Thin Layer Cap Design Work Plan

Orrington Reach Capping Remedy

Prepared for
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ACRONYMS AND ABBREVIATIONS

ADCP	acoustic Doppler current profiler
BOD	Basis of Design
bss	below sediment surface
CBE	cost/benefit evaluation
CSM	conceptual site model
D/B	design/build
D/B/B	design/bid/build
DEM	digital elevation model
DEP	Department of Environmental Protection
EPA	U.S. Environmental Protection Agency
EPC	engineer/procure/construct
ERP	emergency response plan
Estuary	Penobscot River Estuary
FSP	field sampling plan
Greenfield	Greenfield Penobscot Estuary Remediation Trust LLC
HASP	health and safety plan
Integral	Integral Consulting Inc.
ITRC	Interstate Technology and Regulatory Council
LiDAR	light detection and ranging
MBES	multibeam echosounder
MHW	mean high water
MLLW	mean lower-low water
NOAA	National Oceanic and Atmospheric Administration
NRDC	Natural Resources Defense Council, Inc.
NRPA	Natural Resources Protection Act
Pa	Pascal
PDI	pre-design investigation
QAPP	quality assurance project plan

RAO	remedial action objective
redox	reduction-oxidation
Remediation Trust	Penobscot Estuary Mercury Remediation Trust
SPI	sediment profile imaging
SWAC	surface weighted average concentration
TLC	thin layer cap
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WSP	WSP USA Environment & Infrastructure, Inc.

1 INTRODUCTION

This Thin Layer Cap (TLC) Design Work Plan (Design Work Plan) has been prepared by Integral Consulting Inc. (Integral) on behalf of the Greenfield Penobscot Estuary Remediation Trust LLC (Greenfield), Trustee of the Penobscot Estuary Mercury Remediation Trust (the Remediation Trust) for Work on the Penobscot River Estuary located in Hancock, Penobscot, and Waldo counties. This TLC Design Work Plan has been prepared in accordance with the Consent Decree[1] and appendices, including Paragraph 6(a) of the Statement of Work (Appendix A to the Consent Decree) and describes the technical scope, basis of design (BOD), design process, strategy for securing regulatory approvals, and Work schedule for the Orrington Reach Work Category.

As described in the Consent Decree, the Work in Orrington Reach will consist of capping approximately 130 acres of intertidal sediment, primarily on the east side of Orrington Reach. Orrington Reach is a portion of the Penobscot River immediately downstream of the former HoltraChem Facility in Orrington, Maine, as shown on Figure 1.

This TLC Design Work Plan provides the background for the Work; identifies the objectives, requirements, and preliminary design basis to be met by the Orrington Reach remediation work based on the currently available data/understanding; describes the project approach and identifies the data collection and analyses recommended to support the design; and includes a summary of the rationale for why the information is needed and a recommended scope of data collection and analyses for the investigations. As required by Paragraph 5 of the Statement of Work, this TLC Design Work Plan includes the following elements:

- A summary of existing conditions (Section 2.1) and Work objectives (Section 2.2)
- A BOD that identifies the objectives, requirements, and performance criteria to be met by the Work (Section 3.0)
- A description of the overall management strategy for performing the Work, including a proposal for phasing design and construction, if applicable (Section 4.1)
- A schedule for design activities (Section 4.2)
- A description of the proposed approach to contracting, construction, operation, maintenance, and monitoring of the remediation activities as necessary and applicable to implement the Work (Section 4.3)

[1] 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).

- A description of the roles, responsibilities, and authorities of all organizations/entities and key personnel responsible for development of the Work Design for a Work Category (Section 4.4)
- Descriptions of any areas requiring clarification and/or anticipated problems (e.g., data gaps, Site access issues, anticipated permitting issues) (Sections 5.0)
- Descriptions of any proposed investigations, pilot tests, or treatability studies required to complete the design (Section 5.1)
- Descriptions of any uncertainties or data gaps that are not anticipated to require clarification or further investigation (Section 5.5)
- Descriptions of applicable permitting and authorization requirements and other regulatory requirements, including the timeline for securing regulatory approvals and the Trustees' plans for meeting the applicable permitting and regulatory requirements during the Work Design process (Section 6.2)
- Descriptions of plans for obtaining any access rights or other public or private authorizations needed in connection with the Work, such as access agreements, property acquisition, property leases, and/or easements (Section 6.3)
- Preparation of a Health and Safety Plan (HASP), Emergency Response Plan (ERP), Field Sampling Plan (FSP), and Quality Assurance Project Plan (QAPP), both for any proposed investigations, pilot tests, or treatability studies and for the Work itself (Section 6.4).

2 BACKGROUND

This section provides a description of the Site and the objectives of the TLC remedial Work for Orrington Reach.

2.1 SITE DESCRIPTION

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. As described in the Phase III Engineering Report (Amec Foster Wheeler 2018a), the Penobscot River is the second largest river system in New England, draining a watershed of approximately 7,470 mi^2. The lower river is defined by the Penobscot River Estuary (hereafter referred to as the "Estuary"), which extends 22 miles from Bangor to the vicinity of Searsport, Maine. The surface area of the Estuary is approximately 35 mi^2.

The 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 m at Bangor, Maine. Typical of a coastal plain estuary, flow in the Penobscot River is small compared with the tidal prism under typical conditions. Because of the generally limited wave activity in the Estuary, tidal currents in the system make the Penobscot a tide-dominated estuary (Dalrymple et al. 1992). Typical of these systems are salt marshes and intertidal flats that accumulate sediment over time, as is seen in the Penobscot. 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 predominantly as a result of historical releases from the former chlor alkali plant that operated in Orrington, Maine, from 1967 to 2000. Extensive investigations have been completed to characterize the distribution of mercury in environmental media. Results of these investigations, summarized in the Phase III Engineering Report (Amec Foster Wheeler 2018a) and numerous other documents, indicate that the Estuary is recovering naturally, and total mercury concentrations are generally higher in subsurface sediment than in surface sediment. Further, the investigations to date show that total mercury concentrations in surface sediment are generally more elevated within the intertidal zone relative to the subtidal zone. Amec Foster Wheeler (2018a) concluded that the rate of recovery may be slowing due to the redistribution of mercury within the Estuary. As a result, total mercury concentrations remain elevated above levels considered protective of human health and the environment.

On October 11, 2022, a Consent Decree was approved by the Court, which identified the Work to be conducted within the Site, including the capping within Orrington Reach. The Consent Decree defines "Reaches" as portions or components of the Site subject to the remediation activities, which may be defined geographically (e.g., East Channel, Mendall Marsh, Orland River, and Orrington Reach; as shown on Figure 1) or based on hydrodynamic, geophysical, or other scientific bases (e.g., Mobile Sediments and Surface Deposits). Three Work Categories composed of Reaches are identified in the Consent Decree—meaning that funding has been specifically allocated in the Consent Decree to complete remedial activities for these Reaches, with the objective of reducing mercury exposures and accelerating the recovery of the Estuary. These Work Categories are summarized below:

- Orrington Reach: This is the area directly south (downstream) of the former HoltraChem facility in Orrington, Maine.
- Mobile Sediments and Surface Deposits: Mobile Sediments are defined as the 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. Surface Deposits are defined as any subtidal or intertidal region of Mobile Sediment accumulation, including any comingled materials or debris that can be identified by physical, chemical, geophysical, or other scientific methods.
- Orland River and East Channel around Verona Island: This is the area directly east of Verona Island and in the Orland River.

This TLC Design Work Plan focuses on Orrington Reach.

2.2 Work Objectives

The goals for remediation of the Penobscot Estuary are to reduce mercury exposures and to accelerate recovery of the Site.

The Consent Decree specifies the following design criteria for Orrington Reach:

- The remedy is a cap over intertidal sediment.
- The cap is to be placed over an area of 130 acres, primarily on the east side of the reach.
- The cap must be designed such that all related costs fit within the funds provided for the Orrington Reach Work Category by the Consent Decree:
  - Committed Funding of $50 million is provided to design, permit, implement and monitor the remedy.

- An additional $10 million in Contingent Funding is available if the cost of capping in Orrington Reach, including remedy-specific monitoring and maintenance, exceeds $50 million.

The total $60 million, referred to as Capped Funding, is a critical design parameter because the Consent Decree specifies that if the cost of the Work in Orrington Reach is projected to exceed $60 million, then the scope of the Work shall be altered to fit within the Capped Funding amount, taking into account the availability, if any, of Remaining Funding from other Work Categories.

The Consent Decree defines capping as "the placement of a covering or cap of clean material over contaminated sediment that is intended to remain in place in order to create a physical, biological, and/or chemical barrier between contaminated sediment and the water column." The Consent Decree does not specify the type of cap required or performance requirements for the cap. Further, although the Consent Decree states that the cap shall be placed primarily on the east side of Orrington Reach, it does not preclude addressing areas on the west side that could contribute significantly to the natural recovery of the Estuary.

3 BASIS OF DESIGN

This section presents the key factors that inform the preliminary BOD for the Orrington Reach sediment cap remedy. A summary of the elements of the current conceptual site model (CSM) that are most pertinent to the BOD are provided and form the basis for identification of remedial action objectives (RAOs) to guide the BOD for the sediment cap. The CSM and RAOs provide the foundation for the core design elements of the sediment cap, including capping area location and extent, capping material, capping thickness, constructability, and implementation.

3.1 CONCEPTUAL SITE MODEL

The extensive investigations and analyses completed at the Site support a strong understanding of physical, chemical, and biological processes that influence mercury within the Estuary. This understanding, as summarized in the CSM presented in the Phase III Engineering Report (Amec Foster Wheeler 2018a), is a foundational consideration to the design of the Orrington Reach sediment cap. Key elements of the CSM that pertain to the Orrington Reach sediment cap are summarized in Figures 2 and 3, and are described below.

3.1.1 Mercury Sources

Mercury was released to the Estuary from past operations at the former HoltraChem facility and, although the facility is no longer operational, a legacy of residual mercury remains in Estuary sediment. Mercury concentrations in surface sediment are naturally recovering, primarily due to deposition of cleaner sediment and burial of more heavily contaminated sediment.

Ongoing mercury sources were evaluated in the Phase II Penobscot River Mercury Study (The Penobscot River Mercury Study Panel 2013). Based on this study, the annual loading of total mercury to the upper Estuary of the Penobscot River was estimated to be about 57 kg/yr from all sources.[2] Of this total, 86% was estimated to have been contributed by inflow over Veazie Dam and about 9% by tributary inflows below Veazie Dam. Ongoing loadings from HoltraChem, from municipal sources, and by direct atmospheric deposition were estimated to have contributed 4%, 0.4%, and 0.5%, respectively. Based on this analysis and other lines of evidence, the Mercury Study concluded that annual inputs from the ongoing external sources are small compared to the large quantity of legacy mercury stored within the Estuary. However, external sources of mercury are an important consideration to evaluations of long-term recovery of the Estuary following implementation of the remedial Work under the

[2] It is noted that this analysis was conducted prior to the 2013 removal of the Veazie Dam. With its removal, the dam no longer limits tidal influences, and natural flow in the river was restored. The effect the dam removal may have had on the annual loading of total mercury to the upper Estuary has not been evaluated.

Consent Decree; as long-term surface sediment conditions will be influenced by the concentration of total mercury on particulates associated with these sources that accumulate in the Estuary.

3.1.2 Mobile Sediments and Surface Deposits

Large volumes of wood waste material (e.g., wood chips) are present in the Estuary that are believed to be a legacy of discharge to the river during historical wood industry operations within the watershed. Site investigations have identified large deposits of wood waste mixed with fine-grained mineral particulates that have accumulated on the sediment bed surface in localized areas of the river—most notably in the Bucksport, Frankfort Flats, and Verona East reaches (Figure 1). These deposits, termed "surface deposits," appear to be an enduring source of suspended wood waste and particulates to the mobile sediment pool (Figure 2, Panel a), discussed below. Owing to the high organic content of the wood waste, mercury is present at elevated concentrations in wood waste relative to the mineral sediment.

Mobile sediments are an important source of mercury redistribution in the Estuary. The mobile sediments are a pool of fine-grained sediment and wood waste that are persistently present in suspension in bottom waters of the river as a result of hydrodynamic circulation processes. The mobile sediment pool occurs near the landward limit of the salt wedge, where the stratification and convergence of flow created by the interaction of fresh water and salt water promotes the retention, accumulation, and recycling of fine-grained materials. The mobile sediment pool moves up- or downriver as the location of the salt wedge changes in response to changes in the balance of freshwater riverine flow to saltwater tidal flow (Figure 2, Panels b and c). The location of the mobile sediment pool can change on time scales ranging from days (e.g., due to large rainfall or tidal surge events), to weeks (e.g., in response to spring versus neap tides), to seasons (e.g., due to the spring freshet). During high riverine flow conditions, such as the freshet, the salt wedge and associated mobile sediment is pushed downriver. While under low riverine flow conditions, tidal flow pushes the salt wedge and mobile sediment upriver—extending to and beyond Orrington Reach.

Exchange of wood waste from the surface deposits to the mobile sediment pool and, in turn, migration of the mobile sediments up- and downriver, is believed to be a primary source of mercury redistribution to surface sediment in the Estuary—potentially including intertidal flat sediment in Orrington Reach (Figure 2, Panel d). The objective of the remedial Work specified for the Mobile Sediments and Surface Deposits is to remove mercury associated with these features and, in turn, reduce mercury redistribution in the system and accelerate natural recovery.

3.1.3 Mercury Bioaccumulation

Mercury, in both inorganic and organic (methylmercury) forms, enters the food web through direct ecological exposure to surface sediment and to particulates in the water column that interact with the sediment bed surface. The bioaccumulation of mercury, primarily as methylmercury, in the food web results in an unacceptable risk to wildlife in the Estuary and to humans that consume wildlife from the Estuary.

Elevated concentrations of mercury and methylmercury are present in riverbed sediment, including intertidal sediment in Orrington Reach. Generally, mercury concentrations are more elevated in intertidal surface sediment than subtidal surface sediment (Figure 3, Panel b). Mercury and methylmercury in surface sediment are exchanged to particulates in the surface water column as these particulates deposit to and interact with the surface of the sediment bed (Figure 2, Panel e). A thin layer (e.g., <0.5 cm) of unconsolidated particulates (the “fluff layer”) can form on the surface of the sediment bed during lower energy periods (e.g., neap tides). Mercury and methylmercury can be exchanged to the fluff layer particulates while the particulates are on the sediment bed, and the particulates can subsequently be resuspended to the water column during higher energy periods. This process, which is not an erosive process as there is not a net loss of bedded sediment, can be an important process influencing local redistribution and biouptake of mercury and methylmercury.

Mercury methylation is favored under sulfate reducing reduction-oxidation (redox) conditions, which typically occur near the sediment surface (Figure 3). As a result, methylmercury is often present at elevated concentration at locations where mercury is present at elevated concentration in surface sediment.

3.1.4 Estuary Hydrodynamics and Geomorphology

Understanding the hydrodynamic processes (e.g., river flows, tides) and their interactions provides the fundamental basis for characterizing transport in an estuary. Sediment entering the Estuary is transported by tidal and river circulation processes. The majority of the time, flow in the Penobscot River is dominated by tidal exchange, and tidally driven shear stress cycle is responsible for much of the resuspension, deposition, and eventual accumulation of sediment mass in regions of the Penobscot River. Increased velocities and resultant shear stresses occur at the sediment bed during the tidal flood and ebb, particularly in the channelized (subtidal) regions, which convey the higher tidal and river flow. Sediment in suspension under these conditions can be carried to the intertidal flats and marshes where velocities are lower and sediment deposition is favored.

Intertidal flats are geomorphic regions in the Estuary at elevations between the mean lower low water (MLLW) and mean high water (MHW) that are sheltered from higher river flow velocities and associated shear stresses that can lead to erosion (Figure 3). Large expanses of flats are present in coves at various points along the Penobscot River, including Orrington Reach, where the river geomorphology results in sheltered conditions that are broadly stable. These conditions are an ideal setting for placement of a cap, as flow velocities and associated shear stresses are unlikely to result in erosion of the cap. However, during the winter, large blocks of ice are reported to form in the Estuary and have been observed to scour the surface of the intertidal flats as they are moved by river flow and tidal processes. Movement of ice in intertidal regions has the potential to scour surface sediment in the intertidal flats, and thus is an important consideration to the cap design.

3.1.5 Natural Recovery

Site investigations, summarized in the Phase III Engineering Report (Amec Foster Wheeler 2018a) and numerous other documents, indicate that the Estuary is recovering naturally as cleaner sediment enters the Estuary and ultimately accumulates—most notably in the intertidal flats and marshes. Amec Foster Wheeler (2018a) estimated that, in the absence of remedial Work, natural recovery will take at least 45 years. This slow recovery rate reflects, among other factors, the relatively slow rate of sediment accumulation and the concentration of mercury on particulates depositing to the sediment bed (Figure 3).

The mercury concentration associated with future natural sediment accumulation will directly influence the concentration of mercury in surface sediment that can be achieved by natural recovery. Estimates of the mercury concentration in sediment moving into the upper Estuary from upstream sources prior to removal of Veazie Dam range from 240 ng/g estimated by the Penobscot River Mercury Study Panel (2013) to 400 ng/g estimated by Geyer and Ralston (2018). The concentration of mercury in accumulating sediment is also influenced by redistribution of mercury within the Estuary. As discussed in Section 3.1.2, exchange of wood waste from the surface deposits to the mobile sediment pool and, in turn, migration of the mobile sediments up- and downriver, is believed to be a primary source of mercury redistribution to surface sediment in the Estuary—potentially including intertidal sediment in Orrington Reach. Mercury redistribution associated with the mobile sediment pool and wood waste is hypothesized to be a primary factor contributing to total mercury in surface sediment in the Estuary remaining elevated above levels considered protective of human health and the environment (Figure 3). Evidence of these processes is seen in the intermittent deposition of wood waste on the surface of the flats and the integration of wood waste into bedded sediment seen in cores collected from the flats. Understanding this potential is therefore an important consideration to the cap design and in the evaluation of the timing of implementation of the Orrington Reach cap relative to the Mobile Sediments and Surface Deposit remediation Work.

Amec Foster Wheeler (2018d) reported sediment accumulation rates of 0.35 to 0.70 cm/yr for intertidal sediment within Orrington Reach, based on analysis of the vertical profile of radioisotopes cesium-137 and lead-210, and total mercury in sediment cores. Based on these rates, 0.14 to 0.28 in. of sediment is estimated to accumulate in the Orrington Reach intertidal sediment per year. This accumulated sediment will be mixed into the surface of the bedded sediment through bioturbation processes (the physical disturbance of a sediment bed by benthic organisms). Significant bioturbation occurring at depths of 4 to 6 in. is common in estuarine systems (Clarke et al. 2001). As a result, the cleaner particles that have recently accumulated on the sediment surface will be mixed with the existing more contaminated sediments, diluting the near-term influence of the clean particles on the surface sediment concentrations.

3.1.6 Capping of Orrington Reach Intertidal Sediment

As discussed in Section 2.2, the Consent Decree states that the remediation Work in the Orrington Reach shall be capping 130 acres of intertidal sediments, primarily on the east side of the Orrington Reach, to enhance natural recovery of the Estuary. The Consent Decree does not specify the type of cap required or the performance requirements for the cap.

Two types of caps are typically used to remediate contaminated sediment: isolation caps and TLCs. An isolation cap is a thick (typically 3 ft or greater) section of clean material that may have more than one layer and material. Isolation caps are designed to be a permanent feature that physically and/or chemically isolates contamination in underlying native sediments from the surface to prevent exposure to people and the environment, and minimize the potential for contaminant redistribution.

A TLC is a thinner layer (e.g., 2 to 6 in.) of clean material placed on the sediment surface to:

- Accelerate natural recovery by introducing clean sediment more rapidly than can be achieved through natural accumulation processes.
- Creating a layer of sediment with lower mercury concentrations on the intertidal flat surface, thereby reducing the potential for methylmercury production, exposure, and biouptake.

Generally, the design of a TLC will seek to maximize effectiveness by placing clean materials in locations where contaminant concentrations in surface sediment are greatest and where there is minimal potential for movement of the cap material (e.g., through erosion or scour). The Orrington Reach intertidal flats are an ideal setting for TLC placement, as these areas have elevated total mercury concentrations in surface sediment and are protected from high river velocities that can lead to TLC erosion. Placement of a 2 to 6 in. thick TLC of clean material in the intertidal flat is equivalent to 10 to 30 years of natural sediment deposition based on the average rate of sediment accumulation measured in the Orrington Reach intertidal flats.

Unlike an isolation cap, which is designed to permanently isolate contaminated sediment, some degree of movement of the TLC material (e.g., through erosion or ice scour) can occur while still meeting the primary objectives of reducing exposure and accelerating natural recovery. Although processes such as ice scour may lead to movement of portions of the TLC materials, the vast majority of these materials will accumulate within other areas of the Estuary—resulting in lower total mercury concentrations in surface sediment in these areas and indirectly supporting overall natural recovery of the Estuary. Depending on the scale of any such TLC movement, the TLC would continue to provide a benefit to the River.

Implementation of all active sediment remediation technologies can disrupt the environment and ecosystems. Both an isolation cap and TLC bury the habitat of the benthic community in the intertidal sediment being capped and both types of caps have the potential to increase flood risk. Although an isolation cap provides a more stable exposure barrier over contaminated sediment, it is thicker and the impacts to the benthic community and to flood risk are more significant and longer lasting than a TLC. The increase in elevation associated with an isolation cap would substantially reduce, and in some areas eliminate, tidal flooding—altering the habitat function and reducing natural sediment and nutrient inputs to the area associated with tidal processes.

Impacts to the benthic habitat and to flood risks are substantially less for a TLC because of the relatively small change a TLC would have on the elevation of the capped area. The TLC area would largely remain intertidal, and tidal flooding would continue to deliver native sediment and nutrients to the capped area. Experience at similar sites is that native sediment quickly accumulates in areas where a TLC has been placed (particularly when the TLC consists of sand), and that the native benthic communities are reestablished within approximately 2 years (Environ and Anchor 2014; Herrenkohl et al. 2006; Integral 2017). Based on these and other considerations, a TLC is proposed as the capping remedy for Orrington Reach.

TLCs are typically constructed using clean sediment, sand, and/or amendments depending on borrow material availability and on the nature of the underlying sediment and the contaminants that are being capped. The cap material and the thickness of the TLC will be determined during design based on site-specific conditions and borrow material availability and will be optimized to provide risk reduction while minimizing impacts to habitat due to elevation changes and burial of benthic organisms.

3.2 REMEDIAL ACTION OBJECTIVES

The overall goal for the remediation measures set forward in the Consent Decree is to accelerate recovery of the Site. The remediation must consider as paramount the interests of the Estuary, including the river itself, its flora and fauna, and its nearby inhabitants.

The Consent Decree identifies capping of 130 acres of intertidal sediment in Orrington Reach as one of the Work Categories to support achieving these goals by placing a cap of clean material over contaminated sediment to create a physical, biological, and/or chemical barrier between contaminated sediment and the water column. Sediment capping is a well understood and commonly utilized technology for the remediation of impacted sediments and is recognized by multiple regulatory agencies and interest groups, such as the U.S. Environmental Protection Agency (EPA) and the Interstate Technology and Regulatory Council (ITRC).

RAOs have been developed for the Orrington Reach sediment cap remedy to maximize the environmental benefits created with the finite Trust funds and achieve the overall remediation goal for the Estuary. The following RAOs consider the CSM[3] presented in Section 3.1 and provide the foundation for the key design elements presented in Section 3.3:

- Accelerate natural recovery of surface sediment by placing a layer of clean material at the surface of the intertidal sediment and targeting expansive flats that have the highest mercury concentrations in surface sediment.
- Reduce mercury concentrations in intertidal flat surface sediments.
- Reduce the risk to human health and the environment from mercury.
- Maximize the area for capping within the Committed Funding.
- Minimize mixing of contaminated sediments with clean materials in the cap layer resulting from bioturbation.
- Reduce the potential for methylmercury production, exposure, and biouptake by placing clean material on the sediment surface and reducing the concentration of mercury that is available for methylation in surface sediment.
- Minimize the recovery period for the benthic community following TLC placement.
- Reduce potential mercury redistribution from contaminated intertidal sediment to surface water and, in turn, other areas of the Estuary by providing cover and erosion protection sufficient to reduce resuspension and remobilization of contaminants into the water column.

3.3 KEY DESIGN ELEMENTS

This section presents the core elements of the sediment cap design, including the capping area location and extent, capping material, and capping thickness. This section considers the currently available data and analyses completed to date, and identifies the data collection and analysis activities necessary to finalize the BOD and complete the design. Table 1 summarizes the preliminary BOD and the additional data analyses needed to finalize the BOD, and includes cross references to specific locations in this TLC Design Work Plan where the recommended approach and/or scope of data collection and analyses are discussed.

[3] The Phase III Engineering Report (Amec Foster Wheeler 2018a) referred to the CSM as the "conceptual site understanding."

3.3.1 Capping Area Location and Extent

A primary design parameter for the Orrington Reach sediment capping remediation Work is establishing the location and extent of the area to be capped. Although the Consent Decree specifies that the remediation Work for Orrington Reach consist of capping of a total of 130 acres of intertidal sediment primarily on the east side of Orrington Reach, it does not identify the specific location(s) of the intertidal sediment to be capped. Intertidal sediments are present on flats as non-vegetated areas that are flooded when tides rise and become exposed as tides fall.

Determination of the location and extent of the capping area will be based on multiple factors, including, but not necessarily limited to, the following:

- **Total Area:** The total capping area is 130 acres, if Feasible and within the Capped Funding. The Consent Decree specifies that the capped area will be primarily on the east side of Orrington Reach, but does not preclude evaluation of potentially significant areas on the west side of Orrington Reach (e.g., Bald Hill Cove).
- **Geomorphology:** The capped area will consist of intertidal sediment, which, for the purposes of this BOD, is defined as sediment that is at an elevation between the MLLW and MHW elevations. Intertidal flats meet this requirement and will be preferentially targeted for the capping design. These areas represent large expanses of stable sediment, are broadly depositional, and are characterized by shallow slopes upon which a TLC is less likely to be eroded. Further, the intertidal flats are areas with relatively elevated mercury concentrations in surface sediment. The intertidal zone also encompasses the fringing marshes within Orrington Reach. Generally, these areas are less preferred for capping, as placement of a cap in marsh areas has the potential to adversely impact the marsh ecology.[4]
- **Ice Scour:** Ice formation in the Estuary can lead to localized scour of surface sediment along the intertidal flats during the winter months. Such events have the potential to scour away the TLC materials, thereby reducing the TLC effectiveness. Therefore, understanding the extent and magnitude of ice scour in the areas proposed for TLC is an important consideration to the design.
- **Total Mercury Concentration:** The capping area will be selected to reduce the surface weighted average concentration (SWAC) for total mercury in surface sediment across Orrington Reach to as low as practical while remaining within the confines of the Consent Decree's budgetary restrictions.

[4] Natural recovery of marsh areas can be enhanced through the placement of a 2 to 3 in. layer of clean material to reduce contaminant concentrations at the marsh surface and to enhance naturally occurring recovery of marsh sediment.

- **Property Access:** In the state of Maine, property ownership for parcels abutting a river typically include the intertidal zones adjacent to the property. As such, property access and permission to place the capping material is expected to be required from each property owner for parcels that include or abut the area to be capped.

3.3.1.1 Design Basis

The following summarizes the preliminary BOD that has been developed based on the above considerations.

Parameter	Basis	Considerations
Total Area to be Capped	130 Acres	Stipulated in the Consent Decree
Elevation Range of Sediment to Be Capped	Intertidal zone defined as elevations between the MLLW and MHW lines (6.69 to −7.04 ft mean sea level)[5]	Intertidal sediment as stipulated in the Consent Decree
Cap Stability	Physical stability of cap	Place the cap in intertidal flats areas where erosion potential is low and design the cap material to be remain in place for up to a 100-year storm event (see Section 5.1.3.1). Cap material has the potential to be unstable at slopes greater than 3H:1V or 33% grade. Place the cap in areas where potential ice scour has been observed to be limited and/or include provisions (e.g., armoring) to minimize impacts of ice scour on the TLC.
Total Mercury Concentration	Reduce total mercury concentration to as low as practicable	Cap areas of highest concentration (to the extent Feasible)
Property Access	Written permission to access the properties, place the cap and monitor performance over time	Permission required by each property owner to place cap

3.3.2 Capping Material

The design will identify an appropriate grain size for the capping material to both resist significant erosional stresses and minimize transport of mercury contamination from

[5] Tidal datum from NOAA Station 8414612 in Bangor, Maine (https://tidesandcurrents.noaa.gov/datums.html?id=8414612)

underlying sediment into and through the cap. The design of the capping material will consider multiple factors, including, but not limited to the following:

- **Cap Stability:** The nominal diameter of the capping material needs to be properly sized to be sufficiently stable under the range of anticipated future conditions to meet the design objectives. The design of the cap material sizing requirements and the need for armoring will be evaluated based on shear stresses predicted to act on the cap materials estimated from model simulations under typical conditions and a design storm event. A 100-year frequency flood event will be used as the design storm. In addition, the design will include and evaluate the potential influence of prop scour, wind and wave effects, and climate change on the cap stability, including the effects of sea level rise and increased frequency and intensity of large storm events.
- **Borrow Material:** Selection of the final capping material will depend on the characteristics of material available in sufficient quantity from borrow sources in the area. The final selection will weigh the costs/benefits of materials that may be available from more distant sources and will evaluate the methodology of transport of material to the capping locations.
- **Compatibility with Underlying Sediment:** Fine-grained contaminated sediment has the potential to intermix into the cap materials during placement and as the capped area settles under the weight of the newly placed material. If there is a pronounced difference in the grain size of the cap materials and the underlying sediment, mercury-contaminated sediment can migrate into the clean cap materials. The capping design will consider the geotechnical properties of the existing sediment to evaluate the potential for migration of mercury and establish the cap material composition necessary to minimize this potential migration and to provide a suitable substrate for recolonization of the benthic community.
- **Potential Effects on Benthic Community:** Placement of cap material on the underlying sediment will cause an immediate, yet temporary, impact on the sediment benthic community. If the cap material is significantly different from the underlying sediment, the benthic community may take longer to reestablish itself.
- **Potential Benefit-to-Cost of Amendments:** Amendments such as granular activated carbon can be used to enhance TLC effectiveness by reducing mercury bioavailability and/or increasing the TLC stability. Use of amendments significantly increases the costs of TLC and is likely to limit the area that can be capped within the Committed Funding available for Orrington Reach. The design will include a desktop evaluation that weighs the potential benefits of including amendments in the TLC against the estimated additional costs.
- **Placement Considerations:** The design of the cap material will need to be consistent with the method or methods that will be used for cap placement. For example,

placement of too fine-grained of materials may not be conducive to placement "in the wet," as these materials can become readily suspended in the water column during placement. The placement methods will be evaluated as part of the design and will consider factors such as access restrictions from uplands and limitations associated with the tides. As discussed in Section 4.1, it is recommended that the construction be phased and the first construction season will be a "pilot phase" of the proposed capping placement method(s), once identified, be considered.

3.3.2.1 Design Basis

The following summarizes the BOD identified to date for the capping material selection.

Parameter	Basis	Considerations
Cap Stability	Physical stability for a 100-year storm event	Select grain size and/or armoring for a "no movement" condition under a modeled 100-year storm event
Compatibility with Underlying Sediment	Minimize intermixing of underlying sediments into clean cap material	Maximum size ratio of 5:1 between the smallest (<15%) particles of the cap media and the largest (>85%) particles of the sediment layer (Palermo et al. 1996)
	Minimize duration for recolonization of the benthic community	To the extent practicable, select material to be similar to the underlying sediment to mimic existing benthic habitat
Borrow Material Availability	Sufficient material to implement capping	More than 100,000 CY of capping material is likely necessary; identify material availability and transport factors

3.3.3 Cap Thickness

The design of the capping material will consider multiple factors, including, but not limited to the following:

- **Minimal Protective Thickness:** This criterion is based on the anticipated extent of bioturbation and potential upward migration of mercury from the underlying sediment. Although a TLC is not intended to isolate the underlying sediment, an appropriately designed TLC thickness limits sediment breakthrough to surface sediment, thereby limiting direct impacts of contamination to the benthic organisms and uptake of contamination into the food web, and reducing contaminant transport caused by bioturbation and physical transport mechanisms, such as advection, dispersion, and diffusion. In addition, the cap will be of sufficient thickness to ensure that the peak mercury concentrations in sediment are at a depth that is below the redox potential depth, where formation of methylmercury is favored.

- **Destabilization of Underlying Sediment and Adjacent Slopes:** The overburden of the cap materials will compress the underlying sediment and can potentially result in the lateral movement of sediment at the edges of the cap (i.e., mud wave formation) as the capping material is placed. Mud waves can form when the sediment underlying the cap is soft and is characterized by low shear strength. Slope stability in areas where capping and armoring material is placed may be compromised because of the additional material. The potential for compression and movement of the existing sediment during the placement of the cap will depend on the thickness and composition of the cap material, and the geotechnical properties of the existing sediment.
- **Minimize Volume of Fill:** Capping will involve the placement of net fill in the intertidal zone, and the potential effects on intertidal benthic habitat and flood risk will be evaluated by the agencies responsible for the permitting process. By minimizing the thickness of the TLC, the TLC design will limit the duration of impact that placement of clean materials will have on the existing benthic community in the intertidal flat sediment. Placement of clean material in the intertidal flats has potential shoreline effects, including flood risks, associated with the change in flood storage of the river system. A TLC reduces the thickness and volume of material being placed over the intertidal flats when compared to an isolation cap. As such, the cap will be designed to minimize the cap thickness and associated volume of fill placement, while meeting the objectives identified in Section 3.2.

3.3.3.1 Design Basis

The following summarizes BOD elements that have been identified to date that will inform the design of the capping material thickness.

Parameter	Basis	Considerations
Provide Minimum Protective Thickness	Limit migration of mercury into and through the cap material through bioturbation and physical transport mechanisms, such as advection, dispersion, and diffusion	Previous investigations concluded the bioactive zone of the Estuary is at a thickness of 0–6 in. (Amec Foster Wheeler 2018a)
	Place sufficient thickness of clean cap material to bury peak mercury concentrations below the redox zone where methylation is greatest	Evaluation of the sediment redox potential depth
Prevent Destabilization of Underlying Sediment	Minimize mud wave formation during cap placement	Evaluation of sediment geotechnical properties, including shear strength
Minimize Volume of Fill	Minimize potential impacts to intertidal habitat, flood risk, and potential need for mitigation by minimizing the volume of fill	Hydrodynamic modeling to evaluate the influence of cap placement on water depths and inundation frequency of intertidal flats and marshes, and on flood risk of intertidal and upland areas
		Acceptable fill quantities (area, volume, thickness) and potential mitigation requirements will be established through negotiation with permitting agencies

3.3.4 Cap Placement

Additional data collection is recommended to provide important information on the viability of methods for placing cap material. This is an important consideration to the cap design and implementation cost. The feasibility and methods of material placement will be significantly influenced by the access considerations, including:

- The majority of upland areas adjacent to the intertidal flats in Orrington Reach are privately owned, undeveloped, and often consist of steep topography. As a result, it is not practical to use land-based equipment to place the cap, with a few potential minor exceptions.
- Several of the intertidal flats in Orrington Reach occur over a broad area that can extend as much as 1,200 ft from the subtidal area and are likely to be outside of the reach of vessel-based equipment during low tide. Placement of the cap in these areas will likely require floating in equipment when the flats are submerged by the tide.

One method of cap placement considered is using a telebelt system, which would allow for control of the thickness of cap placement and would provide for a reasonable reach. The cap material may be placed "in the dry" (i.e., when the area to be capped is not submerged), "in the wet" (i.e., when the area to be capped is submerged), or a combination of both of these conditions depending on the equipment identified to place the cap and an evaluation of the tidal conditions (e.g., the average duration and depth of tidal flooding). Selection of the cap placement approach will be established based on equipment available from potential contractors in the region, any limitations placed on the approach based on the permitting process, the required cap material and thickness, and other factors.

The selection of the cap placement approach will also consider the location and availability of landside areas to support the TLC implementation. Different cap placement methodologies have varying landside requirements, including staging areas, processing areas, material and equipment storage areas, and personnel facilities. The TLC design will factor in the availability, size, and accessibility of potential landside areas to meet these requirements.

As part of an adaptive management approach to the design and permitting of the TLC, the Remediation Trust is considering phasing construction to monitor the first capped areas and determine whether the design needs to be modified to better meet project objectives in future construction seasons. Information collected through construction monitoring will be used to:

- Evaluate the selected cap placement technology
- Evaluate impacts to intertidal habitat and recolonization of benthic organisms
- Observe the effects of ice scour
- Sequence the cap placement in a manner that reduces the magnitude of impacts to the intertidal habitats and to flood risk at any given time.

3.3.5 Post-Capping Conditions

Orrington Reach intertidal flats are net depositional areas and natural sediment deposition is expected to continue on top of the TLC. As a result, conditions in the capped area will be strongly influenced by the sediment that has accumulated on the cap over time, as exemplified below:

- Long-term mercury concentrations in the capped area will be dictated by the mercury concentration in sediment depositing to the cap. As described in the current CSM (Section 3.1), mercury concentrations in surface sediment are influenced by a number of processes that may contribute to the redistribution of mercury within the Estuary and that have the potential to re-contaminate the surface of the capped area (Figure 3). Removal of mercury associated with the mobile sediment and surface deposits is required by the Consent Decree to reduce mercury redistribution within the Estuary and accelerate long-term natural recovery of surface sediment, including sediment that will accumulate over time on the Orrington Reach TLC.

- The potential for mercury methylation and, in turn, bioaccumulation within the food web is strongly influenced by the redox conditions in surface sediment. The cap material composition (e.g., grain size, organic matter content) will differ from the native sediment, and, as a result, placement of the cap will alter redox conditions in near-surface sediment (Figure 3). Over time, the composition of surface sediment and the associated redox conditions in the capped area will progress back toward the natural condition.
- Placement of the TLC will bury the native sediment and benthic habitat of the intertidal flats. As natural sediment deposits to and accumulates on/in the TLC, the composition of the surface sediment will progress back to its natural condition and the benthic community is expected to reestablish.

The recommended scope of additional data collection to evaluate the post-capping conditions is presented in Section 5.1.4.2.

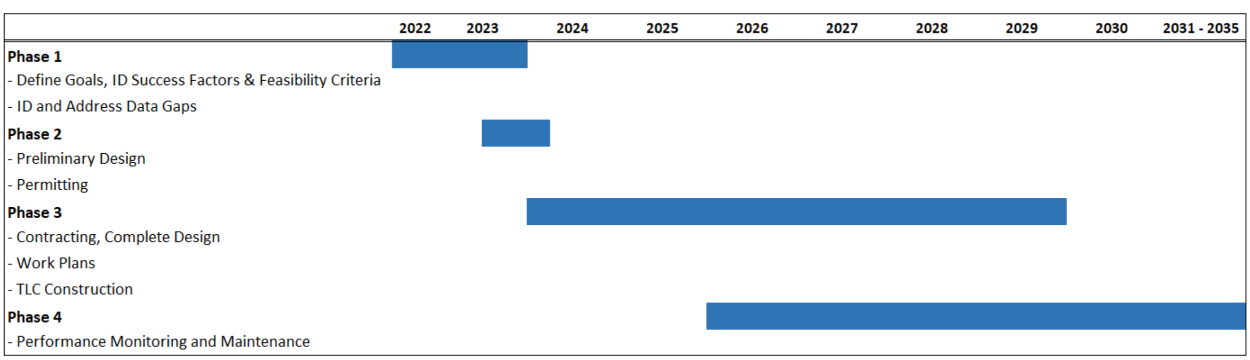
4 PROJECT APPROACH

In order to meet the terms of the Consent Decree and satisfy the Work objectives identified above, this section provides a description of the overall management strategy for performing the Work.

4.1 OVERALL MANAGEMENT STRATEGY

Greenfield's overall management strategy for remediation of the Estuary, including the Orrington Reach TLC, incorporates adaptive management principles into the strategic planning process. The Remediation Trust's strategic planning process has developed management plans that i) focus on desired outcomes to establish clear purpose and context for all tasks; ii) integrate technical, regulatory, financial, and stakeholder goals; iii) identify critical success factors early in the process; iv) minimize unexpected outcomes; and v) identify options for efficient, cost-effective delivery. The Remediation Trust's strategy uses an adaptive management approach to closely monitor results, incorporate new information as it is developed, and adapt or adjust designs, future work plans, and actions based on observed results to achieve an optimal final outcome. Adaptive management is an effective process for implementing remedial actions while dealing with the uncertainties associated with the Estuary's complex and dynamic ecosystem.

As part of the Remediation Trust's adaptive management framework, the Orrington Reach TLC Work will be performed in phases. Each phase will build on information developed by previous tasks, with strategies and plans adjusted as needed with consideration to new information. Work phases will be scheduled with overlap to prioritize activities on elements with long lead times, allow complementary tasks to proceed in parallel, and expedite delivery timeframes. This framework is illustrated in the following graphic and described in the sections below.



4.1.1 Phase I

Phase I started with strategic planning in late 2022 and is scheduled to run through 2023. Phase I efforts will i) identify goals for the Orrington Reach TLC; ii) identify critical success factors and feasibility criteria; iii) review the current CSM to identify key data gaps; and iv) identify the information needed to address data gaps, complete the TLC design, and start the permit application process.

The overall goal for implementation of the TLC, and the other Work set forth in the Consent Decree, is to accelerate the recovery of the Site. Specific goals for the Orrington Reach TLC are reflected in the RAOs described in Section 3.2 of this TLC Design Work Plan.

Critical success factors for TLC implementation are those factors that determine feasibility and the public support for remedial actions. Key factors expected to inform feasibility include i) the need for access to up to 100 separately owned parcels; ii) receipt of permits and permit conditions; iii) regulatory and weather-related constraints on the time periods work can be performed on the river; iv) the ability to complete implementation within the Committed Funding amount specified in the Consent Decree (and if required the Contingent Funding amount); and v) community support for the Work. Plans to define and manage these feasibility criteria integrate technical, regulatory, and community involvement considerations and include the following:

- Access permissions from all landowners whose property is adjacent to the intertidal flats will be a primary factor in determining TLC feasibility. Preliminary design efforts have identified the parcels and landowners whose properties are adjacent to areas to be capped, as well as parcels in alternate areas that could meet project objectives should access to the primary areas be denied. The Remediation Trust started meeting with elected officials and residents in the towns of Orrington, Bucksport, and Winterport early in 2023 to discuss sampling and TLC construction work requiring access, and seek written agreements from landowners.
- The Permitting Plan presented in Appendix A identified multiple federal, state, and local permits required to construct the TLC, key permit conditions that will determine the feasibility of TLC implementation, and actions to address potential issues. Key permit conditions that could determine feasibility of the TLC, including i) the potential requirement to first dredge ±130 acres of intertidal flats prior to placement of the TLC to avoid increasing the elevation of intertidal areas; ii) potential mitigation requirements; and iii) constraints imposed on in-water work windows by regulatory requirements to protect fish habitat, which limit certain types of work in the river to the period between November and April. The permitting strategy includes regular communication with local, state, and federal regulatory agencies. Meetings will be held with Maine DEP, Maine Department of Inland Fisheries & Wildlife, Maine Department of Marine Resources, the U.S. Army Corps of Engineers (USACE), and other key agencies to

provide information on the project, confirm requirements, understand regulatory decision factors, and identify opportunities for coordination throughout the permitting process.

- The Remediation Trust is working with Maine DEP to establish an Adaptive Management Team, comprised of members from key permitting agencies, and to foster communications and a collaborative approach to TLC permitting.

Existing information obtained during the Phase I and II Studies and the Phase III Engineering Study has been used to develop the current CSM presented in Section 3.1 and identify key data gaps.

Investigation work plans are being prepared in parallel with this TLC Design Work Plan in order to perform pre-design investigation (PDI) fieldwork in 2023. As described further in Section 5, investigations will provide data to be used to update and refine the understanding of Site conditions, update the hydrodynamic model, define areas to be capped, and develop information needed to complete the Natural Resources Protection Act (NRPA) Permit application (and other permits).

4.1.2 Phase II

Phase II will start in mid-2023 and continue into 2024. Phase II will include development of the preliminary TLC design, preparation and submittal of the NRPA permit and other key permit applications, and will include engaging with permitting agencies in regular Adaptive Management Team meetings during the application review period.

Preliminary design of the TLC will present the level of detail needed to support initial discussions with Maine DEP, USACE, and other agencies. The 60% design will incorporate the updated information from the PDI and associated design evaluation and will provide sufficient detail to support the NRPA permit application process, update cost estimates, and to perform a constructability review. The tasks necessary to complete the NRPA permit application are identified in Appendix A and include securing all necessary access agreements, investigations to update information on site conditions, and wetlands delineation. As the permit applicant, the Remediation Trust will communicate with Maine DEP, USACE, and other agencies during the permit application process to ensure the application includes the information necessary to support agency decisions. Communications with permitting agencies will continue during the permit review and comment period to ensure timely response to potential agency questions.

The Remediation Trust is also planning to evaluate construction delivery methods and interview potential construction contractors during Phase II. Greenfield has used several different contracting models for delivery of remedial construction in connection with other trust appointments and will consider traditional design/bid/build (D/B/B), design/build (D/B), and engineer/procure/construct (EPC) methods. Considerations will include available information about potential permit requirements, access, and design elements, and comparison of the cost, schedule, and risk management strategies associated with each delivery method. The Remediation Trust will develop a list of pre-qualified contractors for consideration by seeking information and potentially proposals from qualified contractors with experience in the successful delivery of similar sediment remediation projects. Based on an evaluation of prospective contractor qualifications and initial information about each contractor's approach to TLC implementation, the Remediation Trust will engage one or more contractor(s) to provide an initial constructability analysis of the preliminary TLC design and a refined understanding of construction costs, production rates, and schedules.

4.1.3 Phase III

Phase III will include selection the construction contract approach and contractor, completion of the final TLC design, construction of the TLC, and initiation of performance monitoring. The TLC design will be completed towards the end of the agency permit application review period to ensure no major issues are raised by the permitting agencies or the public that would significantly change the design or suggest that permits would not be approved. The level of detail for the final design will be determined based in part on the construction delivery method under consideration. Designs for a D/B/B delivery typically require more detail than D/B or EPC projects to support the competitive bid process and clearly delineate work scopes and requirements in order to manage changes and control costs during construction.

Construction of the TLC cannot start until all permit approvals have been received. To minimize the time between permit approvals and the start of construction, the Remediation Trust envisions selecting the construction delivery method and contractor, and having a contract negotiated as the permit approval process is being completed. Contract award and notice to proceed would not be made until permits were approved.

Construction of the TLC will be completed in phases, with consideration to regulatory timeframes established to protect habitat and fish migration, and weather limitations. The first phase of construction will be planned as a "pilot phase" and provide information that will be used to inform and improve subsequent phases of construction. Elements to be evaluated in the first construction phase may include, but are not limited to, i) cap material placement methods and production rates; ii) cap stability; iii) initial sediment and wood waste deposition/accumulation, if any; iv) underlying sediment response (compression, intermixing, etc.), v) benthic community recolonization, and vi) influences of ice scour.

4.1.4 Phase IV

Phase IV will consist of post-construction performance monitoring and maintenance. At this time, Phase IV is envisioned to start at the end of the first construction season, to provide information on the initial TLC construction that can be used to inform and adjust the implementation plans for subsequent construction seasons, driving continual improvements in safety, efficiency, and cost-control. The scope and schedule for long-term performance monitoring and maintenance will be refined during final design.

Community involvement activities will occur throughout all phases of work to ensure communities are aware of the status and plans for the Work, to obtain necessary access from landowners, and to understand and address, as appropriate, potential concerns that may affect community support for the TLC. The Remediation Trust will make information available and solicit feedback in several ways, including hosting Town Hall meetings, holding community availability sessions, preparing fact sheets, providing progress updates at regularly scheduled local government meetings, and posting materials to a public website.

The sections below identify the strategy for performing the Work, including the design and implementation.

4.2 REMEDIAL DESIGN APPROACH AND SCHEDULE

To implement the remedial design in accordance with Part II of the Statement of Work, Appendix A to the Consent Decree, the following approach has been developed, including field investigations and design. The approach for remedial implementation is discussed in Section 4.3.

A general approach is identified below and a detailed schedule for design activities is included as Figure 4. Note that activities may occur concurrently to complete the remedial design in an efficient and timely manner, and will not necessarily be performed in linear fashion as shown below.

- Develop TLC Design Work Plan (set forth here).
- Develop Supporting Deliverables for design activities, as necessary, in accordance with Paragraph 31 of the Statement of Work, including:
  - HASP
  - ERP
  - FSP
  - QAPP.
- Identify and obtain permits for field activities in accordance with the Permitting Work Plan (Appendix A).
- Identify and obtain access to private property for field activities.
- Implement the investigations identified in Section 5.1.1 to 5.1.4, including:

  - Develop Investigation Work Plans in accordance with Paragraph 6(a) of the Statement of Work.
  - Perform fieldwork.
  - Develop Investigation Reports in accordance with Paragraph 6(b) of the Statement of Work.
- Evaluate non-field investigation design parameters, as identified in Section 5.1, including modeling and material characterization.
- Develop Work Designs in accordance with Paragraphs 8 and 9 of the Statement of Work. Since the Consent Decree does not specify the required submittals. Greenfield proposes to prepare and submit the following Work Designs.
  - Preliminary (30%) Design
    - The 30% Design will support initial discussions with the permitting agencies by providing an initial understanding of the proposed scope of the TLC Work.
    - The 30% Design will include sufficient information to meet with potential contractors to discuss constructability issues, identify areas of concern, and identify potential methodologies of cap placement. Contractors will not be excluded from bidding based on their involvement in this process.
    - The 30% Design will preliminarily identify the methodology for securing a contractor and identify further details about implementation of the remedial design.
  - 60% Design
    - The 60% Design will incorporate the results of the investigations identified in this document and include information gathered though conversations with potential contractors.
    - The 60% design will provide sufficient detail to support the NRPA permit application process, update cost estimates, and perform a constructability review.
    - The 60% Design will be used to secure a contractor, assuming that the final design will be developed by the selected contractor under a D/B or an EPC Contract.
    - The 60% Design will also include the development of bid documents to be used to select a contractor.
- Contractor Notice to Proceed and Final Design. The Remediation Trust does not anticipate a 100% design document will be needed to start construction. Information obtained during the first, "pilot phase" of construction will be incorporated into construction contract documents as necessary. The construction contract will include

terms that contemplate future changes and establish a robust change management framework that will maintain cost-control.

4.3 REMEDIAL IMPLEMENTATION APPROACH

As described in Section 4.1, Greenfield's current approach to construction of the TLC will commence during the Phase II preliminary design process with identification of and interviews with appropriately qualified sediment remediation contractors. A short list of pre-qualified contractors will be developed and serve as a resource during design and as the list of contractors to be considered for implementation. Contractor perspective during design will provide critical constructability and cost information to the design process. As the preliminary design progresses and information becomes available on potential permit requirements and access approvals, Greenfield will start to evaluate delivery methods to determine a contracting approach that will best meet project objectives. Contract award and construction will start in Phase III, upon receipt of all permits needed to implement the Work.

To ensure implementation of the remedial design meets all applicable requirements of the Consent Decree and attachments, a general approach is outlined below. A detailed schedule for implementation activities will be presented in the Implementation Work Plan deliverable. Note that activities will be performed concurrently, when possible, to complete the remedial design in an efficient and timely manner and will not necessarily be performed in linear fashion as shown below.

- Develop an Implementation Work Plans in accordance with Paragraph 11 of the Statement of Work. This plan, at a minimum, will contain:
  - A Work construction schedule in an appropriate format, such as a critical path or Gantt chart
  - An updated HASP that meets all 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 for the Orrington Reach Work
  - Plans for satisfying all authorization and access agreement requirements, for obtaining all necessary authorizations and permissions for on- and off-Site activities, and for satisfying any requirements of such authorizations and permissions.
- Develop and/or update Supporting Deliverables for implementation activities, as necessary, in accordance with Paragraph 31 of the Statement of Work.
  - HASP
  - ERP

  - FSP
  - QAPP
  - Site-Wide Monitoring Plan
  - Transportation and Off-Site Disposal Plan
  - Operation & Maintenance Plan
  - Institutional Controls Implementation and Assurance Plan.
- Conduct Work in accordance with the Implementation Work Plan.
- Conduct Operations and Maintenance of the Work in accordance with the Operation & Maintenance Plan.
- Conduct monitoring in accordance with the Site-Wide Monitoring Plan.

4.4 ROLES AND RESPONSIBILITIES

Pursuant to the Consent Decree requirements, the Remediation Trust is responsible for the development, oversight, funding, and implementation of the Work, including securing all regulatory permits and approvals for the Work. To date, Greenfield has contracted with Integral and WSP USA Environment & Infrastructure, Inc. (WSP) to perform the Phase I and Phase II tasks described in Section 4.1. Key personnel are shown in the organization chart, Figure 5. The roles, responsibilities of Greenfield, Integral, and WSP are presented in Table 2.

5 AREAS REQUIRING CLARIFICATION

This section considers the currently available data and analyses completed to date, and identifies the additional data collection and analyses required to address key data gaps and complete the design. It summarizes considerations that need to be accounted for during the design and remedial implementation process, including areas requiring clarification and/or anticipated problems (e.g., data gaps, Site access issues, anticipated permitting issues). It also identifies key uncertainties ab data gaps that are not anticipated to require clarification or further investigation.

5.1 KEY DATA GAPS

This section summarizes the data collection and modeling analyses recommended to support the design of the Orrington Reach cap. The final scope of the data collection and modeling analyses will be coordinated with the Mobile Sediments and Surface Deposits and the Orland River and East Channel investigations and the Long-Term Monitoring to perform the investigations efficiently and cost-effectively and optimize the overall benefit for the remedial action projects for the Estuary. The final scope and associated details (e.g., sample collection and laboratory methods, number of samples, sample locations, sample depths) will be presented in separate investigation work plans.

Table 1 identifies the key data needs identified in Section 4 and the proposed action to fill those data needs. Each action is described in further detail in the identified sections.

5.1.1 Bathymetric Survey

A thorough understanding of Penobscot River bathymetry and the intertidal regions of Orrington Reach is required to delineate the extent of intertidal sediment for potential capping. Establishing the elevation of the Penobscot River sediment bed is a key component of the numerical modeling exercise (described further in Section 5.1.3), as these elevations dictate the extent and volume of tidally driven water flow and associated sediment exchange in the system. Bathymetric and topographic data are necessary to assign bottom elevations to the hydrodynamic model grid and accurately represent the flow pathways and boundaries.

5.1.1.1 Current Understanding and Data Needs

The existing Penobscot River bathymetric data were derived from available National Oceanic and Atmospheric Administration (NOAA) National Ocean Service surveys, as well as numerous USACE multibeam echosounder (MBES) surveys conducted for select areas of the Estuary from 1984 through 2016. These data were combined to form the digital elevation model

(DEM)[6] used for the Phase III investigation, hydrodynamic modeling, and various expert reports. Because the DEM used for the Phase III hydrodynamic modeling was developed from multiple data sets collected at different points in time (some being almost 20 years old), the existing DEM may not be representative of current conditions and or provide sufficient understanding of contiguous bathymetric conditions in Orrington Reach. More importantly, the DEM coverage is limited for the intertidal flat areas that will be the focus of the capping effort. A more refined bathymetric map is required for Orrington Reach to resolve small scale, steep slope, and/or rapidly changing bathymetric features and to refine the delineation of key morphologic features, such as the channel thalweg. Quantifying these bathymetric and morphologic features is essential to developing a reliable hydrodynamic model for use in forecasting the shear stresses on the sediment cap under design storm flow conditions.

In 2021, the U.S. Geological Survey (USGS) contracted an aerial photogrammetry light detection and ranging (LiDAR) survey along the mid-coast region of Maine that includes the Penobscot River. The LiDAR survey, conducted between May 12, 2021, and May 10, 2022, was acquired using state-of-the-art, fixed-wing aircraft survey technology over 17 flights (NV5 Geospatial 2022). The USGS LiDAR survey provides topographic data for upland and a large proportion of the intertidal areas. Therefore, no additional LiDAR surveys are proposed by the Remediation Trust at this time.

5.1.1.2 Proposed Data Collection

The Bathymetric Survey Work Plan (Integral and WSP 2023) has been prepared to present the recommended scope of bathymetric data collection, including a high resolution MBES bathymetric survey of Orrington Reach and the lower Penobscot River, from Eddington to Turner Point. The bathymetric survey will provide high-resolution mapping of the subtidal channel and of as much of the intertidal flats as Feasible, for remedial design. The proposed bathymetric survey will be integrated with the 2021 USGS LiDAR survey data to generate a refined DEM for use in:

- Updating baseline maps
- Identifying marsh, intertidal, and subtidal areas
- Supporting refinement of the hydrodynamic model
- Supporting sediment sampling
- Refining the remedial design
- Supporting evaluation of remedial cost

[6] A DEM is a 3-dimensional representation of a terrain's surface at regularly spaced intervals in the x and y directions that reference elevation values in a common vertical datum (Maune et al. 2007).

- Supporting quantification of as-built cap thickness following placement (requires a post-bathymetry survey).

As an additional benefit, the refined DEM will be of sufficient resolution to qualitatively and quantitatively evaluate anthropogenic and/or morphological features, such as areas of slope sloughing, bedforms, propeller scour marks, and/or dredged areas within the survey area of the river.

An MBES survey will be conducted at relatively high water levels to attain coverage into as shallow water depths as Feasible along the lower Penobscot River from Eddington to Turner Point. The subcontractor, Aqua Survey Inc. (to be subcontracted by WSP), will be prepared to access water depths as shallow as 4 to 6 ft at the time of survey, and will be prepared to safely navigate near and around visible and submerged hazards that may exist in the survey area. If there are no weather delays, the MBES bathymetric survey of the Estuary is expected to take no more than 10 days to complete.

The MBES survey will be designed to overlap with the 2021 USGS LiDAR survey area to the extent practicable to provide confirmation of the results for intertidal areas of the two surveys. Preliminary evaluation of the 2021 USGS LiDAR data set indicates that the data set provides sufficient spatial coverage and vertical accuracy to meet the data needs for Orrington Reach. Data from intertidal areas where the two data sets overlap will be compared to further evaluate the vertical accuracy of the LiDAR data set and to verify the data are of sufficient accuracy to support the data needs for Orrington Reach.

5.1.2 River Flow Velocity

Selection of the appropriate capping material requires an understanding of the shear stresses that will act on the cap due to river flow. The current understanding of the Site and rationale for the river flow velocity data collection and analyses was presented in the River Flow Velocity Monitoring Work Plan (Integral 2023). The River Flow Velocity Monitoring Work Plan was submitted for Beneficiary review on March 6, 2023, and finalized on March 14, 2023.

5.1.2.1 Current Understanding and Data Needs

The existing hydrodynamic model was calibrated based on river flow velocity measurements collected as part of the Phase II Penobscot River Mercury Study by Geyer and Ralston (2018). The authors obtained multiple field measurements between Bangor and Fort Point, Maine, to characterize active processes during the Phase II study period. The data collection activities included 12 months of velocity and salinity measurements at two moored stations in 2010 and two moored stations in 2011, and multiple shipboard conductivity, temperature, and salinity profiles performed from March through June 2010 and 2011. The 2010 moored stations were located in Mendall Marsh and the Orland River. The 2011 moored stations were located near the thalweg just downstream of Winterport and near the thalweg in Bucksport. The study represents the most comprehensive set of field measurements collected to date in the river for the characterization of hydrodynamic and sediment transport processes. However, these data were representative of the hydrodynamic conditions more than 11 years ago and within the river prior to the removal of the Veazie Dam.

A tide gage was installed and ADCP transecting was conducted as part of Southern Cove PDIs in June and August 2015 (Anchor QEA and CDM Smith 2016). The tide gage, installed along the eastern edge of the waterway, was deployed for 4 days in mid-June. In addition, ADCP transecting was conducted for 12 hours along three shore-normal transect lines at Southern Cove in early August. These data represent a short period of time of the Estuary hydrodynamics, though are within Orrington Reach, and will be considered for their potential use for evaluating the bed shear stress in intertidal areas of Southern Cove.

Additional data were collected as part of the Phase III investigation that inform the understanding of hydrodynamics in the Estuary. This investigation collected data upriver and downriver of Orrington Reach that included, but was not limited to:

- Measurement of water-surface elevations at Fort Point, Bucksport, and Winterport (Figure 1) from September 1, 2017, to November 30, 2017.
- Measurement of water-surface elevations at Bangor from September 1, 2017, to November 30, 2017.
- Measurement of water-surface elevation, flow velocity, salinity, and temperature data in September 2017 along transects located at Fort Point, Sandy Point, Verona, the mouth of Mendall Marsh, and at Frankfort Flats (Figure 1). Flow velocity was measured with an acoustic Doppler current profiler (ADCP) at specific points along each transect.
- Estimation of critical bed shear stress at 17 SEDflume core locations between Orrington and the southern end of Verona Island (Amec Foster Wheeler 2018a).

As discussed in Section 5.1.3, the Phase II and Phase III data will be used in conjunction with the data proposed for collection under the Orrington Reach PDI, discussed below, to support the calibration and validation of a refined hydrodynamic model to evaluate the bed shear stress in intertidal areas in Orrington Reach proposed for capping.

5.1.2.2 Proposed Data Collection

While the existing data are sufficient to support the design of the Orrington Reach TLC, additional data collection was recommended to supplement the design by providing river flow velocity during the spring freshet. The data collection, which commenced on March 16, 2023, involved deployment of a single ADCP at a strategic location within Orrington Reach to quantify velocity and water levels during high river flows to support the calibration and validation of the revised hydrodynamic model and the predictions of shear stress in areas proposed for capping that are most at risk of erosion. Peak flows typically occur with the spring freshet in early April to early May. The velocity monitoring was described in the River Flow Velocity Monitoring Work Plan (Integral 2023) provided to the Beneficiaries for review on March 6, 2023. The velocity monitoring will collect 3 months of river flow velocity data within Orrington Reach. The 3-month monitoring period began on March 16, 2023, and continued through approximately June 15, 2023, to target the occurrence of the spring freshet and to provide data over a range of flow and wind conditions to support the validation of the hydrodynamic model and to support the remedial design.

The monitoring will provide river flow velocity data in Orrington Reach to support refined calibration and validation of the hydrodynamic model. A bottom-mounted ADCP was deployed on March 16, 2023, in the thalweg at a location within Orrington Reach to provide a robust data set that is representative of the bulk of flow in the reach. These data, combined with present-day bathymetry of the river, and supplemented with existing data collected at other locations in the river during previous investigations, will provide a robust data set for calibration and validation of the hydrodynamic model.

5.1.3 Modeling

This section provides a description of the modeling that is proposed to support the Orrington Reach cap remedial design, including hydrodynamic modeling of currents and wind waves, vessel wake modeling, and CapSim modeling.

5.1.3.1 Hydrodynamic Modeling

Selection of the appropriate capping material requires an understanding of the river flow velocities and associated shear stresses that will act on the cap, and of the geotechnical properties of both the capping material and the underlying sediment. The current understanding of the Site and recommended data collection and analyses to support the design of the cap are summarized below.

Current Understanding and Data Needs

A hydrodynamic model will be used to simulate river flow velocities, wind waves, and associated bed shear stresses to identify areas most conducive to capping (i.e., where shear stresses are lowest); determine cap materials, the grain size, and the need for armoring; evaluate the potential to impact the habitat in intertidal flats and marshes; and assess the potential to increase flood risk. These design elements are critical in determining the feasibility and cost of the cap.

Generally, sediment cap designs are recommended to be able to withstand, at a minimum, forces that may occur with a probability of 1% per year, such as the 100-year storm.[7] Therefore, the cap will be designed to be stable under a 100-year flood event. River flow velocities, wind waves, and associated bed shear stresses during a 100-year wind/flood event will be evaluated using a hydrodynamic numerical model. A sensitivity analysis will be conducted to determine if a more conservative condition (e.g., 500-year flood) can be accommodated within the cap design without substantially increasing the cost of the cap.

Previous hydrodynamic modeling during the Phase II and Phase III investigations used 2-dimensional models, which separated the river into multiple grid cells in the horizontal direction, but only a single layer through the water column. This model has been refined to support this BOD to include 3 dimensions to better predict river flow for the stratified conditions present in the Estuary. In addition, the model has been refined to include a finer model grid (i.e., more model cells) to support evaluation of Site conditions at a smaller scale than was supported by the original version of the model.

The hydrodynamic model uses Deltares' Delft3D-FLOW, a state-of-the-science model that solves the 3-dimensional equations of motion in a water body with variable-fluid density using free-surface and hydrostatic conditions. Delft3D-FLOW was selected as the model for this Site based on the following considerations:

- The model is publicly available, open source, technically rigorous and defensible, and has been used widely to evaluate a wide range of systems (Gerritsen et al. 2008). The open-source nature of the modeling tools used for this study permits model source code and executables to be shared with stakeholders. This allows transparency during the review processes, as well as future application of the modeling tools by any interested parties.
- The model has been widely accepted in both industry and academia for high-resolution hydrodynamic and sediment transport studies (Barnard et al. 2009; Montoya et al. 2018).
- The model incorporates complex bathymetry using a curvilinear or Cartesian grid, which allows for more accurate representation of the bottom topography along the Penobscot River.
- The model allows for time-varying inputs of water levels and discharges.
- The model simulates wetting and drying, which is important for modeling regions that may be inundated intermittently, such as the extensive intertidal regions.

[7] Sediment capping guidance documents from EPA and ITRC each use the 100-year storm as a minimum benchmark recommendation. Sources: USEPA (2005), Contaminated Sediment Remediation Guidance for Hazardous Waste Sites; ITRC (2014), Contaminated Sediments Remediation: Remedy Selection for Contaminated Sediments.

The hydrodynamic model contains 17,690 grid cells in a structured curvilinear grid extending from Fort Point upstream to Eddington. The grid has varying horizontal resolution, from 100 to 10,000 m^2. The model has 10 vertical layers spaced uniformly through the water column. The bottom elevations were defined from the existing DEM (Section 5.1.1.1).

The hydrodynamic model was calibrated based on river flow velocity measurements collected in 2010 and 2011 as part of the Phase II Penobscot River Mercury Study by Geyer and Ralston (2018). The authors obtained multiple field measurements between Bangor and Fort Point, Maine, to characterize active processes during the Phase II study period. The data collection activities included 12 months of velocity and salinity measurements at two moored stations in 2010 and two moored stations in 2011 and multiple shipboard conductivity, temperature, and salinity profiles performed from March through June 2010 and 2011. The 2010 moored stations were located in Mendall Marsh and the Orland River. The 2011 moored stations were located near the thalweg just downstream of Winterport and near the thalweg in Bucksport.

The model calibration consisted of running model simulations for April 2011 and June 2011 and comparing the model-predicted velocities to the velocities measured by the Geyer and Ralston (2018) study. These 2 months encompassed a high-flow event (1,420 m^3/s) and low-flow event (270 m^3/s), respectively. The calibrated model has been preliminarily validated against the Phase III water level and velocity data collected at various locations in the Estuary in 2017 (as described in Section 5.1.2.1). These efforts indicate that although the data used to calibrate the model were collected more than a decade ago and prior to the removal of the Veazie Dam, the model accurately predicts flow conditions in the Estuary. However, it is noted that the model calibration and validation do not include data collected within Orrington Reach.

Preliminary hydrodynamic modeling was conducted in 2020 as part of the BOD development to evaluate grain-size requirements to resist typical flood conditions, as described in Section 3.3. The model was used to evaluate shear stresses acting on the preliminary area identified for capping, shown in Figure 6, under a 50-year flood event. The model indicated that shear stresses across the majority (~76%) of the preliminary cap area are less than 1 Pascal (Pa). Using the Shields Curve, it was determined that a coarse sand to fine gravel will resist mobilization at a shear stress of less than 1 Pa.

The preliminary modeling suggests that the remaining 24% of the area may require armoring to prevent erosion. These areas are predominantly at the toe of the intertidal flats, where the elevations transition to subtidal conditions. Armoring could include placement of a coarser-grained capping material and/or placement of a layer of larger material (e.g., gravel) on top of the sand cap in these areas. Velocity and flow depth predictions resulting from the hydrodynamic model will be used to determine the proper armor sizing using the modified EM 1110-2-1601 stone sizing equation (USACE 1994; Maynord 1998; Palermo et al. 1996). Filter requirements to support armor and contain underlying cap layers will be evaluated during the design phase. The extent of armoring, filter requirements, and other associated construction elements will have a significant effect on implementation costs and on feasibility evaluations.

Proposed Modeling

Hydrodynamic modeling is needed to estimate shear stresses to the cap under a range of river conditions and inform determination of appropriate capping material grain size(s), minimum cap thickness, and identify areas requiring armoring. Further, modeling is needed to forecast shear stresses on the cap under current and potential future conditions, such as those resulting from sea level rise and climate change.

The existing 3-dimensional hydrodynamic model needs to be updated to more accurately reflect current conditions in the Estuary. This model update will incorporate the improved understanding of the river bathymetry (Section 5.1.1). It will also validate the model against water level and velocity data collected from Orrington Reach during the PDI (Section 5.1.2) and verify the preliminary model validation against the Phase III water level and velocity data sets. Based on the findings of these validation efforts, a determination will be made as to whether the model calibration needs to be refined.

The model calibration and validation for the updated model will follow typical EPA guidance for employing a numerical model (USEPA 2009). The refined calibration (if necessary) of the hydrodynamic model will consist of systematic adjustments to specific model parameters within a reasonable range until measured Site conditions are accurately simulated. The results of these systematic adjustments will be qualitatively and quantitatively compared to measured data. The calibration and validation step is crucial for increasing confidence in model predictions and accuracy.

Once the refined calibration and validation are complete, the model will be applied to evaluate shear stresses on the capped area under the 100-year design storm event, and model runs will be implemented to assess the potential influence of climate change on cap stability, including sea level rise and increased frequency and intensity of storm events. In addition, the model will be revised to enable prediction of waves to evaluate how wind waves play a role in the resuspension of bedded sediment during return period storm events.

It is anticipated that hydrodynamic modeling will also be needed to support the remedial designs for the Mobile Sediment and Surface Deposits and for the Orland River and East Channel components of the Penobscot remediation Work. A single, non-proprietary, Site-wide model for all three remedial designs[8] will provide consistency throughout the Estuary and will be a cost-effective tool.

[8] Note that sub-versions of the model would be developed as needed to provide for more detailed evaluation (e.g., finer model grids) in specific areas of interest for a given remedial design.

Lastly, a Site-wide hydrodynamic model would have benefit for the evaluation of long-term conditions following the completion of the remedies. The hydrodynamic modeling can be used to assess the effectiveness of the remedies by identifying areas of potential risk and vulnerability in the Estuary, such as areas of high erosion. In addition, the hydrodynamic model can be used to simulate potential future environmental conditions of the Estuary. These can include modeling the impacts of climate change, sea level rise, or changes in tidal patterns. These simulations can help decision-makers evaluate the long-term effectiveness of the remedies.

5.1.3.2 CapSim Modeling

In addition to evaluating long-term stability, the design of the minimum protective thickness of the TLC needs to consider the potential for contaminants to be mixed or migrate into the cap material due to bioturbation and contaminant migration processes. CapSim modeling is recommended to evaluate these processes based on existing Site-specific data and data to be collected as part of the PDI, as described below.

Current Understanding and Data Needs

The following summarizes the current understanding of the Site with respect to the design factors that will influence the design cap thickness.

The minimum protective thickness is typically based on long-term stability, the anticipated extent of bioturbation, and potential upward migration of contaminants from the underlying sediment. Based on a preliminary evaluation of these criteria, a TLC (i.e., a sediment cap less than 1 ft in thickness) will satisfy the design objectives. Mercury and methylmercury have a strong affinity for organic matter (Hollweg et al. 2009), which is abundant (median concentration = 5.6 percent) in the Estuary sediment. As a result, mercury and methylmercury are expected to be strongly partitioned to the native sediment, which reduces dissolved-phase mercury concentrations in porewater (Hammerschmidt and Fitzgerald 2004; Chen et al. 2009) and minimizes the potential for upward migration via groundwater upwelling. Therefore, cap thickness will be primarily driven by bioturbation and stability considerations.

An appropriately designed cap thickness limits chemical breakthrough to the bioturbation (or "bioactive") layer, thereby limiting associated contaminant transport by benthic organisms. Guidance documents provided by EPA have identified the bioactive zone in freshwater tidal environments (like those present in the Penobscot at Orrington Reach) as typically the top 10 to 15 cm (or 4 to 6 in.) of sediment (USEPA 2015). It is recommended that additional analyses be conducted to verify this conclusion, including application of the CapSim model based on available and evaluation of Site-specific bioturbation layer thicknesses during collection of additional Site data.

Proposed Modeling

The CapSim model will be used to evaluate cap thickness and composition. CapSim is a numerical model used to assess contaminant transport through cap material (Shen et al. 2018) and has been used to support cap design at large sediment sites, such as the Lower Passaic River and Portland Harbor Superfund Sites. Contaminant migration through cap material is predicted by evaluating transport mechanisms, such as sorption, advection, dispersion, and diffusion, along with biological and chemical reactions, and physical forces resulting from bioturbation, erosion, consolidation, and groundwater upwelling and hyporheic exchange. CapSim model results will support the design criteria for cap composition and thickness that will limit transport of contaminants from underlying sediment over an established cap design life.

To the extent possible, site-specific data are used to develop the input parameters for the CapSim model, including underlying sediment characteristics, cap material characteristics, groundwater upwelling and hyporheic exchange rates, predicted erosion rates, and bioturbation depths. Sediment geotechnical parameters (bulk density, porosity, permeability, grain size, and strength analyses) and chemistry (contaminant concentrations and organic carbon) are used to predict contaminant transport from baseline conditions and potential consolidation following cap placement. Erosion rates and armoring requirements for design storm conditions are determined by hydrodynamic modeling. Bioturbation depths and groundwater and hyporheic exchange rates are used to determine the extent of mixing and physical transport of contaminants. The cap thickness will be modeled to meet design criteria and withstand erosional forces during design storms (including placement of cap material and necessary armor) and limit the extent of contaminant migration and chemical breakthrough to the bioturbation layer.

5.1.3.3 Vessel Wake and Propeller Scour Modeling

In addition to the simulation of river flow velocity and wind waves and their influence on the erosion potential for the proposed capping efforts, the modeling will help evaluate the impact of vessel wake and propellor wash on the erosion potential.

Current Understanding and Data Needs

Although vessel wake and propellor wash are considered unlikely to result in significant erosion of the cap, these processes have not been previously evaluated for Orrington Reach, and additional evaluation is needed to confirm this understanding.

Proposed Modeling

A USACE-developed vessel wake prediction tool will be used to evaluate the erosion potential resulting from passing vessels. Vessel-generated wake can mobilize bed sediment, leading to shoreline erosion and reduced water quality in shallow areas (Maynord 2008). This simplified vessel wake modeling tool can eliminate the need for complex and computationally expensive numerical models to predict the generation and propagation of vessel wake. Where detailed wake analysis is not necessary, as in the evaluation of cap erosion potential, multiple simplified vessel wake algorithms have been developed and are available to use within the USACE vessel wake prediction tool. This tool utilizes various vessel properties, such as length, beam, draft, speed, and location within a waterway, along with the bathymetry along a transect. The vessel wake tool also incorporates the dissipation of vessel wake energy as a result of riverine and tidal flow. A range of vessel sizes and speeds will be simulated for up to four transects, focusing around Orrington Reach, to evaluate the contribution of vessel wake to the erosion potential at the proposed capping areas.

The USACE method published by Maynord (2000) will be used to evaluate the erosion potential of propeller wash from passing vessels. The impact of propeller wash on bedded sediment is dependent on the amount of throttle used, the duration of the throttle application, and the vessel characteristics (e.g., number of propellers, propeller diameter, engine power, and vessel draft) (Symonds et al. 2016). A range of vessel and propeller sizes for a range of water depths will be simulated to evaluate the contribution of vessel propeller scour to the erosion potential at the proposed capping areas.

The results of the propeller wash simulations will be supplemented by a survey to document the locations of existing and, to the extent known, planned boat launches in Orrington Reach. This information will be supplemented by a review of the results of the bathymetric and LiDAR surveys for evidence of propeller scour on the Orrington Reach intertidal flats. Collectively, these data will be used to identify intertidal areas in Orrington Reach that are most at risk of propeller scour so that appropriate provisions (e.g., additional armoring) may be considered in the design.

5.1.4 Sediment Characterization

This section describes proposed sediment data collection activities recommended to obtain additional mercury concentration and geotechnical data for intertidal sediment in Orrington Reach.

5.1.4.1 Mercury Concentration in Intertidal Sediment

To address key data gaps and increase the potential environmental benefit of the capping, a current, more comprehensive data set of mercury concentrations in surface sediment is necessary. Updated mercury data will be used to identify areas of Orrington Reach intertidal flat sediment targeted for capping. The current understanding of the Site and recommended mercury data collection and analyses to support the design of the cap are summarized below.

Current Understanding and Data Needs

The design will identify the extent of intertidal sediment areas to be capped in order to maximize the reduction in the average total mercury concentration in surface sediment to the extent practical. Capping intertidal sediments with the highest concentrations of mercury will have the largest effect on reducing average concentrations.

Existing Orrington Reach sediment mercury concentration data were obtained from investigations performed between 2006 and 2016 and presented in the Phase III Engineering Study (Amec Foster Wheeler 2018a) on a reach and subarea basis. These data include those collected during Southern Cove PDIs for delineation of sediment removal areas (Anchor QEA and CDM Smith 2016). A subset of the available sediment mercury concentration data for the Orrington Reach intertidal zones from Table 5-2 of the Phase III report is summarized as follows:

Orrington Reach, Intertidal Zone	Acres	Number of Surface (0–0.5 ft) Sediment Samples	Mean Mercury Concentration (ng/g)[9]
Eastern Bank	130	42	1,208.5
Western Bank	112	10	978.6

These data suggest that capping focus on the east side of Orrington Reach. However, given that the sample density is considerably greater on the east side of the reach, there is greater uncertainty about concentrations of total mercury on the west side.

A preliminary analysis of the sediment mercury and bathymetric data presented in the Phase III Engineering Study identified seven coves with intertidal flats on the east side of Orrington Reach that total approximately 130 acres where total mercury concentrations in surface sediment are elevated relative to other areas of the River. These seven areas consist of intertidal flats, located in coves (Figure 6) that are sheltered from higher river velocities. The lower river velocities support the net depositional and broadly stable conditions characteristic of intertidal flats.

[9] The Phase III Engineering Study presented mean mercury concentrations that were calculated via bootstrapping (Amec Foster Wheeler 2018a); the approach and justification for the use of bootstrapping to generate mean concentrations are presented in the "Alternatives Evaluation Report" (Amec Foster Wheeler 2018c). Generally, bootstrapping is a statistical method that estimates parameters, such as the mean, by continually resampling the sample population to generate a mini-population; each mini-population produces slightly different sample statistics that converge over many iterations to provide a value for interpretation.

Additional total mercury concentration data collection is needed to support a refinement of the basis for the area of Orrington Reach to be capped. Because the existing mercury concentration data set is relatively limited and was primarily collected prior to 2016, additional data collection would support refinement and prioritization of the areas within Orrington Reach to be capped to achieve an optimal outcome. Additional sediment mercury concentration data collection would refine the understanding of the areas proposed for capping on the eastern bank of Orrington Reach and identify areas on the western bank of Orrington Reach that would contribute significantly to reducing total mercury concentrations and/or could be targeted for remediation should access be denied to portions of the eastern bank by the adjacent property owners.

The following data are necessary to define the remediation areas and refine the understanding of total mercury concentrations:

- Sediment data from select intertidal flats on the west side of the river are needed to determine whether there are areas of high mercury concentrations that would significantly contribute to reducing the average mercury concentration in Orrington Reach.
- Additional data from select intertidal flats on the east side of the river are recommended to augment the current understanding of mercury concentrations and inform access needs.

Proposed Data Collection

Additional surface (0 to 0.5 ft below ground surface) sediment sampling for mercury analysis is proposed for the intertidal flats on both the east and west sides of Orrington Reach. Mercury samples from the Phase III study were tabulated to identify recent data coverage (i.e., from 2016 or more recent) for each of the seven coves along Orrington Reach's eastern bank preliminarily identified for capping (Figure 6). Some of the areas have little to no recent mercury concentration data, whereas other areas, such as the Southern Cove, have been well characterized and are unlikely to require additional sampling.

Although data for the western bank intertidal areas are limited compared to eastern bank intertidal zones, the available data indicate intertidal sediment in coves on the western bank contain elevated sediment mercury concentrations (albeit at concentrations potentially lower than intertidal sediment on the east side) that could allow for achievement of capping objectives. Further characterization of western bank intertidal areas could provide flexibility in the design should access be denied for a portion of the eastern bank intertidal zone sediment or if capping in those areas is determined to be otherwise not Feasible.

In preparing a sediment sampling work plan, all available data will be further reviewed to determine the scope of sampling needed for each of the seven coves on the east side of

Orrington Reach and for areas on the west. The following have been identified as a preliminary basis for establishing the number of samples needed:

- Minimum of three total recent (post-2016) samples for each cove
- Minimum of one recent (post-2016) sample for every ~4 acres of potential TLC area.

5.1.4.2 Mercury Concentration in Recently Accumulated Sediment

Orrington Reach intertidal flats are net depositional areas, and sediment deposition is expected to continue on top of the sediment cap following the placement in Orrington Reach. Some of the sediment that deposits on the cap may be sediment and wood chips associated with the mobile pool, and thus may be a source of mercury recontamination of the cap.

Current Understanding and Data Needs

The concentrations of mercury at the surface of the TLC will initially be substantially lower than the pre-remedy condition. Over time, mercury concentrations in the capped area will be dictated by the mercury concentration in sediment and wood chips depositing to the cap (see Section 3.1 and Figure 3). Deposition and accumulation of sediment and wood chips associated with the mobile sediment pool is a potential source of recontamination of the TLC. Further, bioturbation processes will result in mixing of accumulated sediment into the cap material. As a result, mercury concentrations in the capped area over time will be influenced by both the rate of sediment accumulation on the TLC and the degree of intermixing with the TLC materials.

A limited number of geochronology core samples were collected from intertidal areas, including two core samples collected from intertidal areas within Orrington Reach (Amec Foster Wheeler 2018d): Core PBR-18 located across from East Cove 3 on the west side of Orrington Reach and Core PBR-19 located within the East Cove 4. Results at these locations show that, as expected, the Orrington Reach intertidal flats are net depositional areas, and indicate that sediment accumulation is likely to continue on top of the sediment cap following TLC placement in Orrington Reach. Further, past experience has shown that fine-grained particulates depositing to the TLC surface will be readily entrained and trapped within the pore space of the coarse-grained sand materials at the surface of the TLC. As a result, sediment accumulation rates are expected to be relatively rapid in the initial period following placement of the TLC.

As discussed in Section 3.1, mercury bioaccumulation in the food web is primarily mediated by uptake of methylmercury. With placement of the TLC, mercury-impacted sediments will be at a deeper depth—limiting the availability for methylation. With the accumulation of sediment on the TLC over time, the composition of surface sediment and the associated redox conditions in the capped area will progress back toward the natural condition—allowing for some of the mercury associated with the accumulated sediment to be converted to methylmercury.

Evaluation of sediment accumulation and redox conditions will provide information for the TLC design thickness necessary to support cap stability and sediment recovery, and to limit mercury methylation.

Proposed Data Collection

Additional data collection is needed to:

- Evaluate the material associated with the mobile sediment pool that accumulates on Orrington Reach intertidal flats, including documentation of the presence or absence of wood chips and quantification of mercury concentration.
- Establish the depth at which redox conditions transition from oxic to anoxic conditions (i.e., the redox potential depth) and associated bioturbation depth.

The approach to the evaluation of material accumulating on the Orrington Reach intertidal flats will be developed in coordination with ongoing and future field activities within Orrington Reach including the investigations identified in this Design Work Plan, the Long-Term Monitoring, and the sediment characterization effort for the Estuary under the Mobile Sediment and Surface Deposits Design Work Plan (WSP, in preparation). The redox potential depth of the intertidal flat sediment will be evaluated through visual logging of sediment cores collected for geotechnical characterization (Section 5.1.4.3) and, to the extent Feasible, sediment grab samples collected for mercury analysis (Section 5.1.4.1).

5.1.4.3 Geotechnical Characterization

The potential for the cap placement to destabilize the underlying sediment and result in mud wave formation and cause slope instability will be dependent on both the cap thickness and the geotechnical characteristics, such as shear strength, of the underlying sediment. There are relatively limited geotechnical data available for intertidal sediment in Orrington Reach. As a result, it is recommended that surface sediment samples be collected from Orrington Reach to characterize the geotechnical properties of the intertidal sediment to support an evaluation of the potential for destabilization due to the cap placement. The current understanding of the Site and recommended data collection and analyses to support the design of the cap are summarized below.

Current Understanding and Data Needs

The cap material should be appropriately sized to ensure compatibility with the underlying sediment and to minimize the degree to which impacted sediment particles migrate from the underlying sediment into the cap layer. A size ratio no greater than 5:1 between the smallest (<15%) particles of the cap media and the largest (>85%) particles of the sediment layer is typically used (Palermo et al. 1996).

Limited geotechnical data exist for intertidal sediments in the Estuary. USACE conducted a cohesive sediment erosion field study and analyzed a number of intertidal sediments throughout the Estuary. This study included analysis of a sample (ON-MU2-SF-1) collected from intertidal sediments within East Cove 4, which was the only sample collected within the Orrington Reach intertidal zone in this study (Amec Foster Wheeler 2018c). Although a complete suite of geotechnical analyses was not completed at this time, sediment grain size and bulk densities were determined from varying sediment depths. Results from this study indicated sediment grain sizes within Orrington Reach consist of primarily sand (38.0%–55.9%) and silt (41.8%–59.6%), with a minimal amount of clays (2.3%–2.9%). Bulk densities of the sediments ranged from 1.16 to 1.19 g/cm^3.

A geotechnical evaluation was performed in 2015 as part of Southern Cove PDIs to support design of a turbidity barrier and an equipment access road across the intertidal flats (Anchor QEA and CDM Smith 2016). Samples were collected from Southern Cove intertidal flats from the following three locations:

- SD-SC-04. Collected by hand auger, to a termination depth of 1.5 ft below sediment surface (bss). Sediment was classified as poorly graded sand.
- SD-SC-05. Collected using split-spoon samplers to a termination depth of 8 ft bss. Sediment was classified as follows, from top of core to bottom: elastic (high-plasticity) silt, poorly graded sand, silty sand, lean (low-plasticity) clay. Field measurements using a pocket penetrometer and handheld vane shear tester were performed on the lean clay layer at the time of sampling.
- SD-SC-06. Collected via vibracore to a termination depth of 1.9 ft bss. Sediment was classified as a lean clay, and field measurements using a pocket penetrometer and handheld vane shear tester were performed at the time of sampling.

Geotechnical samples were also collected in subtidal sediment via split-spoon samplers in the vicinity of the Southern Cove and reached a maximum termination depth of 22.5 ft. Samples were submitted for laboratory analysis of Atterberg limits, particle size, and moisture content. Lithology data collected during Southern Cove PDIs indicated a brown sandy silt between 0.5 and 2 ft bss within most of the intertidal mudflat, then a sand and gravel alluvium, underlain by metamorphic rock that varies substantially in elevation. These data will be considered in the capping design as well as in the design of additional geotechnical evaluations in Orrington Reach.

In addition, a limited number of core samples were collected from intertidal areas as a part of the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018d) and the Intertidal and Subtidal Characterization Report (Amec Foster Wheeler 2018e). One core (PBR-19) was collected from the intertidal areas of Orrington Reach (Amec Foster Wheeler 2018d). PBR-19 was collected at a depth interval of 0–59 cm below the sediment surface. Sediment from PBR-19 had a particulate organic carbon content that ranged from 2.7% to 14.3%, consisted primarily of silt (55.3%–87.4%), and had a lithology classification of clayey silt. Core ON-10-01 was collected within the intertidal zone from Orrington Reach (Amec Foster Wheeler 2018e); however, the sample was collected on the west side of the channel and may not be representative of the primary capping areas. If additional investigations determine capping locations along the western shore, these data may be utilized.

Because available geotechnical data, including grain size, are limited for intertidal sediment outside of Southern Cove in Orrington Reach, collection of representative geotechnical data is recommended to support an evaluation of the capping material grain size requirements to minimize intermixing with the underlying sediment due to cap placement and subsequent settling. Previous geotechnical investigations of Estuary sediments will also be considered, where relevant and appropriate, to support a thorough understanding of intertidal sediment characteristics. In addition, the geotechnical properties of potential borrow materials will need to be understood (Section 5.1.5).

Proposed Data Collection

Analyzing intertidal sediment geotechnical and physical properties provides an understanding of how the sediments will be affected during placement of the capping material. This includes an understanding of the potential compression of the in-river sediments, as well as the foundational stability of the sediments for the cap. Additionally, these properties aid in determining the capping material grain size and the selection of placement methods to reduce the potential for intermixing the contaminated sediments into the cap during installation.

Geotechnical data should be site-specific and representative of the capping areas and should include data from both the intertidal sediments and the interfaces between subtidal and marsh sediment. The following properties of the in-river sediment will be determined[10]:

- Atterberg limits (ASTM D4318)
- Sediment grain size (D6913-sieve and D7928-hydrometer)
- Bulk unit weight (ASTM D7263)
- Percent solids (ASTM 2216)
- Specific gravity (ASTM D854)
- Consolidation (ASTM 2435)
- Permeability (ASTM 5084)
- Shear strength (ASTM D4648/D2850).

[10] The methods for quantifying these properties will be finalized in the Sediment PDI Work Plan.

Representative geotechnical data from the targeted capping areas are required to ensure the cap design is appropriate for each location's specific river conditions. Previous geotechnical data were utilized to develop a generalized understanding of Site conditions; however, additional information is required to confirm sediment conditions and design criteria in each major capping location (e.g., each cove area, contiguous capping sections).

Seven coves along the east side of Orrington Reach have been identified for capping based on existing data (Figure 6). Although the exact location and footprint of the cap are not yet determined, sampling sediment in each of these coves is recommended for a complete geotechnical suite of analyses. The sample locations are intended to be representative of each cove targeted for capping and are distributed evenly, with approximately one sample location per 7 acres. To the extent practicable, the sampling locations will be positioned along a transect oriented perpendicular to the shoreline to evaluate geotechnical conditions across the intertidal flat area from the nearshore area toward the subtidal interface. It is also recommended that geotechnical data be collected in select coves along the western bank of the river, should further investigations and design work determine capping is required in these areas. To evaluate geotechnical conditions within an intertidal area, it is recommended that a transect of sampling locations extending from the nearshore to the subtidal interface be collected for geotechnical analyses. To the extent practicable, geotechnical samples will be collocated with additional investigative samples for cost savings.

It is possible that select capping locations will approach or encompass the interfaces where intertidal flats transition to either the subtidal areas or to intertidal marshes. Therefore, geotechnical samples will be collected that are representative of these interface zones. In addition, an evaluation of bathymetric data following the complete identification of capping areas should also be conducted to verify the cap slope. If the cap area slope exceeds a 3H:1V, additional design components may be required to ensure cap stability.

Additional PDI data collection will be necessary to evaluate slope stability. Slope stability analysis will include consideration of bearing capacity analysis and cap stability analysis as documented in EPA's Assessment and Remediation of Contaminated Sediments (ARCS) Program Guidance for In-situ Subaqueous Capping of Contaminated Sediments (USEPA 1998). As appropriate, models such as Slide will be used to evaluate slope stability of the cap and underlying sediment.

5.1.4.4 Benthic Habitat Evaluation

The cap placement will bury the existing benthic habitat and associated benthic community. The benthic habitat and community will recover as natural sediment accumulates on and mixes into the TLC, and benthic organisms recolonize the capped area. The recovery of the benthic habitat and community following the remedial action is an integral component of the natural recovery of the Estuary. As a result, evaluation of the benthic habitat and community in intertidal flat sediment within Orrington Reach is recommended both pre- and post-capping.

Current Understanding and Data Needs

There are limited Site-specific data/information available for characterizing the existing benthic community in the intertidal flat sediments proposed for TLC. Information is needed to characterize the benthic community and habitat under current (pre-TLC) conditions and to monitor the post-TLC reestablishment of the benthic habitat and recolonization by the benthic community. Information/data recommended for data collection include, but are not limited to, benthic species abundance, richness, and diversity; measurement of the biologically active zone thickness; documentation of biogenic features (e.g., burrows, feeding voids); and evidence of degraded habitat conditions (e.g., reduced sediment, methane pockets).

Proposed Benthic Community Evaluation

The proposed benthic community evaluation consists of two components: 1) sampling to characterize the relative abundance of benthic organisms, and 2) use of sediment profile imaging (SPI) to characterize the quality of the benthic habitat and to document indicators related to benthic community activity and health under baseline conditions and following TLC.[11]

As described in the Coastal Wetlands Assessment Plan (WSP 2023) wetlands characterization will be performed to support the NRPA permit application. The relative abundance of sediment-dwelling macroinvertebrates within areas considered for TLC placement will be evaluated through the collection and processing of sediment samples within the intertidal flats. Taxonomic identification will be performed as feasible to support an understanding of species richness and diversity.

SPI is recommended for use as a primary tool for evaluation of the benthic habitat recovery to the TLC. SPI technology was specifically developed to evaluate benthic community responses to disturbance in fine sedimentary habitats. SPI uses a camera prism system to collect a high-resolution plan view image of the sediment surface and a high-resolution SPI image of the near-surface sediment profile. These images provide direct observational and quantifiable data of *in situ* benthic conditions, including, but not limited to:

[11] Although the benthic community evaluation will include a comparison of the conditions post-TLC to the baseline (pre-TLC) conditions, it is possible that the current (baseline) benthic community is impaired by the elevated mercury concentrations in the intertidal sediment.

- Thickness of the biologically active zone in surface sediment as evidenced by the redox potential depth[12]
- Presence/abundance of biogenic features (e.g., organisms, burrows, feeding voids)
- Sediment grain size
- Evidence of degraded habitat/impairment (e.g., reduced sediment conditions, methane pockets, presence of non-native materials, such as wood chips)
- Post-TLC accumulated sediment thickness and extent of mixing into the TLC.[13]

SPI has been used to map physical, biological, and chemical/nutrient gradients in benthic habitats in a diverse array of freshwater and marine environments and is a well-documented approach to evaluating benthic habitat restoration following disturbances such as dredging or capping, and quantifying the progression of the benthic community successional stages following the disturbance (Germano et al. 2011).

Because SPI can be rapidly deployed from a vessel, does not require laboratory analyses, and can be preliminarily interpreted in real time, it allows for efficient and cost-effective mapping of benthic conditions (e.g., estimated 30–40 images per day) across large areas. Further, because the SPI data can be preliminarily evaluated in real time, it allows for timely investigation of anomalous conditions (e.g., potential areas of degraded benthic habitat) that may be encountered.

Two SPI surveys are proposed as part of the adaptive management approach to the design, permitting, and construction of the TLC. A baseline SPI survey of current benthic conditions will be conducted and the results evaluated along with the results of the coastal wetlands surveys of the proposed TLC areas. A second SPI survey will be done to assess the benthic community after the first-year phase of TLC construction. Subsequent SPI surveys may be considered, if needed, as part of the remedy performance monitoring to document recovery of the benthic community and demonstrate benthic conditions have stabilized post-TLC.

An SPI Survey Work Plan will be drafted, consistent with Paragraph 6(a) of the Statement of Work, to identify the objectives and scope of the initial SPI investigation.

5.1.4.5 Assessment of Ice Scour

During the winter, large sheets of ice form in the Penobscot River and Estuary and have been observed on the intertidal flats. Blocks of ice have been observed to scour the surface of the

[12] The redox potential depth is the depth of surface sediment where oxidized conditions are present that are supportive of benthic community respiration. These conditions can be quantified by SPI based on the thickness of lighter colored (oxidized) sediment.
[13] SPI will also provide visual confirmation of the presence of the TLC material.

intertidal flats as they are moved by the flow of the river. These processes have the potential to scrape away portions of the TLC and affect the TLC's effectiveness.

Current Understanding and Data Needs

Residents and members of the local community familiar with the Estuary have observed river ice can scour sediment on the intertidal flats. Additional information is needed to better understand where ice scour impacts may occur in Orrington Reach (e.g., are they more commonly observed in certain areas or coves?) and the extent and location of ice scour impacts within a given flat (e.g., do they occur broadly across a given flat or are they limited to isolated areas or portions of the flats?). This information will support an understanding of the Feasibility of a capping remedy and, if Feasible, the potential influence of ice scour on the TLC design.

Proposed Data Collection

An evaluation is proposed for 2023/2024 to assess the potential effects of ice scour. This evaluation will collect existing information from parties familiar with the effects of ice in the river, including but not limited to the U.S. Coast Guard, local harbor masters, and the Maine River Flow Advisory Committee. In addition, to the extent practicable, input from local property owners, local vessel operators, and area residents will be sought to support a general understanding of typical ice scour conditions. Based on the evaluation of existing information, a survey will be designed to look for evidence and measure the extent of ice scour on the intertidal flat surface during 2023/2024. The survey may include visual observations from land, boat, and/or drone imagery. If scour is observed, other methods (e.g., LiDAR-based elevation surveys) may be used to locate and quantify the extent of scour-related impacts.

5.1.4.6 Additional Considerations

All available sediment data will be reviewed and considered in the preparation of the Sediment PDI Work Plan. To maximize the efficiency of sample collection efforts, Integral will coordinate with WSP to integrate, to the extent possible, the sediment investigation with other data collection efforts in Orrington Reach proposed to support the remedial designs for other Work Categories. Sample locations and collection timing will be coordinated with WSP to avoid redundant sample collection, minimize the number of field deployments, and maximize efficiency when field teams are mobilized.

As discussed in Section 3.1, deposition and accumulation of wood waste has been identified as a potentially important mechanism for mercury redistribution to intertidal flat sediments in Orrington Reach. Field teams will be instructed to record any observations of wood waste on the surfaces of intertidal flats in Orrington Reach and in sediment samples collected from these areas. These observations will include qualitative observations of wood waste composition, color, and relatively abundance. Field notes will clearly record when and where wood waste is observed. The Sediment PDI Work Plan will specify that the field team collect samples of wood waste if observed on the intertidal flats, or in the grab samples or cores. In addition to noting the presence or absence of wood waste, field teams will observe redox potential depth and bioturbation depth in cores, to the extent possible.

5.1.5 Borrow Material Characterization

The sources of and characteristics of the borrow material used to construct the cap will have significant implications on both the design and cost of the Orrington Reach capping remedy. Efforts will be made to identify a local source of borrow material that can provide the capping material that meets the design criteria. An understanding of the sources of borrow material (e.g., potential location of borrow pits, ability to supply the required volume of material, borrow material geotechnical properties) is required before borrow material can be incorporated into the cap design.

Potential sources for borrow material include upland sources in or around Penobscot River, such as municipal properties, or borrow pits utilized for past remediation efforts in the river such as the Greenfield Road Pit, which was the backfill source for the Southern Cove sediment dredging conducted in 2017 (Anchor QEA and CDM Smith 2018). Sources for borrow material will require screening for accessibility and transport distance, transport to capping areas, likelihood of permission/access, characteristics of the borrow materials available, and volume of material available.

Borrow material from candidate sources will need to be characterized to ensure the material meets performance criteria required for the cap. This will include quantification of the borrow material's geotechnical and physical properties, including but not limited to grain size, moisture content, and any other characteristics that may be relevant to placement methodology. The source of the borrow material will need to be verified as free from environmental contamination, including total mercury and other potential contamination. Representative samples of the borrow material will be collected, analyzed by a laboratory, and evaluated prior to selection for capping.

5.2 PROPERTY ACCESS

As described above, in the state of Maine, property ownership for parcels abutting a river typically includes the intertidal zones adjacent to the property. As such, property access and permission to conduct sediment monitoring and place the capping material will be requested from each property owner for parcels to be sampled. As part of the NRPA permitting process, access will also be required for parcels that include or abut the area to be capped.

Final determination of the areas to be capped depends on securing access from owners of adjacent property to place and monitor the cap. The refined understanding of Site conditions provided by additional data collection will help identify the parcels of highest priority and adjacent parcels that may provide contingent locations in the event that access is not granted for target areas.

Property ownership has been identified for the preliminary target areas along the eastern side Orrington Reach and in Bald Hill Cove on the western side of the river (Figure 7). The Remediation Trust is leading efforts to secure access, and the process includes the following:

- Contacting Municipalities within Orrington Reach. The Remediation Trust has met with representatives of the towns of Orrington, Bucksport, and attended a meeting in Winterport in 2023 to describe the proposed Work, get their feedback, identify key issues, and determine how to reach out to parcel owners (i.e., presentation, mailer).
- Contacting Parcel Owners. Following the meetings with the municipalities, the Remediation Trust will reach out directly to the parcel owners that will have Work performed on the intertidal sediments on their property to request access for design activities (i.e., sediment sampling) and will present the scope of the proposed Work. Access will be required for the implementation of the Work, which will be conducted following the sampling.

5.3 PERMITTING

Implementation of a capping remedy will require permits from the Maine DEP, USACE, and other state, federal, and local agencies. Permits that are potentially required include, but are not limited to:

- Maine DEP Maine NRPA permit
- USACE permit (joint with Maine DEP NRPA permit)
- Construction Stormwater Management permit (shore construction activities, as applicable)
- Post-construction Stormwater Permit (stormwater management at land-based support area)
- Submerged Lands Lease (for activities below mean low water, as applicable)
- Town of Orrington/Bucksport Activities in Shoreland Zone approval
- Town of Orrington/Bucksport Flood Hazard Development Permit (Work in flood zone)
- Town of Orrington/Bucksport Building Permit (shore construction activities).

A Permitting Plan has been developed to identify the tasks required to develop information for permit applications. The Permitting Plan outlines the requirements, approach to address, and suggested schedule and is included as Appendix A. This Permitting Plan is a living document and will be modified as necessary to incorporate information received from permitting agencies during the Remediation Trust's communication with agency staff.

Key items that will affect project feasibility and need to be resolved during the permitting process include:

- Net Fill and Flood Mitigation. During the NRPA permitting process, the permitting agencies will evaluate whether the addition of cap material to the surface of intertidal flats will have a negative effect on adjacent shoreline areas and of available flood storage. A determination that existing sediment must be removed prior to placing cap material to avoid a net gain of in-water material will significantly increase project complexity and cost. If removal of material is required prior to cap construction, implementation of capping may become cost prohibitive and not Feasible.
- In-Water Work Windows. The USACE's standard work window on the Penobscot River 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 has indicated its work window may be modified, depending on the type of work to be done and the potential for habitat disruption. Being able to expand the USACE's work window is important because time available to work on the river is further reduced due to winter weather and Site icing, which typically begins in late December/early January and extends through March. Limitations to on-river work will extend the overall construction timeframe and increase the cost of remedy implementation.

The Remediation Trust will work with state and federal agencies as part of the Adaptive Management Team to identify the information that can be provided during the permit application process to inform decisions on potential permit requirements.

5.4 PUBLIC APPROVAL

Public approval and support for the remedy is paramount to the success of the TLC project. Community involvement activities will occur throughout all phases of work to ensure communities are well informed of remediation activities, to obtain necessary access from landowners, and to understand potential concerns that may affect community support of the proposed TLC. The Remediation Trust will make information available and solicit feedback in several ways, including hosting Town Hall meetings, preparing fact sheets, and posting materials to a public website.

5.5 UNCERTAINTIES OR DATA GAPS NOT ANTICIPATED TO REQUIRE CLARIFICATION OR FURTHER INVESTIGATION

The effectiveness of remedial actions can be limited by technical or physical constraints, incomplete understanding of conditions at a site, or incorrect design assumptions resulting from these data gaps. Specific data gaps that may influence the remedy selection and subsequent design basis include at the Site were identified in Section 5.2. Other data gaps exist that will not substantively affect the design or implementation of the TLC. For sake of completeness, those items are identified here:

- Atmospheric deposition of mercury
- Mercury loading from urban background sources
- Groundwater upwelling.

6 NEXT STEPS

This section identifies the next steps in the Design process based on information presented in this TLC Design Work Plan. The following sections describe the key tasks necessary to implement the remedial design approach and schedule identified in Section 4.2. A detailed schedule is provided in Figure 4.

6.1 WORK DESIGN

The process to complete the data collection and analysis activities necessary to finalize the BOD and complete the design, identified in Section 5, will be implemented. The following tasks will be undertaken:

- The following Investigation Work Plans have been developed in accordance with Paragraph 6(a) of the Statement of Work and were submitted for Beneficiary review in advance of this Design Work Plan to allow the investigations to be performed at appropriate times in 2023:
  - River Flow Velocity Monitoring Work Plan
  - Bathymetric Survey Work Plan
- The Sediment PDI Work Plan is being developed in accordance with Paragraph 6(a) of the Statement of Work and is anticipated to be submitted for Beneficiary review in July 2023. A follow-up Sediment Geotechnical PDI Work Plan will be developed for a more detailed geotechnical investigation in 2024.
- A streamlined SPI Survey Work Plan will be developed in accordance with Paragraph 6(a) of the Statement of Work.
- Upon completion of the investigations identified above, Investigation Reports for each of the field activities will be developed in accordance with Paragraph 6(b) of the Statement of Work.
- Non-field investigation work design tasks will be conducted, including:
  - Hydrodynamic modeling
  - CapSim modeling
  - Wind/Wave analysis
  - Borrow material characterization
- Following completion of the tasks above, the preliminary design work will continue in accordance with Paragraphs 8 and 9 of the Statement of Work.

6.2 PERMITTING AND REGULATORY APPROVALS

As previously noted, a Permitting Work Plan is included as Appendix A to this TLC Design Work Plan. This plan includes descriptions of applicable permitting and authorization requirements and other regulatory requirements, including the timeline for securing regulatory approvals and the Trustees' plans for meeting the applicable permitting and regulatory requirements during the Work Design process.

The primary permit consists of the Maine DEP Maine NRPA permit and the USACE permit (joint with Maine DEP NRPA permit). This permit will identify the requirements that the project needs to meet in its design and implementation phases.

To facilitate the permitting process, the Remediation Trust met with Maine DEP in February to discuss the TLC project, and the use of an Adaptive Management Team to facilitate the permitting process.

6.3 PROPERTY ACCESS

Consistent with Section 5.4, Greenfield has been in contact with Municipalities in Orrington Reach to present the proposed Work, get input on community interests, identify key issues, and provide advice regarding contact with parcel owners.

Greenfield will contact owners of parcels adjacent to intertidal flats to provide information on planned design and permitting activities (e.g., sediment sampling and wetlands assessment surveys) and request access. Additional access permissions from owners of all parcels adjacent to TLC areas will be required for the construction of the TLC.

6.4 SUPPORTING DELIVERABLES

In accordance with Paragraph 31 of the Statement of Work, Supporting Deliverables are being developed for the investigation activities identified in this document. Individual investigation work plans will reference the Site-wide Supporting Deliverables and will include activity specific requirements as appropriate.

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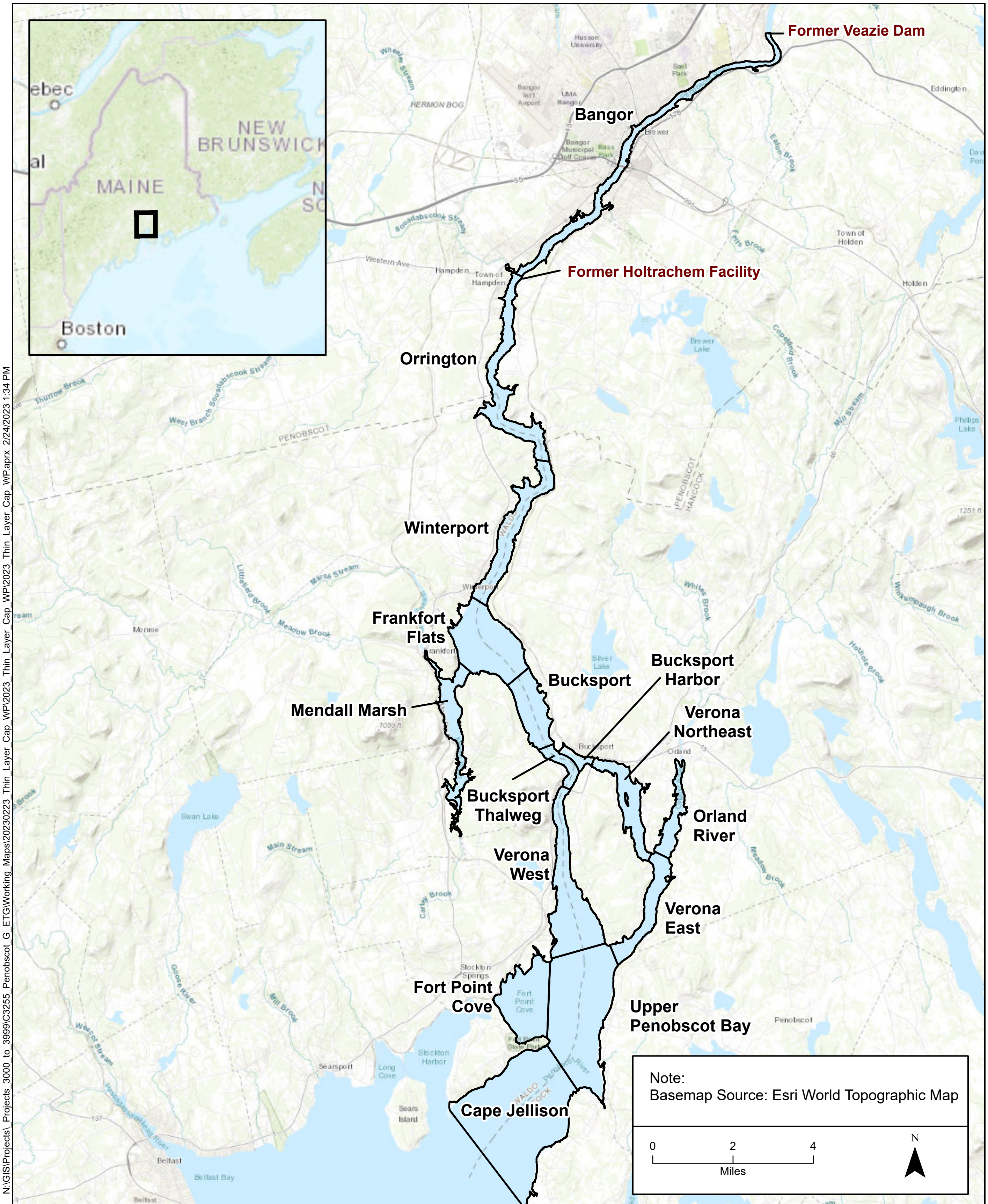
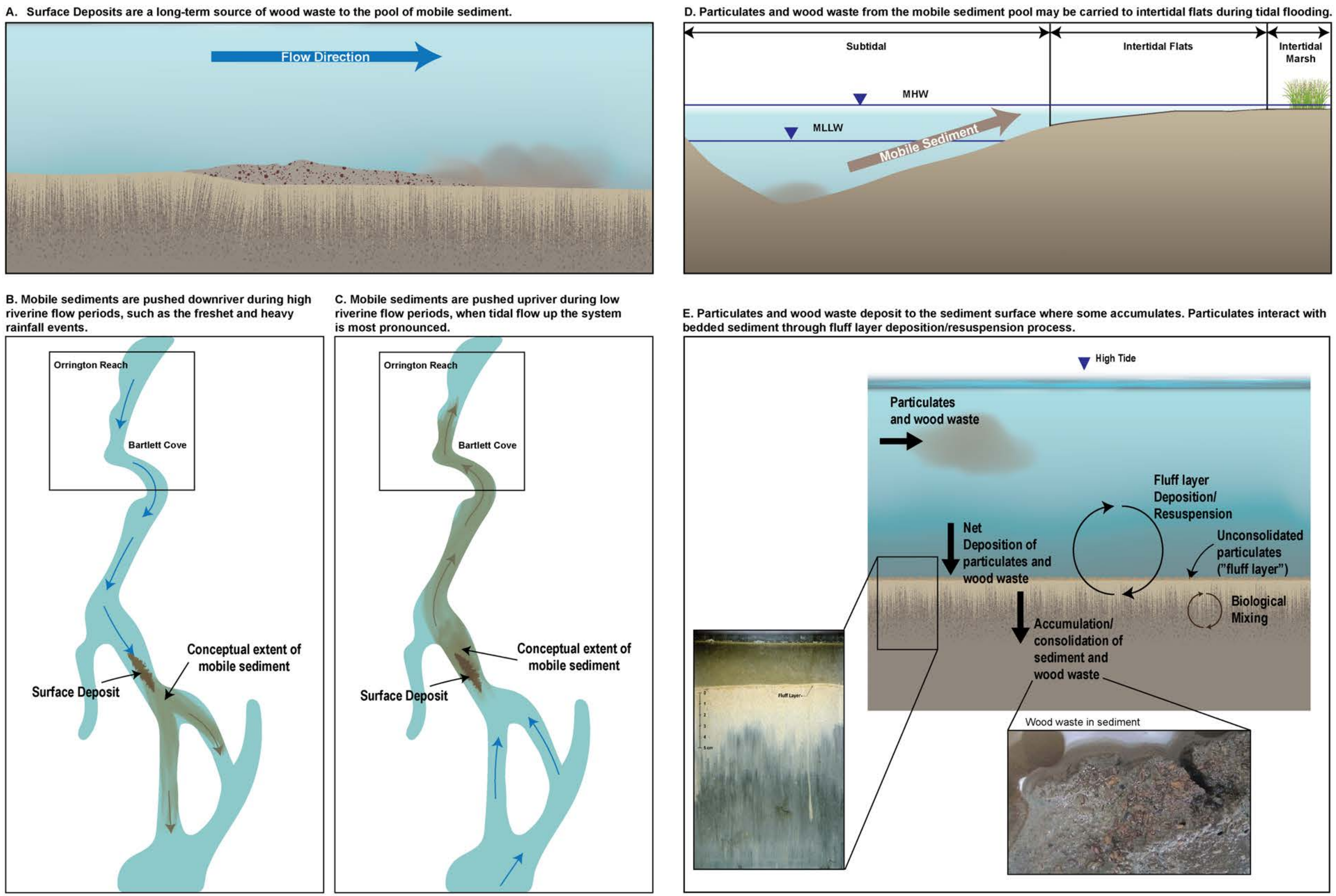


Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee of the Penobscot Estuary Mercury
Remediation Trust

Prepared by: integral consulting inc.

Figure 1.
Penobscot River Reaches
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023

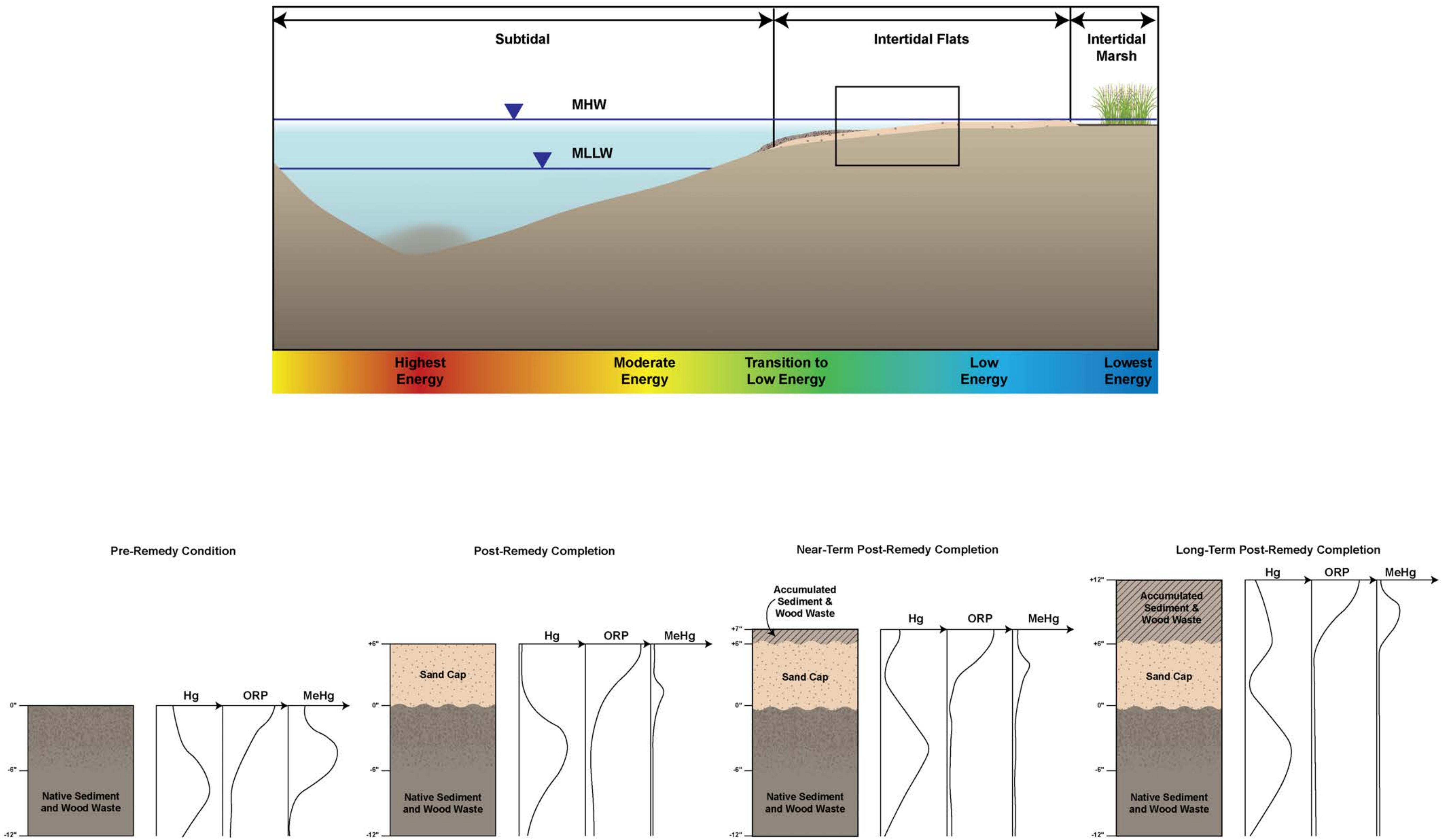


7/5/2023

Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee for Penobscot Estuary Mercury Remediation Trust

Prepared by: integral consulting inc

Figure 2.
Conceptual Site Model Illustrating Key Processes Influencing Mercury Fate and Transport in Orrington Reach Intertidal Flat Sediment under Present Day Conditions
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023



Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee for Penobscot Estuary Mercury Remediation Trust

Prepared by: integral consulting inc

Figure 3.
Conceptual Site Model Illustrating Key Processes Influencing Mercury Fate and Transport in Orrington Reach Intertidal Flat Sediment after TLC Placement
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023

7/5/2023

ID	Task Name	Duration
1	Effective Date of Consent Decree	0 days
2	Orrington Reach	3499 days
3	Planning/Investigation/Studies	492 days
4	Planning & Scheduling	352 days
12	Work Plans	347 days
13	River Flow Velocity Investigation Work Plan	60 days
18	Bathymetric Survey Investigation Work Plan	56 days
28	RT02 Sediment PDI Work Plan	123 days
38	RT02 Benthic Community Assessment Work Plan	179 days
47	RT02 Sediment Geotechnical PDI Work Plan	63 days
58	Field Work & Analyses	369 days
59	River Flow Velocity Investigation (Integral)	148 days
64	Bathymetric Survey (WSP)	157 days
70	Wetlands Assessment Fieldwork (WSP)	60 days
74	Sediment PDI Fieldwork (Integral/WSP)	167 days
81	Sediment Geotech PDI Fieldwork (Integral/WSP)	226 days
87	Benthic Community Baseline Assessment Fieldwork (Integral)	100 days
93	Reporting	341 days
94	Wetlands Assessment Report (WSP)	65 days
103	Sediment PDI Report (Integral)	60 days
112	Sediment Geotech PDI Report (Integral)	60 days
121	River Flow Velocity Report (if necessary)	40 days
123	Bathymetric Survey Report	36 days
132	Benthic Assesment Baseline Report	80 days
141	Permitting & Regulatory Coordination	672 days
142	Planning	95 days
143	Planning	38 days
145	Permitting Plan	95 days
159	Permit Application Preparation	461 days
160	Maine DEP NRPA Permit (application & attachments)	318 days
169	Permit Application Preparation & Submittal	375 days
182	Army Corps of Engineers Permit (Form 4345 or Joint Applicatio	445 days
185	Land-side Facility - Construction Stormwater	41 days

Task
Milestone
Summary
Progress

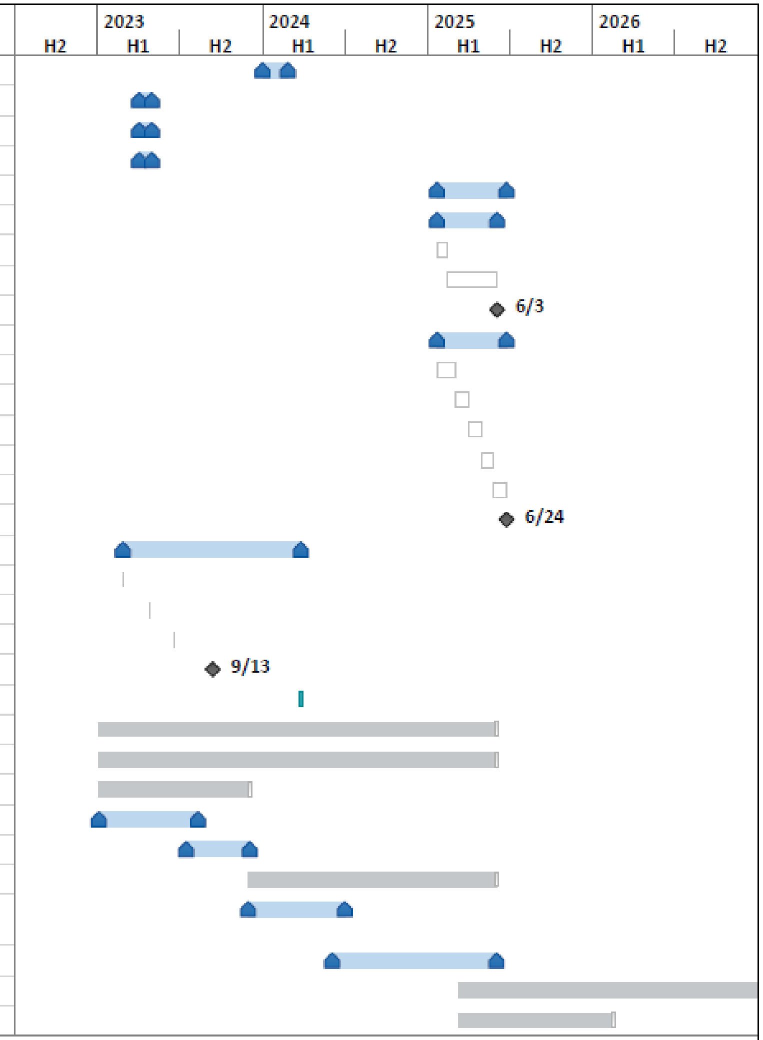
Prepared for:

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

Prepared by:

Figure 4a.
Project Schedule
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023

ID	Task Name	Duration
189	Municipal Shoreland Zoning	40 days
192	Maine Site Location of Development Law - Applicability Reviev	20 days
194	Flood Plain Management/NFIP (Exec Order 11988) - Applicabili	20 days
196	National Pollutant Discharge Elimination Sys (NPDES) - Applica	20 days
198	Regulatory Permit Review/Approval	110 days
199	MAINE DEP APPROVAL (Individual Permit)	95 days
200	Completeness Review	15 days
201	Agency Outreach/Processing*	4 mons
202	Permit Approval Received	0 days
203	ARMY CORPS OF ENGINEERS (ACOE) APPROVAL (Individual Pe	110 days
204	Public Notice	30 days
205	Public Interest Review	20 days
206	Additional Information	20 days
207	Public Hearing, if needed	20 days
208	ACOE Review/Decision	20 days
209	Permit Approval Issued	0 days
210	Regulatory Agency Meetings & Correspondence	272 days
211	MEDEP Introductory Meeting (Remediation Trust)	1 day
212	Pre-Application Meeting (MEDEP & USACE) #1	1 day
213	Pre-Application Meeting (MEDEP & USACE) #2	1 day
214	Pre-Application Meeting (MEDEP & USACE) #3	0 days
215	Pre- Application Submission Meeting	1 day
216	Design, Construction, and Implementation	618 days
217	Design	618 days
218	Preliminary Design	235 days
219	Design Work Plan	157 days
228	30% Design	98 days
239	Final Design	385 days
240	60% Design (Use for Contractor Engagement D/B, EPC)	145 days
249	Final Design Process w/ Contractor	260 days
254	Implementation/Construction	2744 days
255	Implementation Work Plans	246 days



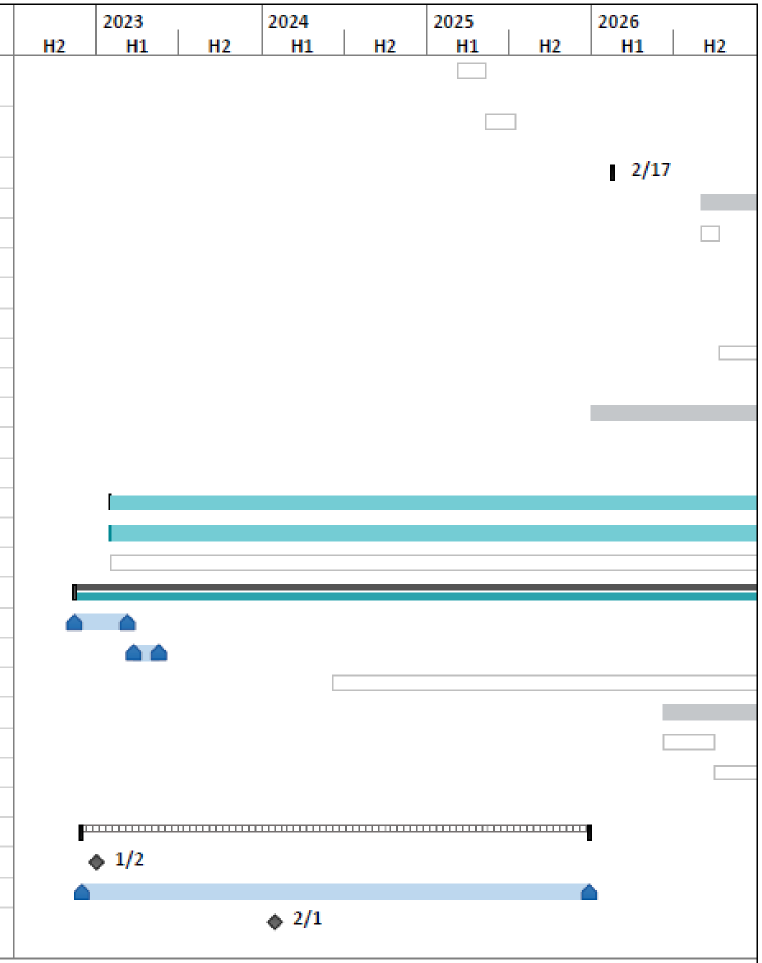
Task Milestone Summary Progress

Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee of the Penobscot Estuary Mercury Remediation Trust

Prepared by: integral consulting inc.

Figure 4b.
Project Schedule
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023

ID	Task Name	Duration
256	Prepare/Submit Implementation Work Plan (incl. Trust Review)	45 days
257	Implementation Work Plan Revisions and Negotiations	45 days
258	Receive TLC Implementation Permit Approval	0 days
259	Implement Remedial Action (Based on Fish Window)	1247 days
260	Season 1 ("Pilot Phase")	28 days
261	Season 2	75 days
262	Season 3	75 days
263	Season 4	75 days
264	Implementation Work Completion Inspections	1219 days
265	Prepare and Submit Final Implementation Work Report	45 days
266	Performance Monitoring & Maintenance (est. 5 years)	1600 days
268	Site Closure	120 days
271	Meetings & Inspections	0 days
272	Community Involvement	3200 days
273	Fact Sheets, Newsletters, & Mailings	3200 days
274	Community Presentations	3200 days
275	Database & Records Management	3200 days
276	Data Platform Work Plan	75 days
284	Data Platform Development	40 days
291	Data Management	3100 days
292	Monitoring and Maintenance	2480 days
293	Work Plan	80 days
294	Fieldwork & Analyses	2400 days
295	Reporting	0 days
296	Access and Property Management	786 days
297	Trustee Costs	0 days
298	Access Agreements	786 days
305	Property Transactions & Management (leases, acquisitions)	0 days

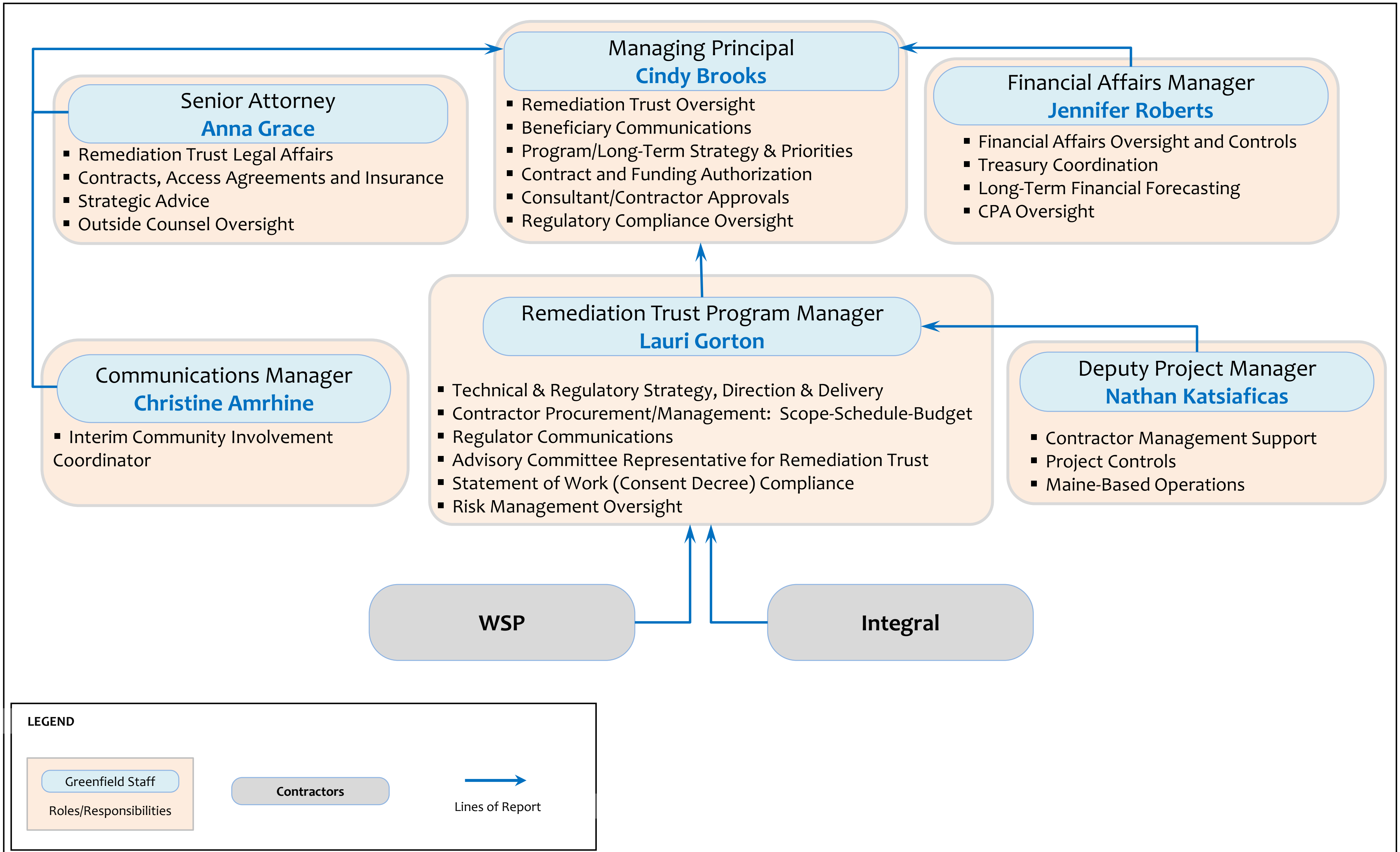


Task
Milestone
Summary
Progress

Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee of the Penobscot Estuary Mercury Remediation Trust

Prepared by: integral consulting inc.

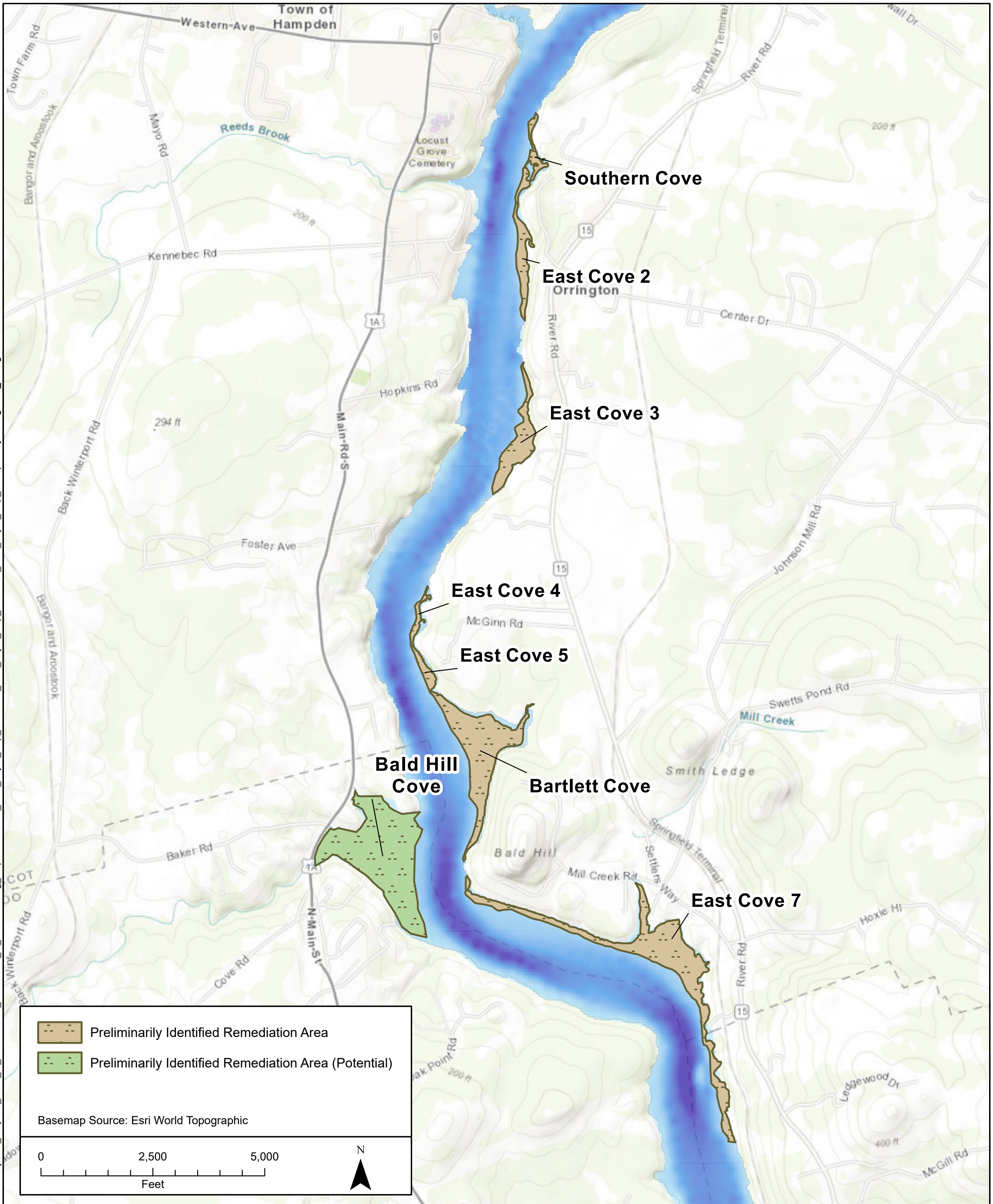
Figure 4c.
Project Schedule
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023



Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee of the Penobscot Estuary Mercury Remediation Trust

Prepared by: Integral Consulting Inc.

Figure 5.
Greenfield, Integral, and WSP Organizational Chart
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023

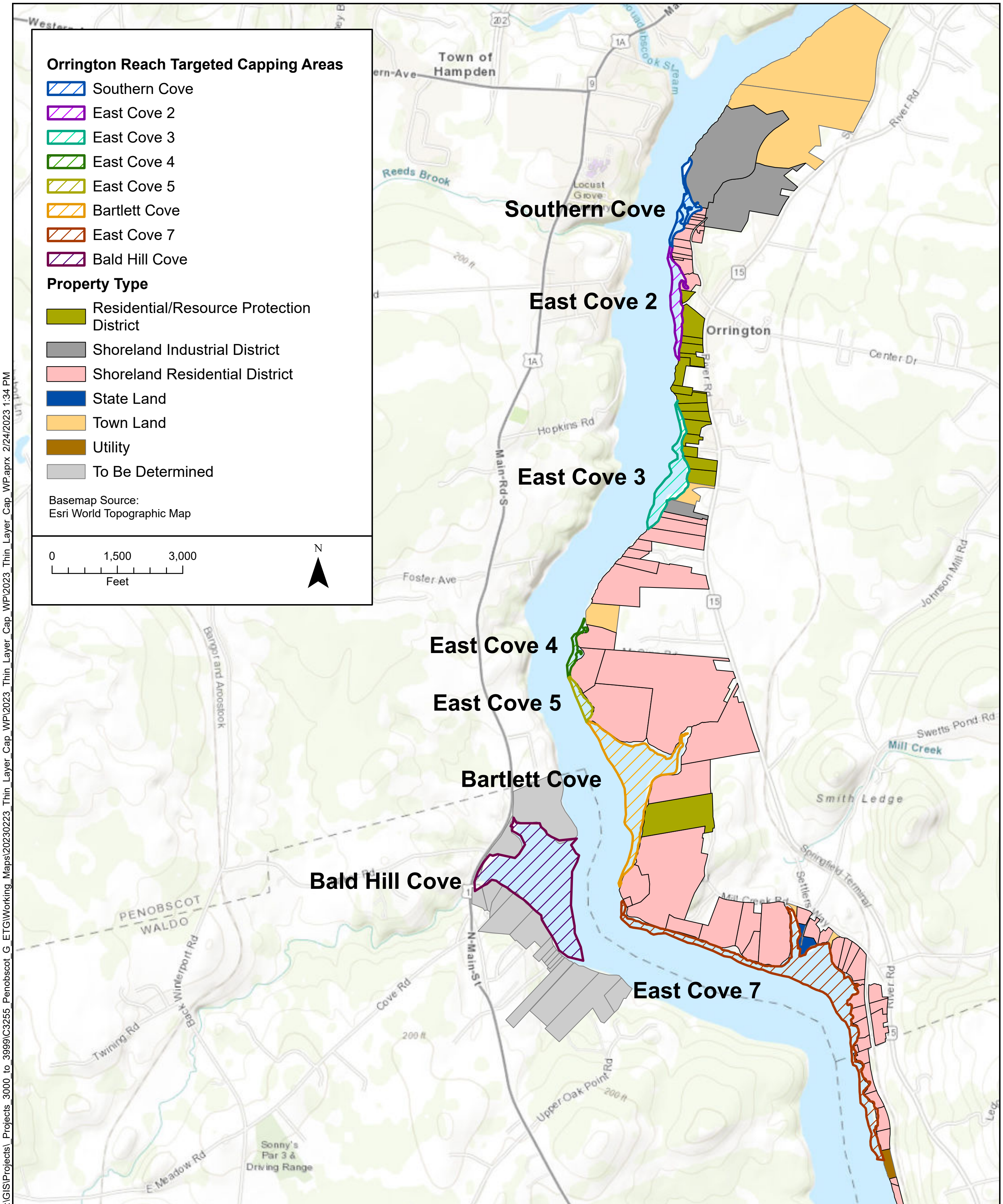


Prepared for:

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

Prepared by: integral consulting inc.

Figure 6.
Seven Coves Preliminarily Identified as the Remediation Area for Orrington Reach
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023



Prepared for: Greenfield Penobscot Estuary Remediation Trust LLC
Trustee of the Penobscot Estuary Mercury Remediation Trust

Prepared by: integral consulting inc.

Figure 7.
Orrington Reach Parcel Ownership
Thin Layer Cap Design Work Plan
Orrington Reach Capping Remedy
July 2023

Tables

Table 1. Summary of the Preliminary Basis of Design and Additional Data Collection and Analysis Needs for the Orrington Reach Capping Remedy

Parameter	Design Basis	Considerations	Current Understanding	Additional Data Collection and Analysis Needs	Scope of Additional Data Collection and Analysis
Capping Area Location and Extent					
Total Area to be Capped	130 acres of intertidal sediment	Stipulated in the Consent Decree	Analysis to date has identified 130 acres on east side of Orrington Reach as the preliminary remediation area	Bathymetry of the area to be capped, including the slope and extent of intertidal area, needs to be established for consideration in the design Assessment of the area and extent of ice scour impacts on intertidal flat sediment in Orrington Reach.	Conduct bathymetric survey (Section 5.1.1) Conduct assessment of ice scour impacts (Section 5.1.4.5)
Elevation Range of Sediment to Be Capped	Intertidal zone defined as elevations between MLLW and MHW elevations (6.69 to −7.04 ft mean sea level)	Intertidal sediment as stipulated in the Consent Decree	Bathymetric survey data collected 1984 through 2016		
Cap Stability	Physical stability of cap	Cap material has the potential to be unstable at slopes greater than 3H:1V or 33% grade	Grades in the preliminary remediation area meet slope criterion		
Total Mercury Concentration	Maximize the reduction in the average total mercury concentration in surface sediment to the extent possible	Existing data indicate that total mercury concentrations are elevated in surface sediment of Orrington Reach intertidal flats	Capping of the preliminary remediation area will result in a substantial reduction in total mercury concention in surface sediment in Orrington Reach	Sediment sampling to supplement the existing mercury data set and support the identification of the final area to be capped	Conduct sediment sampling for chemical concentration analysis in intertidal sediment on east and west side of Orrington Reach (Section 5.1.4.1)
Property Access	Written permission to access the properties and to place the cap	Permission required by each property owner to place cap	A total of 75 tax parcels have been identified as associated with the preliminary remediation area	Property access agreements to allow for sampling and for placement of the cap. Additional areas for capping may need to be identified depending on the access achieved.	Seek property access agreements with parcels' property owners (Section 5.2)
Capping Material					
Cap Stability	Physical stability for a 100-year storm event	Select grain size for a “no movement” condition under a modeled 100-year storm event	Preliminary modeling indicates a course sand to fine gravel will be stable for the majority of the preliminary remediation area	Refined hydrodynamic modeling needed to estimate shear stresses over the cap under 100-year storm event and under future site conditions Bathymetry survey needed of the area to be capped and lower Penobscot River to support calibration of hydrodynamic model Velocity data collection during freshet needed to support calibration of hydrodynamic model	Conduct bathymetric survey (Section 5.1.1) Conduct river flow velocity study (Section 5.1.2) Update hydrodynamic model with bathymetric survey/existing USGS LIDAR survey and velocity data (Section 5.1.3.1)
		Select armoring as needed for a “no movement” condition under a modeled 100-year storm event	Preliminary modeling indicates armoring may be required for 24% of the preliminary remediation area		
Cap Stability (Ice Scour)	Limit movement of clean TLC materials by ice scour	To the extent practicable, prioritize areas for TLC placement where influences of ice scour are limited and/or include provisions (e.g., armoring) to minimize impacts of ice scour on the TLC.	During the winter, large blocks of ice are reported to form in the Estuary and have been observed to scour the surface of the intertidal flats as they are moved by river flow and tidal processes.	Identify intertidal flat areas in Orrington Reach potentially subject to ice scour and collect information to assess the potential magnitude of scour influence (e.g., area affected, depth of scour, etc.)	Collect existing information from parties familiar with the effects of ice in the river. Based on the evaluation of existing information, a survey will be designed to look for evidence and measure the extent of ice scour on the intertidal flat surface during 2023/2024. (Section 5.1.4.5)
Compatibility with Underlying Sediment	Minimize intermixing of underlying sediments into clean cap material	Maximum size ratio of 5:1 between the smallest (<15%) particles of the cap media and the largest (>85%) particles of the sediment layer (Palermo et al. 1996)	Limited available grain size data indicate that the native sediment is fine grained (predominantly silt)	Geotechnical characterization of the native sediment and the proposed cap material needed	Conduct sediment sampling for geotechnical analysis (Section 5.1.4.3) Identify borrow material sources and characterize potential borrow materials (Section 5.1.5)
Borrow Material Availability	Sufficient material to implement capping	More than 100,000 CY of capping material is likely necessary. Identify material availability and transport factors.	Limited information is known about currently available borrow material sources. No transload facilities are present within Orrington Reach.	Borrow material from candidate sources will need to be characterized to ensure the material meets performance criteria required for the cap. Transport options will need to be evaluated.	Identify borrow material sources and characterize potential borrow materials (Section 5.1.5)

Table 1. Summary of the Preliminary Basis of Design and Additional Data Collection and Analysis Needs for the Orrington Reach Capping Remedy

Parameter	Design Basis	Considerations	Current Understanding	Additional Data Collection and Analysis Needs	Scope of Additional Data Collection and Analysis
Capping Thickness					
Minimum Protective Thickness	Limit migration of mercury into and through the cap material through bioturbation and physical transport mechanisms, such as advection, dispersion, and diffusion	Modeling to estimate minimum thickness requirements	Bioactive zone of the Estuary is estimated at a thickness of 0–6 in.	CapSim modeling needed to evaluate the minimum cap thickness requirement	Conduct CapSim modeling (Section 5.1.3.2) SPI investigation to establish the baseline thickness of the bioactive zone (Section 5.1.4.4)
Destabilization of Underlying Sediment	Minimize mud wave formation during cap placement	Evaluation of sediment geotechnical properties, including shear strength	Limited geotechnical data are available for intertidal sediment in Orrington Reach	Geotechnical characterization of the native sediment and the proposed cap material needed	Conduct sediment sampling for geotechnical analysis (Section 5.1.4.3)
Minimize Volume of Fill	Minimize potential impacts to intertidal habitat, flood risk, and need for mitigation by minimizing the volume of fill placement	Acceptable fill quantities (area, volume, thickness) and associated mitigation requirements will be established through negotiation with permitting agencies	Anticipated that preference of permitting agencies will be for minimizing cap thickness	Identify and engage with the appropriate permitting agencies	WSP has prepared a Permitting Work Plan to develop approach for capping (Appendix A)
Additional Considerations					
Post-Capping Conditions	Minimize likelihood of recontamination of capped areas by other sources including other Site remedial actions	Deposition may recontaminate capped areas	Orrington Reach intertidal mudflats are net depositional areas and sediment deposition is expected to continue on top of the sediment cap following placement in Orrington Reach	Sediment sampling needed to characterize mercury concentrations and the composition of particulates and wood chips depositing in the area to be capped and to evaluate biological mixing.	Conduct sediment sampling in Orrington Reach as part of the Mobile Sediment and Surface Deposits design work plan (WSP, in preparation) and visually log the redox potential depth in sediment cores and, if feasible, sediment samples (Section 5.1.4.2)
Post-Capping Benthic Habitat	Demonstrate the reestablishment of the benthic community following TLC placement	TLC placement will temporarily disrupt the benthic community. The community is expected to recolonize the sediment surface over time.	The benthic community health is potentially impaired by the presence of mercury contamination in surface sediment.	Characterization of the benthic community habitat prior to TLC placement to quantify baseline conditions and over time following placement of the TLC to monitor the progression of reestablishment of the benthic community.	Quantify relative abundance of baseline benthic invertebrates to support permitting. Conduct pre- and post-TLC placement SPI investigations to quantify baseline condiitions and to evaluate re-establishment of the benthic habitat over time following TLC placement.

Notes:
MHW = mean high water
MLLW = mean lower low water
SPI = sediment profile imaging
SWAC = surface weighted average concentration
TLC = thin layer cap

Table 2. Roles and Responsibilities for Orrington Reach TLC Design and Permitting

Remedial Design Task	Greenfield Role	Integral Role	WSP Role
Beneficiary Communication	Lead	Technical support	Technical support
TLC Preliminary Design and Primary Deliverables	Oversight, deliverable review, and project management	Lead	Coordination with other Work Categories as appropriate
Supporting Deliverables	Oversight, deliverable review, and project management	Lead for activity-specific plans	Lead for Site-wide plans
Communication with Permitting Agencies	Lead	Technical support	Technical support
Implementation Permits	Permittee	Support permitting efforts with TLC design information	Permit planning and application development
Field Investigation Permits	Permittee	Permit identification and technical support	Permit identification and technical support
Access	Lead	Identification of access needs and technical support	Identification of access needs and technical support
Community Involvement	Greenfield	Support	Support
Investigation Work Plans	Oversight, deliverable review, and project management	Lead for TLC pre-design sampling investigations	Lead for bathymetric investigations and coordination with Mobile Sediments/Surface Deposits investigations
Investigation Field Sampling and Analyses	Oversight, deliverable review, and project management	Lead for analyses, support for and participation in field events	Lead for subcontracting and field implementation
Database Management	Oversight and project management		Lead
Investigation Reports	Oversight, deliverable review, and project management	Lead for TLC pre-design sampling investigations	Lead for bathymetric investigations and coordination with Mobile Sediments/Surface Deposits investigations

Appendix A

Permitting Work Plan

PERMITTING PLAN
ORRINGTON REACH THIN-LAYER CAPPING
PENOBSCOT ESTUARY REMEDIATION

Prepared for

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

Prepared by

511 Congress Street, Suite 200
Portland ME 04101

February 2023
Updated May 2023

S I G N A T U R E S

PREPARED BY

____

Todd Coffin, Permitting Specialist
Senior Associate Environmental Scientist

APPROVED BY *(must be reviewed for technical accuracy prior to approval):*

____

Rod Pendleton, Project Manager
Vice President

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete.

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APPENDICES

1 INTRODUCTION

This Permitting Plan has been prepared to identify and obtain all permits required for the implementation of the Orrington Reach capping remedy pursuant to Paragraph 10 of the United States District Court, District of Maine (the Court) October 11, 2022, Consent Decree and Paragraphs 35 and 36 of the associated Statement of Work (United States District Court, 2022). WSP USA Environment & Infrastructure, Inc. (WSP), has prepared this Permitting Plan for the capping of intertidal sediments in Orrington Reach within the Penobscot River Estuary located in Hancock, Penobscot, and Waldo counties, Maine (the Site) on behalf of the Greenfield Penobscot Estuary Remediation Trust LLC, not individually but solely in its representative capacity as Trustee of the Penobscot Estuary Mercury Remediation Trust (Remediation Trust) (refer to Figure 1).

The Remediation Trust was established pursuant to a Consent Decree approved and entered by the U.S. District Court for the District of Maine (Maine People's Alliance and NRDC v. Holtrachem Manufacturing Company LLC, et al., No. 1:00-cv-00069-JAW (D. Maine October 11, 2022)) (the "Consent Decree"). The Remediation Trust was established to implement the remediation work required under the Consent Decree and to otherwise carry out the important purpose of accelerating recovery of the Penobscot River Estuary.

In accordance with the Consent Decree, the primary components of the approved mercury remediation within the Site include:

1. Design, permitting, implementation, remedy-specific monitoring, and maintenance of a cap for 130 acres of intertidal sediments in the Orrington Reach.
2. Removal of mobile sediments and surface deposits from the Site.
3. Remedy selection, design, implementation and remedy-specific monitoring in the Orland River and East Channel Area.
4. Implementation of Beneficial Environmental Projects at the Site to provide "tangible environmental or public benefits to affected communities or the environment that are intended to mitigate or offset potential adverse impact(s) directly or indirectly caused by mercury contamination at the Site."
5. Long-term monitoring of the Site.

This Permitting Plan has been developed for implementation of a Thin Layer Cap (TLC) in Orrington Reach. Figure 2 shows the preliminary areas within the Orrington Reach targeted for remediation with TLC. The proposed TLC remediation phase of work may include complimentary development of one or more temporary, land-based staging areas and pier/docks for storage, handling and transport of project materials and supplies; the location of the staging area(s) has yet to be determined.

The projected schedule for the Permitting Plan is presented in Appendix A. The primary tasks associated with the Permitting Plan are:

- Regulatory agency meetings;
- Engagement of the public, local municipality governments and other stakeholders;
- Collection and reporting of relevant environmental data from Orrington Reach to support the permit applications;
- Development and submittal of permit applications;
- Support of public notices and public meetings associated with the permitting process; and
- Response to information requests and collaboration with regulatory agencies for permit approval.

2 OBJECTIVES

This Permitting Plan has been prepared to identify the activities necessary to secure all permits needed for the timely implementation of the Orrington Reach TLC remediation phase of work. The Permitting Plan provides details on the following topics:

- Project Organization and Logistics
- Regulatory Framework
- Permit Process

The primary objective of the permitting plan is to direct preparation of thorough, technically defensible permit applications that can be approved by the respective regulatory agencies and authorities. The permitting plan has been designed to meet applicable local, state, and federal regulations while addressing the remedial objectives of the Consent Decree.

3 PROJECT ORGANIZATION AND LOGISTICS

3.1 PROJECT ORGANIZATION

An organization chart for the permitting process for the Orrington Reach TLC remedy is provided as **Figure 3**.

3.2 LOCAL POINTS OF CONTACT

A list of points of contact for implementation of the permitting process is provided as **Table 1**.

3.3 TITLE, RIGHT, OR INTEREST

As described in Section 4.2.2.6, private coastal upland owners in Maine typically hold title to the adjacent land between the mean high-water mark and the mean low-water mark (intertidal zone). Completion of the Natural Resources Protection Act (NRPA) permit includes providing Maine Department of Environmental Protection (MEDEP) documentation of Title, Right, or Interest for the privately-owned land on which the TLC is proposed. As described in the NRPA permit application, the applicant must indicate whether it owns, leases, has an option to buy, or has a written agreement to use the property. The application must include a copy of a deed or other legal documents establishing title, right, or interest in the Site.

In addition to Title, Right, or Interest, permission from the upland owners is anticipated to be required for accessing the intertidal zone for wetlands characterization (e.g., inventory of flora and fauna, functions, and value assessment). The Remediation Trust is completing an inventory of land parcels abutting the Site and is working in parallel with the permitting effort to secure Title, Right, or Interest, and land access.

4 PERMITTING

4.1 REGULATORY FRAMEWORK

Anticipated permits and approvals for the Orrington Reach TLC remedial program are summarized in Table 2. The primary permits are listed below:

- MEDEP NRPA permit
- US Army Corps of Engineers (USACE) permit (joint with MEDEP NRPA permit)
- Construction Stormwater Management permit (shore construction activities, as applicable)
- Post-construction stormwater permit (stormwater management at land-based support area)
- Submerged Lands Lease (for activities below mean low water, as applicable)
- Town of Orrington/Bucksport Activities in Shoreland Zone approval
- Town of Orrington/Bucksport Flood Hazard Development Permit (work in flood zone)
- Town of Orrington/Bucksport Building Permit (shore construction activities)

Review of potential applicability is proposed for the following permits. Section 4.2.2.7 (Other Permits) provides a summary of the applicability considerations for these potential permits:

- Maine Site Location of Development permit
- Floodplain Management under Executive Order 11988
- Maine National Pollutant Discharge Elimination System (NPDES) permit

The Remediation Trust will coordinate with regulatory agencies to obtain the required permits and approvals. Table 3 lists the core requirements of the NRPA permit which fulfills permit application requirements of both the MEDEP and USACE.

Separate permitting plans will be prepared in the future to address the removal of mobile sediments and surface deposits and the remedial action selected for the Orland River and East Channel areas of the Site.

4.2 PERMITTING PROCESS

The overall permitting process and schedule are provided in Appendix A. The schedule identifies the general sequence of regulatory agencies and estimated timeline for permitting and regulatory approval, is provided in Appendix A. As shown, the proposed sequence of permitting has three primary timelines:

- Information required for permit applications;
- Permit application preparation; and
- Agency review and approval.

Section 4.2.1 below provides a summary of additional investigations required to complete the permit applications.

4.2.1 INVESTIGATIONS NEEDED TO SUPPORT PERMIT APPLICATION PROCESS

Field investigations are anticipated to occur primarily during the field season of 2023. This planned field work to support permitting requirements includes:

- Survey of TLC remediation areas including, where applicable, boundaries, elevation, and bathymetry;
- Coastal wetlands characterization using NRPA protocol;
- Geotechnical investigation of soils and sediment for design of potential pier/dock and shore-based staging area(s), if needed; and

- Civil engineering design of dock and shore-based staging area(s) including roads, laydown areas and associated stormwater management, if needed.

Table 3 identifies the NRPA permit elements that depend directly on additional field investigation. Other permit elements may rely on existing information and indirectly on the additional field investigations, such as the construction plan and erosion and sediment control plan. Investigation work plans for the activities noted above will be prepared separately by the Remediation Trust.

4.2.2 PERMIT PREPARATION

4.2.2.1 *NRPA PERMIT*

The primary permit required for the Orrington Reach TCL implementation is the NRPA permit under MEDEP. The NRPA permit includes permit provisions for work in navigable waters of the United States (US) as required under the authority of the USACE. A single NRPA permit application can be submitted jointly to the MEDEP and USACE. A description of the NRPA permit elements is included in Table 3. Details on the respective jurisdiction and supporting environmental agencies for MEDEP and USACE are provided below.

Maine Department of Environmental Protection: The MEDEP Bureau of Land Resources is responsible for protection of natural resources through implementation of the Natural Resource Protection Act (MEDEP, 2019). With some exceptions, the NRPA applies when an "activity" will be:

1. Located in, on or over any protected natural resource, or
2. Located adjacent to (a) a coastal wetland, great pond, river, stream, or brook, or significant wildlife habitat contained within a freshwater wetland, or (b) certain freshwater wetlands.

An "activity" is (a) dredging, bulldozing, removing or displacing soil, sand, vegetation, or other materials; (b) draining or otherwise dewatering; (c) filling, including adding sand or other material to a sand dune; or (d) any construction, repair, or alteration of any permanent structure (MEDEP, 2019).

As the lead agency for natural resource protection, MEDEP conducts outreach to state natural resource agencies for review of, and comment on, the planned activity relative to potential impacts to flora and fauna. These agencies include, but may not be limited to:

- Maine Department of Inland Fisheries and Wildlife (Maine IFW)
- Maine Department of Marine Resources (Maine DMR)
- Maine Natural Areas Program (MNAP)

Permitting under the NRPA also requires applicant outreach to the Maine Historic Preservation Commission (MHPC) and the five native American tribes in Maine for review and comment on cultural resources. The tribes include the Aroostook Band of Micmacs, Houlton Band of Maliseet Indians, Passamaquoddy Tribe of Indian Township, Passamaquoddy Tribe at Pleasant Point, and the Penobscot Nation. This outreach typically takes the form of written correspondence between the applicant and the MHPC and tribes to confirm that appropriate notification of work has been made and document the responses regarding the potential cultural resources within the area of work.

United States Army Corps of Engineers: The USACE has jurisdiction over navigable water of the US and requires permits for:

a. The construction of any structure in, over, or under any navigable water of the U.S. (see 33 CFR 328), the excavating or dredging from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters. The Corps regulates these activities under Section 10 of the Rivers and Harbors Act of 1899 (see 33 CFR 322);

b. The discharge of dredged or fill material and certain discharges associated with excavation into waters of the U.S. including wetlands. The Corps regulates these activities under Section 404 of the Clean Water Act (see 33 CFR 323); and

c. The transportation of dredged material for the purpose of disposal in the ocean. The Corps regulates these activities under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (see 33 CFR 324).

Placement of a TLC at the Site is interpreted as the discharge of fill material, and construction of one or more piers/docks for materials transport is construction in navigable waters. USACE permit requirements will be included in a joint MEDEP-USACE NRPA permit application. MEDEP and USACE will collaborate on NRPA permit application review, acknowledging each agency has its own administrative requirements and potentially different timelines for review and approval. Federal natural resource agencies that support the USACE with permit application review include:

- United States Fish & Wildlife Service (USFWS),
- National Oceanic and Atmospheric Administration (NOAA), and
- National Marine Fisheries Service (NMFS).

The involvement of other federal natural resource agencies is not anticipated; however, WSP recommends discussion of other agency involvement during the planned permit pre-application meeting.

4.2.2.2 *SUBMERGED LAND LEASE PROGRAM*

Under authority of the Maine Bureau of Parks and Lands, leases are required for use of submerged lands (i.e., below mean low water line). As stated in the rules, standard leases may be granted for all structures, permanent or non-permanent, or fill, that in total area occupy 500 square feet or more of submerged lands (Bureau of Parks and Lands, 1986).

If the design for the TLC requires placement of fill along the edge of the subtidal zone adjacent to the intertidal zone below mean low water to add stability and help prevent erosion of the TLC, the Land Lease Program will be applicable. Under the Land Lease Program, proof of land Title, Right, or Interest is required; the Remediation Trust will coordinate with the private property owners for obtaining Title, Right or Interest and supporting documentation.

4.2.2.3 *MUNICIPAL SHORELAND ZONING, FLOOD PROTECTION AND BUILDING PERMITS*

The TLC project lies within Orrington and Bucksport. These two towns have implemented shoreland zoning ordinances that require approval for activities in or within 250 feet of the upland edge of rivers and coastal wetlands, including filling and construction of waterfront structures. Permits are issued by the code enforcement officers of the respective towns, and permit requirements of MEDEP, USACE, and other agencies are referenced in the local ordinances. The towns also require permits for construction projects on the shore (building permit) and for development/construction in the flood zone (flood hazard permit).

4.2.2.4 *STORMWATER CONSTRUCTION PERMIT*

Construction activities that disturb one acre or more require coverage under the Maine Construction General Permit (MCGP). The MCGP is based on the federal National Pollutant Discharge Elimination System (NPDES) Stormwater program and authority to administer this program has been delegated to the MEDEP. Compliance with the MCGP includes submission of a Notice of Intent to file prior to the disturbance, description of proposed work and an erosion and sedimentation control plan for certain projects. The MCGP may apply to construction of a pier/dock and shore staging area to support the Orrington Reach TLC remedial project.

4.2.2.5 *POST-CONSTRUCTION STORMWATER MANAGEMENT*

MEDEP regulates stormwater management for site developments. If new shore support area(s) need to be developed (for staging and storage of materials or river access), they may qualify for a stormwater Permit by Rule assuming development with less than one acre of impervious developed area and less than five acres of developed area. The PBR application includes a description of the site, planned development and erosion and sedimentation controls, among others. The PBR becomes effective following 14 calendar days of permit submission, assuming MEDEP does not respond with concerns and/or information requests.

4.2.2.6 *PRIVATE PROPERTY AGREEMENTS*

Under Maine law, private coastal upland owners usually hold title to the adjacent land between the mean high-water mark and the mean low-water mark. Activities involving placement of fill, structures or related activities require landowner permission (Duff, 20167). Permitted uses include public rights to “fish, fowl, and navigate.” For example, taking, or attempting to take, marine organisms (any animal, plant, or other life that inhabits waters below the head of tide), general watercraft access and hunting.

It is anticipated that permission from owners of private property abutting the Orrington Reach TLC remediation areas will be required prior to access for field work and implementation of the planned remediation. Further, the NRPA permit requires demonstration of Title, Right or Interest for land included in the scope of TLC placement. Please refer to Section 3.3 above for more details on Title, Right or Interest requirements.

4.2.2.7 *OTHER PERMITS*

Maine Site Law: The Maine Site Location of Development Law (Site Law) is triggered by developments over land or water greater than twenty acres (or three acres of impervious surface). The planned TLC remedial program does not appear to involve the type of development that falls within the jurisdiction of the Site Law, but a review of applicability is recommended because the total size of the project exceeds twenty acres.

Maine NPDES Permit: The NPDES is triggered by the discharge of pollutants into a water body, and the program is under the jurisdiction of MEDEP. While the planned TLC remedial program does not appear likely to discharge pollutants to the Site a review of applicability is recommended because of placement of a TLC at the Site.

Maine Floodplain Management Program: Executive Order 11988 and the Maine State Executive Order require all projects that involve the expenditure of Federal or State funds to be reviewed considering flooding potential and to be located outside a Special Flood Hazard Area (e.g., within the 100-year floodplain), if possible. Because the planned Site remediation project is not supported by Federal or State funds, the Executive Order does not appear applicable; however, applicability review is recommended.

This Permitting Plan includes the permits interpreted to be required for the planned TLC placement at the Site and those recommended for applicability review. Outreach to agencies with jurisdiction over the permit may identify other permitting/approval requirements, and those requirements will be addressed by the Remediation Trust.

4.2.3 PERMIT TIMELINE

The permit implementation plan (Appendix A) includes estimated timelines for permit preparation and agency review and approval. Permit planning began in early 2023. The Remediation Trust will lead all outreach to regulatory agencies, the Maine Historic Preservation Commission, Native American tribes, and property owners abutting the Site. Certain permitting tasks and deliverables require information from the planned field studies which are proposed for completion in the latter half of 2023 and early 2024 (e.g., coastal wetlands characterization, project design plans, construction plan).

A key milestone assumed for the permitting effort is the substantive completion of the preliminary TLC design during the first quarter of 2024. The design will include TLC placement techniques, sediment control methodology and sequence of work, among others. The design plan is likely to include a pilot test to evaluate TLC application methods and controls.

Agency review and approval is estimated to take up to 18 months and includes a timeline contingency of up to a year for agency review, stakeholder requests for information and responses. Key permit considerations are described below.

Work in Critical Habitat Areas: Potential extended agency review and public consultation may be required for work in or near Critical Habit areas. The Remediation Trust recognizes the Site is home to protected species such as Atlantic salmon, Atlantic sturgeon and short nose sturgeon, and will collaborate with the agencies to avoid impact to Critical Habitat. Early feedback on permitting concerns is expected to be obtained from the regulatory agencies during the pre-application meeting. Formal agency feedback on the permit review timeline and potential need for additional data is expected upon permit submission and determination the application is complete. Extended agency review may follow permit submission as a result of agency or third-party data requests relating to the TLC scope, techniques for implementation and habitat considerations.

Allowed In-Water Work Windows: The USACE work window for Critical Habitat areas is between November 8 and April 9. The allowed work window is narrow for protection of fish habitat, such as the Atlantic Salmon (spawning in the fall and smolt migration in the spring). The available work window is further reduced due to Site icing which typically begins in late December/early January and extends through March. The work window is a critical TLC implementation factor, and the Remediation Trust has initiated preliminary discussions with the agencies to discuss the potential for expanding the work window. The project design work plan will also consider conducting activities under “dry conditions,” such as work in intertidal zones as the tide is receding and advancing.

Requirements for Wetland Mitigation and/or In Lieu Fees: In general, all projects that require a permit pursuant to the NRPA are required to mitigate their impact to a protected natural resource. Both State and federal agencies administering resource protection regulations may require appropriate and practicable compensatory mitigation as a condition of permit approvals and authorizations. When required, compensation must be provided that offsets a loss of affected resource function with a function of equal or greater value. In addition to compensatory mitigation projects, permittees can pay In Lieu fees based on acres of impact and sensitivity of the resource. The Remediation

Trust will work with the agencies to identify the applicability of mitigation measures and the most appropriate and beneficial measures, as may be required.

Landowner Permission: Permission from private landowners is required to place the TLC in the intertidal zone, and to secure Title, Right or Interest for the NRPA permit and any required submerged land lease. To date, the Remediation Trust has identified 75 parcels and 53 unique parcel owners adjacent to planned TLC areas on the east side of the Orrington Reach. The Remediation Trust will work with the identified landowners to secure written agreements to conduct the planned Site remediation and communicate with the agencies if obstacles for full implementation are identified.

Board of Environmental Protection (BEP): The BEP is an independent citizen board that is part of the MEDEP and decides selected permit applications and considers appeals of MEDEP Commissioner license decisions, among other duties. The BEP may assume jurisdiction over a permit application based on its own initiative or in consideration of a request by any person and/or the MEDEP Commissioner for a project of state-wide significance that meets at least three of the following four criteria:

1. Will have an environmental or economic impact in more than one municipality, territory or county;
2. Involves an activity not previously permitted or licensed in the State;
3. Is likely to come under significant public scrutiny; and
4. Is located in more than one municipality, territory, or county.

While permit oversight by BEP is relatively uncommon, the Orrington Reach TLC may have state-wide significance. If BEP assumes jurisdiction over the permitting effort, it could impact the permit timeline and associated obligations of the Remediation Trust.

Stakeholder Engagement: Work performed by the Remediation Trust is expected to be of interest to numerous stakeholders within the Site, including municipal government and business leaders, recreators, commercial enterprises, and natural-resource protection entities. The Remediation Trust has initiated community outreach activities to share information with stakeholders about its responsibilities and plans. The NRPA process requires the following minimum public engagement activities, however, the Remediation Trust plans more extensive community involvement:

- Public notice of intent to file the NRPA application, with certified mail notice to abutting property owners;
- Availability of draft permit application for public review at the time of submittal;
- Public informational meeting prior to NRPA application submittal;
- Formal response to public comments;
- If deemed appropriate based on stakeholder engagement, a public hearing to allow stakeholder input into the planned restoration project; and
- Response to comments at public hearing.

The Remediation Trust will also post information about the permitting and remediation activities to its website (https://penobscotriverremediation.com), will continue to distribute fact sheets and other information, and prepare and implement a Community Involvement Plan.

5 BIBLIOGRAPHY

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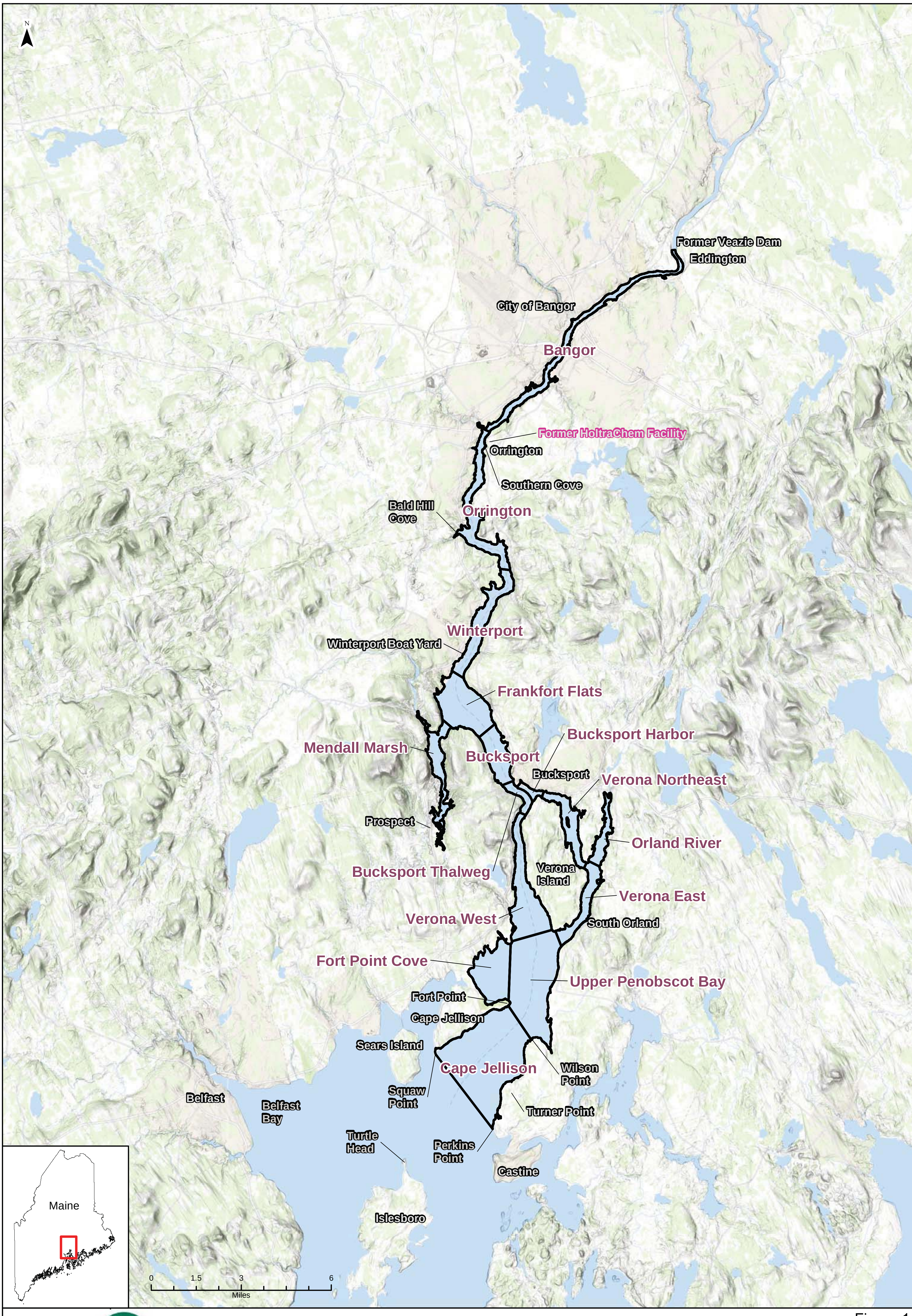
- United States District Court, District of Maine. 2022. Consent Decree. Maine People’s Alliance and Natural Resources Defense Council, Inc., Plaintiffs, v. Holtrachem Manufacturing Company, LLC, and Mallinckrodt US LLC, Defendants. Case 1:00-cv-00069-JAW, filed October 11, 2022.

FIGURES

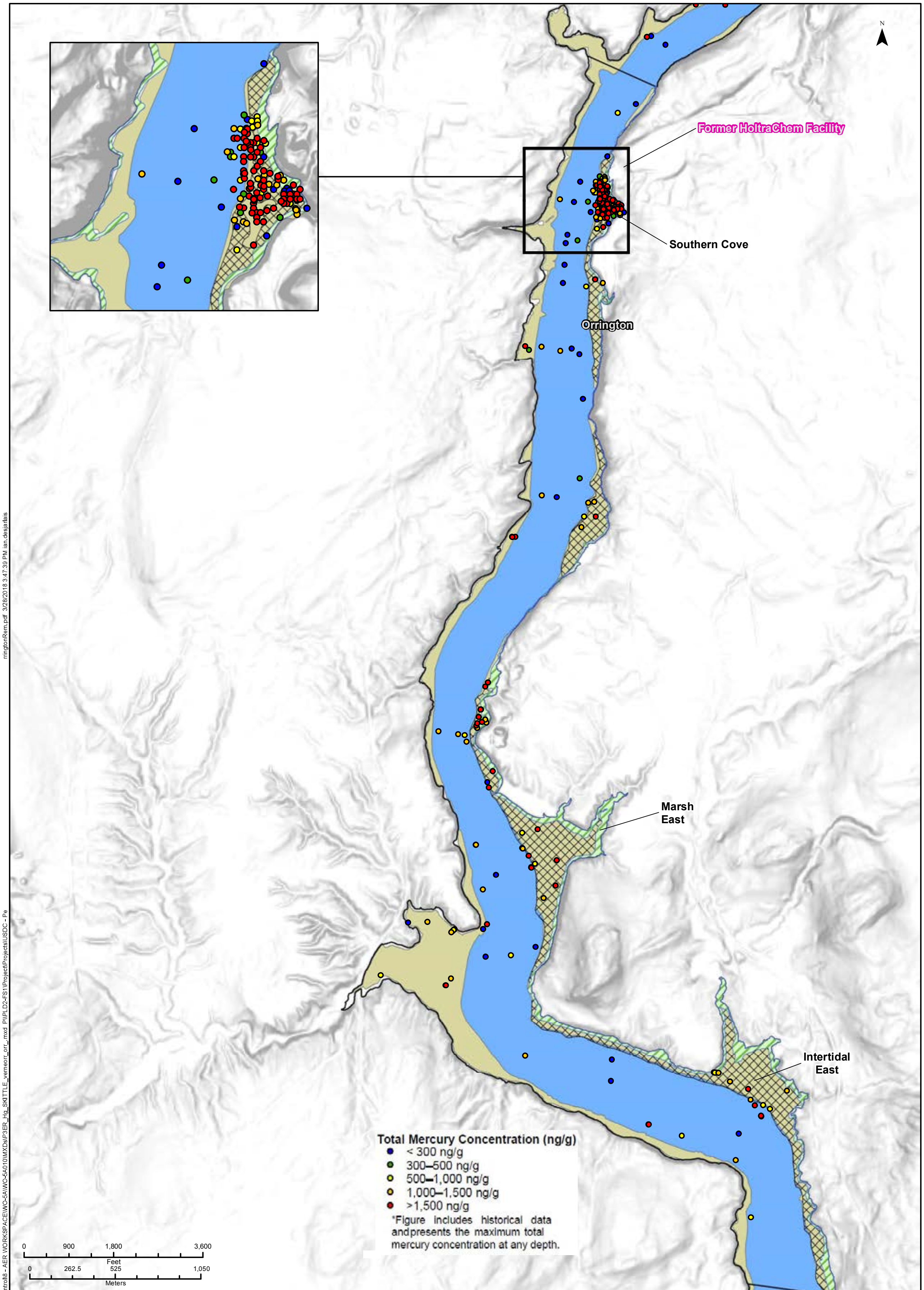


Prepared for: Greenfield Penobscot Estuary Remediation Trust LCC
Trustee of the Penobscot Estuary Mercury Remdiation Trust

Prepared by: WSP USA Environment & Infrastructure, Inc.

Figure 1
Penobscot Estuary Study Reaches

Orrington Reach TLC Permitting Plan
Penobscot Estuary Remediation



Prepared for: Greenfield Penobscot Estuary Remediation Trust, LLC
Trustee of the Penobscot Estuary Mercury Remediation Trust

Prepared by: WSP USA Environment & Infrastructure, Inc.

Symbol Key
- Intertidal Zone recommended for remediation
- Marsh Zone recommended for remediation
- Official Study Reach Boundary
- Intertidal Zone
- Subtidal Zone

Figure 2
TLC Target Areas

Orrington Reach TLC Permitting Plan
Penobscot Estuary Remediation

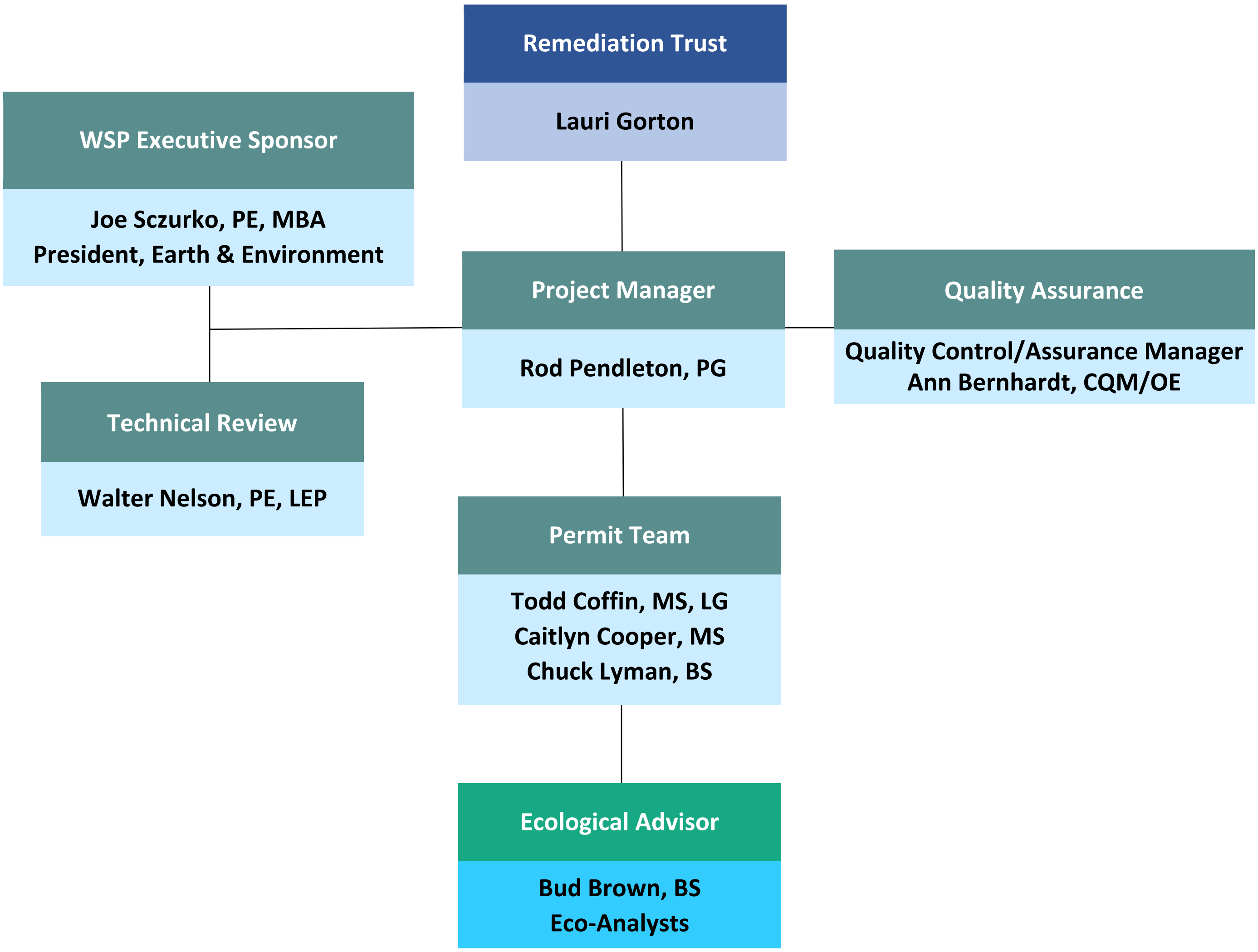


Figure 3
Project Organization Chart

Orrington Reach TLC Permitting Plan
Penobscot Estuary Remediation

TABLES

Table 1 – Contact List, Orrington Reach TLC Permit Plan

Permitting Team	Organization	Role	Email; phone
Greenfield Penobscot Estuary Remediation Trust LLC			
Lauri Gorton	Greenfield	Program Director	lg@g-etg.com; 414-732-4514
WSP Permitting Team			
Rod Pendleton	WSP	Project Manager	rod.pendleton@wsp.com; 207-229-0891
Todd Coffin	WSP	Permitting Specialist	todd.coffin@wsp.com; 207-939-4150
Bud Brown	Eco-Analysts	Ecological/Permitting Specialist	raptor@gwi.net; 207-837-2442
State of Maine Agencies			
Susanne Miller	DEP	Director, Eastern Maine Regional Office	susanne.miller@maine.gov; 207-557-2700
Jim Beyer	DEP	Office of the Commissioner/Eastern Maine Region	jim.R.Beyer@maine.gov; 207-941-4570
Cynthia Darling	DEP	Solid Waste Management, Eastern and Northern Maine Regions	cyndi.w.darling@maine.gov; 207- 446-8219
John Perry	MDIFW	Environmental Review Coordinator	john.perry@maine.gov; 207-446-5145
Denis-Marc Nault	DMR	Environmental Review Coordinator	denis-marc.nault@maine.gov; 207-592-0512
Molly Docherty	DACF	Director, Maine Natural Areas Program	molly.docherty@maine.gov; 207-287-8044
John Noll	DACF	Director (Submerged lands program oversight)	john.noll@maine.gov; 207-287-4919
Kirk F. Mohney	MHPC	Director, Maine Historic Preservation Commission	kirk.mohney@maine.gov; 207-287-3811
Federal Agencies			
Shawn Mahaney	USACE	Project Manager, Maine Projects Office	shawn.b.mahaney@usace.army.mil; 207-623-8367
Wende Mahaney	USFWS	ESA consultations, federal projects and permits	wende_mahaney@fws.gov; 207-902-1569
Michael Simpkins	NOAA	Chief, Resource Evaluation & Assessment Division	michael.simpkins@noaa.gov; 301-713-9090

DACF Maine Department of Agriculture, Conservation, & Forestry
DEP Maine Department of Environmental Protection
DMR Maine Department of Marine Resources
MDIFW Maine Department of Inland Fisheries & Wildlife
MHPC Maine Historic Preservation Commission
NOAA National Oceanic and Atmospheric Administration - Fisheries
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish & Wildlife Service

Table 2 – Permit Overview, Orrington Reach TLC Permit Plan

PERMIT/AGENCY		JURISDICTION	PROJECT NEXUS
Natural Resources Protection Act Permit - NRPA (Joint Permit with USACE)			
Federal			
Lead Agency	US Army Corps of Engineers (USACE)	• Section 10 of Rivers and Harbors Act of 1899: construction of structures in, over, or under navigable waters of the US • Section 401 of the Clean Water Act: construction activities having discharges into navigable waters (see MEDEP) • Section 402 of the Clean Water Act: pollutant discharges to US waters • Section 404 of Clean Water Act: the discharge of dredge of fill matgerial into waters of the US including wetlands • Section 408 of United Sates Code Title 33: alteration of Federal project (e.g., levee, dike, floodwall) • Section 302 of the Marine Protection, Research and Sanctuaries Act of 1972: transport and disposal of dredge materials • Section 7(a) of the Wild and Scenic Rivers Act.	• Placement of Thin Layer Cap (TLC) in navigable waters • Potential impacts to coastal wetlands and river habitat • Possible construction of dock(s)
Supporting Agencies	US Fish and Wildlife Service	• The Fish and Wildlife Coordination Act of 1956 • Fish and Wildlife Conservation Act • Endangered Species Act • Migratory Bird Treaty Act	• TLC placement and potential Impacts to coastal wetlands and river habitat • Essential Fish Habitat (e.g., Atlantic Salmon) • Endangered species
	National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA NMFS)	• Magnuson-Stevens Conservation and Management Act: Essential Fish Habitat • Marine Mammal Protection Act • Incidental Take Permits (NOAA Fisheries)	
State of Maine			
Lead Agency	Department of Environmental Protection (DEP)	• Section 401 of the Clean Water Act: construction activities having discharges into navigable waters; water quality certification.	• TLC placement and potential Impacts to coastal wetlands and river habitat • Essential Fish Habitat (e.g., Atlantic Salmon) • Endangered species • Shorebird wading habitat • Rare plants
Supporting Agencies	Department of Marine Resources	• Maine Marine Endangered Species Act	
	Department of Inland Fisheries & Wildlife	• Maine Endangered Species Act	
	Natural Areas Program (Department of Agriculture)	• NRPA: Imperiled and Critically Imperiled Habitats	
	Floodplain Management Program	• Exec Order 11988, Floodplain Management	• TLC placement in flood zone
	Historic Planning Commission, Tribes	• National Historic Preservation Act • NRPA: archaeological and cultural impacts	• Historic tribal lands • Shipwrecks
Submerged Lands Lease			
Maine Department of Agriculture, Conservation and Forestry, Bureau of Public Parks and Land		Submerged Lands Act	• Placement of TLC (>500 square feet) Title, Right or Interest in adjoing upland areas required with few exceptions
Construction and Post-Construction Stormwater Management			
Maine DEP		• DEP Stormwater Rules Chapters 500, 501, and 502	• Construction activity and development ≥ 1 acre
Local Permitting			
Town of Orrington		• Shoreland Zoning Ordinance • Flood Hazard Development Permit • Building Permit, Land Use Ordinance	• Activities in coastal zone, flood zone • Staging area, dock construction
Town of Bucksport		• Shoreland Zoning Ordinance • Flood Hazard Development Permit • Building Permit, Land Use Ordinance	

Table 3 – NRPA Elements for Individual Permit, Orrington Reach TLC Permit Plan

Permit Element	Description	Comments on Source/Contingent Task	Field Investigation Required[1,2]
Application Form (check boxes and brief entries)			
Sections 1-4	Applicant Information	Remediation Trust	
Sections 9-15	Project Location, Resource Type	Existing background information	
Section 16	Start Date and Brief Activity Description	Existing information and anticipated start date	
Sections 17-27	Parcel Size/ID, Title, Right or Interest Type, Deed Reference, Directions, Attachments Checklist, other	Existing Integral data on abutting parcels	
Attachments			
Attachment 1	Activity Description	Integral ~60% design, hydrodynamic model, wetlands survey, LIDAR; WSP support area ~60% design	**Yes**
Attachment 2	Alternatives Analysis	Integral options analysis (TLC vs dredge, other)	
Attachment 3	Activity Location Map	Existing topographic maps	
Attachment 4	Color Photographs of Area to be Altered	Resource survey with photography	**Yes**
Attachment 5	Overhead and Side View Plan of the Activity Area and Surroundings	Integral ~60% design, hydrodynamic model, resource survey, LIDAR; WSP support area ~60% design	**Yes**
Attachment 6	Additional Plans, if Applicable	To be determined	
Attachment 7	Construction Plan (methods, sequence, timing)	Integral ~60% design, WSP support area ~60% design	
Attachment 8	Erosion Control Plan	Integral ~60% design, WSP support area ~60% design	
Attachment 9	Site Condition Report (for coastal wetland impacts)	Resource survey (flora, fauna), delineation, checklist; field stability assessment; topography/LIDAR survey; existing flood maps	**Yes**
Attachment 10	Notice of Intent to File, Public Notice and Certification; Copy to Municipal Offices	List of abutter names/addresses, certification form	
Attachment 11	Maine Historic Preservation Commission Outreach	Copy of outreach email or letter	
Attachment 12	Functional Assessment of Resource Area	Resource survey; assessment checklist	**Yes**
Attachment 13	Compensation Plan, Narrative, Plans, Monitoring, other	Resource survey, collaboration with MEDEP and USACE, plan details	**Yes**
Appendices			
Appendix A	MEDEP Visual Evaluation Field Survey Checklist	Resource survey	**Yes**
Appendix B	MEDEP Coastal Wetland Characterization Intertidal & Shallow Subtidal Field Survey Checklist	Resource survey	**Yes**
Appendix C	Supplemental Information for Dredging Activities in a Coastal Wetland, Great Pond, River, Stream or Brook	Assume dredging not applicable to TLC	
Appendix D	Project Description Worksheet for a Dock, Pier or Wharf Application	WSP support area ~60% design	

Notes:

1. Permit element directly dependent on field investigation; other elements may indirectly rely on findings of field work, such as construction plan, erosion control plan.
2. Investigation plans for field work will be prepared separately by the Remediation Trust.

ID Identification
LIDAR Light Detection and Ranging
MEDEP Maine Department of Environmental Protection
TLC Thin Layer Cap
WSP WSP USA Environment & Infrastructure, Inc.

APPENDIX A

PERMITTING SCHEDULE

PENOBSCOT ESTUARY REMEDIATION

PERMITTING PLAN: THIN LAYER CAP, ORRINGTON REACH*

2023 | 2024 | 2025: Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

	Time
WSP FIELD STUDIES	
Survey (in collaboration with Integral)	3 months
Wetlands Characterization	4 months
Geotechnical/Soils Investigation	2 months
Geotechnical/Civil Engineering	2 months
WSP PERMIT COMPLETION	
Maine Department of Environmental Protection (DEP) NRPA Permit (application & attachments)	
Penobscot Trust-Led Agency Outreach/Data Review**	3 months
Maine DEP Introductory Meeting	milestone
Pre-application Meeting	milestone
Title, Right or Interest	1 month
Site Topography	1 month
Narrative, plans, photos	3 months
Wetlands Delineation Report	1 month
Alternatives Analysis	3 months
Erosion Control/Construction Plan	1 month
Wetlands Functional Assessment	1 month
Compensation Plan	3 months
MHPC and Tribal Outreach	2 months
Appendix A - MDEP Visual Evaluation Survey Checklist	1 month
Appendix B - Coastal Wetland Characterization	1 month
Appendix C - Supplemental Information for Dredging	NA
Appendix D - Worksheet for Piers, Docks, Wharves	1 month
Pre-submission Meeting	milestone
Public Notice/Response to Comments	2 months
Public Meeting	milestone
Submit Permit	milestone
US Army Corps of Engineers Permit (Joint Application with Maine DEP)	
Pre-application Meeting	milestone
Joint NRPA Permit Submittal	milestone
Construction Stormwater (support facility)	
Submit Notice of Intent (NOI)	milestone
Erosion and Sediment Control Plan	2 months
Submit Notice of Termination (NOT)	milestone (TBD)
Post-Construction Stormwater Management (support facility)	
Prepare and Submit Permit by Rule (PBR)	milestone
Permit effective after 14 days of notice unless notified by Maine DEP	14 days
Municipal Shoreland Zoning, Building Permit, Flood Hazard Permit	
Town of Orrington	3 months
Town of Bucksport	3 months
Property Owners	
Multiple	12 months
Maine Site Location of Development Law	
Applicability Review	1 month
Maine Floodplain Management Program (Exec Order 11988)	
Applicability Review	1 month
National Pollutant Discharged Elimination System (NPDES)	
Applicability Review	1 month
MAINE DEP APPROVAL (Individual Permit)	
Completeness Review	1 month
Maine DEP-Led Partner Agency Outreach/Review	6 months (CONTINGENCY)
US ARMY CORPS OF ENGINEERS (USACE) APPROVAL (Individual Permit)	
Public Notice	1 month
Public Interest Review	1 month
Additional Information	1 month
Public Hearing, if needed	1 month
USACE Review/Decision	2 months (CONTINGENCY)

***ASSUMPTIONS**
1. No direct discharge of stormwater to surface water
2. Shore support area with less than one acre of impervious area and five acres of developed area.
3. NPDES permit not applicable to thin layer cap/placement
4. Project not under jurisdiction of Maine Board of Environmental Protection
5. The Maine Site Law does not apply to restoration project
6. Dredging not required
7. Environmental Assessment and Environmental Impact Statement not required.
8. Completion of TLC hydrodynamic model, alternatives analysis and preliminary design by Integral in Q1 2024
9. Landowners provide access to intertidal zone and approve Title, Right & Interest for permit requirements

**** STRATEGIC AGENCY OUTREACH/DATA REVIEW**

Bureau of Parks & Land (land lease)
Maine Department of Inland Fisheries & Wildlife (DIFW)
Maine Department of Marine Resources (DMR)
Maine Natural Areas Program (MNAP)
US Fish & Wildlife Service (USFWS)
National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS)

ACRONYMS

NA - Not Applicable
NRPA - Natural Resource Protection Act
PBR - Permit by Rule
TBD - To be Determined
TLC - Thin Layer Cap