, and the sediment will be collected for processing. Once the rinsing is completed, the over-sized debris will be stockpiled (including any debris generated from the solids separation) for disposal as described in the off-site treatment and disposal section (Section 7.6).

7.3.2 Dewatering

Following solids separation, dewatering reduces the moisture of sediment to meet the off-site treatment and disposal facilities' criteria (i.e., paint filter test). Dewatering also produces a material more amenable to handling with general construction equipment. The following three process options for dewatering were screened in Table 7-1:

- Geotextile tubes
- Mechanical dewatering
- Gravity dewatering and amendment.

As shown in Table 7-1, two dewatering technologies, geotextile tubes and mechanical dewatering, were retained. Although geotextile tubes were retained, they are a less feasible option for the Phase I Work than mechanical dewatering because of the fine-grained sediments, the longer time needed to dewater the sediment, and the likelihood that additional dewatering in stock piles may be needed. Mechanical dewatering may utilize filter presses, belt presses, or similar equipment. Final equipment selection will be evaluated in the design.

7.4 Water Treatment and Discharge

Treatment of collected water will be required prior to discharging it to the Passaic River. Water that will be treated includes that which is generated during sediment and debris processing and decontamination water. The two general water treatment options that were screened (Table 7-1) include:

- On-site water treatment plant
- Publicly owned treatment works (POTWs).

Passaic Valley Sewerage Commissioners have indicated in the past that they will not accept groundwater unless no other discharge alternative is available (BBL 2006). A similar response to water generated from a sediment remediation project is expected. Consequently, the POTW was not retained for further consideration

As shown in Table 7-1, the on-site water treatment plant process option has been retained. The plant would likely be installed at the upland site, and include physical and chemical processes, such as flocculation, clarification, multimedia filtration, and granular-activated carbon adsorption. On-site water treatment plants have successfully been used at other sites, including OU-1, whose discharges fully comply with all discharge permit quality requirements.

The ability of the water treatment plant to meet discharge standards will be confirmed during design (i.e., treatability studies). The proposed water treatment plant will use similar treatment processes as the existing OU-1 GWTS. The OU-1 GWTS has consistently met the cleanup standards (effluent limitations) for discharge to the Passaic River (BBL 2006). It was also assumed that the permit equivalency for water treatment plant will have associated discharge requirements.

The OU-1 GWTS was not included as a possible water treatment process option given the potential of the regulatory implications of mixing waste streams from two different remediation sites. In addition, it was estimated that the existing system was undersized by at least a factor of ten.

7.5 Off-Site Transport of Sediment

Transportation and disposal will be a major logistical component of any alternative selected. For this Phase I EE/CA, off-site transport technologies are defined as those used to move sediment following processing. For the Phase I Work, the off-site transport will likely be conducted in several phases (if needed), the first of which will be to convey dewatered sediment to the treatment or disposal facility.

Off-site transport modes for dredging projects are commonly overland, but may also include waterborne (or some combination). The selection of the appropriate transportation method will be based on its compatibility with the sediment treatment and disposal facilities.

For purposes of this Phase I EE/CA, transport technologies that were screened in Table 7-1 include:

- Truck transport
- Rail transport
- Barge transport.

Generally, all three transport technologies are feasible, and none of the technologies were eliminated from consideration. Of the three, truck transport is the least desirable mode because of the large number of trucks required, producing greater potential risk to the surrounding community (i.e., diesel fumes, noise, and potential accidents). For the purposes of this Phase I EE/CA, a combination of rail transport from the processing site with some trucking from the rail terminal to the disposal facility was assumed as the method of transport of the processed sediment. It was also assumed that backfill materials would be transported by rail to the site.

The final transport approach will not be determined until the selection of the off-site treatment and disposal facilities, because the two are so closely linked. Regardless of the transport technology ultimately selected, the sediment was assumed to be

transported in sealed intermodal containers. This will allow movement of the sealed container from one transport technology to another, if needed, without direct contact with the sediment. The use of sealed intermodal containers will also help meet the RAO of minimizing release of sediment during transport. Whether debris is transported in a sealed intermodal container will depend on the nature and size of the debris.

7.6 Off-Site Treatment and Disposal

Off-site treatment and disposal of the removed sediment is required per the 2008 AOC (USEPA 2008a). Based on existing analytical data, a portion of the sediment has the potential to be classified as a characteristic hazardous waste due to the presence of hazardous constituents above the toxicity regulatory levels (see Section 3). The existing data also show that some of the sediment contain dioxins as an underlying hazardous constituent.

For purposes of this Phase I EE/CA, it was assumed that 50 percent of the sediment will be classified as a characteristic hazardous waste and also contains dioxin concentrations above the UTS and, therefore, would require treatment before disposal. It was assumed the remaining 50 percent of the sediment will be environmental media and would not require treatment prior to land disposal. It was assumed the debris is not a characteristic hazardous waste and does not contain underlying hazardous constituents that require treatment. Therefore, the debris would require neither treatment nor disposal in a hazardous waste landfill.

During design, the percentage of sediment requiring treatment will be further refined. Characterization may occur either in-situ (i.e., based on characterization of the Phase I Work Area prior to removal) or ex-situ (i.e., based on characterization of stockpiled dewatered sediment). At this time, it is expected that characterization of stockpiled sediment would be performed prior to transport for off-site treatment and disposal. The chemistry of the sediment would be evaluated to determine if treatment is needed and, if so, the appropriate disposal option.

Although RCRA does not specify a technology-based treatment standard for dioxins, incineration is the only technology that has been shown to meet the numerical-based treatment standard in 40 CFR Part 268.48. Incineration would also treat any other organics present in the sediment. The rate at which the treatment facility can accept material may result in processed sediment being stored temporarily at the processing facility.

For purposes of this Phase I EE/CA, it was assumed that incineration would be the selected treatment process option for those sediments with dioxins greater than the UTS. However, during design, other potential treatment methods will be evaluated, such as oxidation or use of polymers, to reduce contaminant levels prior to transport off site and disposal. Presumptive treatment technologies for metals include physical/chemical treatment, such as solidification and stabilization. This may occur after treatment, such as incineration, to stabilize metals in the ash. Given the potential for metals to be present, the sediment may be treated using solidification or stabilization. Following treatment to meet land disposal criteria, the sediment will be disposed in a RCRA-permitted landfill. Sediment off-site treatment and disposal technologies are screened in Table 7-1 and include:

- Subtitle C landfill
- Incineration and Subtitle C and D landfills.

As shown in Table 7-1, the retained sediment off-site treatment and disposal option was combined treatment and landfill disposal. Sediment that is classified as a characteristic hazardous waste and also contains dioxin concentrations above the UTS will be treated and the resulting ash will be disposed in a Subtitle C landfill. Sediment that is considered environmental media will not undergo treatment and will be disposed in a Subtitle C landfill. Debris will likely be disposed in a Subtitle D landfill. The potential for recycling debris will be evaluated in design.

7.7 Backfilling

Following sediment removal, the Phase I Work Area will be restored by backfilling to at or near pre-removal surface elevations. Backfilling will be performed to maintain the stability of existing shoreline structures and to approximate existing groundwater flow conditions in the Phase I Work Area. Backfill material will have similar physical characteristics to the in-situ sediment, but with improved engineering properties, such as low plasticity index. Backfilling process options were not developed because backfilling will not affect the alternatives developed (i.e., sediment removal equipment can be used to backfill the Phase I Work Area). The type of backfill material used also does not affect the alternatives.

Backfill materials and placement methods will be determined during design. Local sources of backfill will be considered during design. Restoration of the Phase I Work Area will also need to consider the schedule and activities of the Phase II Work.

7.8 Summary of Technology Screening

The seven technology screening groups for the Phase I Work include containment and shoreline stability, sediment removal, sediment processing, water treatment and discharge, off-site transport of sediment, off-site treatment and disposal, and backfilling. Within each technology screening group, a number of process options exist. Based on the analysis presented in Table 7-1, most of the process options were found to be effective and implementable for the Phase I Work. The retained process options were used to develop the Phase I Work Alternatives, as described in Section 8 of this Phase I EE/CA.

8. Identification and Evaluation of Phase I Work Alternatives

In accordance with NTCRA guidance, a limited number of alternatives should be identified and assessed based on their ability to address the established RAOs (USEPA 1993). This section discusses how the applicable technologies (and associated process options) were combined to develop the removal action alternatives, provides a description of the alternatives, and evaluates each alternative based on appropriate criteria. These criteria, as required in the NTCRA guidance (USEPA 1993), are outlined in the Phase I EE/CA Work Plan (ARCADIS 2008) as follows:

- Effectiveness
  - Protectiveness
    - Protection of human health and community
    - Protection of workers during implementation
    - Protection of the environment
    - Compliance with ARARs
  - Ability to achieve RAOs
    - Level of treatment/containment expected
    - No residual effect concerns
    - Will maintain control until long-term solution implemented
- Implementability
  - Technical feasibility
    - Constructional and operational considerations
    - Demonstrated performance
    - Adaptability to environmental conditions
    - Compatibility with future LPRSA remedial actions and with the in-place OU-1 selected remedy (with biennial evaluation)
    - Ability to complete within timeframe specified by the 2008 AOC (USEPA 2008a)
  - Availability
    - Availability of equipment, personnel, and labor
    - Available laboratory, treatment, and disposal capacity
    - Post-removal site controls

- Administrative feasibility
  - Required permits
  - Easements
  - Impacts on adjoining properties
  - Institutional controls
  - Likelihood of exemptions
- Relative cost.

Four alternatives were identified and developed for evaluation. These alternatives are described below. It should be noted that for certain technology screening groups, such as water treatment or backfilling, only one applicable process option was determined to be feasible. For those technologies, the single process option was included in all of the alternatives.

Following the identification and evaluation of the Phase I Work Alternatives in this section, the alternatives are compared in Section 9, and a single recommendation is identified in Section 10.

8.1 Identification and Evaluation of Alternatives

The following alternatives were developed from the process options retained in Section 7:

- *Alternative A*: Hydraulic removal with geotextile tube processing
- *Alternative B*: Hydraulic removal with mechanical processing
- *Alternative C*: Mechanical removal with mechanical processing
- *Alternative D*: High-solids pump removal with mechanical processing.

Figures 8-1 through 8-4 provide schematic depictions of the process flow for each of the Phase I Work Alternatives, a summary of the process options chosen for each alternative, and pertinent details and assumptions relating to the process options. These figures are intended to be conceptual in nature and should not be confused with design-level details, which will be provided during design.

The approximate construction durations described for each alternative were based on typical production rates for sheet pile installation, sediment removal, and backfilling that were achieved on similar projects, and extend from mobilization to backfilling. This does not account for subsequent activities (e.g., sheet pile removal, remaining off-site transport and disposal, and demobilization).

8.1.1 Common Elements

Because this Phase I EE/CA focuses solely on sediment removal and associated activities, there are a number of common elements among the four Phase I Work Alternatives. The purpose of this subsection is to present a brief discussion of these elements to avoid having to repeat them throughout.

In general, all four Phase I Work Alternatives involve the removal of 40,000 cy of sediment from within a sheet pile enclosure and off-site treatment/disposal. In addition, the removed sediment will be processed prior to transport off site in accordance with requirements of the disposal facilities and the selected transport method. Water produced from the operations will also require treatment prior to discharge to the Passaic River. To complete the in-river work, the Phase I Work Area will be backfilled.

Each of the Phase I Work Alternatives was developed to include these operational elements. Further details on these and other common processes are provided below.

8.1.1.1 Site Preparation and Baseline Monitoring

All of the Phase I Work Alternatives assumed that upland activities, including staging, sediment and debris processing, and water treatment will occur at the Sherwin-Williams property located to the west of OU-1. Tierra is currently in discussions with Sherwin-Williams to confirm this arrangement. For the purposes of the remaining sections of this Phase I EE/CA, the Sherwin-Williams property will be referred to as the upland site.

To prepare the upland site for work, mobilization activities will commence, including construction of staging areas, stockpile footprint liners, and mobilization of process equipment.

Tierra anticipates that water quality monitoring and air monitoring will begin prior to the start of work to establish baseline conditions against which to compare during and after construction. The monitoring results will be used to assess potential construction-

related impacts to the workers' well-being, and that of the surrounding community and environment. A pre-construction bathymetry survey will also be conducted.

8.1.1.2 Construction Monitoring

It is anticipated that monitoring will be conducted throughout the duration of the Phase I Work, including:

- Health and safety monitoring
- Water quality monitoring
- Air monitoring
- Water treatment discharge monitoring
- Deflection monitoring for the sheet pile enclosure to confirm that construction activities do not cause unacceptable deflections.

Water surface elevation monitoring and current monitoring may also be performed. In addition, overall construction monitoring will likely be conducted by Tierra throughout the Phase I Work. Final definition of all monitoring work will be provided during design.

Tierra recognizes the importance of protecting the surrounding community during a project such as this. Accordingly, Tierra will work together with USEPA, NJDEP, and community members to ensure that quality of life issues, such as noise, odor, road traffic, navigational traffic, water quality, air quality, and light are accounted for during design. Both a CIP and CHASP will be developed as part of the overall project implementation. The CIP will describe measures to coordinate with the public as the design and removal action progress, while the CHASP will address the protection of community health and safety during removal activities.

8.1.1.3 Containment

All of the alternatives assume the use of a sheet pile enclosure to contain the Phase I Work Area. This structure will be designed to contain any dredging-induced sediment resuspension. Sealed joints will be used for all sections of the enclosure to reduce the interlock permeability to negligible values. The portion of the sheet pile enclosure located along the shoreline will provide protection and stability to the existing floodwall

and bulkhead adjacent to the removal area. This stretch of sheeting will be driven as close as practical to the existing structures without impacting their structural integrity.

In addition, the sheet pile enclosure will be used to provide excavation support and regulate the water depth within the Phase I Work Area. The Passaic River is tidally influenced, and during low tides, there may not be adequate draft for vessels to maneuver in the Phase I Work Area. The sheet pile enclosure will allow the water depth to be regulated throughout the removal to provide adequate draft for working vessels.

As indicated in Section 3, a preliminary hydrodynamic model was developed to help assess (at least conceptually) hydrostatic forces along the sheet pile walls, as well as with the potential for scour outside of the structure. With this information, the associated cost estimates were better able to account for sizing of the sheeting and scour protection that may be needed during construction. The model will be developed more thoroughly during the design process, which will also help to determine the potential for flooding as a result of installing this temporary enclosure.

The presence of debris or obstructions will be considered during design and a contingency will be developed should such materials be encountered during installation of the sheeting.

8.1.1.4 Sediment and Debris Removal

Sediment removal activities will commence once the sheet pile enclosure is in place. Sediment removal methods vary among alternatives, and are discussed in the subsections that follow.

Debris removal may occur by multiple methods. Over-sized debris, such as cars, logs, or other large objects, will be removed by a mechanical dredge, regardless of the chosen sediment removal process option. The removal of smaller debris will likely be coincident with sediment removal activities. For the purposes of this Phase I EE/CA, it was assumed that 3 percent of the total volume of the 40,000 cy of material removed will consist of debris, including both over-sized and smaller debris. (Note: this percentage has been factored into the breakout of sediment quantities, as discussed previously.)

8.1.1.5 Sediment Processing

The alternatives have varying upland sediment processing footprint requirements, which are shown on Figures 8-1 through 8-4. All of the alternatives currently assume that the sediment processing equipment will be staged at the upland site. To determine approximate footprints for each alternative, preliminary sizing of dewatering units, water treatment units, and stockpiles were calculated using the production rates shown on Figures 8-1 through 8-4.

For all alternatives, the sediment will be passed through a Grizzly™ screen to separate out smaller debris and vegetation. The resulting sediment slurry will then pass through hydrocyclones to separate out the sand fraction of the material. The sand fraction will be stockpiled and gravity dewatered, and the resultant decant water will be pumped through the water treatment system and subsequently discharged to the Passaic River.

The sediment will then be dewatered using the methods described within the specific alternative descriptions that follow. There will likely be multiple stockpiles of sediment, including sand from the hydrocyclone, dewatered sediment requiring treatment, and dewatered sediment not requiring treatment. Stockpiles will be covered to limit potential exposure to odor, dust, and air quality impacts to site workers and the surrounding community.

As indicated previously, it has been assumed that 3 percent of the total volume of the 40,000 cy of material to be removed will consist of debris. Over-sized debris will be processed separately from all else. First, the material will be rinsed using pressure washing, and the rinse water collected for treatment. The sediment will also be collected for processing. The over-sized debris will be stockpiled together with the smaller debris and vegetation generated from the Grizzly™ screen.

8.1.1.6 Water Treatment and Discharge

Decant water collected from the various upland site operations will be treated as it is generated using a water treatment system. It was assumed the water treatment system will be located adjacent to the sediment processing operations, and will consist of polymer-assisted clarification and sand filtration, followed by granular-activated carbon adsorption. The treated water will be tested to confirm that any effluent limitations are met prior to discharging to the Passaic River. It is expected that initial discharges will be batched.

The ability of the water treatment plant to meet discharge standards will be confirmed through treatability studies during design. The proposed decant water treatment plant will use similar treatment processes as the existing OU-1 GWTS. The OU-1 GWTS has consistently met the cleanup standards (effluent limitations) for discharge to the Passaic River (BBL 2006).

The treated water will be recycled as process water, if needed, and/or will be discharged into the Phase I Work Area, thus creating a “closed loop” system. The discharge of treated water into the Phase I Work Area will help maintain the water level in the work zone. This will limit the need for adding water from other external sources (e.g., Passaic River).

8.1.1.7 Off-Site Transport, Treatment, and Disposal

The stockpiled sediment will be sampled accordingly to determine proper disposal. This ex-situ sampling was assumed for the purposes of the Phase I EE/CA, but its use will be confirmed during design. Characterization may also be conducted in-situ to segregate the material appropriately during removal.

For the purposes of this ex-situ characterization process, it was assumed that one sample will be collected for every 500 cy of stockpiled material. As indicated previously, there will likely be multiple stockpiles of sediment. After accounting for the 3 percent of debris, it was assumed that 50 percent of the sediment volume will qualify for disposal at a Subtitle C landfill, and that the remaining 50 percent of the material will require treatment at an incinerator. Prior to disposal, the approximate amount of space required for stockpiling is shown on Figures 8-1 through 8-4. This footprint size is based on a stockpile turnaround of 3 weeks. It was also assumed that removal will occur 6 days per week. Moisture controls (such as covering the stockpiles with plastic sheeting and runoff controls, such as berms) will be used to minimize, to the extent practicable, water from becoming reintroduced into the dewatered stockpiles. These controls will also provide protection to site workers and the community from potential exposure to potential odor, dust, and air quality impacts.

Regardless of the ultimate disposal facility selected, the stockpiled sediment will be loaded into sealed intermodal containers for off-site transport. Whether debris is transported in a sealed intermodal container will depend on the nature and size of the debris. The sealed intermodal containers will allow for transport by truck, train, or barge. The sediment will be handled in containers for intermodal transport instead of being transloaded or transferred between transportation types to minimize risk of

spillage, worker exposure, or other unforeseen situations that may result in the handling of the material in an uncontrolled manner. For instance, if there is no direct rail access at the treatment facility, the intermodal container could be loaded onto a rail car at the site and could travel by train the majority of the distance to the treatment facility, and could then be transferred to truck for the remainder of the distance. During transportation of the material, any one mode could be utilized, as necessary. As indicated previously, rail and barge are the preferred transport methods, but trucking may be needed for short distance hauling, particularly between the off-site barge/rail terminal and treatment/disposal facilities.

The sediment requiring treatment will then be incinerated (or treated by an alternative method if possible), and the resulting ash will be stabilized, as necessary, to address any remaining leachability of metals that may be present. The stabilized ash will be placed in a Subtitle C landfill. The sediment that does not require treatment will be transported directly to a Subtitle C landfill for disposal.

It is expected that the debris will be transported to a Subtitle D landfill for disposal.

8.1.1.8 Backfilling

Upon completion of the in-river removal activities, the Phase I Work Area will be backfilled. Backfill material will have similar physical characteristics to the in-situ sediment, but with improved engineering properties, such as a low plasticity index. At this time, it is expected that the original grades will be re-established, although this could change during design. The backfill will be compatible with any Phase II work efforts, and will be amenable to habitat restoration (surface only). The backfill was assumed to be placed using excavators on barges.

After completion of the backfill placement, the sheet pile enclosure will be removed.

8.1.2 Alternative A: Hydraulic Removal with Geotextile Tube Processing

A summary of the process options chosen for Alternative A, as well as a conceptual depiction of the process flow, are provided on Figure 8-1.

In addition to the components discussed in Section 8.1.1, Alternative A will include hydraulic dredging to remove the 40,000 cy of Phase I Work Area sediment. The sediment slurry will be transported through a pipeline to the upland site. After the Grizzly screen and hydrocyclone steps, the resulting fine-grained sediment slurry will

be pumped into geotextile tubes. Polymer will likely be added at this step to enhance dewatering, as it promotes sediment flocculation and speeds sediment settling time. The necessity of polymer addition will be determined during design with bench-scale testing.

The geotextile tubes will be staged on top of a liner, such as a geomembrane, with perimeter berms so that the decant water from the geotextile tubes will be contained and ultimately collected in a sump. Water treatment will be conducted throughout the duration of the geotextile tube dewatering as the decant water is generated. Once the dewatering in the geotextile tube is completed, the geotextile tubes will be opened and sampled. The samples will be analyzed to determine the appropriate disposal method. Other in-water activities, such as backfilling and sheet pile removal, will be conducted in parallel with geotextile tube dewatering once sediment removal was complete.

Alternative A will take approximately 27 weeks to complete removal and backfilling. To meet the AOC scheduling requirements, it is estimated that the work will begin in fall 2010 and be completed in spring 2011. This preliminary timeline assumes that there will not be any schedule extensions due to unforeseen administrative procedures (USEPA 2008a). This does not account for subsequent activities (e.g., time to dewater sediment in geotextile tubes, sheet pile removal, remaining off-site transport and disposal, and demobilization).

8.1.2.1 Effectiveness

Protectiveness

Alternative A will be protective as it will remove a mass of contaminated material currently in the river and treat it in accordance with USEPA requirements. Hydraulic dredging reduces worker exposure to the sediment targeted for removal because the sediment is removed from below the water surface and piped directly to the sediment processing area. This also reduces potential health and safety impacts to the community (i.e., dust and odor). Potential exposure of workers to contaminated material on over-sized debris will exist.

Transporting the sediment off site in sealed intermodal containers will also limit worker (and community) exposure.

The sheet pile enclosure prevents short-term exposure to the surrounding environment below the water surface by containing any dredging-induced sediment resuspension

and allowing it to redeposit within the Phase I Work Area. Sealed joints will be used to reduce the interlock permeability to negligible values. The final remedy will be protective of the environment, by removing the contaminated sediment currently in the river and backfilling the removal void with material that has similar physical characteristics to the in-situ sediment, but with improved engineering properties, such as a lower plasticity index.

Alternative A can be designed and implemented to meet the substantive requirements of the ARARs. ARAR waivers are not anticipated to be necessary for this alternative.

Ability to Achieve Removal Action Objectives

Alternative A will achieve the RAOs by removing a portion of the most contaminated sediment in the LPRSA and treating and disposing the sediment off site. It also meets NTCRA guidance, which states a preference for treatment with low residual concentrations remaining in the treated sediment. The migration of sediment resuspended due to removal operations will be mitigated by completing the Phase I Work within the sheet pile enclosure.

Dewatering the sediment will reduce the water content, and thereby reduce the potential for leakage of sediment and contaminants during transport to the disposal site. The potential for spillage or leakage of sediment and contaminants during transport to the disposal site will be further minimized by using sealed intermodal containers, because the containers will leave the site and arrive at their final destination without requiring the material inside to be handled in an uncontrolled manner.

Backfilling the Phase I Work Area will at least partially restore the habitat and allow for future habitat restoration.

8.1.2.2 Implementability

Technical Feasibility

Alternative A requires sheet piles for containment of the Phase I Work Area, which are commonly used in sediment removal projects and prevent the dispersion of resuspended sediment during dredging. The containment allows sediment to be removed at a consistent production rate, without requiring operational controls or other engineering controls to mitigate resuspended sediment from migrating away from the

Phase I Work Area. The sheet pile enclosure also provides excavation support and shoreline structural stability during the removal and maintains a consistent water depth through the duration of the removal by mitigating the impacts of the tidal cycles within the Phase I Work Area.

Hydraulic dredging is a common sediment removal method that is widely available and is advantageous due to the production rate it can achieve under ideal conditions and does not require additional handling between the dredge and processing facility. However, hydraulic dredging does not effectively handle debris. The presence of an abundance of debris can slow the dredging rate significantly and can cause operational difficulties if debris becomes entrained in the dredgehead. Over-sized debris will not be removed by a hydraulic dredge; rather, a mechanical dredge will be used. Further, a higher production rate may not be advantageous if the rate of sediment processing and water treatment capacity have practical limitations, and/or if the ability of the incineration facility to accept transported materials for treatment has constraints on throughput treatment rate. Hydraulic dredging is also less effective at removing material around structures, like the sheet pile enclosure along the shoreline.

Geotextile tube dewatering has been successfully applied as a dewatering means on sediment remediation projects and can be combined seamlessly with hydraulic dredging, because the sediment slurry can be pumped directly into geotextile tubes, and any required polymer can be directly fed without an additional material handling step. Geotextile tubes require a large amount of relatively flat upland space, making them less feasible if available space is restricted. Based on the required residence time in the geotextile tubes, it is expected that the geotextile tube dewatering will take at least 15 weeks, once the tubes were completely filled. Depending on the grain size of the material and whether polymer was added to facilitate the dewatering process, this duration could be longer. These factors will be determined during design. The ability of and required time for geotextile tubes to effectively dewater high plasticity, fine-grained sediment, such as the material to be removed from the Phase I Work Area, also makes geotextile tubes less technically feasible.

All transportation options identified in Section 7 are technically feasible for Alternative A because access is available to all three transportation modes within the vicinity of the Phase I Work Area.

Alternative A will be compatible with Phase II Work. The proposed backfill will allow for future habitat restoration and will allow for adjacent removals to be conducted without constraints on removal extent or methods.

Availability

The equipment and personnel for the proposed process options in Alternative A are typically available. The enclosures required for Alternative A may have lead time requirements that will necessitate their procurement well in advance of construction (about 3 to 4 months). The incineration option for dioxins has limitations on available facilities and maximum throughput quantity. The characterization of stockpiled sediment will also be limited by the capacity of laboratories to provide expedited analytical results. Throughput of the removal process for Alternative A will have to be optimized during design considering the limitations on turnaround time for analytical results, transportation time to the off-site treatment and disposal facilities, and throughput at the off-site treatment and disposal facilities. Backfill is available and local sources of material will be considered during design.

Administrative Feasibility

The permits or permit equivalencies for the Phase I Work are described in Section 6. It is expected that obtaining licenses and permits (or meeting the substantive requirements) will be feasible for Alternative A.

8.1.2.3 Relative Cost

The total estimated cost for Alternative A is $53,900,000. Appendix A provides a breakdown of the costs, as well as a summary of the assumptions made to develop the costs. In accordance with the USEPA cost estimating guidance (USEPA 1993), the costs are intended to be estimates within a -30 to +50 percent range.

8.1.3 Alternative B: Hydraulic Removal with Mechanical Processing

A summary of the process options chosen for Alternative B, as well as a conceptual depiction of the process flow, are provided on Figure 8-2.

In addition to the technology components discussed in Section 8.1.1, Alternative B will include hydraulic dredging to remove the 40,000 cy of Phase I Work Area sediment. The sediment slurry will be transported through a pipeline to the upland site. After the Grizzly™ screen and hydrocyclone steps, the resulting fine-grained sediment slurry will be mechanically dewatered using a filter press, belt press, or equivalent, and the resulting dewatered sediment will be stockpiled and covered. The approximate amount of space required for stockpiling is shown on Figure 8-2. This footprint size is based

on a stockpile turnaround of 3 weeks. It was assumed that removal will occur 6 days per week. The sediment removal duration could be longer if debris is encountered, which will impact the achievable production rate.

Alternative B will take approximately 27 weeks to complete removal and backfilling. To meet the AOC scheduling requirements, it is estimated that the work will begin in fall 2010 and be completed in spring 2011. This preliminary timeline assumes that there will not be any schedule extensions due to unforeseen administrative procedures (USEPA 2008a). This does not account for subsequent activities (e.g., sheet pile removal, remaining off-site transport and disposal, and demobilization).

8.1.3.1 Effectiveness

Protectiveness

Alternative B will be protective because it will remove a mass of contaminated material currently in the river and treat it in accordance with USEPA requirements. Hydraulic dredging reduces worker exposure to the sediment targeted for removal because the sediment is removed from below the water surface and piped directly to the sediment processing area. This also reduces potential health and safety impacts to the community (i.e., dust and odor). Potential exposure of workers to contaminated material on over-sized debris is similar for all alternatives.

Transporting the material off site in sealed intermodal containers will also limit worker (and community) exposure.

The sheet pile enclosure prevents short-term exposure to the surrounding environment below the water surface by containing any dredging-induced sediment resuspension and allowing it to redeposit within the Phase I Work Area. Sealed joints will be used to reduce the interlock permeability to negligible values. The final remedy will be protective of the environment, by removing the contaminated sediment currently in the river and backfilling the removal void with material that has similar physical characteristics to the in-situ sediment, but with improved engineering properties, such as a lower plasticity index.

Alternative B can be designed and implemented to meet the substantive requirements of the ARARs. ARAR waivers are not anticipated to be necessary for this alternative.

Ability to Achieve Removal Action Objectives

Alternative B will achieve the RAOs by removing a portion of the most contaminated sediment in the LPRSA and treating and disposing the sediment off site. It also meets NTCRA guidance, which states a preference for treatment with low residual concentrations remaining in the treated sediment. The migration of sediment resuspended due to removal operations will be mitigated by completing the Phase I Work within the sheet pile enclosure.

Dewatering the sediment will reduce the water content, and thereby reduce the potential for leakage of sediment and contaminants during transport to the disposal site. The potential for spillage or leakage of sediment and contaminants during transport to the disposal site will be further minimized using sealed intermodal containers because the containers will leave the site and arrive at their final destination without requiring the material inside to be handled in an uncontrolled manner.

Backfilling the Phase I Work Area will at least partially restore the habitat and allow for future habitat restoration.

8.1.3.2 Implementability

Technical Feasibility

Alternative B requires sheet piles for containment of the Phase I Work Area, which are commonly used in removal projects and prevent the dispersion of resuspended sediment during dredging. The containment allows sediment to be removed at a consistent production rate, without requiring operational controls or other engineering controls to mitigate resuspended sediment from migrating away from the Phase I Work Area. The sheet pile enclosure also provides excavation support and shoreline structural stability during the removal and maintains a consistent water depth through the duration of the removal by mitigating the impacts of the tidal cycles within the Phase I Work Area.

Hydraulic dredging is a common sediment removal method that is widely available and is advantageous due to the production rate it can achieve under ideal conditions and does not require additional handling between the dredge and processing facility. However, hydraulic dredging does not effectively handle debris. The presence of an abundance of debris can slow the dredging rate significantly and can cause operational difficulties if debris becomes entrained in the dredgehead. Over-sized debris will not be

removed by a hydraulic dredge; rather, a mechanical dredge will be used. Further, a higher production rate may not be advantageous if the rate of sediment processing and water treatment capacity have practical limitations, and/or if the ability of the incineration facility to accept transported materials for treatment has constraints on throughput treatment rate. Hydraulic dredging is also less effective at removing material around structures, like the sheet pile enclosure along the shoreline.

Mechanical dewatering can be combined seamlessly with hydraulic dredging because the sediment slurry can be pumped directly into the sediment processing step without an additional material handling step. It can be used to dewater sediment at rates equal to those at which the dredge material is being produced.

All transportation options identified in Section 7 are technically feasible for Alternative B, because access is available to all three transportation modes within the vicinity of the Phase I Work Area.

Alternative B will be compatible with Phase II Work. The proposed backfill will allow for future habitat restoration and will allow for adjacent removals to be conducted without constraints on removal extent or methods.

Availability

The equipment and personnel for the proposed process options in Alternative B are typically available. The enclosures required for Alternative B may have lead time requirements that will necessitate their procurement well in advance of construction (about 3 to 4 months). The incineration option for dioxins has limitations on available facilities and maximum throughput quantity. The characterization of stockpiled sediment will also be limited by the capacity of laboratories to provide expedited analytical results. Throughput of the removal process for Alternative B will have to be optimized during design considering the limitations on turnaround time for analytical results, transportation time to the off-site treatment and disposal facilities, and throughput at the off-site treatment and disposal facilities. Backfill is available and local sources of material will be considered during design.

Administrative Feasibility

The permits or permit equivalencies for the Phase I Work are described in Section 6. It is expected that obtaining licenses and permits (or meeting the substantive requirements) will be feasible for Alternative B.

8.1.3.3 Relative Cost

The total estimated cost for Alternative B is $49,100,000. Appendix A provides a breakdown of the costs, as well as a summary of the assumptions made to develop the costs. In accordance with the USEPA cost estimating guidance (USEPA 1993), the costs are intended to be estimates within a -30 to +50 percent range.

8.1.4 Alternative C: Mechanical Removal with Mechanical Processing

A summary of the process options chosen for Alternative C, as well as a conceptual depiction of the process flow, are provided on Figure 8-3.

In addition to the technology components discussed in Section 8.1.1, Alternative C will include mechanical dredging to remove the 40,000 cy of Phase I Work Area sediment. As it is removed, the mechanically dredged material will be placed on barges within the enclosure. The barges will then navigate to the upland site within the sheet pile enclosure and be unloaded using excavators. The mechanically dredged material will be passed through a Grizzly™ screen to remove debris and then slurried by adding water. Another possible approach would be to place the sediment directly into a hopper on a barge. The hopper would serve the same function as the Grizzly™ screen to remove debris. After the sediment has passed through the hopper, it would be slurried on the barge and pumped to the upland site for sediment processing. The sediment slurry will then pass through hydrocyclones to separate out the sand fraction of the material.

Following the hydrocyclone step, the resulting fine-grained sediment slurry will be mechanically dewatered using a filter press, belt press, or equivalent, and the resulting dewatered sediment will be stockpiled and covered. The approximate amount of space required for stockpiling is shown on Figure 8-3. This footprint size is based on a stockpile turnaround of 3 weeks. It was assumed that removal will occur 6 days per week. The sediment removal duration could be longer if debris is encountered, which will impact the achievable production rate, although not as significantly as it would for hydraulic or high-solids pump removal.

Alternative C will take approximately 29 weeks to complete removal and backfilling. To meet the AOC scheduling requirements, it is estimated that the work will begin in fall 2010 and be completed in spring 2011. This preliminary timeline assumes that there will not be any schedule extensions due to unforeseen administrative procedures

(USEPA 2008a). This does not account for subsequent activities (e.g., sheet pile removal, remaining off-site transport and disposal, and demobilization).

8.1.4.1 Effectiveness

Protectiveness

Alternative C will be protective because it will remove a mass of contaminated material currently in the river and treat it in accordance with USEPA requirements. Mechanical dredging removes the sediment through the water column and above the water surface; the material is then placed on a barge. The sediment is exposed from the point it is pulled above the water surface until it is slurried, which results in exposure to workers and the surrounding environment within the confines of the Phase I Work Area. Potential volatilization of compounds from exposed sediment will be evaluated during design. Potential exposure of workers to contaminated material on over-sized debris is similar for all alternatives.

Transporting the sediment off site in sealed intermodal containers will also limit worker (and community) exposure.

The sheet pile enclosure prevents short-term exposure to the surrounding environment below the water surface by containing any dredging-induced sediment resuspension and allowing it to redeposit within the Phase I Work Area. Sealed joints will be used to reduce the interlock permeability to negligible values. The final remedy will be protective of the environment by removing the contaminated sediment currently in the river and backfilling the removal void with material that has similar physical characteristics to the in-situ sediment, but with improved engineering properties, such as a lower plasticity index.

Alternative C can be designed and implemented to meet the substantive requirements of the ARARs. ARAR waivers are not anticipated to be necessary for this alternative.

Ability to Achieve Removal Action Objectives

Alternative C will achieve the RAOs by removing a portion of the most contaminated sediment in the LPRSA and treating and disposing the sediment off site. It also meets NTCRA guidance, which states a preference for treatment with low residual concentrations remaining in the treated sediment. The migration of sediment

resuspended due to removal operations will be mitigated by completing the Phase I Work within the sheet pile enclosure.

Dewatering the sediment will reduce the water content, and thereby reduce the potential for leakage of sediment and contaminants during transport to the disposal site. The potential for spillage or leakage of sediment and contaminants during transport to the disposal site will be further minimized by using sealed intermodal containers, because the containers will leave the site and arrive at their final destination without requiring the material inside to be handled in an uncontrolled manner.

Backfilling the Phase I Work Area will at least partially restore the habitat and allow for future habitat restoration.

8.1.4.2 Implementability

Technical Feasibility

Alternative C requires sheet piles for containment of the Phase I Work Area, which are commonly used in removal projects and prevent the dispersion of resuspended sediment during dredging. The containment allows sediment to be removed at a consistent production rate, without requiring operational controls or other engineering controls to mitigate resuspended sediment from migrating away from the Phase I Work Area. The sheet pile enclosure also provides excavation support and shoreline structural stability during the removal and maintains a consistent water depth through the duration of the removal by mitigating the impacts of the tidal cycles within the Phase I Work Area.

Mechanical dredging is commonly used for sediment removal actions and is technically feasible. Over-sized debris that may be encountered during the removal process is better handled using mechanical methods, because mechanical buckets can remove debris more easily as compared to hydraulic or high-solids pump removal methods.

Mechanically dredged material must be slurried before it can be mechanically dewatered, which requires the addition of water to the dredged sediment. It can be used to dewater sediment at rates equal to those at which the dredge material is being produced.

All transportation options identified in Section 7 are technically feasible for Alternative C because access is available to all three transportation modes within the vicinity of the Phase I Work Area.

Alternative C will be compatible with Phase II Work. The proposed backfill will allow for future habitat restoration and will allow for adjacent removals to be conducted without constraints on removal extent or methods.

Availability

The equipment and personnel for the proposed process options in Alternative C are typically available. The enclosures required for Alternative C may have lead time requirements that will necessitate their procurement well in advance of construction (about 3 to 4 months). The incineration option for dioxins has limitations on available facilities and maximum throughput quantity. The characterization of stockpiled sediment will also be limited by the capacity of laboratories to provide expedited analytical results. Throughput of the removal process for Alternative C will have to be optimized during design considering the limitations on turnaround time for analytical results, transportation time to the off-site treatment and disposal facilities, and throughput at the off-site treatment and disposal facilities. Backfill is available and local sources of material will be considered during design.

Administrative Feasibility

The permits or permit equivalencies for the Phase I Work are described in Section 6. It is expected that obtaining licenses and permits (or meeting the substantive requirements) will be feasible for Alternative C.

8.1.4.3 Relative Cost

The total estimated cost for Alternative C is $44,700,000. Appendix A provides a breakdown of the costs, as well as a summary of the assumptions made to develop the costs. In accordance with the USEPA cost estimating guidance (USEPA 1993), the costs are intended to be estimates within a -30 to +50 percent range.

8.1.5 Alternative D: High-Solids Pump Removal with Mechanical Processing

A summary of the process options chosen for Alternative D, as well as a conceptual depiction of the process flow, are provided on Figure 8-4.

In addition to the technology components discussed in Section 8.1.1, Alternative D will include a high-solids pump to remove the 40,000 cy of Phase I Work Area sediment. The sediment slurry will be transported through a pipeline to the upland site. After the Grizzly™ screen and hydrocyclone steps, the resulting fine-grained sediment slurry will be mechanically dewatered using a filter press, belt press, or equivalent, and the resulting dewatered sediment will be stockpiled and covered. The approximate amount of space required for stockpiling is shown on Figure 8-4. This footprint size is based on a stockpile turnaround of 3 weeks. It was assumed that removal will occur 6 days per week. The sediment removal duration could be longer if debris is encountered, which will impact the achievable production rate.

Alternative D will take approximately 27 weeks to complete removal and backfilling. To meet the AOC scheduling requirements, it is estimated that the work will begin in fall 2010 and be completed in spring 2011. This preliminary timeline assumes that there will not be any schedule extensions due to unforeseen administrative procedures (USEPA 2008a). This does not account for subsequent activities (e.g., sheet pile removal, remaining off-site transport and disposal, and demobilization).

8.1.5.1 Effectiveness

Protectiveness

Alternative D will be protective because it will remove a mass of contaminated material currently in the river and treat it in accordance with USEPA requirements. Removal using a high-solids pump reduces worker exposure to the sediment targeted for removal because the sediment is removed from below the water surface and piped directly to the sediment processing area. This also reduces potential health and safety impacts to the community (i.e., dust and odor). However, high-solids pump intakes can clog, requiring workers to directly handle the debris and vegetation in order to clear the intake, which can result in higher potential exposure. Potential exposure of workers to contaminated material on over-sized debris is similar for all alternatives.

Transporting the sediment off site in sealed intermodal containers will also limit worker (and community) exposure.

The sheet pile enclosure prevents short-term exposure to the surrounding environment below the water surface by containing any dredging-induced sediment resuspension and allowing it to redeposit within the Phase I Work Area. Sealed joints will be used to reduce the interlock permeability to negligible values. The final remedy will be

protective of the environment, by removing the contaminated sediment currently in the river and backfilling the removal void with material that has similar physical characteristics to the in-situ sediment, but with improved engineering properties, such as a lower plasticity index.

Alternative D can be designed and implemented to meet the substantive requirements of the ARARs. ARAR waivers are not anticipated to be necessary for this alternative.

Ability to Achieve Removal Action Objectives

Alternative D will achieve the RAOs by removing a portion of the most contaminated sediment in the LPRSA and treating and disposing of the sediment off site. It also meets NTCRA guidance, which states a preference for treatment with low residual concentrations remaining in the treated sediment. The migration of sediment resuspended due to removal operations will be mitigated by completing the Phase I Work within the sheet pile enclosure.

Dewatering the sediment will reduce the water content, and thereby reduce the potential for leakage of sediment and contaminants during transport to the disposal site. The potential for spillage or leakage of sediment and contaminants during transport to the disposal site will be further minimized by using sealed intermodal containers because the containers will leave the site and arrive at their final destination without requiring the material inside to be handled in an uncontrolled manner.

Backfilling the Phase I Work Area will at least partially restore the habitat and allow for future habitat restoration.

8.1.5.2 Implementability

Technical Feasibility

Alternative D requires sheet piles for containment of the Phase I Work Area, which are commonly used in removal projects and prevent the dispersion of resuspended sediment during dredging. The containment allows sediment to be removed at a consistent production rate, without requiring operational controls or other engineering controls to mitigate resuspended sediment from migrating away from the Phase I Work Area. The sheet pile enclosure also provides excavation support and shoreline structural stability during the removal and maintains a consistent water depth through

the duration of the removal by mitigating the impacts of the tidal cycles within the Phase I Work Area footprint.

Removal with a high-solids pump is technically advantageous because of the relatively high-solids content of the slurry that it can achieve, compared to hydraulic dredge. A high-solids pump does not require additional handling between the dredge and processing facility. A high-solids pump is also effective at removing material near structures, like the sheet pile enclosure along the bulkhead. However, high-solids pumps do not effectively handle debris or vegetation. The presence of an abundance of debris can slow the dredging rate significantly. The pump inlet is prone to clogging with vegetation; as a result, production rates can be reduced if the pump regularly needs to be cleared. Over-sized debris will not be removed by a high-solids pump; rather, a mechanical dredge will be used.

Mechanical dewatering can be combined seamlessly with high-solids pump removal because the sediment slurry can be pumped directly into the sediment processing step without an additional material handling step. Mechanical dewatering can be used to dewater sediment at rates equal to those at which the dredge material is being produced.

All transportation options identified in Section 7 are technically feasible for Alternative D because access is available to all three transportation modes within the vicinity of the Phase I Work Area.

Alternative D will be compatible with Phase II Work. The proposed backfill will allow for future habitat restoration and will allow for adjacent removals to be conducted without constraints on removal extent or methods.

Availability

The equipment and personnel for the proposed process options in Alternative D are typically available. High-solids pump dredges are available but there are fewer of them then mechanical or hydraulic dredges. The enclosures required for Alternative D may have lead time requirements that will necessitate their procurement well in advance of construction (about 3 to 4 months). The incineration option for dioxins has limitations on available facilities and maximum throughput quantity. The characterization of stockpiled sediment will also be limited by the capacity of laboratories to provide expedited analytical results. Throughput of the removal process for Alternative D will have to be optimized during design considering the limitations on

turnaround time for analytical results, transportation time to the off-site treatment and disposal facilities, and throughput at the off-site treatment and disposal facilities. Backfill is available and local sources of material will be considered during design.

Administrative Feasibility

The permits or permit equivalencies for the Phase I Work are described in Section 6. It is expected that obtaining licenses and permits (or meeting the substantive requirements) will be feasible for Alternative D.

8.1.5.3 Relative Cost

The total estimated cost for Alternative D is $45,100,000. Appendix A provides a breakdown of the costs, as well as a summary of the assumptions made to develop the costs. In accordance with the USEPA cost estimating guidance (USEPA 1993), the costs are intended to be estimates within a -30 to +50 percent range.

8.2 Summary of Alternatives

All of the Phase I Work Alternatives considered meet the project requirements, namely removal of 40,000 cy of material within a sheet pile enclosure, with subsequent treatment and off-site disposal. The main differences between the Phase I Work Alternatives are the manner in which the sediment is removed and the manner in which the sediment is processed prior to transporting off site.

9. Comparative Analysis of Phase I Work Alternatives

This section presents a comparative analysis of the four Phase I Work Alternatives to evaluate their relative performance in relation to the evaluation criteria (effectiveness, implementability, and relative cost), as described in Section 8.

This comparative analysis was conducted to determine the most appropriate alternative for the Phase I Work. All of the alternatives meet the requirements of the 2008 AOC (USEPA 2008a), including removal of 40,000 cy of material within a sheet pile enclosure, with subsequent off-site treatment and disposal. The main differences between the alternatives include the manner in which the sediment is removed and the manner in which the sediment is processed prior to transporting it off site.

Table 9-1 provides a summary of the alternative comparison using the following criteria:

- *High*: the alternative better meets the criteria, as compared to the other alternatives, and earns a score of one.
- *Medium*: the alternative is similarly suited to meet the criteria as compared to the other alternatives, and earns a score of zero.
- *Low*: the alternative is not as well suited, as compared to the other alternatives, in meeting the criteria, and earns a score of minus one.

As illustrated in Table 9-1, the scores were summed to determine the recommended Phase I Work Alternative. The comparison is discussed below.

9.1 Effectiveness

9.1.1 Protectiveness

All four alternatives are equally protective of the community and the environment. Alternatives A and B are both considered to have the greatest overall protectiveness to workers because they both employ hydraulic dredging, which removes the sediment and transfers it via pipeline to the processing equipment, thereby reducing exposure of the material to on-site workers and the community. Alternative C ranked medium due to potentially increased worker exposure because mechanical dredging will remove the sediment out of the water column and place it in a barge, from which it may be

excavated and transferred or slurried and pumped to the upland site. Comparatively, this process results in greater exposure to on-site workers than the hydraulic alternatives. Alternative D ranks low for protectiveness of workers because of the potential for the high-solids pump to clog with debris and vegetation, requiring the workers to clear the pump inlet manually and, in turn, increasing their exposure risk. This exposure will only occur if debris and vegetation were large enough or prevalent enough to clog the pump inlet screen, otherwise, this level of worker exposure to the sediment will be negligible.

9.1.2 Ability to Achieve Removal Action Objectives

All of the alternatives are equally suited to achieve the RAOs and are all ranked high.

9.2 Implementability

9.2.1 Technical Feasibility

Alternative C is expected to have the highest technical feasibility of the alternatives. Alternative C is ranked high due to the ability of mechanical dredges to effectively remove debris that may exist within the Phase I Work Area, to successfully remove sediment close to shoreline structures, and the ability of mechanical processing to dewater silty, cohesive sediment. Hydrocyclones used to remove the sand content of the sediment, along with mechanical dewatering, all require a sediment slurry with a low-solids content to adequately process the material. Therefore, water will have to be added to the mechanically removed sediment to create a slurry of sufficient water content for processing. The production rates achievable with a mechanical dredge will not diminish its ability to remove the sediment within the AOC scheduling requirements, despite these additional steps.

Alternatives B and D are both ranked medium due to the ability to seamlessly transfer the sediment from the Phase I Work Area to the sediment processing step without requiring additional handling, but do not effectively manage the presence of debris. These two alternatives would require the use of a mechanical dredge to remove over-sized debris. Alternative D, using high-solids pumps, also has the ability to successfully remove sediment close to the containment enclosure. Alternative A is the lowest technically feasible alternative, due to the inability of hydraulic dredging to effectively manage or remove debris, and the inability of geotextile tubes to effectively dewater silty, cohesive sediment, which may require additional drying in stockpiles. Alternative A would also require the use of a mechanical dredge to remove over-sized

debris. Hydraulic and high-solids pump removal technologies may also have a comparatively greater degree of difficulty in removing sediment of high plasticity, as compared to mechanical technologies, which will be a factor with depth in this Phase I Work Area where moisture content may decrease and bulk density may increase. Conversely, the portion of sediment that is currently at or above the Atterberg liquid limit, is debris free, and exhibits behavior nearer to a fluid, may more readily be drawn into the intake of a hydraulic dredge or high-solids pump than a mechanical dredge.

9.2.2 Availability

Alternative A is ranked highest for availability because hydraulic dredges are widely available, and equipment and materials required for geotextile tube dewatering will be more easily procured than those for mechanical dewatering. Although geotextile tubes require a larger amount of upland space, the space is readily available at the upland site; therefore, this constraint is diminished. Alternative C ranks medium for availability because mechanical dredges are widely available, but mechanical dewatering equipment will require procuring more equipment and infrastructure than that required for geotextile tubes. Alternative B is also ranked medium because hydraulic dredges are readily available, and mechanical dewatering equipment will require procuring more equipment and infrastructure than that required for geotextile tubes. Alternative D is ranked low because high-solids pumps are not as readily available as hydraulic or mechanical dredges, and mechanical dewatering equipment will not be as readily available as geotextile tubes. All of the alternatives have equal limitations with regards to the availability of laboratory turnaround time for analytical sample results and throughput rate at the available incineration facilities.

9.2.3 Administrative Feasibility

The alternatives have similar administrative feasibilities. They all require the construction of a sheet pile enclosure and they also require some amount of upland space for sediment processing and material transloading. The required space is readily available for all of the alternatives, so it does not impact the administrative feasibility of any alternative specifically. However, the relative footprints required for each alternative have been noted in the comparison table to indicate relative impacts on the upland site. All of the alternatives will require that the material be transported off site through or near adjoining properties. Permitting (or meeting the substantive requirements of permitting) will be similar for all of the alternatives because they all consist of removing a predetermined volume of material. Stormwater permitting (or meeting the substantive requirements of stormwater permitting) may be a

consideration for Alternative A because geotextile tubes rely on a large amount of exposed surface for dewatering, but the stormwater could be managed appropriately for any of the alternatives. Discharge permitting (or meeting the substantive requirements of discharge permitting) will be the same for all alternatives because the water treatment process will produce the same quality of water for all alternatives. The only difference will be in the quantity of water discharged: Alternatives A and B will discharge the greatest amount of water, followed by Alternative D, then Alternative C. However, discharge quantities will not impact the process.

9.3 Relative Cost

Alterative C is the lowest cost alternative, followed by Alternative D, Alternative B, and finally Alternative A. Higher costs were given a score of low. Alternatives C and D are ranked high because their costs are similar.

9.4 Ranking of Alternatives

Based on the comparative evaluation of the four alternatives against the criteria of effectiveness, implementability, and relative cost (Table 9-1), the alternatives are ranked by score in the following order:

- Alternative C is ranked the highest, reflecting its greatest overall relative performance at meeting the requirements of the evaluation criteria.
- Alternative B ranked second.
- Alternatives A and D are considered to exhibit the least overall relative performance at meeting the requirements of the evaluation criteria, and rank lowest of the alternatives.

10. Recommended Phase I Work Alternative

The recommended alternative is Alternative C: Mechanical Removal with Mechanical Dewatering. This recommendation is based on the individual evaluation against the established NTCRA criteria (Section 8) and the comparative evaluation of alternatives (Section 9).

10.1 Rationale for Recommendation

Alternative C is recommended because it ranks higher overall in effectiveness and implementability than the other Phase I Work Alternatives evaluated, as shown in Table 9-1. Alternative C is recommended for the following reasons:

- Alternative C addresses the RAOs for the project. Conducting the removal within an enclosure will prevent to the extent practicable the dispersion of resuspended sediment. Dewatering the sediment and the use of sealed intermodal containers for transport to the treatment/disposal facility will prevent to the extent practicable the spillage, leakage, and the risk of the material being handled in an uncontrolled manner. Backfilling the Phase I Work Area will partially restore the habitat and allow for future habitat restoration.

- Alternative C ranked medium in protectiveness because mechanical dredging will remove sediment out of the water column and transport it to a barge. Comparatively, this process results in greater exposure to on-site workers than the hydraulic alternatives. This issue will be mitigated in design, to the extent practicable, to increase protectiveness.

- Alternative C process options consist of proven technologies that are available, though there are constraints on the availability of off-site treatment and disposal facilities.

- Mechanical removal is well-suited to handle the presence of abundant debris within the Phase I Work Area. Due to the deep removal depth required (12 ft bss) and the likely presence of debris, debris surveys conducted during design are not likely to identify all of the debris present in the Phase I Work Area; therefore, using a removal method that is able to adapt to unidentified debris and other obstructions is advantageous. Mechanical removal has a higher probability for successfully meeting the schedule approved by USEPA, given the lower risk for decreases in dredging production rates than the other removal methods.

- Mechanical removal methods are more effective at removing material in close proximity to the existing shoreline structures.

- Mechanical processing is suitable for dewatering high plasticity, fine-grained sediment like that in the Phase I Work Area. Mechanical dewatering methods will reduce the potential that additional drying of the sediment, through stockpiling, is needed to reduce moisture content.

10.2 Summary

Based on the considerations provided above, Alternative C exhibits the greatest overall relative performance at meeting the requirements of the evaluation criteria and, for that reason, is the recommended Phase I Work Alternative.

11. References

ARCADIS. 2008. Phase I Engineering Evaluation/Cost Analysis Work Plan. Revision 1. ARCADIS U.S. Inc. August.

Baron, L.A., M.R. Bilimoria, and S.E. Thompson. 2005. Environmental Dredging Pilot Study Successfully Completed on the Lower Passaic River, NJ – One of America's Most Polluted Rivers. *World Dredging Mining &Construction*. December.

BBL. 2003a. Hydraulic Performance Evaluation Progress Report, Diamond Alkali Superfund Site, Newark, New Jersey. Blasland, Bouck & Lee, Inc. March.

BBL. 2003b. Supplemental Hydraulic Performance Evaluation Progress Report, Diamond Alkali Superfund Site, Newark, New Jersey. Blasland, Bouck & Lee, Inc. November.

BBL. 2004. Final Report for Remedial Construction, Diamond Alkali Superfund Site, Newark, New Jersey. August.

BBL. 2006. Remedy Evaluation Work Plan. Tierra Solutions, Inc. Diamond Alkali Superfund Site, Newark, New Jersey. Blasland, Bouck & Lee, Inc. October.

ChemRisk. 1991. Passaic River & Newark Bay Sediment Investigation Sampling Plan and Field Quality Assurance Project Plan. ChemRisk. November.

CLH. 1995a. Investigation Work Plan, Vol. 1 of Passaic River Study Area Remedial Investigation Work Plans. Chemical Land Holdings, Inc. January.

CLH. 1995b. Site Management Plan, Vol. 2 of Passaic River Study Area Remedial Investigation Work Plans. Chemical Land Holdings, Inc. January.

CLH. 1995c. Field Sampling Plan, Vol. 3 of Passaic River Study Area Remedial Investigation Work Plans. Chemical Land Holdings, Inc. January.

CLH. 1995d. Feasibility Study Work Plan, Vol. 3 of Passaic River Study Area Remedial Investigation Work Plans. Chemical Land Holdings, Inc. January.

CLH. 1995e. Quality Assurance Project Plan, Vol. 4 of Passaic River Study Area Remedial Investigation Work Plans. Chemical Land Holdings, Inc. January.

CLH. 1999a. Work Plan, Vol. 1 of Passaic River Study Area Ecological Sampling Work Plans. Chemical Land Holdings, Inc. July.

CLH. 1999b. Field Sampling Plan, Vol. 1 of Passaic River Study Area Ecological Sampling Plan Work Plans. Chemical Land Holdings, Inc. July.

CLH 1999c. Quality Assurance Project Plan, Vol. 2 of Passaic River Study Area Ecological Sampling Plan Work Plans. Chemical Land Holdings, Inc. July.

Drake Jr., A. A., R.A. Volkert, D.H. Monteverde, G.C. Herman, H.F. Houghton, R.A. Parker, and R.F. Dalton. 1996. *Bedrock Geologic Map of Northern New Jersey,* U.S. Department of the Interior and the USGS in cooperation with the New Jersey Geological Survey.

Eckenfelder. 1999. Final Modified (100%) Remedial Design Report.

Environmental Data Services, Inc. 2008. Final Quality Assurance Project Plan, Groundwater Quality Monitoring Program, Diamond Alkali Superfund Site, Newark, New Jersey. May.

Iannuzzi, T.J., D.F. Ludwig, J.M. Wallin, J.C. Kinnell, R.W. Dunford and W.H. Desvousges. 2002. A Common Tragedy: History of an Urban Waterway. Amherst Press, Amherst, MA.

Kay, D.P., J.L. Newsted, M.T. BenKinney, T.J. Iannuzzi and J.P. Giesy. 2008. Passaic river sediment interstitial water phase I toxicity identification evaluation. *Chemosphere.* Volume 70, 1737-1747.

Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environ. Manag.* 19(1):81-87.

Ludwig, D.F., and T.J. Iannuzzi. 2001. Incremental Chemical Risks and Damages in Urban Estuaries: Spatial and Historical Ecosystem Analysis. Chapter 12 in Coastal and Estuarine Risk Assessment. CRC Press/Lewis Publishing, Boca Raton, FL.

Malcolm Pirnie, Inc. 2007. Draft Source Control Early Action Focused Feasibility Study Lower Passaic River Restoration Project. In conjunction with: Battelle and HydroQual, Inc. June.

National Climatic Data Center. 1951 to 1997. Data obtained from the National Climatic Data Center.

NJDEP. 1984a. Administrative Consent Order between Diamond Shamrock Chemicals and NJDEP. New Jersey Department of Environmental Protection. March 13.

NJDEP. 1984b. Administrative Consent Order between Diamond Shamrock Chemicals and NJDEP. New Jersey Department of Environmental Protection. December 20.

NJDEP. 1998. Guidance for sediment quality evaluations. New Jersey Department of Environmental Protection, Site Remediation Program, Trenton, New Jersey. November.

NJDEP. 2000. New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit Equivalent. New Jersey Department of Environmental Quality. May 2.

NOAA. 1972. Tide Tables, High and Low Water Prediction, East Coast of North American and South America Including Greenland. U.S. Dept. of Commerce, National Oceanic Survey, Rockville, Maryland.

NOAA. 1989. Standard Analytical Procedures of the NOAA National Analytical Facility. 2nd ed. NOAA Tech. Memo. NMFS F/NWC-92, 1985-86. Contact: National Status and Trends Program, National Oceanic and Atmospheric Administration, NOAA N/OMA32, 11400 Rockville Pike, Rockville, MD 20852.

Palermo, M. R., N. R. Francingues, and D. E. Averett, 2004. Operational Characteristics and Equipment Selection Factors for Environmental Dredging. Journal of Dredging Engineering, Volume 6, No. 3, December.

Rogers, F.C., G.H. Obear, D.R. Lueder, and W.H. Zimpfer. 1951. Engineering Soil Survey of New Jersey, Report 2, Essex County. The Bureau of Engineering Research Joint Project with New Jersey State Highway Department, in Cooperation with U.S. Bureau of Public Schools, New Brunswick, New Jersey. January.

Rogers, F.C., W.W. Holman, G.H. Obear, and D.R. Lueder. 1952. Engineering Soil Survey of New Jersey, Report 4, Bergen and Hudson Counties. The Bureau of Engineering Research Joint Project with New Jersey State Highway Department, in Cooperation with U.S. Bureau of Public Schools, New Brunswick, New Jersey. September.

Simons and Associates. October 1996. PRSA Sediment Mobility Modeling Calibration and Verification TABS-2 (RMA-2 and STUDH) Status Report.

The State of New Jersey v. Occidental Chemical Corporation, Chemical Land Holdings, Inc. Civil Action No. 89-5064 (JWB) (United States District Court for the District of New Jersey) November 1990.

Stone, B.D., S.D. Stanford, and R.W. Witte. 1995. Map Showing Bedrock Surface Topography, Bedrock Outcrops, and Areas of Shallow Bedrock in the Northern Sheet, New Jersey. U.S. Department of the Interior and the USGS in cooperation with the New Jersey Geological Survey.

Suszkowski, D.J. 1978. Sedimentology of Newark Bay, New Jersey: an urban estuarine bay. Doctoral Dissertation, University of Delaware.

TAMS/Earth Tech and Malcolm Pirnie, Inc. 2005. Data Summary and Evaluation Report, Lower Passaic River Restoration Project. Final. Prepared for New Jersey Department of Transportation Office of Maritime Resources. May.

Tierra. 2007. Newark Bay Study Area Remedial Investigation Work Plan, Sediment Sampling and Source Identification Program, Newark, New Jersey, Phase II, Revision 2, Amendment 1. Tierra Solutions, Inc. November.

USACE. 1987. Flood Protection Feasibility, Main Stem Passaic River. U.S. Army Corps of Engineers. December.

USACE. 2006. Waterborne Commerce of the United States Calendar Year 2006 Part 1: Waterways and Harbors Atlantic Coast. WR-WCUS-06-1. U.S. Army Corps of Engineers.

USACE. 2008. Personal Communication with USACE and Matt Kohlberger (ARCADIS). August.

U.S. District Court for the District of New Jersey. 1990. United States of America, State of New Jersey v. Occidental Chemical Corporation, Chemical Land Holdings, Inc. Consent Decree. November.

USEPA. 1993. Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA. EPA/540-R-93-057, Publication 9360.0-32, PB93-963402. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. August.

USEPA. 1994a. Administrative Order on Consent (AOC). Index No. II-CERCLA-0117. U.S. Environmental Protection Agency. April 20.

USEPA. 1994b. Assessment and Remediation of Contaminated Sediments (ARCS) Program Remediation Guidance Document. ARCS Remediation Guidance Document. EPA 905-B94-003. Great Lakes National Program Office, U.S. Environmental Protection Agency, Chicago, IL.

USEPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Third Edition. EPA-823-B-00-008. Available online at: www.epa.gov/waterscience/fish/advice/volume2/index.html. U.S. Environmental Protection Agency.

USEPA. 2004. Administrative Order on Consent for Remedial Investigation and Feasibility Study, Newark Bay Study Area USEPA Index No. CERCLA-02-2004-2010. U.S. Environmental Protection Agency. February.

USEPA. 2006. Current National Recommended Water Quality Criteria. Accessed at http://www.epa.gov/waterscience/criteria/wqctable/index.html on August 19, 2008. U.S. Environmental Protection Agency.

USEPA. 2007. Administrative Order on Consent with the Cooperating Parties Group. U.S. Environmental Protection Agency. May.

USEPA. 2008a. United States Environmental Protection Agency Region 2 Administrative Settlement Agreement and Order on Consent for Removal Action in the Matter of Lower Passaic River Study Area of the Diamond Alkali Superfund Site Occidental Chemical Corporation and Tierra Solutions, Inc. CERCLA Docket No. 02-2008-2020. U.S. Environmental Protection Agency. June 23.

USEPA. 2008b. Technology Primer Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites. EPA 542-R-08-002. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. April.

USGS. 1995. Water Resources Data - New Jersey Water Year 1994, Volume 1 Surface-Water Data. W.R. Bauersfeld, E.W. Moshinsky, and C.E. Gurney, USGS Water Data Report #NJ-94-1.

USGS. 2002. Streamflow Information. U.S. Geologic Survey. Available at: http://water.usgs.gov/nj/nwis/annual/?site_no=01391500& agency_cd=USGS. February.

Tables

Table 2-1
Bridges Currently Located in the Lower Passaic River Study Area

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

No.	Passaic River Station	Name	Type	Single Opening (ft)	Vertical Clearance(ft-MHW) from NOAA Chart 12337 (2005)
1	40+20	Abandoned Conrail Bridge	Railroad-Swing	100	Open
2	75+20	Lincoln Highway	Highway-Lift	300	40-down 135-up
3	84+80	Pulaski Skyway	Highway-Fixed	520	135
4	114+00	Point No Point Conrail Penn Central	Railroad-Swing	103	16
5	117+90	N.J. Turnpike	Highway-Fixed	319	100
6	222+20	Jackson Street	Highway-Swing	75	15
7	242+40	Amtrak Railroad (Market Street)	Railroad-Lift	200	24-down 138-up
8	276+37	Bridge Street	Highway-Swing	80	7
9	285+52	Newark-Harrison Bridge	Railroad-Swing	75	15
10	287+20	Route 280	Highway-Lift	200	35-down 135-up
11	299+08	Clay Street	Highway-Swing	75	8
12	312+43	Abandoned Bascule Bridge	Railroad-Bascule	126	Open
13	407+09	Conrail Railroad	Railroad-Swing	70	35

Notes:
1. MHW is 3.61 ft above NGVD29.

ft = foot/feet
MHW = mean high water
NGVD29 = National Geodetic Vertical Datum 1929
NOAA = National Oceanic and Atmospheric Administration

Table 3-1
Summary of Sediment Core Locations/Samples in Phase I Work Area

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Sampling Event	Total # of Locations	Total # of Samples	Max Depth (ft)	Chemical/Physical Analyses
1991 Core Sediment Investigation	2	40	17.83	Cyanide, Dioxins/Furans, Geochronology, Metals, PCB Congeners, PCB/PEST, SVOCs, TOC, TPH
1995 Geotechnical Testing Program	2	5	2	Grain Size, Physical Properties
1995 RI Sampling Program	2	39	5.6	Cyanide, Dioxins/Furans, Geochronology, Herbicides, Metals, PCB Congeners, PCB/PEST, SVOCs, TOC, TPH, Volatiles
1999 Late Summer/Early Fall RI-ESP	3	3	0.5	AVS/SEM, Cyanide, Dioxins/Furans, Grain Size, Herbicides, Homologue Groups, Metals, Miscellaneous Chemical, Organotin, PAH-SIM, PCB Congeners, PCB/PEST, Physical Properties, SVOCs, TOC, TPH
1999 Preliminary Toxicity Identification Evaluation Study	1	1	0.5	AVS/SEM, Dioxins/Furans, Grain Size, Metals, Miscellaneous Chemical, PAH-SIM, PCB Congeners, PCB/PEST, SVOCs, TOC
2000 Spring RI-ESP	1	1	0.5	AVS/SEM, Cyanide, Dioxins/Furans, Grain Size, Herbicides, Homologue Groups, Metals, Miscellaneous Chemical, Organotin, PAH-SIM, PCB Congeners, PCB/PEST, Physical Properties, SVOCs, TOC, TPH
2000 Toxicity Identification Evaluation Study	1	1	0.5	AVS/SEM, Cyanide, Dioxins/Furans, Grain Size, Herbicides, Homologue Groups, Metals, Miscellaneous Chemical, Organotin, PAH-SIM, PCB Congeners, PCB/PEST, Physical Properties, SVOCs, TOC, TPH
Totals				
Phase I Removal Area	12	90	-	-

Table 3-1
Summary of Sediment Core Locations/Samples in Phase I Work Area

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Notes:
1. Total samples collected include analytical and geotechnical sample segments.

AVS/SEM = acid volatile sulfides/simultaneously extracted metals
ft = foot/feet
PAH-SIM = polycyclic aromatic hydrocarbons-selected ion monitoring
PCB = polychlorinated biphenyl
PEST = pesticides
RI = remedial investigation
RI-ESP = Remedial Investigation - Ecological Sampling Program
SVOCs = semivolatile organic compounds
TOC = total organic carbon
TPH = total petroleum hydrocarbons

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
Volatile Organic Compounds							
1,1,1-Trichloroethane	ppb	13	0	11.5	15.5	13.6	1.31
1,1,2,2-Tetrachloroethane	ppb	12	0	11.5	15.5	13.6	1.37
1,1,2-Trichloroethane	ppb	13	0	11.5	15.5	13.6	1.31
1,1-Dichloroethane	ppb	13	15.4	11.5	390	44.5	104
1,1-Dichloroethene	ppb	13	0	11.5	15.5	13.6	1.31
1,2-Dichloroethane	ppb	13	0	11.5	15.5	13.6	1.31
1,2-Dichloroethene (total)	ppb	13	0	11.5	15.5	13.6	1.31
1,2-Dichloropropane	ppb	13	7.69	11.5	17,000	1,330	4,710
2-Butanone	ppb	13	61.5	14.0	17,000	1,580	4,710
2-Hexanone	ppb	11	0	11.5	15.5	13.8	1.33
4-Methyl-2-pentanone	ppb	13	0	11.5	15.5	13.6	1.31
Acetone	ppb	13	92.3	44.0	17,000	1,690	4,670
Benzene	ppb	13	46.2	14.0	17,000	3,670	6,050
Bromodichloromethane	ppb	13	0	11.5	15.5	13.6	1.31
Bromoform	ppb	11	0	11.5	15.5	13.8	1.33
Bromomethane	ppb	13	0	11.5	15.5	13.6	1.31
Carbon Disulfide	ppb	13	7.69	11.5	31.0	15.0	4.99
Carbon Tetrachloride	ppb	13	0	11.5	15.5	13.6	1.31
Chlorobenzene	ppb	13	69.2	14.0	290,000	53,700	103,000
Chloroethane	ppb	13	0	11.5	15.5	13.6	1.31
Chloroform	ppb	13	0	11.5	15.5	13.6	1.31
Chloromethane	ppb	13	0	11.5	15.5	13.6	1.31
cis-1,3-Dichloropropene	ppb	13	0	11.5	15.5	13.6	1.31
Dibromochloromethane	ppb	11	0	11.5	15.5	13.8	1.33
Ethylbenzene	ppb	13	30.8	11.5	17,000	1,390	4,690
Methylene Chloride	ppb	13	23.1	11.5	58,000	4,900	16,000
Styrene	ppb	12	0	11.5	15.5	13.7	1.32
Tetrachloroethene	ppb	13	30.8	11.5	240	59.1	77.6
Toluene	ppb	13	7.69	11.5	17,000	3,400	6,150
Total BTEX	ppb	9	100	133	3,750	965	1,160
Total Xylenes	ppb	13	61.5	14.0	17,000	2,560	5,500
trans-1,3-Dichloropropene	ppb	13	0	11.5	15.5	13.6	1.31
Trichloroethene	ppb	13	7.69	11.5	51.0	16.5	10.4
Vinyl Chloride	ppb	13	0	11.5	15.5	13.6	1.31

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
Semivolatile Organic Compounds							
1,6,7-Trimethylnaphthalene	ppb	6	100	35.6	79.3	56.9	15.4
1-Methylnaphthalene	ppb	6	100	142	212	179	31.9
1-Methylphenanthrene	ppb	6	100	114	454	292	137
2,6-Dimethylnaphthalene	ppb	6	100	152	259	207	35.4
2-Methylnaphthalene	ppb	41	39.0	85.0	180,000	6,120	28,100
Acenaphthene	ppb	41	51.2	85.0	43,000	2,190	7,050
Acenaphthylene	ppb	41	43.9	85.0	33,000	1,470	5,080
Anthracene	ppb	41	63.4	200	40000	2490	6410
Benzo(a)anthracene	ppb	41	82.9	370	29,000	3,260	4,840
Benzo(a)pyrene	ppb	41	68.3	370	18,000	2,440	3,030
Benzo(b)fluoranthene	ppb	41	85.4	370	10,000	2,740	2,010
Benzo(e)pyrene	ppb	6	100	1,700	2,790	2,090	453
Benzo(g,h,i)perylene	ppb	41	70.7	250	19,500	1,810	2,970
Benzo(k)fluoranthene	ppb	41	82.9	320	11,000	1,840	1,880
Biphenyl	ppb	6	100	83.0	140	113	21.9
C1-Chrysenes	ppb	6	100	1,470	3,100	2,330	593
C1-Dibenzothiophenes	ppb	6	50.0	95.0	309	176	75.4
C1-Fluoranthenes/Pyrenes	ppb	6	100	2,370	3,660	3,000	441
C1-Fluorenes	ppb	6	100	130	288	228	62.5
C1-Naphthalenes	ppb	6	100	460	603	533	67.3
C1-Phenanthrenes/Anthracenes	ppb	6	100	1,090	1,820	1,400	349
C2-Chrysenes	ppb	6	66.7	630	1,760	1,140	430
C2-Dibenzothiophenes	ppb	6	33.3	210	514	339	133
C2-Fluoranthenes/Pyrenes	ppb	5	100	1,460	2,290	1,820	304
C2-Fluorenes	ppb	6	100	304	556	441	94.7
C2-Naphthalenes	ppb	6	100	387	822	577	161
C2-Phenanthrenes/Anthracenes	ppb	6	83.3	630	1,950	1,380	456

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
C3-Chrysenes	ppb	6	50.0	175	400	294	85.7
C3-Dibenzothiophenes	ppb	6	50.0	271	665	488	179
C3-Fluoranthenes/Pyrenes	ppb	5	40.0	397	1,190	668	323
C3-Fluorenes	ppb	6	50.0	283	609	407	128
C3-Naphthalenes	ppb	6	100	382	893	608	191
C3-Phenanthrenes/Anthracenes	ppb	6	50.0	545	1,220	905	295
C4-Chrysenes	ppb	6	83.3	89.0	375	255	101
C4-Naphthalenes	ppb	6	100	307	782	542	161
C4-Phenanthrenes/Anthracenes	ppb	6	50.0	318	769	517	207
Chrysene	ppb	41	87.8	370	34,000	3,830	5,540
Dibenzo(a,h)anthracene	ppb	41	36.6	85.0	19,500	1,190	2,980
Dibenzothiophene	ppb	6	100	117	222	165	40.4
Fluoranthene	ppb	41	92.7	180	41,000	5,450	6,540
Fluorene	ppb	41	46.3	85.0	42,000	2,080	6,590
Indeno(1,2,3-cd)pyrene	ppb	41	65.9	310	19,500	1,750	2,970
Naphthalene	ppb	41	43.9	85.0	290,000	8,860	45,100
Perylene	ppb	6	100	586	1,090	844	184
Phenanthrene	ppb	41	80.5	330	110,000	5,910	17,600
Pyrene	ppb	41	92.7	210	60,000	7,020	10,300
1,2,4-Trichlorobenzene	ppb	35	17.1	85.0	1,100,000	41,500	187,000
1,2-Dichlorobenzene	ppb	35	14.3	85.0	62,000	5,330	14,000
1,3-Dichlorobenzene	ppb	35	8.57	85.0	19,500	1,830	3,630
1,4-Dichlorobenzene	ppb	35	28.6	85.0	210,000	16,500	49,700
2,4,5-Trichlorophenol	ppb	35	25.7	165	830,000	57,000	170,000
2,4,6-Trichlorophenol	ppb	35	17.1	165	340,000	13,500	57,500
2,4-Dichlorophenol	ppb	35	25.7	165	2,500,000	101,000	428,000
2,4-Dimethylphenol	ppb	35	0	165	19,500	1,350	3,210
2,4-Dinitrophenol	ppb	35	0	485	47,500	3,730	7,990
2,4-Dinitrotoluene	ppb	35	0	165	19,500	1,350	3,210
2,6-Dinitrotoluene	ppb	35	0	85.0	19,500	1,340	3,210
2-Chloronaphthalene	ppb	35	0	85.0	19,500	1,340	3,210
2-Chlorophenol	ppb	35	8.57	85.0	90,000	4,700	16,300

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
2-Methylphenol	ppb	35	2.86	85.0	19,500	1,340	3,210
2-Nitroaniline	ppb	35	0	85.0	47,500	3,070	7,830
2-Nitrophenol	ppb	35	0	165	19,500	1,350	3,210
3,3'-Dichlorobenzidine	ppb	35	0	165	19,500	1,480	3,250
3-Nitroaniline	ppb	35	0	165	47,500	3,080	7,830
4,6-Dinitro-2-methylphenol	ppb	35	0	415	47,500	3,270	7,820
4-Bromophenyl phenyl ether	ppb	35	0	165	19,500	1,350	3,210
4-Chloro-3-Methylphenol	ppb	35	0	165	19,500	1,350	3,210
4-Chloroaniline	ppb	35	0	85.0	19,500	1,340	3,210
4-Chlorophenyl phenyl ether	ppb	35	0	85.0	19,500	1,340	3,210
4-Methylphenol	ppb	35	2.86	165	19,500	1,350	3,210
4-Nitroaniline	ppb	35	0	165	47,500	3,080	7,830
4-Nitrophenol	ppb	34	0	415	47,500	3,310	7,930
bis(2-Chloroethoxy)methane	ppb	35	0	165	19,500	1,350	3,210
bis(2-Chloroethyl)ether	ppb	35	0	85.0	19,500	1,340	3,210
bis(2-Chloroisopropyl)ether	ppb	35	0	85.0	19,500	1,340	3,210
bis(2-Ethylhexyl)phthalate	ppb	35	71.4	370	220,000	41,900	60,800
Butyl benzyl phthalate	ppb	35	11.4	165	19,500	1,320	3,220
Carbazole	ppb	35	2.86	85.0	19,500	1,340	3,210
Dibenzofuran	ppb	35	17.1	85.0	19,500	1,350	3,210
Diethyl phthalate	ppb	35	0	165	19,500	1,350	3,210
Dimethylphthalate	ppb	35	0	165	19,500	1,350	3,210
Di-n-Butylphthalate	ppb	35	2.86	165	19,500	1,370	3,210
Di-n-Octylphthalate	ppb	35	34.3	165	19,500	2,380	3,520

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
Hexachlorobenzene	ppb	35	17.1	85.0	580,000	33,100	120,000
Hexachlorobutadiene	ppb	35	0	165	19,500	1,350	3,210
Hexachlorocyclopentadiene	ppb	35	0	370	19,500	1,480	3,240
Hexachloroethane	ppb	35	0	85.0	19,500	1,340	3,210
Isophorone	ppb	35	0	85.0	19,500	1,340	3,210
Nitrobenzene	ppb	35	0	85.0	19,500	1,340	3,210
N-Nitroso-di-n-propylamine	ppb	35	0	85.0	19,500	1,340	3,210
N-Nitrosodiphenylamine	ppb	35	0	85.0	19,500	1,340	3,210
Pentachlorophenol	ppb	33	0	415	215,000	9,790	37,700
Phenol	ppb	35	5.71	165	19,500	1,480	3,220
HMW PAHs	ppb	34	100	390	203,000	21,900	36,400
LMW PAHs	ppb	29	100	1200	73,800	37,100	137,000
Total PAHs	ppb	36	100	390	941,000	63,000	156,000
Total PAHs (Max DL)	ppb	35	91.4	380	941,000	59,300	159,000
Homolog Polchlorinated Biphenyls (PCBs)							
Total Monochlorobiphenyl	ppb	6	100	0.00500	6.19	3.00	2.00
Total Dichlorobiphenyl	ppb	6	100	0.0790	47.9	37.1	18.4
Total Trichlorobiphenyl	ppb	6	100	0.120	344	223	120
Total Tetrachlorobiphenyl	ppb	6	100	0.470	526	369	193
Total Pentachlorobiphenyl	ppb	6	100	0.300	443	294	175
Total Hexachlorobiphenyl	ppb	6	100	0.300	314	215	116
Total Heptachlorobiphenyl	ppb	6	100	0.160	244	150	95.2
Total Octachlorobiphenyl	ppb	6	100	0.0420	114	51.5	37.3
Total Nonachlorobiphenyl	ppb	6	100	0.0110	18.3	12.6	7.18
Total PCBs - Homologue Groups	ppb	4	100	1,330	1,880	1,710	261
Congener PCBs							
PCB-1	ppb	13	53.8	0.00240	194	56.3	60.6
PCB-3	ppb	6	100	0.00180	1.63	1.20	0.597
PCB-5	ppb	9	0	9.55	63.5	17.1	17.4
PCB-8	ppb	6	100	0.0160	10.0	7.32	3.71
PCB-12	ppb	8	12.5	39.4	2,440	458	820

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
PCB-15	ppb	6	100	0.0310	19.1	14.7	7.26
PCB-18	ppb	6	100	0.0130	30.2	20.5	11.7
PCB-28	ppb	15	80.0	0.0220	900	184	241
PCB-37	ppb	1	100	0.0150	0.0150	0.0150	--
PCB-44	ppb	14	85.7	0.0440	350	122	132
PCB-49	ppb	1	100	0.0490	0.0490	0.0490	--
PCB-52	ppb	6	100	0.0600	66.6	43.2	23.5
PCB-66	ppb	12	100	0.0570	330	110	96.8
PCB-70	ppb	1	100	0.0500	0.0500	0.0500	--
PCB-74	ppb	1	100	0.0250	0.0250	0.0250	--
PCB-77	ppb	35	94.3	0.00170	260	36.4	57.2
PCB-81	ppb	6	100	0.000950	1.01	0.666	0.377
PCB-87	ppb	6	100	0.0220	32.1	24.0	12.2
PCB-90/101	ppb	6	100	0.0570	73.9	52.2	28.3
PCB-99	ppb	1	100	0.0280	0.0280	0.0280	--
PCB-105	ppb	35	94.3	0.00100	450	60.5	100
PCB-110	ppb	10	90.0	0.0350	809	206	235
PCB-114	ppb	19	94.7	0.00190	41.0	8.18	9.77
PCB-115	ppb	1	100	0.00880	0.00880	0.00880	--
PCB-118	ppb	41	90.2	0.00600	1,790	199	338
PCB-119	ppb	1	100	0.00170	0.00170	0.00170	--
PCB-123	ppb	19	89.5	0.0000100	25.0	7.38	7.01
PCB-126	ppb	34	64.7	0.0000100	5.50	0.856	1.32
PCB-128	ppb	6	100	0.00910	13.5	9.79	5.27
PCB-138	ppb	11	90.9	0.110	1,440	264	420
PCB-149	ppb	1	100	0.0470	0.0470	0.0470	--
PCB-151	ppb	1	100	0.0110	0.0110	0.0110	--
PCB-153	ppb	15	66.7	0.0690	695	87.2	172
PCB-156	ppb	19	100	0.00480	47.0	17.9	14.4
PCB-157	ppb	19	94.7	0.00110	11.0	3.91	3.17
PCB-158	ppb	1	100	0.00440	0.00440	0.00440	--

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
PCB-167	ppb	19	94.7	0.00210	120	24.0	27.3
PCB-168	ppb	1	100	0.000140	0.000140	0.000140	--
PCB-169	ppb	34	26.5	0.0000100	1.24	0.124	0.223
PCB-170	ppb	11	72.7	0.0180	47.8	22.3	16.3
PCB-177	ppb	1	100	0.0110	0.0110	0.0110	--
PCB-180	ppb	15	100	0.0450	618	95.7	148
PCB-183	ppb	6	100	0.0110	16.6	10.5	6.50
PCB-184	ppb	5	0	0.0000100	0.258	0.198	0.111
PCB-187	ppb	6	100	0.0280	42.2	25.2	17.2
PCB-189	ppb	19	100	0.000610	13.0	2.30	2.91
PCB-194	ppb	6	83.3	0.00900	15.2	8.51	6.87
PCB-195	ppb	6	83.3	0.00360	6.36	3.54	2.87
PCB-201	ppb	1	100	0.0130	0.0130	0.0130	--
PCB-202	ppb	6	100	0.00290	3.92	2.61	1.48
PCB-206	ppb	6	100	0.00770	13.3	9.32	5.24
PCB-207	ppb	6	83.3	0.000580	0.960	0.608	0.403
PCB-209	ppb	6	100	0.00530	7.30	5.15	2.66
PCB Congener TEQ (WHO TEF)	ppt	35	100	0.0136	646	125	175
Total PCBs - Congeners (NOAA 1989)	ppb	4	100	979	1,550	1,370	268
Total PCBs - Sum of Coplanar Congeners	ppb	32	100	0.0260	1,960	318	432
Aroclor PCBs							
Aroclor-1016	ppb	35	0	18.6	8,200	519	1,660
Aroclor-1221	ppb	35	0	33.0	16,700	1,050	3,390
Aroclor-1232	ppb	35	0	18.6	8,200	519	1,660
Aroclor-1242	ppb	35	8.57	18.6	8,200	839	1,940
Aroclor-1248	ppb	35	51.4	18.8	15,700	1,780	3,090
Aroclor-1254	ppb	34	32.4	18.8	8,200	1,030	1,830
Aroclor-1260	ppb	35	14.3	18.6	8,200	548	1,660
Total Aroclor PCBs	ppb	21	100	504	15,700	3,580	3,570
Total Aroclor PCBs (Max DL)	ppb	35	60.0	33.0	16,700	3,140	4,230

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
Pesticides/Herbicides							
2,4,5-T	ppb	17	23.5	115	212,000	13,100	51,300
2,4,5-TP (Silvex)	ppb	18	11.1	7.20	616	159	119
2,4-D	ppb	15	26.7	276	646,000	48,000	166,000
2,4-DB	ppb	18	5.56	22.0	500	255	87.1
4,4'-DDD	ppb	35	85.7	1.86	11,400,000	331,000	1,930,000
4,4'-DDE	ppb	28	78.6	1.86	1,700	189	374
4,4'-DDT	ppb	34	73.5	1.86	9,520,000	492,000	2,010,000
Total DDT	ppb	33	100	7.03	18,600,000	859,000	3,590,000
Total DDT (Max DL)	ppb	35	94.3	1.86	18,600,000	810,000	3,490,000
Aldrin	ppb	35	2.86	0.650	424	26.8	85.9
Alpha-BHC	ppb	35	5.71	0.650	424	29.9	86.8
Beta-BHC	ppb	35	5.71	0.650	424	28.5	85.8
Delta-BHC	ppb	34	23.5	0.650	424	31.2	86.3
Gamma-BHC (Lindane)	ppb	35	5.71	0.650	424	27.9	85.7
Dieldrin	ppb	34	50.0	1.30	820	91.3	178
Endosulfan I	ppb	35	5.71	0.650	4,240	191	788
Endosulfan II	ppb	34	29.4	1.30	3,540	167	619
Endosulfan Sulfate	ppb	33	9.09	1.30	6,700	390	1,470
Endrin	ppb	31	16.1	1.30	1,660	81.6	303
Endrin Aldehyde	ppb	35	17.1	1.30	820	56.9	165
Endrin Ketone	ppb	35	11.4	1.30	820	60.4	167
Alpha-Chlordane	ppb	33	36.4	0.970	4,240	233	805
Gamma-Chlordane	ppb	31	19.4	0.650	424	50.5	92.1
Total Alpha + Gamma Chlordane	ppb	13	100	4.37	210	96.9	66.2
Heptachlor	ppb	35	0	0.650	424	26.9	85.9
Heptachlor Epoxide	ppb	19	0	0.650	424	48.3	113
Heptachlor epoxide (endo)	ppb	16	0	0.955	2.42	1.59	0.483
Heptachlor epoxide (exo)	ppb	16	25.0	0.970	108	18.5	35.3
Methoxychlor	ppb	35	14.3	6.50	4,240	286	858
Toxaphene	ppb	35	0	65.0	42,400	2,680	8,590

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
Inorganic Compounds							
Total Cyanide	ppm	35	40.0	0.0900	5.40	1.09	1.21
Aluminum	ppm	35	100	4,640	24,100	16,200	5,450
Antimony	ppm	35	25.0	0.210	17.5	6.24	3.30
Arsenic	ppm	34	94.9	0.500	222	29.6	49.7
Barium	ppm	35	100	12.8	968	256	180
Beryllium	ppm	35	75.0	0.290	2.60	1.18	0.646
Cadmium	ppm	35	90.0	0.170	29.5	9.72	7.47
Calcium	ppm	35	100	332	10,000	5,600	2,400
Chromium	ppm	35	100	8.70	1,550	363	315
Cobalt	ppm	35	100	3.50	27.9	14.6	6.05
Copper	ppm	32	100	9.50	1,390	397	310
Iron	ppm	35	100	9,130	43,900	29,500	8,440
Lead	ppm	34	100	7.80	1,650	555	376
Magnesium	ppm	35	100	1,900	9,820	6,120	2,100
Manganese	ppm	35	100	65.4	875	405	195
Mercury	ppm	35	88.9	0.0850	20.9	7.78	5.54
Nickel	ppm	35	100	8.70	178	71.7	44.2
Potassium	ppm	34	100	656	3,690	2,240	796
Selenium	ppm	31	25.0	0.205	5.70	1.79	1.64
Silver	ppm	35	83.3	0.550	15.5	7.02	4.35
Sodium	ppm	35	100	258	14,800	5,240	2,810
Thallium	ppm	34	23.1	0.285	3.80	1.05	0.809
Titanium	ppm	13	100	410	577	506	48.6
Vanadium	ppm	35	100	8.60	113	52.7	24.1
Zinc	ppm	32	100	22.9	2,140	946	656
Dioxins/Furans							
2,3,7,8-TCDD	ppt	35	88.6	0.150	5,300,000	244,000	924,000
2,3,7,8-TCDF	ppt	35	85.7	0.100	17,800	701	3,030
1,2,3,7,8-PeCDD	ppt	35	71.4	0.0650	17,700	829	3,210
1,2,3,7,8-PeCDF	ppt	35	85.7	0.0750	15,600	524	2,630
2,3,4,7,8-PeCDF	ppt	35	85.7	0.115	111,000	3,590	18,700
1,2,3,4,7,8-HxCDD	ppt	35	71.4	0.145	4,470	176	755
1,2,3,4,7,8-HxCDF	ppt	35	85.7	0.175	727,000	22,800	123,000
1,2,3,6,7,8-HxCDD	ppt	35	80.0	0.145	15,800	665	2,670
1,2,3,6,7,8-HxCDF	ppt	35	82.9	0.0550	125,000	3,890	21,100

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Number of Samples	Detection Frequency (%)	Minimum Concentration	Maximum Concentration	Average Concentration	Standard Deviation
1,2,3,7,8,9-HxCDD	ppt	35	80.0	0.140	4,700	220	794
1,2,3,7,8,9-HxCDF	ppt	35	74.3	0.0850	16,400	588	2,800
2,3,4,6,7,8-HxCDF	ppt	35	82.9	0.200	50,200	1,620	8,470
1,2,3,4,6,7,8-HpCDD	ppt	35	88.6	0.175	26,100	2,100	4,450
1,2,3,4,6,7,8-HpCDF	ppt	34	91.2	0.440	124,000	7,150	21,700
1,2,3,4,7,8,9-HpCDF	ppt	35	82.9	0.165	83,100	2,630	14,000
OCDD	ppt	33	90.9	2.45	802,000	36,900	138,000
OCDF	ppt	33	90.9	0.900	117,000	10,600	27,500
Total TCDD	ppt	34	97.1	0.150	2,760,000	115,000	491,000
Total TCDF	ppt	35	94.3	0.275	2,320,000	84,900	393,000
Total PeCDD	ppt	35	85.7	0.0850	552,000	17,400	93,200
Total PeCDF	ppt	35	91.4	0.235	1,680,000	58,000	284,000
Total HxCDD	ppt	35	88.6	0.145	132,000	5,120	22,200
Total HxCDF	ppt	35	91.4	0.470	1,710,000	57,100	289,000
Total HpCDD	ppt	35	88.6	0.245	63,700	4,810	10,800
Total HpCDF	ppt	34	91.2	0.500	263,000	13,600	45,900
Total PCDDs	ppt	32	100	2.50	3,510,000	189,000	646,000
Total PCDFs	ppt	31	100	18.0	5,710,000	252,000	1,030,000
Total 2,3,7,8-Congeners	ppt	31	100	1.30	5,510,000	378,000	1,100,000
WHO Dioxin TEQ (Bird-NDs used at 1/2 DL)	ppt	35	100	0.691	5,330,000	252,000	936,000
WHO Dioxin TEQ (Fish-NDs used at 1/2 DL)	ppt	35	100	0.630	5,320,000	249,000	932,000
Dioxin TEQ (WHO TEF)	ppt	35	100	1.10	5,320,000	250,000	932,000
Miscellaneous							
Ammonia Nitrogen	ppm	6	100	130	560	392	158
Sulfide	ppm	1	100	1,270	1,270	1,270	--
Dibutyltin	ppb	5	100	3.26	15.1	8.40	4.63
Monobutyltin	ppb	5	40.0	0.500	8.27	2.33	3.37
Tetrabutyltin	ppb	5	20.0	0.500	1.14	0.629	0.288
Tributyltin	ppb	5	100	23.2	54.0	32.7	12.2
Total Organic Carbon	ppm	35	100	691	192,000	49,700	53,000
Total TEQ (PCB + Dioxin)	ppt	35	100	1.14	5,320,000	249,000	932,000
Petroleum Hydrocarbons (extractable)	ppm	29	89.7	13.5	39,300	3,560	7,640
TPH - DRO CA LUFT	ppm	5	100	94.0	200	147	45.0

Table 3-2
Summary of Available Phase I Work Area Chemistry Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Notes:
1. For non-detected results, half the detection limit was utilized in total calculation.
2. Duplicate samples were evaluated as individual samples in this summary.

-- = not calculated
BTEX = benzene, toluene, ethylbenzene, and xylene
DL = detection limit
DRO CA LUFT = diesel-range organics California leaking underground fuel tank
HMW = high molecular weight
HpCDD = heptachlorodibenzo-*p*-dioxin
HpCDF = heptachlorodibenzofuran
HxCDD = hexachlorodibenzo-*p*-dioxin
HxCDF = hexachlorodibenzofuran
LMW = low molecular weight
ND = non-detect
OCDD = octachlorodibenzo-*p*-dioxin
OCDF = octachlorodibenzofuran
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
PeCDD = pentachlorodibenzo-*p*-dioxin
PeCDF = pentachlorodibenzofuran
ppb = parts per billion
ppm = parts per million
ppt = parts per trillion
SVOCs = semivolatile organic compounds
TCDD = tetrachlorodibenzo-*p*-dioxin
TCDF = tetrachlorodibenzofuran
TEF = toxicity equivalency factor
TEQ = toxic equivalent
WHO = World Health Organization

Table 3-3
Summary of Available Phase I Work Area Geotechnical Data - Sediment

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Analyte	Units	Count	Minimum	Maximum	Mean	Standard Deviation
0.001 mm	%	6	0.5	11	6.42	3.67
0.002 mm	%	6	10	15.5	12.2	1.97
0.005 mm	%	6	19	24.5	21.8	2.38
0.02 mm	%	6	45.5	69	59.1	7.93
0.05 mm	%	6	68.5	88	79.5	6.30
0.064 mm	%	6	78.5	90	85.2	3.98
0.075 mm	%	6	85.9	91.5	88.5	2.47
0.15 mm	%	6	87.3	94.5	90.3	2.92
0.3 mm	%	6	88.1	95.5	91.2	2.88
0.6 mm	%	6	89	96.3	92.2	2.67
1.18 mm	%	6	90.3	96.8	93.3	2.27
19 mm	%	6	100	100	100	0
2.36 mm	%	6	90.7	97.2	93.9	2.35
3.35 mm	%	6	97.7	99.6	98.5	0.873
37.5 mm	%	6	100	100	100	0
4.75 mm	%	6	98.9	99.9	99.5	0.428
75 mm	%	6	100	100	100	0
Clay	%	1	16	16	16.0	--
Gravel	%	1	3	3	3.00	--
Natural Liquid Limit	%	4	111	147	129	15.9
Ovendried Liquid Limit	%	4	0	0	0	0
Passing # 200 Sieve	%	4	92.83	96.56	95.0	1.68
Percent Moisture	%	5	65.3	72.7	68.0	3.37
Plastic Limit	%	4	47	54	51.0	3.16
Sand	%	1	6	6	6.00	--
Silt	%	1	75	75	75.0	--
Water Content	%	5	169.79	226.26	199	22.5
Water Content ASTM D2216	% by wt.	5	188	266	215	35.0
Bulk Density	lb/ft^3	5	74.28	97.37	80.4	9.59

Notes:
1. Summary from data available from the following programs: 1991 Core Sediment Investigation, 1995 Geotechnical Testing Program, 1999 Late Summer/Early Fall RI-ESP, 1999 Preliminary Toxicity Identification Evaluation Study, 2000 Spring RI-ESP, and 2000 Toxicity Identification Evaluation Study.

-- = not calculated
% = percent
% by wt. = percent by weight
lb/ft^3 = pounds per cubic foot
ASTM = American Society for Testing and Materials
mm = millimeter(s)

Table 6-1
Preliminary List of ARARs and TBCs for Phase I Work

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Potential ARAR Name and Regulation	Description	Action or Process that May Potentially Apply
Chemical-Specific ARARs		
Federal		
Clean Water Act (CWA) (33 U.S. Codes [U.S.C.] Section 1251 *et seq.*) Sections 301-304 Water Quality Standards (40 Code of Federal Regulations [CFR] Part 131) and Water Quality Criteria	Provides minimum standards and guidance for water quality programs established by states. Also publishes Ambient Water Quality Criteria (AWQC) for the protection of aquatic life and human health.	An AWQC may apply to discharge water from a dewatering system.
Clean Air Act, amended 1990, National Ambient Air Quality Standards: 40 CFR part 50	Requires U.S. Environmental Protection Agency (USEPA) to set standards for pollutants considered harmful to public health and the environment; standards are established for six primary and secondary pollutants.	Applicable to on-site activities resulting in releases to the air, including operation of equipment, dredging and open barge transport of dredged material, and on-site treatment.
The Clean Air Act amended 1990: Hazardous Air Pollutants, Section 112	Establishes restrictions on emissions for area sources, carcinogenic pollutants, etc. (NESHAPS)	Applicable to on-site activities resulting in releases to the air, including operation of equipment, dredging and open barge transport of dredged material, and on-site treatment.
State		
New Jersey Water Pollution Control Act of 1977 (New Jersey State Archives [N.J.S.A.] 58:10A-1 *et seq.*) - State Water Quality Programs	Regulates dredged material and administers the CWA 404 program.	Applicable for dredge and disposal in surface waters.
Location Specific ARARs		
Federal		
Rivers and Harbors Act (Section 10) (33 U.S.C. 403) (33 CFR Parts 320, 322)	U.S. Army Corps of Engineers reviews and approves work in navigable waters that may affect the navigable capacity of a water body.	Applicable for activities conducted in navigable waters.
Endangered Species Act (16 U.S.C. 1536(a)(d)) 50 CFR Part 402	Requires evaluation of action's impacts to listed (or proposed for listing) species of fish, wildlife, or plants.	Applicable for activities where endangered species and/or their habitat are present.
Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*) - Coordination by federal agencies through 404 permit	Requires evaluation of action's impacts to fish or wildlife due to modifications to the water body.	Applicable for dredge operations in streams, rivers, or other water bodies.
Federal Coastal Zone Management Act (16 U.S.C. 1451 *et seq.*). Rules on Coastal Zone Management (New Jersey Administration Code [N.J.A.C.] 7:7E-1.1 *et seq.*)	Requires activities that take place in coastal zones be consistent with state act and local programs and regulations.	Any construction activities in state of New Jersey waters.
Sustainable Fisheries Act (16 U.S.C. 1801 *et seq.*). Coordination by federal agencies on Essential Fish Habitat 50 CFR Part 600	Requires evaluation of action's impacts to fish habitat.	Applicable for dredge operations in streams, rivers, or other water bodies.
State		
New Jersey Soil Erosion and Sediment Control Act (N.J.S.A. 4:24-42 and N.J.A.C. 2:90-1.1 *et seq.*)	Regulates construction that will potentially result in erosion of soils.	Applicable for any upland construction activities.
Tidelands Act (N.J.S.A. 12:3-1 *et seq.* & 18:5B-1 *et seq.*)	Requires evaluation of action's impacts to floodplains.	Applicable for construction in floodplain areas.
Waterfront Development Law (N.J.S.A. 12:5-3)	Establishes requirements for waterfront development in tidal waters of the state.	Applicable for dredge operations in tidal waters of the state.
Flood Hazard Area Control Act (N.J.S.A. 15:16A-50 *et seq.*)	Regulates activities (including remedial action) that will impact stream carrying capacity or flow velocity to avoid increasing impacts of flood waters.	Applicable to fills within the river or floodplain.
New Jersey Wetlands Act of 1970	Regulates any action in coastal wetlands which have been mapped or delineated pursuant to the Wetlands Act of 1970.	Potentially applicable to any construction activity that would occur or impact wetlands.

Table 6-1
Preliminary List of ARARs and TBCs for Phase I Work

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Potential ARAR Name and Regulation	Description	Action or Process that May Potentially Apply
Action Specific ARARs		
Federal		
Hazardous Waste Transportation: 49 CFR 107, 171, 172 and potentially 174, 176 or 177	Regulates the transportation of hazardous materials, and include the procedures for the packaging, labeling, manifesting and transporting of hazardous materials.	Applicable during transportation of dredged material and any other hazardous materials or wastes generated during remediation via truck, rail or barge to off-site locations.
Resource Conservation and Recovery Act (RCRA) Management of Solid Waste (40 CFR Parts 257, 258)	Requires designation of solid wastes.	Applicable for generation, treatment, transportation, storage, and disposal of dredged material if classified as solid or hazardous waste.
RCRA Management of Hazardous Waste (40 CFR Parts 261, 262, 264, 265, 268)	Evaluate and control material that contains a listed waste, or that displays a hazardous waste characteristic based on the Toxicity Characteristic Leaching Procedure test. Regulate storage, treatment and disposal of listed or characteristic waste unless an exemption applies.	Applicable to off-site disposal of dredged material.
CWA Sections 401, 404. Discharges of dredged or fill material into waters of the U.S. (33 CFR Parts 320 thru 330 and 40 CFR Parts 230 & 231)	Regulates the discharges of dredged or fill material into waters of the U.S. Requires assurance that action taken meets applicable federal/state water quality limitations.	Requires that construction activities during dredging will protect water quality.
USEPA Off-Site Disposal Rule (40 CFR 300.440)	Establishes approval procedures for USEPA approval of off-site disposal facilities.	Applicable to off-site disposal locations.
RCRA Land Disposal Restrictions (40 CFR 268)	Establishes alternative land disposal restrictions for remediation waste.	Applicable to off-site disposal of dredged material.
State		
New Jersey Solid Waste Management Act (N.J.S.A. 13:1E-1 *et seq.*) - State Waste Management Program	Establishes standards for the land filling of solid waste in New Jersey.	Although this is not applicable for dredged material, it is applicable to transport of solid wastes within New Jersey.
New Jersey Pollutant Discharge Elimination System rules: N.J.A.C. 7:14A	Regulate the direct and indirect discharge of pollutants to the surface water and ground water.	Applicable to barge dewatering and any on-site treatment activities.
New Jersey Technical Requirements for Site Remediation (N.J.A.C. 7:26E-1.13, -2.1, -2.2, -3.4, -3.8, -3.11, -4.5 and - 4.7)	This identifies the minimum technical requirements for remedial sites in New Jersey.	All activities associated with investigation and remediation.
To Be Considered		
USEPA's Guidance on Green Remediation	Provides guidance on considering environmental effects of remediation and options to maximum net environmental benefit of cleanup actions.	All activities associated with remediation.

Table 7-1
Evaluation of Technologies

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Technology Group	Process Option	Process Option Description	Effectiveness[1]	Implementability[1]	Relative Cost[2]	Retained
Containment and Shoreline Stability	Removal in the Dry	A containment structure with the surface water pumped out would allow removal of sediment in relatively dry conditions. This would require a water-tight steel sheet pile wall of sufficient global stability and structural design. Typically, a conventional cantilevered steel sheet pile wall can support an excavation of approximately 10 feet (ft) deep, depending on the sediment types and estimated wall deflections. Because the water depths and the sediment removal depths in the Phase I Work Area could be up to 27 ft, an alternate design, including a double steel sheet pile wall with rock fill, would be required. Once the containment is in place, the enclosed surface water would be pumped and discharged directly to the river without treatment. Water near the sediment surface may require treatment. Sealed interlocks would minimize surface water leakage and horizontal groundwater seepage into the Phase I Work Area. Sediment would likely be removed by a mechanical dredge excavator located on a barge on the river side of the sheet pile wall.	**Moderate:** Removal in the dry can effectively isolate the Phase I Work Area, support the excavation, and provide shoreline stability. Would contain suspended solids generated during sediment removal. Air emissions from exposed sediment, resulting in site worker and/or community exposures, may occur. Increased ecological risks may occur as birds that forage on mudflats may also forage on the exposed sediment. Would produce more water for treatment than removal in wet because some or all of the pumped out surface water would be treated prior to discharge. There is an increased likelihood of release as work would occur outside the sheet pile enclosure. Removed sediment would have similar moisture content as removal in dry sediment. Removal in the dry would produce much more water for treatment than removal in the wet because all of the surface water within the work area enclosure would be pumped out prior to removal and treated prior to discharge. In addition, it is likely that additional pumping/treatment would be required throughout the project due to things such as groundwater infiltration. Resuspended sediment cannot occur for removal in the dry because there is no water in the enclosure.	**Low to Moderate:** Removal in the dry has been used at other sites. Limits removal process option to mechanical dredge excavator. Vertical groundwater seepage would likely occur once dewatered; would require additional pumping to remove this water. Vertical groundwater seepage may destabilize the base of excavation. The production rates would be lower than equivalent mechanical dredge excavator used for removal in the wet because river stage and tide may limit time when there is sufficient water depth for barge to be near sheet pile wall. The schedule requirements may not be met because of the lower production rate. Steel sheet pile wall materials are readily available.	**Low:** Due to the potential hydrostatic loading on the outside of the containment wall from the water column and in-situ sediment, a wall with sufficient structural support would be required. Decreased production rates may result in increased operation costs.	No
	Removal in the Wet	Containment structure would allow sufficient water level to be maintained for removal equipment navigation. Because the difference in surface water level inside and outside the containment would be less than 10 ft, the sheet pile wall could be constructed as a conventional cantilevered steel sheet pile wall or a combination wall, which includes repeating H-piles or pipe piles. Once the containment is in place, the sediment removal could proceed. Sealed interlocks would minimize surface water leakage and horizontal groundwater seepage into the Phase I Work Area. Sediment could be removed by any of the removal process options.	**High:** Removal in the wet can effectively isolate the Phase I Work Area, support the excavation, and provide shoreline stability. Would contain the suspended solids generated during sediment removal but there is an increased risk of suspended solids escaping the containment, compared to removal in the dry. The design will prevent releases, to the extent practicible. For example, the joints in the sheet pile enclosure will be sealed to minimize release. Air emission from exposed sediment would be limited, reducing potential health and safety concerns to the community.	**High:** Removal in the wet has been used at other sites. Any removal process option could be used. Vertical groundwater seepage and the associated destabilization of the base of the excavation is not a concern with this option. The schedule requirements could be met with this option. Steel sheet pile wall materials are readily available.	**High:** The wall would require less time and materials to construct than removal in the dry wall. The production rate would be higher than equivalent mechanical dredge excavator used for removal in the dry because a constant water level would be maintained in the enclosure. Increased production rates may result in decreased operation costs.	Yes

Table 7-1
Evaluation of Technologies

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Technology Group	Process Option	Process Option Description	Effectiveness[1]	Implementability[1]	Relative Cost[2]	Retained
Sediment Removal	Mechanical	Mechanical dredge uses the mechanical action of a bucket or scoop to excavate the sediment at near in-situ density (i.e., with limited added water). A mechanical dredge operated from a barge would remove sediment and place it on a barge. The barge would transport the sediment to the sediment processing facility. Or sediment would be placed directly into a hopper on a barge. After the sediment passed through the hopper, it would be slurried on the barge and pumped to the processing facility. Mechanical dredges appropriate for the site include an excavator and a derrick with an environmental bucket.	**High:** Mechanical dredging has been used to effectively remove contaminated sediment at many dredging sites. Mechanical dredging can use environmental buckets and operational controls to minimize resuspension. Real-time positioning systems on mechanical dredges allows control of position accuracy of the mechanical dredge. Mechanical dredges are more effective at removing debris than hydraulic dredges or high-solids pumps. Mechanical dredges are capable of removing most types of small debris without compromising the effectiveness of the dredge to remove sediment. As the size of the debris increases, the likelihood of sediment resuspension during debris removal increases. Over-sized debris that does not completely fit inside the dredge bucket may prevent complete closure of the bucket, thereby allowing sediment to be released (resuspended) as the bucket rises through the water column and swings to the disposal barge. Although over-sized debris may cause resuspension, mechanical dredges are still capable of removing the debris; hydraulic dredges and high-solids pumps cannot remove over-sized debris. Mechanical dredging may potentially produce noise impacts to the community. If needed, noise impacts would be minimized, to the extent practical, during design. (Palermo et al. 2004)	**High:** Mechanical dredging is commonly used for environmental dredging applications, and mechanical dredges are widely available. Mechanical dredging results in dredged material with a lower water content than other types of sediment removal. Numerous environmental dredging projects have demonstrated that resuspension of sediment could be limited using mechanical dredging. There is a potential for air emissions from exposed sediment on the barge. Mechanical dredging would result in lower water generation and management than hydraulic or high-solids pump. (Palermo et al. 2004)	**High:** Mechanical dredges typically have higher production rates than hydraulic or high-solids dredges. Higher production rates may result in decreased operational costs. Mechanical dredges would require double handling of sediment from removal to the sediment processing area.	Yes

Table 7-1
Evaluation of Technologies

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Technology Group	Process Option	Process Option Description	Effectiveness[1]	Implementability[1]	Relative Cost[2]	Retained
Sediment Removal (cont'd)	Hydraulic	Removes sediment with hydraulic suction and the mechanical force of a rotating cutterhead or horizontal auger to loosen sediment. The sediment would be pumped as slurry through a pipeline to the sediment processing facility. Hydraulic dredges appropriate for the site include a cutterhead and a horizontal auger.	**High:** Hydraulic dredging is effective for removal of soft sediment, and may cause less resuspension than mechanical sediment removal. Real-time positioning systems on hydraulic dredges allow control of position accuracy of the hydraulic dredge. Hydraulic dredges are less effective at handling debris than mechanical dredges. Debris may be removed by a hydraulic dredge if it can be broken into smaller pieces using the cutterhead or auger. Certain types of debris (including cables, hoses, belts, and wires) can decrease the effectiveness of hydraulic dredges by causing damage to the impellers and pumps. A hydraulic dredge cannot remove over-sized debris; a mechanical dredge would be needed instead. Hydraulic dredging may potentially produce noise impacts to the community. If needed, noise impacts would be minimized, to the extent practical, during design. (Palermo et al. 2004)	**Moderate to High:** Hydraulic dredges are commonly used for environmental dredging applications and are widely available. It can be difficult to dredge on a slope and in the presence of debris. Removed sediment has a higher water content than with other types of sediment removal. Hydraulic dredging would result in higher water generation and management than mechanical or high-solids pump. (Palermo et al. 2004)	**Moderate:** Hydraulic dredges typically have a lower production than mechanical. Presence of debris may decrease production rates, which may result in increased operational costs. Hydraulic dredges would move the sediment directly to the sediment processing area. Hydraulic dredging would require use of mechanical dredge for debris removal. (Palermo et al. 2004)	Yes
	High-Solids Pump	High-solids pumping takes in sediment and nearby water through suction; the sediment is removed and transported as slurry by a continuous suction pump. Sediment is removed using a submersible pump (Toyo or Eddy pump) that is attached to a flexible pipe and suspended from a barge-mounted crane, excavator arm, or ladder. The sediment is then pumped through a pipeline to the sediment processing facility.	**High:** High-solids pumps can be used to dredge soft sediment. Real-time positioning systems on high solids pumps allow control of position accuracy of the high solids pump. High-solids pumps can only remove small debris and would have similar or worse problems as hydraulic dredges. High-solids pump dredging may potentially produce noise impacts to the community. If needed, noise impacts would be minimized, to the extent practical, during design. (Palermo et al. 2004)	**Moderate to High:** High-solids pumps have been used for several environmental dredging applications and are available but have lower availability than mechanical or hydraulic dredges. Can be difficult to dredge on a slope and in the presence of debris. Removed sediment has higher water content than mechanical dredging and lower content than hydraulic dredging. High-solids pump would result in higher water generation and management than mechanical but less than hydraulic. (Palermo et al. 2004)	**Moderate:** High-solids pumps production rates are dependent on site-specific conditions. Presence of debris may decrease production rates. Lower production rates may result in increased operational costs. High-solids pumps would move the sediment directly to the sediment processing area. High-solids pumping would require use of mechanical dredge for debris removal. (Palermo et al. 2004)	Yes
	Caisson Dredge	Caisson dredging involves driving in a cylindrical caisson before removing sediment. The sediment is removed by a mechanical dredge or high-solids pump from within the caisson. The removed sediment can then be backfilled before the caisson is removed. This is considered a specialty dredge and would facilitate removal and backfilling adjacent to the floodwall and bulkhead without destabilizing the shoreline structures. Given the circular footprint of the caisson, overlapping of adjacent caissons would be required.	**Moderate:** Caisson dredging is effective for sediment removal. Overlapping of caisson footprints can result in contaminated sediment being left in place. Conventional sediment removal technologies have a more established performance record. Real-time positioning systems on caisson dredges allow control of position accuracy of the caisson dredge. See effectiveness description for mechanical or high-solids pump for total solids, double handling, and debris discussion. Caisson dredging may potentially produce noise impacts to the community. If needed, noise impacts would be minimized, to the extent practical, during design.	**Moderate:** Caisson dredging has been used in a limited number of environmental dredging projects. See implementability description for mechanical dredge and high-solids pump discussion.	**Low:** Caisson dredges typically have lower production rates than the other dredges. Lower production rates may result in increased operation costs.	Yes. Retained for possible sediment removal near bulkheads. Not retained as primary process option.

Table 7-1
Evaluation of Technologies

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Technology Group	Process Option	Process Option Description	Effectiveness[1]	Implementability[1]	Relative Cost[2]	Retained
Sediment Processing	Solids Separation[3]	Separation of sediment by particle size using screens, cyclones, gravity separation, or other methods. Coarser sediment (sand) is separated from the finer sediment. This option is needed to remove large solids that may damage dewatering equipment and prevent dewatering equipment from functioning properly. Sediment would be pumped either directly from a hydraulic dredge or high-solids pump or mechanically transferred from a barge. Sediment would be put on a screen and moved through the screen by shaking and by water jets pushing the sediment through the screen. Coarser sediment would be removed for testing and disposal. Finer sediment would go, as slurry, to the dewatering process. During design, the percentage of sand present in the sediment and the need for solids separation will be evaluated.	**High:** Solids separation has successfully removed large solids from sediment at several sites. Potential air emissions and/or noise impacts from solids separation equipment would be minimized, to the extent practical, during design.	**High:** Solids separation has been conducted at several sites. Solids separation equipment is available.	**Low to Moderate:** Solids separation is evaluated as a stand alone sediment processing option. Solids separation has different objectives than dewatering, so it is not compared to the dewatering process options. Therefore, the cost is not compared to the other process options.	Yes
	Geotextile Tube Dewatering	High-strength permeable geotextile tubes retain sediment while allowing water to drain. The geotextile tubes would be pumped full with sediment directly from the solids separation process. Polymer would be added prior to pumping slurry into the geotextile tube to facilitate settling. Excess water would drain from the small pores in the geotextile tubes and would be collected for treatment. Dewatered sediment would go to transportation. This option is needed to meet treatment and disposal facility requirements for no free-standing water on the sediment (sediment must pass paint filter test).	**Moderate:** Geotextile tubes are less effective for finer materials, such as the organic silt present at the site. Generally, high-solids contents are attainable, but solids contents are lower than for mechanical dewatering. Additional drying in stockpiles or addition of pozzolanic reagents may be required. Potential air emissions and/or noise impacts from geotextile tube dewatering would be minimized, to the extent practical, during design.	**Moderate:** Geotextile tubes have been used in several environmental dredging projects. A large amount of space and time is required; implementability depends on the amount of available space and schedule. Geotextile tubes are readily available.	**High:** Slower rate of dewatering than for mechanical dewatering. Slower rate results in increased operation costs. Operation and maintenance costs are less than mechanical and gravity dewatering.	Yes
	Mechanical Dewatering	Mechanical dewatering of sediment by squeezing or pressing water from sediment. Sediment would be pumped to mechanical dewatering from the solids separation process. Water removed from sediment would be treated. Dewatered sediment would go to separation based on chemistry. This option is needed to meet treatment and disposal facility requirements for no free-standing water on the sediment (sediment must pass paint filter test).	**High:** Mechanical dewatering is effective for fine-grained materials, such as the organic silt present at the site. Potential air emissions and/or noise impacts from mechanical dewatering would be minimized, to the extent practical, during design.	**High:** Mechanical dewatering has been conducted at many sites. Less time and space is required than gravity dewatering or geotextile tubes; however, there are higher operation and maintenance requirements. Mechanical dewatering equipment is available.	**Moderate:** Operation and maintenance costs are more than geotextile tube.	Yes
	Gravity Dewatering and Amendment	The most widely used method to dewater large volumes of sediment is gravity dewatering. Sediment is dewatered by settling, surface drainage, consolidation, and evaporation. Sediment would be pumped either directly from a hydraulic dredge or high-solids pump or mechanically transferred from a barge. The flocculation process can be accelerated through the addition of chemical polymers. These materials can be thoroughly mixed with the dredged sediment by injecting them into a hydraulic pipeline which transports the dredged material to the processing area. During surface drainage, amendment (such as cement) would be added to decrease water content. This option is needed to meet treatment and disposal facility requirements for no free-standing water on the sediment (sediment must pass paint filter test).	**Low:** Gravity dewatering is less effective for fine grained materials such as the organic silt present at the site. Potential air emissions and/or noise impacts from gravity dewatering would be minimized, to the extent practical, during design.	**Moderate:** Gravity dewatering and amendment have been used on other sites. There are significant space and time requirements. Implementability depends on the amount of available space and schedule. There is a potential for air emissions from exposed sediment. There is also increased exposure risk to workers.	**Moderate:** Slower processing rates. The efficiency of this method depends in part on the design of the drainage system and the initial solid content of the sediment. Slower rate results in increased operation costs.	No

Table 7-1
Evaluation of Technologies

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Technology Group	Process Option	Process Option Description	Effectiveness[1]	Implementability[1]	Relative Cost[2]	Retained
Water Treatment and Discharge	On-Site Treatment	An on-site water treatment plant would include treatment processes for particulate and contaminant removal. Treated water would be discharged to the receiving waterbody. The plant would likely include physical and chemical processes, such as flocculation, clarification, multimedia filtration, and granular-activated carbon adsorption.	**High:** Available technologies can treat water to the required discharge requirements, based on available performance data for typical chemical and physical water treatment equipment. Water chemical quality is expected to be similar to the OU-1 groundwater and the water treatment plant will use similar treatment processes as the existing OU-1 Groundwater Treatment System (GWTS). The OU-1 GWTS has consistently met the cleanup standards (effluent limitations) for discharge to the Passaic River (BBL 2006). Potential impacts to the surrounding community are expected to be minimal from an on-site water treatment plant.	**High:** On-site water treatment has been used at other sites and is successfully being used at OU-1. Water treatment equipment is readily available.	**High:** Permitting costs are expected to be lower than POTW permitting costs. Limitations on discharge based on precipitation are not expected, which would decrease operation costs.	Yes
	Publicly Owned Treatment Works (POTW)	Decant water would be discharged to the sewer. The sewer would convey water to the POTW for treatment. Discharges of decant water from the dewatering process to the sanitary sewer would need to meet Newark sewer use by-law limits.	**Low:** The POTW likely will not be capable of treating contaminants in water.	**Low:** Chemical characteristics of the decant water would adversely affect the quality of the POTW sludge; therefore, obtaining a discharge permit to the city sewer would be unlikely. Discharge is limited to dry weather to prevent discharge of contaminants to the river during wet weather sewer overflows. Passaic Valley Sewerage Commissioners have indicated in the past that they will not accept groundwater unless no other discharge alternative is available (BBL 2006). A similar response to water generated from a sediment remediation project could be expected.	**Moderate:** As obtaining a permit or meeting the substantive requirements of a permit would be more difficult than the on-site treatment process option, permitting costs would be higher. Discharging only in dry weather periods would increase operation costs.	No
Off-Site Transport of Sediment	Barge	Barge transportation includes the transport of dewatered sediment via existing navigable waterways.	**Moderate to High:** Low likelihood of sediment release during transport. There is a potential for barge grounding or sinking, which may release sediment. Barge transport may impact recreational boating on the river. However, recreational traffic is expected to be minimal on the river.	**High:** Barges are suitable for sealed intermodal containers. Barges have been used at other sites. Multiple transport technologies may be required if treatment or disposal facilities cannot accept barges. Barges are readily available; however, the quantity of barges needed may be a limitation.	**High:** Generally, barge transport is more cost effective than truck transport.	Yes
	Truck	Trucks can be used to transport sediment to the treatment and disposal facilities. Truck transportation would haul sediment over public roadways.	**Moderate to High:** Moderate to low likelihood of sediment release during transport. Potential for release of sediment during truck transport is greater than rail or barge because the truck transportation routes pass through congested industrial areas with a greater likelihood of traffic accidents. A large number of trucks would be required. Truck traffic may impact the surrounding community but would be minimized during design (e.g., to the extent practical, traffic routes would avoid residential neighborhoods).	**High:** Trucks are suitable for transporting sealed intermodal containers. It is the most flexible transportation technology and can be used with all treatment and disposal facilities. Trucks have been used at other sites. Trucks are readily available.	**Moderate:** Generally, truck transport is less cost effective than barge or rail transport.	Yes
	Rail	Railcars can be used to transport sediment.	**Moderate to High:** Low likelihood of sediment release. There is a potential for rail accidents and release of sediment. Rail transport may result in noise impacts to the surrounding community. Potential impacts would be minimized, to the extent practical, during design.	**High:** Rail is suitable for transporting sealed intermodal containers. Rail transport has been used at other sites. The project may require multiple transport technologies if treatment or disposal facilities cannot accept rail. Rail equipment is readily available.	**High:** Generally, rail transport is more cost effective than truck transport.	Yes

Table 7-1
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Technology Group	Process Option	Process Option Description	Effectiveness[1]	Implementability[1]	Relative Cost[2]	Retained
Off-Site Treatment and Disposal	Subtitle C Landfill	Subtitle C landfills may accept hazardous waste. All sediment must meet LDRs for disposal and pass the paint filter test for acceptance by the landfill.	**Low:** Effectiveness depends on chemistry of sediment. Design and operation of landfill may not be suitable for limiting migration of contaminants present in sediment. This option does not meet 2008 AOC requirement for treatment (USEPA 2008).	**Low to Moderate:** For sediment that meets LDRs, implementability is moderate to high due to the ability to dispose of waste relatively quickly following removal and dewatering. For sediment that does not meet LDRs, disposal in a Subtitle C landfill has low implementability. Landfills would need to be permitted to accept the types and concentrations of contaminants present in the sediment.	**High:** Per ton cost of direct disposal in a Subtitle C landfill is less than per ton cost of treatment and disposal in a Subtitle C landfill.	No
	Incineration and Subtitle C and D Landfills	Incineration is a controlled process that uses high temperatures to achieve complete destruction of organic contaminants. Most incinerators consist of a waste feed system, air or oxygen-fed burner system, combustion chamber, combustion monitoring system, and equipment for air pollution treatment and control and ash removal. Under oxidizing conditions, organic contaminants are converted to carbon dioxide, water, and (if chlorinated organics are present) hydrochloric acid. Nonvolatile metals are converted primarily to metal oxides. Metals may accumulate in the ash and could require treatment, such as stabilization for disposal. Sediment must pass the paint filter test to be accepted at the facility. For purposes of the EE/CA, it was assumed that 50% of the sediment would require treatment before disposal in a Subtitle C landfill. It was assumed that the remaining 50% of the sediment would not require treatment and would be disposed of in a Subtitle C landfill. It was assumed that the debris would be disposed of in a Subtitle D landfill. For Subtitle C landfill disposal, see above description for Subtitle C Landfill. Subtitle D landfills may not accept hazardous waste. All sediment must meet LDRs for disposal and pass the paint filter test for acceptance by the landfill.	**High:** Incineration offers high effectiveness for destroying organic compounds and metals. Organic contamination and removal efficiencies are typically on the order of 99.999 percent. Metals may accumulate in the ash and could require treatment, such as stabilization for disposal. Existing technology for constructing and operating a Subtitle C landfill can limit migration of contaminants remaining in ash.	**Moderate to High:** Due to the limited number of incinerators that can process this waste type, the capacity of available incinerators would limit treatment rates. Incineration rates would be significantly lower than sediment removal and processing rates. This may result in temporary stockpiling of sediment at the processing facility. Landfill disposal could occur at a similar rate to that of waste generation.	**Low:** Per ton cost of treatment and disposal in a Subtitle C landfill is more than per ton cost of direct disposal in a Subtitle C landfill.	Yes

Notes:
1. High, moderate, low – evaluation of how well process option meets criterion of effectiveness or implementability.
   High – the process option meets all of the components of the criterion.
   Moderate – the process option meets most of the components of the criterion.
   Low – the process option meets few to none of the components of the criterion.
2. High, moderate, low – evaluation of how process option compares to other process options in technology group. Process options that are lowest in cost relative to other process options are given a ranking of "high."
   Process options that are highest in cost relative to other process options are given a ranking of "low." Solids separation is evaluated as a stand alone sediment processing option.
   Solids separation has different objectives than dewatering, so it is not compared to the dewatering process options.
3. Solids separation is evaluated as a stand alone sediment processing option. Solids separation has different objectives than dewatering, so it is not compared to the dewatering process options.

Table 9-1
Comparative Analysis of Phase I Work Alternatives

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Alternative	Total Score	Effectiveness				Implementability						Cost	
		Protectiveness[1]		Ability to Achieve RAOs[2]		Technical Feasibility[3]		Availability[4]		Administrative Feasibility[5]		Relative Cost[6]	
		Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score
A: Hydraulic Removal with Geotextile Tube Dewatering	**1**	**High:** Removes and transfers material to sediment processing step with minimal exposure to workers or surrounding community or environment; material is transported off site in sealed intermodal containers that minimize exposure to transportation workers and surrounding community.	**1**	**High:** Removes mass of contaminated material within containment structure to prevent, to the extent practicable, dispersion of resuspended sediment; removal and transport techniques would prevent spillage or leakage to the extent practicable.	**1**	**Low:** Hydraulic dredging and geotextile tube dewatering can be paired seamlessly so additional material handling steps are not required; however, hydraulic dredging cannot easily manage debris, the presence of over-sized debris would require a mechanical dredge to remove it, and the presence of debris may significantly impact the achievable production rates; geotextile tube dewatering will take significantly longer than mechanical dewatering; geotextile tube dewatering may not effectively dewater the Phase I sediment, which is relatively cohesive silt, and additional drying in stockpiles or addition of pozzolanic reagents may be required. Hydraulic dredging has less precise control of equipment for efficient removal close to the wall. It is more efficient for removal of upper soft and potentially fluid-like sediment, but less efficient for the removal of deeper, relatively more consolidated sediment.	**-1**	**High:** Hydraulic dredges are readily available.Geotextile tubes are a readily available dewatering option, and may be easier to procure than the infrastructure and process equipment required for mechanical dewatering. There are limitations on the turnaround time for laboratory analytical results to segregate the material, and availability and throughput capacity of incinerators to treat and dispose of the material.	**1**	**Medium:** Containment structure would need to be constructed along the bulkheads and floodwalls along the Phase I Work Area; transport of the material would require barges or rail lines to carry the material off site through or near adjacent properties; stormwater permitting may be slightly more complicated due to exposed nature of geotextile tubes; has the largest upland footprint of the alternatives.	**0**	**Low: $53.9 million**	**-1**
B: Hydraulic Removal with Mechanical Dewatering	**2**	**High:** Removes and transfers material to the sediment processing step with minimal exposure to workers or surrounding community or environment; material is transported off site in sealed intermodal containers that minimize exposure to transportation workers and surrounding community.	**1**	**High:** Removes mass of contaminated material within containment structure to prevent, to the extent practicable, dispersion of resuspended sediment; removal and transport techniques would prevent spillage or leakage to the extent practicable.	**1**	**Medium:** Hydraulic dredging and mechanical dewatering can be paired seamlessly so additional material handling steps are not required; however, hydraulic dredging cannot easily manage debris, the presence of over-sized debris would require a mechanical dredge to remove it, and the presence of debris may significantly impact the achievable production rates; mechanical dewatering can effectively dewater silty, cohesive sediment. Hydraulic dredging has less precise control of equipment for efficient removal close to the wall. It is more efficient for removal of upper soft and potentially fluid-like sediment, but less efficient for the removal of deeper, relatively more consolidated sediment.	**0**	**Medium:** The equipment required for sediment removal is readily available, but mechanical dewatering equipment may be more difficult to procure than geotextile tubes. There are limitations on the turnaround time for laboratory analytical results to segregate the material, and availability and throughput capacity of incinerators to treat and dispose of the material.	**0**	**High:** Containment structure must be constructed along the bulkheads and floodwalls along the Phase I Work Area; transport of the material would require barges or rail lines to carry the material off site through or near adjacent properties; has the second largest upland footprint of the alternatives.	**1**	**Low: $49.1 million**	**-1**
C: Mechanical Removal with Mechanical Dewatering	**4**	**Medium:** Material is transported off site in sealed intermodal containers that minimize exposure to transportation workers and surrounding community; exposure may occur during dredging and during handling of material prior to the sediment processing step; and the transfer of material from in-situ to sediment processing may require two additional handling steps.	**0**	**High:** Removes mass of contaminated material within containment structure to prevent, to the extent practicable, dispersion of resuspended sediment; removal and transport techniques would prevent spillage or leakage to the extent practicable.	**1**	**High:** Mechanical dredging is capable of handling and removing debris that may be present in the Phase I Work Area; mechanical dredges are effective at removing material close to structures like the containment sheet piling; mechanical dewatering can effectively dewater silty, cohesive sediment. Mechanical dredging is less efficient for removal of upper soft and potentially fluid-like sediment, but more efficient for the removal of deeper, relatively more consolidated sediment.	**1**	**Medium:** The equipment required for sediment removal and processing is readily available, but mechanical dewatering equipment may be more difficult to procure than geotextile tubes. There are limitations on the turnaround time for laboratory analytical results to segregate the material, and availability and throughput capacity of incinerators to treat and dispose of the material.	**0**	**High:** Containment structure must be constructed along the bulkheads and floodwalls along the Phase I Work Area; transport of the material would require barges or rail lines to carry the material off site through or near adjacent properties; has the smallest upland footprint of the alternatives.	**1**	**High: $44.7 million**	**1**

Table 9-1
Comparative Analysis of Phase I Work Alternatives

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Alternative	Total Score	Effectiveness				Implementability						Cost	
		Protectiveness[1]		Ability to Achieve RAOs[2]		Technical Feasibility[3]		Availability[4]		Administrative Feasibility[5]		Relative Cost[6]	
		Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score	Rationale	Score
D: High Solids Pump Removal with Mechanical Dewatering	1	**Low:** Removes and transfers material to the sediment processing step with minimal exposure to workers or surrounding community or environment; material is transported off site in sealed intermodal containers that minimize exposure to transportation workers and surrounding community; however, there may be greater exposure to workers during dredging than standard hydraulic and mechanical processes because of the potential to have to clear pump inlet of debris or vegetation. Workers physically removing debris at the intake of the high-solids pump would have the greatest potential risk of exposure to contaminated sediment among the alternatives, if debris of the type and size to clog the intake screen of the high-solids pump is encountered.	-1	**High:** Removes mass of contaminated material within containment structure to prevent, to the extent practicable, dispersion of resuspended sediment; removal and transport techniques would prevent spillage or leakage to the extent practicable.	1	**Medium:** High-solids pump removal and mechanical dewatering can be paired seamlessly so additional material handling steps are not required; high-solids pumps are effective at removing material close to structures like the containment sheet piling; using a high-solids pump would reduce the volume of decant water requiring treatment as compared to hydraulic removal due to the higher solids content of the high-solids pump slurry; mechanical dewatering can effectively dewater silty, cohesive sediment; however, high-solids pumps cannot easily manage debris and vegetation, the presence of over-sized debris would require a mechanical dredge to remove it, and its presence may significantly impact the ability to achieve the removal depth, volume, or achievable production rates. High-solids pumps are more efficient for removal of upper soft and potentially fluid-like sediment, but less efficient for the removal of deeper, relatively more consolidated sediment.	0	**Low:** The equipment required for processing is readily available, but mechanical dewatering equipment may be more difficult to procure than geotextile tubes. High-solids pumps are less commonly used for sediment removal than mechanical and hydraulic dredges and, similar to the other alternatives, there are limitations on the turnaround time for laboratory analytical results to segregate the material, and availability and throughput capacity of incinerators to treat and dispose of the material.	-1	**High:** Containment structure must be constructed along the bulkheads and floodwalls along the Phase I Work Area; transport of the material would require barges or rail lines to carry the material off site through or near adjacent properties, has the second to smallest upland footprint of the alternatives.	1	**High: $45.1 million**	1

Notes:

1. *Protectiveness* includes how protective the alternative is compared to other alternatives to human health and the community, workers during implementation, the environment, and its compliance with Applicable or Relevant and Appropriate Requirements (ARARs).
2. *Ability to achieve Remedial Action Objectives (RAOs)* includes how the alternative ranks against other alternatives in: 1) Removing a portion of the most contaminated inventory of 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (TCDD), as well as with other hazardous substances, to preclude the possibility of migration due to extreme weather events; 2) Preventing, to the extent practicable, the migration of resuspended sediment during removal operations; 3) Preventing, to the extent practicable, the potential for spillage or leakage of sediment and contaminants during transport to the disposal facility; 4) Restoring habitat (Note that restoration of Phase I Work Area must consider the activities of the bordering Phase II Work efforts. Restoration of the Phase I Work Area may not occur or be completed until Phase II is completed).
3. *Technical feasibility* is how the alternative compares to other alternatives for constructability, ease of operation, demonstrated performance, adaptability to environmental conditions, contribution to remedial performance including compatability with future Lower Passaic River Study Area remedial actions, and abiilty to complete the removal within the timeframe timeframe specified in the 2008 Administrative Order on Consent (USEPA 2008).
4. *Availability* of the alternative as compared to other alternatives includes availability of equipment, personnel and services; outside laboratory testing capabilities; off-site treatment and disposal capacity; and post-removal site controls.
5. *Administrative feasibility* of the alternative as compared to other alternatives includes required permits, easements, and right-of-ways, impacts on adjoining properties, ability to impose institutional controls, and likelihood of exemption from statutory limits
6. See Appendix A for cost estimate assumptions and backup. Alternatives that are low in cost relative to other alternatives are given a score of "high," or 1, and alternatives that are highest in cost relative to other alternatives are given a score of "low," or -1.

Figures

SYR-85 KEW JCR
Tierra (B0009961.0000.000007)
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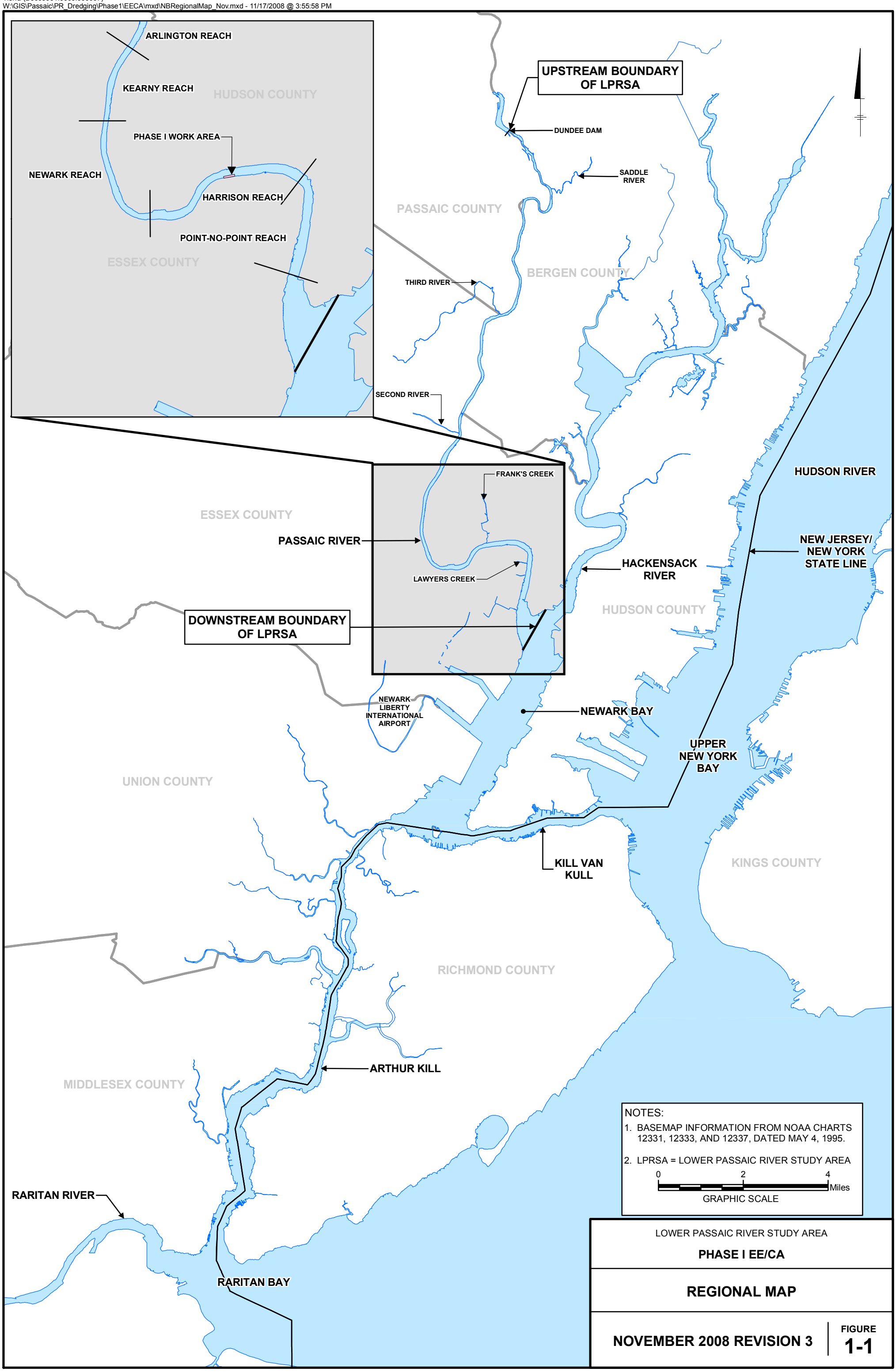

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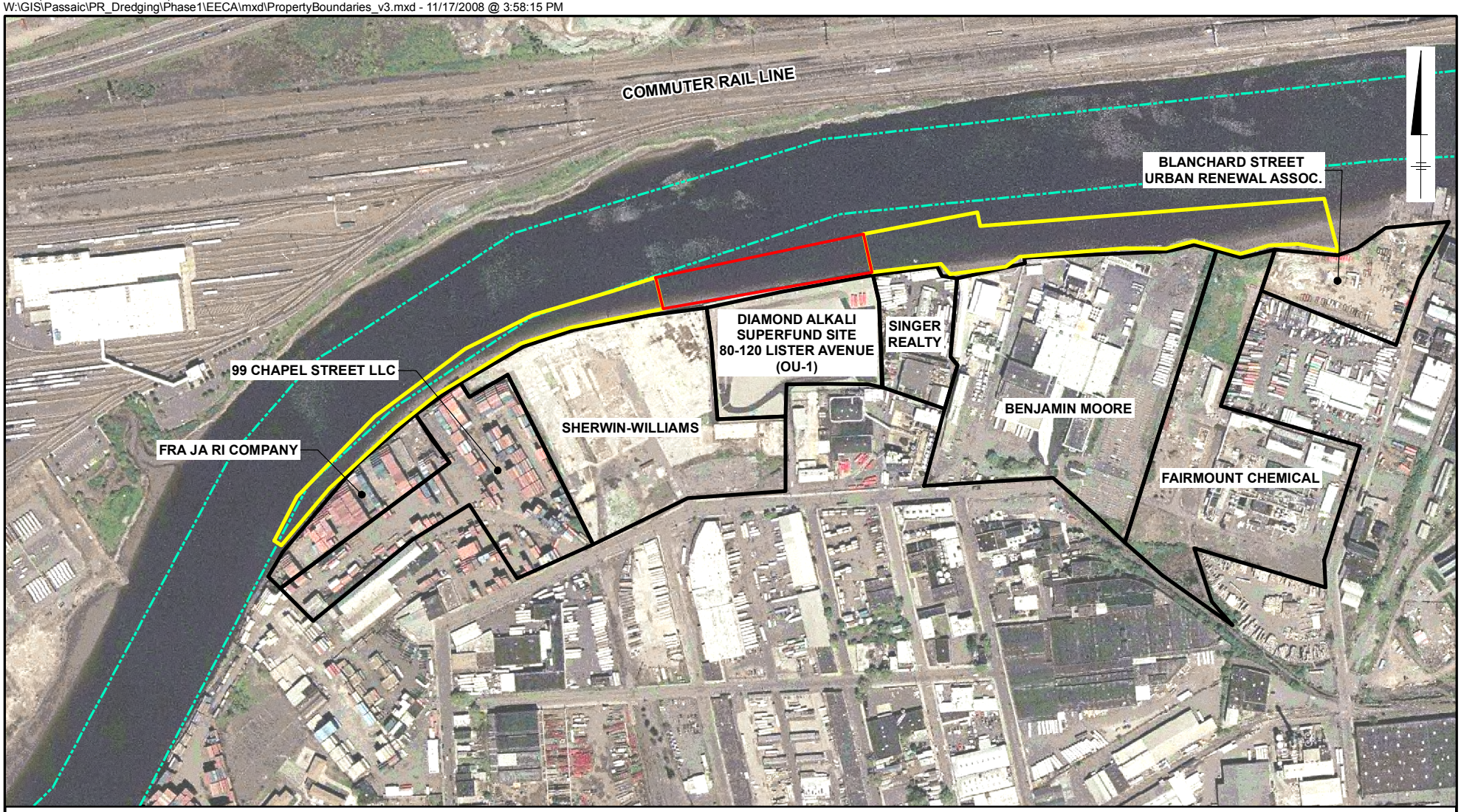

LEGEND:

- PHASE I WORK AREA
- PHASE II WORK AREA
- PROPERTY BOUNDARY
- FEDERAL NAVIGATION CHANNEL

0 500 1,000 Feet

GRAPHIC SCALE

NOTES:

1. PROPERTY BOUNDARIES DIGITIZED FROM CITY OF NEWARK TAX MAP, ESSEX COUNTY, NEW JERSEY, ORIGINAL SURVEY BY JOSEPH F. FOX, JR., P.L.S.
2. THE OVERALL FOOTPRINT OF THE COMBINED PHASE I AND PHASE II WORK AREAS IS CONSISTENT WITH APPENDIX B OF THE ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (USEPA 2008). HOWEVER, THE PHASE I WORK AREA HAS BEEN SHIFTED APPROXIMATELY 30 FEET TO THE WEST TO ALLOW FOR MORE EFFICIENT OPERATIONS DURING PHASE I. THIS SHIFT DOES NOT AFFECT THE OVERALL PHASE I AND PHASE II REMOVAL AREAS (IN TERMS OF OVERALL SQUARE FOOTAGE) OR VOLUMES.

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

PHASE I AND PHASE II WORK AREAS

NOVEMBER 2008 REVISION 3

FIGURE **1-2**

CITY: SYR DIV/GROUP: SYE40 DB: KEW JCR
Tierra (B0009961.0000.000007)
W:\GIS\Passaic\PR_Dredging\Phase1\EECA\mxd\PropertyBoundaries_PhaseI_v3.mxd - 11/17/2008 @ 4:00:56 PM

LEGEND:

PHASE I WORK AREA

PROPERTY BOUNDARY

FEDERAL NAVIGATION CHANNEL

0 150 300 Feet

GRAPHIC SCALE

NOTES:

1. PROPERTY BOUNDARIES DIGITIZED FROM CITY OF NEWARK TAX MAP, ESSEX COUNTY, NEW JERSEY, ORIGINAL SURVEY BY JOSEPH F. FOX, JR., P.L.S.
2. THE OVERALL FOOTPRINT OF THE COMBINED PHASE I AND PHASE II WORK AREAS IS CONSISTENT WITH APPENDIX B OF THE ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (USEPA 2008). HOWEVER, THE PHASE I WORK AREA HAS BEEN SHIFTED APPROXIMATELY 30 FEET TO THE WEST TO ALLOW FOR MORE EFFICIENT OPERATIONS DURING PHASE I. THIS SHIFT DOES NOT AFFECT THE OVERALL PHASE I AND PHASE II REMOVAL AREAS (IN TERMS OF OVERALL SQUARE FOOTAGE) OR VOLUMES.

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

PHASE I WORK AREA

NOVEMBER 2008 REVISION 3

FIGURE
1-3

CITY:SYRACUSE, NY DIV/GROUP:141 DB:LAF KEW KFS KLS LD:(Opt) PIC:(Opt) PM:(Reqd) TM:E. DENKENBERGER LYR:(Opt)ON=*;OFF=*REF*
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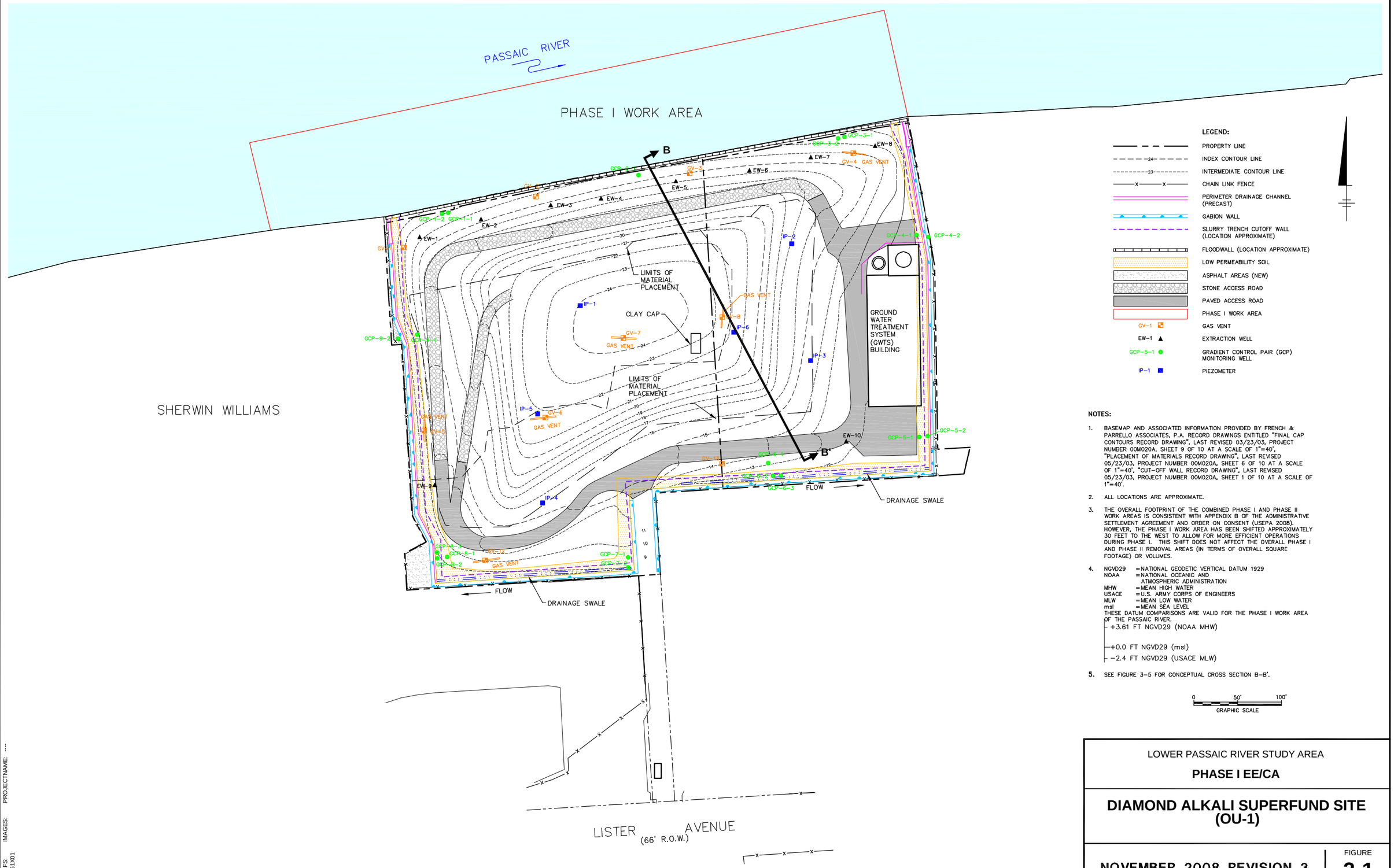

NOTES:

1. BASEMAP AND ASSOCIATED INFORMATION PROVIDED BY FRENCH & PARRELLO ASSOCIATES, P.A. RECORD DRAWINGS ENTITLED "FINAL CAP CONTOURS RECORD DRAWING", LAST REVISED 03/23/03, PROJECT NUMBER 00M020A, SHEET 9 OF 10 AT A SCALE OF 1"=40', "PLACEMENT OF MATERIALS RECORD DRAWING", LAST REVISED 05/23/03, PROJECT NUMBER 00M020A, SHEET 6 OF 10 AT A SCALE OF 1"=40', "CUT-OFF WALL RECORD DRAWING", LAST REVISED 05/23/03, PROJECT NUMBER 00M020A, SHEET 1 OF 10 AT A SCALE OF 1"=40'.

2. ALL LOCATIONS ARE APPROXIMATE.

3. THE OVERALL FOOTPRINT OF THE COMBINED PHASE I AND PHASE II WORK AREAS IS CONSISTENT WITH APPENDIX B OF THE ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (USEPA 2008). HOWEVER, THE PHASE I WORK AREA HAS BEEN SHIFTED APPROXIMATELY 30 FEET TO THE WEST TO ALLOW FOR MORE EFFICIENT OPERATIONS DURING PHASE I. THIS SHIFT DOES NOT AFFECT THE OVERALL PHASE I AND PHASE II REMOVAL AREAS (IN TERMS OF OVERALL SQUARE FOOTAGE) OR VOLUMES.

4. NGVD29 = NATIONAL GEODETIC VERTICAL DATUM 1929
   NOAA = NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
   MHW = MEAN HIGH WATER
   USACE = U.S. ARMY CORPS OF ENGINEERS
   MLW = MEAN LOW WATER
   msl = MEAN SEA LEVEL
   THESE DATUM COMPARISONS ARE VALID FOR THE PHASE I WORK AREA OF THE PASSAIC RIVER.
   - +3.61 FT NGVD29 (NOAA MHW)
   - +0.0 FT NGVD29 (msl)
   - −2.4 FT NGVD29 (USACE MLW)

5. SEE FIGURE 3-5 FOR CONCEPTUAL CROSS SECTION B-B'.

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

DIAMOND ALKALI SUPERFUND SITE (OU-1)

NOVEMBER 2008 REVISION 3

FIGURE **2-1**

CITY: SYR DIV/GROUP: 90 DB: MTK KEW JCR
Tierra (B0009961.0000.000007)
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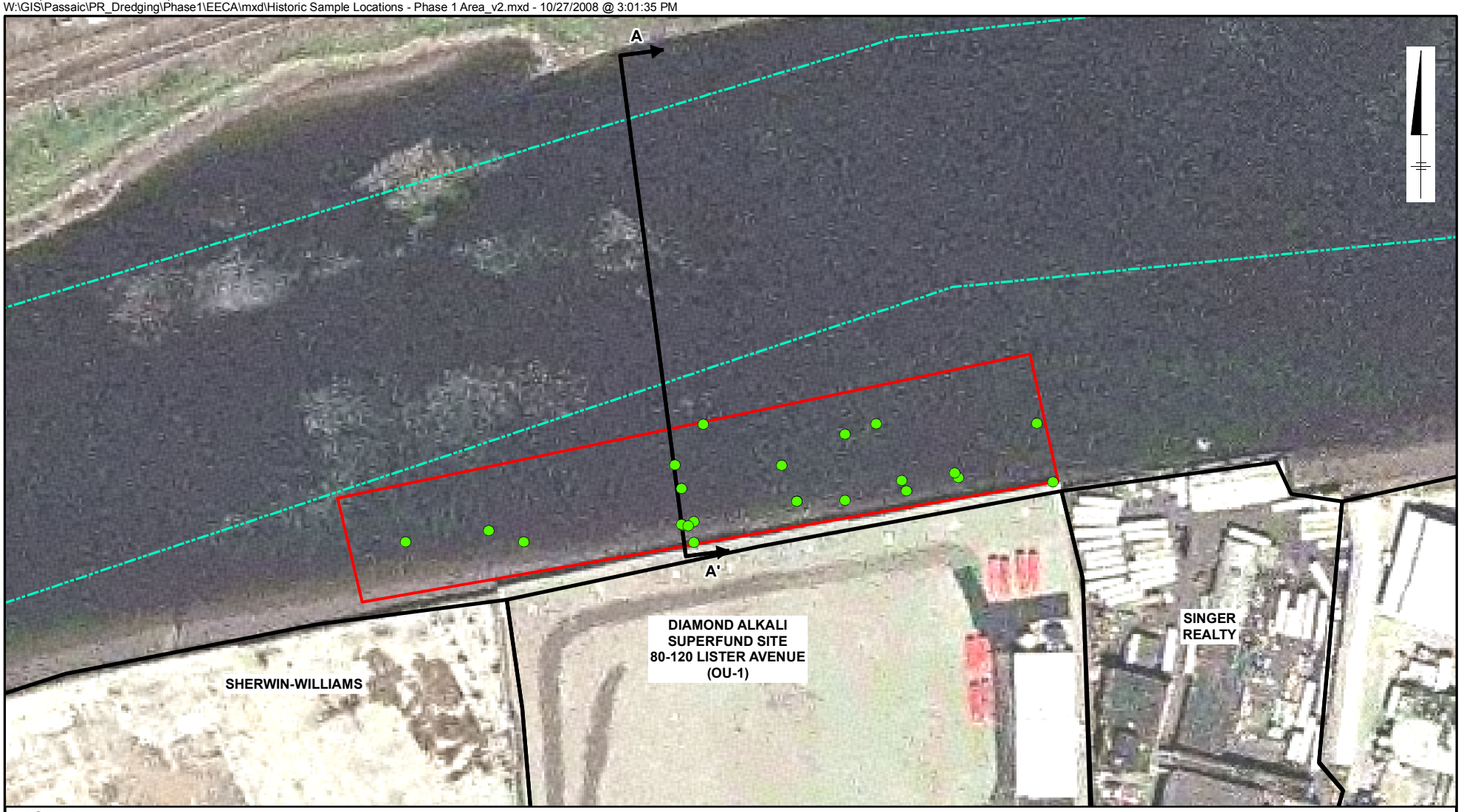

LEGEND:

- HISTORICAL SAMPLE LOCATION
- FEDERAL NAVIGATION CHANNEL
- PHASE I WORK AREA
- PROPERTY BOUNDARY

0 150 300 Feet

GRAPHIC SCALE

NOTES:

1. PROPERTY BOUNDARIES DIGITIZED FROM CITY OF NEWARK TAX MAP, ESSEX COUNTY, NEW JERSEY, ORIGINAL SURVEY BY JOSEPH F. FOX, JR., P.L.S.
2. THE OVERALL FOOTPRINT OF THE COMBINED PHASE I AND PHASE II WORK AREAS IS CONSISTENT WITH APPENDIX B OF THE ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (USEPA 2008). HOWEVER, THE PHASE I WORK AREA HAS BEEN SHIFTED APPROXIMATELY 30 FEET TO THE WEST TO ALLOW FOR MORE EFFICIENT OPERATIONS DURING PHASE I. THIS SHIFT DOES NOT AFFECT THE OVERALL PHASE I AND PHASE II REMOVAL AREAS (IN TERMS OF OVERALL SQUARE FOOTAGE) OR VOLUMES.
3. REFER TO FIGURE 3-3 FOR CONCEPTUAL CROSS SECTION A - A'.

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

HISTORICAL SAMPLE LOCATIONS

NOVEMBER 2008 REVISION 3

FIGURE **3-1**

CITY: SYR DIV/GROUP: 90 DB: MTK KEW JCR
Tierra (B0009961.0000.000007)
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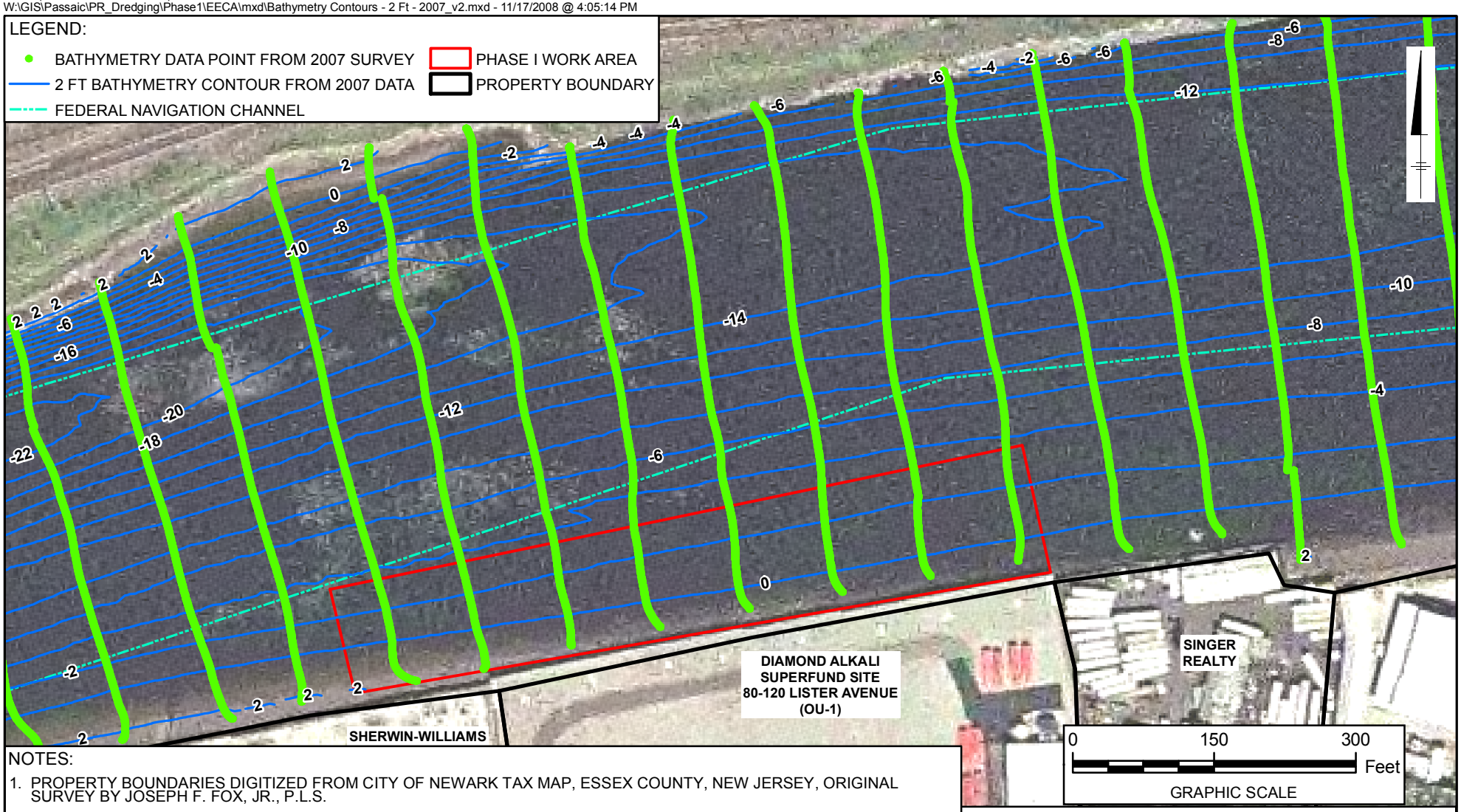


NOTES:

1. PROPERTY BOUNDARIES DIGITIZED FROM CITY OF NEWARK TAX MAP, ESSEX COUNTY, NEW JERSEY, ORIGINAL SURVEY BY JOSEPH F. FOX, JR., P.L.S.
2. THE OVERALL FOOTPRINT OF THE COMBINED PHASE I AND PHASE II WORK AREAS IS CONSISTENT WITH APPENDIX B OF THE ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (USEPA 2008). HOWEVER, THE PHASE I WORK AREA HAS BEEN SHIFTED APPROXIMATELY 30 FEET TO THE WEST TO ALLOW FOR MORE EFFICIENT OPERATIONS DURING PHASE I. THIS SHIFT DOES NOT AFFECT THE OVERALL PHASE I AND PHASE II REMOVAL AREAS (IN TERMS OF OVERALL SQUARE FOOTAGE) OR VOLUMES.
3. BATHYMETRY DATA COLLECTED IN 2007 BY GAHAGAN AND BRYANT ASSOCIATES, INC., ON BEHALF OF ENSR (FOR THE CPG). ELEVATIONS REPORTED IN FEET REFERENCE THE UNITED STATES ARMY CORPS OF ENGINEERS MEAN LOW WATER VERTICAL DATUM.
4. NGVD29 = NATIONAL GEODETIC VERTICAL DATUM 1929
NOAA = NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
MHW = MEAN HIGH WATER
USACE = U.S. ARMY CORPS OF ENGINEERS
MLW = MEAN LOW WATER
msl = MEAN SEA LEVEL

- + 3.61 FT NGVD29 (NOAA MHW)
- + 0.0 FT NGVD29 (msl)
- - 2.4 FT NGVD29 (USACE MLW)

THESE DATUM COMPARISONS ARE VALID FOR THE PHASE I WORK AREA OF THE PASSAIC RIVER.

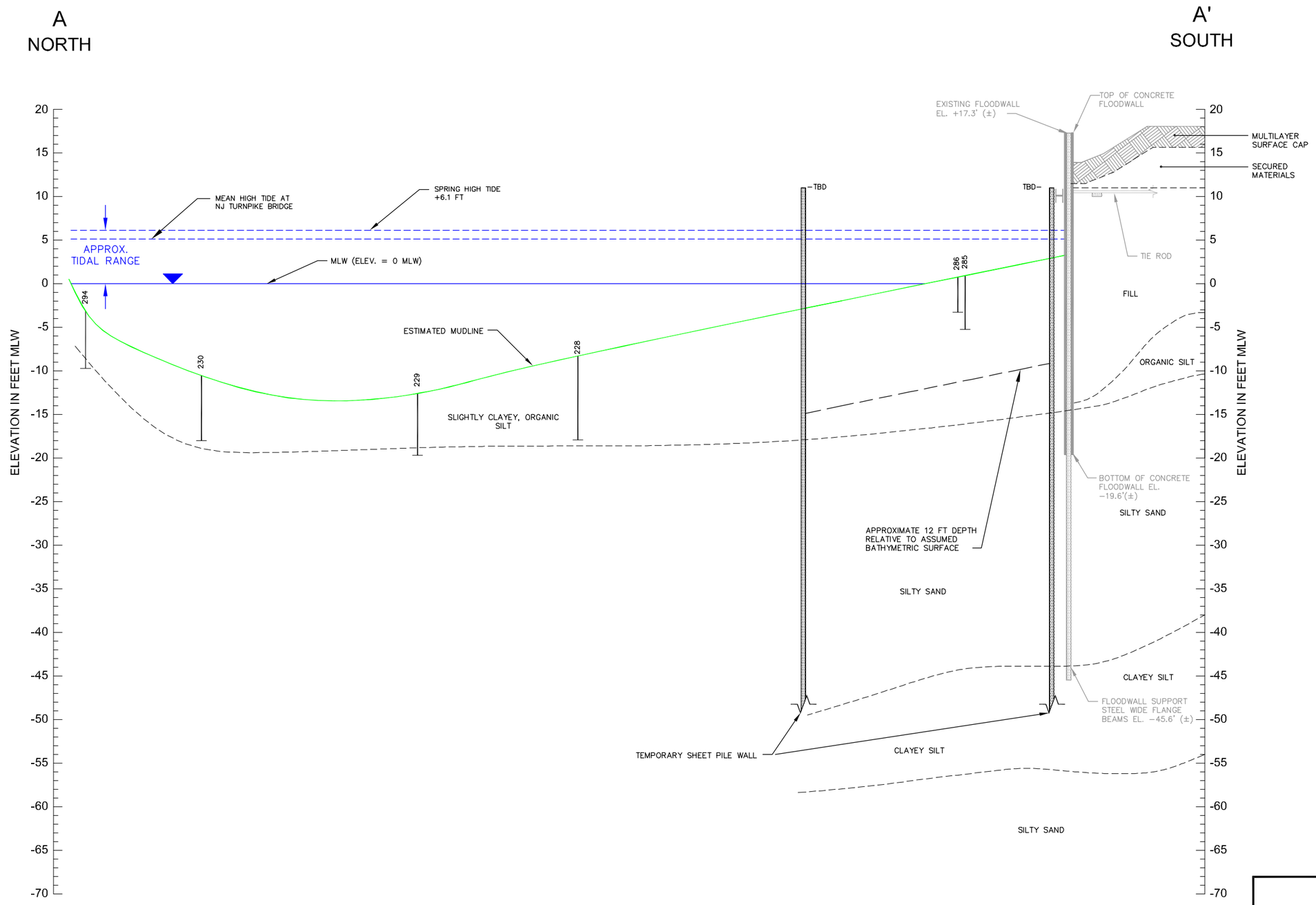
LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

2007 BATHYMETRIC CONTOURS

NOVEMBER 2008 REVISION 3

FIGURE **3-2**



LEGEND:

286 VIBRACORE NUMBER

VIBRACORE LOCATION

NOTES:

1. CROSS SECTION FROM DRAFT FEASIBILITY EVALUATION FOR DREDGING AND DREDGE MATERIAL DISPOSAL REPORT, HART CROWSER, JANUARY 2003.
2. EXISTING FLOODWALL ELEVATIONS APPROXIMATED FROM FLOODWALL DESIGN DRAWINGS; MUESER RUTLEDGE CONSULTING ENGINEERS, FEBRUARY 1996.
3. ELEVATIONS REPORTED IN FEET REFERENCE THE UNITED STATES ARMY CORPS OF ENGINEERS MEAN LOW WATER VERTICAL DATUM.
4. NGVD29 = NATIONAL GEODETIC VERTICAL DATUM 1929
   NOAA = NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
   MHW = MEAN HIGH WATER
   USACE = U.S. ARMY CORPS OF ENGINEERS
   MLW = MEAN LOW WATER
   msl = MEAN SEA LEVEL

   THESE DATUM COMPARISONS ARE VALID FOR THE PHASE I WORK AREA OF THE PASSAIC RIVER.

   +3.61 FT NGVD29 (NOAA MHW)
   +0.0 FT NGVD29 (msl)
   −2.4 FT NGVD29 (USACE MLW)
5. SEE FIGURE 3−1 FOR PLAN VIEW OF A−A'.
6. GENERALIZED SUBSURFACE GEOLOGY BASED ON BORING LOGS FROM ECKENFELDER, 1995.

0 30' 60'
GRAPHIC SCALE

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 5x

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

CONCEPTUAL CROSS SECTION A-A' OF PHASE I WORK AREA

NOVEMBER 2008 REVISION 3

FIGURE **3-3**

CITY: SYRACUSE, NY GROUP: ENV-141 DB: C.DOTSON, RCB, PGL KFS PM: R.ROMAGNOLI TM: E.DENKENBERGER LYR: ON=*;OFF=REF
G:\ENVCAD\SYRACUSE\ACT\B0009961\00000001\4\DWG\REV-3\09961G04.dwg LAYOUT: 3-3 SAVED: 11/18/2008 10:20 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: D2B-PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 11/18/2008 10:20 AM BY: SARTORI, KATHERINE
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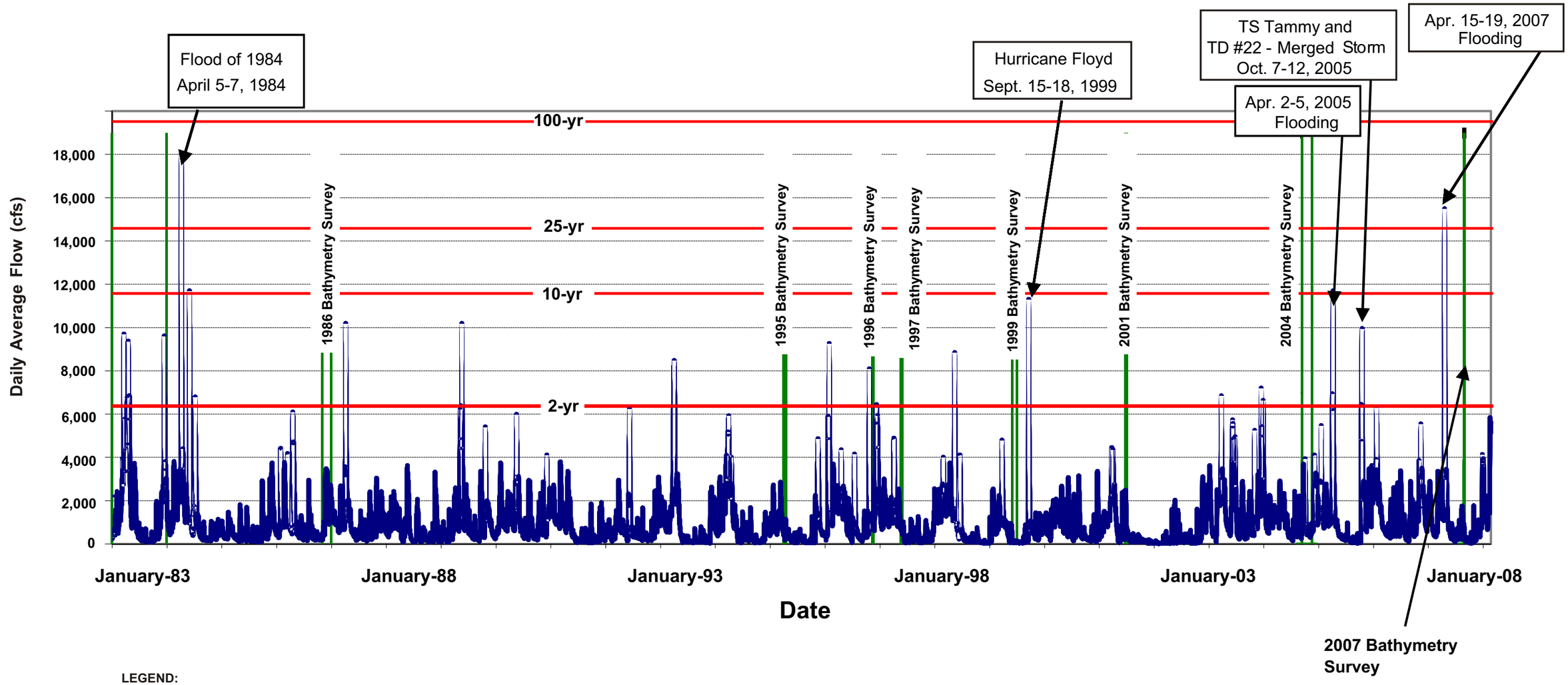


LEGEND:

= Flow measured from gauge

= Predicted event flows

= Bathymetry Surveys

NOTES:

1. Data from USGS Station 01389500-Passaic River at Little Falls, NJ.

LOWER PASSAIC RIVER STUDY AREA

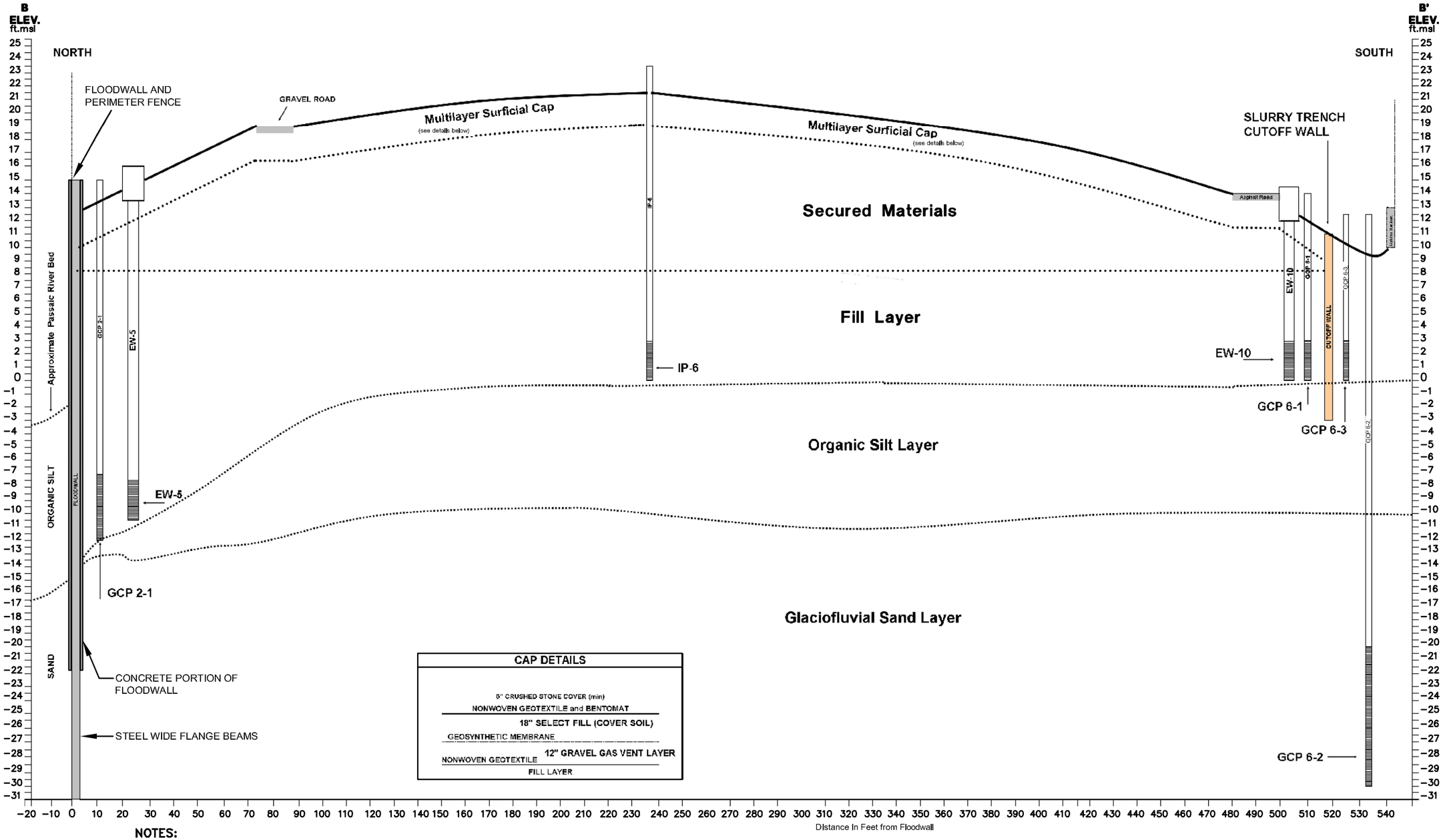
PHASE I EE/CA

PASSAIC RIVER DAILY AVERAGE FLOWS AT LITTLE FALLS, NJ 1983-2008

NOVEMBER 2008 REVISION 3

FIGURE **3-4**

11/18/08 SYR-141ENV-DJH-KLS
B0009961/0000/00014/CDR/09961G05.CDR



NOTES:

1. ELEVATIONS AND LAYOUT PROVIDED BY ECKENFELDER BROWN AND CALDWELL, TITLED: "ATTACHMENT A: FINAL (100%) REMEDIAL DESIGN DRAWINGS" LAST REVISED: JULY 1999.

2. NGVD29 = NATIONAL GEODETIC VERTICAL DATUM 1929
   NOAA = NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
   MHW = MEAN HIGH WATER — +3.61 FT NGVD29 (NOAA MHW)
   USACE = U.S. ARMY CORPS OF ENGINEERS
   MLW = MEAN LOW WATER
   msl = MEAN SEA LEVEL — +0.0 FT NGVD29 (msl)
   THESE DATUM COMPARISONS ARE VALID FOR THE PHASE I WORK AREA OF THE PASSAIC RIVER. — −2.4 FT NGVD29 (USACE MLW)

3. SEE FIGURE 2–1 FOR PLAN VIEW OF B–B'.

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

CONCEPTUAL CROSS SECTION B-B' OF OU-1

NOVEMBER 2008 REVISION 3

FIGURE **3-5**

CITY:(CRANBURY, NJ) SYRACUSE, NY GROUP:ENV-141 DB: (TLF) KLS PGL RCB PM: R. ROMAGNOLI TM: E.DENKENBERGER LYR:(Opt)ON=*;OFF=REF PAGESETUP: BL-PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 11/18/2008 10:19 AM BY: SARTORI, KATHERINE
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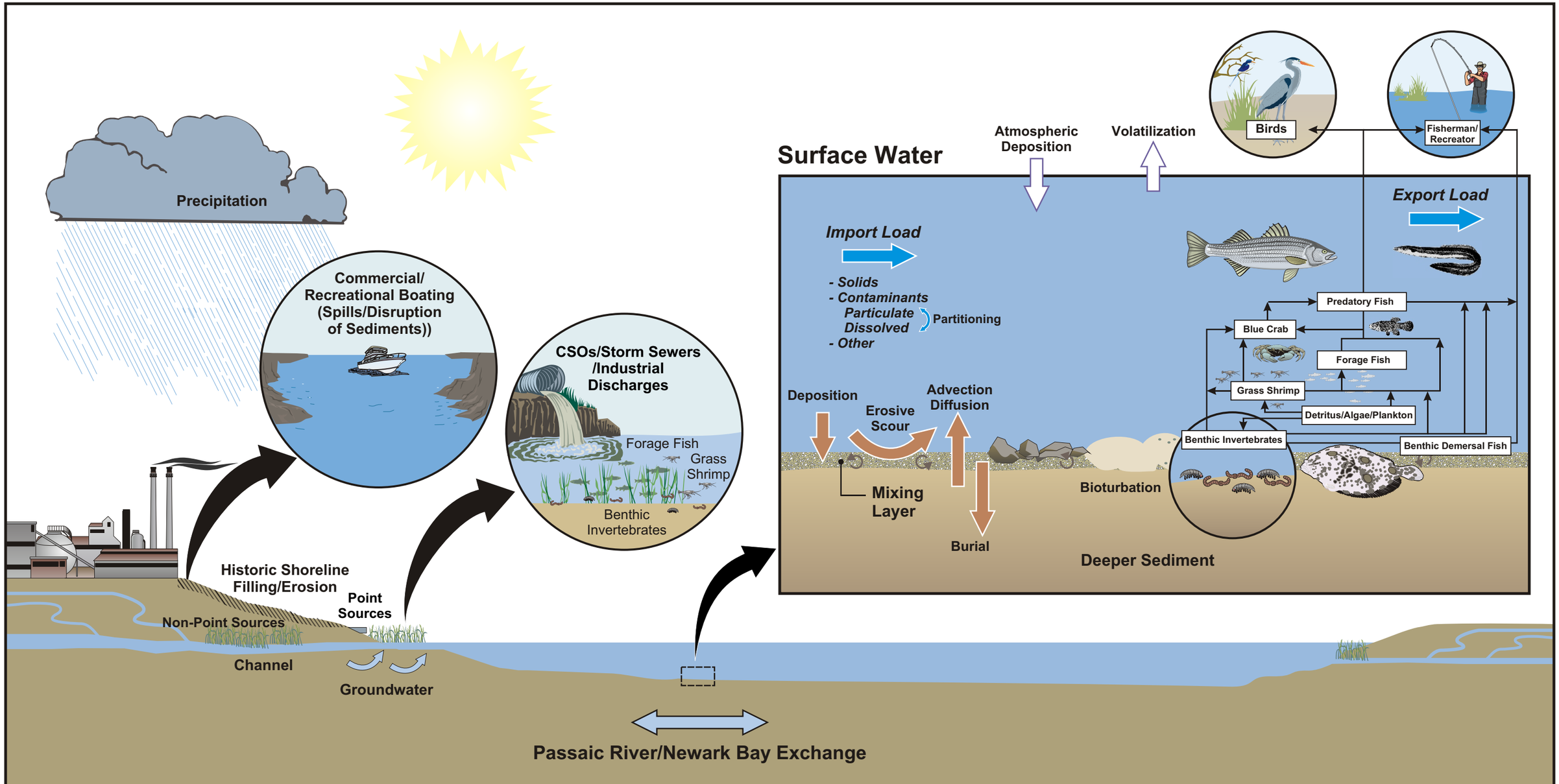


LOWER PASSAIC RIVER STUDY AREA

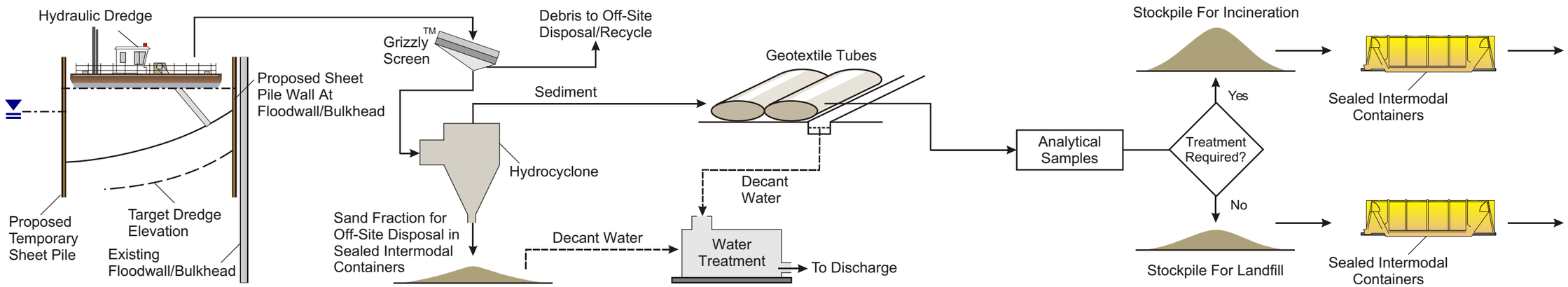
PHASE I EE/CA

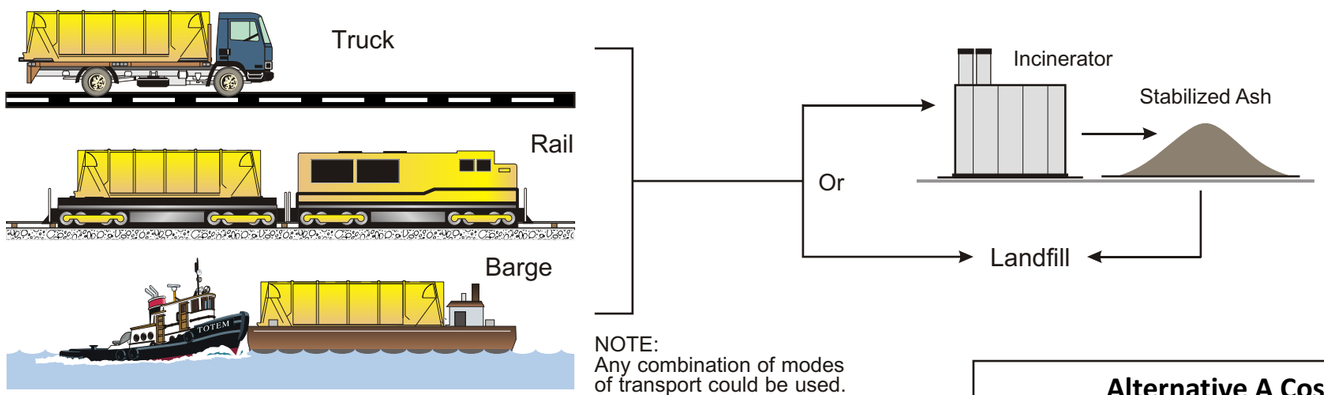
CONCEPTUAL SITE MODEL FOR THE LOWER PASSAIC RIVER

NOVEMBER 2008 REVISION 3

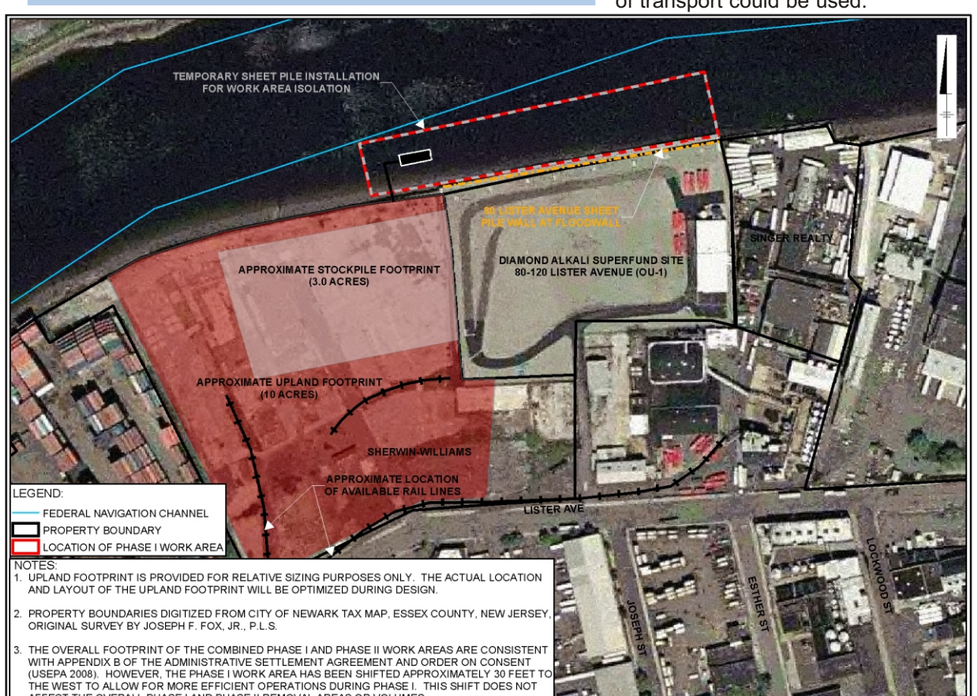
FIGURE 4-1

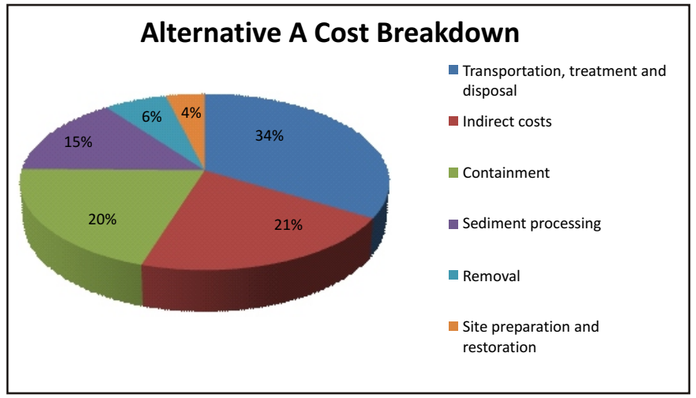
11/18/08 SYR-141ENV-DJH-KLS
B0009961/0000/00014/CDR/NOV-1/09961G06.CDR





NOTE:
Any combination of modes of transport could be used.





NOTES:

1. Sediment removal: **Hydraulic**. For the purposes of evaluating the alternative, it is assumed that an 8-inch cutterhead hydraulic dredge would be employed. The actual dredge to be employed will be determined during design.

2. Sediment processing: **Geotextile Tubes**. Geotextile tubes would be situated on a watertight upland staging area such that decanted water would collect in sumps. Prior to filling the geotextile tubes, the sand fraction would be removed using hydrocyclones or a similar device. Debris, including oversized material removed by the Grizzly, will be rinsed and disposed of separately off site.

3. Water treatment and discharge: **Mechanical**. It is assumed that treatment would include a sand filter and granular activated carbon units. Discharge would occur to the Passaic River. Discharge would occur under a NPDES permit to the Passiac River.

4. Off site transport of sediment: **Truck, rail or barge**. All three options are retained since a combination of transportation types may be necessary to transport the sediment to the selected disposal facility or facilities.

5. Backfill: Backfill material will have similar physical characteristics to the in-situ sediment but with improved engineered properties, such as a low plasticity index.

6. Alternative A would take approximately 27 weeks to complete removal and backfilling. This does not account for subsequent activities (e.g., sheet pile removal, remaining transport and disposal, and demobilization).

Removal quantity (cy):	40,000
Removal method:	hydraulic
Sediment processing method:	geotextile tubes
Approximate upland footprint (acres):	10
Dredging production rate (cy/hr):	135
Assumed removal solids content:	10%
Water treatment rate (gpm):	2,900
Dewatered sediment quantity (cy):	26,000
Estimated total cost ($):	$53,900,000

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

ALTERNATIVE A: HYDRAULIC REMOVAL WITH GEOTEXTILE TUBE DEWATERING

NOVEMBER 2008 REVISION 3

FIGURE **8-1**

11/18/08 SYR-ENV141-DJH-KLS
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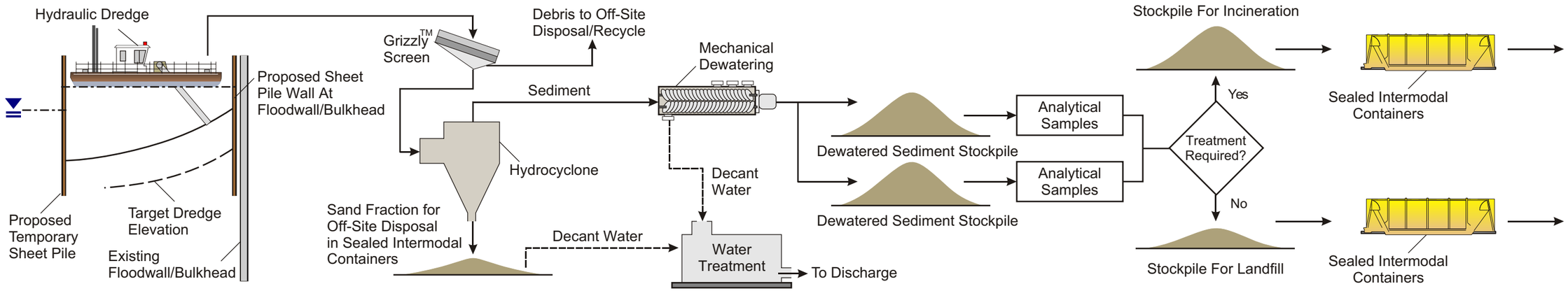
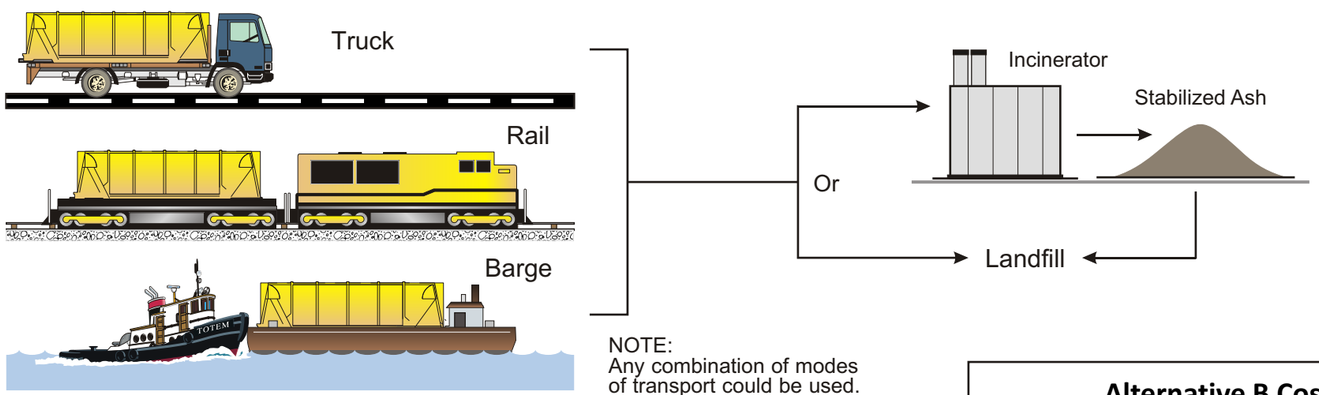
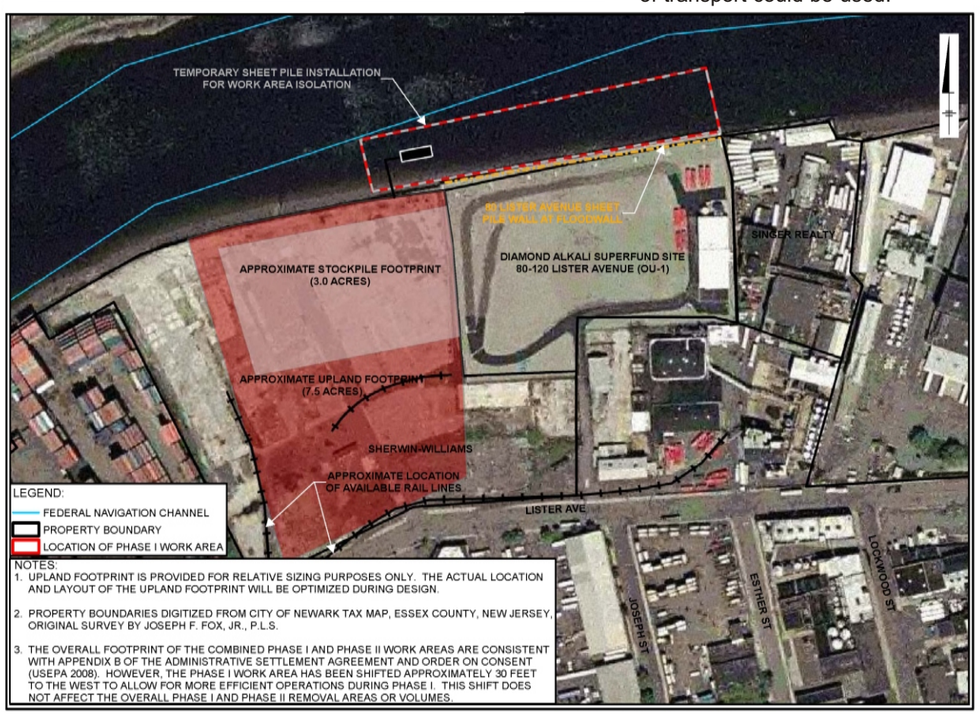
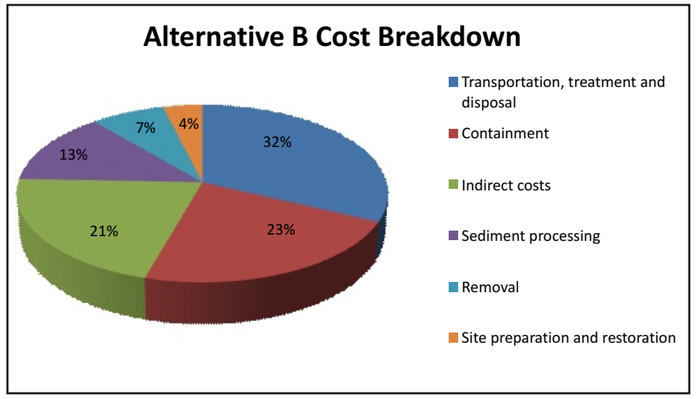




NOTE:
Any combination of modes of transport could be used.





Removal quantity (cy):	40,000
Removal method:	hydraulic
Sediment processing method:	mechanical
Approximate upland footprint (acres):	7.5
Dredging production rate (cy/hr):	135
Assumed removal solids content:	10%
Water treatment rate (gpm):	3,000
Dewatered sediment quantity (cy):	22,600
Estimated total cost ($):	$49,100,000

NOTES:

1. Sediment removal: **Hydraulic**. For the purposes of evaluating the alternative, it is assumed that an 8-inch cutterhead hydraulic dredge would be employed. The actual dredge to be employed will be determined during design.

2. Sediment processing: **Mechanical**. It is assumed that a belt press would be used to dewater the sediment, although a belt press, filter press, or plate and frame press could be considered during design. Prior to dewatering, the sand fraction would be removed using hydrocyclones or a similar device. Debris, including oversized material removed by the Grizzly, will be rinsed and disposed of separately off site.

3. Water treatment and discharge: **Mechanical**. It is assumed that treatment would include a sand filter and granular activated carbon units. Discharge would occur under a NPDES permit to the Passaic River.

4. Off site transport of sediment: **Truck, rail or barge**. All three options are retained for the transport process because a combination of transportation types may be necessary to transport the sediment to the selected disposal facility or facilities.

5. Backfill: Backfill material will have similar physical characteristics to the in-situ sediment but with improved engineered properties, such as a low plasticity index.

6. Alternative B would take approximately 27 weeks to complete removal and backfilling. This does not account for subsequent activities (e.g., sheet pile removal, remaining transport and disposal, and demobilization).

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

ALTERNATIVE B: HYDRAULIC REMOVAL WITH MECHANICAL DEWATERING

NOVEMBER 2008 REVISION 3

FIGURE **8-2**

11/18/08 SYR-141ENV-DJH-KLS
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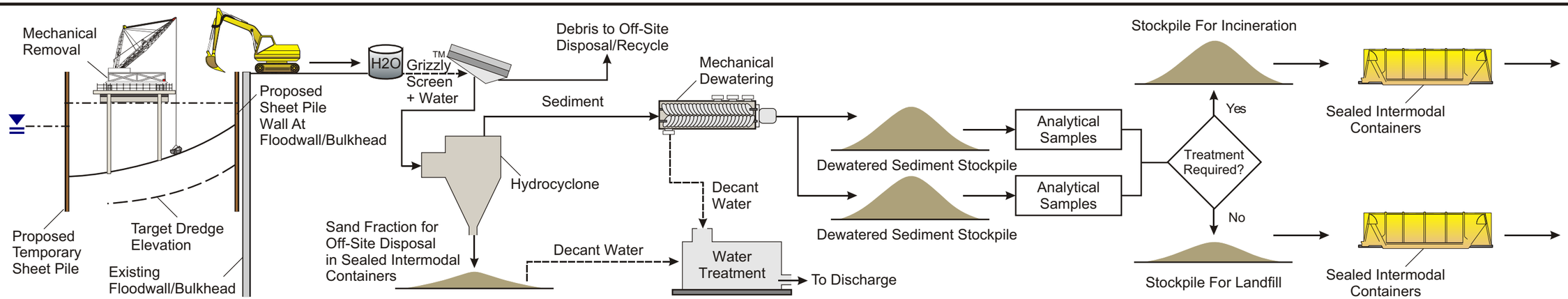
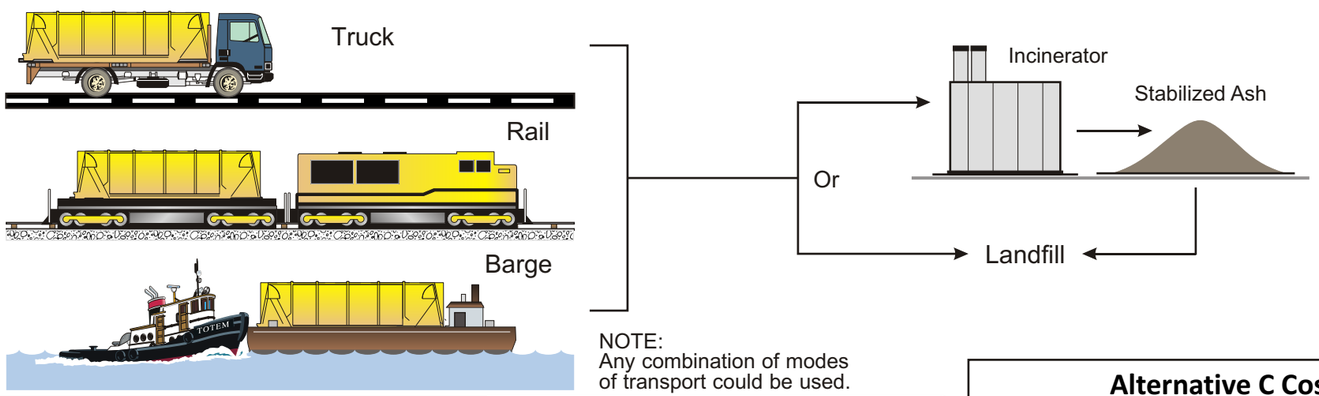
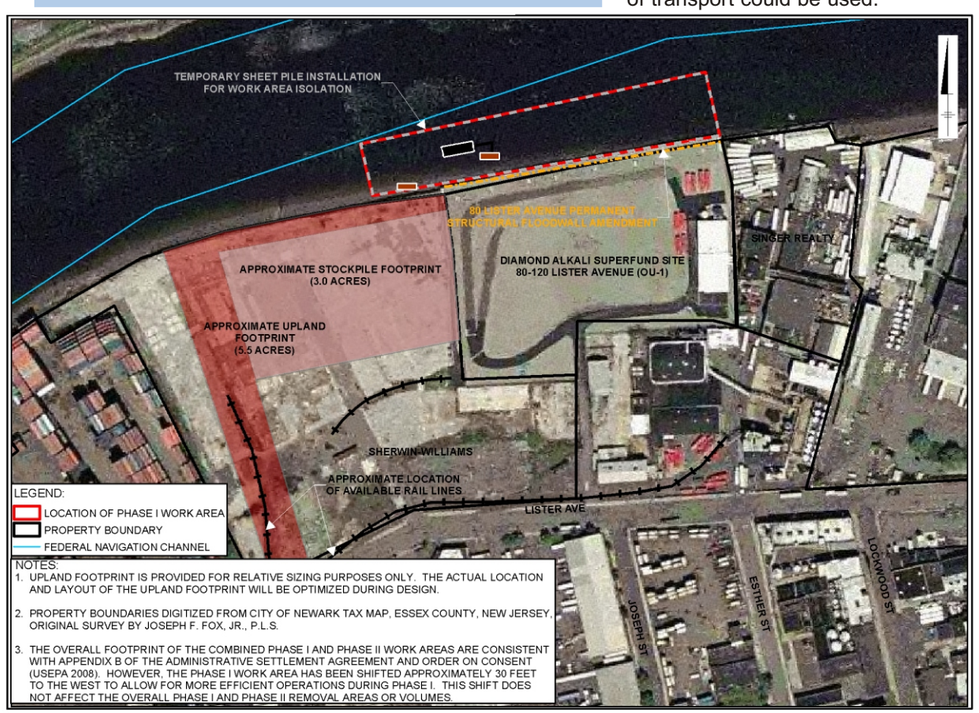
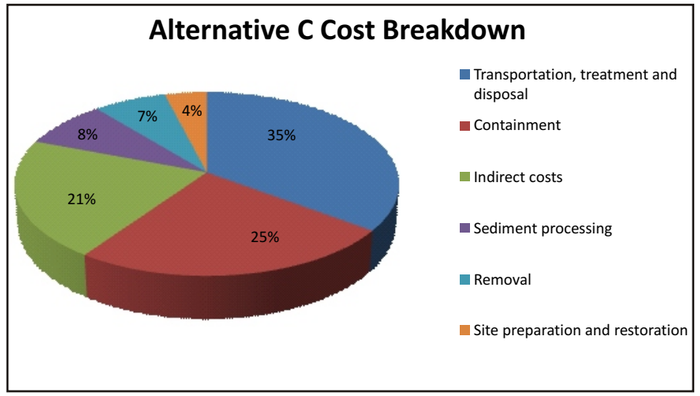




NOTE:
Any combination of modes of transport could be used.





Removal quantity (cy):	40,000
Removal method:	mechanical
Dewatering method:	mechanical
Approximate upland footprint (acres):	5.5
Dredging production rate (cy/hr):	100
Assumed removal solids content:	45%
Water treatment rate (gpm):	500
Dewatered sediment quantity (cy):	22,600
Estimated total cost ($):	$44,700,000

NOTES:

1. Sediment removal: **Mechanical**. For the purposes of evaluating the alternative, it is assumed that a mechanical dredge would be employed. Either a level cut bucket on a cable arm or a long reach excavator fitted with a dredge bucket could be considered. The actual dredge to be employed will be determined during design.

2. Sediment processing: **Mechanical**. It is assumed that a belt press would be used to dewater the sediment, although a belt press, filter press, or plate and frame press could be considered during design. Prior to dewatering, the sand fraction would be removed using hydrocyclones or a similar device. Debris, including oversized material removed by the Grizzly, will be rinsed and disposed of separately off site.

3. Water treatment and discharge: **Mechanical**. It is assumed that treatment would include a sand filter and granular activated carbon units. Discharge would occur under a NPDES permit to the Passaic River.

4. Off site transport of sediment: **Truck, rail or barge**. All three options are retained for the transport process because a combination of transportation types may be necessary to transport the sediment to the selected disposal facility or facilities.

5. Backfill: Backfill material will have similar physical characteristics to the in-situ sediment but with improved engineered properties, such as a low plasticity index.

6. Alternative C would take approximately 29 weeks to complete removal and backfilling. This does not account for subsequent activities (e.g., sheet pile removal, remaining transport and disposal, and demobilization).

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

ALTERNATIVE C: MECHANICAL REMOVAL WITH MECHANICAL DEWATERING

NOVEMBER 2008 REVISION 3

FIGURE **8-3**

11/18/08 SYR-ENV141-DJH-KLS
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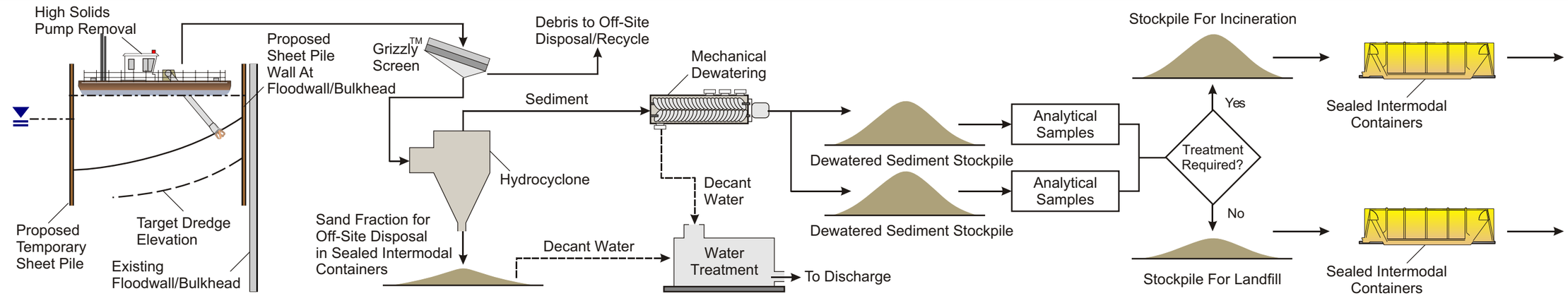
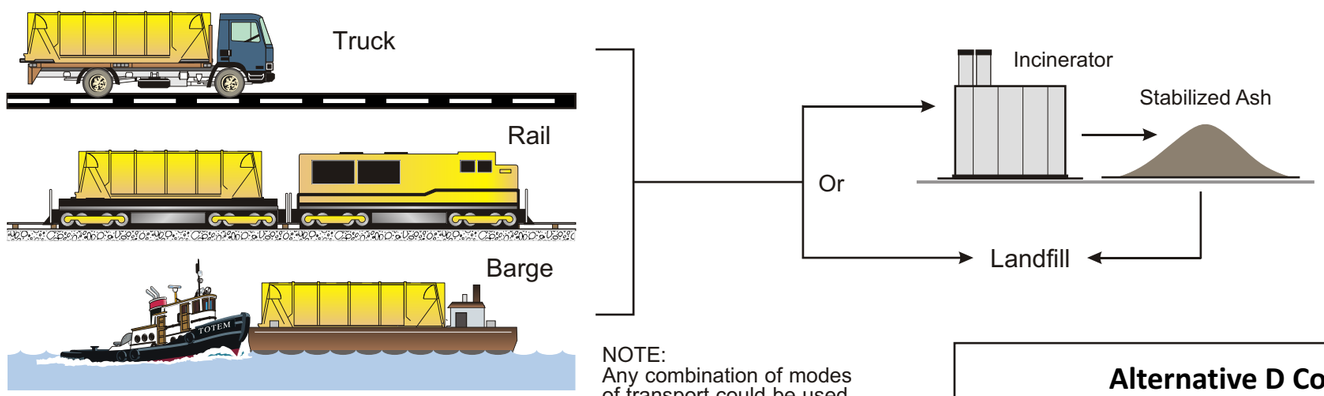
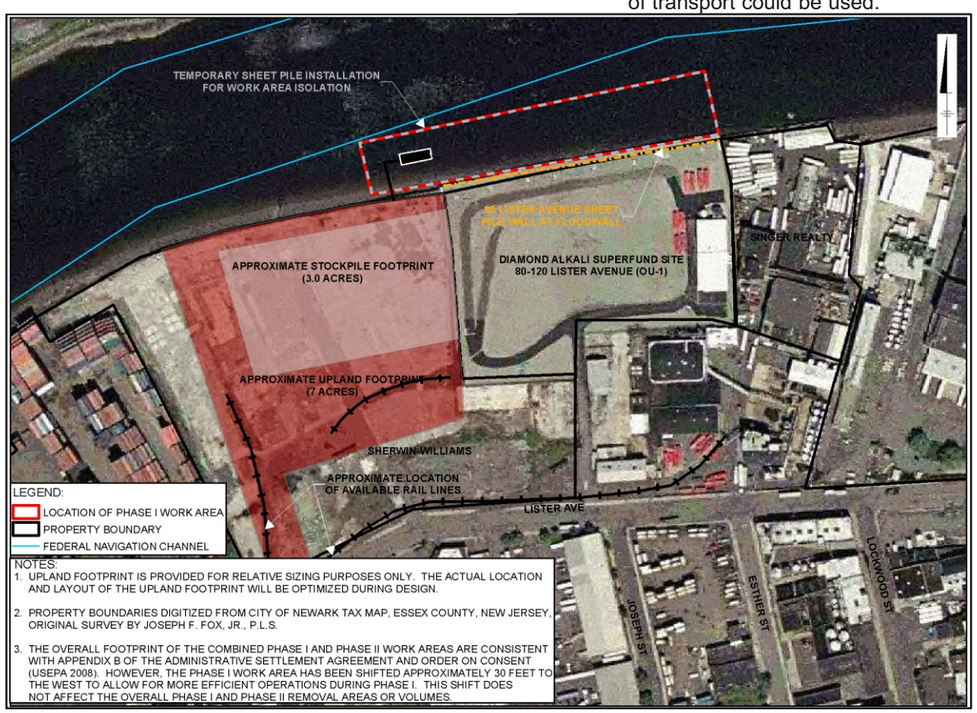
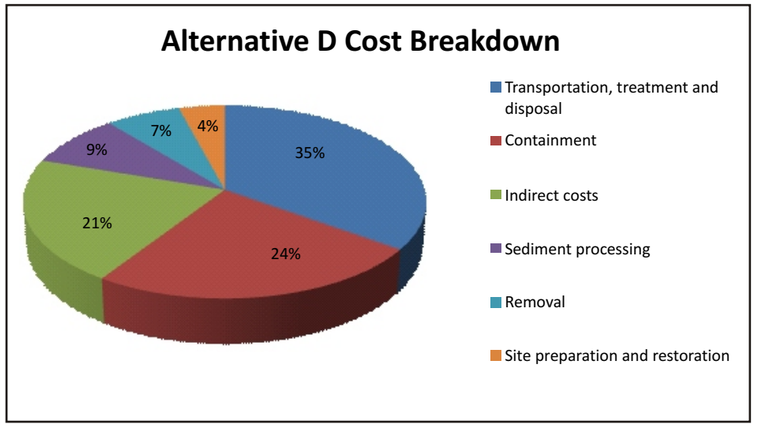




NOTE:
Any combination of modes of transport could be used.





Removal quantity (cy):	40,000
Removal method:	high solids pump
Sediment processing method:	mechanical
Approximate upland footprint (acres):	7
Dredging production rate (cy/hr):	135
Assumed removal solids content:	30%
Water treatment rate (gpm):	700
Dewatered sediment quantity (cy):	22,600
Estimated total cost ($):	$45,100,000

NOTES:

1. Sediment removal: **High solids pump**. For the purposes of evaluating the alternative, it is assumed that a high solids pump, similar to a Toyo or Eddy pump, would be used, however other high solids pump manufacturers could be considered during design. The actual pump to be employed will be determined during design.

2. Sediment processing: **Mechanical**. It is assumed that a belt press would be used to dewater the sediment, although a belt press, filter press, or plate and frame press could be considered during design. Prior to dewatering, the sand fraction would be removed using hydrocyclones or a similar device. Debris, including oversized material removed by the Grizzly, will be rinsed and disposed of separately off site.

3. Water treatment and discharge: **Mechanical**. It is assumed that treatment would include a sand filter and granular activated carbon units. Discharge would occur under a NPDES permit to the Passaic River.

4. Off site transport of sediment: **Truck, rail or barge**. All three options are retained for the transport process because a combination of transportation types may be necessary to transport the sediment to the selected disposal facility or facilities.

5. Backfill: Backfill material will have similar physical characteristics to the in-situ sediment but with improved engineered properties, such as a low plasticity index.

6. Alternative D would take approximately 27 weeks to complete removal and backfilling. This does not account for subsequent activities (e.g., sheet pile removal, remaining transport and disposal, and demobilization).

LOWER PASSAIC RIVER STUDY AREA

PHASE I EE/CA

ALTERNATIVE D:
HIGH SOLIDS PUMP REMOVAL WITH MECHANICAL DEWATERING

NOVEMBER 2008 REVISION 3

FIGURE **8-4**

11/18/08 SYR-141ENV-DJH-KLS
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Appendix A

Preliminary Cost Estimates

Appendix A – Cost Estimates
Phase I
Engineering Evaluation/ Cost Analysis

CERCLA Non-Time-Critical Removal Action -

Lower Passaic River Study Area

Tierra Solutions, Inc.

East Brunswick, New Jersey

November 2008

Revision 3

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A-5 Summary of Preliminary Sediment Dewatering and Water Treatment Calculations

1. Introduction

The cost estimates presented in this appendix are provided for use in evaluating the Phase I Work Alternatives set forth in the Phase I Engineering Evaluation/Cost Assessment (Phase I EE/CA). The estimated costs reflect a conceptual stage of development for each Phase I Work Alternative, or approximately a 15 percent design. The cost estimates were generally been prepared in accordance with regulatory guidance for cost estimating (U.S. Environmental Protection Agency [USEPA] 1993, USEPA 2000), and as such, are intended to provide values within -30 to +50 percent of actual cost.

The estimated removal action costs for Phase I Work Alternatives A through D are as follows:

- Alternative A – Hydraulic Removal with Geotextile Tube Dewatering: $53,900,000
- Alternative B – Hydraulic Removal with Mechanical Dewatering: $49,100,000
- Alternative C – Mechanical Removal with Mechanical Dewatering: $44,700,000
- Alternative D – High Solids Pump Removal with Mechanical Dewatering: $45,100,000.

Tables A-1 through A-4 present the preliminary cost assessments for each of the respective Phase I Work Alternatives. General and specific assumptions made in compiling the respective cost estimates are discussed below. The mass balance calculations used to develop the costs are provided in Table A-5.

2. Direct Cost Assumptions

2.1 Mobilization/Demobilization

Costs related to the mobilization/demobilization of construction materials and equipment are estimated as 8 percent of the sum of all direct costs. This percentage is based on industry standards. Mobilization/demobilization includes the contractor's cost to, for example, transport equipment and construction materials to the site, provide temporary facilities, and prepare staging areas. Mobilization/demobilization costs include any required on-site upgrades of rail lines for transport of material offsite. During design, the use of rail lines for off-site transport will be evaluated to determine if rail transport is a preferred transportation method, or whether barge or truck transport would better address the objectives of the Phase I Work. Note that mobilization/demobilization costs are not applied to costs associated with the transport and disposal of removed materials.

2.2 Site Preparation

2.2.1 Property Lease

A cost of $35,000 per acre per year was assumed for lease of the Sherwin-Williams property adjacent to the site for upland staging, processing and container loading areas. A lease period of 22 months was assumed for all Phase I Work Alternatives.

2.2.2 Temporary Staging Areas

Each of the Phase I Work Alternatives includes provisions for a temporary staging area sufficient for storage/maintenance of construction equipment, establishment of contractor facilities, and temporary staging of construction materials necessary for implementation. For each alternative, the temporary staging area associated with these needs was assumed to be one and one half acres in size, cleared and grubbed prior to construction, and includes a geomembrane overlain with sand and gravel.

2.2.3 Intermodal Container Loading

The Phase I Work Alternatives include transport of dewatered materials in watertight intermodal containers to off-site treatment and disposal facilities. The costs include loading the material into the watertight containers at the sediment processing area prior to off-site transport. Watertight containers filled with dewatered sediment will then be

loaded onto barges, rail cars, or trucks for off-site transport and delivery to appropriate incineration/disposal facilities. For this cost estimate, all containers of dewatered materials are assumed to be transported off site via transportation options available at the upland sediment processing area (i.e., rail, barge, or truck). Costs related to construction of the loading area are included in the costs related to construction of the staging area associated with either the geotextile tube or mechanical dewatering facilities.

2.3 Material Removal

2.3.1 Phase I Work Area Containment Structure

For this cost estimate, all of the Phase I Work Alternatives presented include steel sheet pile installation sufficient for isolating the Phase I Work Area, as well as the structural support of the bank areas within and immediately adjacent to the Phase I Work Area. Actual details on the sheet pile enclosure will be determined during design.

- ***Adjacent Floodwall and Bulkhead Structural Support.*** Based on preliminary design information, shoreline areas located immediately adjacent to the removal area may require structural support to avoid damage due to deflection or overstressing existing structural elements while conducting removal activities. For these bulkhead and floodwall structures, it was assumed that installing steel sheet piles will be sufficient to maintain slope stability and reduce the risk of damage to adjacent structures throughout construction. For all Phase I Work Alternatives discussed herein, it is assumed that such considerations will require installation of 65-foot AZ-48 steel sheet piles, which will be removed at the completion of construction. Phase I sheet piles will be retained for use during the Phase II Work.

- ***Removal Area Containment.*** The 2008 AOC (USEPA 2008) requires isolation of the removal area with a steel sheet pile containment structure. For this cost estimate, the steel and installation requirements are assumed to be constant across all of the Phase I Work Alternatives. For containment of the Phase I Work Area, it is assumed that 60-foot AZ-48 steel sheets will be necessary and installed to approximately 40- to 50-feet below the water surface within the Phase I Work Area. Phase I sheet piles would will be retained for use during the Phase II Work.

2.3.2 Scour Protection

Scour protection consisting of quarry spalls or riprap material approximately 3-feet thick is assumed to be required for the areas along the channel side of the containment structure. This assumption was based on the preliminary hydrodynamic model detailed in Section 8 of the Phase I EE/CA. For this cost estimate, it is assumed that approximately 1,000 feet of the channel side of the steel sheet pile wall will require such armoring, and that the stone will be placed in a wedge 3 feet high by 10 feet wide at the base around the three sides of the containment structure. These assumptions will be refined during the design.

2.3.3 Removal

Dredge volumes are assumed to be consistent across all of the Phase I Work Alternatives and are based on the removal volume requirement of the 2008 Administrative Order on Consent (AOC; USEPA 2008), which is removal of 40,000 cubic yards (cy). No overdredge volume is assumed in the costs.

The costs for the alternatives include removal by one of the following methods:

- ***Hydraulic Dredging.*** Sediment removal for Alternatives A and B is assumed to be performed via hydraulic dredging, using barge-mounted cutterhead dredges and hydraulic pumps. Dredge slurry associated with this technique will be pumped directly to the associated dewatering facility. Based on similar experience and information from vendors, the cost of the dredge and barge operation (including the slurry/booster pumps) will be approximately $75 per cy. Dredge production rates associated with hydraulic dredging are assumed to be 135 cy per hour, with a 10% solids content. For the Phase I EE/CA, it is assumed that the dredging rate will be effectively maintained for 5 hours per day, 6 days per week. This accounts for slower removal rates or downtime typically encountered during such projects.

- ***Mechanical Dredging.*** Sediment removal for Alternative C is assumed to be performed using a crane-mounted clamshell dredge head or a mechanical excavator customized for sediment removal. The crane will be located on a dredge barge within the contained Phase I Work Area. Removed materials will be offloaded onto a series of barges/scows, perhaps as few as two, that will shuttle between the Phase I Work Area and the upland materials handling areas. Based on similar experience, as well as recent information from vendors, the cost of mechanical dredging will be approximately $60/cy. Dredge production rates

associated with mechanical dredging are assumed to be 100 cy per hour, with a 45% solids content. It is assumed that the solids content will be reduced to 30% once water was added to the mechanically dredged sediment in order to slurry it for processing with a mechanical press. For the Phase I EE/CA, it is assumed that the dredging rate will be effectively maintained for 5 hours per day, 6 days per week. This accounts for expected slower removal rats or downtime typically encountered during such projects.

- ***High Solids Pump.*** Sediment removal for Alternative D is assumed to be performed via the combination of a cutterhead dredge and a high solids pump. This technology is similar to that described in Alternatives A and B, but relies on a high solids pump to convey removed materials to shore with a greatly reduced water content. Based on recent information from vendors, the cost of the high solids pump assembly (including a jet pump, makeup water pump, pipes, hoses, and generators) will be approximately $4,000 per calendar day, and the cost for rental and operation of the cutterhead dredge will be approximately $60/cy. Dredge production rates associated with hydraulic dredging are assumed to be 135 cy per hour, with a solids content of 30%. For the Phase I EE/CA, it is assumed that the dredging rate will be effectively maintained for 5 hours per day, six days per week. This accounts for expected slower removal rates and downtime typically encountered during such projects.

2.3.4 Dredging Verification

Dredging verification includes performance of pre- and post-dredge, multibeam bathymetric surveys. Based on recent information from vendors, the cost associated with the performance of each multibeam bathymetric survey will be approximately $40,000.

2.3.5 Debris Handling and Disposal

For the purposes of the cost estimate, it is assumed that 3 percent of the 40,000 cy of material removed (or 1,200 cy) will consist of debris. A volume-to-weight conversion of 3.46 tons per cy was used to convert the debris volume to a disposal weight. It is assumed that the debris will need to be handled separately from the bulk material removal; therefore, a cost of $10 per ton was assumed for debris handling including pressure washing, and a cost of $85 per ton was assumed for transportation and disposal of the debris to a Subtitle D landfill.

2.4 Materials Handling and Dewatering

2.4.1 Sediment Screening and Sand Separation

To adequately dewater the sediment using either of the proposed dewatering techniques (geotextile tubes or mechanical), small debris and vegetation will be removed first from the sediment. To accomplish this, the material will be passed through a Grizzly™ screen (or equivalent equipment) prior to dewatering. After the Grizzly screen, a hydrocyclone will be used to remove the sand fraction. The portion of material separated based on sand size fraction is included in the 50 percent of material assumed to not require treatment prior to disposal, as discussed below. Costs presented herein are based on information from vendors, as well as costs associated with similar recent projects.

2.4.2 Sediment Dewatering

Alternatives B, C, and D include dewatering via mechanical means (e.g., plate and frame filter press, belt presses) following the initial separation of coarse materials, as discussed above. Dewatering will be achieved through geotextile tubes for Alternative A. Each of these dewatering options entails construction of a materials handling area consisting of lined and bermed staging areas, decontamination facilities, stormwater management and treatment, and equipment and facilities for materials staging/handling/transfer. Costs for the various methods anticipated for sediment dewatering were estimated based on costs associated with other similar projects.

2.4.3 Sediment Segregation

For the cost estimate, it is assumed that following dewatering, materials being prepared for transport will be sampled for characterization with respect to treatment and disposal requirements. For the purposes of the Phase I EE/CA, it is assumed that such samples will be collected from dewatered materials at an approximate frequency of one sample per 500 cy. The sampling frequency will be refined during design. The unit cost per sample includes sample collection, laboratory analysis, data management, and validation. For the purposes of the Phase I EE/CA, it is assumed that 50 percent of the remaining volume of material (accounting for 3 percent of debris) will require treatment prior to disposal, and 50 percent will not require treatment prior to disposal. For costing purposes, the treatment method prior to disposal is assumed to be incineration.

2.5 Water Treatment and Disposal

Sediment handling, dewatering, and other sediment processing steps will generate contaminated water that will require treatment prior to disposal. A temporary water treatment plant will be assembled on site using skid-mounted tanks and equipment. The treatment train will consist of polymer-assisted clarification and sand filtration, followed by granular activated carbon adsorption. The hydraulic capacity of the water treatment plant will be 3,000 gallons per minute (gpm) for Alternatives A and B, 500 gpm for Alternative C, and 1,000 gpm for Alternative D. The treated effluent will be tested to confirm that effluent limitations are met before discharged to the Passaic River. Costs for the various methods anticipated for sediment dewatering were estimated based on costs associated with other similar projects.

2.6 Transportation and Disposal

2.6.1 Materials Requiring Treatment Prior to Disposal

2.6.1.1 Transportation

Following loading into watertight containers, the sediment will be transported to one of three incinerators (a Clean Harbors-owned facility in Texas or Utah, or a Veolia-owned facility in Texas). The transportation cost includes transportation to any of the three incineration facilities using any combination of the three available modes of transport (rail, truck, or barge).

2.6.1.2 Treatment and Disposal

For the purposes of the Phase I EE/CA, it has been assumed that treatment will consist of incineration. The costs for incineration assume that the removed materials are “solid wastes” with characteristics similar to existing data, and additional RCRA hazardous waste codes are not identified. A unit price of $420 per cy for treatment and disposal was assumed based on quotes provided from incinerators. Additional information gathered during the design phase may allow some portion of the removed sediment to be disposed of without treatment. The treatment and disposal costs include post-incineration treatment via stabilization to address any remaining metals above UTS in the incinerated sediment. Costs are not included for storing removed sediment prior to treatment due to incineration throughput limitations that may occur at the time of the project.

2.6.2 Materials Not Requiring Treatment Prior to Disposal

As described in the sediment segregation step, for the purposes of the Phase I EE/CA it was assumed that 50 percent of the dewatered sediment will be eligible for landfill disposal. A unit price of $250 per ton for transportation and disposal was assumed based on quotes provided from regional landfills.

2.7 Backfilling

The backfill volume estimate is based on the assumption that the Phase I Work Area will be returned to pre-existing grade. Backfill materials for all Phase I Work Alternatives are assumed to be placed using conventional heavy equipment operating from a barge within the isolated Phase I Work Area. It was assumed the backfill material would come from a local source.

3. Indirect Cost Assumptions

3.1 Permitting

The costs associated with research and submittal of the appropriate required permits (or meeting the substantive requirements of permits) prior to initiating construction activities are assumed to be $150,000.

3.2 Remedial Design

Costs associated with the remedial design are assumed to be 10 percent of the direct and construction activities costs. The remedial design percentage is not applied to the transportation and disposal costs or to the indirect costs. The remedial design costs include costs for conducting a pre-design investigation.

3.3 Contractor Work Plans

For this cost estimate, contractor work plan development costs associated with the remedial design are assumed to be 1 percent of direct and specific construction activities costs. The percentage is not applied to the transportation and disposal costs, or to the indirect costs. Rather, this cost accounts for costs associated with preparing construction/ implementation details and other miscellaneous work plans (e.g., activities related to preparing site management plans, a dredge/cap and sediment management/disposal plan, construction quality control plans, environmental protection plans, and health and safety plans).

3.4 Construction Contingencies

A 10 percent contingency was applied to direct costs to account for unforeseen changes in field conditions or difficulties encountered during implementation. As a result, the total cost presented for each Phase I Work Alternative captures the range of the most likely cost and is generally anticipated to be within the expected accuracy for cost estimates for remedy selection outlined in USEPA (2000; i.e., -30 to +50 percent) of the final Phase I Work cost. Note that the construction contingency percentage was not applied to indirect costs.

3.5 Construction Monitoring and Observation Costs

3.5.1 Health and Safety Monitoring

A lump sum of $2,000 per week was assumed for labor related to health and safety monitoring activities.

3.5.2 Construction Observation

Construction observation costs of $9,000 assumed labor costs for one observer working 10-hour shifts, plus lodging and travel costs.

3.5.3 Water Quality Monitoring

A cost of $6,400 per week is included for water quality monitoring during in-water construction activities. For the purposes of the Phase I EE/CA, the weekly cost includes equipment costs for three continuously logging water quality meters recording standard parameters including turbidity, labor costs for two sampling personnel to download the meters and collect three total suspended solids (TSS) samples daily, laboratory costs to analyze samples for TSS, and labor costs to manage and evaluate the TSS and water quality data. Baseline water quality monitoring will be conducted prior to the start of in-water work, and monitoring will continue throughout the duration of the work until the containment structure has been removed.

3.5.4 Air Emissions Monitoring

A cost of about $7,300 per week is estimate for monitoring of ambient air at the site to ensure that sediment processing is not impacting air quality, including pre-construction baseline monitoring. The cost includes labor for two personnel to provide quality control on the air monitors and change out the sampling filters each week, long-term rental of air monitoring equipment, weekly refills of long-term trap filters for particulate analysis, and a weather station for the site to monitor wind direction and speed.

3.5.5 Water Treatment Discharge Monitoring

A cost of about $1,300 per week is estimated for monitoring of treated water discharges from the site. The cost includes labor for two personnel to collect one sample per week; laboratory costs to analyze samples for TSS, metals, and dioxins; and labor costs to manage and evaluate the laboratory data.

3.5.6 Deflection Monitoring for Permanent Structures

A cost of $3,100 is estimated for one 2-person survey crew, operating for 10 hours per event, to survey the steel sheet pile walls along the bulkheads and Operable Unit 1 floodwall in order to evaluate that deflections outside of a specified tolerance are not occurring due to removal activities. In addition, costs include approximately 12 hours for mid-level data management and 4 hours of senior review of the survey data.

4. References

USEPA. 1993. Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., EPA/540-R-93-057, Publication 9360.0-32, PB93-963402, August 1993.

USEPA. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. Prepared by EPA and USACE, EPA 540-R-00-002, OSWER 9355.0-75.

USEPA. 2008. United States Environmental Protection Agency Region 2 Administrative Settlement Agreement and Order on Consent for Removal Action in the Matter of Lower Passaic River Study Area of the Diamond Alkali Superfund Site Occidental Chemical Corporation and Tierra Solutions, Inc. CERCLA Docket No. 02-2008-2020. U.S. Environmental Protection Agency. June 23.

Tables

Table A-1
Alternative A: Hydraulic Removal with Geotextile Tube Dewatering

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Total Cost
Capital Costs				
Property Lease	ACRE	10	$ 64,166.67	$ 641,666.67
Temporary Staging Area	SF	65,000	$ 4	$ 260,000
Site Preparation				
Clearing and grubbing	SF	65,000	$ 2	$ 130,000
Temporary facilities	WK	46	$ 1,000	$ 45,877
Utility Identification	LS	1	$ 5,000	$ 5,000
Work Area Isolation				
Temporary sheet pile materials	SF	59,900	$ 60	$ 3,594,000
Temporary steel sheet pile installation and extraction	SF	59,900	$ 25	$ 1,497,500
Scour protection on outer temporary wall	CY	30,000	$ 40	$ 1,200,000
Floodwall structural protection materials	SF	47,915	$ 60	$ 2,874,924
Floodwall structural protection installation	SF	47,915	$ 20	$ 958,308
Sherwin-Williams bulkhead temporary structural support materials	SF	9,425	$ 60	$ 565,500
Sherwin-Williams bulkhead temporary structural support installatio	SF	9,425	$ 30	$ 282,750
Sediment Removal				
Hydraulic removal	CY	40,000	$ 70	$ 2,800,000
Pipeline transport	LF	1,000	$ 100	$ 103,000
Bathymetric Verification Survey	EACH	2	$ 40,000	$ 80,000
Debris handling and disposal	TON	4,152	$ 95	$ 394,440
Material Handling and Dewatering				
Material Handling and Segregation	LS	1	$ 100,000	$ 100,000
Geotextile tubes	CY	40,000	$ 15	$ 600,000
Geotextile Tube Staging Area	SF	326,700	$ 6	$ 1,960,200
Sediment Sampling	EACH	50	$ 1,385	$ 69,250
Intermodal Container Loading	CY	26,000	$ 35	$ 910,000
Water Treatment				
Influent Tanks	EACH	12	$ 42,000	$ 504,000
Sand/Carbon Filtration	LS	3	$ 600,000	$ 1,800,000
Backwash Tanks and Pumping	EACH	6	$ 117,500	$ 705,000
Effluent Tanks and Pumping	EACH	6	$ 5,250	$ 31,500
Construction	LS	1	$ 511,750	$ 511,750
Operation and Disposable Materials	WK	24	$ 28,800	$ 691,200
Backfill	CY	40,000	$ 25	$ 1,000,000
			Subtotal Capital Costs	$ 24,316,000
Transportation and Disposal				
Transportation to Incineration Facility	TON	19,715	$ 250	$ 4,928,760
Incineration and Disposal	TON	19,715	$ 420	$ 8,280,316
Subtitle C Transportation and Disposal	TON	19,715	$ 250	$ 4,928,760
			Subtotal Transportation and Disposal Costs	$ 18,138,000
Indirect Costs				
Remedial Design	%	10%	$ 24,316,000	$ 2,431,600
Contractor Work Plans	%	1%	$ 24,316,000	$ 243,160
Mobilization/Demobilization	%	8%	$ 24,316,000	$ 1,945,280
Construction Contingency	%	10%	$ 42,454,000	$ 4,245,400
Permitting	LS	1	$ 150,000	$ 150,000
Construction Monitoring/Observation				
Health and safety monitoring	WK	46	$ 2,000	$ 91,755
Construction Observation	WK	46	$ 9,000	$ 412,896
Water quality monitoring	WK	32	$ 6,900	$ 219,954
Air monitoring	WK	46	$ 7,255	$ 332,840
Water treatment discharge monitoring	WK	24	$ 1,320	$ 31,517
Deflection monitoring for permanent structures	EACH	4	$ 3,100	$ 12,400
			Subtotal Indirect Cost	$ 10,116,801
			Subtotal Cost	$ 52,570,801
			Administration and Engineering (2.5%)	$ 1,314,270
			Total Cost	$ 53,885,071
			Total Estimated Cost (rounded)	**$ 53,900,000**

Notes:
% = percent
CY = cubic yard(s)
LS = lump sum
SF = square foot/feet
WK = week(s)

Table A-2
Alternative B: Hydraulic Removal with Mechanical Dewatering

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Total Cost
Capital Costs				
Property Lease	ACRE	7.5	$ 64,166.67	$ 481,250.00
Temporary Staging Area	SF	65,000	$ 4	$ 260,000
Site Preparation				
Clearing and grubbing	SF	65,000	$ 2	$ 130,000
Temporary facilities	WK	32	$ 1,000	$ 32,000
Utility Identification	LS	1	$ 5,000	$ 5,000
Work Area Isolation				
Temporary sheet pile materials	SF	59,900	$ 60	$ 3,594,000
Temporary steel sheet pile installation and extraction	SF	59,900	$ 25	$ 1,497,500
Scour protection on outer temporary wall	CY	30,000	$ 40	$ 1,200,000
Floodwall structural protection materials	SF	47,915	$ 60	$ 2,874,924
Floodwall structural protection installation	SF	47,915	$ 20	$ 958,308
Sherwin-Williams bulkhead temporary structural support materials	SF	9,425	$ 60	$ 565,500
Sherwin-Williams bulkhead temporary structural support installation	SF	9,425	$ 30	$ 282,750
Sediment Removal				
Hydraulic removal	CY	40,000	$ 75	$ 3,000,000
Pipeline transport	LF	1,000	$ 100	$ 103,000
Bathymetric Verification Survey	EACH	2	$ 40,000	$ 80,000
Debris handling and disposal	TON	4,152	$ 95	$ 394,440
Material Handling and Dewatering				
Material Handling and Segregation	LS	1	$ 100,000	$ 100,000
Mechanical Press	CY	40,000	$ 10	$ 400,000
Dewatering Staging Area	SF	256,212	$ 5	$ 1,281,061
Sediment Sampling	EACH	50	$ 1,385	$ 69,250
Intermodal Container Loading	CY	22,600	$ 35	$ 791,000
Water Treatment				
Influent Tanks	EACH	12	$ 42,000	$ 504,000
Sand/Carbon Filtration	LS	3	$ 600,000	$ 1,800,000
Backwash Tanks and Pumping	EACH	6	$ 117,500	$ 705,000
Effluent Tanks and Pumping	EACH	6	$ 5,250	$ 31,500
Construction	LS	1	$ 511,750	$ 511,750
Operation and Disposable Materials	WK	10	$ 28,800	$ 288,000
Backfill	CY	40,000	$ 25	$ 1,000,000
			Subtotal Capital Costs	$ 22,940,000
Transportation and Disposal				
Transportation to Incineration Facility	TON	17,104	$ 250	$ 4,276,033
Incineration and Disposal	TON	17,104	$ 420	$ 7,183,735
Subtitle C Transportation and Disposal	TON	17,104	$ 250	$ 4,276,033
			Subtotal Transportation and Disposal Costs	$ 15,736,000
Indirect Costs				
Remedial Design	%	10%	$ 22,940,000	$ 2,294,000
Contractor Work Plans	%	1%	$ 22,940,000	$ 229,400
Mobilization/Demobilization	%	8%	$ 22,940,000	$ 1,835,200
Construction Contingency	%	10%	$ 38,676,000	$ 3,867,600
Permitting	LS	1	$ 150,000	$ 150,000
Construction Monitoring/Observation				
Health and safety monitoring	WK	32	$ 2,000	$ 63,755
Construction Observation	WK	32	$ 9,000	$ 286,896
Water quality monitoring	WK	32	$ 6,900	$ 219,954
Air monitoring	WK	32	$ 7,255	$ 231,270
Water treatment discharge monitoring	WK	10	$ 1,320	$ 13,037
Deflection monitoring for permanent structures	EACH	4	$ 3,100	$ 12,400
			Subtotal Indirect Cost	$ 9,203,511
			Subtotal Cost	$ 47,879,511
			Administration and Engineering (2.5%)	$ 1,196,988
			Total Cost	$ 49,076,499
			Total Estimated Cost (rounded)	**$ 49,100,000**

Notes:
% = percent
CY = cubic yard(s)
LS = lump sum
SF = square foot/feet
WK = week(s)

Table A-3
Alternative C: Mechanical Removal with Mechanical Dewatering

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Total Cost
Capital Costs				
Property Lease	ACRE	5.5	$ 64,166.67	$ 352,916.67
Temporary Staging Area	SF	65,000	$ 4	$ 260,000
Site Preparation				
Clearing and grubbing	SF	65,000	$ 2	$ 130,000
Temporary facilities	WK	36	$ 1,000	$ 36,000
Utility Identification	LS	1	$ 5,000	$ 5,000
Work Area Isolation				
Temporary sheet pile materials	SF	59,900	$ 60	$ 3,594,000
Temporary steel sheet pile installation and extraction	SF	59,900	$ 25	$ 1,497,500
Scour protection on outer temporary wall	CY	30,000	$ 40	$ 1,200,000
Floodwall structural protection materials	SF	47,915	$ 60	$ 2,874,924
Floodwall structural protection installation	SF	47,915	$ 20	$ 958,308
Sherwin-Williams bulkhead temporary structural support materials	SF	9,425	$ 60	$ 565,500
Sherwin-Williams bulkhead temporary structural support installati	SF	9,425	$ 30	$ 282,750
Sediment Removal				
Mechanical Removal	CY	40,000	$ 60	$ 2,400,000
Barge unloading	CY	46,512	$ 5	$ 232,561
Bathymetric Verification Survey	EACH	2	$ 40,000	$ 80,000
Debris handling and disposal	TON	4,152	$ 95	$ 394,440
Material Handling and Dewatering				
Material Handling and Segregation	LS	1	$ 100,000	$ 100,000
Mechanical Press	CY	40,000	$ 10	$ 400,000
Dewatering Staging Area	SF	175,566	$ 5	$ 877,830
Sediment Sampling	EACH	50	$ 1,385	$ 69,250
Intermodal Container Loading	CY	22,600	$ 35	$ 791,000
Water Treatment				
Influent Tanks	EACH	4	$ 42,000	$ 168,000
Sand/Carbon Filtration	LS	1	$ 600,000	$ 600,000
Backwash Tanks and Pumping	EACH	2	$ 117,500	$ 235,000
Effluent Tanks and Pumping	EACH	2	$ 5,250	$ 10,500
Construction	LS	1	$ 255,875	$ 255,875
Operation and Disposable Materials	WK	14	$ 14,400	$ 201,600
Backfill	CY	40,000	$ 25	$ 1,000,000
			Subtotal Capital Costs	$ 19,573,000
Transportation and Disposal				
Transportation to Incineration Facility	TON	17,104	$ 250	$ 4,276,033
Incineration and Disposal	TON	17,104	$ 420	$ 7,183,735
Subtitle C Transportation and Disposal	TON	17,104	$ 250	$ 4,276,033
			Subtotal Transportation and Disposal Costs	$ 15,736,000
Indirect Costs				
Remedial Design	%	10%	$ 19,573,000	$ 1,957,300
Contractor Work Plans	%	1%	$ 19,573,000	$ 195,730
Mobilization/Demobilization	%	8%	$ 19,573,000	$ 1,565,840
Construction Contingency	%	10%	$ 35,309,000	$ 3,530,900
Permitting	LS	1	$ 150,000	$ 150,000
Construction Monitoring/Observation				
Health and safety monitoring	WK	35	$ 2,000	$ 70,668
Construction Observation	WK	35	$ 9,000	$ 318,007
Water quality monitoring	WK	35	$ 6,900	$ 243,805
Air monitoring	WK	35	$ 7,255	$ 256,349
Water treatment discharge monitoring	WK	13	$ 1,320	$ 17,600
Deflection monitoring for permanent structures	EACH	4	$ 3,100	$ 12,400
			Subtotal Indirect Cost	$ 8,318,600
			Subtotal Cost	$ 43,627,600
			Administration and Engineering (2.5%)	$ 1,090,690
			Total Cost	$ 44,718,290
			Total Estimated Cost (rounded)	**$ 44,700,000**

Notes:
% = percent
CY = cubic yard(s)
LS = lump sum
SF = square foot/feet
WK = week(s)

Table A-4
Alternative D: High Solids Pump Removal with Mechanical Dewatering

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Total Cost
Capital Costs				
Property Lease	ACRE	7	$ 64,166.67	$ 449,166.67
Temporary Staging Area	SF	65,000	$ 4	$ 260,000
Site Preparation				
Clearing and grubbing	SF	65,000	$ 2	$ 130,000
Temporary facilities	WK	32	$ 1,000	$ 32,000
Utility Identification	LS	1	$ 5,000	$ 5,000
Work Area Isolation				
Temporary sheet pile materials	SF	59,900	$ 60	$ 3,594,000
Temporary steel sheet pile installation and extraction	SF	59,900	$ 25	$ 1,497,500
Scour protection on outer temporary wall	CY	30,000	$ 40	$ 1,200,000
Floodwall structural protection materials	SF	47,915	$ 60	$ 2,874,924
Floodwall structural protection installation	SF	47,915	$ 20	$ 958,308
Sherwin-Williams bulkhead temporary structural support materials	SF	9,425	$ 60	$ 565,500
Sherwin-Williams bulkhead temporary structural support installation	SF	9,425	$ 30	$ 282,750
Sediment Removal				
Hi-solids Pump	CY	40,000	$ 65	$ 2,600,000
Bathymetric Verification Survey	EACH	2	$ 40,000	$ 80,000
Debris handling and disposal	TON	4,152	$ 95	$ 394,440
Material Handling and Dewatering				
Material Handling and Segregation	LS	1	$ 100,000	$ 100,000
Mechanical Press	CY	40,000	$ 10	$ 400,000
Dewatering Staging Area	SF	243,058	$ 5	$ 1,215,288
Sediment Sampling	EACH	50	$ 1,385	$ 69,250
Intermodal Container Loading	CY	22,600	$ 35	$ 791,000
Water Treatment				
Influent Tanks	EACH	4	$ 42,000	$ 168,000
Sand/Carbon Filtration	LS	1	$ 600,000	$ 600,000
Backwash Tanks and Pumping	EACH	2	$ 117,500	$ 235,000
Effluent Tanks and Pumping	EACH	2	$ 5,250	$ 10,500
Construction	LS	1	$ 255,875	$ 255,875
Operation and Disposable Materials	WK	10	$ 14,400	$ 144,000
Backfill	CY	40,000	$ 25	$ 1,000,000
			Subtotal Capital Costs	$ 19,913,000
Transportation and Disposal				
Transportation to Incineration Facility	TON	17,104	$ 250	$ 4,276,033
Incineration and Disposal	TON	17,104	$ 420	$ 7,183,735
Subtitle C Transportation and Disposal	TON	17,104	$ 250	$ 4,276,033
			Subtotal Transportation and Disposal Costs	$ 15,736,000
Indirect Costs				
Remedial Design	%	10%	$ 19,913,000	$ 1,991,300
Contractor Work Plans	%	1%	$ 19,913,000	$ 199,130
Mobilization/Demobilization	%	8%	$ 19,913,000	$ 1,593,040
Construction Contingency	%	10%	$ 35,649,000	$ 3,564,900
Permitting	LS	1	$ 150,000	$ 150,000
Construction Monitoring/Observation				
Health and safety monitoring	WK	32	$ 2,000	$ 63,755
Construction Observation	WK	32	$ 9,000	$ 286,896
Water quality monitoring	WK	32	$ 6,900	$ 219,954
Air monitoring	WK	32	$ 7,255	$ 231,270
Water treatment discharge monitoring	WK	10	$ 1,320	$ 13,037
Deflection monitoring for permanent structures	EACH	4	$ 3,100	$ 12,400
			Subtotal Indirect Cost	$ 8,325,681
			Subtotal Cost	$ 43,974,681
			Administration and Engineering (2.5%)	$ 1,099,367
			Total Cost	$ 45,074,048
			Total Estimated Cost (rounded)	**$ 45,100,000**

Notes:
% = percent
CY = cubic yard(s)
LS = lump sum
SF = square foot/feet
WK = week(s)

Table A-5
Summary of Preliminary Sediment Dewartering and Water Treatment Calculations

Lower Passaic River Study Area
Phase I Engineering Evaluation/Cost Analysis

Phase I Work Alternative	Estimated Quantity
Common Parameters	
Volume of Sediment to be Dredged	40,000 CY
Effective Dredge Daily Operating Time	5 HR/DAY
Effective Dredge Weekly Operating Time	6 DAYS/WK
Alternative A	
Effective In-Situ Production Rate	135 CY/HR
Effective Dredge Operating Time	10 WK
Geotextile Tubes Dewatering Time	14 WK
Percent Solids of Dredge Discharge	10 %
Percent Solids Prior to Dewatering	10 %
Slurry Flow to Geotextile Tubes	3,100 gpm
Percent Solids of Dewatered Sediment	70 %
Effluent Flow to Water Treatment	2,900 gpm
Area of Water Treatment Plant	0.50 ACRE
Geotextile Tube Area	8.00 ACRE
Alternative B	
Effective In-Situ Production Rate	135 CY/HR
Effective Dredge and Plant Operating Time	10 WK
Percent Solids of Dredge Discharge	10 %
Percent Solids Prior to Dewatering	10 %
Slurry Flow to Dewatering Facility	3,100 gpm
Percent Solids of Dewatered Sediment	70 %
Effluent Flow to Water Treatment	2,900 gpm
Area of Sediment Processing and Water Treatment Plant	1.76 ACRE
Area of Dewatered Sediment Stockpiling Area	4.33 ACRE
Alternative C	
Effective In-Situ Production Rate	100 CY/HR
Effective Dredge and Plant Operating Time	13 WK
Percent Solids of Dredge Discharge	45 %
Percent Solids Prior to Dewatering	30 %
Slurry Flow to Dewatering Facility	700 gpm
Percent Solids of Dewatered Sediment	70 %
Effluent Flow to Water Treatment	500 gpm
Area of Sediment Processing and Water Treatment Plant	0.98 ACRE
Area of Dewatered Sediment Stockpiling Area	3.09 ACRE
Alternative D	
Effective In-Situ Production Rate	135 CY/HR
Effective Dredge and Plant Operating Time	10 WK
Percent Solids of Dredge Discharge	30 %
Percent Solids Prior to Dewatering	30 %
Slurry Flow to Dewatering Facility	900 gpm
Percent Solids of Dewatered Sediment	70 %
Effluent Flow to Water Treatment	700 gpm
Area of Sediment Processing and Water Treatment Plant	1.30 ACRE
Area of Dewatered Sediment Stockpiling Area	4.33 ACRE

Notes:
% = percent
CY = cubic yard(s)
gpm = gallons per minute
HR = hour(s)
WK = week(s)