Section 10.0: Feasibility Study Introduction

- Based on the information gathered and evaluated in the RI, the remainder of the document comprises the FS, and includes introduction, evaluation, and selection of remedial actions to address contamination in the Sediment Cleanup Unit (SCU).
- Remedial Action Objectives (RAOs) clearly state what the remedy must achieve to accomplish project goals. The RAOs for the remedy include the following:
  - Achieve sediment cleanup levels protective of benthic toxicity and bioaccumulative risks to human health within an accepted restoration timeframe throughout the SCU.
  - Identify potential contaminant migration pathways for further consideration by Ecology to prevent sediment recontamination at levels of concern relative to sediment cleanup levels.
  - Develop a cleanup remedy that does not measurably impact operations and navigational uses within the working Port Angeles Harbor during construction, or in the long-term.
  - Balance the overall environmental benefit of reducing chemical concentrations in surface sediments with the potential for impact to cultural resources and/or the existing benthic community resulting from remedy implementation.
- Applicable or Relevant and Appropriate Requirements are all potentially applicable federal, state, and local laws that may apply to the proposed cleanup remedy. Although state-led remedial actions are exempt from procedural requirements of certain state and local laws and related permitting requirements, pertinent substantive compliance requirements remain applicable.

10.0 Feasibility Study Introduction

10.1 FEASIBILITY STUDY PURPOSE AND EVALUATION PROCESS

The purpose of this FS is to evaluate alternative cleanup actions that protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through exposure pathways and migration routes present within the SCU. The RI sections of this report have identified the exposure pathways and migration routes, and cleanup standards to be met (which include SCLs and points of compliance). Building off of these evaluations, the FS sections identify remedial objectives (Section 10.0) and divide the SCU into SMAs with similar physical and chemical characteristics (Section 11.0). Potential remedial technologies are then screened, developed, and combined into remedial alternatives (Section 12.0). Remedial alternatives are evaluated in this FS (Sections 13.0 and 14.0), and the proposed preferred cleanup remedy is identified and described (Section 15.0). This evaluation process identifies a preferred cleanup remedy that is permanent to the maximum extent practicable in accordance with WAC 173-204-570 and WAC 173-340-360(3).

10.2 REMEDIAL ACTION OBJECTIVES

RAOs define the objectives that must be met by the remedy to ensure attainment of project goals. RAOs are clear statements of what the remedy needs to accomplish in order to address concerns defined in the CSM. The RAOs for the cleanup action include the following:

- Achieve SCLs protective of benthic toxicity and bioaccumulative risks to human health within an accepted restoration timeframe throughout the SCU.
- Identify potential contaminant migration pathways for further consideration by Ecology to prevent sediment recontamination at levels of concern relative to SCLs (refer to Appendix E).
- Develop a cleanup remedy that does not measurably impact operations and navigational uses within the working Harbor during construction, or in the long-term.
- Balance the overall environmental benefit of reducing chemical concentrations in surface sediments with the potential for impact to cultural resources and/or the existing benthic community resulting from remedy implementation.

10.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

MTCA and SMS provide the primary basis for evaluating and implementing remedial alternatives at the SCU and require that sediment cleanup actions comply with all applicable laws. However, WAC 173-340-710 provides an exemption for those procedural requirements of many ARARs related to the on-site remedial actions. This exemption waives the responsibility to obtain such environmental permits, but does not provide relief from the need to perform the work in a manner that satisfies the substantive requirements of those ARARs. In addition to the RAOs discussed in Section 10.2, the remedial action will be designed to ensure substantive compliance with requirements of ARARs related to on-site remedial actions. Refer to Section 15.2 for an evaluation of the selected remedy against ARARs, and the determination of substantive compliance. As stated in Section 15.2, the selected remedy will continue to be reviewed for substantive compliance with ARARs as the design develops.

Section 11.0: Identification of Sediment Management Areas, Remedial Action Levels, and Remediation Areas

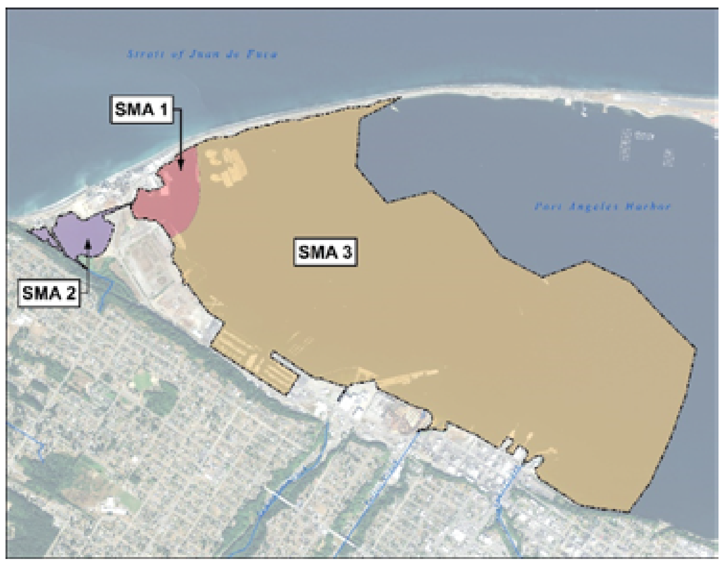
- As described in the Sediment Cleanup User's Manual, larger sites such as Western Port Angeles Harbor can be subdivided into smaller areas for evaluation and selection of remedies. The Sediment Cleanup Unit (SCU) has been divided into three such Sediment Management Areas (SMAs) based primarily on potential risks to human and benthic health within the SMA, relative bioavailability of hydrophobic organic compounds, access and operational considerations, and presence of intertidal areas identified by Ecology.
- Remedial Action Levels (RALs) have been developed that identify the chemical concentration that must be addressed, or cleaned up, to result in achievement of the cleanup standards within the associated restoration timeframe. Restoration timeframes of 0, 10, and 25 years post-construction were determined appropriate for evaluation.
- Remediation areas are areas within the SMAs where active remedial actions are implemented to clean up sediments with chemical concentrations greater than the RALs. Areas where active remedial technologies cannot be implemented effectively, such as thriving salt marsh habitats, beneath pier structures, and within active operational terminals, are considered as part of the remediation area determination.
- SMA 1 is a 37-acre area of the inner harbor with approximately 33 acres of remediation areas; SMA 2 is an approximately 25-acre area within the lagoon, with approximately 24 acres of remediation areas; and SMA 3 is the remaining approximately 1,100-acre area of the SCU, with active remediation areas that vary from 41 to 250 acres with various restoration timeframes.

11.0 Identification of Sediment Management Areas, Remedial Action Levels, and Remediation Areas

As described in SCUM II, larger complex sites may be subdivided into smaller areas, or SMAs, for technology screening and alternatives evaluation (Ecology 2017d). SMAs are defined by a number of factors such as physical, chemical, and biological conditions; potential risks to human health and the environment; accessibility; and site use. The SCU has been sub-divided into three such SMAs to target remedial technologies to those areas where they are most applicable (Section 11.1), and, when combined, will be effective in achieving SCU-wide SCLs and RAOs. Following the development of SMAs, remediation areas were developed to achieve SCLs (Table 8.6) within several restoration timeframes (Section 11.2.2). These SMAs and remediation footprints form the basis for the technology screening and alternative development in subsequent sections of this FS.

11.1 SEDIMENT MANAGEMENT AREA DELINEATION

This section describes the factors considered for SMA delineation, consistent with those presented in the SCUM II guidance. SMA delineation considered the following primary factors:



- Potential Risks to Human Health, Including Intertidal Exposure Areas As Identified by Ecology
- Relative Bioavailability of Hydrophobic Organic Compounds
- Potential Risks to Benthic Health
- Access and Operational Considerations

As presented in Figure 11.1 and the inset figure, the SCU was divided into three SMAs: SMA 1 in the inner harbor, SMA 2 in the lagoon, and SMA 3 covering the remaining waterfront and outer harbor.

11.1.1 Sediment Management Area 1: Inner Harbor

SMA 1 is located in the inner harbor, and is an approximately 37-acre area (Figure 11.1). Relative to other areas of the SCU, SMA 1 encompasses the area with the greatest potential human health and environmental risk. Remedial actions in the SMA will be constrained by multiple industrial overwater operations and existing structures. The contaminant characteristics in the inner harbor include the following:

- Surface sediment concentrations of Total TEQ greater than 70 ng/kg (Figure 7.36). This concentration was selected for SMA 1 delineation based on best professional judgement, encompassing the area of greatest Total TEQ concentrations within the SCU. The 70-ng/kg Total TEQ value corresponds to the 90/90 UTL of the SCU dataset (the value below which 90 percent of the data from within the SCU are expected to fall, with 90 percent confidence). Based on bioaccumulation and porewater measurements (Figure 7.38 and Section 7.4), surface sediment Total TEQ concentrations in SMA 1 are also relatively bioavailable.
- Surface sediment concentrations of mercury greater than 1.5 mg/kg (Figure 7.28). Like Total TEQ, this concentration was selected based on best professional judgement to encompass the areas of greatest concentrations within the SCU, and generally corresponds to the 90/90 UTL of the SCU dataset.
- Surface sediment concentrations of cPAH TEQ elevated compared to the rest of the SCU, with an average cPAH TEQ concentration in SMA 1 of 248 µg/kg, more than 2 times the average concentration of the SCU (surface sediment concentrations of cPAH TEQ measured in the SCU are shown on Figure 7.35).
- Benthic toxicity SCO exceedances collocated with chemical exceedances of benthic IHSs in several locations (Figure 8.4 and Figure 11.2).

The following access and operational considerations were also used to delineate SMA 1:

- SMA 1 includes the inner harbor intertidal area, as shown in Figure 8.2.
- SMA 1 is accessible from the Harbor by marine construction equipment. The inner harbor intertidal area is assumed to be accessible by upland equipment from the shoreline, but would require access agreements for private property entry.
- The eastern edge of the SMA 1 boundary was limited to approximately -50 feet MLLW, which is the water depth at which most regional marine equipment can effectively and safely operate (Section 12.1.2).
- Based on radioisotope and SPI profile interpretations along with hydrodynamic evaluations, part of SMA 1 has the potential for mixing of surface and subsurface sediments from propeller wash and other higher energy forces (Figure 2.3).
- Existing overwater structures (Figure 3.9).
- Operating terminals and berths (Figure 3.9).

- Buried wood debris (including logs) is present throughout SMA 1 (Figures 7.3a through 7.3d), and at substantial depths (e.g., over 12 feet below mudline).

11.1.2 Sediment Management Area 2: Lagoon

SMA 2 is an approximately 25-acre area within the lagoon. Relative to SMA 1, SMA 2 has lower potential human health and environmental risks. The lagoon is connected to the inner harbor by the narrow lagoon channel and has large intertidal areas. Remedial actions in the SMA will be constrained by its physical configuration and adjacent industrial operations. The contaminant characteristics in the lagoon include the following:

- Similar to SMA 1, SMA 2 has elevated surface sediment concentrations of Total TEQ compared to SMA 3 (Figure 7.36), with an average Total TEQ concentration of 55 ng/kg. However, in contrast to SMA 1, SMA 2 contains relatively non-bioavailable Total TEQ concentrations in sediment based on bioaccumulation and porewater measurements (Figure 7.38 and Section 7.4).
- Within SMA 2, the average surface sediment concentration of mercury is 0.48 mg/kg, approximately double the average concentration throughout the SCU of 0.25 mg/kg.
- Average surface sediment concentrations of cPAH TEQ within SMA 2 are 164 µg/kg, compared to the average concentrations throughout the SCU of 109 µg/kg (refer to Figure 7.35 for surface sediment concentrations of cPAH TEQ measured in the SCU).
- In contrast to SMA 1, where bioassay testing was conducted, no sediment toxicity greater than SCO biological criteria were measured (Figures 8.4 and 11.2).

The following access and operational considerations characterize SMA 2:

- SMA 2 is located on private property and access is restricted by signage. SMA 2 is characterized by access constraints as this area is not accessible by water for marine equipment and the developed shoreline of the McKinley Paper Company also limits potential shoreline construction options. Upland access to the lagoon intertidal area (specifically on the northern and western shorelines of the lagoon) for remedy construction is further limited due to expected interference with upland industrial operations during remedy construction.
- SMA 2 includes the lagoon intertidal area as shown in Figure 8.2.

- The lagoon channel connecting the lagoon to the inner harbor is a higher energy environment due to tidal currents that do not allow sediment deposition. Other areas of the lagoon have more stable sediments that are primarily affected by wind/wave forces (Figure 2.3).
- Buried wood debris (including logs) is present in SMA 2 to an estimated depth of 4 feet based on surface conditions and sediment core observations of wood debris (Exponent 2008).
- An established eelgrass meadow is present in the subtidal area in the northeastern corner of the lagoon (Figure 11.3).
- An established and assumed high-value salt marsh is present at the far western corner of the lagoon (Figure 11.3).
- An elevated water main runs along the southwestern edge of the lagoon (Figure 11.3), which would need to be avoided to maintain integrity of the infrastructure.

11.1.3 Sediment Management Area 3: Waterfront and Outer Harbor

SMA 3 encompasses the remaining area of the SCU, and is an approximately 1,100-acre area that spans the industrial/commercial waterfront of Port Angeles as well as the outer harbor of the SCU. Compared to SMA 1 and SMA 2, SMA 3 has the lowest potential human health and environmental risk. Remedial actions in the SMA will be constrained primarily by extensive low-level contaminant concentrations within the SMA and deeper water depths. The contaminant characteristics of SMA 3 include the following:

- In contrast to SMAs 1 and 2, SMA 3 contains relatively diffuse, lower-level Total TEQ, cPAH TEQ, and mercury concentrations. The average Total TEQ concentration in SMA 3 is 11.2 ng/kg, which is slightly more than 2 times the SCL. The average cPAH TEQ concentration in SMA 3 is 104 µg/kg, less than 2 times the SCL. The average mercury concentration in surface sediment in SMA 3 is 0.21 mg/kg, less than 2 times greater than the SCL. (Figures 7.28, 7.35, and 7.36, and Section 11.2).
- SMA 3 contains a limited area of sediment toxicity data greater than SCO biological criteria as measured in bioassays that are attributable to hazardous substances (Figure 11.2).
- Based on radioisotope and SPI profiles, sediments in most of SMA 3 are stable.

The following access and operational considerations characterize SMA 3:

- SMA 3 encompasses approximately 1,100 acres. Application of active remedy throughout this area is not required, given current average surface sediment concentrations across the area.
- Active marine operations, including structures and berths, are present along the shoreline.

- Much of the subtidal area is characterized by water depths greater than -50 feet MLLW.
- No lagoon or inner harbor intertidal areas are located within SMA 3 (Figure 8.2 and Figure 11.3).

11.2 DETERMINATION OF REMEDIAL ACTION LEVELS AND REMEDIATION AREAS

Remedial Action Levels (RALs) are concentrations of contaminants or other metrics that define when active remedial technologies (e.g., removal, capping) should be applied in order to meet RAOs. RALs are often quantitative, but may also be qualitative and consider multiple lines-of-evidence. In most cases, RALs are established at concentrations greater than SCLs.

The SCLs presented in Table 8.6 represent the concentrations that need to be met at the appropriate points of compliance to comply with SMS regulations. To be protective, the bioaccumulative IHSs need to be met as a SWAC in sediment, because the concentrations are developed based on area-wide exposures. Therefore, a "hill-topping" procedure was employed; the hill-topping concept is to remove areas of higher concentrations (reflecting what happens after a remedial action occurs) in order to reduce the re-calculated SWAC. Hill-topping is used to determine a point-based concentration (i.e., RAL) that, upon applying remedial technologies, will result in meeting the intended post-construction SWAC throughout the SCU. RALs were also developed for IHSs in the intertidal areas because compliance with SCLs is considered separately in those areas.[18] To achieve compliance with the SCLs over a reasonable restoration timeframe, active remedial technologies do not require implementation across the entire SCU.

For the SCU, the Remediation Areas were determined using the following steps:

1. **Identify no action areas.** These are areas that will not be actively remediated due to constructability constraints, location outside the SCU exposure areas discussed in Section 8.0 or lack of contribution to area-wide risks. These are identified first, so that the RALs are developed to meet the SCLs without applying active remediation technologies in these areas.
2. **Identify restoration timeframes.** This FS develops alternative RALs to meet SCLs immediately following construction (year 0), 10 years following construction (year 10), and 25 years following construction (year 25).
3. **Calculate the Recovery SWAC Targets.** These are the calculated SCU-wide SWACs that will be necessary to meet immediately following construction to result in achievement of the SCLs after the associated restoration timeframe. These calculations include the projection of natural recovery processes throughout the SCU since data collection occurred (refer to Section 2.1.5 for natural recovery process discussion).

18 For the purposes of this FS, the full extent of the lagoon intertidal area and inner harbor intertidal area depicted on Figure 8.2 is assumed to require remedial action to achieve compliance with SCLs. The extent of intertidal areas requiring remedial actions to achieve compliance with SCLs will be refined during remedial design.

4. **Calculate RALs and delineate remediation areas.** This is the point-based concentration that must be met to achieve the Recovery SWAC Targets. If locations with concentrations of IHSs greater than the RAL (excluding the no action areas identified under step 1) are remediated, then the SCU is predicted to comply with SCLs in the specified restoration timeframe.
5. **Confirm benthic health protection.** Unlike the bioaccumulative IHSs, the benthic health IHSs must comply with SCLs on a point-by-point basis, rather than an area-wide average. For the SCU, the remediation footprints developed for the bioaccumulative IHSs were compared to the extents of benthic IHS exceedances to verify that all benthic IHS exceedances were incorporated into the remediation areas delineated for the bioaccumulative IHSs. In some locations, benthic IHS exceedances are located within a terminal berth, or other areas that would otherwise be identified as a no action area per step 1 (described further in Section 11.2.1.1). During remedial design, potential bioassay toxicity areas will be re-sampled. If remedial design data confirm benthic toxicity in these areas, the remedy will be refined as necessary to achieve benthic SCLs, irrespective of location (inside or outside of a no action area or remediation area). For the purposes of this FS, the extents of no action areas are adjusted to allow for remedy application in all areas with bioassay toxicity.

Additional detail on these steps is presented in the following sections, and a summary of calculated Recovery SWAC Targets and RALs for the various restoration timeframes for the entire SCU and the intertidal areas are provided in Table 11.1.

11.2.1 No Action Areas

The SCU contains numerous nearshore and overwater structures, Port and private industrial operational areas (e.g., berthing areas) and valuable habitat areas that, if remediated, would not materially improve the protectiveness of the remedy, but would result in encumbrances to long term development activities, compromises to structure integrity, or destruction of valuable habitat. The following sections delineate the areas that are excluded from application of active remedy as part of the alternatives development. These no action areas are delineated prior to the RAL development to ensure that the cleanup standards can be met without remediating these areas. Due to relatively low concentrations of bioaccumulative IHSs in sediment, and the low contribution to overall site risk, remediation of these areas is not required to achieve SWAC-based cleanup standards, as remediation can be applied in other lower-contribution risk areas that are more accessible to achieve cleanup standards throughout the SCU.

11.2.1.1 Overwater Structures and Offsets

Sediment below overwater structures is challenging to remediate due to limited access for marine equipment, the structural integrity of structures (particularly older structures), the potential presence of debris, structural fill (e.g., riprap), steep slopes, and ongoing site use. Due to these challenges, and for the purposes of this FS, it is assumed that remedial actions will not be conducted beneath or immediately adjacent to overwater structures. An offset of 50 feet from structures has been assumed as a safe distance for protection of overwater structures. Along the Harbor waterfront, there are a variety of structures that have been constructed at different times and for different purposes (Figure 3.9). However, based on the distribution of contaminants within the SCU, the sediments below the majority of structures within the SCU are not major contributors to site risk, as the majority of structures in the SCU are located outside of the greatest concentration areas in SMA 1 (Figure 11.3). Those structures located within SMA 1 are limited in extent (Figure 11.3). Offsets will be refined during remedial design on a structure-by-structure basis to minimize the extent of offset required for structural protection to the greatest degree practicable. Data collection in offset areas will also be conducted during remedial design. To address marginally contaminated sediments that may remain in areas of structural offsets within the SCU, bioaccumulation risks can be reduced to achieve cleanup standards by remediating more accessible open-water areas. Locations with bioassay failures within an offset area are assumed in this FS to require application of remedy and will be re-sampled during remedial design, as described above. If remedial design data confirm benthic toxicity in these areas, the remedy will be refined as necessary to achieve benthic SCLs, even within an offset area.

In addition, for structural protection of overwater structures, remedial actions often have offsets to ensure that destabilization of sediments supporting the structure foundations does not occur. Given the age of the majority of the structures in the Harbor, a preliminary FS offset (or set-back) of approximately 50 feet was applied to all existing overwater structures within the SCU. Specific offsets will be evaluated and refined on a structure-by-structure basis during remedial design.

Future construction activities may occur on or around these structures as determined by development or maintenance needs. All in-water construction activities will require permits (including Ecology notification) and will need to meet anti-degradation requirements so that sediment quality will not be impaired as part of any future construction.

11.2.1.2 Active Operational Areas with Low-Level Contamination

Marine operational areas (e.g., terminals, marina, log rafting and storage areas, and wharfs; Figure 3.9) are also challenging to remediate due to active site use and proximity to structures. Furthermore, water depth requirements for navigation can limit remedial technology options, and some technology options (e.g., capping or EMNR) can result in long-term encumbrances to operational area use and development. For this reason, the City, Port, and private terminal operators were consulted to confirm the current and anticipated future use and depth requirements for the existing operational areas in the SCU. This evaluation determined that all current operational areas are anticipated to remain in industrial or commercial use for the foreseeable future.

To identify operational areas with relatively low contribution to site risks, an evaluation was conducted to determine the average current contaminant concentrations in each operational area. This evaluation determined that existing average sediment concentrations within all the SCU operational areas were only marginally greater than the lowest RALs (Section 11.2.4), ranging up to about 2 times the RALs. The exceptions were the terminals located in SMA 1 and the Port's log rafting area off of Ediz Hook, which had concentrations that exceeded 2 times the lowest RALs. These berthing areas, excluding the offsets described in Section 11.2.1.1, were included in the remediation footprint. As discussed above, structure offsets will be evaluated and refined on a structure-by-structure basis during remedial design.

Similar to overwater structures, future construction activities (e.g., maintenance dredging) may occur in these areas as determined by development or maintenance needs. All construction activities will require permits for in-water work, and will need to meet anti-degradation requirements so that sediment quality is not impaired as a result of future dredging. It is common for dredging projects to require the placement of 6 inches of sand, similar to EMNR, to mitigate for potential impacts that result from dredging. Therefore, protectiveness will be maintained in no action areas through existing procedures.

11.2.1.3 Intertidal Areas of SMA 3

As discussed in Sections 11.1.1 and 11.1.2, the inner harbor intertidal area and the lagoon intertidal area (Figure 8.2) were incorporated into SMAs 1 and 2, respectively, and will be part of the remediation areas. However, the remaining intertidal areas (Figure 8.2) located within SMA 3 were designated as no action areas based on interpolated contaminant concentrations and constructability considerations.

Compared to the intertidal areas of SMAs 1 and 2, the SMA 3 intertidal areas have lower concentrations and, therefore, contribute less to site risk (Figure 8.2). In addition, the estimated concentrations in intertidal areas are based primarily on interpolated concentrations from subtidal samples. Because wind/wave energy moves fine sediment (where contaminants are commonly detected) from intertidal areas into subtidal areas, the concentrations in intertidal areas are expected to be less than those estimated by extrapolation. In addition, the remedial technology options are more limited in intertidal areas because of higher wind/wave energy compared to subtidal areas (requiring cap or EMNR armoring), and the potential need to conserve elevation for habitat mitigation. Finally, the intertidal areas of SMA 3 will be difficult to access with marine equipment (due to shallow water depth) that will likely be used for most of SMA 3 remediation, and upland access is complicated by the active industrial nature of the waterfront, variation in shoreline conditions, and presence of bulkheads and riprap slopes along a significant portion of the SMA.

11.2.1.4 Existing Habitat and Biological Resources

Certain habitats and biological resources such as eelgrass beds, salt marsh habitats, and rocky bottom habitats may be very slow to recover following an active cleanup method like dredging or capping, or may not be completely restorable at all. In areas of established and thriving habitat, the adverse environmental impacts of cleanup may outweigh the environmental benefits. Few of these areas currently exist in the western portion of the Harbor; however, an established and thriving salt marsh habitat is located in the far western corner of SMA 2 and is designated as a no action area (Figure 11.3). A thriving eelgrass bed is located in the subtidal portion of SMA 2. While the potential destruction of this habitat feature is considered as part of the alternatives comparison, it is not designated as no action, because thin-layer sand placement may be executed without destroying the bed.

11.2.1.5 Lagoon Channel

The lagoon channel can generate relatively high velocity currents during peak ebb and flood tidal flows, which prevents deposition of fine sediment where contaminants are commonly detected. For this reason, the lagoon channel is unlikely to have contaminated sediment concentrations equivalent to those interpolated from nearby sample locations. In addition, the lagoon channel remedial technologies are limited due to high tidal velocities, structural constraints, and access constraints. For these reasons, the lagoon channel is designated as a no action area.

11.2.2 Restoration Timeframe Goals

Because of relatively higher sediment concentrations, active remediation is required throughout SMAs 1 and 2 for all evaluated restoration timeframes. Given this, SMA 1 and SMA 2 alternatives result in a sediment surface that achieves RALs immediately after construction (i.e., Year 0). Because of this, remedy selections for SMA 1 and SMA 2 do not affect the restoration timeframe for the SCU, which is determined by the remedy selected for SMA 3. For SMA 3, the three restoration timeframe goals considered result in three varying remediation footprints. The 0-year restoration timeframe was developed to meet the cleanup standards throughout the SCU immediately following construction, and therefore has the lowest RALs and the largest remediation footprint. The 10-year restoration timeframe has higher RALs and a smaller remediation footprint, and the 25-year restoration timeframe has the highest RALs and the smallest remediation footprint (Table 11.1). For the evaluation of restoration timeframes, natural recovery processes are assumed to have occurred since data collection and are projected to continue in the future, as described in Sections 2.1.5 and 11.2.3.

These three restoration timeframes were selected for the SCU to provide a reasonable range of remedial alternatives and for consistency with other sediment remediation sites. The 0-year restoration timeframe provides the most certainty of achieving the cleanup standards; the 10-year restoration timeframe is generally considered to be a reasonable restoration timeframe under SMS; and the 25-year restoration timeframe is a longer restoration timeframe for comparison. Under SMS, restoration timeframes longer than 10 years would require the designation of a Sediment Recovery Zone (SRZ), which includes additional administrative and monitoring requirements. Discussion of SRZs with longer restoration timeframe alternatives is included in Sections 13.0 and 14.0.

11.2.3 Recovery SWAC Targets

As noted in Section 11.2.2, the remediation footprints vary for each restoration timeframe and, to determine those footprints, the SWAC concentration that must be met following construction is calculated. This concentration is back-calculated based on the estimated recovery rate in the SCU, and the timeframe identified for achieving cleanup standards. In other words, the SWACs immediately following completion of remedial construction will be reduced over time through natural recovery processes in areas of the SCU where active remediation is not conducted, resulting in achievement of cleanup standards in the specified timeframe. These post-construction SCU-wide SWACs are referred to as “Recovery SWAC Targets” (Table 11.1). Recovery SWAC Targets were calculated using a simple surface sediment (top 10 cm) mixing model (SEDCAM), based on average RI surface sample concentrations collected over the past 10 years (average sampling date is 2011), along with the measured Harbor sedimentation rate of 0.17 cm per year. The SEDCAM model, parameters, and assumptions are presented in detail in Appendix A (NewFields 2016). These calculations also assumed sediment deposited during the recovery period has IHS concentrations consistent with watershed loading inputs (Appendix B). Recovery SWAC Targets were calculated incorporating recovery from the average time of RI sampling (2011), until the start of implementation of the remedy (2022). Note that the longer the restoration timeframe, the larger the uncertainty in the natural recovery predictions, because the impact of natural recovery parameter assumptions compounds over time.

11.2.4 Remedial Action Level Determination

Once the Recovery SWAC Target values were determined for different restoration timeframes, an analysis was conducted to identify the concentration of each IHS requiring active remediation to result in achievement of the Recovery SWAC Target following construction, defined as the RAL.

This was done by “hilltopping,” or sequentially replacing sampling data with the greatest chemical concentrations from the dataset (excluding data from the no action areas) with a concentration representative of post-remedial action conditions. For this evaluation, natural background concentrations were used as the replacement values (Ecology 2013b).[19] This process was sequentially repeated until the average of the dataset (including both “replaced” values representing actively remediated areas and original values in all other areas throughout the entire SCU) was equal to or less than the Recovery SWAC Target. The last concentration value that required replacing to achieve the Recovery SWAC Target is the RAL for that chemical. If the existing SCU SWAC is already less than the Recovery SWAC Target, then no RAL is necessary to meet the SCL.

The RALs associated with each evaluated restoration timeframe are shown in Table 11.1. The RI dataset was then contoured to identify the areas within the SCU where sediment concentrations exceed the RALs for the three bioaccumulative IHSs. The output from this RAL process was identification of the areas within the SCU that require active remediation to comply with cleanup standards within a given restoration timeframe.

19 Natural background concentrations were used as replacement values. The remedial action will include adaptive management during construction.

Note that the RAL analysis looks at each IHS in isolation; however, actively remediating for one IHS can reduce post-construction concentrations for other IHSs, resulting in post-construction concentrations that are less than indicated by the RAL analysis.

11.2.5 Confirmation of Benthic Health Protection

Once the extents of the areas requiring active remediation to achieve SCLs for final bioaccumulative IHSs were determined, a confirmation process was conducted to confirm these active remediation extents include the extent of chemical exceedances of the SCLs for the final benthic IHSs (cadmium, mercury, and zinc) that were collocated with benthic toxicity.

All of the locations with benthic IHS exceedances of the SCLs and associated toxicity failures were located within the inner harbor and lagoon and were within the extent of areas requiring active remediation to achieve SCLs for bioaccumulative IHSs or are isolated exceedances located within an offset area that will be re-sampled during remedial design, as previously described. The FS has included these locations in the remediation footprint to address the benthic IHS exceedances, even in offset areas.

In several locations, exceedances of SCLs for benthic IHSs were associated with bioassay test passes. These locations, consistent with the SMS, were not incorporated in the remediation footprints on the basis of benthic toxicity.

11.2.6 Summary of Remediation Areas

SMA 1 consists of approximately 37 acres of sediment. Overwater structures and offset no action areas account for approximately 4 acres, so the total remediation footprint within SMA 1 is approximately 33 acres. The remediation area is based on a 0-year post-construction restoration timeframe.

SMA 2 consists of approximately 25 acres of sediment. The fringing marsh no action area is about 1 acre, leaving 24 acres of SMA 2 for remediation (including the eelgrass meadow). The remediation area is based on a 0-year post-construction restoration timeframe.

SMA 3 consists of approximately 1,100 acres of sediment with relatively lower IHS concentrations. Based on the hilltopping procedure described above, remediating 250 acres is predicted to meet cleanup standards following construction, considering natural recovery occurring between the average time of RI sampling (2011) and the projected start of construction (2022). Remediating 164 acres is predicted to meet cleanup standards 10 years following construction using natural recovery predictions. Finally, remediating 41 acres is predicted to meet cleanup standards 25 years following construction.

Section 11.0: Identification of Sediment Management Areas, Remedial Action Levels, and Remediation Areas

Table

Table 11.1
Surface Weighted Average Concentrations and Remedial Action Levels

Restoration Timeframe (Years Post-Construction)	Indicator Hazardous Substance	SCL	Existing SWAC[1]	Recovery SWAC Target[2]	Remedial Action Level[3]	Required Remediation Area[4] (Acres)
SCU						
0 Years Post-Construction	cPAH TEQ (µg/kg)	64	109	80	292	98
	Mercury (mg/kg)	0.13	0.25	0.16	0.65	98
	Total TEQ (ng/kg)	5.2	14.2	6.8	13	315
	Combination of cPAH TEQ, Mercury, and Total TEQ					365
10 Years Post-Construction	cPAH TEQ (µg/kg)	64	109	89	434	41
	Mercury (mg/kg)	0.13	0.25	0.18	0.84	60
	Total TEQ (ng/kg)	5.2	14.2	7.8	17	210
	Combination of cPAH TEQ, Mercury, and Total TEQ					252
25 Years Post-Construction	cPAH TEQ (µg/kg)	64	109	106	NA	NA
	Mercury (mg/kg)	0.13	0.25	0.21	NA	NA
	Total TEQ (ng/kg)	5.2	14.2	9.4	30	107
	Combination of cPAH TEQ, Mercury, and Total TEQ					107
Lagoon Intertidal Area and Inner Harbor Intertidal Area						
0 Years Post-Construction	Cadmium (mg/kg)	2.4	4.7	3.1	5.7	3.9
	Mercury (mg/kg)	0.13	0.48	0.16	0.48	8.4
	cPAH TEQ (µg/kg)	64	253	80	165	5.2
	Combination of Cadmium, Mercury, and cPAH TEQ					10.8
10 Years Post-Construction	Cadmium (mg/kg)	2.4	4.7	3.5	5.9	2.7
	Mercury (mg/kg)	0.13	0.48	0.18	0.49	8.0
	cPAH TEQ (µg/kg)	64	253	89	203	4.5
	Combination of Cadmium, Mercury, and cPAH TEQ					10.7
25 Years Post-Construction	Cadmium (mg/kg)	2.4	4.7	4.3	6.2	0.89
	Mercury (mg/kg)	0.13	0.48	0.21	0.51	6.2
	cPAH TEQ (µg/kg)	64	253	106	271	3.6
	Combination of Cadmium, Mercury, and cPAH TEQ					8.5

Notes:

1 The Existing SWACs are calculated assuming natural recovery processes (Appendix B) have occurred since the median date of data collection (2011).

2 The Recovery SWAC Target is the concentration required throughout the SCU or Intertidal Areas to result in achievement of cleanup standards for the stated restoration timeframe, projecting natural recovery processes occur as described in Appendix B.

3 The Remedial Action Level is the "hilltop" concentration described in Section 11.2.4 that must be remediated to achieve the associated SCU-wide or intertidal area-wide Recovery SWAC Target immediately following construction.

4 Because the Required Remediation Areas for the IHSs do not fully overlap, nor are they completely separate, the Combined Required Remediation Area is not a straight sum of the three individual areas, and is greater than the largest individual area.

Abbreviations:

cPAH Carcinogenic polycyclic aromatic hydrocarbon
IHS Indicator Hazardous Substance
µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
NA Not applicable - Existing SCU SWAC is less than or equal to the Recovery SWAC Target
ng/kg Nanograms per kilogram
SCL Sediment Cleanup Level
SCU Sediment Cleanup Unit
SWAC Surface-weighted average concentration
TEQ Toxic equivalent

WPAHG

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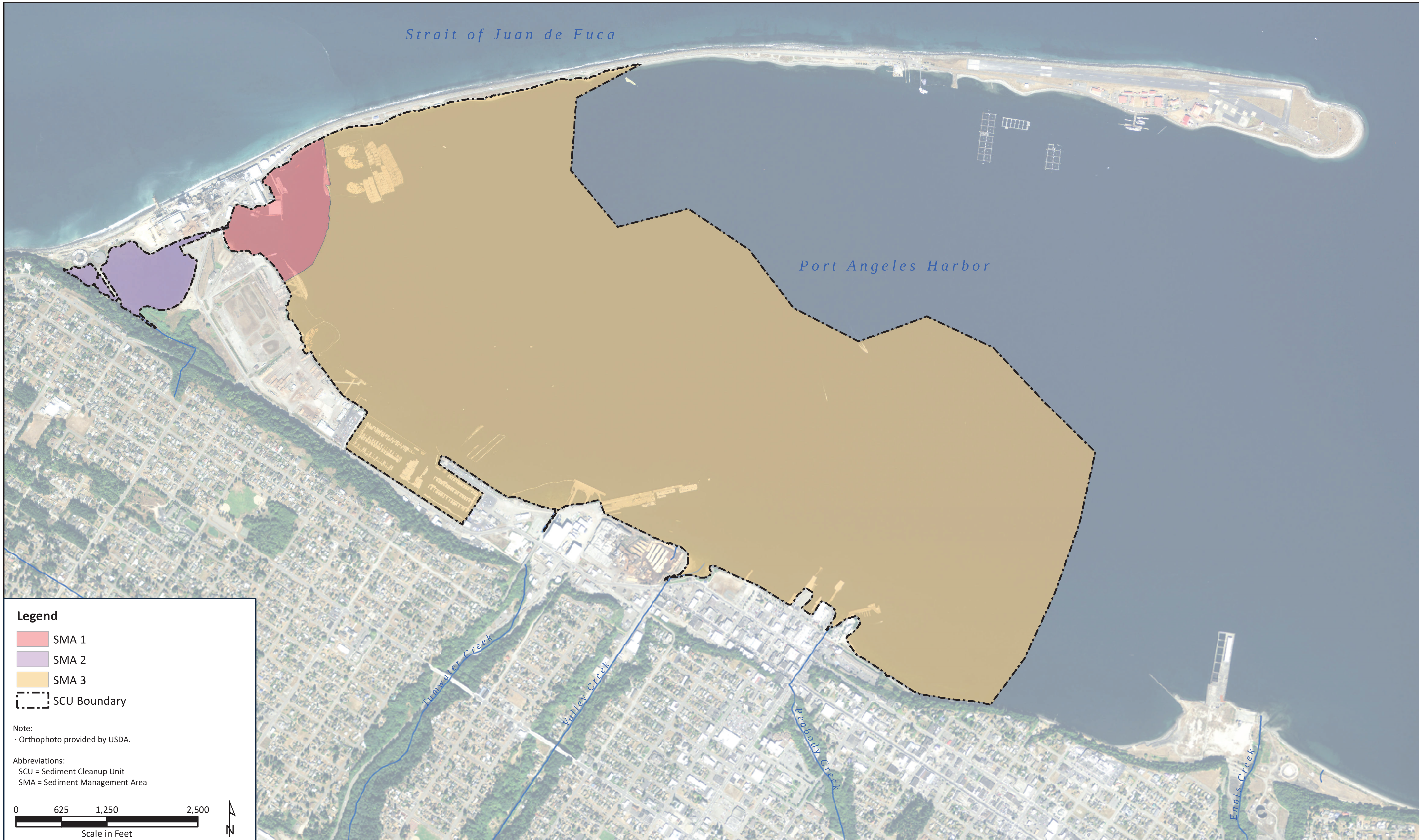
Section 11.0: Identification of Sediment Management Areas, Remedial Action Levels, and Remediation Areas

Figures

Western Port Angeles Harbor
Sediment Cleanup Unit

Remedial Investigation/Feasibility Study



WPAHG

Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 11.1
Sediment Management Areas

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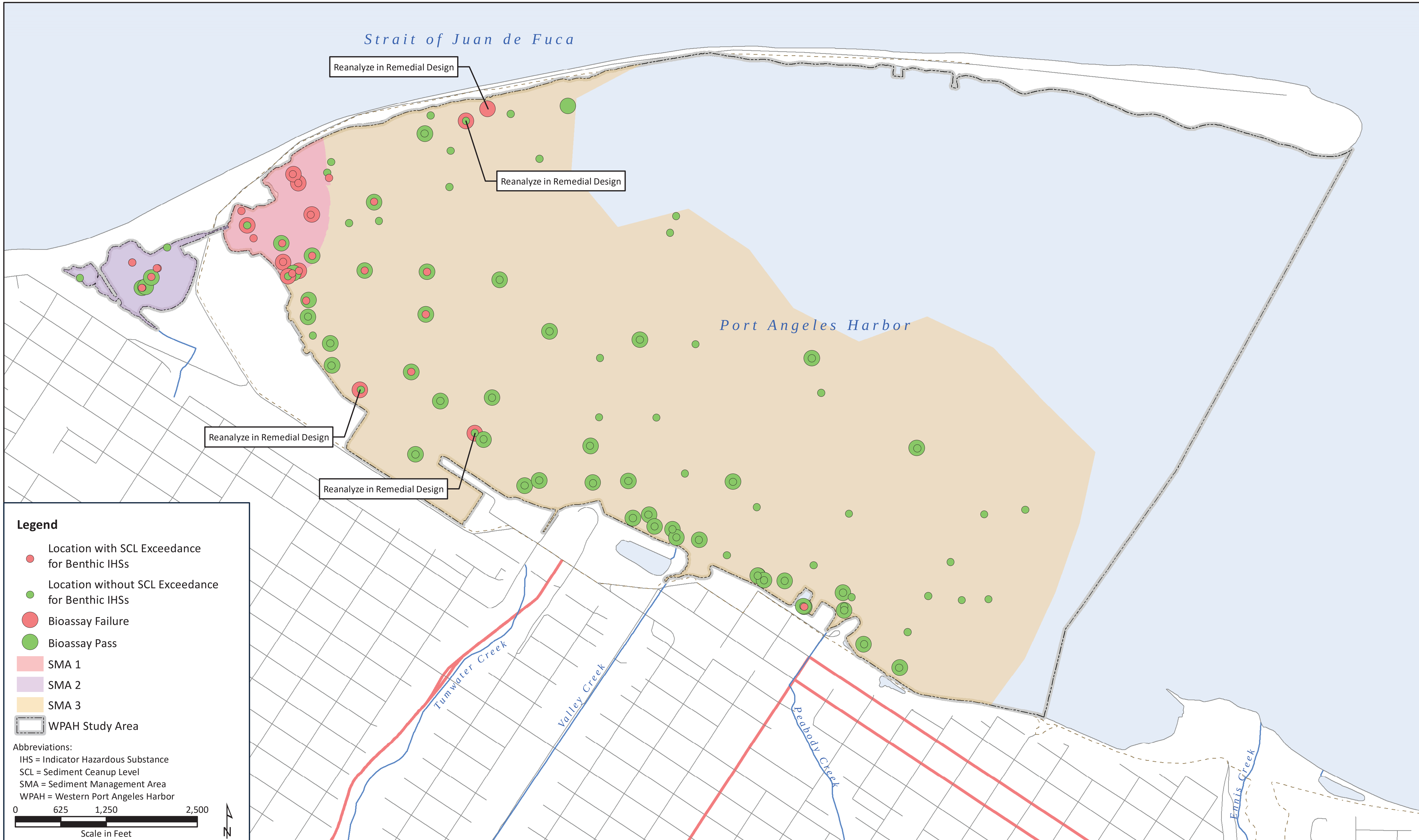
10/29/2020



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Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 11.2
Benthic Health Considerations for
Sediment Management Area Delineation

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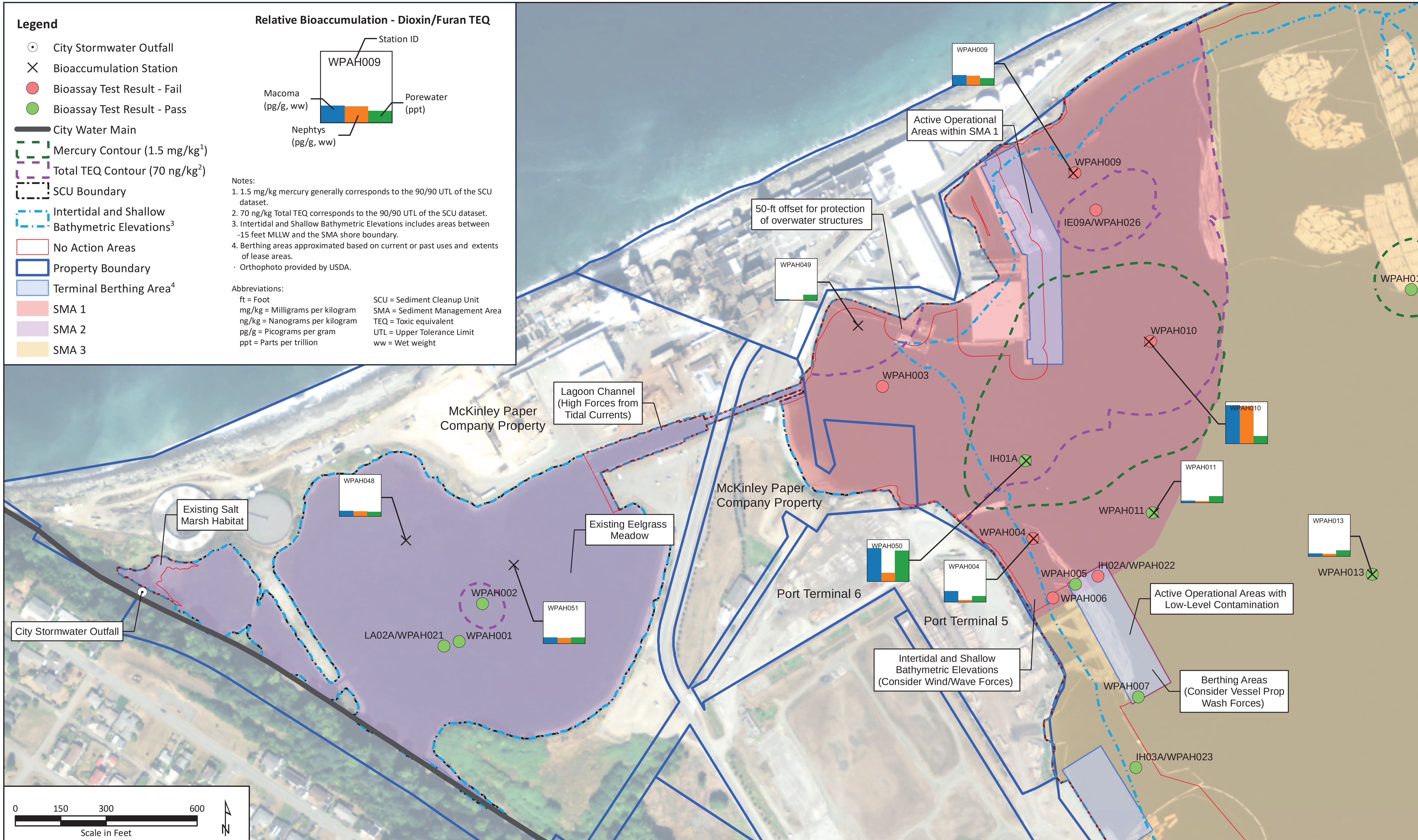

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Port Angeles, Washington

Figure 11.3
Sediment Management Areas 1 and 2 Features

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Section 12.0: Description and Screening of Remedial Technologies

- Common sediment remedial technologies were evaluated for potential application to remediation areas of the Sediment Cleanup Unit (SCU). Technologies that were evaluated for application to the SCU include: sediment removal by intertidal excavation or subtidal dredging, engineered capping, in situ treatment, enhanced monitored natural recovery, and monitored natural recovery.
    - All screened technologies with the exception of in situ treatment are potentially viable options for this project, and were retained for evaluation.
- Sediment disposal options considered include beneficial reuse, open-water disposal, nearshore confined disposal, and landfill disposal.
    - Landfill disposal is the only viable disposal option for this project.
- Source control, institutional controls, and monitoring are retained for inclusion in all remedial alternatives.

12.0 Description and Screening of Remedial Technologies

This section presents a screening of remedial technologies that could be used to remediate contaminated sediment to reduce risks to human health and the environment in the SCU. Remedial technologies and sediment remediation practices are relatively well-established for sediment cleanup sites, and common remedial technologies are listed in the SMS rule (WAC 173-204-570(4)(b) and described in Section 12.4.3 of SCUM II (Ecology 2017d). The following remedial technologies were identified for screening:

- Sediment Removal (Section 12.1)
    - Intertidal Excavation (Section 12.1.1)
    - Subtidal Dredging (Section 12.1.2)
- Sediment Disposal (Section 12.2)
- Engineered Capping (Section 12.3)
- In Situ Treatment (Section 12.4)
- Enhanced Monitored Natural Recovery (Section 12.5)
- Monitored Natural Recovery (Section 12.6)

In addition, institutional controls and monitoring are technologies that will be included in all remedial alternatives and are discussed in Section 12.7. Table 12.1 provides a summary of the technology screening. As a framework for comparison in the table, the remedial technologies are rated low, medium, or high for degree of implementability, degree of effectiveness, cost, and resilience to climate change impacts. Degree of implementability considers the technical feasibility given site conditions; demonstrated technology track-record; and the availability of equipment, space, and services to employ the technology. Degree of effectiveness assesses the anticipated ability of the technology to meet cleanup standards for the SCU. Costs are based on rough order-of-magnitude unit costs for the technology, developed using experience and actual costs for other sites with similar cleanup actions. Finally, resilience to climate change impacts is evaluated using the Ecology guidance *Adaptation Strategies for Resilient Cleanup Remedies* (i.e., climate change guidance, Ecology 2017e). Table 7 of the guidance lists the potential climate change impacts to be considered for sediment cleanup sites, which include sea level risk, coastal storms, salt wedge movement (not applicable in the Harbor), extreme precipitation and flooding, landslide, wildfire, and drought. The potential for these impacts is discussed relative to each remedial technology described below.

12.1 SEDIMENT REMOVAL

Sediment removal can be accomplished using two process options: intertidal excavation (Section 12.1.1) and subtidal dredging (Section 12.1.2). The equipment used and resulting environmental disturbances (e.g., chemical releases and residuals) that occur during removal operations vary widely between intertidal excavation and subtidal dredging, and thus are addressed separately in the following sections.

12.1.1 Intertidal Excavation

Intertidal excavation removes sediment using typical earth-moving equipment such as excavators and backhoes operating from shorelines or wharves. Intertidal excavation is an effective and implementable remedial technology that was retained for alternatives development (Table 12.1).

During remedial design, sampling and analysis of prospective intertidal excavation areas would be performed to accurately refine areas that exceed RALs across the 45-cm-deep point of compliance for the lagoon intertidal area and the inner harbor intertidal area. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Also during remedial design, a cultural resources survey would be performed in prospective intertidal excavation areas, consistent with the LEKT MDP (Appendix F). If the survey revealed that excavation actions could potentially cause unacceptable disturbance of cultural resources, excavation in culturally sensitive areas would be avoided, and it is expected that these areas would be capped instead. Similarly, unacceptable impacts resulting from intertidal excavation to sensitive aquatic habitats such as fringing salt marsh areas would also be avoided or mitigated as appropriate. Excavation residuals may require management (e.g., with a post excavation cover or engineered cap) if concentrations exceeding RALs (or an established performance standard) remain after excavation.

Subject to property owner approval, the inner harbor intertidal area in SMA 1 and the southeast shore of the lagoon intertidal area in SMA 2 are likely to be accessible from the shoreline so that standard upland construction equipment could be used for excavation activities in these areas. However, access to the northern and western shorelines of SMA 2 is limited, given likely interference with industrial operations at McKinley Paper Company, complicating intertidal excavation operations in these areas. Potentially implementable methods for accessing intertidal sediment in the northern and western shorelines of SMA 2 include use of amphibious excavators and/or dozer equipment, building temporary modular pontoons that upland equipment could operate from, constructing and operating from a temporary barge or other mobile platform, and other possible methods. While these methods are technically possible, it is likely that non-standard excavation equipment would either require new fabrication or mobilization from other geographic regions. As discussed in Section 11.0, there are no intertidal areas in SMA 3 proposed for remediation.

Building on recent Puget Sound sediment remediation experience, intertidal excavation operations would be performed to the extent practicable “in the dry,” with work shifts scheduled during low tides. To maximize protectiveness, intertidal cap/backfill material would be placed in excavated areas during the same work shift immediately following completion of excavation to the design grades. Backfilling intertidal excavations to the original grades would also maintain intertidal habitat functions, obviating the need for aquatic habitat mitigation.

Because of relatively higher wind/wave forces compared to subtidal sediments, intertidal sediments in the SCU are predominantly composed of relatively coarse-grained sands and gravels, and are likely to be free-draining. Excavated materials could thus be stockpiled or loaded directly onto trucks near shoreline access locations without the need for dewatering or amendment addition prior to transport to a suitable disposal facility (refer to Section 12.2).

For alternatives development, production rates and unit costs for intertidal excavation were developed based on these location-specific considerations, recent environmental intertidal excavation projects in Puget Sound, and best professional judgement (Appendix G). In-water construction is typically not permitted in the Harbor from mid-February to mid-July to protect salmonid fisheries, forage fish, and other sensitive species and habitat. Specific in-water work windows and BMPs for intertidal excavation operations would be developed during remedial design and permitting. Table 7 of Ecology's climate change guidance (Ecology 2017e) suggests that intertidal excavation and off-site disposal have low vulnerability to climate change impacts such as sea level rise, coastal storms, or extreme precipitation and flooding.

12.1.2 Subtidal Dredging

Dredging removes subtidal sediment by operating within and through the water column, and can be performed using mechanical or hydraulic equipment operating from a barge or other floating platform. Subtidal dredging is a widely used sediment remediation technology that was retained for alternatives development (Table 12.1).

While mechanical dredges function by digging into the sediments with a suitably designed bucket, hydraulic dredges function by loosening sediments with a rotating mechanical device and pumping the sediments along with relatively large quantities of entrained water, transporting the resulting dredge slurry through a pipeline to a facility where the solids and liquids can be separated for subsequent management. Hydraulic dredging equipment is generally design optimized for the removal of semi-homogeneous fine aggregates of sand size and below (i.e., clays and silts). Many subtidal sediment deposits in the SCU, including most of SMA 1 and SMA 2, contain a considerable number of buried logs, wads of wood waste, and other bulky debris that cannot be efficiently removed with a hydraulic dredge or some mechanical dredges (e.g., enclosed clamshell bucket). In these areas, an initial debris sweep using suitable mechanical equipment would likely be required to facilitate follow-on subtidal hydraulic dredging, potentially resulting in multiple environmental disturbances to sediment deposits and contributing to chemical releases and residuals (discussed later in this section). Furthermore, hydraulic dredging would not be feasible for deep deposits of buried debris. Therefore, mechanical dredging is the subtidal removal process option selected for further analysis and alternative development.

Selection of site-specific dredging equipment and methods depends on a number of interrelated factors, including: physical characteristics of the sediments to be dredged; volume and water depth of dredge prism; distance to the disposal area; physical environment of the dredging area; contaminant concentrations in the dredge prism; method of disposal; target production rates; equipment availability; amount and type of debris present; ability to manage produced waters;

and cost balancing (USEPA 2005). Because of the considerable amount of large woody debris (e.g., buried logs and deposits of irregularly shaped wood debris) and consistent with most environmental dredging projects implemented to date in Puget Sound, this FS assumes that subtidal dredging could be performed using suitable mechanical equipment tailored to site specific conditions. However, technical and implementation challenges will significantly complicate subtidal dredging within certain portions of the SCU.

Subtidal mechanical dredging within SMA 1 will be challenging to implement for several reasons (Figure 12.1). The deep water depths present in portions of SMA 1 (deeper than -40 to -50 feet MLLW) limit the dredging equipment available, the precision of dredging, and the production rate that can be achieved. Few vessels within the west coast dredging fleet can operate in such water depths. SMA 1 also includes several stretches of shoreline reinforced with shore protection structures and working waterfront areas supported by overwater wharves. The feasibility of dredging near these structures will be evaluated during the design process on a structure-by-structure basis, to refine the necessary construction offset, particularly in locations with deep dredging cuts that could impact the geotechnical stability of slopes and structure foundations. For the FS evaluation, no offsets are assumed for reinforced shorelines or bulkheads. An assumed average offset of 50 feet was preliminarily applied to overwater structures, as discussed previously.

Experience from prior environmental dredging projects has demonstrated that resuspension of contaminated sediment and release of contaminants occurs during subtidal debris sweep and dredging operations, and that contaminated dredging residuals will remain following operations (USEPA 2005, Patmont and Palermo 2007, Palermo et al. 2008, Bridges et al. 2008, Bridges et al. 2010, Patmont et al. 2018). For example, environmental dredging projects in Commencement Bay resulted in several-fold increases in fish tissue contaminant (e.g., PCB) concentrations that persisted for years during and following construction (Patmont et al. 2018). Based on a detailed review of 26 environmental dredging projects, the National Research Council concluded that subtidal dredging alone (e.g., without a post-dredge cover or cap) frequently does not effectively reduce long-term risk (NRC 2007). Moreover, dredge residuals are expected to be greater in areas with large amounts of debris (such as woody debris in parts of the Harbor) because debris can interfere with proper bucket closure and lead to additional releases of suspended sediment to the water column. Consistent with recent environmental dredging BMPs in Puget Sound, this FS evaluation assumed that shortly following completion of subtidal dredging, either a 6-inch-thick sand layer or engineered cap would be placed to contain dredge residuals, providing a cleaner sediment surface following construction. However, short-term dissolved chemical releases during subtidal dredging operations are unavoidable in tidal environments such as the SCU.

As discussed in Section 11.1.2, subtidal sediments in SMA 2 would be a challenge to access, even more so than for intertidal excavation, as the lagoon is not navigable from the inner harbor. Potentially implementable methods for accessing subtidal sediment would likely occur from the eastern portion of SMA 2 and could include building temporary modular pontoons that a dredge and upland transport equipment could operate from, constructing and operating from a temporary barge or other mobile platform, using a hydraulic dredge, and constructing a settling pond. Significant access restrictions decrease potential implementability and increase the cost uncertainty for subtidal dredging in SMA 2.

Production rates and unit costs for subtidal dredging were developed based on these location specific considerations, recent environmental dredging projects in Puget Sound, and best professional judgement (Appendix G). In-water construction is typically not permitted in the Harbor from mid-February to mid-July to protect salmonid fisheries, forage fish, and other sensitive species and habitat. Specific in-water work windows and BMPs for subtidal dredging operations would be developed during remedial design and permitting.

Table 7 of Ecology's climate change guidance (Ecology 2017e) indicates that subtidal dredging and off-site disposal have low vulnerability to climate change impacts such as sea level rise, coastal storms, or extreme precipitation and flooding.

For those alternatives that target full removal of contaminated sediments (refer to Section 13.0), detailed sampling and analysis of prospective subtidal dredge prisms would be performed during remedial design to accurately refine the depth of contamination and evaluate slope stability. Also during remedial design, a cultural resource survey would be performed in the prospective subtidal dredging areas, consistent with the LEKT MDP (Appendix F). If the survey revealed that dredging actions could potentially cause unacceptable disturbance of cultural resources, dredging in culturally sensitive areas would be avoided, and it is expected that these areas would be capped instead. Similarly, unacceptable impacts to sensitive aquatic habitats such as the eelgrass meadow present in the eastern portion of SMA 2 would also be avoided or mitigated as appropriate.

12.2 SEDIMENT DISPOSAL

Building on recent Puget Sound sediment remediation experience, potential options for disposal of intertidal excavation and/or subtidal dredging sediments include beneficial reuse, open-water disposal, nearshore confined disposal (NCD), and off-site upland landfill disposal. Each of these options is briefly reviewed in the following sections. Production rates and unit costs for sediment disposal were developed based on location-specific considerations, recent sediment disposal and landfill construction projects in the Port Angeles area, and best professional judgement, as outlined in the following sections and detailed in Appendix G. Based on similarity to other projects, and anticipated sediment concentrations, dredged material is not expected to be classified as hazardous or dangerous "Subtitle C" waste. Disposal options discussed in this section assume material is disposed as contaminated non-hazardous "Subtitle D" material.

12.2.1 Transloading and Dewatering

Sediment dredged from SMA 1 would be placed on a barge for transport to a shoreline transloading facility. Consistent with most environmental dredging projects implemented to date in Puget Sound, liquids produced on the barge would be passively dewatered (e.g., using gravity drainage) to reduce the dredged sediment water content. Water generated during dewatering is typically discharged to receiving waters directly after passive filtration of solids (e.g., in a settling basin).

Subtidal dredging operations would require a suitable transload facility to effectively transfer the passively dewatered sediments from the barge onto uplands to facilitate follow-on transport (e.g., rail or truck) and disposal. A key limitation to remedial construction in the SCU is procuring a property for transloading dredged sediment from the water to the shore for disposal, or transloading cap and cover materials from the shore to the water for placement. Based on a review of potentially available facilities in the Harbor and adjacent areas, the only location that appears viable as a sediment transloading facility for sediments dredged from the SCU is a portion of the Port's Terminal 6 facility located adjacent to SMA 1 (Figure 12.2). Improvements to the Terminal 6 site, including construction of a temporary wharf, nearshore sediment processing facility, truck loading, wheel wash, access roads, and associated environmental controls, would be required. This FS assumes that an improved Terminal 6 would be used as the subtidal dredging sediment transload facility. The transload facility location and footprint will be refined during design and in coordination with wetland requirements. Evaluated options for sediment disposal are discussed in Sections 12.2.2 through 12.2.5.

Subtidal sediments in the SCU are predominantly composed of relatively fine-grained silts and clays. Depending on site-specific sediment characteristics and disposal facility requirements (refer to Section 12.2.4), further dewatering of dredged sediments using Portland cement or other suitable drying agent amendments or mechanical dewatering methods will likely be needed at the transload facility. Addition of a drying agent would increase the strength of the sediments (e.g., to facilitate slope placement), but would also bulk up the volume of sediment approximately 10 to 20 percent or more relative to in situ conditions.

12.2.2 Beneficial Reuse

In some cases, the physical and chemical properties of marine sediments allow such materials to be beneficially reused in upland applications (e.g., as landscaping mulch, fill for restoration of Brownfields sites). However, since cPAH TEQ and/or Total TEQ concentrations in most sediments of the SCU exceed MTCA unrestricted land use soil cleanup levels, these materials may only be suitable for limited beneficial reuse applications. Nevertheless, while beneficial reuse of contaminated sediment was not retained in this FS, should intertidal excavation and/or subtidal dredging be selected as part of the final cleanup remedy, further detailed evaluations of potentially cost-effective beneficial reuse options may be performed during remedial design.

12.2.3 Open-Water Disposal

Sediments that are determined by the Puget Sound DMMP to be suitable for open-water disposal may be transported by bottom-dump barge for disposal at either a dispersive or non-dispersive unconfined open-water disposal site in Puget Sound. However, because cPAH TEQ and/or Total TEQ concentrations in most sediments of the SCU exceed DMMP chemical criteria for open water disposal, such sediments would likely not be deemed suitable by the DMMP for open-water disposal. Therefore, this option was not retained for further analysis.

12.2.4 Nearshore Confined Disposal

An NCD facility is an on-site engineered containment structure that allows for dewatering and permanent storage of dredged sediments. NCDs feature both solids separation and landfill characteristics (USEPA 1994), and containment of contaminated sediments in these on-site facilities is often a protective disposal option that may also provide associated land use redevelopment and/or habitat mitigation/restoration benefits (USEPA 1996). Interest in NCDs for disposal of contaminated dredged sediment has led both the U.S. Army Corps of Engineers (USACE) and USEPA to develop detailed guidance documents for NCD design, construction, and long-term management (USACE 1987 and 2000, Averett et al. 1988, Brannon et al. 1990, USEPA 1996), and many protective NCDs have been successfully constructed in Puget Sound, most recently in Commencement Bay. Given the relatively low mobility of dioxins/furans and PCBs in sediments of the SCU as measured by porewater analyses (refer to Section 7.4), NCDs are a potentially protective disposal option. Often, stabilization of sediments by cement amendment is necessary for geotechnical purposes, which would further reduce contaminant mobility and increase the long-term protectiveness of this option.

NCD facilities involve creation of a sediment containment area that has a final filled surface located above tidal elevations. Depending on site-specific designs, NCDs may either involve filling of aquatic areas and conversion of those areas to upland use (e.g., nearshore fills, with associated habitat mitigation requirements), or modification of the existing shoreline with no net loss of aquatic habitat. Based on preliminary reviews, potentially viable NCD options within the SCU area include construction of an NCD concurrent with possible future redevelopment of the Port's Terminal 7 in SMA 3, construction of a shoreline/upland NCD within the far western end of SMA 2, and other possible options. Application of this technology would require that aquatic area to be maintained or its loss mitigated, with uncertain implementability and cost implications. NCD facilities may be vulnerable to climate change impacts, and implementation along the shoreline may not be feasible due to possible future inundation from sea level rise or erosional forces and wave energy from more frequent and severe storms.

Because potentially more implementable and cost-effective upland landfill disposal options may be available in the Port Angeles area (refer to Section 12.2.5), NCD options were not carried forward in this FS. However, should intertidal excavation and/or subtidal dredging be selected as part of the final cleanup remedy, further detailed evaluations of potentially cost effective NCD options may be performed during remedial design.

12.2.5 Off-Site Upland Landfill Disposal

Off-site upland disposal of sediments at a permitted municipal or private landfill (e.g., Subtitle D landfill) is a widely used sediment remediation technology that was retained for alternatives development (Table 12.1). Intertidal excavation sediments from shoreline access locations and/or dewatered subtidal dredging sediments from the prospective Terminal 6 transload facility could be transported by truck and/or rail depending on the specific landfill disposal location. While expansion of the existing, closed City landfill or construction of a new limited purpose landfill in the Port Angeles area are potentially viable options (e.g., consistent with sediment cleanup actions recently completed in Port Gamble), depending on the volume of sediments requiring disposal, the more cost-effective and most certain upland disposal option was retained in this FS —trucking material (e.g., to Tacoma) followed by shipment by rail to a regional Subtitle D landfill facility (e.g., the Roosevelt regional landfill in Eastern Washington). Considerations for each option are discussed in this section.

Between 2004 and 2016, the City designed, permitted, and constructed the Port Angeles Landfill Cell Stabilization Project located approximately 3 miles from the prospective Terminal 6 transload facility. Among other elements, the project relocated solid waste from portions of the previously closed facility into a more protective zone of the landfill. While all landfill infrastructure including leachate collection and treatment was put in place, some landfill facility airspace in the northeast corner of the landfill was permitted but never utilized. Preliminary discussions with the Clallam County Solid Waste Advisory Committee suggest that, subject to permitting and administrative requirements, some of this remaining capacity could be used for disposal of intertidal and/or subtidal sediments from the SCU. Use of the Port Angeles Landfill would require that sediments are dewatered sufficiently to support placement of these materials to a slope of approximately 3 horizontal to 1 vertical (3H:1V), which is anticipated to require passive dewatering of intertidal excavation sediments (at shoreline access locations) or drying amendment addition to subtidal dredged sediments (at the prospective Terminal 6 transload facility) prior to disposal. Dewatered material would be transported by truck to the landfill area, stockpiled locally as necessary, and finally disposed within the landfill. Another potentially viable local option is to construct a limited purpose landfill (e.g., near the Port’s airport facility). A limited-purpose landfill could potentially be designed and permitted to protectively accept intertidal and/or subtidal sediments from the SCU.

Disposal of material removed from the SCU in a local facility will be considered during design, if the volume of material to be disposed is within the capacity of local disposal options, permitting and approvals could be obtained prior to start of construction, and the costs for material handling and disposal are more cost-effective than transport to an existing Subtitle D facility (e.g., the Roosevelt regional landfill in Eastern Washington). However, due to the uncertainty of these local options, and limited applicability to alternatives with smaller removal volumes, all remedial alternatives in this FS assume transport of removed sediment by truck, followed by shipment by rail to a regional Subtitle D landfill facility (e.g., the Roosevelt regional landfill in Eastern Washington). A similar rail/trucking approach was successfully used by the Port during the recent former K Ply facility/MTA nearshore remediation project.

12.3 ENGINEERED CAPPING

Engineered capping is a sediment cleanup technology that has been used extensively in Puget Sound, successfully containing and isolating sediment contaminants and wood debris with associated degradation products from the overlying water column, and preventing direct contact with aquatic biota (Sumeri 1996, Patmont et al. 2013). Caps are designed with the objective of reducing risk through three main mechanisms: (1) physical isolation of the contaminated sediment sufficient to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the cap surface; (2) stabilization of contaminated sediment and erosion protection of the sediment and cap, sufficient to reduce resuspension and transport of contaminants into the water column; and (3) chemical isolation that prevents contaminated sediment from solubilizing and being transported through the cap and into the water column (USEPA 2005). Engineered capping is an effective and implementable remedial technology that was retained for alternatives development (Table 12.1).

Engineered cap designs must meet stringent criteria set forth in USEPA and USACE design guidance (Palermo et al. for USEPA 1998, Palermo et al. for USACE 1998, Palermo 2000 and USEPA 2005). These guidance documents provide detailed procedures for cap designs, cap placement operations, and long-term monitoring, and have been relied upon extensively for successful cap designs at other SMS cleanup sites. Caps designed according to the USEPA and USACE guidance have been demonstrated to be protective of human health and the environment (USEPA 2005). Design specifications for engineered caps in the SCU would be further refined during remedial design based on detailed analyses of the following components:

- Bioturbation
- Erosion (e.g., propeller wash, tidal currents, waves, wakes, and slope stability)
- Chemical isolation
- Consolidation
- Operational considerations (e.g., placement tolerances)

Figure 12.1 also depicts some of the site conditions that require consideration during remedial design. In order to better assess the feasibility of engineered caps to effectively contain and isolate contaminated sediments in the SCU, a preliminary site-specific cap design was developed in accordance with USEPA and USACE cap design guidance (Appendix K). The assessment focused on two primary cap design criteria: (1) transport of IHSs through the cap over time; and (2) hydrodynamic forces that could be exerted on the cap surface. The preliminary design provides an initial estimate of the required engineered cap layer thicknesses and material specifications needed to achieve protective long-term chemical isolation under reasonable worst-case future conditions for specific areas of the SCU, including considerations of potential climate change.

Capping remedies can potentially be affected by climate change impacts from sea level rise and the potential for increased storm severity. Extreme storm events have the potential to increase scouring and erosion of shallow cap material. During remedial design, engineered cap specifications would be refined to ensure that they remain protective under a range of potential future climate change scenarios. Moreover, long-term monitoring and maintenance would be performed to further ensure that caps remain protective. While details would be determined during remedial design, a preliminary long-term OMMP framework is provided in Appendix J.

12.3.1 Preliminary Engineered Cap Design Summary

Appendix K presents a protective preliminary cap design for areas of the SCU that have elevated IHS concentrations and experience effects from extreme hydrodynamic forces. The preliminary cap design was developed in accordance with the following detailed USEPA and USACE guidance for in situ capping:

- *Guidance for Subaqueous Dredged Material Capping* (Palermo et al. for USACE 1998)
- *Assessment and Remediation of Contaminated Sediments Program Guidance for In Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al. for USEPA 1998)

The preliminary cap design focuses on the SMA 1 McKinley dock/berthing area, where relatively elevated surface sediment Total TEQ concentrations overlap with the active operational area (Figure 11.3). Based on radioisotope and SPI profile interpretations along with hydrodynamic evaluations, this portion of SMA 1 currently has the potential for mixing of surface and subsurface sediments from propeller wash and other higher energy forces (Section 2.1.5; Figure 2.3). Therefore, a preliminary design that satisfies chemical isolation and erosion protection requirements in this portion of SMA 1 is anticipated to be protective of the range of conditions present throughout the SCU. If capping is selected as part of the WPAH cleanup remedy, more detailed cap design evaluations would be performed to ensure protectiveness across the SCU.

Consistent with the guidance listed above, the preliminary evaluation for the cap isolation layer used the one-dimensional steady-state model of chemical transport within sediment caps developed by Dr. Danny Reible of Texas Tech University. Steady-state predictions provide a useful means of assessing long-term contaminant profiles within a cap, although the time to reach steady-state concentrations varies depending on the chemical characteristics of the contaminant, sediment geochemical conditions, and subsurface hydrogeology. For this analysis, the fate and transport of all 17 dioxin/furan congeners were simulated, which included the more-mobile IHSs present in the SCU. Model input parameters were based on site-specific data, information from literature, and cap designs successfully constructed at other similar sites. Data from the sampling station with highest dioxin/furan TEQ levels measured in the McKinley dock/berthing area (63 ng/kg TEQ) were input into the model to develop an upper-bound protective cap design.

The steady-state model predicted that a 6-inch sand cap isolation layer with relatively low total OC content (0.1 percent) will maintain long-term dioxin/furan TEQ concentrations in the top 10 cm (vertical average) of the cap below the 5.2 ng/kg SCL (Appendix K). Based on these preliminary modeling results, cap amendments (e.g., activated carbon) are not expected to be required to enhance cap performance and further reduce bioavailability.

Based on preliminary chemical partitioning evaluations and cap designs developed at other similar sites, chemical isolation designs that address elevated dioxin/furan TEQ concentrations in this area of SMA 1 are anticipated to be protective of the range of IHSs and environmental conditions present throughout the SCU. For example, post-construction monitoring demonstrated that a 6-inch pilot sand cap successfully constructed on Ediz Hook protectively isolated underlying wood debris degradation products (WPAH Group 2018). If capping is selected as part of the WPAH cleanup remedy, more detailed cap design evaluations would be performed to develop final cap designs protective across the SCU.

In addition to chemical isolation modeling, an erosion analysis was performed to calculate the stable grain size of capping material both within the McKinley dock/berthing area and the intertidal areas of SMA 1 and SMA 2 that would resist extreme hydrodynamic forces that could be exerted on the cap surface (Appendix K). The erosion-protection analysis focused on resisting forces from potential future extreme wind waves and propeller wash forces.

Within the McKinley dock/berthing area, reasonable worst-case propeller wash forces from tugboat operations may require an armor stone of approximately 6 inches to ensure cap stability. A similarly sized 5-inch armor stone may be required in portions of SMA 1 intertidal areas subject to wind wave forces generated during extreme easterly wind events. Smaller 1- to 2-inch armor stone would be required in the relatively more protected SMA 2 intertidal areas. While in some specific applications it may be necessary to place a filter layer to restrict the movement of finely grained native sediments through the armor, the FS analysis assumed that the isolation layer would be more typically specified as a single, gravelly sand mixture satisfying both functions.

Based on the site-specific cap design analyses summarized in Appendix K, the preliminary cap design used to develop remedial alternatives consists of placement of 6 inches of gravelly sand as a combined chemical isolation and filter layer, followed by placement of 12 inches of gravel/cobble-sized rock for erosion protection. The total minimum cap design thickness is approximately 1.5 feet. For costing purposes, an additional 6 inches of material was included in the total cap thickness to account for construction placement tolerances. In certain intertidal areas of SMA 1 and SMA 2, engineered caps would also need to conform with the 45-cm (1.5-foot) depth point of compliance. Location-specific cap thicknesses and material specifications will be refined during remedial design.

12.3.2 Constructability Considerations

Various equipment types and placement methods have been used for capping projects, including traditional mechanical equipment, hydraulic systems, conveyors, and hopper barges. Mechanical methods (such as clamshells or release from a bottom-dump barge) rely on gravitational settling of cap materials in the water column and have been demonstrated to be effective at the range of depths present in the SCU. Capping materials can be placed from barges or from the shoreline using conventional equipment, such as clamshells. Conveyors have also been used at sites throughout Puget Sound to broadcast capping materials where access is limited.

Like intertidal excavation (Section 12.1.1), intertidal capping areas of SMA 1 and the southeast portion of SMA 2 are likely to be accessible from the shoreline so that standard upland construction equipment could be used for placement activities. Like intertidal excavation (Section 12.1.1) and subtidal dredging (Section 12.1.2) operations, construction access for engineered capping is limited within the western and northern portion of SMA 2, limiting the available options for placement. Hydraulic and/or pneumatic methods of cap placement may also be potentially viable in these areas of SMA 2. Subtidal sediments in SMA 1 and SMA 3 would be accessible with standard marine construction equipment (e.g., barge-mounted equipment); however, similar water depth limitations would also apply in areas deeper than -50 feet MLLW. These areas may require methods such as bottom dump barges, which have limited availability on the west coast, to implement.

Preliminary engineering evaluations revealed that relatively large volumes (greater than 100,000 cubic yards [CY]) of potentially suitable cap materials (e.g., sands, gravels, and cobbles with less than 10 percent fines) are currently available from commercial upland quarries located within approximately 5 miles of the prospective Terminal 6 transload facility. Engineered capping operations would require a suitable transload facility to effectively transfer sands and gravels (and other material as needed) from trucks onto barges. As summarized in Section 12.1.2, the only site that appears viable as a sediment transloading facility for engineered capping operations in the SCU is the Port's Terminal 6 facility located adjacent to SMA 1 (Figure 12.2), as well as use of a Port property located on the other side of Marine Drive. Improvements to the Terminal 6 site and the nearby Port property, including construction of a temporary barge mooring facility, conveyor, access roads, stockpile facilities, sediment handling areas, and associated environmental controls, would be required. Additionally, a delineated wetland is present on the nearby Port property, requiring a special permit to use this area. It is expected that any filling or construction occurring in the wetland and/or buffer area would require mitigation. This FS assumes that an improved Terminal 6 and the nearby Port property would be used as the engineered capping transload facility.

Production rates and unit costs (including long-term monitoring and maintenance) for engineered capping were developed based on these location-specific considerations, recent engineered capping projects in Puget Sound, and best professional judgement (Appendix G). In-water construction is typically not permitted in the Harbor from mid-February to mid-July to protect salmonid fisheries, forage fish, and other sensitive species and habitat. Specific in-water work windows and BMPs for engineered capping operations would be developed during remedial design and permitting.

12.4 IN SITU TREATMENT

Experimental studies and field trials conducted in a wide range of different environmental settings have demonstrated that applying sorbent materials such as AC reduces contaminant bioavailability and can be a protective in situ sediment cleanup remedy or remedy component (Ghosh et al. 2011, Patmont et al. 2015). The focus on AC as a sorbent for sediments stems in part from its successful use for decades as a stable treatment medium for water, wastewater, and air. Over the past decade, pilot- or full-scale sediment treatment projects using AC were completed or underway at 25 sites in the United States, Norway, and the Netherlands. Collectively, these projects have demonstrated the efficacy of AC for in situ treatment in a wide range of contaminated sediment conditions (Patmont et al. 2015). Table 7 of Ecology's climate change guidance (Ecology 2017e) indicates that in situ treatment would need to be designed considering impacts from climate change such as more frequent coastal storms that could lead to remedy damage or failure.

Applying AC amendments to a representative sample of subtidal SMA 2 sediments with relatively higher existing black carbon/soot levels did not markedly reduce the already relatively low bioavailability of these sediments. However, applying AC to a representative sample of subtidal SMA 1 sediments with relatively higher existing bioavailability was effective, suggesting that application of this remedial technology could reduce bioaccumulation/human health risks within this SMA (refer to Section 7.4.1). However, because there may be limited marginal benefits in this situation compared to other cost-effective remedial technologies such as engineered capping (Section 12.3) and EMNR (Section 12.5), and this technology does not change the total sediment concentration for which SCLs have been developed, in situ treatment was not retained for further consideration in this FS. Nevertheless, should engineering capping and/or EMNR be selected as part of the final cleanup remedy, and based on the bioavailability reduction observed in the inner harbor, further detailed evaluations of potentially cost-effective in situ treatment options (such as addition of AC to capping or EMNR materials to reduce cap thicknesses) may be performed during remedial design.

12.5 ENHANCED MONITORED NATURAL RECOVERY

EMNR includes the placement of a thin layer (e.g., about 6 inches on average) of clean sand and/or gravel to accelerate natural recovery. EMNR is often applied in areas where the rate of sedimentation is relatively slow (USEPA 2005), which is the case in the Harbor where net sedimentation rates average approximately 0.17 cm per year (refer to Section 2.1.5). Following placement of a thin layer of EMNR material on the sediment surface, monitoring would be performed to verify that sediment concentrations within the top 10 cm are declining toward achieving SCLs. Building on many successful applications of this technology throughout Puget Sound and the United States, EMNR is an effective and implementable remedial technology that was retained for alternative development (Table 12.1).

Placement of an EMNR cover layer is different than an engineered cap, because the placed cover layer is not designed to provide long-term isolation of underlying sediment contaminants. Clean sand and/or gravel can be placed in a relatively uniform thin layer over existing sediments or these materials can be placed in berms or windrows, allowing natural sediment transport processes to distribute the clean material over wider areas.

EMNR is usually applied in areas that are relatively stable and not subject to scour from natural or maritime-generated erosive forces; however, engineered aggregate mixes consisting of sand and fine gravel may be used to improve long-term stability (Palermo et al. for USEPA 1998 and

Palermo et al. for USACE 1998). Other considerations such as steep bottom slopes, deep water depths, proximity to industrial operations and waterway use, and the geotechnical properties of the seabed would be evaluated during remedial design. As part of the Ediz Hook Restoration Sand Cap Pilot Project (WPAH Group 2018), in June 2017 an average 6-inch-thick layer of gravelly, silty sand (with up to approximately 10-percent fines) was successfully placed in shallow subtidal areas of Ediz Hook with only minor localized increases in turbidity (less than 8 nephelometric turbidity units [NTU] greater than the background level). Placed thicknesses ranged from 4 to 8 inches, consistent with pilot project design. Initial post-construction performance monitoring was performed in December 2017 and demonstrated the uniformity, stability, and integrity of gravelly/silty sands placed in Ediz Hook shallow subtidal areas in June 2017 (Anchor QEA 2018). Physical, chemical, and biological performance monitoring is ongoing to further demonstrate the effectiveness of the placed sand layer in restoring benthic habitat in the Harbor.

EMNR has been used to successfully cover areas with buried wood debris and logs at Ediz Hook (WPAH Group 2018), as well as in Ketchikan (Alaska) and Port Gamble Bay (Washington; Appendix H). Select debris and logs may require removal prior to EMNR implementation and would be included in the remedial design.

Consistent with recent Puget Sound projects and with the Ediz Hook Restoration Sand Cap Pilot Project, EMNR is assumed to include placement of an average 6-inch-thick layer of clean sands and gravels with up to 10-percent fines obtained from a local quarry. As discussed in Section 12.3, relatively large volumes of potentially suitable EMNR materials are currently available from commercial upland quarries located within approximately 5 miles of the prospective Terminal 6 and nearby Port property transload facility (Figure 12.2). EMNR placement operations would require a suitable transload facility to effectively transfer these materials from trucks onto barges. This FS assumes that an improved Terminal 6 and nearby Port property would be used as the EMNR material transload facility. Similar to the Ediz Hook Restoration Sand Cap Pilot Project and other Puget Sound projects, EMNR material in shallower subtidal areas of SMA 1 and SMA 3 would be accurately placed from barges using conventional equipment, such as clamshells, while placement in areas deeper than -50 feet MLLW may require methods such as bottom dump barges, which are limited on the west coast, to implement. Placement of an EMNR layer in intertidal areas and within SMA 2 would be performed using equipment and procedures similar to those described for engineered capping (refer to Section 12.3).

Table 7 of Ecology's climate change guidance (Ecology 2017e) indicates that EMNR cleanup remedies have moderate vulnerability to climate change impacts such as more frequent coastal storms that could lead to infrequent repair, maintenance, or additional monitoring of the remedy in shallow water depths susceptible to impacts from coastal storms. Coastal storms and extreme events may impact bathymetry, sediment transport, and deposition/erosion in shallower nearshore areas. EMNR remedies in subtidal areas are less likely to be impacted by coastal storms and extreme events.

Production rates and unit costs, including long-term monitoring and maintenance, for EMNR were developed based on these location-specific considerations, recent small- and large-scale

EMNR projects in Puget Sound, and best professional judgement (Appendix G). In-water construction is typically not permitted in the Harbor from mid-February to mid-July to protect salmonid fisheries, forage fish, and other sensitive species and habitat. Specific in-water work windows and BMPs for EMNR placement operations would be developed during remedial design and permitting.

12.6 MONITORED NATURAL RECOVERY

Monitored natural recovery (MNR) includes three broad processes that contribute to the recovery of surface sediments over time (Magar et al. 2009), including:

- **Physical processes** such as sedimentation/deposition and mixing
- **Chemical processes** including sorption and oxidation/reduction
- **Biological processes** including biodegradation and benthic habitat succession

As discussed in Sections 2.2.5 and 12.5, the net sedimentation rate measured in the Harbor averages approximately 0.17 cm per year, equivalent to roughly 9 cm of projected sediment deposition over 50 years. This sedimentation rate was used to determine the restoration timeframes and recovery timeframes described in Section 11.0. Radioisotope dating, SPI observations, and wind-wave analyses all reveal that sediments deeper than approximately -10 feet MLLW and away from berthing areas are stable, and thus will continue to recover over time. MNR is implementable and is effective for subtidal sediments with relatively low levels of contamination (including SMA 3). MNR is retained for the alternatives analysis (Table 12.1). MNR is typically combined with active remedial alternatives in areas with greater contaminant concentrations in sediment.

Chemical processes including sorption of cPAH TEQ and Total TEQ onto OC including native black carbon/soot particles present in sediments have contributed to relatively lower bioavailability in SMA 2 compared to SMA 1 as confirmed by bioavailability evaluations of dioxins/furans and PCBs (refer to Section 7.4) and assumed to also occur for cPAHs. These sequestration processes are anticipated to continue, but at an undetermined rate.

As discussed in Sections 7.2.5.3 and 9.4.3, evaluations of SPI surveys performed in the Harbor in 1998 and 2013 reveal that benthic habitat recovery and succession has occurred in areas of the SCU that were affected by historical wood debris releases, and there has been substantial improvement in benthic habitat quality in these areas since 1998. Again, these biological recovery processes are anticipated to continue, but at an undetermined rate.

Natural recovery processes operate regardless of the selected remedy. Effective sediment remedies may incorporate MNR in combination with the other retained technologies summarized above. Characteristics of areas particularly well-suited for MNR include evidence that natural recovery will effectively reduce risks within an acceptable time period, low relative contribution to site risk, and a low potential for exposure of buried contaminants. The practicability of other remedial technologies is also a factor to be considered when determining the applicability of MNR. Table 7 of Ecology's climate change guidance (Ecology 2017e) indicates that MNR cleanup remedies have low vulnerability to climate change impacts such as more frequent coastal storms that can be managed with typical monitoring and repair.

Costs for MNR are limited to long-term monitoring, and were developed based on location-specific considerations, recent small- and large-scale MNR projects in Puget Sound (e.g., Port Gamble Bay [State of Washington 2013b]), and best professional judgement (Appendix G). Consistent with other similar MNR projects, monitoring would be performed to differentiate potential ongoing sources/recontamination associated with diffuse, non-point sources of contaminants (refer to Section 12.7), from natural recovery of legacy sediment contamination.

12.7 SOURCE CONTROL, INSTITUTIONAL CONTROLS, AND MONITORING

Source control, institutional controls, and monitoring are important aspects of all alternatives and are discussed in the following sections.

12.7.1 Source Control

Historical sources of contaminated sediment to the SCU are summarized in Section 9.1. A range of industrial and municipal facilities in the SCU have been associated with historical releases of hazardous substances to sediments. Sources of contamination to the SCU are primarily historical, and have been addressed over time through improvements in industrial practices and upgrades to wastewater discharge systems.

As noted in Section 9.1, diffuse, non-point sources of contaminants currently enter the SCU as a result of releases from existing creosote piles, urban stormwater discharges, and other potential sources. Although additional source control measures are not a part of sediment remediation alternatives, it is expected that loads of non-point sources of contamination will continue to decline over time under other regulatory programs (e.g., the Clean Water Act/ NPDES permitting), further reducing surface sediment concentrations in the SCU. A source control evaluation conducted in association with this project is discussed in greater detail in Appendix E.

As discussed in Appendix E, discrete upland soil/bank erosion areas have been identified that are proximate to sediments in the SCU with elevated IHS concentrations, which may indicate the potential for local ongoing upland sources of some contaminants. As discussed in the Work Plan (WPAH Group 2013), Ecology will use this information, along with its Water Quality Program and MTCA upland cleanup authorities, to ensure the long-term success of the sediment cleanup efforts (outside of the RI/FS AO), and will follow up with the appropriate parties to further evaluate and control those sources as necessary. As stated in the AO, "this Order requires investigation of sediments and identification of ongoing upland sources of contamination that have the potential to result in sediment recontamination at levels greater than prospective sediment cleanup standards. Any such upland sources identified under this Order will be addressed under separate actions, agreements, permits or orders" (State of Washington 2013a).

12.7.2 Institutional Controls

Institutional controls are non-engineered measures and mechanisms for ensuring the long-term performance and protectiveness of cleanup actions. They are applicable to most remedies where contamination is anticipated to remain following active remediation, but they may also be selected as the primary remedial or response action where it is not practicable to implement a more permanent cleanup action.

For sediment remediation projects, permitting review procedures constitute institutional controls. For any aquatic construction projects (e.g., future maintenance dredging in a berth area within the SCU), environmental reviews are conducted by permitting agencies including USACE, Ecology, and other resource agencies. These include a review of area files relating to sediment conditions, and a review of requirements to address materials management and water quality. In particular, future maintenance dredging activities would be required to comply with anti-degradation standards so that sediment quality would not decline as a result of such future projects.

Additional institutional controls may be implemented as appropriate depending on the remedial alternative ultimately selected by Ecology. Such additional controls could include use authorizations by DNR (or by the Port under a Port Management Agreement with DNR) of aquatic lands, and/or notification and documentation of the site remedial action in Clallam County property records, USACE and regulatory agency permit records, and/or records maintained by the State of Washington. For example, institutional controls may be necessary for any caps constructed in areas with berthing depth requirements to ensure that future dredging (if necessary) would be performed in a manner consistent with SCOs (e.g., placing a cover or cap on the post-dredge surface, depending on the level of contamination remaining), or restrictions of activities that could potentially damage the cap.

These and other institutional controls would be detailed as appropriate in an OMMP to be developed and refined during remedial design, also ensuring that such controls minimize the potential to impact the exercise of Tribal treaty rights, including Tribal access to treaty resources, or to unreasonably encumber future uses of state-owned aquatic lands. Institutional controls that have the potential to impact the exercise of Tribal Treaty rights will be developed in consultation with Lower Elwha and the S'Klallam Tribes.

12.7.3 Monitoring

Monitoring is an important aspect of all remedial technologies to confirm protectiveness during and following construction. Monitoring requirements during cleanup construction activities will be detailed in a CQAAMP to be developed during remedial design; post-construction monitoring requirements will be detailed in the OMMP. Conceptual frameworks for the CQAAMP and OMMP are presented in Appendix I and Appendix J, respectively. The CQAAMP and OMMP will describe the type, duration, and frequency of monitoring, the trigger for contingency response actions, and the rationale for terminating monitoring. The three types of compliance monitoring to be described in the CQAAMP and OMMP as appropriate include the following:

- **Protection Monitoring** to confirm that human health and the environment are adequately protected during the construction period of the cleanup action
- **Performance Monitoring** to confirm that the cleanup action has attained site-specific cleanup standards and other performance standards
- **Confirmation Monitoring** to confirm the long-term effectiveness of the cleanup and source control actions once performance standards have been attained

Additional discussion of compliance monitoring is presented in Section 15.4 and Appendices I and J.

Section 12.0: Description and Screening of Remedial Technologies

Table

Table 12.1
Sediment Remediation Technology Screening

Remedial Technology (WAC 173-204-570(4)(b))		Degree of Implementability	Degree of Effectiveness	Costs	Screening Outcome
Intertidal Excavation		**High**	**High**	**High**	**Retained.** Intertidal excavation is a common and proven technology for sediment remediation. Excavation residuals require management (e.g., with a post-excavation cover or engineered cap) to ensure effectiveness. Buried cultural resources may also be disturbed by excavation, requiring careful management and/or avoidance. Although intertidal excavation has high implementability, the significant access constraints, sensitive aquatic habitats, and potential cultural resources limit its implementability in some areas of the Harbor.
Subtidal Dredging		**High**	**High**	**High**	**Retained.** Subtidal dredging is a common and proven technology for sediment remediation, though short-term releases of contaminants to the water column are unavoidable with subtidal dredging technologies. Dredge residuals require management (e.g., with a post-dredge cover or engineered cap) to ensure effectiveness. Buried cultural resources may also be disturbed by removal, requiring careful management and/or avoidance. Although subtidal dredging has high implementability and effectiveness in some settings, due to depth limitations of most dredging equipment this technology has implementability limitations, especially in deeper areas of the Harbor.
Sediment Disposal	Beneficial Reuse	**Low**	**Low**	**Moderate**	**Eliminated.** There is a lack of currently viable beneficial uses for contaminated sediments, and dredged sediments are likely to exceed upland soil cleanup levels for unrestricted land uses, further complicating this technology. Nevertheless, while beneficial reuse of contaminated sediment was not retained in this RI/FS, should removal be selected as part of the final cleanup remedy, further detailed evaluations of potentially viable beneficial reuse options may be assessed during remedial design.
	Open-Water Disposal	**Low**	**Moderate**	**Low**	**Eliminated.** The interagency Puget Sound DMMP has made past determinations that sediments with concentrations similar to those in the SCU are not suitable for open water disposal.
	Nearshore Confined Disposal	**Low**	**High**	**High**	**Eliminated.** This technology would require the need to maintain or mitigate for the loss of aquatic area and no current nearshore facility exists. Additionally, this technology may be vulnerable to climate change impacts and implementation along the shoreline may not be feasible due to anticipated inundation from sea level rise or erosional forces and wave energy from more frequent and severe storms. However, this technology could be reassessed during remedial design should an acceptable nearshore, in-water, confined aquatic disposal facility fill site be identified.
	Off-Site Upland Landfill Disposal	**High**	**High**	**High**	**Retained.** Disposal in an upland engineered facility is a common and proven technology for sediment remediation.
Containment of Contaminated Sediments In-Place with an Engineered Cap		**High**	**High**	**Moderate**	**Retained.** Engineered capping is a common and proven technology for sediment remediation. USEPA and USACE cap design guidance provides detailed procedures to determine the protective thickness and grain size of caps for different conditions. Changes in the sediment surface elevation resulting from capping may require mitigation in some circumstances (e.g., if caps result in a loss of aquatic area or substantively degrade habitat) and resilience to climate change impacts will require evaluation during remedial design.
In Situ Treatment to Immobilize, Destroy, or Detoxify Contaminants		**Moderate**	**Moderate**	**Moderate**	**Eliminated.** Promising in situ treatment technologies are available to successfully reduce the bioavailability of contaminants such as dioxins/furans and cPAHs, but this technology does not change the total sediment concentration for which sediment cleanup levels have been developed. Additionally, this technology may be vulnerable to climate change impacts such as more frequent and severe storms, that could lead to remedy damage or failure. However, this technology could be reassessed during remedial design if alternative technologies such as EMNR are not protective in specific applications.
Enhanced Monitored Natural Recovery (EMNR)		**High**	**Moderate**	**Low**	**Retained.** EMNR is a common and proven technology for sediment remediation. EMNR would consist of the placement of a thin layer (e.g., average 6 inches) of sand and/or gravel, allowing some mixing with underlying contaminated sediments to achieve cleanup goals. EMNR is also a common and effective technology as a post-dredge residual cover.

Table 12.1
Sediment Remediation Technology Screening

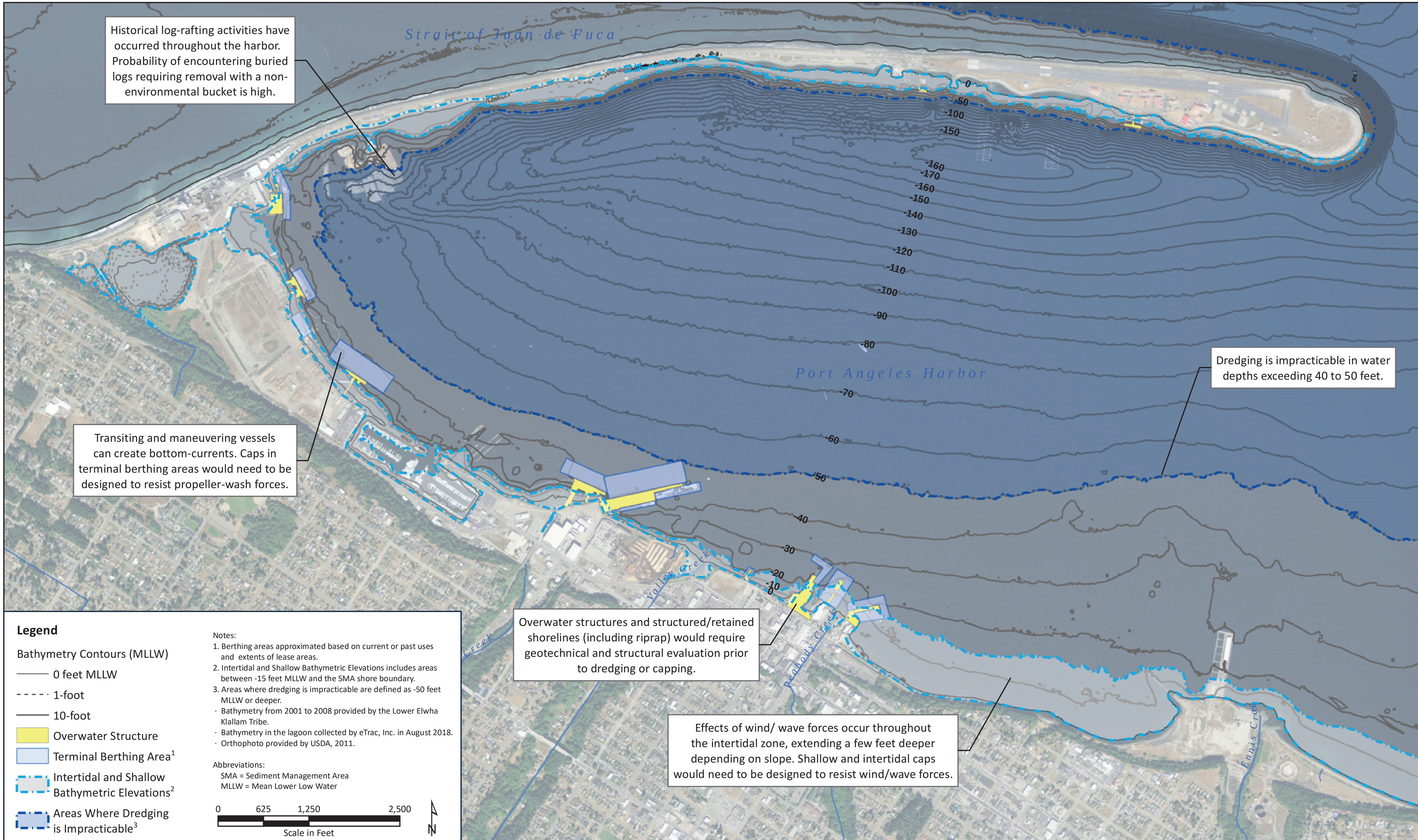
Remedial Technology (WAC 173-204-570(4)(b))	Degree of Implementability	Degree of Effectiveness	Costs	Screening Outcome
Monitored Natural Recovery (MNR)	**High**	**Moderate**	**Low**	**Retained.** Given the average measured sedimentation rate of approximately 0.17 cm per year (in subtidal, depositional areas of the SCU), the rate of natural recovery proceeds relatively slowly, but nevertheless results in significant reductions in surface sediment concentrations over decade-scale restoration time periods, particularly in the relatively broad offshore areas of the SCU. Possible natural recovery restoration timeframes for depositional areas of the SCU are presented in Section 11.0 of this RI/FS report.
Source Controls In Combination With Other Cleanup Technologies	**High**	**High**	**High**	**Retained.** Source control is an important aspect of all remedial alternatives. While the conceptual site model of the SCU (presented in Section 9.0 of this RI/FS report) suggests that current surface sediment contamination is largely attributable to legacy sources that have since been controlled (with relatively low rates of follow-on natural recovery), and significant additional source control efforts have recently been completed (e.g., combined sewer overflow abatement and shoreline site cleanups), diffuse non-point sources of contamination will continue to enter the SCU. Future source control efforts (e.g., additional upland/shoreline cleanup actions, creosote piling removals tied to future redevelopment, etc.) are anticipated to be coordinated between Ecology and the WPAH Group as appropriate.
Institutional Controls And Monitoring	**High**	**Moderate**	**Moderate**	**Retained.** Institutional controls and monitoring are also important aspects of all remedial alternatives. However, consistent with MTCA/SMS requirements, institutional controls and monitoring are not employed as stand-alone technologies, but are used in conjunction with other cleanup technologies.

Abbreviations:

cm	Centimeters
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
DMMP	Dredged Material Management Program
Ecology	Washington State Department of Ecology
EMNR	Enhanced monitored natural recovery
MNR	Monitored natural recovery
MTCA	Model Toxics Control Act
RI/FS	Remedial Investigation/Feasibility Study
SCU	Sediment Cleanup Unit
SMS	Sediment Management Standards
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code
WPAH Group	Western Port Angeles Harbor Group

Section 12.0: Description and Screening of Remedial Technologies

Figures



WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 12.1
Summary of Site Conditions Affecting Technology Application

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10/29/2020

WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 12.2
Conceptual Transload Facility Layout

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10/29/2020

Section 13.0: Development of Remedial Alternatives

- Remedial alternatives identified for Sediment Management Area (SMA) 1 and SMA 2 range from dredging and excavation, to monitored natural recovery (MNR). Alternatives include various combinations of dredging, capping, enhanced monitored natural recovery (EMNR), and MNR.
  - Eight alternatives have been developed for SMA 1.
  - Seven alternatives have been developed for SMA 2.
- Due to the size of the area within SMA 3 requiring remedial actions to achieve cleanup standards, and the low-level contaminant concentrations throughout that area, both dredging and capping are considered technically impracticable, or not feasible, because of the cost of the remedy versus the benefit gained, and the negative impacts to the community and environment resulting from implementation.
- Remedial alternatives identified for SMA 3 involve variable extents of EMNR and MNR that result in a range of restoration timeframes from 0 to 25 years post-construction.
  - Four alternatives have been developed for SMA 3.

13.0 Development of Remedial Alternatives

This section provides an array of remedial alternatives using the retained technologies screened in Section 12.0. These alternatives span the range of potential remediation options for each SMA in the SCU, from full removal to MNR.

13.1 SEDIMENT MANAGEMENT AREA 1 REMEDIAL ALTERNATIVES

SMA 1 is an approximately 37-acre area within the inner harbor that, relative to other areas of the SCU, has greater potential risks to human health and the environment. These greater risks for SMA 1 are summarized below, along with other factors that should be considered for technology application in this SMA (refer to Sections 11.5.1 and 11.7.1):

- Surface sediment concentrations greater than the 90/90 UTL of surface sediment concentrations for Total TEQ within the SCU.
- Surface sediment concentrations greater than the 90/90 UTL of surface sediment concentrations for mercury within the SCU.
- Average cPAH TEQ surface sediment concentration marginally less than the RAL for achievement of the cleanup standards immediately following completion of construction.
- Relatively bioavailable Total TEQ concentrations based on bioaccumulation and porewater measurements.
- Sediment toxicity greater than the SCO biological criteria as measured in bioassays.
- Areas of historically mixed sediments based on radioisotope and SPI profiles.
- Operational overwater structures, terminals, and berths with average sediment concentrations greater than 2 times the RALs calculated for achievement of cleanup standards immediately following completion of construction.
- Substantial accumulation of buried wood debris (including logs).
- Area includes the inner harbor intertidal area.
- Subtidal areas with localized water depths that are at the limit of available equipment.

Eight remedial alternatives were assembled for potential application to SMA 1 that span a wide range of technologies, approaches, and construction timeframes (Table 13.1). The alternatives are depicted in Figures 13.1 through 13.8. Each of these SMA 1 alternatives is described in the following sections.

13.1.1 Alternative 1-A: Maximum Dredging and Excavation

SUMMARY:

- 633,000 CY removal (26,000 CY intertidal/607,000 CY subtidal)
- 51,000 CY backfill and dredge residual layer (26,000 CY intertidal/25,000 CY subtidal)
- 11-year construction
- Cultural resource concerns
- No aquatic habitat mitigation required

Alternative 1-A includes subtidal dredging and intertidal excavation of contaminated sediments to the maximum extent practicable over approximately 33 acres of SMA 1, incorporating 50-foot offsets from existing structures, riprap or bulkheads to protect their integrity (Figure 13.1). Based on the available sediment coring data for SMA 1, an average of approximately 12 feet of contaminated sediment would be dredged or excavated from subtidal and intertidal areas, respectively, across SMA 1, including a 1-foot-deep overdredge/overexcavation allowance. A post-dredge 6-inch-thick sand cover would be placed in subtidal dredging areas for residual management. The intertidal excavations would be backfilled to return these areas to current grade, obviating the need for aquatic habitat mitigation.

During remedial design, further sampling and analysis of the prospective 33-acre subtidal dredging and intertidal excavation areas would be performed. Detailed evaluations of the dredge design depths would be performed to refine dredging volumes and to develop constructible dredge plans. Intertidal sediments identified for remedial action by Ecology with IHS concentrations less than RALs across the 45-cm-deep intertidal point of compliance would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed throughout the prospective 33-acre removal area. If the survey reveals that dredging and/or excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, as described in Alternative 1-E: Subtidal and Intertidal Capping. Dredging and excavation in culturally sensitive areas would be avoided. Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

The upland extent of contaminated intertidal sediments in SMA 1 that would be addressed by Alternative 1-A (as well as all other SMA 1 alternatives) was delineated by Ecology (Ecology *Memorandum Re: Western Port Angeles Harbor: RI/FS Approach*; Ecology 2017a) to be between MHHW and MLLW elevations, except in areas where this tidal level is covered by riprap or bulkheads, as defined under the AO. This intertidal area within SMA 1 covers approximately 1.3 acres. Building on recent Puget Sound sediment remediation experience, intertidal excavations in these areas would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline and scheduling work shifts during low tides. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Intertidal sediments are likely to be free-draining and could thus be stockpiled or loaded directly onto trucks without gravity dewatering or amendment addition. Intertidal backfilling may be completed concurrent with excavation actions, with the backfill placed within the same work shift immediately following completion of excavation if possible.

Subtidal dredging operations would likely be sequenced after completion of intertidal capping, and would be performed using appropriate mechanical equipment such as an enclosed clamshell bucket operating from a barge-mounted dredge. Details on dredge sequencing will be determined during remedial design and contracting and will consider factors such as the equipment type, size and quantity, and the contractor's proposed project schedule. Because of extensive wood debris (e.g., buried logs) present in SMA 1, a pre-dredge debris sweep using mechanical equipment such as a traditional clamshell bucket is expected to be necessary for this alternative. However, in some areas the wood waste impacts are expected to extend below the sea bottom and debris management would likely be performed continuously in some areas, resulting in slower production rates and additional dredge material left behind. Subtidal sediments in SMA 1 are relatively fine-grained and would likely require barge dewatering followed by addition of a dewatering amendment (e.g., Portland cement) during transloading for handling and disposal. Subtidal residual management cover would be placed after completion of dredging. Cultural resource monitoring would be conducted during dredging in accordance with the current LEKT MDP framework (Appendix F).

Alternative 1-A would include dredging and/or excavation of approximately 633,000 CY of in-place contaminated subtidal and/or intertidal sediments (i.e., prior to bulking), along with placement of approximately 51,000 CY of intertidal backfill and dredge residual covers. Dredged and excavated sediment would be transloaded at the prospective Port Terminal 6 transload facility. All sediments are assumed to be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable backfill/cover material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transloaded to barges at the Terminal 6 facility. Implementation of Alternative 1-A would extend over approximately 11 in-water construction seasons (Table 13.1).

13.1.2 Alternative 1-B: Partial Dredging and Excavation with Capping

SUMMARY:

- 105,000 CY removal (4,300 CY intertidal/101,000 CY subtidal)
- 33 acres cap
- Approximately 3-year construction
- Cultural resource concerns
- No aquatic habitat mitigation required

Alternative 1-B includes subtidal dredging and intertidal excavation of the top 2 feet (including overdredge/overexcavation allowances) of contaminated sediments over approximately 33 acres of SMA 1, incorporating 50-foot offsets from existing structures to protect their integrity (Figure 13.2). A 2-foot-thick (including overplacement allowance) engineered cap would be constructed over all dredged and excavated areas, returning these areas to current grade and obviating the need for aquatic habitat mitigation. Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action, tidal currents, and propeller wash forces.

During remedial design, sampling and analysis of the prospective 1.3-acre intertidal excavation area would be performed to more accurately delineate areas that exceed intertidal area RALs (Table 11.1) across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed throughout the prospective 33 acres of dredging and excavation areas. If the survey reveals that dredging and/or excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, as described in Alternative 1-E: Subtidal and Intertidal Capping. Dredging and excavation in culturally sensitive areas would be avoided. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Intertidal excavations would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides, and with cultural resource monitoring. Intertidal capping may be performed immediately following completion of excavation, with the cap material placed within the same work shift immediately following completion of excavation if possible.

Subtidal dredging operations would likely be sequenced after completion of intertidal capping, and would be performed using appropriate mechanical equipment such as an enclosed clamshell bucket operating from a barge-mounted dredge. Details on dredge sequencing will be determined during remedial design and contracting and will consider factors such as the equipment type, equipment size, number of dredge barges, and the contractor’s proposed project schedule. Like Alternative 1-A: Maximum Dredging and Excavation, because of extensive wood debris (e.g., buried logs) present in SMA 1, a pre-dredge debris sweep using mechanical equipment such as a traditional clamshell bucket is expected to be necessary for this alternative. Subtidal sediments in SMA 1 are relatively fine-grained and would likely require barge dewatering followed by addition of a dewatering amendment (e.g., Portland cement) during transloading for handling and disposal. Subtidal capping would be sequenced to follow dredging actions. Cultural resource monitoring would be conducted during dredging in accordance with the current LEKT MDP framework (Appendix F).

Alternative 1-B would include dredging and/or excavation of approximately 105,000 CY of in-place contaminated subtidal and/or intertidal sediments, along with placement of the same volume (105,000 CY) of engineered cap material. Dredged and excavated sediment would be transloaded at the prospective Port Terminal 6 transload facility. All sediments would be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable cap material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transloaded to barges at the

Terminal 6 facility. Implementation of Alternative 1-B would extend over approximately three in-water construction seasons (Table 13.1).

13.1.3 Alternative 1-C: Partial Subtidal Dredging with Subtidal and Intertidal Capping

SUMMARY:

- 27,100 CY subtidal removal
- 33 acres cap
- Approximately 2-year construction
- Cultural resource concerns
- On-site aquatic habitat mitigation required (3,300 CY upland soil excavation from 0.5 acres)

Alternative 1-C includes subtidal dredging to remove the top 2 feet (including overdredge allowance) of contaminated sediments with the greatest overall sediment IHS concentrations, over approximately 8.3 acres of SMA 1 (Figure 13.3). A 2-foot-thick (including overplacement allowance) engineered cap would be constructed over all dredged areas, returning these areas to current grade. Engineered caps would also be placed over an additional approximately 24 acres of intertidal and subtidal sediments in SMA 1, incorporating 50-foot offsets from existing structures, to protect their integrity. Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action, tidal currents, and propeller wash forces.

During remedial design, sampling and analysis of the prospective intertidal capping area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed throughout the prospective dredging area. If the survey reveals that dredging actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, as described in Alternative 1-E: Subtidal and Intertidal Capping. Cultural resource monitoring would be conducted during excavation and dredging in accordance with the current LEKT MDP framework (Appendix F). Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Placement of engineered caps in up to 1.3 acres of intertidal areas (delineated during remedial design) would result in the loss of up to approximately 0.3 acres of aquatic area. Aquatic area loss would be mitigated on-site and in-kind by excavating approximately 3,300 CY of existing uplands from an approximate 0.5-acre area along the SMA 1 shoreline, resulting in no net loss of aquatic habitat. The specific location and layout of the shoreline upland excavation area required for aquatic habitat mitigation would be determined during remedial design, and is shown in concept on Figure 13.3. Removal for the purpose of habitat mitigation would need to consider cultural resources, present and potential future land use, and upland conditions (e.g., the potential presence of contaminants in soil).

Intertidal capping (and shoreline excavation for habitat mitigation) would likely be performed "in the dry" using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides, and with cultural resource monitoring.

Subtidal dredging operations would likely be sequenced after completion of intertidal capping, and would be performed using appropriate mechanical equipment such as an enclosed clamshell bucket operating from a barge-mounted dredge. Details on dredge sequencing will be determined during remedial design and contracting and will consider factors such as the equipment type, equipment size, number of dredge barges, and the contractor's proposed project schedule. Because of extensive wood debris (e.g., buried logs) present in SMA 1, a pre-dredge debris sweep using mechanical equipment such as a traditional clamshell bucket is expected to be necessary for this alternative. Subtidal sediments in SMA 1 are relatively fine-grained and would likely require barge dewatering followed by addition of a dewatering amendment (e.g., Portland cement) during transloading for handling and disposal. Subtidal capping would be sequenced to follow dredging actions.

Alternative 1-C would include dredging and/or excavation of approximately 30,400 CY of in-place contaminated subtidal sediments (27,100 CY) and shoreline soils (3,300 CY; for habitat mitigation), along with placement of approximately 107,000 CY of engineered cap material. Dredged sediment would be transloaded at a prospective Port Terminal 6 transload facility. It is assumed dredged sediments would be transported (by truck and rail) for disposal of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable cap material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transloaded to barges at the Terminal 6 facility. Implementation of Alternative 1-C would extend over approximately two in-water construction seasons (Table 13.1).

13.1.4 Alternative 1-D: Partial Intertidal Excavation and Capping with Subtidal Capping

SUMMARY:

- 4,300 CY intertidal removal
- 33 acres cap
- Approximately 2-year construction
- Cultural resource concerns
- No aquatic habitat mitigation required

Alternative 1-D includes placement of a 2-foot-thick engineered cap over approximately 33 subtidal acres of SMA 1, incorporating 50-foot offsets from existing structures to protect their integrity, along with partial (2 feet, including overexcavation allowance) excavation in up to 1.3 acres of contaminated intertidal sediments (Figure 13.4). The intertidal excavations would be backfilled with a 2-foot-thick (including overplacement allowance) cap to return these areas to current grade, obviating the need for aquatic habitat mitigation, and subtidal caps are not anticipated to require mitigation as they do not result in loss of aquatic area. Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action, tidal currents, and propeller wash forces.

During remedial design, sampling and analysis of the prospective 1.3-acre intertidal excavation area would be performed to more accurately delineate areas that exceed RALs across the

45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed in the prospective 1.3-acre intertidal excavation area. If the survey reveals that excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, as described in Alternative 1-E: Subtidal and Intertidal Capping. Excavation in culturally sensitive areas would be avoided. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Intertidal excavations would likely be performed "in the dry" using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides, and with cultural resource monitoring. Intertidal capping would be completed concurrent with excavation actions, with the cap placed within the same work shift immediately following completion of excavation. Subtidal capping operations would be sequenced after completion of intertidal capping, and would be performed using mechanical placement equipment operating from a marine platform.

Alternative 1-D would include excavation of up to approximately 4,300 CY of in-place contaminated intertidal sediments and approximately 105,000 CY of cap placement over 33 acres. Suitable cap material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at a prospective Port Terminal 6 transload facility. While excavated intertidal sediment would be disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Implementation of Alternative 1-D would extend over approximately two in-water construction seasons (Table 13.1).

13.1.5 Alternative 1-E: Subtidal and Intertidal Capping

SUMMARY:

- 33 acres cap
- Approximately 2-year construction
- On-site aquatic habitat mitigation required (3,300 CY upland soil excavation from 0.5 acres)

Alternative 1-E includes placement of a 2-foot-thick (including overplacement allowance) engineered cap over approximately 33 acres of intertidal and subtidal sediments in SMA 1, incorporating 50-foot offsets from existing structures to protect their integrity (Figure 13.5). Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action, tidal currents, and propeller wash forces.

During remedial design, sampling and analysis of the prospective 1.3-acre intertidal capping area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Means and methods for placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Placement of engineered caps in subtidal areas would not result in loss of aquatic area, and mitigation is not expected to be required for subtidal capping. Placement of engineered caps in up to 1.3 acres of intertidal sediments (delineated during remedial design) would result in the loss of up to approximately 0.3 acres of aquatic habitat. Habitat area would be mitigated on-site and in-kind by excavating approximately 3,300 CY of existing uplands along the SMA 1 shoreline, resulting in no net loss of aquatic habitat. The specific location and layout of the shoreline upland excavation area required for aquatic habitat mitigation would be determined during remedial design, and is shown in concept on Figure 13.5. Removal for the purpose of habitat mitigation would need to consider cultural resources, present and potential future land use, and upland conditions (e.g., the potential presence of contaminants in soil).

Intertidal capping (and shoreline excavation for habitat mitigation) would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline and scheduling work shifts during low tides. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Subtidal capping operations would be sequenced after completion of intertidal capping, and would be performed using mechanical placement equipment operating from a marine platform.

Alternative 1-E would include excavation of up to approximately 3,300 CY of shoreline soils (for aquatic habitat mitigation) and approximately 107,000 CY of cap placement. Suitable cap material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at a prospective Port Terminal 6 transload facility. While excavated shoreline soils would be disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Implementation of Alternative 1-E would extend over approximately two in-water construction seasons (Table 13.1).

13.1.6 Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal Enhanced Monitored Natural Recovery

SUMMARY:

- 33 acres cap and EMNR
- Approximately 1-year construction
- On-site aquatic habitat mitigation required (3,300 CY upland soil excavation from 0.5 acres)

Alternative 1-F includes placement of a 2-foot-thick (including overplacement allowance) engineered cap over approximately 2.5 acres of higher energy intertidal areas and subtidal berthing areas of SMA 1, incorporating 50-foot offsets from existing structures to protect their integrity (Figure 13.6). Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action, tidal currents, and propeller wash forces. An average 6-inch-thick EMNR layer would be placed over approximately 30 acres of contaminated subtidal sediments in lower energy areas of SMA 1 to accelerate natural recovery.

During remedial design, sampling and analysis of the prospective 1.3-acre intertidal capping area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations below RALs would be delineated as no action areas. Means and methods for placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Placement of EMNR in subtidal areas would not result in loss of aquatic area, and mitigation is not expected to be required for subtidal EMNR. Placement of engineered caps in up to 1.3 acres of intertidal sediments (delineated during remedial design) would result in the loss of up to approximately 0.3 acres of aquatic area. Habitat loss in intertidal areas would be mitigated on-site and in-kind by excavating approximately 3,300 CY from approximately 0.5 acres of existing uplands along the SMA 1 shoreline, resulting in no net loss of aquatic habitat. The specific location and layout of the shoreline upland excavation area required for aquatic habitat mitigation would be determined during remedial design, and is shown in concept on Figure 13.6. Removal for the purpose of habitat mitigation would need to consider cultural resources, present and potential future land use, and upland conditions (e.g., the potential presence of contaminants in soil).

Intertidal capping (and shoreline excavation for habitat mitigation) would likely be performed "in the dry" using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Subtidal capping operations in berthing areas along with subtidal EMNR placement would be sequenced after completion of intertidal capping, and would be performed using mechanical placement equipment operating from a marine platform. If large debris that would interfere with EMNR placement is present, removal of this debris would occur prior to EMNR placement.

Alternative 1-F would include excavation of up to approximately 3,300 CY of shoreline soils (for aquatic habitat mitigation) and approximately 34,200 CY of cap/EMNR placement. Suitable cap/EMNR material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at a prospective Port Terminal 6 transload facility. Excavated shoreline soils would be disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Implementation of Alternative 1-F would likely extend over a single in-water construction season (Table 13.1).

13.1.7 Alternative 1-G: Enhanced Monitored Natural Recovery

SUMMARY:

- No removal
- 33 acres EMNR
- Approximately 1-year construction
- No aquatic habitat mitigation required
- Does not address 45-cm intertidal point of compliance

Alternative 1-G includes placement of a 6-inch-thick EMNR layer to accelerate natural recovery over approximately 33 intertidal and subtidal acres of SMA 1, incorporating 50-foot offsets from existing structures to protect their integrity (Figure 13.7).

During remedial design, sampling and analysis of the prospective 1.3-acre intertidal EMNR area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. EMNR placement would not result in the loss of aquatic habitat, obviating the need for aquatic habitat mitigation. Means and methods for placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Alternative 1-G would include approximately 26,400 CY of EMNR placement over 33 acres. Suitable EMNR material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at a prospective Port Terminal 6 transload facility. Implementation of Alternative 1-G would likely extend over a single in-water construction season (Table 13.1).

The SCLs would be met at the 10-cm subtidal point of compliance immediately following construction. However, SCLs would not be met at the 45-cm intertidal point of compliance, and an SRZ would likely be necessary to track the intertidal concentrations (a restoration timeframe was not calculated for intertidal EMNR).

13.1.8 Alternative 1-H: Monitored Natural Recovery

SUMMARY:

- No construction
- Does not address 45-cm intertidal point of compliance
- Sediment Recovery Zone required

Alternative 1-H includes MNR across SMA 1 (Figure 13.8). Monitoring would occur until the cleanup standards are achieved in the SCU, which is estimated to require more than 70 years based on the current surface sediment concentrations, sedimentation rates, and resulting estimated rates of natural recovery (Table 11.1). For compliance with SMS, a practicability evaluation and SRZ would be required under this alternative.

Alternative 1-H would include no construction (Table 13.1).

13.2 SEDIMENT MANAGEMENT AREA 2 REMEDIAL ALTERNATIVES

SMA 2, the lagoon, is an approximately 25-acre area of the SCU that has lower potential risks to human health and the environment than SMA 1. The potential human health and environmental risks for SMA 2 are summarized in the following sections, along with other factors that should be considered for technology application in this SMA (refer to Section 11.1.2). SMA 2 technology applicability considerations including the following:

- Average surface sediment concentration of Total TEQ of 55 ng/kg, however, relatively non-bioavailable Total TEQ concentrations in sediment based on bioaccumulation and porewater measurements (Figure 7.38 and Section 7.4).
- Average surface sediment concentrations of mercury of 0.48 mg/kg.
- No sediment toxicity greater than SCO biological criteria as measured in bioassays.
- Location on private property, with restricted access and signage, and further restriction by upland industrial operations of McKinley Paper Company.
- Inaccessible by water for marine equipment through the lagoon channel, which is narrow, with shallow water depth.
- Area includes the lagoon intertidal area.
- Relatively higher energy environment in lagoon channel, while other areas of the lagoon have more stable sediments that are primarily affected by wind/wave forces.
- Accumulation of wood debris (including buried logs) throughout the SMA.
- An established eelgrass meadow present in the subtidal area of the lagoon.
- An established and assumed high-value salt marsh present at the far western corner of the lagoon.
- An elevated water main along the southwestern edge of the lagoon, which would need to be avoided to maintain integrity of the infrastructure.

Sediments in most of SMA 2 are stable, with the exception of the narrow inflow lagoon channel that has relatively high discharge velocities during peak flood tides. Much of SMA 2 is characterized by access constraints as this area is not accessible by marine equipment, and the developed shoreline of the McKinley Paper Company also limits potential shoreline construction options. Alternatives that involve removal of contaminated sediment or placement of clean material will require access to the lagoon through the adjacent privately owned uplands. The degree of this disruption is relative to the volume of material handled, and duration of construction activities. Construction actions in fringing salt marsh habitat located at the far western corner of SMA 2, located near an existing City stormwater outfall, will be avoided to minimize potential damage to sensitive habitat and minimize infrastructure impacts. These constraints limit active remedy in approximately 1.2 acres of SMA 2 in the alternatives developed in this FS.

Seven remedial alternatives were assembled for potential application to SMA 2 that span a wide range of technologies, approaches, and construction timeframes (Table 13.1). The alternatives are depicted in Figures 13.9 through 13.15. Each of these SMA 2 alternatives is described in the following sections.

13.2.1 Alternative 2-A: Maximum Dredging and Excavation

SUMMARY:

- 152,000 CY removal
  (65,000 CY intertidal/87,000 CY subtidal)
- 152,000 CY backfill
- Approximately 5-year construction
- Cultural resource concerns
- Eelgrass loss evaluation required

Alternative 2-A includes intertidal excavation and subtidal dredging of contaminated sediments to the maximum extent practicable over approximately 24 acres of SMA 2 (Figure 13.9). Based on the available subsurface data for SMA 2, an average of roughly 4 feet of contaminated sediment would be dredged or excavated from subtidal and intertidal areas, respectively, across SMA 2, including a 1-foot overdredge/overexcavation allowance. Both subtidal dredge prisms and intertidal excavations would be backfilled to return these areas to current grade, obviating the need for aquatic habitat mitigation, but still requiring evaluation of the loss of subtidal eelgrass meadows and potentially eelgrass transplanting to mitigate eelgrass loss.

During remedial design, further sampling and analysis of the prospective 24-acre intertidal excavation and subtidal dredging areas would be performed. Detailed evaluations of the excavation and dredging depths would be performed to develop constructible excavation and dredge plans. Intertidal sediments with IHS concentrations less than RALs across the 45-cm-deep intertidal point of compliance would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed throughout the prospective 24-acre excavation and dredging areas. If the survey reveals that dredging and/or excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped (intertidal areas) or receive EMNR placement (subtidal areas), as described in Alternative 2-E: Intertidal Capping with Subtidal EMNR. Excavation and dredging in culturally sensitive areas would be avoided. Cultural resource monitoring would be conducted during excavation and dredging in accordance with the current LEKT MDP framework (Appendix F). Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

The extent of contaminated intertidal sediments that would be addressed under this alternative (as well as all other SMA 2 alternatives) was identified by Ecology (Ecology 2017a). This intertidal area within SMA 2 covers approximately 10 acres.

Intertidal excavations in the southeast portion of SMA 2, as well as other areas as practicable, would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline and scheduling work shifts during low tides. Intertidal sediments in the southeast portion of SMA 2 are likely to be free-draining and could thus be stockpiled in an available staging area or loaded directly onto trucks without gravity dewatering or amendment addition. Intertidal backfilling may be completed concurrent with excavation actions, with the backfill placed within the same work shift immediately following completion of excavation if possible.

Subtidal dredging operations would likely be sequenced after completion of intertidal capping in SMA 2, and would likely be performed using appropriate mechanical equipment such as an enclosed clamshell bucket operating from temporary modular pontoons or similar equipment. Because of extensive wood debris (e.g., buried logs) present in SMA 2, a pre-dredge debris sweep using mechanical equipment such as a traditional clamshell bucket may also be necessary for this alternative, and debris may be encountered in sediments at depth. Subtidal sediments in SMA 2, as well as intertidal sediments in the northwest portion of SMA 2, are relatively fine-grained and would likely require passive dewatering followed by addition of a dewatering amendment (e.g., Portland cement) during transloading at the prospective Port Terminal 6 facility for handling and disposal. A post-dredge 6-inch-thick sand cover would also likely be placed in subtidal dredging areas for residual management.

Alternative 2-A would include excavation and/or dredging of approximately 152,000 CY of contaminated intertidal and subtidal sediments, along with placement of the same volume (152,000 CY) of intertidal and subtidal backfill. The excavated/dredged sediments under Alternative 2-A are assumed to be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable backfill material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles. Implementation of Alternative 2-A would extend over approximately five in-water construction seasons (Table 13.1).

13.2.2 Alternative 2-B: Partial Dredging and Excavation with Capping

SUMMARY:

- 76,100 CY removal
  (32,600 CY intertidal/43,500 CY subtidal)
- 24 acres cap
- Approximately 3-year construction
- Cultural resource concerns
- Eelgrass loss evaluation required

Alternative 2-B includes intertidal excavation and subtidal dredging of the top 2 feet (including overdredge allowance) of contaminated sediments over approximately 24 acres of SMA 2 (Figure 13.10). A 2-foot-thick (including overplacement allowance) engineered cap would be constructed over all excavation and dredging areas, returning these areas to current grade and obviating the need for aquatic habitat mitigation, but still requiring evaluation of the loss of subtidal eelgrass meadows and potentially eelgrass transplanting to mitigate eelgrass loss. Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action and tidal currents.

During remedial design, sampling and analysis of the prospective 10-acre intertidal excavation area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed throughout the prospective 24-acre excavation and dredging area. If the survey reveals that dredging and/or excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, similar to Alternative 2-E: Intertidal Capping with Subtidal EMNR. Excavation and dredging in culturally sensitive areas would be avoided. Cultural resource monitoring would be conducted during excavation and dredging in accordance with the current LEKT MDP framework (Appendix F). Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Intertidal excavations in the southeast portion of SMA 2, as well as other areas as practicable, would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides, and with cultural resource monitoring. Intertidal capping may be performed immediately following completion of excavation, with the cap material placed within the same work shift immediately following completion of excavation if possible.

Subtidal dredging operations would likely be sequenced after completion of intertidal capping in SMA 2, and would be performed using appropriate mechanical equipment such as an enclosed clamshell bucket likely operating from temporary modular pontoons or similar equipment. Because of extensive wood debris (e.g., buried logs) present in SMA 2, a pre-dredge debris sweep using mechanical equipment such as a traditional clamshell bucket may also be necessary for this alternative, and debris may be encountered in sediments at depth. Subtidal sediments in SMA 2, as well as intertidal sediments in the northwest portion of SMA 2, are relatively fine-grained and would likely require passive dewatering followed by addition of a dewatering amendment (e.g., Portland cement) during transloading at the prospective Port Terminal 6 facility for handling and disposal. Subtidal capping would be sequenced to follow dredging actions.

Alternative 2-B would include excavation and/or dredging of approximately 76,100 CY of in-place contaminated intertidal and subtidal sediments, along with placement of the same volume (76,100 CY) of engineered cap material. All sediments are assumed to be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable cap material (e.g., sand and gravel) would likely be sourced locally from existing quarries. Implementation of Alternative 2-B would likely extend over approximately three in-water construction seasons (Table 13.1).

13.2.3 Alternative 2-C: Partial Intertidal Excavation and Capping with Subtidal Enhanced Monitored Natural Recovery

SUMMARY:

- 32,600 CY intertidal removal
- 14 acres subtidal EMNR
- 10 acres intertidal cap
- Approximately 2-year construction
- Cultural resource concerns
- No eelgrass loss anticipated

Alternative 2-C includes partial (2 feet, including overdredge/overexcavation allowance) excavation in up to 10 acres of contaminated intertidal sediments, along with placement of an average 6-inch-thick EMNR layer over approximately 14 subtidal acres of SMA 2, with EMNR placement occurring over two construction seasons (i.e., 3-inch placement each year) to minimize impacts to subtidal eelgrass meadows (Figure 13.11). The intertidal excavations would be backfilled with a 2-foot-thick (including overplacement allowance) cap to return these areas to current grade, obviating the need for aquatic habitat mitigation. Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action and tidal currents.

During remedial design, sampling and analysis of the prospective 10-acre intertidal excavation area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations below RALs would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed in the prospective 10-acre intertidal excavation area. If the survey reveals that excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, similar to Alternative 2-E: Intertidal Capping with Subtidal EMNR. Excavation in culturally sensitive areas would be avoided. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Means and methods for removal and placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Intertidal excavations in the southeast portion of SMA 2, as well as other areas as practicable, would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides, and with cultural resource monitoring. Intertidal capping would likely be performed immediately following completion of excavation, with the cap material placed within the same work shift immediately following completion of excavation. Subtidal EMNR placement operations would likely be sequenced after completion of intertidal capping in SMA 2, and would likely be performed using mechanical placement equipment operating from temporary modular pontoons or similar equipment.

Alternative 2-C would include excavation of up to approximately 32,600 CY of in-place contaminated intertidal sediments and approximately 43,500 CY of cap and EMNR placement. All sediments are assumed to be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable cap/EMNR material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles. Implementation of Alternative 2-C would extend over approximately two in-water construction seasons (Table 13.1).

13.2.4 Alternative 2-D: Optimized Partial Intertidal Excavation and Capping with Subtidal Enhanced Monitored Natural Recovery

SUMMARY:

- 13,600 CY intertidal removal
- 8.4 acres intertidal cap
- 4.3 acres partial excavation and EMNR
- 11 acres subtidal EMNR
- Approximately 2-year construction
- Cultural resource concerns
- On-site aquatic habitat mitigation required (4,400 CY upland soil excavation from 0.5 acres)
- No eelgrass loss anticipated

Alternative 2-D includes partial excavation of varying depths to maximize contaminated sediment removal, while minimizing the footprint of disturbance to ecologically sensitive areas. Alternative 2-D includes partial excavation and backfill/cap in up to 2.0 acres of contaminated intertidal sediments, partial excavation and backfill/EMNR placement in up to 4.3 acres of intertidal and subtidal contaminated sediments, placement of a 2-foot-thick (including overplacement allowance) cap over up to an additional 6.4 acres of intertidal sediments, along with placement of an average 6-inch-thick EMNR layer over approximately 11 subtidal acres of SMA 2, with EMNR placement occurring over two construction seasons (i.e., 3-inch-thick placement each year) to minimize impacts to subtidal eelgrass meadows (Figure 13.12). Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action and tidal currents.

During remedial design, sampling and analysis of the intertidal area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Also during remedial design, a cultural resource survey would be performed in the prospective intertidal excavation area. If the survey reveals that excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be capped, as described in Alternative 2-E: Intertidal Capping with Subtidal EMNR. Excavation in culturally sensitive areas would be avoided. Cultural resource monitoring would be conducted during excavation in accordance with the current LEKT MDP framework (Appendix F). Means and methods for placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Placement of engineered caps in up to 8.4 acres of intertidal sediments (delineated during remedial design) would result in the loss of up to approximately 1.1 acres of aquatic habitat. Habitat area would be mitigated on-site and in-kind by excavating approximately 4,400 CY from an approximate 0.5-acre area of existing upland fill soils (placed in the 1960s) that creates the causeway in the southwest corner of the lagoon, to result in no net loss of aquatic habitat. Cultural resource monitoring would be conducted consistent with intertidal excavation. The specific location and layout of the upland excavation area required for aquatic habitat mitigation would be determined during remedial design, and is shown in concept on Figure 13.12.

Intertidal excavations along the eastern shoreline of SMA 2 would likely be performed “in the dry” using land-based excavation- and/or dozer-type equipment operating from the shoreline, scheduling work shifts during low tides, and with cultural resource monitoring. Intertidal capping would be attempted immediately following completion of excavation, with the cap material placed within the same work shift immediately following completion of excavation if possible. Intertidal capping in other areas of SMA 2 along with subtidal EMNR placement operations would likely be sequenced after completion of intertidal excavation/capping, and would likely be performed using mechanical placement equipment likely operating from temporary modular pontoons or similar equipment. It is assumed that excavation for habitat mitigation purposes would be conducted “in the dry” with access to the area determined during design, in coordination with McKinley Paper Company. Means and methods, as well as project sequencing will be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Alternative 2-D would include excavation of up to approximately 18,000 CY of in-place contaminated intertidal sediments (13,600 CY) and shoreline soils (4,400 CY; for habitat mitigation) and approximately 41,000 CY of cap and EMNR placement. All sediments are assumed to be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Suitable cap/EMNR material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles. Although implementation of Alternative 2-D could likely be conducted in a single in-water construction season, it is expected that construction would extend over two partial in-water construction seasons (placement of the subtidal EMNR layer would be spread out over 2 years to minimize impacts to existing eelgrass meadows; Table 13.1).

13.2.5 Alternative 2-E: Intertidal Capping with Subtidal Enhanced Monitored Natural Recovery

SUMMARY:

- 10 acres intertidal cap
- 14 acres subtidal EMNR
- Approximately 2-year construction
- Cultural resource concerns
- On-site aquatic habitat mitigation required (5,300 CY upland soil excavation from 0.6 acres)
- No eelgrass loss anticipated

Alternative 2-E includes placement of a 2-foot-thick (including overplacement allowance) cap over up to approximately 10 acres of intertidal sediments, along with placement of an average 6-inch-thick EMNR layer over approximately 14 subtidal acres of SMA 2, with EMNR placement occurring over two construction seasons (i.e., 3-inch-thick placement each year) to minimize impacts to subtidal eelgrass meadows (Figure 13.13). Caps would be engineered for long-term stability and chemical isolation, including appropriate armoring to resist wave action and tidal currents.

During remedial design, sampling and analysis of the prospective 10-acre intertidal capping area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Means and methods for placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Placement of engineered caps in up to 10 acres of intertidal sediments (delineated during remedial design) would result in the loss of up to approximately 1.1 acres of aquatic habitat. Habitat area would be mitigated on-site and in-kind by excavating approximately 5,300 CY of existing upland fill soils from approximately 0.6 acres (placed in the 1960s) along the SMA 2 shoreline, resulting in no net loss of aquatic habitat. The specific location and layout of the shoreline upland excavation area required for aquatic habitat mitigation would be determined during remedial design, and is shown in concept on Figure 13.13. During remedial design data collection, a cultural resource survey would be performed in the prospective 1.1-acre habitat mitigation excavation area. If the survey reveals that excavation actions could potentially cause unacceptable disturbance of cultural resources, these areas would be avoided. Cultural resource monitoring during both remedial investigations and remedy construction would be conducted in accordance the current LEKT MDP framework (Appendix F).

Intertidal capping, and excavation for habitat mitigation, would likely be performed “in the dry” as practicable using land-based excavation- and/or dozer-type equipment operating from the shoreline and scheduling work shifts during low tides. Subtidal EMNR placement operations would be sequenced after completion of intertidal capping, and would be performed using mechanical placement equipment likely operating from temporary modular pontoons or similar equipment.

Alternative 2-E would include excavation of up to approximately 5,300 CY of shoreline soils (for habitat mitigation) and approximately 45,000 CY of cap and EMNR placement. Suitable cap/EMNR material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles. All sediments are assumed to be transported (by truck and rail) and disposed of at a regional Subtitle D landfill (e.g., in eastern Washington). Implementation of Alternative 2-E would likely extend over two partial in-water construction seasons (placement of the subtidal EMNR layer would be spread out over 2 years to minimize impacts to existing eelgrass meadows; Table 13.1).

13.2.6 Alternative 2-F: Enhanced Monitored Natural Recovery

SUMMARY:

- No removal
- 10 acres intertidal EMNR
- 14 acres subtidal EMNR
- Approximately 2-year construction
- No aquatic habitat or eelgrass loss anticipated
- Does not address 45-cm intertidal point of compliance

Alternative 2-F includes placement of a 6-inch-thick EMNR layer to accelerate natural recovery over approximately 24 acres of SMA 2: 10 acres intertidal and 14 acres subtidal (Figure 13.14). EMNR placement would occur over two construction seasons (i.e., 3-inch-thick placement each year) to minimize impacts to subtidal eelgrass meadows. EMNR placement would not result in the loss of aquatic habitat, obviating the need for aquatic habitat mitigation.

During remedial design, sampling and analysis of the prospective 10-acre intertidal remediation area would be performed to more accurately delineate areas that exceed RALs across the 45-cm-deep intertidal point of compliance. Intertidal sediments with IHS concentrations less than RALs would be delineated as no action areas. Means and methods for placement activities would be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.

Subtidal EMNR placement operations would likely be performed using mechanical placement equipment operating from temporary modular pontoons or similar equipment, while intertidal EMNR would be performed "in the dry" as practicable using land-based excavation- and/or dozer-type equipment operating from the shoreline and scheduling work shifts during low tides.

Alternative 2-F would include approximately 19,000 CY of EMNR placement. Suitable EMNR material (e.g., sand and gravel) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles. Implementation of Alternative 2-F would likely extend over two partial in-water construction seasons (placement of the subtidal EMNR layer would be spread out over 2 years to minimize impacts to existing eelgrass meadows; Table 13.1).

The SCLs would be met at the 10-cm subtidal point of compliance immediately following construction. However, SCLs would not be met at the 45-cm intertidal point of compliance, and an SRZ would likely be necessary to track the intertidal concentrations (a restoration timeframe was not calculated for intertidal EMNR).

13.2.7 Alternative 2-G: Monitored Natural Recovery

SUMMARY:

- No construction
- Does not address 45-cm intertidal point of compliance
- Sediment Recovery Zone required

Alternative 2-G includes MNR across SMA 2 (Figure 13.15). Monitoring would occur until the cleanup standards are achieved in the SCU, which is estimated to require more than 70 years based on the current surface sediment concentrations, sedimentation rates, and resulting estimated rates of natural recovery (Table 11.1). A practicability evaluation and SRZ would be required under this alternative.

Alternative 2-G would include no construction (Table 13.1).

13.3 SEDIMENT MANAGEMENT AREA 3 REMEDIAL ALTERNATIVES

SMA 3 is an approximately 1,100-acre area (approximately 645 acres of which is within water depths greater than -50 feet MLLW) that spans the industrial/commercial waterfront of Port Angeles as well as the outer harbor of the SCU. Compared to SMA 1 and SMA 2, SMA 3 remediation is driven by lower-level sediment contaminant concentrations spread over a very large area, more than half of which occurs at deep water depths. The SMA provides lower potential to reduce site-wide human health and environmental risks, due in part to relatively diffuse, lower-level cPAH TEQ and Total TEQ concentrations. Application of active remedy throughout this area would not be feasible, nor is it required, given current average surface sediment concentrations across the area. Unlike SMA 1 and SMA 2, engineered remedial actions are not required throughout the entire SMA to achieve compliance with cleanup standards. The potential human health and environmental risks for SMA 3 are summarized in the following section, along with other factors that should be considered for technology application in this SMA (refer to Sections 11.5.3 and 11.7.3). SMA 3 technology applicability considerations including the following:

- SMA 3 contains relatively diffuse, lower-level cPAH TEQ and Total TEQ concentrations that on a point-by-point basis are only marginally (typically less than 2-fold) greater than calculated RALs immediately following completion of construction (Restoration Timeframe = 0). The existing average surface sediment concentrations within SMA 3 for all three bioaccumulative IHSs are less than the calculated RALs for Restoration Timeframe = 0.

- No discernible sediment toxicity greater than SCO biological criteria as measured in bioassays has been identified that is attributable to hazardous substance releases. However, as previously noted in Section 11.1, isolated SCO biological criteria exceedances not associated with chemistry are located in SMA 3. These locations will be re-sampled during remedial design to determine if they need to be addressed.
- Additionally, based on radioisotope and SPI profiles, sediments in most of SMA 3 are stable.
- Construction actions adjacent to structures and within Port operational areas will need to be avoided as practicable to minimize potential infrastructure and economic/operational impacts.[20]
- Subtidal areas with very deep water (nearly 60 percent of the SMA is deeper than -50 feet MLLW) that are at and beyond the limit of available equipment.
- SMA 3 is readily accessible from land or water (assuming terminal access is allowed at an existing Port or City facility), with no navigational concerns.
- Intertidal areas in SMA 3 do not require remediation to achieve Recovery SWAC Target values. Additionally, Ecology did not identify any likely or possible “shellfish harvest areas” (see Section 1.2.6) within SMA 3. Therefore, intertidal areas will be avoided due to the physical challenges associated with construction and lack of human direct contact exposure routes in SMA 3 intertidal areas.

In summary, subtidal sediment areas in SMA 3 are targeted for remedial action to achieve Recovery SWAC Target values on a SCU-wide basis; intertidal areas and industrial operations areas with concentrations marginally exceeding RALs in SMA 3 do not require remediation to achieve these targets.

While subtidal dredging and engineered capping have been retained as potentially viable options for SMA 1 and SMA 2, these technologies have been screened from the SMA 3 alternatives evaluation. Dredging and capping would not be feasible technologies to address widespread low-level sediment concentrations in SMA 3. Dredging and capping are not feasible given the technical impracticability challenges associated with water depths and high costs associated with dredging or capping the extensive remedial footprint as discussed in the following section.

13.3.1 SMA 3 Technical Impracticability Evaluation

This section summarizes environmental and community impacts that render both subtidal dredging and engineered capping technically impracticable for SMA 3. SMS defines the term “practicable” as “able to be completed in consideration of environmental effects, technical feasibility and cost” (WAC 173-204-200(19)). Given the scope and size of the footprint within

[20] During remedial design, structure-by-structure evaluations will be conducted to determine required structural offsets, and sampling will be conducted to confirm sediment conditions in these areas to determine if remedial actions are required in operational areas to achieve RALs.

SMA 3 requiring active remediation, environmental impacts from in-water construction on this scale (dredge residuals, water quality impacts during removal and material placement, impacts to shellfish beds, vessel and vehicle traffic, interference with fisheries, construction noise and light, and air emissions) would be substantial, and uses of the SCU would be restricted for long periods of time during remedy implementation. Further, neither dredging nor capping would be expected to reduce surface sediment concentrations and associated tissue concentrations more than EMNR, based on the effectiveness of these technologies in sediment cleanup sites with conditions similar to SMA 3 (refer to Appendix H).

Dredging resuspension and residuals releases have been well-documented (refer to Section 12.1.2) and would be expected to result in significant impacts to the WPAH Study Area if a subtidal dredging remedy were to be implemented in SMA 3. Based on sediment conditions in the SCU, release and residuals losses on the order of 2 to 5 percent of the contaminant mass dredged would be expected (Bridges et. al. 2008 and 2010).

Under dredging or capping scenarios for SMA 3, community impacts from noise, light, air emissions, and truck traffic would be significantly more than for an EMNR scenario. To remediate the footprint necessary to achieve cleanup standards in 10 years (164 acres, discussed further in Section 13.3.3), off-site transport and disposal of dredge material would require tens of thousands of dump truck trips through the Port Angeles community. Import of hundreds of thousands of cubic yards of dredge residual cover and/or cap material from a local quarry would also require tens of thousands of dump truck trips through the Port Angeles community. Large-scale in-water construction operations would also inhibit the use of the WPAH Study Area for fishing for at least 9 years (based on the construction duration to cap 164 acres) during the in-water construction seasons. Besides the direct community impacts during construction, related indirect impacts such as infrastructure wear and tear (e.g., pavement damage) would require additional mitigation upon completion of the SMA 3 remedial action.

Importantly, implementing dredging or capping in the area of SMA 3 requiring active remediation would increase the construction timeframe, further delaying the benefit of cleanup. Capping would more than double the construction timeframe compared to EMNR, and dredging is estimated to take a decade or more (considering the 164-acre 10-year restoration timeframe footprint).

Based on the effectiveness of EMNR (Appendix H) in the Harbor and nearby sites, the environmental benefits of remediating with dredging or capping are not significantly more than EMNR in conditions similar to SMA 3. Natural recovery processes are expected to result in a reduction in SMA 3 IHS concentrations over time to achieve cleanup standards. Thin-layer placement of clean EMNR sand is expected to be stable in SMA 3, and monitoring would be performed to confirm stability.

Based on considerations of potential environmental and community impacts, logistical complications, and overall feasibility of conducting a large-scale remedy in the Port Angeles community, subtidal dredging and engineered capping remedies are determined to be technically impracticable in SMA 3. As mentioned in Section 13.3, nearly 60 percent of SMA 3 cannot be dredged with available equipment due to water depth. Therefore, only EMNR and MNR were retained for the SMA 3 alternatives comparison. The four alternatives detailed in the following sections were developed with varying ratios of EMNR and MNR, designated by the estimated timeframe necessary to achieve the cleanup standards (i.e., the restoration timeframe), to span a range of restoration timeframes and costs (Table 13.1). This contrasts with the non-MNR SMA 1 (Section 13.1) and SMA 2 (Section 13.2) remedial alternatives, which were developed to meet cleanup standards immediately following the completion of in-water construction. SMA 3 alternatives are depicted in Figures 13.16 through 13.19, and described in the following sections.

13.3.2 Alternative 3-A: Year 0 Enhanced Monitored Natural Recovery

Alternative 3-A includes EMNR placement over approximately 250 acres of SMA 3 to achieve SCU-wide SCLs, calculated using SWACs, as well as achieving point-by-point compliance with benthic SCLs immediately following completion of construction (Figure 13.16). Following placement of a thin layer of EMNR material on the sediment surface, monitoring would be performed to verify that natural recovery has been accelerated.

SUMMARY:

- No removal or cap
- 202,000 CY EMNR placed over 250 acres
- Approximately 5-year construction

Alternative 3-A would include placement of approximately 202,000 CY of EMNR material. Suitable EMNR material (e.g., silty, gravelly sand) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at the prospective Port Terminal 6 transload facility. Implementation of Alternative 3-A would likely extend over approximately five in-water construction seasons (Table 13.1).

13.3.3 Alternative 3-B: Year 10 Enhanced Monitored Natural Recovery with Monitored Natural Recovery

Alternative 3-B includes EMNR placement over approximately 164 acres of SMA 3 to achieve SCU-wide SCLs, calculated using SWACs, approximately 10 years following completion of construction, as well as achieving point-by-point compliance with benthic SCLs immediately following completion of construction (Figure 13.17). MNR monitoring would be performed throughout the SMA (in both EMNR and MNR areas) during this 10-year period.

SUMMARY:

- No removal or cap
- 132,000 CY EMNR placed over 164 acres
- 3-year construction

Alternative 3-B would include placement of approximately 132,000 CY of EMNR material. Suitable EMNR material (e.g., silty, gravelly sand) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at the prospective

Port Terminal 6 transload facility. Implementation of Alternative 3-B would likely extend over approximately three in-water construction seasons (Table 13.1).

13.3.4 Alternative 3-C: Year 25 Enhanced Monitored Natural Recovery with Monitored Natural Recovery

SUMMARY:

- No removal or cap
- 33,000 CY EMNR placed over 41 acres
- Approximately 1-year construction
- Sediment Recovery Zone required

Alternative 3-C includes EMNR placement of approximately 41 acres of SMA 3 to achieve SCU-wide SCLs, calculated using SWACs, approximately 25 years following completion of construction (Figure 13.18), as well as achieving point-by-point compliance with benthic SCLs immediately following completion of construction. MNR monitoring would be performed throughout the SMA during this 25-year period (including both EMNR and MNR areas [Figure 13.19]). An SRZ would be required under this alternative as described in Section 14.1.1.

Alternative 3-C would include placement of approximately 33,000 CY of EMNR material. Suitable EMNR material (e.g., silty, gravelly sand) would likely be sourced locally from existing quarries within approximately 5 miles of Port Angeles, and transferred to barges at the prospective Port Terminal 6 transload facility. Implementation of Alternative 3-C would likely extend over a single in-water construction season (Table 13.1).

13.3.5 Alternative 3-D: Monitored Natural Recovery

SUMMARY:

- No construction
- Sediment Recovery Zone required

Alternative 3-D includes MNR across the entire SMA. Monitoring would occur until the SCLs, calculated using a SWAC, are achieved in the SCU, which is estimated to require more than 70 years based on the current surface sediment concentrations, sedimentation rates, and resulting estimated rates of natural recovery (refer to Appendix B). An SRZ would be required under this alternative, as discussed in Section 14.1.1.

Alternative 3-D would include no construction (Table 13.1).

Section 13.0:
Development of Remedial Alternatives

Table

Table 13.1
Summary of Feasibility Study Alternatives

Alternative Number	Cleanup Alternative Description	Addresses POC	SRZ	Habitat Mitigation	Apprxomate Excavation and/or Dredging Area (acres)	Approximate Capping/ EMNR Area (acres)	Approximate Excavation and/or Dredging Volume (CY)[1,2]	Approximate Capping/ EMNR Volume (CY)3	Construction Duration (years)[4]
SMA 1: Inner Harbor									
1-A	Maximum Dredging and Excavation	Yes	No	No	32.7	0	633,000	51,000	11.0
1-B	Partial Dredging and Excavation with Capping	Yes	No	No	32.7	32.7	105,000	105,000	3.3
1-C	Partial Subtidal Dredging with Subtidal and Intertidal Capping	Yes	No	Yes	8.9	33.2	30,400	107,000	2.2
1-D	Partial Intertidal Excavation and Capping with Subtidal Capping	Yes	No	No	1.34	32.7	4,300	105,000	1.7
1-E	Subtidal and Intertidal Capping	Yes	No	Yes	0.5	33.2	3,300	107,000	1.7
1-F	Intertidal/Berthing Area Capping with Subtidal EMNR	Yes	No	Yes	0	32.7	3,300	34,000	0.8
1-G	EMNR	No	Yes	No	0	32.7	0	26,400	0.6
1-H	MNR	No	Yes	No	0	32.7	0	0	0
SMA 2: Lagoon									
2-A	Maximum Dredging and Excavation	Yes	No	Yes	23.6	0	152,000	152,000	4.8
2-B	Partial Dredgine and Excavation with Capping	Yes	No	Yes	23.6	23.6	76,100	76,100	2.4
2-C	Partial Intertidal Excavation and Capping with Subtidal EMNR	Yes	No	No	10.1	23.6	32,600	43,500	1.3 (2.0)[5]
2-D	Optimized Partial Intertidal Excavation/Capping with Subtidal EMNR	Yes	No	Yes	6.3	24.1	18,000	41,000	1.0 (2.0)[5]
2-E	Intertidal Capping with Subtidal EMNR	Yes	No	Yes	0.6	24.2	5,300	45,400	0.9 (2.0)[5]
2-F	EMNR	No	Yes	No	0	23.6	0	19,000	0.4 (2.0)[5]
2-G	MNR	No	Yes	No	0	23.6	0	0	0
SMA 3: Waterfront and Outer Harbor									
3-A	Year 0 EMNR	Yes	No	No	0	250	0	202,000	4.6
3-B	Year 10 EMNR with MNR	Yes	No	No	0	164	0	132,000	3.0
3-C	Year 25 EMNR with MNR	Yes	Yes	No	0	41	0	33,000	0.7
3-D	MNR	Yes	Yes	No	0	0	0	0	0

Notes:

1 Intertidal excavation or subtidal dredging would only occur if remedial design surveys reveal no potential disturbance of cultural resources; culturally sensitive areas would be avoided.
2 Partial intertidal excavation or subtidal dredging assumes an average 2-foot cut (1.5-foot design depth plus 0.5-foot overexcavation/overdredge allowance).
3 Capping assumes an average placed cap thickness of 2 feet (1.5-foot cap design thickness plus 0.5-foot overplacement allowance).
4 Construction Duration includes all site preparation and mobilization/demobilization, as well as some assumed duration for project standby due to holidays, weekends, and permitting/contracting delays presented in Appendix G, Tables G.6 and G.7.
5 Two in-water construction seasons are assumed for subtidal EMNR placement in the lagoon to minimize potential impacts to eelgrass meadows (refer to Sections 13.2.3 through 13.2.6).

Abbreviations:

CY Cubic yards
EMNR Enhanced monitored natural recovery
MNR Monitored natural recovery
POC Point of compliance
SMA Sediment management area
SRZ Sediment recovery zone

Section 13.0:
Development of Remedial Alternatives

Figures

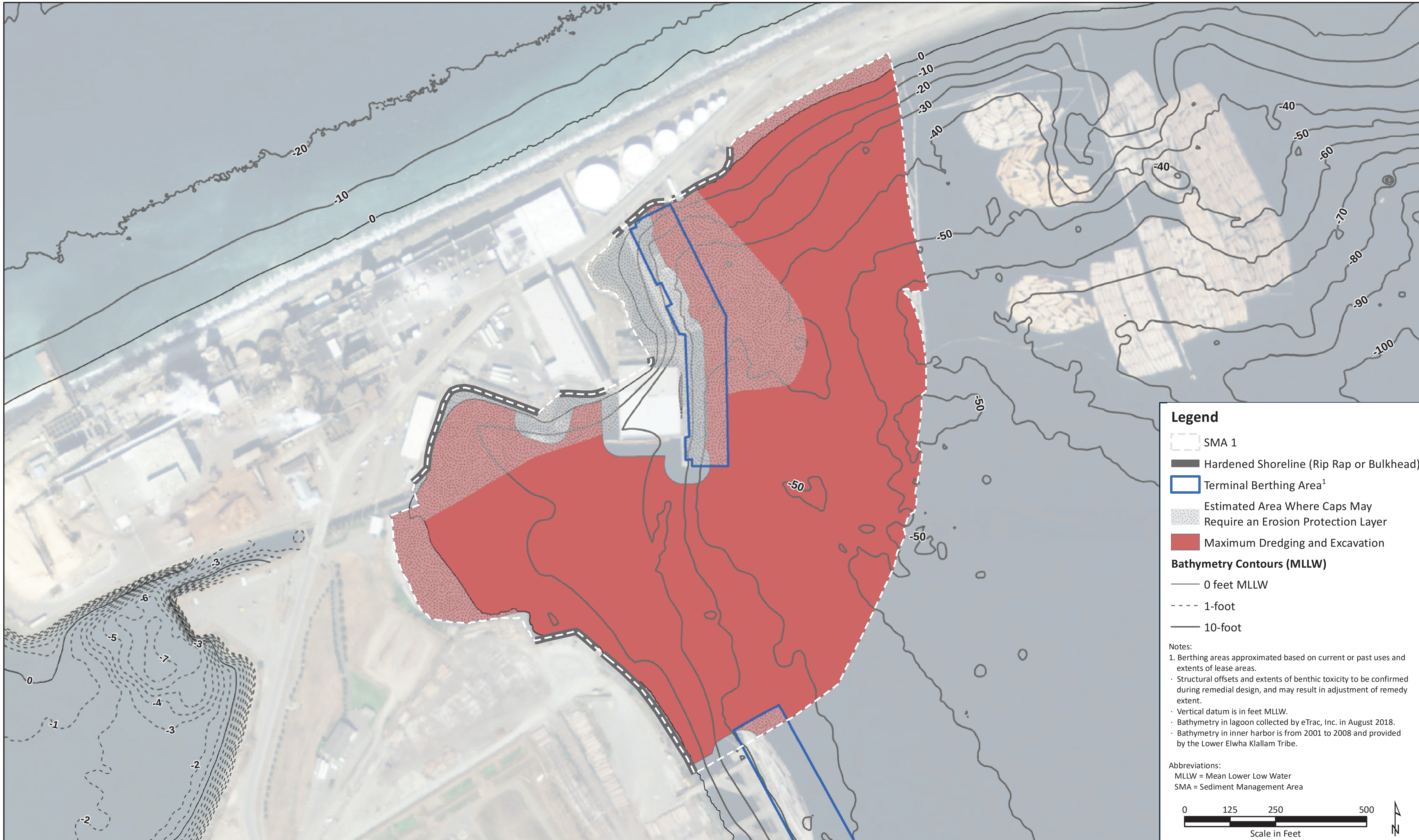

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Figure 13.1
SMA 1 Alternative 1-A: Maximum Dredging and Excavation

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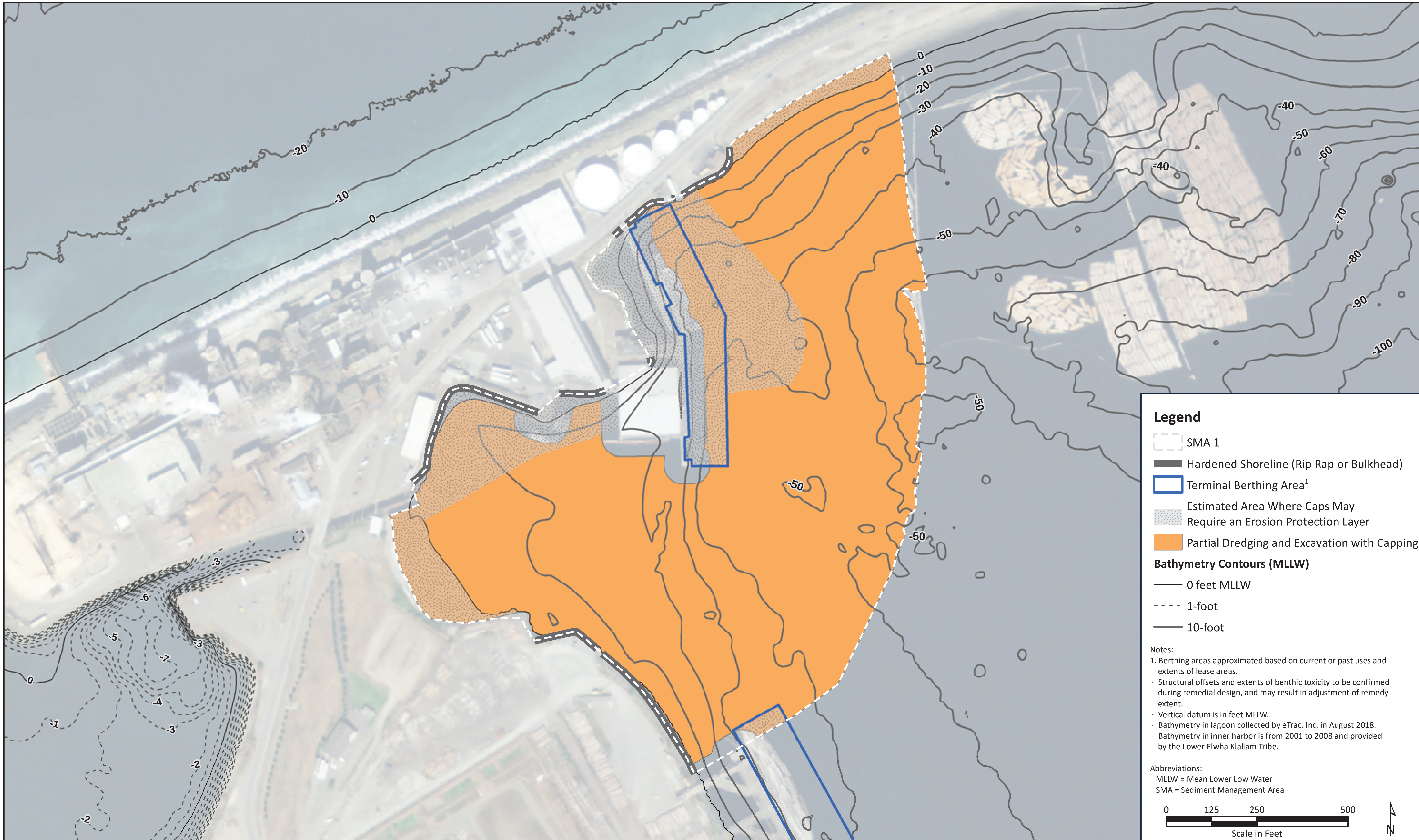

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Figure 13.2
SMA 1 Alternative 1-B: Partial Dredging and Excavation with Capping

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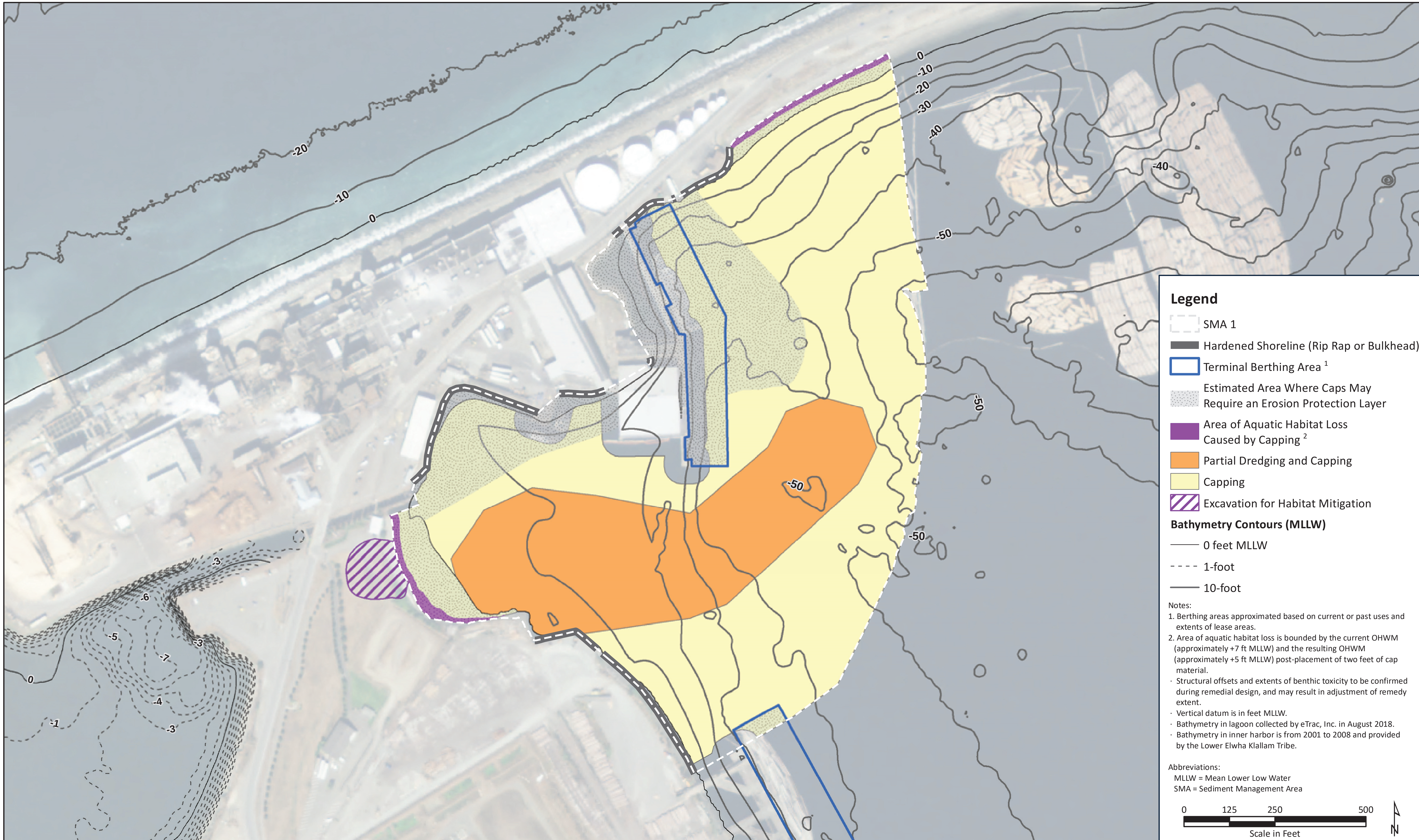

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Figure 13.3
SMA 1 Alternative 1-C: Partial Subtidal Dredging with Subtidal and Intertidal Capping

I:\GIS\Projects\WPAHG-RIFS\MXD\RIFS Final 2020\Figure 13.3 SMA 1 Alternative 1-C Partial Subtidal Dredging with Subtidal and Intertidal Capping.mxd
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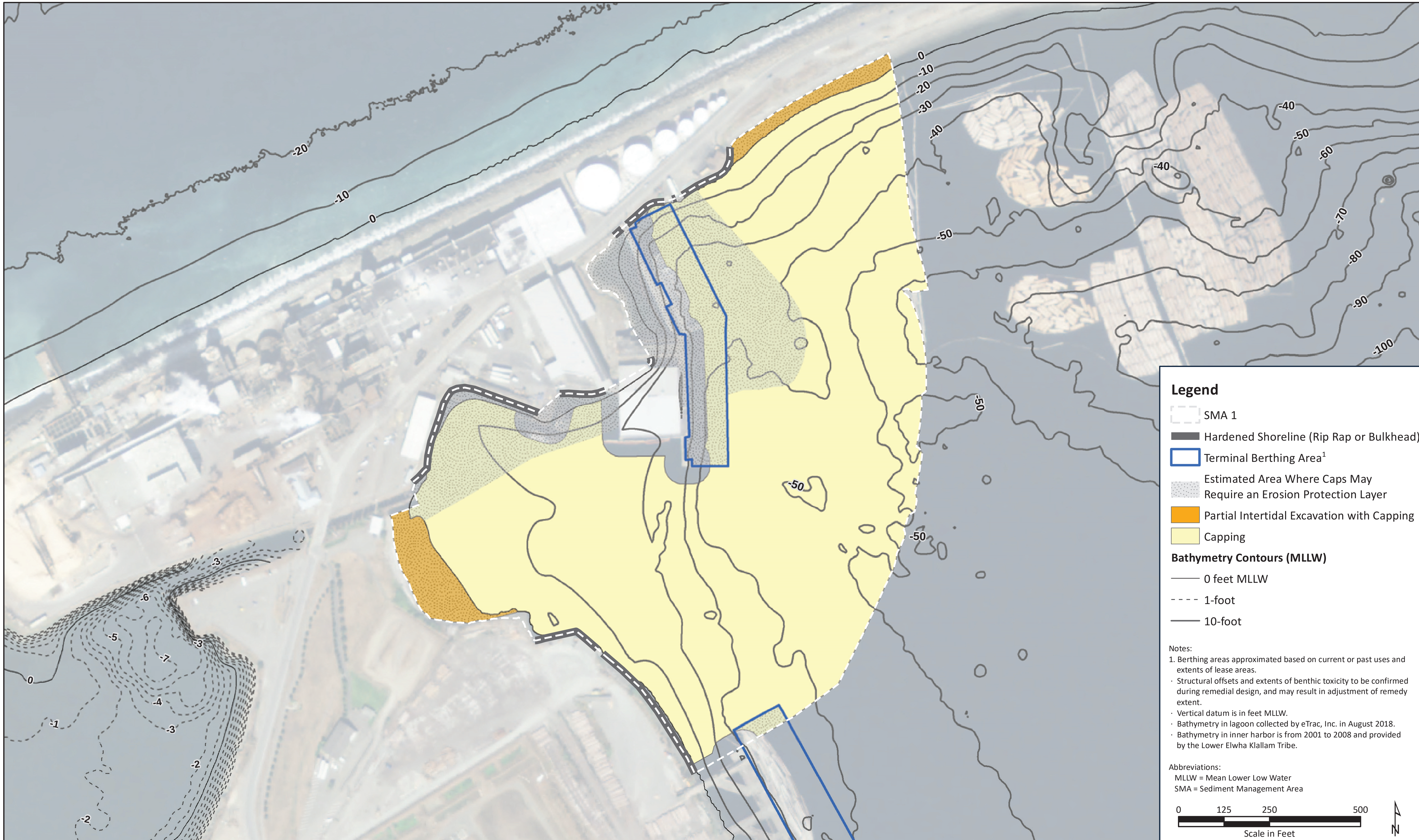

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Figure 13.4
SMA 1 Alternative 1-D: Partial Intertidal Excavation and Capping with Subtidal Capping

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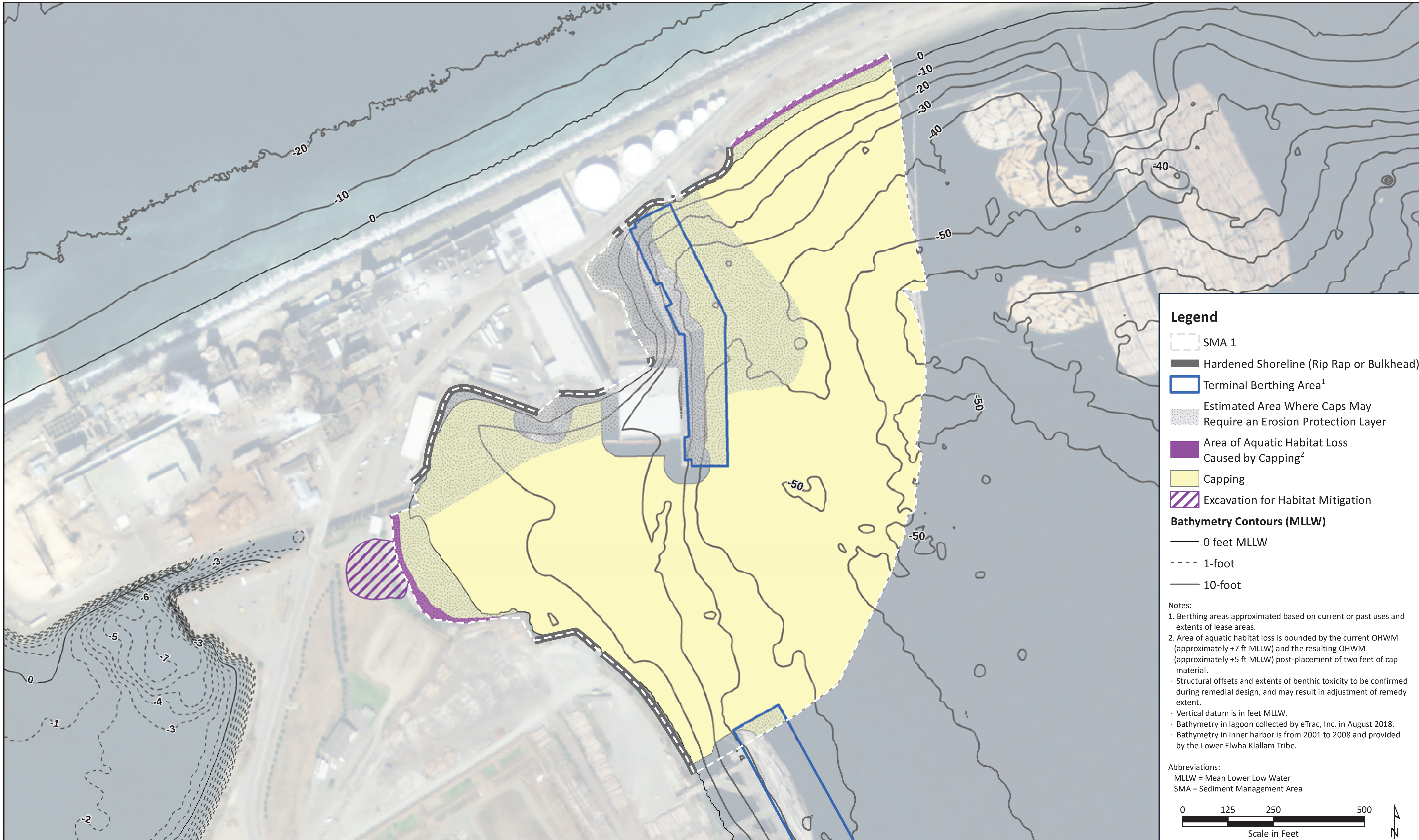

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Figure 13.5
SMA 1 Alternative 1-E: Subtidal and Intertidal Capping

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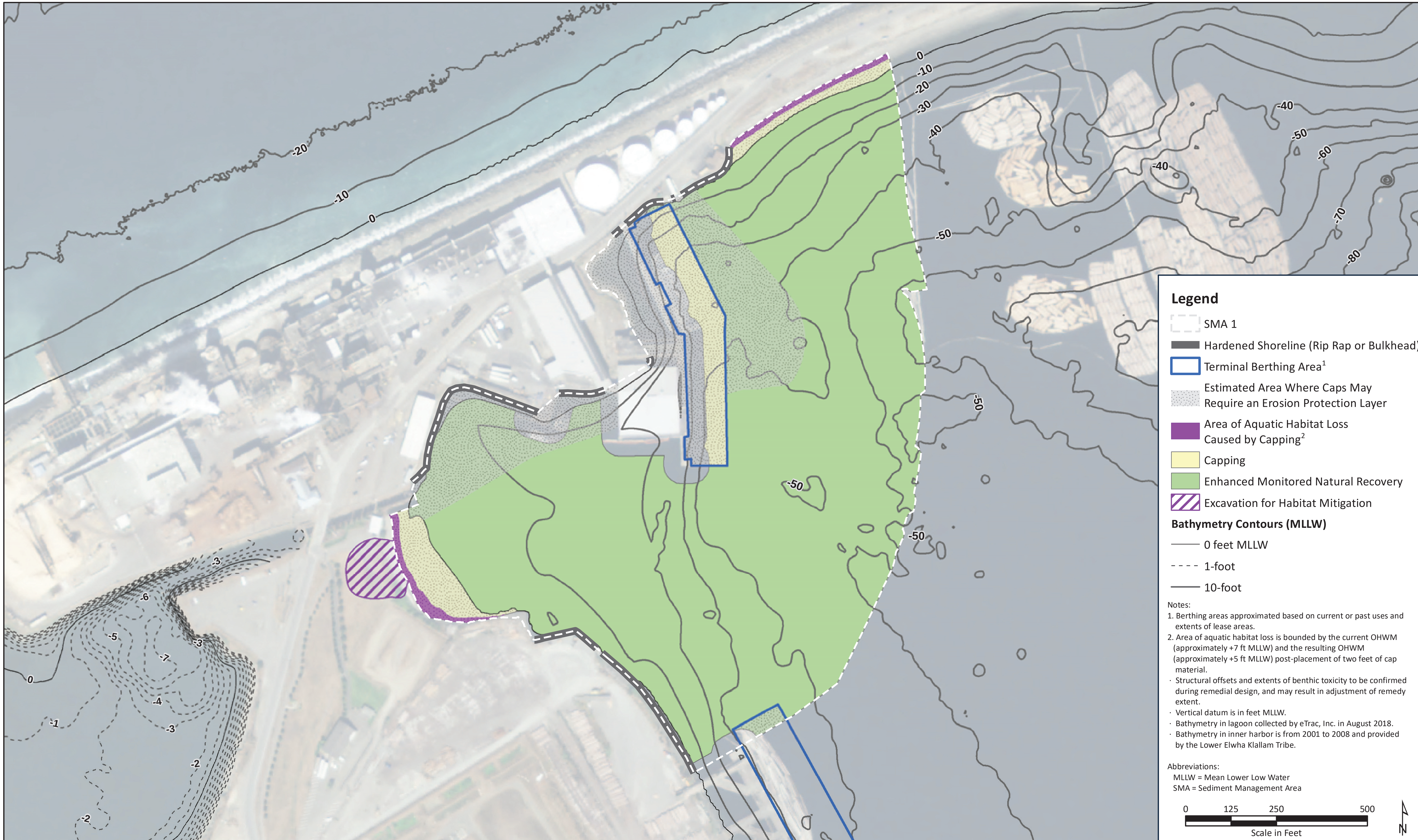

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Figure 13.6
SMA 1 Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal Enhanced Monitored Natural Recovery

I:\GIS\Projects\WPAHG-RIFS\MXD\RIFS Final 2020\Figure 13.6 SMA 1 Alternative 1-F Intertidal Berthing Area Capping with Subtidal Enhanced Monitored Natural Recovery.mxd
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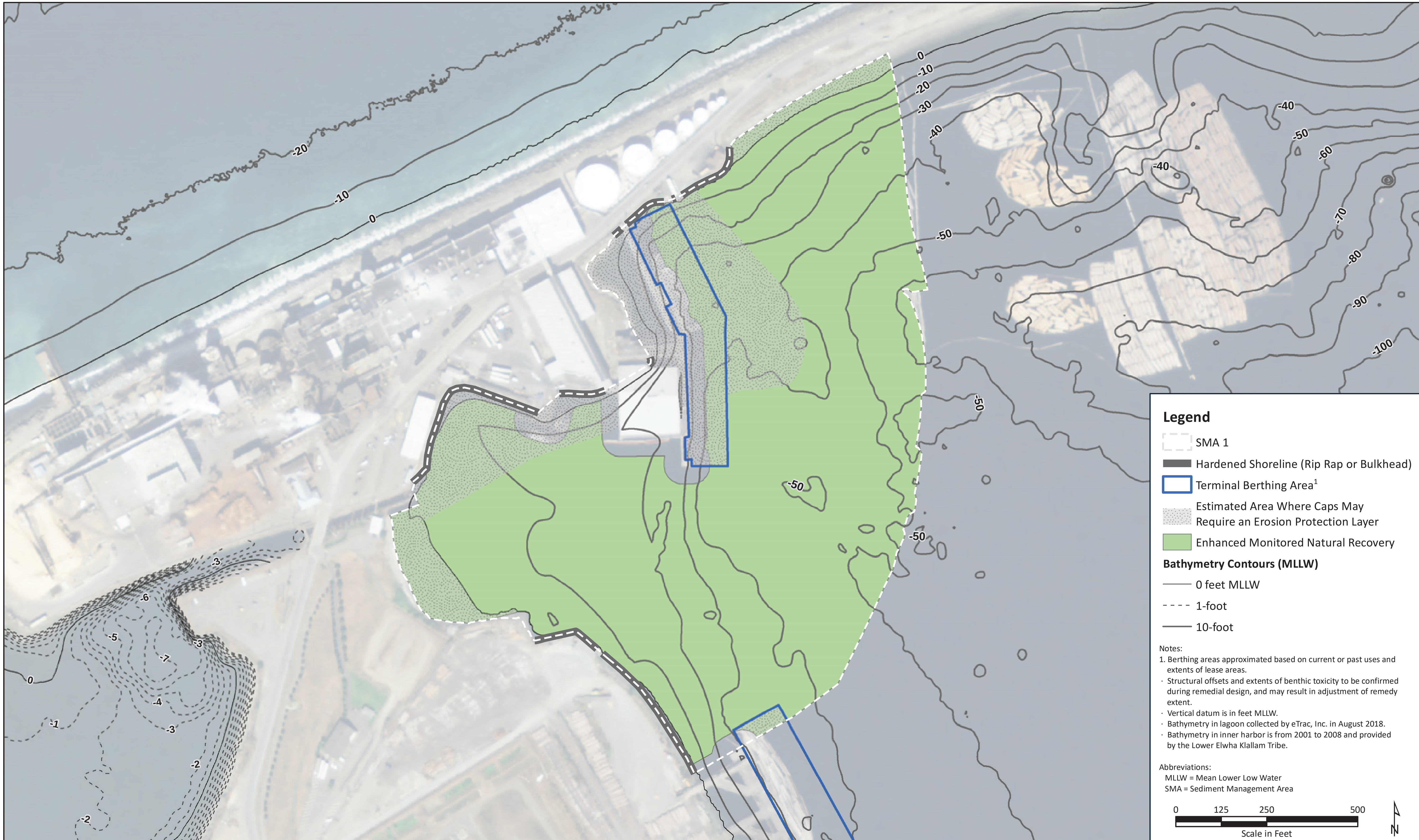

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Figure 13.7
SMA 1 Alternative 1-G: Enhanced Monitored Natural Recovery

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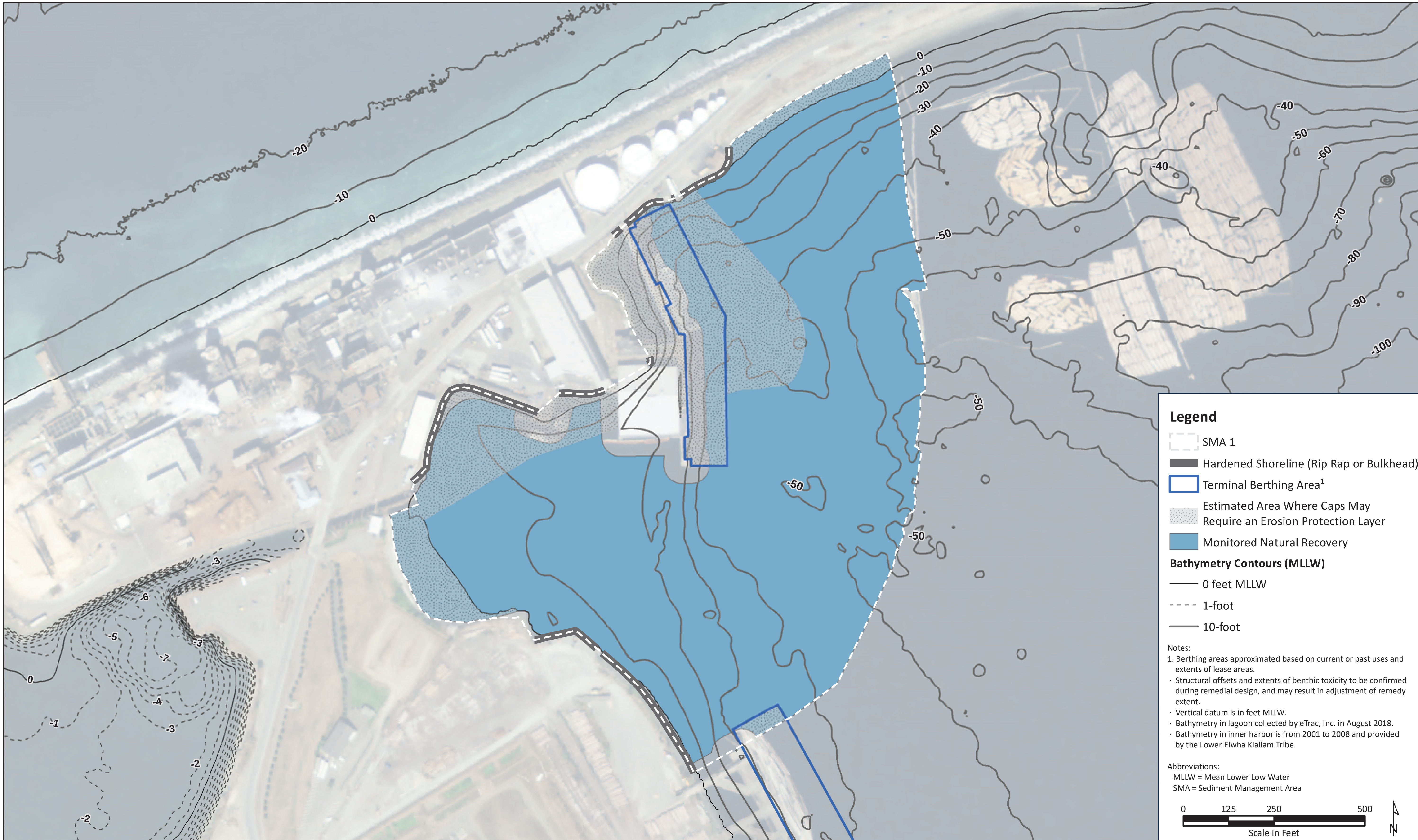

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Figure 13.8
SMA 1 Alternative 1-H: Monitored Natural Recovery

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Figure 13.9
SMA 2 Alternative 2-A: Maximum Dredging and Excavation

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Figure 13.10
SMA 2 Alternative 2-B: Partial Dredging and Excavation with Capping

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Figure 13.11
SMA 2 Alternative 2-C: Partial Intertidal Excavation and Capping with Subtidal Enhanced Monitored Natural Recovery

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Figure 13.12
SMA 2 Alternative 2-D Optimized Partial Intertidal Excavation and Capping with Subtidal Enhanced Monitored Natural Recovery

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Figure 13.13
SMA 2 Alternative 2-E: Intertidal Capping with Subtidal Enhanced Monitored Natural Recovery

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Figure 13.14
SMA 2 Alternative 2-F: Enhanced Monitored Natural Recovery

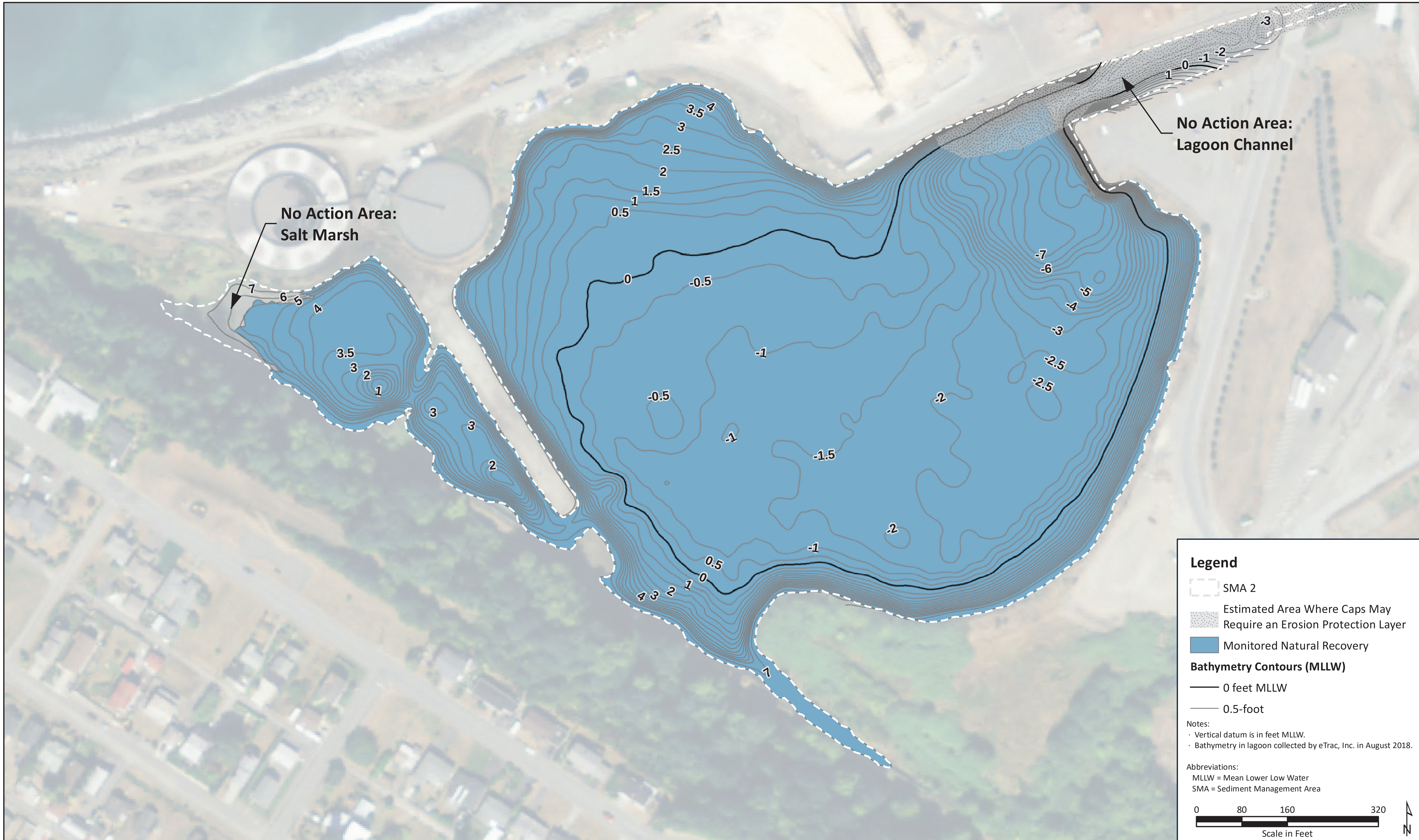

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Figure 13.15
SMA 2 Alternative 2-G: Monitored Natural Recovery

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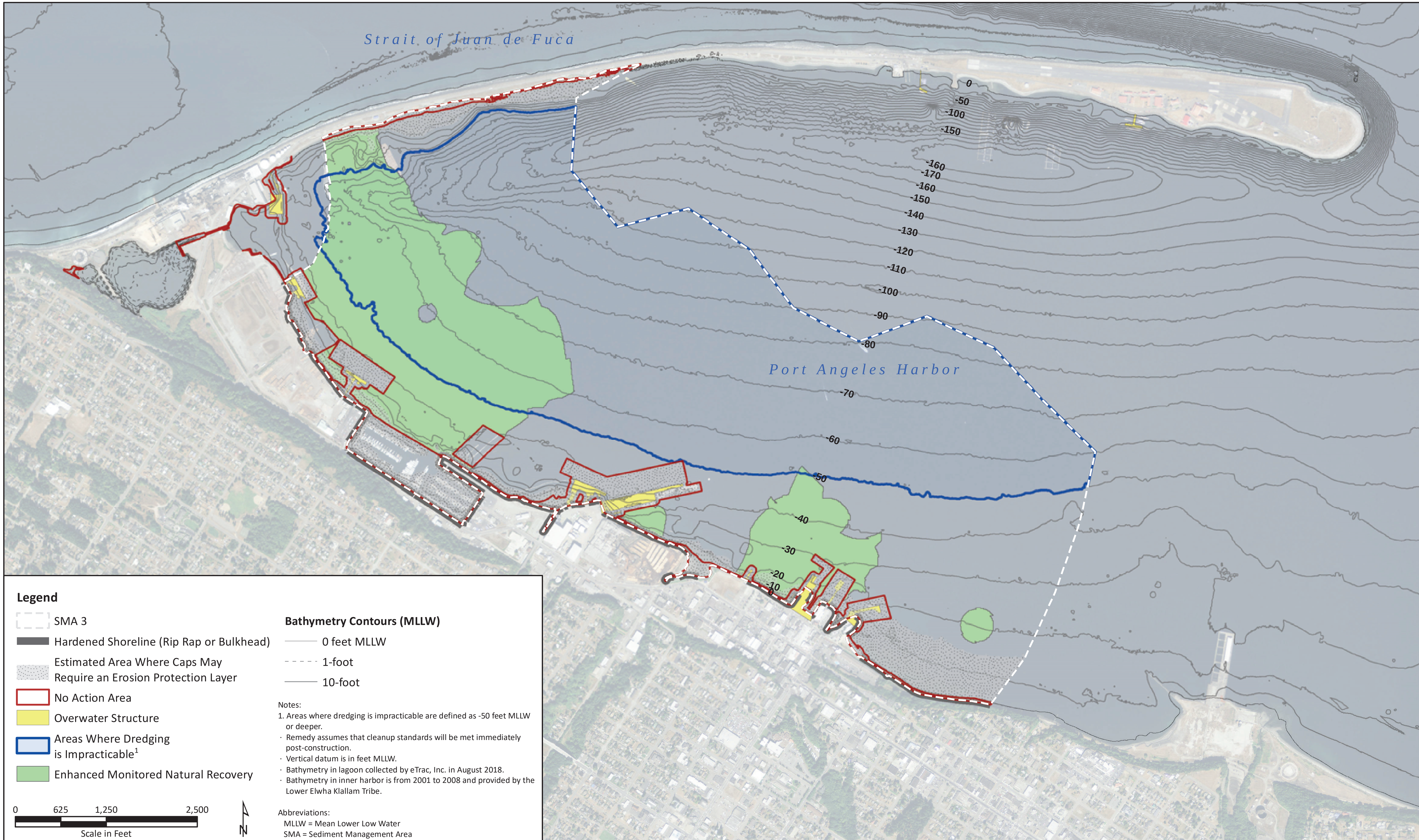

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Figure 13.16
SMA 3 Alternative 3-A: Year 0 Enhanced Monitored Natural Recovery

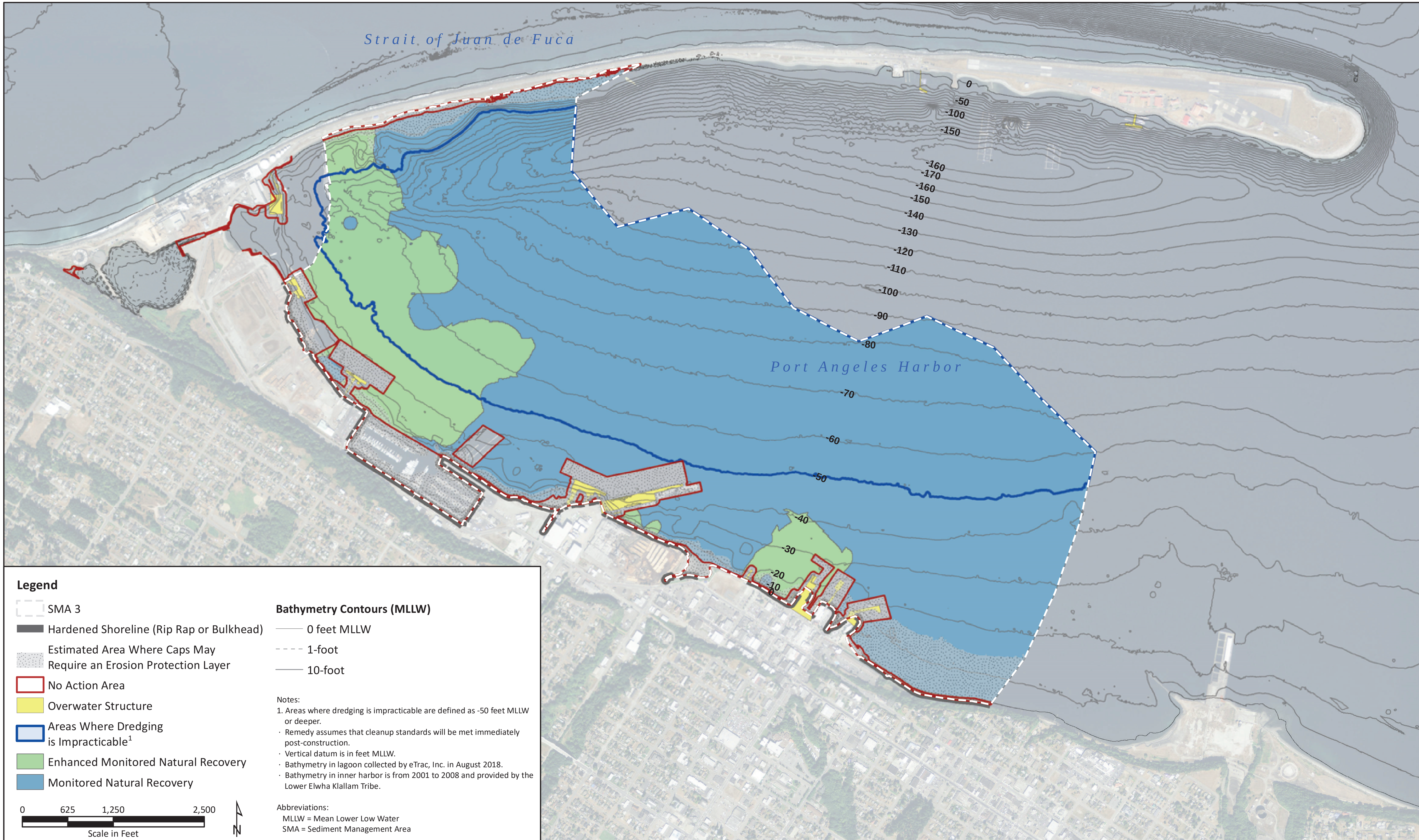

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Figure 13.17
SMA 3 Alternative 3-B: Year 10 Enhanced Monitored Natural Recovery with Monitored Natural Recovery

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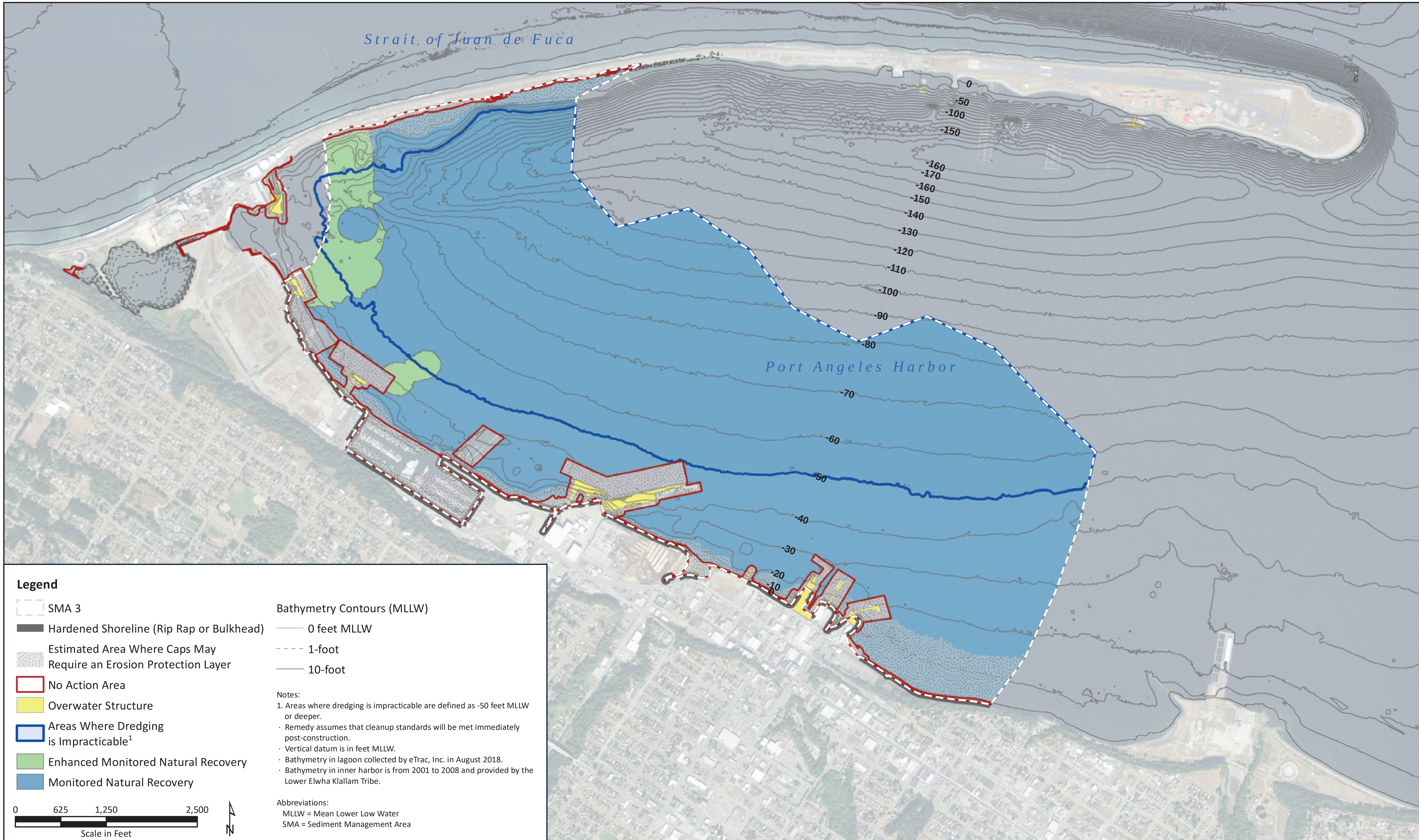

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Figure 13.18
SMA 3 Alternative 3-C: Year 25 Enhanced Monitored Natural Recovery with Monitored Natural Recovery

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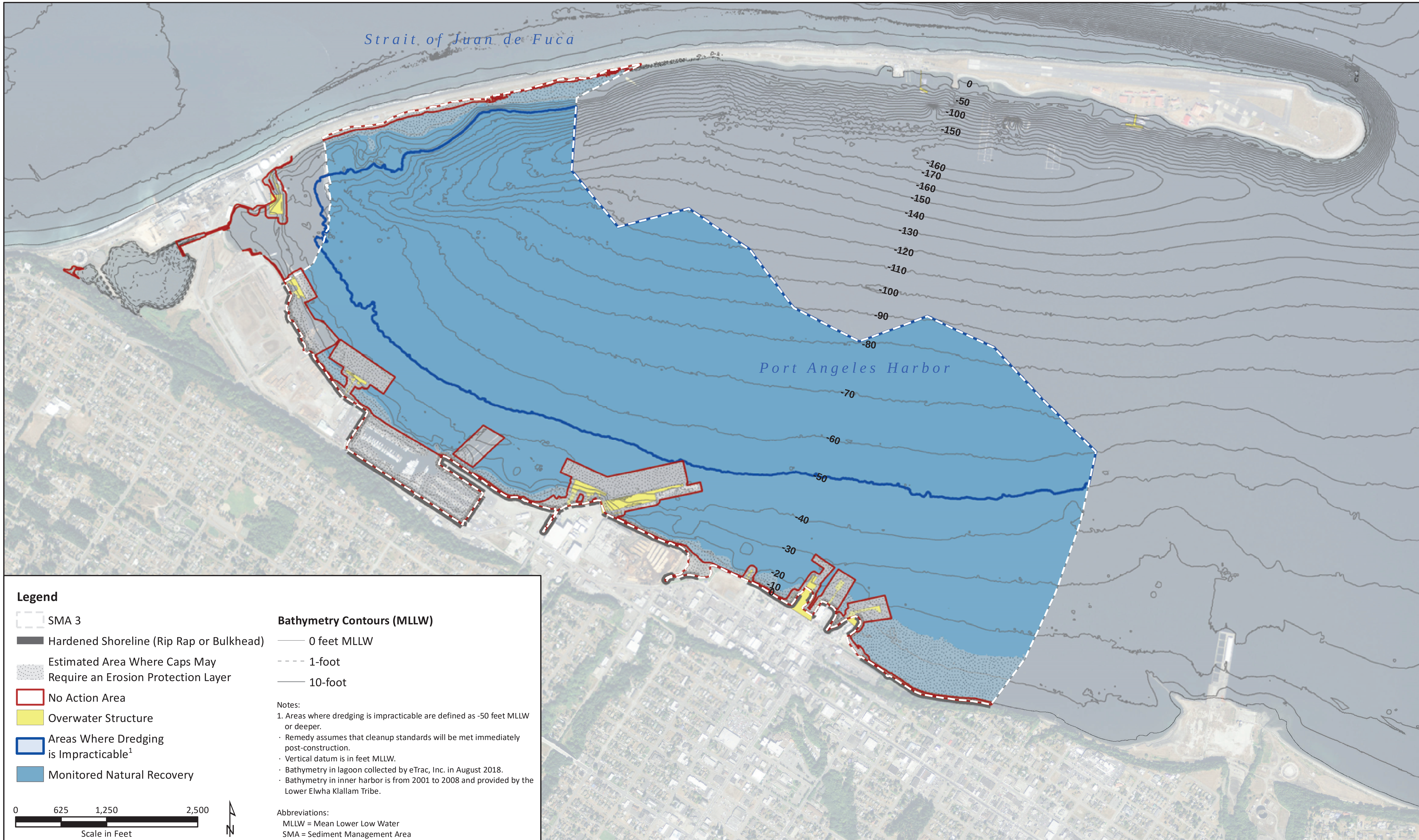

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Figure 13.19
SMA 3 Alternative 3-D: Monitored Natural Recovery

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Section 14.0: Evaluation of Remedial Alternatives

- The remedial alternatives developed in Section 13.0 were evaluated to determine the alternative that provides the greatest degree of benefits that are not disproportionately costly. This evaluation includes:
  - Compliance with the Model Toxics Control Act and Sediment Management Standards minimum requirements such as protecting human health and the environment, compliance with applicable laws, and providing for a reasonable restoration timeframe.
  - Identification of the alternative(s) that are permanent to the maximum extent practicable, through the Disproportionate Cost Analysis (DCA) process.
    - DCA evaluation criteria were weighted, consistent with evaluations performed by Ecology at similar Puget Sound cleanup sites.
    - The DCA process successfully identified a single alternative for each SMA that complies with minimum requirements and is permanent to the maximum extent practicable. These alternatives were combined together to develop the SCU-wide cleanup remedy in Section 15.0.

14.0 Evaluation of Remedial Alternatives

SMS require evaluation of cleanup actions that protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route. Proposed SMS cleanup actions require achieving protection of human health and the environment, compliance with cleanup standards and ARARs, source control, consideration of public concerns, and monitoring. SMS cleanup action decisions must also address practicable restoration timeframes, current and future Harbor uses, and natural recovery processes. In order to comply with applicable ARARs, any changes to ecological conditions resulting from implementation of a remedy would require compensatory mitigation. The process for determination of changes, and the associated required mitigation, is conducted through a separate process with the applicable regulatory agencies, once a remedy has been selected and designed. For the purposes of this FS, remedial alternatives that are expected to require mitigation discuss this mitigation requirement, but do not include detail on what this may entail, as this will be determined during a future phase of work.

The SMS evaluation criteria for comparing remedial alternatives are specified in WAC 173-204-570. For this evaluation, the alternatives are evaluated against the SMS minimum requirements (i.e., threshold requirements; Section 14.1). Then, alternatives are compared using the SMS DCA for determination of the alternative that uses permanent solutions to the maximum extent practicable. A separate DCA is performed for each SMA, considering the characteristics of each area in Tables 14.1, 14.2, and 14.3. Alternatives that comply with threshold requirements are then graphically evaluated to compare total benefit to associated cost in Figures 14.1, 14.2, and 14.3. Subsequently, in Section 15.0, the alternatives for each SMA are identified as permanent to the maximum extent practicable and are combined into a SCU-wide preferred cleanup remedy.

14.1 MINIMUM REQUIREMENTS

Cleanup actions performed under SMS must comply with 11 minimum requirements under WAC 173-204-570(3). These minimum requirements outline Ecology's expectation for potential remedies evaluated for implementation at a site, and ensure that evaluated alternatives all have the ability to achieve the agency's goal of protection of human health and the environment. The minimum requirements are summarized as the following:

- Protect human health and the environment
- Comply with all applicable laws
- Comply with sediment cleanup standards
- Use permanent solutions to the maximum extent practicable (this evaluation is conducted in the following sections)
- Provide for a reasonable restoration timeframe

- Provide necessary source control measures—source control is described in Section 12.7 and Appendix E, and is being managed by a separate process under Ecology's lead
- As necessary, comply with requirements for an SRZ
- Do not rely exclusively on MNR or institutional controls where it is technically possible to implement a more permanent cleanup action
- Provide an opportunity for review and comment by affected landowners and the general public, and consider concerns identified in these comments
- Provide adequate monitoring to ensure the effectiveness of the cleanup action
- Provide for periodic review of non-removal remedies to determine the effectiveness and protectiveness of the cleanup actions.

This section discusses MTCA/SMS minimum requirements for remedial alternatives for SMAs 1 through 3.

14.1.1 Compliance with Cleanup Standards in a Reasonable Timeframe

Under SMS, compliance with cleanup standards represents the measure of whether and when an alternative has reduced risk sufficiently to protect human health and the environment. Prospective site-specific sediment cleanup standards summarized in Sections 8.0 and 8.4 were developed to protect human health, the health of the benthic community, and ecological health (higher trophic level species) under WAC 173-204-560 through 564. Therefore, compliance with cleanup standards is used to evaluate the minimum requirements of "protection of human health and the environment" (WAC 173-204-570(3)(a)), and "compliance with cleanup standards" (WAC 173-204-570(3)(c)), and "provide for a reasonable restoration time frame" (WAC 173-204-570(3)(e)).

Alternatives that achieve cleanup standards within 10 years of completion of remedial action construction are presumed under the SMS to have a reasonable restoration timeframe. However, the SMS regulations allow Ecology to authorize restoration timeframes that exceed 10 years if it is not practicable to accomplish cleanup actions within this amount of time. In this situation, an SRZ is required under the SMS. The designation of an SRZ would likely result in additional administrative, monitoring, and other requirements until the remedy meets cleanup standards.

For SMA 1, Alternatives 1-A: Maximum Dredging and Excavation through 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR would achieve RALs immediately following completion of construction. Consistent with WAC 173-204-570(5)(a), these alternatives would achieve a reasonable restoration timeframe when combined with alternatives in SMA 2 and SMA 3 that also achieve RALs, as compliance with cleanup standards is determined SCU-wide. Alternatives 1-A through 1-F are therefore considered to meet all MTCA/SMS minimum requirements. Alternative 1-G: EMNR and Alternative 1-H: MNR do not achieve SCLs across the 45-cm-deep intertidal point of compliance in intertidal areas identified by Ecology in a reasonable restoration timeframe (due to reliance on natural recovery processes), and thus do not meet the MTCA /SMS minimum requirement of "comply with cleanup standards."

For SMA 2, Alternatives 2-A: Maximum Dredging and Excavation through 2-E: Intertidal Capping with Subtidal EMNR would similarly comply with RALs immediately following completion of construction, and do not affect the overall restoration timeframe for the SCU. For the evaluation of SMA 2 alternatives, and consistent with WAC 173-204-570(5)(a), these alternatives would achieve a reasonable restoration timeframe when combined with alternatives in SMA 1 and SMA 3 that also achieve RALs, and are therefore considered to meet all MTCA/SMS minimum requirements. Alternatives 2-F: EMNR and Alternative 2-G: MNR do not achieve SCLs across the 45-cm-deep intertidal point of compliance in a reasonable restoration timeframe, and thus do not meet the MTCA /SMS minimum requirement of "comply with cleanup standards."

For SMA 3, each of the four alternatives have different restoration timeframes that when combined with alternatives in SMA 1 and SMA 2 (that meet the MTCA/SMS minimum requirements), would determine the SCU-wide restoration timeframe. Subject to SRZ requirements for Alternatives 3-C: Year 25 EMNR with MNR and 3-D: MNR, all four SMA alternatives would meet MTCA/SMS minimum requirements, particularly given the technical impracticability considerations discussed in Section 13.3.1.

SCU-wide remedies that include Alternatives 3-C and 3-D would require an SRZ because cleanup standards would not be achieved SCU-wide within 10 years following construction (WAC 173-204-570(3)(g)).

14.1.2 Other Minimum Requirements

The achievement of other minimum requirements is summarized as follows:

- All alternatives would comply with all applicable laws summarized in Section 10.3 (WAC 173-204-570(3)(b)).
- As discussed in Section 12.7 and Appendix E, source control measures are being addressed separately (WAC 173-204-570(3)(f)) and are part of all alternatives.
- Alternative 3-D would rely primarily on MNR within SMA 3, but would be employed in conjunction with active remediation of SMAs 1 and 2 to reduce SCU-wide risks. None of the alternatives rely primarily on institutional controls (WAC 173-204-570(3)(h).
- This RI/FS will undergo appropriate public review and comment by affected stakeholders and the general public (WAC 173-204-570(3)(i)).
- All alternatives include adequate monitoring to ensure effectiveness of the cleanup action (WAC 173-204-570(3)(j)).
- All alternatives leave some contamination in place, which will be subject to periodic reviews under WAC 173-204-570(3)(k).

The DCA summarized in the next section addresses the minimum requirement of "using permanent solutions to the maximum extent practicable" (WAC 173-204-570(3)(d)). The DCA is presented for each SMA independently.

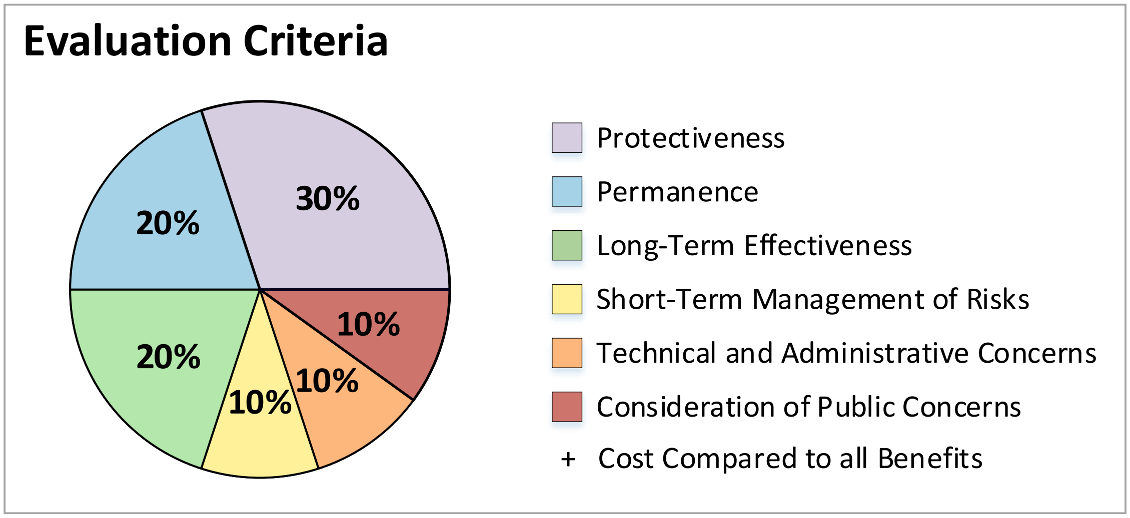
14.1.3 Elimination of Alternatives from Disproportionate Cost Analysis

Alternatives 1-G: EMNR and 1-H: MNR were not included in the DCA for SMA 1 because these alternatives did not meet the SMS minimum threshold requirements. Alternative 1-G: EMNR does not provide for a reasonable restoration timeframe (WAC 173-204-570(3)). Alternative 1-H: MNR does not meet the SMS minimum requirement that cleanup actions not rely exclusively on MNR or institutional controls where it is technically possible to implement a more permanent cleanup action. Similarly, Alternative 2-F: ENMR and Alternative 2-G: MNR were not included in the DCA for SMA 2 because the alternatives would not achieve SCLs across the 45-cm-deep intertidal point of compliance in a reasonable restoration timeframe, and thus do not meet the MTCA/SMS minimum requirement to "comply with cleanup standards."

14.2 DISPROPORTIONATE COST ANALYSIS

MTCA and SMS specify that preference shall be given to cleanup actions that are permanent solutions to the maximum extent practicable. Identifying an alternative that is permanent to the maximum extent practicable requires weighing costs and benefits. SMS uses the MTCA DCA (WAC 173-340-360(3)(e)) as the tool for comparing each remedial alternative's incremental environmental benefits with its incremental costs, with the exception of effectiveness over the long-term, which is described in WAC 173-204-570(4)(b). The DCA is the primary method by which the alternatives are systematically compared to each other in this RI/FS. Under MTCA, costs are considered disproportionate to benefits when the incremental costs of an alternative exceed the incremental benefits compared to other, lower cost, protective alternatives.

Seven MTCA criteria, which are listed in WAC 173-340-360(3)(f), are used to evaluate and compare remedial alternatives when conducting the DCA. Consistent with recent DCA and equivalent evaluations performed by Ecology at similar Puget Sound sediment cleanup sites (e.g., Bellingham Bay, Fidalgo Bay, and Lower Duwamish Waterway), the first six evaluation criteria are weighted and assigned a score for total benefits; those total benefits are then summed and compared with costs of the alternatives. The criteria are ranked using a combination of quantitative and qualitative sub-criteria, following the descriptions in WAC 173-340-360(3)(f). The sub-criteria are evaluated for the alternatives to determine a score for each of the six benefit criteria. Consistent with the cleanup sites listed above, the total benefit scores are a weighted average of the benefit criteria, using the following weighting:



The weighted averaged benefits are compared to costs for the alternatives. The following sections describe the DCA for each SMA.

14.3 SMA 1 DISPROPORTIONATE COST ANALYSIS

The SMA 1 remedial alternatives were scored relative to each DCA evaluation criterion, as summarized in the following sections and detailed in Table 14.1.

14.3.1 Protectiveness

MTCA defines protectiveness as follows:

> *"Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality" (WAC 173-340-360(3)(f)(i)).*

The protectiveness of each remedial alternative was scored based on the MTCA definition of protectiveness, as described above. The scores for protectiveness consider overall risk reduction due to remediation, risks that are a result of remedy implementation, and improvement of overall environmental quality. Protectiveness scores for SMA 1 are presented in Table 14.1 and summarized below.

Alternatives 1-A: Maximum Dredging and Excavation through 1-E: Subtidal and Intertidal Capping all achieve SCLs at the point of compliance immediately following completion of construction. Alternative 1-A reduces the long-term on-site risks following implementation to the greatest extent through removal of the largest volume of contaminated sediment and elimination of potential future exposure. Alternatives 1-B: Partial Dredging and Excavation with Capping through 1-E: Subtidal and Intertidal Capping reduce exposure to contaminated sediment remaining through removal and/or durable engineered caps that control the routes of exposure to contaminants remaining on-site. Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR reduces existing risks to a slightly lesser degree than durable engineered caps through placement of a clean surface layer. Thus, Alternative 1-A: Maximum Dredging and Excavation, received a high score, while Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received a low score. Alternatives with intermediate human health protectiveness were scored proportionately between these two endpoints (Table 14.1) because caps provide protectiveness through elimination of the exposure pathway, but this technology also requires ongoing monitoring and maintenance to ensure that cleanup levels and cap integrity are maintained.

Alternative 1-A provides the highest degree of improvement of overall environmental quality through removal and off-site disposal of contaminated sediment. Alternative 1-F provides a moderate to high degree of improvement to the overall environment through containment of contaminated intertidal and subtidal sediments remaining on-site beneath durable engineered caps and subtidal EMNR. Thus, Alternative 1-A received a high score, while Alternative 1-F received a lower score.

There are no known long-term off-site risks associated with implementation of the alternatives. Short-term risks to human health and the environment associated with the alternatives during construction and implementation are scored under management of short-term risk and discussed in Section 14.3.4.

Based on the MTCA definition of protectiveness, Alternative 1-A: Maximum Dredging and Excavation received the highest balanced protectiveness score (5), while Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received the lowest balanced protectiveness score (2.5). The other four SMA 1 alternatives evaluated received intermediate protectiveness scores (Table 14.1).

14.3.2 Permanence

MTCA defines permanence as follows:

> *"The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated" (173-340-360(3)(f)(ii)).*

The permanence of each remedial alternative was scored based on the MTCA definition of permanence, as detailed in Table 14.1. Permanence scores for SMA 1 are presented in Table 14.1 and summarized below.

The degree of permanent reduction of toxicity, mobility, or volume of hazardous substances is the primary consideration for evaluation of permanence. Intertidal excavation and subtidal dredging technologies scored the highest for this criterion because contaminated sediment would be permanently removed from the SCU, eliminating the potential for future releases. Capping alternatives also provide a high degree of reduction in contaminant mobility and toxicity through placement of engineered caps that control mobility of contaminants to the sediment surface, and reduce toxicity through this reduction in mobility and creation of a clean sediment surface. However, capping is not considered as permanent as dredging, as the contaminated material remains on-site (beneath an engineered cap). Alternatives that rely on EMNR received lower scores because EMNR provides the least degree of contaminant mobility reduction. In SMA 1 where there are shallower water depths, active terminals and over-water operations, and higher sediment contaminant concentrations, there is less permanence with an EMNR-based remedy.

The alternatives proposed in SMA 1 would not destroy hazardous substances but rather would remove contaminants from the site or contain them on-site; therefore, consideration of the adequacy of the alternatives to destroy the hazardous substances and the irreversibility of treatment processes does not affect the alternative scoring for permanence. The site-specific evaluation of the reduction or elimination of hazardous substance releases and source of releases does not affect the alternative scoring for permanence because the site releases of hazardous substances are from historical sources that are no longer in operation. Reduction or elimination of ongoing sources of hazardous substances such as cPAHs are being managed under separate source control authorities.

Based on the considerations outlined above, and discussed in Table 14.1, Alternative 1-A: Maximum Dredging and Excavation received the highest score (5), while Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received the lowest permanence score (2.5). The other four SMA 1 alternatives received intermediate permanence scores (Table 14.1).

14.3.3 Effectiveness over the Long-Term

Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed SCLs, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes (WAC 173-340-360(3)(f)(iv)). The SMS regulation provides a prescriptive hierarchy of remedial technologies with respect to their effectiveness over the long-term, as follows:

> *"When assessing the relative degree of long-term effectiveness of cleanup action components, the following types of components may be used as a guide, in descending order, in place of the components listed in WAC 173-340-360 (3)(f)(iv):*
>
> > *(i) Source controls in combination with other cleanup technologies;*
> >
> > *(ii) Beneficial reuse of the sediments;*

> *(iii) Treatment to immobilize, destroy, or detoxify contaminants;*
>
> *(iv) Dredging and disposal in an upland engineered facility that minimizes subsequent releases and exposures to contaminants;*
>
> *(v) Dredging and disposal in a nearshore, in-water, confined aquatic disposal facility;*
>
> *(vi) Containment of contaminated sediments in-place with an engineered cap;*
>
> *(vii) Dredging and disposal at an open water disposal site approved by applicable state and federal agencies;*
>
> *(viii) Enhanced natural recovery;*
>
> *(ix) Monitored natural recovery; and*
>
> *(x) Institutional controls and monitoring" (WAC 173-204-570(4)(b)).*

Consistent with SMS, remedial technologies were ranked in the following order from most effective to least effective over the long-term: full intertidal excavation and/or subtidal dredging, partial excavation/dredging followed by engineered capping, partial excavation/dredging followed by EMNR, engineered capping, and EMNR. The alternatives were scored based on area-weighting of each technology incorporated into the alternative. Thus, Alternative 1-A: Maximum Dredging and Excavation received the highest score (5), while Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received a lower long-term effectiveness score (2.0). The other four SMA 1 alternatives evaluated received intermediate long-term effectiveness scores (Table 14.1).

14.3.4 Management of Short-Term Risk

MTCA defines management of short-term risk as follows:

> *"The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks" (WAC 173-340-360(3)(f)(v)).*

Evaluation of this criterion considers the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry short-term risks, such as potential mobilization of contaminants during construction (e.g., dredge releases), or safety risks typical of large construction projects. Other impacts to short-term effectiveness include water quality degradation, noise, vessel and vehicle traffic, and air emissions. Some short-term risks can be managed to some degree through the use of BMPs during project design and construction, while other risks are inherent to project alternatives. Those activities that result in unavoidable environmental or safety impacts during construction rank lower than those activities that result in minimal impact.

Consistent with DCAs used by Ecology at other Puget Sound sediment cleanup sites, the management of short-term risks of each remedial alternative was scored primarily based on risks of turbidity and resuspension-related releases during subtidal work and heavy truck traffic and travel on public roads associated with off-site disposal of removed material or import of engineered cap and/or EMNR material. Careful planning, contingency plans, and health and safety requirements for on-site workers will minimize but not fully eliminate the potential for release of contaminated sediment to the water column during dredging, as described in Section 12.1. Transport of materials to and from the site requires interactions with the public while traveling on public roadways. Once again risks can be managed, but the potential for accidents that could result in release of contaminated material and possible exposure both to human and ecological receptors cannot be eliminated. Plans will be developed to implement applicable BMPs, and all contractors participating in site cleanup will be required to comply with project work plans. For evaluation of short-term risks, alternatives were evaluated based on the volume of sediment to be removed, handled, and transported from the site, and the volume of import material to be transported to the site.

Thus, Alternatives 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR and 1-E: Subtidal and Intertidal Capping received the highest score for management of short-term risks (4.0), while Alternative 1-A: Maximum Dredging and Excavation received the lowest score (2.5). The other four SMA 1 alternatives evaluated received intermediate short-term effectiveness scores (Table 14.1).

14.3.5 Technical and Administrative Implementability

Implementability is the criterion expressing the relative difficulty and uncertainty of implementing the cleanup action. MTCA defines technical and administrative implementability as follows:

> *"Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions" (WAC 173-340-360(3)(f)(vi)).*

Evaluation of implementability includes consideration of technical factors such as challenges associated with subtidal dredging in debris areas, dewatering and transloading in limited work areas, exceedance of local landfill capacity for large volumes of dredged sediment, and complications associated with sediment or debris removal from culturally sensitive areas. The evaluation of implementability also includes administrative factors associated with the ability and time required to obtain any necessary approvals and permits from other agencies for the cleanup activities. Administrative implementability also considers disruption to use of the SCU for Port and other industrial/commercial activities and the challenges associated with implementing an

SRZ. To summarize, technical and administrative implementability of each remedial alternative was scored based on the following:

1. Technical feasibility, considering technical challenges associated with the work, such as dredging wood debris or sediments located in culturally sensitive areas; and limitation on the space available for transloading dredged material and placement materials.
2. Administrative feasibility including permitting and regulatory challenges; disruptions to existing SCU economic operations; SRZ development requirements; and mitigation requirements for intertidal capping and transload development.

Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received the highest technical feasibility score because of relatively few technical challenges, and the availability of on-site, in-kind habitat mitigation, while Alternative 1-A: Maximum Dredging and Excavation received the lowest score because of major technical challenges, including the large volumes of dredged sediment and removal in culturally sensitive areas. In addition, Alternative 1-A: Maximum Dredging and Excavation has substantial challenges related to dewatering and transloading dredged sediment. The other SMA 1 alternatives evaluated received intermediate technical feasibility scores (Table 14.1).

Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received the highest administrative feasibility score because its shorter construction duration is less likely to disrupt commercial activities in the SCU, while Alternative 1-A: Maximum Dredging and Excavation received the lowest score because the relatively long construction duration is likely to disrupt commercial activities in the SCU, as well as major traffic impacts for transload and disposal of removed sediment. Again, the other SMA 1 alternatives received intermediate administrative feasibility scores (Table 14.1).

Based on the balance of the technical and administrative implementability scores, Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR received the highest balanced score (4.5), while Alternative 1-A: Maximum Dredging and Excavation received the lowest score (1.5). The other four SMA 1 alternatives received intermediate technical and administrative implementability scores (Table 14.1).

14.3.6 Consideration of Public Concerns

MTCA defines consideration of public concerns as follows:

> *"Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site" (WAC 173-340-360(3)(f)(vii)).*

The public involvement process under SMS is used to identify potential public concerns regarding cleanup action alternatives. The extent to which an alternative addresses those concerns is considered as part of the evaluation process. This includes concerns raised by individuals, community groups, local governments, tribes, federal and state agencies, local businesses, and other organizations with an interest in the SCU. Potential impacts to cultural resources from a given remedy and potential impacts to tribal use of the SCU during remedy implementation are considered under this evaluation criterion. Ecology will continue to evaluate public concerns through the public involvement process as the CAP is developed.

Input from members of the community is used to shape the remedial actions with respect to timing, local or cultural considerations, effects from disturbances including noise, light, and traffic that result from implementation methods or transportation routes, and the like. Different members of the community may have different priorities, and these priorities may or may not be aligned with the goals of the cleanup and/or the specific requirements of SMS.

Consistent with DCAs used by Ecology at other Puget Sound sediment cleanup sites, preliminary consideration of public concerns for this DCA balanced two potentially conflicting public interests:

1. One interest is strongly environmental and generally supports remedial actions that remove the maximum amount of contamination.
2. Another interest is strongly economic, and generally supports remedial actions that achieve regulatory requirements as cost-effectively as possible to minimize impacts on local businesses and public taxes.

The DCA scores for each alternative were based on the degree that an alternative may balance these potentially conflicting priorities. In contrast to the other DCA criteria, which tend to favor alternatives at one end of the range or the other, consideration of public concerns tends to score alternatives in the middle the highest, because of these countervailing priorities.

Alternative 1-D: Partial Intertidal Excavation and Capping with Subtidal Capping received the highest balanced public concern score (4.0) because this alternative may satisfy the public desire for some contaminant mass removal, but provides a relatively cost-effective protective option that does not require habitat mitigation, while Alternative 1-A: Maximum Dredging and Excavation received the lowest score (2.5) because though it may satisfy the public desire for removal, the very high costs of this alternative are likely to be a concern for the public. The other four SMA 1 alternatives received intermediate public concern scores (Table 14.1). These public concern scores will be updated as appropriate in the final RI/FS, following completion of the public comment period.

14.3.7 Cost

The analysis of cleanup action alternative costs includes all costs associated with implementing an alternative, including design, construction, long-term monitoring, and institutional controls.

Costs of the different alternatives are compared to assist in the overall analysis of relative costs and benefits of the alternatives. The costs to implement an alternative include long-term costs (e.g., operation and maintenance, monitoring, equipment replacement, and maintaining institutional controls), along with agency oversight costs. Cost estimates for excavation/dredging and disposal technologies include processing, analytical, labor, and waste management costs. Costs for annual mobilization/demobilization were distributed across the SMA-specific alternatives based on the construction timeframe for each alternative (i.e., total mobilization/demobilization costs equal annual mobilization/demobilization costs multiplied by construction duration for each alternative). The lump-sum costs for transload site preparation and construction were distributed equally across the SMAs (i.e., one-third of the total transload site preparation and construction costs for the active alternatives in each SMA).

Unit costs for each remedial technology and discussion of items included in lump sum line items are described in greater detail in Appendix G, and are based on recent sediment cleanup projects in Puget Sound, considering the location of the SCU. Detailed remedial alternative cost estimates for each alternative include line items for site mobilization and demobilization, intertidal excavation, subtidal dredging, material dewatering transloading and disposal, EMNR and cap material placement, habitat mitigation, cultural resource assessment and monitoring, remedial design, permitting, long-term monitoring and other elements as appropriate. The cost assumptions for each alternative were developed to be accurate within the USEPA target range of -30 percent to +50 percent (USEPA and USACE 2000) and will be refined during remedial design.

Detailed cost estimates for each SMA 1 remedial alternative are summarized in Appendix G. The estimated costs for the SMA 1 alternatives carried forward in the DCA range from approximately $5.0 million for Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal EMNR to approximately $197 million for Alternative 1-A: Maximum Dredging and Excavation. The other four SMA 1 alternatives have intermediate projected costs (Table 14.1). The alternatives are not scored for costs on a scale of 1 to 5 in the DCA; instead, the costs are compared to benefits as discussed in the following section.

14.3.8 Proposed SMA 1 Cleanup Remedy

Total weighted benefit scores and costs for the SMA 1 remedial alternatives are summarized in Table 14.1. Figure 14.1 graphically depicts the relationship of costs and weighted benefits of the SMA 1 alternatives that met threshold requirements, to identify the alternative that uses permanent solutions to the maximum extent practicable. While the DCA is the primary tool used to identify the preferred MTCA cleanup remedy (WAC 173-204-570), further assessments of the degree of risk and certainty associated with each alternative, including remedy stability under both current conditions and future conditions that may include changes or increases in overwater operations, were considered in identifying the preferred cleanup action. These considerations are summaried below.

Alternative 1-A: Maximum Dredging and Excavation received the highest overall weighted benefit score (4.2); however, Alternative 1-A is disproportionately costly relative to its incremental benefits. Alternative 1-D: Partial Intertidal Excavation and Capping with Subtidal Capping, with a total benefit score of 3.5 and a total cost of approximately $12.1 million, provides a high degree of overall benefit, a high degree of certainty that the remedy will protect human health and the environment, and a reasonable restoration timeframe. Alternative 1-C: Partial Subtidal Dredging with Subtidal and Intertidal Capping and Alternative 1-B: Partial Dredging and Excavation with Capping both received slightly higher total benefit scores (3.7 and 3.9 respectively); however, the costs associated with these increased benefits (approximately $20.2 million and $42.9 million respectively) are disproportionately high compared to the incremental benefits provided. Alternative 1-F: Intertidal/Berthing Area Capping with Subtidal Enhanced Monitored Natural Recovery provides the greatest benefit for the associated cost; however, the reliance of this alternative on EMNR in areas of mixed subtidal sediment, elevated IHS concentrations (see Figures 2.3 and 11.3), and overwater operations that may increase in the future results in a higher degree of risk compared with Alternative 1-D. Thus, Alternative 1-D: Partial Intertidal Excavation and Capping with Subtidal Capping is proposed as the preferred cleanup action for SMA 1. Cap designs throughout SMA 1 would be refined during remedial design to ensure that the remedy is protective under current and prospective future uses of SMA 1.

14.4 SMA 2 DISPROPORTIONATE COST ANALYSIS

Using the same methodology described for SMA 1, the SMA 2 remedial alternatives were scored relative to each DCA evaluation criterion, as summarized in the following sections and detailed in Table 14.2.

14.4.1 Protectiveness

Alternatives 2-A: Maximum Dredging and Excavation through 2-E: Intertidal Capping with Subtidal EMNR all achieve prospective cleanup standards within the SMA at the point of compliance immediately following completion of construction and have a moderate to high degree of improvement in overall environmental quality. However, those alternatives that leave greater volumes of contaminated sediment on-site provide less overall improvement in environmental quality than those removing risk through removal of contaminated material. Thus, based on the MTCA definition of protectiveness, Alternative 2-E: Intertidal Capping with Subtidal EMNR received the lowest score (2), while Alternative 2-A: Maximum Dredging and Excavation received a high score (5). Alternatives with intermediate protectiveness were scored between the two endpoints (Table 14.2).

14.4.2 Permanence

Consistent with the evaluation process for permanence described in Section 14.3.2 for SMA 1, Alternative 2-A: Maximum Dredging and Excavation received the highest score (5) as it provides the greatest degree of permanent reduction in contaminant toxicity, mobility, or volume, while

Alternative 2-E: Intertidal Capping with Subtidal EMNR received a lower balanced permanence score (2) as it provides the least degree of contaminant mobility. The other SMA 2 alternatives evaluated received intermediate permanence scores (Table 14.2).

14.4.3 Effectiveness over the Long-Term

The scores for Effectiveness over the Long-Term were based on the technology hierarchy described in Section 14.3.3. Consistent with SMS, Alternative 2-A: Maximum Dredging and Excavation received the highest score (5), while Alternative 2-E: Intertidal Capping with Subtidal EMNR received a lower long-term effectiveness score (2). The other SMA 2 alternatives evaluated received intermediate long-term effectiveness scores (Table 14.2).

14.4.4 Management of Short-Term Risk

The scores for Management of Short-Term Risk were based on the considerations described in Section 14.3.4. Alternative 2-E: Intertidal Capping with Subtidal EMNR received the highest score for management of short-term risk (4.5) due to the relatively smaller impacts from construction and lesser potential for release of contamination during construction compared to the other alternatives. Alternative 2-A: Maximum Dredging and Excavation received the lowest score (2.5) due to the potential for impacts from construction compared to the other alternatives. The other SMA 2 alternatives evaluated received intermediate short-term-risk management scores based on intermediate volumes of contaminated material dredging, handling and export, and the volume of imported sand associated with the alternatives (Table 14.2).

14.4.5 Technical and Administrative Implementability

The scores for Technical and Administrative Implementability were based on the considerations described in Section 14.3.5. Alternative 2-E: Intertidal Capping with Subtidal EMNR received the highest technical feasibility score (5) because of relatively few technical and administrative challenges and the availability of on-site, in-kind habitat mitigation, while Alternative 2-A: Maximum Dredging and Excavation received the lowest score (1.5) because of significant technical and administrative challenges, including difficult access, disruption to surrounding communities and operations, removal in sensitive cultural and habitat areas, and the large volumes of sediment that require disposal. The other SMA 2 alternatives evaluated received intermediate technical feasibility scores (Table 14.2).

14.4.6 Consideration of Public Concerns

The scores for Consideration of Public Concerns were based on the considerations described in Section 14.3.6. Alternative 2-C: Partial Intertidal Excavation and Capping with Subtidal EMNR and Alternative 2-D: Optimized Partial Intertidal Excavation and Capping with Subtidal EMNR received the highest balanced public concern score (4.5) because these alternatives may satisfy the public desire for some contaminated sediment removal, but also provide relatively low cost options that are protective and include in-kind habitat mitigation. Alternative 2-A: Maximum Dredging and Excavation received a low score (2.5) because though it may satisfy the public desire for removal, the very high costs of this alternative, the length of community disruption, and possible disruptions to McKinley Paper Company operations are likely to be a concern for the public. The other SMA 2 alternatives received intermediate public concern scores (Table 14.2).

14.4.7 Cost

The analysis of cleanup action alternative costs was based on the considerations described in Section 14.3.7. Detailed cost estimates for each SMA 2 remedial alternative are summarized in Appendix G. The estimated costs for the SMA 2 alternatives carried forward in the DCA range from approximately $7.0 million for Alternative 2-E: Intertidal Capping with Subtidal EMNR to approximately $59 million for Alternative 2-A: Maximum Dredging and Excavation. The other SMA 2 alternatives have intermediate projected costs (Table 14.2). The alternatives are not scored for costs on a scale of 1 to 5 in the DCA; instead the costs are compared to benefits as discussed in the following section.

14.4.8 Proposed SMA 2 Cleanup Remedy

Total weighted benefit scores and costs for the SMA 2 remedial alternatives are summarized in Table 14.2. Figure 14.2 graphically depicts the relationship of costs and weighted benefits of the SMA 2 alternatives, to identify the alternative that uses permanent solutions to the maximum extent practicable. Alternative 2-A: Maximum Dredging and Excavation received the highest overall total benefit score of 4.2, with total scores descending in order to Alternative 2-E: Intertidal Capping with Subtidal EMNR, which received the lowest overall total benefit score of 2.7. However, the projected cost for Alternative 2-A is also the highest at approximately $59 million, with costs descending in order to the lowest overall cost for Alternative 2-E of approximately $7.0 million. While the degree of overall benefit increases from Alternative 2-E to Alternative 2-D, then 2-C, to 2-B, to 2-A, costs also increase; moreover, the increased costs are not proportional to the increase in benefit. Alternative 2-E has a high degree of certainty that the remedy will protect human health and the environment, under both current and anticipated future uses of the area. Therefore, Alternative 2-E is the alternative that provides the greatest benefit for the proportional cost and is identified as the proposed remedial alternative for SMA 2.

14.5 SMA 3 DISPROPORTIONATE COST ANALYSIS

Using the same methodology described for SMA 1 and SMA 2, the SMA 3 remedial alternatives were scored relative to each DCA evaluation criterion, as summarized in the sections below and detailed in Table 14.3.

14.5.1 Protectiveness

Alternative 3-A: Year 0 EMNR is the only alternative that would achieve SCLs at the point of compliance immediately following completion of construction and thus received a high score (5), while Alternative 3-D: MNR, which is projected to achieve cleanup standards in approximately 70 years, received a low score (1). Alternatives with intermediate human health protectiveness were scored proportionately between the two endpoints (Table 14.3). These scores also reflect the fact that alternatives with long restoration timeframes also have greater uncertainty, because of the inherent uncertainty in natural recovery predictions. The on-site risks resulting from implementation also increase with the decreased extent of remedy application, with all alternatives leaving contamination in place on-site beneath EMNR layers and natural sedimentation layers over time.

14.5.2 Permanence

Consistent with the evaluation process for permanence described in Section 14.3.2 for SMA 1, Alternative 3-A: Year 0 EMNR received the highest score (5), as it provides the greatest degree of contaminant mobility reduction. Alternative 3-D: MNR received the lowest score (2) due to its reliance on natural processes only for reduction in contaminant mobility. The other two SMA 3 alternatives received intermediate permanence scores (Table 14.3).

14.5.3 Effectiveness over the Long-Term

The scores for Effectiveness over the Long-Term were based on the technology hierarchy described in Section 14.3.3. For SMA 3, the alternatives are scored based on a scale from 1 to 5, with EMNR scoring higher than MNR, consistent with SMS. Alternative 3-A: Year 0 EMNR received the highest score (5) because it employs the maximum amount of EMNR, while Alternative 3-D: MNR received the lowest long-term effectiveness score (1) because it includes only MNR. The other two SMA 3 alternatives received intermediate long-term effectiveness scores (Table 14.3), based on employing intermediate amounts of EMNR.

14.5.4 Management of Short-Term Risk

The scores for Management of Short-Term Risk were based on the considerations described in Section 14.3.4. Alternative 3-D: MNR received the highest short-term effectiveness score (5) as there are no construction actions involved with this alternative, while Alternative 3-A: Year 0 EMNR, with a 5-year in-water construction duration, received the lowest score (2).

14.5.5 Technical and Administrative Implementability

The scores for Technical and Administrative Implementability were based on the considerations described in Section 14.3.5. Alternative 3-B: Year 10 EMNR with MNR received the highest technical and administrative feasibility score (5) because of few technical challenges and its moderate (3-year) in-water construction timeframe that is unlikely to significantly disrupt commercial activities in the SCU, while Alternative 3-D: MNR received the lowest score (1) because of its reliance on natural recovery processes that are more uncertain over the relatively longer (70-year) natural recovery projection period and the need for an SRZ, which is likely to be administratively difficult. The other two SMA 3 alternatives received intermediate technical feasibility scores (Table 14.3), considering a longer duration of disruption to commercial activities in the harbor by Alternative 3-A, and the reliance on MNR and necessity for an SRZ associated with alternative 3-C (Table 14.3).

Although use of SRZs allows for evaluation of remedies with restoration timeframes longer than 10 years, there are a number of challenges associated with implementation of an SRZ, including administrative requirements, periodic reviews, potential adjustments to the size of the SRZ, renewal requirements, and the potential for slower recovery trends than anticipated. While the option to establish SRZs has been a component of the SMS regulations for more than 30 years, and was also more recently reaffirmed as part of the 2013 SMS revisions, to date there has never been an SRZ implemented under SMS. Therefore, a significant degree of uncertainty exists with respect to implementing the SRZ.

14.5.6 Consideration of Public Concerns

Alternative 3-B: Year 10 EMNR with MNR received the highest balanced public concern score (5) because this alternative may satisfy the public desire to reduce risks relatively quickly and balances public desire to be cost-effective, while Alternative 3-D: MNR received the lowest score (1) because its relatively long restoration timeframe is likely to be a concern for the public. The other two SMA 3 alternatives received intermediate public concern scores (Table 14.3).

14.5.7 Cost

Detailed cost estimates for each SMA 3 remedial alternative are summarized in Appendix G, and range from approximately $2.8 million for Alternative 3-D: MNR to approximately $22.5 million for Alternative 3-A: Year 0 EMNR. The other two SMA 3 alternatives have intermediate projected costs (Table 14.3). The alternatives are not scored for costs on a scale of 1 to 5 in the DCA; instead the costs are compared to benefits as discussed in the following section.

14.5.8 Proposed SMA 3 Cleanup Remedy

Total weighted benefit scores and costs for the SMA 3 remedial alternatives are summarized in Table 14.3. Figure 14.3 graphically depicts the relationship between costs and weighted benefits of the SMA 3 alternatives. Alternative 3-A: Year 0 EMNR received the highest overall weighted benefit score (4.5). However, the projected cost of Alternative 3-A ($22.5 million) is also the highest. Based on the DCA evaluation, Alternative 3-A is disproportionately costly compared to the incremental benefits provided over Alternative 3-B, which had a total benefit score of 4.1 and an associated cost of approximately $15.4 million. Alternatives 3-C: Year 25 EMNR with MNR and 3-D: MNR also have a higher ratio of total benefit to cost than Alternative 3-B; however, both of these alternatives have longer restoration timeframes and a higher degree of risk associated with navigating the SRZ process (an SRZ has never been authorized by Ecology). Alternative 3-B: Year 10 EMNR with MNR provides the most benefit that is not disproportionately costly, while also achieving MTCA/SMS restoration timeframe expectations.

Section 14.0:
Evaluation of Remedial Alternatives

Tables

Table 14.1
SMA 1 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	1-A Maximum Dredging and Excavation	1-B Partial Dredging and Excavation with Capping	1-C Partial Subtidal Dredging with Subtidal and Intertidal Capping	1-D Partial Intertidal Excavation and Capping with Subtidal Capping	1-E Subtidal and Intertidal Capping	1-F Intertidal/Berthing Area Capping with Subtidal EMNR
Protectiveness	30%	*Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.*	**Degree to Which Existing Risks Are Reduced**	Largest volume of contaminated sediment removed, provides the greatest degree of risk reduction	Large volume of contaminated sediment removed; exposure to sediment remaining controlled by durable engineered cap	Medium volume of contaminated sediment removed; exposure to sediment remaining controlled by durable engineered cap	Low volume of contaminated sediment removed; exposure to sediment remaining controlled by durable engineered cap	No sediment removed, but exposure to sediment remaining controlled by durable engineered cap	No sediment removed; exposure to sediment remaining controlled by durable engineered cap and EMNR
			Time Required to Reduce Risks and Achieve Cleanup Standards (years)[1]	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (11 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (4 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (3 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (2 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (2 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (1 year)
			On-Site Risks Resulting from Implementation	All contaminated sediment removed from site with no potential for future exposure	Contaminated sediment remains on-site beneath caps; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site beneath caps; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site beneath caps; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site beneath caps; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site beneath caps and EMNR layers; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary
			Off-Site Risks Resulting from Implementation	No known off-site risks resulting from remedy implementation					
			Improvement of the Overall Environmental Quality	High degree of improvement in overall environmental quality through removal and off-site disposal of contaminated sediment	High degree of improvement in overall environmental quality through limited contaminated sediment mass removal, and containment of contaminated sediment remaining on-site beneath engineered caps	Moderate to high degree of improvement in overall environmental quality through limited contaminated sediment mass removal, containment of contaminated intertidal and subtidal sediment remaining on-site beneath durable engineered caps	Moderate to high degree of improvement in overall environmental quality through limited contaminated sediment mass removal, containment of contaminated intertidal and subtidal sediment remaining on-site beneath durable engineered caps	Moderate to high degree of improvement in overall environmental quality through containment of contaminated intertidal and subtidal sediment beneath durable engineered caps	Moderate to high degree of improvement in overall environmental quality through containment of contaminated intertidal/berthing sediment remaining on-site beneath durable engineered caps and subtidal EMNR layers
			Total Score	5.0	4.5	4.0	3.5	3.0	2.5
Permanence	20%	*The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*	**Permanent Reduction of Toxicity, Mobility, or Volume of Hazardous Substances**	Dredging and excavation remove sediment exceeding cleanup levels from SMA 1; subtidal dredging residuals would be addressed by post-dredge EMNR	Dredging and excavation remove some contaminants from SMA 1, reducing the on-site contaminant volume; engineered capping control the mobility of contaminants remaining in place, and provide a clean sediment biologically active zone, reducing toxicity to benthic receptors	Dredging removes some of the contaminants from SMA 1, reducing the on-site contaminant volume; engineered capping control the mobility of contaminants remaining in place, and provide a clean sediment biologically active zone, reducing toxicity to benthic receptors	Excavation removes some of the contaminants from SMA 1, reducing the on-site contaminant volume; engineered capping control the mobility of contaminants remaining in place, and provide a clean sediment biologically active zone, reducing toxicity to benthic receptors	No contaminants are removed from the Site; however, engineered capping control the mobility of contaminants remaining in place, and provide a clean sediment biologically active zone, reducing toxicity to benthic receptors	No contaminants are removed from the Site; however, engineered capping and EMNR control the mobility of contaminants remaining in place
			Adequacy of Alternative in Destroying the Hazardous Substance, and Degree of Irreversibility of Waste Treatment Processes	Dredging, excavation, capping, and EMNR are not treatment technologies that result in destruction of hazardous substances but rather remove contaminants from the site, or contain them on-site; therefore, consideration of the adequacy of alternatives to destroy hazardous substances and the irreversibility of treatment processes do not affect the alternative scoring for permanence					
			Reduction or Elimination of Hazardous Substance Releases and Source of	Site releases resulting in contamination are from historical sources and no longer processing/ongoing; ongoing sources of hazardous substances such a cPAHs are outside the scope of this RI/FS and are being managed under separate source control authorities; this site-specific evaluation consideration does not affect alternative scoring for permanence					
			Characteristics and Quantity of Treatment Residuals Generated	All removed sediments and dewatering fluids that contain COCs that must be handled, disposed of, and controlled; significant treatment residuals are associated with this alternative	A smaller volume of removed sediments and dewatering fluids that contain COCs that must be handled, disposed of, and controlled; no treatment residuals are associated with capping except pre-placement debris removal	A smaller volume of removed sediments and dewatering fluids that contain COCs that must be handled, disposed of, and controlled; no treatment residuals are associated with capping except pre-placement debris removal	A smaller volume of removed sediments and dewatering fluids that contain COCs that must be handled, disposed of, and controlled; no treatment residuals are associated with capping except pre-placement debris removal	No treatment residuals are associated with capping except pre-placement debris removal	No treatment residuals are associated with capping or EMNR except pre-placement debris removal
			Total Score	5.0	4.5	4.0	3.5	3.0	2.5

Table 14.1
SMA 1 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	1-A Maximum Dredging and Excavation	1-B Partial Dredging and Excavation with Capping	1-C Partial Subtidal Dredging with Subtidal and Intertidal Capping	1-D Partial Intertidal Excavation and Capping with Subtidal Capping	1-E Subtidal and Intertidal Capping	1-F Intertidal/Berthing Area Capping with Subtidal EMNR
Effectiveness Over the Long-Term	20%	*The degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes.*	SMS Technology	Acres by technology					
			Removal	32.7	0	0	0	0	0
			Partial Removal and Capping	0	32.7	8.4	1.3	0	0.0
			Capping	0	0	24.3	31.3	32.7	2.5
			EMNR	0	0	0	0	0	30.2
			MNR	0	0	0	0	0	0
			Total Score	5.0	4.0	3.5	3.0	2.5	2.0
Management of Short-Term Risk	10%	*The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*	Risk to Human Health and the Environment Associated with Alternative during Construction and Implementation	Dredging and excavation poses the greatest short-term risk to human health and the environment due to: (1) turbidity and resuspension-related releases during subtidal work; and (2) heavy truck traffic and travel on public roads associated with off-site disposal of removed material	Dredging and excavation pose the greatest risk short-term risk to human health and the environment due to: (1) turbidity and resuspension-related releases during subtidal work; and (2) heavy truck traffic and travel on public roads associated with off-site disposal of removed material and import of engineered cap material	Dredging and capping pose the greatest risk short-term risk to human health and the environment due to: (1) turbidity and resuspension-related releases during subtidal dredging work; and (2) heavy truck traffic and travel on public roads associated with off-site disposal of removed material and import of engineered cap material	Intertidal excavation and capping pose lower short-term risk risks to human health and the environment due to: (1) effective control of releases during in-the-dry intertidal excavation work; and (2) less truck traffic and travel on public roads associated with off-site disposal of removed material and import of engineered cap material	Shoreline soil excavation and subtidal and intertidal capping pose lower risks to human health and the environment due to: (1) effective control of releases during in-the-dry shoreline excavation work; and (2) less truck traffic and travel on public roads associated with off-site disposal of removed material and import of engineered cap material	Shoreline soil excavation, intertidal/berthing capping, and subtidal EMNR pose lower risks to human health and the environment due to: (1) effective control of releases during in-the-dry shoreline excavation work; and (2) less truck traffic and travel on public roads associated with off-site disposal of removed material and import of engineered cap and EMNR material
			Effectiveness of Measures That Will Be Taken to Manage Risk	Large amounts of debris (e.g., logs) limit the effectiveness of BMPs to reduce turbidity and resuspension during subtidal dredging; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	Large amounts of debris (e.g., logs) limit the effectiveness of BMPs to reduce turbidity and resuspension during subtidal dredging; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	Large amounts of debris (e.g., logs) limit the effectiveness of BMPs to reduce turbidity and resuspension during subtidal dredging; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	BMPs during intertidal excavation are effective at managing risks of contaminant release; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	BMPs during shoreline soil excavation are effective at managing risks of contaminant release; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	BMPs during shoreline soil excavation are effective at managing risks of contaminant release; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads
			Total Score	2.5	3.0	3.0	3.5	4.0	4.0
Technical and Administrative Implementability	10%	*Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary offsite facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*	Technical Feasibility	Implementation has major technical challenges including subtidal dredging in debris areas, dewatering and transloading in limited available area, large volumes of sediment that substantially exceed local landfill capacity, and removal in sensitive cultural areas	Implementation has major technical challenges including subtidal dredging in debris areas, dewatering and transloading in limited available area, large volumes of sediment that substantially exceed local landfill capacity, and removal in sensitive cultural areas	Implementation has technical challenges including subtidal dredging in debris areas; dewatering and transloading in limited available area; removal in sensitive cultural areas; and on-site, in-kind habitat mitigation	Some technical challenges with limited intertidal removal in sensitive cultural areas; no habitat mitigation required	Few technical challenges; on-site, in-kind habitat mitigation	Few technical challenges; on-site, in-kind habitat mitigation
			Administrative Feasibility	Large disruption to commercial activities due to traffic and safety concerns	Moderate disruption to commercial activities due to traffic and safety concerns	Moderate disruption to commercial activities due to traffic and safety concerns	Moderate disruption to commercial activities due to traffic and safety concerns	Moderate disruption to commercial activities due to traffic and safety concerns	Least disruption to commercial activities due to traffic and safety concerns
			Total Score	1.5	2.0	3.0	4.0	3.5	4.5

Table 14.1
SMA 1 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	1-A Maximum Dredging and Excavation	1-B Partial Dredging and Excavation with Capping	1-C Partial Subtidal Dredging with Subtidal and Intertidal Capping	1-D Partial Intertidal Excavation and Capping with Subtidal Capping	1-E Subtidal and Intertidal Capping	1-F Intertidal/Berthing Area Capping with Subtidal EMNR
Consideration of Public Concerns	**10%**	***Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.***	**Balance the Public Desire for Environmental Cleanup and Sustainable Local Economic Conditions**	May satisfy public desire for removal, but very high costs likely to be a concern for the public	May satisfy public desire for some removal, but relatively high costs likely to be a concern for the public	May satisfy public desire for some removal, but higher costs likely to be a concern for the public	May satisfy public desire for removal; relatively low cost protective option that does not require mitigation	No removal, but relatively low cost protective option requiring mitigation	No removal and relatively low cost, but may not be perceived as protective as other more engineered options, and requires mitigation
			Total Score	2.5	3.0	3.5	4.0	3.5	3.0
			Total Weighted Benefits	4.2	3.9	3.7	3.5	3.1	2.8
			Cost	$197,000,000	$42,900,000	$20,200,000	$12,100,000	$12,000,000	$5,000,000
			Total Benefit per $1 Million Cost	**0.02**	**0.09**	**0.18**	**0.29**	**0.26**	**0.56**

Note:
1 Construction years rounded up to nearest whole number.

Abbreviations:
BMP Best management practice
COC Chemical of concern
cPAH Carcinogenic polycyclic aromatic hydrocarbon
EMNR Enhanced monitored natural recover
MNR Monitored natural recovery
RI/FS Remedial Investigation/Feasibility Study
SMA Sediment Management Area
SMS Sediment Management Standards
WAC Washingotn Administrative Code

Table 14.2
SMA 2 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	2-A Maximum Dredging and Excavation	2-B Partial Dredging and Excavation with Capping	2-C Partial Intertidal Excavation and Capping with Subtidal EMNR	2-D Excavation and Capping with Subtidal EMNR	2-E Intertidal Capping with Subtidal EMNR
Protectiveness	30%	*Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.*	**Degree to Which Existing Risks Are Reduced**	Largest volume of contaminated sediment removed	Large volume of contaminated sediment removed; exposure to sediment remaining controlled by durable engineered cap	Medium volume of contaminated sediment removed; exposure to sediment remaining controlled by durable engineered cap and EMNR	Medium volume of contaminated sediment removed; exposure to sediment remaining controlled by durable engineered cap and EMNR	No sediment removed, but exposure to sediment remaining controlled by durable engineered cap and EMNR
			Time Required to Reduce Risks and Achieve Cleanup Standards (years)[1]	Cleanup levels are achieved (througout the SMA) immediately following construction (5 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (3 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (2 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (2 years)	Cleanup levels are achieved (throughout the SMA) at the point of compliance immediately following construction (2 years)
			On-Site Risks Resulting from Implementation	All contaminated sediment removed from Site with no potential for future exposure	Contaminated sediment remain on-site beneath caps; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remain on-site beneath caps and EMNR layers; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remain on-site beneath caps and EMNR layers; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remain on-site beneath caps and EMNR layers; potential exposure risks controlled by durable cap designs; protectiveness would be confirmed during post-construction monitoring and contingency measures implemented as necessary
			Off-Site Risks Resulting from Implementation	No known off-site risks resulting from remedy implementation				
			Improvement of the Overall Environmental Quality	High degree of improvement in overall environmental quality through removal and off-site disposal of contaminated sediment	High degree of improvement in overall environmental quality through limited contaminated sediment mass removal, and containment of contaminated sediment remaining on-site beneath engineered caps	Moderate to high degree of improvement in overall environmental quality through limited contaminated sediment mass removal, containment of contaminated intertidal sediment remaining on-site beneath durable engineered caps and EMNR layers	Moderate to high degree of improvement in overall environmental quality through limited contaminated sediment mass removal, containment of contaminated intertidal sediment remaining on-site beneath durable engineered caps and EMNR layers	Moderate to high degree of improvement in overall environmental quality through containment of contaminated intertidal sediment beneath durable engineered caps and EMNR layers
			Total Score	5.0	4.5	3.0	2.5	2.0
Permanence	20%	*The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*	**Permanent Reduction of Toxicity, Mobility, or Volume of Hazardous Substances**	Dredging and excavation remove sediment exceeding cleanup levels from SMA 2; subtidal dredging residuals would be addressed by post-dredge EMNR	Dredging and excavation remove some contaminants from SMA 2, reducing the on-site contaminant volume; engineered capping controls the mobility of contaminants remaining in place	Excavation removes some of the contaminants from SMA 2, reducing the on-site contaminant volume; engineered capping and EMNR controls the mobility of contaminants remaining in place	Excavation removes some of the contaminants from SMA 2, reducing the on-site contaminant volume; engineered capping and EMNR control the mobility of contaminants remaining in place	No contaminants are removed from the Site; however, engineered capping and EMNR control the mobility of contaminants remaining in place
			Adequacy of Alternative in Destroying the Hazardous Substance, and Degree of Irreversibility of Waste Treatment Processes	Dredging, excavation, capping, and EMNR are not treatment technologies that result in destruction of hazardous substances but rather remove contaminants from the Site, or contain them on-site: therefore, consideration of the adequacy of alternatives to destroy hazardous substances and the irreversibility of treatment processes do not affect the alternative scoring for permanence				
			Reduction or Elimination of Hazardous Substance Releases and Source of Releases	Site releases resulting in contamination are from historical sources and no longer processing/ongoing; ongoing sources of hazardous substances such a cPAHs are outside the scope of this RI/FS and are being managed under separate source control authorities; this site-specific evaluation consideration does not affect alternative scoring for permanence				
			Characteristics and Quantity of Treatment Residuals Generated	All removed sediments and dewatering fluids will contain COCs that must be handled, disposed of, and controlled; significant treatment residuals are associated with this alternative	A smaller volume of removed sediments and dewatering fluids will contain COCs that must be handled, disposed of, and controlled; no treatment residuals are associated with capping or EMNR except pre-placement debris removal	A smaller volume of removed sediments and dewatering fluids will contain COCs that must be handled, disposed of, and controlled; no treatment residuals are associated with capping or EMNR except pre-placement debris removal	A smaller volume of removed sediments and dewatering fluids will contain COCs that must be handled, disposed of, and controlled; no treatment residuals are associated with capping or EMNR except pre-placement debris removal and upland soil excavated from the causeway	No treatment residuals are associated with capping or EMNR except pre-placement debris removal and upland soil excavated from the causeway
			Total Score	5.0	4.0	3.0	2.5	2.0

Table 14.2
SMA 2 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	2-A Maximum Dredging and Excavation	2-B Partial Dredging and Excavation with Capping	2-C Partial Intertidal Excavation and Capping with Subtidal EMNR	2-D Excavation and Capping with Subtidal EMNR	2-E Intertidal Capping with Subtidal EMNR
Effectiveness Over the Long-Term	20%	***The degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes.***	**SMS Technology**	Acres by technology				
			Removal	23.6	0	0	0	0
			Partial Removal and Capping	0	23.6	10.1	2.0	0.6
			Partial Removal and EMNR	0	0	0	4.3	0
			Capping	0	0	0	6.4	10.1
			EMNR	0	0	13.5	11.4	13.5
			MNR	0	0	0	0	0
			Total Score	5.0	4.0	3.0	2.5	2.0
Management of Short-Term Risk	10%	***The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.***	**Risk to Human Health and the Environment Associated with Alternative during Construction and Implementation**	Dredging poses the greatest risk to human health and the environment due to: (1) uncontrollable releases during subtidal work; and (2) heavy truck traffic and travel on public roads associated with off-site disposal of removed material	Dredging poses the greatest risk to human health and the environment due to: (1) uncontrollable releases during subtidal work; and (2) heavy truck traffic and travel on public roads associated with off-site disposal of removed material	Excavation poses lower risks to human health and the environment due to: (1) effective control of releases during in-the-dry intertidal and shallow subtidal excavation work; and (2) less truck traffic and travel on public roads associated with off-site disposal of removed material	Excavation and limited subtidal dredging poses lower risks to human health and the environment due to: (1) effective control of releases during in-the-dry intertidal and shallow subtidal excavation work; and (2) less truck traffic and travel on public roads associated with off-site disposal of removed material	Less truck traffic and travel on public roads associated with off-site disposal of removed material
			Effectiveness of Measures That Will Be Taken to Manage Risk	Large amounts of debris (e.g., logs) limit the effectiveness of BMPs during subtidal dredging; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	Large amounts of debris (e.g., logs) limit the effectiveness of BMPs during subtidal dredging; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	BMPs during intertidal excavation are effective at managing risks of contaminant release; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	BMPs during intertidal excavation are effective at managing risks of contaminant release; flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	Flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads
			Total Score	2.5	3.0	3.5	4.0	4.5
Technical and Administrative Implementability	10%	***Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary offsite facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.***	**Technical Feasibility**	Implementation has major technical challenges, including large volumes of sediment for off-site disposal, difficult access for dredging equipment, excavation on private property, and removal in sensitive cultural areas	Implementation has major technical challenges, including large volumes of sediment for off-site disposal, difficult access for dredging equipment, excavation on private property, and removal in sensitive cultural areas	Moderate technical challenges with excavation on private property, site access challenges and intertidal removal in culturally sensitive areas	Moderate technical challenges with excavation on private property, site access challenges; intertidal removal in culturally sensitive areas; alternative provides on-site, in-kind habitat mitigation	Few technical challenges; alternative provides on-site, in-kind habitat mitigation
			Administrative Feasibility	Large disruption to McKinley start-up and/or operations due to traffic and safety concerns	Large disruption to McKinley start-up and/or operations due to traffic and safety concerns	Moderate disruption to McKinley start-up and/or operations due to traffic and safety concerns	Moderate disruption to McKinley start-up and/or operations due to traffic and safety concerns	Moderate disruption to McKinley start-up and/or operations due to traffic and safety concerns
			Total Score	1.5	2.0	3.0	4.0	5.0

Table 14.2
SMA 2 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	2-A Maximum Dredging and Excavation	2-B Partial Dredging and Excavation with Capping	2-C Partial Intertidal Excavation and Capping with Subtidal EMNR	2-D Excavation and Capping with Subtidal EMNR	2-E Intertidal Capping with Subtidal EMNR
Consideration of Public Concerns	**10%**	***Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.***	**Balance the Public Desire for Environmental Cleanup and Sustainable Local Economic Conditions**	May satisfy public desire for removal, but very high costs and disruption of McKinley operations likely to be a concern for the public	May satisfy public desire for some removal, but relatively high costs and likely disruption of McKinley operations likely to be a concern for the public	May satisfy public desire for some removal and does not require mitigation; prior input from the public indicate this alternative is preferred, but higher costs and potential disruption of McKinley operations likely to be a concern for the public	May satisfy public desire for some removal and does not require mitigation, and reduced disruption to the community likely to be preferred by the public	Does not provide removal, but reduces risk, does not require mitigation, and is less disruptive to the community, which is likely to be preferred by the public
			Total Score	2.5	4.0	4.5	4.5	3.0
			Total Weighted Benefits	4.2	3.9	3.2	3.0	2.7
			Cost	$59,000,000	$30,000,000	$13,900,000	$9,900,000	$7,000,000
			Total Benefit per $1 Million Cost	**0.07**	**0.13**	**0.23**	**0.30**	**0.38**

Notes:
1 Construction years rounded up to nearest whole number.

Abbreviations:
BMP Best management practice
COC Chemical of concern
cPAH Carcinogenic polycyclic aromatic hydrocarbon
EMNR Enhanced monitored natural recover
MNR Monitored natural recovery
RI/FS Remedial Investigation/Feasibility Study
SMA Sediment Management Area
SMS Sediment Management Standards
WAC Washingotn Administrative Code

Table 14.3
SMA 3 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	3-A Year 0 EMNR	3-B Year 10 EMNR and MNR	3-C Year 25 EMNR with MNR	3-D MNR
Protectiveness	30%	*Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.*	**Degree to Which Existing Risks Are Reduced**	Achieves cleanup standards at the point of compliance immediately following construction	Achieves cleanup standards at the point of compliance 10 years after completion of construction	Benthic-based cleanup standards met at point of compliance immediately following construction, achieves human health-based (regional background) cleanup standards at the point of compliance 25 years after completion of construction; requires a sediment recovery zone	Achieves cleanup standards at the point of compliance in approximately 70 years; requires a sediment recovery zone
			Time Required to Reduce Risks and Achieve Cleanup Standards (years)[1]	5	13	26	70
			On-Site Risks Resulting from Implementation	Contaminated sediment remains on-site beneath EMNR layers; protectiveness of EMNR would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site beneath EMNR layers; protectiveness of EMNR and MNR would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site beneath EMNR layers; protectiveness of EMNR and MNR would be confirmed during post-construction monitoring and contingency measures implemented as necessary	Contaminated sediment remains on-site; protectiveness of MNR would be confirmed during post-construction monitoring and contingency measures implemented as necessary
			Off-Site Risks Resulting from Implementation	No known off-site risks resulting from remedy implementation			
			Improvement of the Overall Environmental Quality	High degree of improvement in overall environmental quality through placement of EMNR layers to achieve Recovery SWAC Target values; shortest time required to achieve cleanup standards	Moderate to high degree of improvement in overall environmental quality through placement of EMNR layers to achieve Recovery SWAC Target values	Moderate degree of improvement in overall environmental quality through placement of EMNR layers with MNR to achieve Recovery SWAC Target values	Low to moderate degree of improvement in overall environmental quality through placement of EMNR layers with MNR to achieve Recovery SWAC Target values
			Total Score	5.0	4.0	2.0	1.0
Permanence	20%	*The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*	**Permanent Reduction of Toxicity, Mobility, or Volume of Hazardous Substances**	No contaminants are removed from the Site; however, 250 acres of EMNR reduce the mobility of contaminants remaining in place	No contaminants are removed from the Site; however, 160 acres of EMNR reduce the mobility of contaminants remaining in place	No contaminants are removed from the Site; however, 40 acres EMNR reduce the mobility of contaminants remaining in place	No contaminants are removed from the Site; mobility is reduced over time by natural sedimentation processes
			Adequacy of Alternative in Destroying the Hazardous Substance, and Degree of Irreversibility of Waste Treatment Processes	EMNR and MNR are not treatment technologies that result in destruction of hazardous substances but rather contain them on-site; therefore, consideration of the adequacy of alternatives to destroy hazardous substances and the irreversibility of treatment processes do not affect the alternative scoring for permanence			
			Reduction or Elimination of Hazardous Substance Releases and Source of Releases	Site releases resulting in contamination are from historical sources and no longer processing/ongoing; ongoing sources of hazardous substances such a cPAHs are outside the scope of this RI/FS and are being managed under separate source control authorities; this site-specific evaluation consideration does not affect alternative scoring for permanence			
			Characteristics and Quantity of Treatment Residuals Generated	No treatment residuals are associated with EMNR and MNR except pre-placement debris removal			
			Total Score	5.0	4.0	3.0	2.0

Table 14.3
SMA 3 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	3-A Year 0 EMNR	3-B Year 10 EMNR and MNR	3-C Year 25 EMNR with MNR	3-D MNR
Effectiveness Over the Long-Term	20%	*The degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes.*	SMS Technology	Acres by technology			
			Removal	0	0	0	0
			Partial Removal and Capping	0	0	0	0
			Capping	0	0	0	0
			EMNR	250	160	40	0
			MNR	0	850	980	1,020
			Total Score	5.0	4.0	2.0	1.0
Management of Short-Term Risk	10%	*The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*	Risk to Human Health and the Environment Associated with Alternative during Construction and Implementation	EMNR placement poses the greatest risk to human health and the environment due to heavy truck traffic and travel on public roads associated import of EMNR material	EMNR placement poses moderate risk to human health and the environment due to truck traffic and travel on public roads associated import of EMNR material	EMNR placement poses low to moderate risk to human health and the environment due to less truck traffic and travel on public roads associated import of EMNR material	No construction; no risks human health and the environment associated with MNR
			Effectiveness of Measures That Will Be Taken to Manage Risk	Flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	Flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	Flaggers and a traffic management plan can reduce risks to the public associated with truck traffic on public roads	No construction; no risk management measures needed for MNR
			Total Score	2.0	3.0	4.0	5.0
Technical and Administrative Implementability	10%	*Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary offsite facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*	Technical Feasibility	Few technical challenges	Few technical challenges	Few technical challenges; natural recovery rates uncertain	No construction; natural recovery rates uncertain
			Administrative Feasibility	Greatest disruption to commercial activities due to traffic and safety concerns	Moderate disruption to commercial activities due to traffic and safety concerns	Moderate disruption to commercial activities due to traffic and safety concerns; sediment recovery zone difficult to achieve	No construction; natural recovery rates uncertain
			Total Score	4.0	5.0	2.0	1.0

Table 14.3
SMA 3 Disproportionate Cost Analysis

Criterion	Weighting	WAC Language	Considerations for Site-Specific Evaluation	3-A Year 0 EMNR	3-B Year 10 EMNR and MNR	3-C Year 25 EMNR with MNR	3-D MNR
Consideration of Public Concerns	**10%**	***Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.***	**Balance the Public Desire for Environmental Cleanup and Sustainable Local Economic Conditions**	May satisfy public desire to reduce risks relatively quickly, but higher costs likely to be a concern for the public	May satisfy public desire to reduce risks relatively quickly, and balances public desire to be cost-effective	Longer restoration timeframe likely to be a concern for the public	Relatively long restoration timeframe likely to be a concern for the public
			Total Score	4.0	5.0	2.0	1.0
			Total Weighted Benefits	4.5	4.1	2.4	1.6
			Cost	$22,500,000	$15,400,000	$5,400,000	$2,800,000
			Total Benefit per $1 Million Cost	**0.20**	**0.27**	**0.44**	**0.57**

Notes:
1 Construction years rounded up to nearest whole number.

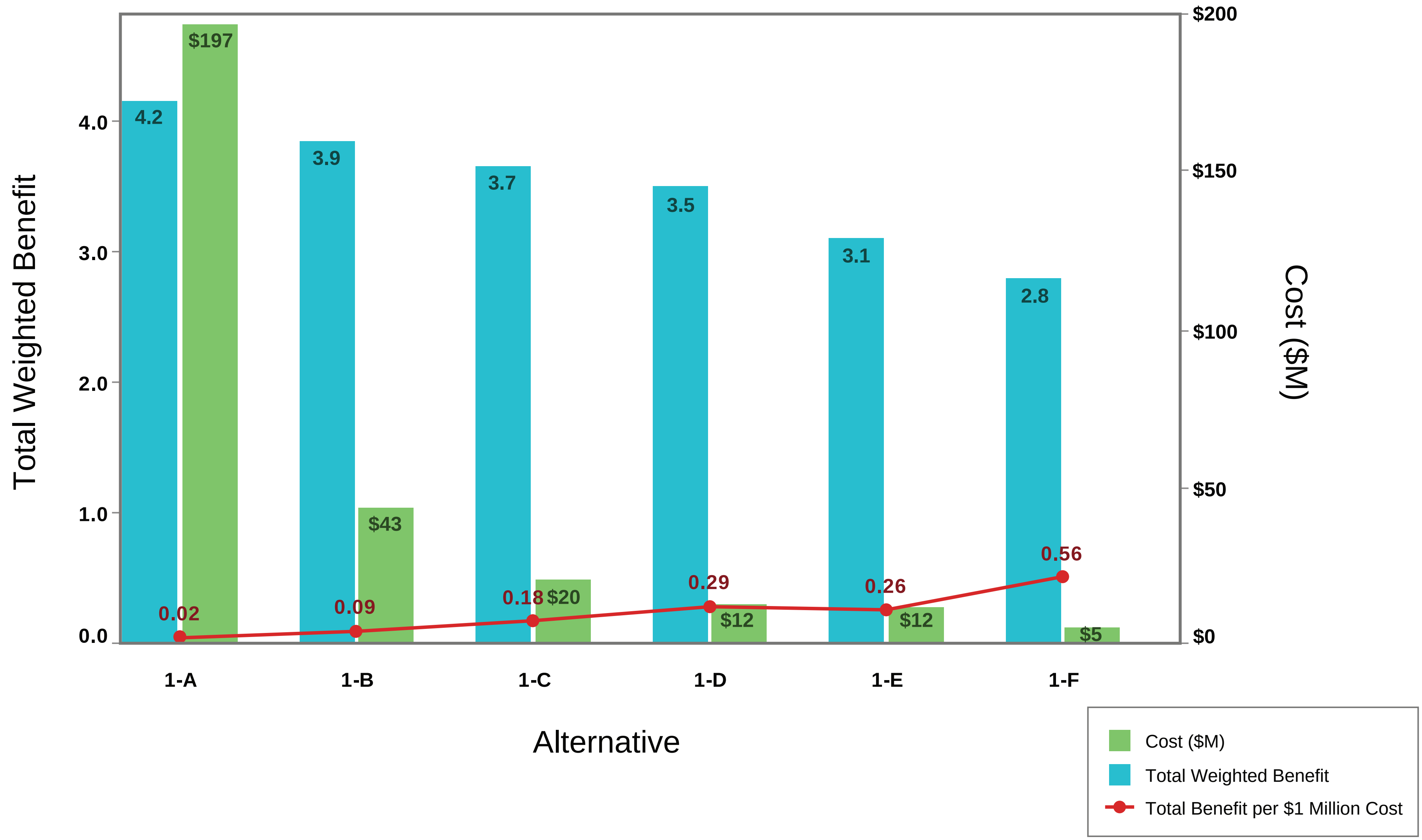
Abbreviations:
BMP Best management practice
COC Chemical of concern
cPAH Carcinogenic polycyclic aromatic hydrocarbon
EMNR Enhanced monitored natural recover
MNR Monitored natural recovery
RI/FS Remedial Investigation/Feasibility Study
SMA Sediment Management Area
SMS Sediment Management Standards
WAC Washingotn Administrative Code

Section 14.0:
Evaluation of Remedial Alternatives

Figures

Western Port Angeles Harbor
Sediment Cleanup Unit

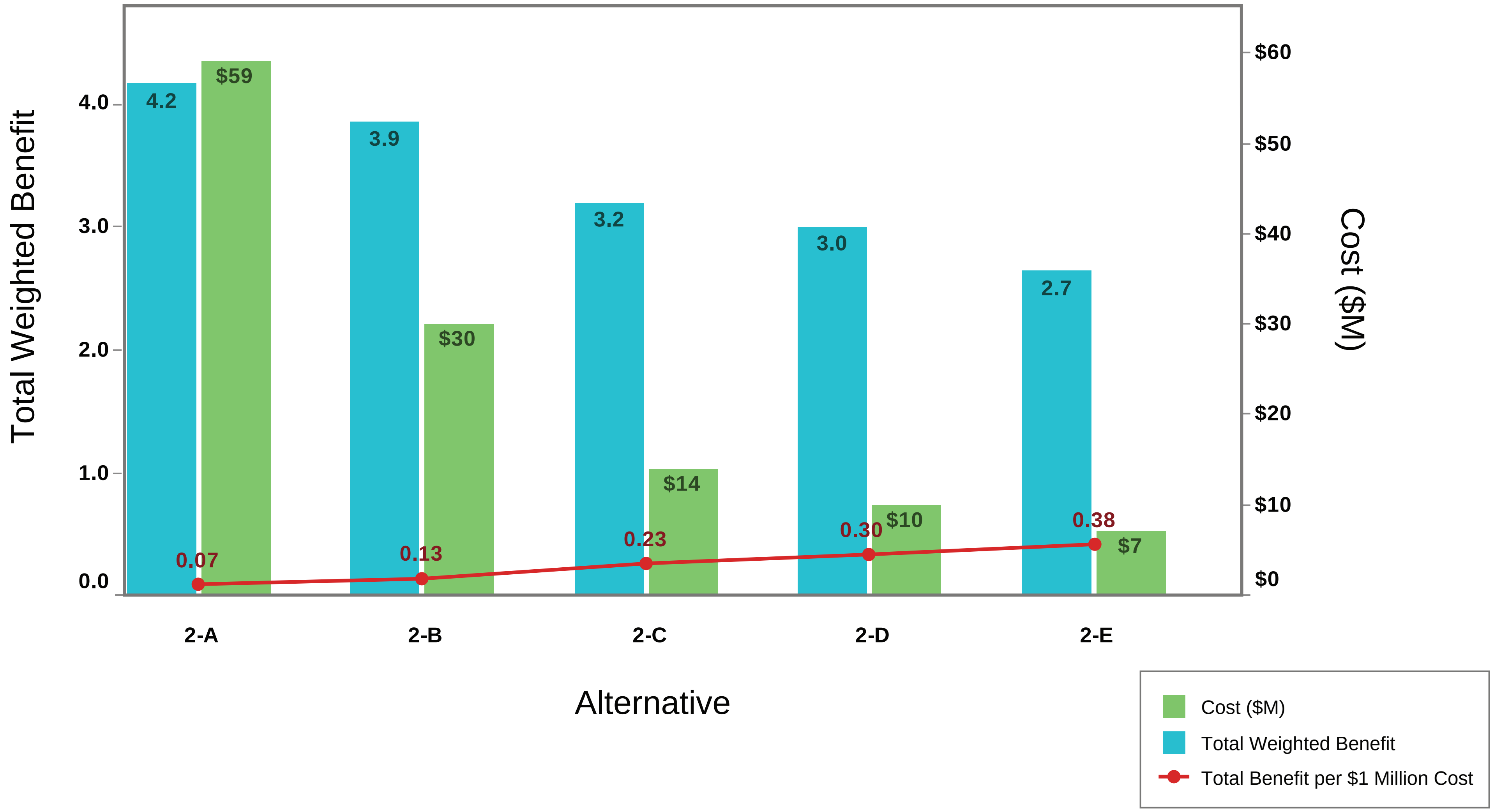
Remedial Investigation/Feasibility Study



WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor
Sediment Cleanup Unti
Remedial Investigation/Feasibility Study
Port Angeles, Washington

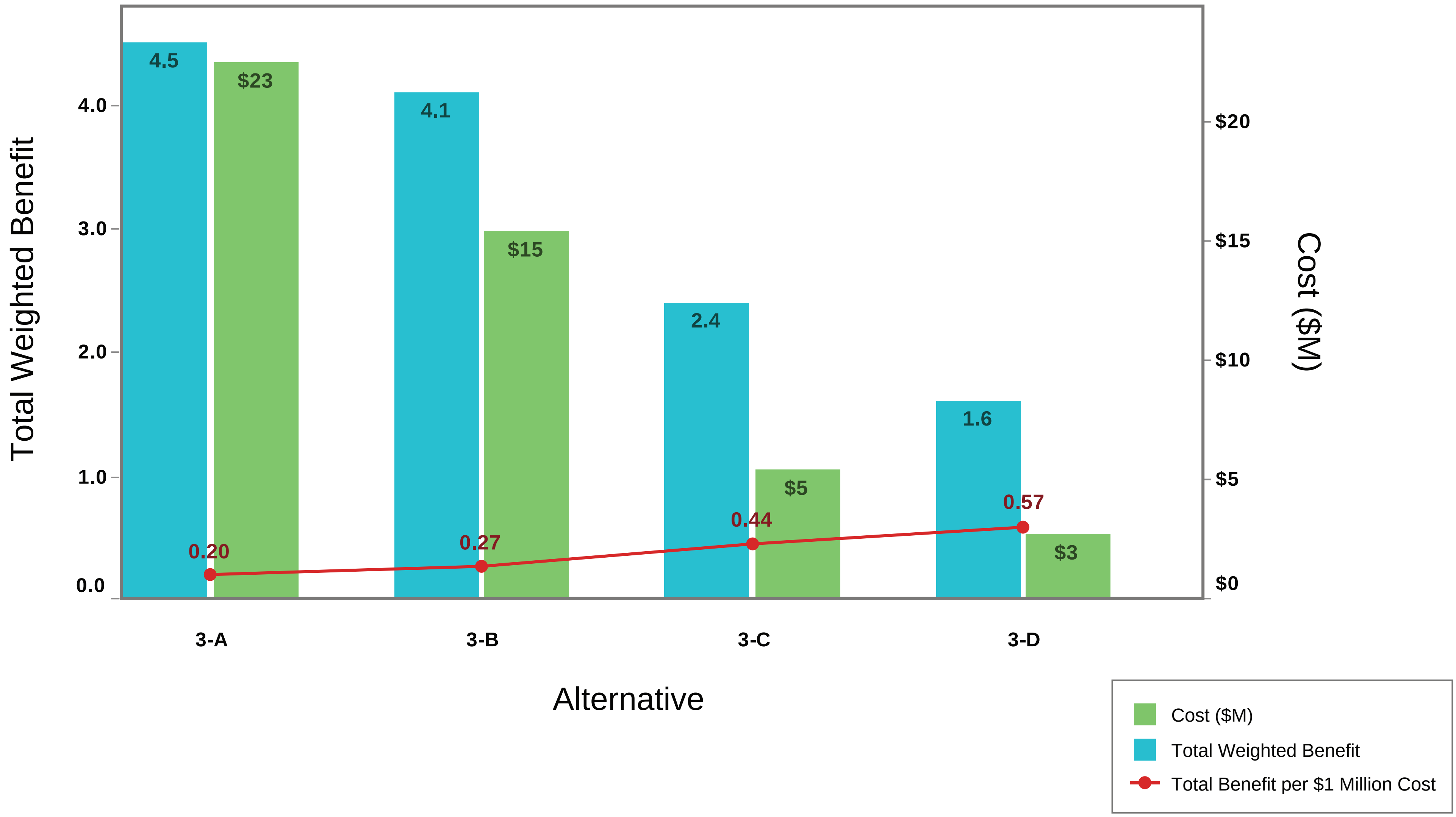
Figure 14.1
SMA 1 Disproportionate Cost Analysis



WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor
Sediment Cleanup Unti
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 14.2
SMA 2 Disproportionate Cost Analysis



WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor
Sediment Cleanup Unti
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 14.3
SMA 3 Disproportionate Cost Analysis

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Section 15.0: Preferred Cleanup Remedy

- The preferred cleanup remedy is composed of the alternatives for each SMA that were found by the Disproportionate Cost Analysis to provide the greatest degree of benefits, including protecting human health and the environment, that are not disproportionately costly. The preferred cleanup remedy includes:
  - Alternative 1-D for SMA 1: partial intertidal excavation and capping with subtidal capping
  - Alternative 2-E for SMA 2: intertidal capping with subtidal EMNR
  - Alternative 3-B for SMA 3: EMNR at an extent that expects to comply with cleanup standards 10 years post-construction with MNR
- Combined, the preferred cleanup remedy provides excavation of approximately 9,600 CY of intertidal sediment and nearshore soils from 1.3 acres of intertidal areas, and placement of 282,000 CY of clean sand and gravel for 43 acres of engineered capping and 178 acres of EMNR. The remainder of the Sediment Cleanup Unit (SCU) is addressed by MNR.
- The preferred cleanup remedy will take approximately six construction seasons to implement, at a cost of approximately $34.4 million.
- Cleanup standards are anticipated to be met SCU-wide approximately 10 years following completion of construction.
- Compliance monitoring to ensure remedy protectiveness over the long-term will be developed during the design process and is expected to include water quality monitoring, physical integrity monitoring, and sediment quality monitoring.
- Institutional controls are anticipated to be required and will be developed during the design process in coordination with the appropriate agencies.

15.0 Preferred Cleanup Remedy

The preceding section evaluated individual remedial alternatives for the three SMAs using MTCA/SMS criteria. For each SMA, the alternative that would be permanent to the maximum extent practicable was identified. Specifically, Alternative 1-D: Partial Intertidal Excavation and Capping with Subtidal Capping for SMA 1, Alternative 2-E: Intertidal Capping with Subtidal EMNR for SMA 2, and Alternative 3-B: Year 10 EMNR with MNR for SMA 3 were identified by the DCA as providing the most benefits that are not disproportionately costly. This section combines these three alternatives into a SCU-wide preferred cleanup remedy (Figure 15.1), describing the basis for selection and planned implementation of the remedy.

15.1 BASIS FOR SELECTION OF THE PREFERRED CLEANUP REMEDY

All alternatives evaluated in the DCA would meet SMS minimum requirements by protecting human health and the environment and meeting cleanup standards within a reasonable restoration timeframe. Alternatives 1-D, 2-E, and 3-B would achieve RALs throughout the SCU immediately following construction and meet cleanup standards throughout the SCU approximately 10 years following completion of construction.

The DCA provided the primary basis for comparing the costs and benefits of the remedial alternatives under MTCA/SMS. For the three SMAs, Alternatives 1-D, 2-E, and 3-B had the highest total benefits compared to costs and were identified as permanent to the maximum extent practicable (refer to Sections 14.3 through 14.5).

15.2 COMPLIANCE WITH ARARS

Remedial actions in the SCU will be performed pursuant to MTCA and the SMS under the terms of a forthcoming Consent Decree. The proposed work, which includes a variety of in-water and upland activities, would also typically be reviewed under a variety of environmental regulations and would trigger a suite of environmental permits. However, WAC 173-340-710 provides an exemption for those procedural requirements of most ARARs related to the on-site remedial actions. This exemption makes it unnecessary to obtain most environmental permits but still requires that the work be performed in a manner that satisfies the substantive requirements of those ARARs.

Table 15.1 was developed as part of this effort to ensure that all ARARs were identified. The work proposed as part of the cleanup action is expected to satisfy the substantive requirements of the ARARs. The applicability of each ARAR and the anticipated substantive compliance is described in more detail in Table 15.1. Additionally, Table 15.1 will be referenced during the development of the remedial design to ensure continued compliance.

15.3 PREFERRED CLEANUP REMEDY IMPLEMENTATION

The preferred cleanup remedy combines Alternatives 1-D, 2-E, and 3-B in SMAs 1, 2, and 3, respectively. In sum, the preferred cleanup remedy includes 1.3 acres of intertidal excavation, 43 acres of engineered capping, 178 acres of EMNR, and 949 acres of MNR (including no action areas). In addition, the preferred cleanup remedy will include excavation of approximately 0.6 acres of shoreline in SMA 2 to ensure no net loss of aquatic habitat. In total, approximately 9,600 CY of intertidal sediment and nearshore soils would be excavated, and approximately 282,000 CY of sand and gravel would be placed, requiring approximately six seasons of construction, at a cost of approximately $34.4 million. Cleanup standards are anticipated to be met SCU-wide approximately 10 years following completion of construction.

This RI/FS will inform Ecology's selection of the preferred cleanup remedy for the SCU. The preferred cleanup remedy will be further articulated for public review in a draft CAP. Following public review of the CAP and entry of the Consent Decree, the cleanup will move forward into pre-design sampling, remedial design, permitting, and construction, and finally into post-construction monitoring.

15.4 COMPLIANCE MONITORING

Compliance monitoring to ensure the protectiveness of the preferred cleanup remedy will be implemented in accordance with WAC 173-340-410, Compliance Monitoring Requirements. Detailed monitoring elements will be described in a CQAAMP and OMMP to be prepared as a part of remedial design. The conceptual frameworks for these documents are presented in Appendix I and Appendix J, respectively. The CQAAMP will describe quality assurance protocols and methods to be used to ensure that remedial actions in the SCU are implemented in accordance with the cleanup design and associated permitting requirements. The OMMP will describe post-construction monitoring and adaptive management to ensure the long-term protectiveness of the remedy. Both plans will be provided as appendices to the Engineering Design Report (EDR), which will describe the approach and criteria for the engineering design of sediment cleanup actions in the SCU, to be set forth in the final CAP and Consent Decree.

15.4.1 Compliance Monitoring Categories

The objectives of compliance monitoring as stated in WAC 173-340-410 are the following:

- **Protection Monitoring.** This type of monitoring is used to confirm that human health and the environment are adequately protected during the construction period of the cleanup action.
- **Performance Monitoring.** This type of monitoring is used to confirm that the cleanup action has attained cleanup standards and other performance standards.
- **Confirmation Monitoring.** This type of monitoring is used to confirm the long-term effectiveness of the cleanup action once cleanup standards have been attained.

SCLs and associated points of compliance, which together with ARARs are the cleanup standards for the cleanup action, are summarized in Section 8.4.

15.4.2 Compliance Monitoring Methods

Three types of compliance monitoring will be undertaken within the SCU as follows:

- **Water Quality (Protection Monitoring).** During remedial action, work will be performed in accordance with permit conditions, including those establishing water quality criteria. Compliance will be verified through a combination of intensive monitoring (e.g., once per construction shift) and routine monitoring (e.g., once weekly). Protection monitoring will identify the need for further controls as appropriate.
- **Physical Integrity (Performance and Confirmation Monitoring).** Physical integrity monitoring may include bathymetric surveys and direct inspections of intertidal and shoreline areas. Monitoring will be conducted during the cleanup action to verify the performance objectives (e.g., minimum cap thickness or minimum excavation depths). Following completion of construction, long-term physical monitoring of cap surfaces and EMNR areas (e.g., sediment cores to confirm cap thickness) will be performed to verify their integrity over time. Evidence of erosion may result in additional monitoring evaluation and contingency actions to protect human health and the environment.
- **Sediment Quality (Performance and Confirmation Monitoring).** Sediment quality in the SCU will be documented during long-term confirmation monitoring. Sediment quality monitoring events are anticipated to be conducted approximately 2, 5, and 10 years after completion of the remedial construction. Additional monitoring events may be required and/or the term extended as necessary. Surface sediment monitoring will be performed to verify that the SCU achieves compliance with SCU cleanup standards as described in Section 8.4. Surface sediment (0- to 10-cm interval) samples will be collected from throughout the SCU to compare with SCU-wide and intertidal SWAC-based cleanup standards. Samples will be analyzed for IHSs, including cadmium (intertidal only), mercury, PCBs and dioxins/furans (for calculation of Total TEQ), and cPAHs. In addition, 0- to 2-cm interval and 2- to 10-cm interval samples will be collected and archived, and then analyzed if IHS concentrations in the 0- to 10-cm interval are observed above projected trends. The 0- to 2-cm interval will be used to assess the quality of recently deposited sediment in the SCU and the 2- to 10-cm interval to evaluate mixing with underlying contaminated sediments. Select samples will also be analyzed for benthic IHSs (cadmium, mercury, and zinc) and compared to benthic SCLs on a point-by-point basis.

Final monitoring requirements (i.e., sample locations, monitoring parameters) will be defined in the CQAAMP and OMMP prepared as part of remedial design and permitting. Detailed contingency response actions as needed will also be described in the CQAAMP and OMMP.

15.5 INSTITUTIONAL CONTROLS

The preferred cleanup remedy was developed to ensure protection under existing and anticipated future shoreline and aquatic land uses. However, in conjunction with compliance monitoring, appropriate institutional controls as outlined in Section 12.7.2 will be undertaken to limit or prohibit activities that could interfere with the integrity of the cleanup action or result in exposure to hazardous substances. During remedial design, institutional controls will be detailed in the OMMP, also ensuring that such controls minimize the potential to impact the exercise of Tribal treaty rights, or unreasonably encumber future uses of state-owned aquatic lands. Multiple fish advisories that are not associated with this cleanup are in effect in the Harbor already. These advisories are anticipated to remain in place following completion of this cleanup. No new advisories are expected to be included in the preferred cleanup remedy.

Upon completion of remedial construction, and in consultation with appropriate federal, state, and local agencies, engineered cap areas will be identified on USCG navigation maps and on Clallam County geographic information system (GIS) files to inform potential future permit reviews for in-water construction actions that may be performed in these areas. Additionally, the USCG may require establishment of a Regulated Navigation Area. The requirement for a Regulated Navigation Area will be determined during design. The OMMP to be prepared as part of the EDR will describe how excavation of engineered caps can be performed protectively (e.g., replacing cap layers at the completion of construction), and describing how future in-water construction in EMNR and MNR areas of the SCU can be performed protectively (e.g., placing a sand cover over the dredged area to achieve anti-degradation requirements). Coordination with DNR will also be conducted to determine if any leases or agreements may be necessary for remedy construction on DNR lands. These and other appropriate institutional controls will be detailed in the OMMP.

15.6 CLIMATE CHANGE RESILIENCE OF PREFERRED REMEDY

Resilience to climate change was evaluated using the Ecology guidance *Adaptation Strategies for Resilient Cleanup Remedies* (Ecology 2017e). Table 7 of the guidance lists potential climate change impacts to be considered for sediment cleanup sites, which includes sea level risk, coastal storms, salt wedge movement, extreme precipitation and flooding, landslide, wildfire, and drought, some of which are not applicable in WPAH. The preferred remedy has a mix of technologies with varying degrees of vulnerability to climate change impacts from sea level rise and more severe coastal storms. Intertidal excavations remove contaminated sediment, which would be backfilled with a cap engineered to ensure long-term stability, and then monitored to ensure long-term protectiveness, resulting in an overall low vulnerability to climate change. EMNR is characterized in Ecology's guidance as having moderate vulnerability to climate change impacts that can be managed with infrequent repair, maintenance, and/or additional monitoring. For WPAH, EMNR and capping are the preferred remedies for subtidal areas that are less likely to be impacted by sea level rise or coastal storms. Potential climate change scenarios will be considered further during the remedial design phase to ensure the continued resilience of the remedy. Additionally, during remedial construction, adaptive management (as described in Appendix I) will be utilized to offset uncertainty related to potential climate change impacts.

15.7 ASPECTS OF PREFERRED CLEANUP REMEDY TO BE DETERMINED OR REFINED IN REMEDIAL DESIGN

Additional data collection and engineering evaluations will occur during the remedial design phase to finalize the remedy details. These activities will include, but are not limited to, the following:

- Sampling and analysis of prospective intertidal excavation areas will be performed to refine areas that exceed RALs across the 45-cm-deep point of compliance for the lagoon intertidal area and the inner harbor intertidal area.
- Sampling and analysis of no action areas, including the lagoon causeway, will be performed to document existing conditions.
- A cultural resources survey will be performed in prospective intertidal excavation areas, consistent with the LEKT MDP (Appendix F). If the survey revealed that excavation actions could potentially cause unacceptable disturbance of cultural resources, excavation in culturally sensitive areas would be avoided.
- Confirmatory bioassay testing will be performed at non-contiguous RI bioassay failure stations that are outside of identified remedial areas (two on Ediz Hook, one adjacent to the Port log rafting area, and one within the Terminal 7 berthing area). If the remedial design data verify benthic protection, no further remedial action will be performed at these stations. Conversely, if confirmatory bioassays reveal sediment toxicity exceeding SCLs, these areas would be addressed as appropriate during remedial design (e.g., expanded EMNR or other actions).
- Design specifications for engineered caps in the SCU will be developed during remedial design based on detailed location-specific analyses of bioturbation, erosion (e.g., propeller wash, tidal currents, waves, wakes, and slope stability), chemical isolation, consolidation, and operational considerations (e.g., placement tolerances), building on the Appendix K preliminary design evaluation.
- The 50-foot offset around structures is a concept-level offset that will be evaluated on a structure-by-structure basis. Offsets will be reduced as much as practicable informed by geotechnical and structural analyses, considering variability of site conditions, the type of structure, the use, and level of protectiveness needed.
- Sequencing of intertidal and subtidal construction will be evaluated during remedial design, and appropriate environmental controls and BMPs will be specified. For example, designs are typically implemented in an upslope to downslope sequence to reduce, as practicable, the potential for undercutting, erosion, and migration of the slope, which typically poses a greater risk than recontamination of completed intertidal remedies from follow-on subtidal dredging.

- Specific in-water work windows and BMPs for intertidal excavation, capping, and EMNR placement operations will be developed during remedial design and permitting. In addition, means and methods for removal and placement activities will be evaluated during remedial design and permitting, and finalized based on input from the remedial contractor selected to perform the work.
- Both the OMMP and CQAAMP will be finalized as part of remedial design.

Section 15.0:
Preferred Cleanup Remedy

Table

Western Port Angeles Harbor
Sediment Cleanup Unit

Remedial Investigation/Feasibility Study

Table 15.1
Applicable or Relevant and Appropriate Requirements

ARAR	Agency	Applicability to the Preferred Cleanup Remedy	Preferred Cleanup Remedy Compliance with the ARAR
Federal Applicable or Relevant and Appropriate Requirements (ARARs)			
Clean Water Act, Section 401 (33 U.S. Code § 1341 *and WAC 173-225*)	*Federal process implemented by* Washington State Department of Ecology	In-water work; discharge into navigable waters	Section 401 of the Clean Water Act (CWA) regulates any discharge into navigable waters of the U.S. In-water work proposed as part of the preferred cleanup remedy will result in turbidity or potentially fill (both defined as discharge) into the waterbody. The potential effects from this work would be minimized in accordance with Section 401 of the CWA, and consistent with standard terms of an associated water quality certification, through a variety of best management practices that would be implemented during construction.
Clean Water Act, Section 402 (33 U.S. Code § 1342 *and WAC 173-220*)	*Federal process implemented by* Washington State Department of Ecology	Upland clearing, grading or excavation; discharge of stormwater into navigable waters	Section 402 of the CWA regulates any discharge of pollutants into navigable waters of the U.S. The preferred cleanup remedy may include upland clearing, grading, or excavation activities in an area greater than 1 acre, with stormwater discharge from this area to surface waters of the state. The potential effects from this work would be minimized in accordance with Section 402 of the CWA, and consistent with standard terms of an associated construction stormwater general permit, through a variety of best management practices that would be implemented during construction.
Clean Water Act, Section 404 (33 U.S. Code § 1344)	U.S. Army Corps of Engineers	In-water work; discharge into navigable waters	Section 404 of the CWA regulates any discharge of dredged or fill material into navigable waters of the U.S., including wetlands. In-water work proposed as part of the preferred cleanup remedy will potentially fill navigable waters, and there is no practicable alternative that is less damaging to the environment since this work would be part of the cleanup remedy. The potential effects from this work would be minimized in accordance with Section 404 of the CWA, and consistent with standard terms of a Department of the Army permit, through a variety of best management practices that would be implemented during construction.
Rivers and Harbors Act, Section 10 (33 U.S. Code § 403)	U.S. Army Corps of Engineers	In-water work; excavation or fill in navigable waters	Section 10 of the Rivers and Harbors Act regulates excavation or fill in any manner that alters or modifies the course, location, condition, or capacity of, any port, roadstead, haven, harbor, or any navigable water of the U.S. In-water work proposed as part of the preferred cleanup remedy will potentially fill navigable waters. The potential effects from this work could be reviewed and permitted by the U.S. Army Corps of Engineers in accordance with Section 10 of the Rivers and Harbors Act.
Coastal Zone Management Act (16 U.S. Code § 1463*)*	*Federal process implemented by* Washington State Department of Ecology	In-water work; work within the shoreline district	The preferred cleanup remedy is consistent with the overarching goal of the Washington State Coastal Zone Management Program, which is to preserve, protect, develop, and, where possible, restore or enhance the resources of the nation's coastal zone. The preferred cleanup remedy, once completed, would result in an overall benefit to the environment and would be constructed in a way that would avoid, minimize, or mitigate potential adverse effects from construction.
Endangered Species Act (16 U.S. Code § 1531-1544*)*	*Collectively implemented by* U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration	In-water work	Several endangered or threatened species exist within or near Port Angeles Harbor. These species are protected under the Endangered Species Act, which requires consultation to ensure that federal actions do not jeopardize the continued existence of a species or adversely affect its critical habitat. Construction of the preferred cleanup remedy is not expected to have an adverse effect, and would be constructed in a way that would avoid, minimize, or mitigate potential adverse effects to these protected species.
Migratory Bird Treaty Act (16 U.S. Code § 703-712)	U.S. Fish and Wildlife Service	Upland clearing	The Migratory Bird Treaty Act prohibits the "take" of migratory birds, which can occur from construction-related activities near nests or nesting sites. Any upland clearing conducted as part of the preferred cleanup remedy would avoid potential disturbance of nests or nesting sites, or would undergo the appropriate consultation to obtain permission for potential take.
National Historic Preservation Act (54 U.S. Code § 300101)	*Federal process implemented by* Department of Archaeology and Historic Preservation	In-water work; ground disturbance	The National Historic Preservation Act provides protection for important historic buildings and archaeological sites and requires coordination with consulting parties (led by the Washington State Department of Archaeology and Historic Preservation) to determine if the undertaking would have a potential effect. The preferred cleanup remedy would be designed and constructed to avoid potential effects to potential and known archaeological resources in the project area. Consultation would occur with the Lower Elwha Klallam Tribe, the City of Port Angeles, and other consulting parties to ensure potential effects are minimize and avoided, consistent with the terms of an existing Settlement Agreement (refer to Appendix F). This consultation also ensures consistency with the federal Native American Graves Protection and Repatriation Act and the state Indian Graves and Archaeological Site protections.

Table 15.1
Applicable or Relevant and Appropriate Requirements

ARAR	Agency	Applicability to the Preferred Cleanup Remedy	Preferred Cleanup Remedy Compliance with the ARAR
Federal ARARs (cont.)			
Resource Conservation and Recovery Act Title D, Solid Waste (RCRA; 42 USC Chapter 82 § 6901 et seq.)	*Federal process implemented by* Washington State Department of Ecology	Management and disposal of non-hazardous waste	Title D of the Resource Conservation and Recovery Act establishes requirements for the generation, identification, handling and transportation, treatment, and disposal of non-hazardous waste. Contaminated material associated with implementation of the preferred cleanup remedy will comply with these requirements, as the material is known to contain contamination, however does not contain hazardous materials that trigger requirements of RCRA Title C. Any non-hazardous waste generated by the cleanup remedy will be profiled, handled and disposed in accordance with the requirements of RCRA Title D.
Occupational Safety and Health Act (OSHA; 29 USC Chapter 15)	*Federal process implemented by* US Department of Labor, Occupational Safety and Health Administration	Worker health and safety	The Occupational Safety and Health Act provides requirements for employers that provide workers with a work environment free from recognized hazards including exposure to toxic chemicals, mechanical- and weather-related hazards, and environmental conditions. The preferred cleanup remedy will be performed by contractors with experience conducting operations in the known hazardous conditions of the project including but not limited to in-water work, heavy mechanical equipment operation, and contact with contaminated materials. Compliance with worker health and safety laws will be a contract requirement.
Occupational Safety and Health Standards (29 CFR 1910, 1926)	*Federal process implemented by* US Department of Labor, Occupational Safety and Health Administration	Worker health and safety	Part 1910 of the Occupational Safety and Health Standards provides general workplace standards, while Part 1926 provides safety and health regulations for construction. The proposed work includes construction; therefore, both regulations apply. The preferred cleanup remedy will be designed and constructed in a manner that complies with all applicable worker health and safety requirements.
State ARARs			
State Environmental Policy Act (RCW 43.21C and WAC 197-11)	*State process implemented by* City of Port Angeles	Agency actions	The preferred cleanup remedy constitutes an agency action, through the proposed work and potential issuance of project-specific permits or approvals. Under the State Environmental Policy Act these agency actions should undergo review to identify potential environmental impacts and mitigation measures. The preferred cleanup remedy, once completed, would result in an overall benefit to the environment and would be constructed in a way that would avoid, minimize, or mitigate potential adverse effects from construction.
Sediment Management Standards (WAC 173-204)	Washington State Department of Ecology	Sediment cleanup standards	The sediment management standards have been used to establish cleanup standards for the future quality of surface sediments and to outline a management and decision process for the proposed cleanup of contaminated sediments.
Water Quality Standards (WAC 173-201A)	Washington State Department of Ecology	Water quality standards	The water quality standards could be applicable to the preferred cleanup remedy in order to protect aquatic life and human exposure from seafood consumption. The water quality standards provide numeric and narrative criteria to protect existing and designated uses within the waterbody.
Model Toxics Control Act (WAC 173-340)	Washington State Department of Ecology	Remedial actions	A remedial investigation/feasibility study is being prepared under the Model Toxics Control Act (MTCA) to evaluate potential impacts to human health and to identify the preferred cleanup remedy to direct cleanup efforts in the SCU. Administrative processes and other standards, including cleanup standards, are also set by MTCA.
Shoreline Management Act (WAC 173-27)	*State process implemented by* City of Port Angeles	In-water work; work within the shoreline district	The Shoreline Master Program of the City of Port Angeles outlines policies to protect natural resources, provide for water-dependent uses, and ensure public access to the shoreline. The preferred cleanup remedy is intended to protect natural resources and would be constructed in a way that minimizes potential adverse effects to the shoreline resources, consistent with standard terms of a shoreline substantial development permit.
Hydraulic Project Code (WAC 220-660)	Washington Department of Fish and Wildlife	In-water work	The Hydraulic Code Rules regulate construction projects that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters in Washington State. The preferred cleanup remedy would be constructed in a manner that minimizes potential effects to fish life, consistent with standard terms of a hydraulic project approval.

Table 15.1
Applicable or Relevant and Appropriate Requirements

ARAR	Agency	Applicability to the Preferred Cleanup Remedy	Preferred Cleanup Remedy Compliance with the ARAR
State ARARs (cont.)			
Aquatic Land Management (WAC 332-30)	*State process implemented by* Dredge Material Management Program	In-water dredge material placement	Open water disposal of dredged material is regulated by the Dredged Material Management Program (DMMP) to ensure the dredged materials are suitable for in-water disposal and do not appear to create a threat to human health, welfare, or the environment, and that disposal would occur within an approved open water disposal site. The chemical quality of any material proposed for open water disposal would be reviewed by the DMMP, and approval would be obtained, prior to disposal. Open water disposal of dredged material is not expected to be included in the preferred cleanup remedy.
Solid Waste Handling Standards (WAC 173-350)	*State process implemented by* Clallam County Solid Waste Division	Dredge and excavated material and construction waste disposal	These state standards establish the minimum standards for handling and disposal of solid waste. Solid waste includes wastes that are likely to be generated as a result of site remediation (e.g., contaminated sediments, construction and demolition wastes, and garbage).
General Occupational Health Standards (WAC 296-62; 29 CFR 1952.4)	*State process implemented by* Washington Department of Labor and Industries, Division of Occupational Safety and Health	Worker health and safety	The federal Occupational Safety and Health Act approves state plans for enforcement of state occupational safety and health standards, which are equal to or more stringent than the federal standards. Washington State general occupational health standards (i.e., the Washington State plan) are established by Part 62 of the Washington Department of Labor and Industries Administrative Code. The Washington State plan for general occupational health standards has been approved by the Occupational Safety and Health Administration, who have entered into an operational status agreement with Washington State. The preferred remedy will be conducted in accordance with the Washington State standards.
Washington Industrial Safety and Health Act (WISHA; RCW 49.17)	*State process implemented by* Washington Department of Labor and Industries, Division of Occupational Safety and Health	Worker health and safety	The Washington Industrial Health and Safety Act provides requirements for employers that provide workers with a work environment free from recognized hazards including exposure to toxic chemicals, mechanical- and weather-related hazards, and environmental conditions. The preferred cleanup remedy will be performed by contractors with experience conducting operations in the known hazardous conditions of the project including but not limited to in-water work, heavy mechanical equipment operation, and contact with contaminated materials. Compliance with worker health and safety laws will be a contract requirement.
Industrial Safety and Health Core Rules (WAC 296-800) and Safety Standards for Construction (WAC 296-155)	*State process implemented by* Washington Department of Labor and Industries, Division of Occupational Safety and Health	Worker health and safety	Part 800 of the Washington Department of Labor and Industries Administrative Code provides core rules for basic workplace safety and health standards and practices, while Part 155 provides safety standards for construction. The proposed work includes construction; therefore, both regulations apply. The preferred cleanup remedy will be designed and constructed in a manner that complies with all applicable worker health and safety standards.
Local ARARs			
Flood Damage Prevention (PAMC 15.12)	City of Port Angeles	Upland development; construction within the floodplain	Upland development or construction within any area of special flood hazard within the City of Port Angeles must undergo review by the Director of Public Works and Utilities to ensure that the proposed work would not increase potential risk to public and private losses due to flood conditions. This local flood damage prevention chapter implements the state and federal requirements of the National Flood Insurance Program Regulations.
Noise Control (PAMC 15.16)	City of Port Angeles	Construction noise above permissible levels	The City of Port Angeles has adopted the Washington State maximum environmental noise levels, and implements these requirements through the noise control code, which sets permissible levels for construction-related noise and a process to obtain a variance for these noise levels, if needed. Construction of the preferred cleanup remedy is not expected to exceed the maximum environmental noise levels for the adjacent environments.
Environmentally Sensitive Areas and Wetland Protection (PAMC 15.20-15.24)	City of Port Angeles	Work within environmentally sensitive areas	The City of Port Angeles defines environmentally sensitive areas as surface streams and flood hazards, geologic hazards, fish and wildlife habitat areas, locally unique features, and wetlands, and protects these features in accordance with requirements of the Washington State Growth Management Act. The preferred cleanup remedy would be designed and constructed to avoid and minimize potential disturbance of these areas and would be consistent with the associated development standards.

Table 15.1
Applicable or Relevant and Appropriate Requirements

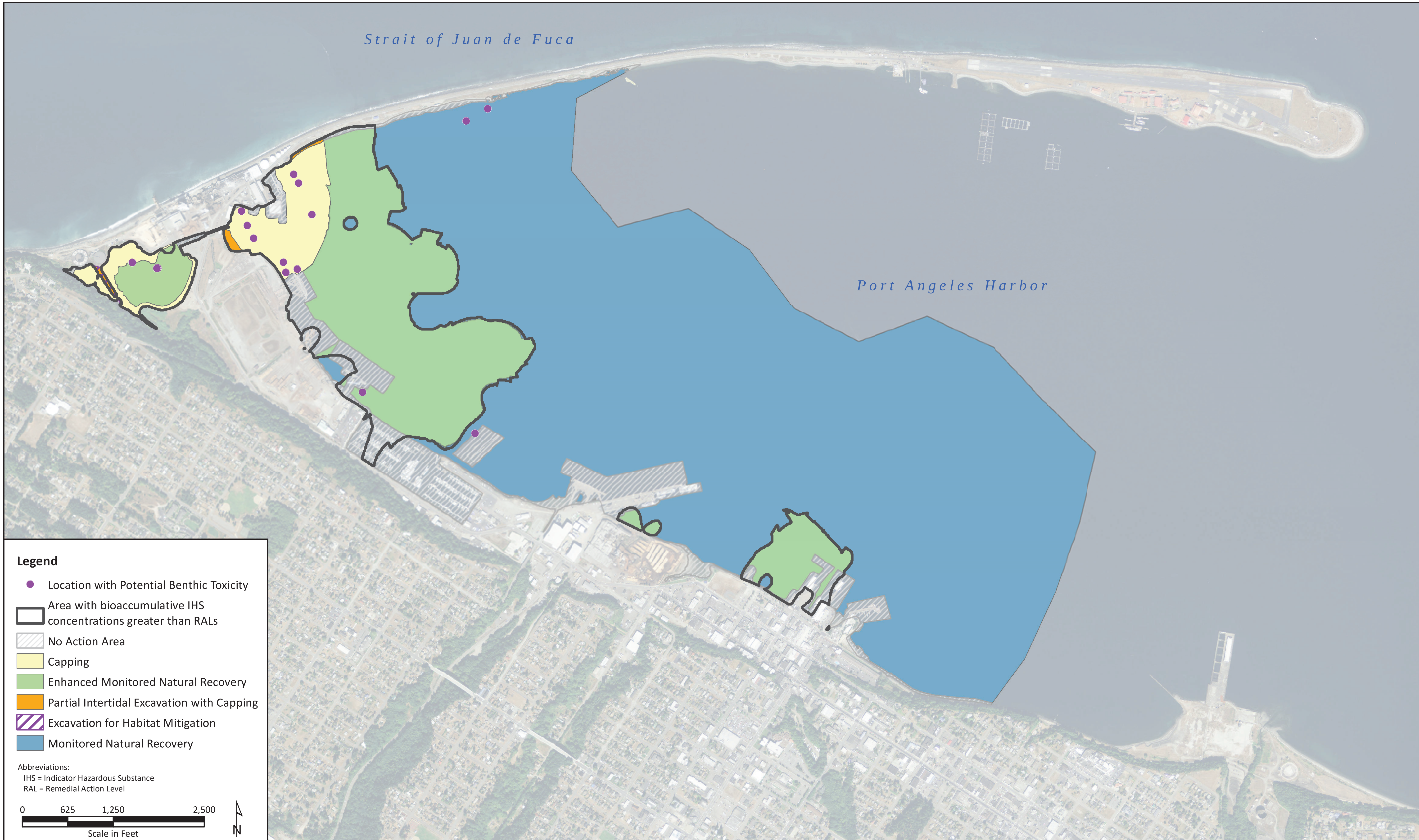
ARAR	Agency	Applicability to the Preferred Cleanup Remedy	Preferred Cleanup Remedy Compliance with the ARAR
Local ARARs (cont.)			
Clearing, Grading, Filling, and Drainage Regulations (PAMC 15.28)	City of Port Angeles	Upland clearing, grading or excavation	Upland clearing, grading, or excavation within the City of Port Angeles is regulated by provisions of the Port Angeles Municipal Code. Any upland ground disturbance required by the preferred cleanup remedy would be designed to minimize potential effects to health and safety, and protect public and private resources of the City of Port Angeles, consistent with standard terms of a clearing and grading permit.

Section 15.0: Preferred Cleanup Remedy

Figure

Western Port Angeles Harbor
Sediment Cleanup Unit

Remedial Investigation/Feasibility Study



WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure 15.1
Preferred Cleanup Remedy

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Section 16.0: References

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