

Appendix M

Intermediate (60%) Remedial Design

Opinion of Probable Cost

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ABBREVIATIONS

BODR	<i>Basis of Design Report</i>
CY	cubic yard
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
LDW	Lower Duwamish Waterway
RAA	remedial action area
RD	remedial design
RMC	residuals management cover

1 Introduction

This appendix presents the Intermediate (60%) Remedial Design (RD) Opinion of Probable Cost and associated cost assumptions for the sediment remedy for the upper reach (river miles 3.0 to 5.0) of the Lower Duwamish Waterway (LDW) Superfund Site in King County, Washington. The design process is presented in the *Remedial Design Work Plan for the Lower Duwamish Waterway Upper Reach* (Anchor QEA and Windward 2019) for the remedy selected in U.S. Environmental Protection Agency's (EPA's) November 2014 *Record of Decision* (EPA 2014). This Intermediate (60%) RD Opinion of Probable Cost was prepared in support of the Intermediate (60%) RD *Basis of Design Report* (BODR), based on the design information provided in the Intermediate Drawings (Appendix D to the BODR). The Opinion of Probable Cost is anticipated to continue to be refined and built upon during future design phases.

This Intermediate (60%) RD Opinion of Probable Cost evaluation was prepared on behalf of the City of Seattle, King County, the Port of Seattle, and The Boeing Company, collectively referred to as the Lower Duwamish Waterway Group.

Based on the BODR's design criteria and other key elements for implementing the sediment remedy, this appendix outlines the basis and rationale for the Intermediate (60%) RD Opinion of Probable Cost and includes the following supporting information:

- **Section 2:** Sources of Cost Information and Costing Approach
- **Section 3:** Direct and Indirect Construction Tasks
- **Section 4:** Costing Assumptions Used for the Intermediate (60%) RD
- **Section 5:** Dredge and Material Placement Quantities Summary
- **Section 6:** Costs Summary

Attachment M-1 contains the detailed cost estimate workbook for the Intermediate (60%) RD Opinion of Probable Cost, organized as follows:

- Attachment M-1.1: Summary 60% RD Opinion of Probable Cost
- Attachment M-1.2: Detailed 60% RD Opinion of Probable Cost
- Attachment M-1.3: Detailed Notes
- Attachment M-1.4: Detailed Quantities
- Attachment M-1.5: Production Rates and Durations
- Attachment M-1.6: Detailed Structural Work Costs

2 Sources of Cost Information and Costing Approach

The development of the Intermediate (60%) RD Opinion of Probable Cost was based on a multiple-step process to derive site-specific unit costs and lump sum prices for the upper reach sediment remedy; this process consisted of using both parametric and bottom-up costing approaches. Parametric costing uses historical cost data to assign a dollar value to certain project costs. Parametric costing applied to this Opinion of Probable Cost consisted of reviewing historical unit costs for similar sediment remediation and/or dredging projects completed locally and regionally, based on their relevance and applicability to the upper reach (i.e., similar quantities and/or remediation conditions).

In bottom-up costing, the large project is broken down into a number of smaller components, and costs are specifically derived for each of these smaller work components. Bottom-up costing applied to this Opinion of Probable Cost was developed by estimating labor, equipment, and other ancillary add-ons for each construction activity based on engineering cost guidance (e.g., RS Means) and past project experience. By comparing bottom-up costs with parametric cost information, along with engineering best professional judgment, “probable” unit costs and “probable” lump sums were then derived.

In addition, a three-point estimating approach was applied to provide a costing range around the “probable” (or “most likely”) cost scenario. In three-point estimating, three separate cost scenarios for the costs associated with the project were generated. While the first point represents an “optimistic” or “lower” cost scenario (assumed to have a 10% decrease in unit costs relative to the “probable” unit costs), the second point represents a “conservative” or “upper” cost scenario (assumed to have a 20% increase in unit costs relative to the “probable” unit costs). The “probable” (or “most likely”) cost scenario represents the third point, which typically falls somewhere in the middle of the first and second cost scenarios.

To support the Intermediate (60%) RD Opinion of Probable Cost, several sources of information were reviewed, including the following:

- Contractors’ bid costs and engineers’ construction cost estimates for similar sediment remediation and/or dredging projects completed locally (in the Seattle area) and regionally (in the Pacific Northwest), as well as knowledge of construction activities and challenges identified during construction oversight. The following project costs were reviewed:
 - Glacier Northwest, Inc., Terminal Maintenance Dredging (Seattle, Washington)
 - Terminal 18 Maintenance Dredging (Seattle, Washington)
 - J.A. Jack & Sons, Inc., and Lehigh Hanson Berths Maintenance Dredging (Seattle, Washington)
 - Denny Way CSO Nearshore Interim Sediment Cleanup (Seattle, Washington)

- Terminal 117 Phase 1 Sediment and Upland Cleanup (Seattle, Washington)
- Jorgenson Forge Sediment Remediation – LDW Early Action Area (Seattle, Washington)
- Slip 4 Sediment Remediation – LDW Early Action Area (Seattle, Washington)
- Port Gamble Bay Sediment Cleanup Project (Port Gamble, Washington)
- Whatcom Waterway Phase 1 Sediment Cleanup (Bellingham, Washington)
- Port of Olympia Marine Berths 2 & 3 Interim Action Dredging (Olympia, Washington)
- Anchor QEA’s engineering best professional judgment based on past experience with similar remedial actions and associated pricing, as well as project-specific considerations that influence key cost factors (e.g., production rates)
- Engineering cost guidance (RS Means)

Some of the above-referenced projects were recently constructed, while others were completed more than 10 years ago. The age of the reference project bid cost data was considered when reviewing historical sediment remediation costs (i.e., unit costs were adjusted for standard inflation to present-day U.S. dollars [2022] for comparison to current costing of the upper reach sediment remedy).

3 Direct, Indirect Construction, and Additional Construction Oversight Tasks

This section describes the activities used to develop costs for direct construction (Section 3.1), indirect construction (Section 3.2), and additional construction oversight (Section 3.3) tasks. Additional detailed descriptions of these tasks are provided in the detailed cost estimate workbook, Attachment M-1 (Attachment M-1.3).

3.1 Direct Construction Tasks

Direct construction tasks include all construction activities anticipated to be conducted by the contractor. The following direct construction tasks are included in this Intermediate (60%) RD Opinion of Probable Cost:

- **Mobilization and demobilization** include the costs associated with mobilizing and demobilizing personnel and marine/land equipment, procedures, contractor work plan development and other submittals, and the contractor site office and administration. Special bonding and insurance are assumed to be included under this task.
- **Site preparation** includes the costs associated preparing the work site—clearing and grubbing upland areas prior to excavation—and preparation, setup, and maintenance of the upland staging area.¹
- **Surveys** include the costs for contractor pre- and post-construction bathymetric and topographic surveys, including progress, post-dredge, post-placement bathymetric/topographic, and as-built surveys.
- **Structural work** includes the costs for temporary dismantle, relocation, and reinstallation of a portion of the South Park Marina floats; temporary shoring of bulkheads; and removal, replacement, offloading, upland transportation, and disposal of timber and steel piles (including dolphins and groins). Costs for outfall temporary pipe support, energy dissipator, and apron installation and protection are included under the structural work task.
- **Dredging and excavation** activities include costs for dredging, contingency re-dredging, excavation, in-water barge transportation, and removal/disposal of both dredge debris (considered incidental to dredging) and identified debris.

¹ As described in Section 10.2.5 of the BODR, it is assumed that the LDW upper reach project will rely on an established commercial transload facility in close proximity (Duwamish Reload Facility, operated by WM [formerly Waste Management]) that could readily be used for offloading from barges and onloading to trucks or railcars for transportation to a disposal facility. Therefore, no costs have been included in this cost estimate for developing a project-specific transload facility.

- **Transloading, upland transportation, and disposal** activities include costs for transloading dredged sediment and dredge and identified debris at the transload facility and upland transportation for final disposal.
- **Material placement** activities include costs for material procurement, material transport to the site, and placement of backfill, residuals management cover (RMC), enhanced natural recovery (ENR), amended cover (area-specific technology for structural offset area; see Section 10.5 of the BODR), and armor rock materials.
- **Environmental controls** include costs for environmental protection during construction by providing an allowance for controls and best management practices.

Additional contractor health and safety, quality control, and project management costs were not separately estimated, as they are assumed to be included under the lump sum for mobilization/demobilization costs.

3.2 Indirect Construction Tasks

Indirect construction tasks include additional activities to provide quality assurance that are necessary to the project but are performed by parties other than the contractor. The following indirect construction tasks have been included in this Intermediate (60%) RD Opinion of Probable Cost:

- **Construction management and engineering support service** costs involve providing oversight of the contractor's implementation of the sediment remedy. Construction management typically refers to in-field work to oversee the contractor's work and includes construction inspection, progress tracking and reporting, reviewing progress payment requests, reviewing contractor submittals and work plans, addressing contractor requests for information and change order requests, leading adaptive design changes, and communicating with the Owner and EPA. Engineering support services are typically provided from the office and include design interpretation, contingency action decision coordination, change order negotiation support, and closeout report preparation.
- **Confirmation sediment sampling and contingency action determination** costs include collecting post-dredge confirmation sediment samples and determining the need for contingency actions.
- **Environmental monitoring** costs include water quality monitoring activities during construction.
- **Site access agreements and temporary leases** include costs for leases, if needed, and coordination costs associated with construction site access (e.g., directed barge or vessel temporary relocations, Tribal Usual and Accustomed fishing agreements).

3.3 Additional Construction Oversight Tasks

Additional construction oversight tasks include supplemental activities conducted by the Owner and EPA to provide quality assurance during construction.

4 Costing Assumptions Used for the Intermediate (60%) RD

The Intermediate (60%) RD criteria form the basis for development of the upper reach Opinion of Probable Cost. General and specific RD costing assumptions are summarized in this section. Further details are contained in the Intermediate Drawings (Appendix D to the BODR) and in the detailed cost estimate workbook (Attachment M-1).

4.1 General Costing Assumptions

The following are general assumptions used in the cost estimate:

- **Construction Seasons:** In-water construction activities for the LDW upper reach will occur during fish windows designated for the LDW (generally from October 1 through February 15, equivalent to 138 calendar days²). Therefore, for the Intermediate (60%) RD, it is estimated that remedial construction for the LDW upper reach will span three construction seasons based on refinements to the Preliminary (30%) RD production rates for dredging, material placement, and structural activities (see Sections 10.2.4 and 10.6.6 of the BODR and Attachment M-1.5) to closely mirror recently experienced regional remediation production rates in Puget Sound and in alignment with anticipated typical daily transloading and dredged material transportation and disposal rates.³
- **Daily Work Schedule:** It is assumed that work will be performed in one 10-hour shift per day, 6 days a week, during the following work hours: 7:00 a.m. to 7:00 p.m. on weekdays and 9:00 a.m. to 7:00 p.m. on Saturdays. Note that this assumption is for cost purposes only; actual work hour limits, to the extent they will be specified, will be included in the project technical specifications.
- **Forecast Inflation Factor:** A forecast inflation factor of 3.1%⁴ was assumed to be applied to the construction costs (before contingency and sales tax) to account for recent price increases in labor, equipment, and materials for all construction activities to be conducted by the contractor.
- **Sales Tax:** Sales tax is included at 10.25% to account for Washington State (6.5%) and the City of Seattle (3.75%) taxes. Although the upper reach remedial action areas (RAAs) fall into both the Cities of Seattle and Tukwila jurisdictions, for the purposes of this Intermediate (60%) RD Opinion of Probable Cost, sales tax for the City of Seattle is included as a conservative assumption for the Intermediate (60%) RD; sales tax for the City of Tukwila tax rate is 10.1%.

² Equivalent to an effective 111 days per construction season, excluding 10 Sundays and 7 holidays.

³ Production rates, sequencing, and the anticipated construction schedule will be further refined in the Pre-Final (90%) RD.

⁴ Based on CPI-U (consumer price index for all urban consumers) for 2023 (Congressional Budget Office, Year-by-Year Projections for Calendar Years 2022 to 2032, Consumer Price Index for All Urban Consumers [<https://www.cbo.gov/system/files/2022-05/51135-2022-05-Economic-Projections.xlsx>]).

- **Contingency:** A 30% contingency is applied to total direct construction, indirect construction, and additional construction oversight costs, based on consideration of potential cost uncertainty associated with the level of information currently available and engineering best professional judgment. Due to the nature of the project (i.e., environmental sediment remediation), additional factors that cannot be forecasted at this time—such as scope unknowns (i.e., significant changes in site conditions or quantities), price uncertainty (i.e., varying market conditions, increasing inflation, fuel and labor changes), or any other unforeseen circumstances (i.e., additional design requirements)—may influence contractor bidding prices and impact the final project costs outside, in excess, or below this contingency.

All costs in this Intermediate (60%) RD Opinion of Probable Cost are presented in present-day U.S. dollars (i.e., 2022).

4.2 Specific Remedial Design Costing Assumptions

The following specific RD assumptions are incorporated into the Intermediate (60%) RD Opinion of Probable Cost:

- **Required Dredging:**
 - Required cut thicknesses or elevations for the RAAs and associated side-slopes, as shown in the Intermediate Drawings (Appendix D to the BODR)
 - Overdredge allowance of 1 foot in excess of the required cut thickness or elevation within the dredge footprint and associated side-slopes
 - Dredging around existing structures considers horizontal dredge offset requirements based on adjacent required sediment removal elevations/thickness cuts and associated short- and long-term structure stability (see Section 9.2.1 of the BODR)
- **Contingency Re-Dredging:** Consists of one additional dredging pass conducted over a portion of the total dredge area with the following assumptions:
 - 15% of the total dredge area to be re-dredged to a total 1-foot thickness (including a 6-inch overdredge allowance) to address generated residuals that have concentrations elevated above RMC placement criteria
 - An additional 20% of the total dredge area to be re-dredged to a total 2.5-foot thickness (including a 6-inch overdredge allowance) to remove missed inventory
- **Barge Dewatering with Cement Amendment:** For costing purposes, it is assumed that dewatering of dredge material from RAA 22 and a portion of RAA 18c will be conducted by addition of Portland cement at a 3% dose (by dry weight).
- **Identified Debris:** An estimated 650 tons of larger debris are assumed for this cost estimate for discrete and separate removal and disposal, based on visual aerial observations, shoreline photograph inventory, and measurements derived from ArcGIS LDW web map imagery of the

LDW upper reach shorelines/banks; identified debris includes those items generally larger than 12 inches in size (see also Section 2.3.10 of the BODR). For this Opinion of Probable Cost, buried and smaller debris is considered to be incidental dredge debris, and its removal, transportation, and disposal are accounted for in the total dredge volume.

- **Structural Work:** This item includes the costs for temporary dismantling, relocation, and reinstallation of some of the South Park Marina floats; removal, offloading, upland transportation, and disposal of 20 timber and steel piles (including dolphins and groins), and replacement with 6 new steel piles. Costs for outfall temporary pipe support, energy dissipator, and apron installation and protection are included under the structural work task.
- **Disposal of Dredge/Excavated Sediment at Permitted Off-Site Subtitle D Disposal Facility:** For costing purposes, it is assumed that all dredge material will be disposed of at a Subtitle D landfill. Waste characterization (Section 10.2.6.1 of the BODR) conducted in Phase III of the pre-design investigation in December 2022 will inform additional disposal requirements for specific RAA in the design and will be presented in the Pre-Final (90%) RD.
- **Stand-by Time:** Assumed for costing purposes to be 21 days total over the three construction seasons. This is the time for work stoppage related to relocation of contractor construction equipment to accommodate emergencies, downtime due to inclement weather, and/or directed but unexpected operational needs (i.e., unforeseen or unplanned vessel access or passage through the upper reach).
- **Placement of Backfill:**
 - Backfill is intended to restore, for habitat purposes, the sediment bed to pre-construction elevations and to flatten temporary steeper dredge cuts (e.g., along the Boeing Plant 2 Early Action Area).
 - For the Intermediate (60%) RD, all dredge areas located outside of the federal navigation channel and above elevation -10 feet mean lower low water are assumed to be backfilled and integrated with habitat material placement in intertidal areas as appropriate, as shown in the Intermediate Drawings (Appendix D) to the BODR (see also Section 10.2.9 of the BODR). As described in Section 14.1 of the BODR, the backfill design will be developed during the Pre-Final (90%) RD, after the dredge plan is revised based on the results from Phase III pre-design investigation; as backfill volumes are dependent on the final dredge cut surface and may not exactly match the pre-dredge elevations due to equipment placement accuracy, and geotechnical properties of the placement materials.
 - For costing purposes, backfill material is assumed to conform to a granular gravelly sand material (see Section 10.6.1 of the BODR).

- **Placement of Required RMC:**
 - RMC is assumed to be placed over 100% of the dredge area that does not receive backfill and in specific RAAs (as shown in the Intermediate [60%] Drawings [Appendix D]).
 - The RMC placement footprint includes dredge cut side slopes areas (top to toe of dredge cut daylight)
 - For costing purposes, RMC is assumed to be placed at a minimum 6-inch thickness, with a 6-inch maximum overplacement allowance in the specific RAAs, and at a 24-inch thickness on the dredge cut side slopes (top to toe of dredge cut daylight; see Section 10.2.9 of the BODR).
 - For costing purposes, RMC material is assumed to conform to a medium-to-coarse-grained sand (see Section 10.6.1 of the BODR).
- **Placement of Inner and Outer Perimeter RMC:**
 - Perimeter RMC placement will also be directed based on post-dredge confirmation sample analytical results. The post-dredge decision framework and flow chart (including sediment quality sampling, reporting, contingency re-dredging decision logic, and communication) are detailed in the Construction Quality Assurance Plan summary table (see Section 10.2.9 of the BODR and Appendix F). The perimeter RMC placement surrounding the dredge areas consists of two 20-foot-wide areas: inner and outer perimeter RMC.
 - Inner perimeter RMC will be automatically placed within a 20-foot-wide perimeter surrounding the dredge area (from top of dredge cut daylight), without the need for post-dredge confirmation sampling.
 - Outer perimeter RMC consists of RMC placed within an assumed 25% of a 20-foot-wide perimeter outside and surrounding the inner RMC perimeter. Confirmation sampling within the outer perimeter will be performed to determine whether there is a need for RMC placement in the outer perimeter.
 - For costing purposes, both inner and outer perimeter RMCs are assumed to be placed at a minimum 6-inch thickness, with a 6-inch maximum overplacement allowance.
- **Placement of ENR:**
 - ENR will be placed in specific RAAs (as shown in the Intermediate Drawings [Appendix D to the BODR]). The ENR quantity assumes a placement footprint that includes a 10-foot buffer around the planned ENR placement area.
 - For costing purposes, ENR is assumed to be placed at a minimum 6-inch thickness, with a 6-inch maximum overplacement allowance.
 - For costing purposes, ENR material is assumed to conform to a coarse grained sand (see Section 10.6.1 of the BODR).

- **Placement of Area-Specific Technology B – Amended Cover:**
 - Amended cover will be placed to limited portions of RAAs 18, 24, and 26), as shown in the Intermediate Drawings [Appendix D to the BODR]. For costing purposes, the amended cover material is assumed to include amendment (uniform blending) with granular activated carbon at a 1.5% dose (by dry weight, to achieve a minimum of 1.0% dosage; see Section 10.5.2 of the BODR and Appendix Q).
 - For costing purposes, amended cover is assumed to be placed at a minimum 12-inch thickness, with a 6-inch maximum overplacement allowance.
 - For costing purposes, amended cover material is assumed to conform to gravelly sand (see Section 10.6.1 of the BODR).
- **Placement of Prospective Cap:**
 - As described in Section 10.3 of the BODR, a prospective cap is assumed to be placed within the shoreline slope of RAA 27 (as shown in the Intermediate Drawings [Appendix D]). For costing purposes, the prospective cap is assumed to consist of two layers:
 - Isolation layer (conforming to gravelly sand material, with 12-inch minimum thickness and a 6-inch maximum overplacement allowance)
 - Erosion protection layer (conforming to a light riprap, with a 12-inch minimum thickness and a 6-inch maximum overplacement allowance)
- **Construction Management and Engineering Support:** This cost is assumed on a monthly basis for the total construction duration.
- **Confirmation Sediment Sampling:** This includes costs for equipment, labor, analytical, and data validation. Sediment sampling of surface grabs and cores is assumed to occur throughout the total dredge area post-dredging to evaluate the potential need for contingency re-dredging.
- **Environmental Monitoring (water quality):** This includes costs for equipment, labor, and field measurements of water samples collected during dredging and placement activities. Costs for environmental monitoring of water quality are assumed on a monthly basis for the total dredging and placement duration.
- **Site Access Agreements and Temporary Leases:** This is assumed to include allowances for Tribal Usual and Accustomed fishing agreements and directed barge or vessel temporary relocations. It is not anticipated that special leases will be required.
- **Owner Construction Oversight:** This cost is assumed on a monthly basis for the total construction duration.
- **EPA Construction Oversight:** This cost is assumed on a monthly basis for the total construction duration.

5 Dredge and Material Placement Quantities Summary

The Intermediate (60%) RD dredging and material placement quantities for the LDW upper reach are summarized in Tables M-1 and M-2, respectively.

Table M-1
Summary of Intermediate (60%) RD Dredging Quantities

Required Dredge Volume (CY)	Overdredge Allowance Volume (CY)	Contingency Re-Dredging Volume (CY)	Total Dredge Volume ¹ (CY)
76,000	21,400	10,100	107,500

Notes:

Total dredge volume includes the following: 1) required dredge volume, including associated external side-slope and transition (between RAAs) volumes, as shown on the Intermediate (60%) RD Drawings (Appendix D); 2) 1-foot overdredge allowance on the entire dredge footprint; and 3) contingency re-dredging volume. Total dredge volume includes required dredge and excavation volumes.

1. Volumes are rounded to the nearest hundred. See the detailed cost estimate workbook, Attachment M-1 (Attachment M-1.4), for detailed dredging quantities.

CY: cubic yard

RAA: remedial action area

RD: remedial design

Table M-2
Summary of Intermediate (60%) RD Material Placement Quantities

Backfill Placement Volume (CY)	RMC + Inner/Outer Perimeter RMC Placement Volume (CY)	ENR Placement Volume (CY)	Amended Cover Placement Volume (CY)	Prospective Cap (RAA 27) Placement Volume (CY)	Total Placement Volume (CY)
45,700	24,500	600	300	2,400	73,500

Notes:

Volumes are rounded to the nearest hundred. See the detailed cost estimate workbook, Attachment M-1 (Attachment M-1.4), for detailed material placement quantities.

Amended cover is to be placed in limited portions of RAAs 18, 24, and 26, as shown on the Intermediate Drawings (Appendix D to the BODR).

'Prospective' cap is to be placed along the shoreline portion of RAA 27, as shown on the Intermediate Drawings (Appendix D to the BODR).

BODR: *Basis of Design Report*

CY: cubic yard

ENR: enhanced natural recovery

RAA: remedial action area

RD: remedial design

RMC: residuals management cover

6 Costs Summary

The Opinion of Probable Cost for the Intermediate (60%) RD for the upper reach is summarized in Table M-3.

As described in Section 4.1, a contingency of 30% was applied at the Intermediate (60%) RD level to the total direct construction, total indirect construction, and total additional construction oversight costs. This contingency is based on potential cost uncertainty associated with the level of information currently available and best professional judgment. It also accounts for scope unknowns, price uncertainty, and any other unforeseen circumstances that may impact the final project costs.

In addition, specific construction tasks are included in this Intermediate (60%) RD Opinion of Probable Cost but considered as allowances to cover potential costs incurred due to uncertainty in the associated scope. These construction elements will be refined as more information becomes available in the next RD phase (Pre-Final [90%] RD). Two types of allowances are included:

1) allowances for construction tasks considered reasonably likely to occur and their scope, which is pending further design (e.g., contingency re-dredging, debris quantity, and stand-by time), and potential need for barge dewatering of dredge material from RAA 22 and a portion of RAA 18c by cement amendment; and 2) allowances for construction tasks considered highly unlikely to occur but are still presented pending further design (e.g., presence of hazardous waste and environmental controls).

**Table M-3
Total Project Cost for LDW Upper Reach Implementation at Intermediate (60%) RD**

Task ID	Task Description	Lower Probable Total Cost (\$)	Probable Total Cost (\$)	Upper Probable Total Cost (\$)
Direct Construction Costs				
1	Mobilization/Demobilization	\$3,212,190	\$3,569,100	\$4,282,920
2	Site Preparation	\$245,000	\$278,000	\$338,000
3	Surveys	\$608,393	\$883,266	\$1,160,529
4	Structural Work	\$1,225,321	\$1,361,468	\$1,633,762
5	Dredging, Excavation, Transloading, Upland Transportation, and Disposal	\$17,681,073	\$19,646,337	\$23,574,764
6	Material Placement	\$5,605,500	\$6,162,062	\$7,276,949
7	Environmental Controls	\$135,000	\$150,000	\$180,000
Direct Construction Costs Subtotal		\$28,712,478	\$32,050,233	\$38,446,924
8	Forecast Inflation Factor (3.1%)	\$890,087	\$993,557	\$1,191,855
9	Direct Construction Contingency (30.0 %)	\$8,613,743	\$9,615,070	\$11,534,077
Direct Construction Costs Subtotal with Contingency		\$38,216,308	\$42,658,860	\$51,172,856
10	Sales Tax (10.25%)	\$3,917,172	\$4,372,533	\$5,245,218
Total Direct Construction Costs (with Contingency and Sales Tax) – Rounded		\$42,134,000	\$47,032,000	\$56,419,000
Indirect Construction Costs				
11	Other Indirect Construction Costs	\$4,158,000	\$4,620,000	\$5,544,000
Indirect Construction Costs Subtotal		\$4,158,000	\$4,620,000	\$5,544,000
12	Indirect Construction Contingency (30.0 %)	\$1,247,000	\$1,386,000	\$1,663,200
Total Indirect Construction Costs (with Contingency) – Rounded		\$5,406,000	\$6,006,000	\$7,208,000
Additional Construction Oversight Costs				
13	Additional Construction Oversight Costs	\$1,009,800	\$1,122,000	\$1,346,400
Additional Construction Oversight Costs Subtotal – Rounded		\$1,009,800	\$1,122,000	\$1,346,400
14	Additional Construction Oversight Contingency (30.0 %)	\$302,940	\$336,600	\$403,920
Total Additional Construction Oversight Costs (with Contingency) – Rounded		\$1,313,000	\$1,459,000	\$1,751,000
15	Total Project Costs – Rounded	\$48,853,000	\$54,497,000	\$65,378,000

Notes:

Costs are presented in present-day U.S. dollars (i.e., 2022). A forecast inflation factor was included for increased construction costs in 2023.

Sales tax is included at 10.25% to account for Washington State (6.5%) and the City of Seattle (3.75%) taxes.

Attachment M-1 contains the detailed cost estimate workbook for the Intermediate (60%) RD Opinion of Probable Cost.

Long-term monitoring costs are not included in this opinion of probable cost as assumptions for these activities will be developed consistent with the Long-Term Maintenance and Monitoring Plan in subsequent RD phases.

LDW: Lower Duwamish Waterway

RD: remedial design

7 References

Anchor QEA and Windward (Anchor QEA, LLC, and Windward Environmental), 2019. *Remedial Design Work Plan for the Lower Duwamish Waterway Upper Reach*. Final. Submitted to EPA December 16, 2019.

EPA (U.S. Environmental Protection Agency), 2014. *Record of Decision*. Lower Duwamish Waterway Superfund Site. November 2015.

Attachment M-1
Detailed Cost Estimate Workbook

Task ID	Task Description	Lower Probable Total Cost (\$)	Probable Total Cost (\$)	Upper Probable Total Cost (\$)
DIRECT CONSTRUCTION COSTS				
1	Mobilization/Demobilization	\$ 3,212,190.00	\$ 3,569,100.00	\$ 4,282,920.00
2	Site Preparation	\$ 245,000.00	\$ 278,000.00	\$ 338,000.00
3	Surveys	\$ 608,393.00	\$ 883,266.00	\$ 1,160,529.00
4	Structural Work	\$ 1,225,321.00	\$ 1,361,468.00	\$ 1,633,762.00
5	Dredging, Excavation, Transloading, Upland Transportation, and Disposal	\$ 17,681,073.00	\$ 19,646,337.00	\$ 23,574,764.00
6	Material Placement	\$ 5,605,500.00	\$ 6,162,062.00	\$ 7,276,949.00
7	Environmental Controls	\$ 135,000.00	\$ 150,000.00	\$ 180,000.00
Direct Construction Costs Subtotal		\$ 28,712,478.00	\$ 32,050,233.00	\$ 38,446,924.00
8	Forecast Inflation Factor (3.1%; CPI-U)	\$ 890,087.00	\$ 993,557.00	\$ 1,191,855.00
9	Direct Construction Contingency (30.0%)	\$ 8,613,743.00	\$ 9,615,070.00	\$ 11,534,077.00
Direct Construction Cost Subtotal with Contingency and Inflation Adjustment		\$ 38,216,308.00	\$ 42,658,860.00	\$ 51,172,856.00
10	Sales Tax (10.25%)	\$ 3,917,172.00	\$ 4,372,533.00	\$ 5,245,218.00
Total Direct Construction Costs (with Contingency and Sales Tax) - Rounded		\$ 42,134,000.00	\$ 47,032,000.00	\$ 56,419,000.00
INDIRECT CONSTRUCTION COSTS				
11	Indirect Construction Costs	\$ 4,158,000.00	\$ 4,620,000.00	\$ 5,544,000.00
Indirect Construction Costs Subtotal		\$ 4,158,000.00	\$ 4,620,000.00	\$ 5,544,000.00
12	Indirect Construction Contingency (30.0%)	\$ 1,247,400.00	\$ 1,386,000.00	\$ 1,663,200.00
Indirect Construction Costs Subtotal with Contingency		\$ 5,405,400.00	\$ 6,006,000.00	\$ 7,207,200.00
Total Indirect Construction Costs (with Contingency) - Rounded		\$ 5,406,000.00	\$ 6,006,000.00	\$ 7,208,000.00
ADDITIONAL CONSTRUCTION OVERSIGHT COSTS				
13	Additional Construction Oversight Costs	\$ 1,009,800.00	\$ 1,122,000.00	\$ 1,346,400.00
Additional Construction Oversight Costs Subtotal - Rounded		\$ 1,009,800.00	\$ 1,122,000.00	\$ 1,346,400.00
14	Additional Construction Oversight Contingency (30.0%)	\$ 302,940.00	\$ 336,600.00	\$ 403,920.00
Additional Construction Oversight Costs Subtotal with Contingency		\$ 1,312,740.00	\$ 1,458,600.00	\$ 1,750,320.00
Total Additional Construction Oversight Costs (with Contingency) - Rounded		\$ 1,313,000.00	\$ 1,459,000.00	\$ 1,751,000.00
15	TOTAL PROJECT COSTS	\$ 48,853,000.00	\$ 54,497,000.00	\$ 65,378,000.00

- Notes:
- In providing this Opinion of Probable Cost, the Client understands that the Consultant (Anchor QEA, LLC) has no control over the cost or availability of labor, equipment, or materials, or over market condition or the Contractor's method of pricing, and the Consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied, that the bids or the negotiated cost of the work will not vary from the Consultant's opinion of probable construction cost.
 - Costs are presented in present-day U.S. dollars (i.e., 2022).
 - Although the upper reach SMAs fall into both the Cities of Seattle and Tukwila jurisdictions, for the purposes of this opinion of probable cost, sales tax is included at 10.25% (to account for Washington State [6.5%] and the City of Seattle [3.75%] taxes), as a conservative assumption for Intermediate (60%) RD; City of Tukwila tax rate is 10.1%.
 - A 30% contingency is applied to both total direct construction, total indirect construction costs and total additional construction oversight costs, based on consideration of potential cost uncertainty associated with the level of information currently available and engineering best professional judgement. Due to the nature of the project (i.e., environmental sediment remediation), additional factors that cannot be forecasted at this time—such as scope unknowns (i.e., significant changes in site conditions or quantities), price uncertainty (i.e., varying market conditions, increasing inflation, fuel and labor changes), or any other unforeseen circumstances (i.e., additional design requirements)—may influence contractor bidding prices and impact the final project costs outside, in excess, or below this contingency.
 - Long-term monitoring costs are not included in this opinion of probable cost because assumptions for these activities will be developed consistent with the Long-Term Maintenance and Monitoring Plan in subsequent remedial design phases.

Task ID	Task Description	Quantity	Unit	Unit Costs			Total Costs		
				Lower Probable Unit Cost (\$)	Probable Unit Cost (\$)	Upper Probable Unit Cost (\$)	Lower Probable Total Cost (\$)	Probable Total Cost (\$)	Upper Probable Total Cost (\$)
DIRECT CONSTRUCTION COSTS									
1	Mobilization/Demobilization								
1 a	Mobilization/Demobilization for All Equipment (In-Water, Specialized, Upland)	3	LS	\$ 990,000.00	\$ 1,100,000.00	\$ 1,320,000.00	\$ 2,970,000.00	\$ 3,300,000.00	\$ 3,960,000.00
1 b	Procedural Costs and Contractor Workplan Submittals	3	LS	\$ 80,730.00	\$ 89,700.00	\$ 107,640.00	\$ 242,190.00	\$ 269,100.00	\$ 322,920.00
2	Site Preparation								
2 a	Shoreline/Upland Site Preparation (Removal, Handling, Disposal and/or Reuse)	2	AC	\$ 10,000.00	\$ 14,000.00	\$ 19,000.00	\$ 20,000.00	\$ 28,000.00	\$ 38,000.00
2 b	Upland Staging Area Setup and Site Decommissioning	1	LS	\$ 225,000.00	\$ 250,000.00	\$ 300,000.00	\$ 225,000.00	\$ 250,000.00	\$ 300,000.00
3	Surveys								
3 a	Contractor Progress Surveys	210	EA	\$ 1,000.00	\$ 2,100.00	\$ 3,000.00	\$ 209,602.96	\$ 440,166.22	\$ 628,808.89
3 b	Pre-Construction Surveys (Bathy and Topo)	3	LS	\$ 20,970.00	\$ 23,300.00	\$ 27,960.00	\$ 62,910.00	\$ 69,900.00	\$ 83,880.00
3 c	Post-Dredge Construction Survey (per SMA)	17	EA	\$ 7,200.00	\$ 8,000.00	\$ 9,600.00	\$ 122,400.00	\$ 136,000.00	\$ 163,200.00
3 d	Post-Placement Construction Survey (per SMA)	18	EA	\$ 7,200.00	\$ 8,000.00	\$ 9,600.00	\$ 129,600.00	\$ 144,000.00	\$ 172,800.00
3 e	Post-Construction Survey (Bathy and Topo)	3	LS	\$ 20,970.00	\$ 23,300.00	\$ 27,960.00	\$ 62,910.00	\$ 69,900.00	\$ 83,880.00
3 f	As-Built Surveys	1	LS	\$ 20,970.00	\$ 23,300.00	\$ 27,960.00	\$ 20,970.00	\$ 23,300.00	\$ 27,960.00
4	Structural Work								
4 a	Remove Timber Piles, Including Dolphins and Groins	1	LS	\$ 49,760.10	\$ 55,289.00	\$ 66,346.80	\$ 49,760.10	\$ 55,289.00	\$ 66,346.80
4 b	Remove Steel Pipe Piles	1	LS	\$ 8,403.30	\$ 9,337.00	\$ 11,204.40	\$ 8,403.30	\$ 9,337.00	\$ 11,204.40
4 c	Replace Steel Pipe Piles and Timber Piles with Steel Pipe Piles	1	LS	\$ 68,698.80	\$ 76,332.00	\$ 91,598.40	\$ 68,698.80	\$ 76,332.00	\$ 91,598.40
4 d	Limit Load and Temporary Support/ Shoring of Existing Bulkheads	1	LS	\$ 402,613.92	\$ 447,348.80	\$ 536,818.56	\$ 402,613.92	\$ 447,348.80	\$ 536,818.56
4 e	Temporary Relocation of Floats	1	LS	\$ 207,000.00	\$ 230,000.00	\$ 276,000.00	\$ 207,000.00	\$ 230,000.00	\$ 276,000.00
4 f	Pipe Protection and Bank Protection, Including Apron	1	LS	\$ 284,625.00	\$ 316,250.00	\$ 379,500.00	\$ 284,625.00	\$ 316,250.00	\$ 379,500.00
4 g	Structural-Specific Contingency	20.00%	PERCENT	-	-	-	\$ 204,220.22	\$ 226,911.36	\$ 272,293.63
5	Dredging, Excavation, Transloading, Upland Transportation, and Disposal								
5 a	Required Dredging and In-Water Transportation (Open-Water)	64,374	CY	\$ 23.54	\$ 26.16	\$ 31.39	\$ 1,515,373.34	\$ 1,683,748.16	\$ 2,020,497.79
5 b	Required Dredging and In-Water Transportation (Nearshore)	11,458	CY	\$ 38.42	\$ 42.69	\$ 51.23	\$ 440,238.96	\$ 489,154.40	\$ 586,985.29
5 c	Required Dredging and In-Water Transportation (Restricted Access)	1,670	CY	\$ 49.79	\$ 55.32	\$ 66.38	\$ 83,159.34	\$ 92,399.26	\$ 110,879.12
5 d	Contingency Re-Dredging - Allowance	10,071	CY	\$ 37.34	\$ 41.49	\$ 49.79	\$ 376,036.31	\$ 417,818.12	\$ 501,381.75
5 e	Shoreline/Bank Excavation	19,892	CY	\$ 37.47	\$ 41.63	\$ 49.96	\$ 745,331.25	\$ 828,145.83	\$ 993,775.00
5 f	Procure/Mix Material Amendment for RAAs 18C and 22 - Allowance	185	TON	\$ 170.98	\$ 189.97	\$ 227.97	\$ 31,705.18	\$ 35,227.98	\$ 42,273.57
5 g	Dredged/Excavated Material Transloading	163,859	TON	\$ 4.50	\$ 5.00	\$ 6.00	\$ 737,367.15	\$ 819,296.83	\$ 983,156.20
5 h	Dredged/Excavated Material Upland Transportation and Disposal (Subtitle D)	163,209	TON	\$ 81.00	\$ 90.00	\$ 108.00	\$ 13,219,950.56	\$ 14,688,833.95	\$ 17,626,600.74
5 i	Identified Debris Removal - Allowance	5	DAY	\$ 18,000.00	\$ 20,000.00	\$ 24,000.00	\$ 90,000.00	\$ 100,000.00	\$ 120,000.00
5 j	Identified Debris Upland Transportation and Disposal (Subtitle D) - Allowance	650	TON	\$ 108.00	\$ 120.00	\$ 144.00	\$ 70,210.80	\$ 78,012.00	\$ 93,614.40
5 k	Standby Time - Allowance	21	DAY	\$ 17,700.00	\$ 19,700.00	\$ 23,600.00	\$ 371,700.00	\$ 413,700.00	\$ 495,600.00

Task ID	Task Description	Quantity	Unit	Unit Costs			Total Costs		
				Lower Probable Unit Cost (\$)	Probable Unit Cost (\$)	Upper Probable Unit Cost (\$)	Lower Probable Total Cost (\$)	Probable Total Cost (\$)	Upper Probable Total Cost (\$)
6	Material Placement								
6 a	Procure/Deliver Sand for RMC (+Inner/Outer Perimeter RMC), and ENR	33,946	TON	\$ 24.00	\$ 26.00	\$ 30.00	\$ 814,711.59	\$ 882,604.22	\$ 1,018,389.48
6 b	Procure/Deliver Gravelly Sand for Backfill and 'Prospective' Cap Chemical Isolation Layer (RAA 27)	75,967	TON	\$ 23.00	\$ 25.00	\$ 29.00	\$ 1,747,232.33	\$ 1,899,165.57	\$ 2,203,032.06
6 c	Procure/Deliver Light Riprap for 'Prospective' Cap Erosion/Protection Layer (RAA 27)	1,764	TON	\$ 31.00	\$ 34.00	\$ 41.00	\$ 54,674.56	\$ 59,965.64	\$ 72,311.51
6 d	Procure/Mix Gravelly Sand with Granular Activated Carbon for Amended Cover (RAAs 18, 24, 26)	412	TON	\$ 3,478.50	\$ 3,865.00	\$ 4,638.00	\$ 1,433,783.49	\$ 1,593,092.76	\$ 1,911,711.31
6 e	Place Sand for RMC (+Inner/Outer Perimeter RMC) and ENR (Open-Water)	17,971	CY	\$ 17.61	\$ 19.57	\$ 23.48	\$ 316,452.24	\$ 351,613.60	\$ 421,936.33
6 f	Place Sand for RMC (+Inner/Outer Perimeter RMC) and ENR (Nearshore)	3,342	CY	\$ 20.41	\$ 22.68	\$ 27.21	\$ 68,208.52	\$ 75,787.25	\$ 90,944.70
6 g	Place Sand for RMC (+Inner/Outer Perimeter RMC) and ENR (Restricted Access)	934	CY	\$ 30.27	\$ 33.64	\$ 40.36	\$ 28,271.63	\$ 31,412.92	\$ 37,695.50
6 h	Place Sand for RMC (+Inner/Outer Perimeter RMC) and ENR (Land-Based Equipment)	2,896	CY	\$ 24.22	\$ 26.91	\$ 32.29	\$ 70,134.88	\$ 77,927.64	\$ 93,513.17
6 i	Place Gravelly Sand for Backfill (Open-Water)	17,662	CY	\$ 17.61	\$ 19.57	\$ 23.48	\$ 311,003.60	\$ 345,559.56	\$ 414,671.47
6 j	Place Gravelly Sand for Backfill (Nearshore)	10,460	CY	\$ 20.41	\$ 22.68	\$ 27.21	\$ 213,477.24	\$ 237,196.94	\$ 284,636.32
6 k	Place Gravelly Sand for Backfill (Restricted Access)	35	CY	\$ 30.27	\$ 33.64	\$ 40.36	\$ 1,067.87	\$ 1,186.52	\$ 1,423.83
6 l	Place Gravelly Sand for Backfill (Land-Based Equipment)	17,566	CY	\$ 25.78	\$ 28.65	\$ 34.38	\$ 452,889.18	\$ 503,210.20	\$ 603,852.24
6 m	Place Blended Gravelly Sand with GAC for Amended Cover (RAAs 18, 24, 26; Land- Based Equipment)	264	CY	\$ 26.08	\$ 28.98	\$ 34.77	\$ 6,874.25	\$ 7,638.06	\$ 9,165.67
6 n	Place Gravelly Sand for 'Prospective' Cap Chemical Isolation Layer (RAA 27)	1,176	CY	\$ 35.74	\$ 39.15	\$ 45.98	\$ 42,013.75	\$ 46,028.78	\$ 54,058.85
6 o	Place Light Riprap for 'Prospective' Cap Erosion /Protection Layer (RAA 27)	1,176	CY	\$ 38.02	\$ 42.25	\$ 50.70	\$ 44,704.92	\$ 49,672.14	\$ 59,606.56
7	Environmental Controls								
7 a	Environmental Controls - Allowance	3	LS	\$ 45,000.00	\$ 50,000.00	\$ 60,000.00	\$ 135,000.00	\$ 150,000.00	\$ 180,000.00
	Direct Construction Costs Subtotal						\$ 28,712,478.00	\$ 32,050,233.00	\$ 38,446,924.00
8	Forecast Inflation Factor (CPI-U)	3.10%	PERCENT				\$ 890,087.00	\$ 993,557.00	\$ 1,191,855.00
9	Direct Construction Contingency	30.00%	PERCENT				\$ 8,613,743.00	\$ 9,615,070.00	\$ 11,534,077.00
	Direct Construction Cost Subtotal with Contingency and Inflation Adjustment						\$ 38,216,308.00	\$ 42,658,860.00	\$ 51,172,856.00
10	Sales Tax	10.25%	PERCENT				\$ 3,917,172.00	\$ 4,372,533.00	\$ 5,245,218.00
	Total Direct Construction Costs (with Contingency and Sales Tax) - Rounded						\$ 42,134,000.00	\$ 47,032,000.00	\$ 56,419,000.00
INDIRECT CONSTRUCTION COSTS									
11	Indirect Construction Costs								
11 a	Construction Management (Inspection and Oversight) and Engineering Support	10.0	MO	\$157,500.00	\$175,000.00	\$210,000.00	\$ 1,575,000.00	\$ 1,750,000.00	\$ 2,100,000.00
11 b	Confirmation Sediment Sampling	1	LS	\$657,000.00	\$730,000.00	\$876,000.00	\$ 657,000.00	\$ 730,000.00	\$ 876,000.00
11 c	Environmental Monitoring (Water Quality)	10.0	MO	\$179,100.00	\$199,000.00	\$238,800.00	\$ 1,791,000.00	\$ 1,990,000.00	\$ 2,388,000.00
11 d	Site Access Agreements and Temporary Leases	1	LS	\$135,000.00	\$150,000.00	\$180,000.00	\$ 135,000.00	\$ 150,000.00	\$ 180,000.00
	Indirect Construction Costs Subtotal						\$ 4,158,000.00	\$ 4,620,000.00	\$ 5,544,000.00
12	Indirect Construction Contingency	30.00%	PERCENT				\$ 1,247,400.00	\$ 1,386,000.00	\$ 1,663,200.00
	Indirect Construction Costs Subtotal with Contingency						\$ 5,405,400.00	\$ 6,006,000.00	\$ 7,207,200.00
	Total Indirect Construction Costs (with Contingency) - Rounded						\$ 5,406,000.00	\$ 6,006,000.00	\$ 7,208,000.00

Task ID	Task Description	Quantity	Unit	Unit Costs			Total Costs		
				Lower Probable Unit Cost (\$)	Probable Unit Cost (\$)	Upper Probable Unit Cost (\$)	Lower Probable Total Cost (\$)	Probable Total Cost (\$)	Upper Probable Total Cost (\$)
ADDITIONAL CONSTRUCTION OVERSIGHT COSTS									
13	Additional Construction Oversight Costs								
13 a	Owner Oversight	11.0	MO	\$36,000.00	\$40,000.00	\$48,000.00	\$ 396,000.00	\$ 440,000.00	\$ 528,000.00
13 b	EPA Oversight	11.0	MO	\$55,800.00	\$62,000.00	\$74,400.00	\$ 613,800.00	\$ 682,000.00	\$ 818,400.00
	Additional Construction Oversight Costs Subtotal - Rounded						\$ 1,009,800.00	\$ 1,122,000.00	\$ 1,346,400.00
14	Additional Construction Oversight Contingency	30.00%	PERCENT				\$ 302,940.00	\$ 336,600.00	\$ 403,920.00
	Additional Construction Oversight Costs Subtotal with Contingency						\$ 1,312,740.00	\$ 1,458,600.00	\$ 1,750,320.00
	Total Additional Construction Oversight Costs (with Contingency) - Rounded						\$ 1,313,000.00	\$ 1,459,000.00	\$ 1,751,000.00
15	TOTAL PROJECT COSTS						\$48,853,000.00	\$54,497,000.00	\$65,378,000.00

Notes:

- In providing this Opinion of Probable Cost, the Client understands that the Consultant (Anchor QEA, LLC) has no control over the cost or availability of labor, equipment, or materials, or over market condition or the Contractor's method of pricing, and the Consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied, that the bids or the negotiated cost of the work will not vary from the Consultant's opinion of probable construction cost.
- Costs are presented in present-day US dollars (i.e., 2022).
- Although the upper reach SMAs fall into both the Cities of Seattle and Tukwila jurisdictions, for the purposes of this opinion of probable cost, sales tax is included at 10.25% (to account for Washington State [6.5%] and the City of Seattle [3.75%] taxes), as a conservative assumption for Intermediate (60%) RD; City of Tukwila tax rate is 10.1%.
- A 30% contingency is applied to both total direct construction, total indirect construction costs and total additional construction oversight costs, based on consideration of potential cost uncertainty associated with the level of information currently available and engineering best professional judgement. Due to the nature of the project (i.e., environmental sediment remediation), additional factors that cannot be forecasted at this time—such as scope unknowns (i.e., significant changes in site conditions or quantities), price uncertainty (i.e., varying market conditions, increasing inflation, fuel and labor changes), or any other unforeseen circumstances (i.e., additional design requirements)—may influence contractor bidding prices and impact the final project costs outside, in excess, or below this contingency.
- Long-term monitoring costs are not included in this opinion of probable cost because assumptions for these activities will be developed consistent with the Long-Term Maintenance and Monitoring Plan in subsequent RD phases.

AC: acre
 CY: cubic yard
 EA: each
 GAC: granular activated carbon
 LS: lump sum
 MO: month
 RD: remedial design
 SF: square foot
 SMA: sediment management area
 TON: U.S. ton

General Notes	
1	<p>The approach for developing the LDW upper reach Opinion of Probable Cost Estimate was based on several sources of information, including the following:</p> <ul style="list-style-type: none"> Anchor QEA's best professional judgment and past experience with similar remedial actions and associated pricing Review of contractor's bid costs and engineer's construction cost estimates for similar remediation projects completed (locally) in Seattle, Washington and (regionally) in the Pacific Northwest, as well as knowledge of construction activities and challenges identified during construction oversight. Engineering cost guidance (RS Means). <p>Anchor QEA performed a detailed internal review of the cost assumptions and unit prices to determine their relevance, anticipated accuracy, and cost variability. In addition, engineering best professional judgment was used to evaluate different prices obtained from various sources of information to select the lower, probable, and upper unit costs or lump sum prices (three-point estimating).</p>
2	Assumed CY to TON conversions: 1) sediment: 1.5 TON/CY (in situ); 2) sand/gravel mix: 1.6 TON/CY; 3) sand: 1.4 TON/CY; 4) for armor: 1.5 TON/CY.
3	Although the upper reach SMAs fall into both the Cities of Seattle and Tukwila jurisdictions, for the purposes of this opinion of probable cost, sales tax is included at 10.25% (to account for Washington State [6.5%] and the City of Seattle [3.75%] taxes), as a conservative assumption for Intermediate (60%) RD; City of Tukwila tax rate is 10.1%.
4	Estimated costs assume that construction could occur without interruptions from ongoing site operational uses, except as noted by stand-by time.
Specific Notes by Task ID	
DIRECT CONSTRUCTION COSTS	
1	Mobilization/Demobilization
1	a Mobilization/Demobilization cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Assumes three mobilization/demobilization events, which includes: 150-ton derrick/spud rig, 5- to 8-cy buckets, 2 tugs, up to 4 x 1,700-ton scows, work boat, front-end loader, and specialized equipment (i.e., various bucket sizes) for working in shallow-water environments and under restricted conditions. Costs also includes costs for bond and insurance premiums (estimated to be 2% of the total direct construction costs). Includes three mobilization/demobilization events for three construction seasons (in-water work window is defined as October 1 through February 15).
1	b Includes labor for procedural costs and contractor's development of required workplans and submittals. Costs estimated from Anchor QEA past project experience. Includes three sets of project workplans and submittals for three construction seasons.
2	Site Preparation
2	a Includes shoreline preparation and remediation, estimated on a acre-basis, from Anchor QEA past project experience for similar projects of similar size.
2	b Includes preparation of an upland area at a designated location (TBD) for contractor use for on site trailer office and other temporary facilities, as well as staging of equipment. Also, site decommissioning costs are included. Estimated from Anchor QEA past project experience for similar projects of similar size.
3	Surveys
3	a Contractor progress bathymetric survey cost assumes multi-beam hydrographic survey equipment using: Real-Time Kinematic (RTK) GPS Positioning, Motion Platform, Multibeam Sonar, SV Profiler, eqQPS QINSy Software, mobilization/demobilization of survey vessel and survey equipment, data processing and product generation, one boat operator, and one licensed surveyor. Cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Contractor progress bathymetric survey costs assumed for the dredging and placement durations.
3	b Includes costs for payment bathymetric and topographic surveys to be conducted prior to construction for the whole LDW upper reach site. Cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Includes three sets of pre-construction bathy/topo surveys for three construction seasons.
3	c Includes costs for payment bathymetric survey to be conducted post-dredging for each SMA that requires dredging. Cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects.
3	d Includes costs for payment bathymetric survey to be conducted post-backfill/RMC/ENR/Amended Cover/Armor placement for each SMA that requires material placement. Cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects.
3	e Includes costs for payment bathymetric and topographic surveys to be conducted post-construction for the whole LDW upper reach site. Cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Includes three sets of post-construction bathy/topo surveys for three construction seasons.
3	f Includes costs for final as-built surveys to be conducted post-construction for the whole LDW upper reach site. Cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Includes one set of as-built surveys at the end of the third construction season.

4	Structural Work	
4	a	Cost provided by Bright Engineering Inc. in February, 2023. See Attachment M-1.6 for detailed assumptions for costing.
4	b	Cost provided by Bright Engineering Inc. in February, 2023. See Attachment M-1.6 for detailed assumptions for costing.
4	c	Cost provided by Bright Engineering Inc. in February, 2023. See Attachment M-1.6 for detailed assumptions for costing.
4	d	Cost provided by Bright Engineering Inc. in February, 2023. See Attachment M-1.6 for detailed assumptions for costing.
4	e	Cost provided by Bright Engineering Inc. in February, 2023. See Attachment M-1.6 for detailed assumptions for costing.
4	f	Cost provided by Bright Engineering Inc. in February, 2023. See Attachment M-1.6 for detailed assumptions for costing.
4	g	Structural-specific contingency of 20% is applied to direct construction of structural work elements only, as provided by Bright Engineering Inc. in December, 2022. See table M-1.6 for detailed assumptions for costing. This structural-specific contingency is based on consideration of potential cost uncertainty associated with the level of information currently available and engineering best professional judgement.
5	Dredging, Excavation, Transloading, Upland Transportation, and Disposal	
5	a	Open-water dredging unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Volume includes required dredge volume and daylight dredge volume for open-water dredging. Probable open-water dredge production rate estimated to be approximately 1,100 CY/10-hour shift.
5	b	Nearshore dredging unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Volume includes required dredge volume and daylight dredge volume for dredging conducted in nearshore shallow areas, slopes, and any slow dredging. Probable nearshore dredge production rate estimated to be approximately 700 CY/10-hour shift.
5	c	Restricted access dredging unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Volume includes required dredge volume and daylight dredge volume for dredging conducted under bridge, near structures or bulkhead. Probable restricted access dredge production rate estimated to be approximately 500 CY/10-hour shift.
5	d	Contingency re-dredging unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Contingency re-dredging conducted over a portion of the total dredge area, applied to a 1-ft thickness to address generated residuals (15% of area; 1-ft thickness includes a 6-in overdredge allowance) and 2.5-ft thickness to remove missed inventory (20% of area; 2.5-ft thickness includes a 6-in overdredge allowance). Contingency re-dredging production rate estimated to be 700 CY/10-hour shift. These costs are considered an 'allowance' for this Intermediate (60%) RD cost estimate.
5	e	Excavation unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Volume includes required excavated volume and daylight excavated volume in shorelines and riverbanks. Probable excavation production rate estimated to be approximately 600 CY/10-hour shift.
5	f	Unit cost for dewatering amendment (assumed to be Portland cement) based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Assumed unit cost includes delivery of material to the LDW upper reach site and mixing of material with the dredge volume from RAAs 18C and 22. These costs are considered an 'allowance' for this Intermediate (60%) RD cost estimate.
5	g	Transloading unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. contractor's tonnage for transloading calculated from the contractor's dredge/excavated and incidental debris volume (converted with a 1.5 TON/CY factor) and anticipated identified debris tonnage.
5	h	Transportation and disposal unit cost in a Subtitle D landfill facility based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Tonnage for transportation and disposal calculated from the contractor's dredge/excavated, amended dredge and incidental debris volume (converted with a 1.5 TON/CY factor) for material designated as "Subtitle D Landfill Waste".

5	i	Identified debris removal unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Debris removal includes visible and potentially buried debris associated with concrete blocks, timber piling, steel I beams, rubble, cables, and other items. Identified debris dimensions/quantities estimated based on visual aerial observations, shoreline photograph inventory, and measurements derived ArcGIS LDW webmap imagery, of the LDW upper reach shorelines/riverbanks for debris items generally larger than 12 inches in size. Buried and smaller debris is considered incidental dredge debris and its removal, transportation, and disposal are already accounted for in the contractor's dredge volume. These costs are considered an 'allowance' for this Intermediate (60%) RD cost estimate.
5	j	Identifies debris transportation and disposal unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. These costs are considered an 'allowance' for this Intermediate (60%) RD cost estimate.
5	k	In-water standby time is estimated to be 21 days of contractor's time, over three construction seasons. Unit cost assumed to include equipment and labor costs at 70% of the daily dredging/placement costs; unit costs based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Work stoppage during dredging and/or placement activities is assumed to relate to relocation of contractor construction equipment to accommodate emergencies, downtime due to inclement weather, and/or directed but unexpected operational needs (i.e., unforeseen or unplanned vessel access or passage through the upper reach, inclement weather). These costs are considered an 'allowance' for this Intermediate (60%) RD cost estimate.
6	Material Placement	
6	a	Unit cost for medium-to-coarse sand material based on discussion with local material supplier, review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Assumed sand unit cost from a local supplier includes loading onto barge; delivery of material by barge to the LDW upper reach site has also been accounted for in the unit cost. Clean sand is assumed to be used for placement of RMC at 6-in (plus 6-in maximum overplacement allowance) on the neatline dredge surface area and 1-ft (plus 1-ft in maximum overplacement allowance) on the side slope surface area, and ENR at 6-in (plus 6-in maximum overplacement allowance). The RMC quantity also includes an additional 20-ft inner and outer placement buffer surrounding the dredge area (at 6-in plus 6-in maximum overplacement allowance); the outer perimeter RMC consists of RMC placed within an assumed 25% of a 20-ft-wide perimeter outside of and surrounding the inner RMC perimeter. The ENR quantity assumes a placement footprint that includes a 10-ft buffer around the planned ENR placement area.
6	b	Unit cost for granular gravelly sand based on discussion with local material supplier, review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Assumed gravelly sand unit cost from a local supplier includes loading onto barge; delivery of material by barge to the LDW upper reach site has also been accounted for in the unit cost. Gravelly sand is assumed to be used for placement of backfill (to pre-construction elevations and to flatten temporary steeper dredge cuts in all dredge areas located outside of the FNC above -10-ft mean lower low water), and for placement of 'prospective' cap isolation layer at 1-ft (plus 6-in maximum overplacement allowance).
6	c	Unit cost for light riprap based on discussion with local material supplier, review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Assumed light riprap unit cost from a local supplier includes loading onto barge; delivery of material by barge to the LDW upper reach site has also been accounted for in the unit cost. Total RAA 27 cap erosion/protection layer placement thickness is assumed to be 1-ft (plus 6 inches maximum overplacement allowance).
6	d	Unit cost for gravelly sand and granular activated carbon (GAC) based on discussion with local material supplier, review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Assumed gravelly sand unit cost from a local supplier includes loading onto barge; delivery of material by barge to the LDW upper reach site has also been accounted for in the unit cost. Assumed GAC unit cost includes delivery by truck (from Pacific Coast Carbon, Ridgefield, WA) to LDW upper reach site. GAC material is assumed to be blended at 1.5% by weight with gravelly sand and placed in RAAs 18, 24, 26. Assumed unit cost includes equipment and labor cost for mixing.
6	e	Clean sand open-water placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Clean sand open-water placement rate for RMC/ENR is estimated to be 1,100 CY/10-hour shift.
6	f	Clean sand nearshore placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Clean sand nearshore placement rate for RMC/ENR is estimated to be 1,000 CY/10-hour shift.
6	g	Clean sand restricted access placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Clean sand restricted access placement rate for RMC/ENR is estimated to be 700 CY/10-hour shift.
6	h	Clean sand land-based equipment placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Clean sand land-based equipment placement rate for RMC/ENR is estimated to be 800 CY/10-hour shift.
6	i	Gravelly sand open-water placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Gravelly sand open-water placement rate for backfill and is estimated to be 1,100 CY/10-hour shift.

6	j	Gravelly sand nearshore placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Gravelly sand nearshore placement rate for backfill and is estimated to be 1,000 CY/10-hour shift.
6	k	Gravelly sand restricted access placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Gravelly sand restricted access placement rate for backfill and is estimated to be 700 CY/10-hour shift.
6	l	Gravelly sand land-based equipment placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Gravelly sand land-based equipment placement rate for backfill and is estimated to be 800 CY/10-hour shift.
6	m	Blended gravelly sand with GAC land-based equipment placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Blended gravelly sand with GAC land-based equipment placement rate for backfill and is estimated to be 800 CY/10-hour shift.
6	n	Gravelly sand placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Gravelly sand placement rate for RAA 27- cap chemical isolation layer is estimated to be 600 CY/10-hour shift.
6	o	Light riprap placement unit cost based on review of contractor's bid costs, construction cost estimates of projects recently completed in Washington State, and Anchor QEA's best professional judgement based on past project experience for similar projects. Light riprap placement rate for RAA 27-cap erosion/protection layer and is estimated to be 500 CY/10-hour shift.
7	Environmental Controls	
7	a	Costs assume general environmental controls during construction activities. These costs are considered an 'allowance' for this Intermediate (60%) RD cost estimate.
Direct construction costs subtotal is the sum of costs from all direct construction tasks.		
8	Forecast inflation factor of 3.1% (CPI-U) is applied to the direct construction costs subtotal due to price uncertainty (i.e., varying market conditions, increasing inflation, fuel and labor changes). CPI-U (consumer price index for all urban consumers) for 2023 (Congressional Budget Office, Year-by-Year Projections for Calendar Years 2022 to 2032, Consumer Price Index for All Urban Consumers (https://www.cbo.gov/system/files/2022-05/51135-2022-05-Economic-Projections.xlsx).	
9	Direct construction contingency of 30% is applied to the direct construction costs subtotal.	
Direct construction costs subtotal with contingency is the sum of direct construction cost subtotal and contingency costs.		
10	Although the upper reach SMAs fall into both the Cities of Seattle and Tukwila jurisdictions, for the purposes of this opinion of probable cost, sales tax is included at 10.25% (to account for Washington State [6.5%] and the City of Seattle [3.75%] taxes), as a conservative assumption for Intermediate (60%) RD; City of Tukwila tax rate is 10.1%.	
Total direct construction costs are the sum of direct construction cost subtotal, contingency costs, and sales tax.		
INDIRECT CONSTRUCTION COSTS		
11	Indirect Construction Costs	
11	a	Construction management (including inspection and oversight) and engineering support costs include providing oversight of the contractor's implementation of the sediment remedy. Construction management costs typically refers to in-field work to oversee the contractor's work and includes construction inspection, progress tracking and reporting, reviewing progress payment requests, reviewing contractor submittals and work plans, addressing contractor Requests for Information and change order requests, leading adaptive design changes, and communicating with the Owner and EPA. Engineering support services are typically provided from the office and include design interpretation, contingency action decision coordination, change order negotiation support, and closeout report preparation. Construction management and engineering support effort is assumed on a monthly basis for the total construction duration.
11	b	Confirmation sediment sampling activities include collecting post-dredge confirmation sediment samples throughout the total dredge area post-dredging to evaluate the potential need for contingency actions. Confirmation sediment sampling include costs for equipment, labor, analytical, and data validation.
11	c	Environmental monitoring (water quality sampling) costs include water quality monitoring activities during construction. Environmental monitoring includes costs for equipment, labor, and field measurements of water samples collected during dredging and placement activities. Costs for environmental monitoring for water quality are assumed on a monthly basis for the total dredging and placement duration.
11	d	Site access agreements and temporary leases include costs for leases, if needed, and coordination costs associated with site access (e.g., directed barge or vessel temporary relocations, Tribal Usual and Accustomed Fishing agreements. It is not anticipated that special leases will be required.
Indirect construction costs subtotal is the sum of costs from all indirect construction tasks.		
12	Indirect construction contingency of 30% is applied to the indirect construction cost subtotal.	
Indirect construction costs subtotal with contingency is the sum of indirect construction cost subtotal and contingency costs.		
Total indirect construction costs are the sum of indirect construction cost subtotal and contingency costs.		

ADDITIONAL CONSTRUCTION OVERSIGHT COSTS	
13	a Owner oversight costs include supervision activities during implementation of the sediment remedy. Owner oversight costs are assumed on a monthly basis for the total construction duration.
13	b EPA oversight costs include supervision activities by EPA during implementation of the sediment remedy. EPA oversight costs are assumed on a monthly basis for the total construction duration.
Additional construction oversight costs subtotal is the sum of costs from implementing oversight and EPA oversight tasks.	
14	Additional construction oversight contingency of 30% is applied to the additional construction oversight cost subtotal.
Additional construction oversight costs subtotal with contingency is the sum of additional construction oversight cost subtotal and contingency costs.	
Total additional construction oversight costs are the sum of additional construction oversight cost subtotal and contingency costs.	
15	Total project cost is the sum of total direct construction costs, indirect construction costs, and additional construction oversight costs.

Notes:

- CY: cubic yard
- ENR: enhanced natural recovery
- EPA: Environmental Protection Agency
- GAC: Granular Activated Carbon
- LDW: Lower Duwamish Waterway
- LS: lump sum
- MO: month
- RD: remedial design
- RMC: residuals management cover
- SMA: sediment management area
- TBD: to be determined
- TON: U.S. ton

**Attachment M-1.4
Detailed Quantities**

SMA (Preliminary; Updated on 11/16/2022)	Remedial Action Area	Technology Assignment	Slope Assumptions Description	Quantities Throughout LDW Upper Reach								Quantities Inside FNC						Quantities Outside FNC					
				Required ENR/ Amended Cover Surface Area (SF)	Required Dredge Surface Area (No Side-Slopes) (SF)	Required Side-Slope Surface Area (SF)	Required Dredge Volume (CY)	Overdredge Allowance Volume (No Side-Slopes) (CY)	Overdredge Allowance Volume for Side-Slopes Only (CY)	Total Payable Dredge Volume (No Contingency Re-Dredging Included) (CY)	Contingency Re-Dredge Volume (Generated Residuals and Missed Inventory)	Required Dredge Surface Area (No Side-Slopes) (SF)	Required Side-Slope Surface Area (SF)	Required Dredge Volume (CY)	Overdredge Allowance Volume (No Side-Slopes) (CY)	Overdredge Allowance Volume for Side-Slopes Only (CY)	Total Payable Dredge Volume (No Contingency Re-Dredging Included) (CY)	Required Dredge Surface Area (No Side-Slopes) (SF)	Required Side-Slope Surface Area (SF)	Required Dredge Volume (CY)	Overdredge Allowance Volume (No Side-Slopes) (CY)	Overdredge Allowance Volume for Side-Slopes Only (CY)	Total Payable Dredge Volume (No Contingency Re-Dredging Included) (CY)
18 (1/2/3A and partial 1/2/3B), 17 (1/2/3b partial and 1/2/3C)	AREA 01/02/3	Dredge and Partial Backfill/Partial RMC	2:1 Outside FNC, 3:1 Inside FNC (7/18/22)		70,704	34,704	17,677	2,619	1,285	21,581	1,702	61,223	16,143	11,676	2,268	598	14,541	9,480	18,562	6,001	351	687	7,040
16 (4/5A, 4/5B, 4/5C), 15 (4/5D, 4/5E, 4/5F and 4/5G), 14 (4/5H and 4/5I)	AREA 04/5	Dredge and Partial Backfill/Partial RMC	2:1 outside FNC, 3:1 Inside (12/7/22)		135,851	48,757	25,938	5,032	1,806	32,776	3,270	123,422	32,094	20,569	4,571	1,189	26,329	12,430	16,663	5,369	461	617	6,447
14	AREA 04/5	ENR		685																			
15	AREA 06	Dredge and Backfill	3:1 Slopes All Around (3/17/22)		869	541	84	32	20	136	21							869	541	84	32	20	136
15	AREA 07	ENR		1,201																			
14	AREA 08	Dredge and Backfill	2:1 Slopes All Around (6/21/22)		900	255	38	33	9	80	22							900	256	38	33	9	80
	AREA 09 (Not included)																						
14	AREA 10	ENR		1,558																			
14	AREA 11	Dredge and Partial Backfill/Partial RMC	2:1 Slopes All Around (12/5/22)		1,527	2,769	692	57	103	852	37	355	315	54	13	12	79	1,172	2,454	638	43	91	772
14	AREA 12	Dredge and RMC	3:1 Slopes All Around (6/20/22)		900	570	43	33	21	97	22	900	570	43	33	21	97						
13	AREA 13	Dredge and Backfill	3:1 waterward, 2:1 from the Toe of Armored Slope into the Dredge Area (4/13/22)		725	2,184	329	27	81	437	17							725	2,184	329	27	81	437
13	AREA 13	ENR		3,717																			
12	AREA 14	Dredge and Partial Backfill/Partial RMC	3:1 Slopes All Around (7/20/22)		11,785	13,425	5,329	436	497	6,262	284	11,785	11,407	5,146	436	422	6,004		2,018	183		75	258
12	AREA 15/16	Dredge and Partial Backfill/Partial RMC	2:1 Shoreline Slope, 3:1 for the Rest (6/3/22)		13,547	12,568	5,797	502	465	6,764	326	2,968	5,680	1,676	110	210	1,996	10,580	6,888	4,121	392	255	4,768
12	AREA 17	Dredge and Partial Backfill/Partial RMC	3:1 Slopes All Around (6/3/22)		3,658	1,204	155	135	45	335	88	3,658	514	145	135	19	299		691	10		26	36
10	AREA 18	Dredge and Backfill	2:1 Shoreline Slope, 3:1 for the Rest (12/7/22)		19,991	3,455	2,371	740	128	3,239	481							19,991	3,455	2,371	740	128	3,239
10	AREA 18	Amended Cover (Area Specific Technology-B)		684																			
11	AREA 19/20	Dredge and Backfill	2:1 Slopes All Around (6/7/22)		4,828	2,073	537	179	77	793	116							4,828	2,073	537	179	77	793
10	AREA 21	Dredge and Backfill	2:1 Slopes All Around (4/15/22)		2,223	975	200	82	36	318	54							2,223	975	200	82	36	318
9	AREA 22	Dredge and Partial Backfill/Partial RMC	3:1 Slopes toward the FNC, 2:1 for the rest (12/9/22)		23,606	3,281	1,870	874	122	2,866	568							23,606	3,281	1,870	874	122	2,866
8	AREA 23	ENR		2,739																			
7	AREA 24/25 A	ENR		3,464																			
7	AREA 24/25	Amended Cover (Area Specific Technology-B)		1,171																			
7	AREA 24/25 B	Dredge and Backfill	2:1 Slopes All Around (12/8/22)		5,934	2,580	923	220	96	1,239	143							5,934	2,580	923	220	96	1,239
7	AREA 26	Dredge and Backfill	2:1 Slopes All Around (12/8/22)		8,806	837	342	326	31	699	212							8,806	837	342	326	31	699
7	AREA 26	Amended Cover (Area Specific Technology-B)		2,890																			
6 (27A, partial 27B, partial 27C), 5 (partial 27B and partial 27C)	AREA 27	Dredge and Backfill/ Cap	2:1 Slopes All Around (6/21/22)		81,247	22,341	11,872	3,009	827	15,709	1,956							81,247	22,341	11,872	3,009	827	15,709
5	AREA 27	ENR		867																			
4	AREA 28	Dredge and Backfill	3:1 Slopes All Around (6/7/22)		7,038	2,440	610	261	90	961	169							7,038	2,440	610	261	90	961
3	AREA 29	Dredge and Backfill	2:1 Slopes All Around (8/11/22)		5,388	1,093	329	200	40	569	130							5,388	1,093	329	200	40	569
2	AREA 30	Dredge and Backfill	2:1 Slopes All Around (4/7/22)		1,304	426	84	48	16	148	31							1,304	426	84	48	16	148
2	AREA 31	Dredge and Backfill	2:1 Slopes All Around (4/7/22)		1,489	716	136	55	27	218	36							1,489	716	136	55	27	218
1	AREA 32	Dredge and Backfill	2:1 All Around, Ex Shoreline Toe of Slope (6/6/22)		2,578	621	107	95	23	225	62							2,578	621	107	95	23	225
1	AREA 33/34/35 A	ENR		2,390																			
1	AREA 33/34/35 B	Dredge and Backfill	2:1 Slopes All Around Ex Shoreline Toe of Slope (12/8/22)		13,424	1,841	527	497	68	1,092	323							13,424	1,841	527	497	68	1,092

Total Quantities Throughout Site								Total Quantities Inside FNC						Total Quantities Outside FNC					
Required ENR/ Amended Cover Surface Area (SF)	Required Dredge Surface Area (No Side-Slopes) (SF)	Required Side-Slope Surface Area (SF)	Required Dredge Volume (CY)	Overdredge Allowance Volume (No Side-Slopes) (CY)	Overdredge Allowance Volume for Side-Slopes Only (CY)	Total Payable Dredge Volume (No Contingency Re-Dredging Included) (CY)	Contingency Re-Dredge Volume (Generated Residuals and Missed Inventory)	Required Dredge Surface Area (No Side-Slopes) (SF)	Required Side-Slope Surface Area (SF)	Required Dredge Volume (CY)	Overdredge Allowance Volume (No Side-Slopes) (CY)	Overdredge Allowance Volume for Side-Slopes Only (CY)	Total Payable Dredge Volume (No Contingency Re-Dredging Included) (CY)	Required Dredge Surface Area (No Side-Slopes) (SF)	Required Side-Slope Surface Area (SF)	Required Dredge Volume (CY)	Overdredge Allowance Volume (No Side-Slopes) (CY)	Overdredge Allowance Volume for Side-Slopes Only (CY)	Total Payable Dredge Volume (No Contingency Re-Dredging Included) (CY)
21,366	418,322	159,656	75,990	15,492	5,913	97,395	10,071	204,311	66,722	39,309	7,566	2,471	49,346	214,011	92,934	36,681	7,925	3,442	48,049

**Attachment M-1.4
Detailed Quantities**

SMA (Preliminary; Updated on 11/16/2022)	Remedial Action Area	Technology Assignment	Slope Assumptions Description	% Volume Assumptions for Production Rates				Dredge/Excavation Volume Distribution (CY)				Material Placement Volume Distribution (CY)										
				Open Water (%)	Nearshore / Slope / Slow (%)	Restricted Access (%)	Excavation (Shoreline/Bank) (%)	Open Water Dredging (CY)	Nearshore / Slope / Slow Dredging (CY)	Restricted Access Dredging (CY)	Excavation (Shoreline/Bank) (CY)	Sand Material				Gravelly Sand Material				Gravelly Sand Material Blended with Granular Activated Carbon		
												RMC/ ENR (Open Water) (CY)	RMC/ ENR (Nearshore) (CY)	RMC/ ENR (Restricted Access) (CY)	RMC/ ENR (Land-Based Equipment) (CY)	Backfill (Open Water) (CY)	Backfill (Nearshore) (CY)	Backfill (Restricted Access) (CY)	Backfill (Land-Based Equipment) (CY)		Amended Cover (Land- Based Equipment)	
18 (1/2/3A and partial 1/2/3B), 17 (1/2/3b partial and 1/2/3C)	AREA 01/02/3	Dredge and Partial Backfill/Partial RMC	2:1 Outside FNC, 3:1 Inside FNC (7/18/22)	100%				21,581				3,463				7,040						
16 (4/5A, 4/5B, 4/5C), 15 (4/5D, 4/5E, 4/5F and 4/5G), 14 (4/5H and 4/5I)	AREA 04/5	Dredge and Partial Backfill/Partial RMC	2:1 outside FNC, 3:1 Inside (12/7/22)	94%		6%		31,105		1,670		6,289		659		6,413		35				
14	AREA 04/5	ENR				100%							25									
15	AREA 06	Dredge and Backfill	3:1 Slopes All Around (3/17/22)	100%				136							136							
15	AREA 07	ENR			100%							44										
14	AREA 08	Dredge and Backfill	2:1 Slopes All Around (6/21/22)				100%				80								80			
	AREA 09 (Not included)																					
14	AREA 10	ENR			100%								58									
14	AREA 11	Dredge and Partial Backfill/Partial RMC	2:1 Slopes All Around (12/5/22)	100%				852				36			772							
14	AREA 12	Dredge and RMC	3:1 Slopes All Around (6/20/22)	100%				97				76										
13	AREA 13	Dredge and Backfill	3:1 waterward, 2:1 from the Toe of Armored Slope into the Dredge Area (4/13/22)		100%				437							437						
13	AREA 13	ENR					100%							138								
12	AREA 14	Dredge and Partial Backfill/Partial RMC	3:1 Slopes All Around (7/20/22)	100%				6,262				1,281			258							
12	AREA 15/16	Dredge and Partial Backfill/Partial RMC	2:1 Shoreline Slope, 3:1 for the Rest (6/3/22)	50%	50%			3,382	3,382			265	265		2,384	2,384						
12	AREA 17	Dredge and Partial Backfill/Partial RMC	3:1 Slopes All Around (6/3/22)	100%				335				174			36							
10	AREA 18	Dredge and Backfill	2:1 Shoreline Slope, 3:1 for the Rest (12/7/22)	8%	50%		42%	306	1,376		1,557				306	1,376			1,557			
10	AREA 18	Amended Cover (Area Specific Technology-B)					100%														38	
11	AREA 19/20	Dredge and Backfill	2:1 Slopes All Around (6/7/22)				100%				793										793	
10	AREA 21	Dredge and Backfill	2:1 Slopes All Around (4/15/22)	100%				318							318							
9	AREA 22	Dredge and Partial Backfill/Partial RMC	3:1 Slopes toward the FNC, 2:1 for the rest (12/9/22)		50%		50%		1,433		1,433					1,433				1,433		
8	AREA 23	ENR					100%							101								
7	AREA 24/25 A	ENR			100%								128									
7	AREA 24/25	Amended Cover (Area Specific Technology-B)					100%														65	
7	AREA 24/25 B	Dredge and Backfill	2:1 Slopes All Around (12/8/22)				100%				1,239										1,239	
7	AREA 26	Dredge and Backfill	2:1 Slopes All Around (12/8/22)		50%		50%		350		350				350						350	
7	AREA 26	Amended Cover (Area Specific Technology-B)					100%														161	
6 (27A, partial 27B, partial 27C), 5 (partial 27B and partial 27C)	AREA 27	Dredge and Backfill/ Cap	2:1 Slopes All Around (6/21/22)		10%		90%		1,633		14,076					1,633					11,749	
5	AREA 27	ENR					100%							32								
4	AREA 28	Dredge and Backfill	3:1 Slopes All Around (6/7/22)		100%				961						961							
3	AREA 29	Dredge and Backfill	2:1 Slopes All Around (8/11/22)			100%			569						569							
2	AREA 30	Dredge and Backfill	2:1 Slopes All Around (4/7/22)				100%				148										148	
2	AREA 31	Dredge and Backfill	2:1 Slopes All Around (4/7/22)				100%				218										218	
1	AREA 32	Dredge and Backfill	2:1 All Around, Ex Shoreline Toe of Slope (6/6/22)		100%				225						225							
1	AREA 33/34/35 A	ENR			100%									89								
1	AREA 33/34/35 B	Dredge and Backfill	2:1 Slopes All Around Ex Shoreline Toe of Slope (12/8/22)		100%				1,092						1,092							

Open Water Dredging (CY)	Nearshore / Slope / Slow Dredging (CY)	Restricted Access Dredging (CY)	Excavation (Shoreline/Bank) (CY)
64,374	11,458	1,670	19,892

RMC/ ENR (Open Water) (CY)	RMC/ ENR (Nearshore) (CY)	RMC/ ENR (Restricted Access) (CY)	RMC/ ENR (Land-Based Equipment) (CY)	Backfill (Open Water) (CY)	Backfill (Nearshore) (CY)	Backfill (Restricted Access) (CY)	Backfill (Land-Based Equipment) (CY)	Amended Cover (Land- Based Equipment)
11,585	265	659	271	17,662	10,460	35	17,566	264

**Attachment M-1.4
Detailed Quantities**

SMA (Preliminary; Updated on 11/16/2022)	Remedial Action Area	Technology Assignment	Slope Assumptions Description	Capping Materials		RAAs	SMAs	Inner Dredge Perimeter RM Area (SF)	Outer Dredge Perimeter RMC Area (SF, Assumed to be 25% of Outer RMC Placement Area)	Inner Dredge Perimeter RMC Volume (CY)	Outer Dredge Perimeter RMC Volume
				Gravelly Sand For Cap Chemical Isolation Layer (CY)	Light Riprap Erosion/Protection Layer (CY)						
18 (1/2/3A and partial 1/2/3B), 17 (1/2/3b partial and 1/2/3C)	AREA 01/02/3	Dredge and Partial Backfill/Partial RMC	2:1 Outside FNC, 3:1 Inside FNC (7/18/22)			Area 01/02/03	18, 17	36,540	9,320	1,353	345
16 (4/5A, 4/5B, 4/5C), 15 (4/5D, 4/5E, 4/5F and 4/5G), 14 (4/5H and 4/5I)	AREA 04/5	Dredge and Partial Backfill/Partial RMC	2:1 outside FNC, 3:1 Inside (12/7/22)			Area 04/05, 06, 08, 11	16, 15, 14	72,426	16,882	2,682	625
14	AREA 04/5	ENR				Area 12	14	4,216	1,269	156	47
15	AREA 06	Dredge and Backfill	3:1 Slopes All Around (3/17/22)			Area 13	13	980			36
15	AREA 07	ENR				Area 14, 15/16	12	26,586	6,790	985	251
14	AREA 08	Dredge and Backfill	2:1 Slopes All Around (6/21/22)			Area 17	12	7,390	2,505	274	93
	AREA 09 (Not included)					Area 19/20	11	9,141	2,374	339	88
14	AREA 10	ENR				Area 18/21	10	11,220	2,973	416	110
14	AREA 11	Dredge and Partial Backfill/Partial RMC	2:1 Slopes All Around (12/5/22)			Area 22	9	15,711	4,071	582	151
14	AREA 12	Dredge and RMC	3:1 Slopes All Around (6/20/22)			Area 24/25A, 26	7	12,528	3,639	464	135
13	AREA 13	Dredge and Backfill	3:1 waterward, 2:1 from the Toe of Armored Slope into the Dredge Area (4/13/22)			Area 27	6, 5	16,700	4,390	619	163
13	AREA 13	ENR				Area 28	4	9,816	2,953	364	109
12	AREA 14	Dredge and Partial Backfill/Partial RMC	3:1 Slopes All Around (7/20/22)			Area 29	3	7,604	1,990	282	74
12	AREA 15/16	Dredge and Partial Backfill/Partial RMC	2:1 Shoreline Slope, 3:1 for the Rest (6/3/22)			Area 30, 31	2	9,384	3,446	348	128
12	AREA 17	Dredge and Partial Backfill/Partial RMC	3:1 Slopes All Around (6/3/22)			Area 32	1	6,205	1,822	230	67
10	AREA 18	Dredge and Backfill	2:1 Shoreline Slope, 3:1 for the Rest (12/7/22)			Area 33/34/35B	1	11,533	2,086	427	77
10	AREA 18	Amended Cover (Area Specific Technology-B)									
11	AREA 19/20	Dredge and Backfill	2:1 Slopes All Around (6/7/22)				Total	257,000	67,489	9,519	2,500
10	AREA 21	Dredge and Backfill	2:1 Slopes All Around (4/15/22)								
9	AREA 22	Dredge and Partial Backfill/Partial RMC	3:1 Slopes toward the FNC, 2:1 for the rest (12/9/22)								
8	AREA 23	ENR									
7	AREA 24/25 A	ENR									
7	AREA 24/25	Amended Cover (Area Specific Technology-B)									
7	AREA 24/25 B	Dredge and Backfill	2:1 Slopes All Around (12/8/22)								
7	AREA 26	Dredge and Backfill	2:1 Slopes All Around (12/8/22)								
7	AREA 26	Amended Cover (Area Specific Technology-B)									
6 (27A, partial 27B, partial 27C), 5 (partial 27B and partial 27C)	AREA 27	Dredge and Backfill/ Cap	2:1 Slopes All Around (6/21/22)	1,176	1,176						
5	AREA 27	ENR									
4	AREA 28	Dredge and Backfill	3:1 Slopes All Around (6/7/22)								
3	AREA 29	Dredge and Backfill	2:1 Slopes All Around (8/11/22)								
2	AREA 30	Dredge and Backfill	2:1 Slopes All Around (4/7/22)								
2	AREA 31	Dredge and Backfill	2:1 Slopes All Around (4/7/22)								
1	AREA 32	Dredge and Backfill	2:1 All Around, Ex Shoreline Toe of Slope (6/6/22)								
1	AREA 33/34/35 A	ENR									
1	AREA 33/34/35 B	Dredge and Backfill	2:1 Slopes All Around Ex Shoreline Toe of Slope (12/8/22)								

Gravelly Sand For Cap Chemical Isolation Layer (CY)	Light Riprap Erosion/Protection Layer (CY)
1,176	1,176

Attachment M-1.4
Detailed Quantities Notes

Notes:

1. ENR material assumed to be a medium-to- coarse grained sand, applied at a minimum 6-in thickness, with a 6-in maximum overplacement allowance intended in specific RAAs (as shown in the Intermediate Drawings [Appendix D]). ENR quantity assumes a placement footprint that includes a 10-foot buffer around the planned ENR placement area.
2. Total payable dredge volume includes: 1) required dredge volume (neatline), including associated external side-slope and transition (between RAAs) volumes, as shown on the Intermediate Drawings (Appendix D); and 2) 1-ft overdredge allowance on the entire dredge footprint. Includes required dredge and excavation volumes.
3. Backfill material assumed to be a gravelly sand material, intended to restore for habitat purposes sediment bed to pre-dredge elevations in specific RAAs, for areas above -10-ft MLLW (as shown in the Intermediate Drawings [Appendix D]). For 60% RD, the backfill volumes were assumed to be equal to the dredge volumes in the habitat areas and may be overestimated. The backfill design will be developed during Intermediate (60%) RD, as backfill volumes are dependent on the final dredge cut surface and may not exactly match the pre-dredge elevations due to equipment placement accuracy, and geotechnical
4. RMC material assumed to be a medium-to- coarse grained sand, applied at a minimum 6-in thickness, with a 6-in maximum overplacement allowance on the neatline surface area and at a minimum 1-ft, with 1-ft maximum overplacement allowance on the sideslope surface area, over 100% of the dredge area that does not receive backfill (including side slopes. The RMC quantity also includes an additional 20-ft inner and outer placement buffer surrounding the dredge area (at 6-in plus 6-in maximum overplacement allowance); the outer perimeter RMC consists of RMC placed within an assumed 25% of a 20-ft-wide perimeter outside of and surrounding the inner RMC perimeter.
5. Amended cover is assumed to be a blend of gravelly sand and granular activated carbon (GAC; 1% by weight), applied at a minimum 12-in thickness, with a 6-in maximum overplacement allowance intended in specific RAAs 18, 24, and 26 (as shown in the Intermediate Drawings [Appendix D]).
6. Only 25 % of the Outer Dredge Perimeter surface area is considered for RMC placement (as shown in the intermediate Drawings [Appendix D]).
7. Engineered cap includes: 1) isolation layer (conforming to sand material, with 12-in. minimum thickness and a 6-inch maximum overplacement allowance); 2) filter layer (conforming to gravel to cobble-sized material, with a 6-in. minimum thickness and a 6-inch maximum overplacement allowance), and 3) erosion protection layer (conforming to a light riprap, with a 12-in. minimum thickness and a 6-inch maximum overplacement allowance.
8. RAA 9 is not included in the Intermediate (60%) RD.

CY: cubic yard

ENR: enhanced natural recovery

FNC: Federal Navigation Channel

GAC: granular activated carbon

MLLW: mean lower low water

RAA: remedial action area

RD: remedial design

RMC: residuals management cover

SF: square foot

Attachment M-1.5
Production Rates and Durations

Summary Table

Item Description	Unit	Dredging/Excavation					Material Placement										
		Dredging (Open Water)	Dredging (Nearshore/Slope/ Slow Dredging)	Dredging (Restricted Access)	Contingency Re-Dredging	Excavation (Shoreline/Bank)	Sand for RMC/ENR (Open Water)	Sand for RMC/ENR (Nearshore)	Sand for RMC/ENR (Restricted Access)	Sand for RMC/ENR (Land-Based Equipment)	Gravelly Sand for Backfill (Open Water)	Gravelly Sand for Backfill (Nearshore)	Gravelly Sand for Backfill (Restricted Access)	Gravelly Sand for Backfill (Land-Based Equipment)	Gravelly Sand Blended with GAC for Amended Cover (Land-Based Equipment)	Gravelly Sand for Cap Chemical Isolation Layer (Land-Based Equipment)	Light Riprap for Cap Erosion/ Protection Layer (Land-Based Equipment)
Dredge Volume/Placement Volume	CY	64,374	11,458	1,670	10,071	19,892	17,971	3,342	934	2,896	17,662	10,460	35	17,566	264	1,176	1,176
Cycle Time	min	2.03	2.13	2.53	2.07	2.03	2.23	2.40	2.67	2.30	2.23	2.40	2.67	2.30	2.30	2.53	3.13
Daily Production Rate	CY/day	1,076	659	509	678	621	1,130	975	657	822	1,130	975	657	822	763	647	523
	CY/day (rounded)	1,100	700	500	700	600	1,100	1,000	700	800	1,100	1,000	700	800	800	600	500
Daily Cost per Unit Volume	\$/CY-day	\$26.16	\$42.69	\$55.32	\$41.49	\$41.63	\$19.57	\$22.68	\$33.64	\$26.91	\$19.57	\$22.68	\$33.64	\$28.65	\$28.98	\$34.15	\$42.25
No. Dredge/Placement Work Days	Days	60	18	3	15	33	16	4	2	4	16	11	1	21	1	2	3
No. Dredge/Placement Calendar Days	Days	70	21	4	17	39	19	5	2	5	18	13	1	25	1	2	4

Cycle Times

Item Description	Unit	Dredging/Excavation					Material Placement										
		Dredging (Open Water)	Dredging (Nearshore/Slope/ Slow Dredging)	Dredging (Restricted Access)	Contingency Re-Dredging	Excavation (Shoreline/Bank)	Sand for RMC/ENR (Open Water)	Sand for RMC/ENR (Nearshore)	Sand for RMC/ENR (Restricted Access)	Sand for RMC/ENR (Land-Based Equipment)	Gravelly Sand for Backfill (Open Water)	Gravelly Sand for Backfill (Nearshore)	Gravelly Sand for Backfill (Restricted Access)	Gravelly Sand for Backfill (Land-Based Equipment)	Gravelly Sand Blended with GAC for Amended Cover (Land-Based Equipment)	Gravelly Sand for Cap Chemical Isolation Layer (Land-Based Equipment)	Light Riprap for Cap Erosion/ Protection Layer (Land-Based Equipment)
Load Bucket	sec	22	24	30	24	22	20	22	22	20	20	22	22	20	20	28	32
Lift Load	sec	18	20	22	18	18	18	20	22	18	18	20	22	18	18	24	28
Swing Load	sec	16	16	22	16	16	20	20	22	20	20	20	22	20	16	20	
Lower Load	sec	16	18	18	16	18	20	22	24	22	20	22	24	22	18	24	
Dump/Place Load	sec	12	12	12	12	10	18	22	28	20	18	22	28	20	22	30	
Return Swing	sec	12	12	16	12	12	12	12	12	12	12	12	12	12	12	14	
Lower Bucket	sec	14	14	16	14	14	14	14	16	14	14	14	16	14	18	22	
Lost Time (accelerating, positioning, stepping ahead, weather, hydraulics, bucket change, shifting anchors/silt curtains)	sec	12	12	16	12	12	12	12	14	12	12	12	14	12	14	18	
Total Cycle Time	sec	122	128	152	124	122	134	144	160	138	134	144	160	138	138	152	188
	min	2.03	2.13	2.53	2.07	2.03	2.23	2.40	2.67	2.30	2.23	2.40	2.67	2.30	2.30	2.53	3.13

Daily Production Rate

Item Description	Unit	Dredging/Excavation					Material Placement										
		Dredging (Open Water)	Dredging (Nearshore/Slope/ Slow Dredging)	Dredging (Restricted Access)	Contingency Re-Dredging	Excavation (Shoreline/Bank)	Sand for RMC/ENR (Open Water)	Sand for RMC/ENR (Nearshore)	Sand for RMC/ENR (Restricted Access)	Sand for RMC/ENR (Land-Based Equipment)	Gravelly Sand for Backfill (Open Water)	Gravelly Sand for Backfill (Nearshore)	Gravelly Sand for Backfill (Restricted Access)	Gravelly Sand for Backfill (Land-Based Equipment)	Gravelly Sand Blended with GAC for Amended Cover (Land-Based Equipment)	Gravelly Sand for Cap Chemical Isolation Layer (Land-Based Equipment)	Light Riprap for Cap Erosion/ Protection Layer (Land-Based Equipment)
Cycle Time	min	2.03	2.13	2.53	2.07	2.03	2.23	2.40	2.67	2.30	2.23	2.40	2.67	2.30	2.30	2.53	3.13
Bucket Capacity	CY	8	6	6	6	5	8	8	6	6	8	8	6	6	6	6	6
Effective Bucket Capacity	%	70%	65%	65%	65%	70%	75%	75%	75%	75%	75%	75%	75%	75%	70%	70%	
	CY	5.6	3.9	3.9	3.9	3.5	6	6	4.5	4.5	6	6	4.5	4.5	4.2	4.2	
Shift Duration	hrs/day	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
No. of Shifts	No.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Work Days/Week	No.	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
Running Time Efficiency	%	65%	60%	55%	60%	60%	70%	65%	65%	70%	70%	65%	65%	70%	65%	65%	
Daily Production Rate (per Shift)	cy/day	1,076	659	509	678	621	1,130	975	657	822	1,130	975	657	822	763	647	523

Attachment M-1.5
Production Rates and Durations

Specific Durations

Item Description	Unit	Dredging/Excavation					Material Placement									Gravelly Sand Blended with GAC for Amended Cover (Land-Based Equipment)	Gravelly Sand for Cap Chemical Isolation Layer (Land-Based Equipment)	Light Riprap for Cap Erosion/ Protection Layer (Land-Based Equipment)
		Dredging (Open Water)	Dredging (Nearshore/ Slope/ Slow Dredging)	Dredging (Restricted Access)	Contingency Re-Dredging	Excavation (Shoreline/ Bank)	Sand for RMC/ENR (Open Water)	Sand for RMC/ENR (Nearshore)	Sand for RMC/ENR (Restricted Access)	Sand for RMC/ENR (Land-Based Equipment)	Gravelly Sand for Backfill (Open Water)	Gravelly Sand for Backfill (Nearshore)	Gravelly Sand for Backfill (Restricted Access)	Gravelly Sand for Backfill (Land-Based Equipment)				
Total Dredge Volume/Placement Volume	CY	64,374	11,458	1,670	10,071	19,892	17,971	3,342	934	2,896	17,662	10,460	35	17,566	264	1,176	1,176	
No. Dredge/Placement Work Days	Days	60	18	3	15	33	16	4	2	4	16	11	1	21	1	2	3	
No. Dredge/Placement Work Hours	hrs	598	180	33	148	330	159	40	20	40	156	107	10	214	10	20	30	
Total Dredge/Placement Duration (Work Days)	Days	129					81											
No. Dredge/Placement Calendar Days	Days	70	21	4	17	39	19	5	2	5	18	13	1	25	1	2	4	
Total Dredge/Placement Duration (Calendar Days)	Days	151					94											

Daily Unit Costs

Item Description	Unit	Dredging/Excavation					Material Placement									Gravelly Sand Blended with GAC for Amended Cover (Land-Based Equipment)	Gravelly Sand for Cap Chemical Isolation Layer (Land-Based Equipment)	Light Riprap for Cap Erosion/ Protection Layer (Land-Based Equipment)
		Dredging (Open Water)	Dredging (Nearshore/ Slope/ Slow Dredging)	Dredging (Restricted Access)	Contingency Re-Dredging	Excavation (Shoreline/ Bank)	Sand for RMC/ENR (Open Water)	Sand for RMC/ENR (Nearshore)	Sand for RMC/ENR (Restricted Access)	Sand for RMC/ENR (Land-Based Equipment)	Gravelly Sand for Backfill (Open Water)	Gravelly Sand for Backfill (Nearshore)	Gravelly Sand for Backfill (Restricted Access)	Gravelly Sand for Backfill (Land-Based Equipment)				
Dredge/Excavator	\$/day	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 5,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	\$ 7,000	
Tug (2 for dredging and 1 for material placement)	\$/day	\$ 4,000	\$ 4,000	\$ 4,000	\$ 4,000	\$ 4,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	
Barge (2 for dredging and 1 for material placement)	\$/day	\$ 4,000	\$ 4,000	\$ 4,000	\$ 4,000	\$ 4,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	\$ 2,000	
Work Boat	\$/day	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	\$ 600	
Front-end loader	\$/day	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	\$ 500	
Daily Subtotal Cost for Equipment	\$/day	\$ 16,100	\$ 16,100	\$ 16,100	\$ 16,100	\$ 14,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	\$ 12,100	
FOG (15%)	\$/day	\$ 2,415	\$ 2,415	\$ 2,415	\$ 2,415	\$ 2,115	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	\$ 1,815	
Daily Total Cost for Equipment	\$/day	\$ 18,515	\$ 18,515	\$ 18,515	\$ 18,515	\$ 16,215	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	\$ 13,915	
	\$/cy	\$ 17	\$ 28	\$ 36	\$ 27	\$ 26	\$ 12	\$ 14	\$ 21	\$ 17	\$ 12	\$ 14	\$ 21	\$ 17	\$ 18	\$ 21	\$ 27	
Superintendent	\$/day	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	
Operator Foreman	\$/day	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	
Dredge/Excavator Operator	\$/day	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	
Deck Hands for Dredge (assumed 3)	\$/day	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	\$ 1,950	
Tug Operator (2 for dredging and 1 for material placement)	\$/day	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 1,300	\$ 650	\$ 650	\$ 650	
Deck Hands for Tug (2 for dredging and 1 for material placement)	\$/day	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 650	\$ 1,300	\$ 650	\$ 650	\$ 650	
Front-loader Operator (assumed 2)	\$/day	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	\$ 1,300	
Health and Safety and Quality Assurance	\$/day	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	\$ 800	
Daily Subtotal Cost for Labor	\$/day	\$ 8,750	\$ 8,750	\$ 8,750	\$ 8,750	\$ 8,750	\$ 7,450	\$ 7,450	\$ 7,450	\$ 7,450	\$ 7,450	\$ 7,450	\$ 7,450	\$ 8,750	\$ 7,450	\$ 7,450	\$ 7,450	
Travel / Per Diem Allowance (10%)	\$/day	\$ 875	\$ 875	\$ 875	\$ 875	\$ 875	\$ 745	\$ 745	\$ 745	\$ 745	\$ 745	\$ 745	\$ 745	\$ 875	\$ 745	\$ 745	\$ 745	
Daily Total Cost for Labor	\$/day	\$ 9,625	\$ 9,625	\$ 9,625	\$ 9,625	\$ 9,625	\$ 8,195	\$ 8,195	\$ 8,195	\$ 8,195	\$ 8,195	\$ 8,195	\$ 8,195	\$ 9,625	\$ 8,195	\$ 8,195	\$ 8,195	
	\$/cy	\$ 9	\$ 15	\$ 19	\$ 14	\$ 16	\$ 7	\$ 8	\$ 12	\$ 10	\$ 7	\$ 8	\$ 12	\$ 12	\$ 11	\$ 13	\$ 16	
Daily Total Cost for Equipment and Labor	\$/day	\$ 28,140	\$ 28,140	\$ 28,140	\$ 28,140	\$ 25,840	\$ 22,110	\$ 22,110	\$ 22,110	\$ 22,110	\$ 22,110	\$ 22,110	\$ 22,110	\$ 23,540	\$ 22,110	\$ 22,110	\$ 22,110	
	\$/cy	\$ 26	\$ 43	\$ 55	\$ 41	\$ 42	\$ 20	\$ 23	\$ 34	\$ 27	\$ 20	\$ 23	\$ 34	\$ 29	\$ 29	\$ 34	\$ 42	

Attachment M-1.5
Production Rates and Durations

Project Quantities and Durations

Item Description	Totals
Dredge Volume (CY)	77,502
Contingency Re-Dredging Volume (CY)	10,071
Excavation Volume (CY)	19,892
Material Placement Volume (CY)	73,481
Total Dredge Duration (Work Days)	129
Total Material Placement Duration (Work Days)	81
Total Mob/Demob + Dredge/Material Placement Durations + Structural Work (Work Days)	280
Total Duration (Work Months)	9.2
Total Duration (Work Months) - Rounded	10.0
Total Dredge Duration (Calendar Days)	151
Total Material Placement Duration (Calendar Days)	94
Total Mob/Demob + Dredge/Material Placement Durations + Structural Work (Calendar Days)	327
Total Duration (Calendar Months)	10.7
Total Duration (Calendar Months) - Rounded	11.0

Notes:

- CY/day: cubic yard per day
- CY: cubic yard
- \$/CY-day: dollars per cubic yard per day
- ENR: enhanced natural recovery
- GAC: granular activated carbon
- hrs/day: hours per day
- min: minute
- RMC: residuals management cover
- sec: second
- SF: square foot

LDWG - Structures and Outfalls
Sediment Cleanup of Upper Reach of Lower Duwamish Waterway
 Probable Construction Cost Estimate
 60% Design - Phase 3, Revised February 14, 2023

Bid Item No.	Specs Section No.	Item	Quantity	Unit	Min Unit Cost	Max Unit Cost	Bracketed Avg Unit Cost ¹	Probable Unit Cost ²	Min Total Cost	Max Total Cost	Bracketed Avg Total Cost	Probable Total Cost ²	Duration (days)
SCHEDULE A - Structures													
OVER AND IN-WATER STRUCTURES													
Remove Timber Piles, Incl Dolphins and Groins													
		Remove Creosote Timber Piles (6 per day, Say 3 days total)	17	Ea	\$ 50.00	\$ 3,500.00	\$ 2,729.46	\$ 3,138.88	\$ 850	\$ 59,500	\$ 46,401	\$ 53,361	3
		Timber Pile Disposal (10" Dia Avg x 40ft @ 36pcf)	6.68	Ton	\$ 100.99	\$ 650.00	\$ 251.12	\$ 288.79	\$ 674	\$ 4,339	\$ 1,676	\$ 1,928	
		Sub Total							\$ 1,524	\$ 63,839	\$ 48,077	\$ 55,289	3
Remove Steel Pipe Piles													
		Remove Piles (2 per day, 2 days total)	3	Ea	\$ 1,670.00	\$ 3,017.86	\$ 2,343.93	\$ 2,695.52	\$ 5,010	\$ 9,054	\$ 7,032	\$ 8,087	2
		Pile Disposal (14"Dia x 0.5" Wall x 50ft)	4.33	Ton	\$ 100.99	\$ 650.00	\$ 251.12	\$ 288.79	\$ 437	\$ 2,814	\$ 1,087	\$ 1,250	
		Sub Total							\$ 5,447	\$ 11,868	\$ 8,119	\$ 9,337	2
Replace Steel Pipe Piles and Timber Piles with Steel Pipe Piles													
		New Coated Steel Pipe Piles - Material and Driving (4 per day)	6	Ea	\$ 5,500.00	\$ 13,712.67	\$ 11,062.56	\$ 12,721.94	\$ 33,000	\$ 82,276	\$ 66,375	\$ 76,332	2
		Sub Total							\$ 33,000	\$ 82,276	\$ 66,375	\$ 76,332	2
Limit Load and Temporary Support/Shoring of Existing Bulkheads													
		Upland Excavation (480ft Long x 10ft Wide x 4ft Deep, 20ft per day)	1	LS	\$ 30,000.00	\$ 30,000.00	\$ 30,000.00	\$ 34,500.00	\$ 30,000	\$ 30,000	\$ 30,000	\$ 34,500	24
		Ground Restoration (100ft per day)	1	LS	\$ 50,000.00	\$ 50,000.00	\$ 50,000.00	\$ 57,500.00	\$ 50,000	\$ 50,000	\$ 50,000	\$ 57,500	5
		Install Temporary Tieback of Bulkheads (Tieback @8ft Centers, 4 tiebacks per day), Incl Walers and de-stressing	480	LF	\$ 610.00	\$ 677.50	\$ 643.75	\$ 740.31	\$ 292,800	\$ 325,200	\$ 309,000	\$ 355,349	16
		Sub Total							\$ 372,800	\$ 405,200	\$ 389,000	\$ 447,349	45
Temporary Relocation of Floats													
		Removal, Storage, Reinstallation and Minor Repairs - 3 Floats (15 days total)	1	LS	\$ 200,000.00	\$ 200,000.00	\$ 200,000.00	\$ 230,000.00	\$ 200,000	\$ 200,000	\$ 200,000	\$ 230,000	15
		Sub Total							\$ 200,000	\$ 200,000	\$ 200,000	\$ 230,000	15
		Total							\$ 612,774	\$ 763,183	\$ 711,572	\$ 818,306	67
SCHEDULE B - Outfalls													
Pipe Protection and Bank Protection, Incl Apron													
		Pipe Protection (2 days total)	7	EA	\$ 5,000.00	\$ 5,000.00	\$ 5,000.00	\$ 5,750.00	\$ 35,000	\$ 35,000	\$ 35,000	\$ 40,250	4
		Energy Dissipator/Apron/Bank Protection (3 days Ea)	4	EA	\$ 60,000.00	\$ 60,000.00	\$ 60,000.00	\$ 69,000.00	\$ 240,000	\$ 240,000	\$ 240,000	\$ 276,000	12
		Sub Total							\$ 275,000	\$ 275,000	\$ 275,000	\$ 316,250	16
		Total							\$ 275,000	\$ 275,000	\$ 275,000	\$ 316,250	16

SUB TOTAL	\$	1,134,556
50% Contingency	\$	567,278
TOTAL	\$	1,701,834
		83

¹ Bracketed Average is calculated average with outliers omitted.

² Probable Cost is Bracketed Average plus 15% bump.

Structures (ST) - Bulheads, Single Pile Fields, Guide Piles, Dolphins and Bridge Work Inventory
(See 60% Structural Drawings and Structural Decision Table in BODR for Quantities Indicated)

Structure ID	RAA	RM	Riverbank Stationing				LF	Adjacent Property Owner	Description	# Piles			Creosote Dolphin Removal	Dolphin Replacement w/ Steel Piles	Cleat Replacement	Stub Pile Bulkhead Removal	Bulkhead Replacement w/ Steel Sheet Piles, SF (Exposed)	Bulkhead Shoring or Support, LF	Comments
			Start STA	End STA						Creosote Single/Groin Piles Removal	Steel Piles Removal	Steel Pile Replacement							
ST02	8	3.3					South Park Bridge	Fenders											
	9	3.3						Bascule Pier											
	10	3.3						South Abutment											
ST03		3.5	284	10	289	70	560	Star Forge (Jorgensen Forge)											
		3.7	289	70	291	60	190	Star Forge (Jorgensen Forge)	Bulkhead - New Sheet Piles										
		3.7	291	60	294	80	320	Boeing (Boeing Vacant Land)	Bulkhead - H-Piles							0			Assumed per total LF, Piles @ 8ft oc & 15ft tall walls
		3.7	294	80	295	40	60	Boeing (Thompson Site)	Bulkhead - H-Piles										
	18C	3.7	295	40	295	90	50	Boeing (Thompson Site)	Bulkhead - H-Piles							0	50		Assumed per total LF, Piles @ 8ft oc & 15ft tall walls
	18C, D and E	3.8	295	90	298	00	210	Boeing (Thompson Site)	Bulkhead - Newer Sheet Piles							0	210		Assumed per total LF, 15ft tall walls
		3.8	298	00	301	50	350	Boeing (Thompson Site)	Bulkhead - Stub Piles						0	0			Assume stub piles @18" oc, 15ft long. 5ft exposed
	22	3.9	301	50	302	90	140	Centerpoint Properties	Bulkhead - Older Sheet Piles							0	140		Assumed per total LF, 15ft tall walls
	24/25B	3.9					80	Centerpoint Properties	Bulkhead - Older Sheet Piles							0	80		Assumed per total LF, 15ft tall walls
		3.9	0	0	306	20	306 20	Centerpoint Properties	Bulkhead - Older Sheet Piles							0	0		Assumed per total LF, 15ft tall walls
ST04	27A, 27B, 27C	4.0-4.1	309	60	315	80	620	Container Properties, LLC	Piles (Delapidated Dock)	1		1	7						Replaced. Assumed it is a fishing Pole
	27							Dolphins											
ST07	29	4.6	361	70	362	90	120	Boeing Developmental Center	Wharf										
ST07	32	4.8	371	20	371	40	20	Boeing Developmental Center	Groin	0		0							Not to be removed
ST07	33	4.8	371	60	372	00	40	Boeing Developmental Center	Groin?										
ST07	34	4.8	372	40	373	00	60	Boeing Developmental Center	Groin	0		0							Not to be removed
ST10	30	4.7	410	70	410	90	20	Port of Seattle	Piles	7									Demolish Piles, not replaced
ST20	13	3.5	492	20	492	60	40	South Park Marina	Guide Piles	2	3	5							
								Totals		10	3	6	7	0	0	0	0	480	

#P235 Sheets: 187

