PHASE III ENGINEERING STUDY REPORT

Penobscot River Estuary, Maine

Prepared for:

United States District Court

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.

511 Congress Street, Suite 200
Portland, Maine 04101

Project No. 3616166052

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EXECUTIVE SUMMARY

This Phase III Engineering Study Report for the Penobscot River Estuary (Estuary) provides the Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) recommended remedial alternatives to address mercury in the Estuary, as directed by the US District Court for the District of Maine (the Court). Our recommended remedial strategy is as follows:

- Placement of a thin layer cap (approximately three inches thick) on approximately 50% of the Mendall Marsh platform;
- Dredging to remove 950,000 cubic yards (cy) of mercury contaminated subtidal surface deposits;
- Dredging/excavation of 215,000 cy of mercury contaminated sediments in the Orrington Reach intertidal east and marsh platform east (the area adjacent to and immediately downstream of the former HoltraChem facility);
- Comprehensive long-term monitoring to evaluate Estuary response to these active remediation activities; and
- Initiation of modeling and pilot studies to evaluate enhanced MNR for the Orland River and the channel on the east side of Verona Island.

In January 2016, the Court selected Amec Foster Wheeler to conduct the Penobscot River Phase III Engineering Study (Phase III Engineering Study) to identify and evaluate feasible, effective and cost-effective measures to remediate mercury in the Estuary. The geographic area to be addressed within the Phase III Engineering Study is described by the Court as *“the region from the site of the former Veazie Dam south to Upper Penobscot Bay, including Mendall Marsh and the Orland River."*

Beginning in 1967, a chlor-alkali facility located in Orrington, Maine, released mercury into the Estuary. Releases of mercury continued throughout facility operation and ceased with facility closure in 2000. In 2002, the Court ordered an independent scientific study, the Penobscot River Mercury Study, to assess the spatial distribution and impact of mercury discharge in the Penobscot River. Two phases of that scientific study were completed: Phase I in 2008 (PRMSP 2008) and Phase II in 2013 (PRMSP 2013).

The Phase I Report (PRMSP 2008) concluded there was enough scientific evidence to conclude that the Penobscot River is contaminated with mercury to an extent that poses risks to some wildlife species, and potentially limited risk for human consumers of fish and shellfish. The Penobscot River Mercury Study Panel recommended the study proceed to Phase II. Although the Estuary has recovered significantly since the period of peak mercury discharge, the Phase II Study estimated it will take well over 100 years for mercury concentrations in Estuary sediment to decrease to a level consistent with regional background concentrations in sediment at the then-predicted rate of system recovery (PRMSP 2013). The Penobscot River Mercury Study Panel concluded that the slow rate of decline of mercury concentrations in the Estuary is attributable, in part, to the presence of a large pool of mercury-affected mobile sediment retained in the Estuary and its associated recycling within the Estuary under the influence of the tide.

With the results from these studies and additional sampling and analyses conducted by Amec Foster Wheeler in 2016–2018 to address identified data gaps, this Phase III Engineering Study Report presents recommendations to the Court for a feasible, effective and cost-effective remedial strategy for the Estuary. The remedial strategy detailed in this report was developed following the evaluation criteria established by the Court, namely that in evaluating and selecting a proposed remedy, options be evaluated in terms of: (1) the viability of the remedy; (2) whether the proposed remedy has been successfully attempted previously or is innovative; (3) the likely cost of the remedy; (4) the length of time to complete the recommendations; (5) the likely effectiveness of the remedy; and (6) any potential environmental harm that may be caused by the proposed remedy. The evaluation process employed throughout this study was iterative and relied on multiple lines of evidence. Evaluation of the list of potential alternatives to develop recommendations for remediation followed established processes common to environmental site assessments that were tailored specifically to the Estuary, as well as the administrative requirements the Court established for the Phase III Engineering Study. The investigations conducted by Amec Foster Wheeler (summarized in this report), the professional experience of Amec Foster Wheeler project engineers, scientists, and risk assessors, and the body of scientific literature and similar remediation case studies were key inputs to this process of evaluating and developing the findings and recommendations.

Potential Remediation Goals

For the purposes of developing remedial alternatives for long-term risk reduction in the Estuary, risk-based preliminary remediation goals (PRGs) were developed for total mercury in the bioactive zone (0–0.5 foot) of Estuary sediment. PRGs are based on both food web modeling (for tissue- and dietary-based approaches) and bioaccumulation modeling using target tissue levels for human and ecological receptors. Two sets of total mercury PRGs have been developed and used in the evaluation of remedial alternatives for the Estuary:

- 500 nanograms per gram (ng/g) for the marsh platform, intertidal, and subtidal sediments; and
- 300 ng/g for the marsh platform, intertidal, and subtidal sediments.

The 500 ng/g sediment PRG was developed in the Risk Assessment and Preliminary Remediation Goal Development Report to be protective of ecological risk and the local consumer (Amec Foster

Wheeler, 2018a). The 300 ng/g sediment PRG is a total mercury concentration that is expected to meet the Maine Center for Disease Control and Prevention (MeCDC) 200 ng/g fish tissue action level in edible tissues.

Alternatives Evaluation Report:

Six remedial alternatives were initially developed during the alternatives evaluation process:

- ***Alternative 1: Monitored Natural Recovery***, including institutional controls and long-term (45-year) monitoring of sediment, surface water (including total suspended solids) and biota to assess progress toward system-wide ecological recovery;
- ***Alternative 2: Enhanced Monitored Natural Recovery***, effected through the addition of clean sediment to the system with the goal of reducing total mercury concentrations in mobile sediment throughout the intertidal and subtidal zones, as well as on marsh platforms where mobile sediment can deposit following inundation of the platform;
- ***Alternative 3: Dredging***, consisting of mechanical removal of either/both subtidal/intertidal sediment and fringing and pocket marsh sediments, with dredged or excavated material to be either disposed of off-site or available for beneficial reuse;
- ***Alternative 4: Thin Layer Capping*** on the Mendall Marsh platform to reduce total mercury concentrations across the biological mixed depth on the marsh platform;
- ***Alternative 5: Amendment Application***, consisting of addition of sediment amendments to the Mendall Marsh platform to reduce biological accumulation of methyl mercury from porewater on the marsh platform; and
- ***Alternative 6: Dredging in Intertidal and Subtidal Zones & Thin Layer Capping,*** a combination remedy for Mendall Marsh that includes thin layer capping or amendment addition on the marsh platform and dredging in the marsh intertidal and subtidal zones.

Recommended Remedial Alternatives:

Elements of these alternatives are carried forward into the recommendations for remediation of the Estuary. The alternatives recommended for implementation focus on: (1) locations characterized by unacceptable levels of risk to sensitive receptors from exposure to mercury; (2) locations in which the sediment bed may be unstable resulting in elevated potential for erosion and/or the location may represent an area in the Estuary in which material enriched in mercury accumulates in identifiable deposits; and/or (3) locations characterized by the highest sediment mercury concentrations in the Estuary. To address these three focus areas, recommended remedial alternatives include the following components (see **Figure ES-1**):

- Placement of a thin layer cap on portions of Mendall Marsh;

- Dredging to remove subtidal surface deposits;
- Dredging/excavation of the Orrington Reach intertidal east and marsh platform east sediments;
- Comprehensive long-term monitoring to evaluate Estuary response to the active remediation activities; and
- Initiation of modeling and pilot studies to evaluate enhanced MNR for the Orland River and the channel on the east side of Verona Island.

Thin Layer Capping in Mendall Marsh: This recommendation involves broadcasting imported clean sediment on a portion of the marsh platform to create a 3-inch minimum cap layer. Thin layer capping would immediately reduce the area weighted average concentration of total mercury in the biologically active zone of the marsh platform to below the 500 ng/g PRG. Under this remedial strategy, approximately 50 percent of the marsh platform in Mendall Marsh would be capped with a thin layer of clean sediment, with the cap area footprint primarily in the marsh areas below the 7.5-foot North American Vertical Datum of 1988 elevation. Capping in the higher elevation areas of the marsh is generally not needed because mercury concentrations are lower in this portion of the marsh and the 500 ng/g PRG can be met without capping the entire marsh platform. Capping approximately 50 percent of the Mendall Marsh platform with a thin layer of material would require approximately 191,000 cy of clean sediment.

Two pilot-scale tests are recommended prior to implementation of this remedy: an initial test to assess potential impacts of cap material placement on vegetation, followed by a larger-scale test (in subsequent years) to evaluate the stability of the cap and to assess the effectiveness of capping to reduce tissue mercury concentrations in biota from within the footprint of the pilot test area. It is expected that the pilot tests would be conducted on the scale of acres and that pilot test plots would encompass a range of marsh elevations and vegetation types. Because mobile sediment will continue to deposit on the marsh over time, it is estimated that the design life of an ecologically functioning thin layer cap on Mendall Marsh would be 30 to 35 years, based on the rate at which sediment currently deposits on the marsh platform. Active remedies taken elsewhere in the Estuary to decrease the concentration of mercury in mobile sediment would extend the ecological function of the cap through decreasing the concentration of mercury in material that is transported onto the marsh platform and deposited during platform inundation.

Surface Deposit Dredging: This recommendation involves dredging of five surface deposits representing approximately 950,000 cy of mixed mineral sediment and wood waste characterized by mercury concentrations generally greater than system-wide average mercury concentrations in bedded sediment. These surface deposits are in the Frankfort Flats, Verona East, and Orland River reaches and would be mechanically dredged, dewatered, and either beneficially reused or disposed of in a landfill. Dredging the surface deposits would decrease the estimated time required to meet the system-wide PRG of 500 ng/g total mercury in sediment from a minimum time of 45 years to a minimum time of 25 years. This estimate assumes that the surface deposits mix and are mobile on the same time scale as the rest of the mobile sediment in the system.

Orrington Intertidal East and Orrington Marsh Platform East Dredging: This recommendation involves dredging the intertidal and marsh zones along the eastern banks of the Orrington Reach. Sediment in these locations would be mechanically dredged or excavated, dewatered, and either beneficially reused or disposed of in a landfill. The dredging and excavation footprints would be backfilled with clean material and the marsh areas restored with plantings. This recommendation involves dredging and excavation of approximately 215,000 cy of sediments over 132 acres of intertidal sediment and marsh. The bootstrap mean mercury concentrations in shallow sediments in the Orrington marsh and Orrington intertidal east are the two highest bootstrap mean concentrations in the Estuary.

Dredging the intertidal east and marsh platform portions of the Orrington Reach will reduce risks to biota in the upper portions of the Estuary and decrease the time required to meet the system-wide PRG of 500 ng/g total mercury in sediment through achieving source control for downgradient reaches in the Estuary.

The Estuary system is complex. Uncertainties in system characterization remain that affect the estimated effectiveness, cost, and recovery timeframes associated with the recommended remedial alternatives. These uncertainties have been reduced through the investigations, geophysics and mapping, and bench-scale testing and evaluations performed during this Phase III Engineering Study, as well as the evaluations performed during the preceding Phase I and Phase II Studies, although the uncertainties have not been eliminated. To address these uncertainties, active remediation measures are paired with long-term monitoring to evaluate the response to remediation efforts, track concentration trends, and provide indication if and when selected additional and targeted remediation efforts may be effective. In addition, institutional controls, including educational programs, warning signs, consumption advisories, and fishery closures are recommended in addition to long-term monitoring to limit human exposure until biota tissue concentrations decline to levels considered safe for consumption.

While the Phase III Study recommends active remediation via the capping and dredging strategy described above, long-term ecological recovery monitoring will be required for the recovery of the Estuary. The active dredging remedies recommended (dredging surface deposits and dredging in the Orrington Reach) are not expected to achieve system-wide PRGs of either 500 ng/g or 300 ng/g immediately after completion. The active remedy recommended for Mendall Marsh achieves the 500 ng/g PRG upon completion only for the marsh platform. It is expected that following completion of the remedial work, a likely minimum of an additional 25 years of long-term monitoring will be needed for recovery system-wide to meet a PRG of 500 ng/g total mercury in sediment. This estimation of the rate of system-wide recovery is based on a combination of the estimated recovery rate following removal of the surface deposits and the assumption that a partial dredge remedy applied to the upgradient Orrington Reach for source control will provide reduction in the overall time required for the system to recover to achieve the 500 ng/g PRG for total mercury in sediment. System-wide recovery to meet a PRG of 300 ng/g total mercury will likely require over 100 years, even with the implementation of the partial dredge remedies recommended here.

Regarding background system recovery rates, biota mercury concentrations are decreasing at approximately two percent annually, a decrease generally consistent with decreases in sediment mercury concentrations over time. Thus, once sediment concentrations have stabilized after implementation of active remedies, it is expected that biota mercury concentrations will also generally decrease at similar rates and in similar timeframes to the reductions achieved for sediment. Because the 500 ng/g PRG for sediment was developed to be protective of local consumers and biota using site-specific biota sediment accumulation factors (BSAFs), and BSAFs were developed based on the relationship between the species-specific concentration of mercury in biota and in sediment, it is expected that when sediment concentrations are reduced to 500 ng/g, tissue concentrations will also decline to a level of acceptable risk for system biota. Based on both the range of trophic levels for biota being monitored and the need for the system to re-equilibrate or stabilize following the disturbance of remedial activities, it is expected that the recovery timeframe for biota could lag as much as five to ten years (depending on the trophic level of the organism) behind the recovery timeframe for sediment following remediation construction.

Long-Term Monitoring:

Comprehensive environmental monitoring is recommended starting during remedial design efforts (i.e., prior to remediation beginning), continuing through active remediation, and culminating in long-term monitoring. Long-term monitoring should include biota, sediment, and surface water programs. Recommendations for a long-term monitoring plan are presented in this report and include a focus on species/groups, sample numbers, sampling locations, analytes, and sampling frequency. Long-term monitoring as discussed here is distinct from post-implementation monitoring. Post-implementation monitoring is focused on the identification and monitoring of metrics linked to successful implementation of a remedy. In general, post-implementation monitoring would be conducted for a period of five years as confirmation that the remedial action successfully achieved the design goals. Long-term monitoring, while linked to successful implementation of recommended remedies, is focused specifically on the long-term achievement of remedial action objectives for the Estuary.

The design and implementation of a long-term monitoring program as recommended in this report should be approached iteratively. That is, recognizing uncertainties associated with implementation and recovery as determined from sediment-based PRGs in the Estuary, long-term monitoring should follow a course of ongoing data collection and analysis relative to stated system recovery goals. Estimates of system recovery presented in this report indicate a likely minimum of 45 years (and possibly longer) for the system to recover to meet the total mercury PRG of 500 ng/g in sediments. Thus, the long-term monitoring plan recommended here should be periodically re-evaluated to assess the need for adjustments to the duration of the monitoring program as well as the number and types of samples and/or sampling locations included.

Recommendations for long-term monitoring of biota species include the following guidelines to continue to reduce variability (uncertainty) in regression model results and to increase interpretability of the statistical trends analysis: (1) standardize sample locations, time of year of collection for each species, and analytical methods; (2) maximize the number of samples; (3) increase multiplicity of efforts to improve biota collection (such as employing multiple types of nets and traps to collect sufficient samples for each species); and (4) focus on co-location of predator and prey tissue samples (to the extent possible), rather than collecting only one type of sample in a specific sampling location. Based on the analyses presented in this report, it is recommended that biota sampling for long-term monitoring be conducted every three years and include 12 species/groups divided as: three species for system-wide monitoring (tomcod, smelt, and black ducks); six species for partial-system monitoring (mussels, lobster, American eel, mummichogs, Nelson’s sparrows, and red-winged blackbirds); and three groups for additional evaluation of prey species (polychaetes, spiders, and other marsh platform insects).

For sediment monitoring, based on the general absence of system recovery trends over the interval 2006 to 2017 as determined by loglinear regression of sediment total mercury and methyl mercury data, Amec Foster Wheeler recommends extending the proposed sediment sampling interval from annual sampling to sampling every three years. This interval for long-term sediment monitoring is consistent with the recommended interval for biota monitoring and is a reasonable baseline sampling interval for the Estuary based on recovery rate estimates. Stations recommended for long-term sediment monitoring fall into four categories: (1) stations for assessing temporal and/or spatial trends in surface sediment mercury concentrations; (2) stations for monitoring the mobility or mixing of surface deposits; (3) stations for co-locating with biota sampling to facilitate monitoring of changes to species-specific BSAFs; and (4) stations for monitoring long-term trends in system recovery via geochronology.

Potential Adaptive Management Alternatives:

Adaptive management is a key principle of effective environmental remediation, and involves planning, implementing, monitoring, and analyzing data gathered during monitoring to achieve the best outcome based on current knowledge and site understanding. As a strategy for monitoring remedial progress, adaptive management focuses on iteratively altering or updating a course of action based on on-going data collection and analysis. Adaptive management is specifically included in the recommendations presented in this engineering study, either by way of pre-construction additional delineation activities, pilot testing, implementation and monitoring, or long-term monitoring to assess temporal trends toward system recovery.

For the Estuary, adaptive management describes an approach to re-evaluating system recovery potential in a portion of the system in which there is a greater degree of uncertainty that remediation would directly, predictably, and measurably result in system-wide improvements with respect to the principal focus areas guiding remedial recommendations for the Estuary. Potential adaptive management alternatives are provided as a contingency and may be implemented to accelerate remediation if long-term monitoring indicates that the rate of system-wide recovery has not changed following implementation of thin layer capping and the partial dredging remedies. Long-term monitoring to assess the impact of implementing partial remedies on system-wide recovery rates would include updating currently projected system recovery rates based on sediment geochronology studies, box model estimates of recovery rate, and/or trends in declining tissue mercury concentrations over time. Based on the current Estuary characterization, the Phase III Study recommends adaptive management alternatives target the eastern channel (Verona Northeast and Verona East reaches) and Orland River. These adaptive management actions depend on the implementation of the recommended remedial alternatives and are not intended to be implemented independently or instead of the recommended remedial alternatives. Remedial alternatives that could be evaluated for the Estuary following a strategy of adaptive management are:

- ***Enhanced Monitored Natural Recovery – in the Orland River:*** Enhanced MNR could be implemented in the future as an adaptive management alternative for the Orland River. This contingent alternative would involve the addition of clean sediment to Orland River; addition of clean sediment would result in remediation through mixing and dilution across the biological mixed depth in sediment. Sediment transport modeling and a pilot test are recommended for assessing the feasibility of this contingent alternative. Sediment transport modeling would be used to identify placement locations and addition rates for clean sediment. A pilot test would include hydrographic surveying and sediment trap measurements following addition of sediment to assess the distribution of the added material. If the results of modeling and pilot testing described above confirm the approach of adding sediment that redistributes to effect a decrease in mercury concentration, enhanced MNR would be implemented in the Orland River. The effectiveness of this approach to accelerating ecological recovery in Orland River would be determined by on-going monitoring of mercury concentrations in sediment and biota. Based on preliminary evaluation, it is anticipated that enhanced MNR of Orland River through addition of clean sediment would require approximately 150,000 cy of clean sediment, assuming the clean sediment ultimately disperses evenly over the intertidal and subtidal zones at a uniform three-inch thickness.

- ***Verona East, Verona Northeast, and Orland River Dredging:*** This potential adaptive management action could be considered for implementation after post-construction monitoring of the recommended remedial alternative of dredging the surface deposits. Implementation of this adaptive management action within the Orland River assumes that the enhanced MNR adaptive management action in Orland River is not performed. Dredging of Verona East, Verona Northeast, and Orland River would be designed to remove approximately 1,800,000 cy of mercury-affected sediment. Based on the volume of sediment that would be removed – approximately 50% of the volume that would be required to achieve the system-wide PRG of 500 ng/g total mercury in sediment after the surface deposits are removed – implementation of this potential adaptive management action could reduce the system-wide recovery rate by about half beyond the recovery rate estimated from the removal of the surface deposits (estimated at a minimum of 25 years to meet the 500 ng/g PRG for total mercury in sediment and assuming the surface deposits mix and are mobile on the same time scale as the rest of the mobile sediment in the system). Because it is expected that the ecological recovery rate is roughly equivalent to the sediment remediation period, removal of sediment from Verona East, Verona Northeast, and Orland River is anticipated to accelerate the recovery rate for American black ducks in the Orland River and for lobster in upper Penobscot Bay.

Communication and Community Involvement

Communication and community involvement activities undertaken during the Phase III Engineering Study completed Stages One and Two of the Communication and Community Involvement Plan. The plan contains recommendations for the remaining three stages as follows:

- Stage Three: the development of clear, plain language documents to deliver information to stakeholders to maximize understanding and accessibility when the final Phase III Engineering Study is submitted, and the Court begins its deliberations;
- Stage Four: communication and involvement with the community when the Court issues its decisions on remediation; and
- Stage Five: communication and community involvement during the implementation of remediation.

Estimated Costs of Recommended Remedial Alternatives

Costs associated with the recommended alternatives presented in this report are summarized in **Table ES-1** below. Cost estimates were developed with a target accuracy of plus 50 percent/minus 30 percent.

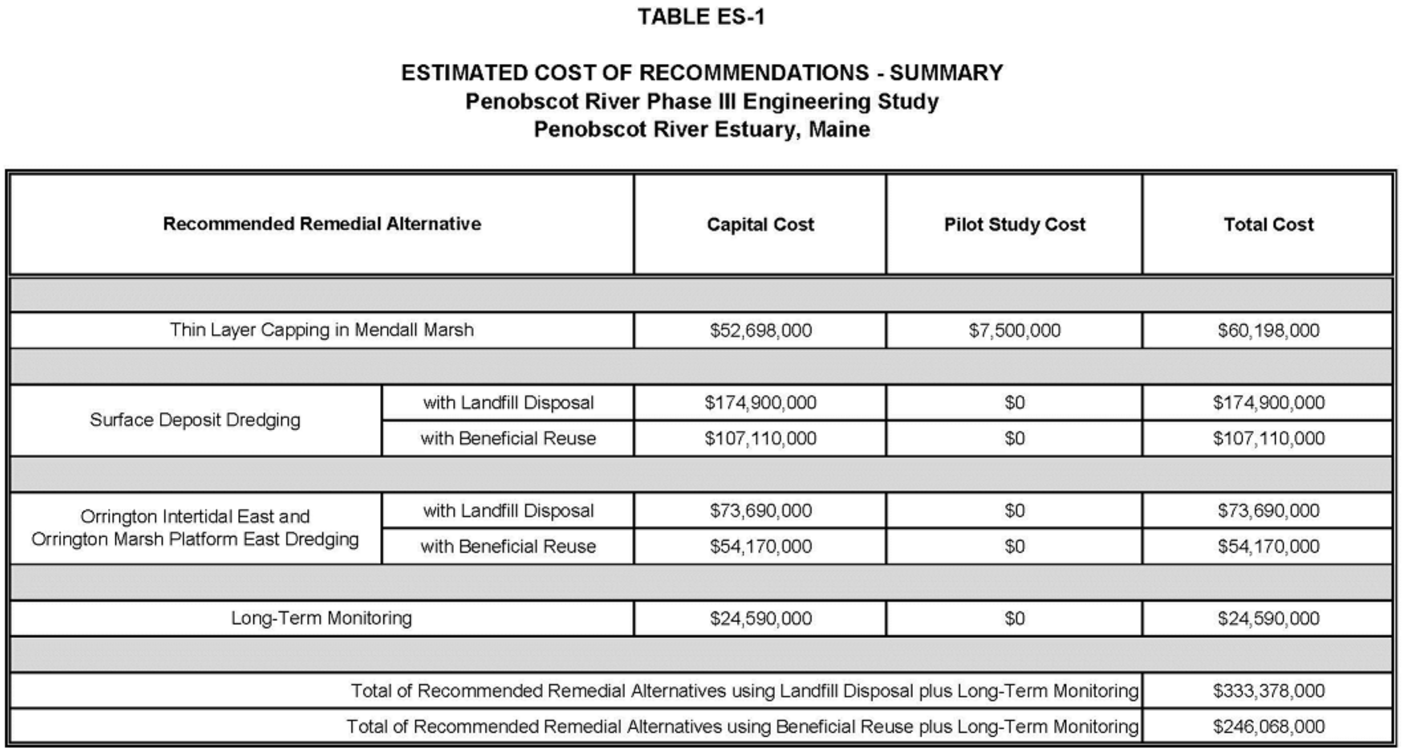
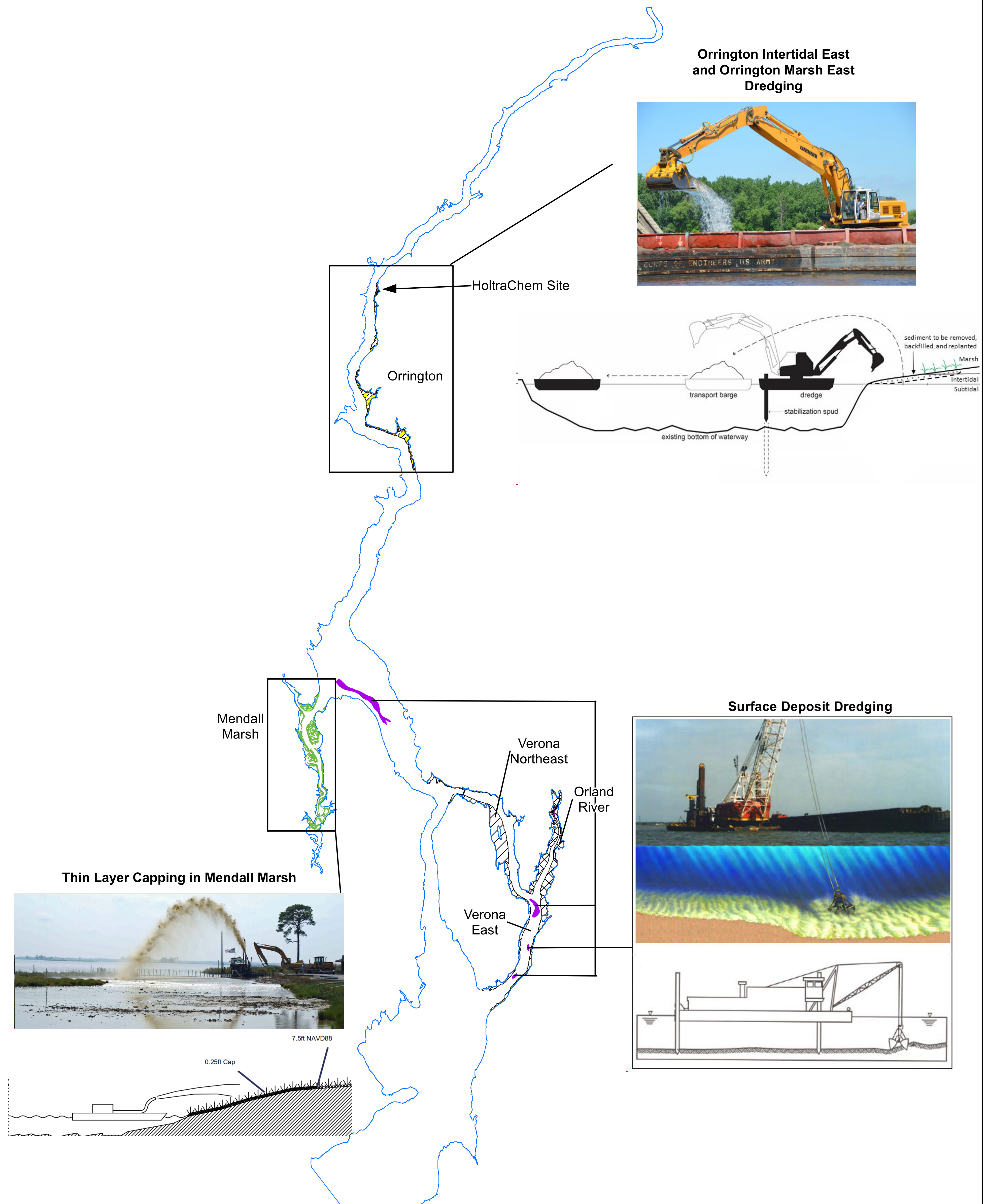


TABLE ES-1

ESTIMATED COST OF RECOMMENDATIONS - SUMMARY
Penobscot River Phase III Engineering Study
Penobscot River Estuary, Maine

Recommended Remedial Alternative		Capital Cost	Pilot Study Cost	Total Cost
Thin Layer Capping in Mendall Marsh		$52,698,000	$7,500,000	$60,198,000
Surface Deposit Dredging	with Landfill Disposal	$174,900,000	$0	$174,900,000
	with Beneficial Reuse	$107,110,000	$0	$107,110,000
Orrington Intertidal East and Orrington Marsh Platform East Dredging	with Landfill Disposal	$73,690,000	$0	$73,690,000
	with Beneficial Reuse	$54,170,000	$0	$54,170,000
Long-Term Monitoring		$24,590,000	$0	$24,590,000
Total of Recommended Remedial Alternatives using Landfill Disposal plus Long-Term Monitoring				$333,378,000
Total of Recommended Remedial Alternatives using Beneficial Reuse plus Long-Term Monitoring				$246,068,000



Legend

☒	Contingency Action: Enhanced MNR Contingency Action:
▨	Intertidal and Marsh Dredging
▨	Orrington Intertidal East and Orrington Marsh East Dredging
▨	Thin Layer Capping
●	Layer Deposit Dredging

Images Source: United States Army Corps of Engineers

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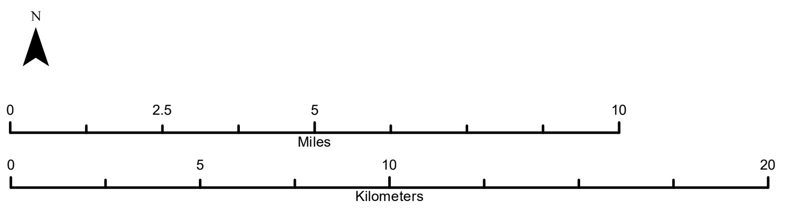

Figure ES-1
Recommended Remedial Alternatives

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052	Prepared/Date: MKM 3/30/2018	Checked/Date: JKT 3/30/2018	NAD83 State Plane Maine East, US Survey Feet

Document: P:\Comm-Ind\Projects\Clients M to S\Penobscot(GIS)\Engineering Report\Inset_2_1.1.mxd 3/30/2018 4:23:16 PM david.young2

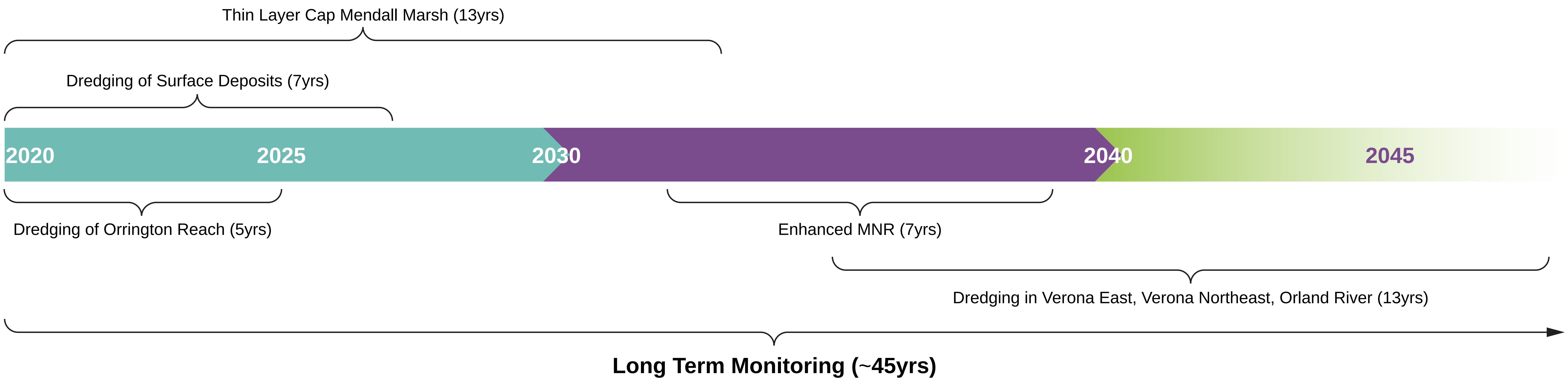

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Figure ES-2
Conceptual Timeline for Remedy Implementation

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052	Prepared/Date: JPH 9/13/2018	Checked/Date: MKM 9/13/2018

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APPENDICES

ACRONYMS AND ABBREVIATIONS

Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure Solutions
BERA	Baseline Ecological Risk Assessment
BSAF	biota-sediment accumulation factor
CCIP	Communication and Community Involvement Plan
cm	centimeters
Court	United States District Court for the District of Maine
CWA	Clean Water Act
cy	cubic yards
DMR	Department of Marine Resources
EPA	(US) Environmental Protection Agency
Estuary	Penobscot River Estuary
ETM	estuarine turbidity maximum
HHRA	Human Health Risk Assessment
HQ	hazard quotient
KOH	potassium hydroxide
LOAEL	lowest observed adverse effects level
MeCDC	Maine Center for Disease Control and Prevention
MEDEP	Maine Department of Environmental Protection
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MLLW	mean lower low water
MNR	monitored natural recovery

NAVD88	North American Vertical Datum of 1988
ng/g	nanograms per gram
ng/L	nanograms per liter
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effects level
Phase III Engineering Study	Penobscot River Phase III Engineering Study
ppt	parts per thousand
PRGs	preliminary remediation goals
RAO	remedial action objective
SMA	sediment management area
TOC	total organic carbon
USACE	United States Army Corps of Engineers

1.0 INTRODUCTION

In January 2016, the United States District Court for the District of Maine (the Court) selected Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) to conduct the Penobscot River Phase III Engineering Study (Phase III Engineering Study), to identify and evaluate feasible, effective and cost-effective measures to remediate mercury in the Penobscot River Estuary (Estuary). The geographic area to be addressed within the Phase III Engineering Study is defined by the Court as ranging from the site of the former Veazie Dam south to upper Penobscot Bay, including Mendall Marsh and the Orland River (**Figure 1-1**).

In September 2015, after completion of the Phase I and Phase II Studies, the Court issued an Order on Remediation Plan. As part of that Order, the Court concluded that a Phase III engineering study was a necessary next step in evaluating the *"the range, practicality, and cost of potential solutions."* The Court further concluded that *"although the Study Panel scientists have educated notions about solutions, feasibility is a matter for engineers who unite the theoretical with the practical. The appointment of an engineering firm is essential to the task."* The Court ordered that the engineering firm identify cost-effective and effective remedies (if any) to clean up the remaining mercury in the Penobscot River system and to provide recommendations regarding possible remedial alternatives. Criteria provided by the Court for evaluation of remedial alternatives included:

1. Viability of the proposed remedy;
2. Whether the recommended alternative has been successfully attempted previously or is innovative;
3. The likely costs of the recommended alternative;
4. The length of time to implement the recommended alternative;
5. The likely effectiveness of the recommended alternative; and
6. Any potential environmental harm that may result from the recommended alternative.

In October 2015 the Court issued an Order for Evaluation of Potential Active Remedies. The Order required that *"[t]here will be an immediate, thorough, open, and independent identification and evaluation of potential active remedies to speed the recovery of the Penobscot River estuary from its present state of mercury contamination ("Evaluation of Potential Active Remedies"). The Evaluation of Potential Active Remedies will be designed to identify feasible, effective, and cost-effective remedies to achieve the objectives set forth in the Court's opinion dated September 2, 2015, and the Resource Conservation and Recovery Act."* The Order also required that *"[a]t the end of the Evaluation of Potential Active Remedies, the engineering firm will submit a written report, recommending to the Court a remedial plan or plans that would be effective and cost-justified, or explaining why there is no viable remedy to pursue."*

This Phase III Engineering Report includes Amec Foster Wheeler recommendations to the Court for remediation plans that are believed to be effective and cost effective.

This report presents:

- A summary of background information from the Phase I and Phase II Studies, along with a synopsis of the sampling and studies completed as part of the Phase III Engineering Study;
- A description of the current conceptual site understanding;
- A summary of the human health and ecological risk assessment completed during the Phase III Engineering Study;
- A summary of the remedial action objectives (RAO), and selection, screening, and evaluation of remedial alternatives;
- A summary of the risk reduction potentially achieved for each remedial alternative;
- A summary of the community involvement activities; and
- Recommendations for the Court, including proposed costs, schedule, and long-term monitoring associated with alternatives considered and recommended.

2.0 SUPPORTING INFORMATION

Supporting information used in the development of remedial alternatives consists of the Phase I and Phase II Studies (Section 2.1), and reports and technical memoranda presenting data collected in support of the Phase III Engineering Study (Section 2.2). Results from these Phase III field efforts, laboratory studies and associated data evaluations are synthesized in the reports that are summarized in Sections 4.0 – 6.0 of this Phase III Engineering Study; these sections focus on risk assessment (Section 4.0); remedial alternatives evaluation (Section 5.0) and risk reduction (Section 6.0).

2.1 BACKGROUND DOCUMENTATION

Sections 2.1.1 and 2.1.2 summarize the Phase I and Phase II studies.

2.1.1 Phase I Study

In July 2005, the Penobscot River Mercury Study Panel submitted A Study Plan for Evaluation of the Mercury Contamination of the Penobscot River/Estuary, Maine, with the overall objective of determining whether mercury concentrations in biota in the Penobscot River and Estuary were a concern, and whether remediation within the river or additional remediation at the HoltraChem facility was necessary.

Phase I sampling of water, sediment, benthic invertebrates, finfish, shellfish, birds, and mammals was carried out in 2006–2007 to evaluate mercury and methyl mercury concentrations and spatial patterns in the Estuary. Four criteria were used to evaluate whether mercury concentrations in water, sediment, and biota were a concern and whether the source of that mercury appeared to be related to the HoltraChem facility. These four criteria were:

1. Comparison of concentrations of mercury in the Penobscot system to available National Oceanic and Atmospheric Administration (NOAA), Maine Department of Environmental Protection (MEDEP), and U.S. Environmental Protection Agency (EPA) benchmarks for toxic effects to benthic organisms and human consumers;

2. Comparison of mercury concentrations in the Penobscot system to scientific literature on toxicological effects;

3. Assessment of geographical patterns of mercury distribution within the Penobscot system, especially in spatial relation to the HoltraChem facility; and

4. Comparison of mercury concentrations in the Penobscot system to concentrations observed in other contaminated and uncontaminated sites.

The Phase I Report concluded that, based on available evidence, mercury present in the Estuary posed risks to some wildlife species, as well as limited risks to human consumers of finfish and shellfish. The Penobscot River Mercury Study Panel recommended that a Phase II Study be undertaken to examine the dynamics of mercury cycling in the Estuary, including estimation of the rate of natural attenuation of mercury in the system.

2.1.2 Phase II Study

A Phase II Study Plan was submitted to and approved by the Court in July 2008. Primary objectives of the Phase II Study were to assess whether the process of natural attenuation could reduce concentrations of mercury in sediments in the Estuary to acceptable levels within a reasonable time frame, and to evaluate whether active remediation measures could feasibly accelerate system recovery.

The Final Penobscot River Mercury Study Report (Phase II Report) (PRMSP 2013), submitted in April 2013, concluded that inorganic mercury discharged from the HoltraChem facility was present in high concentrations in Estuary sediments and that it was being converted by bacteria into methyl mercury.

The Phase II Report noted that while total mercury concentrations were declining in some areas of the Estuary, at the current estimated rate of decline it would take greater than 100 years (specifically, 106 to 390 years depending on location and choice of recovery rate parameters) for mercury concentrations in sediment and biota to decrease to levels that no longer pose ecological risks. The Phase II Report attributed this slow rate of decline of mercury concentrations in the Estuary to the presence of a large pool of mercury-affected mobile sediment (estimated at 320,000 tons of sediment) that is trapped in the upper Estuary by natural circulation dynamics. Based on ongoing ecological risks, the Penobscot River Mercury Study Panel recommended an evaluation of active remedies, if any, that could be implemented to shorten the duration of estimated recovery times and reduce mercury concentrations in sediments and biota in the Estuary.

2.2 PHASE III ENGINEERING STUDY TECHNICAL MEMORANDA AND REPORTS

After the completion of the Phase I and Phase II Studies, the Court concluded that a Phase III engineering study should be conducted to identify cost-effective and effective remedies to clean up the remaining mercury in the Estuary and provide recommendations regarding possible remedial alternatives. As part of that work, Amec Foster Wheeler completed additional field and laboratory studies to support the identification and evaluation of remedial alternatives.

Sections 2.2.1 through 2.2.18 summarize technical memoranda and reports that were prepared as the result of Phase III field and laboratory studies. Integration of data from these technical memoranda and reports (as well as data and understanding from other systems) serve as the basis of the Amec Foster Wheeler Phase III Engineering Study. Results of this integration are summarized in Sections 4.0 – 6.0 of this Report, with each section presenting a summary of the relevant preceding Amec Foster Wheeler reports. **Appendix A** contains additional summary information compiled in response to a Request for Information (RFI) received by Amec Foster Wheeler in April 2018. To the extent that queries posed in the RFI resulted in updates to the content of text, tables, or Appendices in other Amec Foster Wheeler reports, these changes are noted in the associated responses and are reflected in the final versions of those project reports.

2.2.1 2016 Sediment and Surface Water Quality and Monitoring Report

The 2016 Sediment and Surface Water Quality Monitoring Report (Amec Foster Wheeler 2017a) presented the results of sediment and surface water quality monitoring, as well as an assessment of physical/chemical processes affecting the distribution of mercury and methyl mercury in sediment and surface waters in the Estuary. Sediment sampling including intertidal, subtidal, and marsh platform environments to allow evaluation of spatial trends as well as temporal trends with respect to data collected during the Phase II Study. Data collected during the Phase III Study were used in conjunction with historical data to assess temporal and geographical patterns of mercury and methyl mercury distribution in sediments and surface waters of the Estuary, and to evaluate system recovery potential under current conditions.

Results of sediment monitoring were consistent with results presented in the Phase II Study (PRMSP 2013) in which total mercury concentrations in surface sediment generally ranged from 300 to 1,100 nanograms per gram (ng/g) and covaried with total organic carbon (TOC). No consistent temporal trends in mercury concentration were apparent. Given the heterogeneity of site sediment, including the presence of wood waste at varying concentrations throughout the system, it was concluded that the 10-year interval assessed (2006–2016) was likely too short an interval for the identification of statistically robust linear regression trends in system recovery.

Results of water quality monitoring showed that: (1) consistent with commonly observed Estuary dynamics, mixing of river water with seawater was accompanied by flocculation and settling of dissolved organic carbon; and (2) the calculated total mercury concentration in suspended sediment in the Estuary was approximately 600 ng/g.

Based on these results, continued sediment and water quality monitoring was recommended for 2017 with a base program consistent with the 2016 program and a focus on sediment monitoring to support remedial design.

2.2.2 2017 Sediment and Surface Water Quality and Monitoring Report

Sediment and surface water quality monitoring was undertaken in 2017 following the recommendation of the 2016 sediment and water quality monitoring program. Results from the 2017 sediment and surface water quality monitoring program are presented in the 2017 Sediment and Water Quality Monitoring Report (Amec Foster Wheeler 2018b).

Overall 2017 sediment monitoring results were consistent with system-wide spatial trends observed in the Phase II Study (PRMSP 2013). For spatial trends analysis for sediment samples collected across intertidal, subtidal, and marsh platform environments, the total mercury concentration in surface sediment collected on the marsh platform in 2017 generally decreased moving from the low marsh to mid marsh to high marsh, within each marsh platform transect sampled. This trend was not consistently observed in 2016 sampling. For temporal trends relative to data collected from 2006–2012, while there was some evidence of decreasing concentrations of mercury and/or methyl mercury over time in some reaches of the Estuary, most specifically in Mendall Marsh, trends in decreasing concentration were not consistently apparent either within reaches or across reaches. The trends that were observed were only generally apparent when data were normalized to the organic carbon content of samples.

Water quality monitoring results from the site of the former Veazie Dam were also consistent with Phase II Study results. Specifically, both the range of particulate loading and the associated concentration of particulate mercury (ranging from 131 ng/g [qualified] to 242 ng/g) entering the Estuary were consistent with the range determined in the Phase II Study and applied in mass balance estimates of loading to the Estuary.

Results from sediment monitoring suggest that the time frame of 2006–2017 may not be a long enough period to demonstrate consistent trends in sediment recovery by simple linear regression analysis, and that the lack of significant trending over this interval suggests that sampling on an interval longer than annually would be warranted.

2.2.3 2016 Mobile Sediment Characterization Report

The 2016 Mobile Sediment Characterization Report (Amec Foster Wheeler 2017b) presented the results of a sediment characterization study conducted between May 2016 and March 2017. This study was undertaken to better understand the size, location, seasonal movement, and composition of the mobile sediment pool, a volume of material including both mineral sediment and wood waste that recycles within the Estuary. The spatial distribution of wood waste in the Estuary was specifically targeted for evaluation based on the known industrial history of the Penobscot River (discussed further in Section 3.0), Phase II data suggesting that mercury concentrations in wood waste can be elevated relative to mercury concentrations in mineral sediment (Chapter 8; PRMSP 2013), and Amec Foster Wheeler professional opinion that the areal extent, thickness, and volume of this material in the Estuary was under characterized from the perspective of remedial evaluation.

Field activities completed during May 2016 included geophysical surveys in limited areas of the Estuary for sediment characterization. The surveys employed side-scan sonar, dual-frequency sonar, and sub-bottom profiling. Results of the side-scan sonar survey were used to characterize sediment types and features, including areas of scour and ripple features. In terms of sediment type (i.e., sand versus soft sediment), side-scan survey results were verified with ponar grab samples for general, visual characterization. Dual-frequency and sub-bottom profiling results characterized suspended and bedded material, respectively, with different compositional and potential transport properties.

Characterization of the mobile sediment pool in limited areas incorporated chemical and physical analyses and included total mercury and ancillary chemistry, sediment physical and geophysical properties, and a preliminary evaluation of the chemistry and distribution of wood waste in Estuary sediment. The purpose of the characterization and analysis was to evaluate patterns of mercury distribution within the Estuary, as well as estimating the volume of mercury-affected sediment and wood waste in the system.

Spatial characterization suggested sediment deposits enriched in wood waste reach 8 feet thick in some locations, and that the mobile sediment pool may contain more material than estimated by the Phase II Study (PRMSP 2013). Chemical analysis of wood waste suggested that concentrations of total mercury and methyl mercury in this material, either as a component of the sediment bed or in the mobile sediment pool, are elevated relative to concentrations in either bulk sediment or sediment that is sieved to exclude visible wood waste. Further characterization efforts for 2017 were recommended to refine the conceptual site understanding and the development of potential remedial options for the Estuary, particularly with respect to the volume and mobility of mercury-affected material (including mineral sediment and wood waste).

2.2.4 2017 Mobile Sediment Characterization Report

The 2017 Mobile Sediment Characterization Report (Amec Foster Wheeler 2018c) broadened the focus of the 2016 geophysical survey with respect to characterizing the size, location, seasonal movement, and composition of the mobile sediment pool. Work undertaken as components of this characterization included:

- Mapping deposits of bedded mineral sediment and wood waste;
- Estimating the mass of sediment and wood waste that moves in suspension under the influence of the tide;

- Estimating the volume of soft sediment on intertidal flats that is potentially erodible; and
- Mapping areas of bedrock, boulders, or hardpan in which sediment deposition is absent and/or where the presence of outcroppings or boulders could limit effective in-water remediation work.

Based on the results of the dual-frequency survey, the suspension layer (composed of both mineral sediment and wood waste in suspension) ranged from 0 to 31 feet thick and was generally less than 1 foot thick throughout the Estuary. A limited sampling (n = 6) of the suspended material suggested that it was enriched in wood waste and characterized by a total mercury concentration greater than 1,000 ng/g. The bedded material identified through sub-bottom profiling, and further evaluated with sediment sampling, was substantially composed of mineral sediment and wood waste. The thickness of the surface layer of material identified through sub-bottom profiling (i.e., the Reflector 1 layer) reached 6 feet in some locations, and was, on average less than 2 feet thick over the areas surveyed. Erosional indicator measurements taken in the intertidal and shallow subtidal zones suggested erosional features ranging from 0.2 foot to 6.6 feet wide and between 0.1 and 1.0 foot deep. Approximately 22 percent of the subtidal area from Bangor to south of Verona Island was characterized as bedrock/hardpan and between 14 percent and 20 percent of the intertidal area between Bangor and Cape Jellison was characterized as boulders or bedrock.

Based on results obtained in 2016 and 2017, there appears to be approximately 6.6 million cubic yards (cy) or 6.5 million tons (wet weight) of material in the system that can be characterized as a mix of bedded mineral sediment and wood waste. Of this total volume, approximately 50 percent appears to be in accumulations of greater than 1 foot thick. While the volume of material in suspension is small relative to the volume of material mapped as the Reflector 1 layer, the elevated mercury concentration and lower density of this material relative to mineral sediment may have implications for tidally-related fate and transport of mercury within the Estuary.

2.2.5 2017 Subtidal and Intertidal Characterization Report

The 2017 Intertidal and Subtidal Sediment Characterization Report (Amec Foster Wheeler 2018d) describes the results of sediment data collection efforts and geotechnical testing conducted in the Estuary in 2017. The overall objective of the work was estimate volumes of contaminated sediment in intertidal and subtidal areas; to obtain data for assessing the thickness, distribution, and mercury concentration of unconsolidated sediment in the Estuary; and to measure shear strength of consolidated sediment. Data collected for characterization of unconsolidated sediment were collected with the intention of combining these data with similar data collected under parallel field efforts (as described in other summaries in Section 2.2 of the Phase III Engineering Study Report). The goal of this sampling and analysis was to refine the operationally-defined Phase II characterization of mobile sediment (i.e., the ‘mobile pool’) thickness in the Estuary.

Sediment sampling focused on areas in which there was limited prior characterization from Phase II and Phase III investigations. Analytical results are presented by zone (intertidal or subtidal) as well as by sampling strategy (grab sample or core). For sampling conducted by coring, data are also presented to identify whether material sampled is unconsolidated or represents the collection of bedded or more consolidated sediment. For short cores of unconsolidated sediment, analyses included total mercury, methyl mercury, TOC, organic content, and total solids. For cores of consolidated sediment, analyses included total mercury, TOC, organic content, and total solids. Geotechnical testing was performed on select stations for cores of consolidated sediment. Data collected from this investigation provided additional data for estimating remedial volumes as a component of the evaluation of remedial alternatives, as well as providing a partial data set (as described above) for the characterization of soft unconsolidated sediment in the Estuary.

2.2.6 Thin Interval Core Sampling Report

The Thin Interval Core Sampling program was undertaken to advance the understanding of recovery rates throughout the Estuary; to broaden the understanding of sediment deposition patterns and sediment stability throughout the Estuary; and to improve the understanding of mercury transport and deposition within Mendall Marsh and Orland River. The field program included the recovery of short cores of unconsolidated material to supplement and broaden the system-wide understanding of the thickness, organic content, and total mercury concentration of this material (Amec Foster Wheeler 2018e).

Geochronology and mercury chemistry data from suitable cores were used to evaluate the rate at which the Estuary is recovering based on the apparent half time to recovery model, as employed in the Phase II Study (PRMSP 2013). The term ‘apparent’ is used herein consistent with its use in the Phase II Study in which the calculation of recovery rates is dependent on data extrapolation and assumptions regarding temporal mixing and redistribution of mercury in the Estuary. Consistent with the approach taken in the Phase II Study, application of this model employed either an exponential fit to an asymptotic mercury concentration of 0 ng/g or an exponential fit to a defined target concentration (Hg [∞]) of 400 ng/g.

Apparent recovery rate modeling was applied separately to geochronology and mercury-specific cores and focused on the portion of the overall data set for which sediment profiles allowed the application of the model. For locations in which cores were collected in 2009 and 2017, the 2017 data were compared with apparent recovery rates calculated from 2009 data.

Overall results from this effort suggest that the apparent natural recovery rate is slowing in the Estuary relative to rates estimated during the Phase II Study. The slowing of the apparent natural recovery rate in 2017 relative to the apparent rate presented in the Phase II Study for 2009 data is likely the result of two linked factors: the overall mixing and homogenization of surface sediment total mercury concentrations throughout the Estuary and the relative mass and mercury concentration of mobile material (both sediment and wood waste) recirculating within the Estuary relative to the mass and mercury concentration of clean sediment entering the Estuary from upstream.

Additionally, the report presents data collected in support of assessing sediment deposition patterns, lateral sediment transport and physical sediment mixing within the Estuary; data in support of the system-wide characterization of soft, unconsolidated intertidal and subtidal material; and data in support of improving understanding of mercury transport and deposition patterns within Mendall Marsh and Orland River.

2.2.7 2017 Marsh Platform Sediment Characterization Report

The 2017 Marsh Platform Sediment Characterization (Amec Foster Wheeler 2018f) assessed total mercury and methyl mercury concentrations in sediment from marsh platform locations that had not been previously sampled or in areas requiring further characterization; assessed gradients in total mercury and methyl mercury storage across the marsh platform in Mendall Marsh; and improved chemical characterization of sediment in Orland River. The objective of this investigation was to improve the spatial delineation of total mercury and methyl mercury in marsh platform and intertidal sediments.

Overall findings suggest that for marsh platform sediments, concentrations of total mercury in the Orland River were generally higher than in Mendall Marsh; the sediment depth associated with the highest concentrations was deeper in Orland River (> 0.5 foot) than in either Mendall Marsh (0.3–0.5 foot) or the pocket and fringe marshes along the main channel (0.3–0.5 foot). Concentrations of methyl mercury were generally higher in the surface interval (0–0.1 foot) than in the sub-surface interval (0.1–0.3 foot) for cores collected from Mendall Marsh, Orland River, and the pocket and fringe marshes. For both organic content and TOC, the concentrations (percent) were highest in Mendall Marsh and lowest in Orland River. The organic content of Orland River sediment was approximately 50 percent of the organic content of Mendall Marsh sediment. The data set generated from this study is incorporated into the larger marsh platform data set for the Estuary and is used to support the ecological risk assessment, improve the conceptual site understanding of mercury fate and transport in the Estuary, and aid in the evaluation and development of remedial alternatives for the Estuary.

2.2.8 2016 Biota Monitoring Report

As a component of the Phase III Engineering Study, the 2016 biota monitoring study was undertaken to better understand mercury concentrations in aquatic organisms and food webs and to assess whether mercury in the Estuary was: (1) having significantly adverse effects on populations of organisms and food webs; and (2) posing an unacceptable risk to human health (Amec Foster Wheeler 2017c). To achieve these objectives, biota species were monitored to determine tissue mercury concentrations and to assess trends (if present) in tissue mercury concentrations between Phase II Study data (collected 2006–2012), and Phase III Engineering Study data (collected in 2016). Results were presented for twelve species selected as representative of different trophic levels of terrestrial and aquatic species.

Results showed that mercury concentrations in most biota species and locations in the Estuary were either decreasing or stable. For many species, mercury concentrations decreased with distance downstream (on ebb tide) from the location of the HoltraChem facility. Mercury concentrations increased with trophic level, as hypothesized, and lower trophic and terrestrial mid-trophic level species showed limited or no change in tissue concentrations over time. Upper trophic level species showed more reduction in mercury concentrations than low trophic level or terrestrial mid-trophic level species. Biota collected in the areas of Mendall Marsh and South Verona tended to have higher tissue mercury concentrations than biota from other areas of the Estuary.

Based on these results, subsequent biota sampling was recommended for 2017 to increase the robustness of the statistical analysis for improved assessment of spatial patterns in mercury bioaccumulation within the Estuary.

2.2.9 2017 Biota Monitoring Report

The 2017 biota data built upon historical data sets to better understand mercury concentrations in aquatic organisms and food webs and to assess whether mercury was: (1) resulting in significantly adverse effects to populations of organisms and food webs, and (2) posing an unacceptable risk to human health. This report continued documentation of patterns of mercury concentrations within the Estuary, with the objective of evaluating the potential, or lack thereof, for recovery of the system given current conditions and historical trends (Amec Foster Wheeler 2018g).

Twelve species/groups were selected to represent various trophic levels of terrestrial and aquatic species. Low trophic level species (typically collected as composite samples) are represented by terrestrial insects, spiders, polychaetes, and blue mussels. Mid- and upper trophic level species are represented by two species of songbirds, one waterfowl species, one shellfish species, and four fish species. Historical data for most of these species were collected between 2006 and 2012, with the exception of the waterfowl species, for which samples were collected as recently as winter 2014. The addition of 2016 and 2017 data provides an update on tissue concentrations.

Overall, mercury concentrations in aquatic biota (lobster, blue mussel, rainbow smelt, eel, tomcod, and mummichog) in the Penobscot River either are generally decreasing (0.2 to 6.5 percent annual decline), indicating the potential for some natural attenuation, or are stable. Blue mussels at two locations and red-winged blackbirds at most locations had increasing mercury concentrations (0.4 to 2.2 percent annual increase). Aquatic low trophic level species (one shellfish species) and terrestrial mid-trophic level species (two songbird species) tended to show limited or no change in concentrations through time. Upper trophic level species showed more reduction through time in mercury concentrations than aquatic low trophic level or terrestrial mid-trophic level species. Biota collected in the areas of Mendall Marsh and South Verona tended to have higher mercury concentrations than in other parts of the Penobscot River Estuary. This tendency depended on the species analyzed. For many species, mercury concentrations decreased with distance downstream.

Long-term monitoring for representative species is recommended to increase the robustness of the statistical analyses for particular sampling areas and to better understand the distribution, trends, and bioaccumulation of mercury concentrations in representative species. Recommendations for long-term monitoring are presented in Section 8.7.

2.2.10 Summary of Biota-Sediment Accumulation Factor Evaluation

The 2017 biota-sediment accumulation factor (BSAF) evaluation assessed relationships between mercury concentrations in sediment and mercury concentrations in biota within the Estuary. These relationships were examined to better understand the extent to which mercury is being methylated and is accumulating in aquatic organisms and food webs; as well as whether mercury is (1) having significantly adverse effects on populations of organisms and food webs and (2) posing an unacceptable risk to human health (Amec Foster Wheeler 2017d).

Relationships between mercury concentrations in sediment and biota were quantified as BSAFs, which provide insight into bioaccumulation of total mercury and methyl mercury and are used to evaluate biological uptake for receptors exposed to mercury-affected sediment. This evaluation reflected sediment and biota sampling undertaken in 2016 and early 2017. BSAFs were calculated and evaluated for different trophic levels and at multiple locations within the Estuary. Additional characterizations presented in this report included normalization of data by lipid and organic carbon content, and calculation and comparison of BSAFs generated from Phase II data (2006–2012).

Based on these results, it was recommended that preliminary 2016 BSAFs be updated for use in development of preliminary remediation goals (PRGs) and associated risk reduction calculations for the Estuary.

2.2.11 Hydrodynamic Simulation Report

A hydrodynamic simulation study of the Penobscot River, Orland River, and Marsh River was undertaken to better understand the physical processes that affect or govern the distribution of mercury and methyl mercury in Estuary sediments (Amec Foster Wheeler 2018h). Hydrodynamic events were simulated using the unstructured mesh hydrodynamic model Delft3D-FM for the period between September 1 and September 16, 2017. The objective of the hydrodynamic simulation was to produce a tool to use with other tools to identify and evaluate potential remedial alternatives for the Estuary.

Findings of the hydrodynamic model Delft3D-FM included:

- The hydrodynamic model Delft3D–FM reasonably simulated measured water-surface elevation, and depth-average velocity calculated from measured velocity throughout the water column. Simulated elevation and velocity matched measured elevation and velocity with reasonable mean-absolute errors or reasonable root-mean-square deviations.
- Simulated water-surface elevations during the episodic coastal event were higher than simulated water-surface elevations during episodic riverine events throughout the study area.
- In a lower reach of the Penobscot, Orland, and Marsh Rivers, simulated depth-average flow velocities and bed shear stresses were generally greater during the episodic coastal event than during episodic riverine events. Localized exceptions to this generalized inequality existed.
- In an upper reach of the Penobscot, Orland, and Marsh Rivers, simulated depth-average flow velocities and bed shear stresses were generally greater during the episodic riverine event in that river than during the episodic coastal event. Localized exceptions to this generalized inequality existed.
- Simulated water-surface elevations, depth-average velocities, and bed shear stresses during episodic events were generally greater than simulated water-surface elevations, depth-average velocities, and bed shear stresses for a simulation of a two-week period in September 2017, throughout most of the study area. Localized exceptions to this generalized inequality existed.
- Simulated maximum bed shear stress during normal hydrodynamic conditions in early September 2017, exceeded estimated critical shear stress for part of the tidal cycle. This inequality was consistent with qualitative bed load observations of a persistent, mobile pool of sediment in the Estuary.
- Simulated maximum bed shear stress during episodic events exceeded critical shear stress estimated under normal hydrodynamic conditions. Based on these simulation results, it is likely that relatively large volumes of sediment would be mobilized during episodic events, compared with typical volumes mobilized under normal hydrodynamic conditions.

2.2.12 Analytical Method Comparison Technical Memorandum

In 2016, Amec Foster Wheeler performed an analytical methods comparison study to evaluate the various procedures available for obtaining accurate and defensible results for analysis of mercury and methyl mercury in Estuary sediment (Amec Foster Wheeler 2018i). The study assessed different digestion and/or extraction methodologies to determine which methodology yielded the highest and the most consistent total mercury and methyl mercury data. This study showed that:

- For analysis of total mercury in sediment, hot aqua regia digestion and thermal decomposition appear to be the most effective methods for achieving high, consistent analytical recovery in sediment samples having substantial amounts of wood waste;
- Wood waste is highly heterogeneous, which necessitates either homogenizing samples or analyzing samples in triplicate in certain situations;
- Extraction of sediments and wood waste with methanolic potassium hydroxide (KOH) yields higher methyl mercury results than extraction with methylene chloride;
- Extraction of sediments with methanolic KOH generally yields lower methyl mercury results than analysis following distillation; and
- Based on the findings of this study, the sediment samples that were collected during 2016, as well as all samples collected in 2017, were analyzed for total mercury using hot aqua regia digestion.

Because the methanolic KOH extraction method is more widely available in commercial laboratories than the distillation method and so may be more feasibly applied across current and future monitoring programs, methyl mercury analyses in sediment using methanolic KOH extraction was recommended.

2.2.13 Analysis of Lignin Oxidation Products in Sediment

This Technical Memorandum (Amec Foster Wheeler 2018j) summarizes the findings of a geochemistry assessment demonstrating the utility of lignin breakdown products as an analytical tool for determining the contribution of legacy wood waste to the overall organic carbon budget in Estuary sediments. Specifically, this assessment provided proof-of-concept evidence that organic carbon in the sediments analyzed was predominantly derived from wood waste.

For the six samples analyzed, the sum of oxidation products (Λ_8) ranges from 7 to 24 mg lignin / 100 mg organic carbon, compared to between 0.5 and 3.2 mg lignin / 100 mg organic carbon for particulate organic matter from typical U.S. rivers (Onstad et al., 2000). The relative abundance of lignin in the samples analyzed indicates that organic carbon in these samples is enriched in lignin oxidation products and is within the range of lignin oxidation product values calculated for fresh wood (in which Λ_8 ranges from 5 to 25 mg lignin / 100 mg organic carbon). These data suggest that the organic carbon in these samples is predominantly derived from terrigenous plant matter. Results further suggest that lignin in the samples analyzed is primarily of gymnosperm origins with very little soft plant tissue. This predominance of gymnosperm wood origin is evident for sediment samples that are primarily comprised of wood chips, such as Bucksport-1 (51 percent [%] organic carbon), as well as for mixtures of sediment and wood waste in which the organic carbon content ranges from 3-10 percent. Although results suggest that Estuary sediments are enriched in terrestrially-derived wood waste, they do not necessarily suggest that all organic carbon in the mobile sediment pool is predominantly of terrestrial origin.

2.2.14 Technical Memorandum Leachability Bench-Scale Testing

A leachability bench-scale study was undertaken in support of the remedial evaluation to assess the leachability of mercury and methyl mercury from sediment and mixtures of sediment and wood waste. This study also assessed whether salinity influences the leachability of mercury and methyl mercury from sediment and from mixtures of sediment and wood waste. The study findings are presented in a technical memorandum (Amec Foster Wheeler 2017e).

For testing, bulk sediment samples were collected from three areas (Verona Northeast intertidal, Frankfort Flats/Bucksport intertidal, and Bucksport subtidal) for leachability testing. These locations were chosen to represent a range of organic carbon concentrations (two samples had organic carbon content between 5 and 10 percent and the third had organic carbon content of approximately 45 percent). Surface water samples were collected from two locations: near Fort Point at high tide for higher salinity conditions (24 parts per thousand [ppt]) and near Hampden at low tide for low salinity conditions (0 ppt).

Leachability testing included two scenarios:

- Scenario 1: Sediment and wood waste mixed with river water, shaken, settled, decanted and filtered; elutriate analyzed for total mercury and methyl mercury.
- Scenario 2: Sediment and wood waste mixed with river water, shaken, settled, centrifuged and pressed; elutriate analyzed for total mercury and methyl mercury.

Results did not indicate rapid transfer of dissolved mercury from the particulate phase to the aqueous phase, even with aggressive sample agitation. Elutriate mercury concentrations were reported at concentrations below the Maine Freshwater Chronic Water Quality Criteria of 910 nanograms per liter (ng/L), suggesting that water treatment for mercury removal during sediment dewatering may not be needed prior to discharge.

2.2.15 Toxicity Study

A toxicity study was undertaken to evaluate potential impacts of activated carbon-based amendments on the survival, growth, or body burden of test organisms. Toxicity testing included an estuarine amphipod (*Leptocheirus plumulosus*) and a marine polychaete worm (*Nereis virens*) exposed to varying application rates (3, 5, and 10 percent dry weight) of amendments (activated carbon, SediMite™, and biochar) mixed with sediment collected from Mendall Marsh. The average total mercury concentration in the test sediment was 347.7 nanograms per gram (ng/g) (± 11.4 ng/g; n = 3). The average methyl mercury concentration in the test sediment was 9.7 ng/g (± 1.1 ng/g; n = 3). The location for test sediment collection was based on existing sediment mercury data for the south branch of Marsh River; sediment was collected from the upper intertidal zone. The endpoints evaluated for the amphipod included survival, growth (dry biomass and dry weight), and reproduction (juvenile production per organism and juvenile production per female) in 28-day tests. The endpoints evaluated for the polychaete worm included survival and body burden in a 28-day test.

Overall, the study findings show that adding SediMite™ at a rate of 3 percent achieved the best performance for nearly all endpoints measured based on mean survival, growth, and reproduction. The addition of activated carbon at either 5 percent or 10 percent generated results similar to the addition of 3 percent SediMite™. The addition of biochar resulted in reduced survival relative to the control across all application rates. The methyl mercury body burden in polychaetes for each treatment within the 28-day toxicity test did not show a difference in concentration relative to the control. Data generated in this evaluation were used in consideration of amendment application as a potential remedial strategy for Mendall Marsh (as well as other marsh platforms) in the Estuary. Data from the toxicity study are included as an Appendix to the Alternatives Evaluation Report (Amec Foster Wheeler, 2018k).

2.2.16 Dewatering Study

A dewatering study was undertaken to evaluate dewatering technologies for dredged sediments and wood waste. The study was conducted on composite samples of sediment and wood waste collected from the Estuary to evaluate mechanical technologies, geotextile fabric and gravity drainage technologies, and commonly available reagents and additives to increase material percent solids and material density for potential disposal.

For mechanical dewatering, belt press testing was performed on the bulk polymer treatment and bulk screening polymer treatment material conditions. The results of testing indicated that both materials produce similar percent solids and pass the paint filter test. Both materials failed uniaxial compressive strength testing and showed no pocket penetrometer strength. Based on the study, belt filter press technology requires the use of polymer in order to create a material capable of belt dewatering. The resultant filter cake passed paint filter testing either with or without removal of wood waste from the material.

Centrifugation testing was performed on the four material conditions. After centrifuging, the raw hydraulic dredge and bulk pre-screening materials exhibited the lowest percent solids. The raw hydraulic dredge, bulk polymer treatment, and bulk screening polymer treatment materials passed the paint filter test while the bulk pre-screening material failed the paint filter test. All materials failed uniaxial compressive strength testing and showed no pocket penetrometer strength. Based on the study, centrifugation technology appears to provide multiple options for full scale treatment. Treatment involving centrifugation does not appear to require the use of polymer to create a material that passes paint filter testing; removal of wood waste does not appear required.

Filter press testing was performed on the four material conditions. Results of the filter press tests show that the raw hydraulic dredge and bulk pre-screening materials achieved higher percent solids compared to the bulk polymer treatment and bulk screening polymer treatment materials. Filter press tests were less effective with polymer treatment and the resultant filter cakes did not pass the paint filter test. When polymer was not used, filter press tests were more effective following removal of wood waste, although for the raw hydraulic dredge material, even with wood waste present the filter cake passed the paint filter test.

Rapid dewatering testing and geotube dewatering testing were performed on the bulk polymer treatment and bulk screening polymer treatment materials. After allowing 15 gallons of test slurry to drain for 24 hours, the materials passed the paint filter test. Percent solids for the bulk polymer treatment and bulk screening polymer treatment materials were 35 percent and 46 percent, respectively. Neither material exhibited strength by uniaxial compressive strength testing or pocket penetrometer testing. Gravity drainage testing was conducted on the composited bulk sediment material at the "as received" moisture content to evaluate the reduction in moisture achieved by allowing the material to drain while stockpiled. After 24 hours of gravity draining, the percent solids increased from 36 percent to 40 percent. The material failed paint filter testing and did not exhibit strength by uniaxial compressive testing or pocket penetrometer testing. Gravity drainage does not appear to be an effective dewatering technology.

Overall, the study findings showed that mechanical press, centrifugation, and solidification with 4 percent Portland Cement were suitable methods for dewatering the dredged sediments and wood waste. Portland cement was the only technology tested that increased the material strength sufficiently for transport and disposal. Data from this study are included as an Appendix to the Alternatives Evaluation Report (Amec Foster Wheeler, 2018k).

2.2.17 Technical Memorandum Amendment Plot Resampling Study

The Smithsonian Environmental Research Center (SERC) conducted resampling of the amendment test plots initially established by SERC as a component of the Phase II Study (PRMSP, 2013). The test plots were initially established by SERC as a component of the Phase II Study (PRMSP, 2013). As detailed in the Phase II Study, the establishment and monitoring of amendment test plots was designed to assess the effectiveness of amendments as a remediation strategy for mercury in Mendall Marsh. While four amendments (iron as $FeCl_2$, lime, activated carbon formulated as SediMite® and biochar) were initially applied in 2010, iron and lime were dropped from further evaluation in 2012 based on the results of interim sampling and analysis. The 2017 sampling focused on the test plots containing SediMite® and biochar. The overall objective of 2017 sampling was consistent with the Phase II objectives, namely evaluation of the effectiveness of SediMite® and biochar in reducing soil and porewater concentrations of total mercury and methyl mercury relative to concentrations in control plots with no amendment addition.

Results of the 2017 resampling demonstrate that SediMite® and biochar applied in 2010 remain visible and measurable after 7 years in the field. Marsh accretion has buried the amendments to a current depth of 2-3 centimeters. Based on analytical measurement of soil carbon, the retention rate of SediMite® through 2017 was 127 ± 57 % at the Central site and 90 ± 32% at the West site. For biochar, the retention rate was 62 ± 26% at the Central site, and 29 ± 11% at the West site.

For depth-integrated porewater analyses (0-5 cm), the addition of both SediMite® and biochar decreased porewater concentrations of total mercury and methyl mercury relative to the control for the Central location but not the West location. Overall, throughout this study, SediMite® was more effective than biochar in reducing concentrations of porewater total mercury and methyl mercury.

For depth-integrated marsh soil analyses (0-3 cm), the addition of SediMite® appears to have minimal impact on concentrations of total mercury and methyl mercury in either the Central or West location. In contrast, the addition of biochar, while having no impact on the soil total mercury concentration in either the Central or West location, significantly increased the soil concentration of methyl mercury in both test locations. The increased concentration of soil-associated methyl mercury following the addition of biochar may result from the ability of biochar to sorb or bind methyl mercury and inhibit demethylation back to inorganic mercury.

Based on the review of these data, the use of amendment application as a component of site remedy for the Penobscot River Estuary has not been proven effective. It is currently not possible to evaluate whether the amendments, either applied as a stand-alone remedy or incorporated into a thin layer cap, would result in decreased biological update and trophic transfer of methyl mercury as there are only limited data on biota uptake of mercury with amendment addition. While SediMite® was more effective than biochar in reducing porewater concentrations of total mercury and methyl mercury over the study period (2010 – 2017), the impact of SediMite® addition was not equally apparent between the Central and West locations. Moreover, changes in soil redox conditions in 2017 relative to the earlier sampling period adds uncertainty to the evaluation of the long-term effectiveness of amendment addition by complicating interpretation of 2017 data relative to 2010 - 2012 data. For other sites, if biochar is to be evaluated as a potential amendment for reducing biological uptake of methyl mercury, Amec Foster Wheeler recommends that the bioavailability of methyl mercury that sorbs to biochar, particularly as the amendment ages in the field, should be assessed. The technical memorandum presenting the results of the amendment plot resampling (Amec Foster Wheeler 2018l) is included as an Appendix to the Alternatives Evaluation Report (Amec Foster Wheeler 2018k).

2.2.18 Technical Memorandum: Cohesive Sediment Erosion Field Study

The United States Army Corps of Engineers (USACE) Coastal and Hydraulics Laboratory was contracted to conduct a sediment bed erosion study which included erosion testing for 15 cores collected from select reaches of the Estuary. The study used the USACE High Shear Stress flume (SEDflume) designed for estimating erosion rates of fine-grained and mixed fine/coarse grained sediments collected as cores and analyzed across the depth profile of each core.

Data generated from the SEDflume testing indicated that distinct sediment layers with varied erosional resistance could be identified in each core collected from the Estuary, with the exception of one core collected from Mendall Marsh (MM-MU6-SF-1). Frequently, the boundary of erosional layers within cores was associated with zones of visible bioturbation. Other commonly observed markers of erosional layers included the surface layer (the upper 1 centimeter [cm] of sediment within each core), variations in sediment grain size, and changes in sediment bulk density.

In general, it was found that erosion rates tended to decrease with depth in the core; however, instances of more easily erodible layers were observed at depth in some cores. Critical shear stresses ranged from 0.11–1.21 pascal across the sediment layers assessed. For identified surface layers, the range of critical shear stress was found to be 0.11–0.43 pascal. For the Estuary, critical shear stress values generated from this study are synthesized with simulated bed shear stress values and evaluated with respect to sediment distribution in the Hydrodynamic Simulation Report (Amec Foster Wheeler 2018h). The technical memorandum describing the SEDflume testing is included as an Appendix to the Alternatives Evaluation Report (Amec Foster Wheeler, 2018k).

3.0 CONCEPTUAL SITE UNDERSTANDING

This section presents the current site understanding and includes an overview of the Estuary, including division of the river into reaches to facilitate delineation and assessment of remedial alternatives; a description of site geomorphology, including sediment transport dynamics and Estuary circulation; an overview of historical human activities in the Penobscot River watershed; a description of current activities that affect the Estuary; a conceptual understanding of mercury fate and transport; spatial distribution of mercury and methyl mercury by reach; ecological exposure; wood waste/wood products fate and transport; and system recovery times.

3.1 SITE OVERVIEW AND REACH DESIGNATIONS

The Penobscot River is the second largest river system in New England, draining a watershed of approximately 7,470 square miles. The lower river is defined by the Penobscot River Estuary, which extends 22 miles from Bangor to the vicinity of Searsport, Maine. The surface area of the Estuary is approximately 35 square miles. The geographic area of the river addressed in the Phase III Engineering Study is described by the Court as “the region from the site of the former Veazie Dam south to upper Penobscot Bay, including Mendall Marsh and the Orland River” (**Figure 1-1**). The Estuary also includes reference stations from upgradient of the former Veazie Dam.

Tidal range in the Estuary can vary from 9.5 feet at neap tides to 16 feet at spring tides, with a tidal velocity that ranges from 2.3 feet per second during neap tides to 4.3 feet per second during spring tides (Geyer and Ralston 2018). Salinity within the Estuary ranges from 0 to 30 ppt depending on location and season, and the upgradient limit of tidal influence can exceed the upgradient limit of saltwater incursion. Freshwater outflow from the Penobscot River varies seasonally from approximately 5,000 cubic feet per second during low flow conditions to 63,000 cubic feet per second during peak spring freshet, with an average annual discharge of 12,000 cubic feet per second (Geyer and Ralston 2018). During seasonal periods of high freshwater outflow, tidal inflow does not mix saltwater throughout the water column; during these periods, stratification or layering is created in the water column, resulting in freshwater outflow predominating in surface waters and tidal (saltwater) inflow being confined to the lower water column. Under these high river flow conditions, the extent of saltwater incursion into the Estuary is restricted, and salinity may be 0 ppt north of Winterport (Geyer and Ralston 2018). During seasonal periods of lower freshwater outflow, tidal inflow may significantly mix saltwater throughout the water column. This vertical mixing of saltwater reduces stratification or layering of the water column and under these conditions, the tidal incursion may be evident as far upgradient as Bangor (Geyer and Ralston 2018). The impact of seasonal variations in stratification and saltwater incursion on sediment transport dynamics is discussed in greater detail in Section 3.2.2.

To characterize sections of the Estuary that may be distinct in terms of river flow, tidal influence, and/or the transport and deposition of mercury associated with sediment, Amec Foster Wheeler has delineated 15 Estuary reaches (**Figure 1-1**). Reach boundaries incorporate physical river features so that field personnel can recognize these features during sample collection efforts. For the 15 reaches delineated for the Estuary, the lateral landward extent of the reach boundary is the 14-foot MLLW (8 feet North American Vertical Datum of 1988 [NAVD88]) elevation contour that corresponds with the highest annual tide.

3.2 SITE GEOMORPHOLOGY AND ESTUARINE CHARACTERIZATION

Regarding geomorphology (or shape), the upper Penobscot River Estuary is defined by a narrow channel (< 0.5 mile) that is generally bound by bedrock. The channel widens downgradient of Winterport in the vicinity of Frankfort Flats and then narrows again in the vicinity of Verona Island. The Estuary channel divides around Verona Island, with the main flow passing to the west of Verona Island; a secondary channel passes to the east of Verona Island where it is joined by the Orland River at Gross Point. South of Gross Point, the eastern channel narrows and, passing south of Verona Island, rejoins the western channel. South of Verona Island the single main channel enters the lower Estuary and widens considerably to more than a mile in width. The lower Estuary is defined by the broadening and deepening area from the southern tip of Verona Island south past Fort Point Cove, Cape Jellison, and Sears Island, and south to the upper extent of Penobscot Bay. The upper extent of Penobscot Bay (distinct from the reach named “Upper Penobscot Bay” on **Figure 1-1**) is generally defined by a line drawn from Belfast Bay on the west side of the upper bay across Turtle Head on Islesboro to Castine on the east side of the upper bay. Overall, the Estuary can be described as a drowned river channel carved and framed by glaciers.

3.2.1 Glacial History and Sediment Inputs

The glacial framing of the Penobscot River and Estuary has resulted in features including shoaled or shallow areas, such as in the vicinity of Frankfort Flats, as well as areas in which the bedrock has been scoured and incised. Water depth in the upper Estuary is generally less than 30 feet, increasing to more than 60 feet in the vicinity of Bucksport and in the main channel west of Verona Island. Water depth east of Verona Island and in the Orland River is generally consistent with water depth in the upper Estuary and increases to more than 30 feet southeast of Verona Island, where the east and west channels converge.

Sediment inputs to the upper Estuary are derived from multiple sources, including transport from upgradient in the river, lateral transport into the Estuary from creeks or tributary streams (such as Marsh River), and landward transport from downgradient in the Estuary as the result of tidal action. Mass estimates of sediment input to the Estuary are on the order of 44,000 (metric) tons per year from sources upstream of the Estuary and 12,300 (metric) tons per year from lateral creeks and tributaries from within the Estuary, as discussed in Chapter 18 of the Phase II Report (PRMSP 2013). The mass of sediment annually transported into the Estuary from Upper Penobscot Bay is currently unknown.

3.2.2 Estuary Characterization

An estuary can be generally defined as a semi-enclosed coastal body of water that exists at the interface between an outflowing body of fresh water (i.e., a river) and an incursion of saltwater (i.e., ocean tides). A more complete characterization of sediment transport in estuaries therefore requires understanding the processes regulating the potential for that transport. The dominant processes regulating transport described further in this section include tidal circulation and the impact of that circulation on the balance between burial/storage versus resuspension and redistribution of particulate matter. Particulate matter includes mineral sediment as well as organic particles that may originate from upgradient transport and/or from primary production (i.e., phytoplankton growth) within the estuary. For the Penobscot River, organic particle transport into the Estuary includes an unknown volume of wood waste originating from upstream historical sawmill activities along the river (see Section 3.3.1.2). Chapter 18 of the Phase II Report estimated that the rate of new particle formation within the Penobscot River Estuary is approximately 12,500 (metric) tons per year (PRMSP 2013), with an uncertain fraction of this material being recycled in the water column versus depositing (either temporarily or as a component of stable storage) on the sediment bed. Stable storage results from the settling of particulate material to the Estuary bed where it may be ultimately buried by continued deposition. Resuspension refers to the re-entrainment of material into the water column as the result of natural (e.g., tidal action, storm events) or anthropogenic (i.e., vessel traffic, dredging activities) disturbances to the sediment bed.

3.2.2.1 Tidal Volume/Circulation

Estuaries can be generally described in terms of two features: the balance between the magnitude of freshwater outflow and the tidal amplitude; and the impact of that balance on the salinity profile of the water column. Geyer and Ralston (2018) describe the profile of the Penobscot River Estuary as a tidally forced salt wedge. A salt wedge is created when the magnitude of freshwater outflow is sufficient to stratify the water column and create a vertical gradient in water column salinity (**Figure 3-1**). This gradient is driven by the difference in density between fresh water (lower density) and saltwater (higher density).

Although density gradients can be created by multiple factors, including water temperature and variations in suspended sediment concentrations, the principal driving mechanism for stratification in estuaries is the salinity gradient. In a salt-wedge estuary, surface water flowing downgradient (i.e., flowing toward the coastal ocean) is fresh (salinity = 0 ppt) and bottom water flowing upgradient (i.e., moving upstream within the estuary from the ocean) reflects the salinity of the incoming tide. Geyer and Ralston (2018) have documented that under high freshwater outflow conditions, such as occurs in the spring, a salinity greater than zero is measurable in the bottom water as far upgradient as Mendall Marsh on the incoming tide. During outgoing (ebb) tide in a salt-wedge estuary, the structure of the salt wedge can collapse, resulting in a water column salinity profile that is more evenly mixed throughout the water column. Under these ebb tide conditions, the upgradient extent of saltwater incursion will move back downgradient toward the mouth of the estuary. For the Penobscot River Estuary, under spring flow conditions, the ebb tide limit of saltwater incursion can move downgradient from Mendall Marsh to the vicinity of Bucksport (Geyer and Ralston 2018).

During low flow (summer) conditions in a tidally stratified estuary, the decrease in the volume of freshwater outflow results both in an increased incursion of saltwater further up the estuary and a general decrease in water column stratification as saltwater is mixed farther up into the water column. For the Penobscot River Estuary, data collected during lower flow conditions have demonstrated measurable saline bottom water as far up as Orrington during the flood tide, and salinity remaining measurable in the vicinity of Winterport during ebb tide (Geyer and Ralston 2018). For the data presented in Geyer and Ralston (2018), although the water column was stratified and vertical profiles in salinity were measurable throughout the June (low flow) 2011 sampling cycle, the extent of stratification was not as significant as it was during high flow/flood tide conditions measured in the spring of that year.

The 2011 data presented by Geyer and Ralston (2018) highlight the balance between freshwater outflow and saltwater inflow that characterize the dominant circulation within estuaries. Depending on the size and shape of an estuary, other mechanisms can contribute to circulation, although the overall impacts of these mechanisms may be less significant (such as residual circulation resulting from Coriolis forcing), localized (such as meanders or other variabilities in channel shape or depth), and/or episodic (such as wind-driven forcing during storm events). For the Penobscot River Estuary, localized cross-channel circulation occurs at Frankfort Flats because of the shape of channel meanders in this reach (Hegermiller 2011). This localized cross-channel circulation enhances sediment trapping in this area.

3.2.2.2 Sediment Storage/Recirculation

Estuaries tend to function as traps for sediment and suspended particulate matter due to a combination of factors, including a change in channel slope in an estuary relative to the slope in the upgradient river and the impact of tidal inflow on freshwater outflow. While some portion of the sediment in estuaries is in either periodic or continuous motion, much of the sediment in estuaries is deposited on the sediment bed or (if present) within adjoining marshes, either within marsh channels or on marsh platforms. Sediment deposition on marsh platforms is the result of inundation of the platform; site-specific sediment accumulation rates on platforms vary as a function of factors including inundation frequency, vegetation (amount and type) and the presence of pannes or other topographic low spots. The rate at which sediment accumulates in estuaries can vary significantly as a function of background/natural factors and human activities. If an estuary is considered as an equilibrium profile that joins a riverine reach and the coastal ocean, the dominant process responsible for sediment storage in estuaries is the accommodation space created by sea level rise. That is, as sea level rises, underwater space is created in estuaries for the settling and storage of sediment. In a typical New England estuary like the Penobscot River Estuary, the accommodation space created by sea-level rise allows for the deposition of approximately 2 millimeters of sediment per year as a background sedimentation rate, as detailed in Chapter 7 of the Phase II Report (PRMSP 2013). Within the Estuary, sediment accumulation rates vary from 0–2.5 cm per year (Santschi et al. 2017; Amec Foster Wheeler 2018e) depending on site-specific factors, including location on marsh platforms (near the edge versus in the interior) and hydrodynamic controls on potential deposition and accumulation in intertidal areas (**Figure 3-2**). The rate at which sediment accumulates in a location will influence both the spatial pattern and the site-specific inventory of particulate-associated contaminants such as mercury.

Sediment deposition can be enhanced or reduced by a range of human use activities that disturb the equilibrium profile in estuaries. Activities that can enhance sediment deposition include dredging and the placement of structures such as docks or groins that change localized circulation patterns in an estuary. Activities that reduce sediment deposition include the placement of upgradient structures like dams that might limit sediment supply to an estuary or activities within an estuary, such as placement of bulkheads or other channelizing structures that would limit or prevent sediment deposition and storage. Overall, historical dam construction on the Penobscot River was typically run-of-river and did not result in significant fine-grained sediment retention upgradient of the Estuary (see Section 3.3.1.3).

Following deposition, the resuspension of particulate matter from the sediment bed requires a disturbance of that bed. Disturbance can be localized (such as from the passage of a vessel) or more broadly distributed (such as from a storm surge), but in either scenario, the resuspension of bed sediment is the result of shear stress applied to the bed surface. Two of the factors influencing the magnitude of the sediment bed response to the applied shear stress are: the size and density of bed particles (with greater shear stress required to re-suspend larger and/or denser particles), and the overall previous stability of the sediment bed (with a consolidated bed requiring greater shear stress to re-suspend particles than a bed enriched in unconsolidated or flocculant material).

Regarding the question of mercury fate and transport (Section 3.5), this model of sediment retention and recirculation in estuaries suggests that for contaminants such as mercury associated with fine-grained sediment or low-density organic matter, there is likely to be significant mixing and retention of contaminants within estuaries. The cycling and retention of fine-grained sediment or low-density organic matter within estuaries can therefore have the effect of homogenizing or blurring contaminant concentration gradients (either spatially or vertically) which may have implications for the ability to use the spatial distribution (either/both vertical or horizontal) of contaminants to assess fate and transport dynamics and/or system recovery rates for that estuary. Use of site data to assess system recovery rates for the Penobscot River Estuary is discussed in Section 3.9.

3.2.2.3 Estuarine Turbidity Maximum

In some scenarios and under specific conditions of freshwater outflow and tidal range, hydrodynamic circulation can create regions in an estuary in which a pool of mobile material is maintained continuously in suspension. This feature is described as an estuarine turbidity maximum (ETM) and defines a location, typically near the landward limit of saltwater incursion, where the stratification and convergence of flow created by the interaction of fresh and saltwater promotes the retention, accumulation, and recycling of fine-grained materials (**Figure 3-3**) (Geyer 1993). As its location relative to the limit of saltwater incursion suggests, if an estuary has an identifiable ETM, the feature will move seasonally as changes in the volume of freshwater outflow influence the location of the salt wedge. The concentration of particulate matter in the ETM may also vary seasonally as the extent of water column stratification will influence the vertical expression of water column turbidity and the magnitude of freshwater discharge will influence the concentration of suspended particulate matter in the water column.

In general, for energetic salt-wedge estuaries, sediment accumulation occurs predominantly in mud-dominated environments that fringe the main estuary channel (Yellen et al. 2017). Yellen et al. (2017) observe that, for the Connecticut River, a combination of: (1) the presence of a pool of re-suspended/mobile fine-grained particulate matter in an ETM that seasonally moves into the vicinity of an off-channel cove; (2) a salinity (density) gradient between saltier water in the main estuary channel and fresher water in that cove; and (3) vertical water column stratification within the cove that tends to limit localized sediment resuspension, create a dynamic in which embayments and off-channel coves can significantly retain particulate matter. Conceptually, this model of sediment accumulation has relevance for the Penobscot River Estuary in locations including Mendall Marsh and the Orland River, as well as for smaller embayments like Bald Hill Cove along the main Estuary channel.

3.2.2.4 Penobscot River Estuary/Mobile Pool

Consistent with the general model of sediment transport dynamics in estuaries presented in Sections 3.2.2.2 and 3.2.2.3, the Phase II Report (PRMSP 2013) identified a pool of mobile sediment in the Estuary that appears to migrate upgradient and downgradient in response to variations in tidal range and freshwater discharge. This appears to concentrate in the vicinity of Mendall Marsh and the Orland River as the result of tidal movement and associated sediment trapping. Additional detail is presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k). As described in Geyer and Ralston (2018), tidal effects on the mobility of this sediment pool occur on the time scale of weeks (i.e., spring versus neap tides) to seasons (i.e., movement of the salt wedge as the result of seasonal variation in the magnitude of freshwater discharge). These effects are associated with two distinct, localized turbidity maxima within the Estuary, with a more upgradient ETM located near the point of maximum saltwater incursion, and a further downgradient ETM located at the point of ebb tide retreat (Amec Foster Wheeler 2018k). During high-flow spring freshet conditions in the Estuary, the upgradient ETM moves into the vicinity of Frankfort Flats and Mendall Marsh and suspended particulate matter concentrations in this region can exceed 1,000 milligrams per liter (mg/L) in bottom water (Geyer and Ralston 2018). As context for evaluating this concentration of suspended particulate matter, concentrations of suspended solids entering the Estuary from upgradient of the former Veazie Dam site range from 0.5–23 mg/L (PRMSP 2013; Amec Foster Wheeler 2018b) and concentrations of suspended solids in the water column within the Estuary range from 5–50 mg/L (Amec Foster Wheeler 2017a) and non-detect to 1,710 mg/L (n = 973) with an average of 32 mg/L (PRMSP 2013).

During low flow conditions in the Estuary, these two turbidity features remain, although the increase in overall water column mixing that occurs during periods of lower freshwater outflow results in a decrease in the concentration of suspended particulate matter in the water column. For the location in the Estuary in which the upgradient ETM was described during freshet conditions, suspended sediment concentrations decreased to < 200 mg/L during 2011 sampling (Geyer and Ralston 2018). During low-flow conditions in the Estuary, a third localized ETM may also appear; during 2011 sampling, suspended sediment concentrations at the location of the third localized ETM reached 400 mg/L (Geyer and Ralston 2018). This third localized ETM appeared during late flood tide in the vicinity of Orrington (Amec Foster Wheeler 2018k). A 2017 geophysical survey conducted in the Estuary also documented an area of enhanced water column turbidity in the vicinity of Orrington (Amec Foster Wheeler 2018c). While the concentration of suspended particulate matter in that area could not be measured via geophysical survey techniques, the dual-frequency separation indicated the presence of a region of elevated water column turbidity that exceeded 20 feet thick in at least one Orrington transect (Amec Foster Wheeler 2018c). Further discussion of the geophysical survey data is presented in Section 3.8.1.

The location and intensity of the ebb tide ETM is also important from the perspective of particulate transport and retention in the Estuary. Under both high-flow and low flow conditions in 2011, elevated suspended sediment concentrations were documented near Bucksport in the location where the river channel deepens to greater than 60 feet (Amec Foster Wheeler 2018k). This bathymetric low spot appears associated with the retention and recycling of suspended sediment. Likewise, data presented in Chapter 7 of the Phase II Report (PRMSP 2013) suggest that sediment trapping occurs at least temporarily in the area southeast of Verona Island, and that near-bottom flow in this reach of the Estuary is typically in the landward direction. Geophysical survey data from this area collected by Amec Foster Wheeler in 2017 have identified a bedded deposit of mixed non-cohesive sediment and wood waste that is more than 6-feet thick near the convergence of the East Channel and Orland River (Amec Foster Wheeler 2018c). A sediment core collected from within this deposit (Station VE-05-01-E) contained concentrations of total mercury between 1,200 and 1,600 ng/g over 4 feet of the recovered core (Amec Foster Wheeler 2018d), further supporting the characterization of this area as a zone of physical mixing and at least temporary material trapping. Overall, for the area east of Verona Island, these characteristics suggest that sediment resuspension and cycling in this reach is influenced by both seasonal variations in the magnitude of freshwater discharge in the main Estuary channel (west of Verona Island) and the relationship between the size/shape of the channel east of Verona Island and tidal forcing through this channel constriction.

Other locations in the Estuary with similar characteristics regarding sediment mercury profiles and the composition of the sediment bed (i.e., a bedded mixture of non-cohesive sediment and wood waste) include stations in the upper Orland River (Station OR-T3-C3) and Frankfort Flats (Station FF-04-01). For both these locations, the bedded deposit is at least 3 feet thick and the mercury concentration profile is generally above 1,000 ng/g throughout the deposit (Amec Foster Wheeler 2018d).

Relatedly, if an ETM facilitates the transport of fine-grained sediment or low-density organic matter into off-channel coves, then these environments may play a key role in highlighting aspects of site variability that impact understanding of chemical fate and transport dynamics throughout the system. An embayment that serves to focus sediment characterized by a spatially and temporally averaged contaminant concentration (such as would result from mixing and transport under the influence of the ETM) may preserve a chemical input and burial record. This may appear different than the record preserved in a location in which contaminant storage may more directly reflect a chemical discharge history without the significant resuspension, mixing, and redistribution that characterizes deposition in an ETM-influenced embayment.

An example of an embayment in which sediment mixing and/or deposition may be influenced by the ETM is the embayment upgradient of Snub Point (Station PBR-19). For this station, the mercury concentration profile from 2017 sampling shows a broadly defined mercury concentration peak (2,682 ng/g) at a depth of 17–18 cm, with mercury concentrations over the top 1 foot ranging from 1,300 ng/g (at 30–32 cm) to 1,164 ng/g (at 0–1 cm). Below a depth of 32 cm, mercury concentrations are consistently below 366 ng/g (Amec Foster Wheeler 2018e). The sediment accumulation rate calculated from the cesium radioisotope (^{137}Cs) profile for this location was 0.51 cm per year, with the cesium radioisotope, calculated excess lead radioisotope ($^{210}Pbxs$), and total mercury profiles each showing similarly broadly defined maxima over the top foot of the core and decreasing to low or background concentrations below this depth in the core. A core collected in approximately the same location in 2009 was characterized by a peak in mercury concentration (6,440 ng/g) at a depth of 50–55 cm and mercury concentrations that decreased slowly and inconsistently toward the surface (PRMSP 2013). The calculated sediment accumulation rate for this location in 2009 was 1.0 cm per year, and the rate for that coring program was elevated relative to the average sediment accumulation rate (0.56 cm per year) for cores (n = 24) characterizing the main Estuary channel (Santschi et al. 2017).

Overall, with respect to sediment mobility, sediment resuspension and mobilization in the Estuary occurs on the time scale of days (i.e., flood versus ebb tides), weeks (i.e., spring versus neap tides) and seasons (i.e., movement of the salt wedge as the result of seasonal variation in the magnitude of freshwater discharge), suggesting that material available for resuspension is bedded through at least a portion of these different cycles. The thickness (and therefore the volume) of these transiently bedded deposits can be estimated in a range of ways, including redox effects on sediment color (see Chapter 7 of the Phase II Report [PRMSP 2013] and Geyer and Ralston [2018]), ruler resistance measures of sediment consolidation, measurements of critical shear stress for erosion, geophysical survey techniques, sediment chemical profiles, and changes in sediment physical properties (Amec Foster Wheeler 2018a, 2018e, and 2018g). The combination of these approaches suggests an unconsolidated mobile sediment layer thickness of approximately 0.3 foot (3.6 inches) (**Table 3-1**), depending on how this layer is defined and over what time scale it is considered mobile. The volume of this material is an important variable in modeling system recovery, because it contributes to the residence time of sediment (and mercury) in the system.

3.3 HISTORY OF HUMAN ACTIVITIES IN THE PENOBSCOT RIVER AND ESTUARY

A range of activities have played a role in shaping current conditions in the Estuary, including:

- Natural resource use;
- Dredging in support of navigation or commerce;
- Industrial activities, including use of the chlor-alkali process for the manufacture of caustic soda and chlorine;
- The passage of federal and state legislation that affect water quality;
- Removal of dams as a component of ecosystem restoration; and

- Current (ongoing) remedial activities resulting from historical use of mercury within the Estuary.

3.3.1 Natural Resource Use

This section summarizes natural resources uses of fisheries, timber/lumber/pulp and paper, hydroelectric power, and quarrying.

3.3.1.1 Fisheries/Fish Species

Historically, the Penobscot River and Estuary were home to 11 sea-run fish species: shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus*), Atlantic salmon (*Salmo salar*), alewife (*Alosa pseudoharengus*), tomcod (*Microgadus tomcod*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), sea-run brook trout (*Salvelinus fontinalis*), striped bass (*Morone saxatilis*), rainbow smelt (*Osmerus mordax*), sea lamprey (*Petromyzon marinus*), as well as American eel (*Anguilla rostrata*). As with many east coast rivers, historical activities include dam construction, overfishing, dredging and resultant impacts on benthic habitat, and industrial discharges, including logging and sawmill wastes. The resulting impacts on water quality have negatively affected the distribution and abundance of these fish in the Penobscot River and Estuary. Shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon are currently protected under the Endangered Species Act (NOAA 2017a).

Shortnose sturgeon have been documented as foraging and wintering in the Estuary (Lachapelle 2013). Wintering is a behavior in which sturgeon cluster together and swim in place while orienting into the freshwater current. The upstream limit of sturgeon migration in rivers is generally defined by the location of the most downstream obstruction to fish passage, because sturgeon do not typically use fish ladders. Due to this limitation, prior to the removal of the Veazie and Great Works Dams (see Section 3.3.2), shortnose sturgeon were not able to reach historic spawning grounds in the Penobscot River (Wegener 2012). Following dam removal, it is expected that shortnose sturgeon will be able to access their historical range, including potential breeding grounds (Wegener 2012). It is currently estimated that around 1,000 shortnose sturgeon forage and winter in the Estuary. Tagged Penobscot shortnose sturgeon have been recorded as far away as the Kennebec River in Maine, approximately 100 miles (NOAA 2017b).

Atlantic sturgeon are less well studied in the Penobscot River than shortnose sturgeon, but estimates suggest that there are currently >600 Atlantic sturgeon in the Gulf of Maine (Wippelhauser et al. 2017). An unknown number of Atlantic sturgeon spend at least a portion of the year foraging in the Penobscot River Estuary, with data from Wippelhauser et al. (2017) suggesting that the annually returning population of Atlantic sturgeon to the Penobscot River is approximately 40 fish. While tagged Atlantic sturgeon have been detected as far upriver as

Bangor, they more typically forage in the reach between Winterport and Bucksport. Atlantic sturgeon tagged in the Penobscot River have been detected as far north as Minas Basin (Bay of Fundy) and as far south as the Hudson River (Altenritter et al. 2017).

In August 2017, NOAA designated the Penobscot River as critical habitat for the Atlantic sturgeon. Critical habitat is designated based on *"physical or biological features essential to the conservation of the listed entity (e.g., species, subspecies or DPS [Distinct Population Segment]) and which may require special management or protection"* (NOAA 2017c). In the Penobscot River, the critical habitat unit for the Atlantic sturgeon extends from the Milford Dam (approximately 15 miles upriver from Bangor) to the mouth of the river in Penobscot Bay. Four additional critical habitat units are included in the overall Gulf of Maine Distinct Population Segment. These four units are in the lower Kennebec River, lower Androscoggin River to Merrymeeting Bay, lower Piscataqua River, and the lower Merrimack River. Overall, the total length of designated critical habitat within these five units is approximately 152 miles.

For Atlantic salmon, historical numbers suggest catches of >20,000 fish/year were common on the Penobscot River in the late 1800s, with catch numbers decreasing until the commercial fishery closed in the late 1940s. Fishermen caught 40 salmon in 1947, the final year in which commercial fishing was allowed in the Penobscot River (EPA 1980). Current estimates of Atlantic salmon in the Penobscot River suggest fewer than 1,000 individuals returning annually to the river (State of Maine Department of Marine Resources 2017). Critical habitat for the Gulf of Maine Distinct Population Segment of Atlantic salmon includes remnant populations from the Kennebec River downstream of the former Edwards Dam site to the St. Croix River, also including the Penobscot River. It is estimated that 75 percent of the remaining adult Atlantic salmon in the United States are found in the Penobscot River (NMFS and USFWS 2005).

3.3.1.2 Lumber/Timber/Pulp and Paper

Maine is one of the most heavily forested eastern states and historically hosted one of the largest wood products industries in the United States. The Penobscot River watershed has a long history of timber harvesting and sawmill production. Bangor, in the 1850s, was identified as the "Queen City" of lumber and served as the largest lumber exporting port in the world (Bloom 1971, Mower 2009). At that time, there were approximately 410 sawmills operating along the river, with 52 operating in the vicinity of Bangor (Bloom 1971). Wastes from sawmill operations, including sawdust, wood slabs, bark, and edgings, were disposed of directly into the river. Over 100 years later, the Penobscot River Estuary was still characterized by the presence of *"great islands and bogs of sawdust"* (Bloom 1971) in deposits reaching 22 feet thick and visible in the area of Frankfort Flats (Davies 1972) resulting from historical use and discharge practices. Direct discharge of wood waste into the Penobscot River was curtailed by the 1972 Clean Water Act (CWA) and ceased by the mid-1980s.

Pulp and paper production began on the Penobscot River in 1882, with early mills constructed along the lower river in Brewer, Howland, and Old Town, followed by the upper West Branch mills in Millinocket and East Millinocket (Mower 2009). Pulp and paper production expanded along the Penobscot River to ultimately include seven mills, including the mill in Bucksport. As of 2017, only a portion of the Bucksport mill was still operating. Prior to the construction of wastewater treatment facilities, including clarifiers and stabilization basins as required by the CWA, pulp and paper mills discharged effluent directly into the river.

3.3.1.3 Dam Construction/Hydroelectricity Generation

Construction of dams on the Penobscot River, like other Maine rivers, was historically connected to flow control, log driving, and/or power generation for mills. Currently, there are 13 dams along the Penobscot River, with seven of those structures located on the West Branch of the river (Kleinschmidt 2015). Two additional dams located along the lower river were removed between 2013 and 2014 as a component of the Penobscot River Restoration Project (see Section 3.3.2). Not all dams remaining on the Penobscot River are power generating, as some structures on the West Branch serve flow and flood control purposes. Total hydroelectric power generation capacity on the Penobscot River is currently <200 megawatts (Kleinschmidt 2015). Overall, dam construction on the Penobscot River was typically run-of-river, meaning that power generation did not involve the creation of a reservoir or significant pondage upstream of the dam. One implication of run-of-river construction is that without an impoundment defined by quiescent conditions, fine-grained sediment storage upstream of the dams is generally minimal.

The presence of dams on the Penobscot River has resulted in historical and ongoing impacts on fisheries and fish habitat. Fish passage to spawning grounds is limited by the dams. Water quality and riparian and upland habitat are altered, with associated species impacts in these areas. Dams along the Penobscot River have also likely served to trap an unknown volume of logs and wood debris from historical upgradient timber/lumber works.

3.3.1.4 Quarrying

Historical quarrying activities along the lower Penobscot River have included granite, clay, and ice. Granite quarrying occurred principally at the Mount Waldo Granite formation in Frankfort, Maine, along the North Branch of Marsh River. Stone was quarried from a range of hills in the vicinity of Frankfort, including Mount Waldo, Mosquito Mountain, Mack Mountain, Heagan Mountain, and Treat Hill. The granite was cut and processed along Marsh River and then transported via the Penobscot River to cities along the east coast and the Great Lakes. Quarrying in Frankfort began in the early 1800s and lasted until the mid-1900s. Cut stone transport via the river ceased in the early 1900s, when rail replaced schooners and barges. Quarrying still occurs on Mosquito Mountain for local, small-scale processing and use. There are no data readily available on the impact of stone quarrying and cutting activities on sediment transport in Marsh River or the Penobscot River Estuary.

3.3.2 Dam Removal/River Restoration

The Penobscot River Restoration Project commenced with the signing of the Lower Penobscot River Settlement Accord in 2004 and the creation of the Penobscot Trust (Penobscot River Restoration Trust 2017). In 2010, having reached financing goals and receiving the necessary state and federal permits, the Penobscot Trust purchased the Great Works (Bradley), Veazie, and Howland Dams. The Great Works Dam was removed in 2012 and the Veazie Dam in 2013. A fish bypass around the Howland Dam was completed in 2016. With the completion of the bypass, and the installation of a fish elevator at the Milford Dam, access to more than 1,000 miles of riverine and lacustrine habitat has been re-opened for native sea-run fish species on the Penobscot River.

Sediment sampling conducted in the impoundments upstream of the Great Works and Veazie Dams prior to dam removal indicated low sediment total mercury concentrations. Sediment total mercury concentrations at two locations within Great Works impoundment were 0.094 milligrams per kilogram (mg/kg) (equivalent to 94 ng/g) and 0.12 mg/kg (120 ng/g); sediment total mercury concentrations at two locations within the Veazie Dam impoundment were 0.042 mg/kg (42 ng/g) and 0.074 mg/kg (74 ng/g) (Kleinschmidt 2008). These four sediment samples were characterized as silty sands, with the impoundments upstream of each (former) dam being described as lacking in fine grained (<0.0625 millimeter) material. These data suggest both that chemical inputs from upgradient reaches of the Penobscot River are limited and, consistent with the conceptual understanding of these dams as run-of-river structures (Section 3.3.1.3), that historical (and current) impoundments on the river are not serving as significant depositional areas for fine-grained sediment or sediment-associated contaminants.

3.3.3 Navigation/Dredging

There are three federally-authorized channels and an anchorage within the Estuary. The channels are the Lawrence Cove Channel (historically dredged to 22 feet mean lower low water [MLLW]), the Frankfort Flats Channel (historically dredged to 22 feet MLLW), and the Bangor Harbor Channel (historically dredged to 14 feet MLLW); the anchorage is the Middle Ground Area in Bucksport Harbor, historically dredged to 16 feet MLLW. Of these locations, only the Lawrence Cove Channel has been dredged since the 1960s. USACE records indicate that Lawrence Cove Channel was dredged five times between 1960 and 1985, with a total dredge volume of ~ 300,000 cy. A 2008 USACE bathymetric survey of the Lawrence Cove Channel suggested that the cove had accumulated approximately 7 feet of sediment within the dredge footprint since the most recent dredge activity in 1984. If that sediment accumulation is considered as an annual average process rather than as the (more likely) rapid infilling of the dredge channel by mobile material, the accumulation rate since 1984 would be approximately 6 cm per year.

USACE records of where dredged material was disposed of in the Estuary are limited. Great Lakes Dredge & Dock Company, LLC, who provided project engineering services for the maintenance dredging of the Lawrence Cove Channel in the 1980s, indicated that mechanically dredged silts and wood waste were disposed of by open scow dump north of the Verona Island Bridge (Stan Ekren, personal communication). Mr. Ekren stated anecdotally that the area north of the Verona Island Bridge was a historic disposal site commonly used for disposal of dredged material. Relatedly, the 2010 USACE bathymetric survey data indicated the presence of sediment ridges or elevation changes oriented parallel to both the Frankfort Flats and Lawrence Cove navigational channels in 2010. The orientation of these bed features suggests that sidecast disposal of sediment dredged from the navigational channels also may have occurred.

3.3.4 Mercury Utilization in the Penobscot Estuary

As detailed in the Phase II Report (PRMSP 2013), mercury discharge to the Penobscot River was predominantly associated with the operation of a mercury cell chlor-alkali facility in Orrington, Maine from 1967 to 2000. The mercury cell chlor-alkali process employed mercury as a mobile cathode in an electrolytic cell that decomposed sodium chloride brine into caustic soda and chlorine. The Orrington facility produced chlorine for Maine's pulp and paper industry. Mercury released from the facility during the history of operation likely included atmospheric/volatile emissions, releases to soils and waste ponds on site, and discharge via the facility outfall into Southern Cove in the Estuary. The amount of mercury released from the facility over time, as well as the relative magnitude of releases via these different pathways, is uncertain.

Regarding both atmospheric emissions and the potential for spills/release on site, it was estimated that during the early years of facility operation, approximately 90 pounds of mercury per day were lost from facility inventory through routes other than the facility outfall in Southern Cove (PRMSP 2013). Mass release to the Southern Cove outfall (initially) and to a brine sludge pond on site (post-1970), has been estimated at approximately 19 pounds per day, with an unspecified amount of this sludge being recycled back into the system for reuse. The Phase II Report calculated that from 6–12 metric tons (equivalent to approximately 7–13 U.S. [short] tons) of mercury were discharged through the facility outfall into Southern Cove during the initial years of facility operation.

As detailed in the Phase I Report (PRMSP 2008), a 2003 review of reported mercury releases from operational chlor-alkali facilities in the United States suggests that total mercury releases from the Orrington facility over its 33-year operating life were likely between 30 and 640 tons, or approximately 1–20 tons per year. This estimate of total mercury releases includes atmospheric/volatile emissions, release to soils and waste ponds on site, and discharge via the facility outfall into Southern Cove. The level of uncertainty in this estimate is typical of estimates from other mercury cell chlor-alkali facilities (PRMSP 2008).

Regarding the current distribution of mercury in Estuary sediment, the Phase II Report estimated 10.2 tons of mercury is present in the Estuary, with a large fraction of the total mass in the sediment of the outer Estuary south of Verona Island, where much of the long-term sediment deposition and accumulation in this system occurs (PRMSP 2013). This estimate of mercury storage is based on bedded sediment and may not include mercury that is associated with unconsolidated mobile sediment or mercury associated with bedded wood waste (see Section 3.8).

Current estimates of additional mercury storage in the Estuary include an additional 0.5 ton associated with mobile sediment and 2.3 tons associated with bedded deposits of mixed mineral sediment and wood waste. For mobile sediment, this estimate of additional mercury storage is based on an average unconsolidated layer thickness of 3.6 inches, a total depositional area (40.1 square kilometers) and a mass of mobile sediment (700,000 tons) as presented in Geyer and Ralston (2018) with the inclusion of Fort Point Cove, and an average total mercury concentration in mobile sediment of 760 ng/g. For bedded deposits of mixed mineral sediment and wood waste, this estimate is based on an approximate mass of 1,500,000 tons of mixed mineral sediment and bedded wood waste in deposits less than 1 foot thick plus an additional 450,000 tons of wood waste in discrete surface deposits greater than 3 feet thick (Amec Foster Wheeler 2017b), as discussed further in Section 5.0, and an average total mercury concentration in this material of 1,175 ng/g. The average total mercury concentration applied to the unconsolidated sediment is based on the evaluations presented in **Table 3-1**. The average total mercury concentration applied to the bedded deposits of mixed mineral sediment and wood waste is not well constrained because of low sample density within the footprint of these deposits. Based on cores that were recovered from within the footprint of these discrete deposits during Phase III sampling, the total mercury concentration in these locations can range from equivalent to the unconsolidated sediment (approximately 760 ng/g) to approximately twice that value (Amec Foster Wheeler 2018e). Considering this possible range of total mercury concentrations, an average total mercury concentration of 1,175 ng/g is used in the estimation of additional mercury mass associated with bedded deposits of mixed mineral sediment and wood waste. Further discussion of wood waste cycling in the Estuary, including the associated mercury content and implications regarding fate and transport, is presented in Section 3.8.

3.3.5 Passage of the Clean Water Act

Direct discharges to the lower river during the 1940s–1960s included municipal sewerage, waste from tanneries and textile facilities, lumber wastes (largely curtailed by the 1950s) and pulp and paper industry discharges from seven operating mills. Pulp and paper mill discharges included pulping liquors as well as fibers and paper coatings. In 1964, the Penobscot River received a Class D rating, with the State of Maine Water Improvement Commission reporting that dissolved oxygen concentration in the river were as low as zero for sections of the river during certain times of the year. Following passage of the 1967 Maine Revised Standards, the Penobscot River was reclassified as a potential Class C waterway, suitable for water contact recreation (except swimming) and acceptable for municipal water supply following treatment and disinfection (EPA 1980), with the goal of achieving this designation by 1976.

Following passage of the CWA in 1972, water quality in the Penobscot River improved significantly as mills installed pollution controls for addressing organic wastes and suspended solids, and municipalities constructed sewage treatment plants. By 1977, the river met the state Class C water quality standard and dissolved oxygen concentrations had increased along the length of the river to 5 parts per million or more (the state water quality standard for Class C waters) (EPA 1980). Water quality continued to improve as the EPA and MEDEP issued discharge permits under the National Pollutant Discharge Elimination System to 26 industrial and municipal discharge operators along the river between 1978 and 1979, as well as widening their focus to include non-point source discharges from agriculture, private, and solid waste disposal activities. The lower Penobscot River is currently classified as a Class B river basin; the dissolved oxygen concentration of Class B waters must equal or exceed 7 parts per million (Maine Legislature 2017).

3.4 CURRENT REMEDIATION AND MONITORING ACTIVITIES IN THE PENOBSCOT RIVER AND ESTUARY

Recent active remediation in the Estuary focused primarily on sediment removal in Southern Cove. Current biological monitoring in the Estuary includes lobster, crab, mussels, and American black ducks.

As detailed in the Corrective Measures Implementation Plan for Southern Cove (Anchor QEA and CDM Smith, Inc. 2017), a range of bathymetric, geotechnical, hydrodynamic, ecological, and geochemical data, including in situ characterization and characterization for material disposal following removal/dredging, were conducted from 2015 to 2016. The overall design objectives for sediment removal in Southern Cove were to remove sediment where mercury concentrations exceed 2.2 mg/kg over a 0.25-acre area, as well as where specific locations (hot spots) of elevated mercury concentration were identified. Sediment dredged from Southern Cove can be characterized as solid, non-hazardous waste using the toxicity characteristic leaching procedure (Anchor QEA and CDM Smith, Inc. 2017).

Three sediment management areas (SMAs) were defined in the Southern Cove Corrective Measures Plan: SMA-1 (a nearshore area with a shallow dredge depth delineation); SMA-2 (a northern area in the cove characterized by elevated mercury concentrations and located adjacent to the historical facility wastewater discharge point); and SMA-3 (a southern area characterized by elevated mercury concentrations and adjacent to SMA-2). Proposed dredge depth delineations in SMA-2 ranged from 1 foot (in the outer cove) to 3 feet (adjacent to the historical wastewater outfall); the proposed dredge depth delineation in SMA-3 ranged from 1 foot to 1.5 feet throughout the SMA. Details regarding the implementation of the Corrective Measures Plan have not been provided to Amec Foster Wheeler, and so are not available for inclusion in this report.

In terms of biological monitoring, current and ongoing monitoring programs in the Estuary that involve tissue analysis for mercury include the Maine Department of Marine Resources (DMR) monitoring of mercury in lobster and crab tissue and the NOAA National Status and Trends Mussel Watch program, with stations in Penobscot Bay and the Estuary. These monitoring programs are discussed further in Section 3.7.2.1 (including the spatial extent of the lobster closure areas resulting from Maine DMR monitoring) and 3.7.2.2. Maine Department of Inland Fisheries and Wildlife also conducts biological monitoring of American black ducks in the Estuary, although monitoring does not include tissue analyses for mercury.

3.5 CONCEPTUAL FATE AND TRANSPORT

The conceptual understanding of mercury fate and transport in the Estuary described in this section includes an overview of mercury and methyl mercury chemistry, as well as mercury transformation, transport, and sequestration dynamics in the water column, in sediment, and on marsh platforms.

3.5.1 Contaminants of Concern

The principal contaminant of concern in this system is mercury. As described in Section 3.3.4, mercury was discharged into the Penobscot River as a component of brine waste from a mercury cell chlor-alkali facility in Orrington. The chlor-alkali process uses mercury in its elemental form (Hg^0). Discharge of mercury into the environment results in its oxidation to cationic mercury (Hg^{2+}), which sorbs to suspended particulate matter (e.g., fine-grained mineral sediment, algal cells, other sources of organic matter) and settles with that particulate matter to the sediment bed. Much of the mercury remains in inorganic form in the sediment bed in estuaries, adsorbed to particles and/or ultimately stably buried in association with sulfide or selenide minerals.

Under a specific set of geochemical conditions, including the availability of dissolved sulfate and sufficient easily degradable organic matter to create oxygen-poor conditions in sediment porewater, a small fraction of the inorganic mercury in sediment is converted to methyl mercury (**Figure 3-4**). The conversion from inorganic mercury to methyl mercury occurs predominantly through the respiratory action of sulfate-reducing bacteria (Compeau and Bartha 1985) and occurs in the aqueous phase in porewater. If the depth increment in sediment in which this specific microbial process dominates bacterial activity is within the biologically active zone for prey species such as benthic invertebrates, the methylated mercury that is created can enter the food web. Transfer of methyl mercury from sediment or sediment porewater to biota can occur through either porewater exposure (aqueous phase) or via consumption of sediment organic matter to which methyl mercury has adsorbed (solid phase; deposit feeding). Because both inorganic mercury and methyl mercury are taken up in biological tissue and methyl mercury is more slowly excreted from tissue than inorganic mercury, the transfer of mercury up the food chain through the consumption of prey species results in an increased body burden of total mercury in consumer species and an increased percentage of that total body burden in the form of methyl mercury (Morel et al. 1998).

Food web transfer of methyl mercury to higher trophic level consumers can also occur through the diffusion of methyl mercury from sediment porewater into overlying (surface) water. Through this transfer mechanism, methyl mercury may become available to water column species by direct exposure or via trophic transfer from phytoplankton to zooplankton to higher trophic level consumers. For fish species, in the absence of a direct source of water column discharge of mercury, such as originating from industrial wastewater, exposure to mercury results predominantly from consumption of prey species. Because of this variability in exposure routes for different organisms with different feeding strategies, the recovery rate for different species following remedy implementation can vary depending on factors such as trophic level (e.g., forage fish vs. predatory fish).

3.5.2 Methylation Dynamics

As described in Section 3.5.1, within sediment and under a specific set of geochemical conditions, a small fraction of the inorganic mercury can be converted to methyl mercury. Microbial methylation of inorganic mercury is dominated by the action of sulfate-reducing bacteria in a process that results from either the diffusive or facilitated uptake of inorganic mercury by microbial cells or the subsequent release of methyl mercury back into porewater (Schaefer et al. 2011). Once released into porewater, aqueous phase methyl mercury may sorb or partition to sediment solid phases (including sediment organic matter), be taken up by biota, be transported to surface water (or to porewater at different sediment depths) via advection or diffusion, and/or be demethylated back to inorganic mercury. The inorganic mercury generated via demethylation may, in turn, sorb to sediment or be incorporated into stable aqueous phase complexes with organic matter and dissolved sulfide (Graham et al. 2012).

Overall, the production and accumulation of methyl mercury occurs most readily in estuary and marine environments and under low oxygen (i.e., suboxic) conditions (Merritt and Amirbahman 2009; Cossa et al. 2014). For a specific location, however, the processes of methyl mercury production and accumulation (if it occurs) represent a dynamic equilibrium that is influenced by a range of environmental factors. On a mechanistic level, the relationship between methylation potential and the concentration of porewater and sediment-associated methyl mercury that has been measured will depend on both the site-specific turnover rate of methyl mercury and the extent to which the methyl mercury measured is the result of in situ production versus transport from other locations. If the turnover rate between methylation and demethylation favors net methyl mercury production, an elevated production rate can result in proportionately higher aqueous and solid phase methyl mercury concentrations (Drott et al. 2008). Because there are many variables that can influence both methylation rates and methyl mercury accumulation (in either porewater or sediment), it is important to recognize that methyl mercury production may be more or less strongly associated with its accumulation. Relevant variables include:

- Flow dynamics in the overlying water (Merritt and Amirbahman 2008);
- Organic matter input and/or accumulation rates (Lambertsson and Nilsson 2006);
- Organic matter quality (Graham et al. 2012; Chiasson-Gould et al. 2014; Mazrui et al. 2016);
- The relationship between organic matter quality and sediment sampling location (e.g., position along a transect;
- The dominance of in situ production versus ex situ transport at that location (Mason and Lawrence 1999); and
- Ambient variables that would influence microbial respiration rates (e.g., season, temperature).

Field and laboratory studies have also established that the degree of bioturbation or physical mixing of the sediment by benthic infauna strongly influences the presence and persistence of chemical concentration gradients in both aqueous and sediment solid phases (Fisher and Matisoff 1981; D'Andrea et al. 2002; Kostka et al. 2002; Benoit et al. 2006). Because of the relationship between the biogeochemical environment and mercury methylation dynamics (see Section 3.5.1), significant bioturbation or physical mixing likely also alters in situ relationships between methyl mercury production and either/both aqueous phase concentrations and sediment accumulation. Likewise, while the concentration of inorganic mercury in a system may be generally correlated with methylation rates and/or methyl mercury accumulation (Merritt and Amirbahman 2009; Cossa et al. 2014) there can be considerable variability within these relationships, both within a site and across sites with similar sediment total mercury concentrations. For the Penobscot River Estuary, the depth and extent of sediment mixing likely varies across the Estuary. Within Mendall Marsh, analysis of the depth distribution of the radioisotope ^{7}Be suggested a mixing depth of 3–4 cm (see Chapter 7 of the Phase II Report [PRMSP 2013]), although application of this mixing depth system-wide should be approached with caution in the absence of additional data.

For remedial investigations, the variability in the relationship between the total mercury loading at a site and the production and accumulation of methyl mercury highlights the necessity of exploring site-specific linkages (and uncertainties) between remedial decisions based on bulk sediment total mercury chemistry and the time frame for achieving methyl mercury-based ecological risk reduction goals.

From the context of biological exposure, the data presented in **Table 3-1** for mixing depth in Mendall Marsh are correct in the sense that they describe site-specific potential for mercury exposure in individual locations with specific biological and hydrodynamic conditions, but they also describe two potentially distinct exposure scenarios: the first, in which there may be evidence of sediment physical stability and only small-scale biological mixing, and the second, in which there is evidence of sediment physical mixing and an unknown association between the physical mixed depth and the potential for either biological exposure or sediment redistribution (which may ultimately result in exposure elsewhere in the system).

3.5.3 Water Column Transport and Sedimentation

Mercury transport in aquatic ecosystems can occur in the dissolved phase or in the particulate phase. Because of its association with organic matter, dissolved phase transport of mercury in oxygenated waters is typically in the form of complexes with dissolved organic matter. For this aqueous phase of mercury associated with dissolved organic matter, sedimentation of mercury can result from the flocculation and settling of dissolved organic matter. This mechanism, resulting most commonly from the increase in salinity of surface water in estuaries, is defined as salting out, and is responsible for the observed non-conservative behavior of dissolved organic matter, as well as associated mercury, in estuarine transects (Turner et al. 2001), including in the Penobscot River Estuary (PRMSP 2013; Amec Foster Wheeler 2017a).

Particulate phase transport of mercury in surface waters of an estuary may involve erosion and transport of watershed soils and sediments that contain mercury, or transport of mercury associated with organic particulates such as algal cells. Sorption of mercury onto mineral or organic surfaces or diffusion into algal cells can serve as mechanisms for transferring dissolved mercury to the particulate fraction (Pickhardt and Fisher 2007). Both inorganic mercury and, to a lesser extent, methyl mercury, have an affinity for sorption and, for systems at equilibrium, this affinity results in much of the mercury or methyl mercury that is present being associated with solids. Distribution coefficients, the ratio of the analyte concentration in the solid phase to the concentration in the aqueous phase, for total mercury commonly range from 10^3–10^5, highlighting the extent to which mercury is associated with solid phases (Turner et al. 2001). Distribution coefficient values for methyl mercury range commonly from 10^3–10^4 (including for the Penobscot River Estuary), are typically lower than for total mercury, but still suggest transport dominantly associated with solids (PRMSP 2013).

3.5.4 Internal Recycling through Estuary Circulation

Because of the affinity of inorganic mercury and methyl mercury for solid phases such as algal cells and sediment, the hydrodynamic processes discussed in Section 3.2.2.2 that influence sediment transport and deposition in estuaries also influence the transport and deposition of mercury. That is, if fine-grained sediment and organic matter are retained in an estuary as the result of tidally-influenced circulation, then mercury associated with those particles is also retained. One principal implication of this retention is that the recovery rate of an estuary from historical mercury inputs may be controlled more by the (slow) loss rate of contaminated sediment from the estuary than by either the input rate of clean sediment from upgradient (i.e., recovery by solids dilution) or the transit time of river discharge.

A second implication of this retention is that the eventual in-estuary burial of contaminated sediment (if it occurs) may follow a prolonged period of sediment mobility and redistribution. For mercury associated with mineral sediment, estuary cycling, including recycling with an ETM, does not appear to be associated with significant desorption or repartitioning of mercury from the solids to the aqueous phase (Heyes et al. 2004; Gosnell et al. 2016). The implication of this general stability of sediment-associated mercury is that the process of sediment redistribution does not necessarily result in significant changes to the biological availability of the bulk of mercury associated with mineral sediment.

For mercury associated with wood waste mixed with mineral sediment, while desorption from wood particles may not be a significant loss mechanism during the resuspension and redistribution of wood waste, the abrading of wood particles into smaller size pieces may be associated with the transfer of mercury and/or methyl mercury into a solids fraction that does not readily resettle. Results of leachability tests conducted in 2017 on mercury-enriched wood waste samples suggest that wood waste does not readily leach mercury, but when centrifuged and pressed, low concentrations of mercury are measurable in suspension in unfiltered leachate samples, likely associated with wood fines (Amec Foster Wheeler 2017e). These results indicate that the mechanism of release mercury from wood waste is likely principally through degradation and/or breakdown of wood waste rather than through desorption of mercury into the aqueous phase. While the breakdown rate of wood waste is not well constrained in this Estuary (or other estuaries), Louchouarn et al. (1997) have observed that for sediment in the Lower St. Lawrence Estuary, the degradation rate of historical pulp and paper mill solid wastes is on the order of 2–5 percent of the residual mass per year. The cycling of wood waste in the Penobscot River Estuary is discussed in more detail in Section 3.8.1.

These factors highlight the multiple processes that influence estuary-specific recovery rates. For a specific estuary, modeling or estimating recovery requires understanding the balance between eventual mercury loss through stable sediment burial versus discharge from the estuary, a process balance which itself is a function of the size and shape of the estuary, flow hydrodynamics, sediment bed stability and the availability of clean sediment for dilution and burial. On a system-wide scale, estuary-specific recovery rates from mercury discharge can range from years (Bothner et al. 1980) to decades (Bloom et al. 2004; Santschi et al. 2017). A more detailed discussion of recovery rate models for the Penobscot River Estuary are presented in Section 3.9.

3.6 SPATIAL DISTRIBUTION OF MERCURY AND METHYL MERCURY BY REACH

This section presents a summary of the current understanding of the spatial distribution of mercury and methyl mercury in the Penobscot River Estuary. Data are presented by reach for surface water (Section 3.6.1) and sediment (Section 3.6.2).

3.6.1 Surface Water Data

Surface water data for total mercury and methyl mercury are summarized by reach in **Table 3-2**. **Table 3-2** does not include historical (pre-Phase III) data, because the historical aqueous data set includes a range of sampling types, including surface water, pore water, and discharge monitoring data, that are not well characterized or identified by sampling type and so may not be not directly comparable with Phase III field data.

For Phase III data collected in 2016, total mercury concentrations in surface water range from non-detect to 37.2 ng/L for sampling stations from throughout the Estuary. For Phase III data collected in 2017, total mercury concentrations in surface water range from 2.94 ng/L to 4.93 ng/L. The 2017 total mercury surface water data were collected in the Bangor reach.

For Phase III methyl mercury data collected in 2016, concentrations in surface water range from 0.029 ng/L to 0.617 ng/L for sampling stations from throughout the Estuary. For Phase III methyl mercury data collected in 2017, concentrations in surface water range from non-detect to 0.101 ng/L. The 2017 methyl mercury surface water data were collected in the Bangor reach.

3.6.2 Sediment Data

Total mercury and methyl mercury concentrations in sediment are summarized for historical (pre-Phase III; 2000 - 2012) and for Phase III (2016 – 2017) data by reach in **Tables 3-3 and 3-4**. These tables include data for both surface sediment (0–0.5 foot) and subsurface sediment (deeper than 0.5 foot). For each reach, the data range, mean values and the number of data points are presented. For both total mercury and methyl mercury, concentrations in surface sediment (0–0.5 foot) for both historical (pre-Phase III) and Phase III data are presented in **Figures 3-5 and 3-6.** Data summarized in Tables 3-3 and 3-4 and presented in Figures 3-5 and 3-6 are as discrete data points. The summaries presented in these tables and figures include data collected by different methods (i.e., grab samples, sediment cores) across different environments (i.e., marshes, intertidal zone, subtidal zone) with different strategies for depth-sectioning/processing cores (where relevant). The depth-averaging of the total mercury data summarized in **Table 3-3** to create the interval participation weighted concentration applied in the calculation of area weighted average concentrations for remedial evaluation is summarized in Section 5.2 of this Report and presented in detail in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k).

For historical data (**Table 3-3**), total mercury concentrations in surface sediment (0–0.5 foot) range from 0.01 to 12,500 ng/g. Total mercury concentrations in subsurface sediment (> 0.5 foot) range from 0.03 ng/g to 73,300 ng/g.

Methyl mercury concentrations in historical surface sediment range from less than 0.001 ng/g to 98.4 ng/g. For subsurface sediments, historical methyl mercury data are limited to the Bangor and Orrington reaches. For these reaches, subsurface methyl mercury concentrations are below 0.04 ng/g.

For Phase III (2016–2017) data (**Table 3-4**), total mercury concentrations in surface sediment (0–0.5 foot) range from 0.08 ng/g to 100,200 ng/g. Total mercury concentrations in subsurface sediment (>0.5 foot) range from 1.71 ng/g to 5,570 ng/g.

For Phase III (2016–2017) data, methyl mercury concentrations in surface sediment range from less than 0.02 ng/g to 55.8 ng/g. Subsurface methyl mercury was not analyzed in Phase III.

3.7 ECOLOGICAL EXPOSURE

This section presents a brief overview of mercury biomagnification in biota and describes the ecological exposure pathways for species of potential concern in the Estuary. Species of potential concern include lobster, blue mussel, forage and predatory fish, songbirds, and American black ducks. Trending of tissue chemistry data for species of potential concern are discussed in Section 3.9.3.4. A more complete discussion of ecological exposure, trophic transfer, and species of potential concern for the Estuary can be found in the 2017 Biota Monitoring Report (Amec Foster Wheeler 2018g) and the 2018 Risk Assessment and Preliminary Remediation Goal Development Report (Amec Foster Wheeler 2018a).

3.7.1 Biomagnification

Biomagnification is the uptake of a chemical from one trophic level to the next, where the concentration of the contaminant of concern is greater in each subsequent higher trophic level compared to the concentration in the previous lower trophic level. Biomagnification occurs through the dietary pathway of exposure; thus, the accumulation and magnification of the contaminant of concern depends on chemical concentrations in prey species consumed by the next higher trophic level consumer species. The potential for biomagnification is typically a concern for chemicals that are fat-soluble or protein binding (in the case of mercury), mobile in the environment, and persistent. For mercury, biomagnification principally involves the trophic transfer of methyl mercury, as this form is excreted more slowly from tissue than inorganic mercury (Tsui and Wang 2004; Dutton and Fisher 2011).

3.7.2 Species of Potential Concern and Exposure Pathways

Ecological species of potential concern were selected to represent specific positions on the food chain and thus multiple trophic levels. Terrestrial and aquatic species were selected to understand differences in the exposure pathways for each different species. Mid- and upper-trophic-level species were selected to understand biomagnification at different positions of the food chain. Using the example of an aquatic food chain, forage fish and predatory fish were investigated to understand how much of the mercury is magnified in the food chain via benthic invertebrates, then the forage fish, and then the predatory fish consuming lower trophic level organisms. Tissue concentrations of total mercury and methyl mercury for species described in Sections 3.7.2.1 through 3.2.7.6 are presented in the 2016 and 2017 Biota Monitoring Reports (Amec Foster Wheeler 2017c and 2018g).

3.7.2.1 Lobster

Lobsters (*Homarus americanus*) are a predatory benthic invertebrate that are restricted to saltwater habitat and broadly inhabit Penobscot Bay. Lobsters have a strong preference for rock crab but consume a variety of prey species including fish, crustaceans, and their molted exoskeletons (including other lobsters), mollusks, and polychaetes. Additional prey items known to be consumed infrequently by lobsters are plant matter, detritus, and other aquatic invertebrates such as sponges, gastropods, echinoderms, and tunicates.

Lobsters are commonly consumed by humans and are a potential source of human exposure to mercury in the lower Estuary. In 2014, Maine DMR designated a lobster fishing closure area in part of Upper Penobscot Bay in response to elevated mercury concentrations in lobster tissue. The closure area was north (riverward) from a line drawn from Fort Point to Wilson Point. Following further evaluation of lobster tissue mercury concentrations in 2014 and 2015, the Maine DMR expanded the closure area southward in 2016 to a line from Squaw Point to Perkins Point (MeCDC 2016).

3.7.2.2 Other Shellfish

Other shellfish of concern are blue mussels (*Mytilus edulis*). Shellfish are typically exposed to mercury in surface water and sediment via direct contact or via filtering of food particles from the water column. Blue mussels are commonly monitored along the East Coast of the United States, including in the Penobscot Bay region, allowing comparison of tissue mercury concentrations in blue mussels from the Penobscot River Estuary and Penobscot Bay versus tissue mercury concentrations in blue mussels from other locations (NOAA 2017d).

3.7.2.3 Forage Fish

Forage fish inhabit riverine and estuarine habitats, as well as wetland habitats such as the pocket and fringe marshes along the Estuary main channel, the Orland River, and Mendall Marsh. The mummichog (*Fundulus heteroclitus*) is a benthopelagic mid-trophic level receptor that consumes benthic and terrestrial invertebrates, predominantly insects. Rainbow smelt (*Osmerus mordax*) is another mid-trophic level receptor, but is a nerito-pelagic (occurs midwater, but in shallow areas where it is also associated with the bottom) schooling species that feeds predominantly on shrimp and other forage fish.

3.7.2.4 Predatory Fish

Predatory fish are upper trophic level fish that consume benthic and terrestrial invertebrates, forage fish, and crustaceans. Predatory fish inhabit riverine and estuarine habitats and can be found throughout the Penobscot River system. Atlantic tomcod (*Microgadus tomcod*) is an anadromous demersal (bottom associated) species that feeds predominantly on crustaceans, particularly shrimp, but also feeds on worms and forage fish. The American eel (*Anguilla rostrata*) is a demersal catadromous species, primarily feeding on benthic invertebrates, including insects, worms, and shrimp, but also consuming forage fish.

3.7.2.5 Songbirds

Marsh songbirds are mid- to upper-trophic-level terrestrial species that feed on insects, spiders and seeds. Mercury exposure for songbirds is principally through consumption of prey species. These birds, including Nelson’s sparrow (*Ammodramus nelsoni*) and red-winged blackbird (*Agelaius phoeniceus*), forage and breed in marsh and wetlands habitats along the river and in Mendall Marsh. Songbirds typically arrive at the Estuary in the spring (March for red-winged blackbirds and late May for Nelson’s sparrows) and depart in late summer or early fall.

3.7.2.6 American Black Duck

The American black duck (*Anas rubripes*) is a mid-trophic level species that forages and overwinters in aquatic habitats including small coves and shallow water/intertidal areas. American black ducks migrate south from Canada and typically arrive in the Estuary in September/October. American black ducks represent a species that serves as a potential route for human exposure to mercury. Humans hunt ducks in November and December and consume the tissue.

3.8 WOOD WASTE/WOOD PRODUCTS FATE AND TRANSPORT

This section describes the contemporary impact of the historic wood processing industry on the Estuary. Impacts of the historic wood processing industry include the spatial distribution of residual wood deposits, as well as the role that wood waste plays in the fate and transport of mercury in this system. Impacts of wood waste on mercury fate and transport include impacts of wood waste on mercury methylation dynamics and the transport of methyl mercury associated with wood waste.

3.8.1 Contemporary Cycling of Wood Waste

Sub-bottom profiling surveys generated as a component of the 2016-2017 site characterizations and presented in the 2016 and 2017 Mobile Sediment Characterization Reports (Amec Foster Wheeler 2017b and 2018c) suggest that there may be as much as 3,000,000 tons (dry weight) of material on the Estuary sediment bed that appears as a mixture of wood waste and mineral sediment. Approximately half of this material is in deposits more than 1 foot thick, with some deposits reaching 6 feet in thickness. This material appears to be distributed throughout the system, with specific, identifiable deposits of varying thickness in the vicinity of Snub Point, Winterport, Frankfort Flats, upgradient of Bucksport, in the Orland River, and in the Verona East channel (Amec Foster Wheeler 2018c). These deposits are likely somewhat mobile, may occur in locations in which material is at least temporarily (seasonally) trapped, and may contribute material to the mix of sediment and wood waste that moves in suspension in the water column. The Amec Foster Wheeler 2016 field program also documented sediment samples visibly enriched with wood waste in Orrington, Frankfort Flats, Bucksport, Verona Northeast, Verona East, and Orland River (Amec Foster Wheeler 2017b). Evidence of annual mobility of the material identified through sub-bottom profiling was observed in the vicinity of Bucksport for a feature identified in the 2016 geophysical survey as the "Bucksport Mill Pile." Between the 2016 and 2017 geophysical surveys, this feature appears to have moved upgradient into the deeper water channel near Bucksport relative to its position in 2016 (mapping presented in Amec Foster Wheeler 2018c).

Regarding wood waste that moves in suspension (in contrast to the 3,000,000 tons [dry weight] of bedded material discussed in the previous paragraph), the 2016 Mobile Sediment Characterization Report described the recovery of modified eel traps full of wood waste from deployments in the vicinity of Frankfort Flats and Verona East (Amec Foster Wheeler 2017b). Likewise, a streambed sampling net deployed in the vicinity of the Lawrence Cove Channel in September 2017 was recovered containing wood waste (Amec Foster Wheeler 2018c). Wood particles recovered through both these sampling efforts are described as medium brown in color and uniform in composition. Particles are somewhat blocky in shape, clearly identifiable as wood and approximately 1/8–1/16 inch. These descriptive data are supported by visual observations of suspended material by Amec Foster Wheeler staff during deployment of an underwater camera, and reports of an equipment tripod being temporarily buried by a moving wave of material (W. Rockwell Geyer, personal communication). Combining the results of the near-bed suspended sediment sampling (average total suspended solids concentration of 1.0 grams per liter) and the geophysical survey data suggests on the order of 4,000 tons (dry weight) or 41,000 tons (wet weight) of low density wood waste and mineral sediment in suspension in the Estuary (Amec Foster Wheeler 2018c). This mass of material captured in suspension is a fraction of the mass of mineral sediment and wood waste identified through the sub-bottom profiling survey.

Corroboration of a mass of material in suspension is available from the 2016 and 2017 geophysical survey data in which, for some areas of the Estuary, the dual frequency separation is greater than the depth to hardpan/bedrock defined by sub-bottom profiling. One possible explanation for this variability between results for different geophysical survey techniques is that the dual frequency separation is detecting material transported in suspension. Extrapolation and averaging of the dual frequency separation across the Estuary suggests an average thickness of this material of 1 foot, roughly consistent with what was observed from the stream bed sampling net deployment.

If the material identified through the dual frequency survey is the same material recovered in modified eel traps and by the stream bed sampling net, a small fraction of the bedded wood waste that is a component of the mix of wood waste and mineral sediment identified by the sub-bottom profiling survey is moving in suspension. This material may have ecological impacts on benthic habitat, as well as serving as a mobile pool of wood waste that may be transported to more stable depositional areas, such as onto the Mendall Marsh platform, during high tides. Under this scenario, bedded wood waste could serve as a significant ongoing source of wood-enriched fines in suspension. Preliminary assessment of lignin oxidation products in Estuary sediments (n = 6) suggests that the organic carbon in unconsolidated surface sediments does contain a significant component of wood waste (Amec Foster Wheeler 2018j) although the transport and degradation rate of this material in the Estuary is not well constrained. Louchouarn et al. (1997) observed that for sediment in the Lower St. Lawrence Estuary, for example, the degradation rate of historical pulp and paper mill solid wastes is on the order of 2–5 percent of the residual mass per year.

3.8.2 Mercury and Wood Waste

Regarding mercury methylation dynamics, it is not currently clear whether wood waste provides enhanced potential habitat for methylating microbes or enhanced sorption of methylated mercury. Sampling suggests that wood waste contains elevated concentrations of total mercury and methyl mercury on a dry weight basis relative to concentrations in either bulk mineral sediment or the fraction of a bulk sediment sample passing through a #40 sieve. A #40 sieve will retain sand-sized particles approximately 0.42 millimeters in diameter or larger. For wood waste sampled as a discrete particulate class or for sediment samples sieved to remove wood waste, the average concentration of total mercury in the wood waste fraction can be as much as 50 percent higher than the concentration of total mercury in unsieved or bulk sediment sample (PRMSP 2013; Amec Foster Wheeler 2017b).

The physical manipulation of wood waste samples appears to release some mercury, both to a very small extent in the dissolved (filtered) phase and, to a more significant (although still small) extent, after the physical manipulation of wood waste samples and/or the centrifugation and pressing of wood-enriched suspensions. These observations of elevated mercury concentration in wood waste samples suggest that the resuspension, movement, deposition, and breakdown of wood waste may contribute to the variability in surface sediment mercury concentrations in the Estuary through the transport of mercury associated with wood particles and wood fines/fibers. Transport of wood waste enriched in mercury and/or methyl mercury onto the marsh platform may provide an additional exposure route for mercury and/or methyl mercury for organisms feeding on the platform. Because the breakdown rate of wood particles is slow in aqueous environments (Louchouarn et al. 1997), the dominant mechanisms for removal of this fines/low density wood-rich material from the Estuary may be a combination of transport into environments such as Mendall Marsh, where degradation by fungi may occur, and discharge from the Estuary into Penobscot Bay at a slow, but non-zero rate.

Based on Amec Foster Wheeler current site understanding, of the approximately 1,500,000 tons [dry weight] of material on the Estuary bed that appears as a mixture of bedded wood waste and mineral sediment in deposits greater than 1 foot thick (i.e., 50 percent of the total mass of material discussed in Section 3.3.4.2), approximately 70 percent of this mixture is characterized by mercury concentrations above 500 ng/g (Amec Foster Wheeler 2018d). There is approximately 1,000,000 tons [dry weight] of mixed mineral sediment and wood waste in deposits greater than 1 foot thick with total mercury concentrations above 500 ng/g. The ongoing erosion r of these wood-enriched deposits may serve as an ongoing source of mercury to depositional areas, including marsh platforms. Accumulations of bedded wood waste and mineral sediment that may be slowing system recovery are consistent with the hypothesis presented in Chapter 18 of the Phase II Report (PRMSP 2013) that there may be *"additional sediment zones in non-depositional areas that are contaminated and interacting with the mobile bed;"* the presence of this material can explain discrepancies between previously calculated rates of sediment turnover versus previously modeled rates of decreasing mercury concentration and system recovery in the Estuary.

3.9 SYSTEM RECOVERY TIME

This section reviews the concept of system recovery, including what is meant by the term recovery, whether the focus of recovery is physical or ecological, and the impact of key system dynamics, including the nature of Estuary circulation and the impact of legacy wood waste, on defining a recovery time for the Estuary. This section also reviews lines of evidence for evaluating the Estuary recovery rate, including the evaluation of vertical trends in sediment chemical concentrations, a mixing model that assesses the potential for diluting chemically impacted sediment with cleaner sediments, spatial (lateral) trends in sediment chemistry, and trends in biota tissue chemistry.

3.9.1 Mechanisms of System Recovery

In the context of remedial engineering, recovery can be defined as allowing system conditions to evolve toward the achievement of stated engineering and/or ecological objectives. Objectives can be defined in terms of changes to sediment chemical concentrations or in terms of ecological goals, such as improving habitat quality or reducing tissue concentrations of contaminants of concern in receptors of interest. Recovery either implicitly or explicitly includes a time component, as, for example, with projecting a time frame for ecological recovery following completion of sediment remediation.

Physical recovery of chemically-affected systems can be achieved through a variety of strategies, including sediment removal (i.e., dredging), in situ burial of contaminated sediment (isolation capping), dilution/mixing of contaminated sediment with cleaner material (thin layer capping), and reliance on natural processes such as dispersion, chemical precipitation, and/or chemical breakdown (for organic contaminants) to reduce chemical concentrations in surface sediment. Remedial design focused on physical recovery, sediment clean up targets may be defined as a function of costs, limitations on the practicality of achieving lower concentration targets, and/or the desire to accomplish mass removal goals, such as with hot spot removals in locations with significantly elevated but laterally constrained chemical distributions.

In contrast, remedial design focused on ecological recovery explicitly addresses the recovery of receptors of interest. Overall ecological recovery objectives can include improvements to habitat quality, declines in chemical concentrations in biota (such as tissue and blood concentrations), or changes to behavioral dynamics, either at the organism level or population level. The focus for biota can be on direct exposure through contact, such as with surface water or sediment, or exposure through food web transfer via consumption of prey species.

3.9.2 Factors Affecting Recovery Time

Processes that control the internal cycling of sediment in an estuary will significantly influence the recovery time of the system. Processes influencing recovery time include the timing and extent of historical chemical discharge, the magnitude of tidal circulation, the availability of clean sediment for burial, and the impact of tidal circulation on the presence, seasonal movement, and sediment redistribution potential of an ETM or bedded deposits. For estuaries historically impacted by chlor-alkali discharge, recovery times have been documented to vary from years (Bothner et al. 1980) to decades (Bloom et al. 2004; Merritt et al. 2009; Santschi et al. 2017), depending on how recovery is defined.

The presence of wood waste in the Penobscot River Estuary can impact system recovery time in various ways. Amec Foster Wheeler data on the concentration of mercury in wood waste suggest that total mercury and methyl mercury concentrations in wood waste are elevated overall relative to concentrations in mineral sediment. This elevated concentration, coupled with the lower density of wood waste relative to mineral sediment, and a poorly constrained understanding of its mobility (on seasonal, annual, or decadal time scales) suggests that the resuspension/transport/recycling of wood waste within the system may not follow modelling predictions for transport/recycling of mineral sediment.

These impacts on system recovery time are a function of the volume of wood waste potentially present in the system, the concentration of mercury in that material, and the impact of system hydrodynamics on the mobility of this material. As noted in Section 3.8.2, the breakdown rate of wood waste in aqueous environments is sufficiently slow that material may cycle for decades, contributing to mercury remobilization and redistribution within the Estuary before it is removed from the system through burial or transport out of the Estuary.

3.9.3 Proposed Recovery Time – Lines of Evidence

Multiple lines of evidence can be integrated to evaluate potential recovery scenarios for the Estuary. Relevant lines of evidence include numerical modeling applied to data collected from sediment cores, evaluation of recovery rates through sediment mixing models, and analysis of temporal trends in sediment chemistry and biotic tissue concentrations. This section reviews the existing data on these relevant lines of evidence.

3.9.3.1 Apparent Half-Time Modeling – Sediment Cores

Apparent half-time recovery modeling as applied to the Estuary has focused on sediment cores collected in 2009 (PRMSP 2013) and in 2017 (Amec Foster Wheeler 2018e). The term ‘apparent’ is used herein consistent with its use in the Phase II Study in which the calculation of recovery rates is dependent on data extrapolation and assumptions regarding temporal mixing and redistribution of mercury in the Estuary. For the cores collected in 2009, mercury concentration profiles were evaluated over two intervals: a rapid recovery interval defined as 1967–1988, and a slower recovery interval defined as 1988–2009. For the slower recovery interval, an apparent recovery rate was calculated by fitting an exponential curve to the concentration profile under the assumption that mixing chemically-affected sediment with sediment having lower mercury concentrations has yielded exponentially decreasing concentrations of mercury over the interval from 1988–2009. Assuming an exponential fit to the data, an apparent recovery half-time (i.e., the time required for the concentration of mercury to decrease by 50 percent relative to the concentration in 1988, the beginning of the slower recovery interval), was then calculated, with the goal of evaluating the rate at which surface sediment concentrations could be predicted to decrease toward stated concentration targets of 0, 100, and 400 ng/g. These concentration targets were chosen by the Phase II Study based on an asymptotic model fit to a zero concentration (0 ng/g), an estimate of regional background mercury concentration (100 ng/g), and a recommendation made for the protection of wildlife and human health (400 ng/g) (PRMSP 2013).

For the cores collected in 2017, the same model was applied with a few initial modifications: (1) the slower recovery interval was considered either to be 1988–2017 (i.e., with the same start year as for the 2009 study and including 29 years) or to be 1996–2017 (i.e., with the same interval length of 21 years as for the 2009 study) and (2) only the 0 ng/g and the 400 ng/g recovery targets were applied (Amec Foster Wheeler 2018e). Based on preliminary review and the similarity of modeling results for either the 21-year or the 29-year interval as evaluated by Dr. Kevin Yeager, only the 21-year interval was carried through the apparent recovery rate modeling exercise.

For the 2009 cores, application of the apparent recovery rate modeling strategy to cores recovered from throughout the Estuary resulted in average (mean) recovery half times of 22 years for cores collected from Mendall Marsh; 31 years for cores collected along the main stem of the Estuary channel; 69 years for cores collected from Orland River; and 120 years for cores collected from Fort Point Cove and the outer Estuary (PRMSP 2013; Santschi et al. 2017).

As summarized in the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018e), looking specifically at the 21 stations that were sampled in both 2009 and again 2017, calculated apparent mercury recovery half times show that natural recovery is slowing in the Penobscot River system. For apparent mercury recovery half times calculated assuming $Hg(\infty)$ = an asymptotic concentration of 0 ng/g, nine of 11 stations (82 percent) for which recovery half times could be calculated showed increasing half times relative to rates calculated for 2009 data applying the same asymptotic concentration of 0 ng/g; for apparent mercury half times calculated assuming $Hg(\infty) = 400$ ng/g, eight of 10 stations (80 percent) showed increasing half times for recovery relative to 2009 rates modeled by applying the same $Hg(\infty) = 400$ ng/g concentration. Increasing apparent recovery half times result from incrementally decreasing changes in sediment mercury concentration in surface intervals of cores over a consistent 21-year interval. Thus, for a station sampled in both 2009 and 2017, an increasing recovery half time calculated in 2017 relative to the recovery half time calculated in 2009 suggests that the rate of change in the mercury profile over the 21-year interval from 1996–2017 is decreasing relative to the rate of change in the mercury profile over the 21-year interval from 1988–2009 used in the Phase II modeling.

While the apparent half time to recovery model presented here allows for curve-fitting of current and historical sediment data to reflect sediment mixing processes over time, the extrapolation of this approach to future recovery should be approached with caution. In evaluation of Penobscot River Estuary sediment mercury data, Santschi et al. (2017) characterized the system as being defined by three intervals: a release phase characterized by mercury inputs to the Estuary, a redistribution phase characterized by the equilibration or homogenization of surface sediment mercury concentrations throughout the Estuary via mixing processes, and a recovery phase characterized by the continued decrease of surface sediment mercury concentrations from the equilibration concentration toward a desired concentration target. For cores collected in 2009 from locations defined as reflecting representative physical mixing and chemical attenuation within the Estuary (i.e., cores described as being from locations in communication with the larger system), surface sediment concentrations in 2009 appeared to be converging toward 600-700 ng/g (Santschi et al. 2017). As shown in **Table 3-4** for Phase III data collected in 2016-2017, surface sediment total mercury concentrations in the main channel of the Estuary do not appear to have changed significantly from this average, and in some reaches, remain higher than 700 ng/g.

The general consistency in average total mercury concentrations in surface sediment over much of the Estuary supports the concept that the Estuary is achieving some level of homogenization or equilibrium redistribution of mercury-affected sediment and wood waste. If this approach toward homogenization accurately reflects system dynamics, then in the absence of sediment removal by engineered means, the process of continued natural recovery via declining surface sediment mercury concentration will be driven more specifically by the input rate of clean sediment from upgradient (assuming mixing of that clean upgradient sediment within the Estuary) than by the combination of clean sediment input and mixing/redistribution within the system. The relative size of these two pools of material (i.e., sediment from upgradient sources versus mobile/re-suspended sediment from within the Estuary) is currently not well constrained and is discussed further in the evaluation of box models (Section 3.9.3.2). Likewise, if surface sediment mercury concentrations in those portions of the system that are not in communication with the larger system are elevated relative to a homogeneously mixed concentration, then changes to the dynamic processes controlling sediment mixing (e.g., increases in wind/wave action, changes to flow regime) have the potential to re-entrain sediments into suspension that would be a continuing source of mercury that further slows projected system-wide recovery rates.

3.9.3.2 Box Models

Box model approaches to evaluating system recovery have focused on estimating the turnover time of sediment in the system. Box model estimates for the Estuary have observed that based on the annual mass of sediment entering the Estuary from upgradient (40,000–50,000 tons) and the estimated mass of mobile sediment within the upper Estuary (320,000 tons; defined by the Phase II Study as the “mobile pool”), the turnover time of mobile sediment should be on the order of <10 years (PRMSP 2013). That this time scale does not appear to correspond to the time scale for mercury recovery in the Estuary suggests that: (1) the mass of mobile material in the Estuary has been underestimated (i.e., that the mass of material in the system that mixes with new sediment from upgradient is larger than 320,000 tons); (2) new sediment entering the Estuary annually from upgradient passes through the system without mixing with mobile sediment within the Estuary; and/or (3) there are additional sources of mercury within the Estuary that are contributing to the delay in the system recovery rate relative to what would be expected simply based on the turnover time of sediment defined as ‘mobile’ in the system.

To assess the scenario that the mass of the “mobile pool” has been underestimated, Geyer and Ralston (2018) estimated that by entraining an additional 10–15 percent of solids from the consolidated sediment bed, a mixing model recovery rate can be generated that roughly matches the apparent half-time recovery model estimate for Mendall Marsh. That is, the Geyer and Ralston (2018) model predicts that by increasing the volume of mobile sediment by 10–15 percent through inclusion of re-suspended bed sediment, the modeled mercury concentration in that mobile sediment will decrease exponentially over an estimated 25 years, an interval similar to the average modeled apparent recovery half-time for Mendall Marsh (mean half time = 22 years) (Santschi et al. 2017). This box model assumes that the concentration of mercury in mobile sediment is more homogeneous than the concentration of mercury in bed sediment and that the mass of mobile material in the system is in steady-state on a yearly time scale (i.e., on an annual basis there is approximately as much particulate matter leaving the Estuary as entering the Estuary from upgradient sources).

One implication of the convergence in time scales between the apparent recovery half-time model for Mendall Marsh and the box model recovery estimate for the whole Estuary as presented in Geyer and Ralston (2018) is that the mercury distribution and recovery rate in off-channel areas such as Mendall Marsh (and Orland River) is therefore influenced by the redistribution of mercury-affected sediment and wood waste from within the remainder of Estuary. This implication is important in that it: (1) highlights the role that Estuary processes, including the ETM and variability in sediment transport and deposition rates in off-channel areas, play in slowing the turnover rate of sediment and wood waste throughout the Estuary; and (2) introduces uncertainty to predictions regarding the rate at which inputs of clean sediment to the Estuary will result in continued declines in surface sediment mercury concentrations within the Estuary. For example, if the system-wide average thickness of unconsolidated sediment is approximately 9 cm and the thickness of the mixed sediment and wood waste is an additional 15–20 cm (**Table 3-1**), then the mass of the material that could be defined as “mobile” (i.e., the material captured by the Reflector 1 return in the sub-bottom profiling data; Amec Foster Wheeler 2018c) may be closer to 1,950,000 tons (dry weight) versus the 320,000 tons defined by the 5 cm thick (on average) redox color change in bed sediment evaluated by Geyer and Ralston (2018). That data presented in the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018e) suggest that apparent system-wide recovery rates have effectively stalled relative to apparent system-wide recovery rates modeled in 2009, supports the idea that the volume of material recycling within the system is likely larger than Phase II box model estimates, even including the 10–15 percent of re-suspended bed sediment that Geyer and Ralston (2018) have modeled as an addition to what they define as the mobile pool.

Of importance here from the vantage of evaluating system recovery is that neither the volume of ‘mobile’ sediment in the Estuary nor the calculated or apparent recovery rates for this system are well constrained. Likewise, while the term ‘mobile pool’ as introduced in the Phase II Study is intended to describe sediment that may mix and redistribute on a time-scale that creates visible redox boundaries in the sediment bed (i.e., material described in the Phase II Study as “a recently deposited, light colored unconsolidated mud”), multiple lines of evidence suggest that additional volumes or higher concentrations of sediment and/or wood waste may be serving to slow system-wide recovery rates in the Estuary through resuspension/erosion, transport and mixing on seasonal, annual or decadal time scales.

In considering system recovery, an additional implication of the box model assumptions discussed above is that re-deposition of mobile sediment within the Estuary (either in off-channel areas or as the result of dredging) or removal/release of this material from the Estuary will occur at a mercury concentration that is equivalent to the homogeneous mixed concentration in the mobile pool. While this statement is generally true and the mercury and TOC content of unconsolidated sediments appears similar in different parts of the system (i.e., Mendall Marsh, the main channel, and the East Channel including Orland River), the extent to which the mobile pool is a mixture of mineral sediment and wood waste, two distinct phases with differing particle sizes and densities, mercury concentrations, and transport properties, will influence the extent to which box models are useful tools for projecting recovery rates for the Estuary. Box model scenarios considering different volumes of mobile sediment characterized by different concentrations of total mercury and/or the specific inclusion of surface deposits enriched in wood waste are discussed in the evaluation of Monitored Natural Recovery (Section 8.2.1), Recommended Remedial Alternatives (Section 8.3), Risk Reduction and Recovery Times (Section 8.5) and Long-Term Monitoring Recommendations (Section 8.7).

3.9.3.3 Sediment Spatial and Temporal Trends

System recovery rates also can be assessed through the evaluation of spatial trends in surface sediment chemistry. For the Estuary, evaluation of sediment spatial trends includes evaluation of data presented in the Phase II Report (PRMSP 2013) as well as 2016 Amec Foster Wheeler data evaluated for continuing changes in sediment chemistry over time. Sediment trends analysis presented here are included in the Phase II Report (PRMSP 2013) and the 2017 Sediment and Water Quality Monitoring Report (Amec Foster Wheeler 2018b).

The Phase II Report (PRMSP 2013) concluded that for sampling conducted between 2006 and 2012, total mercury concentrations in surface sediments were generally unchanged. When analyzed by sediment class (subtidal, intertidal, wetland high elevation, wetland medium elevation, wetland low elevation, and wetland mudflats), there were significant trends over time only for intertidal and wetland mudflat sites. For one out of the seven intertidal sites evaluated, there was a significant increase in total mercury concentration over the interval 2006–2012, while for two out of six wetland mudflat sites, there was a significant decrease in total mercury concentration.

Sediment concentrations were also generally consistent for methyl mercury over this same time interval, although with more variability than for total mercury concentrations. Site-specific factors including sediment organic matter content, sediment grain size distribution, and availability of dissolved oxygen and sulfate influence in situ methyl mercury production and consequently influence temporal and spatial trends in methyl mercury distribution (Merritt and Amirbahman 2009). Overall, the spatial and temporal distribution of sediment methyl mercury concentrations for 2006–2012 typically reflects the distribution of total mercury concentrations (PRMSP 2013).

Amec Foster Wheeler sampling in 2016 concluded that, overall, when 2016 data were integrated with the Phase II data, no consistent temporal trends were evident for either total mercury or methyl mercury concentrations in sediment (Amec Foster Wheeler 2017a). The absence of temporal trends in decreasing sediment mercury concentrations is consistent with observations discussed in Section 3.9.3.1 regarding the system reaching or having reached a level of equilibrium redistribution of mercury-affected sediment. The inclusion of 2017 data does not change this conclusion overall. With the inclusion of 2017 data, while there is some evidence of decreasing concentrations of mercury and/or methyl mercury over time, particularly when data are normalized to the organic carbon content of samples, these results were apparent at only six out of 37 stations, with five of the six in Mendall Marsh, and were not consistently apparent across reaches (Amec Foster Wheeler 2018b). If the temporal trend analysis is correct, it supports the suggestion of an overall spatial equilibration of surface sediment chemistry occurring in the system and slow or minimal recovery.

3.9.3.4 Biota Trends

System recovery rates also can be assessed through the evaluation of trends in biota tissue chemistry. For the Estuary, evaluation of tissue trends includes evaluation of data presented in the Phase II Report (PRMSP 2013) as well as 2016–2017 Amec Foster Wheeler data evaluated for continuing changes in tissue chemistry over time (Amec Foster Wheeler 2017c; 2018g).

The Phase II Report (PRMSP 2013) concluded that for sampling conducted between 2006 and 2012, there were no significant overall temporal trends in tissue mercury chemistry for biota species, including fish (American eels, tomcod, rainbow smelt, winter flounder), lobster, and birds (Nelson's sparrow, song sparrow, swamp sparrow, red-winged blackbird, Virginia rail). For blue mussels, tissue concentrations declined at study sites in the upper Estuary, but not at study sites in the lower Estuary below Fort Point. For mummichogs, double-crested cormorants, American black ducks and bats, sampling limitations precluded the ability to assess trends in tissue chemistry.

In terms of spatial trends, the Phase II Report (PRMSP 2013) concluded that tissue concentrations of mercury generally declined with distance from the HoltraChem facility for most fish species (American eels, tomcod, rainbow smelt, winter flounder), lobster, mussels, and double-crested cormorants. For birds, the highest tissue mercury concentrations in marsh birds (Nelson's sparrow, song sparrow, swamp sparrow, red-winged blackbird, Virginia rail and American black duck) were found in Mendall Marsh, likely reflecting the proximity of the marsh to the HoltraChem facility. One caveat to this conclusion presented in the Phase II Report is that birds were sampled at a limited number of sampling locations, primarily focused in the Mendall Marsh area.

Amec Foster Wheeler sampling in 2016 concluded that, overall, when 2016 data were integrated with the Phase II data, fish showed more significant declines in tissue mercury concentration than songbirds (Amec Foster Wheeler 2017c). Overall, 2016 songbird results were similar to what was found in the Phase II Report. For aquatic biota, (lobster, blue mussel, rainbow smelt, eel, tomcod, and mummichog) tissue mercury concentrations in the Estuary are either generally decreasing (0.5 to 9 percent annually) or are stable. For bird species at two sampling locations (south of Verona Island and Mendall Marsh Southeast) and for blue mussels at one location (ES-FP), mercury concentrations appear to be increasing over time.

Geographically, biota collected in the areas of Mendall Marsh and south of Verona Island tend to have higher tissue mercury concentrations than biota collected in other parts of the Estuary. For many species (tomcod, smelt, lobster, and polychaetes), mercury concentrations continue to show decreases with distance downstream from the HoltraChem facility. Blue mussel and mummichog showed no strong spatial patterns of mercury concentrations within the Estuary (Amec Foster Wheeler 2017c). In terms of trophic level, low trophic level, and terrestrial mid-trophic level species (one shellfish, two songbird species, and one waterfowl species) tend to show limited or no change in tissue mercury concentrations through time; whereas upper trophic level species show greater reduction in mercury tissue concentrations than either low trophic level or terrestrial mid-trophic level species.

With the inclusion of 2017 data (Amec Foster Wheeler 2018g), Amec Foster Wheeler concluded that overall, mercury concentrations in aquatic biota (lobster, blue mussel, rainbow smelt, eel, tomcod, and mummichog) in the Estuary are generally decreasing (0.2 to 6.5 percent annual decline), indicating either the potential for some natural recovery or that tissue concentrations are stable. Blue mussels at two locations and red-winged blackbirds at most locations had increasing mercury concentrations (0.4 to 2.2 percent annual increase). Aquatic low trophic level species (one shellfish species) and terrestrial mid-trophic level species (two songbird species) tended to show limited or no change in concentrations through time. Upper trophic level species showed more reduction through time in mercury concentrations than aquatic low trophic level or terrestrial mid-trophic level species. Results from 2017 biota monitoring also indicated that biota collected in the areas of Mendall Marsh and south of Verona Island tended to have higher mercury concentrations than biota in other parts of the Estuary. This tendency toward higher tissue concentrations in the areas of Mendall Marsh and south Verona Island depended on the species analyzed. For many species, mercury concentrations decreased with distance downstream, consistent with results presented in the Phase II Study Report (PRMSP 2013).

4.0 RISK ASSESSMENT

The Risk Assessment and Preliminary Remediation Goal Development Report (Amec Foster Wheeler 2018a) presented the Human Health Risk Assessment (HHRA) and Baseline Ecological Risk Assessment (BERA) evaluating current conditions for the site. Baseline risk assessments evaluate the potential threats to human health and the environment, aid in determining whether remedial action is needed, and serve as the basis for the evaluation of the effectiveness of any subsequent remedial action. The report also included the development of risk-based PRGs for human health and ecological receptors for total mercury and methyl mercury.

The evaluation of risk reduction focuses on the PRGs for total mercury. Reductions in total mercury concentrations should result in reduced methyl mercury concentrations and a decreased potential for biological uptake and trophic transfer of methyl mercury, because the rate at which mercury is methylated is related to, although not necessarily directly proportional to, the concentration of total mercury present in sediment (Cossa et. al. 2014). Thus, while the decrease in exposure point concentrations in sediment from pre- to post-remediation activities represents a “step-down” in sediment concentrations, it does not concurrently indicate recovery time.

4.1 HUMAN HEALTH RISK ASSESSMENT

The HHRA was completed using methodologies developed by EPA and MEDEP. Consistent with EPA and MEDEP risk assessment guidance, exposures to total mercury and methyl mercury were quantified to characterize risk from the consumption of biota by adult and younger child local consumers. Local consumers are defined as those individuals who consume locally-caught shellfish, finfish, and duck as part of their diet. Risk was characterized for the consumption of the following species: American lobster, blue mussels, soft-shell clam, rainbow smelt, Atlantic tomcod, American eel (representing trophic level 4 fish species), and American black duck.

The results of the quantitative HHRA indicated that the noncarcinogenic hazard from exposure to inorganic mercury and methyl mercury via consumption of locally harvested American lobster, blue mussels, soft-shell clams, rainbow smelt, Atlantic tomcod, and American black duck is not of concern. For consumption of American eel (representing trophic level 4 fish species), the noncarcinogenic hazard from exposure to methyl mercury in tissue exceeded a target hazard quotient (HQ) of 1. However, the noncarcinogenic hazard from ingestion of inorganic mercury in the American eel tissue did not exceed acceptable hazard levels. When evaluated by species and sample location, risks from exposure decrease from north to south, from samples taken near the former chlor-alkali facility to those samples in Penobscot Bay.

4.2 BASELINE ECOLOGICAL RISK ASSESSMENT

The BERA addressed the likelihood that adverse effects on the environment, and on the population of specific ecological receptors, may occur or are occurring because of mercury exposure in the Estuary. Ecological receptors may be exposed via incidental ingestion, direct contact, and/or the food web. Mercury biomagnifies in the food web, resulting in greater exposure to higher trophic level organisms. Multiple lines of evidence were used in the BERA to assess the potential for risk to representative receptors (i.e., blue mussels, American lobster, mummichog, rainbow smelt, Atlantic tomcod, American eel, American black duck, Nelson's sparrow, red-winged blackbird, belted kingfisher, bald eagle, and mink) due to mercury exposure. Total mercury and/or methyl mercury concentrations in surface water, sediment, prey tissue, and receptor tissue were evaluated to characterize risk either through direct contact with surface water, food web exposure (i.e., dietary), and/or body burden (i.e., tissue accumulation).

The results of the BERA indicated that there is the potential for unacceptable risk to several receptors because body burden (i.e., tissue concentration) and/or dietary exposure no observed adverse effects level (NOAEL) HQs are greater than 1.0. However, the only receptors with lowest observed adverse effects level (LOAEL) HQs above 1.0 are the Nelson's sparrow and red-winged blackbird. When the NOAEL HQs are greater than or equal to 1.0, but the LOAEL HQs are less than 1.0, ecologically significant adverse effects to that receptor are possible as the threshold for effects is assumed to be between the NOAEL and LOAEL. There is uncertainty associated with defining the true toxicity threshold, however, adverse effects are considered possible. A LOAEL-based HQ greater than or equal to 1.0 indicates potential for adverse effects. Thus, there is potential for risk to marsh songbirds due to mercury exposure in the Estuary based on NOAEL and LOAEL HQs greater than 1.0.

4.3 SEDIMENT PRELIMINARY REMEDIATION GOALS

For the purposes of developing long-term remedial options, risk-based sediment PRGs for mercury were developed. The PRGs were based on food web modeling (for tissue- and dietary-based approaches) and bioaccumulation modeling using target tissue levels for human and ecological receptors. PRGs were calculated using a weight of evidence approach involving multiple lines of evidence. Sediment PRGs were calculated for ecological receptors using three approaches: (1) food web modeling tissue-based approach; (2) biota-sediment accumulation factor (BSAF) tissue-based approach; and (3) food web modeling dietary-based approach.

Sediment PRGs were calculated for human health using food web modeling and BSAF tissue-based approaches. Human health-based sediment PRGs were also calculated for two different scenarios: the local consumer and the Maine Center for Disease Control and Prevention (MeCDC) fish tissue action level for finfish consumption.

Sediment PRGs were calculated for ecological receptors using food web modeling and BSAF tissue-based approaches, as well as the dietary-based approach. The sediment PRGs were developed for total mercury and methyl mercury, using site-specific and species-specific BSAFs and biota-biota (i.e., predator-prey) accumulation factors (BAFs). BSAFs/BAFs provide insight into conditions driving bioaccumulation within a system and can be used to gauge the potential success of a remedy.

Two sets of PRGs were proposed for evaluation. These PRGs are protective of both ecological and human receptors:

- Total mercury: 300 ng/g and 500 ng/g for the marsh platform, intertidal, and subtidal sediments.
- Methyl mercury: 8 ng/g and 10 ng/g for the marsh platform, intertidal, and subtidal sediments.

The proposed sediment PRGs are applicable to all sediments within the bioactive zone for estuarine environments. The bioactive zone in estuarine environments like the Penobscot system is typically 10–15 cm (4–6 inches) (EPA 2015).

While PRGs have been developed for both total mercury and methyl mercury, the evaluation of remedial alternatives as developed in the Alternatives Evaluation Report (Amec Foster Wheeler, 2018k) has focused on the PRGs for total mercury. Reductions in total mercury concentrations should result in reduced methyl mercury concentrations and a decreased potential for biological uptake and trophic transfer of methyl mercury, because the rate at which mercury is methylated is related to, although not necessarily directly proportional to, the concentration of total mercury present in sediment (Cossa et. al. 2014). For total mercury, the 300 ng/g sediment PRG is a concentration that is expected to meet the MeCDC 200 ng/g fish tissue action level in edible tissues; the 500 ng/g sediment PRG was developed in the risk assessment to be protective of ecological risk and the local consumer.

5.0 REMEDIAL ALTERNATIVES EVALUATION

The evaluation of remedial alternatives used the criteria discussed in this section, which were expanded and further defined from the criteria developed by the Court.

5.1 TECHNOLOGY SCREENING REPORT

The Technology Screening Report (Amec Foster Wheeler 2017f) presented a preliminary evaluation and screening of potentially applicable technologies for remediation of mercury in sediments. Evaluation and screening was based on effectiveness, implementability, and relative cost. The Technology Screening Report summarized potentially applicable statutory and regulatory requirements, identified general response actions, and screened viable remedial technologies based on the understanding of the nature and extent of mercury contamination in the Estuary at the time of publication.

The report recommended the use of the following six evaluation criteria and associated sub-criteria for detailed evaluation of remedial alternatives. These criteria were established based on the Court Order, the Phase III Engineering Study process, and site-specific considerations.

1) Viability of Remedy:
    - Ability to construct and/or operate the remedial alternative,
    - Applicable regulations, coordination with agencies, and permits and approvals needed, and
    - Community acceptance.
2) Whether the proposed solution has been successfully attempted previously or is innovative:
    - Where the solution has been successfully implemented in the past, and
    - Status of the technology/innovation status/reliability.
3) The likely cost of the solutions:
    - Capital costs, and
    - Operation and maintenance costs.
4) The length of time to complete the recommendations:
    - Time to implement the remedy, and
    - Time until RAOs are achieved.
5) The likely effectiveness of the remedial alternative:
    - Reduction in amount/concentration of mercury/methyl mercury available in the system or available to receptors after remediation,
    - Reduction of risk to people and biota, and
    - Permanence of the remedy/remedy effectiveness.

6) Potential environmental harm that may be caused by the proposed solution:
    - Adverse environmental impacts for remediation,
    - Short- and long-term impacts to the community,
    - Short-term impact to workers, and
    - Sustainability/green remediation factors.

The remedial technologies and process options that were retained from this initial screening were further evaluated based on the results of concurrent characterization and risk evaluations, the development of PRGs, constructability reviews, and bench-scale studies, and were assembled into remedial alternatives. The evaluation of remedial alternatives is presented in Section 5.2 (below) that summarizes the Alternatives Evaluation Report (Amec Foster Wheeler 2018k).

5.2 ALTERNATIVES EVALUATION REPORT

The Alternatives Evaluation Report (Amec Foster Wheeler 2018k) presents the results of the development, evaluation, and comparison of remedial alternatives that could be implemented to reduce ecological and human health risks resulting from mercury in the sediments of the Estuary. Alternatives were developed, evaluated, and compared based on the evaluation criteria as established by the Court Order and the Phase III Engineering Study process (as discussed above). A summary of the remedial alternatives evaluated is presented in **Table 5-1**.

5.2.1 Remedial Action Objectives

RAOs were developed to identify measurable indicators of risk reduction, including reduced exposure of humans to elevated mercury in edible tissues, as well as declines in key biota mercury concentrations. The following RAOs were developed:

- Protect humans who consume Penobscot Estuary edible biota from exposure to elevated mercury concentrations that exceed protective levels; and

- Protect ecological receptors from exposure to mercury concentrations in sediment that exceed protective levels.

These RAOs are based on the development and implementation of PRGs as was described in Section 4.3 (Sediment Preliminary Remediation Goals). Sediment-based PRGs were developed based on both the HHRA and the BERA, as presented in the Penobscot River Risk Assessment and Preliminary Remediation Goal Development Report (Amec Foster Wheeler 2018a).

5.2.2 Area Weighted Average Concentrations

The remedial evaluation included the delineation of the Estuary into reaches and hydrodynamic zones, and calculation of area weighted average total mercury concentrations within each reach/zone unit. The area weighted average calculation used all total mercury data in the project database from 2000–2017, with the exception of data for which either the analytical laboratory or the analytical method were unclear, or sampling details (e.g., uncertain sampling location, undefined sampling depth increments) could not be confirmed. Data were grouped into discrete depth increments using an interval participation weighted concentration approach. This approach allows for the integration of data from a project database that includes a range of sampling types (e.g., grab samples and sediment cores) that may have been collected for differing objectives and depth sectioned at differing interval schemes (e.g., tenths of a foot versus centimeters).

Following identification of reach/zone units, calculation of interval participation weighted concentrations, and application of exclusion zones (including areas of exposed bedrock, boulders or hardpan, locations of archeological significance, and the footprint of the 2017 sediment excavation in Southern Cove), a bootstrap mean total mercury concentration was calculated for each reach/hydrodynamic zone unit. Areas were prioritized for remediation based on: (1) the comparison of bootstrap mean total mercury concentrations with PRGs calculated to reduce risks for ecological receptors and human consumers; and (2) consideration of particular reach/zone units of specific habitat significance. As summarized in Section 4.3 (Sediment Preliminary Remediation Goals), two total mercury-based PRGs were identified: 300 ng/g total mercury in sediment and 500 ng/g total mercury in sediment. The 300 ng/g sediment PRG is a concentration that is expected to meet the MeCDC 200 ng/g fish tissue action level in edible tissues; the 500 ng/g PRG was developed in the risk assessment to be protective of ecological risk and the local consumer.

In addition to the identification of reach/hydrodynamic zone units warranting remedy based on this prioritization, the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) also evaluated remedial feasibility and costs associated with removal of surface deposits of mixed mineral sediment and wood waste from the Frankfort Flats, Orland River, and Verona East reaches of the Estuary, and included a summary of bootstrap means calculated for each reach/hydrodynamic zone unit with remedial area and volume calculations, which are presented in **Tables 5-2 through 5-7**.

5.2.3 Remedial Alternatives

The process of developing remedial alternatives consisted of: (1) an initial screening of remedial technologies; (2) identification of technologies for which treatability studies (bench- and/or pilot-scale studies) are or would be needed to evaluate site-specific effectiveness; (3) identification of general response actions; (4) development of the list of potential remedial technologies consistent with general response actions; and (5) screening of potential remedial technology process options against the criteria of effectiveness, implementability, and relative cost. Following this development process, six remedial alternatives were retained and evaluated:

- **Alternative 1: Monitored Natural Recovery**, including institutional controls and long-term (45-year) monitoring of sediment, surface water (including total suspended solids) and biota to assess progress toward system-wide ecological recovery;
- **Alternative 2: Enhanced Monitored Natural Recovery**, effected through the addition of clean sediment to the system with the goal of reducing total mercury concentrations in mobile sediment throughout the intertidal and subtidal zones, as well as on marsh platforms where mobile sediment can deposit following inundation of the platform;
- **Alternative 3: Dredging**, consisting of mechanical removal of either/both subtidal/intertidal sediment and fringing and pocket marsh sediments, with dredged or excavated material to be either disposed of off-site or available for beneficial reuse;
- **Alternative 4: Thin Layer Capping** on the Mendall Marsh platform to reduce total mercury concentrations across the biological mixed depth on the marsh platform;
- **Alternative 5: Amendment Application**, consisting of addition of sediment amendments to the Mendall Marsh platform to reduce biological accumulation of methyl mercury from porewater on the marsh platform; and
- **Alternative 6: Dredging in Intertidal and Subtidal Zones & Thin Layer Capping,** a combination remedy for Mendall Marsh that includes thin layer capping or amendment addition on the marsh platform and dredging in the marsh intertidal and subtidal zones.

The applicability of remedial alternatives was tailored and grouped based on: (1) the constructability assessments; (2) the ability to achieve PRGs; and (3) the ability to reduce system-wide area weighted average concentrations of total mercury in sediments.

To achieve system-wide remedy, the pertinent remedial alternatives identified in the Alternatives Evaluation Report (Amec Foster Wheeler, 2018k) were:

- Alternative 1: Monitored Natural Recovery
- Alternative 2: Enhanced Monitored Natural Recovery

For remedies that focus on portions of the system, the pertinent remedial alternative identified for the main channel of the Estuary and the Orland River was:

- Alternative 3: Dredging

The pertinent remedial alternatives identified for Mendall Marsh were:

- Alternative 4: Thin Layer Capping
- Alternative 5: Amendment Application
- Alternative 6: Dredging in Intertidal and Subtidal Zones & Thin Layer Capping

The evaluation of remedial alternatives identified that the six alternatives could be implemented as stand-alone remedies or portions of different alternatives could be combined to achieve an overall goal of system-wide reductions in the area weighted average concentration of total mercury in Estuary sediments. For all potential remedial alternatives, long-term ecological recovery monitoring was recommended. The stand-alone or integrated potential remedial alternatives are summarized as follows:

Alternative 1: Monitored Natural Recovery

- MNR would be implementable as a stand-alone system-wide remedial alternative.
- Components of MNR (monitoring and institutional controls) could be implemented either in combination with other active remedy alternatives or as a stand-alone remedial alternative; application of MNR would be appropriate for the main channel of the Estuary, the Orland River, and Mendall Marsh.

Alternative 2: Enhanced Monitored Natural Recovery

- Enhanced MNR through addition of clean sediment could be implementable as a stand-alone system-wide remedial alternative or could be implemented in portions of the system.
- Enhanced MNR could improve the ecological recovery timeframe in pocket and fringe marshes along the main channel of the Estuary, as well as in Mendall Marsh, through the eventual redistribution of cleaner mobile sediment into the marshes and onto the marsh platforms during inundation.

Alternative 3: Dredging

- Dredging would be implementable as a stand-alone remedial alternative for both the main channel of the Penobscot River Estuary and the Orland River.
- Dredging could be implemented in conjunction with marsh platform alternatives such as thin layer capping or amendment addition.
- Dredging could be implemented to address smaller footprint and/or specific areas of elevated mercury concentration targeted for accelerating system recovery.

Alternative 4: Thin Layer Capping

- Thin layer capping would be implementable as a stand-alone remedial alternative for the marsh platform in Mendall Marsh.
- Thin layer capping could be implemented as a remedy for other marsh areas in the Estuary, or in combination with the dredging alternative for either the main channel of the Estuary or the Orland River.

Alternative 5: Amendment Application

- Amendment application would be implementable as a stand-alone remedial alternative for the marsh platform in Mendall Marsh.
- Amendment application could be implemented as a remedy for other marsh areas in the Estuary, or in combination with the dredging alternative for the main channel of the Estuary and the Orland River.
- Amendment application could be implemented in combination with the thin layer capping alternative for the marsh platform in Mendall Marsh.

Alternative 6: Dredging in Intertidal and Subtidal Zones & Thin Layer Capping

- Dredging in the intertidal and subtidal zones of Mendall Marsh and thin layer capping on the marsh platform would be implementable as a stand-alone remedial alternative.
- Enhanced MNR (addition of clean sediments) could be applied in Mendall Marsh as a post-remediation adjunct to dredging and backfilling in the intertidal/subtidal zones.
- Amendment application could be combined with thin layer capping as a remedial alternative for the Mendall Marsh platform.

Table 5-8 summarizes the estimated implementation costs for each of these remedial alternatives as developed and presented in the Alternatives Evaluation Report (Amec Foster Wheeler, 2018k).

6.0 RISK REDUCTION FROM REMEDIAL ALTERNATIVES

The risk reduction compares pre- and post-remediation risk to human health and ecological receptors from mercury exposure in the Estuary to aid in evaluating the effectiveness of each potential remedy. The remedial alternatives identified in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) and summarized in Section 5.2.3 were assessed and the findings presented in the Risk Reduction Report (Amec Foster Wheeler 2018m).

Risk reduction was quantified in terms of a percentage of reduction to identified receptors based on the alternatives identified in Section 5.0. Alternative 5 (Amendment Application) is excluded from evaluation because of the high level of unknowns associated with field-scale implementation and performance of this alternative. As summarized in Section 2.2.17 (Technical Memorandum Amendment Plot Resampling Study), it is currently not possible to evaluate whether amendments, either applied as a stand-alone remedy or incorporated into a thin layer cap, would result in decreased biological update and trophic transfer of methyl mercury. A summary of the results of the risk reduction evaluation are presented in **Table 6-1**.

6.1 DEVELOPMENT OF POST-REMEDIAL ACTION SURFACE AREA WEIGHTED AVERAGE CONCENTRATIONS

Exposures to affected sediment are biota-specific. Marsh songbirds are exposed to marsh platform sediments, but not to intertidal and subtidal sediments. Aquatic receptors are exposed to intertidal and subtidal sediments, but not to marsh platform sediments. Ducks, while feeding primarily in the intertidal zone, would also be exposed on the marsh platform, especially during spring tides when the marsh platform is inundated and ducks feed on the platform. Thus, the effects of a given remedial alternative are also biota-specific. To account for this effect, pre-, current-, and post-remediation surface area weighted average concentrations (SWACs) were calculated on a biota-specific basis.

The pre-remediation sediment and biota concentrations associated with the footprints of each remedial alternative were adjusted by replacing the pre-remediation concentrations with concentrations expected post-remediation; this replacement generated a post-remediation action focused on the 0 to 0.5-foot depth interval. This depth interval is defined as the bioactive depth in sediment. For each reach/zone affected by the proposed remediation action, an area weighted average post-remediation sediment mercury concentration was calculated by applying a bootstrap mean technique to the expected (post-remediation) sediment mercury concentration. The area weighted average total mercury concentrations calculated in each area for which receptor tissue data had been collected in 2016 and 2017 as part of Amec Foster Wheeler biota monitoring were used to calculate a SWAC representing the area within (or across) reach/zone units used by the receptor.

6.2 PRE- AND POST-REMEDIATION ASSESSMENT OF HUMAN HEALTH RISK

The human health risk reduction evaluation was based on the results of the HHRA, which identified potential elevated risk levels for local consumers resulting from the consumption of locally harvested seafood and waterfowl.

The results of the HHRA indicated that for the local consumer, the biota that have the potential to result in elevated risk levels is the American eel (representing trophic level 4 fish species). Shellfish, American lobster, Atlantic tomcod, rainbow smelt, and American black duck were not identified as a source of potential elevated risk for the local consumer in the HHRA. However, because both the American lobster and American black duck are associated with local consumption limits, these two biota types, along with the American eel, for which potential risks exist for local consumers, were further evaluated for the local consumer.

Risk reduction was quantified by calculating the potential risks from the consumption of methyl mercury in biota tissue based on the modeled concentrations of total mercury in tissues and an assumed biota-specific percentage of total mercury present as methyl mercury in tissue. Concentrations in tissue for the characterization of risk to human health were developed using two different approaches:

- Food web modeling tissue-based approach; and
- BSAF tissue-based approach.

Concentrations of mercury in biota tissue were developed using site-specific and species-specific BSAFs and biota-biota (i.e., predator-prey) accumulation factors. In addition, the modelled methyl mercury tissue concentrations were compared to the MeCDC fish tissue action level of 200 ng/g.

6.3 PRE- AND POST-REMEDIATION ASSESSMENT OF ECOLOGICAL RISK

The ecological risk reduction evaluation was based on the results of the BERA presented in the Penobscot River Risk Assessment and Preliminary Remediation Goal Development Report (Amec Foster Wheeler 2018a). The BERA indicated a potential for adverse risk (defined as LOAEL-based HQs above 1.0) to marsh songbirds (i.e., Nelson's sparrow and red-winged blackbird) due to exposure to mercury in the Estuary. Ecological receptors that were identified as not adversely impacted through exposure to mercury in the BERA were not included in the risk reduction evaluation. The ecological risk reduction evaluation focused on the Nelson's sparrow and red-winged blackbird and the potential for adverse risk associated with body burden (i.e., mercury accumulation in blood). Concentrations of total mercury in marsh songbird blood were developed using the same methodologies for the tissue concentrations in the human health risk reduction evaluation.

6.4 SUMMARY OF RISK REDUCTION EVALUATION

The remedial alternatives that would result in a decrease of potential human health and ecological risks to HQs below 1.0 are summarized in Sections 6.4.1 through 6.4.3.

The evaluation of remedial alternatives focuses on the PRGs of 500 ng/g and 300 ng/g total mercury in sediment. Methyl mercury data were included in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) as a screening tool for prioritizing (if necessary) remedial decisions between reach/zones with potentially similar (and/or low) area weighted average concentrations of total mercury but different (and/or elevated) concentrations of methyl mercury. Following this approach, evaluation of methyl mercury data was completed on a station-specific basis; area weighted average concentrations of methyl mercury were not calculated. It should be noted that remediation to total mercury concentrations at or below background (180 ng/g) would be technically impractical to achieve, given the likelihood of continuing sediment migration and redistribution in the Penobscot River as well as specifically in the Estuary.

Summaries of the risk reduction evaluation are presented below for three areas: (1) the main channel of the Penobscot River Estuary and the Orland River; (2) Mendall Marsh; and (3) Southern Cove. As discussed further in Section 8.0 (Recommendations) of this report, Amec Foster Wheeler recommends that dredging be undertaken in the Orrington reach and include intertidal and marsh areas that include and extend beyond Southern Cove. Evaluation of risk reduction presented in the Risk Reduction Report for Southern Cove is based on SWACs generated for habitat as defined by biota monitoring stations in the Bangor reach (Station BO-04) and Orrington reach (Station OB-05). Dredging in the Orrington reach, including Southern Cove as well as intertidal and marsh areas outside of the Cove, would likely result in further risk reduction beyond what is summarized for Southern Cove in Section 6.4.3 (below).

6.4.1 Main Channel of the Penobscot River Estuary and the Orland River

The results of the human health risk reduction evaluation for the main channel of the Penobscot River and the Orland River indicated that a decrease in levels of potential risk depended on the species and the remedial alternative. The receptor-specific results of the evaluation are as follows:

Local Consumers

- Potential risks from the consumption of American eel (representing trophic level 4 fish species) by local consumers – For local consumers, Alternative 2: Enhanced MNR (PRG of 300 ng/g) and Alternative 3: Dredging (PRGs of 500 ng/g and 300 ng/g) would result in a decrease in potential risk to acceptable levels. Alternative 2: Enhanced MNR (PRG of 500 ng/g) would result in potential risk levels near 1 (HQs ranging from 1.2 to below 1).

- Potential risks from the consumption of American black duck by local consumers – The remedial alternative that would result in a decrease in potential risk to acceptable levels is Alternative 3: Dredging (PRGs of 500 ng/g and 300 ng/g). Alternative 2: Enhanced MNR (PRG of 500 ng/g and 300 ng/g) would result in potential risk levels near 1 (HQs ranging from 1.3 to below 1).

- Potential risks from the consumption of lobster by local consumers – Because pre-remediation risks for both the 2014 and 2016 closure areas were below acceptable levels and lobster is an important economic resource for the State of Maine, a more conservative risk reduction approach was undertaken for lobster consumption using an upper-bound BSAF. Under this more conservative risk reduction approach (using the upper bound BSAF), no remedial action is needed to meet acceptable risk levels for the lobster based on the local consumer consumption rates.

MeCDC Fish Tissue Action Level

- Concentration of methyl mercury in American eel tissue (representing trophic level 4 fish species) – Alternative 3: Dredging (PRG of 300 ng/g) would result in a decrease in tissue concentrations to below the MeCDC fish tissue action level of 200 ng/g.

- Concentration of methyl mercury in American black duck tissue – Alternative 3: Dredging (PRG of 300 ng/g) would result in a decrease in tissue concentrations to at or below the MeCDC fish tissue action level of 200 ng/g.

- Concentration of methyl mercury in American lobster tissue – Because pre-remediation risks for both the 2014 and 2016 closure areas were below acceptable levels and lobster is an important economic resource for the State of Maine, a more conservative risk reduction approach was undertaken using an upper-bound BSAF. Under the more conservative risk reduction approach (using the upper bound BSAF), Alternative 2: Enhanced MNR (PRG of 300 ng/g) and Alternative 3: Dredging (PRG of 300 ng/g) would result in a decrease to below 200 ng/g, with the exception of the 2016 lobster closure area when assuming the upper bound BSAF.

6.4.2 Mendall Marsh

The results of the human health and ecological risk reduction evaluation for Mendall Marsh indicated a decrease in levels of potential risk dependent on the receptor (human or ecological) and the remedial alternative. The receptor-specific results of the evaluation for Mendall Marsh are as follows:

Local Consumers

- Potential risks from the consumption of American black duck by local consumers – The BSAF approach risk level for black duck has an HQ less than 1.0. The food chain black duck risk has an HQ greater than 1.0. The remedial alternatives that would result in a decrease in potential food chain risk to acceptable levels for Mendall Marsh are Alternative 4: Thin-layer capping and Alternative 6: Dredging and thin-layer capping.

MeCDC Fish Tissue Action Level

- Concentration of methyl mercury in American black duck tissue – The remedial alternatives that would result in a decrease in methyl mercury tissue concentration to below 200 ng/g for Mendall Marsh are Alternative 4: Thin layer capping (BSAF approach only), and Alternative 6: Dredging and thin layer capping (BSAF approach only).

Ecological Receptors

- Potential ecological risks for the Nelson's sparrow and red-winged blackbird – The remedial alternative that would result in a decrease in potential LOAEL risk levels below 1.0 for Mendall Marsh – West and Mendall Marsh – East is Alternative 6: Dredging and thin-layer capping. The additional remedial alternatives which would result in reduction of potential risk levels to near 1.0 (HQs ranging from 1.5 to below 1.0) are Alternative 3: Dredging (PRGs of 500 ng/g and 300 ng/g) for Mendall Marsh - West and Alternative 4: Thin-layer capping for both Mendall Marsh – East and West.

6.4.3 Southern Cove

The results of the human health and ecological risk reduction evaluation for Southern Cove indicated a decrease in levels of potential risk depending on the species and the remedial alternative. Evaluation of risk reduction presented in the Risk Reduction Report for Southern Cove and summarized here is based on SWACs generated for habitat as defined by biota monitoring stations in the Bangor reach (Station BO-04) and Orrington reach (Station OB-05). As discussed further in Section 8.0 (Recommendations) of this report, Amec Foster Wheeler recommends that dredging be undertaken in the Orrington reach and include intertidal and marsh areas that include and extend beyond Southern Cove. Dredging in the Orrington reach, including Southern Cove as well as intertidal and marsh areas outside of the Cove, would likely result in further risk reduction beyond what is summarized below. The receptor-specific results of the evaluation are as follows:

Local Consumers

- Potential risks from the consumption of American eel (representing trophic level 4 fish species) by local consumers – For local consumers, Alternative 3: Dredging (PRGs of 500 ng/g and 300 ng/g) would result in potential risk levels below 1.0 in Southern Cove. Alternative 2: Enhanced MNR (PRG of 300 ng/g) would result in potential risk levels near 1 (HQs ranging from 0.88 to 1.3).

- Potential risks from the consumption of American black duck by local consumers – No remedial alternatives based on the food web approach would result in potential risk levels below 1.0 in Southern Cove. Alternative 3: Dredging (PRGs of 500 ng/g and 300 ng/g) would result in the lowest potential risk levels for local consumers (HQs of 0.75 to 1.6), while Alternative 2: Enhanced MNR (PRGs of 500 ng/g and 300 ng/g) would result in a slightly higher risk range (HQs of 0.84 to 1.9).

<u>MeCDC Fish Tissue Action Level</u>

- Concentration of methyl mercury in American eel tissue (representing trophic level 4 fish species) – Alternative 3: Dredging (PRG of 300 ng/g) would result in methyl mercury tissue concentrations below 200 ng/g for the American eel.

- Concentration of methyl mercury in American black duck tissue – None of the remedial alternatives would result in a decrease in methyl mercury tissue concentration to below 200 ng/g for Southern Cove. However, Alternative 3: Dredging (PRG of 300 ng/g) would result in the lowest potential tissue concentrations.

<u>Ecological Receptors</u>

- Potential ecological risks for the Nelson's Sparrow – No remedial alternatives would result in potential risk levels below 1.0 in Southern Cove. The remedial alternative that would result in the lowest LOAEL HQs is Alternative 3: Dredging with a PRG of 300 ng/g, which would result in a potential risk range of 1.5 to 2.5.

- Potential ecological risks for the red-winged blackbird – No remedial alternatives would result in potential risk levels below 1.0 in Southern Cove. The remedial alternative that would result in the lowest LOAEL HQs is Alternative 3: Dredging with a PRG of 300 ng/g, which would result in a potential risk range of 1.8 to 2.5.

7.0 COMMUNICATION AND COMMUNITY INVOLVEMENT

As part of the Phase III Engineering Study, the Communication and Community Involvement Plan (CCIP) (Amec Foster Wheeler 2018n) has been designed to help guide and support the community involvement process to:

- Build awareness and educate stakeholders about the Phase III Engineering Study, challenges, proposed alternatives, and selected evaluation criteria;
- Solicit feedback on stakeholders' interest in the project; and
- Solicit feedback about the Phase III Engineering Study, proposed alternatives, and evaluation criteria.

The CCIP was not part of direction provided by the Court; however, Amec Foster Wheeler identified the need and value of an involvement process in the consideration of remedial alternatives and future implementation of selected remedial alternatives. A defined stakeholder involvement process supports projects through the sharing of relevant, accessible information, providing opportunities for input and establishing clear expectations on how that input will be considered, therefore enabling stakeholders to see their voice in the process while avoiding stakeholder fatigue. Regular, meaningful engagement with stakeholders is valuable because it creates open lines of communication, develops trust, and maintains transparency.

The CCIP has been designed as a living document to support the Court through deliberations, decisions, and implementation of those decisions that may affect stakeholders. The CCIP is designed to be updated as new information arises and feedback is received. This document has been developed based on our current knowledge of the project and engagement with various stakeholder groups along the Penobscot River and the Estuary.

Amec Foster Wheeler identified five stages to guide and give structure to engagement activities as they relate to each of the predicted project milestones:

- Stage One – Pre-Planning and Relationship Building;
- Stage Two – Information Sharing and Transparency;
- Stage Three – Alternatives Information, Transparency, and Court Deliberation;
- Stage Four – Court Decision; and
- Stage Five – Implementation of Court Decision.

CCIP Stage One was initiated at the launch of the Phase III Engineering Study. The intent of Stage One was to determine communication guidelines and messaging, identify potentially interested community groups, map stakeholder relationships and interactions, and make initial contact with key stakeholders. CCIP Stage Two is currently underway and will continue until the projected completion of the final Phase III Engineering Study report in September 2018. Communication and community engagement activities to date have been tracked and maintained using a tracking database. Data tracking and management are used to ensure that a continuous, thorough record of engagement is available for the life of the project.

Amec Foster Wheeler is recommending that CCIP Stage Three (Alternatives Information, Transparency and Court Deliberations) would begin when the final Phase III Engineering Study is submitted, the Parties review and present their views on the recommendations to the Court, and the Court begins its deliberations. The intent of this stage is to:

- Provide information in plain-language to stakeholders about each of the remedial alternatives;
- Provide opportunities for stakeholders to provide feedback on the remedial alternatives so that the feedback can be considered in the selection and planning for implementation of alternatives, as appropriate; and
- Set clear expectations for stakeholder involvement during Court deliberations (e.g., stakeholders may not have an opportunity to provide direct feedback to the Court).

During this stage, it is important to continue to provide and deliver information to stakeholders in ways that maximize understanding and accessibility. Public presentations, fact sheets, a web site, an interactive kiosk, and email updates are some of the tools and activities that can be used to help advance the goals of this stage as described in the Communications and Community Involvement Plan (Amec Foster Wheeler 2018n).

It is recommended that CCIP Stage Four (Court Decision) would begin when the Court reaches a decision on the recommended remedial alternatives. The intent of this stage is to maintain transparency and inform stakeholders about the Court's decision in a timely and effective manner. The Future Consulting Team would be responsible to select tools and activities that advance the goals and principles of the CCIP.

It is recommended that CCIP Stage Five (Implementation of Court Decision) would begin coincident with the implementation of the Court decision regarding remedial action(s) to address the mercury impacts to the Estuary. Regardless of the remedial action(s) the Court chooses to apply, some degree of communication and community involvement is warranted throughout implementation stage. There are significant opportunities during this stage to include stakeholders as participants and advocates in the implementation of the Court decision. However, the level of stakeholder involvement that is feasible and appropriate during this stage cannot be determined until:

- The determined remedial action(s) have been selected and released to the public;
- Information is available about how and when the remedial actions would be implemented;
- Stakeholder groups most likely to be affected and the degree of impact are identified; and
- A decision is made about who would be implementing the remedial action activities.

Based on the remedial alternatives recommended in the Phase III Engineering Study and Amec Foster Wheeler understanding of the current stakeholder environment, the following tools and activities are suggested for consideration in the detailed planning of Stage Five:

- Provide continual website maintenance and updating.
- Consider meeting with the following:
  - General-public individuals or groups, or specific groups;
  - Penobscot Indian Nation Tribal Council and representatives;
  - Lobstermen and crab fishermen; and
  - Youth, to provide education and knowledge building.
- Provide opportunity to organize community liaison panels.

Amec Foster Wheeler acknowledges that detailed planning will not occur until the Court Decision is released.

Regarding roles and responsibilities, Amec Foster Wheeler developed the CCIP and facilitated Stage One and Stage Two engagement activities. Following submission and acceptance of the final Phase III Engineering Study Report, the Court will be responsible for deciding how to implement the CCIP and carry engagement activities forward. Amec Foster Wheeler recommends that the mechanism to advance the CCIP through Stages Three to Five should be developed to allow community involvement to continue.

8.0 RECOMMENDATIONS

This section presents the recommendations for remedial alternatives proposed to reduce risks to humans and ecological receptors from mercury present in the Estuary; discusses relative risk and recovery times; estimates cost and schedule for the alternatives; and provides recommendations for long-term monitoring and community involvement.

The preceding sections of this report summarize the work that led to the identification of the six remedial alternatives that were assessed in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) and are summarized in Section 5.2.3 of this report. Some of the alternatives identified were intended to achieve PRGs for system-wide recovery, while others focused on portions of the Estuary. The recommendations contained in this section combine various elements of these alternatives to balance viability, effectiveness, and cost-effectiveness.

The alternatives recommended for implementation focus on: (1) locations characterized by unacceptable levels of risk to sensitive receptors from exposure to mercury; (2) locations in which the sediment bed may be unstable resulting in elevated potential for erosion and/or the location may represent an area in the Estuary in which material enriched in mercury accumulates in identifiable deposits; and/or (3) locations characterized by the highest sediment mercury concentrations in the Estuary. To address these three focus areas, recommended remedial alternatives (see Section 8.3) include the following components:

- Placement of a thin layer cap on portions of Mendall Marsh;
- Dredging to remove subtidal surface deposits;
- Dredging/excavation of the Orrington Reach intertidal and marsh platform sediments; and
- Long-term monitoring subsequent to these three active remedies.

With the exception of the thin layer cap on Mendall Marsh, the other active remedies recommended (dredging surface deposits and dredging in the Orrington reach) are not expected to achieve PRGs of either 500 ng/g or 300 ng/g immediately upon completion. It is expected that following completion of the remedial work, a likely minimum of an additional 25 years of long-term monitoring will be needed for system-wide recovery to meet a PRG of 500 ng/g total mercury. System-wide recovery to meet a PRG of 300 ng/g total mercury will likely require over 100 years, even with the implementation of the dredging remedies recommended here. Because the system is complex, uncertainties in system characterization remain that will affect the estimated effectiveness, cost, and recovery time associated with the recommended remedial alternatives. These uncertainties remain despite the investigations, bench-scale testing, and evaluations performed during this engineering study, as well as the evaluations performed during the preceding Phase I and Phase II studies. Recommendations presented in this report are based on both the criteria defined by the Court and on the multiple lines of evidence resulting from these studies; this integrated approach serves to reduce but not eliminate uncertainties in making remedial recommendations.

The remedial evaluation presented in this Report included the calculation of area weighted average concentrations of total mercury in sediment using all total mercury data in the project database from 2000–2017, with the exception of data for which either the analytical laboratory, the analytical method, or sampling details were unclear. Further details regarding this approach were summarized in Section 5.2.2 of this Report and presented in full in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k). Based on the data used for the calculation of area weighted average concentrations, data were available from 493 distinct sediment sampling locations for the interval 2000 - 2015. For the interval 2016 – 2017, data from an additional 413 distinct sediment sampling locations were added to the project database. The majority of sampling locations (90%) are located in the upper Estuary (as defined from the former Veazie Dam to the south tip of Verona Island including Mendall Marsh and the Orland River).

For the upper Estuary, based on an estimated area of 10,180 acres, the approximate sampling location density at the completion of the Phase II Study was one station per 23 acres; the approximate sampling location density at the completion of the Phase III Study is currently one station per 12 acres. Implications of this sampling density for remedial evaluation, including statistical limitations on the robust application of kriging for delineating the areal footprint of potential in-water work and recognition that sampling stations are not uniformly spaced or placed with the intention of delineating a uniform station grid, remain as uncertainties in system characterization of the Estuary. These uncertainties will affect the estimated effectiveness, cost, and recovery timeframes associated with the recommended remedial alternatives presented in this Phase III Engineering Study. Further details regarding constraints on geospatial data visualization are presented in the Alternatives Evaluation Report (and associated Appendix I).

Section 8.4 identifies additional potential adaptive management alternatives that could be implemented to accelerate remediation if future long-term monitoring indicates that the Estuary is not recovering at a reasonable rate following implementation of some or all of the recommended remedial alternatives. These adaptive management alternatives would be targeted at the eastern channel (Verona Northeast and Verona East reaches) and Orland River. Adaptive management is a key principle of environmental remediation, and involves planning, implementing actions, monitoring, and analyzing data gathered during monitoring to achieve the best outcome. As a strategy for monitoring remedial progress, adaptive management focuses on iteratively altering or updating a course of action based on ongoing data collection and analysis. Overall, adaptive management is included in the recommendations presented in this engineering study, either by way of pre-construction delineation activities, pilot testing, implementation and monitoring, or long-term monitoring to assess temporal trends toward system recovery.

During the evaluation of remedial alternatives, the assumed construction means and methods were tailored to the reach, zone, and conditions; the sediments' physical properties; and commonly available equipment. Variation of the underlying assumptions such as production rates, equipment capacity, work days, haul cycles, etc. can generate different schedules and costs. The cost estimates presented in Section 8.6 have been developed with a target accuracy of plus 50 percent/minus 30 percent.

8.1 COURT CRITERIA

In October 2015, the Court issued an Order for Evaluation of Potential Remedies, which required that there be:

> *"….an immediate, thorough, open, and independent identification and evaluation of potential active remedies to speed the recovery of the Penobscot River estuary from its present state of mercury contamination"*

and that:

> *"…the engineering firm will submit a written report, recommending to the Court a remedial plan or plans that would be effective and cost-justified, or explaining why there is no viable remedy to pursue."*

The prior September 2015 Court Order on Remediation Plan identified factors that the Court would consider in evaluating the recommendations of the engineering firm. Six criteria were used in the evaluation of potential remedial alternatives for the Estuary based on the direction of the Court:

- Viability of the proposed remedy;
- Whether the proposed remedy has been successfully attempted previously or is innovative;
- The likely cost of the recommended alternative;
- The length of time to implement the recommended alternative;
- The likely effectiveness of the recommended alternative; and
- Potential environmental harm that may result from the recommended alternative.

8.2 ALTERNATIVES NOT RECOMMENDED

Several of the alternatives developed and evaluated in the Alternatives Evaluation Report (Amec Foster Wheeler (2018k) and described in Section 5.2.3 of this report are recommended to be partially implemented or not recommended to be implemented. The alternatives that are not being recommended for full implementation are presented below, with the rationale for their exclusion.

8.2.1 Alternative 1: Monitored Natural Recovery

Alternative 1 is not recommended to be carried forward alone as a remedial alternative based on a likely time frame of at least 45 years to meet the 500 ng/g PRG, and at least 100 years to meet the 300 ng/g PRG in the absence of active remediation (**Figure 8-1**, Case I). Monitoring in support of long-term ecological recovery is recommended as a component of other recommended alternatives, however, as they are not expected to meet PRGs immediately after implementation. Monitoring in support of long-term ecological recovery is discussed further in Section 8.7.

Recommendation: MNR is not recommended system-wide as a stand-alone remedy. Regarding biological recovery in the Estuary, tissue mercury concentrations are decreasing at an approximate rate of two percent annually for many aquatic species (Amec Foster Wheeler 2018g), consistent with decreases in sediment mercury concentrations over time. Because the 500 ng/g PRG for sediment was developed to be protective of local consumers and biota using BSAFs, and BSAFs were developed based on the relationship between the species-specific concentration of mercury in biota and in sediment, it is expected that when sediment concentrations reach 500 ng/g, tissue concentrations will also decline to a level of acceptable risk for system biota. The recovery timeframe for biota is expected to lag as much as five to ten years behind the recovery timeframe for sediment. The expected time lag in biota recovery is a function of the range of trophic levels being monitored (i.e., not all monitored species will recover at the same rate because species represent different trophic levels with different exposure pathways) and the need for system re-equilibration or stabilization following the disturbance of remedial activities.

8.2.2 Alternative 2: System-Wide Enhanced Monitored Natural Recovery

Alternative 2 is not recommended as a system-wide recommendation based on the uncertainty as to how this remedial alternative would be applied system-wide and the potential for negative effects from its application. While the strategy of enhancing natural recovery through placement of a thin layer cap has been demonstrated and applied on the field scale in other river systems, the strategy of adding material in bulk and allowing hydrodynamics to facilitate dispersion and mixing is innovative and has not been demonstrated on the field scale for open systems such as estuaries. System-wide application of this alternative would require extensive pre-design modeling to determine the implementation strategy. There is the concern that added material might deposit in unintended areas such as in shipping channels and adversely impact navigation.

In addition, permits for this alternative could be difficult to obtain, due to the increased turbidity and particulate load that would result from material addition which could affect biota (e.g., burial of fish eggs). Application of enhanced MNR is discussed further in Section 8.4.1 as a potential smaller-scale strategy for remediation of Orland River sediments. Sediment transport modeling and a pilot test are recommended for assessing the feasibility of this contingent alternative. Sediment transport modeling would be used to identify placement locations and addition rates for clean sediment. A pilot test would include hydrographic surveying and sediment trap measurements following addition of sediment to assess the distribution of the added material. If the results of modeling and pilot testing described above confirm the approach of adding sediment that redistributes to effect a decrease in mercury concentration, enhanced MNR would be implemented in the Orland River.

Recommendation: Enhanced MNR is not recommended system-wide, however, it is a potential adaptive management strategy for the Orland River. Assessing the feasibility of this adaptive management strategy for Orland River would require development of a sediment transport model and pilot testing to confirm material characteristics, material placement locations, material placement rates and a post-placement monitoring approach. These preliminary data would be required for full evaluation of the approach under the evaluation criteria presented in Section 8.1

8.2.3 Alternative 3: Dredging

Alternative 3 is not recommended system wide due to the time required for implementation (a minimum 22-year construction period would be necessary to meet a system-wide PRG of 500 ng/g), destruction to habitat, the potential for increased mercury uptake by biota during and post dredging, and the relatively high cost associated with the alternative. Large-scale dredging to achieve a system-wide PRG of 500 ng/g total mercury in sediment would have a capital cost of $1,713,820,000; dredging to achieve a system-wide PRG of 300 ng/g total mercury in sediment would have a capital cost of $5,544,190,000 assuming off-site disposal. Selective dredging is recommended in areas with higher sediment total mercury concentrations in the Orrington Reach adjacent to and downstream of the former HoltraChem facility, and in surface deposits that represent accumulations of mercury contaminated sediment and wood waste located in Frankfort Flats, Verona East, and Orland River. These partial dredging remedial alternatives are described in Section 8.3.

Recommendation: Dredging is being recommended for select areas of higher mercury concentrations in sediment.

8.2.4 Alternative 5: Amendment Application

Alternative 5 is not recommended based on the current absence of data demonstrating: (1) the long-term effectiveness of amendment application in reducing biota uptake of methyl mercury; and (2) successful field-scale application of amendments for mercury-affected sites. The effectiveness of amendments in both the short and long-term is questionable given the potential need to reapply every few years as well as uncertainty regarding the long-term bioavailability of mercury and methyl mercury associated with (sorbed to) amendments. While data generated in support of the Phase II Study suggest that amendment application can reduce porewater concentrations of total mercury and methyl mercury over a several year period, and toxicity testing conducted during this Phase III Engineering Study indicate that a single application of amendments is unlikely to be toxic to invertebrates at the rate at which it could be applied on a larger scale (i.e., 3 to 5 percent activated carbon addition), this approach requires scaling up and further demonstration of long-term effectiveness in reducing biological update of methyl mercury before its potential effectiveness as a remedial strategy for Mendall Marsh (or the pocket or fringe marshes) can be evaluated.

With respect to the questions regarding (1) comparison of amendment application versus thin layer capping (discussed further below); and (2) integrating amendments into a thin layer cap, considerable uncertainty exists regarding the relative benefit of amendment application. Given that the effectiveness of amendment application is uncertain and may be only a few years, and multiple re-applications would be required, the integrated cost of amendment addition may be potentially much higher than the cost of placing a thin layer cap on marsh platform sediments, even including potential that cap material could require placement via multiple lifts over a period of 2-3 years to facilitate ecological recovery of marsh flora and fauna during remedy implementation. Likewise, whereas the addition of amendments to a thin layer cap could function to either reduce porewater concentrations of methyl mercury within the cap layer and/or allow for placement of a thinner cap, there are currently very limited data for evaluating the effectiveness, relative costs and ecological benefits of this approach.

Recommendation: Amendment additions are not recommended either as a stand-alone remedy or as a component of a thin layer capping remedy for Mendall Marsh or the pocket and fringe marshes in the Estuary.

8.2.5 Alternative 6: Dredging in Intertidal and Subtidal Zones & Thin Layer Capping

Alternative 6 includes dredging in the intertidal and subtidal zones of the Marsh River, combined with thin layer capping on the marsh platform. This alternative is not recommended because the approach of thin layer capping (Alternative 4) would be less invasive to the marsh environment, less costly, and with lower potential for negative impacts to the marsh than dredging in the Marsh

River. Thin layer capping on the Mendall Marsh platform is projected to meet a total mercury PRG of 500 ng/g and mercury concentration in sediments deposited in Mendall Marsh will continue to decrease over time. Remediation of Mendall Marsh through placement of a thin layer cap on the marsh platform to meet the 500 ng/g total mercury PRG is carried forward and discussed in Section 8.3.

Recommendation: Thin layer capping is recommended for a portion of the Mendall Marsh platform. Dredging of the intertidal and subtidal areas in the Marsh River is not a recommended alternative.

8.3 RECOMMENDED REMEDIAL ALTERNATIVES

This section presents alternatives that are carried forward into recommendations for remediation of the Estuary. Recommendations presented in this section are either for alternatives as defined and scoped in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k), such as thin layer capping in Mendall Marsh, or for modified alternatives tailored to specific remedial goals for portions of the system.

The recommendations presented in Section 8.3 contain components of implementation that are standard across alternatives. These components include requirements for long-term monitoring, the establishment and maintenance of institutional controls, and the potential for introduction of adaptive management as a strategy for re-evaluating progress toward system-wide recovery goals. For long-term monitoring, while the details will vary by recommended alternative, monitoring is recommended to evaluate or verify: (1) the continued function of the remedy (such as following placement of a thin layer cap); (2) the rate at which material reaccumulates in an area (such as in an area where a deposit has been dredged); and/or (3) overall progress toward system-wide recovery following implementation of a partial remedy. Because partial remedies are not intended to achieve PRGs of either 500 ng/g or 300 ng/g total mercury in sediment system-wide, long-term monitoring and adaptive management alternatives are intended as components of the strategy for system-wide risk reduction and ecological recovery. Likewise, the implementation of institutional controls, by serving to reduce exposures to human consumers that comply with the controls, are considered a standard component of all recommended remedial alternatives.

8.3.1 Thin Layer Capping in Mendall Marsh

Thin layer capping in Mendall Marsh, listed as Alternative 4 in Section 5.2.3, is a recommended remedial alternative. Implementation of this recommended remedial alternative will require monitoring and institutional controls. As noted in Section 5.2.3 (Alternatives), while the focus of the thin layer capping alternative as presented in this Report is Mendall Marsh, implementation of thin layer caps could be expanded to other marsh areas in the Estuary. Much less study has been completed in these other marshes, so expansion of the consideration of thin layer capping to pocket and fringe marshes in the Estuary would require further evaluation to predict the reduction of surface sediment mercury concentrations. In addition, an evaluation of the reduction in mercury concentrations in impacted biota may be different than Mendall Marsh as the individual marshes may serve only as a fraction their habitat.

This remedial alternative involves broadcasting clean sediment on a portion of the marsh platform to create a 3-inch minimum cap layer. Installation of a thin layer cap would immediately reduce the area weighted average concentrations of total mercury in the biologically active zone to below the 500 ng/g PRG. Sediment from lower elevations of the marsh platform was characterized by higher total mercury concentrations than sediment from higher elevations on the marsh platform (Amec Foster Wheeler 2018k). Accordingly, the thin layer cap would primarily target areas of the marsh platform at and below the 7.5-foot elevation contour (using the NAVD88 datum) (**Figure 8-2**). To achieve the total mercury 500 ng/g PRG for Mendall Marsh, 100 percent of the marsh platform at elevations between 2.0-7.5 feet would be capped, along with 20 percent of the marsh platform at elevations above 7.5 feet NAVD88. The area to be capped under this scenario is approximately 50 percent of the overall marsh platform in Mendall Marsh.

As presented in **Table 5-5**, the bootstrap mean total mercury concentration for the portion of Mendall Marsh at elevations above 7.5 feet NAVD88 is 429.4 ng/g and is already below the 500 ng/g PRG for total mercury. Because the mercury concentration at higher elevations in Mendall Marsh is already below the 500 ng/g PRG for total mercury, uniform thin layer capping covering the higher elevations would not shorten the time to reach the 500 ng/g PRG for the marsh. The lower PRG of 300 ng/g is not considered essential for Mendall Marsh because achieving the 500 ng/g PRG reduces risks to songbirds to near acceptable levels and will assist in lowering tissue concentrations of mercury in black ducks for local consumers.

Thin layer capping is a proven technology and is not anticipated to cause long-term environmental harm. Application of thin layers of sediment to marsh platforms has been more typically applied to address marsh disturbance or marsh platform subsidence resulting from a lack of natural sedimentation (e.g., Slocum et al. 2005; Stagg and Mendelssohn 2011). Thin layer capping is recommended for evaluation here as a strategy for achieving the 500 ng/g PRG for total mercury while limiting the ecological impact of active remedy in the marsh. The thickness of the cap may initially inhibit plant growth or potentially smother some existing plants and biota during the installation process, but it is expected that the marsh platform will revegetate and re-populate within the capped area. The thin layer cap is anticipated to be applied by spreader thereby reducing construction impacts to the habitat and biota. The three-inch cap would be installed with appropriate sloping of the edges of the cap to match the existing grade. This sloping would maintain hydraulic connectivity to the marsh and facilitate maintenance and reestablishment of the biotic community. This method would incur significantly less disturbance than dredging or grading. Because much of the biological community will remain and have connectivity with the water body, the biological community is expected to recover quickly. The placement of a thin layer cap will reduce the recovery time frame for biota that inhabit or feed in Mendall Marsh by maintaining mercury concentrations at or below the 500 ng/g PRG in the biological mixed depth in marsh sediment, as well as providing an upper layer of clean substrate in the capped area and facilitating natural recruitment of local flora and fauna. The timeframe for biota recovery could be as long as five to ten years after installation of the thin layer cap is complete. While capping could potentially be completed as a single application of cap material, it is likely that short-term ecological impacts of cap material placement could be reduced by placing material in two or more lifts over a 2-3 year period. The development of a placement strategy to minimize ecological impacts of cap material placement is a component of the pilot-scale testing described further below.

Based on the potential for recontamination of the cap by transport and deposition of mobile sediment onto the cap surface, the design life of an ecologically functioning thin layer cap in Mendall Marsh is estimated at 30 to 35 years. This design life estimate is based on a minimum proposed cap thickness of 3 inches, an estimated sedimentation rate for the marsh platform of 0.4 cm per year (Amec Foster Wheeler 2018e), an assumption that all cap material stays in place, and a recontamination concentration based on the projected natural attenuation rate of mercury concentrations in mobile sediment over time in the system (**Figure 8-1**, Case I). This estimation also assumes that any upgradient remedial work described in Section 8.3.2 (Partial Dredging Scenarios), including dredging of surface deposits in Frankfort Flats and/or dredging in the Orrington Reach, would be undertaken prior to remedy implementation in Mendall Marsh. Post-placement monitoring will be necessary to identify whether or when material re-application is required to maintain sediment total mercury concentrations across the biological mixed depth either at or below the 500 ng/g PRG. Post-placement monitoring is scoped and priced as a component of long-term monitoring for Mendall Marsh and is included in costing (Section 8.6) and long-term monitoring recommendations (Section 8.7).

Two pilot-scale tests are recommended prior to implementation of this remedy: an initial test to assess potential impacts of cap material placement on vegetation, followed by a larger-scale test (likely in subsequent years) to evaluate the stability of the cap, and to assess the effectiveness of capping to reduce tissue mercury concentrations in biota from within the footprint of the pilot test area. It is expected that the pilot tests would be conducted on the scale of acres and that pilot test plots would encompass a range of marsh elevations and vegetation types. Details regarding the pilot tests, including engineering specifications, material specifications (i.e., sourcing, chemical characteristics and particle size limitations), timing of material placement relative to the growing season on the marsh, pilot study design and success metrics for evaluating ecological effectiveness of the thin layer cap will be developed during the pre-design phase of remedy.

It is recognized that the thin layer capping alternative recommended here is somewhat innovative from the vantage of remediation strategies for mercury-affected sites. Given the ecologically sensitive nature of Mendall Marsh as habitat, additional evaluation of potential environmental impacts from placement of cap material, potential limitations on permitting and requirements for mitigation (if necessary) should be evaluated prior to the inception of pilot testing.

8.3.2 Partial Dredging Scenarios

Dredging in two areas of the Estuary (surface deposits and Orrington Reach) is recommended and described here as partial dredging scenarios. Alternative 3 as described in the Alternatives Evaluation Report is not recommended as it includes larger scale dredging of approximately 3,500,000 cy of material in the Estuary to meet the 500 ng/g PRG for the main and east channels and Orland River or 11,600,000 cy of material to meet the 300 ng/g PRG. The partial dredging scenarios presented here consist of the dredging of subtidal surface deposit layers and the dredging/excavation of intertidal and marsh sediments along the eastern shoreline of the Orrington Reach. The partial dredging scenarios focus on removing approximately 1,200,000 cy of sediment characterized by significantly elevated area weighted average concentrations of total mercury, as well as sediments that are likely to be mobile and/or prone to erosion and redistribution.

For both the surface deposits (Section 8.3.2.1) and the Orrington Reach (8.3.2.2), additional sediment sampling is recommended to improve delineation of the dredge area footprints. Long-term monitoring and institutional controls are recommended as components of both partial dredge scenarios.

Based on recent local sediment projects in the area that have included dredging, excavating and backfilling, and replanting, pilot tests in support of partial dredge remedies are not recommended as necessary. Recent local sediment projects in the area include remedial dredging conducted in Southern Cove as well as dredging of mixed wood waste and sediment in the Union River at Ellsworth, Maine and of the Lawrence Cove Channel in the 1980s. The construction means and methods performed in these local and relevant projects were taken into consideration to support recommendations in this report.

8.3.2.1 Surface Deposit Dredging

Dredging of the surface deposits, included as a component of Alternative 3 (Section 5.2.3), is recommended as a partial dredge scenario. This remedial alternative involves dredging of mineral sediment and wood waste from five distinct accumulation/deposit locations. The locations of these deposits are shown on **Figure 8-3**. These five locations have been recommended for dredging based on: (1) the deposits appearing on the geophysical survey as identifiable targets above bathymetric grade (Amec Foster Wheeler 2018k); and (2) for the three larger of the deposits, consistency of elevated mercury concentrations in cores recovered from within deposit footprints (Amec Foster Wheeler 2018d). These deposits would be mechanically dredged, dewatered, and either beneficially reused or disposed of in a landfill. This alternative involves dredging approximately 950,000 cy of mineral sediment and wood waste that have mercury concentrations that exceed the 500 ng/g total mercury PRG.

As presented in the 2017 Intertidal and Subtidal Sediment Characterization Report (Amec Foster Wheeler 2018d), this volume of mixed mineral sediment and wood waste accounts for approximately 1/3 of the overall volume of mixed mineral sediment and wood waste identified through the geophysical survey, and (for the three larger of the deposits) represents that fraction of the total volume for which there are currently both a geophysical basis and confirmatory sediment mercury cores for recommending removal. While the recommendation for dredging the surface deposits assumes an approximate material volume of 950,000 cy, additional geophysical survey work and confirmatory sampling will be required to improve delineation of these deposits and refine this volume estimate. As example, as noted in **Appendix A**, the surface deposit identified as VE-1 (**Figure 8-3)** may be larger than the footprint presented in **Figure 8-3**. Some portion of the additional material (identified in Appendix A as Deposit VE-1A) may satisfy the criteria for dredging, specifically that the deposit appears above bathymetric grade and is characterized by sediment total mercury concentrations elevated above the PRGs.

As discussed further in Section 8.7 (Long-Term Monitoring), these surface deposits may also represent locations in the Estuary in which sediment and wood waste reaccumulate at a sufficient rate to create natural sediment traps. Post-dredge monitoring for these locations includes both geophysical surveys and targeted sampling to assess the rate of sediment reaccumulation in these locations.

Dredging is a proven remediation technology and is not anticipated to cause long-term environmental harm. It is recognized that system conditions – including current, tidal range, and water depths in the locations of the surface deposits - preclude the use of turbidity curtains or other means of isolation and that: (1) dredging the surface deposit in Frankfort Flats could result in the resuspension of sediment and wood waste that could increase particle transport into Mendall Marsh; and (2) dredging the surface deposits in Verona East and Orland River could result in the resuspension and transport of sediment and wood waste to the outer Estuary and upper Penobscot Bay. To limit the potential for sediment resuspension, transport and short-term ecological exposure, management practices applicable to dredging in New England navigation channels and open waters will include performing in-water dredging during practical environmental windows when fish receptors are reduced or absent, using environmental closed bucket mechanical dredging, controlled bucket cycles, no scow overflow, and limiting bucket loss. If thin layer capping is undertaken in Mendall Marsh, dredging the surface deposit in Frankfort Flats is recommended to be completed prior to cap material placement.

Removal of surface deposits is anticipated to accelerate system recovery and reduce the time required to achieve system-wide PRGs for total mercury by removing discrete deposits of material characterized by mercury concentrations greater than 500 ng/g (**Figure 8-1,** Case IV).

Regarding recovery rates (**Figure 8-1)**, the estimated time required for the system-wide average concentration of total mercury to decrease to the 500 ng/g PRG was calculated using two numerical analyses: (1) recovery rate curves based on a single box model; and (2) apparent half-time to recovery calculations based on the Phase II and Phase III geochronology cores that have been determined in each program (Phase II or Phase III) to be appropriate for apparent half-time to recovery modeling.

Box model recovery curves were estimated based on the current system understanding of the mass of mobile sediment in the Estuary (Case I), as well as conceptual error estimates of the mobile sediment mass assuming 50 percent of the currently estimated mass (Case II) and 200 percent of the currently estimated mass (Case III) (**Figure 8-1**). In **Figure 8-1**, the mass of mobile sediment in the Estuary is estimated as the mass of material identified via the 2017 sub-bottom mapping as Reflector 1 material less than 1 foot thick, plus the mass of material identified as "Surface Deposits – Layers." The fourth scenario (Case IV) presented in the box model represents the change in the estimated system-wide recovery rate if only the approximately 950,000 cy (450,000 tons dry weight) in the five surface deposits (**Figure 8-3**) is removed. To allow evaluation of the relative impact of surface deposit removal on estimated system-wide recovery rates, the recovery curve presented in Case IV assumes the same start time (2017) as the other scenarios evaluated in the box model.

As discussed in Section 3.9.3.2 (Box Models), Amec Foster Wheeler believes that the volume of mobile material recirculating in the Estuary and slowing the rate of system-wide recovery has been previously underestimated. The volume of mobile sediment and wood waste included in Figure 8-1 and defined as Reflector 1 material less than 1 foot thick is approximately 4× the volume of the mobile pool calculated and presented by the Phase II Study Group in simulation of the Estuary recovery rate (Chapter 18; PRMSP 2013). With respect to the volume associated with “Surface Deposits – Layers,” the extent to which this material is mobile on the same time scale as the “recently deposited, light colored unconsolidated mud” that is both well mixed and mobile in the Estuary (i.e., the Phase II mobile pool) is unknown without further sampling/surveying. The inclusion of the Surface Deposit – Layers in the box model presented in Figure 8.1 is based on professional judgement that these accumulations likely contribute material to suspension and redistribution in the Estuary through the erosion and/or the breakdown of wood waste contained in these deposits.

To support the box model baseline condition, core-based geochronology data were used to calculate apparent system-wide half-times to recovery. The core-based geochronology data were evaluated independently for the two data sets: Phase II and Phase III data. For Phase II data, surface sediment total mercury concentrations and apparent half-times to recovery were obtained from Santschi et al. (2017); for Phase III data, surface sediment total mercury concentrations and apparent half-times to recovery were obtained from the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018e).

For each station location for which there were data in the Phase II or Phase III geochronology data set, the surface sediment total mercury concentration and the calculated apparent half-time to recovery under the assumption of an asymptotic recovery concentration of 400 ng/g, were used to calculate the station-specific mercury concentration across three apparent half-times to recovery. Surface sediment total mercury concentrations and associated apparent half-times to recovery were used as presented in the Phase II Report (PRMSP 2013) and the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018e). The choice of 400 ng/g as the recovery concentration used in calculating apparent half-times to recovery in the Phase II Study was based on Phase II assessment of the total mercury concentration likely to be protective of wildlife and human health (PRMSP 2013). Application of the same asymptotic recovery concentration for calculating apparent half-times to recovery for the Phase III data was based on the objective of maintaining consistency between Phase II and Phase III data sets so that a comparative assessment of system recovery in the interval between Phase II and Phase III sampling and analysis could be conducted.

For each station location, after calculating a station-specific mercury concentration across three apparent half-times to recovery, a curve was then fit to the resultant data set. That is, beginning with the surface sediment total mercury concentration and applying the apparent half-time to reach 400 ng/g (as calculated for each station location from the Phase II or Phase III geochronology data sets), the concentration at three apparent half-times toward reaching 400 ng/g was calculated, a curve was fit to the resultant data, and the equation that fit the curve was used to solve for the time required to reach the 500 ng/g PRG. Following this approach, the time to reach the 500 ng/g total mercury PRG was calculated for 29 stations from the Phase II data set and 25 stations from the Phase III data set.

The results of the box model comparison (**Figure 8-1**) suggest that under the assumptions described below, the removal of the five surface deposits would accelerate the time for system-wide recovery to meet the 500 ng/g total mercury PRG from a minimum of 45 years (Case I) to a minimum of 25 years (Case IV). The 45-year interval (Case I) corresponds to the time required for the system-wide mobile sediment mercury concentration to decrease to the PRG of 500 ng/g. This 45-year interval is approximately equivalent to: (1) the median time required to reach 500 ng/g as calculated from the apparent half-time to recovery model applied to relevant Phase III geochronology data; and (2) the 75th percentile time required to reach 500 ng/g as calculated from the apparent half-time recovery model applied to relevant Phase II geochronology data (**Figure 8-1**).

Applying the box model to the calculation of the change in overall system-wide recovery following removal of material in the surface deposits assumes that the surface deposits mix and are mobile on the same time scale as the rest of the mobile sediment in the system. If the surface deposits represent material that accumulates and/or erodes over a timescale that is longer than the mixing time scale of mobile sediment throughout the system, then the gain in the system-wide recovery rate achieved through removal of these deposits would likely be less than the estimated 20 years presented in **Figure 8.1**.

The recommendation for dredging these five surface deposits is based on multiple lines of evidence developed during this Phase III Engineering Study:

- The elevated mercury concentrations in these deposits (more than twice the 500 ng/g PRG throughout much of the deposits) and the potential for on-going erosion of material characterized by elevated concentrations of total mercury, identifies them as locations where remediation could result in the removal of an ongoing source of mercury to the mobile sediment pool.
- The geophysical mapping performed in 2016 and 2017 indicate that Surface Deposits FF-1 and VE-1 were in the same locations between years, suggesting that these deposits would likely be present for future dredging. The remaining three locations presented on **Figure 8-3** were not mapped during the 2016 geophysical survey but were mapped and identified during the system-wide geophysical mapping conducted during 2017.
- Side scan sonar images of Surface Deposits FF-1 and VE-1 collected in 2016 indicate an undulating surface with no large surface debris; sub-bottom profiling of all five surface deposits also indicate an absence of large debris. These two observations taken together indicate that these deposits are good candidates for dredging.
- Sediment cores collected in 2017 from within the footprint of these deposits (Amec Foster Wheeler 2018d and 2018e) confirmed the volume and weight of material in these deposits

and indicated that mercury concentrations are generally elevated above 1,000 ng/g through three feet or more of deposit material.

Amec Foster Wheeler recognizes that sampling density is low within the footprint of these surface deposits, many of which were mapped and cored for the first time in 2017. Further study of these deposits should be completed to better delineate their vertical and horizonal limits for use during design and construction. Dredging of these deposits may also create traps in which mobile sediment can accumulate; post-implementation monitoring will assess the re-accumulation rate of material in these locations. Post-implementation monitoring of remedy effectiveness is included in the Long-term Monitoring Plan recommendations (see Section 8.7).

8.3.2.2 Orrington Intertidal East and Orrington Marsh Platform East Dredging

Dredging of the Orrington Reach is a recommended remedial alternative. This remedial alternative is a partial dredge remedy, considered as a component of Alternative 3, Dredging (see Section 5.2.3).

This remedial alternative involves dredging of the intertidal and marsh zones along the eastern shoreline of the Orrington Reach. Consistent with the assumptions outlined in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k), sediment from this location would be mechanically dredged or excavated, dewatered, and either beneficially reused or disposed of in a landfill. The dredging and excavation footprints would be backfilled with clean material and the marsh area would be restored with plantings. The recommended area to be dredged is the area within the Orrington Intertidal East and Orrington Marsh Platform East zones where sediment total mercury concentrations are above the mercury PRG of 500 ng/g. Areas of the Orrington Intertidal East and Orrington Marsh Platform East zones with mercury concentrations lower than 500 ng/g will not need to be dredged. Additional delineation is necessary within these zones (as well as, potentially, throughout the Orrington Reach) to constrain the dredging and excavation footprints, and to exclude areas with mercury concentrations lower than 500 ng/g (**Figures 8-4 and 8-5**).

Dredging/excavation of the intertidal and marsh sediments is a proven technology, although there may be permitting challenges for tidal marsh excavation, and requirements for mitigation and the restoration of tidal marshes following excavation. However, given the significantly elevated mercury concentrations detected in the Orrington marsh in shallow sediments (up to 73,300 ng/g at a depth of 17-18 cm during the Phase II Study and 108,600 ng/g at a depth of 1 foot during the Phase III Work), excavation of this marsh is recommended to mitigate availability to biota and to prevent the contribution of additional mercury to the estuary should it erode. Following dredging/excavation, the intertidal areas would be backfilled to match existing elevations and the marsh platform would be restored. Removal of sediment from these areas would accelerate overall system recovery by removing sediments characterized by some of the higher total mercury concentrations in the system. The Orrington Reach includes the area adjacent to and directly downstream from the former HoltraChem facility, the original source of mercury to the system.

The recommendation for dredging the intertidal and marsh zones in the Orrington reach is based on multiple lines of evidence developed during this Phase III Engineering Study:

- Sediment mercury concentrations in individual samples are above 1,500 ng/g in several locations in this area, including within and south of Southern Cove along the eastern bank or shoreline of the reach.
- The elevated area weighted average concentrations (presented as bootstrap mean values) for Orrington Marsh (1,877 ng/g) and Orrington Intertidal East (1,208 ng/g) are the two highest area weighted average concentrations in the system (**Tables 5-2 through 5-7**).

As detailed in the Alternatives Evaluation Report and summarized in Section 5.2.2 of this Report, the bootstrap mean values presented for the Orrington Reach exclude those sediment mercury data from within the footprint of the 2017 dredge removal in Southern Cove.

Post-construction monitoring of remedy effectiveness is included in the long-term monitoring recommendations (see Section 8.7)

8.3.2.3 Long-Term Monitoring and Institutional Controls

Long-term monitoring and institutional controls are recommended following implementation of the partial dredge remedies. Long-term monitoring will focus on progress toward achieving the system-wide PRGs. Institutional controls will limit human exposure until biota tissue concentrations decrease to concentrations that allow safe consumption.

The link between PRGs and biota tissue concentrations is summarized in Section 4.3 (Sediment Preliminary Remediation Goals). As noted, the rate at which mercury is methylated is generally related to the concentration of total mercury present in sediment (Cossa et. al. 2014), therefore reductions in sediment total mercury concentrations should result in reduced methyl mercury concentrations and a decreased potential for biological uptake and trophic transfer of methyl mercury. Because the relationship between sediment mercury concentration and mercury methylation rate varies across locations and between environments, however, it is not possible to exactly predict the rate and which ecological recovery following dredging (or otherwise) will occur in the Estuary. Thus, both long-term monitoring in support of ecological recovery and the placement and maintenance of institutional controls are warranted following implementation of partial dredge remedies. Long-term monitoring is discussed in Section 8.7.

Institutional controls will include educational programs, warning signs, consumption advisories, and fishery closures. These controls are recommended because: (1) they can be effective communication tools for consumers of locally caught food sources; and (2) they function as an efficient means to update or maintain existing programs to educate the public on exposure to contaminants via consumption. The current programs will need to be updated to advise on biota consumption limitations to reduce exposure to unacceptable mercury concentrations.

Placement and ongoing maintenance of institutional controls requires coordination with state and local authorities, as well as coordination with regulators who are not parties to the Court proceedings. Review of the institutional controls after implementation of each of the long-term monitoring events is recommended to assess whether the controls should be modified or removed.

8.4 POTENTIAL ADAPTIVE MANAGEMENT ALTERNATIVES

This section describes two remedial alternatives that could be further evaluated through an adaptive management approach. Adaptive management is a strategy for monitoring remedial progress, and then iteratively altering or updating a course of action based on ongoing data collection and analysis. The goal of adaptive management is to improve the overall system-wide remedial outcome while reducing uncertainty in the effectiveness of remedial implementation.

These adaptive management actions depend on the implementation of the recommended remedial alternatives (Section 8.3) and are not intended to be implemented independently or instead of the recommended remedial alternatives. For the alternatives presented below, adaptive management describes an approach to re-evaluating system recovery after implementation of the recommended remedial alternatives.

Specifically, with respect to alternatives targeting the eastern channel and Orland River, adaptive management describes an approach to re-evaluating system recovery potential in a portion of the system in which there is a greater degree of uncertainty that remediation would directly, predictably, and measurably result in system-wide improvements with respect to the three remediation focus areas described above. For Orland River, the adaptive management alternative considered – enhanced MNR through the addition of clean material in bulk and allowing hydrodynamics to facilitate dispersion and mixing – was initially proposed by the Phase II Study Panel for the entire Estuary (PRMSP 2013). The inclusion of this potential remedial alternative for the more hydrodynamically restricted area of Orland River requires further evaluation of the implementation strategy – including numerical modeling and pilot testing of materials, material placement locations and material placement rates – prior to evaluation of whether this alternative would be effective at achieving sediment-based PRGs.

8.4.1 Enhanced Monitored Natural Recovery in the Orland River

Enhanced MNR in the Orland River is an adaptive management alternative to be considered for potential implementation after the recommended remedial alternatives described in Section 8.3.2 (Partial Dredge Scenarios) are completed. This adaptive management alternative is a component of system-wide enhanced MNR presented as Alternative 2 in Section 5.2.3 and consists of the introduction of clean sediment to the system to reduce concentrations of mercury in surface sediments in Orland River through mixing and dilution of the total mercury concentration across the biological mixed depth in the Orland River. For implementation, sediment transport modeling and a pilot test are recommended for assessing the feasibility of this contingent remedial alternative. Sediment transport modeling would be used to identify placement locations and addition rates for clean sediment. A pilot test would include hydrographic surveying and sediment trap measurements following addition of sediment to assess the distribution of the added material. If the results of modeling and pilot testing described above confirm the approach of adding sediment that redistributes to effect a decrease in mercury concentration, enhanced MNR would be implemented in the Orland River.

Enhanced MNR in the Orland River could be considered for implementation if, after dredging of surface deposits in Verona East and Orland River and an interval of at least 10 years of long-term monitoring data, total mercury concentrations in sediment and biota local to the Orland River are not decreasing at a rate sufficient to meet long-term ecological recovery objectives for the Orland River. This statement assumes that the results of pilot testing described above confirm that the approach is feasible for the Orland River. Measures of the recovery rate relative to objectives for the Orland River could be based on either (1) recovery rates calculated from past and present system-wide biota monitoring and/or (2) as a function of Orland River-wide surface sediment monitoring. Specific conditions – defined in terms of either rates of recovery or concentration targets – that would warrant consideration of adaptive management approaches to remediation of the Orland River are included in long-term monitoring (Section 8.7).

Enhanced MNR through the addition of clean sediment to Orland River is a strategy to accelerate the recovery time frame for this portion of the Estuary. The potential effectiveness of this remedial alternative should be evaluated through numerical modeling (to identify clean sediment material characteristics, placement locations, addition rate, etc.) and pilot scale implementation (with monitoring) to determine effectiveness in material placement and dispersal. While enhanced MNR through placement of a thin layer cap or the distribution of thin layer capping material following windrow placement of that material have been shown to be effective remedial strategies for a range of sediment sites (Lampert et al. 2011; Merritt et al. 2011), addition of clean sediment in bulk with the expectation that hydrodynamics and mixing (physical and biological) would drive dispersion is an innovative technique, particularly in open systems such as estuaries. The potential effectiveness of this approach to accelerating ecological recovery in this portion of the Estuary would be determined during and post-implementation by ongoing monitoring of mercury concentrations in sediment and biota.

Enhanced MNR is innovative in estuaries, but the Orland River has lower-energy characteristics similar to locations where capping has been a proven technology and likely represents a reach in this system in which this innovative remedial approach could be tested. With respect to the question of direct placement of a thin layer cap in Orland River, while capping could prove technologically feasible in this reach, the higher degree of uncertainty that exists in determining whether remediation in the Orland River would result in system-wide improvements for the Estuary remains as justification for considering this remediation strategy as an adaptive management alternative for this reach.

It is not anticipated that either the pilot testing or implementation of enhanced MNR in the Orland River would cause significant environmental harm.

Based on preliminary evaluation, it is expected that enhanced MNR of Orland River through addition of clean sediment would require approximately 150,000 cy of clean sediment, assuming the clean sediment disperses evenly over the intertidal and subtidal zones at a uniform depth of 3 inches. A minimum of three material addition events are recommended because a phased approach to application would allow for mapping of deposition zones followed by adaptation of the material addition technique needed. This phased approach to material addition would minimize impacts during implementation by allowing evaluation of potential placement strategies to protect water quality. The actual schedule for implementation would depend on the outcome of the recommended numerical modeling to generate forecasts of clean sediment dispersal rate and extent but is estimated to take approximately three years for implementation. Over the years of implementation, it is anticipated that multiple small piles or layers of clean sediment would be seasonally placed each year for three years.

Post-construction monitoring of remedy effectiveness would be necessary to evaluate sediment dispersion and resulting sediment mercury concentrations throughout the Orland River.

8.4.2 Verona East, Verona Northeast, and Orland River Dredging

Dredging of Verona East, Verona Northeast, and the Orland River is an adaptive management alternative to be considered as a more comprehensive adaptive management approach to the approach described in Section 8.4.1 for Orland River. Similar to the criteria for implementation of the enhanced MNR alternative in the Orland River, the decision regarding whether to implement this alternative would be based on recovery rates for sediment and biota in this area of the Estuary following implementation of the recommended Partial Dredge Scenarios (Section 8.3.2) and at least 10 years of long-term monitoring. Implementation of this adaptive management alternative within the Orland River assumes that the adaptive management option of applying enhanced MNR in the Orland River is not performed. This adaptive management alternative is a component of system-wide dredging presented as Alternative 3 in Section 5.2.3.

Specifically, dredging of the following areas would be considered:

- Verona East intertidal east and west,
- Verona East subtidal main,
- Verona East marsh,
- Verona Northeast intertidal east and west,
- Verona Northeast marsh,
- Orland River intertidal east and west, and
- Orland River marsh.

The locations of these areas are shown on **Figure 8-6**. Bootstrap mean total mercury concentrations for these areas are presented in **Table 5-4.** Dredging of these areas would remove approximately 1,800,000 cy of sediment. In addition to accelerating recovery in Verona East, Verona Northeast, and the Orland River, the removal of sediment from these Reaches characterized by elevated total mercury concentrations would likely result in improved recovery rates in upper Penobscot Bay. Reducing sediment mercury concentrations in upper Penobscot Bay would, in turn, likely result in lower lobster tissue mercury concentrations, although the rate at which ecological recovery would proceed in upper Penobscot Bay is uncertain.

Dredging of the subtidal, intertidal, and marsh sediments is a proven technology, and is not anticipated to cause significant long-term environmental harm. Consistent with the remedial approach described for the Orrington Reach (Section 8.3.2.2) however, ecological and regulatory challenges with marsh excavation, mitigation, and restoration exist. Likewise, as described in Section 8.3.2.1 regarding the dredging of surface deposits, in the short term, dredging is associated with the potential for sediment resuspension, transport, and ecological exposure. In the long-term it is expected that the removal of contaminated sediment will result in improved substrate for aquatic vegetation, benthic invertebrates, and other aquatic biota and will result in higher quality habitat within the remediated area.

8.5 RISK REDUCTION AND RECOVERY TIMES

8.5.1 Institutional Controls

The implementation and/or maintenance of institutional controls will result in long-term risk reduction for local consumers through limiting consumption of biota including American eel, American black duck, and American lobster.

It is anticipated that institutional controls would remain in place until tissue concentrations of these species decrease to concentrations that no longer pose risks to consumers.

8.5.2 Thin Layer Capping in Mendall Marsh

The placement of a thin layer cap on the marsh platform in Mendall Marsh would reduce risk by decreasing the concentration of mercury in the bioactive zone to a concentration below the 500 ng/g total mercury PRG. The lower PRG of 300 ng/g is not considered essential for Mendall Marsh because achieving the 500 ng/g PRG reduces risks to songbirds to near acceptable levels and will assist in lowering tissue concentrations of mercury in black ducks for local consumers. Thin layer capping would result in risk reduction: (1) for consumers from the consumption of American black duck; and (2) for Nelson's sparrow and red-winged blackbird from the consumption of prey species exposed to mercury and methyl mercury on the marsh platform. In contrast to other biota where long-term trends generally show reductions in mercury concentrations (0.2 to 6.5 percent annual decline for most other biota), the blood mercury concentrations in songbirds in Mendall Marsh have shown only marginal decreases (Nelson's sparrow) or increases (red-winged blackbird). Thin layer capping in Mendall Marsh is intended to reduce marsh sediment total mercury concentrations on a habitat scale which will lead to risk reduction for songbirds.

Placement of a thin layer cap would reduce the recovery time frame for species in Mendall Marsh through maintaining mercury concentrations at or below the 500 ng/g PRG over the bioactive zone in marsh sediment. While placement of a clean thin layer cap will result in immediate achievement of the PRG of 500 ng/g for sediment, recovery of biota will take additional time to allow the reductions in sediment concentrations to reach multiple levels of the food chain (including prey species). While the rate at which mercury is methylated is generally related to the concentration of total mercury present in sediment (Cossa et. al. 2014), and reductions in sediment total mercury concentrations should therefore result in reduced methyl mercury concentrations and a decreased potential for biological uptake and trophic transfer of methyl mercury, it is not possible to exactly predict the rate at which ecological recovery will occur following thin layer capping in Mendall Marsh (or elsewhere in the Estuary).

To assess the impact of sediment mercury concentrations on biological uptake, BSAFs were developed for songbirds to evaluate the relationship between songbird blood and sediment mercury concentrations. The relationship was relatively strong between songbirds and sediment (adjusted R^2 of 0.53 and 0.61; Amec Foster Wheeler 2018a). The 500 ng/g PRG is based on this relationship, meaning that if sediment concentrations are reduced to 500 ng/g, then blood concentrations should also decline to a level of acceptable risk for marsh biota. The timeframe for biota recovery could be as much as five to ten years after remediation construction is completed; this time lag allowing for sediment and biota concentrations to reflect the new environmental conditions following disturbance of the system during remediation activities as well as accounting for the range of trophic levels being monitored (i.e., not all monitored species will recover at the same rate because species represent different trophic levels with different exposure pathways).

This timeframe would include any active construction anywhere in the Estuary. As described in Section 8.3.1, it is anticipated that mercury concentrations may increase over time in the cap material as the cap is recontaminated via ongoing transport and deposition of sediment from the mobile sediment pool. Thus, long-term ecological recovery in Mendall Marsh will require long-term monitoring and maintenance of cap stability (including cap thickness) to continue to achieve the 500 ng/g total mercury PRG across the biological mixed depth on the Mendall Marsh platform.

8.5.3 Surface Deposit Dredging

Dredging the surface deposits is expected to contribute to system-wide reduction in sediment mercury concentrations through removal of discrete sediment and wood waste accumulations characterized by mercury concentrations elevated relative to area weighted average concentrations of total mercury throughout much of the Estuary. Based on current estimation of the volume of mobile sediment and wood waste in the system – approximately 2,000,000 tons, of which approximately 25% is in discrete deposits at least 3 feet thick (Amec Foster Wheeler 2018k; **Figure 8-3**) – removal of these deposits is predicted to decrease the system-wide recovery period by 15 – 20 years (**Figure 8-1)**.

8.5.4 Orrington Intertidal East and Marsh Platform East Dredging

Dredging in these areas would contribute to system-wide recovery through removal of sediment with total mercury concentrations currently elevated relative to area weighted average concentrations of total mercury throughout much of the Estuary. While the footprint of the proposed remedial area for this alternative is small on a system-wide basis, source control achieved through dredging this area of elevated total mercury concentrations would reduce local ecological exposure in and near the Orrington Reach (thereby reducing risks for organisms at monitoring stations BO-04 and OB-05 as summarized in Section 6.4.3), and reduce risks associated with the potential erosion and transport of sediment from Orrington Intertidal East and Orrington Marsh Platform East area to downgradient locations in the Estuary. The timeframe for biota recovery could be as much as five to ten years after remediation construction is completed;

this time lag allowing for sediment and biota concentrations to reflect the new environmental conditions following disturbance of the system during remediation activities as well as accounting for the range of trophic levels being monitored (i.e., not all monitored species will recover at the same rate because species represent different trophic levels with different exposure pathways).

8.5.5 Long-Term Monitoring and Institutional Controls

The recommended partial dredging remedies will contribute to system-wide recovery through removal of material characterized by elevated concentrations of total mercury. Because neither partial dredge remedy will meet either the system-wide PRGs of 500 ng/g or 300 ng/g total mercury in sediment, long-term monitoring and institutional controls will be required to achieve long-term risk reduction.

In the event that system-wide recovery does not occur at the projected or predicted rate following partial dredging, adaptive management alternatives could be considered to improve the system-wide recovery rate.

8.5.6 Enhanced Monitored Natural Recovery – Orland River

Following application of the adaptive management approach, implementation of this contingency remedial alternative for the Orland River would result in risk reduction by decreasing the concentration of total mercury over the biological mixed depth in Orland River to a concentration below the 500 ng/g PRG. It is expected that this risk reduction would be achieved by adding clean sediment that would then mix with native sediment. Some level of risk reduction would be achieved for local consumers eating American eel (representing trophic level 4 fish species) and American black ducks from the area of the Orland River.

8.5.7 Verona East, Verona Northeast, and Orland River Dredging

Dredging portions of Verona East, Verona Northeast, and the Orland River would contribute to system-wide recovery through removal of sediment with elevated total mercury concentrations. This adaptive management alternative would result in achieving a PRG of 500 ng/g total mercury in sediment for this portion of the system following dredging. Additional time would be required for mercury concentrations in bird blood and lobster tissue to decrease to acceptable levels because the reductions in sediment concentrations would take time to propagate through multiple levels of the food chain (including prey species and lobsters downstream of the area being dredged). Risk reduction would be achieved for local consumers eating American eel (representing trophic level 4 fish species) and American black ducks.

8.6 COST AND SCHEDULE FOR RECOMMENDED REMEDIAL AND POTENTIAL ADAPTIVE MANAGEMENT ALTERNATIVES

Estimated costs and project schedules for implementation are presented in the following sections. Cost estimates were developed with a target accuracy of plus 50 percent/minus 30 percent.

8.6.1 Thin Layer Capping in Mendall Marsh

The cost and schedule for this remedial alternative were detailed in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) and summarized in Section 5.2; costs developed and presented in the Alternative Evaluation Report are presented in **Table 5-8**. Capital and pilot study costs were estimated at $60,050,000 assuming a single placement of cap material on the marsh platform. It is anticipated that permitting, design, pilot tests, and full-scale construction would require 13 years to complete (up to six years for pilot testing, five years for design and permitting, and two to three years for implementation depending on ultimate material placement rate). It is recommended that any upgradient remedial work, including dredging of surface deposits in Frankfort Flats and/or dredging in the Orrington Reach, be undertaken prior to remedy implementation in Mendall Marsh. It is assumed that shoreside staging in support of thin layer capping would occur in the area of Frankfort Flats or Bucksport.

8.6.2 Surface Deposit Dredging

Cost and schedule estimates were developed for this partial dredge recommendation (**Table 8–2**). Costing assumptions were modified from the Alternative 3 costs developed in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) and summarized in Section 5.2 to reflect the specific footprints, volumes, material characteristics, and locations of the surface deposits based on these considerations:

- As physically characterized by cores collected in 2017 (stations FF-04-01, VE-05-01 and OR-T3-C3), the material is a mixture of mineral sediment and wood waste;
- Debris is limited based on review of side scan sonar (2016) and sub-bottom profiling (2017) surveys; side-scan sonar surveys captured surface deposits VE-01 and FF-01; sub-bottom profiling captured all five surface deposits.
- Two different mechanical dredging equipment fleets will be necessary, based on vessel access restrictions, water depth, current velocity and thickness of the deposits:
    - Four of the surface deposits (FF-01, VE-01, VE-02, and VE-03) are located within subtidal areas where draft restrictions will not limit vessel access or daily production rates. These deposits are suitable for dredging with a 10 cy environmental closed bucket with an anticipated dredging production rate of about 1,400 in-situ cy per 12-hour workday. Costing includes two concurrently operating

mechanical dredges. The volume of material in these deposits is estimated to be approximately 920,000 cy.

  - One of the surface deposits (OR-1) is in a shallow subtidal area where vessel draft and tidal access restrictions will limit daily production rates. This deposit is suitable for dredging with a 3.5 cy environmental closed bucket with an anticipated dredging production rate of approximately 400 in-situ cy per 12-hour workday. Costing includes one shallow draft mechanical dredge. The volume of material in this deposit is estimated to be approximately 37,000 cy.

- The surface deposits will not be backfilled, and a 0.5-foot over-dredge allowance is assumed.
- The volume-to-weight conversion for this material is lower than for typical sediments; the conversion factor used for the surface deposits is 0.78 ton per cy based on the dry weight of the core samples collected from within the deposits.
- One landside processing facility with deep water access would be necessary for this alternative.
- Long-term post-construction monitoring costs were excluded; costs for post-construction monitoring are included in the long-term monitoring program summarized in Section 8.7.
- Costs were developed for two sediment disposal options: beneficial reuse and landfill disposal.
- Other assumptions presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) for Alternative 3 remain unchanged.

As presented in **Table 8-2**, the estimated costs to dredge the surface deposits are:

- For beneficial re-use: $110 per cy for a total of approximately $107,110,000.
- For landfill disposal: $170 per cy for a total of approximately $174,900,000.

It is anticipated that dredging the surface deposits would require seven years for permitting, design, and full-scale construction (three years for design and permitting, and four years for implementation). The extent to which the dredging of surface deposits can be undertaken concurrently with dredging along the eastern shoreline of Orrington Reach will depend on the availability of shoreside space for material offloading and treatment prior to disposal. In this costing evaluation it is assumed (as noted) that one landside processing facility with deep water access would be necessary. The physical location of this processing facility has not been identified as there has not been any communication with landowners about availability of potential shoreside processing areas.

8.6.3 Orrington Intertidal East and Orrington Marsh Platform East Dredging

Cost and schedule estimates were developed for this partial dredge recommendation (**Table 8–2**). Costing assumptions were modified from the Alternative 3 costs developed in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) and summarized in Section 5.2 to reflect the specific footprints, volumes, material characteristics, and locations for the Orrington Intertidal East and Orrington Marsh Platform East areas. Modifications are as follows:

- The intertidal material is largely a sandy silt.
- For the purpose of the cost estimate, quantities associated with the Orrington Reach were reduced by 25 percent to reflect the possibility that some portions of the area may not warrant dredging after additional delineation. A total dredge volume of 215,000 cy was used in the cost estimate.
- Multiple shallow-draft, mechanical dredges would be used based on access requirements, water depths, current velocity, and thickness of materials. Five shallow draft mechanical dredges operating concurrently were included in costing for this recommendation consistent with assumptions in the Alternatives Evaluation Report.
- One land-side processing facility would be necessary for this alternative. It is assumed that this facility would be located on the former HoltraChem property in Orrington.
- Long-term monitoring costs post-construction were excluded; costs for post-construction monitoring are included in the long-term monitoring program (Section 8.7).
- Costs were developed for two sediment disposal options: beneficial reuse or landfill disposal.
- Other assumptions presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) for Alternative 3 remain unchanged.

As presented in **Table 8-2**, the estimated cost range to dredge the Orrington Intertidal East and Orrington Marsh Platform East are:

- For beneficial re-use: $260 per cy for a total of approximately $54,170,000.
- For landfill disposal: $350 per cy for a total of approximately $73,690,000.

It is anticipated that dredging would require five years for permitting, design, and full-scale construction (three years for design and permitting, and two years for implementation). As noted for dredging of surface deposits, the extent to which the two partial dredge recommendations can be undertaken concurrently will depend on the availability of shoreside space for material offloading and treatment prior to disposal.

8.6.4 Long-Term Monitoring

The cost of long-term monitoring is based on costs developed for recommendations presented in Section 8.7 and assuming 45 years of ecological recovery monitoring. Because the recommended institution controls are largely an extension of existing in-place controls by State agencies, costs for maintenance of institutional controls are not anticipated to affect the overall cost of Estuary remediation. For the purpose of this report, there are no capital costs associated with long-term monitoring. As presented in **Table 8-2**, the total estimated cost associated with the recommended long-term monitoring program is $24,590,000.

8.6.5 Enhanced Monitored Natural Recovery in the Orland River (Contingency Remedial Option)

Cost and schedule estimates for enhanced MNR in the Orland River were developed to support recommendations for this report. Costing assumptions were modified from the Alternative 2 costs developed in the alternatives evaluation (Section 5.2) to reflect the footprint, material volumes, material characteristics, and locations in the Orland River. Other assumptions associated with enhanced MNR through material addition are as presented in Sections 7.1.2 and 8.1.2 the Alternatives Evaluation Report (Amec Foster Wheeler 2018k).

Capital costs associated with enhanced MNR in Orland River are estimated to be approximately $15,070,000. It is anticipated that permitting, design, and full-scale construction will require seven years (four years for design and permitting and three years for implementation). During the years for implementation, it is anticipated that multiple small piles or layers would be seasonally placed. This schedule depends on the numerical modeling recommended to assess dispersal rates (and displacement) of clean sediment and pilot testing of the alternative within the Orland River with associated monitoring of material dispersion.

8.6.6 Verona East, Verona Northeast, and Orland River Dredging (Contingency Remedial Option)

Cost and schedule estimates were developed for dredging in Verona East, Verona Northeast, and Orland River to support the recommendations for this report. Costing assumptions were modified from the Alternative 3 costs developed in the alternatives evaluation (Section 5.2) to reflect that for this partial remedy, the dredge and backfill volume associated with Verona East, Verona Northeast and Orland River is approximately 1.8 million cy. All other dredge-related assumptions included in the Alternatives Evaluation Report (Amec Foster Wheeler 2018k) and summarized in Section 5.2 of this report remain unchanged.

As shown in **Table 8-2**, the estimated cost range to dredge the Verona East, Verona Northeast, and Orland River are:

- For beneficial re-use: $280 per cy for a total of approximately $496,640,000.
- For landfill disposal: $370 per cy for a total of approximately $675,900,000.

Dredging in Verona East, Verona Northeast and Orland River is estimated to require 10 dredging seasons (10 calendar years). It is anticipated that dredging would require 13 years for permitting, design, and full-scale construction.

8.7 LONG-TERM MONITORING RECOMMENDATIONS

The long-term monitoring plan recommendations made in the 2017 Sediment and Surface Water Monitoring Report (Amec Foster Wheeler 2018b) require re-evaluation based on the recommendations for remedial alternatives made in the preceding sections of this Phase III Engineering Study Report. Recommendations for a long-term monitoring plan presented herein (Section 8.7) have been developed based on the integrated analysis of all site data and include locations, frequency and rationale for biota, sediment, and surface water monitoring. Further refinement to the recommendations presented below will be developed as a component of remedial pre-design. Amec Foster Wheeler recommends that long-term monitoring begin in the near future and be undertaken every three years until the system-wide PRG of 500 ng/g total mercury in sediment is achieved. The rationale for this monitoring interval is included in the discussion of biota monitoring (Section 8.7.1) and sediment monitoring (Section 8.7.2) below.

The design and implementation of a long-term monitoring program as recommended in the following sections of this report (below) should be approached iteratively. That is, recognizing uncertainties associated with implementation and recovery as determined from sediment-based PRGs in the Estuary, long-term monitoring should follow a course of ongoing data collection and analysis relative to stated system recovery goals. Estimates of system recovery presented in **Figure 8-1** indicate a likely minimum of 45 years (and possibly longer) for the system to recover to meet the total mercury PRG of 500 ng/g in sediments. Thus, long-term monitoring recommendations presented here should be periodically re-evaluated to assess the need for adjustments to the duration of the monitoring program as well as the number and types of samples and/or sampling locations included. Recommendations for long-term monitoring stations for biota, sediment and surface water are presented in **Figure 8-7** for the Estuary and in **Figure 8-8** for reference locations.

Long-term monitoring as presented in this section is distinct from post-implementation monitoring. Post-implementation monitoring is focused on the identification and monitoring of metrics linked to successful implementation of a remedy. Aspects of post-implementation monitoring have been included in the costing presented in **Table 8-2**, although a refinement of the post-implementation monitoring plan should be conducted during design. In general, post-implementation monitoring would be conducted for a period of five years as confirmation that the remedial action successfully achieved the design goals. Long-term monitoring, while linked to successful implementation of recommended remedies, is focused specifically on the long-term achievement of remedial action objectives for the Estuary. This approach to long-term monitoring is therefore focused on analyses and matrices for which evaluation criteria and success metrics can be identified and linked to system recovery. The distinction between post-implementation monitoring and long-term recovery monitoring is discussed further in Section 8.7.2 (Sediment Monitoring).

8.7.1 Biota Monitoring

The addition of 2016 and 2017 biota monitoring data collected during the Phase III Engineering Study provided an update on tissue mercury data for these species/groups analyzed during the Phase II Study. For biota monitoring conducted in 2016 and 2017, Amec Foster Wheeler selected twelve species/groups to represent various trophic levels of terrestrial and aquatic species. Based on Amec Foster Wheeler analysis, mercury concentrations in aquatic biota (lobster, blue mussel, rainbow smelt, eel, tomcod, and mummichog) in the Estuary are generally either decreasing (0.2 to 6.5 percent annual decline) or were stable over the timeframe of 2006 to 2017. Nelson's sparrows are generally either decreasing (0.4 to 0.6 percent annual decline) or stable over time. Blue mussels at two locations and red-winged blackbirds at most locations had increasing mercury concentrations (0.4 to 2.2 percent annual increase). Overall, biota collected in Mendall Marsh and South Verona tended to have higher mercury concentrations than biota collected in other parts of the Estuary.

Long-term monitoring is recommended to continue documenting biota recovery resulting from declining tissue concentrations of mercury in biota. Long-term monitoring recommendations for biota include the following guidelines to continue to reduce variability (uncertainty) in regression model results and to increase interpretability of the statistical trends analysis:

- Standardize sample locations, time of year of collection for each species, and analytical methods;
- Maximize the number of samples;
- Increase multiplicity of efforts to improve biota collection (such as employing multiple types of nets and traps to collect sufficient samples for each species); and
- Focus on co-location of predator and prey tissue samples (to the extent possible), rather than collecting only one type of sample in a specific sampling location.

Figure 8-7 and **Figure 8-8** presents suggested stations for long-term biota monitoring. Stations are coded numerically based on the type of biota proposed at each station. Similar to biota sampling in 2016 and 2017, biota recommended for long-term monitoring include 12 species/groups. These 12 species/groups are divided as: three species for system-wide monitoring (tomcod, smelt, and black ducks); six species for partial-system monitoring (mussels, lobster, American eel, mummichogs, Nelson's sparrows, and red-winged blackbirds); and three groups for additional evaluation of prey species (polychaetes, spiders, and other marsh platform insects). For these groupings, system-wide is defined as able to be sampled across the Estuary salinity gradient, while partial-system is defined as a function of species-specific salinity tolerances or area. Power analyses to determine number of replicate samples required per species for different sampling frequencies are included in **Table 8-3 through Table 8-12**. Power analyses to achieve a statistical power of 0.9 or greater were conducted using a Type I error of 0.05 and an effect size based on the coefficient of determination (R2) from biota temporal trends presented in the 2017 Biota Monitoring Report (Amec Foster Wheeler 2018g). Based on the analyses presented in **Table 8-3 through Table 8-12**, it is recommended that biota sampling for long-term monitoring be conducted every three years and include 20 samples for aquatic biota species; 15 samples for avian species; and five samples for spiders, marsh platform insects, and polychaetes per monitoring event.

Biota monitoring is recommended to continue as described herein. In the event that active remedy is undertaken in the Estuary, it is possible that biota monitoring conducted during the remedial period would reflect transient disturbances to the system that can accompany active remediation work.

8.7.2 Sediment Monitoring

This section provides an overview of recommendations for sediment monitoring in support of Long-Term Monitoring (Section 8.7.2.1) and Post-Implementation Monitoring (8.7.2.2). Long-term monitoring focuses on progress toward achieving the system-wide PRG of 500 ng/g total mercury in sediment. Post-implementation monitoring focuses on the identification and monitoring of metrics linked to successful engineering implementation of a remedy, whether or not that remedy specifically achieves a PRG (either locally or system-wide) in the short term.

8.7.2.1 Long-Term Sediment Monitoring

In 2016 and 2017, Amec Foster Wheeler collected sediment samples across intertidal, subtidal and marsh platform environments to evaluate spatial and temporal trends with respect to Phase II Study data. Analysis of spatial trends suggested that for marsh platforms, total mercury concentrations in surface sediments generally decrease moving from the low marsh to mid marsh to high marsh within each platform sampled. Analysis of temporal trends suggested that: (1)

mercury concentrations over the interval 2006 to 2017 did not decrease consistently either within reaches or across reaches; and (2) trends, overall, were only generally apparent when data were normalized to the organic carbon content of samples.

Based on the general absence of system recovery trends over the interval 2006 to 2017 as determined by loglinear regression of sediment total mercury and methyl mercury data (Amec Foster Wheeler 2018b), the continuation of sediment monitoring on an annual basis is not recommended. Amec Foster Wheeler recommends extending the proposed sediment sampling interval from annual sampling to sampling every three years. This interval for long-term sediment monitoring is consistent with the proposed interval for biota monitoring and is a reasonable recommended baseline sampling interval for the Estuary based on recovery rate estimates (**Figure 8-1**). Recovery rate estimates (**Figure 8-1**) suggest that in the absence of active remediation, it is likely to take a minimum of 45 years to achieve the system-wide PRG of 500 ng/g total mercury in sediment. Stations recommended for long-term sediment monitoring fall into four categories: (1) stations for assessing temporal and/or spatial trends in surface sediment mercury concentrations; (2) stations for monitoring the mobility or mixing of surface deposits; (3) stations for co-locating with biota sampling to facilitate monitoring of changes to species-specific BSAFs; and (4) stations for monitoring long-term trends in system recovery via geochronology (**Figure 8-7**). Details regarding the justification and location of long-term sediment monitoring stations are discussed further below and are summarized in **Table 8-13**.

Overall, the evaluation of stations for long-term sediment monitoring includes consideration of:

- Appropriateness of the location of existing stations, including assessment of low-, mid-, and high-marsh transect stations in portions of the system recommended for remedy;
- Co-location of sediment stations with biota monitoring stations to allow monitoring of changes to station-specific and species-specific BSAFs;
- Identification of stations based on 2016 and 2017 sampling that suggest elevated potential for methylation of mercury in sediment (as identified based on elevated sediment methyl mercury concentrations);
- Identification of stations relevant for assessing whether system-wide recovery post-implementation is achieving sediment-based PRGs within the timeframe in which recovery is predicted to occur;
- Identification of stations in which remediation implementation allows monitoring of the infill or re-accumulation rate of sediment and wood waste with mercury concentrations elevated relative to system-wide average concentrations; and

- Identification of stations relevant for assessing long-term recovery with respect to recovery rates calculated from Phase II and Phase III data.

Based on this evaluation, a total of 60 sediment monitoring stations are proposed, of which 20 are co-located with biota. Sediment sampling stations intended to provide co-location with biota may move relative to their position on **Figure 8-7** and **Figure 8-8** based on where representative associated biota are collected during sampling. That is, for those sediment sampling stations identified as co-located with biota sampling, the specific location in which biota are sampled will dictate the specific location in which the associated sediment is sampled. Sediment sampling to provide co-location with biota would be undertaken as grab sample or short cores. If short cores are collected at biota co-location stations, sectioning of those cores would be as described below for cores associated with system-wide sediment sampling.

In addition to sediment sampling recommended to provide co-located sediment data in support of biota sampling, long-term monitoring of sediment to evaluate progress toward achieving system recovery objectives includes three additional recommended general scenarios of sediment sampling and processing:

- The collection of short cores (1 foot) with cores sectioned into five increments (0 – 0.1 foot; 0.1 – 0.3 foot; 0.3 – 0.5 foot; 0.5 – 0.7 foot; 0.7 – 1.0 foot) for analysis; these cores are associated with system-wide sediment sampling on a three-year interval;

- The collection of long cores (90 centimeters) with cores sectioned for evaluation of recovery rates by geochronology; these cores are associated with a subset of stations for which geochronology is recommended on a nine-year interval;

- The collection of long cores (to refusal) with cores sectioned into 0.5-foot increments; these cores are recommended for sampling within the footprint of the Surface Deposits to evaluate either the physical stability of these deposits (pre-implementation) or the rate at which material re-accumulates in these locations after dredging (if implemented as recommended); sediment sampling of these surface deposits should occur every three years before the dredge remedy is implemented; following dredging of these surface deposits, the timing for collection of cores in these locations would be triggered by the results of the geophysical survey (discussed further below).

For short cores collected as a component of the standard long-term monitoring program, chemical analyses should remain consistent with the analyses presented in the 2017 Sediment and Water Quality Monitoring Report (Amec Foster Wheeler 2018b). Chemical analyses should include total mercury, sediment organic content (either as total organic carbon or organic content), and bulk density in all five depth increments of the core (0–0.1 foot; 0.1–0.3 foot; 0.3–0.5 foot; 0.5 – 0.7

foot; 0.7–1.0 foot) and methyl mercury in the top two depth increments of the core (0–0.1 foot and 0.1–0.3 foot).

For long cores collected in support of evaluating recovery through geochronology, it is recommended that chemical analyses be conducted consistent with analyses presented in the Thin Interval Core Sampling Report (Amec Foster Wheeler, 2018e) and include radiochemistry (^{137}Cs and ^{210}Pb); total mercury, sediment organic content (either as total organic carbon or organic content), bulk density and grain size analysis. As presented in Amec Foster Wheeler (2018e), the sectioning of geochronology cores should be 1-cm increments from 0–20 cm depth in the core; 2-cm increments from 20–40 cm depth; and 5-cm increments from 40–90 cm depth or to the bottom of the core.

For long cores collected in support of evaluating the potential infill rate of areas in which surface deposits are recommended for removal, recommended chemical analysis should include: total mercury, sediment organic content (either as total organic carbon or organic content), and bulk density.

Amec Foster Wheeler recommends that long-term sediment monitoring begin in the near future and be conducted on the same time interval as biota sampling. Long-term sediment monitoring should be conducted consistent with methodologies and protocols developed during the Phase III Engineering Study. Methodologies include analytical methods for total mercury, methyl mercury, and organic content (including total organic carbon) analyses in sediment; protocols include material handling and laboratory preparation procedures for addressing sample heterogeneity (Amec Foster Wheeler 2018i).

8.7.2.2 Post-Implementation Monitoring

As noted in the introduction to Section 8.7, long-term monitoring as presented above is distinct from post-implementation monitoring. Long-term monitoring focuses on progress toward achieving system-wide PRGs of 500 ng/g total mercury in sediment. Post-implementation monitoring focuses on data collection to evaluate whether the remedy was effectively implemented as designed, and whether that remedy specifically achieves the planned local or system-wide PRG in the short term. Aspects of post-implementation monitoring have been included in the costing presented in **Table 8-2**, although it is recommended that a refinement of post-implementation monitoring costs and detailed success metrics be undertaken during design of the remedy.

An overview of post-implementation monitoring recommendations for the remedial alternatives recommended in this report is presented below.

Thin Layer Capping of Mendall Marsh

For Mendall Marsh, post-implementation monitoring would be performed to confirm the physical stability and function of the cap in maintaining depth-integrated total mercury concentrations in the capped area below the 500 ng/g PRG. Post-implementation monitoring of the thin layer cap would be based on the footprint of the area capped and would include stations at a spatial density of one or two stations per 10 acres cap coverage. Confirmation sampling at this spatial density would result in between 24 and 48 monitoring stations within the thin layer cap footprint. For post-implementation monitoring, stations would be monitored annually for five years after cap placement. Post-implementation monitoring would include: (1) visual confirmation sampling of cap material thickness; (2) sampling and chemical analysis to confirm that the total mercury concentration over the biological mixed depth (0–0.5 foot) in samples from within the cap area footprint remains below the 500 ng/g PRG for total mercury in sediment; and (3) sampling in support of ecological recovery of marsh vegetation within the capped area.

Sampling in support of vegetative growth would be undertaken in compliance with USACE and MEDEP permit requirements (USACE 2016; MEDEP 1997) and would follow standard ecological recovery metrics for vegetation surveys associated with marsh restoration (e.g., Konisky et al. 2006; Neckles et al. 2002). At a minimum, vegetation surveys would include composition/abundance/density counts for marsh vegetation within a defined area (commonly a 1 square meter quadrat). Quadrats would be assessed along transects at a sampling density of one transect per linear marsh acre. Spacing between quadrats along individual transects would depend on the width of the capped area (defined by distance from the edge of the marsh platform) and would focus on capturing plant growth through the cap layer across the range of marsh elevations capped. As detailed in Konisky et al (2006), as example, other post-implementation monitoring metrics could be developed for assessing the impact of thin layer cap placement and should be evaluated in the process of developing and implementing the recommended pilot testing for this remedial alternative. Biota sampling of lower trophic level organisms as a component of the recommended pilot-scale testing of the thin layer cap is included in the cost estimate for the recommended pilot test (Table 8-2). The broader (i.e., multiple trophic level) biota sampling recommended as a component of long-term monitoring would be on-going as recommended in discussion of Biota Monitoring (Section 8.7.1).

Surface Deposit Dredging

Post-implementation sampling for the partial remedy focused on dredging the surface deposits would be undertaken to evaluate the rate at which material reaccumulates in these locations after dredging. Post-implementation monitoring would include geophysical surveys and (potentially) confirmation chemistry sampling. The geophysical survey would include a bathymetric survey and sub-bottom profiling within the footprint of the dredged deposit to evaluate the rate at which material reaccumulates within these areas. Geophysical surveying is recommended annually for at least the first three years after dredging and would be followed by confirmation sampling of sediment chemistry if there is evidence of rapid material re-accumulation in these areas. As a specific decision criterion, sediment sampling as a long core (advanced to refusal) would be undertaken at the point that the geophysical survey confirmed that 1 foot or more of material had reaccumulated within the dredge area footprint. It is recommended that following three to five years of post-implementation surveying and sampling (if the decision criterion is met), sampling in these locations would transition back to the three-year interval recommended for the long-term sediment monitoring program. Long-term monitoring of these locations would continue to focus on the thickness and chemical signature (i.e., total mercury and organic content) of material re-accumulating in these locations. Sampling within the footprint of the surface deposits includes eight sampling stations.

Orrington Intertidal East and Orrington Marsh Platform East Dredging

Post-implementation monitoring for this partial remedy would be performed to: (1) confirm that surface sediment concentrations within the dredge/backfill footprint are below the 500 ng/g PRG for total mercury in sediment; and (2) monitor the restoration of Orrington marsh platform east. For the intertidal portion of the remedy, sediment sampling is recommended on a spatial density of one or two stations per 10 acres dredged. Sediment sampling at this spatial density would correspond to between 13 and 26 sampling stations. Sampling in these locations would occur annually for the first five years after remedy implementation and would include short cores to confirm that the total mercury concentration over the biological mixed depth (0–0.5 foot) in samples from within the dredge and backfill footprint remain below the 500 ng/g PRG for total mercury in sediment.

Post-implementation monitoring for the Orrington marsh platform east would include monitoring of sediment chemistry as well as ecological recovery for the restored marsh platform. Sediment sampling would occur at a spatial density of one to two stations per 10 acres of marsh platform. At this spatial density, sampling would include 5 to 10 sampling stations. Sampling in support of recovery of the marsh platform would be undertaken in compliance with USACE and MEDEP permit requirements (USACE 2016; MEDEP 1997) and would follow standard ecological recovery metrics for marsh restoration (e.g., Konisky et al. 2006; Neckles et al. 2002). At minimum, monitoring would focus on marsh regrowth as defined for Mendall Marsh. Identification of specific additional marsh platform metrics and decision criteria for evaluation of successful marsh platform restoration would be developed during design.

Potential Adaptive Management Alternatives

Development of post-implementation monitoring plans for the adaptive management alternatives presented in Section 8.4 is recommended as a component of the pilot test and/or design of these alternatives. As presented in Section 8.4, it is recommended that approximately 10 years of long-term monitoring data (biota, sediment and surface water) be collected following implementation of the partial dredge remedies to evaluate whether total mercury concentrations in sediment and biota are decreasing at a rate sufficient to meet long-term ecological recovery objectives in the east channel and/or Orland River without the requirement for dredging and/or enhanced MNR in this portion of the system. Based on this time frame, and consistent with the application of the adaptive management approach, specific post-implementation monitoring protocols for the east channel and/or Orland River are not presented here. As shown on **Figure 8–7**, the selection of recommended long-term monitoring stations for the Estuary includes multiple stations in this portion of the system to provide a robust dataset for evaluation of progress toward meeting the PRGs for total mercury in sediment in these reaches.

8.7.3 Surface Water Monitoring

Surface water monitoring should remain as a component of the long-term monitoring plan to provide an ongoing dataset for this component of the Estuary ecosystem, although no significant mercury-related trends have been observed in either the Phase II or Phase III surface water monitoring programs. As detailed in the 2016 Sediment and Surface Water Monitoring Report (Amec Foster Wheeler 2017a), mercury concentrations in surface water showed no statistically significant trends over time from 2006 to 2016 within the Estuary; likewise, no significant trends were observed in mercury concentrations over the period from 2006 to 2017 in surface water or on particles coming into the Estuary from upgradient sources (Amec Foster Wheeler 2018b). Although no significant temporal trends have been observed between Phase II and Phase III data, long-term monitoring should continue to include surface water sampling because surface water remains an exposure route for aquatic species and provides an input term for system flux modeling. It is recommended that surface water monitoring be conducted on the same three-year interval as biota and sediment sampling; that sampling should continue at the stations sampled in 2016 (**Figure 8-7** and **Figure 8-8**); and that sampling begin (or continue) in the near future. Surface water sampling should include total mercury (dissolved, particulate, and unfiltered), dissolved organic carbon, and total suspended solids, as well as standard water quality parameters that may be required for exposure modeling (e.g., salinity, pH, temperature, conductivity, and dissolved oxygen concentration).

8.8 COMMUNICATION AND COMMUNITY INVOLVEMENT RECOMMENDATIONS

As part of the Phase III Engineering Study, a CCIP was prepared to:

- Build awareness and educate stakeholders about the Phase III Engineering Study, challenges, proposed alternatives, and selected evaluation criteria;

- Solicit feedback on stakeholders' interest in the project; and
- Solicit feedback about the Phase III Engineering Study, proposed alternatives, and evaluation criteria.

The CCIP was not part of direction provided by the Court; however, Amec Foster Wheeler identified the need and value of an involvement process in the consideration of remedial alternatives and future implementation of selected remedial alternatives. A defined stakeholder involvement process supports projects through the sharing of relevant, accessible information, providing opportunities for input and establishing clear expectations on how that input will be considered, therefore enabling stakeholders to see their voice in the process while avoiding stakeholder fatigue. Regular, meaningful engagement with stakeholders is valuable because it creates open lines of communication, develops trust, and maintains transparency.

Amec Foster Wheeler identified five stages to guide and give structure to engagement activities as they relate to each of the predicted project milestones:

- Stage One – Pre-Planning and Relationship Building;
- Stage Two – Information Sharing and Transparency;
- Stage Three – Alternatives Information, Transparency, and Court Deliberation;
- Stage Four – Court Decision; and
- Stage Five – Implementation of Court Decision.

Stage One and Stage Two activities were undertaken during the Phase III Engineering Study.

8.8.1 Stage Three – Alternatives Evaluation and Court Deliberations Recommendations

CCIP Stage Three should be initiated when the final Phase III Engineering Study is submitted, the Parties review and present their views on the recommendations to the Court, and the Court begins its deliberations. The intent of this stage is to:

- Provide clear, plain-language information to stakeholders about each of the remedial alternatives;
- Provide opportunities for stakeholders to provide feedback on the remedial alternatives; and
- Set clear expectations for stakeholder involvement during Court deliberations.

During this stage, it is important to continue to provide and deliver information to stakeholders in ways that maximize understanding and accessibility. Public presentations, fact sheets, a web site, an interactive kiosk, and email updates are some of the tools and activities that can be used to help advance the goals of this stage as described in the Communications and Community Involvement Plan (Amec Foster Wheeler 2018n).

8.8.2 Stage Four – Court Decision Recommendations

Stage Four will begin when the Court reaches a decision on the recommended remedial alternatives. The intent of this stage is to maintain transparency and inform stakeholders about the Court's decision in a timely and effective manner. The Future Consulting Team would be responsible to select tools and activities that advance the goals and principles of the CCIP.

8.8.3 Stage Five – Implementation of Court Decision Recommendations

Stage Five will coincide with the implementation of the Court decision regarding remedial action(s) to address the mercury impacts to the Estuary. Regardless of the remedial action(s) the Court chooses to apply, some degree of communication and community involvement is warranted throughout the implementation stage. There are significant opportunities during this stage to include stakeholders as participants and advocates in the implementation of the Court decision. However, the level of stakeholder involvement that is feasible and appropriate during this stage cannot be determined until:

- The determined remedial action(s) have been selected and released to the public;
- Information is available about how and when the remedial actions will be implemented;
- Stakeholder groups most likely to be affected and the degree of impact are identified; and
- A decision is made about who will be implementing the remedial action activities.

Based on the remedial alternatives recommended in the Phase III Engineering Study and Amec Foster Wheeler understanding of the current stakeholder environment, the following tools and activities are suggested for consideration in the detailed planning of Stage Five:

- Provide continual website maintenance and updating.
- Consider meeting with the following:
  - General-public individuals or groups, or specific groups;
  - Penobscot Indian Nation Tribal Council and representatives;
  - Lobstermen and crab fishermen; and
  - Youth, to provide education and knowledge building.
- Provide opportunity to organize community liaison panels.

Amec Foster Wheeler acknowledges that detailed planning will not occur until the Court Decision is released.

8.8.4 Roles and Responsibilities

Amec Foster Wheeler developed the CCIP and facilitated Stage One and Stage Two engagement activities. Following submission and acceptance of the final Phase III Engineering Study Report, the Court will be responsible for deciding how to implement the CCIP and carry engagement activities forward. Amec Foster Wheeler recommends that the mechanism to advance the CCIP through Stages Three to Five should be developed to allow community involvement to continue.

9.0 REFERENCES

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TABLES

TABLE 3-1

EVALUATION OF SEDIMENT STABILITY AND MIXING DEPTH
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Sediment Type	Evaluation Method	System Depth Average (feet)	Total Mercury	
			Average Mercury Concentration (ng/g)	**Standard Deviation (ng/g)**
Unconsolidated Sediments[1]	SedFlume Erosional Depth[2]	0.4	794	289
	Average Depth of Erosional Rivulets[3]			
	Ruler Resistance Depth "Intact Sediment Surface"			
	Interval Participation Weighted Concentration	0.3	728	288
Consolidated	Mixed Sediments - Mercury Based[4]	0.7	787	408
	Mixed Sediments - Modeled Geochronology (Original)[5,6]	1.0	629	560
		0.4	868	318
Surface Deposits[3]	Layer Thickness[7]	2.9	1,330	338
	Trap Thickness[8]	1.2	924	345
	Trench Thickness[9]	1.3	934	214
	All Surface Deposits	1.8	1,175	367

Notes:

1. Sediments above the intact sediment surface.
2. SEDflume erosional depths were determined from the US Army Corps of Engineers report found in Appendix D of the Alternatives Evaluation Report (Amec Foster Wheeler, 2018b).
3. 2017 Mobile Sediment Characterization Report (Amec Foster Wheeler 2018d).
4. 2017 Intertidal and Subtidal Sediment Characterization Report (Amec Foster Wheeler 2018e) and the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018f).
5. Corresponds with Table 1 presented in *Appendix C of the Thin Interval Core Sampling Report (Amec Foster Wheeler 2018f).*
6. Modeled geochronology data adjusted to reflect total mercury profile and lithology.
7. Layer = Uniformly mixed deposit extending above grade compared to the river bottom.
8. Trap = Partially exposed deposit in topographic depression of the river bottom.
9. Trench = Partially exposed deposit, but laterally confined and extending below grade compared to river bottom.

Abbreviations:

ng/g = nanograms per gram

Prepared By: BPW 3/22/2018
Checked By: DY 3/22/2018

TABLE 3-2

MERCURY AND METHYL MERCURY SURFACE WATER DATA BY REACH

Phase III Engineering Study Report

Penobscot River Estuary, Maine

		Mercury			Methyl Mercury		
Reach	**Dates[1]**	**Result Range (ng/L)**	**Average[2] Result**	**Number of Hits/Total Results**	**Result Range (ng/L)**	**Average Result**	**Number of Hits/Total Results**
Bangor	2016	0.96 - 2.18	1.61	3/6	0.078 - 0.205	0.13	5/6
Bangor	2017	2.94 - 4.93	3.82	9/9	0.074 - 0.101	0.09	6/9
Orrington	2016	1.99 - 37.2	11.3	6/6	0.12 - 0.617	0.28	6/6
Winterport	2016	3.31 - 34.9	11.2	6/6	0.062 - 0.423	0.22	5/6
Frankfort Flats	Historic	NA	NA	NA	NA	NA	NA
Mendall Marsh	Historic	NA	NA	NA	NA	NA	NA
Bucksport	2016	2.5 - 8.05	4.65	6/8	0.029 - 0.132	0.08	5/6
Verona Northeast	2016	0.32 - 0.32	0.32	1/3	NA	NA	0/0
Orland River	2016	ND	ND	0/2	NA	NA	0/0
Verona East	2016	2.3 - 9.14	5.33	6/7	0.036 - 0.155	0.10	4/6
Verona West	2016	1.72 - 21	7.76	5/6	0.043 - 0.345	0.20	3/6
Fort Point Cove	Historic	NA	NA	NA	NA	NA	NA
Upper Penobscot Bay	2016	1.44 - 1.87	1.65	5/6	0.035 - 0.04	0.04	2/6

Notes:

1. 2016 data from Amec Foster Wheeler (2017a); 2017 data from Amec Foster Wheeler (2018c); historic data are pre-Phase III (no current data are available for these reaches).
2. Average as mean values calculated from detects.

Prepared by: ESS 3/1/18
Checked by: CP 3/7/18

Abbreviations:

NA = no data available
ND = non detect
ng/L = nanograms per liter

TABLE 3-3

HISTORICAL MERCURY AND METHYL MERCURY SEDIMENT DATA BY REACH

Phase III Engineering Study Report

Penobscot River Estuary, Maine

Reach	Dates	Sample Depth[1]	Mercury			Methyl Mercury		
			Result Range (ng/g)	Average[2] Result	Number of Results	Result Range (ng/g)	Average[2] Result	Number of Results
Bangor	Historical	Surface	0.04 - 2700	545	625	0.0007 - 5.29	1.15	75
		Subsurface	0.21 - 4260	602	332	0.00088 - 0.00639	-	11
Orrington	Historical	Surface	0.01 - 12500	1100	521	0.00024 - 58.5	6.45	80
		Subsurface	0.025 - 73300	2100	221	0.00006 - 0.0437	0.01	21
Winterport	Historical	Surface	62.3 - 1840	720	70	3.91 - 3.91	3.91	1
		Subsurface	22.4 - 1580	508	50	-	-	-
Frankfort Flats	Historical	Surface	0.13 - 2670	676	266	0.00121 - 61.5	13.6	45
		Subsurface	2.86 - 1100	53.9	98	-	-	-
Mendall Marsh	Historical	Surface	10 - 3200	695	597	1.12 - 98.4	24.7	261
		Subsurface	13.9 - 6310	950	334	-	-	-
Bucksport	Historical	Surface	104 - 1340	663	16	-	-	-
Bucksport Thalweg	Historical	Surface	16.3 - 1750	849	9	-	-	-
Bucksport Harbor	Historical	Surface	361 - 782	645	16	-	-	-
		Subsurface	49.1 - 8810	784	25	-	-	-
Verona Northeast	Historical	Surface	57.6 - 3150	937	221	3.02 - 27.7	10.5	16
		Subsurface	13.7 - 3390	867	65	-	-	-
Orland River	Historical	Surface	39 - 2640	1082	195	0.19 - 19.6	7.15	13
		Subsurface	10.8 - 4650	679	155	-	-	-
Verona East	Historical	Surface	18.6 - 2310	663	134	1.54 - 18.9	8.14	21
		Subsurface	5.42 - 4510	720	50	-	-	-
Verona West	Historical	Surface	0.23 - 3470	637	81	0.00459 - 2.61	0.66	4
		Subsurface	5.74 - 4240	567	75	-	-	-
Fort Point Cove	Historical	Surface	0.09 - 2090	630	160	0.00169 - 31.7	8.17	20
		Subsurface	16.2 - 2710	803	110	-	-	-
Upper Penobscot Bay	Historical	Surface	14.7 - 1860	368	164	0.015 - 16.1	4.92	19
		Subsurface	3.77 - 1380	251	46	-	-	-
Cape Jellison	Historical	Surface	12.3 - 934	510	48	-	-	-
		Subsurface	4.53 - 959	253	75	-	-	-

1. Surface depth is 0–0.5 foot; Subsurface depth is deeper than 0.5 foot.
2. Average as mean values.

Prepared by: ESS 3/1/18
Checked by: CP 3/7/18

Abbreviations:

- = no data available
ng/g = nanogrmas per gram

TABLE 3-4

PHASE III MERCURY AND METHYL MERCURY SEDIMENT DATA BY REACH

Phase III Engineering Study Report

Penobscot River Estuary, Maine

Reach	Dates	Sample Depth[1]	Mercury			Methyl Mercury		
			Result Range (ng/g)	Average[2] Result	Number of Results	Result Range (ng/g)	Average[2] Result	Number of Results
Veazie	Phase III	Surface	11.4 - 109	43.8	11	0.02 - 3.68	1.34	9
		Subsurface	15.1 - 15.1	15.1	1	-	-	-
Bangor	Phase III	Surface	1.4 - 1793	523	40	1.08 - 31.7	8.03	8
		Subsurface	1.71 - 3270	624	41	-	-	-
Orrington	Phase III	Surface	10.5 - 100200	2700	128	0.232 - 37.4	9.22	32
		Subsurface	7.46 - 2880	780	122	-	-	-
Winterport	Phase III	Surface	33.2 - 1150	690	34	1.1 - 37.5	15.2	19
		Subsurface	13.5 - 3770	741	22	-	-	-
Frankfort Flats	Phase III	Surface	14.7 - 3480	569	100	2.2 - 50.7	13.9	30
		Subsurface	8.1 - 3890	265	128	-	-	-
Mendall Marsh	Phase III	Surface	4.64 - 3820	645	674	0.067 - 51.8	9.33	109
		Subsurface	1.97 - 5570	572	827	-	-	-
Bucksport	Phase III	Surface	82 - 3590	837	44	2.7 - 16	8.37	5
		Subsurface	15.7 - 2870	838	56	-	-	-
Bucksport Thalweg	Phase III	Surface	539 - 706	600	3	3.4 - 4	3.70	2
		Subsurface	478 - 478	478	1	-	-	-
Bucksport Harbor	Phase III	Surface	134 - 806	474	8	15.6 - 21.1	18.4	2
		Subsurface	338 - 1820	781	11	-	-	-
Verona Northeast	Phase III	Surface	0.08 - 2380	797	114	1.4 - 55.8	11.3	30
		Subsurface	13.8 - 2570	525	168	-	-	-
Orland River	Phase III	Surface	20.2 - 2310	851	327	1.9 - 30.6	10.9	30
		Subsurface	12.4 - 5260	886	441	-	-	-
Verona East	Phase III	Surface	51.2 - 1620	605	65	1.11 - 39.5	12.0	25
		Subsurface	4.43 - 1850	587	71	-	-	-
Verona West	Phase III	Surface	33.5 - 1140	330	31	0.533 - 14.5	4.27	16
		Subsurface	9.68 - 813	98.1	30	-	-	-
Fort Point Cove	Phase III	Surface	1.42 - 1620	684	64	0.7 - 12.3	3.56	11
		Subsurface	9.76 - 1200	343	83	-	-	-
Upper Penobscot Bay	Phase III	Surface	129 - 935	523	49	2.3 - 9.38	6.22	6
		Subsurface	10.1 - 3190	696	73	-	-	-
Cape Jellison	Phase III	Surface	27.2 - 765	433	14	0.244 - 13.2	3.24	14

Prepared by: ESS 3/1/18
Checked by: CP 3/7/18

Notes:
1. Surface depth is 0–0.5 foot; Subsurface depth is deeper than 0.5 foot.
2. Average as mean values.

Abbreviations:
- = no data available
ng/g = nanogrmas per gram

TABLE 5-1

SUMMARY OF REMEDIAL ALTERNATIVES
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Alternative	Remedial Technology Components				Hydrodynamic Zone			
	Institutional Controls[1]	Place Clean Sediment[2]	Remove Sediment[3]	Apply Amendments[4]	Marsh	Intertidal	Subtidal	Thalweg/Main Channel
1.Monitored Natural Recovery	✓	--	--	--	✓	✓	✓	✓
2.Enhanced Monitored Natural Recovery	✓	✓	--	--	✓	✓	✓	✓
3.Dredging	✓	✓	✓	--	✓	✓	✓	✓
4.Thin Layer Capping	✓	✓	--	--	✓	--	--	--
5.Amendment Application	✓	--	--	✓	✓	--	--	--
6.Dredging in Intertidal and Subtidal Zones & Thin Layer Capping	✓	✓	✓	--	✓	✓	✓	✓

Notes:

1. Institutional controls consist of the following:
   - Monitor sediment & biota concentrations/trends
   - Enact or maintain species-specific fishing/consumption advisories and bans
   - Conduct public outreach/education programs
2. Place clean sediment consists of the following:
   - Procure clean sediments
   - Apply clean sediments
3. Remove sediment consists of the following:
   - Dredge sediments
   - Replace with clean sediment
   - Dewater sediments
   - Reuse or dispose of sediments off-site
4. Apply amendments consists of the following:
   - Procure amendments
   - Apply amendments

Abbreviations:

-- = not applicable

Prepared by: BPW 3/20/18
Checked by: KAM 3/26/18

TABLE 5-2

REMEDIAL AREA AND VOLUME CALCULATION FOR 500 ng/g PRG – MAIN CHANNEL
Phase III Engineering Study Report
Penobscot River Estuary, Maine

	Pre-Remedy	Post-Remedy
Total Area (sf)	417,646,688	417,646,688
Area Weighted Average Concentration (ng/g)	586.5	496.4
Remediation Area (sf)	NA	45,270,470
Remediation Volume @ 0.5 foot depth plus 0.5 foot overdredge (cy)	NA	1,676,684

	Remediation Area/Volume
Area (sf) intertidal/marsh	31,982,485
Area (sf) subtidal	0
Volume (cy) intertidal/marsh	1,676,684
Volume (cy) subtidal	0
Area (sf) marsh restoration	13,287,985

Reach	Ribbon_classification	ZONE	N-Value[1]	Shape Area (sf)	Pre-Remedy BOOTMEAN[2] (ng/g)	PRG 500 BOOTMEAN POST REMEDY (ng/g)	PRG 500 Remediation Area[3]
Bucksport Main	Bucksport_Main_Int_W	Intertidal	3	1,951,631	885.5	180.0	x
Frankfort Flats	Frankfort Flats_Main_Int_E	Intertidal	7	6,343,948	1,046.5	180.0	x
Frankfort Flats	Frankfort Flats_Main_Int_W	Intertidal	10	4,602,034	732.2	180.0	x
Frankfort Flats	Frankfort Flats_Marsh	Marsh	18	4,019,444	855.5	180.0	x
Orrington	Orrington_Main_Int_E	Intertidal	42	5,653,943	1,208.5	180.0	x
Orrington	Orrington_Main_Int_W	Intertidal	10	4,857,852	978.6	180.0	x
Orrington	Orrington_Marsh	Marsh	21	4,103,967	1,877.2	180.0	x
Winterport	Winterport_Main_Int_E	Intertidal	1	2,871,876	856.6	180.0	x
Winterport	Winterport_Main_Int_W	Intertidal	12	5,701,202	747.0	180.0	x
Winterport	Winterport_Marsh	Marsh	9	5,164,574	884.6	180.0	x
Bangor	Bangor_Main_Int_E	Intertidal	13	1,842,352	288.9	288.9	
Bangor	Bangor_Main_Int_W	Intertidal	13	2,241,045	489.4	489.4	
Bangor	Bangor_Main_Main	Subtidal	5	12,218,249	566.6	566.6	
Bangor	Bangor_Main_Sub_E	Subtidal	6	3,063,527	546.4	546.4	
Bangor	Bangor_Main_Sub_W	Subtidal	6	2,210,677	681.1	681.1	
Bangor	Bangor_Marsh	Marsh	4	3,133,390	183.7	183.7	
Bucksport Main	Bucksport_Main_Int_E	Intertidal	4	1,089,903	464.3	464.3	
Bucksport Main	Bucksport_Main_Main	Subtidal	11	8,393,990	769.6	769.6	
Bucksport Main	Bucksport_Main_Sub_E	Subtidal	2	3,369,202	852.0	852.0	
Bucksport Main	Bucksport_Main_Sub_W	Subtidal	20	13,463,520	826.2	826.2	
Bucksport Thalweg	Bucksport Thalweg_Int_E	Intertidal	NA	195,574	464.3	464.3	
Bucksport Thalweg	Bucksport Thalweg_Int_W	Intertidal	NA	50,905	885.5	885.0	
Bucksport Thalweg	Bucksport Thalweg_Main_Main	Subtidal	7	2,662,612	908.2	908.2	
Bucksport Thalweg	Bucksport Thalweg_Main_Sub_E	Subtidal	1	456,684	669.0	669.0	
Bucksport Thalweg	Bucksport Thalweg_Main_Sub_W	Subtidal	2	362,900	604.5	604.5	
Fort Point Cove	Fort Point Cove_Main_Int_W	Intertidal	8	6,097,823	155.8	155.8	
Fort Point Cove	Fort Point Cove_Main_Sub_W	Subtidal	27	46,332,364	712.0	712.0	
Fort Point Cove	Fort Point Cove_Marsh	Marsh	3	1,882,852	34.6	34.6	
Frankfort Flats	Frankfort Flats_Main_Main	Subtidal	9	11,330,591	358.5	358.5	
Frankfort Flats	Frankfort Flats_Main_Sub_E	Subtidal	27	25,918,954	361.1	361.1	
Frankfort Flats	Frankfort Flats_Main_Sub_W	Subtidal	22	9,956,488	597.3	597.3	
Orrington	Orrington_Main_Main	Subtidal	20	10,401,016	582.7	582.7	
Orrington	Orrington_Main_Sub_E	Subtidal	26	9,076,556	819.2	819.2	
Orrington	Orrington_Main_Sub_W	Subtidal	8	5,647,649	648.5	648.5	
Upper Penobscot	Upper Penobscot Bay_Main_Int_E	Intertidal	2	5,631,795	56.6	56.6	
Upper Penobscot	Upper Penobscot Bay_Main_Sub	Subtidal	25	121,726,846	478.6	478.6	
Upper Penobscot	Upper Penobscot Bay_Marsh	Marsh	1	1,786,058	19.3	19.3	
Verona West	Verona West_Main_Int_E	Intertidal	1	2,354,275	92.2	92.2	
Verona West	Verona West_Main_Int_W	Intertidal	NA	1,325,312	92.2	92.2	
Verona West	Verona West_Main_Main	Subtidal	11	5,822,655	473.6	473.6	
Verona West	Verona West_Main_Sub_E	Subtidal	12	13,564,329	806.4	806.4	
Verona West	Verona West_Main_Sub_W	Subtidal	11	17,071,629	505.0	505.0	
Verona West	Verona West_Marsh	Marsh	2	2,161,307	220.5	220.5	
Winterport	Winterport_Main_Main	Subtidal	15	13,205,976	569.1	569.1	
Winterport	Winterport_Main_Sub_E	Subtidal	3	4,300,253	332.6	332.6	
Winterport	Winterport_Main_Sub_W	Subtidal	2	2,026,960	801.4	801.4	

Notes:

1. N-Value is the number of samples in that specific reach/zone
2. Error estimates for BOOTMEAN values presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b)
3. x = area targeted for remedy to meet PRG

Prepared By: ESS 3/1/18
Checked By: KC 3/7/18

Abbreviations:

cy = cubic yard
NA = not applicable
ng/g = nanograms per gram
PRG = preliminary remediation goal
sf = square foot

TABLE 5-3

REMEDIAL AREA AND VOLUME CALCULATION FOR 300 ng/g PRG – MAIN CHANNEL
Phase III Engineering Study Report
Penobscot River Estuary, Maine

	Pre-Remedy	Post-Remedy
Total Area (sf)	417,646,688	417,646,688
Area Weighted Average Concentration (ng/g)	586.5	267.8
Remediation Area (sf)	NA	263,686,448
Remediation Volume @ 0.5 foot depth plus 0.5 foot overdredge (cy)	NA	9,766,165

	Remediation Area/Volume
Area (sf) intertidal/marsh	48,652,322
Area (sf) subtidal	215,034,125
Volume (cy) intertidal/marsh	1,801,938
Volume (cy) subtidal	7,964,227
Area (sf) marsh restoration	13,287,985

Reach	Ribbon_classification	ZONE	N-Value[1]	Shape Area (sf)	Pre-Remedy BOOTMEAN[2] (ng/g)	PRG 300 BOOTMEAN POST REMEDY (ng/g)	PRG 300 Remediation Area[3]
Bangor	Bangor_Main_Int_W	Intertidal	13	2,241,045	489.4	180.0	x
Bangor	Bangor_Main_Main	Subtidal	5	12,218,249	566.6	180.0	x
Bangor	Bangor_Main_Sub_E	Subtidal	6	3,063,527	546.4	180.0	x
Bangor	Bangor_Main_Sub_W	Subtidal	6	2,210,677	681.1	180.0	x
Bucksport Main	Bucksport_Main_Int_E	Intertidal	4	1,089,903	464.3	180.0	x
Bucksport Main	Bucksport_Main_Int_W	Intertidal	3	1,951,631	885.5	180.0	x
Bucksport Main	Bucksport_Main_Main	Subtidal	11	8,393,990	769.6	180.0	x
Bucksport Main	Bucksport_Main_Sub_E	Subtidal	2	3,369,202	852.0	180.0	x
Bucksport Main	Bucksport_Main_Sub_W	Subtidal	20	13,463,520	826.2	180.0	x
Bucksport Thalweg	Bucksport Thalweg_Int_W	Intertidal	NA	50,905	885.5	180.0	x
Bucksport Thalweg	Bucksport Thalweg_Main_Main	Subtidal	7	2,662,612	908.2	180.0	x
Bucksport Thalweg	Bucksport Thalweg_Main_Sub_E	Subtidal	1	456,684	669.0	180.0	x
Bucksport Thalweg	Bucksport Thalweg_Main_Sub_W	Subtidal	2	362,900	604.5	180.0	x
Fort Point Cove	Fort Point Cove_Main_Sub_W	Subtidal	27	46,332,364	712.0	180.0	x
Frankfort Flats	Frankfort Flats_Main_Int_E	Intertidal	7	6,343,948	1,046.5	180.0	x
Frankfort Flats	Frankfort Flats_Main_Int_W	Intertidal	10	4,602,034	732.2	180.0	x
Frankfort Flats	Frankfort Flats_Main_Main	Subtidal	9	11,330,591	358.5	180.0	x
Frankfort Flats	Frankfort Flats_Main_Sub_E	Subtidal	27	25,918,954	361.1	180.0	x
Frankfort Flats	Frankfort Flats_Main_Sub_W	Subtidal	22	9,956,488	597.3	180.0	x
Frankfort Flats	Frankfort Flats_Marsh	Marsh	18	4,019,444	855.5	180.0	x
Orrington	Orrington_Main_Int_E	Intertidal	42	5,653,943	1,208.5	180.0	x
Orrington	Orrington_Main_Int_W	Intertidal	10	4,857,852	978.6	180.0	x
Orrington	Orrington_Main_Main	Subtidal	20	10,401,016	582.7	180.0	x
Orrington	Orrington_Main_Sub_E	Subtidal	26	9,076,556	819.2	180.0	x
Orrington	Orrington_Main_Sub_W	Subtidal	8	5,647,649	648.5	180.0	x
Orrington	Orrington_Marsh	Marsh	21	4,103,967	1,877.2	180.0	x
Verona West	Verona West_Main_Sub_E	Subtidal	12	13,564,329	806.4	180.0	x
Verona West	Verona West_Main_Sub_W	Subtidal	11	17,071,629	505.0	180.0	x
Winterport	Winterport_Main_Int_E	Intertidal	1	2,871,876	856.6	180.0	x
Winterport	Winterport_Main_Int_W	Intertidal	12	5,701,202	747.0	180.0	x
Winterport	Winterport_Main_Main	Subtidal	15	13,205,976	569.1	180.0	x
Winterport	Winterport_Main_Sub_E	Subtidal	3	4,300,253	332.6	180.0	x
Winterport	Winterport_Main_Sub_W	Subtidal	2	2,026,960	801.4	180.0	x
Winterport	Winterport_Marsh	Marsh	9	5,164,574	884.6	180.0	x
Bangor	Bangor_Main_Int_E	Intertidal	13	1,842,352	288.9	288.9	
Bangor	Bangor_Marsh	Marsh	4	3,133,390	183.7	183.7	
Bucksport Thalweg	Bucksport Thalweg_Int_E	Intertidal	NA	195,574	464.3	464.3	
Fort Point Cove	Fort Point Cove_Main_Int_W	Intertidal	8	6,097,823	155.8	155.8	
Fort Point Cove	Fort Point Cove_Marsh	Marsh	3	1,882,852	34.6	34.6	
Upper Penob	Upper Penobscot Bay_Main_Int_E	Intertidal	2	5,631,795	56.6	56.6	
Upper Penob	Upper Penobscot Bay_Main_Sub	Subtidal	25	121,726,846	478.6	478.6	
Upper Penob	Upper Penobscot Bay_Marsh	Marsh	1	1,786,058	19.3	19.3	
Verona West	Verona West_Main_Int_E	Intertidal	1	2,354,275	92.2	92.2	
Verona West	Verona West_Main_Int_W	Intertidal	NA	1,325,312	92.2	92.2	
Verona West	Verona West_Main_Main	Subtidal	11	5,822,655	473.6	473.6	
Verona West	Verona West_Marsh	Marsh	2	2,161,307	220.5	220.5	

Prepared by: ESS 3/1/18
Checked by: KC 3/7/18
Modified by: RMB 8/24/18

Notes:

1. N-Value is the number of samples in that specific reach/zone
2. Error estimates for BOOTMEAN values presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b)
3. x = area targeted for remedy to meet PRG

Abbreviations:

cy = cubic yard
NA = not applicable
ng/g = nanograms per gram
PRG = preliminary remediation goal
sf = square foot

TABLE 5-4

REMEDIAL AREA AND VOLUME CALCULATION FOR 500 ng/g and 300 ng/g PRG – ORLAND RIVER/VERONA NORTHEAST/VERONA EAST
Phase III Engineering Study Report
Penobscot River Estuary, Maine

	Pre-Remedy	Post-Remedy
Total Area (sf)	79,991,381	79,991,381
Area Weighted Average Concentration (ng/g)	766.6	303.5
Remediation Area (sf)	NA	48,970,864
Remediation Volume @ 0.5 foot depth plus 0.5 foot overdredge (cy)	NA	1,813,736

	Remediation Area/Volume
Area (sf) intertidal/marsh	39,103,782
Area (sf) subtidal	9,867,083
Volume (cy) intertidal/marsh	1,448,288
Volume (cy) subtidal	365,448
Area (sf) marsh restoration	5,240,661

Reach	Ribbon_classification	ZONE	N-Value[1]	Shape Area (sf)	Pre-Remedy BOOTMEAN[2] (ng/g)	PRG 500/300 BOOTMEAN POST REMEDY (ng/g)	PRG 300 Remediation Area[3]
Orland River	Orland River_Marsh	Marsh	12	1,871,555	940.4	180.0	x
Orland River	Orland_Int_E	Intertidal	24	5,521,538	1,086.8	180.0	x
Orland River	Orland_Int_W	Intertidal	29	5,958,311	867.7	180.0	x
Verona East	Verona_E_Int_E	Intertidal	9	3,231,540	935.7	180.0	x
Verona East	Verona_E_Int_W	Intertidal	13	1,874,751	647.6	180.0	x
Verona East	Verona_E_Main	Subtidal	9	9,867,083	1,020.6	180.0	x
Verona East	Verona_E_Marsh	Marsh	1	923,687	755.9	180.0	x
Verona NE	Verona_NE_Int_E	Intertidal	17	5,144,979	847.2	180.0	x
Verona NE	Verona_NE_Int_W	Intertidal	29	12,132,002	924.1	180.0	x
Verona NE	Verona_NE_Marsh	Marsh	5	2,445,418	961.1	180.0	x
Orland River	Orland_Main	Subtidal	7	4,628,944	569.3	569.3	
Verona East	Verona_E_Sub_E	Subtidal	5	6,739,305	320.0	320.0	
Verona East	Verona_E_Sub_W	Subtidal	4	3,667,825	312.5	312.5	
Verona NE	Verona_NE_Main	Subtidal	12	6,506,812	598.0	598.0	
Verona NE	Verona_NE_Sub_E	Subtidal	8	5,417,724	562.0	562.0	
Verona NE	Verona_NE_Sub_W	Subtidal	18	4,059,906	637.8	637.8	

Prepared by: ESS 3/1/18
Checked by: KC 3/7/18
Modified by: RMB 8/24/18

Notes:

1. N-Value is the number of samples in that specific reach/zone
2. Error estimates for BOOTMEAN values presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b)
3. x = area targeted for remedy to meet PRG

Abbreviations:

cy = cubic yard
NA = not applicable
ng/g = nanograms per gram
PRG = preliminary remediation goal
sf = square foot

TABLE 5-5

REMEDIAL VOLUME CALCULATION FOR 500 ng/g PRG – MENDALL MARSH
Phase III Engineering Study Report
Penobscot River Estuary, Maine

	Pre-Remedy	Post-Remedy
Total Area (sf)	34,707,401	34,707,401
Area Weighted Average Concentration (ng/g)	578.1	498.5
Cap Area (sf) 100% of marsh platform (elevation 2–7.5 feet NAVD88 zone) and 20% of marsh platform (elevation 7.5 feet - boundary edge zone)	NA	10,347,937
Cap Import Volume (cy) (3" thick with 3" overplacement)	NA	191,628
Dredge Remediation Area (sf)	NA	NA
Remediation Volume @ 0.5 foot depth plus 0.5 foot overdredge (cy)	NA	NA

Reach	Ribbon_classification	ZONE	N-Value[1]	Shape Area (sf)	Pre-Remedy BOOTMEAN[2] (ng/g)	PRG 500 BOOTMEAN POST REMEDY (ng/g)	PRG 300 Remediation Area[3]
Mendall Marsh	MM_Elev1 (2-5.8 ft elev)	Marsh	15	2,353,002	665.8	342.9	x
Mendall Marsh	MM_Elev2 (5.8-7 ft elev)	Marsh	22	2,370,493	721.8	370.9	x
Mendall Marsh	MM_Elev3 (7-7.5 ft elev)	Marsh	25	3,103,348	513.2	266.6	x
Mendall Marsh	MM_Elev4 (7.5-boundary edge)	Marsh	57	12,605,472	429.4	388.5	x
Mendall Marsh	Mendall Marsh_Main_Sub_W	Subtidal	8	4,957,839	641.6	641.6	
Mendall Marsh	Mendall Marsh_Mendall_Int	Intertidal	61	9,317,247	708.2	708.2	

Prepared by: ESS 3/1/18
Checked by: CP 3/7/18
Modified by: KAM 9/04/18

Notes:
1. N-Value is the number of samples in that specific reach/zone
2. Error estimates for BOOTMEAN values presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b)
3. x = area targeted for remedy to meet PRG

Abbreviations:
cy = cubic yard
NA = not applicable
NAVD88 = North American Vertical Datum of 1988
ng/g = nanograms per gram
PRG = preliminary remediation goal
sf = square foot

TABLE 5-6

REMEDIAL VOLUME CALCULATION FOR 300 ng/g PRG – MENDALL MARSH
Phase III Engineering Study Report
Penobscot River Estuary, Maine

	Pre-Remedy	Post-Remedy
Total Area (sf)	34,707,401	34,707,401
Area Weighted Average Concentration (ng/g)	578.1	287.5
Cap Area (sf) 100% of marsh platform (elevation 2–7.5 feet NAVD88 zone) and 20% of marsh platform (elevation 7.5 feet - boundary edge zone)	NA	10,347,937
Cap Import Volume (cy) (3" thick with 3" overplacement)	NA	191,628
Dredge Remediation Area (sf)	NA	14,275,086
Remediation Volume @ 0.5 foot depth plus 0.5 foot overdredge (cy)	NA	528,707

Reach	Ribbon_classification	ZONE	N-Value[1]	Shape Area (sf)	Pre-Remedy BOOTMEAN[2] (ng/g)	PRG 300 BOOTMEAN POST REMEDY (ng/g)	PRG 300 Remediation Area[3]
Mendall Marsh	MM_Elev1 (2-5.8 ft elev)	Marsh	15	2,353,002	665.8	342.9	x
Mendall Marsh	MM_Elev2 (5.8-7 ft elev)	Marsh	22	2,370,493	721.8	370.9	x
Mendall Marsh	MM_Elev3 (7-7.5 ft elev)	Marsh	25	3,103,348	513.2	266.6	x
Mendall Marsh	MM_Elev4 (7.5-boundary edge)	Marsh	57	12,605,472	429.4	388.5	x
Mendall Marsh	Mendall Marsh_Main_Sub_W	Subtidal	8	4,957,839	641.6	180.0	x
Mendall Marsh	Mendall Marsh_Mendall_Int	Intertidal	61	9,317,247	708.2	180.0	x

Prepared by: ESS 3/1/18
Checked by: CP 3/7/18
Modified by: KAM 9/04/18

Notes:

1. N-Value is the number of samples in that specific reach/zone
2. Error estimates for BOOTMEAN values presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b)
3. x = area targeted for remedy to meet PRG

Abbreviations:

cy = cubic yard
NA = not applicable
NAVD88 = North American Vertical Datum of 1988
ng/g = nanograms per gram
PRG = preliminary remediation goal
sf = square foot

TABLE 5-7

REMEDIAL VOLUME OF WOOD-ENRICHED SEDIMENT DEPOSITS[1]
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Reach	AER Ribbon_classification	Surface Deposit - Layer Identification	ZONE	N-Value[2]	Shape Area (sf)	Pre-Remedy BOOTMEAN[3] (ng/g)	Thickness (feet)	Overdredge Allowance (at 0.5 feet)	Remedial Depth (feet)	Volume (cy)
Frankfort Flats	Elev_Hg_FF	FF-01	Subtidal	7	4,463,457	919	3	0.5	3.5	578,596
Orland River	Elev_Hg_Orland	OR-1	Subtidal	2	288,438	1,409	3	0.5	3.5	37,390
Verona East	Elev_Hg_V_NE	VE-1	Subtidal	5	1,276,709	1,113	6	0.5	6.5	307,356
Verona East	Elev_Hg_V_E	VE-2	Subtidal	NA	184,725	NA	1	0.5	1.5	10,262
Verona East	Elev_Hg_V_S	VE-3	Subtidal	NA	250,257	NA	1	0.5	1.5	13,903
TOTAL										**947,508**

Prepared by: CP 3/25/18
Checked by: NW 3/25/18
Modified by: RMB 8/24/18

Notes:

1. Adapted from Table 5-15 in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b); adaptation includes new column (Surface Deposit-Layer Identification); re-arrangement of rows; identification of zones as 'subtidal' and increase in significant figures in presentation of estimated overdredge allowance and remedial depths.
2. N-Value is the number of samples in that specific reach/zone.
3. Error estimates for BOOTMEAN values presented in the Alternatives Evaluation Report (Amec Foster Wheeler 2018b)

Abbreviations:
cy = cubic yard
NA = not applicable
ng/g = nanograms per gram
sf = square feet

TABLE 5-8

ESTIMATED COST OF REMEDIAL ALTERNATIVES
Penobscot River Phase III Engineering Study
Penobscot River Estuary, Maine

Description	Alternative 1: Monitored Natural Recovery	Alternative 2: Enhanced Monitored Natural Recovery (500 ng/g)	Alternative 2: Enhanced Monitored Natural Recovery (300 ng/g)	Alternative 3: Dredging (500 ng/g with Offsite Disposal)	Alternative 3: Dredging (500 ng/g with Beneficial Reuse)	Alternative 3: Dredging (300 ng/g with Offsite Disposal)	Alternative 3: Dredging (300 ng/g with Beneficial Reuse)	Alternative 4 and 6: Thin-Layer Capping	Alternative 5: Amendment Application	Alternative 6: Dredging in Intertidal and Subtidal Zones (with Offsite Disposal)	Alternative 6: Dredging in Intertidal and Subtidal Zones (with Beneficial Reuse)
Performance and Payment Bond	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Work Plans, Permits and Submittals	$0	$180,000	$490,000	$1,050,000	$1,050,000	$2,240,000	$2,240,000	$80,000	$20,000	$150,000	$150,000
Mobilization	$0	$9,970,000	$73,600,000	$112,510,000	$112,510,000	$646,760,000	$646,760,000	$2,280,000	$70,000	$2,590,000	$2,590,000
Temporary Construction	$0	$2,710,000	$2,710,000	$14,850,000	$14,850,000	$14,850,000	$14,850,000	$2,710,000	$2,710,000	$0	$0
Surveys	$0	$4,290,000	$11,660,000	$6,640,000	$6,640,000	$18,020,000	$18,020,000	$710,000	$200,000	$670,000	$670,000
Environmental Monitoring	$0	$4,630,000	$12,700,000	$19,350,000	$19,350,000	$28,110,000	$28,110,000	$700,000	$0	$580,000	$580,000
Debris Removal	$0	$0	$0	$3,150,000	$3,150,000	$9,900,000	$9,900,000	$0	$0	$1,210,000	$1,210,000
Dredging and Offloading	$0	$0	$0	$119,730,000	$119,730,000	$236,330,000	$236,330,000	$0	$0	$14,340,000	$14,340,000
Dredge Material Processing	$0	$0	$0	$73,150,000	$73,150,000	$203,590,000	$203,590,000	$0	$0	$8,420,000	$8,420,000
Backfill Material Procurement and Delivery	$0	$149,070,000	$408,990,000	$144,120,000	$144,120,000	$491,730,000	$491,730,000	$7,510,000	$21,020,000	$21,730,000	$21,730,000
Backfilling and Loading of Backfill	$0	$40,130,000	$109,920,000	$96,910,000	$96,910,000	$227,920,000	$227,920,000	$21,550,000	$2,540,000	$15,410,000	$15,410,000
T&D Offsite	$0	$0	$0	$497,930,000	$0	$1,375,340,000	$0	$0	$0	$57,350,000	$0
T&D Beneficial Reuse	$0	$0	$0	$0	$197,290,000	$0	$544,940,000	$0	$0	$0	$22,730,000
Water Treatment	$0	$0	$0	$5,880,000	$5,880,000	$12,300,000	$12,300,000	$0	$0	$0	$0
Restoration Plantings and Access Agreements	$0	$0	$0	$23,410,000	$23,410,000	$69,050,000	$69,050,000	$0	$0	$0	$0
Demobilization	$0	$9,970,000	$73,600,000	$112,510,000	$112,510,000	$646,760,000	$646,760,000	$2,280,000	$70,000	$2,590,000	$2,590,000
Total No Contingency	$0	$220,950,000	$693,670,000	$1,231,190,000	$930,550,000	$3,982,900,000	$3,152,500,000	$37,820,000	$26,630,000	$125,040,000	$90,420,000
20% Contingency	$0	$44,190,000	$138,730,000	$246,240,000	$186,110,000	$796,580,000	$630,500,000	$7,560,000	$5,330,000	$25,010,000	$18,080,000
Total with Contingency	$0	$265,140,000	$832,400,000	$1,477,430,000	$1,116,660,000	$4,779,480,000	$3,783,000,000	$45,380,000	$31,960,000	$150,050,000	$108,500,000
Project Management (5%)	$0	$13,260,000	$41,620,000	$73,870,000	$55,830,000	$238,970,000	$189,150,000	$2,270,000	$1,600,000	$7,500,000	$5,430,000
Remedial Design (5%)	$0	$13,260,000	$41,620,000	$73,870,000	$55,830,000	$238,970,000	$189,150,000	$2,270,000	$1,600,000	$7,500,000	$5,430,000
Construction Management (6%)	$0	$15,910,000	$49,940,000	$88,650,000	$67,000,000	$286,770,000	$226,980,000	$2,720,000	$1,920,000	$9,000,000	$6,510,000
Total Capital Cost	**$0**	**$307,570,000**	**$965,580,000**	**$1,713,820,000**	**$1,295,320,000**	**$5,544,190,000**	**$4,388,280,000**	**$52,640,000**	**$37,080,000**	**$174,050,000**	**$125,870,000**
Long Term Monitoring Program	**$16,540,000**	**$18,300,000**	**$21,620,000**	**$12,460,000**	**$12,460,000**	**$15,780,000**	**$15,780,000**	**$5,910,000**	**$6,290,000**	**$11,250,000**	**$11,250,000**
Pilot Test #1	**$0**	**$10,000,000**	**$10,000,000**	**$0**	**$0**	**$0**	**$0**	**$2,500,000**	**$2,500,000**	**$0**	**$0**
Pilot Test #2	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$5,000,000**	**$5,000,000**	**$0**	**$0**
Total Cost	**$16,540,000**	**$335,870,000**	**$997,200,000**	**$1,726,280,000**	**$1,307,780,000**	**$5,559,970,000**	**$4,404,060,000**	**$66,050,000**	**$50,870,000**	**$185,300,000**	**$137,120,000**
Unit Cost Per Cubic Yard	**-**	**-**	**-**	**$390**	**$290**	**$440**	**$350**	**$270**	**$4,010**	**$330**	**$240**
Unit Cost Per Acre	**-**	**-**	**-**	**$800,000**	**$600,000**	**$190,000**	**$780,000**	**$230,000**	**$80,000**	**$540,000**	**$390,000**

Notes:
ng/g = nanograms per gram

Prepared by: ESS 9/4/18
Checked by: KM 9/5/18

TABLE 6-1

PERCENT DECREASE OF HUMAN HEALTH AND ECOLOGICAL RISK BY ALTERNATIVE[1, 2, 3, 4, 5]
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Exposure Scenario	Alternative 1: Monitored Natural Recovery	Alternative 2: Enhanced Monitored Natural Recovery		Alternative 3: Dredging (Surface Deposits, Subtidal, Intertidal, Thalweg)		Alternative 4: Thin Layer Capping	Alternative 6: Dredging in Intertidal and Subtidal Zones & Thin Layer Capping
		PRG = 500 ng/g	PRG = 300 ng/g	PRG = 500 ng/g	PRG = 300 ng/g		
Main Channel of the Penobscot River and the Orland River							
Local Consumer – Child							
American Eel	0%	5.8% - 19%	22% - 31%	0% - 56%	**56% - 77%**		
American Black Duck	0%	14%-20%	22%-29%	63%-80%	64%-80%		
American Lobster	**0%**	5.8%	**21%**	**4.9%**	**34%**		
American Lobster – Upper End BSAF	0%	5.8%	21%	4.9%	34%		
Mendall Marsh							
Local Consumer – Child							
American Black Duck	0%	5.1%	5.1%	0%	0%-58%	22%	47%
Nelson's Sparrow							
NOAEL TRV	0%	4.1%-5.1%	8.7%-10%	0%-21%	0%-21%	18%-19%	33%-42%
LOAEL TRV	0%	4.1%-5.1%	8.7%-10%	0%-21%	0%-21%	18%-19%	33%-42%
Red-winged Blackbird							
NOAEL TRV	0%	4.1%-5.1%	8.7%-10%	0%-21%	0%-21%	18%-19%	33%-42%
LOAEL TRV	0%	4.1%-5.1%	8.7%-10%	0%-21%	0%-21%	18%-19%	33%-42%
Southern Cove [6]							
Local Consumer – Child							
American Eel	0%	23%	34%	42%	**80%**		
American Black Duck	1%	35%	41%	46%	47%		
Nelson's Sparrow							
NOAEL TRV	0.6%	35%	41%	46%	47%		
LOAEL TRV	0.6%	35%	41%	46%	47%		
Red-winged Blackbird							
NOAEL TRV	0.6%	35%	41%	46%	47%		
LOAEL TRV	0.6%	35%	41%	46%	47%		

Prepared by: IMR 08/28/18
Checked by: NSR 08/29/18

Notes:

1. Table includes only those biota with a pre-remediation HQ above 1.0.
2. Green cells signify percent decreases that correspond to an HQ to below 1.0 for all portions of the exposure scenario.
3. Yellow cells signify percent decreases that correspond to an HQ above 1.0 for all portions of the exposure scenario.
4. Blue cells signify that the alternative is not applicable as a remedial alternative for that exposure scenario.
5. Bolded values indicate a percent decrease would result in a methyl mercury tissue concentration less than 200 ng/g for American Lobster, American black duck, and American eel.
6. Orrington and Lower Bangor reaches percent differences are the percent difference between the current post-remediation concentration and each post-remediation alternative concentration. Evaluation of risk reduction for Southern Cove is as defined by biota monitoring stations in the Bangor reach (Station BO-04) and Orrington reach (Station OB 05). Dredging in the Orrington reach, including Southern Cove as well as intertidal and marsh areas outside of the Cove, would likely result in further risk reduction beyond what is summarized here.

Abbreviations:

BSAF = biota-sediment accumulation factor
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
ng/g = nanograms per gram
NOAEL = no observed adverse effect level
PRG = preliminary remediation goal
TRV = toxicity reference value

TABLE 8-1

BOX MODEL INPUT TERMS
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Reflector 1 Material				Annual Mass Loading					
Bedded Deposits < 1 foot		Surface Deposits – Layers		Veazie Inflow		Tributary Inflow		Export[4, 6]	
Mass[1] (tons)	Mercury Concentration[2] (ng/g)	Mass[1] (tons)	Mercury Concentration[3] (ng/g)	Mass[4] (tons/year)	Mercury Concentration[5] (ng/g)	Mass[4] (tons/year)	Mercury Concentration[5] (ng/g)	Mass[4] (tons/year)	Mercury Concentration[6] (ng/g)
1,500,000	760	450,000	1,330	44,000	200	12,300	200	5,100	variable

Notes:

1. Dry weight; Reflector 1 thickness to 1 foot; surface deposits as identified in 2017 Mobile Sediment Characterization Report (Amec Foster Wheeler 2018d).
2. Average estimated concentration of mercury in unconsolidated sediment (Table 3-1).
3. Average estimated concentration of mercury in surface deposits (Table 3-1).
4. Includes estimated burial and export from the system (Chapter 18 of Penobscot River Mercury Study Final Report [PRMSP 2013]).
5. Average estimated concentration of mercury on particles entering the system from upgradient (Amec Foster Wheeler 2018b; PRMSP 2013).
6. Calculate at each time step [t] as the average mercury concentration in the box from the [t-1] time step; assumes that net export of particles from the system occurs at a mercury concentration equivalent to the mixed concentration in the system.

Abbreviations:

ng/g = nanograms per gram

Prepared By: KSM 03/23/18
Checked By: RMB 03/23/18

TABLE 8-2

ESTIMATED COST OF RECOMMENDED REMEDIAL ALTERNATIVES AND POTENTIAL ADAPTIVE MANAGEMENT ALTERNATIVES
Draft Phase III Engineering Study Report
Penobscot River Estuary, Maine

Description	Recommended Remedial Alternatives					Institutional Controls/ Administrative Restrictions	Long-Term Monitoring	Potential Adaptive Management Alternatives		
	Thin Layer Capping in Mendall Marsh	Surface Deposit Dredging		Orrington Intertidal East and Orrington Marsh Platform East Dredging				Enhanced Monitored Natural Recovery in the Orland River	Verona East, Verona Northeast, and Orland River Dredging	
		With Landfill Disposal	With Beneficial Reuse	With Landfill Disposal	With Beneficial Reuse				With Landfill Disposal	With Beneficial Reuse
Performance and Payment Bond	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Work Plans, Permits and Submittals	$80,000	$110,000	$110,000	$60,000	$60,000	$0	$0	$10,000	$480,000	$480,000
Mobilization	$2,280,000	$1,500,000	$1,500,000	$520,000	$520,000	$0	$0	$50,000	$21,170,000	$21,170,000
Temporary Construction	$2,710,000	$2,710,000	$2,710,000	$2,710,000	$2,710,000	$0	$0	$2,710,000	$14,860,000	$14,860,000
Surveys	$720,000	$2,750,000	$2,750,000	$520,000	$520,000	$0	$0	$570,000	$3,390,000	$3,390,000
Environmental Monitoring	$700,000	$4,370,000	$4,370,000	$230,000	$230,000	$0	$0	$180,000	$2,330,000	$2,330,000
Debris Removal	$0	$800,000	$800,000	$180,000	$180,000	$0	$0	$0	$1,760,000	$1,760,000
Dredging and Offloading	$0	$16,640,000	$16,640,000	$5,820,000	$5,820,000	$0	$0	$0	$48,620,000	$48,620,000
Dredged Material Processing	$0	$13,000,000	$13,000,000	$3,410,000	$3,410,000	$0	$0	$0	$31,400,000	$31,400,000
Backfill Material Procurement and Delivery	$7,510,000	$0	$0	$8,800,000	$8,800,000	$0	$0	$5,710,000	$75,230,000	$75,230,000
Backfilling and Loading of Backfill	$21,560,000	$0	$0	$6,250,000	$6,250,000	$0	$0	$1,540,000	$48,070,000	$48,070,000
Transport & Off-Site Disposal	$0	$80,640,000	$0	$23,220,000	$0	$0	$0	$0	$213,310,000	$0
Transport & Disposal for Beneficial Reuse	$0	$0	$31,950,000	$0	$9,200,000	$0	$0	$0	$0	$84,530,000
Water Treatment	$0	$1,600,000	$1,600,000	$480,000	$480,000	$0	$0	$0	$3,090,000	$3,090,000
Restoration Plantings and Access Agreements	$0	$0	$0	$200,000	$200,000	$0	$0	$0	$670,000	$670,000
Demobilization	$2,280,000	$1,500,000	$1,500,000	$520,000	$520,000	$0	$0	$50,000	$21,170,000	$21,170,000
Total No Contingency	**$37,840,000**	**$125,620,000**	**$76,930,000**	**$52,920,000**	**$38,900,000**	**$0**	**$0**	**$10,820,000**	**$485,550,000**	**$356,770,000**
20% Contingency	$7,568,000	$25,130,000	$15,390,000	$10,590,000	$7,780,000	$0	$0	$2,170,000	$97,110,000	$71,360,000
Total with Contingency	**$45,408,000**	**$150,750,000**	**$92,320,000**	**$63,510,000**	**$46,680,000**	**$0**	**$0**	**$12,990,000**	**$582,660,000**	**$428,130,000**
Project Management (5%)	$2,280,000	$7,550,000	$4,620,000	$3,180,000	$2,340,000	$0	$0	$650,000	$29,140,000	$21,410,000
Remedial Design (5%)	$2,280,000	$7,550,000	$4,620,000	$3,180,000	$2,340,000	$0	$0	$650,000	$29,140,000	$21,410,000
Construction Management (6%)	$2,730,000	$9,050,000	$5,550,000	$3,820,000	$2,810,000	$0	$0	$780,000	$34,960,000	$25,690,000
Total Capital Cost	**$52,698,000**	**$174,900,000**	**$107,110,000**	**$73,690,000**	**$54,170,000**	**$0**	**$0**	**$15,070,000**	**$675,900,000**	**$496,640,000**
Long Term Monitoring Program	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$24,590,000**	**$0**	**$0**	**$0**
Pilot Test #1	**$2,500,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$2,500,000**	**$0**	**$0**
Pilot Test #2	**$5,000,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$7,500,000**	**$0**	**$0**
Total Cost	**$60,198,000**	**$174,900,000**	**$107,110,000**	**$73,690,000**	**$54,170,000**	**$0**	**$24,590,000**	**$25,070,000**	**$675,900,000**	**$496,640,000**
Unit Cost Per Cubic Yard	**$320**	**$170**	**$110**	**$350**	**$260**	**-**	**-**	**$170**	**$370**	**$280**
Unit Cost Per Acre	**$260,000**	**$1,080,000**	**$660,000**	**$560,000**	**$410,000**	**-**	**-**	**$70,000**	**$610,000**	**$450,000**

Abbreviations:
-- = not applicable

Prepared by: ESS 9/11/18
Checked by: KM 9/11/18

Total of Recommended Remedial Alternatives using Landfill Disposal plus Long-Term Monitoring	**$333,378,000**
Total of Recommended Remedial Alternatives using Beneficial Reuse plus Long-Term Monitoring	**$246,068,000**

Table 8-3

SUMMARY OF PHASE II AND PHASE III LONG-TERM MONITORING
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Biota	2013 Phase II Proposed[1]	2018 Phase III Proposed
System-Wide[7]		
Tomcod[2]	17 locations	8 locations (w. reference)
Smelt[2]	12 locations	8 locations (w. reference)
American Black Duck[3]	--	3 locations (w. reference)
Partial System[8]		
Mussel[4]	7 to 8 locations	7 locations (w. reference)
Lobster[2]	8 locations	7 locations (w. reference)
Eel[2]	6 locations (w. reference)	4 locations (w. reference)
Mummichog[2]	9 locations	3 locations (w. reference)
Songbirds[5]	4 locations (w. reference)	4 locations (w. reference)
Possible Additions		
Polychaetes[6]	Not proposed	14 locations (w.reference)
Spiders[6]	Not proposed	4 songbird locations (w. reference)
Marsh Platform Insects[6] (Identified)	Not proposed	4 songbird locations (w. reference)
Long-Term Monitoring Time Frame	**2 Years**	**3 Years**

Prepared by/Date: LO 03/21/18
Checked by/Date: EFC 03/21/18

Notes:

1. Proposed in Chapter 13 of the Phase II Report (PRMSP 2013).
2. Tomcod, smelt, eel, lobster, and mummichog: up to 20 samples per fish species per location.
3. American Black Duck: up to 15 blood samples per location.
4. Mussel: up to 20 composite samples per location.
5. Songbird (Nelson's sparrow and Red-winged blackbird): up to 15 blood samples per songbird species per location.
6. Polychaete, terrestrial insect, and spider: up to five composite samples per invertebrate group per location.
7. Salt water and fresh water.
8. Salt water or fresh water only.

Table 8-4

POWER ANALYSIS FOR LONG-TERM MONITORING FOR TOMCOD
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	44	5	3	2
BO-04	158	16	11	6
OB-05	221	23	15	8
OB-01	107	11	8	4
ES-13	26	3	2	1
Proposed for Future Analysis				
Each Location	--	20	15	8

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-5

POWER ANALYSIS FOR LONG-TERM MONITORING FOR SMELT
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	22	3	2	1
OB-05	1,221	123	82	41
OB-04	17	2	2	1
OB-01	28	3	2	1
Proposed for Future Analysis				
Each Location	--	20	15	8

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-6

POWER ANALYSIS FOR LONG-TERM MONITORING FOR AMERICAN BLACK DUCK
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	620	62	42	21
Mendall Marsh	3,442	345	230	115
South Verona	43	5	3	2
Proposed for Future Analysis				
Each Location	--	15	10	5

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-7

POWER ANALYSIS FOR LONG-TERM MONITORING FOR MUSSEL
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	202	21	14	7
ES-03	338	34	23	12
ES-15	116	12	8	4
ES-13	60	6	4	2
Proposed for Future Analysis				
Each Location	--	20	15	8

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-8

POWER ANALYSIS FOR LONG-TERM MONITORING FOR LOBSTER
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	79	8	6	3
Odom Ledge	1,312	132	88	44
South Verona	23	3	2	1
Cape Jellison	154	16	11	6
Proposed for Future Analysis				
Each Location	--	20	15	8

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-9

POWER ANALYSIS FOR LONG-TERM MONITORING FOR EEL
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	20	2	2	1
BO-04	64	7	5	3
OB-05	32	4	3	2
OB-01	1,934	194	129	65
Proposed for Future Analysis				
Each Location	--	20	15	8

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-10

POWER ANALYSIS FOR LONG-TERM MONITORING FOR MUMMICHOG
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	**1 Sampling Event**	**10 Sampling Events**	**15 Sampling Events**	**30 Sampling Events**
Calculated				
Mendall Marsh	7	1	1	1
Proposed for Future Analysis				
Each Location	--	20	15	8

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-11

POWER ANALYSIS FOR LONG-TERM MONITORING FOR NELSON'S SPARROW
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	98	10	7	4
W-17	81	9	6	3
MM-SE	3,602	361	241	121
MM-SW	107	11	8	4
Proposed for Future Analysis				
Each Location	--	15	10	5

Abbreviations:

-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-12

POWER ANALYSIS FOR LONG-TERM MONITORING FOR RED-WINGED BLACKBIRD
Phase III Engineering Study Report
Penobscot River Estuary, Maine

Location	1 Sampling Event	10 Sampling Events	15 Sampling Events	30 Sampling Events
Calculated				
System-wide	145	15	10	5
W-17	437	44	30	15
MM-SE	120	12	8	4
MM-SW	284	29	19	10
Proposed for Future Analysis				
Each Location	--	15	10	5

Abbreviations:
-- = not recommended

Prepared by/Date: LSV 3/20/18
Checked by/Date: EFC 3/20/18

Table 8-13

RECOMMENDED LONG-TERM MONITORING STATIONS
Phase III Engineering Study Report
Penobscot River Estuary, Maine

				Media Sampled		
Station ID	**Reach**	**Station Type**	**Rationale**	**Biota**	**Sediment**	**Surface Water**
OV-02	Veazie	Reference (site)	Surface Water Monitoring			x
WQ1b-C	Orrington	Site	Surface Water Monitoring			x
WQ2-C	Winterport	Site	Surface Water Monitoring			x
WQ3-L	Bucksport	Site	Surface Water Monitoring			x
WQ-ECH	Verona East	Site	Surface Water Monitoring			x
ES-15	Verona West	Site	Surface Water Monitoring			x
WQ-FPT	Upper Penobscot Bay	Site	Surface Water Monitoring			x
ADD-02	Addison	Reference (regional)	Sediment Sampling & Surface Water Monitoring		x	x
ADD-01	Addison	Reference (regional)	Co-located Biota and Sediment	x	x	
FRB-01	Frenchman's Bay	Reference (regional)	Co-located Biota and Sediment	x	x	
FRB-02	Frenchman's Bay	Reference (regional)	Co-located Biota and Sediment	x	x	
OV-04	Veazie	Reference (site)	Co-located Biota and Sediment	x	x	
OV-01	Veazie	Reference (site)	Sediment Sampling		x	
BO-04	Bangor	Site	Co-located Biota and Sediment	x	x	
PBR-18	Orrington	Site	Geochronology Station		x	
OB-05	Orrington	Site	Co-located Biota and Sediment	x	x	
ON-18-01	Orrington	Site	Surface Deposit Monitoring		x	
WP-06-02	Winterport	Site	Surface Deposit Monitoring		x	
W-17-N	Frankfort Flats	Site	Co-located Biota and Sediment	x	x	
W-17-High	Frankfort Flats	Site	Sediment Sampling		x	
W-17-Mid	Frankfort Flats	Site	Sediment Sampling		x	
W-17-Low	Frankfort Flats	Site	Sediment Sampling		x	
W-17-Intertidal	Frankfort Flats	Site	Sediment Sampling		x	
FF-08-02	Frankfort Flats	Site	Sediment Sampling		x	
FF-9	Frankfort Flats	Site	Surface Deposit Monitoring		x	
OB-01	Orrington	Site	Co-located Biota and Sediment	x	x	
FF-16H	Frankfort Flats	Site	Surface Deposit Monitoring		x	
FF-04-01	Frankfort Flats	Site	Surface Deposit Monitoring		x	
MM-T1-C2	Mendall Marsh	Site	Sediment Sampling		x	
MMMC-01	Mendall Marsh	Site	Co-located Biota and Sediment	x	x	
MMSE-01	Mendall Marsh	Site	Co-located Biota and Sediment	x	x	

Table 8-13

RECOMMENDED LONG-TERM MONITORING STATIONS
Phase III Engineering Study Report
Penobscot River Estuary, Maine

				Media Sampled		
Station ID	**Reach**	**Station Type**	**Rationale**	**Biota**	**Sediment**	**Surface Water**
MM-T2-C3	Mendall Marsh	Site	Sediment Sampling		x	
MM-T2-C1	Mendall Marsh	Site	Sediment Sampling		x	
MM-T5-C1	Mendall Marsh	Site	Sediment Sampling		x	
MM-T5-C3	Mendall Marsh	Site	Sediment Sampling		x	
MMBKD-01	Mendall Marsh	Site	Co-located Biota and Sediment	x	x	
MMSW-C	Mendall Marsh	Site	Co-located Biota and Sediment	x	x	
MM-C2	Mendall Marsh	Site	Geochronology Station		x	
W-22-Mid	Mendall Marsh	Site	Sediment Sampling		x	
BU-01-01	Bucksport	Site	Sediment Sampling		x	
BU-2	Bucksport	Site	Sediment Sampling		x	
PBR-28	Verona Northeast	Site	Sediment Sampling/Geochronology Station		x	
VN-02-04	Verona Northeast	Site	Sediment Sampling		x	
VN-MU-3-GC-1	Verona Northeast	Site	Sediment Sampling/Geochronology Station		x	
ES-02	Verona Northeast	Site	Co-located Biota and Sediment	x	x	
EC-41	Verona East	Site	Surface Deposit Monitoring		x	
VE-05-01	Verona East	Site	Surface Deposit Monitoring		x	
W-61-High	Verona East	Site	Sediment Sampling		x	
W-61-Mid	Verona East	Site	Sediment Sampling		x	
W-61-Low	Verona East	Site	Sediment Sampling		x	
W-61-Intertidal	Verona East	Site	Sediment Sampling		x	
ES-13	Verona East	Site	Co-located Biota and Sediment	x	x	
SVE-01	Verona East	Site	Co-located Biota and Sediment	x	x	
OR-01	Orland River	Site	Co-located Biota and Sediment	x	x	
OR-T1-C1	Orland River	Site	Sediment Sampling/Geochronology Station		x	
OR-T1-C3	Orland River	Site	Sediment Sampling		x	
OR-T1-C5	Orland River	Site	Sediment Sampling		x	
OR-T3-C3	Orland River	Site	Surface Deposit Monitoring		x	

Table 8-13

RECOMMENDED LONG-TERM MONITORING STATIONS
Phase III Engineering Study Report
Penobscot River Estuary, Maine

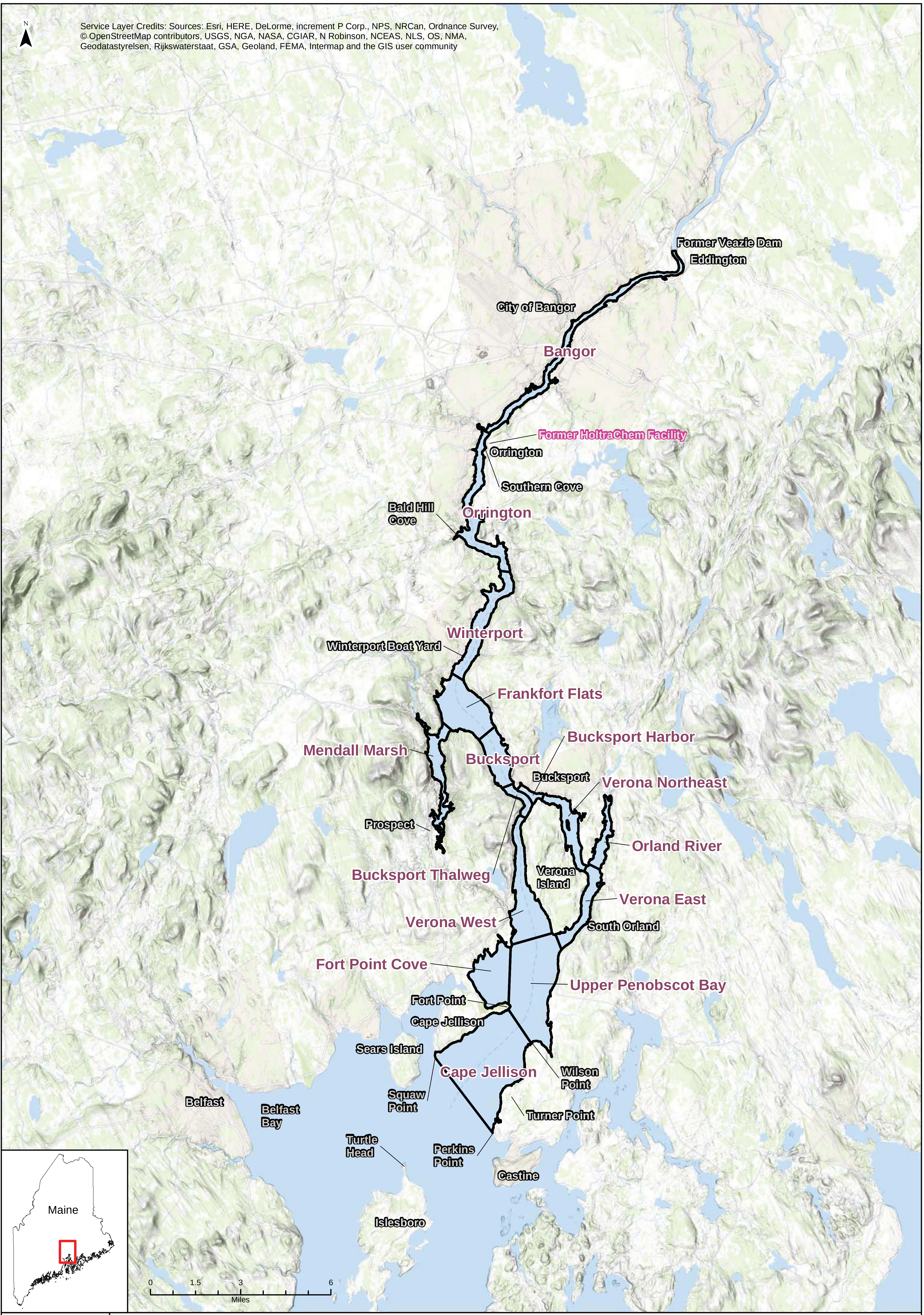
				Media Sampled		
Station ID	**Reach**	**Station Type**	**Rationale**	**Biota**	**Sediment**	**Surface Water**
OL-01	Verona West	Site	Co-located Biota and Sediment	x	x	
UPB-MU11-GC-1	Upper Penobscot Bay	Site	Geochronology Station		x	
E-01-03	Upper Penobscot Bay	Site	Sediment Sampling		x	
E-01-04	Upper Penobscot Bay	Site	Sediment Sampling		x	
E-01-01	Fort Point Cove	Site	Sediment Sampling		x	
ES-20	Fort Point Cove	Site	Geochronology Station		x	
ES-FP	Fort Point Cove	Site	Co-located Biota and Sediment	x	x	
CJ-04	Cape Jellison	Site	Co-located Biota and Sediment	x	x	
L9-45	Cape Jellison	Site	Co-located Biota and Sediment	x	x	

Notes:

Prepared By: LSV 4/06/18
Checked By: KAM 4/06/18

Rationale briefly described here (more detail in text):
Co-located Biota and Sediment sampling will include co-located biota and sediment for monitoring changes to species-specific BSAFs
Sediment Sampling locations will be used to monitor system-wide spatial and temporal trends
Geochronology Stations will be used to assess system recovery rates via geochronology dating
Surface Deposit Monitoring locations will be used to monitor sediment mobility (pre-remedy) and sediment reaccumulation rates (post-remedy)
Surface Water Monitoring locations will be used to continue the long term monitoring of Estuary surface water

FIGURES



Legend

▭ Official Study Reach Boundary

Winterport Official Study Reach Name

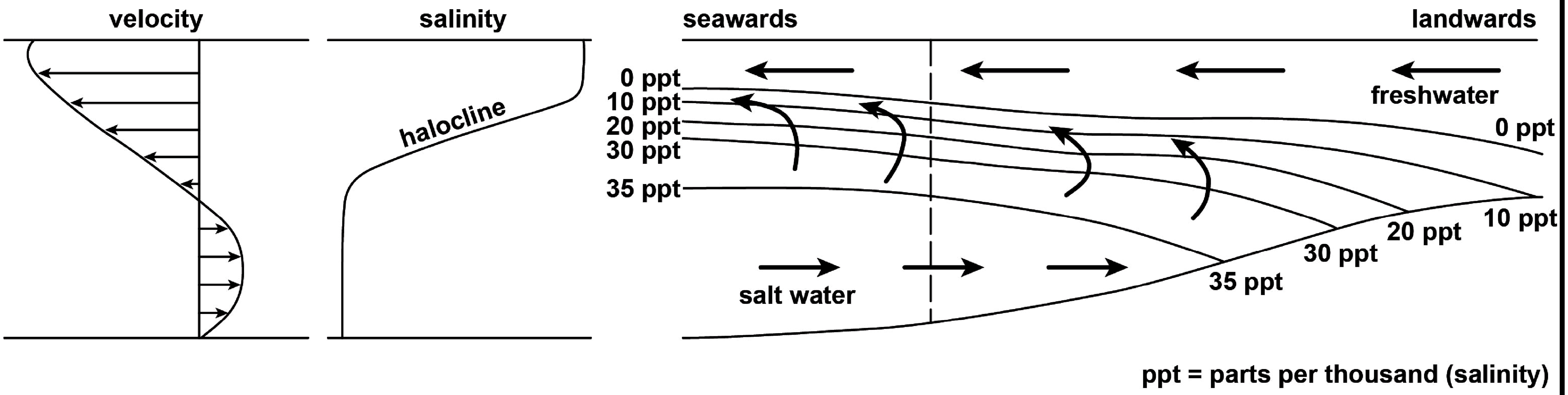
Figure 1-1
Study Reaches

Phase III Engineering Study Report

Penobscot River Phase III Engineering Study

Project: 3616166052	Prepared: ICD 3/9/2018	Checked: BPW 3/9/2018

Document: P:\Projects\USDC - Penobscot River\4.0_Deliverables\4.5_Databases\GIS\PreliminaryWork\MapDocuments\SW_SED_REPORT_FIGS\Project_Location_11x17P_Index1.mxd PDF: \\PLD2-FS1\Project\Projects\USDC - Penobscot River\4.0_Deliverables\4.1_Reports\AER Report\Working AER Draft\Figures

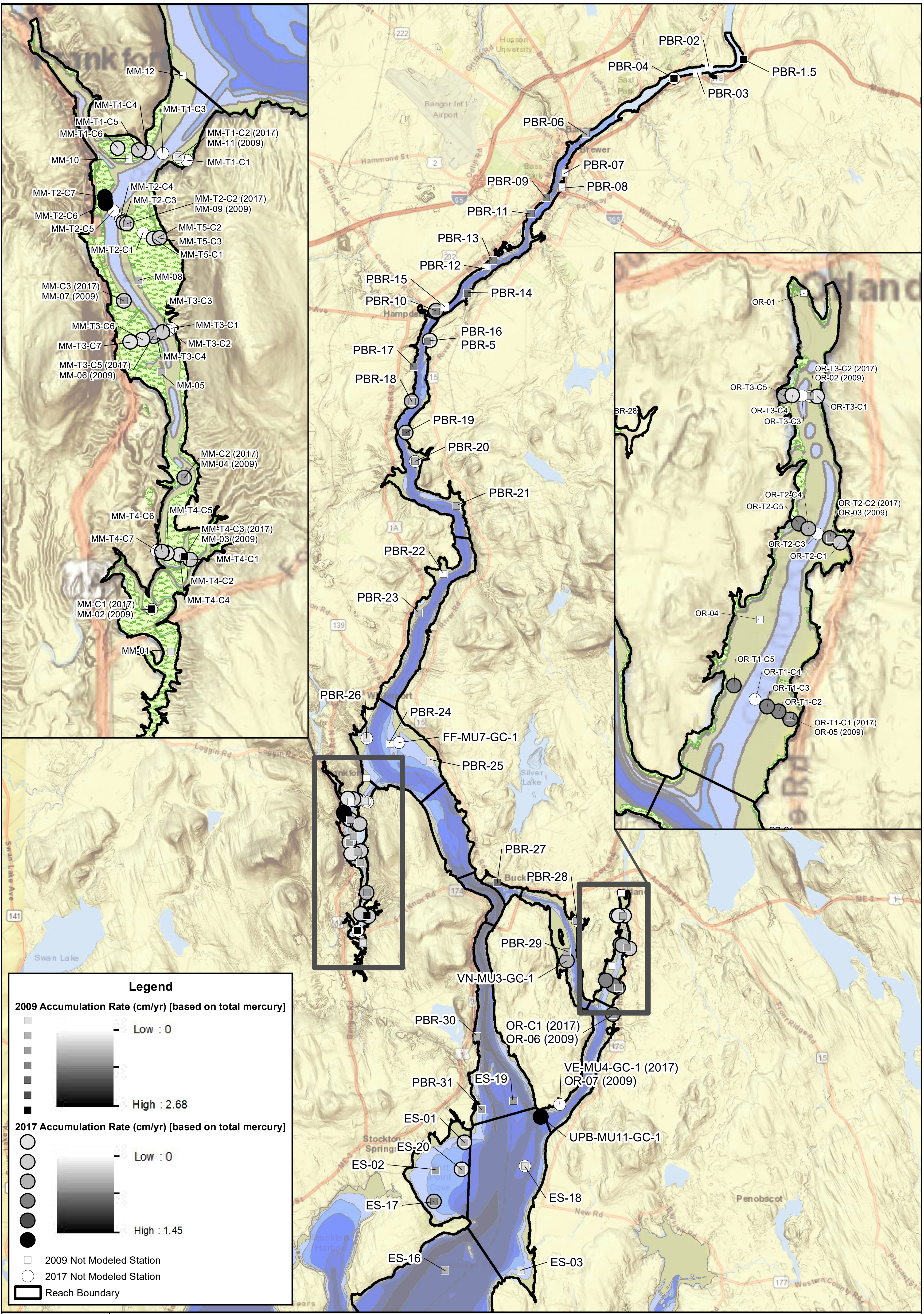


Modified from Woodroffe (2002)

Figure 3-1
Circulation in a Salt-Wedge Estuary

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052 | Prepared: ICD 9/12/2018 | Checked: RB 9/12/2018



Bathymetry

Water Depth feet (MLLW)

0 6 12 18 30 60 120 600

Marsh Platform

N

0 5,000 10,000 20,000 Feet

0 2.5 5 10 Kilometers

Figure 3-2
Sediment Accumulation Rate

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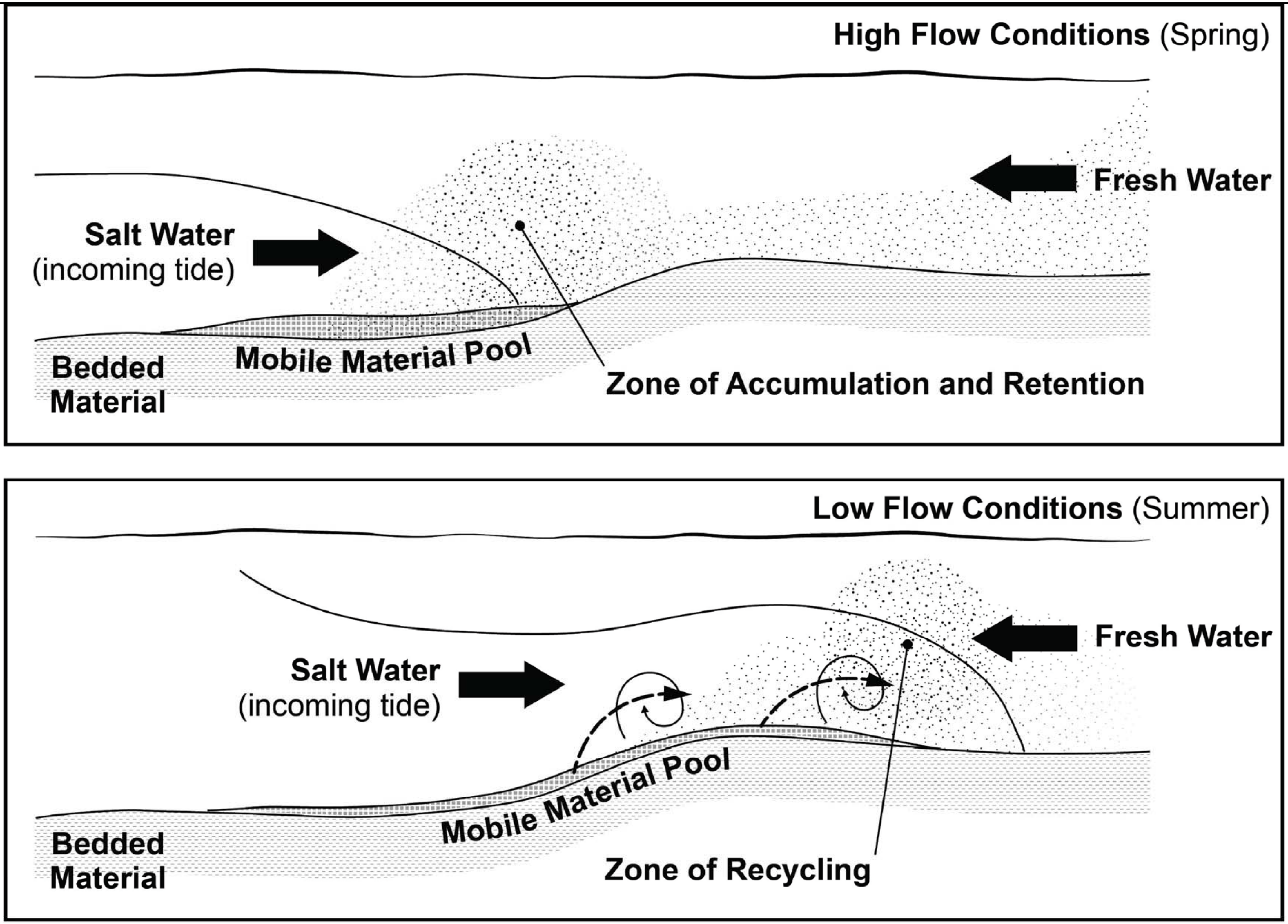
Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052 | Prepared/Date: DRY 3/29/2018 | Checked/Date: JKT 3/29/2018 | NAD83 State Plane Maine East, US Survey Feet

Document:P:\Comm-Ind\Projects\Clients M to S\Penobscot(GIS)\Work Order 4A-80\Sedimentation Rates\Figure 4-3.mxd 3/29/2018 5:50:50 PM david.young2



Modified from Geyer and Ralston (2018)

Mobile Material = wood waste and mineral sediment mixture

Figure 3-3
Material Recycling in Estuaries

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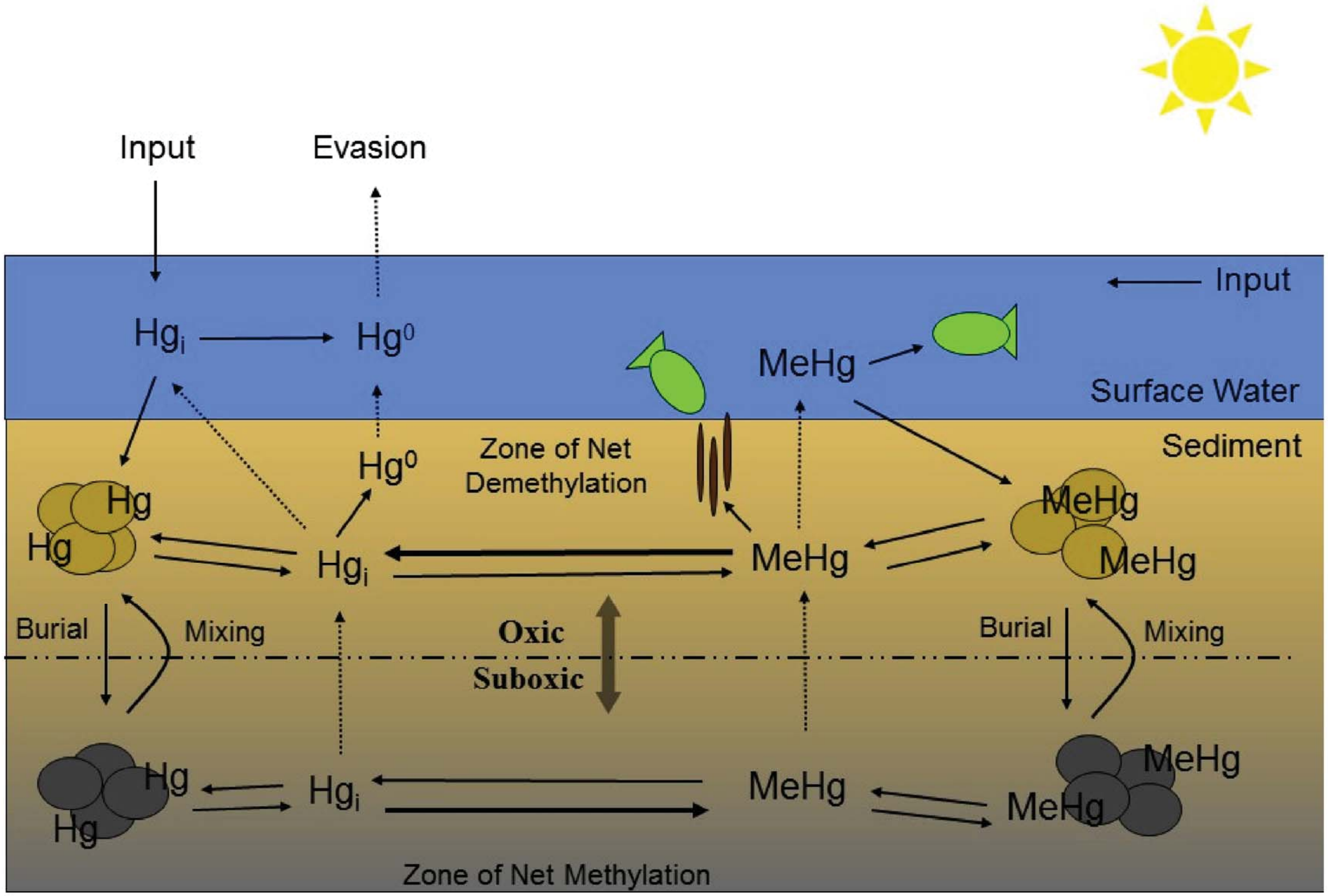
Project: 3616166052	Prepared: ICD3/9/2018	Checked: BPW 3/9/2018



Source: Merritt and Amirbahman (2009)

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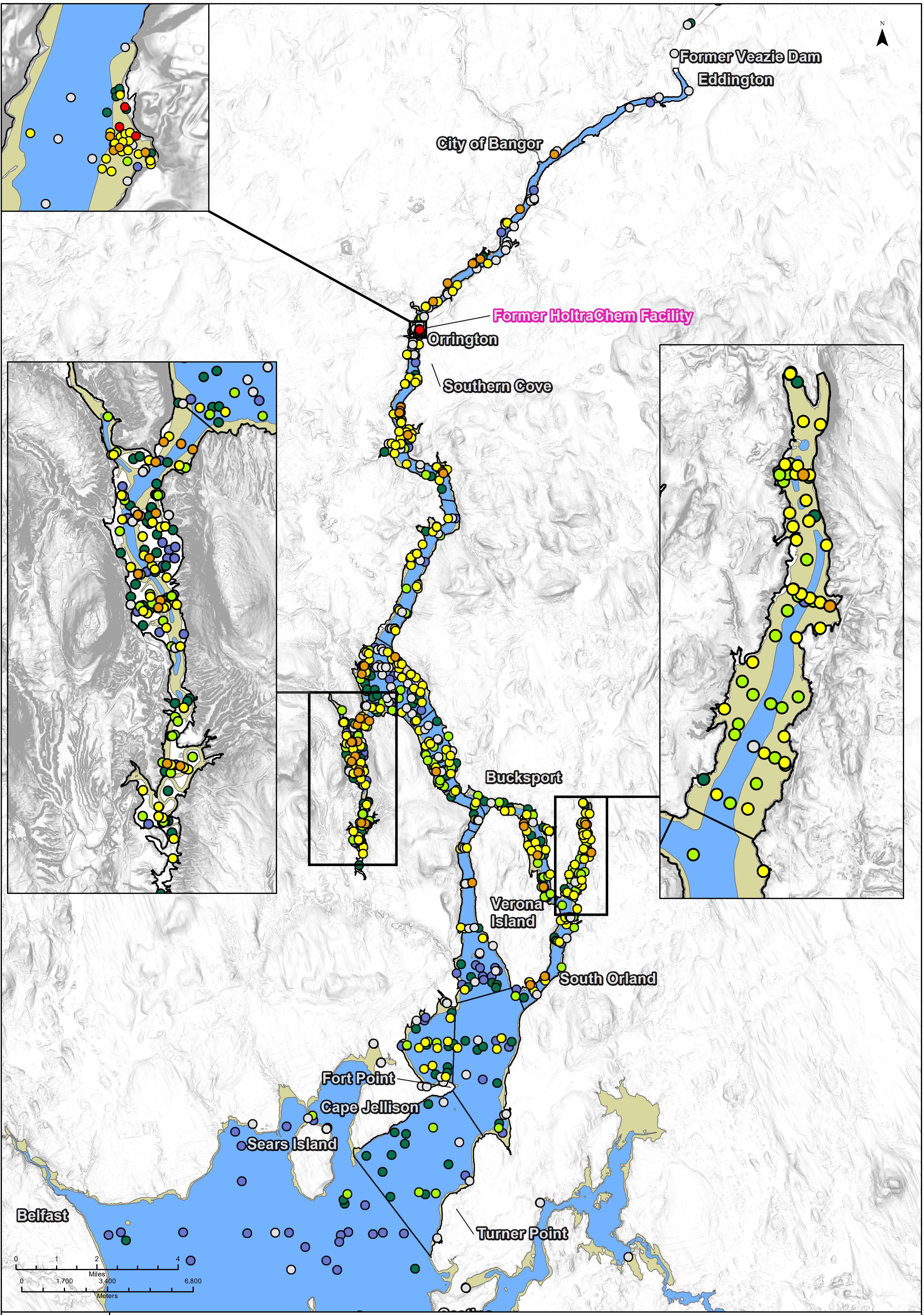
Figure 3-4
Mercury Fate and Transport Dynamics

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052	Prepared: ICD3/9/2018	Checked: BPW 3/9/2018



Symbol Key
○ Sediment Sampling Location
☐ Official Study Reach Boundary
▨ Intertidal Zone
▨ Subtidal Zone

Total Mercury Concentration (ng/g)
● 0 - 200
● 201 - 450
● 451 - 750
● 751 - 1000
● 1001 - 2200
● 2201 - 5000
● > 5000

Figure 3-5
Total Mercury Concentration (ng/g)
Surface Sediment 0.0 - 0.5 ft

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052 | Prepared: ICD 3/22/2018 | Checked: BPW 3/22/2018

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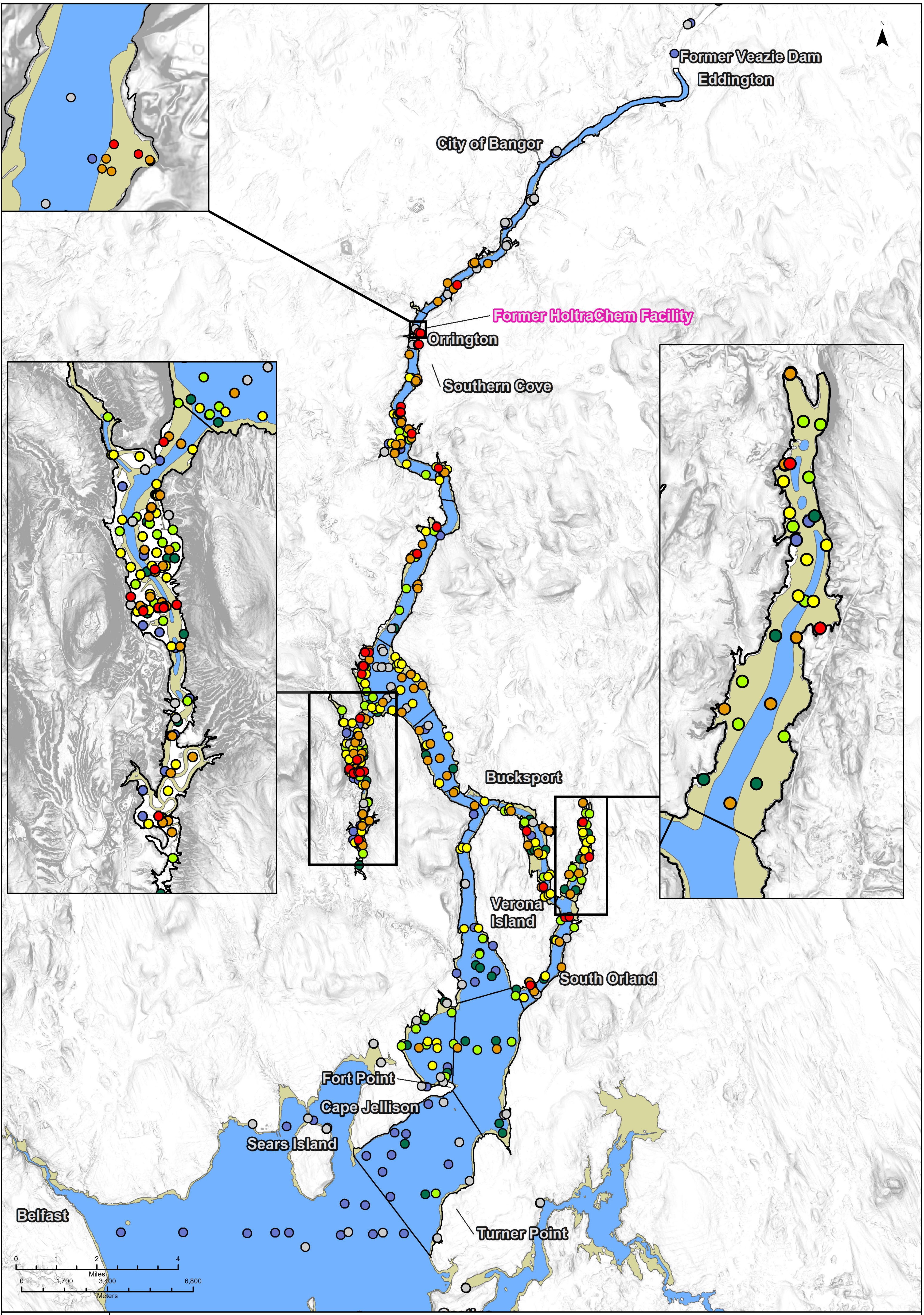

Symbol Key
○ Sediment Sampling Location
☐ Official Study Reach Boundary
▨ Intertidal Zone
▨ Subtidal Zone

Total Methyl Mercury Concentration (ng/g)
● 0.0 - 2.0
● 2.0 - 4.5
● 4.5 - 7.5
● 7.5 - 15
● 15 - 25
● 25 - 50
● >50

Figure 3-6
Total Methyl Mercury Concentration (ng/g)
Surface Sediment 0.0 - 0.5 ft

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

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Project: 3616166052	Prepared: ICD 3/22/2018	Checked: BPW 3/22/2018

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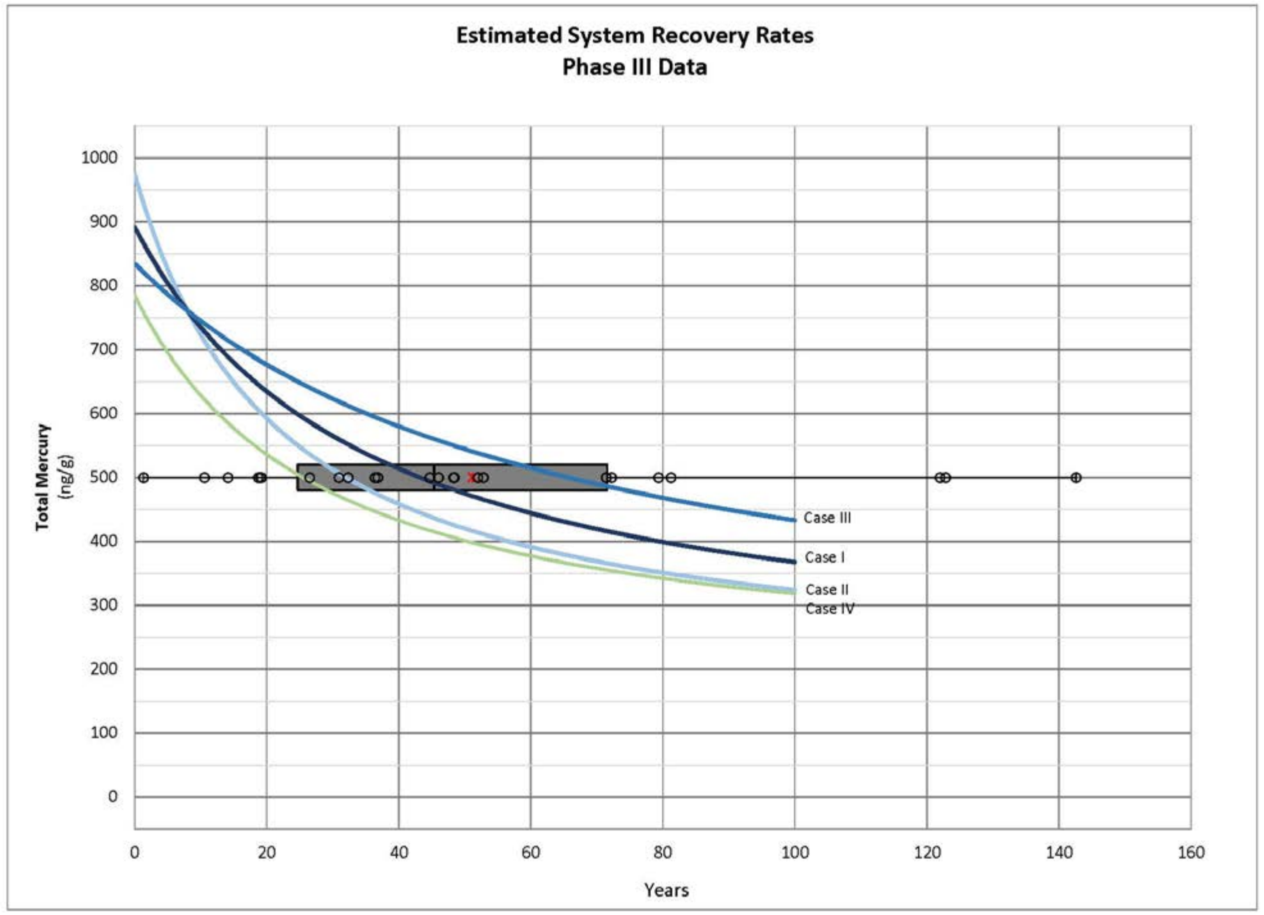

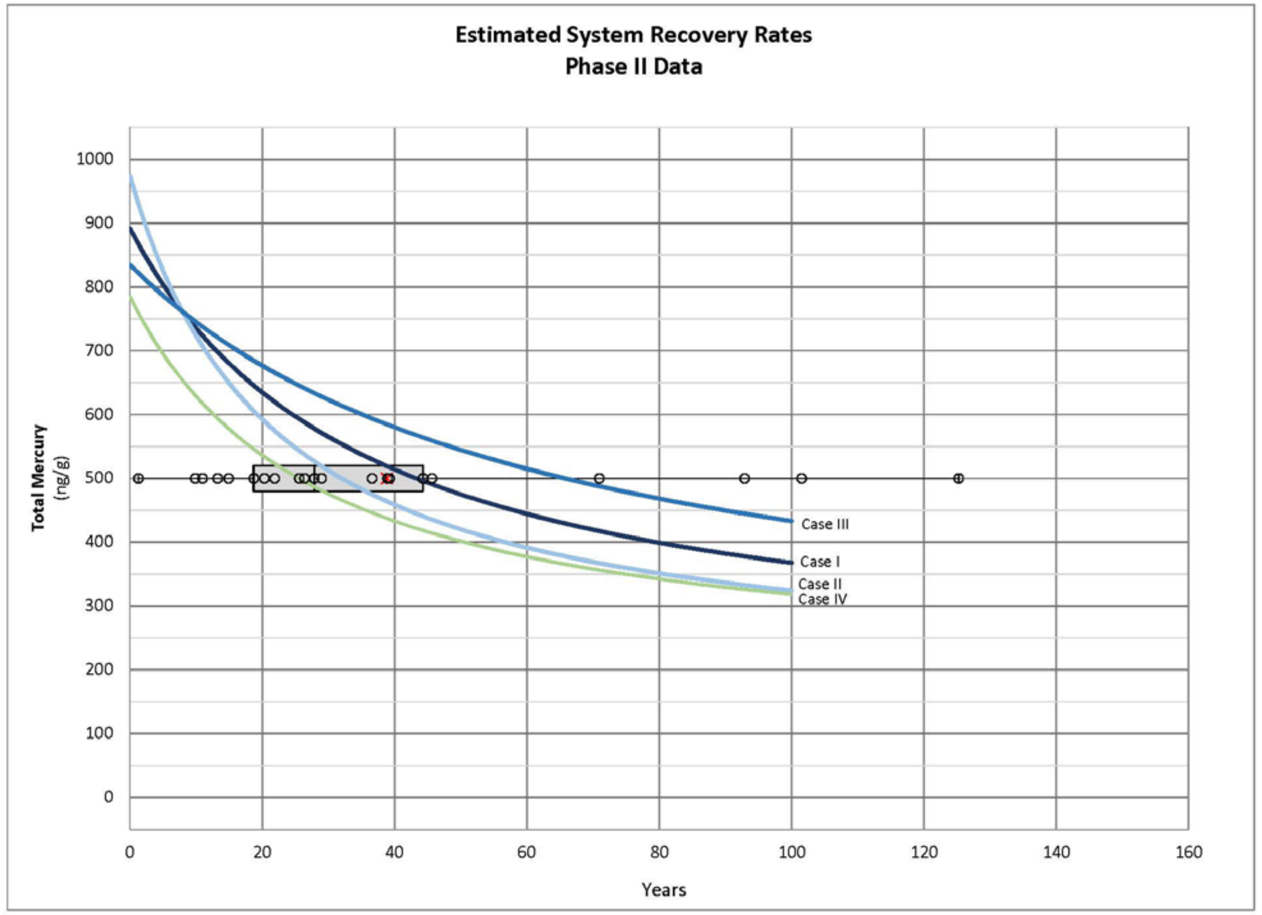

The graphs above show the estimated time required for the system-wide average concentration of total mercury to decrease to the 500 ng/g PRG. Box model curves are presented for:

- Case I – Based on estimated mass of mobile sediment in the Estuary;
- Case II – Assumes 50% of currently estimated mass of mobile sediment;
- Case III – Assumes 200% of the currently estimated mass of mobile sediment;
- Case IV – Assumes removal of surface deposits.

Box and whisker plots are based on Phase III and Phase II geochronology data for the scenario in which recovery has been defined as 400 ng/g. As presented, box and whisker plots represent time to reach the 500 ng/g PRG for total mercury in sediment. For these data, the box represents the interquartile range (IQR; 25–75%) of the data distribution for cores from which the time to reach the 500 ng/g PRG for total mercury could be calculated; the center line within the box represents the median of the data distribution; the [x] within the box represents the mean of the data distribution; the whiskers represent the outer 25% of the data beyond the interquartile range (0–25% and 75–100%); and data beyond the whiskers represents outliers to the data distribution.

Figure 8-1
Estimated System Recovery Rates

Draft Phase III Engineering Study Report
Penobscot River Estuary Phase III Engineering Study

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

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NAD83 State Plane Maine East, US Survey Feet

0 0.225 0.45 Miles

Symbol Key

Elevations NAVD88-Foot Groupings

- 🟥 2–5.8
- 🟦 5.8–7.5
- 🟩 7.5–9

Figure 8-2
Mendall Marsh
Elevation Analysis

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052	Prepared/Date: MKM 3/9/2018	Checked/Date:CP 3/9/2018

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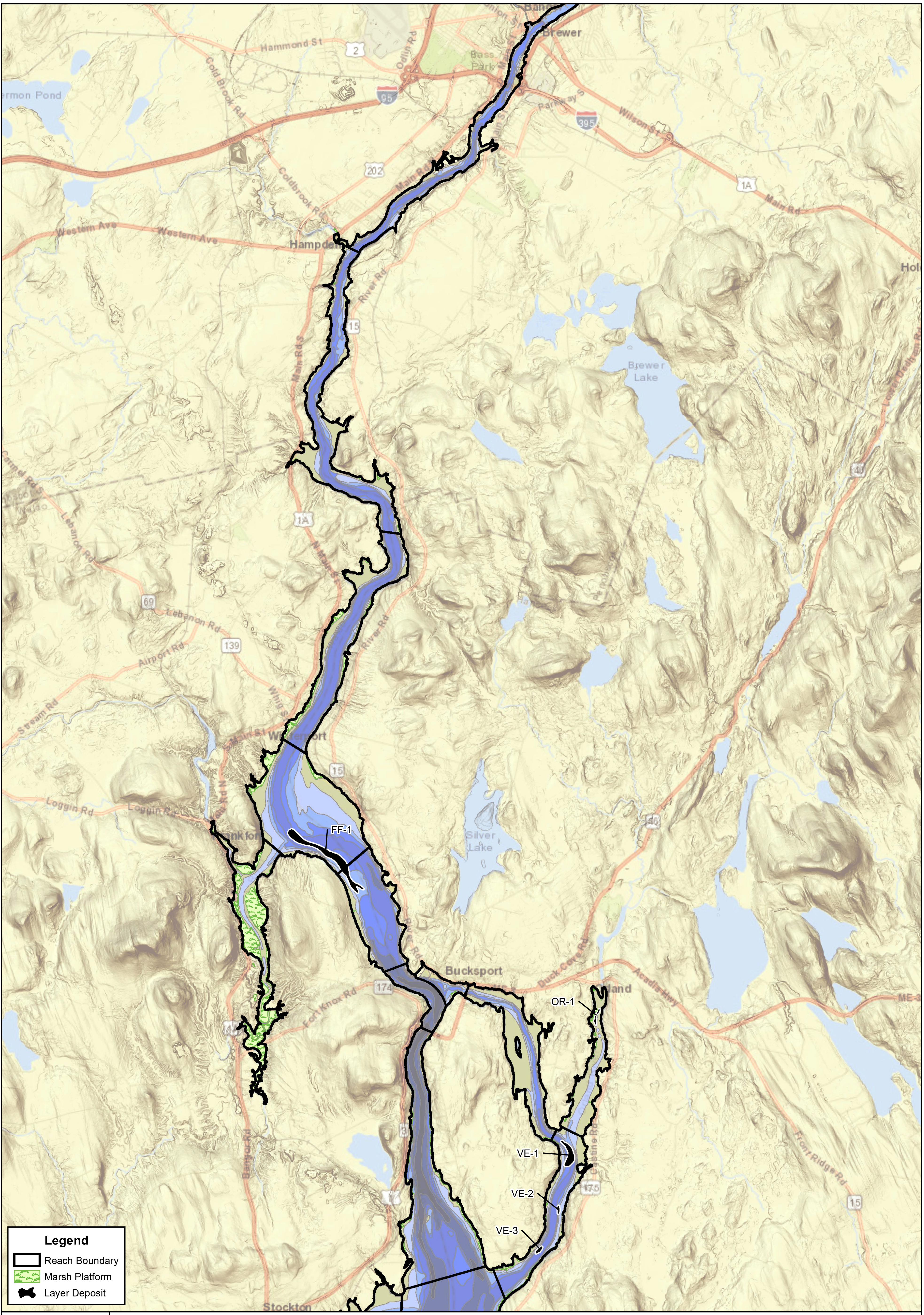

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N

Bathymetry

Water Depth feet (MLLW)

0 6 12 18 30 60 120 600

0 5,000 10,000 20,000
Feet

0 2.5 5 10
Kilometers

Figure 8-3
Recommended Remedial Alternative -
Surface Deposit Dredging

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052	Prepared/Date: 3/29/2018	Checked/Date: 3/29/2018	NAD83 State Plane Maine East, US Survey Feet

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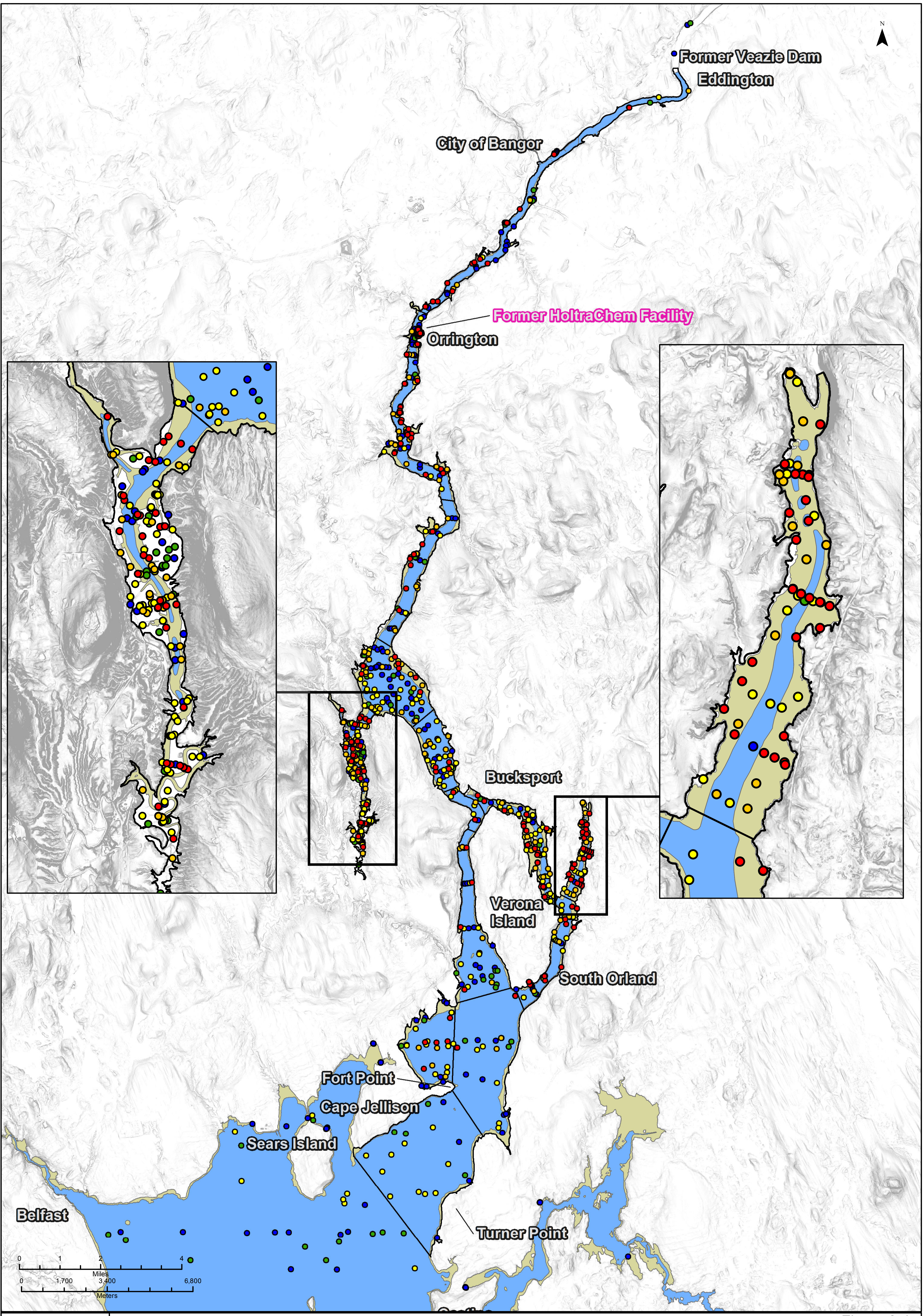

Symbol Key

☐ Official Study Reach Boundary

▨ Intertidal Zone

▨ Subtidal Zone

Total Mercury Concentration (ng/g)

- ● < 300 ng/g
- ● 300–500 ng/g
- ● 500–1,000 ng/g
- ● 1,000–1,500 ng/g
- ● >1,500 ng/g

*Figure includes historical data and presents the maximum total mercury concentration at any depth.

Figure 8-4
Distribution of Total Mercury in Estuary Sediment

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052 | Prepared: ICD 3/28/2018 | Checked: BPW 3/28/2018

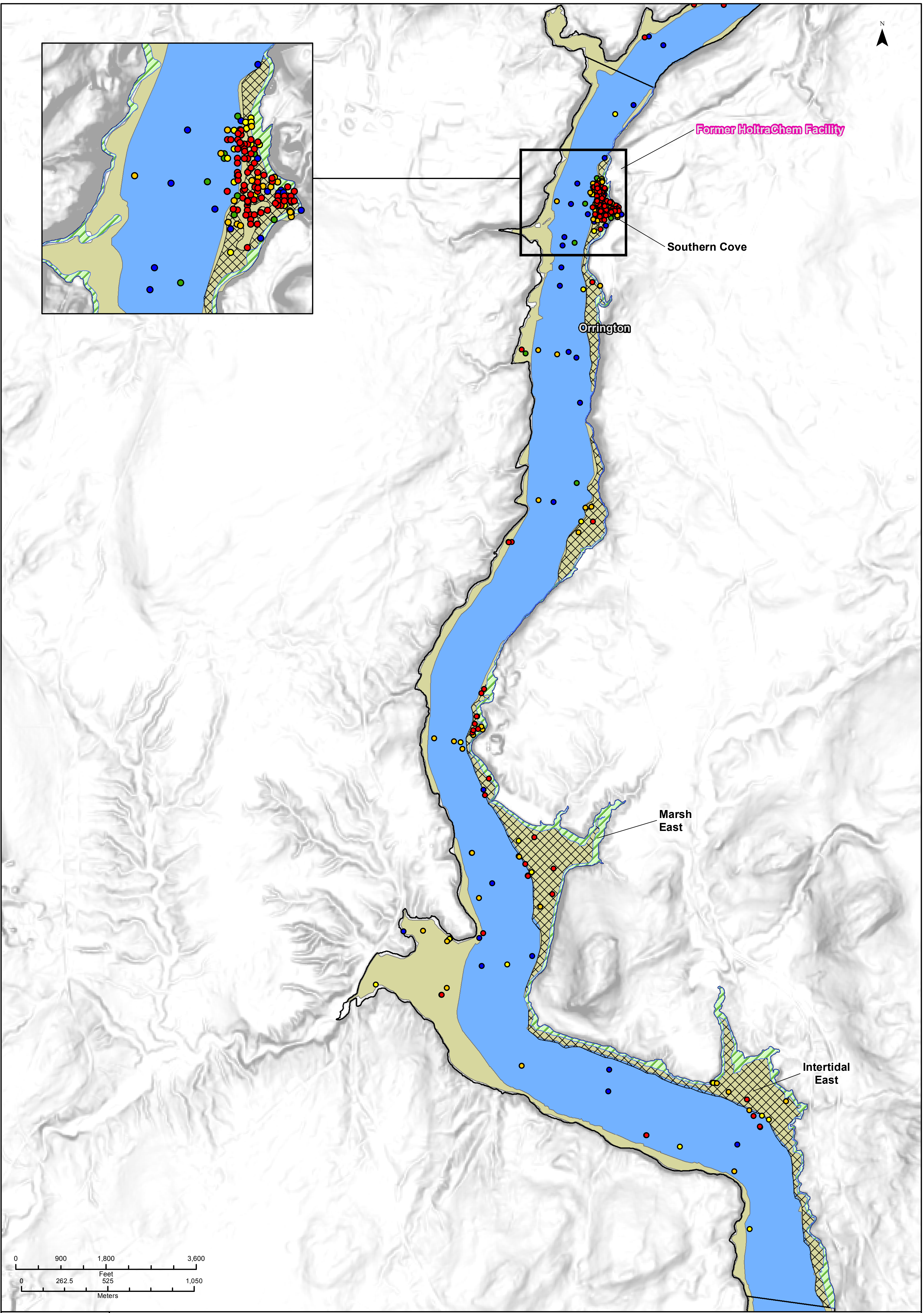

Figure 8-5
Recommended Remedial Alternative, Partial Dredge Scenario – Orrington Intertidal East and Orrington Marsh Platform East Dredging

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

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

Total Mercury Concentration (ng/g)
- ● < 300 ng/g
- ● 300–500 ng/g
- ● 500–1,000 ng/g
- ● 1,000–1,500 ng/g
- ● >1,500 ng/g

*Figure includes historical data and presents the maximum total mercury concentration at any depth.

Project: 3616166052 | Prepared: ICD 3/28/2018 | Checked: BPW 3/28/2018

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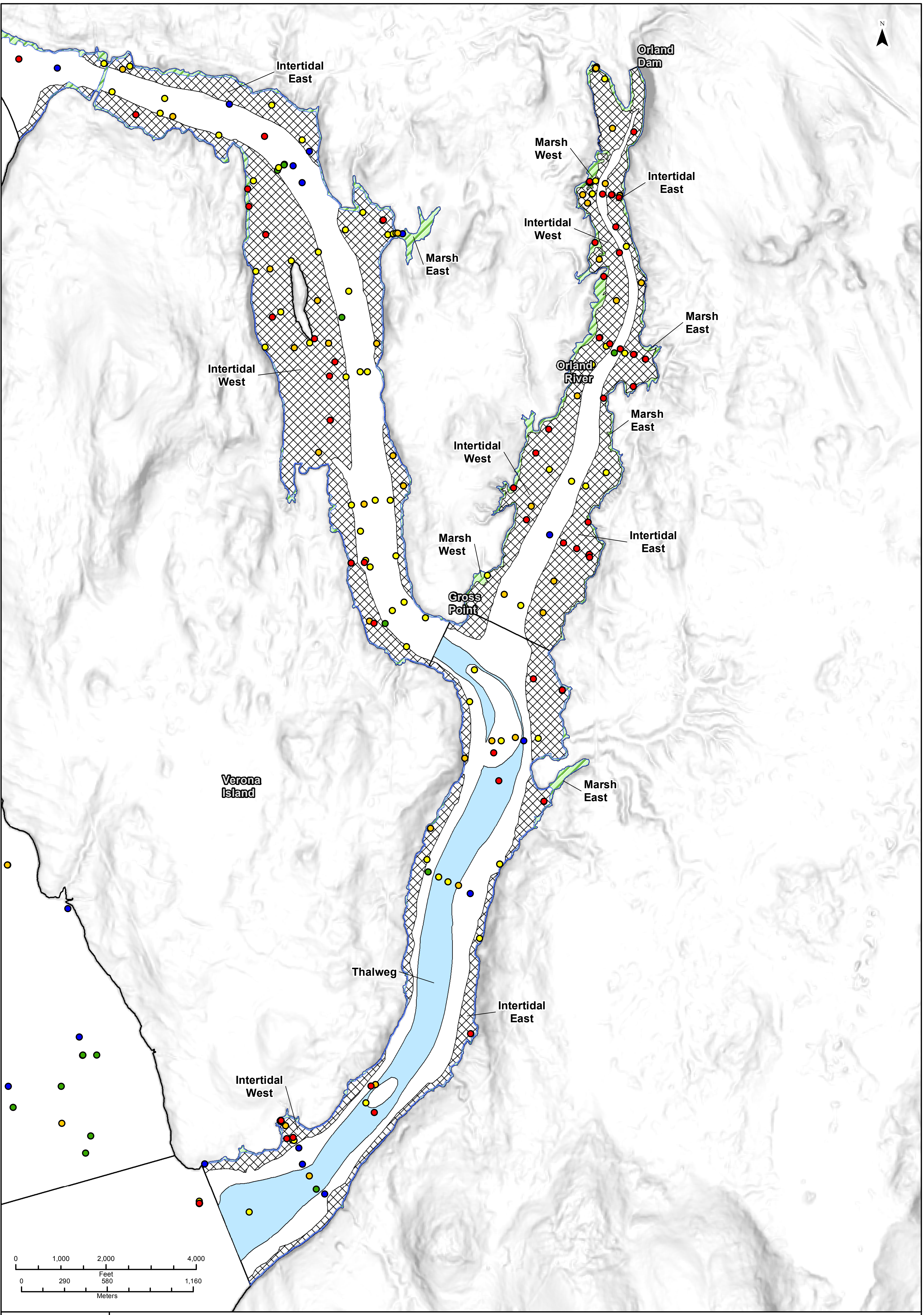

Symbol Key
▨ Intertidal
🟦 Main
▨ Marsh
☐ Official Study Reach Boundary

Total Mercury Concentration (ng/g)
🔵 < 300 ng/g
🟢 300–500 ng/g
🟡 500–1,000 ng/g
🟠 1,000–1,500 ng/g
🔴 >1,500 ng/g

*Figure includes historical data and presents the maximum total mercury concentration at any depth.

Figure 8-6
Potential Adaptive Management Alternative – Verona East, Verona Northeast and Orland River Dredging

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052 | Prepared: ICD 3/28/2018 | Checked: BPW 3/28/2018

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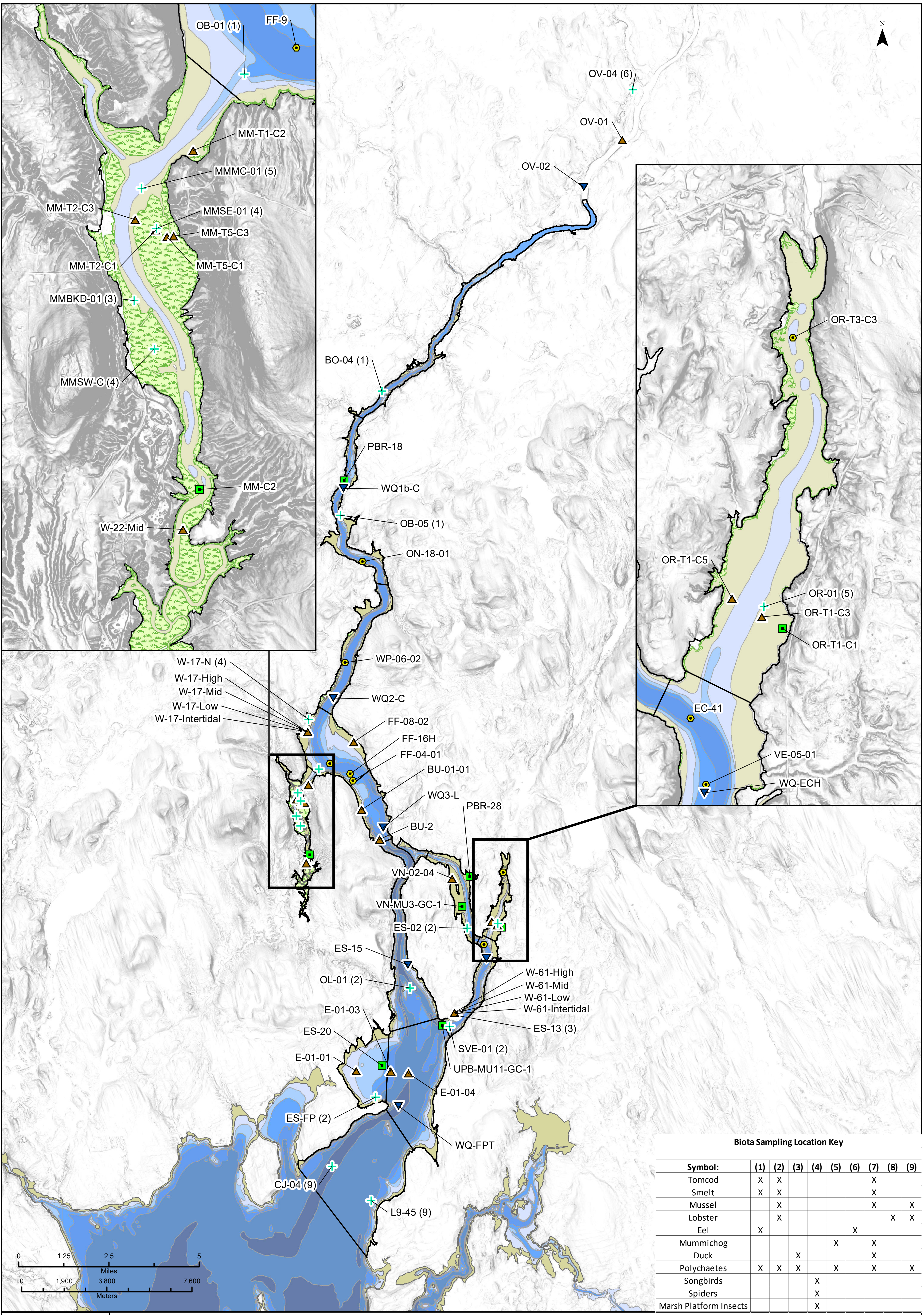

Biota Sampling Location Key

Symbol:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tomcod	X	X					X		
Smelt	X	X					X		
Mussel		X					X		X
Lobster		X						X	X
Eel	X					X			
Mummichog					X		X		
Duck			X				X		
Polychaetes	X	X	X		X		X		X
Songbirds				X					
Spiders				X					
Marsh Platform Insects				X					

Symbol Key

- ▼ Surface Water Sampling Station
- + Co-located Biota and Sediment Station
- 🟩 Geochronology Station
- ▲ Sediment Sampling Station
- ● Surface Deposit Station
- ☐ Study Reach Boundary
- ▨ Intertidal Zone
- ▨ Marsh Platform

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Figure 8-7
Recommended Long-Term Monitoring Stations - Penobscot River Estuary

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Project: 3616166052 | Prepared: ICD 4/6/2018 | Checked: KAM 4/6/2018

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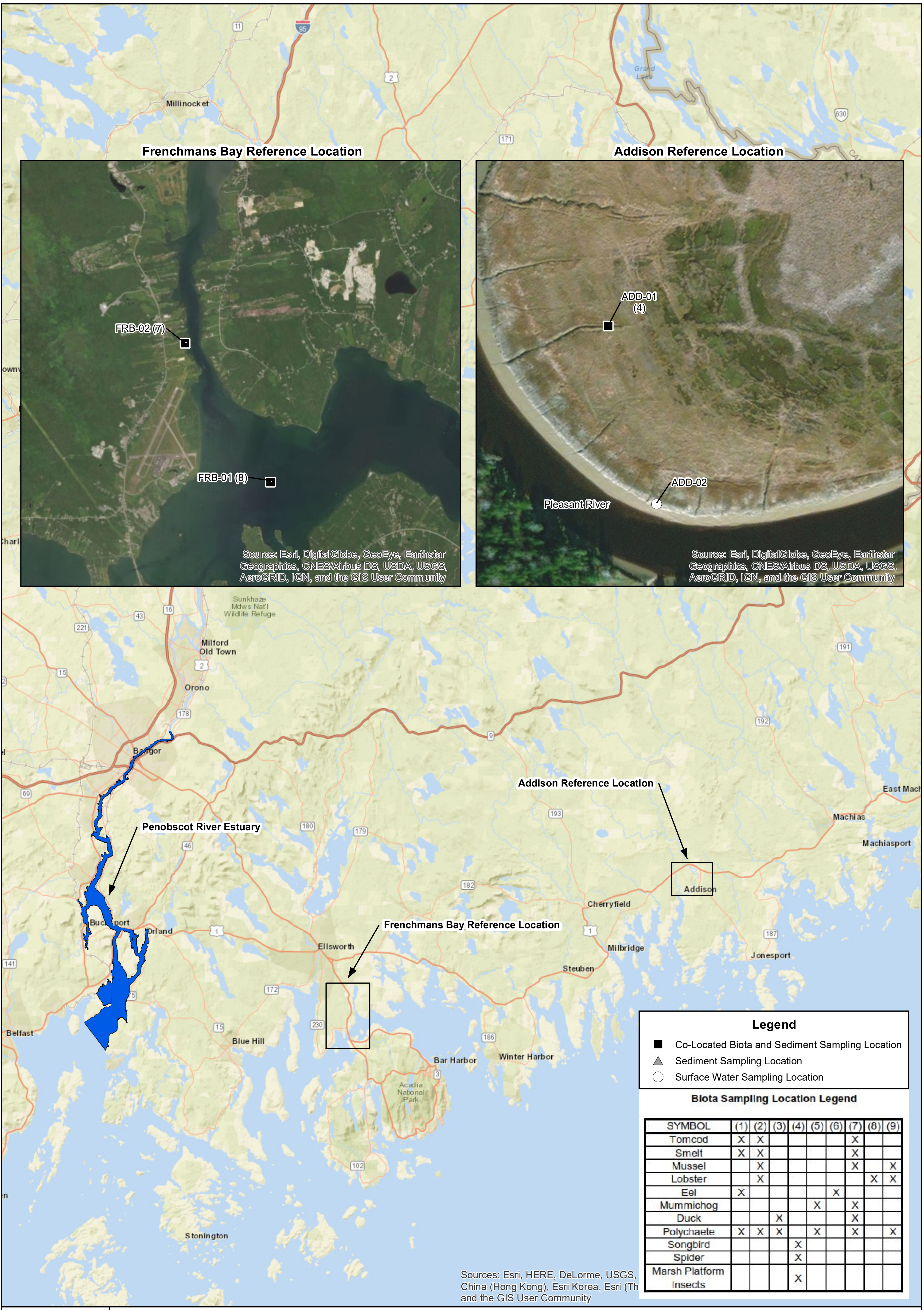

Legend

■ Co-Located Biota and Sediment Sampling Location
▲ Sediment Sampling Location
○ Surface Water Sampling Location

Biota Sampling Location Legend

SYMBOL	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tomcod	X	X					X		
Smelt	X	X					X		
Mussel		X					X		X
Lobster		X						X	X
Eel	X					X			
Mummichog					X		X		
Duck			X				X		
Polychaete	X	X	X		X		X		X
Songbird				X					
Spider				X					
Marsh Platform Insects				X					

Figure 8-8
Recommended Long-Term Monitoring Stations - Reference Locations

Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

amec foster wheeler

Project: 3616166052 | Prepared/Date: MKM 3/30/2018 | Checked/Date: JKT 3/30/2018 | NAD83 State Plane Maine East, US Survey Feet

Document:P:\Comm-Ind\Projects\Clients M to S\Penobscot(GIS)\Engineering Report\Figure 8-5d2_Reference.mxd 3/30/2018 10:38:06 AM david.young2

APPENDIX A

LITIGANT REQUEST FOR INFORMATION (RFI) – APRIL 2018

(PROVIDED ON DVD)

Litigant Request for Information (RFI) – April 2018
Penobscot River Phase III Engineering Study

Commentor	Comment #	Comment/Request	Appendix
NRDC	NRDC #4	4. All data and analysis produced by Dr. Gilmour or her lab regarding the Mendall Marsh amendment plots and the 2017 resampling study. In addition, all communications between Amec and Dr. Gilmour relating to the possibility of applying carbon-based amendments to soils within Mendall Marsh or elsewhere in the estuary (and all documents reflecting or relating to the substance of all such communications that were oral).	A-1 Amendment Plots
		One additional attachment "PB veg survey rev 2013_0104.pptx" from Dr Gilmour added to subfolder Correspondence 5/4/2018; also please note that as of 5/2/2018 all attachemnts to Dr Gilmour emails had been loaded to Sharepoint	A-1 Amendment Plots
NRDC	NRDC #5	5. Any data files and GIS shapefiles related to the geostatistical and traditional statistical analysis of sediment concentrations presented in Appendix G of the Alternatives Evaluation Report.	A-2 GIS and Statistics
Mallinckrodt	Mallinckrodt Costs & Schedule	o Costs & Schedule - Information and data supporting the cost and schedule estimates in subsection 8.6 of the draft Phase III Engineering Report. Any support for the cost estimates for any other measures (adaptive management remedies, operation and maintenance, long- term monitoring).	A-3 Costs and Schedule
NRDC	NRDC #6	6. Geotechnical information on sediment and wood waste that would impact the effectiveness of the remedy (i.e., grain size, material density, critical shear stress, and other parameters that would impact cap design).	A-4 Geotechnical Information
Mallinckrodt	Mallinckrodt Basic Info (2)	The data supporting the tables and figures in the draft Phase III Engineering Report along with any interactive maps or “map packages” that support the figures in the draft Phase III Engineering Report and the draft Thin Layer Sampling (Geochron Core) Report.	A-5 GIS Map Packages
Mallinckrodt	Mallinckrodt Implementability (1)	o Implementability - Information and data regarding the possible locations of on-shore facilities required for project implementation.	A-6 Implementability
Mallinckrodt	Mallinckrodt Implementability (2)	o Implementability - Beneficial reuse – Data or other information to support the conclusion on pg. 6-9 of the Alternatives Evaluation Report that dredged sediments would meet primary landfill acceptance criteria for off-site disposal/beneficial reuse criteria.	A-6 Implementability
Mallinckrodt	Mallinckrodt Implementability (3)	o Implementability - Information and data regarding evaluation and analysis of constructability and pilot tests or studies for each alternative.	A-6 Implementability
NRDC	NRDC #3	3. A clear statement, with supporting calculations and analysis, of the total quantity of mobile sediment in the system with mercury concentrations greater than 1,000 ng/g.	A-7 Mobile Sediment Volume Calculations
Mallinckrodt	Mallinckrodt Basic Info	o A revised copy of the draft Phase III Report figures. The copy of the figures transmitted on March 31, 2018 contain unreadable text.	Not Included (see September 2018 Phase III Engineering Study Report)
Mallinckrodt	Mallinckrodt Recovery Times (1)	o Recovery Times - Any analysis supporting the recovery half-time calculations. Information and data supporting the 25-year estimate of the time required for post-remediation MNR, as described on pg. 8-1.	A-8 Recovery Times
Mallinckrodt	Mallinckrodt Recovery Times (2)	o Recovery Times - Information and data related to the estimated timeframe of 45 years to achieve the 500 ng/g PRG and 100 years to achieve the 300 ng/g PRG associated with MNR, as referenced on pg. 8-3.	A-8 Recovery Times
NRDC	NRDC #2	2. Calculations and analysis regarding the estimated quantities of materials to be removed and/or placed for each of the proposed remedies (including the adaptive management options).	A-9 Removal-Replacement Volume
Mallinckrodt	Mallinckrodt (Risk Reduction & Effectiveness)	o Risk Reduction & Effectiveness - Any analysis regarding how much each primary remedy will reduce the time to reach the PRG of 500 ng/g.	A-10 Risk Reduction

Commentor	Comment #	Comment/Request	Appendix
NRDC	NRDC #7	7. The SedFlume report has a table of results for critical shear stresses for the cores the USACE collected (Table 3-13), but these data do not appear to be included in the project database. Please provide all the SedFlume data in useable, electronic form (e.g., MS Excel or Access), or identify how to locate them in the project database.	A-11 Sedflume Data
NRDC	NRDC #7a	7a. Please provide any other data or analyses that are available regarding measures of critical shear stress in the Penobscot Estuary.	A-11 Sedflume Data
Mallinckrodt	Mallinckrodt Subsurface Deposits (1)	o Subsurface Deposits - Information and data regarding the estimated quantity of mixed wood waste and mineral sediment on the estuary bed (e.g. thickness of the deposits of this material, the distribution of this material throughout the system, and the percentages of the mixture that exceed mercury concentrations of 500 ng/g).	A-12 Subsurface Deposits
Mallinckrodt	Mallinckrodt Subsurface Deposits (2)	o Subsurface Deposits - Information and data supporting the statement on pg. 3-27 that the suspended mix of wood waste and unconsolidated sediment may have ecological impacts on benthic habitat and may be transported to more stable depositional areas such as Mendall Marsh.	A-12 Subsurface Deposits
Mallinckrodt	Mallinckrodt Subsurface Deposits (3)	o Subsurface Deposits - Information and data supporting the suggestion on pg. 3-27 that "bedded wood waste could serve as a significant ongoing source for wood-enriched fines in suspension."	A-12 Subsurface Deposits
Mallinckrodt	Mallinckrodt Subsurface Deposits (4)	o Subsurface Deposits - Information and data in support of the suggestion on pg. 8-10 that the contemplated removal would accelerate system-wide recovery to meet the 500 ng/g total mercury PRG from a minimum of 45 years to a minimum of 25 years	A-12 Subsurface Deposits
NRDC	NRDC #1	1. Calculations and analysis that generated and/or support the pre-, current-, and post-remediation surface area weighted average concentrations (SWACs) for all parts of the Penobscot Estuary (referenced on page 6-1 of the Phase III Report). We would like to see how these values (pre-, current-, and post- remediation) are calculated for (a) the entire system, (b) the individual reaches and management units of the system, especially in the Orrington, Winterport, Frankfort Flats, Bucksport, Bucksport Harbor, Verona Northeast, Verona East, Mendall Marsh, and the Orland River reaches, and (c) each of the areas proposed for active remediation, including Mendall Marsh, the Orrington Intertidal East and Orrington Marsh Platform East units, and the five subtidal dredging deposits. We would like to see the same calculations for the proposed adaptive management options for the Orland River, Verona Northeast, and Verona East.	A-13 SWAC Calculations and Analyses
NRDC		1a. Also, if they are not part of the SWAC calculations, please provide any calculations and analysis that generated interval participation weighted concentrations (IPWCs) from multiple samples collected at different depths at the same location, and the resulting IPWCs paired with their GIS coordinates.	A-13 SWAC Calculations and Analyses
Mallinckrodt	Mallinckrodt (Calcs of SWAC and time to PRGs)	o Calculations of the SWAC & Time to Meet PRGs - Any documents, analysis, or calculations to support the calculation of the surface area weighted average concentrations of mercury.	A-13 SWAC Calculations and Analyses
Mallinckrodt	Mallinckrodt Orrington Dredging	o Orrington Dredging - Calculations and inputs to calculate the SWAC of mercury in this area and reductions that would be achieved by dredging in this reach.	A-13 SWAC Calculations and Analyses
NRDC	NRDC #8	8. Any supporting analysis, calculations, or justification for the design of thin layer capping in Mendall Marsh or other areas (e.g., documentation on the depth of the biological active zone in the Penobscot or other tidal estuaries, erosion and flow potential based on tidal fluctuations, breakthrough potential for isolation barrier, etc.). Please include any analyses that resulted in decisions to not recommend thin layer capping in any locations within the ecosystem.	A-14 Thin-Layer Capping

Litigant Request for Information (RFI) – April 2018
Penobscot River Phase III Engineering Study

Commentor	Comment #	Comment/Request	Appendix
Mallinckrodt	Mallinckrodt TLC (1)	o Thin-layer Capping - Information and data supporting the estimated design-life of 30 to 35 years for the Mendall Marsh thin layer cap.	A-14 Thin-Layer Capping
Mallinckrodt	Mallinckrodt TLC (2)	o Thin-layer Capping - Any analysis of thin layer capping in the Orland river or East Verona (size, location, amount of material, costs, time to implement, impact on the SWAC). (This remedial alternative was presented at the July 20, 2017 Quarterly Meeting).	A-14 Thin-Layer Capping

APPENDIX B

SUPPORTING COST DOCUMENTATION FOR RECOMMENDED REMEDIAL ALTERNATIVES

Phase III Engineering Study Report Cost Estimate Supporting Documentation

Thin Layer Capping in Mendall Marsh

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond	LS	1														
Work Plans and Submittals	LS	1					$72,732.19				$3,636.61	$76,368.80	$72,732.19	$76,368.80	$76,369	$80,000
Mobilization	LS	1					$2,168,187.81				$108,409.39	$2,276,597.20	$2,168,187.81	$2,276,597.20	$2,276,597	$2,280,000
Temporary Construction	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Conditions Surveys	LS	1	$16,988	$0	$797	$0	$17,784.27	$43.82	$2,134.11	$0.00	$995.92	$20,958.11	$17,784.27	$20,958.11	$20,958	$30,000
Topographic Surveys - TLC - 500	LS	1	$0	$0	$0	$618,739	$618,738.55	$0.00	$0.00	$30,936.93	$32,483.77	$682,159.25	$618,738.55	$682,159.25	$682,159	$690,000
Environmental Monitoring - Mendall - TLC - 500	LS	1	$57,671	$0	$513,293	$0	$570,963.41	$28,231.10	$68,515.61	$0.00	$31,973.95	$699,684.07	$570,963.41	$699,684.07	$699,684	$700,000
Material Procurement and Delivery - TLC - 500	Ton	265,166	$0	$6,098,815	$0	$0	$6,098,815.37	$335,434.85	$731,857.84	$0.00	$341,533.66	$7,507,641.72	$23.00	$28.31	$7,507,642	$7,510,000
Loading - TLC - 500	CY	196,419	$1,641,259	$132,130	$2,038,688	$0	$3,812,076.47	$119,394.98	$457,449.18	$0.00	$213,476.28	$4,602,396.90	$19.41	$23.43	$4,602,397	$4,610,000
Backfilling - TLC - 500	CY	196,419	$5,377,416	$430,965	$8,195,238	$0	$14,003,619.43	$474,441.17	$1,680,434.33	$0.00	$784,202.69	$16,942,697.62	$71.29	$86.26	$16,942,698	$16,950,000
Monitoring Program - TLC	LS	1	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0	$0
Restoration Plantings and Access Agreements- TLC - 500	LS	1	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0	$0
Demobilization	LS	1					$2,168,187.81	$0.00	$0.00	$0.00	$108,409.39	$2,276,597.20	$2,168,187.81	$2,276,597.20	$2,276,597	$2,280,000
		TOTALS	$7,273,219.33	$7,095,332.22	$10,840,939.03	$2,289,363.55	$31,907,961.93	$986,494.92	$3,025,138.87	$114,468.18	$1,752,378.45	$37,786,442.35	$7,993,564.37	$8,733,844.11	$37,786,442.35	$37,840,000.00

Worksheet Cost-TLC-500

Backfill for TLC of Mendall Marsh	
Item	**QTY**
Placement Area (SF)	10,347,937
Placement Area (Acres)	237.56
Min. Layer Thickness (FT)	0.25
Allowable Overplacement (FT)	0.25
Volume (CY)	191,628
Material Loss (%)	2.5%
Volume w/Loss (CY)	**196,419**
Weight (TON)	**265,166**

Unloading, Loading, and Processing - Mechanical		
Bucket Size	10.0	cy
Bucket % Full	90%	%
Cycle Time	1.5	min
Uptime	85%	%
# of Equipment	2	ea.
Hourly Rate	612	cy/hr
Shift	12	hrs/day
Production Rate	**7,344**	**cy/day**
Production Rate (Season)	**822,528**	**cy/season**

Thin Layer Capping - Hydraulic		
Discharge Size	12	Inch
Discharge Velocity	10	fps
Flow Rate (Q)	7.85	cfs
Flow Rate (Q)	3525.13	GPM
Conversion Factor	0.297	
Insitu % Solids	60%	%
Max % Solids	5%	%
Target % Solids	60%	%
Production Factor	1.0	
Dredge Efficiency	70%	%
# of dredges	1	ea.
Hourly Rate	37	cy/hr
Shift	12.0	hrs/day
Production Rate	**440**	**cy/day**

ESTIMATE WORKSHEET 4A

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - Main NE Coal Processing	4A

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.0	1.15	-	30

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - Main NE Coal Processing	4A	$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	
UNIT PRICES		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ELECTRICAL INSTALLATION	ELECTRIC	1	$10,000.00	LS	$10,000.00
WATER UTILITY INSTALLATION	WATER	1	$10,000.00	LS	$10,000.00
ASPHALT PAVING	SPA	215,125	$5.00	SF	$1,075,625.00
Dolphin Install	Barge docking	8	$50,000.00	SF	$400,000.00
Temporary Dock	Barge docking	350	$500.00	LF	$175,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,670,625.00	TOTAL COST →			$1,670,625.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	360	$65.51	$23,585.13
KOMATSU D39P	SPA/RSA		1	360	$34.48	$12,414.51
Wheeled Loaded WA320	SPA/RSA		1	360	$41.72	$15,020.00
84" SMOOTH COMPACTOR	SPA/RSA		1	360	$38.96	$14,024.25
CRANE - 40 TON	SPA/RSA		1	360	$77.44	$27,880.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$92,923.89	0		TOTAL RENTED EQUIP →		$92,923.89

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	360	$71.24	$25,645.20
OPERATOR 3	WA320/D39P	2	720	$70.43	$50,710.80
LABORER	ALL	4	1440	$53.80	$77,464.80
Crane Operator	40-ton	1	360	$72.40	$26,065.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$179,886.00	TOTAL LABOR COST →			$179,886.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.24	$12.00	MTH	$110.85
Per Diem	ALL	240	$51.00	MD	$12,240.00
Misc Safety Supplies	ALL	1.15	$1,000.00	MD	$1,154.73
Hdpe Liner - 20 Mil	SPA	282,725.00	$0.27	SF	$76,335.75
Geotextile	SPA	282,725.00	$0.08	SF	$22,920.20
Jersey Barriers	SPA	338.00	$295.00	EA	$99,710.00
Bin Blocks	SPA	1,530.00	$37.50	EA	$57,375.00
Concrete Sumps	SPA	4.00	$1,500.00	EA	$6,000.00
Silt Fence	SPA	18,000.00	$0.26	LF	$4,680.00
6" Hdpe Pipe	SPA	1,600.00	$17.36	LF	$27,776.00
Tarp 60'x60'	Drip Apron	2.00	$500.00	Ea	$1,000.00
Straw Hay Bales	Drip Apron	23.13	$4.25	Ea	$98.28
Stockpile Tarps	SPA	60.00	22.00	Ea	$1,320.00
DGA	SPA	5,577	22.00	Ton	$122,700.93
					$0.00
BARE UNIT COST → $433,421.75		TOTAL MATERIAL COST →			$433,421.75

ESTIMATE WORKSHEET 7

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Conditions Surveys	7

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1		12	6	1.7	0.38	-	10
BID UNIT	LS							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Conditions Surveys	7	$16,987.60	$0.00	$796.67	$0.00	$17,784.27	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$16,987.60	$0.00	$796.67	$0.00	$17,784.27	
UNIT PRICES		$16,987.60	$0.00	$796.67	$0.00	$17,784.27	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Workboat	TRANSPORT		1	120	$6.64	$796.67
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$796.67	0		TOTAL RENTED EQUIP →		$796.67

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Boat Operator	Survey	1	120	$62.23	$7,467.60
Foreman	Survey	1	120	$79.33	$9,520.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$16,987.60	TOTAL LABOR COST →		$16,987.60

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 9

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Topographic Surveys - TLC - 500	9

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	1	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	LS		12	6	19.9	4.59	-	119

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Topographic Surveys - TLC - 500	9	$0.00	$0.00	$0.00	$618,738.55	$618,738.55	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$618,738.55	$618,738.55	
UNIT PRICES		$0.00	$0.00	$0.00	$618,738.55	$618,738.55	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	1,192	$90.00	HR	$107,254.37
Establish Benchmarks	Survey	60	$2,500.00	LS	$148,964.40
Topographic Survey	Survey	119	$2,500.00	DAY	$297,928.81
Per Diem	Survey	238	$35.00	DAY	$8,342.01
Expenses & Fuel	Survey	1	$56,248.96	of Total (	$56,248.96
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$618,738.55	TOTAL COST →		$618,738.55

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 29

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Environmental Monitoring - Mendall - TLC - 500	29

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	74.4	17.19	2,822	447

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Environmental Monitoring - Mendall - TLC - 500	29	$57,670.75	$0.00	$513,292.66	$0.00	$570,963.41	Include Monitoring during all silt producing activities. Initial install and ongoing maintenance included. Assumes 2 laborers for maintenance and demob at 10% of total duration. Additional Maintenance is covered under other water tasks.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$57,670.75	$0.00	$513,292.66	$0.00	$570,963.41	
UNIT PRICES		$57,670.75	$0.00	$513,292.66	$0.00	$570,963.41	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS/MONTHS	UNIT RATE	TOTAL COST
Workboat	INSTALL/MAINTAIN		2	1072	$6.64	$7,117.20
Water Quality Monitoring Buoy (	Monitor		10	172	$2,944.00	$506,175.46
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$513,292.66	0		TOTAL RENTED EQUIP →		$513,292.66

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Laborer	Install	2	1072	$53.80	$57,670.75
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$57,670.75	TOTAL LABOR COST →			$57,670.75

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 81

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Material Procurement and Delivery - TLC - 500	81

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	265,166		12	6	0.0	0.00	--	0
BID UNIT	Ton							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Material Procurement and Delivery - TLC - 500	81	$0.00	$6,098,815.37	$0.00	$0.00	$6,098,815.37	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$6,098,815.37	$0.00	$0.00	$6,098,815.37	
UNIT PRICES		$0.00	$23.00	$0.00	$0.00	$23.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Misc Safety Supplies	ALL	0.00	$1,000.00	MTH	$0.00
Sand Habitat Restoration Material	BACKFILL	265,166	$23.00	TON	$6,098,815.37
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$23.00	TOTAL MATERIAL COST →			$6,098,815.37

ESTIMATE WORKSHEET 95

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Loading - TLC - 500	95

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	196,419	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	74.4	17.19	7,344	447

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Loading - TLC - 500	95	$1,641,258.71	$132,130.02	$2,038,687.74	$0.00	$3,812,076.47	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,641,258.71	$132,130.02	$2,038,687.74	$0.00	$3,812,076.47	
UNIT PRICES		$8.36	$0.67	$10.38	$0.00	$19.41	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	10720	$158.89	$1,703,362.97
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	10720	$31.28	$335,324.77
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$10.38	0		TOTAL RENTED EQUIP →		$2,038,687.74

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	10720	$72.40	$776,197.49
Laborer	DREDGE	3	16081	$53.80	$865,061.22
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$8.36	TOTAL LABOR COST →			$1,641,258.71

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	85.97	$12.00	MTH	$1,031.61
Per Diem	ALL	2,233	$51.00	MD	$113,904.95
Misc Safety Supplies	ALL	17.19	$1,000.00	MD	$17,193.46
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.67	TOTAL MATERIAL COST →			$132,130.02

ESTIMATE WORKSHEET 109

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Backfilling - TLC - 500	109

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	196,419	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	74.4	17.19	440	447

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Backfilling - TLC - 500	109	$5,377,416.27	$430,965.08	$8,195,238.08	$0.00	$14,003,619.43	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$5,377,416.27	$430,965.08	$8,195,238.08	$0.00	$14,003,619.43	
UNIT PRICES		$27.38	$2.19	$41.72	$0.00	$71.29	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
DREDGE BOOSTER PUMP - 12"	Backfilling		1	5360	$140.00	$750,432.64
DREDGE PIPE - 8"-12" (PER FT)	Backfill/Transport		20000	107204662	$0.02	$2,144,093.25
Workboat	Backfill/Transport		2	10720	$6.64	$71,171.98
HD Long Reach Excavator (Dredge)	Backfill		3	16081	$103.33	$1,661,672.27
Hydraulic Booster Pump	Backfill/Transport		3	16081	$11.32	$181,987.36
Dredge Tender (Push Boat)	Backfill/Transport		3	16081	$71.67	$1,152,450.12
Hopper Barge (2000 cy)			3	16081	$138.89	$2,233,430.46
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$41.72	0		TOTAL RENTED EQUIP →		$8,195,238.08

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 1	Backfill	3	16081	$71.82	$1,154,915.83
Laborer	Backfill	6	32161	$53.80	$1,730,122.44
Deckhand	Backfill	3	16081	$45.02	$723,982.29
Boat Operator	Backfill	2	10720	$62.23	$667,134.61
Foreman	Backfill	1	5360	$79.33	$425,245.16
Tug Operator	Backfill	3	16081	$42.04	$676,015.94
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$27.38	TOTAL LABOR COST →			$5,377,416.27

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	309.48	$12.00	MTH	$3,713.79
Per Diem	ALL	8,040	$51.00	MD	$410,057.83
Misc Safety Supplies	ALL	17.19	$1,000.00	MD	$17,193.46
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$2.19	TOTAL MATERIAL COST →			$430,965.08

ESTIMATE WORKSHEET 144D

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Monitoring Program - TLC	144D

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.0	0.00	-	0

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Monitoring Program - TLC	144D	$0.00	$0.00	$0.00	$0.00	$0.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$0.00	$0.00	
UNIT PRICES		$0.00	$0.00	$0.00	$0.00	$0.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Monitored Natural Recover (Limited)	Monitoring	0	$500,000.00	Each	$0.00
Post Construction Bathy Survey	Survey	0	$100,000.00	Each	$0.00
Post Construction Sampling (Land)	Sample	0	$500.00	Each	$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.00	$12.00	MTH	$0.00
Per Diem	ALL	0	$51.00	MD	$0.00
Misc Safety Supplies	ALL	0.00	$1,000.00	MD	$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 157

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Restoration Plantings and Access Agreements- TLC - 500	157

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	1	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	LS		12	6	0.0	0.00	-	0

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Restoration Plantings and Access Agreements-TLC - 500	157	$0.00	$0.00	$0.00	$0.00	$0.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$0.00	$0.00	
UNIT PRICES		$0.00	$0.00	$0.00	$0.00	$0.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Restoration Planting	Restore	0	$5,000.00	Acre	$0.00
Access Agreements	Access	0	$25,000.00	Each	$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

Phase III Engineering Study Report Cost Estimate Supporting Documentation

Surface Deposit Dredging

Frankfort Flats and Verona Dredging with Offsite Disposal

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$79,087.10				$3,954.36	$83,041.46	$79,087.10	$83,041.46	$83,041	$90,000
Mobilization	LS	1					$1,367,123.54				$68,356.18	$1,435,479.71	$1,367,123.54	$1,435,479.71	$1,435,480	$1,440,000
Temporary Construction	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Conditions Surveys	LS	1	$16,988	$0	$797	$0	$17,784.27	$43.82	$2,134.11	$0.00	$995.92	$20,958.11	$17,784.27	$20,958.11	$20,958	$30,000
Topographic Surveys - Dredge	LS	1	$0	$0	$0	$129,800	$129,800.00	$0.00	$0.00	$6,490.00	$6,814.50	$143,104.50	$129,800.00	$143,104.50	$143,105	$150,000
Hydrographic Surveys - FF & VE - Deep	LS	1	$0	$0	$0	$1,299,486	$1,299,485.50	$0.00	$0.00	$64,974.28	$68,222.99	$1,432,682.77	$1,299,485.50	$1,432,682.77	$1,432,683	$1,440,000
Utilities Surveys	LS	1	$0	$0	$0	$360,869	$360,868.75	$0.00	$0.00	$18,043.44	$18,945.61	$397,857.80	$360,868.75	$397,857.80	$397,858	$400,000
Debris Surveys	LS	1	$0	$0	$0	$375,463	$375,463.00	$0.00	$0.00	$18,773.15	$19,711.81	$413,947.96	$375,463.00	$413,947.96	$413,948	$420,000
Environmental Monitoring - FF & VE - Deep	LS	1	$49,261	$0	$179,026	$3,670,000	$3,898,287.51	$9,846.44	$27,394.50	$183,500.00	$205,459.10	$4,324,487.54	$3,898,287.51	$4,324,487.54	$4,324,488	$4,330,000
Debris Removal - FF & VE - Deep	CY	5,082	$341,685	$28,426	$266,636	$0	$636,747.08	$16,228.42	$76,409.65	$0.00	$35,657.84	$765,042.98	$125.30	$150.55	$765,043	$770,000
Dredging - FF & VE - Deep	CY	1,016,344	$4,478,841	$365,957	$4,077,293	$0	$8,922,091.26	$244,378.76	$1,070,650.95	$0.00	$499,637.11	$10,736,758.08	$8.78	$10.56	$10,736,758	$10,740,000
Offloading - FF & VE - Deep	CY	1,016,344	$1,323,113	$106,518	$1,643,503	$0	$3,073,132.86	$96,251.12	$368,775.94	$0.00	$172,095.44	$3,710,255.36	$3.02	$3.65	$3,710,255	$3,720,000
Processing - FF & VE - Deep	CY	1,016,344	$1,073,614	$8,332,569	$575,439	$0	$9,981,621.42	$489,940.40	$1,197,794.57	$0.00	$558,970.80	$12,228,327.19	$9.82	$12.03	$12,228,327	$12,230,000
T&D - FF & VE - Deep	Ton	856,168	$0	$6,085	$0	$70,890,726	$70,896,811.19	$334.70	$730.25	$3,544,536.29	$3,722,103.89	$78,164,516.31	$82.81	$91.30	$78,164,516	$78,170,000
Water Treatment - FF & VE - Deep	LS	1	$445,323	$32,392	$0	$940,000	$1,417,714.70	$1,781.56	$57,325.76	$47,000.00	$76,102.02	$1,599,924.05	$1,417,714.70	$1,599,924.05	$1,599,924	$1,600,000
Demobilization	LS	1					$1,367,123.54	$0.00	$0.00	$0.00	$68,356.18	$1,435,479.71	$1,367,123.54	$1,435,479.71	$1,435,480	$1,440,000
		TOTALS	$7,908,710.34	$9,305,368.13	$6,835,617.69	$79,336,968.02	$106,199,998.35	$887,754.22	$2,885,963.54	$3,966,848.40	$5,652,640.51	$119,593,205.03	$12,689,824.28	$13,988,573.19	$119,593,205.03	$119,680,000.00

Orland Dredging with Offsite Disposal

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$11,486.64				$574.33	$12,060.97	$11,486.64	$12,060.97	$12,061	$20,000
Mobilization	LS	1					$49,349.67				$2,467.48	$51,817.16	$49,349.67	$51,817.16	$51,817	$60,000
Hydrographic Surveys - Orland River	LS	1	$0	$0	$0	$278,996	$278,995.58	$0.00	$0.00	$13,949.78	$14,647.27	$307,592.62	$278,995.58	$307,592.62	$307,593	$310,000
Environmental Monitoring - Orland River	LS	1	$10,069	$0	$18,918	$0	$28,986.62	$1,040.47	$3,478.39	$0.00	$1,623.25	$35,128.73	$28,986.62	$35,128.73	$35,129	$40,000
Debris Removal - Orland River	CY	160	$10,775	$896	$8,408	$0	$20,078.94	$511.74	$2,409.47	$0.00	$1,124.42	$24,124.57	$125.30	$150.55	$24,125	$30,000
Dredging - Orland River	CY	32,049	$613,250	$50,719	$483,268	$0	$1,147,237.40	$29,369.30	$137,668.49	$0.00	$64,245.29	$1,378,520.48	$35.80	$43.01	$1,378,520	$1,380,000
Offloading - Orland River	CY	32,049	$284,068	$22,869	$352,855	$0	$659,792.25	$20,664.82	$79,175.07	$0.00	$36,948.37	$796,580.51	$20.59	$24.86	$796,581	$800,000
Processing - Orland River	CY	32,049	$230,502	$278,872	$123,545	$0	$632,918.44	$22,132.92	$75,950.21	$0.00	$35,443.43	$766,445.01	$19.75	$23.91	$766,445	$770,000
T&D - Orland River	Ton	26,998	$0	$192	$0	$2,235,441	$2,235,632.72	$10.55	$23.03	$111,772.04	$117,371.39	$2,464,809.73	$82.81	$91.30	$2,464,810	$2,470,000
Demobilization	LS	1					$49,349.67	$0.00	$0.00	$0.00	$2,467.48	$51,817.16	$49,349.67	$51,817.16	$51,817	$60,000
		TOTALS	**$1,148,663.58**	**$353,548.53**	**$986,993.43**	**$2,514,436.40**	**$5,113,827.92**	**$73,729.81**	**$298,704.67**	**$125,721.82**	**$276,912.72**	**$5,888,896.94**	**$418,452.41**	**$458,750.26**	**$5,888,896.94**	**$5,940,000.00**

Frankfort Flats and Verona Dredging with Beneficial Reuse

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$79,087.10				$3,954.36	$83,041.46	$79,087.10	$83,041.46	$83,041	$90,000
Mobilization	LS	1					$1,367,123.54				$68,356.18	$1,435,479.71	$1,367,123.54	$1,435,479.71	$1,435,480	$1,440,000
Temporary Construction	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Conditions Surveys	LS	1	$16,988	$0	$797	$0	$17,784.27	$43.82	$2,134.11	$0.00	$995.92	$20,958.11	$17,784.27	$20,958.11	$20,958	$30,000
Topographic Surveys - Dredge	LS	1	$0	$0	$0	$129,800	$129,800.00	$0.00	$0.00	$6,490.00	$6,814.50	$143,104.50	$129,800.00	$143,104.50	$143,105	$150,000
Hydrographic Surveys - FF & VE - Deep	LS	1	$0	$0	$0	$1,299,486	$1,299,485.50	$0.00	$0.00	$64,974.28	$68,222.99	$1,432,682.77	$1,299,485.50	$1,432,682.77	$1,432,683	$1,440,000
Utilities Surveys	LS	1	$0	$0	$0	$360,869	$360,868.75	$0.00	$0.00	$18,043.44	$18,945.61	$397,857.80	$360,868.75	$397,857.80	$397,858	$400,000
Debris Surveys	LS	1	$0	$0	$0	$375,463	$375,463.00	$0.00	$0.00	$18,773.15	$19,711.81	$413,947.96	$375,463.00	$413,947.96	$413,948	$420,000
Environmental Monitoring - FF & VE - Deep	LS	1	$49,261	$0	$179,026	$3,670,000	$3,898,287.51	$9,846.44	$27,394.50	$183,500.00	$205,459.10	$4,324,487.54	$3,898,287.51	$4,324,487.54	$4,324,488	$4,330,000
Debris Removal - FF & VE - Deep	CY	5,082	$341,685	$28,426	$266,636	$0	$636,747.08	$16,228.42	$76,409.65	$0.00	$35,657.84	$765,042.98	$125.30	$150.55	$765,043	$770,000
Dredging - FF & VE - Deep	CY	1,016,344	$4,478,841	$365,957	$4,077,293	$0	$8,922,091.26	$244,378.76	$1,070,650.95	$0.00	$499,637.11	$10,736,758.08	$8.78	$10.56	$10,736,758	$10,740,000
Offloading - FF & VE - Deep	CY	1,016,344	$1,323,113	$106,518	$1,643,503	$0	$3,073,132.86	$96,251.12	$368,775.94	$0.00	$172,095.44	$3,710,255.36	$3.02	$3.65	$3,710,255	$3,720,000
Processing - FF & VE - Deep	CY	1,016,344	$1,073,614	$8,332,569	$575,439	$0	$9,981,621.42	$489,940.40	$1,197,794.57	$0.00	$558,970.80	$12,228,327.19	$9.82	$12.03	$12,228,327	$12,230,000
T&D Ben - FF & VE - Deep	Ton	856,168	$0	$6,085	$0	$28,082,316	$28,088,401.91	$334.70	$730.25	$1,404,115.82	$1,474,662.40	$30,968,245.08	$32.81	$36.17	$30,968,245	$30,970,000
Water Treatment - FF & VE - Deep	LS	1	$445,323	$32,392	$0	$940,000	$1,417,714.70	$1,781.56	$57,325.76	$47,000.00	$76,102.02	$1,599,924.05	$1,417,714.70	$1,599,924.05	$1,599,924	$1,600,000
Demobilization	LS	1					$1,367,123.54	$0.00	$0.00	$0.00	$68,356.18	$1,435,479.71	$1,367,123.54	$1,435,479.71	$1,435,480	$1,440,000
		TOTALS	$7,908,710.34	$9,305,368.13	$6,835,617.69	$36,528,558.74	$63,391,589.07	$887,754.22	$2,885,963.54	$1,826,427.94	$3,405,199.03	$72,396,933.80	$12,689,774.28	$13,988,518.07	$72,396,933.80	$72,480,000.00

Orland Dredging with Beneficial Reuse

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$11,486.64				$574.33	$12,060.97	$11,486.64	$12,060.97	$12,061	$20,000
Mobilization	LS	1					$49,349.67				$2,467.48	$51,817.16	$49,349.67	$51,817.16	$51,817	$60,000
Hydrographic Surveys - Orland River	LS	1	$0	$0	$0	$278,996	$278,995.58	$0.00	$0.00	$13,949.78	$14,647.27	$307,592.62	$278,995.58	$307,592.62	$307,593	$310,000
Environmental Monitoring - Orland River	LS	1	$10,069	$0	$18,918	$0	$28,986.62	$1,040.47	$3,478.39	$0.00	$1,623.25	$35,128.73	$28,986.62	$35,128.73	$35,129	$40,000
Debris Removal - Orland River	CY	160	$10,775	$896	$8,408	$0	$20,078.94	$511.74	$2,409.47	$0.00	$1,124.42	$24,124.57	$125.30	$150.55	$24,125	$30,000
Dredging - Orland River	CY	32,049	$613,250	$50,719	$483,268	$0	$1,147,237.40	$29,369.30	$137,668.49	$0.00	$64,245.29	$1,378,520.48	$35.80	$43.01	$1,378,520	$1,380,000
Offloading - Orland River	CY	32,049	$284,068	$22,869	$352,855	$0	$659,792.25	$20,664.82	$79,175.07	$0.00	$36,948.37	$796,580.51	$20.59	$24.86	$796,581	$800,000
Processing - Orland River	CY	32,049	$230,502	$278,872	$123,545	$0	$632,918.44	$22,132.92	$75,950.21	$0.00	$35,443.43	$766,445.01	$19.75	$23.91	$766,445	$770,000
T&D Ben - Orland River	Ton	26,998	$0	$192	$0	$885,537	$885,728.84	$10.55	$23.03	$44,276.85	$46,501.44	$976,540.71	$32.81	$36.17	$976,541	$980,000
Demobilization	LS	1					$49,349.67	$0.00	$0.00	$0.00	$2,467.48	$51,817.16	$49,349.67	$51,817.16	$51,817	$60,000
		TOTALS	**$1,148,663.58**	**$353,548.53**	**$986,993.43**	**$1,164,532.52**	**$3,763,924.04**	**$73,729.81**	**$298,704.67**	**$58,226.63**	**$206,042.77**	**$4,400,627.91**	**$418,402.41**	**$458,695.13**	**$4,400,627.91**	**$4,450,000.00**

Debris Disposal Quantities	Frankfort Flats and Verona (Deep)	Orland River (Shallow)
Dredge Volume (CY)	1,016,344	32,049
Debris Area (% of Dredge Volume)	1%	1%
Debris Volume (CY)	**5082**	**160**
Debris Volume (TONS)	**3,964**	**125**

Dredging & Disposal Quantities	Frankfort Flats and Verona (Deep)	Orland River (Shallow)
Dredge Depth	5.00	3.00
Dredge Volume (CY)	1,016,344	32,049
Dredge Area (SF)	6,204,437	865,314
Total Area Footprint (ACRES)	142.43	19.86
Overdepth Dredge (FT)	0.00	0.00
Overdepth Dredge (CY)	0	0
Total Dredging Volume (CY)	1,016,344	32,049
Total Dredging Volume Bulked (CY)	**1,016,344**	**32,049**
Total Dredging Volume (TON)	792,748	24,998
Portland Cement Addition (TON)	63,420	2,000
(TON)	**856,168**	**26,998**

Deep Dredging - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.5	min
Uptime	70%	%
# of dredges	2	ea.
Hourly Rate	235	cy/hr
Shift	12	hrs/day
Production Rate	**2,822**	**cy/day**
Production Rate (Season)	**316,109**	**cy/season**

Shallow Dredging - Mechanical		
Bucket Size	3.5	cy
% Full	70%	%
Cycle Time	2.0	min
Uptime	47%	%
# of dredges	1	ea.
Hourly Rate	35	cy/hr
Shift	12	hrs/day
Production Rate	**415**	**cy/day**
Production Rate (Season)	**46,428**	**cy/season**

Unloading, Loading, and Processing - Mechanical		
Bucket Size	10.0	cy
Bucket % Full	90%	%
Cycle Time	1.5	min
Uptime	85%	%
# of Equipment	2	ea.
Hourly Rate	612	cy/hr
Shift	12	hrs/day
Production Rate	**7,344**	**cy/day**
Production Rate (Season)	**822,528**	**cy/season**

Debris Removal		
Bucket Size	3.5	cy
% Full	50%	%
Cycle Time	5.0	min
Uptime	47%	%
# of Equipment	2	ea.
Hourly Rate	20	cy/hr
Shift	12	hrs/day
Production Rate	**237**	**cy/day**

ESTIMATE WORKSHEET 5

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - Main NE Coal Processing	5

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.0	1.15	-	30

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - Main NE Coal Processing	5	$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	
UNIT PRICES		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ELECTRICAL INSTALLATION	ELECTRIC	1	$10,000.00	LS	$10,000.00
WATER UTILITY INSTALLATION	WATER	1	$10,000.00	LS	$10,000.00
ASPHALT PAVING	SPA	215,125	$5.00	SF	$1,075,625.00
Dolphin Install	Barge docking	8	$50,000.00	SF	$400,000.00
Temporary Dock	Barge docking	350	$500.00	LF	$175,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,670,625.00	TOTAL COST →			$1,670,625.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	360	$65.51	$23,585.13
KOMATSU D39P	SPA/RSA		1	360	$34.48	$12,414.51
Wheeled Loaded WA320	SPA/RSA		1	360	$41.72	$15,020.00
84" SMOOTH COMPACTOR	SPA/RSA		1	360	$38.96	$14,024.25
CRANE - 40 TON	SPA/RSA		1	360	$77.44	$27,880.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$92,923.89	0		TOTAL RENTED EQUIP →		$92,923.89

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	360	$71.24	$25,645.20
OPERATOR 3	WA320/D39P	2	720	$70.43	$50,710.80
LABORER	ALL	4	1440	$53.80	$77,464.80
Crane Operator	40-ton	1	360	$72.40	$26,065.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$179,886.00	TOTAL LABOR COST →			$179,886.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.24	$12.00	MTH	$110.85
Per Diem	ALL	240	$51.00	MD	$12,240.00
Misc Safety Supplies	ALL	1.15	$1,000.00	MD	$1,154.73
Hdpe Liner - 20 Mil	SPA	282,725.00	$0.27	SF	$76,335.75
Geotextile	SPA	282,725.00	$0.08	SF	$22,920.20
Jersey Barriers	SPA	338.00	$295.00	EA	$99,710.00
Bin Blocks	SPA	1,530.00	$37.50	EA	$57,375.00
Concrete Sumps	SPA	4.00	$1,500.00	EA	$6,000.00
Silt Fence	SPA	18,000.00	$0.26	LF	$4,680.00
6" Hdpe Pipe	SPA	1,600.00	$17.36	LF	$27,776.00
Tarp 60'x60'	Drip Apron	2.00	$500.00	Ea	$1,000.00
Straw Hay Bales	Drip Apron	23.13	$4.25	Ea	$98.28
Stockpile Tarps	SPA	60.00	22.00	Ea	$1,320.00
DGA	SPA	5,577	22.00	Ton	$122,700.93
					$0.00
BARE UNIT COST → $433,421.75		TOTAL MATERIAL COST →			$433,421.75

ESTIMATE WORKSHEET 8

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Conditions Surveys	8

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	1.7	0.38	-	10

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Conditions Surveys	8	$16,987.60	$0.00	$796.67	$0.00	$17,784.27	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$16,987.60	$0.00	$796.67	$0.00	$17,784.27	
UNIT PRICES		$16,987.60	$0.00	$796.67	$0.00	$17,784.27	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Workboat	TRANSPORT		1	120	$6.64	$796.67
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$796.67	0		TOTAL RENTED EQUIP →		$796.67

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Boat Operator	Survey	1	120	$62.23	$7,467.60
Foreman	Survey	1	120	$79.33	$9,520.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$16,987.60	TOTAL LABOR COST →		$16,987.60

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 9

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Topographic Surveys - Dredge	9

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Topographic Surveys - Dredge	9	$0.00	$0.00	$0.00	$129,800.00	$129,800.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$129,800.00	$129,800.00	
UNIT PRICES		$0.00	$0.00	$0.00	$129,800.00	$129,800.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	250	$90.00	HR	$22,500.00
Establish Benchmarks	Survey	13	$2,500.00	LS	$31,250.00
Topographic Survey	Survey	25	$2,500.00	DAY	$62,500.00
Per Diem	Survey	50	$35.00	DAY	$1,750.00
Expenses & Fuel	Survey	1	$11,800.00	of Total (	$11,800.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$129,800.00	TOTAL COST →			$129,800.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 11

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Hydrographic Surveys - FF & VE - Deep	11

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	15.0	3.47	-	90

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Hydrographic Surveys - FF & VE - Deep	11	$0.00	$0.00	$0.00	$1,299,485.50	$1,299,485.50	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$1,299,485.50	$1,299,485.50	
UNIT PRICES		$0.00	$0.00	$0.00	$1,299,485.50	$1,299,485.50	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	900	$90.00	HR	$81,022.32
Hydrographic Survey Mob/Demob	Survey	3	$4,200.00	EA	$13,503.72
Hydrographic Survey	Pre-Dredge	30	$12,000.00	DAY	$360,099.21
Hydrographic Survey	Post-Dredge	30	$12,000.00	DAY	$360,099.21
Hydrographic Survey	Post-Cap/Cap Layer	30	$12,000.00	DAY	$360,099.21
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	186	$35.00	DAY	$6,526.80
Expenses & Fuel	Survey	1	$118,135.05	of Total (	$118,135.05
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,299,485.50	TOTAL COST →			$1,299,485.50

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 12

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Hydrographic Surveys - Orland River	12

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	3.2	0.74	-	19

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Hydrographic Surveys - Orland River	12	$0.00	$0.00	$0.00	$278,995.58	$278,995.58	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$278,995.58	$278,995.58	
UNIT PRICES		$0.00	$0.00	$0.00	$278,995.58	$278,995.58	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	193	$90.00	HR	$17,395.25
Hydrographic Survey Mob/Demob	Survey	1	$4,200.00	EA	$2,899.21
Hydrographic Survey	Pre-Dredge	6	$12,000.00	DAY	$77,312.20
Hydrographic Survey	Post-Dredge	6	$12,000.00	DAY	$77,312.20
Hydrographic Survey	Post-Cap/Cap Layer	6	$12,000.00	DAY	$77,312.20
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	40	$35.00	DAY	$1,401.28
Expenses & Fuel	Survey	1	$25,363.23	of Total (	$25,363.23
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$278,995.58	TOTAL COST →		$278,995.58

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 13

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Utilities Surveys	13

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Utilities Surveys	13	$0.00	$0.00	$0.00	$360,868.75	$360,868.75	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$360,868.75	$360,868.75	
UNIT PRICES		$0.00	$0.00	$0.00	$360,868.75	$360,868.75	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep/Processing	Survey	250	$90.00	HR	$22,500.00
Hydrographic Survey Mob/Demob	Survey	1	$4,200.00	EA	$3,750.00
Hydrographic Survey	SubBottom/Mag	25	$12,000.00	DAY	$300,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	52	$35.00	DAY	$1,812.50
Expenses & Fuel	Survey	1	$32,806.25	of Total (	$32,806.25
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$360,868.75	TOTAL COST →			$360,868.75

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 14

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Surveys	14

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Surveys	14	$0.00	$0.00	$0.00	$375,463.00	$375,463.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$375,463.00	$375,463.00	
UNIT PRICES		$0.00	$0.00	$0.00	$375,463.00	$375,463.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	250	$90.00	HR	$22,500.00
Hydrographic Survey Mob/Demob	Survey	4	$4,200.00	EA	$16,800.00
Hydrographic Survey	SideScan/Mag	25	$12,000.00	DAY	$300,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	58	$35.00	DAY	$2,030.00
Expenses & Fuel	Survey	1	$34,133.00	of Total (	$34,133.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$375,463.00	TOTAL COST →		$375,463.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 15

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Environmental Monitoring - FF & VE - Deep	15

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	63.6	14.69	2,822	382

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Environmental Monitoring - FF & VE - Deep	15	$49,261.41	$0.00	$179,026.10	$0.00	$228,287.51	Include Monitoring during all silt producing activities. Initial install and ongoing maintenance included. Assumes 2 laborers for maintenance and demob at 10% of total duration. Additional Maintenance is covered under other water tasks.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$49,261.41	$0.00	$179,026.10	$0.00	$228,287.51	
UNIT PRICES		$49,261.41	$0.00	$179,026.10	$0.00	$228,287.51	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS/MONTHS	UNIT RATE	TOTAL COST
Workboat	INSTALL/MAINTAIN		2	916	$6.64	$6,079.39
Water Quality Monitoring Buoy (	Monitor		4	59	$2,944.00	$172,946.71
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$179,026.10	0		TOTAL RENTED EQUIP →		$179,026.10

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Laborer	Install	2	916	$53.80	$49,261.41
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$49,261.41	TOTAL LABOR COST →			$49,261.41

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 16

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Environmental Monitoring - Orland River	16

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	13.0	3.00	2,822	78

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Environmental Monitoring - Orland River	16	$10,068.96	$0.00	$18,917.65	$0.00	$28,986.62	Include Monitoring during all silt producing activities. Initial install and ongoing maintenance included. Assumes 2 laborers for maintenance and demob at 10% of total duration. Additional Maintenance is covered under other water tasks.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$10,068.96	$0.00	$18,917.65	$0.00	$28,986.62	
UNIT PRICES		$10,068.96	$0.00	$18,917.65	$0.00	$28,986.62	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS/MONTHS	UNIT RATE	TOTAL COST
Workboat	INSTALL/MAINTAIN		2	187	$6.64	$1,242.62
Water Quality Monitoring Buoy (	Monitor		2	6	$2,944.00	$17,675.03
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$18,917.65	0		TOTAL RENTED EQUIP →		$18,917.65

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Laborer	Install	2	187	$53.80	$10,068.96
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$10,068.96	TOTAL LABOR COST →			$10,068.96

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 17

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Removal - FF & VE - Deep	17

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	5,082	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	3.6	0.83	237	21

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Removal - FF & VE - Deep	17	$341,684.97	$28,425.68	$266,636.44	$0.00	$636,747.08	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$341,684.97	$28,425.68	$266,636.44	$0.00	$636,747.08	
UNIT PRICES		$67.24	$5.59	$52.47	$0.00	$125.30	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredg	DREDGE		2	515	$103.33	$53,202.74
Cable Arm Hydraulic Clamshell (1	DREDGE		2	515	$31.28	$16,104.44
Dredge Barge	DREDGE BARGE		2	515	$41.67	$21,452.72
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		5	1287	$71.67	$92,246.69
Hopper Barge	DREDGE/TRANSPORT		7	1802	$41.67	$75,084.52
Workboat	DREDGE/TRANSPORT		5	1287	$6.64	$8,545.33
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$52.47	0		TOTAL RENTED EQUIP →		$266,636.44

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	2	515	$71.24	$36,677.28
Laborer	DREDGE	5	1287	$53.80	$69,242.94
Deckhand	TRANSPORT	5	1287	$45.02	$57,950.42
Boat Operator	TRANSPORT	5	1287	$62.23	$80,100.16
Tug Operator	TRANSPORT	5	1287	$42.04	$54,111.00
Deckhand	DREDGE	2	515	$45.02	$23,180.17
Foreman	DREDGE	1	257	$79.33	$20,422.99
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$67.24	TOTAL LABOR COST →			$341,684.97

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	20.64	$12.00	MTH	$247.72
Per Diem	ALL	536	$51.00	MD	$27,352.22
Misc Safety Supplies	ALL	0.83	$1,000.00	MD	$825.74
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$5.59	TOTAL MATERIAL COST →			$28,425.68

ESTIMATE WORKSHEET 18

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Removal - Orland River	18

BID DATA		
TOTAL QUANTITY ON PROPOSAL	160	Bid Data Notes
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.1	0.03	237	1

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Removal - Orland River	18	$10,774.56	$896.36	$8,408.01	$0.00	$20,078.94	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$10,774.56	$896.36	$8,408.01	$0.00	$20,078.94	
UNIT PRICES		$67.24	$5.59	$52.47	$0.00	$125.30	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST	$0.00	TOTAL COST			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredg	DREDGE		2	16	$103.33	$1,677.67
Cable Arm Hydraulic Clamshell (1	DREDGE		2	16	$31.28	$507.83
Dredge Barge	DREDGE BARGE		2	16	$41.67	$676.48
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		5	41	$71.67	$2,908.87
Hopper Barge	DREDGE/TRANSPORT		7	57	$41.67	$2,367.69
Workboat	DREDGE/TRANSPORT		5	41	$6.64	$269.47
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST	$52.47	0		TOTAL RENTED EQUIP		$8,408.01

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	2	16	$71.24	$1,156.57
Laborer	DREDGE	5	41	$53.80	$2,183.48
Deckhand	TRANSPORT	5	41	$45.02	$1,827.39
Boat Operator	TRANSPORT	5	41	$62.23	$2,525.85
Tug Operator	TRANSPORT	5	41	$42.04	$1,706.32
Deckhand	DREDGE	2	16	$45.02	$730.95
Foreman	DREDGE	1	8	$79.33	$644.01
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST	$67.24	TOTAL LABOR COST			$10,774.56

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.65	$12.00	MTH	$7.81
Per Diem	ALL	17	$51.00	MD	$862.51
Misc Safety Supplies	ALL	0.03	$1,000.00	MD	$26.04
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST	$5.59	TOTAL MATERIAL COST			$896.36

ESTIMATE WORKSHEET 20

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Dredging - FF & VE - Deep	20

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,016,344	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	60.0	13.86	2,822	360

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Dredging - FF & VE - Deep	20	$4,478,840.99	$365,956.99	$4,077,293.28	$0.00	$8,922,091.26	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$4,478,840.99	$365,956.99	$4,077,293.28	$0.00	$8,922,091.26	
UNIT PRICES		$4.41	$0.36	$4.01	$0.00	$8.78	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	8642	$158.89	$1,373,178.31
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	8642	$31.28	$270,324.47
Dredge Tender (Push Boat)	DREDGE BARGE		4	17285	$71.67	$1,238,741.27
Hopper Barge	DREDGE/TRANSPORT		6	25927	$41.67	$1,080,297.62
Workboat	DREDGE/TRANSPORT		4	17285	$6.64	$114,751.61
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$4.01	0		TOTAL RENTED EQUIP →		$4,077,293.28

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	8642	$72.40	$625,737.19
Laborer	DREDGE	4	17285	$53.80	$929,833.77
Deckhand	TRANSPORT	4	17285	$45.02	$778,191.37
Boat Operator	TRANSPORT	4	17285	$62.23	$1,075,630.73
Tug Operator	TRANSPORT	4	17285	$42.04	$726,633.48
Foreman	DREDGE	1	4321	$79.33	$342,814.44
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$4.41	TOTAL LABOR COST →			$4,478,840.99

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	263.35	$12.00	MTH	$3,160.22
Per Diem	ALL	6,842	$51.00	MD	$348,936.13
Misc Safety Supplies	ALL	13.86	$1,000.00	MD	$13,860.63
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.36		TOTAL MATERIAL COST →			$365,956.99

ESTIMATE WORKSHEET 21

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Dredging - Orland River	21

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	32,049	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	CY		12	6	12.9	2.98	415	77

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Dredging - Orland River	21	$613,250.15	$50,719.42	$483,267.83	$0.00	$1,147,237.40	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$613,250.15	$50,719.42	$483,267.83	$0.00	$1,147,237.40	
UNIT PRICES		$19.13	$1.58	$15.08	$0.00	$35.80	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredge)	DREDGE		1	928	$103.33	$95,867.13
Cable Arm Hydraulic Clamshell (3.5 CY) w	DREDGE		1	928	$22.63	$20,992.41
Dredge Barge	DREDGE BARGE		1	928	$41.67	$38,656.10
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		3	2783	$71.67	$199,465.48
Hopper Barge	DREDGE/TRANSPORT		3	2783	$41.67	$115,968.30
Workboat	DREDGE/TRANSPORT		2	1855	$6.64	$12,318.41
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$15.08	0		TOTAL RENTED EQUIP →		$483,267.83

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	1	928	$71.24	$66,089.56
Laborer	DREDGE	2	1855	$53.80	$99,816.24
Deckhand	TRANSPORT	2	1855	$45.02	$83,537.66
Boat Operator	TRANSPORT	3	2783	$62.23	$173,200.98
Tug Operator	TRANSPORT	3	2783	$42.04	$117,004.49
Foreman	DREDGE	1	928	$79.33	$73,601.22
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$19.13	TOTAL LABOR COST →			$613,250.15

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	35.71	$12.00	MTH	$428.52
Per Diem	ALL	928	$51.00	MD	$47,315.07
Misc Safety Supplies	ALL	2.98	$1,000.00	MD	$2,975.84
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.58	TOTAL MATERIAL COST →			$50,719.42

ESTIMATE WORKSHEET 23

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Offloading - FF & VE - Deep	23

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,016,344	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	60.0	13.86	7,344	360

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Offloading - FF & VE - Deep	23	$1,323,112.51	$106,517.57	$1,643,502.78	$0.00	$3,073,132.86	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,323,112.51	$106,517.57	$1,643,502.78	$0.00	$3,073,132.86	
UNIT PRICES		$1.30	$0.10	$1.62	$0.00	$3.02	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	8642	$158.89	$1,373,178.31
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	8642	$31.28	$270,324.47
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.62	0		TOTAL RENTED EQUIP →		$1,643,502.78

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	8642	$72.40	$625,737.19
Laborer	DREDGE	3	12964	$53.80	$697,375.33
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.30	TOTAL LABOR COST →			$1,323,112.51

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	69.30	$12.00	MTH	$831.64
Per Diem	ALL	1,800	$51.00	MD	$91,825.30
Misc Safety Supplies	ALL	13.86	$1,000.00	MD	$13,860.63
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.10	TOTAL MATERIAL COST →			$106,517.57

ESTIMATE WORKSHEET 24

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Offloading - Orland River	24

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	32,049							
BID UNIT	CY		12	6	12.9	2.98	7,344	77

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Offloading - Orland River	24	$284,068.22	$22,869.00	$352,855.04	$0.00	$659,792.25	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$284,068.22	$22,869.00	$352,855.04	$0.00	$659,792.25	
UNIT PRICES		$8.86	$0.71	$11.01	$0.00	$20.59	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
					$0.00	150 Ton Barge Mounted Crane	DREDGE		2	1855	$158.89	$294,817.19
					$0.00	Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	1855	$31.28	$58,037.84
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00	BARE UNIT COST →	$11.01	0		TOTAL RENTED EQUIP →		$352,855.04

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Crane Operator	DREDGE	2	1855	$72.40	$134,343.87	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Laborer	DREDGE	3	2783	$53.80	$149,724.36	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	14.88	$12.00	MTH	$178.55
					$0.00	Per Diem	ALL	387	$51.00	MD	$19,714.61
					$0.00	Misc Safety Supplies	ALL	2.98	$1,000.00	MD	$2,975.84
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$8.86	TOTAL LABOR COST →			$284,068.22	BARE UNIT COST →	$0.71	TOTAL MATERIAL COST →			$22,869.00

ESTIMATE WORKSHEET 26

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Processing - FF & VE - Deep	26

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,016,344	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	60.0	13.86	7,344	360

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Processing - FF & VE - Deep	26	$1,073,614.18	$8,332,568.71	$575,438.53	$0.00	$9,981,621.42	Includes Residuals.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,073,614.18	$8,332,568.71	$575,438.53	$0.00	$9,981,621.42	
UNIT PRICES		$1.06	$8.20	$0.57	$0.00	$9.82	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
WA 320 broom	Clean		1	4321	$5.17	$22,326.15
Wheeled Loaded WA320	Processing		2	8642	$41.72	$360,579.34
John Deer Skidsteer CT332	Processing		2	8642	$22.28	$192,533.04
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.57	0		TOTAL RENTED EQUIP →		$575,438.53

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 3	Loader	2	8642	$70.43	$608,697.29
Laborer	Processing	2	8642	$53.80	$464,916.88
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.06	TOTAL LABOR COST →			$1,073,614.18

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	55.44	$12.00	MTH	$665.31
Per Diem	ALL	1,440	$51.00	MD	$73,460.24
Misc Safety Supplies	ALL	13.86	$1,000.00	MD	$13,860.63
Portland Cement Type 1	Stabilize	63,419.87	$130.00	Ton	$8,244,582.53
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$8.20	TOTAL MATERIAL COST →			$8,332,568.71

ESTIMATE WORKSHEET 27

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Processing - Orland River	27

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	32,049	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	CY		12	6	12.9	2.98	7,344	77

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Processing - Orland River	27	$230,501.69	$278,871.85	$123,544.90	$0.00	$632,918.44	Includes Residuals.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$230,501.69	$278,871.85	$123,544.90	$0.00	$632,918.44	
UNIT PRICES		$7.19	$8.70	$3.85	$0.00	$19.75	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
WA 320 broom	Clean		1	928	$5.17	$4,793.36
Wheeled Loaded WA320	Processing		2	1855	$41.72	$77,415.28
John Deer Skidsteer CT332	Processing		2	1855	$22.28	$41,336.26
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$3.85	0		TOTAL RENTED EQUIP →		$123,544.90

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 3	Loader	2	1855	$70.43	$130,685.45
Laborer	Processing	2	1855	$53.80	$99,816.24
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$7.19	TOTAL LABOR COST →		$230,501.69

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	11.90	$12.00	MTH	$142.84
Per Diem	ALL	309	$51.00	MD	$15,771.69
Misc Safety Supplies	ALL	2.98	$1,000.00	MD	$2,975.84
Portland Cement Type 1	Stabilize	1,999.86	$130.00	Ton	$259,981.49
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$8.70	TOTAL MATERIAL COST →			$278,871.85

ESTIMATE WORKSHEET 29

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D - FF & VE - Deep	29

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	856,168	
BID UNIT	Ton	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	26.3	6.09	-	158

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D - FF & VE - Deep	29	$0.00	$6,085.42	$0.00	$70,890,725.77	$70,896,811.19	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$6,085.42	$0.00	$70,890,725.77	$70,896,811.19	
UNIT PRICES		$0.00	$0.01	$0.00	$82.80	$82.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Total Analytical Testing	Test	1,712	1400	$29.00	$2,397,270.92
Non-TSCA Transportation for Disposal	Transport	856,168	20	Ton	$17,123,363.71
Non-TSCA Disposal	Disposal	856,168	60	Ton	$51,370,091.14
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$82.80	TOTAL COST →		$70,890,725.77

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.00	$12.00	MTH	$0.00
Per Diem	ALL	0	$51.00	MD	$0.00
Misc Safety Supplies	ALL	6.09	$1,000.00	MD	$6,085.42
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.01	TOTAL MATERIAL COST →			$6,085.42

ESTIMATE WORKSHEET 30

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D - Orland River	30

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	26,998		12	6	0.8	0.19	-	5
BID UNIT	Ton							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D - Orland River	30	$0.00	$191.90	$0.00	$2,235,440.83	$2,235,632.72	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$191.90	$0.00	$2,235,440.83	$2,235,632.72	
UNIT PRICES		$0.00	$0.01	$0.00	$82.80	$82.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Total Analytical Testing	Test	54	1400	Ea	$75,594.62
Non-TSCA Transportation for Disposal	Transport	26,998	20	Ton	$539,961.55
Non-TSCA Disposal	Disposal	26,998	60	Ton	$1,619,884.66
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$82.80	TOTAL COST →		$2,235,440.83

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.00	$12.00	MTH	$0.00
Per Diem	ALL	0	$51.00	MD	$0.00
Misc Safety Supplies	ALL	0.19	$1,000.00	MD	$191.90
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.01	TOTAL MATERIAL COST →			$191.90

ESTIMATE WORKSHEET 32

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D Ben - FF & VE - Deep	32

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	856,168	
BID UNIT	Ton	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	26.3	6.09	5,415	158

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D Ben - FF & VE - Deep	32	$0.00	$6,085.42	$0.00	$28,082,316.49	$28,088,401.91	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$6,085.42	$0.00	$28,082,316.49	$28,088,401.91	
UNIT PRICES		$0.00	$0.01	$0.00	$32.80	$32.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Total Analytical Testing	Test	1,712	1400	Ea	$2,397,270.92							$0.00
Transportation for Beneficial Reuse	Transport	856,168	20	Ton	$17,123,363.71							$0.00
Beneficial Reuse	Disposal	856,168	10	Ton	$8,561,681.86							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$32.80	TOTAL COST →			$28,082,316.49	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	0.00	$12.00	MTH	$0.00
					$0.00	Per Diem	ALL	0	$51.00	MD	$0.00
					$0.00	Misc Safety Supplies	ALL	6.09	$1,000.00	MD	$6,085.42
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00	BARE UNIT COST → $0.01		TOTAL MATERIAL COST →			$6,085.42

ESTIMATE WORKSHEET 33

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D Ben - Orland River	33

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	26,998		12	6	0.8	0.19	5,415	5
BID UNIT	Ton							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D Ben - Orland River	33	$0.00	$191.90	$0.00	$885,536.95	$885,728.84	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$191.90	$0.00	$885,536.95	$885,728.84	
UNIT PRICES		$0.00	$0.01	$0.00	$32.80	$32.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Total Analytical Testing	Test	54	1400	Ea	$75,594.62							$0.00
Transportation for Beneficial Reuse	Transport	26,998	20	Ton	$539,961.55							$0.00
Beneficial Reuse	Disposal	26,998	10	Ton	$269,980.78							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$32.80	TOTAL COST →			$885,536.95	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	0.00	$12.00	MTH	$0.00
					$0.00	Per Diem	ALL	0	$51.00	MD	$0.00
					$0.00	Misc Safety Supplies	ALL	0.19	$1,000.00	MD	$191.90
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00	BARE UNIT COST →	$0.01	TOTAL MATERIAL COST →			$191.90

ESTIMATE WORKSHEET 35

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Water Treatment - FF & VE - Deep	35

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	60.0	13.86	-	360

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Water Treatment - FF & VE - Deep	35	$445,322.69	$32,392.02	$0.00	$940,000.00	$1,417,714.70	Assumes Replacement filter media and bags as 15% of equipment total
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$445,322.69	$32,392.02	$0.00	$940,000.00	$1,417,714.70	
UNIT PRICES		$445,322.69	$32,392.02	$0.00	$940,000.00	$1,417,714.70	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
Mobilization (1000GPM)	Water Treatment	1	$150,000.00	LS	$150,000.00							$0.00
Monthly Rental w/PH Adjustment (1000GPM)	Water Treatment	14	$50,000.00	Month	$700,000.00							$0.00
Demobilization (1000GPM)	Water Treatment	1	$20,000.00	LS	$20,000.00							$0.00
Consumables (1000GPM)	Water Treatment	14	$5,000.00	Month	$70,000.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$940,000.00	TOTAL COST →			$940,000.00	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Water Treatment Operator Blended Rate	Water Treatment	1	4321	$103.06	$445,322.69	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	13.86	$12.00	MTH	$166.33
					$0.00	Per Diem	ALL	360	$51.00	MD	$18,365.06
					$0.00	Misc Safety Supplies	ALL	13.86	$1,000.00	MD	$13,860.63
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$445,322.69	TOTAL LABOR COST →			$445,322.69	BARE UNIT COST →	$32,392.02	TOTAL MATERIAL COST →			$32,392.02

Phase III Engineering Study Report Cost Estimate Supporting Documentation

Orrington Intertidal East and Orrington Marsh Platform East Dredging

Orrington Intertidal East and Orrington Marsh Platform East Dredging
Final Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Offsite Dispsoal

Description	Units of Meas.	Quanity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$56,408.37				$2,820.42	$59,228.79	$56,408.37	$59,228.79	$59,229	$60,000
Mobilization	LS	1					$494,932.63				$24,746.63	$519,679.26	$494,932.63	$519,679.26	$519,679	$520,000
Temporary Construction - Main NE Processing	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Conditions Surveys	LS	1	$6,795	$0	$319	$0	$7,113.71	$17.53	$853.64	$0.00	$398.37	$8,383.25	$7,113.71	$8,383.25	$8,383	$10,000
Topographic Surveys - Dredge - NE	LS	1	$0	$0	$0	$38,940	$38,940.00	$0.00	$0.00	$1,947.00	$2,044.35	$42,931.35	$38,940.00	$42,931.35	$42,931	$50,000
Hydrographic Surveys	LS	1	$0	$0	$0	$245,223	$245,222.94	$0.00	$0.00	$12,261.15	$12,874.20	$270,358.29	$245,222.94	$270,358.29	$270,358	$280,000
Utilities Surveys	LS	1	$0	$0	$0	$72,174	$72,173.75	$0.00	$0.00	$3,608.69	$3,789.12	$79,571.56	$72,173.75	$79,571.56	$79,572	$80,000
Debris Surveys	LS	1	$0	$0	$0	$90,123	$90,123.00	$0.00	$0.00	$4,506.15	$4,731.46	$99,360.61	$90,123.00	$99,360.61	$99,361	$100,000
Environmental Monitoring	LS	1	$18,512	$0	$164,762	$0	$183,273.69	$9,061.91	$21,992.84	$0.00	$10,263.33	$224,591.76	$183,273.69	$224,591.76	$224,592	$230,000
Debris Removal	CY	2,141	$76,816	$6,334	$65,342	$0	$148,491.91	$3,942.16	$17,819.03	$0.00	$8,315.55	$178,568.65	$69.37	$83.42	$178,569	$180,000
Dredging	CY	214,054	$2,194,749	$180,963	$1,866,914	$0	$4,242,625.89	$112,633.25	$509,115.11	$0.00	$237,587.05	$5,101,961.29	$19.82	$23.83	$5,101,961	$5,110,000
Offloading	CY	214,054	$249,682	$20,101	$310,142	$0	$579,923.88	$18,163.33	$69,590.87	$0.00	$32,475.74	$700,153.81	$2.71	$3.27	$700,154	$710,000
Processing	CY	214,054	$202,599	$2,465,376	$108,590	$0	$2,776,564.89	$141,568.11	$333,187.79	$0.00	$155,487.63	$3,406,808.42	$12.97	$15.92	$3,406,808	$3,410,000
Material Procurement and Delivery	Ton	310,645	$0	$7,144,839	$0	$0	$7,144,838.88	$392,966.14	$857,380.67	$0.00	$400,110.98	$8,795,296.66	$23.00	$28.31	$8,795,297	$8,800,000
Loading	CY	230,108	$268,408	$21,608	$333,402	$0	$623,418.17	$19,525.58	$74,810.18	$0.00	$34,911.42	$752,665.34	$2.71	$3.27	$752,665	$760,000
Backfilling	CY	230,108	$2,359,355	$194,536	$2,006,932	$0	$4,560,822.83	$121,080.74	$547,298.74	$0.00	$255,406.08	$5,484,608.39	$19.82	$23.83	$5,484,608	$5,490,000
T&D	Ton	254,296	$0	$3,059	$0	$21,055,674	$21,058,732.81	$168.23	$367.05	$1,052,783.70	$1,105,594.18	$23,217,645.98	$82.81	$91.30	$23,217,646	$23,220,000
Water Treatment	LS	1	$84,036	$6,113	$0	$335,000	$425,148.45	$336.19	$10,817.81	$16,750.00	$22,635.81	$475,688.27	$425,148.45	$475,688.27	$475,688	$480,000
Restoration Plantings and Access Agreements	LS	1	$0	$0	$0	$176,652	$176,651.52	$0.00	$0.00	$8,832.58	$9,274.20	$194,758.30	$176,651.52	$194,758.30	$194,758	$200,000
Demobilization	LS	1					$494,932.63	$0.00	$0.00	$0.00	$24,746.63	$519,679.26	$494,932.63	$519,679.26	$519,679	$520,000
		TOTALS	**$5,640,836.75**	**$10,476,349.68**	**$4,949,326.27**	**$23,684,410.23**	**$45,797,196.56**	**$848,412.18**	**$2,527,981.53**	**$1,184,220.51**	**$2,475,469.93**	**$52,833,280.70**	**$4,662,010.52**	**$5,195,845.33**	**$52,833,280.70**	**$52,920,000.00**

Orrington Intertidal East and Orrington Marsh Platform East Dredging
Final Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Beneficial Reuse

Description	Units of Meas.	Quanity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$56,408.37				$2,820.42	$59,228.79	$56,408.37	$59,228.79	$59,229	$60,000
Mobilization	LS	1					$494,932.63				$24,746.63	$519,679.26	$494,932.63	$519,679.26	$519,679	$520,000
Temporary Construction - Main NE Processing	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Conditions Surveys	LS	1	$6,795	$0	$319	$0	$7,113.71	$17.53	$853.64	$0.00	$398.37	$8,383.25	$7,113.71	$8,383.25	$8,383	$10,000
Topographic Surveys - Dredge - NE	LS	1	$0	$0	$0	$38,940	$38,940.00	$0.00	$0.00	$1,947.00	$2,044.35	$42,931.35	$38,940.00	$42,931.35	$42,931	$50,000
Hydrographic Surveys	LS	1	$0	$0	$0	$245,223	$245,222.94	$0.00	$0.00	$12,261.15	$12,874.20	$270,358.29	$245,222.94	$270,358.29	$270,358	$280,000
Utilities Surveys	LS	1	$0	$0	$0	$72,174	$72,173.75	$0.00	$0.00	$3,608.69	$3,789.12	$79,571.56	$72,173.75	$79,571.56	$79,572	$80,000
Debris Surveys	LS	1	$0	$0	$0	$90,123	$90,123.00	$0.00	$0.00	$4,506.15	$4,731.46	$99,360.61	$90,123.00	$99,360.61	$99,361	$100,000
Environmental Monitoring	LS	1	$18,512	$0	$164,762	$0	$183,273.69	$9,061.91	$21,992.84	$0.00	$10,263.33	$224,591.76	$183,273.69	$224,591.76	$224,592	$230,000
Debris Removal	CY	2,141	$76,816	$6,334	$65,342	$0	$148,491.91	$3,942.16	$17,819.03	$0.00	$8,315.55	$178,568.65	$69.37	$83.42	$178,569	$180,000
Dredging	CY	214,054	$2,194,749	$180,963	$1,866,914	$0	$4,242,625.89	$112,633.25	$509,115.11	$0.00	$237,587.05	$5,101,961.29	$19.82	$23.83	$5,101,961	$5,110,000
Offloading	CY	214,054	$249,682	$20,101	$310,142	$0	$579,923.88	$18,163.33	$69,590.87	$0.00	$32,475.74	$700,153.81	$2.71	$3.27	$700,154	$710,000
Processing	CY	214,054	$202,599	$2,465,376	$108,590	$0	$2,776,564.89	$141,568.11	$333,187.79	$0.00	$155,487.63	$3,406,808.42	$12.97	$15.92	$3,406,808	$3,410,000
Material Procurement and Delivery	Ton	310,645	$0	$7,144,839	$0	$0	$7,144,838.88	$392,966.14	$857,380.67	$0.00	$400,110.98	$8,795,296.66	$23.00	$28.31	$8,795,297	$8,800,000
Loading	CY	230,108	$268,408	$21,608	$333,402	$0	$623,418.17	$19,525.58	$74,810.18	$0.00	$34,911.42	$752,665.34	$2.71	$3.27	$752,665	$760,000
Backfilling	CY	230,108	$2,359,355	$194,536	$2,006,932	$0	$4,560,822.83	$121,080.74	$547,298.74	$0.00	$255,406.08	$5,484,608.39	$19.82	$23.83	$5,484,608	$5,490,000
T&D Ben	Ton	254,296	$0	$3,059	$0	$8,340,895	$8,343,953.81	$168.23	$367.05	$417,044.75	$438,068.28	$9,199,602.13	$32.81	$36.18	$9,199,602	$9,200,000
Water Treatment	LS	1	$84,036	$6,113	$0	$335,000	$425,148.45	$336.19	$10,817.81	$16,750.00	$22,635.81	$475,688.27	$425,148.45	$475,688.27	$475,688	$480,000
Restoration Plantings and Access Agreements	LS	1	$0	$0	$0	$176,652	$176,651.52	$0.00	$0.00	$8,832.58	$9,274.20	$194,758.30	$176,651.52	$194,758.30	$194,758	$200,000
Demobilization	LS	1					$494,932.63	$0.00	$0.00	$0.00	$24,746.63	$519,679.26	$494,932.63	$519,679.26	$519,679	$520,000
		TOTALS	**$5,640,836.75**	**$10,476,349.68**	**$4,949,326.27**	**$10,969,631.23**	**$33,082,417.56**	**$848,412.18**	**$2,527,981.53**	**$548,481.56**	**$1,807,944.03**	**$38,815,236.86**	**$4,661,960.52**	**$5,195,790.20**	**$38,815,236.86**	**$38,900,000.00**

Orrington Intertidal East and Orrington Marsh Platform East Dredging
Final Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Debris Disposal Quantities	Orrington
Dredge Volume (CY)	107,027
Debris Area (% of Dredge Volume)	2%
Debris Volume (CY)	**2141**
Debris Volume (TONS)	**2,355**

Dredging & Disposal Quantities	Orrington
Dredge Depth (FT)	0.50
Dredge Volume (CY)	107,027
Dredge Area (SF)	5,779,445
Total Area Footprint (ACRES)	132.68
Overdepth Dredge (FT)	0.50
Overdepth Dredge (CY)	107,027
Surface Deposits (CY)	0
Subtotal Dredging Volume (CY) (Dredge+Overdredge+Surface Deposits)	214,054
Side Slopes (CY)	0
Total Dredging Volume (CY)	214,054
Total Dredging Volume Bulked (CY)	**214,054**
Total Dredging Volume (TON)	235,459
Portland Cement Addition (TON)	18,837
Total Disposal Volume (TON)	**254,296**

Backfill Quantities	Orrington
Placement Area (SF)	5,779,445
Placement Area (Acres)	132.68
Min. Layer Thickness (FT)	0.50
Allowable overplacement (FT)	0.50
Volume (CY)	214,054
Material Loss (%)	7.5%
Volume w/Loss (CY)	**230,108**
Weight (TON)	**310,645**

Restoration Plantings and Access Agreements	Orrington
Number of SF	1,538,988.00
Number of Acres	35.33
Access Agreements	0.00

Shallow Dredging - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.0	min
Uptime	25%	%
# of dredges	5	ea.
Hourly Rate	263	cy/hr
Shift	12	hrs/day
Production Rate	**3,150**	**cy/day**
Production Rate (Season)	**352,800**	**cy/season**

Shallow Backfilling - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.0	min
Uptime	25%	%
# of Equipment	5	ea.
Hourly Rate	263	cy/hr
Shift	12	hrs/day
Production Rate	**3,150**	**cy/day**

Unloading, Loading, and Processing - Mechanical		
Bucket Size	10.0	cy
Bucket % Full	90%	%
Cycle Time	1.5	min
Uptime	85%	%
# of Equipment	2	ea.
Hourly Rate	612	cy/hr
Shift	12	hrs/day
Production Rate	**7,344**	**cy/day**
Production Rate (Season)	**822,528**	**cy/season**

Debris Removal		
Bucket Size	10.0	cy
% Full	50%	%
Cycle Time	5.0	min
Uptime	25%	%
# of Equipment	5	ea.
Hourly Rate	75	cy/hr
Shift	12	hrs/day
Production Rate	**900**	**cy/day**

ESTIMATE WORKSHEET 4

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - Main NE Coal Processing	4

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.0	1.15	-	30

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - Main NE Coal Processing	4	$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	
UNIT PRICES		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ELECTRICAL INSTALLATION	ELECTRIC	1	$10,000.00	LS	$10,000.00
WATER UTILITY INSTALLATION	WATER	1	$10,000.00	LS	$10,000.00
ASPHALT PAVING	SPA	215,125	$5.00	SF	$1,075,625.00
Dolphin Install	Barge docking	8	$50,000.00	SF	$400,000.00
Temporary Dock	Barge docking	350	$500.00	LF	$175,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,670,625.00	TOTAL COST →			$1,670,625.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	360	$65.51	$23,585.13
KOMATSU D39P	SPA/RSA		1	360	$34.48	$12,414.51
Wheeled Loaded WA320	SPA/RSA		1	360	$41.72	$15,020.00
84" SMOOTH COMPACTOR	SPA/RSA		1	360	$38.96	$14,024.25
CRANE - 40 TON	SPA/RSA		1	360	$77.44	$27,880.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$92,923.89	0		TOTAL RENTED EQUIP →		$92,923.89

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	360	$71.24	$25,645.20
OPERATOR 3	WA320/D39P	2	720	$70.43	$50,710.80
LABORER	ALL	4	1440	$53.80	$77,464.80
Crane Operator	40-ton	1	360	$72.40	$26,065.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$179,886.00	TOTAL LABOR COST →			$179,886.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.24	$12.00	MTH	$110.85
Per Diem	ALL	240	$51.00	MD	$12,240.00
Misc Safety Supplies	ALL	1.15	$1,000.00	MD	$1,154.73
Hdpe Liner - 20 Mil	SPA	282,725.00	$0.27	SF	$76,335.75
Geotextile	SPA	282,725.00	$0.08	SF	$22,920.20
Jersey Barriers	SPA	338.00	$295.00	EA	$99,710.00
Bin Blocks	SPA	1,530.00	$37.50	EA	$57,375.00
Concrete Sumps	SPA	4.00	$1,500.00	EA	$6,000.00
Silt Fence	SPA	18,000.00	$0.26	LF	$4,680.00
6" Hdpe Pipe	SPA	1,600.00	$17.36	LF	$27,776.00
Tarp 60'x60'	Drip Apron	2.00	$500.00	Ea	$1,000.00
Straw Hay Bales	Drip Apron	23.13	$4.25	Ea	$98.28
Stockpile Tarps	SPA	60.00	22.00	Ea	$1,320.00
DGA	SPA	5,577	22.00	Ton	$122,700.93
					$0.00
BARE UNIT COST →	$433,421.75	TOTAL MATERIAL COST →			$433,421.75

ESTIMATE WORKSHEET 5

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Conditions Surveys	5

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	0.7	0.15	-	4

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Conditions Surveys	5	$6,795.04	$0.00	$318.67	$0.00	$7,113.71	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$6,795.04	$0.00	$318.67	$0.00	$7,113.71	
UNIT PRICES		$6,795.04	$0.00	$318.67	$0.00	$7,113.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Workboat	TRANSPORT		1	48	$6.64	$318.67
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$318.67	0		TOTAL RENTED EQUIP →		$318.67

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Boat Operator	Survey	1	48	$62.23	$2,987.04
Foreman	Survey	1	48	$79.33	$3,808.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$6,795.04	TOTAL LABOR COST →			$6,795.04

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 7

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Topographic Surveys - Dredge - NE Coal	7

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	1.3	0.29	-	8

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Topographic Surveys - Dredge - NE Coal	7	$0.00	$0.00	$0.00	$38,940.00	$38,940.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$38,940.00	$38,940.00	
UNIT PRICES		$0.00	$0.00	$0.00	$38,940.00	$38,940.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	75	$90.00	HR	$6,750.00
Establish Benchmarks	Survey	4	$2,500.00	LS	$9,375.00
Topographic Survey	Survey	8	$2,500.00	DAY	$18,750.00
Per Diem	Survey	15	$35.00	DAY	$525.00
Expenses & Fuel	Survey	1	$3,540.00	of Total (	$3,540.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$38,940.00	TOTAL COST →		$38,940.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 8

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Hydrographic Surveys	8

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	2.8	0.65	-	17

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Hydrographic Surveys	8	$0.00	$0.00	$0.00	$245,222.94	$245,222.94	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$245,222.94	$245,222.94	
UNIT PRICES		$0.00	$0.00	$0.00	$245,222.94	$245,222.94	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	170	$90.00	HR	$15,289.54
Hydrographic Survey Mob/Demob	Survey	1	$4,200.00	EA	$2,548.26
Hydrographic Survey	Pre-Dredge	6	$12,000.00	DAY	$67,953.50
Hydrographic Survey	Post-Dredge	6	$12,000.00	DAY	$67,953.50
Hydrographic Survey	Post-Cap/Cap Layer	6	$12,000.00	DAY	$67,953.50
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	35	$35.00	DAY	$1,231.66
Expenses & Fuel	Survey	1	$22,292.99	of Total (	$22,292.99
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$245,222.94	TOTAL COST →		$245,222.94

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 9

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Utilities Surveys	9

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.8	0.19	-	5

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Utilities Surveys	9	$0.00	$0.00	$0.00	$72,173.75	$72,173.75	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$72,173.75	$72,173.75	
UNIT PRICES		$0.00	$0.00	$0.00	$72,173.75	$72,173.75	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep/Processing	Survey	50	$90.00	HR	$4,500.00
Hydrographic Survey Mob/Demob	Survey	0	$4,200.00	EA	$750.00
Hydrographic Survey	SubBottom/Mag	5	$12,000.00	DAY	$60,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	10	$35.00	DAY	$362.50
Expenses & Fuel	Survey	1	$6,561.25	of Total (	$6,561.25
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$72,173.75	TOTAL COST →			$72,173.75

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 10

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Surveys	10

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.8	0.19	-	5

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Surveys	10	$0.00	$0.00	$0.00	$90,123.00	$90,123.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$90,123.00	$90,123.00	
UNIT PRICES		$0.00	$0.00	$0.00	$90,123.00	$90,123.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	50	$90.00	HR	$4,500.00
Hydrographic Survey Mob/Demob	Survey	4	$4,200.00	EA	$16,800.00
Hydrographic Survey	SideScan/Mag	5	$12,000.00	DAY	$60,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	18	$35.00	DAY	$630.00
Expenses & Fuel	Survey	1	$8,193.00	of Total (	$8,193.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$90,123.00	TOTAL COST →		$90,123.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 11

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Environmental Monitoring	11

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	23.9	5.52	#REF!	143

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Environmental Monitoring	11	$18,511.75	$0.00	$164,761.94	$0.00	$183,273.69	Include Monitoring during all silt producing activities. Initial install and ongoing maintenancce included. Assumes 2 laborers for maintenance and demob at 10% of total duration. Additional Maintenace is covered under other water tasks.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$18,511.75	$0.00	$164,761.94	$0.00	$183,273.69	
UNIT PRICES		$18,511.75	$0.00	$164,761.94	$0.00	$183,273.69	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS/MONTHS	UNIT RATE	TOTAL COST
Workboat	INSTALL/MAINTAIN		2	344	$6.64	$2,284.55
Water Quality Monitoring Buoy (	Monitor		10	55	$2,944.00	$162,477.39
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$164,761.94	0	TOTAL RENTED EQUIP →			$164,761.94

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Laborer	Install	2	344	$53.80	$18,511.75
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$18,511.75	TOTAL LABOR COST →			$18,511.75

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 12

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Removal	12

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	2,141		12	6	0.4	0.09	900	2
BID UNIT	CY							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Removal	12	$76,816.20	$6,333.72	$65,341.98	$0.00	$148,491.91	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$76,816.20	$6,333.72	$65,341.98	$0.00	$148,491.91	
UNIT PRICES		$35.89	$2.96	$30.53	$0.00	$69.37	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredg	DREDGE		5	143	$103.33	$14,745.91
Cable Arm Hydraulic Clamshell (1	DREDGE		5	143	$31.28	$4,463.58
Dredge Barge	DREDGE BARGE		5	143	$41.67	$5,945.93
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	285	$71.67	$20,454.00
Hopper Barge	DREDGE/TRANSPORT		15	428	$41.67	$17,837.79
Workboat	DREDGE/TRANSPORT		10	285	$6.64	$1,894.77
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$30.53	0		TOTAL RENTED EQUIP →		$65,341.98

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	143	$71.24	$10,165.64
Laborer	DREDGE	10	285	$53.80	$15,353.35
Deckhand	TRANSPORT	10	285	$45.02	$12,849.44
Boat Operator	TRANSPORT	10	285	$62.23	$17,760.73
Tug Operator	TRANSPORT	10	285	$42.04	$11,998.12
Deckhand	DREDGE	5	143	$45.02	$6,424.72
Foreman	DREDGE	1	29	$79.33	$2,264.21
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$35.89	TOTAL LABOR COST →			$76,816.20

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	4.67	$12.00	MTH	$56.03
Per Diem	ALL	121	$51.00	MD	$6,186.15
Misc Safety Supplies	ALL	0.09	$1,000.00	MD	$91.55
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$2.96	TOTAL MATERIAL COST →			$6,333.72

ESTIMATE WORKSHEET 13

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Dredging	13

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	214,054	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	11.3	2.62	#REF!	68

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Dredging	13	$2,194,748.66	$180,963.41	$1,866,913.82	$0.00	$4,242,625.89	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$2,194,748.66	$180,963.41	$1,866,913.82	$0.00	$4,242,625.89	
UNIT PRICES		$10.25	$0.85	$8.72	$0.00	$19.82	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredge)	DREDGE		5	4077	$103.33	$421,311.69
Cable Arm Hydraulic Clamshell (10.0 CY) v	DREDGE		5	4077	$31.28	$127,530.78
Dredge Barge	DREDGE BARGE		5	4077	$41.67	$169,883.74
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	8154	$71.67	$584,400.08
Hopper Barge	DREDGE/TRANSPORT		15	12232	$41.67	$509,651.23
Workboat	DREDGE/TRANSPORT		10	8154	$6.64	$54,136.29
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$8.72	0		TOTAL RENTED EQUIP →		$1,866,913.82

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	4077	$71.24	$290,446.84
Laborer	DREDGE	10	8154	$53.80	$438,667.01
Deckhand	TRANSPORT	10	8154	$45.02	$367,126.79
Boat Operator	TRANSPORT	10	8154	$62.23	$507,449.54
Tug Operator	TRANSPORT	10	8154	$42.04	$342,803.36
Deckhand	DREDGE	5	4077	$45.02	$183,563.39
Foreman	DREDGE	1	815	$79.33	$64,691.73
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$10.25	TOTAL LABOR COST →		$2,194,748.66

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	133.40	$12.00	MTH	$1,600.75
Per Diem	ALL	3,466	$51.00	MD	$176,747.05
Misc Safety Supplies	ALL	2.62	$1,000.00	MD	$2,615.61
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.85	TOTAL MATERIAL COST →			$180,963.41

ESTIMATE WORKSHEET 14

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Offloading	14

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	214,054							
BID UNIT	CY		12	6	11.3	2.62	7,344	68

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Offloading	14	$249,681.54	$20,100.69	$310,141.65	$0.00	$579,923.88	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$249,681.54	$20,100.69	$310,141.65	$0.00	$579,923.88	
UNIT PRICES		$1.17	$0.09	$1.45	$0.00	$2.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	1631	$158.89	$259,129.34
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	1631	$31.28	$51,012.31
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.45	0		TOTAL RENTED EQUIP →		$310,141.65

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	1631	$72.40	$118,081.43
Laborer	DREDGE	3	2446	$53.80	$131,600.10
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.17	TOTAL LABOR COST →			$249,681.54

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	13.08	$12.00	MTH	$156.94
Per Diem	ALL	340	$51.00	MD	$17,328.14
Misc Safety Supplies	ALL	2.62	$1,000.00	MD	$2,615.61
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.09	TOTAL MATERIAL COST →			$20,100.69

ESTIMATE WORKSHEET 15

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Processing	15

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	214,054	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	11.3	2.62	7,344	68

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Processing	15	$202,599.28	$2,465,375.92	$108,589.69	$0.00	$2,776,564.89	Includes Residuals.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$202,599.28	$2,465,375.92	$108,589.69	$0.00	$2,776,564.89	
UNIT PRICES		$0.95	$11.52	$0.51	$0.00	$12.97	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
WA 320 broom	Clean		1	815	$5.17	$4,213.12
Wheeled Loaded WA320	Processing		2	1631	$41.72	$68,044.10
John Deer Skidsteer CT332	Processing		2	1631	$22.28	$36,332.47
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.51	0		TOTAL RENTED EQUIP →		$108,589.69

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 3	Loader	2	1631	$70.43	$114,865.87
Laborer	Processing	2	1631	$53.80	$87,733.40
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.95	TOTAL LABOR COST →			$202,599.28

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	10.46	$12.00	MTH	$125.55
Per Diem	ALL	272	$51.00	MD	$13,862.51
Misc Safety Supplies	ALL	2.62	$1,000.00	MD	$2,615.61
Portland Cement Type 1	Stabilize	18,836.71	$130.00	Ton	$2,448,772.25
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$11.52	TOTAL MATERIAL COST →			$2,465,375.92

ESTIMATE WORKSHEET 16

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Material Procurement and Delivery	16

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	310,645							
BID UNIT	Ton		12	6	0.0	0.00	--	0

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Material Procurement and Delivery	16	$0.00	$7,144,838.88	$0.00	$0.00	$7,144,838.88	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$7,144,838.88	$0.00	$0.00	$7,144,838.88	
UNIT PRICES		$0.00	$23.00	$0.00	$0.00	$23.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Misc Safety Supplies	ALL	0.00	$1,000.00	MTH	$0.00
Sand Habitat Restoration Material	BACKFILL	310,645	$23.00	TON	$7,144,838.88
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$23.00	TOTAL MATERIAL COST →			$7,144,838.88

ESTIMATE WORKSHEET 17

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Loading	17

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	230,108							
BID UNIT	CY		12	6	12.2	2.81	7,344	73

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Loading	17	$268,407.65	$21,608.24	$333,402.28	$0.00	$623,418.17	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$268,407.65	$21,608.24	$333,402.28	$0.00	$623,418.17	
UNIT PRICES		$1.17	$0.09	$1.45	$0.00	$2.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	1753	$158.89	$278,564.04
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	1753	$31.28	$54,838.24
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.45	0		TOTAL RENTED EQUIP →		$333,402.28

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	1753	$72.40	$126,937.54
Laborer	DREDGE	3	2630	$53.80	$141,470.11
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.17	TOTAL LABOR COST →			$268,407.65

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	14.06	$12.00	MTH	$168.71
Per Diem	ALL	365	$51.00	MD	$18,627.75
Misc Safety Supplies	ALL	2.81	$1,000.00	MD	$2,811.78
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.09	TOTAL MATERIAL COST →			$21,608.24

ESTIMATE WORKSHEET 18

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Backfilling	18

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	230,108	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	CY		12	6	12.2	2.81	3,150	73

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Backfilling	18	$2,359,354.81	$194,535.66	$2,006,932.36	$0.00	$4,560,822.83	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$2,359,354.81	$194,535.66	$2,006,932.36	$0.00	$4,560,822.83	
UNIT PRICES		$10.25	$0.85	$8.72	$0.00	$19.82	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredge)	DREDGE		5	4383	$103.33	$452,910.06
Cable Arm Hydraulic Clamshell (10.0 CY) v	DREDGE		5	4383	$31.28	$137,095.59
Dredge Barge	DREDGE BARGE		5	4383	$41.67	$182,625.03
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	8766	$71.67	$628,230.09
Hopper Barge	DREDGE/TRANSPORT		15	13149	$41.67	$547,875.08
Workboat	DREDGE/TRANSPORT		10	8766	$6.64	$58,196.51
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$8.72	0		TOTAL RENTED EQUIP →		$2,006,932.36

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	4383	$71.24	$312,230.35
Laborer	DREDGE	10	8766	$53.80	$471,567.04
Deckhand	TRANSPORT	10	8766	$45.02	$394,661.30
Boat Operator	TRANSPORT	10	8766	$62.23	$545,508.26
Tug Operator	TRANSPORT	10	8766	$42.04	$368,513.61
Deckhand	DREDGE	5	4383	$45.02	$197,330.65
Foreman	DREDGE	1	877	$79.33	$69,543.61
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$10.25	TOTAL LABOR COST →			$2,359,354.81

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	143.40	$12.00	MTH	$1,720.81
Per Diem	ALL	3,726	$51.00	MD	$190,003.08
Misc Safety Supplies	ALL	2.81	$1,000.00	MD	$2,811.78
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.85	TOTAL MATERIAL COST →			$194,535.66

ESTIMATE WORKSHEET 19

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D	19

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	254,296	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	Ton		12	6	13.2	3.06	3,200	79

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D	19	$0.00	$3,058.79	$0.00	$21,055,674.02	$21,058,732.81	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$3,058.79	$0.00	$21,055,674.02	$21,058,732.81	
UNIT PRICES		$0.00	$0.01	$0.00	$82.80	$82.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Total Analytical Testing	Test	509	1400	Ea	$712,027.62
Non-TSCA Transportation for Disposal	Transport	254,296	20	Ton	$5,085,911.60
Non-TSCA Disposal	Disposal	254,296	60	Ton	$15,257,734.80
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$82.80	TOTAL COST →		$21,055,674.02

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.00	$12.00	MTH	$0.00
Per Diem	ALL	0	$51.00	MD	$0.00
Misc Safety Supplies	ALL	3.06	$1,000.00	MD	$3,058.79
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.01		TOTAL MATERIAL COST →			$3,058.79

ESTIMATE WORKSHEET 20

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D Ben	20

BID DATA		
TOTAL QUANTITY ON PROPOSAL	254,296	Bid Data Notes
BID UNIT	Ton	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	13.2	3.06	3,200	79

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D Ben	20	$0.00	$3,058.79	$0.00	$8,340,895.02	$8,343,953.81	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$3,058.79	$0.00	$8,340,895.02	$8,343,953.81	
UNIT PRICES		$0.00	$0.01	$0.00	$32.80	$32.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Total Analytical Testing	Test	509	1400	Ea	$712,027.62							$0.00
Transportation for Beneficial Reuse	Transport	254,296	20	Ton	$5,085,911.60							$0.00
Beneficial Reuse	Disposal	254,296	10	Ton	$2,542,955.80							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$32.80	TOTAL COST →			$8,340,895.02	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	0.00	$12.00	MTH	$0.00
					$0.00	Per Diem	ALL	0	$51.00	MD	$0.00
					$0.00	Misc Safety Supplies	ALL	3.06	$1,000.00	MD	$3,058.79
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00	BARE UNIT COST →	$0.01	TOTAL MATERIAL COST →			$3,058.79

ESTIMATE WORKSHEET 21

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Water Treatment	21

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	11.3	2.62	-	68

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Water Treatment	21	$84,035.83	$6,112.62	$0.00	$335,000.00	$425,148.45	Assumes Replacement filter media and bags as 15% of equipment total
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$84,035.83	$6,112.62	$0.00	$335,000.00	$425,148.45	
UNIT PRICES		$84,035.83	$6,112.62	$0.00	$335,000.00	$425,148.45	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
Mobilization (1000GPM)	Water Treatment	1	$150,000.00	LS	$150,000.00							$0.00
Monthly Rental w/PH Adjustment (1000GPM)	Water Treatment	3	$50,000.00	Month	$150,000.00							$0.00
Demobilization (1000GPM)	Water Treatment	1	$20,000.00	LS	$20,000.00							$0.00
Consumables (1000GPM)	Water Treatment	3	$5,000.00	Month	$15,000.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$335,000.00	TOTAL COST →			$335,000.00	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Water Treatment Operator Blended Rate	Water Treatment	1	815	$103.06	$84,035.83	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	2.62	$12.00	MTH	$31.39
					$0.00	Per Diem	ALL	68	$51.00	MD	$3,465.63
					$0.00	Misc Safety Supplies	ALL	2.62	$1,000.00	MD	$2,615.61
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$84,035.83	TOTAL LABOR COST →			$84,035.83	BARE UNIT COST →	$6,112.62	TOTAL MATERIAL COST →			$6,112.62

ESTIMATE WORKSHEET 23

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Restoration Plantings and Access Agreements	23

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	2.9	0.68	-	18

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Restoration Plantings and Access Agreements	23	$0.00	$0.00	$0.00	$176,651.52	$176,651.52	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$176,651.52	$176,651.52	
UNIT PRICES		$0.00	$0.00	$0.00	$176,651.52	$176,651.52	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Restoration Planting	Restore	35	$5,000.00	Acre	$176,651.52
Access Agreements	Access	0	$25,000.00	Each	$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$176,651.52	TOTAL COST →			$176,651.52

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

Phase III Engineering Study Report Cost Estimate Supporting Documentation

Enhanced Monitored Natural Recovery in the Orland River

Enhanced Monitored Natural Recover in the Orland River
Final Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Description	Units of Meas.	Quanity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$8,255.90				$412.79	$8,668.69	$8,255.90	$8,668.69	$8,669	$10,000
Mobilization	LS	1					$40,784.76				$2,039.24	$42,823.99	$40,784.76	$42,823.99	$42,824	$50,000
Temporary Construction - Main NE Processing	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Conditions Surveys	LS	1	$6,795	$0	$319	$0	$7,113.71	$17.53	$853.64	$0.00	$398.37	$8,383.25	$7,113.71	$8,383.25	$8,383	$10,000
Topographic Surveys - Dredge - NE	LS	1	$0	$0	$0	$38,940	$38,940.00	$0.00	$0.00	$1,947.00	$2,044.35	$42,931.35	$38,940.00	$42,931.35	$42,931	$50,000
Hydrographic Surveys	LS	1	$0	$0	$0	$146,583	$146,583.27	$0.00	$0.00	$7,329.16	$7,695.62	$161,608.06	$146,583.27	$161,608.06	$161,608	$170,000
Utilities Surveys	LS	1	$0	$0	$0	$144,348	$144,347.50	$0.00	$0.00	$7,217.38	$7,578.24	$159,143.12	$144,347.50	$159,143.12	$159,143	$160,000
Debris Surveys	LS	1	$0	$0	$0	$161,458	$161,458.00	$0.00	$0.00	$8,072.90	$8,476.55	$178,007.45	$161,458.00	$178,007.45	$178,007	$180,000
Environmental Monitoring	LS	1	$5,244	$0	$138,735	$0	$143,979.23	$7,630.42	$17,277.51	$0.00	$8,062.84	$176,950.00	$143,979.23	$176,950.00	$176,950	$180,000
Material Procurement and Delivery	Ton	201,359	$0	$4,631,263	$0	$0	$4,631,262.75	$254,719.45	$555,751.53	$0.00	$259,350.71	$5,701,084.45	$23.00	$28.31	$5,701,084	$5,710,000
Loading	CY	149,155	$149,248	$12,015	$185,389	$0	$346,652.48	$10,857.22	$41,598.30	$0.00	$19,412.54	$418,520.54	$2.32	$2.81	$418,521	$420,000
Backfilling	CY	149,155	$484,416	$45,461	$398,329	$0	$928,205.90	$24,408.45	$111,384.71	$0.00	$51,979.53	$1,115,978.58	$6.22	$7.48	$1,115,979	$1,120,000
Demobilization	LS	1					$40,784.76	$0.00	$0.00	$0.00	$2,039.24	$42,823.99	$40,784.76	$42,823.99	$42,824	$50,000
		TOTALS	**$825,589.76**	**$5,122,160.82**	**$815,695.13**	**$2,161,953.77**	**$9,015,224.90**	**$326,582.08**	**$811,613.49**	**$108,097.69**	**$496,746.80**	**$10,758,264.95**	**$3,109,135.31**	**$3,522,719.98**	**$10,758,264.95**	**$10,820,000.00**

Enhanced Monitored Natural Recover in the Orland River
Draft Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Enhanced MNR	**Orland Intertidal**
Area	**16,108,793**
Area Acres	**370**
Volume	**149,155**
Weight (TON)	**201,359**

Unloading, Loading, and Processing - Mechanical		
Bucket Size	10.0	cy
Bucket % Full	90%	%
Cycle Time	1.5	min
Uptime	85%	%
# of Equipment	2	ea.
Hourly Rate	612	cy/hr
Shift	12	hrs/day
Production Rate	**7,344**	**cy/day**
Production Rate (Season)	**822,528**	**cy/season**

EMNR Dump Scow Placement		
Barge Capacity	1500	CY
Bucket Size	5.0	cy
Bucket % Full	90%	%
Cycle Time	1.5	min
Uptime	85%	%
# of Equipment	2	ea.
Hourly Rate	306	cy/hr
Shift	12	hrs/day
Production Rate	**3,672**	**cy/day**

ESTIMATE WORKSHEET 4

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Temporary Construction - Main NE Coal Processing	4

BID DATA		
TOTAL QUANTITY ON PROPOSAL	1	Bid Data Notes
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.0	1.15	-	30

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - Main NE Coal Processing	4	$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	
UNIT PRICES		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ELECTRICAL INSTALLATION	ELECTRIC	1	$10,000.00	LS	$10,000.00
WATER UTILITY INSTALLATION	WATER	1	$10,000.00	LS	$10,000.00
ASPHALT PAVING	SPA	215,125	$5.00	SF	$1,075,625.00
Dolphin Install	Barge docking	8	$50,000.00	SF	$400,000.00
Temporary Dock	Barge docking	350	$500.00	LF	$175,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,670,625.00	TOTAL COST →			$1,670,625.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	360	$65.51	$23,585.13
KOMATSU D39P	SPA/RSA		1	360	$34.48	$12,414.51
Wheeled Loaded WA320	SPA/RSA		1	360	$41.72	$15,020.00
84" SMOOTH COMPACTOR	SPA/RSA		1	360	$38.96	$14,024.25
CRANE - 40 TON	SPA/RSA		1	360	$77.44	$27,880.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$92,923.89	0		TOTAL RENTED EQUIP →		$92,923.89

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	360	$71.24	$25,645.20
OPERATOR 3	WA320/D39P	2	720	$70.43	$50,710.80
LABORER	ALL	4	1440	$53.80	$77,464.80
Crane Operator	40-ton	1	360	$72.40	$26,065.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$179,886.00	TOTAL LABOR COST →			$179,886.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.24	$12.00	MTH	$110.85
Per Diem	ALL	240	$51.00	MD	$12,240.00
Misc Safety Supplies	ALL	1.15	$1,000.00	MD	$1,154.73
Hdpe Liner - 20 Mil	SPA	282,725.00	$0.27	SF	$76,335.75
Geotextile	SPA	282,725.00	$0.08	SF	$22,920.20
Jersey Barriers	SPA	338.00	$295.00	EA	$99,710.00
Bin Blocks	SPA	1,530.00	$37.50	EA	$57,375.00
Concrete Sumps	SPA	4.00	$1,500.00	EA	$6,000.00
Silt Fence	SPA	18,000.00	$0.26	LF	$4,680.00
6" Hdpe Pipe	SPA	1,600.00	$17.36	LF	$27,776.00
Tarp 60'x60'	Drip Apron	2.00	$500.00	Ea	$1,000.00
Straw Hay Bales	Drip Apron	23.13	$4.25	Ea	$98.28
Stockpile Tarps	SPA	60.00	22.00	Ea	$1,320.00
DGA	SPA	5,577	22.00	Ton	$122,700.93
					$0.00
BARE UNIT COST → $433,421.75		TOTAL MATERIAL COST →			$433,421.75

ESTIMATE WORKSHEET 5

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Conditions Surveys	5

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.7	0.15	-	4

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Conditions Surveys	5	$6,795.04	$0.00	$318.67	$0.00	$7,113.71	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$6,795.04	$0.00	$318.67	$0.00	$7,113.71	
UNIT PRICES		$6,795.04	$0.00	$318.67	$0.00	$7,113.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Workboat	TRANSPORT		1	48	$6.64	$318.67
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$318.67	0		TOTAL RENTED EQUIP →		$318.67

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Boat Operator	Survey	1	48	$62.23	$2,987.04
Foreman	Survey	1	48	$79.33	$3,808.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$6,795.04	TOTAL LABOR COST →			$6,795.04

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 6

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Topographic Surveys - Dredge - NE Coal	6

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	1.3	0.29	-	8

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Topographic Surveys - Dredge - NE Coal	6	$0.00	$0.00	$0.00	$38,940.00	$38,940.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$38,940.00	$38,940.00	
UNIT PRICES		$0.00	$0.00	$0.00	$38,940.00	$38,940.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	75	$90.00	HR	$6,750.00
Establish Benchmarks	Survey	4	$2,500.00	LS	$9,375.00
Topographic Survey	Survey	8	$2,500.00	DAY	$18,750.00
Per Diem	Survey	15	$35.00	DAY	$525.00
Expenses & Fuel	Survey	1	$3,540.00	of Total (	$3,540.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$38,940.00	TOTAL COST →			$38,940.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 7

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Hydrographic Surveys	7

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1		12	6	1.7	0.39	-	10
BID UNIT	LS							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Hydrographic Surveys	7	$0.00	$0.00	$0.00	$146,583.27	$146,583.27	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$146,583.27	$146,583.27	
UNIT PRICES		$0.00	$0.00	$0.00	$146,583.27	$146,583.27	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	102	$90.00	HR	$9,139.40
Hydrographic Survey Mob/Demob	Survey	0	$4,200.00	EA	$1,523.23
Hydrographic Survey	Pre-Dredge	3	$12,000.00	DAY	$40,619.55
Hydrographic Survey	Post-Dredge	3	$12,000.00	DAY	$40,619.55
Hydrographic Survey	Post-Cap/Cap Layer	3	$12,000.00	DAY	$40,619.55
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	21	$35.00	DAY	$736.23
Expenses & Fuel	Survey	1	$13,325.75	of Total (	$13,325.75
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$146,583.27	TOTAL COST →			$146,583.27

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 8

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Utilities Surveys	8

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	1.7	0.38	-	10

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Utilities Surveys	8	$0.00	$0.00	$0.00	$144,347.50	$144,347.50	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$144,347.50	$144,347.50	
UNIT PRICES		$0.00	$0.00	$0.00	$144,347.50	$144,347.50	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep/Processing	Survey	100	$90.00	HR	$9,000.00
Hydrographic Survey Mob/Demob	Survey	0	$4,200.00	EA	$1,500.00
Hydrographic Survey	SubBottom/Mag	10	$12,000.00	DAY	$120,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	21	$35.00	DAY	$725.00
Expenses & Fuel	Survey	1	$13,122.50	of Total (	$13,122.50
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$144,347.50	TOTAL COST →			$144,347.50

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 9

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Debris Surveys	9

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1		12	6	1.7	0.38	-	10
BID UNIT	LS							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Surveys	9	$0.00	$0.00	$0.00	$161,458.00	$161,458.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$161,458.00	$161,458.00	
UNIT PRICES		$0.00	$0.00	$0.00	$161,458.00	$161,458.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Administrative/Survey Prep	Survey	100	$90.00	HR	$9,000.00							$0.00
Hydrographic Survey Mob/Demob	Survey	4	$4,200.00	EA	$16,800.00							$0.00
Hydrographic Survey	SideScan/Mag	10	$12,000.00	DAY	$120,000.00							$0.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00							$0.00
Per Diem	Survey	28	$35.00	DAY	$980.00							$0.00
Expenses & Fuel	Survey	1	$14,678.00	of Total (	$14,678.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →		$161,458.00	TOTAL COST →		$161,458.00	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00	BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 10

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Environmental Monitoring	10

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	6.8	1.56	#REF!	41

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Environmental Monitoring	10	$5,244.31	$0.00	$138,734.92	$0.00	$143,979.23	Include Monitoring during all silt producing activities. Initial install and ongoing maintenance included. Assumes 2 laborers for maintenance and demob at 10% of total duration. Additional Maintenance is covered under other water tasks.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$5,244.31	$0.00	$138,734.92	$0.00	$143,979.23	
UNIT PRICES		$5,244.31	$0.00	$138,734.92	$0.00	$143,979.23	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS/MONTHS	UNIT RATE	TOTAL COST
					$0.00	Workboat	INSTALL/MAINTAIN		2	97	$6.64	$647.20
					$0.00	Water Quality Monitoring Buoy (	Monitor		30	47	$2,944.00	$138,087.72
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00	BARE UNIT COST →		$138,734.92	0	TOTAL RENTED EQUIP →		$138,734.92

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Laborer	Install	2	97	$53.80	$5,244.31	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →		$5,244.31	TOTAL LABOR COST →		$5,244.31	BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 11

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Material Procurement and Delivery	11

BID DATA			
TOTAL QUANTITY ON PROPOSAL	201,359	Bid Data Notes	
BID UNIT	Ton		

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.0	0.00	--	0

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Material Procurement and Delivery	11	$0.00	$4,631,262.75	$0.00	$0.00	$4,631,262.75	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$4,631,262.75	$0.00	$0.00	$4,631,262.75	
UNIT PRICES		$0.00	$23.00	$0.00	$0.00	$23.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Misc Safety Supplies	ALL	0.00	$1,000.00	MTH	$0.00
Sand Habitat Restoration Material	BACKFILL	201,359	$23.00	TON	$4,631,262.75
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$23.00	TOTAL MATERIAL COST →			$4,631,262.75

ESTIMATE WORKSHEET 12

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Loading	12

BID DATA			
TOTAL QUANTITY ON PROPOSAL	149,155	Bid Data Notes	
BID UNIT	CY		

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	6.8	1.56	7,344	41

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Loading	12	$149,248.42	$12,015.29	$185,388.77	$0.00	$346,652.48	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$149,248.42	$12,015.29	$185,388.77	$0.00	$346,652.48	
UNIT PRICES		$1.00	$0.08	$1.24	$0.00	$2.32	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	975	$158.89	$154,895.90
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	975	$31.28	$30,492.87
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.24	0		TOTAL RENTED EQUIP →		$185,388.77

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	975	$72.40	$70,583.79
Laborer	DREDGE	3	1462	$53.80	$78,664.64
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$1.00	TOTAL LABOR COST →		$149,248.42

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	7.82	$12.00	MTH	$93.81
Per Diem	ALL	203	$51.00	MD	$10,357.99
Misc Safety Supplies	ALL	1.56	$1,000.00	MD	$1,563.49
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.08	TOTAL MATERIAL COST →			$12,015.29

ESTIMATE WORKSHEET 13

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 26, 2018	Penobscot	Backfilling	13

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	149,155							
BID UNIT	CY		12	6	6.8	1.56	3,672	41

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Backfilling	13	$484,415.98	$45,461.04	$398,328.88	$0.00	$928,205.90	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$484,415.98	$45,461.04	$398,328.88	$0.00	$928,205.90	
UNIT PRICES		$3.25	$0.30	$2.67	$0.00	$6.22	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Dump Scow (2000yard)	Backfilling		3	1462	$141.89	$207,484.68
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		5	2437	$71.67	$174,664.08
Workboat	DREDGE/TRANSPORT		5	2437	$6.64	$16,180.12
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$2.67	0		TOTAL RENTED EQUIP →		$398,328.88

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Tug Operator	DREDGE	5	2437	$42.04	$102,456.24
Laborer	DREDGE	5	2437	$53.80	$131,107.73
Deckhand	TRANSPORT	5	2437	$45.02	$109,725.96
Foreman	TRANSPORT	1	487	$79.33	$38,669.81
Tug Operator	TRANSPORT	5	2437	$42.04	$102,456.24
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$3.25	TOTAL LABOR COST →		$484,415.98

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	32.83	$12.00	MTH	$394.00
Per Diem	ALL	853	$51.00	MD	$43,503.54
Misc Safety Supplies	ALL	1.56	$1,000.00	MD	$1,563.49
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.30	TOTAL MATERIAL COST →			$45,461.04

Phase III Engineering Study Report Cost Estimate Supporting Documentation

Verona East, Verona Northeast, and Orland River Dredging

Verona East, Verona Northeast, and Orland River Dredging
Final Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Offsite Disposal

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$448,626.10				$22,431.31	$471,057.41	$448,626.10	$471,057.41	$471,057	$480,000
Mobilization	LS	1					$20,155,277.39				$1,007,763.87	$21,163,041.26	$20,155,277.39	$21,163,041.26	$21,163,041	$21,170,000
Temporary Construction - Main FF Processing	LS	1	$269,829	$722,809	$139,386	$3,670,000	$4,802,023.49	$47,420.70	$135,842.82	$183,500.00	$256,068.32	$5,424,855.32	$4,802,023.49	$5,424,855.32	$5,424,855	$5,430,000
Temporary Construction - Main NE Processing	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Temporary Construction - FF Storage 1	LS	1	$149,905	$461,699	$77,437	$1,750,000	$2,439,040.69	$29,652.46	$82,684.88	$87,500.00	$130,461.28	$2,769,339.32	$2,439,040.69	$2,769,339.32	$2,769,339	$2,770,000
Temporary Construction - FF Storage 2	LS	1	$179,886	$658,858	$92,924	$2,550,000	$3,481,668.01	$41,348.01	$111,800.16	$127,500.00	$186,048.41	$3,948,364.59	$3,481,668.01	$3,948,364.59	$3,948,365	$3,950,000
Conditions Surveys	LS	1	$13,590	$0	$637	$0	$14,227.41	$35.05	$1,707.29	$0.00	$796.74	$16,766.49	$14,227.41	$16,766.49	$16,766	$20,000
Topographic Surveys - Dredge	LS	1	$0	$0	$0	$129,800	$129,800.00	$0.00	$0.00	$6,490.00	$6,814.50	$143,104.50	$129,800.00	$143,104.50	$143,105	$150,000
Topographic Surveys - Dredge - NE	LS	1	$0	$0	$0	$38,940	$38,940.00	$0.00	$0.00	$1,947.00	$2,044.35	$42,931.35	$38,940.00	$42,931.35	$42,931	$50,000
Hydrographic Surveys - Deep	LS	1	$0	$0	$0	$467,257	$467,256.91	$0.00	$0.00	$23,362.85	$24,530.99	$515,150.74	$467,256.91	$515,150.74	$515,151	$520,000
Hydrographic Surveys - Shallow	LS	1	$0	$0	$0	$1,659,181	$1,659,180.83	$0.00	$0.00	$82,959.04	$87,106.99	$1,829,246.86	$1,659,180.83	$1,829,246.86	$1,829,247	$1,830,000
Utilities Surveys	LS	1	$0	$0	$0	$360,869	$360,868.75	$0.00	$0.00	$18,043.44	$18,945.61	$397,857.80	$360,868.75	$397,857.80	$397,858	$400,000
Debris Surveys	LS	1	$0	$0	$0	$375,463	$375,463.00	$0.00	$0.00	$18,773.15	$19,711.81	$413,947.96	$375,463.00	$413,947.96	$413,948	$420,000
Environmental Monitoring	LS	1	$132,435	$0	$1,759,918	$0	$1,892,353.09	$96,795.48	$227,082.37	$0.00	$105,971.77	$2,322,202.71	$1,892,353.09	$2,322,202.71	$2,322,203	$2,330,000
Debris Removal	CY	18,137	$650,885	$53,667	$553,661	$0	$1,258,213.74	$33,403.06	$150,985.65	$0.00	$70,459.97	$1,513,062.42	$69.37	$83.42	$1,513,062	$1,520,000
Debris Removal - FF Dredge for Draft	CY	2,778	$99,685	$8,219	$84,794	$0	$192,698.31	$5,115.76	$23,123.80	$0.00	$10,791.11	$231,728.97	$69.37	$83.42	$231,729	$240,000
Dredging - Deep	CY	365,448	$1,610,460	$131,587	$1,466,075	$0	$3,208,122.55	$87,871.44	$384,974.71	$0.00	$179,654.86	$3,860,623.57	$8.78	$10.56	$3,860,624	$3,870,000
Dredging - Shallow	CY	1,448,288	$14,849,691	$1,224,400	$12,631,557	$0	$28,705,648.69	$762,077.67	$3,444,677.84	$0.00	$1,607,516.33	$34,519,920.53	$19.82	$23.83	$34,519,921	$34,520,000
Dredging - FF Dredge for Draft	CY	152,778	$1,566,472	$129,160	$1,332,484	$0	$3,028,116.33	$80,390.44	$363,373.96	$0.00	$169,574.51	$3,641,455.25	$19.82	$23.83	$3,641,455	$3,650,000
Offloading - Deep	CY	365,448	$475,752	$38,301	$590,955	$0	$1,105,008.52	$34,609.08	$132,601.02	$0.00	$61,880.48	$1,334,099.10	$3.02	$3.65	$1,334,099	$1,340,000
Offloading - Shallow	CY	1,448,288	$1,689,348	$136,001	$2,098,421	$0	$3,923,770.68	$122,893.26	$470,852.48	$0.00	$219,731.16	$4,737,247.58	$2.71	$3.27	$4,737,248	$4,740,000
Offloading - FF Dredge for Draft	CY	152,778	$178,207	$14,347	$221,359	$0	$413,912.75	$12,963.83	$49,669.53	$0.00	$23,179.11	$499,725.23	$2.71	$3.27	$499,725	$500,000
Processing - Deep	CY	365,448	$386,040	$4,212,357	$206,911	$0	$4,805,307.89	$243,059.72	$576,636.95	$0.00	$269,097.24	$5,894,101.81	$13.15	$16.13	$5,894,102	$5,900,000
Processing - Shallow	CY	1,448,288	$1,370,789	$16,680,758	$734,719	$0	$18,786,265.49	$957,851.22	$2,254,351.86	$0.00	$1,052,030.87	$23,050,499.44	$12.97	$15.92	$23,050,499	$23,060,000
Processing - FF Dredge for Draft	CY	152,778	$144,602	$1,759,628	$77,504	$0	$1,981,735.30	$101,042.31	$237,808.24	$0.00	$110,977.18	$2,431,563.02	$12.97	$15.92	$2,431,563	$2,440,000
Material Procurement and Delivery - Deep	Ton	555,023	$0	$12,765,539	$0	$0	$12,765,538.63	$702,104.62	$1,531,864.64	$0.00	$714,870.16	$15,714,378.06	$23.00	$28.31	$15,714,378	$15,720,000
Material Procurement and Delivery - Shallow	Ton	2,101,828	$0	$48,342,050	$0	$0	$48,342,050.50	$2,658,812.78	$5,801,046.06	$0.00	$2,707,154.83	$59,509,064.16	$23.00	$28.31	$59,509,064	$59,510,000
Loading - Deep	CY	411,128	$535,222	$43,088	$664,825	$0	$1,243,134.58	$38,935.22	$149,176.15	$0.00	$69,615.54	$1,500,861.49	$3.02	$3.65	$1,500,861	$1,510,000
Loading - Shallow	CY	1,556,910	$1,816,049	$146,202	$2,255,803	$0	$4,218,053.48	$132,110.26	$506,166.42	$0.00	$236,210.99	$5,092,541.15	$2.71	$3.27	$5,092,541	$5,100,000
Backfilling - Deep	CY	411,128	$1,811,767	$148,036	$1,649,335	$0	$3,609,137.87	$98,855.37	$433,096.54	$0.00	$202,111.72	$4,343,201.51	$8.78	$10.56	$4,343,202	$4,350,000
Backfilling - Shallow	CY	1,556,910	$15,963,418	$1,316,230	$13,578,924	$0	$30,858,572.35	$819,233.49	$3,703,028.68	$0.00	$1,728,080.05	$37,108,914.57	$19.82	$23.83	$37,108,915	$37,110,000
T&D - Deep	Ton	434,152	$0	$4,352	$0	$35,947,757	$35,952,108.61	$239.35	$522.22	$1,797,387.84	$1,887,500.93	$39,637,758.95	$82.81	$91.30	$39,637,759	$39,640,000
T&D - Shallow	Ton	1,720,566	$0	$17,247	$0	$142,462,899	$142,480,145.09	$948.56	$2,069.58	$7,123,144.93	$7,480,267.98	$157,086,576.13	$82.81	$91.30	$157,086,576	$157,090,000
T&D - FF Dredge for Draft	Ton	181,500	$0	$1,819	$0	$15,028,200	$15,030,019.31	$100.06	$218.32	$751,410.00	$789,082.38	$16,570,830.07	$82.81	$91.30	$16,570,830	$16,580,000
Water Treatment - Deep	LS	1	$160,125	$11,647	$0	$445,000	$616,772.21	$640.60	$20,612.66	$22,250.00	$32,981.74	$693,257.21	$616,772.21	$693,257.21	$693,257	$700,000
Water Treatment - Shallow	LS	1	$568,587	$41,358	$0	$1,160,000	$1,769,945.30	$2,274.69	$73,193.44	$58,000.00	$95,056.94	$1,998,470.37	$1,769,945.30	$1,998,470.37	$1,998,470	$2,000,000
Water Treatment - FF Dredge for Draft	LS	1	$59,979	$4,363	$0	$280,000	$344,342.23	$239.95	$7,721.07	$14,000.00	$18,303.16	$384,606.41	$344,342.23	$384,606.41	$384,606	$390,000
Restoration Plantings and Access Agreements	LS	1	$0	$0	$0	$601,545	$601,545.11	$0.00	$0.00	$30,077.26	$31,581.12	$663,203.48	$601,545.11	$663,203.48	$663,203	$670,000
Demobilization	LS	1					$20,155,277.39	$0.00	$0.00	$0.00	$1,007,763.87	$21,163,041.26	$20,155,277.39	$21,163,041.26	$21,163,041	$21,170,000
		TOTALS	**$44,862,610.07**	**$89,507,144.51**	**$40,310,554.79**	**$208,597,534.96**	**$424,037,025.22**	**$7,139,973.46**	**$20,961,637.12**	**$10,429,876.75**	**$22,771,426.95**	**$485,339,939.51**	**$62,130,028.01**	**$67,062,441.60**	**$485,339,939.51**	**$485,550,000.00**

Verona East, Verona Northeast, and Orland River Dredging
Final Phase III Engineering Study Report
Penobscot River Phase III Engineering Study

Beneficial Reuse

Description	Units of Meas.	Quantity	Labor	Material	Equipment	Subcontractor	Total Field Cost	Taxes	12% Overhead - Labor, Materials, Equipment (No T&D)	5% Overhead (Subcontractors)	5% Profit	Bid Amount	Base Unit Price (does not include taxes, OH, profit)	Unit Price	Total Cost	Rounded Total Cost
Performance and Payment Bond																
Work Plans and Submittals	LS	1					$448,626.10				$22,431.31	$471,057.41	$448,626.10	$471,057.41	$471,057	$480,000
Mobilization	LS	1					$20,155,277.39				$1,007,763.87	$21,163,041.26	$20,155,277.39	$21,163,041.26	$21,163,041	$21,170,000
Temporary Construction - Main FF Processing	LS	1	$269,829	$722,809	$139,386	$3,670,000	$4,802,023.49	$47,420.70	$135,842.82	$183,500.00	$256,068.32	$5,424,855.32	$4,802,023.49	$5,424,855.32	$5,424,855	$5,430,000
Temporary Construction - Main NE Processing	LS	1	$179,886	$433,422	$92,924	$1,670,625	$2,376,856.64	$28,949.01	$84,747.80	$83,531.25	$127,256.78	$2,701,341.48	$2,376,856.64	$2,701,341.48	$2,701,341	$2,710,000
Temporary Construction - FF Storage 1	LS	1	$149,905	$461,699	$77,437	$1,750,000	$2,439,040.69	$29,652.46	$82,684.88	$87,500.00	$130,461.28	$2,769,339.32	$2,439,040.69	$2,769,339.32	$2,769,339	$2,770,000
Temporary Construction - FF Storage 2	LS	1	$179,886	$658,858	$92,924	$2,550,000	$3,481,668.01	$41,348.01	$111,800.16	$127,500.00	$186,048.41	$3,948,364.59	$3,481,668.01	$3,948,364.59	$3,948,365	$3,950,000
Conditions Surveys	LS	1	$13,590	$0	$637	$0	$14,227.41	$35.05	$1,707.29	$0.00	$796.74	$16,766.49	$14,227.41	$16,766.49	$16,766	$20,000
Topographic Surveys - Dredge	LS	1	$0	$0	$0	$129,800	$129,800.00	$0.00	$0.00	$6,490.00	$6,814.50	$143,104.50	$129,800.00	$143,104.50	$143,105	$150,000
Topographic Surveys - Dredge - NE	LS	1	$0	$0	$0	$38,940	$38,940.00	$0.00	$0.00	$1,947.00	$2,044.35	$42,931.35	$38,940.00	$42,931.35	$42,931	$50,000
Hydrographic Surveys - Deep	LS	1	$0	$0	$0	$467,257	$467,256.91	$0.00	$0.00	$23,362.85	$24,530.99	$515,150.74	$467,256.91	$515,150.74	$515,151	$520,000
Hydrographic Surveys - Shallow	LS	1	$0	$0	$0	$1,659,181	$1,659,180.83	$0.00	$0.00	$82,959.04	$87,106.99	$1,829,246.86	$1,659,180.83	$1,829,246.86	$1,829,247	$1,830,000
Utilities Surveys	LS	1	$0	$0	$0	$360,869	$360,868.75	$0.00	$0.00	$18,043.44	$18,945.61	$397,857.80	$360,868.75	$397,857.80	$397,858	$400,000
Debris Surveys	LS	1	$0	$0	$0	$375,463	$375,463.00	$0.00	$0.00	$18,773.15	$19,711.81	$413,947.96	$375,463.00	$413,947.96	$413,948	$420,000
Environmental Monitoring	LS	1	$132,435	$0	$1,759,918	$0	$1,892,353.09	$96,795.48	$227,082.37	$0.00	$105,971.77	$2,322,202.71	$1,892,353.09	$2,322,202.71	$2,322,203	$2,330,000
Debris Removal	CY	18,137	$650,885	$53,667	$553,661	$0	$1,258,213.74	$33,403.06	$150,985.65	$0.00	$70,459.97	$1,513,062.42	$69.37	$83.42	$1,513,062	$1,520,000
Debris Removal - FF Dredge for Draft	CY	2,778	$99,685	$8,219	$84,794	$0	$192,698.31	$5,115.76	$23,123.80	$0.00	$10,791.11	$231,728.97	$69.37	$83.42	$231,729	$240,000
Dredging - Deep	CY	365,448	$1,610,460	$131,587	$1,466,075	$0	$3,208,122.55	$87,871.44	$384,974.71	$0.00	$179,654.86	$3,860,623.57	$8.78	$10.56	$3,860,624	$3,870,000
Dredging - Shallow	CY	1,448,288	$14,849,691	$1,224,400	$12,631,557	$0	$28,705,648.69	$762,077.67	$3,444,677.84	$0.00	$1,607,516.33	$34,519,920.53	$19.82	$23.83	$34,519,921	$34,520,000
Dredging - FF Dredge for Draft	CY	152,778	$1,566,472	$129,160	$1,332,484	$0	$3,028,116.33	$80,390.44	$363,373.96	$0.00	$169,574.51	$3,641,455.25	$19.82	$23.83	$3,641,455	$3,650,000
Offloading - Deep	CY	365,448	$475,752	$38,301	$590,955	$0	$1,105,008.52	$34,609.08	$132,601.02	$0.00	$61,880.48	$1,334,099.10	$3.02	$3.65	$1,334,099	$1,340,000
Offloading - Shallow	CY	1,448,288	$1,689,348	$136,001	$2,098,421	$0	$3,923,770.68	$122,893.26	$470,852.48	$0.00	$219,731.16	$4,737,247.58	$2.71	$3.27	$4,737,248	$4,740,000
Offloading - FF Dredge for Draft	CY	152,778	$178,207	$14,347	$221,359	$0	$413,912.75	$12,963.83	$49,669.53	$0.00	$23,179.11	$499,725.23	$2.71	$3.27	$499,725	$500,000
Processing - Deep	CY	365,448	$386,040	$4,212,357	$206,911	$0	$4,805,307.89	$243,059.72	$576,636.95	$0.00	$269,097.24	$5,894,101.81	$13.15	$16.13	$5,894,102	$5,900,000
Processing - Shallow	CY	1,448,288	$1,370,789	$16,680,758	$734,719	$0	$18,786,265.49	$957,851.22	$2,254,351.86	$0.00	$1,052,030.87	$23,050,499.44	$12.97	$15.92	$23,050,499	$23,060,000
Processing - FF Dredge for Draft	CY	152,778	$144,602	$1,759,628	$77,504	$0	$1,981,735.30	$101,042.31	$237,808.24	$0.00	$110,977.18	$2,431,563.02	$12.97	$15.92	$2,431,563	$2,440,000
Material Procurement and Delivery - Deep	Ton	555,023	$0	$12,765,539	$0	$0	$12,765,538.63	$702,104.62	$1,531,864.64	$0.00	$714,870.16	$15,714,378.06	$23.00	$28.31	$15,714,378	$15,720,000
Material Procurement and Delivery - Shallow	Ton	2,101,828	$0	$48,342,050	$0	$0	$48,342,050.50	$2,658,812.78	$5,801,046.06	$0.00	$2,707,154.83	$59,509,064.16	$23.00	$28.31	$59,509,064	$59,510,000
Loading - Deep	CY	411,128	$535,222	$43,088	$664,825	$0	$1,243,134.58	$38,935.22	$149,176.15	$0.00	$69,615.54	$1,500,861.49	$3.02	$3.65	$1,500,861	$1,510,000
Loading - Shallow	CY	1,556,910	$1,816,049	$146,202	$2,255,803	$0	$4,218,053.48	$132,110.26	$506,166.42	$0.00	$236,210.99	$5,092,541.15	$2.71	$3.27	$5,092,541	$5,100,000
Backfilling - Deep	CY	411,128	$1,811,767	$148,036	$1,649,335	$0	$3,609,137.87	$98,855.37	$433,096.54	$0.00	$202,111.72	$4,343,201.51	$8.78	$10.56	$4,343,202	$4,350,000
Backfilling - Shallow	CY	1,556,910	$15,963,418	$1,316,230	$13,578,924	$0	$30,858,572.35	$819,233.49	$3,703,028.68	$0.00	$1,728,080.05	$37,108,914.57	$19.82	$23.83	$37,108,915	$37,110,000
T&D Ben - Deep	Ton	434,152	$0	$4,352	$0	$14,240,174	$14,244,526.01	$239.35	$522.22	$712,008.71	$747,852.85	$15,705,149.13	$32.81	$36.17	$15,705,149	$15,710,000
T&D Ben - Shallow	Ton	1,720,566	$0	$17,247	$0	$56,434,578	$56,451,824.69	$948.56	$2,069.58	$2,821,728.91	$2,963,781.16	$62,240,352.89	$32.81	$36.17	$62,240,353	$62,250,000
T&D Ben - FF Dredge for Draft	Ton	181,500	$0	$1,819	$0	$5,953,200	$5,955,019.31	$100.06	$218.32	$297,660.00	$312,644.88	$6,565,642.57	$32.81	$36.17	$6,565,643	$6,570,000
Water Treatment - Deep	LS	1	$160,125	$11,647	$0	$445,000	$616,772.21	$640.60	$20,612.66	$22,250.00	$32,981.74	$693,257.21	$616,772.21	$693,257.21	$693,257	$700,000
Water Treatment - Shallow	LS	1	$568,587	$41,358	$0	$1,160,000	$1,769,945.30	$2,274.69	$73,193.44	$58,000.00	$95,056.94	$1,998,470.37	$1,769,945.30	$1,998,470.37	$1,998,470	$2,000,000
Water Treatment - FF Dredge for Draft	LS	1	$59,979	$4,363	$0	$280,000	$344,342.23	$239.95	$7,721.07	$14,000.00	$18,303.16	$384,606.41	$344,342.23	$384,606.41	$384,606	$390,000
Restoration Plantings and Access Agreements	LS	1	$0	$0	$0	$601,545	$601,545.11	$0.00	$0.00	$30,077.26	$31,581.12	$663,203.48	$601,545.11	$663,203.48	$663,203	$670,000
Demobilization	LS	1					$20,155,277.39	$0.00	$0.00	$0.00	$1,007,763.87	$21,163,041.26	$20,155,277.39	$21,163,041.26	$21,163,041	$21,170,000
		TOTALS	**$44,862,610.07**	**$89,507,144.51**	**$40,310,554.79**	**$91,786,631.96**	**$307,226,122.22**	**$7,139,973.46**	**$20,961,637.12**	**$4,589,331.60**	**$16,638,854.55**	**$356,555,918.95**	**$62,129,878.01**	**$67,062,276.23**	**$356,555,918.95**	**$356,770,000.00**

Debris Disposal Quantities	Deep	Shallow
Dredge Volume (CY)	182,724	724,144
Debris Area (% of Dredge Volume)	2%	2%
Debris Volume (CY)	**3654**	**14483**
Debris Volume (TONS)	**4,020**	**15,931**

Dredging & Disposal Quantities	Deep	Shallow
Dredge Depth (FT)	0.50	0.50
Dredge Volume (CY)	182,724	724,144
Dredge Area (SF)	9,867,083	39,103,782
Total Area Footprint (ACRES)	226.52	897.70
Overdepth Dredge (FT)	0.50	0.50
Overdepth Dredge (CY)	182,724	724,144
Surface Deposits (CY)	0	0
Subtotal Dredging Volume (CY) (Dredge+Overdredge+Surface Deposits)	365,448	1,448,288
Side Slopes (CY)	0	0
Total Dredging Volume (CY)	365,448	1,448,288
Total Dredging Volume Bulked (CY)	**365,448**	**1,448,288**
Total Dredging Volume (TON)	401,992	1,593,117
Portland Cement Addition (TON)	32,159	127,449
Total Disposal Volume (TON)	**434,152**	**1,720,566**

Backfill Quantities	Deep	Shallow
Placement Area (SF)	9,867,083	39,103,782
Placement Area (Acres)	226.52	897.70
Min. Layer Thickness (FT)	0.50	0.50
Allowable overplacement (FT)	0.50	0.50
Volume (CY)	365,448	1,448,288
Material Loss (%)	12.5%	7.5%
Volume w/Loss (CY)	**411,128**	**1,556,910**
Weight (TON)	**555,023**	**2,101,828**

Restoration Plantings and Access Agreements	Shallow
Number of SF	5,240,661.00
Number of Acres	120.31
Access Agreements	0.00

Deep Dredging - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.5	min
Uptime	70%	%
# of dredges	2	ea.
Hourly Rate	235	cy/hr
Shift	12	hrs/day
Production Rate	**2,822**	**cy/day**
Production Rate (Season)	**316,109**	**cy/season**

Shallow Dredging - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.0	min
Uptime	25%	%
# of dredges	5	ea.
Hourly Rate	263	cy/hr
Shift	12	hrs/day
Production Rate	**3,150**	**cy/day**
Production Rate (Season)	**352,800**	**cy/season**

Deep Backfilling - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.5	min
Uptime	70%	%
# of Equipment	2	ea.
Hourly Rate	235	cy/hr
Shift	12	hrs/day
Production Rate	**2,822**	**cy/day**

Shallow Backfilling - Mechanical		
Bucket Size	10.0	cy
% Full	70%	%
Cycle Time	2.0	min
Uptime	25%	%
# of Equipment	5	ea.
Hourly Rate	263	cy/hr
Shift	12	hrs/day
Production Rate	**3,150**	**cy/day**

Unloading, Loading, and Processing - Mechanical		
Bucket Size	10.0	cy
Bucket % Full	90%	%
Cycle Time	1.5	min
Uptime	85%	%
# of Equipment	2	ea.
Hourly Rate	612	cy/hr
Shift	12	hrs/day
Production Rate	**7,344**	**cy/day**
Production Rate (Season)	**822,528**	**cy/season**

Debris Removal		
Bucket Size	10.0	cy
% Full	50%	%
Cycle Time	5.0	min
Uptime	25%	%
# of Equipment	5	ea.
Hourly Rate	75	cy/hr
Shift	12	hrs/day
Production Rate	**900**	**cy/day**

ESTIMATE WORKSHEET 4

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - Main FF Processing	4

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	1	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	LS		12	6	7.5	1.73	-	45

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - Main FF Processing	4	$269,829.00	$722,808.65	$139,385.84	$3,670,000.00	$4,802,023.49	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$269,829.00	$722,808.65	$139,385.84	$3,670,000.00	$4,802,023.49	
UNIT PRICES		$269,829.00	$722,808.65	$139,385.84	$3,670,000.00	$4,802,023.49	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ELECTRICAL INSTALLATION	ELECTRIC	1	$10,000.00	LS	$10,000.00
WATER UTILITY INSTALLATION	WATER	1	$10,000.00	LS	$10,000.00
ASPHALT PAVING	SPA	540,000	$5.00	SF	$2,700,000.00
Dolphin Install	Barge docking	15	$50,000.00	SF	$750,000.00
Temporary Dock	Barge docking	400	$500.00	LF	$200,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$3,670,000.00	TOTAL COST →			$3,670,000.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	540	$65.51	$35,377.70
KOMATSU D39P	SPA/RSA		1	540	$34.48	$18,621.77
Wheeled Loaded WA320	SPA/RSA		1	540	$41.72	$22,530.00
84" SMOOTH COMPACTOR	SPA/RSA		1	540	$38.96	$21,036.38
CRANE - 40 TON	SPA/RSA		1	540	$77.44	$41,820.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$139,385.84	0		TOTAL RENTED EQUIP →		$139,385.84

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	540	$71.24	$38,467.80
OPERATOR 3	WA320/D39P	2	1080	$70.43	$76,066.20
LABORER	ALL	4	2160	$53.80	$116,197.20
Crane Operator	40-ton	1	540	$72.40	$39,097.80
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$269,829.00	TOTAL LABOR COST →			$269,829.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	13.86	$12.00	MTH	$166.28
Per Diem	ALL	360	$51.00	MD	$18,360.00
Misc Safety Supplies	ALL	1.73	$1,000.00	MD	$1,732.10
Hdpe Liner - 20 Mil	SPA	624,000.00	$0.27	SF	$168,480.00
Geotextile	SPA	624,000.00	$0.08	SF	$50,586.99
Jersey Barriers	SPA	420.00	$295.00	EA	$123,900.00
Bin Blocks	SPA	510.00	$37.50	EA	$19,125.00
Concrete Sumps	SPA	8.00	$1,500.00	EA	$12,000.00
Silt Fence	SPA	6,000.00	$0.26	LF	$1,560.00
6" Hdpe Pipe	SPA	1,000.00	$17.36	LF	$17,360.00
Tarp 60'x60'	Drip Apron	2.00	$500.00	Ea	$1,000.00
Straw Hay Bales	Drip Apron	23.13	$4.25	Ea	$98.28
Stockpile Tarps	SPA	20.00	22.00	Ea	$440.00
DGA	SPA	14,000	22.00	Ton	$308,000.00
					$0.00
BARE UNIT COST →	$722,808.65	TOTAL MATERIAL COST →			$722,808.65

ESTIMATE WORKSHEET 5

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - Main NE Coal Processing	5

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.0	1.15	-	30

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - Main NE Coal Processing	5	$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	
UNIT PRICES		$179,886.00	$433,421.75	$92,923.89	$1,670,625.00	$2,376,856.64	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ELECTRICAL INSTALLATION	ELECTRIC	1	$10,000.00	LS	$10,000.00
WATER UTILITY INSTALLATION	WATER	1	$10,000.00	LS	$10,000.00
ASPHALT PAVING	SPA	215,125	$5.00	SF	$1,075,625.00
Dolphin Install	Barge docking	8	$50,000.00	SF	$400,000.00
Temporary Dock	Barge docking	350	$500.00	LF	$175,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,670,625.00	TOTAL COST →			$1,670,625.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	360	$65.51	$23,585.13
KOMATSU D39P	SPA/RSA		1	360	$34.48	$12,414.51
Wheeled Loaded WA320	SPA/RSA		1	360	$41.72	$15,020.00
84" SMOOTH COMPACTOR	SPA/RSA		1	360	$38.96	$14,024.25
CRANE - 40 TON	SPA/RSA		1	360	$77.44	$27,880.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$92,923.89	0		TOTAL RENTED EQUIP →		$92,923.89

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	360	$71.24	$25,645.20
OPERATOR 3	WA320/D39P	2	720	$70.43	$50,710.80
LABORER	ALL	4	1440	$53.80	$77,464.80
Crane Operator	40-ton	1	360	$72.40	$26,065.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$179,886.00	TOTAL LABOR COST →			$179,886.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.24	$12.00	MTH	$110.85
Per Diem	ALL	240	$51.00	MD	$12,240.00
Misc Safety Supplies	ALL	1.15	$1,000.00	MD	$1,154.73
Hdpe Liner - 20 Mil	SPA	282,725.00	$0.27	SF	$76,335.75
Geotextile	SPA	282,725.00	$0.08	SF	$22,920.20
Jersey Barriers	SPA	338.00	$295.00	EA	$99,710.00
Bin Blocks	SPA	1,530.00	$37.50	EA	$57,375.00
Concrete Sumps	SPA	4.00	$1,500.00	EA	$6,000.00
Silt Fence	SPA	18,000.00	$0.26	LF	$4,680.00
6" Hdpe Pipe	SPA	1,600.00	$17.36	LF	$27,776.00
Tarp 60'x60'	Drip Apron	2.00	$500.00	Ea	$1,000.00
Straw Hay Bales	Drip Apron	23.13	$4.25	Ea	$98.28
Stockpile Tarps	SPA	60.00	22.00	Ea	$1,320.00
DGA	SPA	5,577	22.00	Ton	$122,700.93
					$0.00
BARE UNIT COST →	$433,421.75	TOTAL MATERIAL COST →			$433,421.75

ESTIMATE WORKSHEET 6

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - FF Storage 1	6

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - FF Storage 1	6	$149,905.00	$461,699.12	$77,436.58	$1,750,000.00	$2,439,040.69	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$149,905.00	$461,699.12	$77,436.58	$1,750,000.00	$2,439,040.69	
UNIT PRICES		$149,905.00	$461,699.12	$77,436.58	$1,750,000.00	$2,439,040.69	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ASPHALT PAVING	SPA	350,000	$5.00	SF	$1,750,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,750,000.00	TOTAL COST →			$1,750,000.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	300	$65.51	$19,654.28
KOMATSU D39P	SPA/RSA		1	300	$34.48	$10,345.43
Wheeled Loaded WA320	SPA/RSA		1	300	$41.72	$12,516.67
84" SMOOTH COMPACTOR	SPA/RSA		1	300	$38.96	$11,686.88
CRANE - 40 TON	SPA/RSA		1	300	$77.44	$23,233.33
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$77,436.58	0		TOTAL RENTED EQUIP →		$77,436.58

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	300	$71.24	$21,371.00
OPERATOR 3	WA320/D39P	2	600	$70.43	$42,259.00
LABORER	ALL	4	1200	$53.80	$64,554.00
Crane Operator	40-ton	1	300	$72.40	$21,721.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$149,905.00	TOTAL LABOR COST →			$149,905.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	7.70	$12.00	MTH	$92.38
Per Diem	ALL	200	$51.00	MD	$10,200.00
Misc Safety Supplies	ALL	0.96	$1,000.00	MD	$962.28
Hdpe Liner - 20 Mil	SPA	404,000.00	$0.27	SF	$109,080.00
Geotextile	SPA	404,000.00	$0.08	SF	$32,751.83
Jersey Barriers	SPA	270.00	$295.00	EA	$79,650.00
Bin Blocks	SPA	510.00	$37.50	EA	$19,125.00
Concrete Sumps	SPA	2.00	$1,500.00	EA	$3,000.00
Silt Fence	SPA	6,000.00	$0.26	LF	$1,560.00
6" Hdpe Pipe	SPA	300.00	$17.36	LF	$5,208.00
Stockpile Tarps	SPA	20.00	22.00	Ea	$440.00
DGA	SPA	9,074	22.00	.	$199,629.63
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$461,699.12	TOTAL MATERIAL COST →			$461,699.12

ESTIMATE WORKSHEET 7

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Temporary Construction - FF Storage 2	7

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.0	1.15	-	30

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Temporary Construction - FF Storage 2	7	$179,886.00	$658,858.12	$92,923.89	$2,550,000.00	$3,481,668.01	Sediment Processing Area Only
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$179,886.00	$658,858.12	$92,923.89	$2,550,000.00	$3,481,668.01	
UNIT PRICES		$179,886.00	$658,858.12	$92,923.89	$2,550,000.00	$3,481,668.01	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
ASPHALT PAVING	SPA	510,000	$5.00	SF	$2,550,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$2,550,000.00	TOTAL COST →			$2,550,000.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
KOMATSU PC300	SPA/RSA		1	360	$65.51	$23,585.13
KOMATSU D39P	SPA/RSA		1	360	$34.48	$12,414.51
Wheeled Loaded WA320	SPA/RSA		1	360	$41.72	$15,020.00
84" SMOOTH COMPACTOR	SPA/RSA		1	360	$38.96	$14,024.25
CRANE - 40 TON	SPA/RSA		1	360	$77.44	$27,880.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$92,923.89	0		TOTAL RENTED EQUIP →		$92,923.89

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
OPERATOR 2	PC300	1	360	$71.24	$25,645.20
OPERATOR 3	WA320/D39P	2	720	$70.43	$50,710.80
LABORER	ALL	4	1440	$53.80	$77,464.80
Crane Operator	40-ton	1	360	$72.40	$26,065.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$179,886.00	TOTAL LABOR COST →			$179,886.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance / Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.24	$12.00	MTH	$110.85
Per Diem	ALL	240	$51.00	MD	$12,240.00
Misc Safety Supplies	ALL	1.15	$1,000.00	MD	$1,154.73
Hdpe Liner - 20 Mil	SPA	590,000.00	$0.27	SF	$159,300.00
Geotextile	SPA	590,000.00	$0.08	SF	$47,830.64
Jersey Barriers	SPA	400.00	$295.00	EA	$118,000.00
Bin Blocks	SPA	510.00	$37.50	EA	$19,125.00
Concrete Sumps	SPA	2.00	$1,500.00	EA	$3,000.00
Silt Fence	SPA	6,000.00	$0.26	LF	$1,560.00
6" Hdpe Pipe	SPA	300.00	$17.36	LF	$5,208.00
Stockpile Tarps	SPA	20.00	22.00	Ea	$440.00
DGA	SPA	13,222	22.00	Ton	$290,888.89
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$658,858.12	TOTAL MATERIAL COST →			$658,858.12

ESTIMATE WORKSHEET 8

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Conditions Surveys	8

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	1.3	0.31	-	8

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Conditions Surveys	8	$13,590.08	$0.00	$637.33	$0.00	$14,227.41	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$13,590.08	$0.00	$637.33	$0.00	$14,227.41	
UNIT PRICES		$13,590.08	$0.00	$637.33	$0.00	$14,227.41	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Workboat	TRANSPORT		1	96	$6.64	$637.33
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$637.33	0		TOTAL RENTED EQUIP →		$637.33

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Boat Operator	Survey	1	96	$62.23	$5,974.08
Foreman	Survey	1	96	$79.33	$7,616.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$13,590.08	TOTAL LABOR COST →		$13,590.08

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 9

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Topographic Surveys - Dredge	9

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Topographic Surveys - Dredge	9	$0.00	$0.00	$0.00	$129,800.00	$129,800.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$129,800.00	$129,800.00	
UNIT PRICES		$0.00	$0.00	$0.00	$129,800.00	$129,800.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Administrative/Survey Prep	Survey	250	$90.00	HR	$22,500.00							$0.00
Establish Benchmarks	Survey	13	$2,500.00	LS	$31,250.00							$0.00
Topographic Survey	Survey	25	$2,500.00	DAY	$62,500.00							$0.00
Per Diem	Survey	50	$35.00	DAY	$1,750.00							$0.00
Expenses & Fuel	Survey	1	$11,800.00	of Total (	$11,800.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$129,800.00	TOTAL COST →			$129,800.00	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00	BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 10

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Topographic Surveys - Dredge - NE Coal	10

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	1	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	LS		12	6	1.3	0.29	-	8

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Topographic Surveys - Dredge - NE Coal	10	$0.00	$0.00	$0.00	$38,940.00	$38,940.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$38,940.00	$38,940.00	
UNIT PRICES		$0.00	$0.00	$0.00	$38,940.00	$38,940.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Administrative/Survey Prep	Survey	75	$90.00	HR	$6,750.00							$0.00
Establish Benchmarks	Survey	4	$2,500.00	LS	$9,375.00							$0.00
Topographic Survey	Survey	8	$2,500.00	DAY	$18,750.00							$0.00
Per Diem	Survey	15	$35.00	DAY	$525.00							$0.00
Expenses & Fuel	Survey	1	$3,540.00	of Total (	$3,540.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →		$38,940.00	TOTAL COST →		$38,940.00	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00	BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 11

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Hydrographic Surveys - Deep	11

BID DATA

		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA

HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	5.4	1.25	-	32

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Hydrographic Surveys - Deep	11	$0.00	$0.00	$0.00	$467,256.91	$467,256.91	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$467,256.91	$467,256.91	
UNIT PRICES		$0.00	$0.00	$0.00	$467,256.91	$467,256.91	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	324	$90.00	HR	$29,133.25
Hydrographic Survey Mob/Demob	Survey	1	$4,200.00	EA	$4,855.54
Hydrographic Survey	Pre-Dredge	11	$12,000.00	DAY	$129,481.12
Hydrographic Survey	Post-Dredge	11	$12,000.00	DAY	$129,481.12
Hydrographic Survey	Post-Cap/Cap Layer	11	$12,000.00	DAY	$129,481.12
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	67	$35.00	DAY	$2,346.85
Expenses & Fuel	Survey	1	$42,477.90	of Total (	$42,477.90
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$467,256.91	TOTAL COST →			$467,256.91

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.00		TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 12

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Hydrographic Surveys - Shallow	12

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	19.2	4.42	-	115

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Hydrographic Surveys - Shallow	12	$0.00	$0.00	$0.00	$1,659,180.83	$1,659,180.83	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$1,659,180.83	$1,659,180.83	
UNIT PRICES		$0.00	$0.00	$0.00	$1,659,180.83	$1,659,180.83	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	1,149	$90.00	HR	$103,449.16
Hydrographic Survey Mob/Demob	Survey	4	$4,200.00	EA	$17,241.53
Hydrographic Survey	Pre-Dredge	38	$12,000.00	DAY	$459,774.04
Hydrographic Survey	Post-Dredge	38	$12,000.00	DAY	$459,774.04
Hydrographic Survey	Post-Cap/Cap Layer	38	$12,000.00	DAY	$459,774.04
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	238	$35.00	DAY	$8,333.40
Expenses & Fuel	Survey	1	$150,834.62	of Total (	$150,834.62
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$1,659,180.83	TOTAL COST →		$1,659,180.83

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 13

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Utilities Surveys	13

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Utilities Surveys	13	$0.00	$0.00	$0.00	$360,868.75	$360,868.75	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$360,868.75	$360,868.75	
UNIT PRICES		$0.00	$0.00	$0.00	$360,868.75	$360,868.75	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep/Processing	Survey	250	$90.00	HR	$22,500.00
Hydrographic Survey Mob/Demob	Survey	1	$4,200.00	EA	$3,750.00
Hydrographic Survey	SubBottom/Mag	25	$12,000.00	DAY	$300,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	52	$35.00	DAY	$1,812.50
Expenses & Fuel	Survey	1	$32,806.25	of Total (	$32,806.25
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$360,868.75	TOTAL COST →		$360,868.75

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 14

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Surveys	14

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	4.2	0.96	-	25

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Surveys	14	$0.00	$0.00	$0.00	$375,463.00	$375,463.00	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$375,463.00	$375,463.00	
UNIT PRICES		$0.00	$0.00	$0.00	$375,463.00	$375,463.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Administrative/Survey Prep	Survey	250	$90.00	HR	$22,500.00
Hydrographic Survey Mob/Demob	Survey	4	$4,200.00	EA	$16,800.00
Hydrographic Survey	SideScan/Mag	25	$12,000.00	DAY	$300,000.00
Survey Vessel Standby	Survey	0	$2,250.00	DAY	$0.00
Per Diem	Survey	58	$35.00	DAY	$2,030.00
Expenses & Fuel	Survey	1	$34,133.00	of Total (	$34,133.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$375,463.00	TOTAL COST →		$375,463.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 15

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Environmental Monitoring	15

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1		12	6	171.0	39.48	2,822	1,026
BID UNIT	LS							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Environmental Monitoring	15	$132,435.25	$0.00	$1,759,917.84	$0.00	$1,892,353.09	Include Monitoring during all silt producing activities. Initial install and ongoing maintenance included. Assumes 2 laborers for maintenance and demob at 10% of total duration. Additional Maintenance is covered under other water tasks.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$132,435.25	$0.00	$1,759,917.84	$0.00	$1,892,353.09	
UNIT PRICES		$132,435.25	$0.00	$1,759,917.84	$0.00	$1,892,353.09	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS/MONTHS	UNIT RATE	TOTAL COST
Workboat	INSTALL/MAINTAIN		2	2462	$6.64	$16,343.95
Water Quality Monitoring Buoy (	Monitor		15	592	$2,944.00	$1,743,573.89
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1,759,917.84	0		TOTAL RENTED EQUIP →		$1,759,917.84

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Laborer	Install	2	2462	$53.80	$132,435.25
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$132,435.25	TOTAL LABOR COST →			$132,435.25

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00

ESTIMATE WORKSHEET 16

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Removal	16

BID DATA		
TOTAL QUANTITY ON PROPOSAL	18,137	Bid Data Notes
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	3.4	0.78	900	20

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Removal	16	$650,885.32	$53,667.39	$553,661.03	$0.00	$1,258,213.74	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$650,885.32	$53,667.39	$553,661.03	$0.00	$1,258,213.74	
UNIT PRICES		$35.89	$2.96	$30.53	$0.00	$69.37	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredg	DREDGE		5	1209	$103.33	$124,946.24
Cable Arm Hydraulic Clamshell (1	DREDGE		5	1209	$31.28	$37,821.15
Dredge Barge	DREDGE BARGE		5	1209	$41.67	$50,381.55
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	2418	$71.67	$173,312.53
Hopper Barge	DREDGE/TRANSPORT		15	3627	$41.67	$151,144.65
Workboat	DREDGE/TRANSPORT		10	2418	$6.64	$16,054.92
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$30.53	0		TOTAL RENTED EQUIP →		$553,661.03

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	1209	$71.24	$86,136.33
Laborer	DREDGE	10	2418	$53.80	$130,093.22
Deckhand	TRANSPORT	10	2418	$45.02	$108,876.90
Boat Operator	TRANSPORT	10	2418	$62.23	$150,491.70
Tug Operator	TRANSPORT	10	2418	$42.04	$101,663.43
Deckhand	DREDGE	5	1209	$45.02	$54,438.45
Foreman	DREDGE	1	242	$79.33	$19,185.29
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$35.89	TOTAL LABOR COST →			$650,885.32

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	39.56	$12.00	MTH	$474.73
Per Diem	ALL	1,028	$51.00	MD	$52,416.96
Misc Safety Supplies	ALL	0.78	$1,000.00	MD	$775.70
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$2.96	TOTAL MATERIAL COST →			$53,667.39

ESTIMATE WORKSHEET 17

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Debris Removal - FF Dredge for Draft	17

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	2,778	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.5	0.12	900	3

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Debris Removal - FF Dredge for Draft	17	$99,684.58	$8,219.28	$84,794.45	$0.00	$192,698.31	
						$0.00	
						$0.00	
						$17.00	
GRAND TOTALS		$99,684.58	$8,219.28	$84,794.45	$0.00	$192,715.31	
UNIT PRICES		$35.89	$2.96	$30.53	$0.00	$69.38	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredg	DREDGE		5	185	$103.33	$19,135.80
Cable Arm Hydraulic Clamshell (1	DREDGE		5	185	$31.28	$5,792.40
Dredge Barge	DREDGE BARGE		5	185	$41.67	$7,716.05
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	370	$71.67	$26,543.21
Hopper Barge	DREDGE/TRANSPORT		15	556	$41.67	$23,148.15
Workboat	DREDGE/TRANSPORT		10	370	$6.64	$2,458.85
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$30.53	0		TOTAL RENTED EQUIP →		$84,794.45

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	185	$71.24	$13,191.98
Laborer	DREDGE	10	370	$53.80	$19,924.07
Deckhand	TRANSPORT	10	370	$45.02	$16,674.75
Boat Operator	TRANSPORT	10	370	$62.23	$23,048.15
Tug Operator	TRANSPORT	10	370	$42.04	$15,569.99
Deckhand	DREDGE	5	185	$45.02	$8,337.37
Foreman	DREDGE	1	37	$79.33	$2,938.27
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$35.89	TOTAL LABOR COST →		$99,684.58

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	6.06	$12.00	MTH	$72.71
Per Diem	ALL	157	$51.00	MD	$8,027.78
Misc Safety Supplies	ALL	0.12	$1,000.00	MD	$118.80
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $2.96		TOTAL MATERIAL COST →			$8,219.28

ESTIMATE WORKSHEET 18

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Dredging - Deep	18

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	365,448	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	21.6	4.98	3,150	129

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Dredging - Deep	18	$1,610,459.97	$131,587.41	$1,466,075.18	$0.00	$3,208,122.55	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,610,459.97	$131,587.41	$1,466,075.18	$0.00	$3,208,122.55	
UNIT PRICES		$4.41	$0.36	$4.01	$0.00	$8.78	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	3108	$158.89	$493,754.68
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	3108	$31.28	$97,200.76
Dredge Tender (Push Boat)	DREDGE BARGE		4	6215	$71.67	$445,415.06
Hopper Barge	DREDGE/TRANSPORT		6	9323	$41.67	$388,443.37
Workboat	DREDGE/TRANSPORT		4	6215	$6.64	$41,261.32
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$4.01	0		TOTAL RENTED EQUIP →		$1,466,075.18

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	3108	$72.40	$224,996.76
Laborer	DREDGE	4	6215	$53.80	$334,340.97
Deckhand	TRANSPORT	4	6215	$45.02	$279,814.81
Boat Operator	TRANSPORT	4	6215	$62.23	$386,765.29
Tug Operator	TRANSPORT	4	6215	$42.04	$261,276.10
Foreman	DREDGE	1	1554	$79.33	$123,266.03
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$4.41	TOTAL LABOR COST →			$1,610,459.97

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	94.69	$12.00	MTH	$1,136.32
Per Diem	ALL	2,460	$51.00	MD	$125,467.21
Misc Safety Supplies	ALL	4.98	$1,000.00	MD	$4,983.88
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.36	TOTAL MATERIAL COST →			$131,587.41

ESTIMATE WORKSHEET 19

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Dredging - Shallow	19

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,448,288	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	76.6	17.70	2,822	460

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Dredging - Shallow	19	$14,849,691.13	$1,224,400.21	$12,631,557.35	$0.00	$28,705,648.69	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$14,849,691.13	$1,224,400.21	$12,631,557.35	$0.00	$28,705,648.69	
UNIT PRICES		$10.25	$0.85	$8.72	$0.00	$19.82	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredge)	DREDGE		5	27586	$103.33	$2,850,599.04
Cable Arm Hydraulic Clamshell (10.0 CY) v	DREDGE		5	27586	$31.28	$862,874.54
Dredge Barge	DREDGE BARGE		5	27586	$41.67	$1,149,435.10
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	55173	$71.67	$3,954,056.73
Hopper Barge	DREDGE/TRANSPORT		15	82759	$41.67	$3,448,305.29
Workboat	DREDGE/TRANSPORT		10	55173	$6.64	$366,286.65
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$8.72	0		TOTAL RENTED EQUIP →		$12,631,557.35

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	27586	$71.24	$1,965,166.20
Laborer	DREDGE	10	55173	$53.80	$2,968,025.33
Deckhand	TRANSPORT	10	55173	$45.02	$2,483,983.47
Boat Operator	TRANSPORT	10	55173	$62.23	$3,433,408.61
Tug Operator	TRANSPORT	10	55173	$42.04	$2,319,410.89
Deckhand	DREDGE	5	27586	$45.02	$1,241,991.74
Foreman	DREDGE	1	5517	$79.33	$437,704.88
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$10.25	TOTAL LABOR COST →			$14,849,691.13

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	902.56	$12.00	MTH	$10,830.70
Per Diem	ALL	23,448	$51.00	MD	$1,195,872.27
Misc Safety Supplies	ALL	17.70	$1,000.00	MD	$17,697.23
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.85	TOTAL MATERIAL COST →			$1,224,400.21

ESTIMATE WORKSHEET 20

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Dredging - FF Dredge for Draft	20

BID DATA		
TOTAL QUANTITY ON PROPOSAL	152,778	Bid Data Notes
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	8.1	1.87	2,822	49

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Dredging - FF Dredge for Draft	20	$1,566,471.91	$129,160.16	$1,332,484.26	$0.00	$3,028,116.33	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,566,471.91	$129,160.16	$1,332,484.26	$0.00	$3,028,116.33	
UNIT PRICES		$10.25	$0.85	$8.72	$0.00	$19.82	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredge)	DREDGE		5	2910	$103.33	$300,705.47
Cable Arm Hydraulic Clamshell (10.0 CY) v	DREDGE		5	2910	$31.28	$91,023.36
Dredge Barge	DREDGE BARGE		5	2910	$41.67	$121,252.20
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	5820	$71.67	$417,107.58
Hopper Barge	DREDGE/TRANSPORT		15	8730	$41.67	$363,756.61
Workboat	DREDGE/TRANSPORT		10	5820	$6.64	$38,639.04
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$8.72	0		TOTAL RENTED EQUIP →		$1,332,484.26

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	2910	$71.24	$207,302.47
Laborer	DREDGE	10	5820	$53.80	$313,092.59
Deckhand	TRANSPORT	10	5820	$45.02	$262,031.73
Boat Operator	TRANSPORT	10	5820	$62.23	$362,185.19
Tug Operator	TRANSPORT	10	5820	$42.04	$244,671.22
Deckhand	DREDGE	5	2910	$45.02	$131,015.87
Foreman	DREDGE	1	582	$79.33	$46,172.84
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$10.25	TOTAL LABOR COST →			$1,566,471.91

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	95.21	$12.00	MTH	$1,142.51
Per Diem	ALL	2,474	$51.00	MD	$126,150.79
Misc Safety Supplies	ALL	1.87	$1,000.00	MD	$1,866.85
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.85	TOTAL MATERIAL COST →			$129,160.16

ESTIMATE WORKSHEET 21

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Offloading - Deep	21

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	365,448	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	21.6	4.98	7,344	129

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Offloading - Deep	21	$475,752.49	$38,300.60	$590,955.44	$0.00	$1,105,008.52	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$475,752.49	$38,300.60	$590,955.44	$0.00	$1,105,008.52	
UNIT PRICES		$1.30	$0.10	$1.62	$0.00	$3.02	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	3108	$158.89	$493,754.68
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	3108	$31.28	$97,200.76
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.62		0	TOTAL RENTED EQUIP →		$590,955.44

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	3108	$72.40	$224,996.76
Laborer	DREDGE	3	4661	$53.80	$250,755.73
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$1.30	TOTAL LABOR COST →		$475,752.49

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	24.92	$12.00	MTH	$299.03
Per Diem	ALL	647	$51.00	MD	$33,017.69
Misc Safety Supplies	ALL	4.98	$1,000.00	MD	$4,983.88
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.10	TOTAL MATERIAL COST →			$38,300.60

ESTIMATE WORKSHEET 22

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Offloading - Shallow	22

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,448,288	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	76.6	17.70	7,344	460

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Offloading - Shallow	22	$1,689,347.75	$136,001.44	$2,098,421.48	$0.00	$3,923,770.68	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,689,347.75	$136,001.44	$2,098,421.48	$0.00	$3,923,770.68	
UNIT PRICES		$1.17	$0.09	$1.45	$0.00	$2.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	11035	$158.89	$1,753,271.67
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	11035	$31.28	$345,149.82
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.45	0		TOTAL RENTED EQUIP →		$2,098,421.48

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	11035	$72.40	$798,940.15
Laborer	DREDGE	3	16552	$53.80	$890,407.60
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.17	TOTAL LABOR COST →			$1,689,347.75

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	88.49	$12.00	MTH	$1,061.83
Per Diem	ALL	2,299	$51.00	MD	$117,242.38
Misc Safety Supplies	ALL	17.70	$1,000.00	MD	$17,697.23
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.09	TOTAL MATERIAL COST →			$136,001.44

ESTIMATE WORKSHEET 23

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Offloading - FF Dredge for Draft	23

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	152,778	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	CY		12	6	8.1	1.87	7,344	49

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Offloading - FF Dredge for Draft	23	$178,206.79	$14,346.59	$221,359.37	$0.00	$413,912.75	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$178,206.79	$14,346.59	$221,359.37	$0.00	$413,912.75	
UNIT PRICES		$1.17	$0.09	$1.45	$0.00	$2.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	1164	$158.89	$184,950.03
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	1164	$31.28	$36,409.34
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.45	0		TOTAL RENTED EQUIP →		$221,359.37

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	1164	$72.40	$84,279.01
Laborer	DREDGE	3	1746	$53.80	$93,927.78
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1.17	TOTAL LABOR COST →			$178,206.79

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	9.33	$12.00	MTH	$112.01
Per Diem	ALL	243	$51.00	MD	$12,367.72
Misc Safety Supplies	ALL	1.87	$1,000.00	MD	$1,866.85
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.09		TOTAL MATERIAL COST →			$14,346.59

ESTIMATE WORKSHEET 24

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Processing - Deep	24

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	365,448							
BID UNIT	CY		12	6	21.6	4.98	7,344	129

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Processing - Deep	24	$386,040.20	$4,212,356.86	$206,910.83	$0.00	$4,805,307.89	Includes Residuals.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$386,040.20	$4,212,356.86	$206,910.83	$0.00	$4,805,307.89	
UNIT PRICES		$1.06	$11.53	$0.57	$0.00	$13.15	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
WA 320 broom	Clean		1	1554	$5.17	$8,027.83
Wheeled Loaded WA320	Processing		2	3108	$41.72	$129,653.76
John Deer Skidsteer CT332	Processing		2	3108	$22.28	$69,229.24
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.57	0		TOTAL RENTED EQUIP →		$206,910.83

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 3	Loader	2	3108	$70.43	$218,869.71
Laborer	Processing	2	3108	$53.80	$167,170.49
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$1.06	TOTAL LABOR COST →		$386,040.20

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	19.94	$12.00	MTH	$239.23
Per Diem	ALL	518	$51.00	MD	$26,414.15
Misc Safety Supplies	ALL	4.98	$1,000.00	MD	$4,983.88
Portland Cement Type 1	Stabilize	32,159.38	$130.00	Ton	$4,180,719.61
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$11.53	TOTAL MATERIAL COST →			$4,212,356.86

ESTIMATE WORKSHEET 25

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Processing - Shallow	25

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1,448,288		12	6	76.6	17.70	7,344	460
BID UNIT	CY							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Processing - Shallow	25	$1,370,788.71	$16,680,757.86	$734,718.91	$0.00	$18,786,265.49	Includes Residuals.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,370,788.71	$16,680,757.86	$734,718.91	$0.00	$18,786,265.49	
UNIT PRICES		$0.95	$11.52	$0.51	$0.00	$12.97	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
WA 320 broom	Clean		1	5517	$5.17	$28,505.99
Wheeled Loaded WA320	Processing		2	11035	$41.72	$460,387.07
John Deer Skidsteer CT332	Processing		2	11035	$22.28	$245,825.85
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.51	0		TOTAL RENTED EQUIP →		$734,718.91

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 3	Loader	2	11035	$70.43	$777,183.64
Laborer	Processing	2	11035	$53.80	$593,605.07
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.95	TOTAL LABOR COST →			$1,370,788.71

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	70.79	$12.00	MTH	$849.47
Per Diem	ALL	1,839	$51.00	MD	$93,793.90
Misc Safety Supplies	ALL	17.70	$1,000.00	MD	$17,697.23
Portland Cement Type 1	Stabilize	127,449.36	$130.00	Ton	$16,568,417.26
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$11.52	TOTAL MATERIAL COST →			$16,680,757.86

ESTIMATE WORKSHEET 26

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Processing - FF Dredge for Draft	26

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	152,778	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	8.1	1.87	7,344	49

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Processing - FF Dredge for Draft	26	$144,602.47	$1,759,628.42	$77,504.41	$0.00	$1,981,735.30	Includes Residuals.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$144,602.47	$1,759,628.42	$77,504.41	$0.00	$1,981,735.30	
UNIT PRICES		$0.95	$11.52	$0.51	$0.00	$12.97	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
WA 320 broom	Clean		1	582	$5.17	$3,007.05
Wheeled Loaded WA320	Processing		2	1164	$41.72	$48,565.55
John Deer Skidsteer CT332	Processing		2	1164	$22.28	$25,931.80
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.51	0		TOTAL RENTED EQUIP →		$77,504.41

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Operator 3	Loader	2	1164	$70.43	$81,983.95
Laborer	Processing	2	1164	$53.80	$62,618.52
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.95	TOTAL LABOR COST →			$144,602.47

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	7.47	$12.00	MTH	$89.61
Per Diem	ALL	194	$51.00	MD	$9,894.18
Misc Safety Supplies	ALL	1.87	$1,000.00	MD	$1,866.85
Portland Cement Type 1	Stabilize	13,444.44	$130.00	Ton	$1,747,777.78
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$11.52	TOTAL MATERIAL COST →			$1,759,628.42

ESTIMATE WORKSHEET 27

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Material Procurement and Delivery - Deep	27

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	555,023	
BID UNIT	Ton	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	0.0	0.00	--	0

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Material Procurement and Delivery - Deep	27	$0.00	$12,765,538.63	$0.00	$0.00	$12,765,538.63	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$12,765,538.63	$0.00	$0.00	$12,765,538.63	
UNIT PRICES		$0.00	$23.00	$0.00	$0.00	$23.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Misc Safety Supplies	ALL	0.00	$1,000.00	MTH	$0.00
Sand Habitat Restoration Material	BACKFILL	555,023	$23.00	TON	$12,765,538.63
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$23.00	TOTAL MATERIAL COST →			$12,765,538.63

ESTIMATE WORKSHEET 28

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Material Procurement and Delivery - Shallow	28

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	2,101,828	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	Ton		12	6	0.0	0.00	--	0

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Material Procurement and Delivery - Shallow	28	$0.00	$48,342,050.50	$0.00	$0.00	$48,342,050.50	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$48,342,050.50	$0.00	$0.00	$48,342,050.50	
UNIT PRICES		$0.00	$23.00	$0.00	$0.00	$23.00	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Misc Safety Supplies	ALL	0.00	$1,000.00	MTH	$0.00
Sand Habitat Restoration Material	BACKFILL	2,101,828	$23.00	TON	$48,342,050.50
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$23.00	TOTAL MATERIAL COST →			$48,342,050.50

ESTIMATE WORKSHEET 29

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Loading - Deep	29

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	411,128	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	24.3	5.61	7,344	146

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Loading - Deep	29	$535,221.55	$43,088.17	$664,824.87	$0.00	$1,243,134.58	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$535,221.55	$43,088.17	$664,824.87	$0.00	$1,243,134.58	
UNIT PRICES		$1.30	$0.10	$1.62	$0.00	$3.02	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL COST →		$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	3496	$158.89	$555,474.01
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	3496	$31.28	$109,350.85
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$1.62	0		TOTAL RENTED EQUIP →		$664,824.87

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	3496	$72.40	$253,121.35
Laborer	DREDGE	3	5244	$53.80	$282,100.20
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$1.30	TOTAL LABOR COST →		$535,221.55

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	28.03	$12.00	MTH	$336.41
Per Diem	ALL	728	$51.00	MD	$37,144.90
Misc Safety Supplies	ALL	5.61	$1,000.00	MD	$5,606.86
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.10	TOTAL MATERIAL COST →			$43,088.17

ESTIMATE WORKSHEET 30

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Loading - Shallow	30

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1,556,910		12	6	82.4	19.02	7,344	494
BID UNIT	CY							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Loading - Shallow	30	$1,816,048.83	$146,201.55	$2,255,803.10	$0.00	$4,218,053.48	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,816,048.83	$146,201.55	$2,255,803.10	$0.00	$4,218,053.48	
UNIT PRICES		$1.17	$0.09	$1.45	$0.00	$2.71	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
					$0.00	150 Ton Barge Mounted Crane	DREDGE		2	11862	$158.89	$1,884,767.04
					$0.00	Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	11862	$31.28	$371,036.05
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00	BARE UNIT COST →	$1.45	0		TOTAL RENTED EQUIP →		$2,255,803.10

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Crane Operator	DREDGE	2	11862	$72.40	$858,860.66	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Laborer	DREDGE	3	17793	$53.80	$957,188.17	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	95.12	$12.00	MTH	$1,141.47
					$0.00	Per Diem	ALL	2,471	$51.00	MD	$126,035.56
					$0.00	Misc Safety Supplies	ALL	19.02	$1,000.00	MD	$19,024.52
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$1.17	TOTAL LABOR COST →			$1,816,048.83	BARE UNIT COST → $0.09		TOTAL MATERIAL COST →			$146,201.55

ESTIMATE WORKSHEET 31

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Backfilling - Deep	31

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	411,128							
BID UNIT	CY		12	6	24.3	5.61	2,822	146

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Backfilling - Deep	31	$1,811,767.46	$148,035.83	$1,649,334.58	$0.00	$3,609,137.87	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$1,811,767.46	$148,035.83	$1,649,334.58	$0.00	$3,609,137.87	
UNIT PRICES		$4.41	$0.36	$4.01	$0.00	$8.78	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
150 Ton Barge Mounted Crane	DREDGE		2	3496	$158.89	$555,474.01
Cable Arm Hydraulic Clamshell (10.0	DREDGE		2	3496	$31.28	$109,350.85
Dredge Tender (Push Boat)	DREDGE BARGE		4	6992	$71.67	$501,091.94
Hopper Barge	DREDGE/TRANSPORT		6	10488	$41.67	$436,998.79
Workboat	DREDGE/TRANSPORT		4	6992	$6.64	$46,418.98
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$4.01	0		TOTAL RENTED EQUIP →		$1,649,334.58

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Crane Operator	DREDGE	2	3496	$72.40	$253,121.35
Laborer	DREDGE	4	6992	$53.80	$376,133.60
Deckhand	TRANSPORT	4	6992	$45.02	$314,791.66
Boat Operator	TRANSPORT	4	6992	$62.23	$435,110.95
Tug Operator	TRANSPORT	4	6992	$42.04	$293,935.62
Foreman	DREDGE	1	1748	$79.33	$138,674.28
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$4.41	TOTAL LABOR COST →			$1,811,767.46

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	106.53	$12.00	MTH	$1,278.36
Per Diem	ALL	2,768	$51.00	MD	$141,150.61
Misc Safety Supplies	ALL	5.61	$1,000.00	MD	$5,606.86
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.36	TOTAL MATERIAL COST →			$148,035.83

ESTIMATE WORKSHEET 32

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Backfilling - Shallow	32

BID DATA		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,556,910	
BID UNIT	CY	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	82.4	19.02	3,150	494

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Backfilling - Shallow	32	$15,963,417.96	$1,316,230.23	$13,578,924.16	$0.00	$30,858,572.35	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$15,963,417.96	$1,316,230.23	$13,578,924.16	$0.00	$30,858,572.35	
UNIT PRICES		$10.25	$0.85	$8.72	$0.00	$19.82	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL COST →			$0.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
HD Long Reach Excavator (Dredge)	DREDGE		5	29655	$103.33	$3,064,393.97
Cable Arm Hydraulic Clamshell (10.0 CY) v	DREDGE		5	29655	$31.28	$927,590.13
Dredge Barge	DREDGE BARGE		5	29655	$41.67	$1,235,642.73
Dredge Tender (Push Boat)	DREDGE/TRANSPORT		10	59311	$71.67	$4,250,610.99
Hopper Barge	DREDGE/TRANSPORT		15	88966	$41.67	$3,706,928.19
Workboat	DREDGE/TRANSPORT		10	59311	$6.64	$393,758.15
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$8.72	0		TOTAL RENTED EQUIP →		$13,578,924.16

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Dredge Operator	DREDGE	5	29655	$71.24	$2,112,553.66
Laborer	DREDGE	10	59311	$53.80	$3,190,627.23
Deckhand	TRANSPORT	10	59311	$45.02	$2,670,282.23
Boat Operator	TRANSPORT	10	59311	$62.23	$3,690,914.26
Tug Operator	TRANSPORT	10	59311	$42.04	$2,493,366.71
Deckhand	DREDGE	5	29655	$45.02	$1,335,141.12
Foreman	DREDGE	1	5931	$79.33	$470,532.75
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$10.25	TOTAL LABOR COST →			$15,963,417.96

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	970.25	$12.00	MTH	$11,643.01
Per Diem	ALL	25,207	$51.00	MD	$1,285,562.70
Misc Safety Supplies	ALL	19.02	$1,000.00	MD	$19,024.52
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST → $0.85		TOTAL MATERIAL COST →			$1,316,230.23

ESTIMATE WORKSHEET 33

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D - Deep	33

BID DATA			PRODUCTION DATA					
TOTAL QUANTITY ON PROPOSAL	434,152	Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
BID UNIT	Ton		12	6	18.8	4.35	-	113

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D - Deep	33	$0.00	$4,351.82	$0.00	$35,947,756.79	$35,952,108.61	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$4,351.82	$0.00	$35,947,756.79	$35,952,108.61	
UNIT PRICES		$0.00	$0.01	$0.00	$82.80	$82.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
Total Analytical Testing	Test	868	1400	Ea	$1,215,624.63							$0.00
Non-TSCA Transportation for Disposal	Transport	434,152	20	Ton	$8,683,033.04							$0.00
Non-TSCA Disposal	Disposal	434,152	60	Ton	$26,049,099.12							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$82.80	TOTAL COST →			$35,947,756.79	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
					$0.00	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	0.00	$12.00	MTH	$0.00
					$0.00	Per Diem	ALL	0	$51.00	MD	$0.00
					$0.00	Misc Safety Supplies	ALL	4.35	$1,000.00	MD	$4,351.82
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$0.00	TOTAL LABOR COST →			$0.00	BARE UNIT COST → $0.01		TOTAL MATERIAL COST →			$4,351.82

ESTIMATE WORKSHEET 34

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D - Shallow	34

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1,720,566	
BID UNIT	Ton	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	74.7	17.25	-	448

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D - Shallow	34	$0.00	$17,246.50	$0.00	$142,462,898.58	$142,480,145.09	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$17,246.50	$0.00	$142,462,898.58	$142,480,145.09	
UNIT PRICES		$0.00	$0.01	$0.00	$82.80	$82.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Total Analytical Testing	Test	3,441	1400	Ea	$4,817,585.94
Non-TSCA Transportation for Disposal	Transport	1,720,566	20	Ton	$34,411,328.16
Non-TSCA Disposal	Disposal	1,720,566	60	Ton	$103,233,984.48
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$82.80	TOTAL COST →		$142,462,898.58

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.00	$12.00	MTH	$0.00
Per Diem	ALL	0	$51.00	MD	$0.00
Misc Safety Supplies	ALL	17.25	$1,000.00	MD	$17,246.50
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.01	TOTAL MATERIAL COST →			$17,246.50

ESTIMATE WORKSHEET 35

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	T&D - FF Dredge for Draft	35

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	181,500							
BID UNIT	Ton		12	6	7.9	1.82	3,840	47

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
T&D - FF Dredge for Draft	35	$0.00	$1,819.31	$0.00	$15,028,200.00	$15,030,019.31	Assumes one test per 500 tons. Loading cost covered under processing.
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$1,819.31	$0.00	$15,028,200.00	$15,030,019.31	
UNIT PRICES		$0.00	$0.01	$0.00	$82.80	$82.81	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Total Analytical Testing	Test	363	1400	Ea	$508,200.00
Non-TSCA Transportation for Disposal	Transport	181,500	20	Ton	$3,630,000.00
Non-TSCA Disposal	Disposal	181,500	60	Ton	$10,890,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$82.80	TOTAL COST →		$15,028,200.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL HOURS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	0.00	$12.00	MTH	$0.00
Per Diem	ALL	0	$51.00	MD	$0.00
Misc Safety Supplies	ALL	1.82	$1,000.00	MD	$1,819.31
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.01	TOTAL MATERIAL COST →			$1,819.31

ESTIMATE WORKSHEET 39

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Water Treatment - Deep	39

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	21.6	4.98	-	129

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Water Treatment - Deep	39	$160,124.99	$11,647.22	$0.00	$445,000.00	$616,772.21	Assumes Replacement filter media and bags as 15% of equipment total
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$160,124.99	$11,647.22	$0.00	$445,000.00	$616,772.21	
UNIT PRICES		$160,124.99	$11,647.22	$0.00	$445,000.00	$616,772.21	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST	RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
Mobilization (1000GPM)	Water Treatment	1	$150,000.00	LS	$150,000.00							$0.00
Monthly Rental w/PH Adjustment (1000GPM)	Water Treatment	5	$50,000.00	Month	$250,000.00							$0.00
Demobilization (1000GPM)	Water Treatment	1	$20,000.00	LS	$20,000.00							$0.00
Consumables (1000GPM)	Water Treatment	5	$5,000.00	Month	$25,000.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
					$0.00							$0.00
BARE UNIT COST →	$445,000.00	TOTAL COST →			$445,000.00	BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST	MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Water Treatment Operator Blended Rate	Water Treatment	1	1554	$103.06	$160,124.99	Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00	PPE Level D	ALL	4.98	$12.00	MTH	$59.81
					$0.00	Per Diem	ALL	129	$51.00	MD	$6,603.54
					$0.00	Misc Safety Supplies	ALL	4.98	$1,000.00	MD	$4,983.88
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
					$0.00						$0.00
BARE UNIT COST →	$160,124.99	TOTAL LABOR COST →			$160,124.99	BARE UNIT COST →	$11,647.22	TOTAL MATERIAL COST →			$11,647.22

ESTIMATE WORKSHEET 40

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Water Treatment - Shallow	40

BID DATA		
		Bid Data Notes
TOTAL QUANTITY ON PROPOSAL	1	
BID UNIT	LS	

PRODUCTION DATA					
HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
12	6	76.6	17.70	-	460

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Water Treatment - Shallow	40	$568,587.23	$41,358.07	$0.00	$1,160,000.00	$1,769,945.30	Assumes Replacement filter media and bags as 15% of equipment total
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$568,587.23	$41,358.07	$0.00	$1,160,000.00	$1,769,945.30	
UNIT PRICES		$568,587.23	$41,358.07	$0.00	$1,160,000.00	$1,769,945.30	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Mobilization (1000GPM)	Water Treatment	1	$150,000.00	LS	$150,000.00
Monthly Rental w/PH Adjustment (1000GPM)	Water Treatment	18	$50,000.00	Month	$900,000.00
Demobilization (1000GPM)	Water Treatment	1	$20,000.00	LS	$20,000.00
Consumables (1000GPM)	Water Treatment	18	$5,000.00	Month	$90,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$1,160,000.00	TOTAL COST →			$1,160,000.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Water Treatment Operator Blended Rate	Water Treatment	1	5517	$103.06	$568,587.23
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$568,587.23	TOTAL LABOR COST →			$568,587.23

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	17.70	$12.00	MTH	$212.37
Per Diem	ALL	460	$51.00	MD	$23,448.48
Misc Safety Supplies	ALL	17.70	$1,000.00	MD	$17,697.23
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$41,358.07	TOTAL MATERIAL COST →			$41,358.07

ESTIMATE WORKSHEET 41

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Water Treatment - FF Dredge for Draft	41

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1							
BID UNIT	LS		12	6	8.1	1.87	-	49

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Water Treatment - FF Dredge for Draft	41	$59,979.42	$4,362.80	$0.00	$280,000.00	$344,342.23	Assumes Replacement filter media and bags as 15% of equipment total
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$59,979.42	$4,362.80	$0.00	$280,000.00	$344,342.23	
UNIT PRICES		$59,979.42	$4,362.80	$0.00	$280,000.00	$344,342.23	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Mobilization (1000GPM)	Water Treatment	1	$150,000.00	LS	$150,000.00
Monthly Rental w/PH Adjustment (1000GPM)	Water Treatment	2	$50,000.00	Month	$100,000.00
Demobilization (1000GPM)	Water Treatment	1	$20,000.00	LS	$20,000.00
Consumables (1000GPM)	Water Treatment	2	$5,000.00	Month	$10,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$280,000.00	TOTAL COST →			$280,000.00

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
Water Treatment Operator Blended Rate	Water Treatment	1	582	$103.06	$59,979.42
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$59,979.42	TOTAL LABOR COST →			$59,979.42

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
PPE Level D	ALL	1.87	$12.00	MTH	$22.40
Per Diem	ALL	49	$51.00	MD	$2,473.54
Misc Safety Supplies	ALL	1.87	$1,000.00	MD	$1,866.85
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$4,362.80	TOTAL MATERIAL COST →			$4,362.80

ESTIMATE WORKSHEET 42

BID DATE	PROJECT LOCATION	DESCRIPTION OF ITEM	ITEM NO.
March 7, 2018	Penobscot	Restoration Plantings and Access Agreements	42

BID DATA			PRODUCTION DATA					
		Bid Data Notes	HOURS PER DAY	DAYS PER WEEK	TOTAL WEEKS	TOTAL MONTHS	DAILY UNIT PRODUCTION RATE	DAYS REQ. TO COMPLETE
TOTAL QUANTITY ON PROPOSAL	1		12	6	10.0	2.32	-	60
BID UNIT	LS							

ESTIMATE WORKSHEET	ITEM NO.	TOTAL LABOR	TOTAL MATERIAL	TOTAL RENTED EQUIP	TOTAL SUB-CONTRACTOR	TOTAL	Notes
Restoration Plantings and Access Agreements	42	$0.00	$0.00	$0.00	$601,545.11	$601,545.11	
						$0.00	
						$0.00	
						$0.00	
GRAND TOTALS		$0.00	$0.00	$0.00	$601,545.11	$601,545.11	
UNIT PRICES		$0.00	$0.00	$0.00	$601,545.11	$601,545.11	

SUB-CONTRACTOR	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Restoration Planting	Restore	120	$5,000.00	Acre	$601,545.11
Access Agreements	Access	0	$25,000.00	Each	$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$601,545.11	TOTAL COST →		$601,545.11

RENTAL EQUIP	WORK TO PERFORM	FUEL GALS.	TOTAL UNITS	TOTAL DAYS	UNIT RATE	TOTAL COST
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
BARE UNIT COST →	$0.00	0		TOTAL RENTED EQUIP →		$0.00

LABOR CLASSIFICATION	WORK TO PERFORM	TOTAL MEN	TOTAL HOURS	HRLY RATE	TOTAL COST
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →		$0.00	TOTAL LABOR COST →		$0.00

MATERIAL / SERVICES	WORK TO PERFORM	QUANTITY UNITS	UNIT COST	UNIT OF MEAS.	TOTAL COST
Fuel	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
Maintenance/Grease	ALL	FUEL AND LUBE INCLUDED IN EQUIPMENT HOURLY RATES ABOVE			
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
BARE UNIT COST →	$0.00	TOTAL MATERIAL COST →			$0.00