Preliminary Removal Action Design Work Plan

Mobile Sediments and Surface Deposits Work

Penobscot River Estuary, Maine

Prepared for

**Greenfield Penobscot Estuary Remediation Trust LLC,
Trustee of the Penobscot Estuary Mercury Remediation Trust**

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EXECUTIVE SUMMARY

This Preliminary Removal Action (RA) Design Work Plan presents the approach for implementing the Mobile Sediments and Surface Deposits Work Category based on the Consent Decree (¶11.a) for the Penobscot River Estuary. This document describes how the Remediation Trust will design and carry out sediment removal to accelerate recovery of the Estuary, where mercury contamination from historical industrial releases persists. Although natural recovery processes are occurring, Estuary hydrodynamics remobilize and redistribute mercury-contaminated sediments, particularly those enriched with wood waste, slowing recovery. As a result, mercury concentrations in Estuary sediment, biota, and marsh ecosystems continue to be higher than concentrations observed in reference locations outside the Estuary. Without targeted intervention, the system has been estimated to take 45 to 100 years to recover.

The RA is intended to reduce both the mass of mercury in the system and the volume of contaminated material that is easily resuspended. Using available data from Phase II and Phase III studies and a structured feasibility evaluation, the plan identifies seven preliminary target removal areas in Frankfort Flats, Bucksport, Verona East, and the Orland River. These areas contain Surface Deposits with unconsolidated sediment that is readily remobilized, favorable thickness or volume for efficient removal, and conditions that support the implementability of removal. Intertidal flats and marsh areas are excluded from consideration as preliminary removal targets because deposits in these locations are thin, and difficult to remove, and many are located in ecologically sensitive environments that would require extensive restoration. Subsequent pre-design investigations will include sampling to confirm the Surface Deposits are still present and contain elevated mercury concentrations.

Feasibility considerations shape the design strategy. All removal, processing, transportation, and disposition activities must be achievable within the available Committed Funding, with Contingent Funding reserved for situations in which Beneficial Reuse proves to be infeasible and landfill disposal is required. Permitting will be a major driver of schedule and design refinement and may impose limitations on work windows, natural resource protections, turbidity management, and monitoring requirements. Property access—both landside and in-water—must also be secured for staging, processing, and navigation. The physical and chemical composition of the target materials will influence dewatering, separation, water treatment, and the feasibility of Beneficial Reuse. Beneficial Reuse options are not expected to accommodate all material, so a portion of the removed materials will likely require disposal at appropriately permitted facilities. Treatability studies are needed to determine the processing steps required to meet Beneficial Reuse or disposal facility acceptance criteria.

Through this targeted and adaptive strategy, the Remediation Trust intends to accelerate the recovery of the Penobscot River Estuary consistent with the requirements of the Consent Decree. As noted in the Consent Decree, the benefits of the remediation measures are difficult to predict and measure with certainty. To reduce uncertainties, this plan outlines additional investigations to update Surface Deposit boundaries and thicknesses, characterize material properties, and evaluate hydrodynamic conditions. These data will inform preliminary and final design and support permit applications. The project will be managed using an adaptive

approach that incorporates evolving information, promotes parallel sequencing of design and permitting activities, and supports early and continual engagement with regulatory agencies, contractors, and community stakeholders.

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ACRONYMS AND ABBREVIATIONS

¶	paragraph
CSM	conceptual site model
DEP	Department of Environmental Protection
mg/kg	milligram(s) per kilogram
ng/g	nanogram(s) per gram
NOAA	National Oceanic and Atmospheric Administration
NRPA	Natural Resources Protection Act
QC	quality control
RA	removal action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
USACE	U.S. Army Corps of Engineers

GLOSSARY[1]

Beneficial Reuse	Shall mean "beneficial use" as defined in CMR 06-096 Chapter 418 of Maine's Solid Waste Regulations or other state and federal agencies as applicable.
Beneficiary, Beneficiaries	Shall mean, with respect to the Remediation Trust, Mallinckrodt US LLC, Natural Resources Defense Council, Maine People's Alliance, and their successors.
Committed Funding	Shall mean those portions of funding for the remedial activities set forth in Paragraphs 10 through 15 (Paragraph 11 of the Consent Decree [Mobile Sediments and Surface Deposits]) that are required to be paid by Mallinckrodt.[2]
consolidated sediment	The layer above bedrock and beneath unconsolidated sediment. Limited remobilization occurs. Consists predominantly of subtidal inorganic mineral sediment. Can be distinguished from unconsolidated sediment by its geophysical or geotechnical properties.
design	Removal action design for the Mobile Sediments and Surface Deposits Work.
East Channel	Shall mean "the portion of the Penobscot River along the entire eastern side of Verona Island from the northernmost tip of Verona Island to the southernmost tip of Verona Island."
estuary	The lowercase term refers to any partially enclosed body of water where fresh water from a river mixes with salt water from the ocean.
Estuary	The uppercase term refers specifically to the Penobscot River Estuary system.
Feasible	Shall mean "capable of being accomplished with reasonable professional efforts, taking into account scientific, technical, legal, practicability, and other relevant constraints… cost; time to

[1] Note: **Bolded/Capitalized** terms are defined in the Consent Decree (U.S. District Court 2022); however, the definitions provided herein may have been abbreviated or annotated for clarity. If any conflict occurs, the definition provided in the Consent Decree governs.

[2] The Consent Decree provides Committed Funding of $70 million for the Mobile Sediments and Surface Deposits remedy, and up to $50 million in Contingent Funding if the removal action design requires landfill disposal. Unless the contingency is triggered, the Consent Decree requires that the Work be designed to remain within the limits of the Committed Funding.

	implement; potential benefits and risks; engineering, legal, and permitting considerations and processes; and input from stakeholders.”
freshet	A period of high river flow resulting from snow melt and ice melt.
intertidal	The zone between mean low water and mean high water (i.e., underwater at high tide but above water at low tide). In Maine, the intertidal zone is typically privately owned; however, the public has rights for fishing, fowling, and navigation as established by the Colonial Ordinance of 1647. Related terms include intertidal marsh (a zone characterized by vegetation such as grasses) and intertidal flats (a zone characterized by sediment without vegetation, also known as mud flats).
mean high water	Average elevation of all high tides recorded each day during a 19-year period.
mean higher high water	Average elevation of the highest tide recorded on each day during a 19-year period. Also known as mean high water springs.
mean low water	Average elevation of all low tides recorded each day during a 19-year period.
mean lower low water	Average elevation of the lowest tide recorded on each day during a 19-year period. Also known as mean low water springs.
Mendall Marsh	Shall mean “the tidal portions of the north and south branches of the Marsh River and all adjacent intertidal areas in Frankfort and Prospect, Maine ... includes, but is not limited to, the intertidal and subtidal portions of the Howard L. Mendall (Marsh Stream) Wildlife Management Area.”
Mobile Sediment	Shall mean “any mineral or organic sediment, including wood waste, that may be mobilized and homogenized by natural processes in the Penobscot River over timescales relevant to affect the fate and transport of mercury within the Site” per the Consent Decree.[3]

[3] For purposes of this document, the term “Penobscot River” as used in this definition is interpreted to mean “Penobscot River Estuary,” which is the “Site,” and does not include the freshwater portions of the Penobscot River above the former Veazie Dam.

natural recovery	Naturally occurring physical, chemical, and biological processes that contain, degrade, or reduce the bioavailability or toxicity of contaminants.
Orland River	Shall mean "the tidal portion of the Orland River, and adjacent intertidal areas, from the head of tide at the Orland Dam to the junction of the Orland River and the East Channel at Gross Point."
point of reference	A quantitative value or values used for comparison purposes. As an example, the proposed Phase III Engineering Study Preliminary Remediation Goal of 500 nanograms per gram (ng/g), identified in the Phase III Engineering Study Report (AFW 2018a), is used herein as a point of reference for designating elevated mercury concentrations.
processing	Includes physical, chemical, or thermal manipulation or treatment.
physical processing	Includes dewatering, filtration, debris removal, separation of solids into desirable (or required) fractions, physical screening or sieving to isolate or remove certain fractions, segregation of solids based on size or density, and methods required to carry out processing needs.
Reach	Shall mean a defined portion or component of the Site subject to the remediation activities set forth in the Consent Decree. Defined geographically or based on hydrodynamic, geophysical, or other scientific bases.
shoreline	See "mean high water."
Site	Shall mean "the Penobscot River Estuary, which generally includes the tidal portions of the Penobscot River from the location of the former Veazie Dam to upper Penobscot Bay. Specifically, the Site includes each of the Study Reaches shown in Appendix E of the Consent Decree, including any intertidal areas that fringe the Study Reaches."
removed material	Material (e.g., sediment, debris, wood chips) removed from the Penobscot River Estuary.
subtidal	The zone below the mean low water level that is underwater at both high tide and low tide. In tidal rivers, all lands in the subtidal zone upstream to the farthest natural reaches of the tides is known as "submerged lands," which are publicly owned in the State of Maine.

Surface Deposit	Shall mean "any subtidal or intertidal region of Mobile Sediment accumulation, including any commingled materials or debris, that can be identified by physical, chemical, geophysical, or other scientific methods" per the Consent Decree.
suspended sediment	Sediment suspended in the water column that can be transported by water flow.
target material	In-place (pre-removal) material (e.g., sediment, debris, wood chips) located within the areas targeted for removal within the Penobscot River Estuary.
unconsolidated sediment	Non-cohesive sediment layers or deposits that may be mobilized or resuspended in the water column through hydrodynamic processes.
water column	The vertical interval between the surface of a water body and the upper extent of unconsolidated sediment (i.e., the air-water interface to the water-sediment interface).
wood waste	Organic sediment or debris originating primarily from historical sawmill operations along the Penobscot River.
Work Category, Work Categories	Shall mean, individually or collectively, the remedial activities, described in Consent Decree Paragraphs 10 through 14, to which funding is specifically allocated.

1 INTRODUCTION

This Preliminary Removal Action (RA) Design Work Plan for the Mobile Sediments and Surface Deposits Work Category was prepared by Jacobs on behalf of Greenfield Penobscot Estuary Remediation Trust LLC, Trustee of the Penobscot Estuary Mercury Remediation Trust (collectively, the Remediation Trust) for Work[4] on the Penobscot River Estuary (Figure 1-1). This Preliminary RA Design Work Plan has been developed in accordance with the Consent Decree[5] and its appendices, including applicable requirements of the Statement of Work (Appendix A of the Consent Decree). The Mobile Sediments and Surface Deposits Work Category is one of the remediation actions intended to reduce mercury exposure and enhance recovery of the Penobscot River Estuary.

As outlined in Paragraph (¶) 11 of the Consent Decree, the Mobile Sediments and Surface Deposits Work Category is one of three remediation Work Categories identified in the Consent Decree:

1. Orrington Reach: Orrington Reach extends from Orrington, just south (downstream) of the former HoltraChem facility, to North Bucksport. The remedy for this Work Category is thin layer capping of 130 acres of intertidal flats.

2. Mobile Sediments and Surface Deposits (the subject of this Preliminary RA Design Work Plan): The remedy for this Work Category is removal of a portion of these materials from the Site. There are no geographic limits within the Site specified for this Work.

3. Orland River and East Channel around Verona Island: The remedy for this Work Category is to be determined by the Trustee and may include capping, removal, or other remediation actions within the East Channel and Orland River.

The purpose of this Preliminary RA Design Work Plan is to outline the approach for design and implementation of the Work specified in ¶11 of the Consent Decree. Statement of Work ¶5 describes the purpose of, and elements to be included in, design work plans, and in consideration of this guidance, the Preliminary RA Design Work Plan accomplishes the following:

- Presents the basis of design (Section 3) developed using currently available data and understanding, supported by a description of the current conceptual site model (CSM), remediation objectives, factors to be considered when determining what is feasible, a list of preliminary target removal areas, and the key anticipated design elements.

[4] The term "Work" is defined in the Consent Decree as all activities and obligations, the performance of which the Remediation Trust or the Project Trust, and their respective Trustees, is required to cause under the Consent Decree, including all remediation activities.

[5] The Consent Decree was approved and entered by the U.S. District Court for the District of Maine in the case *Maine People's Alliance and NRDC v. HoltraChem Manufacturing Company LLC, et al.*, No. 1:00-cv-00069-JAW (D. Me.) (ECF No.1187, October 11, 2022).

- Describes implementation considerations and areas requiring clarification (Section 4), specifically associated with key data gaps, permitting, and property access.

- Provides the overall approach for implementation (Section 5), including the overall management strategy, community involvement, planning for design investigations, studies or tests to be performed in support of the design and permit applications, and removal action implementation along with associated roles and responsibilities.

- Presents the anticipated delivery schedule (Section 6).

Design of the Mobile Sediments and Surface Deposits RA will build upon existing information from the following:

- *Penobscot River Mercury Study – Phase I of the Study: 2006–2007* (PRMSP 2008) and *Penobscot River Mercury Study, Update to the Phase I Report* (PRMSP 2009), both of which are referred to herein as the Phase I Study
- *Penobscot River Mercury Study Final Report: Mercury Contamination of the Penobscot River Estuary: Current Situation, Remediation Targets, and Possible Remediation Procedures*, referred to herein as the Phase II Study (PRMSP 2013)
- *Phase III Engineering Study Report, Penobscot River Estuary, Maine*, referred to herein as the Phase III Engineering Study (AFW 2018a) and associated Phase III Engineering Study reports (AFW 2018b, c, d)
- Relevant published data
- Findings from the Orrington Reach Work Category
- Evaluation of the following key feasibility[6] factors:
  - Cost
  - Permitting
  - Access
  - Implementability (removal and dewatering)
  - Beneficial Reuse
  - Disposal

This Preliminary RA Design Work Plan will be updated to incorporate new information if material changes in the approach outlined herein are recommended.

[6] The term "Feasible" is defined in the Consent Decree as capable of being accomplished with reasonable professional efforts, taking into account scientific, technical, legal, practicability, and other relevant constraints. Determinations of feasibility will be made by the Trustee of each Trust and may take into account, among other factors, the following: cost; time to implement; potential benefits and risks; engineering, legal, and permitting considerations and processes; and input from stakeholders. A determination of feasibility does not require or imply that a harm or risk is readily quantifiable or abatable, or that a particular increment of risk reduction or harm abatement will occur.

2 BACKGROUND

As defined in the Consent Decree, the Site is the Penobscot River Estuary, which generally includes the tidal portions of the Penobscot River from the location of the former Veazie Dam to upper Penobscot Bay (Figure 1-1). As described in the Phase III Engineering Study, the Penobscot River is the second largest river system in New England, draining a watershed of approximately 7,470 square miles. The lower Penobscot River is defined by the Penobscot River Estuary, which extends 22 miles with a surface area of approximately 35 square miles (AFW 2018a).

The Penobscot River Estuary is typical of a coastal plain estuary formed by the flooding of previously incised valleys (Dyer 1995; Pritchard 1952). The system widens and deepens downstream of the head of tide and is macrotidal, with tides of up to 5.5 meters at Bangor. Downstream flow in the Penobscot River Estuary is small compared with the tidal prism under typical conditions. Because of the generally limited wave activity, tidal currents in the system make the Penobscot River Estuary tide-dominated (Dalrymple et al. 1992). Coastal plain estuaries typically include salt marshes and intertidal flats that accumulate sediment over time, as are seen in the Penobscot River Estuary. The Veazie Dam, which was constructed in 1912 and removed in the summer of 2013, acted as the head of tide for the system by not allowing significant tidal flow above the dam; however, it did allow downstream flow of fresh water in the river. With its removal, the dam no longer limits tidal influences, and natural flow in the river was restored.

Mercury concentrations in sediment and biota are elevated in the Penobscot River Estuary predominantly because of historical releases from the former chlor-alkali plant that operated in Orrington, Maine, from 1967 to 2000. Investigations conducted during litigation between 2000 and 2013 provided initial data on the mercury distribution in environmental media and biota resulting from these releases. Findings summarized in the Phase III Engineering Study and other supporting documents indicate that the Penobscot River Estuary is undergoing natural recovery, as evidenced by data showing that total mercury concentrations are generally higher in subsurface sediment than in surface sediment. However, the Phase III Engineering Study concluded that the rate of recovery is hindered by the suspension and redistribution of mercury-contaminated sediments (Mobile Sediments). As a result, total mercury concentrations in sediment and biota remain elevated above levels observed in areas selected as "reference locations" for long-term monitoring of the Site (Addison and Frenchman's Bay) (WSP 2025).

The removal action specified in ¶11 of the Consent Decree is intended to accelerate recovery of the Penobscot River Estuary by removing a portion of the mercury-contaminated sediment that continues to be redistributed by natural river and tidal processes.

3 BASIS OF DESIGN

This section outlines the preliminary basis of design for actions required to remove a portion of the Mobile Sediments and Surface Deposits as specified in ¶11 of the Consent Decree. The basis of design is supported by the CSM (Section 3.1), the remedial action objectives (RAOs) (Section 3.2), and key feasibility criteria (Section 3.3). Preliminary target removal areas are identified (Section 3.4), and key design elements presented (Section 3.5).

3.1 CONCEPTUAL SITE MODEL

The current CSM is based on the investigations and analyses completed during the Phase II Study and Phase III Engineering Study. The Site extends from the former Veazie Dam downstream (south) to upper Penobscot Bay, and includes such features as Mendall Marsh, the Orland River, and the channel around Verona Island. In addition, the Site includes all subtidal areas within the Penobscot River Estuary, and the intertidal zone between mean lower low water and mean higher high water.

For use in this Preliminary RA Design Work Plan and as Work proceeds, the following clarifications are provided with respect to Consent Decree definitions and similar terms used in the Phase II Study and Phase III Engineering Study:

- As provided in the Glossary, the term "Mobile Sediment" means "any mineral or organic sediment, including wood waste, that may be mobilized and homogenized by natural processes in the Penobscot River[7] over relevant timescales to affect the fate and transport of mercury within the Site." Mobile Sediment therefore includes sediment that is suspended in the water column at any given time and deposited sediments that can readily be resuspended via the hydrodynamic conditions of the Site. For clarity, the portion of Mobile Sediment present in the water column and moved by tides and downstream river flow is referred to as "suspended sediment." The portion of Mobile Sediments not in active suspension is referred to as "Surface Deposits."

- Mobile Pool – This term was used interchangeably with the term "Mobile Sediment" in the Phase II Study and Phase III Engineering Study. It was defined in Chapter 7 of the Phase II Study as "the presence of uniform layers of light colored, unconsolidated mud, sometimes 10-cm or greater in thickness. The color and texture of this sediment indicates that it was recently deposited. These deposits make up a 'mobile pool' of sediment that is remobilized and redistributed by changes in the hydrodynamic forcing conditions throughout the year" (PRMSP 2013). The term "mobile pool" will be retired to avoid confusion.[8]

The extensive investigations and analyses completed at the Site during the Phase I, Phase II, and Phase III Studies form the current understanding of the Site conditions. The current CSM, summarized in the following Sections 3.1.1 through 3.1.5, is a foundational component for

[7] In this context "Penobscot River" is the same as "Penobscot River Estuary."
[8] The term "mobile pool" is referenced in the Consent Decree but is not a defined term.

identifying materials to be removed under the Mobile Sediments and Surface Deposits Work Category. Additional information, described in Section 4, is needed to support feasibility evaluations and RA design and permitting. As additional information and data are collected, the CSM will be updated to support ongoing Work.

3.1.1 Mercury Sources to the Penobscot River Estuary

Previous studies have identified industrial discharges from the former HoltraChem facility in Orrington as the predominant source of mercury in the Penobscot River Estuary. Releases of mercury from the facility occurred primarily via an outfall into Southern Cove, which is immediately downstream of the HoltraChem facility on the Penobscot River, between 1967 and the early 1970s. There were also mercury releases to soils and waste ponds, and atmospheric/volatile emissions. Whereas the total amount of mercury released from the facility is unknown, it is estimated that 6 to 12 metric tons (equivalent to approximately 7 to 13 U.S. [short] tons) of mercury were discharged through the facility outfall into Southern Cove during the late 1960s (PRMSP 2013). Over the decades since the initial facility discharges, mercury contamination in sediment has migrated through a variety of environmental processes to locations both upstream and downstream of the HoltraChem facility and has accumulated in biota in the ecosystem.

Ongoing mercury sources were evaluated in the Phase II Study. Based on this study, the annual loading of total mercury to the Site was estimated to be about 57 kilograms per year from all sources. Of this total, 86% was estimated to have been contributed by inflow over Veazie Dam and about 9% by tributary inflows below Veazie Dam. The upstream contribution of mercury to the Site has not been reassessed since the Veazie Dam removal, which was completed in 2013. Ongoing loadings from HoltraChem, from municipal sources, and by direct atmospheric deposition were estimated in the Phase II Study to have contributed 4%, 0.4%, and 0.5%, respectively, of annual mercury loading to the Site. Based on this analysis and other lines of evidence, it was concluded that annual inputs from the ongoing external sources are small compared to the large quantity of legacy mercury within the Penobscot River Estuary, including in both buried or permanently trapped sediments, as well as Mobile Sediments that continually mix within the system (PRMSP 2013). External sources of mercury are, however, an important consideration to evaluations of long-term recovery of the Penobscot River Estuary following implementation of the removal Work under this Work Category.

Since the early 1970s, when mercury discharge from the former HoltraChem facility was eliminated, mercury concentrations in the uppermost layer of Penobscot River Estuary sediment have generally decreased because of the deposition of cleaner more recent sediments on top of the more heavily contaminated sediments. This natural burial is a key component of ecological recovery in aquatic systems, although this process can take decades. For the Penobscot Estuary, reliance on natural recovery processes will likely take a minimum of 45 years for total mercury concentrations in surface sediment to decline to 500 nanograms per gram (ng/g), a level considered protective of ecological receptors and human consumers of fish (AFW 2018a). The multi-decade duration of this natural recovery time frame results from the continuous resuspension and redeposition of mercury-contaminated sediments within the Penobscot River Estuary.

A principal organic component of Mobile Sediments and Surface Deposits is wood waste from the legacy timber, pulp, and paper industries along the Penobscot River. Wood waste tends to sorb higher levels of mercury than inorganic sediment and, as lower-density material, is both more readily resuspended as well as significantly retained within the system under the hydrodynamic conditions within the Penobscot River Estuary.

3.1.2 Mobile Sediments and Surface Deposits

Within the Penobscot River Estuary, unconsolidated sediments are remobilized over variable timescales by influences including the saltwater front formed by incoming tides and seasonal variability in the magnitude of downstream riverine flows. Within the Estuary, a natural cycle of material resuspension, migration, and redeposition has tended to homogenize the properties of suspended and bedded surface sediments, with surface sediment mercury concentrations throughout the estuary ranging between 500 and 1,500 ng/g (AFW 2018a). For several months following resuspension, the sediment is exposed to oxygen in the water column, changing the color of the sediment to tan, in contrast to the black or gray color of the consolidated, anoxic sediment below the Surface Deposits (Geyer and Ralston 2018). This color variation is one line of evidence that supports the identification of recently deposited Mobile Sediment when observed in the form of Surface Deposits.

The seasonal and episodic variations in Penobscot River flow cause sediments suspended from a Surface Deposit to migrate up and down the Penobscot River Estuary. The suspended sediments eventually settle out of the water column at various locations as Surface Deposits (Figure 3-1) and may be resuspended. During high freshwater river flow, the near-bottom currents are persistently southward all the way to Bucksport (Figure 1-1), causing the sediments to be swept out of the upstream portions of the Site and to be redeposited adjacent to Bucksport and as far south as the southern tip of Verona Island. During periods of higher tides and lower freshwater discharge, the salt front advances north of Frankfort Flats and as far upstream as Bangor, reaching further along the channel bottom due to the higher density (heavier) nature of salt water. The estuarine tidal currents associated with the advancing salt front reverse the net direction of sediment transport, redistributing the sediments as Surface Deposits that extend north past Orrington Reach. Because of the high-energy environment of the Penobscot River Estuary, portions of suspended sediment settle out of the water column and accumulate as Surface Deposits in both the subtidal and intertidal zones of the Penobscot River Estuary (Figure 3-2).

Surface Deposits vary in thickness and are subjected to repeated cycles of periodic erosion and deposition with temporal and spatial variability. The location of suspended sediment can change on timescales ranging from days (e.g., because of large rainfall or tidal surge events) to weeks (e.g., in response to spring versus neap tides), to seasons (e.g., because of the spring freshet).

3.1.3 Characterization and Extent of Surface Deposits

The Phase II and Phase III studies used different methods to evaluate the mass of Surface Deposits within the Penobscot River, resulting in reported ranges of 500,000 to 3,000,000 tons, as discussed in this subsection. This information, along with understanding of the mercury concentrations within the Surface Deposits, is critical to the selection of target removal areas.

During the Phase II Study, thickness measurements were limited to ponar grab samples, with only 10-centimeter vertical penetration. As such, little resolution was provided as to the volume and thickness of the Surface Deposits. Geophysical survey data collected in 2016 and 2017 as part of the Phase III Engineering Study included dual-frequency sonar and sub-bottom profiling that identified and generally characterized suspended and bedded sediment, respectively, with different compositional and potentially erosional properties (AFW 2017, 2018b). Sub-bottom profiling data and associated confirmation sediment cores identified “Reflector 1” Surface Deposits, characterized as a mixture of low-density unconsolidated sediment and wood waste. Spatial characterization based on sub-bottom profiling data suggested Surface Deposits enriched in wood waste reach up to 6 feet thick in some locations, with a system-wide average of 0.6 foot (AFW 2018a).

Chemical analysis of wood waste samples of Surface Deposits (15 cores from 13 locations) and suspended sediment from near the riverbed conducted during the Phase III Engineering Study suggested that concentrations of total mercury in wood waste were elevated relative to concentrations in mineral sediment samples, as summarized in Exhibit 1.

Exhibit 1. Comparison of Total Mercury in Mobile Sediment

Mobile Sediment Partition	Material Type	Total Mercury (average, ng/g)
Suspended Sediments	Wood Waste	> 1,500
Surface Deposits	Wood Waste	> 1,000
	Mineral Sediment	500–1000

Data Source: Phase III Engineering Study (AFW 2018a)

The locations, areal extent, thickness, volume, and mercury concentrations of Surface Deposits in the Penobscot River Estuary are not currently well characterized from the perspective of temporal and spatial variability, which is information needed to design an effective remedy. Information presented in the Phase III Engineering Study regarding identification and estimates of the volume and mass of the Surface Deposits was developed to satisfy the study objectives and represents the hydrodynamic conditions encountered at the time data were collected, and as such, these data alone are insufficient to complete feasibility evaluations or RA design.

Sub-bottom profiling surveys performed in 2016 and 2017 and presented in the *2016 Mobile Sediment Characterization Report* and *2017 Intertidal and Subtidal Sediment Characterization Report* (AFW 2017, 2018b) estimate that as much as 3,000,000 tons (dry weight) of Surface Deposits may be on the riverbed and appear as a mixture of wood waste and mineral sediment.

Approximately half of this material was estimated to be in deposits more than 1 foot thick, with some deposits reaching 6 feet thick. These deposits appear to be distributed throughout the Penobscot River Estuary, with specific, identifiable Surface Deposits of varying thicknesses in the vicinity of Snub Point, Winterport, and Frankfort Flats; upgradient of Bucksport; in the Orland River; and in the Verona East channel (AFW 2018c). These Surface Deposits are susceptible to remobilization, which contributes to the mix of sediment and wood waste suspended in the water column. Surface Deposit samples were visibly enriched with wood waste in Orrington, Frankfort Flats, Bucksport, Verona Northeast, Verona East, and in the Orland River (AFW 2017). Evidence of Surface Deposit mobility was observed in the vicinity of Bucksport for a feature identified in the 2016 geophysical survey as the "Bucksport Mill Pile" (AFW 2017). Between the 2016 and 2017 geophysical surveys, this feature appears to have moved upgradient into the deeper water channel near Bucksport (AFW 2018c).

The Phase II Study estimated the mass of Surface Deposits to be on the order of 500,000 tons (dry weight) based on the limited vertical resolution of ponar grabs, a 0.05-meter (2-inch) thickness, and estimated fractions of "new mud or wood chips" (Geyer and Ralston 2013). However, Phase III Engineering Study geophysical surveys of the system resulted in an estimated Surface Deposit volume significantly larger than the Phase II Study estimates, on the order of 1,100,000 dry tons within the Orrington, Winterport, Frankfort Flats, Bucksport, Verona Northeast, Orland River, and Verona East areas (AFW 2017), which do not encompass all areas evaluated in the Phase II Study estimate. The difference in the Phase II Study and Phase III Engineering Study volume estimates is due primarily to the thickness assumed in the volume estimate calculations. The Phase II Study assumed an average thickness of 2 inches, which was based on direct visual observation, while the Phase III Engineering Study thickness estimates were based on geophysical measurements and limited field observations, which ranged from 0.5 foot (Verona Northeast) to 7 feet (Bucksport).

3.1.4 Characterization and Extent of Suspended Sediments

The mass of suspended Mobile Sediment in the Penobscot River Estuary is estimated to be much smaller than the mass of mineral sediment and wood waste Surface Deposits identified through sub-bottom profiling. Near-bed suspended sediment sampling (indicating an average total suspended solids concentration of 1 gram per liter) combined with geophysical data suggest that approximately 4,000 dry tons (or 41,000 wet tons) of low-density wood waste and mineral sediment are present in suspension at any given time (AFW 2018c). In contrast, the estimated mass in dry tons of Surface Deposits ranges from 500,000 tons to more than 1,000,000 tons (Section 3.1.3).

Multiple observations demonstrate that suspended wood waste is highly mobile. During the 2016 and 2017 field programs, eel traps and a streambed sampling net deployed near Frankfort Flats, Verona East, and Lawrence Cove Channel rapidly accumulated wood waste particles. These particles were consistently described as medium brown, uniform, blocky in shape, and approximately 0.0625 to 0.125 inch in size (AFW 2018c).

Additional visual evidence (such as underwater camera observations and reports of a 1-meter-tall equipment tripod being temporarily buried by a moving wave of suspended sediment) further confirms the dynamic and mobile nature of the suspended wood waste fraction (AFW 2018a).

3.1.5 Mercury Methylation and Bioaccumulation

Mercury methylation is a complex biochemical process in which a methyl group is added to a mercury atom, converting inorganic mercury into methylmercury, an organic form that is more toxic and more readily bioavailable. This transformation is mediated by anaerobic microorganisms, such as sulfate-reducing and iron-reducing bacteria, in environments with low oxygen and low sulfate levels. Sulfate-reducing conditions are present in marshes within the Penobscot River Estuary, leading to elevated methylation rates.

Mercury, in both inorganic and organic (methylmercury) forms, enters the food web through direct ecological contact with surface sediments (stable or unstable shallow sediment deposits) and particulates in the suspended sediment (mobilized throughout the water column) that interact with the surface of the riverbed. The bioaccumulation of mercury in the food web, primarily as methylmercury, results in receptor exposure and potentially adverse effects on wildlife in the Penobscot River Estuary and on humans that consume wildlife from the Penobscot River Estuary.

In *Penobscot River Risk Assessment and Preliminary Remediation Goal Development* (AFW 2018c), a mercury concentration of 500 ng/g was developed as a reference concentration that is protective of ecological receptors and human consumers of biota. Sediments exceeding this reference concentration for mercury are present in sensitive ecosystems, such as Mendall Marsh, the Orland River, and other areas of the Site. Similar reference values were developed for methylmercury; however, given the complex nature of methylmercury production, the RAOs in this Preliminary RA Design Work Plan focus on mercury. Methylmercury concentrations are often elevated where total mercury concentrations are elevated; therefore, removing sources of inorganic mercury will reduce the amount of mercury available for methylation, thereby lowering methylmercury formation. More detailed investigation of mercury methylation within the Penobscot River Estuary is not required to achieve RAOs.

3.2 REMEDIAL ACTION OBJECTIVES

The Consent Decree specifies removal of a portion of the Mobile Sediments and Surface Deposits, with the intent to reduce mercury exposures and accelerate recovery of the Penobscot River Estuary. Sediment removal as a remedy for rivers and estuary systems is a well understood technology and is an approach recognized by regulatory agencies and supported by various state environmental and U.S. Environmental Protection Agency guidance documents. Based on the current CSM and requirements of the Consent Decree, the following RAOs were developed with the intent to accelerate system recovery by addressing Mobile Sediments and Surface Deposits within the Penobscot River Estuary, and maximize the benefits achievable within the finite funding provided for this Work Category:

- Reduce the volume of mercury-contaminated sediment susceptible to resuspension and migration.

- Reduce the mass of mercury in the Penobscot River Estuary by removing sediment with elevated mercury concentrations.

3.3 FEASIBILITY SCREENING

The key factors that determine whether an RA is Feasible were evaluated based on existing information to guide RA planning and design. Identification and evaluation of key feasibility factors early in the planning and design process will reduce the potential for allocating planning and investigation funds to an RA with a low likelihood of success.

Feasibility factors and associated questions and evaluation approaches are outlined in Table 3-1. Feasibility factors include the following:

1. **Cost.** Cost is a critical factor in determining the feasibility of the RA because all activities throughout the life cycle of the project must be completed within the limits of the Committed Funding for removal and Beneficial Reuse. Contingent Funding is available if landfill disposal is required because Beneficial Reuse is infeasible for some or all materials removed, as specified in ¶11(b) of the Consent Decree. To understand the extent of removal and disposition that can be completed using only the finite funding, cost considerations will be integrated throughout the preliminary design investigations, design, and implementation phases. Major cost elements are presented in Table 3-2. As the project progresses, cost estimates will be developed and refined to support accurate budgeting and informed decision-making.

2. **Permitting.** Work is not Feasible if the required permits are not obtained. In addition, any regulator-imposed permit conditions can affect project feasibility by significantly influencing design, schedule, and cost. Permitting is also closely linked to other feasibility factors, including implementability (e.g., removal and dewatering), Beneficial Reuse, disposal, and property access. The Remediation Trust will lead permit activities, including interacting directly with each agency. Early engagement with lead permitting agencies (e.g., Maine Department of Environmental Protection [DEP] and the U.S. Army Corps of Engineers [USACE]) and proactive community involvement to build support for the removal action are key to obtaining necessary permits. Anticipated permits are discussed in Section 4.2.

3. **Access (property).** The Work is not Feasible if the required access is not obtained to landside and waterside properties owned by public or private entities. Access to the Site and property for equipment and material staging, sediment processing (such as dewatering, treatment, or segregation), and transport to final disposition locations will be necessary. The size and location of the landside support areas, as well as the duration of use, will be determined as removal plans are developed. The Remediation Trust will develop access plans based on input from remediation contractors and lead all communication with

property owners and development of access agreements. Access may be gained through the following means:

- Leasing needed to perform Work
- Obtaining access agreements
- Obtaining permits to perform a Work element on publicly owned lands or submerged land, such as the navigable portion of the Penobscot River Estuary

A list of selection criteria to evaluate material processing and support areas is presented in Table 3-3. Criteria for property access from the water are presented in Table 3-4.

4. **Implementability (removal).** Table 3-5 presents removal technologies and evaluates them against technical implementability criteria. Given the physical complexity of the Site and its integration with surrounding communities, factors such as accessibility and permitting play a critical role in assessing the implementability of target material removal. This table demonstrates there are various feasible options for working in the challenging conditions of the Site. Removal approaches will be designed to minimize undesirable environmental impacts (e.g., turbidity), which are expected to be temporary and to subside within the defined project time frame.

5. **Implementability (dewatering).** Table 3-6 presents dewatering technologies and evaluates them against key implementability criteria. Dewatering affects cost, permitting, Beneficial Reuse, and disposal factors, and informs their associated feasibilities. For example, removed materials that require longer or more complex dewatering methods cost more to handle and potentially require additional permitting for landside discharge of larger amounts of collected waters. Similarly, dewatering costs also strongly influence Beneficial Reuse and disposal options because various degrees of dewatering are required depending on the proposed disposition of removed materials.

6. **Beneficial Reuse.** The availability of acceptable Beneficial Reuse options and the cost to process and transport materials removed from the Site are major feasibility factors (Table 3-7). Beneficial reuse of non-hazardous, dewatered removed materials must meet the applicable requirements of the Maine Solid Waste Management Rules, Chapter 418 Beneficial Use of Solid Waste, including the contaminant concentration criteria of 27 mg/kg specified for mercury in Section 7.A(3), as well as the concentration criteria for all contaminants detected in the removed materials.

   Several potential Beneficial Reuse applications have been preliminarily identified, including use in Maine Department of Transportation applications requiring general fill (such as road subgrade) and use by waste management facilities for daily cover or road material. These, along with additional options to be identified, will be investigated to determine chemical concentration and physical requirements to accept material for Beneficial Reuse. Processing costs will be estimated based on the level of treatment required to meet Beneficial Reuse criteria and a range of material volumes. To determine the necessary processing steps, the physical and chemical properties of the target material will be compared to the requirements of potential Beneficial Reuse applications. This comparison includes evaluating associated costs, permitting and stockpiling needs, and landside access. Key considerations in processing materials removed from the Site include contaminant concentrations, grain size, organic content, and water content.

Additionally, the removal schedule must align with the operational timeline of the Beneficial Reuse scenario to avoid costly delays or the need for interim storage. Misalignment can lead to logistical challenges, increased handling costs, and even loss of suitability of the sediment for its intended purpose because of changes in moisture content or material properties. Therefore, early coordination between removal operations and potential end-users is needed to fully assess Beneficial Reuse Feasibility. A flow chart for evaluating potential Beneficial Reuse opportunities is presented on Figure 3-3.

Currently, there is no known Beneficial Reuse option or combination of options that would use 100% of the removed materials. In addition, processing of removed materials for Beneficial Reuse will generate waste that will require landfill disposal.

7. **Disposal.** The availability of appropriately permitted and compliant waste management facilities and the cost of landfill disposal are significant feasibility factors (Table 3-7). The estimated cost will include waste characterization sampling, processing costs to comply with landfill physical and chemical requirements, transportation, and tipping fees. Landfill disposal of materials removed by the Remediation Trust is a significant community concern at this time because of the presence of two landfills near the Penobscot River (one adjacent to the Site and one significantly upstream of the Site), with heightened concern over the potential to leach or discharge contaminants to the river.

   Two potential waste management facility scenarios to be explored that could potentially reduce disposal costs are material characteristics necessary to qualify dredged material for use as daily cover or on-facility road material. Key assumptions to be verified during the preliminary design investigations are that removed materials will be acceptable as non-hazardous waste[9] and material will require processing to meet transport and disposal facility strength and workability requirements. Waste management facility acceptance criteria may include material properties that allow the facility to achieve necessary compaction for daily cover, and sufficient availability of "dry" waste materials to mix with Site materials to achieve required properties.

In conclusion, the removal, processing, and ultimate disposition of removed materials (i.e., as beneficially reused materials or as waste to be disposed of in a permitted and compliant facility)

[9] Note that mercury concentrations in the Mobile Sediments and Surface Deposits are generally not high enough to exceed the "20 times" rule, in this case, 0.2 milligram per liter (the Resource Conservation and Recovery Act [RCRA] toxicity characteristic leaching procedure standard) times 20, or 4 milligrams per kilogram (mg/kg). Exceeding the 20 times rule does not mean the material is a RCRA hazardous waste, but rather, it is a threshold above which this is a consideration. In addition, samples tested as part of the Phase III Engineering Study did not exceed the leachability criterion for mercury. The presence or absence of other contaminants in target material is currently unknown.

are considered Feasible based on currently available information. As additional information is obtained throughout the investigation and design process for the Mobile Sediments and Surface Deposits Work Category, assessments of feasibility will be conducted and conclusions will be fine-tuned, as needed.

3.4 IDENTIFICATION OF PRELIMINARY TARGET REMOVAL AREAS

The CSM (and data from the Phase III Engineering Study), feasibility factors, and ability to meet RAOs were evaluated to identify preliminary target removal areas. The preliminary target removal areas will be characterized to verify the locations, and determine the thickness and mercury concentrations of the Surface Deposits to support remedial design.

Eighteen areas of Surface Deposits were identified using available information from the 2016 and 2017 investigations (Table 3-8 and Figure 3-4). These areas were preliminarily screened based on known mercury concentrations and the thickness of deposits to provide a high-level screening, which reveals whether removal of these areas would provide substantial achievement of the RAOs. To prioritize potential target areas, deposits with mercury concentrations less than 500 ng/g or with thicknesses of less than 1 foot were eliminated from further consideration. Verona West, Fort Point Cove, Upper Penobscot Bay, and Cape Jellison were not retained as potential target removal areas because Surface Deposits were not identified in those areas and/or average mercury concentrations were observed to be less than 500 ng/g during prior investigations.

The remaining 14 areas were then subjected to a more detailed screening, evaluation, and ranking process to help identify the most promising Surface Deposit areas for further investigation and potential removal. The more detailed screening process was completed using three broad categories of criteria: chemical characteristics, physical characteristics, and removal implementability. Each of the broad categories of criteria have the following subcriteria:

- Chemical Characteristics
  - Mercury concentrations – Higher concentrations score higher.
  - Methylmercury concentrations – Presence of methylmercury scores higher.
- Physical Characteristics
  - Thickness of deposit – Thickness affects removal efficiency. Thicker deposits score higher.
  - Volume of deposit – Volume affects removal efficiency. Larger volumes score higher.
  - Likely impact of salt front on mobility – More impacts (e.g., remobilization) score higher.
  - Deposit unit type – This subcriterion evaluates the likely challenges posed by the Surface Deposit configuration when performing removal. A layer scores highest, a trap lower, and a trench lowest.

   - Previous identification of Deposit – Deposits identified in the Phase II Study and/or Phase III Engineering Study score higher.
   - Wood waste primary material – Presence of wood waste scores higher due to elevated total mercury concentrations in wood waste relative to mineral sediment samples.

- Removal Implementability
   - Water depth – Depth affects the selection of removal technology and efficiency of removal. Very shallow and very deep depths score lower, while intermediate depths score higher.
   - Tide window – Window affects the time available for removal due to changes in water depth. A larger available window scores higher, while a smaller available window scores lower.
   - Current – Flow conditions could affect the efficiency and effectiveness of removal or have impacts on the selected removal technology. Higher currents score lower.
   - Resuspension best management practice implementability – Assesses the ability to use various best management practices effectively given the anticipated conditions at that location. Better implementability scores higher while difficult implementability scores lower.

The Surface Deposits were evaluated in Table 3-9 with respect to these subcriteria and scored using the following scale:

- 1 = favorable with respect to investigation and potential removal
- 0 = neutral; neither favorable nor unfavorable with respect to investigation and potential removal
- -1 = unfavorable with respect to investigation and potential removal

The footnotes to Table 3-9 describe the scoring rubric for each subcriterion. The scoring includes both subjective and objective evaluations. A cumulative score across all criteria was then developed, yielding a preliminary target removal area ranking. The scores ranged from -6 to 9, with an average score of 3. To focus on high prospect target areas, those with a score of 4 or greater were identified as Preliminary Target Areas; seven locations were retained. These retained locations are in the areas of Frankfort Flats, Bucksport, the Orland River, and Verona East.

The highest-ranking reaches included Surface Deposits located in Frankfort Flats (identified in the Phase III Engineering Study as deposit FF-1, scoring 8 points), Bucksport (identified in the Phase III Engineering Study as deposits BU-1 and the "mill pile," scoring 6 points and 5 points, respectively), the Orland River (identified in the Phase III Engineering Study as deposit OR-1, scoring 4 points), and Verona East (identified in the Phase III Engineering Study as deposits

VE-1, VE-2, and VE-3, scoring 9, 7, and 8 points, respectively). The specific locations selected as preliminary target removal areas are shown on Figure 3-4. The previously identified Surface Deposits within these locations all have generally favorable characteristics with respect to their potential to meet RAOs relative to other identified Surface Deposits and will be carried forward for additional investigation. Key attributes for each area are presented below in Exhibit 3-2.

Exhibit 3-2. Key Attributes of the Preliminary Target Removal Areas

Preliminary Target Removal Area	Mercury Surface Concentration (0 to 0.5 foot) Average / Maximum (ng/g)	Estimated Surface Deposit Volume (cubic yards)	Estimated Surface Deposit Thickness (feet)	Removal Implementability
Frankfort Flats (FF-1)	569 / 3,480	650,000	4	Generally favorable conditions for removal; tide window may be a concern
Bucksport (BU-1 and Mill Pile)	837 / 3,590 (BU-1) No Data (Mill Pile)[a]	270,000 (BU-1) No Data (Mill Pile)[a]	3.5 (BU-1) 10 (Mill Pile)	Somewhat less favorable due to water depth and flows
Verona East (VE-1, VE-2, VE-3)	605 / 1,620	200,000 (VE-1) 20,000 (VE-2) 50,000 (VE-3)	6 (VE-1) 3 (VE-2) 5 (VE-3)	Favorable removal conditions, shallower with moderate currents
Orland River (OR-1)	851 / 2,310	30,000	3	Less favorable generally due to shallow depths

[a] The Bucksport Mill Pile was retained as a preliminary target removal area due to its estimated thickness of approximately 10 feet, indicating a potentially significant volume of material. The pile will be sampled and analyzed for mercury, and will be removed from consideration as a removal target if concentrations are below 500 ng/g.

Data Source: Phase III Engineering Study (AFW 2018a)

Although Surface Deposits were identified in these areas during the Phase III investigations, the Surface Deposits were not characterized to the degree necessary to support feasibility evaluations or preliminary design. Additional data are required to confirm their current locations, better define the size and thickness of the deposits, and identify physical and chemical characteristics (as outlined in Section 5). Additionally, geophysical data used to identify Surface Deposits during the Phase III Engineering Study will be compared to data from the physical collection of samples. If sampling data and geophysical data correlate well, geophysical investigations may be an efficient and cost-effective method for collecting additional information on Surface Deposit locations and volumes.

Surface Deposits present on marsh platforms or intertidal flats were **not** identified as preliminary target removal areas for the following reasons:

- Surface Deposits in these areas tend to be more thinly distributed than subtidal Surface Deposits; therefore, removals from these locations are less Feasible to implement because their removal would require more precise methods, resulting in more costly removals per unit volume. In addition, removal in these areas is subject to challenges because of shallow water and tide windows.

- Removals from marsh platforms or intertidal flats would potentially damage sensitive, high-value ecosystems and require restoration after removals, including the installation of appropriate backfill material, replantings, and an extended period of monitoring to ensure progress toward revegetation and healthy community; restoration, including backfill, is not expected to be necessary after removal of Surface Deposits from subtidal areas.

- Marsh platform areas are generally considered to be permanent trapping zones, and as such, Mobile Sediments deposited at these locations would not be considered Surface Deposits.

- Surface Deposits on marsh platforms and intertidal flats are more likely to have higher concentrations of mercury buried at depth (with generally decreasing mercury concentrations in the more recently deposited upper layers), whereas Surface Deposits in subtidal areas are more likely to have homogenous mercury concentrations throughout the deposit.

Both the marsh platform and intertidal locations are likely to have additional challenges not included in Table 3-9, such as access concerns and obtaining permits. In contrast, Work in subtidal areas would likely have fewer concerns regarding access and the ability to obtain permits.

Also note that the preliminary target removal areas are limited to Surface Deposits, not suspended material actively being transported within the water column. Suspended material being moved by hydrodynamic forces is anticipated to be extremely difficult to locate, remove, and dewater. In addition, because of the dispersed nature of suspended sediments, they are expected to have a significantly lower solids content than Surface Deposits (Section 3.1.4 addresses suspended sediments). Therefore, suspended sediments are not potential removal targets and only the Surface Deposits fraction of the Mobile Sediments will be considered as potential target removal areas.

3.5 KEY DESIGN ELEMENTS

The key RA design elements include the following:

- Target removal area characteristics (location, size, depth, and physical and chemical material properties)

- Beneficial Reuse and disposal requirements (potential Beneficial Reuse option locations and schedules, regulatory criteria for Beneficial Reuse, physical and chemical criteria for acceptance, and waste management facility locations and cost)

- Processing and staging area requirements (locations, area required, duration of activities, and lease or purchase costs)

- Community interests, questions, and concerns

Additional design elements, if materially different from those presented herein, will be documented in an addendum to this Preliminary RA Design Work Plan, as applicable to the Work.

4 IMPLEMENTATION CONSIDERATIONS AND AREAS REQUIRING CLARIFICATION

This section identifies anticipated considerations[10] and areas requiring clarification in accordance with ¶5(g) of the Statement of Work, as follows:

- Key Data Gaps and Investigations or Studies to Address (Section 4.1)
- Permitting (agency priorities and potential permit conditions) (Section 4.2)
- Property Access (Section 4.3)

The feasibility and effectiveness of the RA may be constrained by technical and physical limitations, uncertainties related to dynamic Site conditions, and design assumptions based on available data. These challenges will be addressed by reducing uncertainties through resolving key data and information gaps before the design phase, and by implementing measures to mitigate anticipated issues.

4.1 KEY DATA GAPS AND INVESTIGATIONS OR STUDIES TO ADDRESS

Although significant data were obtained during the Phase II Study and Phase III Engineering Study, the information was developed to meet the specific objectives of each Court-ordered study and is insufficient to support feasibility, design, and permitting evaluations. In addition, data collected between 2006 and 2017 may no longer be representative of current conditions. Therefore, additional focused investigations and treatability studies (bench and possibly pilot tests, if applicable) will be conducted to confirm selection of target removal areas and inform future work. Treatability studies will be conducted to evaluate dewatering and treatment technologies and the level of processing required to meet criteria for Beneficial Reuse and/or disposal facility acceptance. Dewatering, treatment, and physical separation methods will be assessed based on the physical and chemical characteristics of the removed materials, transportation requirements, permitting feasibility, and associated costs.

Table 4-1 summarizes the data gaps and the current understanding, and it outlines the investigation approach to addressing the data gaps, which are presented in further detail in Sections 4.1.1 through 4.1.3.

[10] The Statement of Work ¶5(g) uses the term “anticipated problems”; however, for purposes of this document, the term “considerations” will be used instead.

4.1.1 Target Removal Area Characteristics

Preliminary target removal areas will be characterized to confirm they meet the criteria for a removal area, identify processing requirements, and evaluate feasibility of the RA. Answers to the following questions will be used to support final target area identification:

- Does the Surface Deposit have total mercury concentrations greater than 500 ng/g?
- Is the Surface Deposit of sufficient size and thickness to be removed efficiently?
- To evaluate Beneficial Reuse and disposal options, what contaminants are present, and at what concentrations, in the material to be removed?
- What is the material composition of the Surface Deposit (e.g., percentage of wood waste, granular material, fines), and does the composition vary significantly over the area of the Surface Deposit?

Investigations will include the collection of grab samples, the visual inspection and chemical analysis of grab samples, and the collection of sediment cores at selected locations based upon the results of grab sample collection, as presented in further detail in Table 4-1.

4.1.2 Flow Dynamics

Data on seasonal and tidal flow dynamics and the effects they have on Mobile Sediments and Surface Deposit accumulation in the preliminary target removal areas are needed to answer the following questions:

- What are the characteristics of the hydrodynamics near the target removal areas during the likely time of year when sediments would be removed?
- What is the water quality at these areas at the expected time of removal (e.g., turbidity, salinity, temperature, suspended solids)?
- What are the characteristics of flow throughout the entire water column at the relevant locations at the relevant time of year?

Investigations will include installation of acoustic doppler current profiling sensors and other monitoring equipment at the selected areas as presented in Table 4-1.

4.1.3 Material Processing and Disposition

An evaluation of the materials processing methods available to meet acceptance criteria for various disposition options (Beneficial Reuse or disposal) is needed to determine feasibility and associated costs. This information will answer the following questions:

- What technologies are needed to appropriately dewater sediment?

- How does the wood waste content affect dewatering?
- Can wood waste be separated cost effectively from the mineral fraction?
- What additives are needed and at what dosages to meet strength and workability requirements?
- What water treatment technologies can be employed to meet the likely discharge criteria for water flowing back to the Site?

Investigations and treatability studies will be used to evaluate the following parameters at each preliminary target removal area to assess material suitability for Beneficial Reuse or disposal. These investigations and studies will be detailed in a forthcoming Investigation and Treatability Study Work Plan developed in accordance with ¶6(a) and ¶7(b) of the Statement of Work. The following parameters will be evaluated:

- **Chemical:** Characterize target materials for leachability, chemical concentrations, and physical content such as woody organics or fine-grained soils to determine acceptability for Beneficial Reuse and disposal options.
- **Geotechnical/physical:** Evaluate target material properties, including grain size distribution, organic content, wood chip content, water content, strength, and workability, to determine acceptability for Beneficial Reuse and disposal options.
- **Dewatering:** Perform a pilot test to identify the potential dewatering processes needed to reach the end usage requirements, including process type, process duration, materials and infrastructure requirements, and efficiency. Use the test to identify a discharge point and associated treatment requirements prior to discharge.
- **Physical separation:** Evaluate physical separation needs (e.g., screening, sieving, or hydrocyclonic methods) and associated costs via bench testing to meet criteria for disposal or Beneficial Reuse.

Evaluating disposition options will require communication with disposal facilities, potential Beneficial Reuse project stakeholders, and regulators. Beneficial Reuse criteria include the State of Maine's concentration threshold for dewatered material of 27 mg/kg of mercury (or 27,000 ng/g [parts per billion], in accordance with Maine Solid Waste Management Rules, Chapter 418, Beneficial Use of Solid Waste, Part 7) and the specific requirements of potential uses and users (e.g., material properties, availability, or amount). In addition, removed material must meet Chapter 418 criteria for all contaminants detected,[11] not just mercury.

[11] Chapter 418, Beneficial Use of Solid Waste, Part 7 includes concentration criteria for the following constituents: arsenic, cadmium, chromium, lead, mercury, select polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and dioxin toxic equivalency.

Disposal of a portion of the removed material in an appropriately permitted disposal facility is expected due to the presence of wood waste observed during Phase III investigations and other factors, including the potential presence of other contaminants, specific processing requirements needed for Beneficial Reuse projects, and the timing of such projects. However, the presence of wood waste alone does not guarantee the material cannot be beneficially reused. Beneficial Reuse options will be identified by the Remediation Trust and vetted with the Beneficiaries.

As the generator, Mallinckrodt will be asked to identify acceptable, appropriately permitted, and compliant disposal facilities and provide all direction on waste management and disposal processes. The Remediation Trust will obtain information from each approved facility on location, capacity, costs, schedules, status of permits and compliance, and material acceptance criteria.

Cost estimates for potential Beneficial Reuse and disposal options will include estimated processing costs necessary to meet Beneficial Reuse or disposal criteria. Initial feasibility evaluations will compare estimated unit costs for processing, transportation, permitting and administrative costs, and waste management facility fees.

4.2 PERMITTING

As noted in Section 3.3, Work specified in ¶11 of the Consent Decree for the Mobile Sediments and Surface Deposits Work Category is not Feasible if permits for an RA are not obtained. As the scope of RAs is better defined, permit requirements will be reviewed and updated as needed. Feedback from consultations with the relevant agencies will further inform the selection of target removal areas for design and construction. The Remediation Trust will lead all permit-related activities, including communication with all permitting agencies.

The following permits are anticipated:

- Federal Permits
  - USACE, Section 404 of the Clean Water Act
  - USACE, Section 10 of the Rivers and Harbors Act of 1899
  - USACE, Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972
  - Maine Historic Preservation Commission, Section 106 of the National Historic Preservation Act of 1966
  - U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service, Section 7 of the Federal Endangered Species Act (16 United States Code 1531-1544)
  - U.S. Environmental Protection Agency, Discharges from Construction Activities (Section 301(a) of the Clean Water Act)

- State Permits
  - Maine DEP Bureau of Land Resources, Natural Resources Protection Act (NRPA) of 2019
  - Maine DEP, Section 401 of the Clean Water Act, Water Quality Certification and CMR 06, 096, Ch. 521, National Pollutant Discharge Elimination System permit
  - Maine Bureau of Parks and Lands, Submerged Lands Rule, May 28, 2000
  - Maine Department of Marine Resources, Coastal Program, Coastal Zone Management Act Consistency (16 United States Code § 1456)
  - Maine DEP, Stormwater Construction Permit
  - Maine Natural Areas Program, Section 7 of the State Endangered Species Act
  - Submerged Lands Program

- Local Permits (as applicable)
  - Municipal Shoreland Zoning, Flood Protection, and Building Permits
  - The Maine Site Location of Development Law

The following permit considerations will affect project feasibility and will be identified early in the design and permitting process:

- **Potential Impact on Protected Natural Resources.** Maine's NRPA was established in 1988 to recognize the significance of Maine's natural resources in terms of their recreational, historical, and environmental value to present and future generations, and to prevent any unreasonable impact on, degradation of, or destruction of the resources. In addition, the goals of federal regulations enacted under the Clean Water Act and the Rivers and Harbors Act are to restore and maintain the integrity of the nation's waters and to protect fish, wildlife, and other "outstandingly remarkable values" of rivers and waterways. As part of the NRPA permitting process, the permitting agencies will evaluate whether the removal activities will have an unreasonable impact on protected resources. If a determination is made that materials removed will have an unreasonable impact, the permit can be denied, even if no practicable alternative exists. An RA may not be Feasible if permits are granted and include requirements for natural resource damage compensation or mitigation, construction controls, monitoring, or water treatment requirements that will significantly affect the cost and schedule for the Work.

- **In-Water Work Windows.** USACE's standard work window on the Penobscot River Estuary for critical habitat areas is between November 8 and April 9 and was established to protect fish habitat, such as the Atlantic salmon (spawning in the fall and smolt migration in the spring). USACE and NOAA National Marine Fisheries Service personnel have indicated during discussions regarding the Orrington Reach Thin Layer Cap Pilot project that the on-water work window may be modified, depending on the type of work to be done and the potential for habitat disruption. The timing, duration, and seasonal considerations of the on-water work window are critical elements of the permitting process for the following reasons:

- High spring freshwater flows support removal by promoting resuspension of Surface Deposits, followed by downstream transport and consolidation of the suspended sediment into thicker Surface Deposits (Figure 3-2). However, these conditions typically occur outside the approved work window at the preliminarily identified target removal areas.
- Limitations to in-river work windows may extend the overall RA time frame to more than a single season and increase the cost of RA implementation. The advantages and disadvantages of working within only certain portions of the tide cycle (e.g., performing removals during incoming tides only) will need to be assessed for net benefits, given that further limitations on the removal windows will decrease efficiency and increase the time required to complete the Work.

The Remediation Trust will build on its understanding of the NRPA permit process and permitting agency interests. The Remediation Trust will continue to work with state and federal agencies to familiarize agencies with proposed work, understand their interests and concerns, and identify the information to support the permit application review.

4.3 PROPERTY ACCESS

Property access will need to be obtained for Work on public (e.g., parks) or privately owned portions of the Site (i.e., intertidal flats) and landside for access to the water and a location for contractor staging and processing. Table 3-3 and Table 3-4 identify attributes to be evaluated for landside and on-water property access needs, respectively.

During each phase of work, property owners will be identified, and the Remediation Trust will engage with these property owners to discuss project information, access needs, and potential agreement terms and conditions. Access agreements similar to those used for the Orrington Reach Thin Layer Cap, Long-Term Monitoring, and Remediation Trust sampling will be used as a template, albeit modified specifically to the Mobile Sediments and Surface Deposits Work.

To determine property access requirements, the potential target removal areas will be cross-referenced against publicly available property ownership records. Shoreline properties in Maine often include intertidal flats if there is deeded title to the mean low water line. Therefore, for intertidal areas, property ownership (public, private, or corporate) will need to be determined and discussions conducted for each parcel. For subtidal areas, submerged land leases may be required. In addition, the location of the federal navigational channel in relation to the target removal areas needs to be identified so that impacts on navigation can be assessed and incorporated into permits, design requirements, and aids to navigation. The Remediation Trust will work with the appropriate agencies (e.g., U.S. Coast Guard and USACE) to determine limitations, notifications, and other administrative and safety requirements associated with work within the federal navigational channel.

Landside access will be required to stage equipment and material, process and treat material removed from the Penobscot River Estuary, and temporarily stockpile treated material until it can be transported to the Beneficial Reuse project or waste management facility. The size and location of a parcel needed for processing, treatment, and storage of equipment and materials will be determined based on estimated rates of removal, volumes of material, and types of processing required.

Access to the Site will be necessary. Property may be needed for support vessels to dock overnight and to transport staff to and from the landside for activities on the water or to the dredge vessels. Depending on the property, transfer technologies and dredge technologies must be considered for direct water access or overland transfer.

Feasibility of the RA is contingent upon securing property access. If access to a specific property cannot be obtained, the investigation, design, and implementation Work will be adjusted accordingly.

5 PROJECT APPROACH

This section presents the approach for planning, managing, and executing the RA Work in accordance with the Consent Decree. It presents an overall management strategy, community involvement activities, and the approach to all phases of Work from preliminary design to final implementation.

5.1 OVERALL MANAGEMENT STRATEGY

The overall strategy for the Mobile Sediments and Surface Deposits RA integrates adaptive management principles into the planning and design process (EPA 2022). Adaptive management is a flexible, science-based approach to managing complex systems with inherent uncertainty. This approach is particularly well suited to the Penobscot River Estuary, given its complex and dynamic environment. Adaptive management is an effective process for developing a plan based on existing information and probable outcomes, implementing the plan, monitoring its effectiveness, and adjusting future actions based on observations and the evolving understanding of Site conditions. This approach emphasizes the development of management plans that incorporate the following elements as appropriate:

- Focus on desired outcomes and Feasible actions to establish a clear purpose and context for all tasks.
- Integrate technical, regulatory, financial, and stakeholder objectives.
- Identify key factors early in the process to assess the feasibility of the RA.
- Reduce the likelihood of unforeseen challenges and create a framework for addressing these challenges when they arise.
- Explore options for efficient and cost-effective implementation.
- Emphasize flexibility and evolution in thinking, given the complex nature of the Penobscot River Estuary and the Mobile Sediments and Surface Deposits Work Category.

To support this approach, Work will be scheduled with intentional overlap to prioritize activities with long lead times, enabling complementary activities to proceed in parallel and accelerating delivery timelines where appropriate.

5.2 COMMUNITY PERSPECTIVE

Community involvement activities will be conducted throughout all phases of the Work to keep communities informed of project status and plans, provide opportunities for dialogue with interested parties, obtain necessary access from landowners, build support for potential permit approvals, and identify and address potential concerns that may influence community support for the RA.

The following outreach efforts will be used to build trust and encourage informed engagement:

- Explain how the removal process will manage risks related to sediment resuspension in the water column.
- Provide details on removal technologies and safety measures.
- Highlight the long-term benefits of removing mercury-contaminated sediments from the Penobscot River Estuary.
- Describe the process for selection of disposition options (Beneficial Reuse or disposal) to ensure that the removed material is permanently managed in a manner that is protective of human health and the environment.

The Remediation Trust will remain accessible and transparent, proactively seeking community feedback through various potential means, including town hall meetings, community availability sessions, fact sheets, progress updates at local government meetings, and materials posted to the Remediation Trust's publicly accessible website.

5.3 PRELIMINARY DESIGN INVESTIGATIONS, TREATABILITY STUDIES, AND BENCH OR PILOT TESTS

Preliminary design investigations will be conducted to develop the information necessary to address key data needs identified in Section 4, complete feasibility evaluations, and update the CSM to support design. Bench- and pilot-scale treatability studies may be performed on materials collected from the preliminary target removal areas to inform the type of processing required for materials to meet Beneficial Reuse or offsite disposal facility acceptance criteria.

The Remediation Trust will engage experienced sediment remediation contractors during investigation work planning to better understand the data contractors need to select appropriate removal and treatment means and methods. The Remediation Trust will also consult with permitting authorities to address agency questions regarding RAs, identify critical data needed to support permit applications, and determine whether permits are required for the preliminary design investigations, treatability studies, and bench or pilot tests (if applicable).

As needed, work plans will be developed in accordance with ¶6(a) (Investigation Work Plan) and ¶7(b) (Treatability Study and Pilot Test Work Plans) of the Statement of Work. These work plans will include the following:

- Summaries of existing relevant data and descriptions of the data gaps
- Data quality objectives, including problem statements, decision rules (i.e., criteria to evaluate new data), and specific questions (i.e., what decisions will be made with the new data?)

- Schedules for the sampling, evaluation, and reporting activities

The following addenda to existing supporting deliverables will be developed in accordance with ¶31 of the Statement of Work:

- Health and Safety Plan
- Emergency Response Plan
- Field Sampling Plan
- Quality Assurance Project Plan

The need for property access will be identified and access agreements obtained if necessary for the proposed investigation activities.

Upon completion of the data collection activities, investigation reports, treatability study reports, and pilot test evaluation reports will be prepared in accordance with ¶6(b) and ¶7(c) of the Statement of Work, as follows:

- Summaries of the investigations or studies performed, noting any deviations
- Summaries of the results and analyses, and photographs documenting the Work conducted, including laboratory data and validation reports
- Narrative interpretation of data and results, including whether data quality objectives or design objectives were met
- Conclusions and recommendations for the Work design, including resulting modifications to design parameters based on the feasibility criteria

5.4 PRELIMINARY DESIGN, PERMITTING, AND REMEDIATION CONTRACTOR ENGAGEMENT

The preliminary design will describe the Work to be implemented in sufficient detail to support initial discussions with Maine DEP and USACE as needed to prepare and submit the NRPA permit application to meet state and federal requirements. As the permit applicant, the Remediation Trust will maintain ongoing communication with Maine DEP, USACE, the community, and other interested parties to support agency review and decision-making. These communications will continue throughout the permit review and comment period to facilitate timely responses to agency questions.

The preliminary design will identify target removal areas; outline specifications for sediment removal; and address removed material management, processing, and treatment. The preliminary design will outline attributes of landside property needed for material processing and contractor staging (e.g., location, size, proximity to utilities, and transportation routes) and estimate the duration for which access will be required. The design will inform the Remediation

Trust's determination regarding the type of property rights (i.e., lease or purchase) needed to satisfy project requirements.

The Remediation Trust will engage appropriately qualified sediment remediation contractors early in the investigation and design process to provide input on proposed preliminary design investigations (e.g., treatability studies, bench tests, or pilot tests); provide constructability input on the preliminary design; and help refine construction costs, production rates, and schedules. Sediment remediation contractors may be asked to submit an approach and proposals for pre-design Work such as dewatering bench or pilot tests. The Remediation Trust anticipates contracting directly with a sediment remediation contractor and will consider various contracting models that will satisfy project goals. Participation in this early phase will not preclude contractors from bidding on future construction work.

The preliminary design will incorporate updated information from the preliminary design investigations. It will be used to support initial discussions with permitting agencies, refine cost estimates, and enable a constructability review.

5.5 FINAL DESIGN, PERMITTING, AND REMEDIATION CONTRACTING

The preliminary RA design will be updated as needed to satisfy permit application requirements, incorporate comments from permitting agencies and contractors, and incorporate new information on removal area conditions, Beneficial Reuse opportunities, and disposal facility requirements. The final design will be used to support the competitive bid process and clearly delineate work scopes and requirements in order to manage changes and control costs during construction. The Work design will be completed near the end of the agency permit application review period so that issues raised by the permitting agencies or the public that would require design changes can be addressed to facilitate permit approval.

Implementation of the RA cannot begin until all permits are approved, access to a landside staging and process area has been secured, and agreements are in place with a Beneficial Reuse entity and a waste management facility for landfill disposal.

Plans for RA implementation will be provided in a future Implementation Work Plan and developed in accordance with ¶11 of the Statement of Work. Plans for RA implementation include the following:

- A Work construction schedule in an appropriate format, such as a critical path or Gantt chart
- An updated Health and Safety Plan that meets applicable regulatory requirements and covers activities required to implement the Work
- A Permitting Work Plan that documents the items, approach, and schedule for securing the necessary permits

- Plans for satisfying authorization and access agreement requirements for obtaining necessary authorizations and permissions for onsite and offsite activities, and for satisfying requirements of such authorizations and permissions

Concurrently, supporting deliverables will be developed or updated in accordance with ¶31 of the Statement of Work. Additional supporting deliverables may include the following:

- Contractor Quality Control (QC) Plan: Details the acceptable criteria for management, QC, and documentation of the work to successfully meet the Work Objectives.
- Beneficial Reuse Plan: Details the procedures for evaluating and processing removed materials to determine suitability for Beneficial Reuse applications and disposal in an appropriately permitted disposal facility.

5.6 REMOVAL ACTION IMPLEMENTATION

The general sequence of events during RA implementation is as follows:

1. **Confirm permit and access approvals** for support facilities and activities.
2. **Select a construction contractor**, if one is not identified during the design phase.
3. **Construct onsite support facilities**, including landside and nearshore infrastructure, such as staging areas, docking facilities, dewatering systems, and water treatment units. These facilities will be established before removal begins.
4. **Perform sediment removal**, with contingency plans built into the Work Design and Implementation Work Plan, providing the ability to adapt to changing Site conditions.
5. **Perform sediment processing**, to prepare removed material for Beneficial Reuse or disposal.
6. **Transport material and place in final disposition**, at the Beneficial Reuse location and the approved waste management facility. It is unlikely that all materials removed from the Penobscot River Estuary will be acceptable for Beneficial Reuse, and some portion will require landfill disposal.
7. **Demobilize**, including removal of temporary facilities, restoration of disturbed areas, and removal of equipment and materials from the Site.

Upon completion of the RA, a Work Completion Inspection will be performed, and a Final Implementation Work Report will be prepared in accordance with ¶16 of the Statement of Work.

5.7 ROLES AND RESPONSIBILITIES

Pursuant to Consent Decree ¶22, the Remediation Trust is responsible for the development, oversight, funding, and implementation of the Work. The Remediation Trust also takes a lead role in communications with Beneficiaries, regulatory agencies, and community stakeholders. The Remediation Trust has contracted with Jacobs to provide technical support as detailed in Table 5-1. Key personnel are shown in the organizational chart (Figure 5-1).

6 NEXT STEPS – SEQUENCE AND SCHEDULE

The primary tasks and sequence of Work currently anticipated for implementation of an RA are presented on Figure 6-1. The time frames required to develop a preliminary RA design and submit a NRPA permit application have been estimated using work completed to date for the Orrington Reach Work Category. Because of the uncertainty associated with state and federal review timelines, the schedule for Work elements to be completed between submittal of permit applications and implementation of an RA was estimated based on the assumptions noted on Figure 6-1.

7 REFERENCES

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Tables

Table 3-1. Summary of Feasibility Factors

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Feasibility Factor	Feasibility Question	Approach to Evaluation
Cost	Can the Work be completed within the limits of the Committed Funding?	• Review and update Phase III Engineering Study cost information • Engage contractor early to support realistic evaluations • Identify key cost assumptions for each element of work • Update cost estimates as new information is developed
Permitting	Is the project permittable? What permit conditions could affect preliminary design investigations, remedy design, or removal action implementation?	• Leverage learning from permitting efforts of other Work Categories • Engage agency and community early • Consider timing of application based on experience of other Work Categories
Access (Property)	Can sufficient access be secured to perform the Work?	• Identify property needs for landside facilities • Identify property needs for property access from the water • Identify potential properties and assess ability to secure access (lease or purchase)
Implementability (Removal)	What technology will be most effective? What are the associated costs? What are the potential undesirable environmental impacts?	• Identify removal targets and characteristics • Identify potential impacts (e.g., turbidity) and associated mitigation measures • Engage contractor early to review existing information, identify options, and start cost estimating process
Implementability (Dewatering)	What technology will be most effective? What are the associated costs?	• Identify removal targets and characteristics • Engage contractor early to review existing information, identify options, and start cost estimating process

Table 3-1. Summary of Feasibility Factors

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Beneficial Reuse	Can removed material be beneficially reused? What are the associated costs and how do they compare to disposal costs?	• Review state and federal regulations • Identify Beneficial Reuse options • Identify processing and treatment required for material to meet reuse criteria • Estimate volume and characteristics of material to be reused, such as contaminant concentrations, organic content, water content, and grain size • Establish alignment between the timing of reuse opportunities and the availability of removed materials • Determine transportation distance, method of transportation, and estimate cost
Disposal	What are the disposal requirements? What are the associated costs?	• Obtain list of acceptable facilities from Mallinckrodt • Estimate volume and characteristics of material to be disposed of, such as contaminant concentrations, organic content, and water content • Contact landfill for acceptance criteria and cost • Determine transportation distance and method of transportation, and estimate cost

Table 3-2. Cost Elements

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Cost Element	Description
Permitting, Design, and Procurement	Includes costs for obtaining permits, preparing detailed engineering designs, and procuring specialized services to conduct the removal action.
Mobilization and Site Preparation	Covers expenses related to transporting equipment and personnel to the Site, establishing temporary facilities, and preparing the work area for construction. Includes clearing, grading, and installing erosion controls to minimize environmental impact. Includes in-water activities necessary to prepare the target areas for dredging, including installation of turbidity controls, conveyance pipelines, and other safety and administrative elements.
Negotiation of Access/Staging Area/ Access Agreements	Accounts for securing and preparing staging areas for equipment and material storage, as well as negotiating and maintaining access agreements with property owners.
Dredging	Includes costs for sediment removal using mechanical or hydraulic dredging methods. Factors influencing this category include sediment characteristics, water depth, and production rates, as well as fuel and labor costs.
Dewatering, Material Processing, and Water Treatment	Encompasses expenses for separating water from removed material and processing material to meet waste management facility or reuse specifications to the extent necessary to be accepted for reuse or disposal. Includes treating water to comply with discharge standards.
Material Transportation	Costs associated with preparing and transporting material to final disposition location (Beneficial Reuse and landfill disposal). Includes tipping fees, material testing and certification, and fuel costs.

Table 3-3. Material Processing and Support Area Selection Criteria

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Selection Criteria	Description
Property Location	Multiple parcels may be required during the removal action to accommodate material processing, treatment, and equipment storage. Factors including direct river access and distance from target removal areas will influence material handling logistics and transportation efficiency.
Usable Area (Acres)	Usable acreage based on existing Site use. Required acreage depends on material processing and treatment methods, material staging needs, and space for equipment and access. Site visit during procurement will be necessary to assess true usable area.
Existing Utilities	Existing utilities include water, electricity, and discharge for water treatment effluent. Onsite modifications assessed during procurement.
Existing Infrastructure for Access to River	Existing docks, mooring locations, piers, or other in-water infrastructure that can be used as-is or improved to support water access, or the material processing and staging area must be considered and could benefit the property choice.
Access Roads	Properties situated along residential roads must undergo thorough vetting to secure community approval and address potential concerns. Other considerations include road weight limits, noise, traffic safety, and dust suppression.
Existing Structures and Buildings Onsite	Existing structures will be assessed at the time of procurement and may have a variety of uses, such as offices and materials storage.
Cost	Cost considerations to access land for the project's duration (material staging and processing). Considerations must be made for leasing, long-term purchases, and any land improvements such as utilities or permanent/temporary structures.

Note: Selection criteria are listed without prioritization.

Table 3-4. On-water Access Selection Criteria

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Consideration Criteria	Description
Cost	Cost considerations to access land to perform the removal action. Costs include access agreement preparation, community outreach, or permitting fees and associated labor expenses.
Existing Utilities	Existing utilities may be present within a target removal area and must be identified to avoid a strike.
Existing Infrastructure from River	In-river infrastructure may impede Work. Any infrastructure should be identified during design.
Permits and Access Needs	Access agreements must be acquired for private property access to perform the Work. Construction and Submerged Lands permits may also be required.

Note: Selection criteria are listed without prioritization.

Table 3-5. Removal Technologies Evaluated Against Selection Criteria

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Criteria	Mechanical Cable Crane (Clamshell)	Mechanical (Articulated Fixed Arm)	Hydraulic (Cutterhead)	Hydraulic (Plain Suction)	Pneumatic (Vacuum)
Cost to operate (daily cost)	◐	◐	○	●	●
Minimum water depth (m)	< 1-2	< 1-2	1	< 1	5
Operating production rates (m^3/hour)[a]	2-m^3 bucket (48) 8-m^3 bucket (193)	2-m^3 bucket (48) 8-m^3 bucket (193)	15-cm pump (23) 30-cm pump (93)	15-cm pump (23) 30-cm pump (93)	Site-specific
Horizontal/vertical accuracy (+/- cm)[b]	15 / 10	10 / 10	10 / 10	10 / 10	15 / 10
Limit sediment and contaminant resuspension	○	●	◐	◐	◐
Transfer by pipeline[c]	◐	◐	●	●	●
Transfer by barge[d]	●	●	○	○	○
Positioning and control in currents, winds, or tides (overall maneuverability)	●	●	◐	◐	◐
Docking/portability[e]	●	●	●	●	●
Effectiveness in large debris, rock, or vegetation	●	●	○	○	○
Flexibility of varying conditions within river	●	◐	●	○	○
Thin lift or residual removal	○	◐	◐	●	●

[a] Based on average conditions under normal working periods of operation.

[b] Assumes use of common industry accepted GPS units accurate to within a few inches; additional uncertainty added from the linkages of the dredgehead and GPS unit.

[c] Transfer by pipeline based on the need to reduce slurry viscosity if pipeline transfer is needed or preferred.

[d] Transfer by barge based on need to potentially add solidification amendments.

[e] Includes ability to maneuver into standard ports and travel down the river.

Notes

m = meter

m^3 = cubic meter

m^3/hour = cubic meter(s) per hour

cm = centimeter

GPS = global positioning system

Legend

● Removal technology is highly suitable for the criterion.

◐ Removal technology is suitable for the criterion but not preferred.

○ Removal technology is not suitable for the criterion.

Table 3-6. Dewatering Technologies Evaluated Against Selection Criteria

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Selection Criteria	Passive (Gravity Fed)[d]	Filter Press	Geotextile Tube	Centrifuge	Hydrocyclone/ Horizontal Vacuum Belt Filter	Polymer Amendments	Solidification Amendments
Cost to operate (daily cost)	●	○	●	○	○	◍	○
Time	○	●	○	◍	◍	◍	●
Effectiveness[a,b]	○	●	◍	●	●	●	●
Limitations due to water content[c]	○	●	◍	●	●	●	●
Limitations due to fines (clay/silt)	○	●	◍	◍	◍	◍	●

[a] Dewatering technology and effectiveness will be directly correlated with the processing needs for Beneficial Reuse or disposal; this ranking is focused on general technological capabilities compared to the criteria.
[b] Variability based on components of the removed material impact the effectiveness of the technology; therefore, treatability studies will be conducted to further determine overall effectiveness.
[c] High water content due to removal technology may affect other criteria, such that it becomes infeasible because of holding times or actual ability to remove the water content.
[d] Passive dewatering technologies include basins with underdrains for gravity discharge and land-based placement in drying beds.

Legend

● Dewatering technology is highly suitable for the criterion.

◍ Dewatering technology is suitable for the criterion but not preferred.

○ Dewatering technology is not suitable for the criterion.

Table 3-7. Beneficial Reuse and Disposal Selection Criteria

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Criterion	Description	Disposal Considerations	Beneficial Reuse Considerations
Beneficiary and Public Acceptance	The degree to which the Beneficiaries and the public support the selected final disposition options.	Location will be selected from Mallinckrodt's list of acceptable disposal facilities.	Beneficial Reuse Options must be approved by the Beneficiaries and supported by the public.
Regulatory Compliance of End Use (Disposal Facility/Beneficial Reuse opportunity)	Adherence to local, state, and federal regulations for material handling.	Permits; hazardous waste classification compliance.	Permits, Beneficial Reuse approvals, and contaminant thresholds.
Processing and Dewatering	The steps and requirements for preparing removed material to consistently meet acceptance criteria for its final disposition (Beneficial Reuse and/or disposal facility).	Operational challenges include space for dewatering operations, handling filtrate water, and compliance with discharge permits for water removed during processing. Additional stabilization (e.g., adding lime or cement) may be necessary to meet landfill acceptance criteria.	Dewatering plus additional processing, which may include screening for debris, particle size adjustments, or chemical amendments. Quality control testing for geotechnical properties (e.g., shear strength, permeability) and contaminant levels to verify compliance with Beneficial Reuse criteria.
Transportation	Logistics of moving material from removal site to destination. Includes distance, route conditions, and fuel. Modes include truck, rail, and barge.	Hauling distance to disposal site, fuel costs, road restrictions.	Hauling (similar considerations to disposal) to Beneficial Reuse site (e.g., construction, habitat restoration) and proximity to end-use.
Capacity	Ability of the site to handle the required volume within the removal action timelines.	Landfill capacity limits and scheduling availability.	Beneficial Reuse opportunity demand and ability to accept material in timeframe that matches removal action timeframe.
Material Acceptance Criteria of Disposal Facility/Beneficial Reuse	Types of sediment accepted, including contamination levels.	Restrictions on contaminants; testing requirements for landfill acceptance.	Suitability for Beneficial Reuse (e.g., grain size, contaminant levels, geotechnical properties).
Material Acceptance Fees	Charges per ton or cubic yard for accepting material.	Landfill tipping fees and surcharges for contaminated material.	Typically none but may include handling fees at Beneficial Reuse site.
Site Accessibility	Ease of access for trucks and equipment.	Road conditions, weight limits, seasonal restrictions.	Similar considerations to disposal.

Table 3-8. Initial Target Removal Area Screening

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

		Preliminary Screening	
Potential Target Area	**Exclude (X) from Further Consideration?**	**Average Mercury Concentrations Greater Than 500 ng/g Identified During the Phase III Engineering Study?[a]** **Exclude if No**	**Surface Deposit Thickness Greater Than 1 foot Identified During the Phase III Engineering Study?[b]** **Exclude if No**
Bangor		Yes	Yes
Orrington Reach		Yes	Yes
Winterport		Yes	Yes
Frankfort Flats		Yes	Yes
Mendall Marsh		Yes	Yes
Bucksport			
Bucksport Reach		Yes	Yes
Bucksport Mill Pile		To Be Determined	Yes
Bucksport Thalweg		Yes	Yes
Bucksport Harbor		Yes	Yes
Verona Northeast		Yes	Yes
Orland River		Yes	Yes
Verona East			
Surface Deposit VE-1		Yes	Yes
Surface Deposit VE-2		Yes	Yes
Surface Deposit VE-3		Yes	Yes
Verona West	X	No	
Fort Point Cove	X		No
Upper Penobscot Bay	X		No
Cape Jellison	X		No

[a] Phase III Engineering Report, Table 3-4 (AFW 2018a). The proposed Phase III Engineering Study Preliminary Remediation Goal of 500 ng/g is used as a point of reference for designating elevated mercury concentrations.

[b] Intertidal and Subtidal Sediment Characterization Report, Table 4-3 (AFW 2018b)

Table 3-9. Preliminary Target Removal Area Ranking and Selection

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

			Chemical Characteristics		Physical Characteristics							Removal Implementability			
River Reach	Preliminary Target Removal Area Ranking Scale Sum (X = Selected Area)		Average Mercury Concentration[1]	Methylmercury Present[2]	Thickness of Deposit[3]	Volume of Deposit[4]	Likely Impact of Salt Wedge on Mobility[5]	Deposit Unit Type[6]	Deposit Identified in the Phase II Study[7]	Deposit Identified in the Phase III Engineering Report[8]	Wood Waste Primary Material[9]	Water Depth[10]	Tide Window[11]	Current[12]	Resuspension BMP Implementability[13]
Bangor		-6	-1	1	-1	-1	-1	--	-1	-1	-1	0	0	0	0
Orrington Reach		2	1	1	-1	1	0	0	0	1	-1	0	0	0	0
Winterport		-1	-1	1	0	1	0	0	0	1	-1	-1	0	0	-1
Frankfort Flats	X	8	0	1	0	1	0	1	1	1	1	1	-1	1	1
Mendall Marsh		-6	-1	1	-1	-1	-1	--	1	-1	-1	-1	-1	1	-1
Bucksport															
Bucksport Reach	X	6	1	1	1	1	1	0	1	1	1	-1	1	-1	-1
Bucksport Mill Pile	X	5	--	--	1	-1	1	1	1	1	1	0	1	-1	0
Bucksport Thalweg		2	-1	1	1	0	0	0	1	1	1	-1	1	-1	-1
Bucksport Harbor		1	-1	1	0	-1	0	--	1	-1	1	0	1	0	0
Verona Northeast		3	0	1	0	-1	0	0	1	1	-1	1	-1	1	1
Orland River	X	4	1	1	0	-1	-1	1	1	1	1	0	-1	1	0
Verona East															
Surface Deposit VE-1	X	9	1	1	1	0	-1	1	1	1	1	1	0	1	1
Surface Deposit VE-2	X	7	1	1	0	-1	-1	1	1	1	1	1	0	1	1
Surface Deposit VE-3	X	8	1	1	1	-1	-1	1	1	1	1	1	0	1	1

Notes:

Shading for ranking scale sum: dark green (high) to white (low)

Selected preliminary target removal areas are presented on Figure 4-1.

BMP = best management practice

-- = not applicable or information to evaluate criterion not available

CY = cubic yard(s)

ft/s = feet per second

m/s = meter(s) per second

ng/g = nanogram(s) per gram

Ranking Scale:

1 = favorable with respect to investigation and potential removal

0 = neutral; neither favorable nor unfavorable with respect to investigation and potential removal

-1 = unfavorable with respect to investigation and potential removal

Footnote	Criterion	Ranking Scale 1	Ranking Scale 0	Ranking Scale -1	References and Notes
1	Average (Surface) Mercury Concentration	>1500 ng/g	1500 - 800 ng/g	800 - 500 ng/g	Table 3-4, Phase III Engineering Report (AFW 2018a); 800-1500 ng/g typical concentration range for mobile sediments and surface deposits.
2	Methylmercury Present	Yes	No		Table 3-4, Phase III Engineering Report (AFW 2018a).
3	Thickness of Deposit	> 4 feet	2 - 4 feet	1 - 2 feet	Table 4-3, Intertidal and Subtidal Sediment Characterization Report (AFW 2018b); Ranges based on removal efficiency.
4	Volume of Deposit	> 200,000 CY	50,000 - 200,000 CY	50,000 CY <	Table 4-3, Intertidal and Subtidal Sediment Characterization Report (AFW 2018b); Ranges based on removal efficiency.
5	Likely Impact of Salt Wedge on Mobility	High	Medium	Low to None	Figure 3-1, Conceptual Site Model (this Work Plan).
6	Deposit Unit Type	Layer	Trap	Trench	Table A-4, Mobile Sediment Characterization Report (AFW 2017). Layer = uniformly mixed deposit extending above grade compared to the river bottom. Trap = partially exposed deposit in bathymetric depression of the river bottom. Trench = partially exposed, laterally confined deposit that does not rise above the river bottom grade. Ranges based on removal efficiency.
7	Deposit Identified in the Phase II Study	Yes, grabs predominantly wood chips, mixed, unconsolidated mud	Grabs mixture of hard, sand, consolidated mud, wood chips, and unconsolidated	Grabs predominantly hard, sand, and consolidated mud	Phase II Study (PRMSP 2013) Chapter 7 and Geyer and Ralston 2017.
8	Deposit Identified in the Phase III Eng. Report	Yes		No	Table A-4, Mobile Sediment Characterization Report (AFW 2017).
9	Wood Waste Primary Material	Yes		No	Table 4-3, Intertidal and Subtidal Sediment Characterization Report (AFW 2018b).
10	Water Depth	30 ft < Depth > 6 ft	Varies between Ranking Scale 1 and -1	Depth > 30 ft or < 6 ft	Table 4-3, Intertidal and Subtidal Sediment Characterization Report (AFW 2018b); Ranges based on removal efficiency and implementability.
11	Tide Window	Removal unimpacted	Varies between Ranking Scale 1 and -1	Removal impacted	Appendix F, Alternatives Evaluation Report (AFW 2018d).
12	Current	Current less than 1 m/s (3.3 ft/s)	Varies between Ranking Scale 1 and -1	Current greater than 1 m/s (3.3 ft/s)	Ranges based on removal efficiency and implementability.
13	Resuspension BMP Implementability	Multiple BMP options can be implemented	Varies between Ranking Scale 1 and -1	Few BMP options / difficult to implement	Based on water depth, current, and tide window.

Table 4-1. Summary of Data Gaps and Investigation Approaches

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Category	Data Gaps	Currently Available Data and Information	Investigation Approach
Preliminary Target Removal Area Characteristics	Preliminary target removal areas have been identified based on limited existing information. The following information is necessary to finalize target area selection, update feasibility evaluations, begin preliminary design and prepare permit applications: 1. Horizontal and vertical limits of target removal areas. 2. Total estimated volume of removal and mass of mercury/methylmercury that can be removed. 3. Locations of Surface Deposits, their thickness, and repeatability over time (i.e., spatial and temporal variability; where are the Surface Deposits likely to repeatedly accumulate over time?). 4. Geotechnical (e.g., density, grain size, fraction of organic carbon) and chemical characteristics (e.g., mercury and methylmercury concentrations). 5. Presence of large debris and wood debris.	The Phase III Engineering Study identified several Surface Deposits believed to be consistently present, where repeated accumulations occur on a seasonal cycle (AFW 2018a). There is a wide range of estimated quantities of Mobile Sediments and Surface Deposits (i.e., 500,000 tons in the Phase II [PRMSP 2013]; 320,000 tons to 1,950,000 tons in Phase III [AFW 2018a]), resulting from differing characterization methods. Suspended sediment is predominantly wood waste and has an average total mercury concentration of greater than 1,500 ng/g. Surface Deposits consist of variable components of wood waste and mineral sediment with average total mercury concentrations of 500 to greater than 1,000 ng/g and less than 500 ng/g, respectively.	To the extent possible, sampling will be conducted to coincide with likely work windows for removal activities. Collect samples in and around preliminary target removal areas for visual observations of surficial materials to accomplish the following: • Identify and estimate the volume of wood waste commingled with Surface Deposits. • Confirm sediment chemical and geotechnical characteristics. • Identify oxidization state (tan color) to achieve horizontal delineation. Collect sediment cores at select locations based on results of grab sampling to accomplish the following: • Delineate vertical extents. • Characterize geotechnical properties and chemical concentrations (mercury and all other potential contaminants). Develop estimates of the probable volume of sediments and mass of mercury that can be removed based on the available funding. Conduct bathymetric (single beam, multi-beam sonar for subtidal or submerged intertidal zone) and LiDAR (intertidal zone) surveys for comparison against previously conducted surveys to characterize changes in bathymetric elevations due to material accumulation and remobilization over time. Conduct surveys at appropriate times of year to confirm that various states of accumulation are documented. Conduct a geophysical survey and confirmatory sediment cores to evaluate the extent to which geophysical surveys can be used to delineate Surface Deposits.
Flow Dynamics	Hydrodynamic data upstream of, within, and downstream of the initially identified target removal areas have not been collected on a seasonal scale.	Tides, freshwater flow (seasonal and episodic), and estuarine conditions affect the location and movement of the salt front, which is an important factor in the mobilization and redistribution of Surface Deposits. Previous river flow velocity studies were Penobscot Estuary-wide and did not specifically delineate velocity in the preliminary target removal areas. Measurements were collected over a 12-month period in 2010 and 2011 as part of the Phase II Study (PRMSP 2013). The monitoring included measurements between Bangor and Fort Point and also Mendall Marsh and the Orland River. Moored stations were located just downstream of Winterport and near Bucksport.	Collect real-time flow measurements focused in the proposed target removal areas and immediate surroundings to understand the hydrodynamics of the river during the removal time frames. Collect water quality parameters, including turbidity, salinity, and temperature. Improve understanding of flow across the entire water column.

Table 4-1. Summary of Data Gaps and Investigation Approaches
Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Category	Data Gaps	Currently Available Data and Information	Investigation Approach
Material Processing and Disposition	Chemical, physical, and geotechnical data, combined with bench-scale tests, are needed to evaluate options for Beneficial Reuse and disposal and to determine the processing necessary to meet the criteria for each option.	A leachability study performed as part of the Phase III Engineering Study, while not specifically focused on the Mobile Sediments and Surface Deposits Work, found that the leachability of total mercury and methylmercury was greater when they were in contact with lower salinity water compared to higher salinity surface water, suggesting higher mobility of mercury in the freshwater portion of the Penobscot Estuary (AFW 2018a). Dewatering studies were completed as part of the Phase III Engineering Study Report (Amec 2018a). Dredge sediments and wood waste were collected at three locations in the Penobscot Estuary and evaluated using various dewatering technologies, including belt filter press, centrifuge, recessed plate, geotube, gravity, and solidification. Further studies will advance upon this work to assess appropriate technologies for meeting Beneficial Reuse and disposal criteria for preliminary target removal area material. Existing study data suggest that some sediments may be suitable for Beneficial Reuse, but limited information is available to confirm the needs for material processing to meet either landfilling or Beneficial Reuse requirements in target removal areas.	Collect samples from preliminary target removal areas and analyze for chemical and geotechnical properties. Assess chemical properties of Surface Deposits for waste characterization (i.e., mercury totals, toxicity characteristic leaching procedure, Resource Conservation and Recovery Act). Assess geotechnical and physical properties (i.e., sieve analysis, density, organic content, and percent moisture) for Beneficial Reuse options such as roadway base or daily cover and for dredging technologies. Perform size/density particle separation and dewatering tests (i.e., gravity, hydrocyclone, filter press, geotextile, centrifuge, or shaker/agitator) to understand the time and effort needed to separate various fractions of the sediment and to dewater it during processing to reach the requirements of final potential uses. Understand processing that is required to strengthen material to meet landfilling or Beneficial Reuse requirements. These tests would include the addition of strengthening additives such as Portland cement to assess duration and costs needed to reach final material characteristics for Beneficial Reuse or landfill disposal. Estimate processing costs in conjunction with transportation expenses and waste management facility fees. Then, compare Beneficial Reuse and landfill disposal options.

Notes:

Specific analytical methods are not detailed and will be developed and provided in the Investigation Quality Assurance Project Plan.

Specific treatability studies will be presented in the Investigation Work Plan.

Cost-benefit evaluation methodology will be detailed as part of the 30% and 60% designs.

LiDAR = light detection and ranging

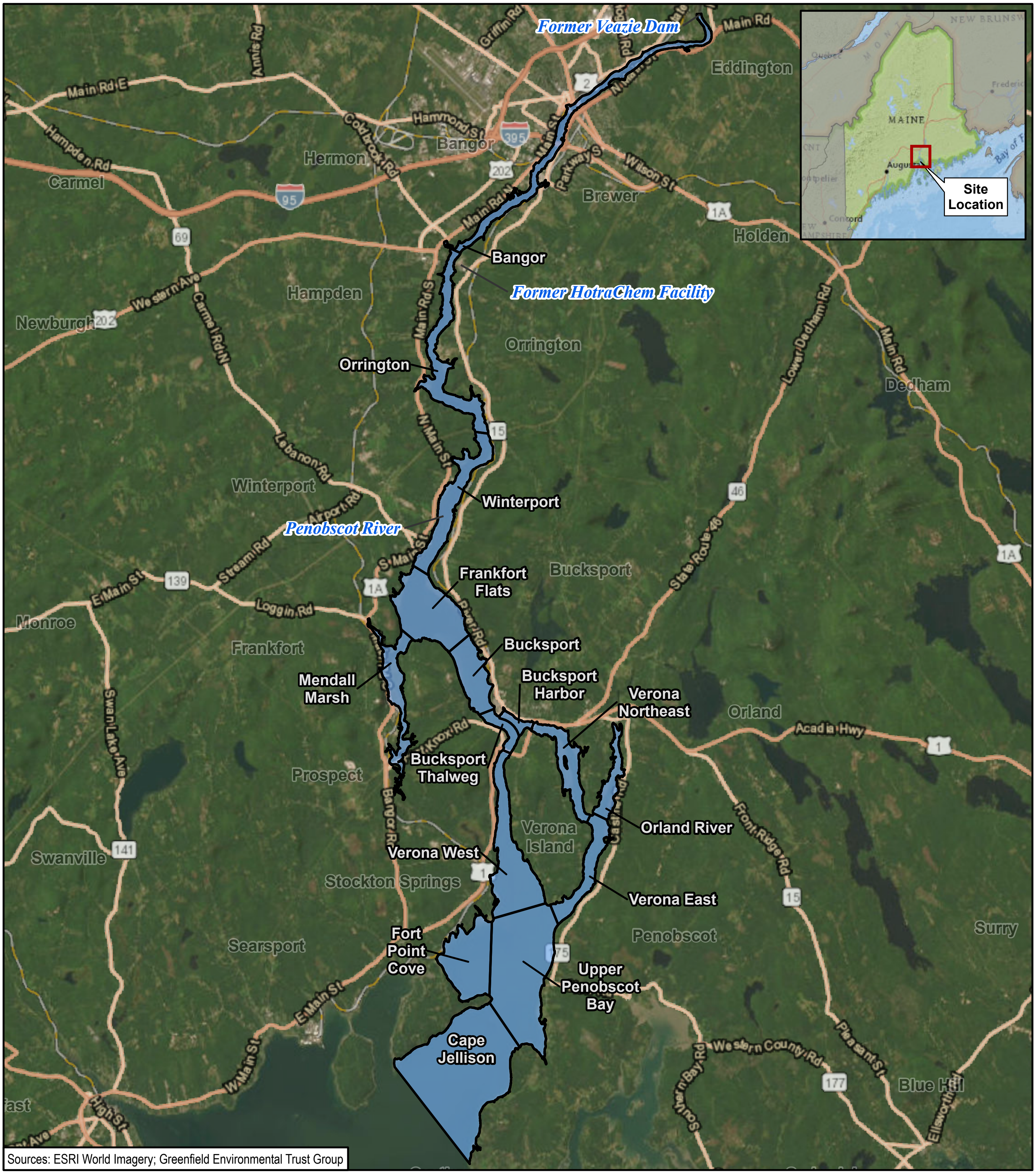
ng/g = nanogram(s) per gram

Table 5-1. Roles and Responsibilities for the Mobile Sediments and Surface Deposits Removal Action

Preliminary Removal Action Design Work Plan, Mobile Sediments and Surface Deposits, Penobscot River Estuary, Maine

Removal Action Task	Remediation Trust Role	Jacobs Role
Beneficiary Communication	Lead	Technical support
Removal Action Deliverables	Oversight, deliverable review, and project management	Lead
Supporting Deliverables	Oversight, deliverable review, and project management	Lead
Communication with Permitting Agencies	Lead	Technical support
Implementation Permits	Permittee	Permit planning and application development support
Field Investigation Permits	Permittee	Permit identification and technical support
Access	Lead	Identification of access needs and technical support
Community Involvement	Lead	Support
Investigation Work Plans	Oversight, deliverable review, and project management	Lead
Investigation Field Sampling and Analyses	Oversight, deliverable review, and project management	Lead
Database Management	Oversight and project management	
Investigation Reports	Oversight, deliverable review, and project management	Lead

Figures



LEGEND

Penobscot River

Reach Boundaries Shown in Consent Decree Exhibit E

0 1.75 3.5

Approximate scale in miles

Figure 1-1

PENOBSCOT RIVER SITE MAP

Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits
Penobscot River Estuary, Maine

Jacobs

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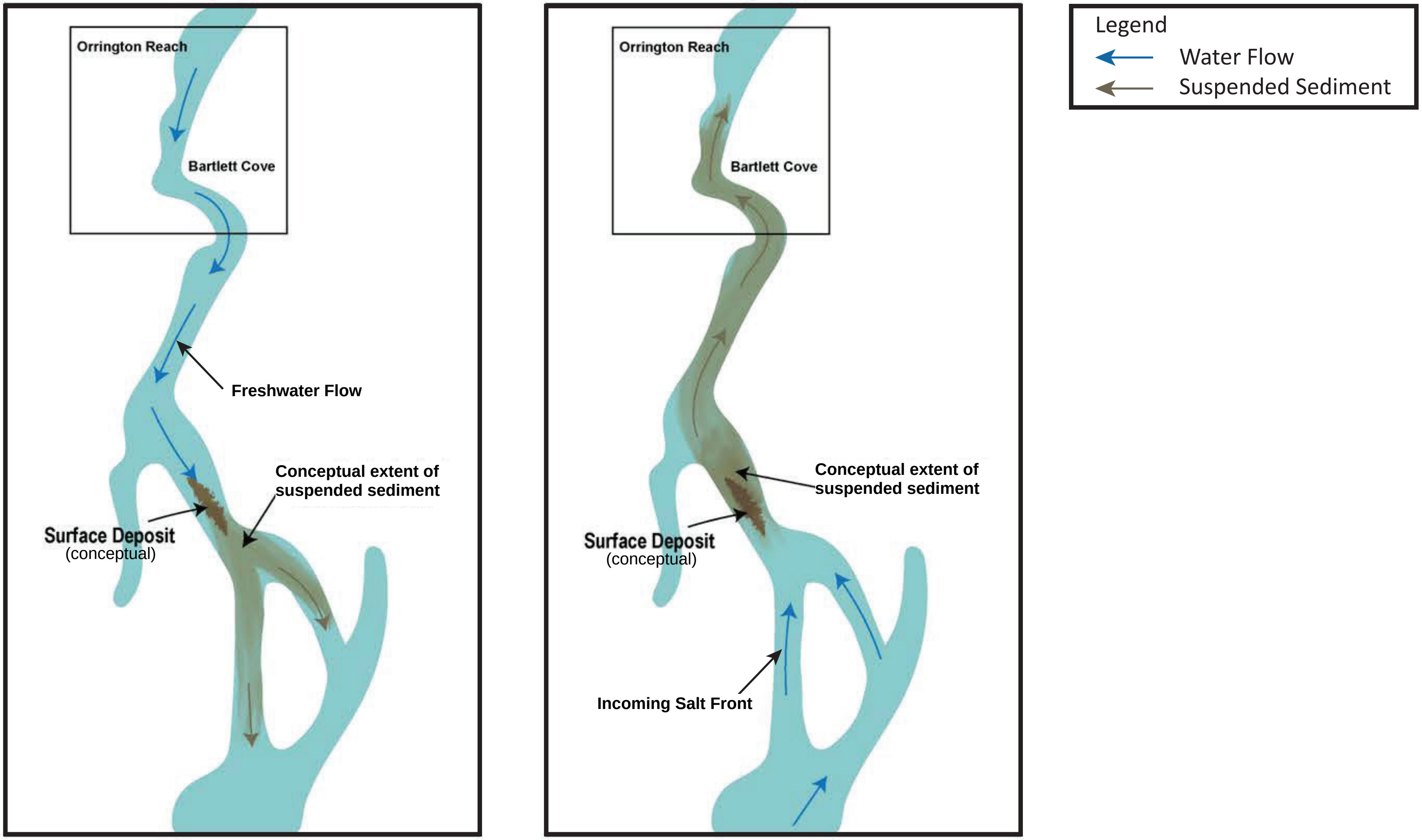


A. Mobile sediments (surface deposits) are pushed downriver during high flow periods, such as the freshet and heavy rainfall events.

B. Mobile sediments (surface deposits) are pushed upriver during low flow periods, when tidal flow up the system is most pronounced.

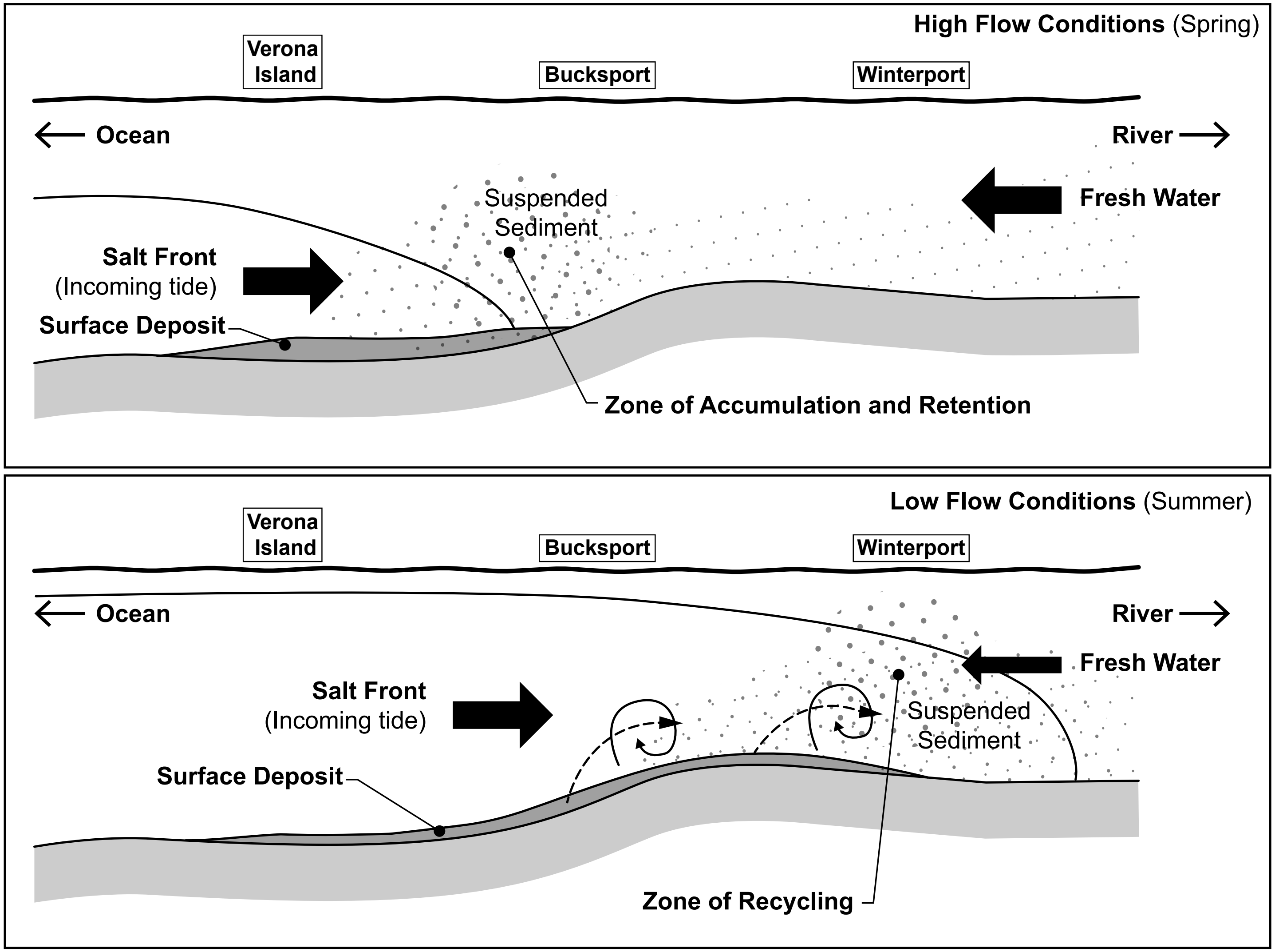
Adapted From: Figure 2, Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy, July 2023

Figure 3-1

CONCEPTUAL UNDERSTANDING OF SEDIMENT TRANSPORT

Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits,
Penobscot River Estuary, Maine

Jacobs



Modified from the Phase III Engineering Report (AFW 2018a) and Geyer and Ralston (2018)

Figure 3-2
Material Recycling in Estuaries
Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits,
Penobscot River Estuary, Maine

Jacobs

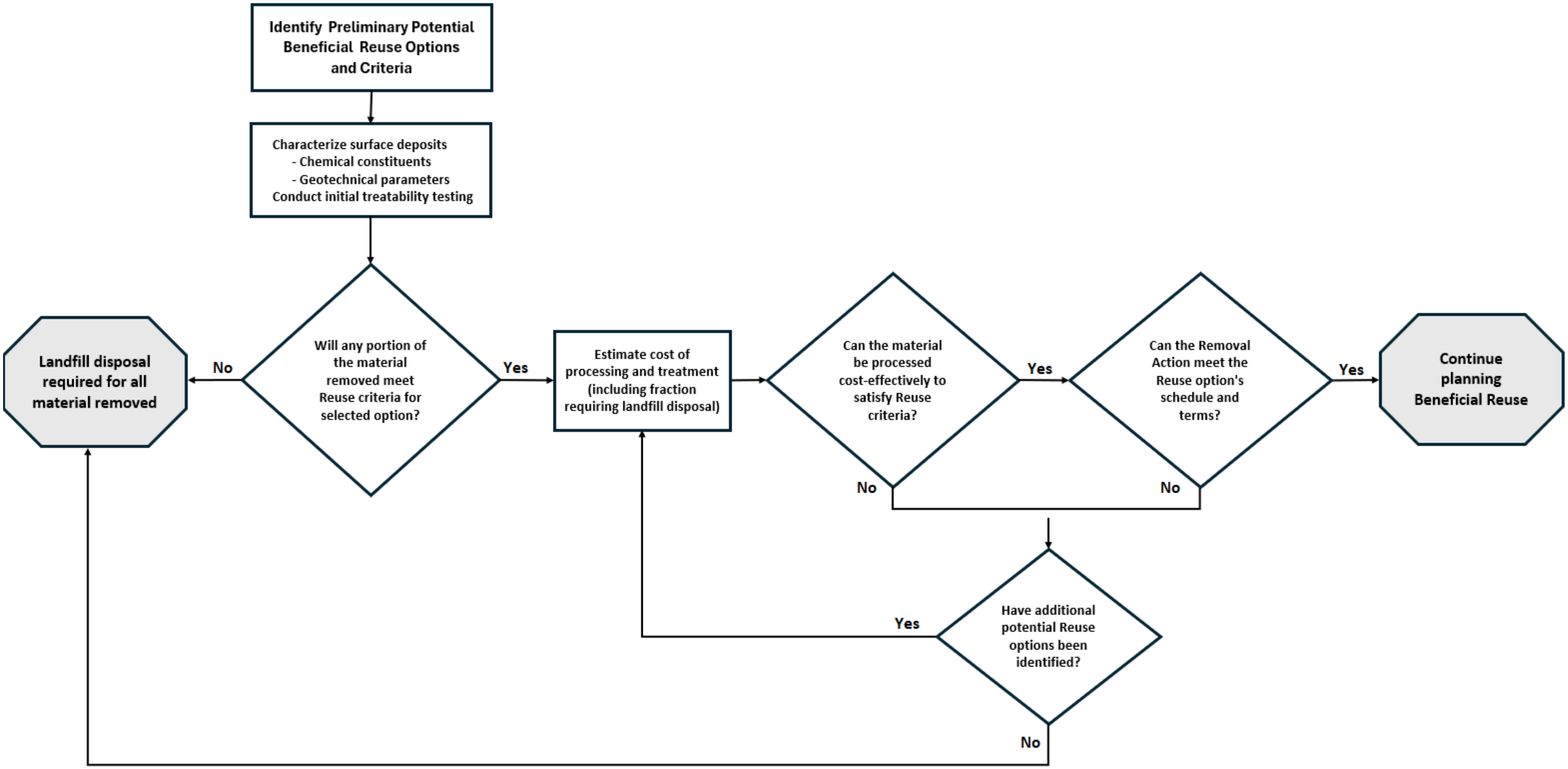
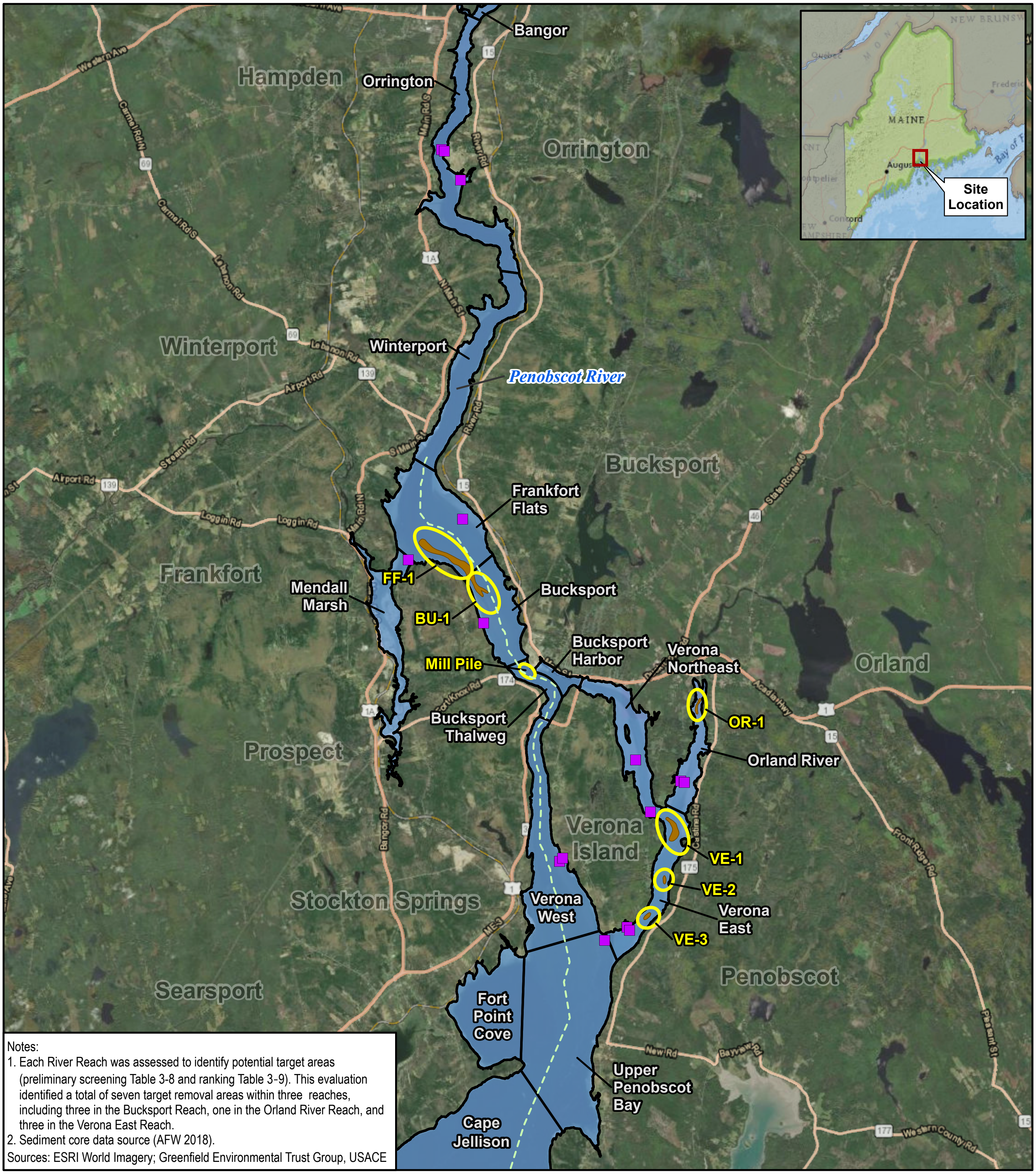


Figure 3-3
BENEFICIAL REUSE EVALUATION FLOWCHART
Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits,
Penobscot River Estuary, Maine

Jacobs



Notes:
1. Each River Reach was assessed to identify potential target areas (preliminary screening Table 3-8 and ranking Table 3-9). This evaluation identified a total of seven target removal areas within three reaches, including three in the Bucksport Reach, one in the Orland River Reach, and three in the Verona East Reach.
2. Sediment core data source (AFW 2018).

Sources: ESRI World Imagery; Greenfield Environmental Trust Group, USACE

LEGEND

- Sediment Core Location, Phase III Engineering Study (AFW 2018)
- USACE Waterway Network
- Preliminary Target Removal Area
- Surface Deposit Identified in Phase III Engineering Study (AFW 2018)
- Penobscot River
- Reach Boundaries Shown in Consent Decree Exhibit E

N

0 1.25 2.5
Approximate scale in miles

Figure 3-4
PRELIMINARY TARGET REMOVAL AREAS
Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits
Penobscot River Estuary, Maine

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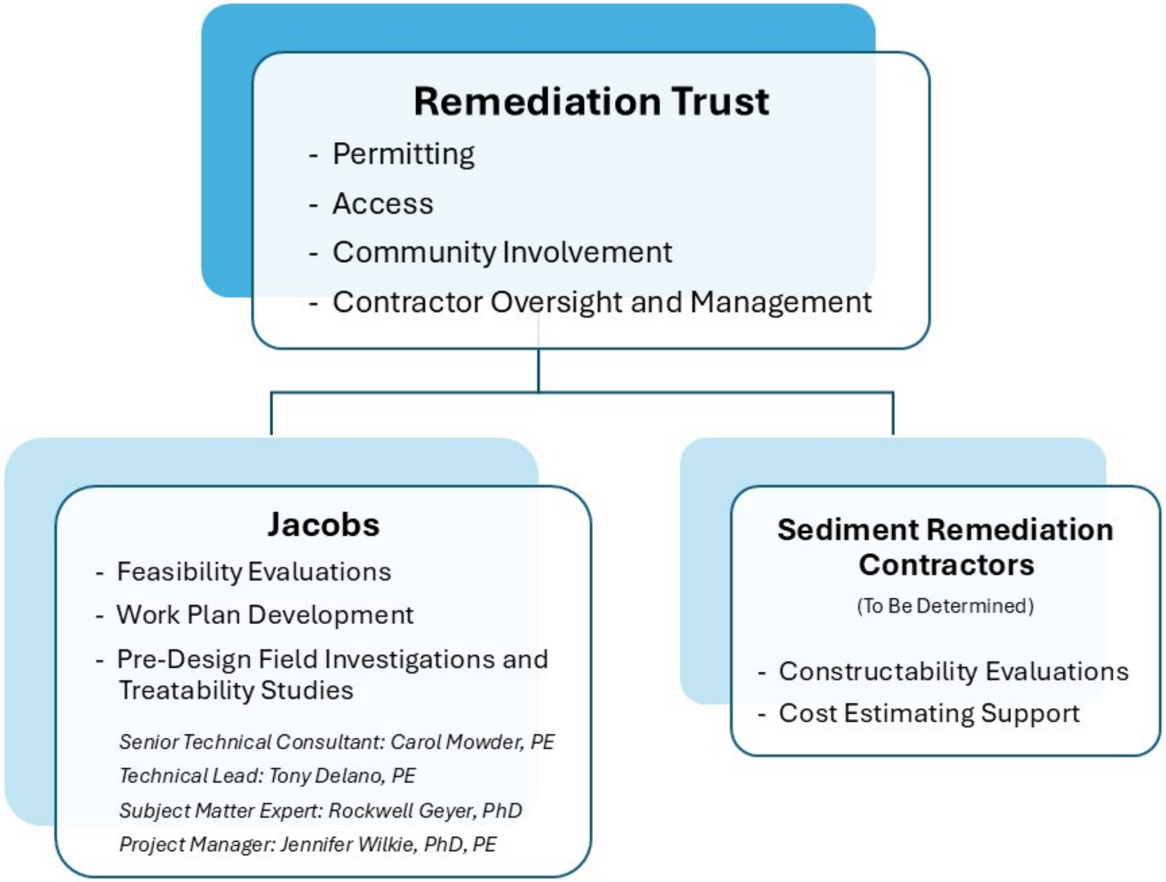

Figure 5-1
ORGANIZATIONAL CHART
Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits,
Penobscot River Estuary, Maine

Jacobs

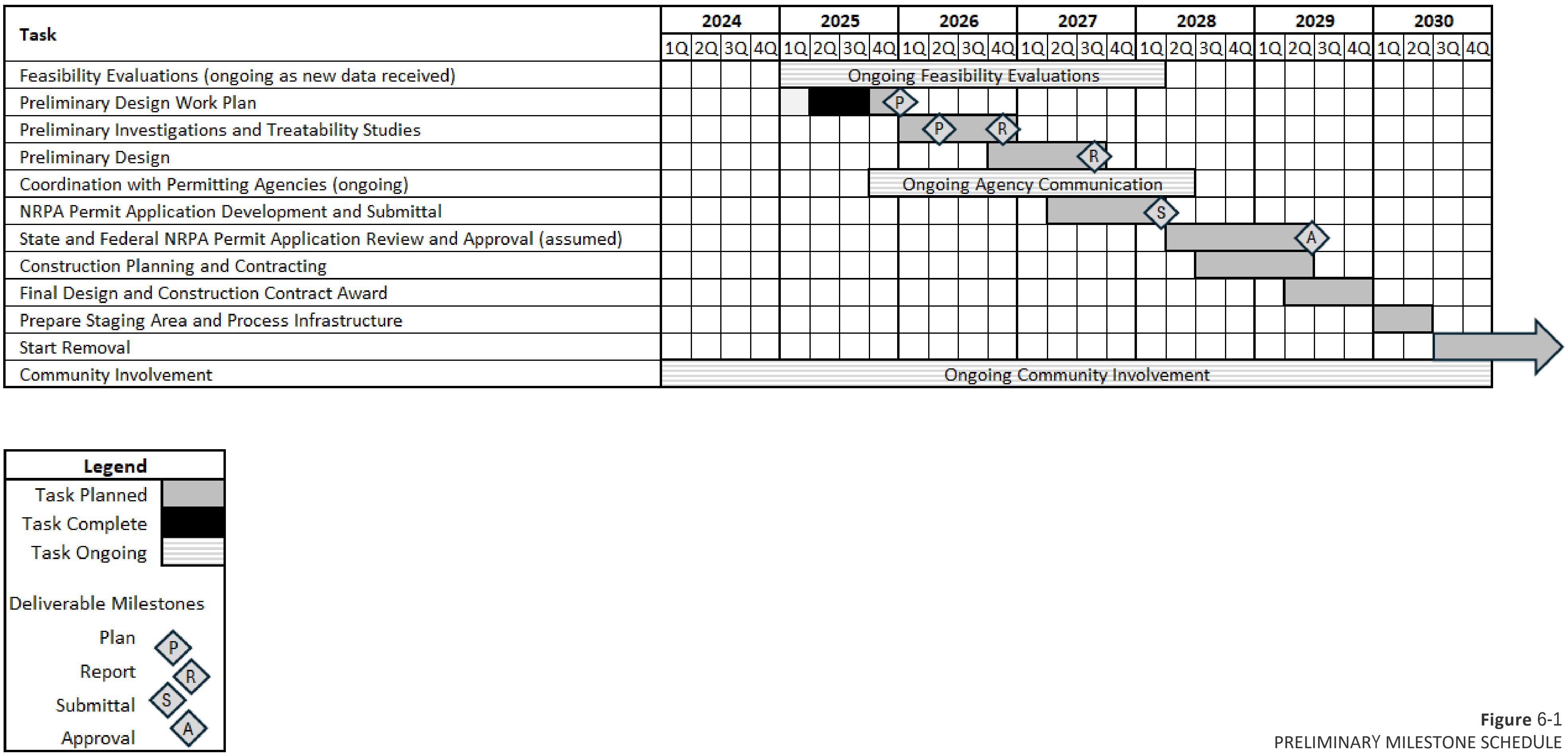

Figure 6-1
PRELIMINARY MILESTONE SCHEDULE
Preliminary Removal Action Design Work Plan
Mobile Sediments and Surface Deposits,
Penobscot River Estuary, Maine