Final Feasibility Study Report
(Volume 2 of Supplemental Remedial Investigation and Feasibility Study Report)

Everett Smelter Lowland Area
Everett, Washington

for
Washington State Department of Ecology

February 8, 2016

GeoEngineers
Earth Science + Technology

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ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirement
ASARCO	American Smelting and Refining Company
bml	below mudline
BNSF	BNSF Railway
CAOs	cleanup action objectives
cm	centimeter
CWA	Clean Water Act
CY	cubic yards
DCA	disproportionate cost analysis
DW	dangerous waste
Ecology	Washington State Department of Ecology
EHW	extremely hazardous waste
FS	Feasibility Study
IHSs	indicator hazardous substances
Lowland or Lowland Area	Everett Smelter Lowland Area
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MTCA	Model Toxic Control Act
NPDES	National Pollutant Discharge Elimination System
NWP 38	Nationwide Permit 38
PCULs	preliminary cleanup levels
POCs	points of compliance
PQL	Practical Quantitation Limit
ROW	right-of-way
SMS	Sediment Management Standards
S/S	solidification and stabilization
TCLP	toxicity leaching characteristic procedure
USACE	U.S. Army Corps of Engineers
WAC	Washington Administrative Code

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1.0 INTRODUCTION

This report presents the Feasibility Study (FS) for the Everett Smelter Lowland Area (*Lowland* or *Lowland Area)* located in northeast Everett, Washington (Figure 1). This FS has been completed on behalf of the Washington State Department of Ecology (Ecology) who is performing the work under a bankruptcy settlement agreement with ASARCO, the prior owner of the smelter, to address environmental impacts from the smelter.

The Everett Smelter Site is comprised of two areas: the Upland Area and the Lowland Area. The Lowland Area is generally situated between Marine View Drive and the Snohomish River and is located east of the Everett Smelter Upland Area where a former lead smelter and an associated arsenic extraction facility operated from approximately 1892 to 1912 (Hydrometrics, 1995). The general area that was occupied by the former smelter is shown in relation to the Upland and Lowland areas in Figure 2.

The Lowland Area is zoned for industrial and commercial use. A portion of the property in the Lowland Area south of the intersection of East Marine View Drive and Pacific Highway is zoned C-2 "Heavy Commercial – Light Industrial" and a portion of the property on the northern boundary of the Lowland Area is zoned M-S "Marine Services." The remaining properties within the Lowland Area are zoned M-2 "Heavy Manufacturing" according to a City of Everett zoning map. In general, the property uses in the Lowland Area are industrial in nature and include recycling facilities and transfer stations, a substation, rail transport, bus repair and materials storage that are generally characterized by concrete, asphalt and gravel paved surfaces and buildings and structures that support facility operations. Future use will continue to be for commercial and industrial purposes characterized by paved surfaces with supporting buildings and structures.

This FS was prepared based on the results of the supplement remedial investigation of the Lowland Area as presented in the Lowland Area Supplemental Remedial Investigation Report (SRI Report; GeoEngineers, 2015). The overall objectives of the FS are to develop and evaluate a range of remedial alternatives for the Site in accordance with Model Toxic Control Act (MTCA) and Sediment Management Standards (SMS) and to identify the preferred remedial alternative for the Lowland Area.

The SRI report presented the following information developed for the Lowland Area:

- Background and history;
- Environmental setting (e.g. land use, site geology, hydrogeology, etc.);
- Remedial investigation approach and investigation activities;
- Development of preliminary cleanup levels and indicator hazardous substances;
- Nature and extent of contamination; and
- Conceptual site models (sources, transport and exposure pathways for contamination, etc.).

The SRI Report also identified areas and media within the Lowland Area that require evaluation of remedial alternatives in the FS.

This FS report follows procedures outlined in MTCA (Washington Administrative Code [WAC] 173-340-350[8]) and SMS (WAC 173-204-550[7]), and is organized as follows:

Section 2.0 summarizes preliminary cleanup standards developed in the SRI Report including preliminary cleanup levels (PCULs) and points of compliance (POCs) at which the cleanup levels must be met. This section also presents additional regulatory requirements applicable to the Lowland Area cleanup action.

Section 3.0 summarizes areas and media containing contamination and requiring evaluation of remedial alternatives.

Section 4.0 presents cleanup action objectives (CAOs) for the Lowland Area.

Section 5.0 identifies and screens potentially applicable remedial technologies for each contaminated media.

Section 6.0 presents remedial alternatives considered for each area requiring remedial alternative evaluation and seven site-wide remedial alternatives developed for the Lowland Area.

Section 7.0 presents criteria used in the FS to evaluate the site-wide remedial alternatives.

Section 8.0 compares and evaluates site-wide remedial alternatives based on FS evaluation criteria and proposes a preferred remedial alternative for the Lowland Area. The MTCA disproportionate cost analysis (DCA) process is used to identify a preferred remedy for Ecology's consideration.

Section 10.0 provides references to reports, documents, publications that were referred in preparing the FS report.

2.0 CLEANUP REQUIREMENTS

Cleanup requirements consist of cleanup standards and additional regulatory requirements that apply to the cleanup action because of the type of action and/or the location of the site (WAC 173-340-200). Cleanup standards consist of cleanup levels that are protective of human health and the environment and the points of compliance at which the cleanup levels must be met. Additional regulatory requirements include requirements of applicable laws and requirements that are legally applicable and determined by Ecology to be relevant and appropriate (ARARs). The preliminary cleanup standards for the Lowland Area are summarized in Section 2.1 and additional regulatory requirements are identified in Section 2.2.

2.1. Preliminary Cleanup Standards

This section summarizes the media-specific PCULs and POCs for the indicator hazardous substances (IHSs) that were developed in the SRI Report for the Lowland Area. The IHSs for the Lowland Area include arsenic, lead and mercury.

The preliminary cleanup levels are expected to be adopted as final cleanup levels by Ecology in the Cleanup Action Plan (CAP) and serve as the basis for developing CAOs, evaluating remedial alternatives and selecting the preferred remedial alternative.

2.1.1. Soil

The PCULs and POCs for soil IHSs are presented in Table 1. The IHSs for "shallow soil" which includes fill, native surface, silt and till are arsenic, lead and mercury. The IHS for "deeper soil" which includes alluvium and outwash is arsenic. The depths and locations at which these soils are observed within the Lowland Area vary and are generally shown on the geologic cross-sections prepared as part of the SRI Report (GeoEngineers, 2015). As detailed in the SRI Report, the PCULs for soil were developed based on protection of human health (industrial worker, trespasser and visitor) and terrestrial ecological receptors (plants, soil biota and wildlife). MTCA (WAC 173-340-705[6]) specifies that the cleanup level for a given constituent shall not be set at a level lower than the natural background concentration or the practical quantitation limit (PQL), whichever is higher. Therefore, PCULs were selected based on the lowest applicable cleanup levels (i.e., protection of human health and/or terrestrial ecological receptors) and then for soil, adjusted based on background concentrations.

Properties in the Lowland Area are "Industrial Properties" as defined under MTCA. Therefore, the soil PCULs for the Lowland Area are primarily based on industrial land use and include PCULs for protection of industrial workers and wildlife which apply to the entire Lowland Area. Soil PCULs based on protection of trespassers are also applicable in areas between the Marine View Drive Right of Way (ROW) and BNSF Subarea where a trespasser exposure pathway potentially exists.

Soil PCULs based on protection of a site visitor were also applied as part of the RI to a portion of the Slope Subarea that is property owned by the City of Everett as part of American Legion Park where a site visitor exposure pathway potentially exists if the slope area was used as park. However, the property is not currently and is not planned in the future for park use based on the steepness of the property. Soil PCULs based on protection of plants and soil biota were also applied to the Slope Subarea property associated with American Legion Park based on a potential exposure pathway related to redevelopment as urban forest habitat. However, the City of Everett is not redeveloping the property for urban forest habitat. Therefore, the PCULs for protection of industrial workers and wildlife apply to the entire Slope Subarea.

The POCs for PCULs based on protection of industrial worker are applicable to soil from surface to a depth of 15 feet below ground surface (bgs) which is MTCA standard POC [WAC 173-340-740(6)(d)]. The POCs for PCULs based on protection of trespasser are applicable to soil from the surface to a depth of 1-foot bgs, a depth below which trespassers are typically not expected to contact soil. The POCs for PCULs based on protection of terrestrial ecological receptors (wildlife) are applicable to soil from surface to a depth of 6 feet bgs, which is the MTCA conditional POC for terrestrial ecological evaluation [WAC 173-340-7490(4)].

For cleanup actions that involve capping/containment of hazardous substances however, the soil cleanup levels will typically not have to be met at the above mentioned points of compliance if the following criteria are demonstrated as required under WAC 173-340-740(6)(f):

- The selected remedy is permanent to the maximum extent practicable using the procedures in WAC 173-340-360;
- The cleanup action is protective of human health;
- The cleanup action is demonstrated to be protective of terrestrial ecological receptors;
- Institutional controls are put in place that prohibit or limit activities that could interfere with the long-term integrity of the containment system;

- Compliance monitoring and periodic reviews are designed to ensure the long-term integrity of the containment systems; and
- The types, levels and amount of hazardous substances remaining on site and the measures that will be used to prevent migration and contact with those substances will be specified in the draft CAP for the Site.

2.1.2. Groundwater

The PCULs and POCs for groundwater IHSs are presented in Table 2. The IHSs for shallow aquifer groundwater are arsenic, lead and mercury. The IHS for deep aquifer groundwater is arsenic. The depths of the shallow and deep groundwater aquifers are generally shown on the geologic cross-sections prepared as part of the SRI Report (GeoEngineers, 2015). As detailed in the SRI Report, the PCULs for groundwater were developed based on protection of Lowland Area surface water (wetlands and ponds) and surface water in the Snohomish River since groundwater in the Lowland Area is not classified as a potable water source. MTCA (WAC 173-340-705[6]) specifies that the cleanup level for a given constituent shall not be set at a level lower than the natural background concentration or the PQL, whichever is higher. Therefore, PCULs were selected based on the lowest of the applicable cleanup levels (i.e., protection of surface water in the Lowland Area and/or Snohomish River) and then adjusted based on background concentrations.

The POC for groundwater PCULs developed based on protection of Lowland Area surface water are in surface waters of the Lowland Area (wetlands and ponds). The POC for groundwater PCULs developed based on protection of Snohomish River surface water are at the shoreline of the Snohomish River where groundwater discharges to the river. The PCULs developed based on protection of Lowland Area surface water are not applicable to groundwater in the deep aquifer as deep groundwater does not discharge to surface water in the Lowland Area because a silt layer separates deep and shallow aquifers.

2.1.3. Surface Water (includes Seep- and Outfall-Water)

The PCULs and POCs for surface water IHSs are presented in Table 3. The IHSs for surface water are arsenic and mercury. The PCULs for the surface water IHSs are same as the PCULs for groundwater.

The POC for surface water PCULs developed based on protection of Lowland Area surface water are in surface waters of the Lowland Area (wetlands and ponds). The POC for surface water PCULs developed based on protection of Snohomish River surface water are at the shoreline of the Snohomish River where groundwater, seeps and outfalls discharge to the Snohomish River. The surface water PCULs are theoretically, not applicable to outfall-water as stormwater outfalls are regulated under the National Pollutant Discharge Elimination System (NPDES) program. However, outfall-water will be screened based on the surface water PCULs developed based on protection of Snohomish River surface water to evaluate and address sources of contamination and contaminant transport pathways.

2.1.4. Sediment

The PCULs and POCs for sediment IHSs are presented in Table 4. The IHSs for sediment are arsenic and mercury. As detailed in the SRI Report (GeoEngineers, 2015), the PCULs for sediment were developed based on protection of benthic organisms, human health and/or aquatic/aquatic-dependent ecological receptors. MTCA (WAC 173-340-705[6]) specifies that the cleanup level for a given constituent shall not be set at a level lower than the natural background concentration or the PQL, whichever is higher. Therefore, PCULs were selected based on the lowest applicable cleanup levels (i.e. protection of benthic organisms,

human health and/or aquatic/aquatic-dependent ecological receptors) and then for sediment, adjusted based on background concentrations.

The POC for sediment PCULs is 0 to 10 centimeter (cm) (i.e., approximately 0 to 4 inches) below mudline (bml), which is the biologically active zone. The POC of 0 to 10 cm applies to sediment present in Lowland Area surface water features and sediment on the Snohomish River shoreline adjacent to the Lowland Area.

2.2. Applicable Local, State and Federal Laws

Under WAC 173-340-710, MTCA requires that cleanup actions comply with all legally applicable local, state and federal laws, and requirements that are legally applicable and determined by Ecology to be relevant and appropriate (ARARs) for the cleanup site.

Legally "applicable" requirements under MTCA are those cleanup standards, standards of control, and other human health and environmental protection requirements, criteria, or limitations adopted under state or federal law that specifically address a hazardous substance, cleanup action, location, or other circumstance at a site (WAC 173-340-200). "Relevant and appropriate" requirements include those cleanup standards, standards of control, and other human health and environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site (WAC 173-340-200).

Potentially applicable local, state and federal laws, ARARs and their descriptions/applicability are presented in Table 5.

In accordance with WAC 173-340-710(9)(b), cleanup actions conducted by Ecology under MTCA are exempt from the procedural requirements of following local and state laws. The cleanup action must still comply with the substantive requirements of these laws in accordance with WAC 173-340-710(9)(c).

- Washington Clean Air Act, Chapter 70.94 RCW;
- Washington Solid Waste Management Act, Chapter 70.95 RCW;
- Washington Hazardous Waste Management Act, Chapter 70.105 RCW;
- Washington Construction Projects in State Waters Act, Chapter 70.20 RCW;
- Washington Water Pollution Control Act, Chapter 90.48 RCW;
- Washington Shoreline Management Act, Chapter 90.58 RCW; and
- Any laws requiring or authorizing local government permits or approvals for the remedial action.

Because this exemption only applies to the above-referenced list of local and state laws and regulations, the anticipated cleanup action will need to comply with both substantive and procedural requirements of applicable federal laws, such as U.S. Army Corps of Engineers (USACE) Nationwide Permit 38 (NWP 38), federal consultation under the Endangered Species Act, the Clean Water Act (CWA) Section 404/401, etc. Substantive requirements of all applicable state and local laws and ARARs must also be met by the cleanup action.

The procedural/substantive requirements of potentially applicable local, state and federal laws, and ARARs are identified in Table 5.

Additionally, the Weyerhaeuser Everett East Site, which is located within the Riverside Business Park portion of the Lowland Area, underwent remedial action under a Consent Decree (No. 972027738) with Ecology. A restrictive covenant was placed on the deeds of properties within the Weyerhaeuser Everett East Site because the remedial action resulted in residual soil concentrations of total petroleum hydrocarbons (TPH) above Ecology's Method A soil cleanup level for direct contact, and pentachlorophenol (PCP), polychlorinated biphenyls (PCBs) and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) concentrations above Ecology's Method B soil cleanup levels established under WAC 173-340-745 (2) and (3). The restrictive covenant was also placed since the remedial action for Weyerhaeuser Everett East Site did not address arsenic groundwater contamination. The restrictive covenant includes requirements that are applicable when performing actions on the Site conducted by the property owners.

3.0 AREAS AND MEDIA REQUIRING REMEDIAL ALTERNATIVE EVALUATION

The areas and media requiring remedial alternative evaluation were identified in the SRI Report based on locations and concentrations of the indicator hazardous substances exceeding PCULs. Overall, the contaminated media at the Lowland Area requiring remedial alternative evaluation include the following:

- Soil, slag and debris (debris from the demolition of the smelter facility);
- Groundwater (shallow and deep);
- Surface water within surface water features in the Lowland Area (ponds and wetlands);
- Sediment within surface water features in the Lowland Area (ponds and wetlands);
- Outfall-water;
- Seep-water; and
- Sediment on the shoreline of the Snohomish River.

For the purposes of the FS, the areas requiring remedial alternative evaluation were divided into four groups, Area Groups A through D, based on their location relative to the Snohomish River and interaction of the contaminated material present at these areas with the groundwater contamination (i.e., source vs. non-source). The area groupings were done to facilitate development of the remedial alternatives that address the CAOs for each of the area groups. Multiple individual areas are identified in each area group (ex. Areas A1 and A2 in Area Group A).

The locations of the areas in each area group and contaminated media requiring remedial alternative evaluation for each area are shown on Figure 3. The following sections describe the area groups, area locations and contaminated media for at each area.

3.1. Group A

Group A consists of contaminated upland areas that are primary sources to groundwater contamination. Areas A1 and A2 fall under this group.

3.1.1. Area A1

Area A1 is located at the intersection of East Marine View Drive and Weyerhaeuser Bridge Road and is a primary source to deep groundwater arsenic contamination at the Lowland Area. The contaminated media at A1 requiring remedial alternative evaluation include:

- Soil and slag/debris contaminated with arsenic and lead; and
- Groundwater (shallow and deep) contaminated with arsenic.

Based on existing data presented in the SRI Report, the volume of contaminated material (soil and slag/debris) at Area A1 is estimated to be approximately 6,800 cubic yards (CY).

3.1.2. Area A2

Area A2 is a contaminated soil containment area and is located in the northern portion of the Riverside Business Park (east of Weyerhaeuser Bridge Road) adjacent to the Snohomish River. Contaminated soil at A2 is a primary source to elevated arsenic and lead concentrations observed in the shallow groundwater at/downgradient of Area A2. The contaminated media at A2 requiring remedial alternative evaluation include:

- Soil (surface) contaminated with arsenic and lead; and
- Groundwater (shallow) contaminated with arsenic and lead.

Based on existing data presented in the SRI Report, the volume of contaminated soil at Area A2 is estimated to be approximately 3,400 CY.

3.2. Group B

Group B consists of contaminated upland areas that are contributing sources to groundwater contamination. Areas B1, B2 and B3 fall under this group.

3.2.1. Area B1

Area B1 consists of portions of East Marine View Drive other than Area A1, areas immediately east of East Marine View Drive (i.e. the Benson Subarea) and portions of Pacific Highway ROW. The contaminated media at Area B1 requiring remedial alternative evaluation include:

- Soil and slag/debris contaminated with arsenic and lead;
- Groundwater (shallow) contaminated with arsenic, lead and mercury;
- Groundwater (deep) contaminated with arsenic;
- Surface water contaminated with arsenic and mercury; and
- Sediment contaminated with arsenic and mercury.

Based on existing data presented in the SRI Report, the volume of contaminated material (soil, slag/debris and sediment) at Area B1 is estimated to be approximately 266,500 CY.

3.2.2. Area B2

Area B2 is located in the northern portion of the Riverside Business Park. The contaminated media at Area B2 requiring remedial alternative evaluation include:

- Soil and slag contaminated with arsenic and lead; and
- Groundwater (shallow and deep) contaminated with arsenic.

Based on existing data presented in the SRI Report, the volume of contaminated material (soil and slag) at Area B2 is estimated to be approximately 35,400 CY.

3.2.3. Area B3

Area B3 is located in the central-west portion of the Riverside Business Park. The contaminated media at Area B3 requiring remedial alternative evaluation include:

- Soil contaminated with arsenic and lead; and
- Groundwater (shallow) contaminated with lead.

Based on existing data presented in the SRI Report, the volume of contaminated soil at Area B3 is estimated to be approximately 10,800 CY.

3.3. Group C

Group C consists of contaminated upland areas that do not contain source material to groundwater contamination and contain only one media requiring remedial alternative evaluation. Areas C1 through C6 fall under this group.

3.3.1. Area C1

Area C1 consists of central portion of the Riverside Business Park. The contaminated media at Area C1 requiring remedial alternative evaluation is:

- Groundwater (deep) contaminated with arsenic.

Contaminated source material (e.g. contaminated soil and slag/debris) to deep groundwater are not known to be present at Area C1 based on data collected as part of the SRI Report.

3.3.2. Area C2

Area C2 is a parcel associated with American Legion Park. Area C2 is located within the steep forested Slope Subarea. The contaminated media at Area C2 requiring remedial alternative evaluation is:

- Soil contaminated with arsenic.

Based on existing data presented in the SRI Report, the volume of contaminated soil at Area C2 is estimated to be approximately 10,000 CY.

3.3.3. Area C3

Area C3 is the steep forested area located within the Slope Subarea (other than American Legion Park). The contaminated media at C3 requiring remedial alternative evaluation is:

- Soil contaminated with arsenic.

Based on existing data presented in the SRI Report, the volume of contaminated soil at Area C3 is estimated to be approximately 20,000 CY.

3.3.4. Area C4

Area C4 is a relatively small and isolated area located west of East Marine View Drive. The contaminated media at Area C4 requiring remedial alternative evaluation is:

- Soil contaminated with lead.

Based on existing data presented in the SRI Report, the volume of contaminated soil at Area C4 is estimated to be approximately 400 CY.

3.3.5. Area C5

Area C5 is located in the southern portion of the Riverside Business Park. The contaminated media at Area C5 requiring remedial alternative evaluation is:

- Soil contaminated with arsenic.

Based on existing data presented in the SRI Report, the volume of contaminated soil at Area C5 is estimated to be approximately 34,800 CY.

3.3.6. Area C6

Area C6 is located at the Snohomish County PUD Subarea. The contaminated media C6 requiring remedial alternative evaluation is:

- Groundwater (deep) contaminated with arsenic.

Contaminated source material (e.g. contaminated soil and slag/debris) to deep groundwater are not known to be present at Area C6 based on data collected as part of the SRI Report.

3.4. Group D

Group D consists of contaminated marine areas on the Snohomish River shoreline and include Areas D1 through Area D4.

3.4.1. Area D1

Area D1 is located north of the Pacific Highway. The contaminated media at Area D1 requiring remedial alternative evaluation include:

- Outfall-water contaminated with arsenic; and

- Sediment contaminated with arsenic and mercury.

Based on existing data presented in the SRI Report, the volume of contaminated sediment at Area D1 is estimated to be approximately 730 CY.

3.4.2. Area D2

Area D2 is located adjacent to the northern portion of the Riverside Business Park. The contaminated media at Area D2 requiring remedial alternative evaluation include:

- Outfall-water contaminated with arsenic; and
- Sediment contaminated with arsenic.

Based on existing data presented in the SRI Report, the volume of contaminated sediment at Area D2 is estimated to be approximately 730 CY.

3.4.3. Area D3

Area D3 is located adjacent to the central portion of the Riverside Business Park. The contaminated media at Area D3 requiring remedial alternative evaluation include:

- Outfall-water contaminated with arsenic; and
- Sediment contaminated with mercury.

Based on existing data presented in the SRI Report, the volume of contaminated sediment at Area D3 is estimated to be approximately 730 CY.

3.4.4. Area D4

Area D4 is located adjacent to the northern portion of the Riverside Business Park. The contaminated media at Area D4 requiring remedial alternative evaluation is:

- Seep-water contaminated with mercury.

4.0 CLEANUP ACTION OBJECTIVES (CAOs)

The CAOs consist of chemical- and media-specific goals for the protection of human health and the environment and are intended to assist in focusing the development and evaluation of remedial alternatives. The objective of the cleanup action is to eliminate, reduce, or otherwise control to the extent feasible and practicable, unacceptable risks to human health and the environment posed by hazardous substances in contaminated media of the Lowland Area in accordance with the MTCA Cleanup Regulation (WAC 173-340), SMS regulations (WAC 173-204) and other applicable regulatory requirements. The specific CAOs for the Lowland Area are presented in Table 6. In summary, the CAOs for the Lowland Area were developed to mitigate contaminant transport and exposure to contaminated media thereby protecting human health, terrestrial ecological receptors, and marine/freshwater aquatic and benthic organisms at the Site.

5.0 SCREENING OF REMEDIAL TECHNOLOGIES

Under MTCA, remedial alternatives are developed from remedial technologies that are screened and identified to be capable of meeting cleanup requirements and able to achieve the CAOs. Initial screening of remedial technologies allows development of a range of tools that can be used individually or in combination to address contamination at the Site. Each technology is initially screed based on implementability effectiveness, and cost. These three key initial evaluation factors are described below:

Implementability: This evaluation encompasses both technical and administrative feasibility of implementing a technology. Aspects of implementability includes the ability to obtain permits, the availability of treatment methods and availability of required equipment and skilled workers.

Effectiveness: This evaluation focuses on 1) the potential effectiveness of a technology in handling the estimated areas or volumes of media and meeting cleanup action objectives; 2) the potential impacts to human health and the environment during the construction and implementation phase; and 3) how proven and reliable a technology is with respect to the contaminants and conditions at the site.

Cost: This evaluation takes into consideration relative capital, and operation and maintenance (O&M) cost rather than detailed estimates. At this initial screening stage, the cost analysis is made on the basis of engineering judgement, and each technology is evaluated as to whether costs are high, low, or medium relative to the other technologies in the same technology type. Since remedial alternatives and associated quantities are not defined during technology screening stage, relative cost is presented qualitatively as a range rather than quantitatively.

This section presents the results of remedial technology screening for each of the contaminated media (soil, slag/debris, groundwater, seep-water, outfall-water, surface water, and sediment in the Lowland Area and on the Snohomish River shoreline) requiring remedial alternative evaluation. Based on the results of screening, remedial technologies that had limited implementability, low effectiveness, and/or high relative cost were screened out and the most appropriate technologies were retained for use in the development of remedial alternatives. The technologies retained were selected as is or combined into remedial alternatives, as appropriate, to be evaluated in the detailed analysis of alternatives.

The following sections present remedial technologies for each of the contaminated media.

5.1. Remedial Technologies for Soil and Slag/Debris

Descriptions and screening of applicable remedial technologies for soil and slag/debris are presented in Table 7. Based on the results of screening, the following are the remedial technologies for soil and slag/debris that are retained for development of remedial alternatives:

- Institutional controls including environmental covenants, land use restrictions and fencing and signage;
- Capping including low permeability caps comprised of asphalt or concrete pavement and soil with underlying low permeability barrier or a permeable cap comprised of soil;
- In situ treatment including in situ solidification and stabilization (S/S); and
- Removal including excavation and offsite disposal at a landfill.

5.2. Remedial Technologies for Groundwater

Descriptions and screening of applicable remedial technologies for groundwater are presented in Table 8. Based on the results of screening, the following are the remedial technologies for groundwater that are retained for development of remedial alternatives:

- Monitoring to assess performance of remedial technologies and ensure compliance with cleanup standards;
- Institutional controls including environmental covenants and groundwater use restrictions;
- Natural attenuation of contaminants in groundwater via natural processes;
- Containment using barriers such as slurry or sheet pile walls; and
- In situ treatment including reactive media in a permeable reactive barrier wall.

5.3. Remedial Technologies for Surface Water in the Lowland Area

Surface water contamination in the Lowland Area is only observed within Area B1. The remedial technologies considered for contaminated source material (i.e. soil, slag/debris, and groundwater) to surface water is anticipated to address surface water contamination. In addition, the following remediation technologies were considered and retained for surface water in the Lowland Area:

- Surface water monitoring to assess the performance of the remedial technologies implemented for source material and to ensure compliance with cleanup standards.
- Removal of contaminated surface water (dewatering), on site temporary storage in portable above-ground storage tanks and treatment (if necessary), and permitted disposal.

5.4. Remedial Technologies for Sediment in the Lowland Area

The remedial technologies considered and retained for sediment in surface water features in the Lowland Area are the same as technologies retained for soil and slag/debris (Section 5.1) with the exception of access restrictions and information devices (fencing and warning signage). Fencing and warning signage is not applicable for sediment in the Lowland Area since it does not address applicable exposure/transport pathways.

The remedial technology selected for sediment in the Lowland Area will determine the need for mitigation of surface water features such as wetlands at an off-site location or restoring wetlands on site. For example, if sediment within a surface water feature is capped or stabilized in situ resulting in loss of wetland habitat, then the lost wetland habitat will need to be mitigated elsewhere within the site or at an off-site location in accordance with state and federal requirements. Conversely, if sediment are removed and replaced, the wetland habitat will be restored in-situ.

5.5. Remedial Technologies for Outfall-Water

Contaminated water from outfalls into the Snohomish River in the Lowland Area is observed at Areas D1, D2 and D3 and the sources of the contamination are located in Areas B1, B2 and C5, respectively as discussed in Section 4.0. Remedial technologies that are applicable and retained to address outfall-water contamination are described below:

- Outfall-water monitoring to assess performance of remedial technologies and ensure compliance with cleanup standards.
- Modifications to water conveyance system components that include the following:
    - Stormwater conveyance pipes installed in contaminated groundwater located within Area B2 are the source of contaminants from Area B2 to the outfall located at Area D2. Therefore, the stormwater conveyance system that allow contaminated groundwater to infiltrate into the pipes require repair, lining or replacement.
    - Underdrain pipes that collect water from Area C5 are a potential source of contaminants from Area C5 to the outfall at Area D3. Therefore, the underdrain pipes within Area C5 need to be cut and plugged.

Outfall-water contamination is located in Area D1 and the source of the contamination is contaminated groundwater and surface water discharging from Area B1. Therefore, remedial technologies retained to address groundwater and surface water contamination in Area B1 are anticipated to address outfall-water contamination at Area D1 and no additional remedial technologies other than monitoring are specifically considered for outfall-water at Area D1.

5.6. Remedial Technologies for Seep-Water

Seep-water contamination is located in Area D4 and the source of the contamination is contaminated groundwater discharging from adjacent Area B2. Therefore, remedial technologies retained to address groundwater contamination are anticipated to address seep-water contamination and no additional remedial technologies are specifically considered other than monitoring seep-water to assess performance of the remedial technologies in Area B2 and ensure compliance with cleanup standards.

5.7. Remedial Technologies for Sediment on the Snohomish River Shoreline

Descriptions and screening of applicable remedial technologies for surface sediment on the Snohomish River Shoreline are presented in Table 9. Based on the results of screening, the following are the remedial technologies for sediment on the Snohomish River shoreline that are retained for development of remedial alternatives;

- Institutional controls including environmental covenants and area use restrictions;
- Natural recovery including monitored natural recovery and enhanced natural recovery; and
- Removal including dredging/excavation and offsite disposal at a landfill.

5.8. Summary of Retained Remedial Technologies

The remedial technologies retained for each of the media are summarized in Table 10. Each technology that has been retained is assigned an identification symbol/abbreviation as shown in Table 10. The identification symbols/abbreviations are used in subsequent tables to identify the remedial technologies that have been combined for development of remedial alternatives.

6.0 DESCRIPTION OF REMEDIAL ALTERNATIVES

Remedial alternatives were first developed for each Area (Areas A1, A2, B1 through B3, C1 through C6, and D1 through D4) by combining remedial technologies retained through the screening process (Section 5.0). Each area remedial alternative was developed to meet the intention of the CAOs. Table 11 identifies the CAOs applicable to each area and remedial alternatives that were developed for each area. Remedial technologies are identified in Table 11 using their identification symbol/abbreviation and are organized based on contaminated media they address. Up to three remedial alternatives were developed for each area to provide a representative range of protectiveness for evaluation purposes. The identification nomenclature used for the area remedial alternatives consist of the area identification as prefix and alternative sequence number as suffix. For example, the three area remedial alternatives developed for Area A1 are identified as A1-ALT-1 through A1-ALT-3. In general, a larger sequence number for an alternative indicates a higher degree of protectiveness achieved either by treatment or removal of contaminated media. Descriptions of the remedial alternatives for Areas A1, A2, B2 through B3 and C1 are detailed in Tables 12 through 17 respectively. Descriptions of the area remedial alternatives for Areas C2 and C3 are detailed in Table 18. Descriptions of the area remedial alternatives for Areas C4 through C6 are detailed in Table 19 through 21 respectively. Descriptions of the area remedial alternatives for Area D1 through D3 are detailed in Table 22 and for Area D4 the area remedial alternatives are described in Table 23.

The estimated costs to implement each area remedial alternative including costs for design, permitting, construction and performance/compliance monitoring were estimated for the purposes of the Feasibility Study evaluation. Cost estimates for Areas A1, A2, B1 through B3, C1 are presented in Tables 24 through 29. Cost estimates for Areas C2 and C3 are presented in Table 30. Cost estimates for Areas C4 through C6 are presented in Tables 31 through 33. Cost estimates for Areas D1, D2 and D3 are presented in Table 34. Cost estimates for Area D4 is presented in Table 35. These tables also provide details on specific assumptions, quantity estimates, and unit costs used in developing area remedial alternative cost estimates.

The following site-wide assumptions for site IHSs were made in determining quantities of potentially hazardous waste material and estimating costs for area remedial alternatives that involve excavation and off-site disposal of contaminated material:

- Arsenic: The toxicity leaching characteristic procedure (TCLP) studies completed as part of Smelter Area Investigation Report (ASARCO, 1998; SAI Report) concluded that the material with arsenic concentrations at or above 3,000 milligrams/kilogram (mg/kg) has a potential of exceeding the TCLP standard for arsenic of 5 milligrams per liter (mg/L) (i.e., a potential federal hazardous waste). Based on results of bioassay studies completed as part of a report prepared by SAI, state dangerous waste (dangerous waste [DW] and extremely hazardous waste [EHW]) levels for arsenic were above 10,000 mg/kg. For quantity/cost estimation purposes, material with arsenic concentrations at or above 3,000 mg/kg (i.e., a more conservative number between federal and state) was considered hazardous waste for disposal purposes. Based on data presented in the SRI Report (GeoEngineers, 2015), contaminated material with arsenic concentrations greater than 3,000 mg/kg that are considered for excavation and disposal as part of the area remedial alternatives are only located within Areas A1 and B1.

- Lead: The TCLP data evaluated as part of the SAI Report indicates that the lead concentrations of less than 3,000 mg/kg do not exceed TCLP lead standard of 5 mg/L. Bioassay studies to determine state dangerous waste concentrations of lead was not completed as part to the SAI Report. However, based on the book designation method, the SAI Report indicated that the state dangerous waste concentration for lead is at or above 10,000 mg/kg. For quantity/cost estimation purposes, material with lead concentrations at or above 3,000 mg/kg (i.e., a more conservative number between federal and state) was considered hazardous waste for disposal purposes. Based on data presented in the SRI Report (GeoEngineers, 2015), contaminated material with lead concentrations greater than 3,000 mg/kg that are considered for excavation and disposal as part of the area remedial alternatives are only located within Areas A1 and B1.
- Mercury: The SAI Report did not evaluate mercury for dangerous waste purposes. The 20-times rule (EPA, 1992) indicates that mercury concentration of 4 mg/kg (20 times the TCLP mercury standard of 0.2 mg/L) has a potential of exceeding TCLP mercury standard. Based on the book designation method, the state dangerous waste concentration for mercury is at 10 mg/kg. For quantity/cost estimation purposes, material with mercury concentrations at or above 4 mg/kg (i.e., a more conservative number between federal and state) would be considered hazardous waste for disposal purposes. Based on data presented in the SRI Report (GeoEngineers, 2015), contaminated material with mercury concentrations at or above 4 mg/kg is not present within the Lowland Area.

6.1. Site-Wide Remedial Alternatives

The individual area remedial alternatives were combined in multiple ways to develop a range of site-wide remedial alternatives that address the identified contaminated media and CAOs of the Lowland Area and meet MTCA and/or SMS threshold requirements. A total of seven site-wide remedial alternatives were developed:

- Site-Wide Remedial Alternatives 1(i) through 1(iii);
- Site-Wide Remedial Alternative 2;
- Site-Wide Remedial Alternatives 3(i) and 3(ii); and
- Site-Wide Remedial Alternative 4.

The site-wide remedial alternatives are generally presented in order of increasing levels of treatment and/or removal of contaminated media with the last alternative involving complete removal of contaminated media to the extent practicable.

The alternatives were developed and the costs estimated on a conceptual level to meet the primary objective of the FS which include: to perform a comparative evaluation of site-wide remedial alternatives and identify a preferred alternative for the Site. The final design for the selected alternative may differ from the alternative descriptions presented in this FS based on agency decisions, input from the public and other stakeholders, permit requirements, supplemental data that may be collected to support design and other factors. The assumptions, and quantity/cost estimates used in developing alternatives are conceptual-level and are based on engineering judgment and current knowledge of site conditions. The final design for the selected, preferred alternative may require additional characterization and analysis of site media in addition to specific plans for the future development of the site to better define the remedial alternative and associated costs.

6.1.1. Site-Wide Remedial Alternatives 1(i) Through 1(iii)

The Site-Wide Remedial Alternatives 1(i) through 1(iii) are identical to each other with the exception of the area remedial alternatives selected for Areas A1 and A2, which are primary sources to groundwater contamination at the site. Site-Wide Alternative 1(i) includes the Area Remedial Alternatives A1- and A2-ALT-1, which primarily consist of low permeability surface capping and containment (sheet pile and/or slurry wall). Alternative 1(ii) includes the Area Remedial Alternatives A1- and A2-ALT-2, which primarily consist of in situ S/S. Alternative 1(iii) includes the Area Remedial Alternatives A1- and A2-ALT-3, which primarily consist of excavation and off-site disposal to address contaminated soil, slag/debris and/or shallow/deep groundwater present at Areas A1 and A2. Additional details on the area remedial alternatives selected for Areas A1 and A2 as part of the Site-Wide Remedial Alternatives 1(i), 1(ii) and 1(iii) are presented in Tables 11 through 13.

The common elements of Alternatives 1(i) through 1(iii) are summarized below:

- Install and/or maintain existing caps at Areas B1, B2 and B3, which are secondary sources to groundwater contamination, to address contaminated soil, sediment and/or slag/debris present at these areas. Additional details for this element are presented in the descriptions of the Area Remedial Alternatives B1-, B2-, and B3-ALT-1 (Table 11 and Tables 14 through 16). Contaminated groundwater present at these areas is addressed through permeable reactive barriers (PRBs) and/or groundwater natural attenuation processes as described further below;
- Perform treatment (if necessary) and permitted disposal of contaminated surface water prior to capping sediment in the surface water features at Area B1. This element is a part of the Area Remedial Alternative B1-ALT-1 (Tables 11 and 14);
- Mitigate loss of surface water features (including wetlands) at Area B1 at an off-site location;
- Install shallow groundwater PRB along the shoreline of Area B2 to address contaminated shallow groundwater present at Areas B1 and B2 prior to discharge of groundwater into the Snohomish River. Following the installation of shallow groundwater PRB, groundwater natural attenuation processes are expected to address localized deep groundwater contamination observed at Area B2. Additional details for this element are presented in the descriptions of the Area Remedial Alternative B2-ALT-1 (Tables 11 and 15);
- Repair, install lining or replace stormwater pipes that may allow infiltration and are responsible for transport of contaminants from Area B2 to the outfall located at Area D2. This element is part of the Area Remedial Alternative B2-ALT-1 (Tables 11 and 15);
- Monitor groundwater natural attenuation processes that are expected to address contaminated shallow groundwater present at Area B3. Additional details for this element are presented in the descriptions of the Area Remedial Alternative B3-ALT-1 (Tables 11 and 16);
- Install deep groundwater PRB along the shoreline of Area C1 to address contaminated deep groundwater present at Areas B1 and C1 prior to discharge of groundwater into the Snohomish River. Natural attenuation processes are expected to address deep groundwater contamination at Areas B1 and C1 following the implementation of the source control remedy selected for the primary groundwater source Area A1 located upgradient of Areas B1 and C1. In addition to the natural attenuation process, deep groundwater PRB will be installed along the shoreline of Area C1 as a polishing technology intended to reduce the timeframe for achieving the cleanup standards. Additional details for this

element are presented in the descriptions of the area remedial alternative C1-ALT-2 (Tables 11 and 17);

- Install fencing around the entire perimeter of Areas C2 and C3 and install warning signage (as necessary) to address exposure to contaminated soil present at these areas. This element is part of the Area Remedial Alternatives C2- and C3-ALT-1 (Tables 11 and 18);
- Cap Areas C4 and C5 to address contaminated soil present at these areas. Additional details for this element are presented in the descriptions of the Area Remedial Alternatives C4- and C5-ALT-1 (Tables 11, 19 and 20);
- Cut and plug underdrains that are responsible for transport of contaminants from Area C5 to the outfall at Area D3. This element is part of the Area Remedial Alternative C5-ALT-1 (Tables 11 and 20);
- Monitor groundwater natural attenuation processes that are expected to address localized contaminated deep groundwater present at Area C6. Additional details for this element are presented in the descriptions of the Area Remedial Alternative C6-ALT-1 (Tables 11 and 21);
- Complete outfall-water monitoring at Areas D1 through D3 to assess performance of the remedies that are implemented at other upgradient areas to address sources to outfall-water contamination. Additional details for this element are presented in the description of the Area Remedial Alternatives D1- through D3-ALT-1 (Tables 11 and 22);
- Monitor sediment conditions at Areas D1 through D3 to assess natural recovery processes that are expected to address contaminated sediment present at these areas following the sources to sediment contamination (i.e., contaminated outfall-water) are addressed. Additional details for this element are presented in the description of the Area Remedial Alternatives D1- through D3-ALT-1 (Tables 11 and 22);
- Complete seep-water monitoring at Area D4 to access performance of the remedies implemented at the upgradient Area B2 to address the source of seep-water contamination (i.e., contaminated groundwater). Additional details for this element are presented in the description of the Area Remedial Alternative D4-ALT-1 (Tables 11 and 23);
- Complete groundwater monitoring to assess performance of the remedies or groundwater natural attenuation processes and/or compliance with the cleanup standards as applicable. Groundwater monitoring activities will be implemented for Areas A1, A2, B1 through B3, C1 and C6 where groundwater contamination exists; and
- Implement institutional controls (governmental/property controls – environmental covenants, resource [land/water] use restrictions and resource management plans/requirements) for the areas where contamination will be left in-place.

Table 36 presents a summary of the Site-Wide Remedial Alternatives 1(i) through 1(iii) by identifying and summarizing the area remedial alternatives that were selected for each area as part of the site-wide remedial alternative. Table 36 also summarizes contaminated media present at each area and identifies the area remedial alternatives/remedial technologies that address the media. The Site-Wide Remedial Alternatives 1(i) through 1(iii) are graphically presented on Figures 4 through 6, respectively.

Total estimated cost for the Site-Wide Remedial Alternatives 1(i) through 1(iii) were calculated by summing the estimated costs for each area remedial alternative that were combined to develop the site-wide

remedial alternatives. Total estimated cost for Site-Wide Remedial Alternatives 1(i) through 1(iii) are the following:

- Remedial Alternative 1(i) – $14.7 million
- Remedial Alternative 1(ii) – $17.6 million
- Remedial Alternative 1(iii) – $20.4 million

6.1.2. Site-Wide Remedial Alternative 2

The Site-Wide Remedial Alternative 2 is identical to the Site-Wide Remedial Alternative 1(iii) with the exception of the remedy selected to address contaminated deep groundwater at Areas B1 and C1. The Site-Wide Remedial Alternative 2 relies on the groundwater natural attenuation processes (Remedial Alternative 1(iii) includes PRBs) to address deep groundwater contamination at Areas B1 and C1 following the implementation of the source control remedy selected for the primary groundwater source Area A1 located upgradient of Areas B1 and C1. Additional details are presented in the description of the Area Remedial Alternative C1-ALT-1 in Tables 11 and 17.

Existing groundwater data presented as part of the SRI Report (GeoEngineers, 2015) are indicative of substantial groundwater natural attenuation processes already occurring at the Lowland Area between the primary source Area A1 and the point where deep groundwater discharges into the Snohomish River at the Area C1 shoreline. The source control remedy selected for Area A1 as part of the Site-Wide Remedial Alternative 2 is expected to enhance these already occurring natural attenuation processes at Areas B1 and C1 and consequently achieve the cleanup standards. The remedies selected for other areas as part of the Site-Wide Remedial Alternative 2 are same as that selected for the Site-Wide Remedial Alternative 1(iii) and are described in Section 6.1.1.

Table 37 presents a summary of the Site-Wide Remedial Alternative 2. Table 37 also summarizes contaminated media present at each area and identifies the area remedial alternatives/remedial technologies that addresses these media. The Site-Wide Remedial Alternative 2 is graphically presented on Figure 7.

Total estimated cost for the Site-Wide Remedial Alternative 2 was calculated by summing the estimated costs for each area remedial alternative that were combined to develop the site-wide remedial alternative. Total estimated cost for the Site-Wide Remedial Alternative 2 is $18.8 million.

6.1.3. Site-Wide Remedial Alternatives 3(i) and 3(ii)

The Site-Wide Remedial Alternatives 3(i) and 3(ii) are identical to each other with the exception of the area remedial alternatives selected for Areas A1 and A2 which are primary sources to groundwater contamination. Site-Wide Alternative 3(i) includes the Area Remedial Alternatives A1- and A2-ALT-2, which primarily consist of in situ S/S. Alternative 3(ii) includes Area Remedial Alternatives A1- and A2-ALT-3, which primarily consist of excavation and off-site disposal to address contaminated soil, slag/debris, and/or shallow/deep groundwater present at Areas A1 and A2. Additional details on the area remedial alternatives selected for Areas A1 and A2 as part of the Site-Wide Remedial Alternatives 3(i) and 3(ii) are presented in Tables 11 through 13.

The common elements of Alternatives 3(i) and 3(ii) are summarized below:

- Perform in situ S/S at Areas B1 (including sediment in the surface water features), B2 and B3, which are secondary sources to groundwater contamination to address contaminated media (contaminated soil, sediment, slag/debris and/or shallow groundwater present at these areas. Contaminated deep groundwater present at Areas B1 and B2 are addressed by groundwater natural attenuation processes. Additional details for this element are presented in the descriptions of the Area Remedial Alternatives B1-, B2- and B3-ALT-2 (Table 11 and Tables 14 through 16). The in situ S/S of the contaminated material located within the following two portions of Areas B1 and B2 will not be completed as discussed below:
    - The Pacific Highway (Highway 529) located within Area B1 will not be disturbed and the limited quantity of contaminated material that exists underneath this highway (based on data presented in the SRI Report [GeoEngineers, 2015]) will be left in-place. The benefits achieved by treating this limited quantity of material are disproportionate to the costs of disturbing, demolishing and reconstructing the highway to facilitate in situ S/S; and
    - The building located within Area B2 will not be disturbed and the limited quantity of contaminated material that exists underneath this building (GeoEngineers, 2015) will be left in-place. The benefits achieved by treating this limited quantity of material are disproportionate to the costs of demolishing and reconstructing the building to facilitate in situ S/S. Since this building is relatively close to the shoreline where the groundwater contamination poses a threat of discharging into the Snohomish River, a low-permeability containment (sheet pile and/or slurry wall) will be installed along the perimeter of this building to contain/isolate the contaminated material left in-place from the groundwater flow.
- Perform treatment (if necessary) and permitted disposal of contaminated surface water prior to performing in situ S/S of the sediment in the surface water features at Area B1. This element is a part of the Area Remedial Alternative B1-ALT-2 (Tables 11 and 14);
- Mitigate loss of surface water features (including wetlands) at Area B1 at an off-site location;
- Monitor groundwater natural attenuation processes that are expected to address localized contaminated deep groundwater present at Area B2 following the implementation of the source control remedy selected for Area B2. Additional details for this element are presented in the descriptions of the Area Remedial Alternative B2-ALT-2 (Tables 11 and 15);
- Repair, install lining or replace stormwater pipes that may allow infiltration and are responsible for transport of contaminants from Area B2 to the outfall located at Area D2. This element is part of the Area Remedial Alternative B2-ALT-2 (Tables 11 and 15);
- Monitor groundwater natural attenuation processes that are expected to address contaminated deep groundwater present at Areas B1 and C1 following the implementation of the source control remedy selected for the primary groundwater source Area A1 located upgradient of Areas B1 and C1. Additional details for this element are presented in the descriptions of the Area Remedial Alternative C1-ALT-1 (Tables 11 and 17);
- Install fencing around the entire perimeter of Areas C2 and C3 and install warning signage (as necessary) to address contaminated soil present at these areas. This element is part of the Area Remedial Alternatives C2- and C3-ALT-1 (Tables 11 and 18);
- Perform in situ S/S at Areas C4 and C5 to address contaminated soil present at these areas. Additional details for this element are presented in the descriptions of the Area Remedial Alternatives C4- and C5-ALT-2 (Tables 11, 19 and 20);

- Cut and plug underdrains that are responsible for transport of contaminants from Area C5 to the outfall at Area D3. This element is part of the Area Remedial Alternative C5-ALT-2 (Tables 11 and 20);
- Monitor groundwater natural attenuation processes that are expected to address localized contaminated deep groundwater present at Area C6. Additional details for this element are presented in the descriptions of the Area Remedial Alternative C6-ALT-1 (Tables 11 and 21);
- Complete outfall-water monitoring at Areas D1 through D3 to assess performance of the remedies that are implemented at other upgradient areas to address sources to outfall-water contamination. Additional details for this element are presented in the description of the Area Remedial Alternatives D1- through D3-ALT-2 (Tables 11 and 22);
- Place a thin layer of clean sand cap (approximately 10 cm [i.e., thickness of biologically active zone]) over the area of contaminated sediment to enhance natural sediment recovery processes. Monitor sediment conditions at Areas D1 through D3 to assess enhanced natural recovery processes that are expected address contaminated sediment present at these areas following the sources to sediment contamination (i.e., contaminated outfall-water) are addressed. Additional details for this element are presented in the description of the Area Remedial Alternatives D1- through D3-ALT-2 (Tables 11 and 22);
- Complete seep-water monitoring at Area D4 to assess performance of the remedies implemented at the upgradient Area B2 to address the source of seep-water contamination (i.e., contaminated groundwater). Additional details for this element are presented in the description of the Area Remedial Alternative D4-ALT-1 (Tables 11 and 23);
- Complete groundwater monitoring to assess performance of the remedies or groundwater natural attenuation processes and/or compliance with the cleanup standards as applicable. Groundwater monitoring activities will be implemented for Areas A1, A2, B1 through B3, C1 and C6 where groundwater contamination exits; and
- Implement institutional controls (governmental/property controls – environmental covenants, resource (land/water) use restrictions and resource management plans/requirements) for the areas where contamination will be left in-place.

Table 38 presents a summary of the Site-Wide Remedial Alternatives 3(i) and 3(ii) by identifying and summarizing the area remedial alternatives that were selected for each area as part of the site-wide remedial alternative. The Site-Wide Remedial Alternatives 3(i) and 3(ii) are graphically presented on Figures 8 and 9, respectively.

Total estimated cost for the Site-Wide Remedial Alternatives 3(i) and 3(ii) were calculated by summing the estimated costs for each area remedial alternative that were combined to develop the site-wide remedial alternatives. Total estimated cost for the Site-Wide Remedial Alternatives 3(i) and 3(ii) are the following:

- Remedial Alternative 3(i) – $107.2 million
- Remedial Alternative 3(ii) – $110.1 million

6.1.4. Site-Wide Remedial Alternative 4

Site-Wide Remedial Alternative 4 relies primarily on excavation and off-site disposal of contaminated material. Site-Wide Remedial Alternative 4 consists of the following elements:

- Perform excavation and off-site disposal of contaminated material at Areas A1 and A2, which are primary sources to groundwater contamination, to address contaminated soil, slag/debris, and/or shallow/deep groundwater. Additional details for this element are presented in the descriptions of Area Remedial Alternatives A1- and A2-ALT-3 (Tables 11 through 13).
- Perform excavation and off-site disposal of contaminated material at Areas B1 (including sediment in the surface water features), B2 and B3, which are secondary sources to groundwater contamination, to address contaminated media (contaminated soil, sediment, slag/debris and/or shallow groundwater) present at these areas. Contaminated deep groundwater present at Areas B1 and B2 are addressed by groundwater natural attenuation processes as described further below. Additional details for this element are presented in the descriptions of the Area Remedial Alternatives B1-, B2- and B3-ALT-3 (Table 11 and Tables 14 through 16). Excavation and off-site disposal of the contaminated material located within the following two portions of Areas B1 and B2 will not be completed as discussed below:
    - The Pacific Highway (Highway 529) located within Area B1 will not be disturbed and the limited quantity of contaminated material that exists underneath this highway (based on data presented in the SRI Report [GeoEngineers, 2015]) will be left in-place. The benefits achieved by treating this limited quantity of material are disproportionate to the costs of disturbing, demolishing and reconstructing the highway to facilitate excavation; and
    - The building located within Area B2 will not be disturbed and the limited quantity of contaminated material that exists underneath this building (based on data presented in the SRI Report [GeoEngineers, 2015]) will be left in-place. The benefits achieved by treating this limited quantity of material are disproportionate to the costs of demolishing and reconstructing the building to facilitate excavation. Since this building is relatively closer to the shoreline of Area B2 where the groundwater contamination poses a threat of discharge into the Snohomish River, a low-permeability containment (sheet pile and/or slurry wall) will be installed along the perimeter of this building to isolate the contaminated material that will be left in-place from the groundwater flow.
- Perform treatment (if necessary) and permitted disposal of contaminated surface water prior to performing excavation of sediment in the surface water features. This element is a part of the Area Remedial Alternative B1-ALT-3 (Tables 11 and 14);
- Restore impacted surface water features (including wetlands) on site following excavation;
- Complete surface water monitoring following restoration to monitor performance of the remedy and compliance with the cleanup standards. Additional details for this element are presented in the description of the Area Remedial Alternative B1-ALT-3 (Tables 11 and 14);
- Monitor groundwater natural attenuation processes that are expected to address localized contaminated deep groundwater present at Area B2 following the implementation of the source control remedy selected for Area B2. Additional details for this element are presented in the descriptions of the Area Remedial Alternative B2-ALT-3 (Tables 11 and 15);
- Monitor groundwater natural attenuation processes that are expected to address contaminated deep groundwater present at Areas B1 and C1 following the implementation of the source control remedy selected for the primary groundwater source Area A1 located upgradient of Areas B1 and C1. Additional details for this element are presented in the descriptions of the Area Remedial Alternative C1-ALT-1 (Tables 11 and 17);

- Perform excavation and off-site disposal of the contaminated soil present at Areas C2 through C5. Additional details for this element are presented in the description of the Area Remedial Alternatives C2- and C3-ALT-2, and C4- and C5-ALT-3 (Tables 11, 18, 19 and 20). Excavation and off-site disposal of the contaminated material located within the following portion of Area C3 will not be completed as discussed below:
    - The Bridge Way and the road to Snohomish County PUD Substation located within Area C3 will not be disturbed and the contaminated material that may exists underneath this roads will be left in-place. The benefits achieved by removing the contaminated material that may exists below these roads are disproportionate to the costs of disturbing, demolishing and reconstructing the roads to facilitate excavation.
- Monitor groundwater natural attenuation processes that are expected to address localized contaminated deep groundwater present at Area C6. Additional details for this element are presented in the descriptions of the Area Remedial Alternative C6-ALT-1 (Tables 11 and 21);
- Complete outfall-water monitoring at Areas D1 through D3 to assess performance of the remedies that are implemented at other upgradient areas to address sources of outfall-water contamination. Additional details for this element are presented in the description of the Area Remedial Alternatives D1- through D3-ALT-3 (Tables 11 and 22);
- Perform dredging/excavation and off-site upland disposal of the contaminated sediment present at Areas D1 through D3. Additional details for this element are presented in the description of the Area Remedial Alternatives D1- through D3-ALT3 (Tables 11 and 22);
- Complete seep-water monitoring at Area D4 to assess performance of the remedies implemented at the upgradient Area B2 to address the source of seep-water contamination (i.e., contaminated groundwater). Additional details for this element are presented in the description of the Area Remedial Alternative D4-ALT-1 (Tables 11 and 23);
- Complete groundwater monitoring to access performance of the remedies or groundwater natural attenuation processes and/or compliance with the cleanup standards as applicable. Groundwater monitoring activities will be implemented for Areas A1, A2, B1 through B3, C1 and C6 where groundwater contamination exits; and
- Implement institutional controls (governmental/property controls – environmental covenants, resource (land/water) use restrictions and resource management plans/requirements) for the areas where contamination will be left in-place.

Table 39 presents a summary of the Site-Wide Remedial Alternative 4 by identifying and summarizing the area remedial alternatives that were selected for each area as part of the site-wide remedial alternative. Site-Wide Remedial Alternative 4 is graphically presented on Figure 10.

Total estimated cost for the Site-Wide Remedial Alternative 4 was calculated by summing the estimated costs for each area remedial alternative that were combined to develop the site-wide remedial alternatives. Total estimated cost for the Site-Wide Remedial Alternative 4 is $221.4 million.

7.0 FEASIBILITY STUDY EVALUATION CRITERIA

This section presents a description of the threshold requirements for cleanup actions under MTCA and the additional criteria used in this FS to evaluate the remedial alternatives.

7.1. Threshold Requirements

Remedial actions performed under MTCA must comply with threshold requirements. Remedial alternatives that do not comply with the threshold requirements are not considered suitable remedial alternatives under MTCA. As provided in WAC 173-340-360(2)(a), remedial alternatives shall meet the following four threshold requirements:

7.1.1. Protect Human Health and the Environment

The results of remedial actions performed under MTCA must ensure that both human health and the environment are protected.

7.1.2. Comply with Cleanup Standards

Compliance with cleanup standards requires, in part, that cleanup levels are met at the applicable points of compliance. If a remedial action does not comply with cleanup standards, the remedial action is an interim action, not a remedial action. Where a remedial action involves containment of soils with hazardous substance concentrations exceeding cleanup levels at the point of compliance, the remedial action may be determined to comply with cleanup standards, provided the requirements specified in WAC 173-340-740(6)(f) are met.

7.1.3. Comply with Applicable State and Federal Laws

Remedial actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710.

7.1.4. Provide for Compliance Monitoring

The remedial action must allow for compliance monitoring in accordance with WAC 173-340-410. Compliance monitoring consists of protection monitoring, performance monitoring and confirmational monitoring. Protection monitoring is conducted to confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of a cleanup action. Performance monitoring is conducted to confirm that the remedial action has attained cleanup standards and, if appropriate, remediation levels or other performance standards. Confirmational monitoring (soil, groundwater, sediment, and/or other media) is conducted to confirm the long-term effectiveness of the remedial action once cleanup standards and, if appropriate, remediation levels or other performance standards have been attained.

7.2. Other MTCA Requirements

In accordance with the MTCA, when selecting from remedial alternatives that fulfill the threshold requirements, the alternatives shall be further evaluated against the criteria presented in the following sections.

7.2.1. Use Permanent Solutions to the Maximum Extent Practicable

MTCA requires that when selecting a remedial alternative, preference shall be given to permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]. MTCA specifies that the permanence of remedial alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a "disproportionate cost analysis" in accordance with WAC 173-340-360(3)(e). The criteria for conducting this analysis are described in Section 7.3 below.

7.2.2. Provide for a Reasonable Restoration Time Frame

In accordance with WAC 173-340-360(2)(b)(ii), MTCA places a preference on those remedial action alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. According to MTCA, following factors shall be considered to determine whether a remedial alternative provides for a reasonable restoration time frame:

- Potential risks posed by the site to human health and the environment;
- Practicability of achieving a shorter restoration time frame;
- Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
- Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
- Availability of alternative water supplies;
- Likely effectiveness and reliability of institutional controls;
- Ability to control and monitor migration of hazardous substances from the site;
- Toxicity of the hazardous substances at the site; and
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

7.2.3. Consider Public Concerns

In accordance with WAC 173-340-360(2)(b)(iii), Ecology will consider public comments submitted during the RI/FS process in making its preliminary selection of an appropriate remedial alternative. This preliminary selection is subject to further public review and comment when the proposed remedy is published in the draft CAP.

7.3. MTCA Disproportionate Cost Analysis (DCA)

The MTCA DCA is used to further evaluate which of the alternatives that meet the threshold requirements are permanent to the maximum extent practicable. This analysis involves comparing the costs and benefits of alternatives and selecting the alternative whose incremental costs are not disproportionate to the incremental benefits. The evaluation criteria for the disproportionate cost analysis are specified in WAC 173-340-360(2) and (3), and include protectiveness, permanence, cost, long-term effectiveness, management of short-term risks, implementability and consideration of public concerns.

As outlined in WAC 173-340-360(3)(e), MTCA provides a methodology that uses the criteria listed below to determine whether the costs associated with each remedial alternative are disproportionate relative to the incremental benefit of the alternative above the next lowest-cost alternative. The comparison of benefits relative to costs may be quantitative, but will often be qualitative. When possible for this FS, quantitative factors such as mass of contaminant removed or percentage of area of impacts remaining were compared to costs for the alternatives evaluated, but many of the benefits associated with the criteria described below were necessarily evaluated qualitatively. Costs are disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental degree of benefits achieved by the other lower-cost alternative [WAC 173-340-360(e)(i)]. Where two or more alternatives are equal in benefits, Ecology selects the less costly alternative [WAC 173-340-360(e)(ii)(c)].

Each of the MTCA criteria used in the DCA is described below.

7.3.1. Protectiveness

The overall protectiveness of a cleanup action alternative is evaluated based on several factors. First, the extent to which human health and the environment are protected and the degree to which overall risk at a Site is reduced are considered. Both on-site and off-site reduction in risk resulting from implementing the alternative are considered.

7.3.2. Permanence

MTCA specifies that when selecting a cleanup action alternative, preference shall be given to actions that are "permanent solutions to the maximum extent practicable." Evaluation criteria include the degree to which the alternative permanently reduces the toxicity, mobility or mass of hazardous substances, including the effectiveness 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 processes, and the characteristics and quantity of treatment residuals generated.

7.3.3. Cost

The analysis of remedial action alternative costs under MTCA includes the costs associated with implementing an alternative, such as design, construction, long-term monitoring and institutional controls. Costs are intended to be comparable among different alternatives to assist in the overall analysis of relative costs and benefits of the alternatives. The costs to implement an alternative include the cost of construction, the net present value of any long-term costs and agency oversight costs. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs and the cost of maintaining institutional controls. Unit costs used to develop overall remediation costs for this FS were derived using a combination of published engineering reference manuals (RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment.

7.3.4. Long-Term Effectiveness

Long-term effectiveness is a parameter that expresses the degree of certainty that the alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the cleanup action. The MTCA regulations contain a specific preference ranking for different types of technologies that is to be considered as part of the comparative analysis. The ranking places the highest preference on technologies such as reuse/recycling, treatment, immobilization/solidification, and disposal

in an engineered, lined, and monitored facility. Lower preference rankings are applied for technologies such as on-site isolation/containment with attendant engineered controls, and institutional controls and monitoring.

7.3.5. Management of Short-Term Risks

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 remedial actions. Remedial actions involving mobilization of contaminants or heavy construction elements carry a higher short-term risks associated with health and safety. In-water dredging activities carry a risk of temporary water quality degradation and potential sediment recontamination. Some short-term risks can be managed through the use of best management practices during project construction, while other risks are inherent to project alternatives and can offset the long-term benefits of an alternative.

7.3.6. Implementability

Implementability is a parameter expressing the relative difficulty and uncertainty of implementing a given remedial action. Evaluation of implementability includes consideration of technical factors such as the availability of mature technologies and experience of contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting and completing the cleanup.

7.3.7. Consideration of Public Concerns

The public involvement process under MTCA is used to identify potential public concerns regarding remedial 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, and other organizations that may have an interest in or knowledge of the site.

8.0 EVALUATION AND COMPARISON OF REMEDIAL ALTERNATIVES

This section provides an evaluation and comparative analysis of the site-wide remedial alternatives developed for the Lowland Area. The site-wide remedial alternatives are evaluated with respect to the MTCA evaluation criteria described in Section 7, and then compared to each other relative to their expected performance under each criterion. The detailed evaluation of the site-wide remedial alternatives is presented in Table 40. The results of the evaluation and MTCA DCA are summarized in Table 41.

8.1. Compliance with MTCA Requirements

Each site-wide remedial alternative was evaluated to ensure compliance with the MTCA threshold and other requirements including reasonable restoration time frame and permanence to the maximum extent practicable. The following sections (Sections 8.1.1 through 8.1.3) discuss how each site-wide remedial alternative developed for the Lowland Area meet these MTCA requirements.

8.1.1. Threshold Requirements

Each of the site-wide remedial alternatives developed for the Lowland Area described in this FS meet the four MTCA threshold requirements including protection of human health and the environment, compliance with cleanup standards, compliance with applicable state and federal regulations, and provision for

compliance monitoring. The site-wide remedial alternatives developed meet these threshold requirements by utilizing a combination of remedial technologies to prevent human and ecological exposures to Site contaminants.

The seven site-wide remedial alternatives differ in the manner in which the MTCA threshold requirements would be met. Site-Wide Remedial Alternative 4 utilizes removal of contaminated media to the greatest extent and thus is the most permanent solution and serves as the baseline remedial alternative [WAC 173-340-350(8)(c)(ii)(A) and 173-340-360(3)(e)(ii)(B)]. Site-Wide Remedial Alternative 1(i) does not involve removal of contaminated media but addresses the requirements by eliminating exposure/transport pathways through the use of capping, containment and in situ groundwater treatment (PRBs) technologies. Site-Wide Remedial Alternatives 1(ii), 1(iii), 2, 3(i) and 3(ii) meet the threshold requirements utilizing a combination of source removal, in situ soil treatment (S/S), in situ groundwater treatment (PRBs), capping and containment and/or institutional controls.

8.1.2. Requirement for Permanent Solutions to the Maximum Extent Practicable

Under MTCA, preference is given to cleanup actions that use permanent solutions to the maximum extent practicable. By definition (WAC 173-340-200), permanent remedies are those that would require no additional action to meet cleanup standards following implementation. A practicable cleanup action is one that can be designed, constructed and implemented in a reliable, cost-effective manner. To determine which cleanup actions are permanent to the maximum extent practicable, MTCA specifies that a DCA be used to compare the probable remedy cost to the relative benefits of the alternative. A cleanup action is not considered practicable if the incremental costs are disproportionate to the benefits when compared to lower cost alternatives. This determination is demonstrated by the relative benefit/cost ratio such that alternatives having additional incremental benefits that are disproportionate to the incremental additional cost, produce lower relative benefit/cost ratios.

The DCA used to determine which site-wide remedial alternative is most permanent to the maximum extent practicable is presented in Section 8.2.

8.1.3. Requirement for Reasonable Restoration Time Frame

Each of the site-wide remedial alternatives developed for the Lowland Area are expected to achieve CAOs within a reasonable time frame. The time frame required to achieve CAOs was evaluated in accordance with the factors outlined in WAC 173-340-360(4). As described in Section 6, contaminated media will be addressed using a combination of remedial technologies that have been proven reliable at other cleanup sites.

The restoration time frame for each site-wide alternative includes design, permitting, construction, and implementation of the cleanup action components. For Site-Wide Remedial Alternatives 1(i), 1(ii), 1(iii) and 2, the restoration time frame is estimated to be on the order of 10 years, which includes implementation of the remedial technologies specific to each alternative and performance monitoring for in situ groundwater treatment. For Site-Wide Remedial Alternatives 3(i), 3(ii) and 4, the restoration time frame is estimated to be on the order of three years or less to complete in situ soil treatment and/or source removal activities followed by one year of performance groundwater monitoring.

It should be noted that the time frame for alternatives utilizing in situ groundwater treatment (PRBs) may be prolonged in the event that additional treatment applications are required to meet the CAOs following

the initial application. In addition, the time frame for natural recovery of contaminated sediment on the Snohomish River shoreline is dependent on physical (i.e., deposition) and biological (i.e., biodegradation, bioturbation, etc.) processes which may have varying timeframes that are difficult to predict. However it is estimated to be on the order of 10 years after control of the source of contaminants to sediment. Management of institutional controls in the form of restrictive covenants would also be required where residual contamination is left in place following implementation of the cleanup action. Long-term monitoring may be necessary to ensure compliance with the environmental covenants established as part of institutional controls and would extend the duration of the associated alternative.

8.2. Site-Wide Remedial Alternative Disproportionate Cost Analysis

The DCA is used to compare the relative benefit of a remedial alternative to the probable remedy cost to select a remedy that is the most permanent and practicable. The relative benefit, estimated alternative cost and comparative analysis for the site-wide remedial alternative developed for the Lowland Area are presented in the following sections (Sections 8.2.1 through 8.2.3).

8.2.1. Remedial Alternative Benefit

For each site-wide remedial alternative, the overall relative benefit was determined based on the summation of weighted scores for each DCA criterion, including protectiveness, permanence, long-term effectiveness, management of short-term risks, technical and administrative implementability and consideration of public concerns. For each criterion, the alternative was scored on a 1 to 10 scale based on the degree to which the alternative satisfies the full description of the individual criterion. A score of 1 indicates the alternative is considered to satisfy the elements of the criterion to a very low degree while a score of 10 indicates the alternative is considered to satisfy the elements of the criterion to a very high degree. For each alternative, the individual criterion scores were then weighted according to the following weighting factors identified by Ecology to be used in feasibility studies.

DCA CRITERIA WEIGHTING FACTORS

DCA Criteria	Weighting Factor (%)
Protectiveness	30
Permanence	20
Long-term effectiveness	20
Management of short-term risks	10
Technical and administrative implementability	10
Consideration of public concerns	10

The DCA criterion and scoring for each site-wide remedial alternatives are presented in Table 40. Determination of the relative benefit score for each of the six MTCA criterion are discussed in the following sections (Sections 8.2.1.1 through 8.2.1.6).

8.2.1.1. Protectiveness

Site-Wide Remedial Alternative 4 achieves the highest level of protectiveness of the alternatives as a result of achieving the highest feasible degree of removal for soil and sediment exceeding cleanup levels. Site-Wide Remedial Alternatives 3(ii) and to a slightly lesser degree, Alternative 3(i), provide similar levels of protectiveness with Alternative 4 by utilizing site-wide in situ soil treatment (S/S) technologies. Site-Wide

Remedial Alternatives 1(i), 1(ii), 1(iii) and 2 primary rely on capping and containment to address Site contamination and are therefore, less permanent than the other alternatives evaluated due to the untreated volume of contamination remaining in place following implementation. Site-Wide Remedial Alternatives 1(iii) and 2 receive slightly higher scores over Alternative 1(ii) as a result of primary groundwater source removal component of these alternatives. Site-Wide Remedial Alternative 1(i) receives the lowest overall score relative to the other alternatives because it leaves the most contaminants in place and relies on long-term monitoring and cap maintenance to maintain protection of human health and the environment.

8.2.1.2. Permanence

Site-Wide Remedial Alternative 4 achieves a high level of permanence through removal of the largest amount of Site contamination. The permanence of Site-Wide Remedial Alternatives 3(ii) and to a lesser degree, Alternative 3(i), receive lower scores compared to Site-Wide Remedial Alternative 4 due to the volume of contaminant mass remaining at the Site following implementation. Site-Wide Remedial Alternatives 1(ii), 1(iii) and 2 are less permanent than Alternatives 3(ii) and 3(iii) because they primarily rely on capping and containment technologies to prevent exposure as opposed to Alternatives 3(ii) and 3(iii) which utilize more permanent S/S technologies. Site-Wide Remedial Alternative 1(i) is the least permanent of the alternatives evaluated due to the level of contaminant mass left in place following implementation of the remedy.

8.2.1.3. Long-Term Effectiveness

The long-term effectiveness of the site-wide remedial alternatives have similar relative rankings to those described above for the protectiveness and permanence criterion. The long-term effectiveness of alternatives that rely heavily on using proven technologies to remove contaminant mass (i.e., Site-Wide Remedial Alternative 4) are more effective in the long term than alternatives that rely primarily on in situ soil treatment technologies (i.e., Site-Wide Remedial Alternatives 3(i) and 3(ii)). Similarly, the long-term effectiveness of alternatives that rely heavily on in situ soil treatment technologies are more effective in the long term than alternatives that rely primarily on capping and containment technologies (i.e., Site-Wide Remedial Alternatives 1(i), 1(ii), 1(iii) and 2). This is due to the long-term monitoring requirement following implementation of the cleanup action to ensure that the function of the remedial technology is being maintained.

Site-Wide Remedial Alternative 4 would achieve contaminant mass removal from the Site to the greatest extent practicable and therefore, achieves the highest level of long-term effectiveness. Similarly, Site-Wide Remedial Alternative 3(ii) receives a slightly lower score followed by (in order) Alternative 3(i), 1(iii), 2 and 1(ii). Site-Wide Remedial Alternative 1(i) receives the lowest score due to the volume of contaminant mass left in place requiring long-term maintenance and monitoring to ensure its effectiveness in preventing explore to human and ecological receptors.

8.2.1.4. Management of Short-Term Risks

Site-Wide Remedial Alternative 1(i) has the least invasive scope of work and therefore, is expected to have lowest degree of associated short-term risk. Due to the increasing complexities in planning and permitting for the remaining alternatives, each alternative receives a progressively lower score with one exception. Site-Wide Remedial Alternatives 1(ii) and 2 are expected to have fewer associated short-term risks than Alternative 1(ii) because they utilize commonly available construction equipment to a higher degree. Remedial alternatives that rely on the use of specialty equipment for in situ soil treatment are expected to

have more associated short-term risks due to the more limited availability of this equipment to implement the remedy.

8.2.1.5. Technical and Administrative Implementability

All of the remedial alternatives evaluated are generally technically implementable using commonly available methods. However the level of administrative implementability associated Site-Wide Remedial Alternatives 1(i), 1(ii), 1(iii) and 2 is expected to increase due to the mitigation required to account for wetland habitat loss associated with capping technologies. Similarly, the level of administrative implementability associated Site-Wide Remedial Alternatives 3(i), 3(ii) and 4 is expected to increase due to the degree of complex project planning and permitting required to complete site-wide source removal and/or in situ soil stabilization. Site-Wide Remedial Alternative 1(i) receives the highest overall score due to the limited degree of land disturbance required to implement this remedy. Site-Wide Remedial Alternatives 3(i) and 3(ii) receive the lowest overall scores due the high degree of land disturbance required to implement this remedy and the need of specialty construction equipment to perform in situ soil treatment.

8.2.1.6. Considerations of Public Concerns

The remedial alternatives proposed for the Site are generally expected to be acceptable to the public. The alternatives expected to achieve the greatest level of protection and certainty rely on the greatest level of contaminant removal and result in the most intrusive Site activities. Site-Wide Remedial Alternative 4, which involves significant removal of contaminated soil and sediment, scored the highest for this criterion (i.e., low to moderate public concern). Site-Wide Remedial Alternatives 3(i) and 3(ii) which rely on in situ soil treatment technologies leave contamination in place and as a result, is expected to have a higher level of public concern. However, the level of public concern for Site-Wide Remedial Alternatives 3(i) and 3(ii) is expected to be less than Site-Wide Remedial Alternatives 1(i), 1(ii), 1(iii) and 2 which primarily rely on capping and containment technologies that leave the greatest volume of contaminant mass in place.

8.2.2. Remedial Alternative Cost

For each site-wide remedial alternative, probable remedy costs (+50/-30 percent) were developed as described in Section 7.3.3 using a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual), construction cost estimates solicited from applicable vendors and contractors, review of actual costs incurred during similar, applicable projects and professional judgment. Concept design level remedial alternative costs for Areas A1, A2, B1 through B3 and C1 are presented in Tables 24 through 29. Costs for Areas C2 and C3 are presented in Table 30. Costs for Areas C4 through C6 are presented in Tables 31 through 33. Costs for Areas D1, D2 and D3 are presented in Table 34. Cost for Area D4 is presented in Table 35. The overall cost for each site-wide remedial alternative is presented in Table 41.

8.2.3. Comparative Analyses

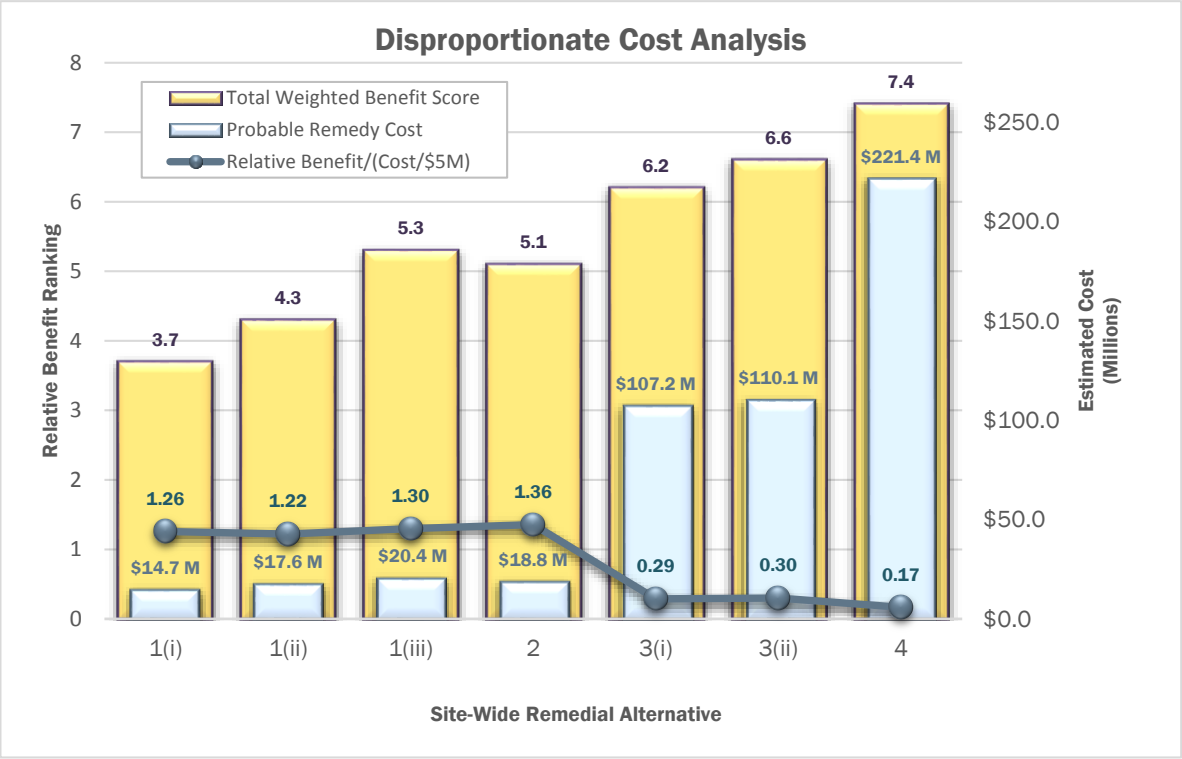
The MTCA DCA analysis uses a relative benefit/cost ratio to compare each of the remedial alternatives developed and is used to determine whether overall remedy cost is disproportionate to the relative benefit when compared to other alternatives. Using the summation of the weighted benefit scores described in Section 8.2.1 and the estimated remedy cost described in Section 8.2.2, a relative benefit/cost ratio was calculated for each site-wide remedial alternative. The benefit/cost ratio was calculated by dividing the total weighted benefit score by the total cost for each alternative. The resulting relative benefit/cost ratio for each site-wide remedial alternative is plotted relative to the overall benefit score and probable remedy

cost below. To facilitate graphical presentation of the relative benefit/cost shown below, the total cost of each site-wide remedial alternative was divided by $5,000,000.

The individual DCA criterion benefit scores (Section 8.2.1), weighting factors, weighted scores and total weighted benefit score and probable remedy cost for each of the site-wide remedial alternatives used to generate the graphic below are presented in Table 41.

8.3. Preferred Cleanup Alternative

Under MTCA, "costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of lower cost alternative" (WAC 173-340-360[3][e][i]). From the resulting relative benefit/cost ratio graphically illustrated below, the overall cost for Site-Wide Remedial Alternatives 3(i), 3(ii) and 4 are disproportionate to the environmental benefit that they provide. Furthermore, the environmental benefit for Site-Wide Remedial Alternative 1(iii) is greater than for Site-Wide Remedial Alternative 2. However, Site-Wide Remedial Alternative 1(iii) is less cost effective than the environmental benefit gained through implementing Site-Wide Remedial Alternative 2. As a result, Site-Wide Remedial Alternative 2 emerges as the preferred alternative for the Lowlands Area.



Implementation of Site-Wide Remedial Alternative 2 uses a combination of remedial technologies to mitigate risk for potential human and ecological receptors including:

- Removal of the contaminated material from Areas A1 and A2 that are primary sources to groundwater contamination at the site;

- Capping within Areas B1 through B3, C4 and C5 to reduce infiltration of stormwater/surface water and/or prevent human and ecological receptor exposure to contaminated media;
- Application of a shallow PRB within Area B2 to treat groundwater contamination;
- Implementation of institutional controls in the form of fencing and signage encompassing Areas C2 and C3;
- Repair, install lining or replace stormwater pipes that may allow infiltration and are responsible for transport of contaminants from Area B2 to the outfall located at Area D2;
- Cut and plug underdrains that are responsible for transport of contaminants from Area C5 to the outfall at Area D3;
- Monitoring of the natural attenuation of contaminant concentrations in groundwater;
- Monitored natural recovery of contaminated sediments near stormwater outfalls to the Snohomish River; and
- Complete groundwater monitoring to assess performance of the remedies or groundwater natural attenuation processes and/or compliance with the cleanup standards as applicable.

Based on the comparative analysis of the DCA, Site-Wide Remedial Alternative 2 uses permanent solutions to the maximum extent practicable and achieves the highest overall cost to benefit ratio. Remedial technologies implemented through Site-Wide Remedial Alternative 2 are shown on Figure 7. A description of the preferred alternative is provided in Section 6.1.2.

9.0 REFERENCES

ASARCO, "Smelter Area Investigation Report, Everett Smelter Site, Everett, Washington," prepared by Asarco Incorporated for Washington Department of Ecology, dated October 7, 1998.

GeoEngineers, Inc., "Supplemental Remedial Investigation Report, Everett Smelter Lowland Area, Everett, Washington," For the Washington State Department of Ecology, GEI File No. 0504-068-01, February 8, 2016.

Hydrometrics, "Remedial Investigation, Everett Smelter Site, Everett, Washington," prepared by Hydrometrics, Inc. for ASARCO Incorporated, September 1995.

Environmental Protection Agency (EPA). "Method 1311: Toxicity characteristic leaching procedure." SW-846 test methods for evaluating solid wastes, http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/1311.pdf. July 1992.

Washington State Department of Ecology (Ecology), "Model Toxics Control Act (MTCA) Regulation and Statute, Publication No. 94-06, Revised 2013.

Table 1

Preliminary Soil Cleanup Levels and Points of Compliance for Indicator Hazardous Substances

Everett Smelter Site - Lowland Area

Everett, Washington

Indicator Hazardous Substances (IHSs)[1]	POCs (feet bgs)	Lowest Applicable Soil Cleanup Levels[2] (mg/kg)			Background Concentrations[3] (mg/kg)	Soil PCULs[4] (mg/kg)
		Based on Protection of Human Health		Based on Protection of Terrestrial Ecological Receptors		
		Industrial Worker	Trespassers	Wildlife		
Areas west of BNSF Railroad with the exception of American Legion Park						
Arsenic	0 to 1	88	9	132	20	20
	1 to 6		--			88
	6 to 15			--		
Lead	0 to 1	1,000	250	118	24	118
	1 to 6		--			
	6 to 15			--		1,000
Mercury	0 to 1	1,100	1,500	5.5	0.07	5.5
	1 to 6		--			
	6 to 15			--		1,100
Areas east of BNSF Railroad						
Arsenic	0 to 1	88	--	132	20	88
	1 to 6					
	6 to 15			--		
Lead	0 to 1	1,000	--	118	24	118
	1 to 6					
	6 to 15			--		1,000
Mercury	0 to 1	1,100	--	5.5	0.07	5.5
	1 to 6					
	6 to 15			--		1,100

Notes:

[1] The IHSs for "shallow soil" which includes fill, native surface, silt and till are arsenic, lead and mercury. The IHS for "deeper soil" which includes alluvium and outwash is arsenic. The depths and locations at which these soils are observed within the Lowland Area vary and are generally shown on the geologic cross-sections prepared as part of the SRI Report (GeoEngineers, 2015).

[2] Lowest applicable cleanup levels are identified for each category. Refer to SRI Report (GeoEngineers, 2015) for a complete list of applicable cleanup levels considered in deriving PCULs.

[3] Background concentrations (Puget Sound Region 90th percentile values) are from Natural Background Soil Metals Concentrations in Washington State (Ecology Publication #94-115, 1994) except for arsenic. Background for arsenic as established in the MTCA Method A Table 745-1 (WAC 173-340-900).

[4] The soil PCULs are the lowest of the applicable soil cleanup levels except where the background concentration is higher than the lowest applicable cleanup level. Refer SRI Report (GeoEngineers, 2015) for detailed derivation of PCULs.

POCs = Points of compliance

PCULs = Preliminary cleanup levels

bgs = below ground surface

mg/kg = milligrams per kilogram

"--" = not applicable

Table 2

Preliminary Groundwater Cleanup Levels and Points of Compliance for Indicator Hazardous Substances

Everett Smelter Site - Lowland Area

Everett, Washington

Indicator Hazardous Substances (IHSs)[1]	POCs	Lowest Applicable Groundwater Cleanup Levels[2] (µg/l)				Background Concentrations (µg/l)	Groundwater PCULs[4,5] (µg/l)
		Based on Protection of Surface Water in Lowland Area[3]	Based on Protection of Surface Water in Snohomish River				
		Fresh Water Criteria/Protection of Aquatic Life	Marine Water Criteria/Protection of Aquatic Life	Marine Water Criteria/Protection of Human Health	Marine Water Criteria/Protection of Sediment		
Shallow Aquifer Groundwater							
Arsenic	Surface water within surface water features in the Lowland Area	150	--	--	--	5[6]	150
	Groundwater that discharges into the Snohomish River	--	36	0.14	2,000		5
Lead	Surface water within surface water features in the Lowland Area	2.2	--	--	--	NE	2.2
	Groundwater that discharges into the Snohomish River	--	8.1	NE	45		8.1
Mercury	Surface water within surface water features in the Lowland Area	0.012	--	--	--	NE	0.02[7]
	Groundwater that discharges into the Snohomish River	--	0.025	0.15	7.9		0.025
Deep Aquifer Groundwater							
Arsenic	Surface water within surface water features in the Lowland Area	--	--	--	--	5[6]	--
	Groundwater that discharges into the Snohomish River	--	36	0.14	2,000		5

Notes:

[1] The IHSs for shallow aquifer groundwater are arsenic, lead and mercury. The IHS for deep aquifer groundwater is arsenic. The depths of shallow and deep groundwater aquifer are generally shown on the geologic cross-section prepared as part of the SRI Report (GeoEngineers, 2015).

[2] Lowest applicable cleanup levels are identified for each category. Refer to SRI Report (GeoEngineers, 2015) for a complete list of applicable cleanup levels considered in deriving the PCULs.

[3] The cleanup levels developed based on protection of surface water in the Lowland Area are not applicable to groundwater in the deep aquifer. Groundwater in the deep aquifer does not discharge to surface water in the Lowland Area because a silt layer separates deep and shallow aquifers.

[4] The groundwater PCULs are the lowest of the applicable groundwater cleanup levels except if the background groundwater concentration or PQL is higher. Refer SRI Report (GeoEngineers, 2015) for detailed derivation of PCULs.

[5] The cleanup levels listed for each metal apply to the dissolved fraction with the exception of mercury. The cleanup level for mercury applies to the total mercury concentration.

[6] Background for arsenic is established in the MTCA A Table 720-1 (WAC 173-340-900).

[7] The laboratory PQL for mercury is used for the groundwater cleanup level.

POCs = Points of compliance

PCULs = Preliminary cleanup levels

PQL = Practical quantitation limit

µg/l = Micrograms per liter

"–" = not applicable

NE = No criteria is currently established for this analyte

Table 3

Preliminary Surface Water Cleanup Levels and Points of Compliance for Indicator Hazardous Substances

Everett Smelter Site - Lowland Area

Everett, Washington

Indicator Hazardous Substances (IHSs)	POCs	Lowest Applicable Surface Water Cleanup Levels[1] (µg/l)				Background Concentrations (µg/l)	Surface Water PCULs[2,3] (µg/l)
		Based on Protection of Surface Water in Lowland Area	Based on Protection of Surface Water in Snohomish River				
		Fresh Water Criteria/Protection of Aquatic Life	Marine Water Criteria/Protection of Aquatic Life	Marine Water Criteria/Protection of Human Health	Marine Water Criteria/Protection of Sediment		
Arsenic	Surface water within surface water features in the Lowland Area	150	--	--	--	5[4]	150
	Groundwater, seep-water, and outfall-water that discharges into the Snohomish River	--	36	0.14	2,000		5
Mercury	Surface water within surface water features in the Lowland Area	0.012	--	--	--	NE	0.02[5]
	Groundwater, seep-water, and outfall-water that discharges into the Snohomish River	--	0.025	0.15	7.9		0.025

Notes:

[1] Lowest applicable cleanup levels are identified for each category. Refer to SRI Report (GeoEngineers, 2015) for a complete list of applicable cleanup levels considered in deriving PCULs.

[2] The surface water PCULs are the lowest of the applicable surface water cleanup levels except if the background groundwater concentration or PQL are higher. Refer SRI Report (GeoEngineers, 2015) for detailed derivation of PCULs.

[3] The cleanup levels listed for each metal apply to the dissolved fraction with the exception of mercury. The cleanup level for mercury applies to the total mercury concentration.

[4] Background for arsenic is established in the MTCA A Table 720-1 (WAC 173-340-900).

[5] The laboratory PQL for mercury is used for the groundwater cleanup level.

POCs = Points of compliance

PCULs = Preliminary cleanup levels

PQL = Practical quantitation limit

µg/l = Micrograms per liter

"--" = not applicable

NE = No criteria is currently established for this analyte

Table 4

Preliminary Sediment Cleanup Levels and Points of Compliance for Indicator Hazardous Substances

Everett Smelter Site - Lowland Area

Everett, Washington

Indicator Hazardous Substance (IHS)	POCs (cm bml)	Lowest Applicable Sediment Cleanup Levels[1] (mg/kg - DW)				Background Concentrations[2] (mg/kg - DW)	Sediment PCULs[3]
		Based on Fresh Water Criteria for Protection of Benthic Organisms	Based on Marine Water Criteria for Protection of Benthic Organisms	Based on Protection of Human Health (Direct Contact/ Bioaccumulation)	Based on Protection of Aquatic/Aquatic Dependent Ecological Receptors (Bioaccumulation)		
Arsenic	0 to 10 cm of sediment within surface water features in the Lowland Area	14	--	--	--	20	20
	0 to 10 cm of sediment on the shoreline of the Snohomish River	--	57	0.00028	0.59		
Mercury	0 to 10 cm of sediment within surface water features in the Lowland Area	0.66	--	--	--	0.07	0.66
	0 to 10 cm of sediment on the shoreline of the Snohomish River	--	0.41	0.15	0.0074		0.07

Notes:

[1] Lowest applicable cleanup levels are identified for each category. Refer to SRI Report (GeoEngineers, 2015) for a complete list of applicable cleanup levels considered in deriving PCULs.

[2] Background concentrations (Puget Sound Region 90th percentile values) are from Natural Background Soil Metals Concentrations in Washington State (Ecology Publication #94-115, 1994) except for arsenic. Background for arsenic as established in the MTCA Method A Table 745-1 (WAC 173-340-900).

[3] The sediment PCULs are the lowest of the applicable sediment cleanup levels, except if background concentration is higher. Refer to SRI Report (GeoEngineers, 2015) for detailed derivation of PCULs.

PCULs = Preliminary cleanup levels

PQL = Practical quantitation limit

bml = below mudline

mg/kg - DW = milligram per kilogram, dry weight

Table 5

Potentially Applicable Laws, and Applicable, or Relevant and Appropriate Requirements (ARARs)

Everett Smelter Site - Lowland Area
Everett, Washington

Laws and ARARs	Description and Applicability	Procedural/Substantive Requirements
Model Toxics Control Act (MTCA) Cleanup Regulation (RCW 70.105D; Chapter 173-340 WAC)	MTCA is the primary regulation governing upland cleanup actions at the Site.	Cleanup actions conducted by Ecology under MTCA are exempt from the procedural requirements of most state and local laws/permits; however, must meet substantive requirements of the laws/permits.
Sediment Management Standards (SMS) (RCW 90.48 and 70.105D; Chapter 173-204 WAC)	SMS is the primary regulation governing sediment cleanup actions at the Site.	MTCA is one of the authorities defining the SMS; thus, waivers of state and local laws/permits also apply to sediment cleanups.
State Environmental Policy Act (SEPA) (RCW 43.21C, Chapters 197-11 and 173-802 WAC)	Applicable to site cleanup action and is intended to ensure that state and local government officials consider environmental values when making decisions or taking an official action such as approving the cleanup action plan (CAP).	The requirements will be met by preparing a SEPA checklist and obtaining SEPA determination from the lead agency.
Federal Clean Water Act (CWA), Section 404 (Dredge and Fill Regulations)	Section 404 requires a permit for the discharge of dredge or fill material into waters of the United States, including filling or construction activities in navigable waters and wetlands. These requirements are applicable to proposed remedial alternatives that include in-water dredging, filling, capping and/or enhanced natural recovery (ENR) actions.	The requirements will be met by preparing Joint Aquatic Resource Permit Application (JARPA) for U.S Army Corps of Engineers (USACE) review to obtain coverage under an USACE Nationwide Permit (NWP) 38. NWP 38 applies to the "Cleanup of Hazardous and Toxic Waste".
Federal Clean Water Act (CWA), Section 401 (Water Quality Certification)	Section 401 requires that any activity which may result in a discharge into the navigable waters shall obtain a certification from the state that the water quality standards will be met. These requirements are applicable to proposed remedial alternatives that consist of in-water dredging, filling, capping and/or enhanced natural recovery (ENR) actions.	The requirements will be met by preparing JARPA for Washington State Department of Ecology's review to obtain 401 Water Quality Certification.
Washington Hydraulic Project Approval (HPA), Chapter 77.55.061 RCW, Chapter 220-110 WAC	Hydraulic Project Approval (HPA) and associated requirements for construction projects in state waters have been established for the protection of fish and shellfish. Any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water or saltwater of the state requires an HPA. These requirements are applicable to proposed remedial alternatives that consist of in-water dredging, filling, capping and/or include ENR actions.	Because activities will be performed as part of a MTCA cleanup action, procedural requirements of an HPA permit would not be applicable; however, substantive requirements of HPA will be applicable. The requirements will be met by preparing JARPA for the Washington Department of Fish and Wildlife (WDFW) review. The substantive requirements of an HPA includes restrictions on dates of in-water work (in-water windows) to protect fish species at critical life history stages (e.g., spawning season for salmonids). For cleanup action alternatives in marine waters (i.e. Snohomish River within Site), the in-water work windows will be met during performance of the cleanup action.
Stormwater Permit Program, Water Pollution Control Act (RCW 90.48); National Pollution Discharge Elimination System Program (Chapter 173-220 WAC)	The Federal Clean Water Act (CWA), as delegated to Department of Ecology under RCW 90.48.260, requires that coverage under the general stormwater permit must be obtained for stormwater discharges associated with construction activities disturbing over 1 acre. The disturbed area for this project is expected to be greater than 1 acre.	To meet this requirement, the Project will obtain coverage under the Washington State Construction Stormwater General Permit (CSWGP). In addition, a stormwater pollution prevention plan (SWPPP) will be prepared before start of land disturbing activities, which will describe the best management practices (BMPs) that will be implemented to protect surface water quality. These requirements would be coordinated with any applicable local grading and erosion control.
Dangerous Waste Regulations (Chapter 173-303 WAC); Solid and Hazardous Waste Management Act (RCW 70.105)	These requirements will apply if dangerous wastes are generated during the cleanup action. Based on the analytical data generated during the RI, soil and/or debris at the site may be characterized as dangerous waste if excavated.	Material removed as part of the cleanup that characterize as dangerous waste will be managed, transported and disposed in accordance with the requirements of the regulation. Under WAC 173-303-170, the Dangerous Waste regulations specify requirements for generators to follow including responsibility for designating dangerous and extremely hazardous waste, and an allowance for treating dangerous waste in tanks or containers without triggering permit requirements. The following dangerous waste requirements are not ARARs for Site activities but may be applicable if dangerous or hazardous waste is transported off site: • Notification numbers for generator, transporter and disposal facilities under WAC 173-303-060. • Land disposal restrictions under WAC 173-303-140. • Treatment, storage and disposal of dangerous waste under WAC 173-303-141. • Manifest for off site transport of dangerous waste under WAC 173-303-180. • Preparation of waste for shipment, including labeling, marking, packaging, placarding under WAC 173-303-190. • Generator record keeping and reporting under WAC 173-303-210 and –220. • Dangerous waste transportation off site under WAC 173-303-240.

Laws and ARARs	Description and Applicability	Procedural/Substantive Requirements
Washington Solid Waste Management Act and Solid Waste Management Handling Standards Regulations, Chapter 70.95 RCW, Chapter 173-350 WAC.	The solid waste requirements are applicable to remedial alternatives that consist of off-site disposal of solid non-hazardous wastes and contaminated media.	For off site disposal activities, waste materials will be sent to facilities licensed and permitted to accept the specific waste material and documentation will be obtained of such disposition.
Shoreline Management Act (RCW 90.58; Chapter 173-16 and 173-27-060 WAC); City of Everett Shoreline Master Program (SMP)	The Shoreline Management Act (RCW 90.58) and its implementing regulations establish requirements for substantial developments occurring within waters of the state or within 200 feet of the shoreline. Local shoreline management programs are adopted under state regulations, creating an enforceable state law. Applicable to upland cleanup action alternatives that include activities within 200 feet of the shoreline and cleanup action alternatives for sediment on the Snohomish River shoreline	Cleanup actions under MTCA are exempt from shoreline management act permitting; however, will need to meet substantive requirements. To ensure that the cleanup actions meet the substantive requirements, the City of Everett will be consulted.
Federal Coastal Zone Management Act (CZMA), 16 USC 1451-1464; RCW 90.58; WAC 173-27-060, 15 CFR 923-930	The CZMA requires that federal agency action that is reasonably likely to affect use of shorelines be consistent with the approved coastal zone management plan to the maximum extent practicable, subject to limitations set forth in the CZMA. These requirements are applicable to proposed remedial alternatives that include in-water dredging, filling, capping and/or ENR actions.	The requirements will be met by preparing a CMZA form for Washington State Department of Ecology's review. Ecology reviews the proposed project for consistency with state environmental requirements, including shoreline permitting requirements. If the project is consistent, Ecology concurs with the certification in writing.
Endangered Species Act (ESA), 16 USC 1531-1543, 50 CFR 402, 50 CFR 17	The Endangered Species Act protects fish, wildlife and plants that are threatened or endangered with extinction. It also protects habitat designated as critical to the conservation of threatened or endangered species. Applicable to alternatives that have potential to impact endangered species and/or habitat.	The requirements include consultation with United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) Fisheries, and Ecology to evaluate whether threatened or endangered species will be impacted. This consultation will be coordinated by USACE as part of coverage under the CWA Section 404 Nationwide Permit 38. Based on consultation, development of a biological assessment (BA) or biological opinion (BO) may be needed to demonstrate compliance.
Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), 16 USC 1801 et. seq., 50 CFR Part 600	The MSFCMA was adopted to conserve and manage the fishery resources found off the coasts of the United States and the anadromous species and Continental Shelf fishery resources of the United States by protecting essential fish habitat. Applicable to alternatives that have potential to impact such habitat.	The requirements include consultation with USFWS, NOAA Fisheries, and Ecology to evaluate MSFCMA requirements. This consultation will be coordinated with the Endangered Species Act consultation by USACE as part of coverage under the CWA Section 404 Nationwide Permit 38. Based on consultation, development of a biological assessment (BA) or biological opinion (BO) may be needed to demonstrate compliance.
Fish and Wildlife Conservation Act (FWCA), 16 USC 2901; 50 CFR 83	The FWCA requires federal agencies to use their authority to conserve and promote conservation of non-game fish and wildlife. Non-game fish and wildlife are defined as fish and wildlife that are not taken for food or sport, that are not endangered or threatened and that are not domesticated.	Requirements of the FWCA will be evaluated in conjunction with the Endangered Species Act consultation with USFWS and NOAA Fisheries.
Clean Air Act (RCW 70.94); Ambient Air Quality Standards (Chapter 173-746 WAC)	Applicable to construction activities during implementation of the remedy. Administered by the State and local authorities.	Because activities will be performed as part of a MTCA cleanup action, a permit would not be required but compliance with the substantive requirements of this ARAR would be required. The applicability of the substantive requirements will be determined through consultation with the State/local authorities.
City of Everett Title 19, Chapter 37 Critical Areas; Growth Management Act (GMA) (RCW 36.70A)	City ordinance implementing State's GMA requirements for identifying and restoring sensitive habitats and other natural resources that provide critical services (water quality, habitat, erosion protection, etc.).	Because activities will be performed as part of a MTCA cleanup action, a permit would not be required but compliance with the substantive requirements of this ARAR would be required. The applicability of the substantive requirements will be determined through consultation with the City of Everett.
Washington Industrial Safety and Health Act (WISHA) (RCW 49.17; Chapters 296-62, 296-843 WAC and others); Occupational Safety and Health Act (OSHA) (29 USC Chapter 15; 29 CFR 1910, 1926)	Applicable to investigation and construction phases of a cleanup.	Investigation/construction activities will be conducted in accordance with the requirements of OSHA/WISHA.
Archaeological and Historic Preservation Act, 16 USC 469	This act establishes procedures to provide for the preservation of historical and archeological resources that might be destroyed through alteration of terrain as a result of a federally licensed activity or program.	This regulation will be considered during implementation of the cleanup action. Appropriate measures will be taken to evaluate the presence of cultural resources. If a potential for an existence of cultural resources exists then appropriate measures will be taken during excavation activities and appropriate tribal members will be contacted in the event that an artifact is encountered.
City of Everett Grading Code, Title 18.28.200 Everett Municipal Code (EMC).	Applicable to remedial alternative where site grading/modification activities that may disturb or remove existing features.	Title 18.28 EMC, Land Division Evaluation Criteria and Development Standards, requires a grading plan to be submitted to the city engineer "before any site modification where existing natural features would be disturbed or removed." [18.28.200(A)]. Because activities will be performed as part of a MTCA cleanup action, a permit would not be required but compliance with the substantive requirements of this ARAR would be required. The applicability of the substantive requirements of the grading code will be determined through consultation with the City of Everett.

Laws and ARARs	Description and Applicability	Procedural/Substantive Requirements
City of Everett Traffic Code, Title 46 EMC	Applicable to construction traffic associated with a cleanup action.	Construction activities such as haul truck operations may require that traffic be directed by flaggers and signage. The applicability of the traffic code will be determined through consultation with the City of Everett.
City of Everett Discharge to Publicly Owned Treatment Works (POTW) Title 14.40 EMC	Applicable to remedial alternatives that involve dewatering and discharge of construction wastewater to POTW.	Dewatering activities associated with the cleanup action alternatives will require a wastewater discharge permit to discharge water to the POTW. The applicability of the substantive requirements of the Title 14.40 EMC will be determined through consultation with the City of Everett.
City of Everett Noise Control, Title 20.08 EMC	Applicable to construction noise generated due to a cleanup action.	Construction activities associated with the cleanup action alternatives will comply with City of Everett noise control requirements.
Minimum Standards for Construction and Maintenance of Wells, Chapter 173-160 WAC	Applicable to remedial alternatives that involve construction of wells for groundwater withdrawal and monitoring and decommissioning of existing or future wells.	Construction and/or decommissioning of wells will be completed in accordance will applicable laws and regulations.

Table 6

Cleanup Action Objectives (CAOs)

Everett Smelter Site - Lowland Area

Everett, Washington

ID	CAOs	Applicable Area															Comments
		A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6[1]	D1	D2	D3	D4	
CAO-1	Mitigate risk of human exposure from direct contact with contaminated soil and/or slag/debris.	X	X	X	X	X		X	X	X	X						Contaminated soil and slag/debris are not present at Areas C1, C6, and D1 through D4 and therefore, this CAO is not applicable to these areas.
CAO-2	Mitigate risk of terrestrial ecological receptor (wildlife) exposure from direct contact with contaminated soil and/or slag/debris.	X	X	X	X			X	X	X							Contaminated soil and slag/debris are not present at Areas C1, C6, and D1 through D4 and therefore, this CAO is not applicable to these areas. Contaminated soil at Areas B3 and C5 is located 6 feet below ground surface which is MTCA conditional point of compliance for terrestrial ecological receptors and therefore, this CAO is not applicable to Area C5.
CAO-3	Mitigate risk associated with the discharge of contaminated shallow groundwater into Lowland Area surface water. The discharge of contaminated shallow groundwater poses an exposure risk to freshwater aquatic organisms.			X													Based on data collected as part of the supplemental remedial investigation (SRI), the risk of contaminated shallow groundwater discharge to surface water in the Lowland Area exists only for the surface water features located within Area B1. Therefore this CAO is only applicable to Area B1.
CAO-4	Mitigate risk associated with the discharge of contaminated shallow groundwater into Snohomish River surface water. The discharge of contaminated shallow groundwater poses an exposure risk to marine aquatic organisms as well as human health resulting from consumption of contaminated marine aquatic organisms.		X		X												Based on data collected as part of the SRI, the risk of contaminated shallow groundwater discharge to the Snohomish River is present only at Areas A2 and B2. Therefore this CAO is only applicable to Areas A2 and B2.
CAO-5	Mitigate risk associated with the discharge of contaminated shallow groundwater into Snohomish River surface water in the form of seep-water.				X												Based on data collected as part of the SRI, contaminated seep-water is only present at Area D4. The source of this seep-water contamination is contaminated shallow groundwater from Area B2. Therefore this CAO is only applicable to Area B2.
CAO-6	Mitigate risk associated with the discharge of the contaminated deep groundwater into Snohomish River surface water. The discharge of contaminated deep groundwater poses an exposure risk to marine aquatic organisms as well as human health resulting from consumption of contaminated marine aquatic organisms.				X		X										Based on data collected as part of the SRI, the risk of contaminated deep groundwater discharge to the Snohomish River is present only at Areas B2 and C1. Therefore this CAO is only applicable to Areas B2 and C1.
CAO-7	Mitigate risk of freshwater aquatic and benthic organism exposure to contaminated surface water and sediment in the Lowland Area.			X													Based on data collected as part of the SRI, contaminated surface water and sediment in the Lowland Area are only present within Area B1. Therefore this CAO is only applicable to Area B1.
CAO-8	Mitigate contaminant transport from upgradient sources to outfalls where contaminated outfall-water is a source of Snohomish River sediment contamination.			X	X						X						Sources to outfall-water contamination are located at Areas B1, B2 and C5. Therefore this CAO is only applicable to Areas B1, B2 and C5.
CAO-9	Mitigate risk of human exposure from direct contact with contaminated sediment.												X	X	X		Based on data collected as part of the SRI, contaminated sediment are present only at Areas D1 through D3 and therefore, this CAO is applicable only to Areas D1 through D3.
CAO-10	Mitigate risk of marine benthic organisms exposure to contaminated sediment.												X	X	X		Based on data collected as part of the SRI, contaminated sediment is present only at Areas D1 through D3. Therefore this CAO is applicable only to Areas D1 through D3.
CAO-11	Mitigate risk of marine aquatic organism exposure to contaminated sediment as well as human exposure resulting from consumption of contaminated marine aquatic organisms.												X	X	X		Based on data collected as part of the SRI, contaminated sediment is present only at Areas D1 through D3. Therefore this CAO is applicable only to Areas D1 through D3.
CAO-12	Mitigate risk of marine aquatic organism exposure to contaminated seep-water as well as human exposure resulting from consumption of contaminated marine aquatic organisms.															X	Based on data collected as part of the SRI, seep-water contamination is only present at Area D4. Therefore this CAO is only applicable to Area D4.

Notes:

[1] The SRI Report does not indicate presence of any contaminant exposure and transport pathways for Area C6 since the only contaminated media present at Area C6 is deep groundwater and this deep groundwater contamination is observed to be localized and is not migrating downgradient.

Table 7

Soil and Slag/Debris Remedial Technologies Screening

Everett Smelter Site - Lowland Area

Everett, Washington

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
Institutional Controls (ICs)	Governmental/Property Controls	Environmental Covenants	Legal restrictions associated with future land use and activities (e.g., development, construction, etc.); may also be used to specify long-term maintenance requirements of remediation systems.	Technically implementable. Specific legal requirements and authority would need to be met.	Not effective for remediating contaminants. Can be effective at reducing risks and maintaining integrity of a remedy.	Low	Low	Applicable and/or required in combination with other technologies.	Yes
		Land Use Restrictions, Soil Management Plans/ Requirements	Restrictions on activities such as excavation to prevent physical damage to in situ remedies (e.g., caps) and/or exposure of humans and environment to hazardous substances that remain in-place. Implement soil management plans/requirements so that contaminated soils are managed properly in an event that it is necessary to disturb/excavate (e.g., utility work, etc.).	Technically implementable but administratively more difficult. Requires an implementing agency.	Not effective for remediating contaminants. Enforcement would be required for restrictions to be effective.	Low	Low	Applicable and/or required in combination with other technologies.	Yes
	Access Restrictions and Information Devices	Fencing and Warning Signage	Placement of fencing and warning signs to prevent access and inform the public regarding health risks.	Technically implementable. Implementability and applicability depends on current and future site uses.	Not effective for remediating contaminants. Effective in minimizing human exposure to contaminated media by preventing access. Not effective in preventing exposure of ecological receptors.	Moderate	Low	Applicable and/or required in combination with other technologies.	Yes
Capping	Low-permeability Cap with Drainage Controls	Asphalt and/or Concrete Cap	Install and/or maintain existing asphalt or concrete cap over contaminated soil. Surface/storm water collection and discharge would be designed to reduce infiltration of stormwater at the site. Primary function of the cap is to prevent/minimize stormwater infiltration, contaminant migration and direct contact of human and ecological receptors with contaminated soil.	Technically implementable. Implementability and applicability depends on current and future site uses. Additional considerations for stormwater collection, treatment, and discharge will be needed.	Effective for preventing direct contact exposure of human and ecological receptors, erosion of source material, reducing stormwater infiltration, and enhancing immobility.	Moderate	Low	Applicable and effective where hard surfaces and structures are planned.	Yes
		A minimum of 1-Foot of Soil Cover with underlying Low-permeability Barrier	Install soil cover (a minimum of 1-foot thick) with underlying barrier (plastic or similar) over contaminated soil. Surface/storm water collection and discharge would be designed to reduce infiltration of stormwater at the site. Primary function of the cover is to prevent/minimize contaminant migration and direct contact of human and ecological receptors with contaminated soil. Additionally, the cover minimizes stormwater infiltration.	Technically implementable. Implementability and applicability depends on current and future site uses. Additional considerations for stormwater collection, treatment, and discharge will be needed.	Effective for preventing direct contact exposure of human and ecological receptors, erosion of source material, reducing stormwater infiltration, and enhancing immobility.	Low to Moderate	Low	Applicable and effective where vegetated surfaces are planned.	Yes
	Permeable Cap	Permeable Soil Cover	Install and/or maintain existing 6-feet thick (conditional point of compliance for ecological receptors) soil cover over contaminated soil. Can be vegetated at the surface based on current/future site use. Primary function of the cover is to prevent/minimize contaminant migration and direct contact of human and ecological receptors with contaminated soil. Not effective at reducing infiltration.	Technically implementable. Implementability and applicability depends on current and future site uses.	Effective for preventing direct contact exposure (i.e., dermal contact or ingestion) and erosion of source material. Not effective at reducing infiltration.	Low to Moderate	Low	Applicable and effective where 6-feet of clean soil cover can be maintained.	Yes
In Situ Treatment	In Situ Solidification and Stabilization (S/S)	In situ S/S using cementitious (cement, lime, etc.), chemical (zero valent iron [ZVI] or combination of ZVI, iron sulfide, iron oxide and/or calcium carbonate [pH adjusting agent]) reagents.	In situ S/S is accomplished by injecting/mixing solutions of cementitious binders and/or chemical reagents with in situ soil to create a slurry, paste, or other semi-liquid state which is allowed time to cure into a solid/stable form. The process also may include the addition of pH adjustment agents, phosphates, or sulfur reagents to reduce the setting or curing time, increase the compressive strength, or reduce the leachability of contaminants.	Technically implementable. Buried debris or subsurface obstruction such as foundation/utilities may interfere and would require prior removal. Solidification and stabilization processes can result in an increase in volume. Treatability testing is required.	Effective for reducing mobility of metals. Most common in situ source control technology for metals used at CERCLA sites.	Moderate to High	Low	Applicable for site conditions and contaminants but requires treatability testing.	Yes

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
In Situ Treatment	Soil Flushing	Soil Flushing	The extraction of contaminants from soil with aqueous solution accomplished by passing fluid through in-place soils using an injection or infiltration process. Extraction fluids must be recovered from underlying groundwater.	Technically implementable, but would require significant safety components to prevent exacerbating groundwater contamination. Regulatory concerns over potential to wash contaminants beyond fluid capture zones and introduction of surfactants in to the subsurface would make permitting difficult.	Effective for more soluble chemicals. Presence of fine-grained soils and debris limits effectiveness.	High	Moderate	High cost and uncertainty relative to other remedial technologies.	No
	Phytoremediation	Phytoextraction/Phytodegradation	Plants, called "Hyperaccumulators" (e.g. Chinese brake fern) have the capacity to extract and store large amounts of contaminants (metals, hydrocarbons etc.) from soil and use them as nutrients during metabolism. Phytoremediation typically involves interaction of plant roots and microorganisms associated with them to remediate soil.	Technically implementable. However, there has been little commercial application. Disposal of accumulated waste materials or plant materials may be necessary. Pilot testing that would be required will significantly delay implementation of full-scale remediation.	Use for Chinese brake fern for remediating soil contaminated with metals were evaluated as part of Tacoma Smelter Plume and the study concluded that phytoremediation is not a good cleanup option due to following reasons: Phytoremediating plants (Chinese brake fern) did not grow well in climatic conditions of Puget Sound, arsenic level in the fronds pose a health risk, fronds hyperacuumulated arsenic and became dangerous waste and fern did not take up lead or other metals.	Moderate	Moderate	Not applicable to all contaminants on site (e.g. lead) and to climatic conditions on site.	No
Removal	Soil Excavation and Off-Site Disposal	Excavation and Landfill	Removal of impacted soil using common excavation techniques. Disposal of impacted soil at an off-site, permitted landfill. May include treatment of contaminated soil by off-site landfill prior to disposal.	Technically implementable where accessibility allows for excavation.	Effective for all site soil contaminants.	High	Low	Commonly used established technology effective for all site soil contaminants.	Yes
	Soil Excavation, Ex Situ Treatment and Off-Site Disposal/On Site Reuse	Solidification/Stabilization (S/S)	Removal of impacted soil using common excavation techniques. Contaminants are physically bound or enclosed within a stabilized mass using cementitious reagents (cement, lime, etc.) or surface adsorption/chemical reagents.	Requires sufficient space on site to set up temporary treatment plant and treat/process excavated material prior to disposal. S/S processes result in significant increase in volume requiring disposal. Additionally S/S processes increases density which increases disposal costs.	Stabilization is a common and effective technology for reducing the leachability of metals in soil.	High	Low	Requires sufficient space on site to set up ex-situ treatment. High capital cost and does not provide specific advantage over in situ S/S.	No
		Soil Washing	Removal of impacted soil using common excavation techniques. Wash soil with water-based surfactants, detergents, acids, etc., to remove chemicals from soil particles. Treat or dispose of high chemical concentration residuals fluids.	Technically implementable. Require sufficient space on site to set up temporary treatment plant and treat/process excavated material prior to disposal/reuse. Require treatment of residual fluids.	Effective for more soluble chemicals. Presence of fine-grained soils and debris limits effectiveness.	High	Moderate	High cost and uncertainty relative to other remedial technologies.	No

Table 8

Groundwater Remedial Technologies Screening

Everett Smelter Site - Lowland Area

Everett, Washington

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
Monitoring	Groundwater Monitoring	Performance and/or Compliance Monitoring of Groundwater Quality	Monitoring to assure compliance with cleanup standards to assess performance of other remedial technologies during operation and/or to measure continued effectiveness over time.	Technically implementable. Existing monitoring wells may be used and new wells may be added to monitor completed remedial actions.	Effective for assessing groundwater concentrations and conditions, and contaminant attenuation processes and plume migration at the site. Not effective for remediating contaminants.	Low	Low to Moderate	Applicable in combination with other technologies.	Yes
Institutional Controls (ICs)	Governmental/ Property Controls	Environmental Covenants	Legal restrictions associated with future land use and activities (e.g., development, construction, etc.); may also be used to specify long-term maintenance requirements of remediation systems.	Technically implementable. Specific legal requirements and authority would need to be met.	Not effective for remediating contaminants. Can be effective at reducing risks and maintaining integrity of a remedy.	Low	Low	Applicable and/or required in combination with other technologies.	Yes
		Groundwater Use Restrictions, Groundwater Management Plan Requirements	Restrictions on groundwater extraction and use and/or exposure of humans and environment to hazardous substances present in groundwater. Implement groundwater management plans/requirements so that contaminated groundwater is managed properly in an event that it is necessary to remove groundwater (e.g., utility work, etc.)	Technically implementable but administratively more difficult. Requires an implementing agency.	Not effective for remediating contaminants. Enforcement would be required for restrictions to be effective.	Low	Low	Applicable and/or required in combination with other technologies.	Yes
Natural Attenuation	Monitored Natural Attenuation (MNA)	Monitor natural processes occurring in site groundwater	Monitoring of naturally occurring physical, chemical and biological processes that reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. Involves monitoring over time to confirm that natural processes are occurring to reduce risk associated with contaminant concentrations. A contingency plan is needed if the expected processes do not occur.	Technically implementable but requires significant site characterization, long-term monitoring and institutional controls . Cleanup time frame longer than other remedial technologies. Source to groundwater generally requires treatment such as removal, containment or stabilization.	Factors affecting effectiveness include removal/containment/stabilization of source and stability of end-products.	Low	Low	Applicable in combination with other technologies.	Yes
	Enhanced Natural Attenuation (ENA)	Manipulating geochemical parameters such as pH, ORP, alkalinity and/or oxidation state to alter natural precipitation/absorption processes.	Enhanced Natural Attenuation (ENA) is the use of low-energy, long-acting (sustainable) technologies to augment the natural attenuation processes, essentially bridging the gap between high-energy, short-term remedial alternatives and MNA. Oxygen releasing material (additive) is injected into ground to increase ORP (oxidation reduction potential) to oxidize As III to As V. As V is more stable (less mobile) species of As. Enhanced attenuation is based on a mass balance between contaminant loading into the system and the attenuation capacity of the system that will result in contaminants meeting the remediation goals for the system.	Technically implementable but requires significant site characterization, long-term monitoring and institutional controls. Cleanup time frame longer than other remedial technologies but shorter compared to MNA. Source to groundwater generally requires treatment such as removal, containment or stabilization.	Not anticipated to be effective over long term because additive injected into ground to alter geochemical parameters of groundwater can be consumed over time. Pre-treatment groundwater geochemical parameters may return after the additives are consumed which may re-release contaminants that were stabilized. May not be effective on metals such as lead.	Moderate	Low to Moderate	Pre-treatment groundwater geochemical parameters may return after the additives are consumed which may re-release contaminants that are stabilized. May not be effective on metals such as lead. Not a permanent solution.	No
Containment	Low-Permeability Physical Vertical Barriers	Vertical barriers using slurry wall and/or sheet piles	Placement of vertical, low-permeability barriers to isolate contaminated source area soil from groundwater flow path thereby preventing/minimizing contaminant migration via groundwater flow.	Technically implementable. Buried debris or subsurface obstructions such as foundations/utilities may interfere and would require prior removal. Vertical barriers need to be keyed into aquitard so that underflow is prevented/minimized.	Established technology effective for reducing mobility of contaminants. However, does not provide treatment of contaminants. Effectiveness likely to increase if implemented to encapsulate the entire source area such that upgradient groundwater flows around the source area thereby minimizing contaminant mobility.	Moderate	Moderate	Applicable for site conditions and contaminants.	Yes

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
In situ Treatment	Hydraulic Groundwater Barrier	Groundwater Pumping	Groundwater pumping to establish a hydraulic capture zone and restrict groundwater flow and contaminant migration in the downgradient direction. May be used in conjunction with a physical barrier to achieve full containment.	Technically implementable using standard groundwater extraction methods. The need to treat extracted groundwater to acceptable levels to allow discharge will reduce the implementability.	Potentially effective for hydraulic control of impacted groundwater. May be implemented to increase effectiveness of physical barrier technologies. Requires continuous long-term operation to achieve effective containment and maintenance of treatment components to prevent discharge of contaminated groundwater.	Moderate	High	Potentially applicable in combination with other technologies, but at high cost. Not expected to be cost effective if applied as sole containment method.	No
	Permeable Reactive Barrier (PRB)	Reactive media used are chemical reagent such as zero valent iron (ZVI) or combination of ZVI, iron sulfide, iron oxide and/or calcium carbonate (pH adjusting agent).	PRBs are walls containing reactive media that are installed across the path of contaminated groundwater flow to intercept and treat contaminated groundwater. The barrier allows water to pass through while the media remove the contaminants by precipitation, degradation, adsorption, or ion exchange. PRB wall can be installed by excavating a trench (continuous or funnel/gate) or by injection method.	Technically implementable. Buried debris and pilings would require removal before barrier installation. PRBs are best applied to depths less than 40 ft and unconfined aquifers in unconsolidated deposits. PRB's are difficult to install at depths greater than 70 ft.	PRBs have limited life and may require replacement if treatment time frame exceeds barrier life. Chemical precipitation and biological activity may decrease permeability of PRBs. Additionally, PRBs can only be effective as part of the remedy and requires source control (source removal/isolation/containment, or other in situ treatment) to address the source.	Moderate	Moderate	Applicable in combination with other technologies.	Yes
	Electrokinetics Remediation (ER)	Chemicals used in electrokinetic process to treat arsenic include sulfuric acid, phosphoric acid and oxalic acid.	ER includes passing a low density current between electrodes to mobilize contaminants through soil and water in form of charged species. Positively-charged metal or metalloid cations migrate to the negatively-charged electrode (cathode), while metal or metalloid anions migrate to the positively charged electrode (anode). Contaminants arriving at the electrodes can be removed by means of electroplating/electrodeposition, precipitation/coprecipitation, adsorption, complexing with ion exchange resins, or by pumping of water (or other fluid) near the electrode.	Difficult implementability. ER is an emerging technology with relatively few applications for arsenic treatment.	Effectiveness may be limited by a variety of contaminants and soil and water characteristics. Treatment depth is limited by the depth to which the electrodes can be placed. ER is most applicable to saturated soil and soil with small particle sizes, such as clay.	High	High	Emerging technologies with limited case studies. Difficult Implementability. High capital and O&M cost.	No

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
Ex-Situ Treatment	Pump and Treat	Precipitation/coprecipitation	Extracted groundwater is treated by either mixing treatment chemicals into groundwater or by passing extracted groundwater through a fixed bed of media (e.g. ferric salts, alum) to form solid matrix through precipitation/coprecipitation. Usually involves pretreatment of pH adjustment and addition of chemical oxidant to create oxidizing environment to increase effectiveness. The precipitated/coprecipitated solid is then removed from the liquid phase by clarification or filtration.	Technically implementable. Long treatment time frame. Permitting may be required for discharge of treated water. May need to be combined with pre- and post-treatment steps. Treatment byproducts (e.g., settled solids) require management. Systems using this technology generally require skilled operators.	The effectiveness of this technology is less likely to be reduced by characteristics and contaminants other than arsenic, compared to other pump and treat water treatment technologies. It is also capable of treating heavy metals.	High	High	Potential physical constraints in relation to future site use. The wide spread nature of the groundwater contamination source at the site (i.e. Area A1, A2, B1, B2 and B3), makes actively pumping and treating groundwater expensive and timeframe for running an active system uncertain if source to groundwater contamination is left in-place.	No
		Adsorption	Extracted groundwater is treated by passing extracted groundwater through a fixed bed of adsorption media (e.g. activated alumina, activated carbon). As contaminated water is passed through the adsorption media, contaminants are adsorbed. When adsorption sites become filled, the column must be regenerated or disposed of and replaced with new media. Like precipitation/coprecipitation, this technology requires pretreatment of pH adjustment and addition of chemical oxidant to create oxidizing environment to increase effectiveness.	Technically implementable. Long treatment time frame. Permitting may be required for discharge of treated water. May need to be combined with pre- and post-treatment steps. Treatment byproducts (e.g., spent carbon) require management. Systems using this technology generally require skilled operators.	Effectiveness of adsorption treatment process is sensitive to a variety of untreated water contaminants and characteristics. Competition for adsorption sites could reduce the effectiveness of adsorption because other constituents may be preferentially adsorbed, resulting in a need for more frequent bed regeneration or replacement. It is used less frequently than precipitation/coprecipitation, and is most commonly used as a polishing step for other water treatment processes.	High	High	Less effective in treating arsenic as compared to pump and treat with precipitation/coprecipitation. The wide spread nature of the groundwater contamination source at the site (i.e. Area A1, A2, B1, B2 and B3), makes actively pumping and treating groundwater expensive and timeframe for running an active system uncertain if source to groundwater contamination is left in-place.	No

Table 9

Sediment (Snohomish River) Remedial Technology Screening

Everett Smelter Site - Lowland Area
Everett, Washington

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
Institutional Controls	Governmental/Property Controls	Environmental Covenants	Legal restrictions associated with future land use and activities (e.g., development, construction, etc.); may also be used to specify long-term maintenance requirements of remediation systems.	Technically implementable. Specific legal requirements and authority would need to be met.	Not effective for remediating contaminants. Can be effective at reducing risks and maintaining integrity of a remedy.	Low	Low	Applicable in combination with other technologies.	Yes
		Area Use Restrictions, Sediment Management Plan Requirements	Restrictions on activities such as dredging, boat anchoring, navigation or other activities to prevent physical damage to in situ remedies.	Technically implementable but administratively more difficult. Requires an implementing agency.	Not effective for remediating contaminants. Enforcement would be required for restrictions to be effective.	Low	Low	Some restrictions (i.e., dredging, anchoring, etc.) are potentially applicable in combination with other technologies.	Yes
	Access Restrictions and Information Devices	Fencing and Warning Signage	Placement of fencing and warning signs to prevent access and inform the public regarding health risks.	Complicated to implement and maintain in marine/river environment.	Not effective for remediating contaminants. Enforcement would be required for restrictions to be effective.	Low	Low	Fencing not applicable in the river/marine environment and based on current/future land use.	No
Natural Recovery	Sedimentation/ Deposition	Monitored Natural Recovery (MNR)	Reduction of toxicity and bioavailability of contaminants through natural deposition of clean sediment, physical and biological mixing and biodegradation. Monitoring in the form of periodic sediment sampling is performed to verify natural recovery occurs within a reasonable time frame.	Technically implementable. Monitoring would be required to confirm recovery rate.	The Site is located adjacent to the Snohomish River delta and therefore, depositional conditions are expected to occur. Effectiveness limited to areas of low contaminant concentrations/low risk and high sedimentation rates of clean sediment. Long-term risk reduction occurs incrementally over a 10-year period.	Negligible	Moderate	Common method for low-level sediment contaminants. Has been used throughout Puget Sound. Applicable in combination with source (outfall-water) control.	Yes
		Enhanced Natural Recovery (ENR)	Natural sedimentation is enhanced by placement of a thin layer of clean sand. Technology relies on natural mixing processes (e.g., bioturbation) to reduce contaminant levels over time. Similar to MNR, monitoring is performed to confirm performance and rate of recovery.	Technically implementable. Monitoring would be required to confirm recovery rate.	Initial placement of sediment typically equivalent to thickness of biologically active zone (i.e. 10 cm), effectively reducing risks in the short-term. Some movement/mixing is expected over time that achieves long-term reduction in surface sediment concentrations. Not effective in areas where sediment may be eroded or mobilized via currents, vessel activity or other physical means.	Moderate	Moderate	Common method for low-level sediment contaminants. Has been used throughout Puget Sound. Applicable in combination with source (stormwater outfall) control.	Yes
Capping	Conventional Cap	Placement of Sand Cap on Top of Contaminated Sediment	Installation of clean sand cap over contaminated sediment to prevent exposure and isolate contaminants. Armoring is used to prevent erosion and ensure cap longevity. Cap must be designed to withstand erosive forces generated by tidal and wave action and must be thick enough to provide the required isolation of the material contained by the cap.	Technically implementable. Aquatic caps have been successfully constructed in multiple Puget Sound locations. At the site, it may be difficult to place a cap without altering habitat and requiring mitigation.	Effective for preventing direct contact exposure and for containing contaminated sediment. Aquatic caps are designed using methods developed by the U.S. Army Corps of Engineers.	Moderate to High	Low	Course material used to provide erosion protection to cap are different from native soft bottom material which may alter the habitat and require mitigation.	No
Removal	Dredging/Excavation of Sediment and Off-Site Upland Disposal	Dredging/Excavation and Landfilling	Dredging/excavation of contaminated sediment using land-based and/or water-based methods, as applicable. Land-based removal would include use of land-based excavation equipment and transport vehicles (ex. dump trucks) operated from the shoreline during low tides when the work area is exposed. Water-based removal would include use of a barge-mounted clamshell dredge and a material barge for dredge sediment transport to an upland off-load facility. Dredged/excavated sediment would be transported and disposed of at a permitted, off-site upland landfill.	Technically implementable. Dredging is commonly used in the marine environment to remove contaminated sediment. Contaminated sediment must be profiled to verify that the materials meet land disposal restrictions.	Effective for range of contaminant groups. However, dredging in conjunction with capping may be required where the contaminated sediment cannot be completely removed due to access issues or where a cap is to be placed without changing the surface elevation.	High	Low	Common removal and disposal method for contaminated sediment. Applicable in combination with source (outfall-water) control.	Yes

Remedial Technology Identification			Description	Implementability	Effectiveness	Relative Cost		Summary of Screening	Technology Retained?
Category	Type	Option				Capital	O&M		
Removal	Dredging/Excavation of Sediment and Off-Site Open-water Disposal	Dredging/Excavation, Transport With Bottom-Dump Barge, and Disposal at Open-water Disposal Site	Dredging of contaminated sediment using common dredging methods. Removal of sediment performed from the water using barge-mounted clamshell dredge and a bottom-dump barge for dredge sediment transport and disposal. Sediment targeted for open-water disposal would require a suitability determination from the Dredged Material Management Program (DMMP).	Technically implementable. Impacted sediment must be profiled to verify that the materials meet DMMP suitability criteria. Dredging is commonly used in the marine environment to remove contaminated sediment.	Effective for removal and disposal of sediment with low contaminant concentrations and limited or no debris. Approval for open-water disposal expected to be difficult for contaminated sediment at Site.	Moderate	Low	Sediment at the site are contaminated and therefore, approval for open water disposal not likely to be approved.	No
In Situ Sediment Treatment	Chemical Treatment	Amendment Mixing	Amendments are mixed in situ with contaminated sediment rather than being placed as a cap to reduce the bioavailability of metals through adsorption, ion exchange and precipitation. Amendments used to treat metals include bauxite or phosphate additives (such as apatite).	Technically implementable. Equipment such as rototiller, back-hoe mounted on barge are used for sediment mixing.	Effective in sequestering metals such as arsenic, mercury, lead, etc. through a combination of adsorption, ion exchange and precipitation. However, this is an emerging technology with no full-scale applications.	Moderate	Moderate	Effective is treating site contaminants; however, this is an emerging technology with only bench- or pilot-scale studies. There have been no full-scale applications.	No

Table 10

Summary of Retained Remedial Technologies

Everett Smelter Site - Lowland Area

Everett, Washington

Category	Type	Identification Symbol and Abbreviation	Applicable Area														
			A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6[1]	D1	D2	D3	D4
Soil/Slag/Debris and Sediment in Lowland Area Surface Water Features																	
Institutional Controls	Governmental/property controls including environmental covenants, land use restrictions and soil management plans/requirements	ICS	X	X	X	X	X		X	X	X	X					
	Access restrictions and information devices consisting of fencing and warning signage[1]	FEN							X	X							
Capping	Low-permeability cap consisting of asphalt/concrete pavement with drainage controls	CAP	X	X	X	X				X							
	Low-permeability cap with drainage controls consisting a minimum of 1-foot of clean soil cover with underlying low-permeability barrier (i.e. plastic or similar)	1FT			X	X					X						
	Permeable cap consisting of a minimum of 6-feet of clean soil cover	6FT					X					X					
In Situ Treatment	In situ solidification/stabilization (S/S) using cementitious (cement, lime, etc.) or chemical (zero valent iron [ZVI] or combination of ZVI, iron sulfide, iron oxide and/or calcium carbonate [pH adjusting agent]) reagents	ISS	X	X	X	X	X				X	X					
Removal	Soil excavation and off-site disposal. May include soil treatment at an off-site permitted disposal facility prior to disposal.	EXC	X	X	X	X	X		X	X	X	X					
Groundwater																	
Monitoring	Performance and/or compliance monitoring of groundwater quality	GWM	X	X	X	X	X	X					X				
Institutional Controls	Governmental/property controls including environmental covenants, groundwater use restrictions and groundwater management plans/requirements	ICS	X	X	X	X	X	X					X				
Natural Attenuation	Monitored natural attenuation of groundwater	GNA				X	X	X					X				
Containment	Low-permeability physical vertical barrier using slurry wall and/or sheet piles	CON	X	X		X											
In Situ Treatment	Permeable reactive barriers (PRBs) with reactive media consisting of chemical reagents (zero valent iron [ZVI] or combination of ZVI, iron sulfide, iron oxide and/or calcium carbonate [pH adjusting agent])	PRB				X		X									
Surface Water in the Lowland Area																	
Surface Water Monitoring	Performance and/or compliance monitoring of surface water quality	SWM			X												
Removal	Removal of contaminated surface water (dewatering), on site temporary storage in portable above-ground storage tanks and treatment (if necessary), and permitted disposal/discharge	DWT			X												

Category	Type	Identification Symbol and Abbreviation	Applicable Area													
			A1	A2	B1	B2	B3	C1	C2	C3	C4	C5	C6[1]	D1	D2	D3	D4
Outfall-Water																	
Outfall-Water Monitoring	Performance and/or compliance monitoring of outfall water quality	OWM												X	X	X	
Repairs to Stormwater Conveyance System	Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants to the outfall at area D2	SWR				X											
	Cut and cap (or backfill with grout slurry) underdrains that are potentially responsible for transport of contaminants to the outfall at area D3	CUT										X					
Seep-Water																	
Seep-water Monitoring	Performance and/or compliance monitoring of seep-water quality	SPM															X
Sediment on the Snohomish River Shoreline																	
Institutional Controls	Governmental/property controls including environmental covenants, use restrictions and sediment management plans/requirements	ICS												X	X	X	
Natural Recovery	Monitored natural recovery (MNR) of sediment	MNA												X	X	X	
	Enhanced natural recovery (ENR) of sediment	ENA												X	X	X	
Removal	Dredging/excavation of sediment and off-site upland disposal	DRE												X	X	X	

Notes:

[1] Fencing/warning signage is not applicable to sediment of the Lowland Area since it does not address applicable exposure/transport pathways and is not consistent with future use of the property.

Table 11
Summary of Area Remedial Alternatives
Everett Smelter Site - Lowland Area
Everett, Washington

Area Group[1]	Contaminated Media Present in the Lowland Area			Soil and Slag/Debris (S, S/D)	Shallow Groundwater (SG)	Deep Groundwater (DG)	Surface Water in the Lowland Area (SW)	Outfall-Water at Snohomish River Shoreline (O)	Seep-Water at Snohomish River Shoreline (SP)	Sediment (SE)		Summary of Remedial Technologies Considered as Part of the Area Remedial Alternative
										In the Lowland Area	On Snohomish River Shoreline	
	Area ID[1]	Applicable CAOs[2]	Area Remedial Alternative ID	Remedial Technology[3] or Technologies considered for each Applicable Contaminated Media as part of the Area Remedial Alternative								
A	A1	1 and 2	A1-ALT-1:	CAP, ICS	CON, GWM, ICS	CON, GWM, ICS	NA	NA	NA	NA	NA	CAP, CON, GWM, ICS
			A1-ALT-2:	ISS, ICS	GWM, ICS	GWM, ICS	NA	NA	NA	NA	NA	ISS, GWM, ICS
			A1-ALT-3:	EXC	GWM	GWM	NA	NA	NA	NA	NA	EXC, GWM
	A2	1, 2 and 4	A2-ALT-1:	CAP, ICS	CON, GWM, ICS	NA	NA	NA	NA	NA	NA	CAP, CON, GWM, ICS
			A2-ALT-2:	ISS, ICS	GWM, ICS	NA	NA	NA	NA	NA	NA	ISS, GWM, ICS
			A2-ALT-3:	EXC	GWM	NA	NA	NA	NA	NA	NA	EXC, GWM
B	B1	1, 2, 3, 7 and 8	B1-ALT-1:[4]	CAP, 1FT, ICS	GWM, ICS	GWM, ICS	DWT	See Note 5	NA	CAP, 1FT, ICS	NA	CAP, 1FT, DWT, GWM, ICS
			B1-ALT-2:[4]	ISS, CAP, ICS	GWM, ICS	GWM, ICS	DWT	See Note 5	NA	ISS, ICS	NA	ISS, CAP, DWT, GWM, ICS
			B1-ALT-3:[4]	EXC, CAP, ICS	GWM	GWM	DWT, SWM	See Note 5	NA	EXC	NA	EXC, CAP, DWT, GWM, SWM, ICS
	B2	1, 2, 4, 5, 6 and 8	B2-ALT-1:[4,6]	CAP, 1FT, ICS	PRB, GWM, ICS	GNA, GWM, ICS	NA	SWR	See Note 7	NA	NA	CAP, 1FT, PRB, GNA, GWM, SWR, ICS
			B2-ALT-2:[4,6]	ISS, ICS	GWM, CON, ICS	GNA, GWM, ICS	NA	SWR	See Note 7	NA	NA	ISS, CON, GNA, GWM, SWR, ICS
			B2-ALT-3:[4,6]	EXC, ICS	GWM, CON, ICS	GNA, GWM, ICS	NA	See Note 5	See Note 7	NA	NA	EXC, CON, GNA, GWM, ICS

Area Group[1]	Contaminated Media Present in the Lowland Area			Soil and Slag/Debris (S, S/D)	Shallow Groundwater (SG)	Deep Groundwater (DG)	Surface Water in the Lowland Area (SW)	Outfall-Water at Snohomish River Shoreline (O)	Seep-Water at Snohomish River Shoreline (SP)	Sediment		Summary of Remedial Technologies Considered as Part of the Area Remedial Alternative
										In the Lowland Area (SE)	On Snohomish River Shoreline	
	Area ID[1]	Applicable CAOs[2]	Area Remedial Alternative ID	Remedial Technology[3] or Technologies considered for each Applicable Contaminated Media as part of the Area Remedial Alternative								
B	B3	1 and 2	B3-ALT-1:	6FT, ICS	GWM, GNA, ICS	NA	NA	NA	NA	NA	NA	6FT, GNA, GWM, ICS
			B3-ALT-2:	ISS, ICS	GWM, ICS	NA	NA	NA	NA	NA	NA	ISS, GWM, ICS
			B3-ALT-3:	EXC	GWM	NA	NA	NA	NA	NA	NA	EXC, GWM
C	C1	6	C1-ALT-1:	NA	NA	GNA, GWM, ICS	NA	NA	NA	NA	NA	GNA, GWM, ICS
			C1-ALT-2:	NA	NA	PRB, GWM, ICS	NA	NA	NA	NA	NA	PRB, GWM, ICS
	C2	1 and 2	C2-ALT-1:	FEN, ICS	NA	NA	NA	NA	NA	NA	NA	FEN, ICS
			C2-ALT-2:	EXC	NA	NA	NA	NA	NA	NA	NA	EXC
	C3	1 and 2	C3-ALT-1:	FEN, ICS	NA	NA	NA	NA	NA	NA	NA	FEN, ICS
			C3-ALT-2:	EXC, CAP, ICS	NA	NA	NA	NA	NA	NA	NA	EXC, CAP, ICS
	C4	1, 2 and 8	C4-ALT-1:	1FT, ICS	NA	NA	NA	NA	NA	NA	NA	1FT, ICS
			C4-ALT-2:	ISS, ICS	NA	NA	NA	NA	NA	NA	NA	ISS, ICS
			C4-ALT-3:	EXC	NA	NA	NA	NA	NA	NA	NA	EXC
	C5	1 and 8	C5-ALT-1:[4]	6FT, ICS	NA	NA	NA	CUT	NA	NA	NA	6FT, CUT, ICS
			C5-ALT-2:[4]	ISS, ICS	NA	NA	NA	CUT	NA	NA	NA	ISS, CUT, ICS
			C5-ALT-3:[4]	EXC	NA	NA	NA	See Note 5	NA	NA	NA	EXC
	C6	NA[8]	C6-ALT-1:	NA	NA	GNA, GWM, ICS	NA	NA	NA	NA	NA	GNA, GWM, ICS

Area Group[1]	Contaminated Media Present in the Lowland Area			Soil and Slag/Debris (S, S/D)	Shallow Groundwater (SG)	Deep Groundwater (DG)	Surface Water in the Lowland Area (SW)	Outfall-Water at Snohomish River Shoreline (O)	Seep-Water at Snohomish River Shoreline (SP)	Sediment		Summary of Remedial Technologies Considered as Part of the Area Remedial Alternative
										In the Lowland Area (SE)	On Snohomish River Shoreline	
	Area ID[1]	Applicable CAOs[2]	Area Remedial Alternative ID	Remedial Technology[3] or Technologies considered for each Applicable Contaminated Media as part of the Area Remedial Alternative								
D	D1, D2 and D3	9, 10 and 11	D1-ALT-1: D2-ALT-1: D3-ALT-1:	NA	NA	NA	NA	OWM [9]	NA	NA	MNR, ICS	MNR, OWM, ICS
			D1-ALT-2: D2-ALT-2: D3-ALT-2:	NA	NA	NA	NA	OWM [9]	NA	NA	ENR, ICS	ENR, OWM, ICS
			D1-ALT-3: D2-ALT-3: D3-ALT-3:	NA	NA	NA	NA	OWM [9]	NA	NA	DRE	DRE, OWM
	D4	12	D4-ALT-1:	NA	NA	NA	NA	NA	SPM, ICS [10]	NA	NA	SPM, ICS

Notes:

[1] Descriptions of area groups and approximate location of each area are shown on Figure 1.

[2] CAOs are presented in Table 6.

[3] Descriptions of remedial technologies symbols/abbreviations are provided in Table 10.

[4] Areas B1, B2 and C5 are sources to outfall-water contamination at areas D1, D2 and D3 respectively. Therefore area remedial alternatives for these areas (i.e., B1, B2 and C5) are developed to address contaminated outfall-water in addition to the identified applicable contaminated media.

[5] Remedial technologies considered for soil, slag/debris, sediment (in the Lowland Area) and/or surface water address sources to outfall-water contamination.

[6] Area B2 is a source to seep-water contamination at area D4. Therefore area remedial alternatives for area B2 are developed to address contaminated seep-water in addition to identified applicable contaminated media.

[7] Remedial technologies considered for shallow groundwater address source to seep-water contamination.

[8] The SRI Report does not indicate presence of any contaminant exposure and transport pathways for area C6 since the only contaminated media present at area C6 is deep groundwater and this deep groundwater contamination is observed to be localized and is not migrating downgradient. Therefore there are no CAOs for area C6.

[9] The sources to outfall-water contamination at areas D1, D2 and D3 are addressed by remedial alternatives developed for areas B1, B2 and C5, respectively.

[10] The source to seep-water contamination is addressed by remedial alternatives developed for areas B2.

Table 12

Description of Area A1 Remedial Alternative

Everett Smelter Site - Lowland Area

Everett, Washington

Area A1 Remedial Alternative		
A1-ALT-1	**A1-ALT-2**	**A1-ALT-3**
■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate installation of containment wall.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities; demolish existing surfaces including asphalt/concrete surfaces of streets and sidewalks; and install temporary shoring as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities; demolish existing surfaces including asphalt/concrete surfaces of streets and sidewalks; and install temporary shoring as necessary to facilitate excavation of contaminated material.
■ Install vertical containment wall (sheet pile and/or slurry wall) along the entire perimeter of the area to contain/isolate contaminated material from groundwater flow. Slurry wall will be used in the portions where sheet pile wall cannot be installed due to underground obstructions such as utility corridors. Construction of slurry wall will consist of trenching and permitted off-site disposal of the volume generated due to trenching, as necessary.	■ Perform in situ S/S of contaminated material. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required.	■ Excavate contaminated material and dispose at a permitted off-site disposal facility.
■ Maintain existing asphalt/concrete surfaces of streets and sidewalks where possible, replace asphalt/concrete surfaces removed to install containment wall and construct asphalt/concrete cap (with appropriate drainage controls) over the portions of the area that currently do not have a low-permeability surface cap.	■ Restore disturbed surfaces.	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of excavation water.
■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
■ Complete 1-year of post-construction shallow and deep groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Complete 1-year of post-construction shallow and deep groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Backfill and restore excavated/disturbed surfaces.
■ Perform long-term cap monitoring.		■ Complete 1-year of post-construction shallow and deep groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.

Table 13

Description of Area A2 Remedial Alternative

Everett Smelter Site - Lowland Area

Everett, Washington

Area A2 Remedial Alternative		
A2-ALT-1	**A2-ALT-2**	**A2-ALT-3**
■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate installation of containment wall.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate excavation of contaminated material.
■ Install vertical containment wall (sheet pile and/or slurry wall) along the entire perimeter of the area to contain/isolate contaminated material from groundwater flow. Slurry wall will be used in the portions where sheet pile wall cannot be installed due to underground obstructions such as utility corridors. Construction of slurry wall will consist of trenching and permitted off-site disposal of the volume generated due to trenching, as necessary.	■ Perform in situ S/S of contaminated material. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required.	■ Excavate contaminated material and dispose at a permitted off-site disposal facility.
■ Construct asphalt/concrete cap (with appropriate drainage controls) over the entire area.	■ Restore disturbed surfaces.	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of excavation water.
■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Backfill and restore excavated/disturbed surfaces.
■ Perform long-term cap monitoring.		■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.

Table 14

Description of Area B1 Remedial Alternative

Everett Smelter Site - Lowland Area

Everett, Washington

Area B1 Remedial Alternative		
B1-ALT-1	**B1-ALT-2**	**B1-ALT-3**
■ Maintain existing clean soil cover and asphalt/concrete surfaces of streets and sidewalks. Construct a low-permeability cap with drainage controls (asphalt/concrete cap and/or a minimum of 1-foot of soil cover with underlying plastic or similar) over the portions that contain contaminated material (including sediment of the surface water features) and currently do not have this kind of protective capping/cover.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities; demolish existing asphalt/concrete surfaces of streets and sidewalks; and install temporary shoring as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material. Existing asphalt/concrete surfaces of the Pacific Highway (Highway 529) will be maintained and limited quantity of contaminated material located underneath this highway will be left in-place.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities; demolish existing asphalt/concrete surfaces of streets and sidewalks; and install temporary shoring as necessary to facilitate excavation of contaminated material. Existing asphalt/concrete surfaces of the Pacific Highway (Highway 529) will be maintained and limited quantity of contaminated material located underneath this highway will be left in-place.
■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of surface water prior to capping.	■ Excavate overburden material as necessary to access contaminated material for in situ S/S. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.	■ Excavate overburden material as necessary to access contaminated material for removal. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.
■ Mitigate loss of surface water feature at an off-site location as per the requirements of project permits.	■ Perform in situ S/S of contaminated material including sediment of the surface water features. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required.	■ Excavate contaminated material (including sediment of the surface water features) and dispose at a permitted off-site disposal facility.
■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of surface water prior to in situ S/S.	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of surface water prior to excavation.
■ Complete 10-years of post-construction shallow and deep groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Mitigate loss of surface water feature at an off-site location as per the requirements of the project permit.	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of excavation water.
■ Perform long-term cap monitoring.	■ Restore disturbed surfaces.	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Backfill and restore excavated/disturbed surfaces. Restore surface water features on site following excavation as per the requirements of project permits.
	■ Complete 1-year of post-construction shallow and deep groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).
	■ Perform long-term cap monitoring of the Pacific Highway.	■ Complete 1-year of post-construction shallow and deep groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.
		■ Complete 1-year of post-construction surface water monitoring from the restored surface water features to evaluate performance of the remedy and compliance with the cleanup standards.
		■ Complete 5-years of post-construction performance monitoring of restored surface water features in accordance with the project permits (i.e., restoration monitoring).
		■ Perform long-term cap monitoring of the Pacific Highway.

Table 15

Description of Area B2 Remedial Alternative

Everett Smelter Site - Lowland Area

Everett, Washington

Area B2 Remedial Alternative		
B2-ALT-1	**B2-ALT-2**	**B2-ALT-3**
■ Maintain existing clean soil cover and asphalt/concrete surfaces of streets, parking lot and sidewalks. Construct a low-permeability cap with drainage controls (asphalt/concrete cap and/or a minimum of 1-foot of soil cover with underlying plastic or similar) over the portions that contain contaminated material and currently do not have this kind of protective capping/cover.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities and demolish existing asphalt/concrete surfaces of streets and sidewalks as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities and demolish existing asphalt/concrete surfaces of streets and sidewalks as necessary to facilitate excavation of contaminated material.
■ Construct a permeable reactive barrier (PRB) along the shoreline of Area B2 to intercept and treat shallow groundwater contamination. The specific design components of the PRB will be determined as part of the engineering design process if considered as part of the preferred site-wide remedial alternative. A design life of 10 years is assumed for the FS.	■ Protect the existing building in-place. Contain/isolate contaminated material located underneath the building from groundwater flow by installing a vertical containment wall (sheet pile and/or slurry wall) along the entire perimeter of the building. Slurry wall will be used in the portions where sheet pile wall cannot be installed due to underground obstructions such as utility corridors. Construction of slurry wall will consist of trenching and permitted off-site disposal of the volume generated due to trenching, as necessary.	■ Protect the existing building in-place. Contain/isolate contaminated material located underneath the building from groundwater flow by installing a vertical containment wall (sheet pile and/or slurry wall) along the entire perimeter of the building. Slurry wall will be used in the portions where sheet pile wall cannot be installed due to underground obstructions such as utility corridors. Construction of slurry wall will consist of trenching and permitted off-site disposal of the volume generated due to trenching, as necessary.
■ Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2.	■ Excavate overburden material as necessary to access contaminated material for in situ S/S. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.	■ Excavate overburden material as necessary to access contaminated material for removal. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.
■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Perform in situ S/S of contaminated material located outside the limits of the existing building. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required.	■ Excavate contaminated material located outside the limits of existing building and dispose at a permitted off-site disposal facility.
■ Complete 10-years of post-construction shallow groundwater monitoring upgradient, within and downgradient of the PRB to evaluate performance of the PRB both in terms of performance objectives and overall compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2.	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of excavation water.
■ Complete 10-years of post-construction deep groundwater monitoring downgradient of the Area/PRB and in the vicinity of the existing well LLMW-07D (the only location within Area B2 where deep groundwater contamination has been observed) to evaluate performance of the remedy/natural attenuation processes and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Restore disturbed surfaces.	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
■ Perform long-term cap monitoring.	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Backfill and restore excavated/disturbed surfaces.
	■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).
	■ Complete 10-years of post-construction deep groundwater monitoring downgradient of the area and in the vicinity of the existing well LLMW-07D (the only location within Area B2 where deep groundwater contamination has been observed) to evaluate performance of the remedy/natural attenuation processes and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.
	■ Perform long-term cap monitoring for the surfaces of the existing building.	■ Complete 10-years of post-construction deep groundwater monitoring downgradient of the area and in the vicinity of the existing well LLMW-07D (the only location within Area B2 where deep groundwater contamination has been observed) to evaluate performance of the remedy/natural attenuation processes and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.
		■ Perform long-term cap monitoring for the surfaces of the existing building.

Table 16

Description of Area B3 Remedial Alternative

Everett Smelter Site - Lowland Area

Everett, Washington

Area B3 Remedial Alternative		
B3-ALT-1	**B3-ALT-2**	**B3-ALT-3**
■ Maintain the existing 6-feet of clean soil cover that isolates soil contamination.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities and demolish existing asphalt/concrete surfaces of streets and sidewalks as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities and demolish existing asphalt/concrete surfaces of streets and sidewalks as necessary to facilitate excavation of contaminated material.
■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Excavate overburden material as necessary to access contaminated material for in situ S/S. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.	■ Excavate overburden material as necessary to access contaminated material for removal. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.
■ Complete 10-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy/groundwater natural attenuation processes. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Perform in situ S/S of contaminated material. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required.	■ Excavate contaminated material and dispose at a permitted off-site disposal facility.
■ Perform long-term cap monitoring.	■ Restore disturbed surfaces.	■ Perform dewatering, storage and treatment (if necessary) and permitted disposal of excavation water.
	■ Implement institutional controls (governmental/property controls – environmental covenants, land/groundwater use restrictions and soil/groundwater management plans/requirements).	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
	■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Backfill and restore excavated/disturbed surfaces.
		■ Complete 1-year of post-construction shallow groundwater monitoring downgradient of the area to evaluate performance of the remedy. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.

Table 17

Description of Area C1 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Area C1 Remedial Alternatives	
C1-ALT-1	**C1-ALT-2**
■ Complete 10-year of post-construction deep groundwater monitoring downgradient of the area to evaluate performance of groundwater natural attenuation processes and compliance with the cleanup standards after completion of remedy in Area A1. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.	■ Construct a permeable reactive barrier (PRB) along the shoreline of area C1 to intercept and treat deep groundwater contamination. The specific design components of the PRB will be determined as part of the engineering design process if considered as part of the preferred site-wide remedial alternative. A design life of 10 years is assumed for the FS.
■ Implement institutional controls (governmental/property controls – environmental covenants, groundwater use restrictions and groundwater management plans/requirements).	■ Implement institutional controls (governmental/property controls – environmental covenants, groundwater use restrictions and groundwater management plans/requirements).
	■ Complete 10-years of post-construction deep groundwater monitoring upgradient, within, downgradient and side-gradient (as necessary) of the PRB to evaluate performance of the PRB both in terms of performance objectives and overall compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring.

Table 18

Description of Areas C2 and C3 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Area C2 and C3 Remedial Alternatives	
C2-ALT-1 and C3-ALT-1	**C2-ALT-2 and C3-ALT-2**
■ Install fencing around the entire area and warning signage.	■ Maintain asphalt/concrete surfaces of surface streets (Bridge Way and the road to Snohomish County PUD Substation) and sidewalks.
■ Implement institutional controls (governmental/property controls – environmental covenants, land use restrictions and soil management plans/requirements).	■ Perform deforestation of the entire area to facilitate excavation and dispose off deforested trees at an appropriate facility.
■ Perform long-term fence monitoring and maintenance.	■ Temporarily disconnect, reroute and restore utilities as necessary to facilitate excavation of contaminated material.
	■ Excavate contaminated soil and dispose at a permitted off-site disposal facility.
	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
	■ Backfill and restore excavated/disturbed surfaces including re-vegetation/re-forestation of the entire area.

Table 19

Description of Area C4 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Area C4 Remedial Alternatives		
C4-ALT-1	**C4-ALT-2**	**C4-ALT-3**
■ Install a minimum of 1-foot of soil cover with underlying plastic or similar over the area where contamination exists.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate excavation of contaminated material.
■ Implement institutional controls (governmental/property controls – environmental covenants, land use restrictions and soil management plans/requirements).	■ Excavate overburden material as necessary to access contaminated material for in situ S/S. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.	■ Excavate overburden material as necessary to access contaminated material for removal. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.
■ Perform long-term cap monitoring.	■ Perform in situ S/S of contaminated material. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required.	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
	■ Restore disturbed surfaces.	■ Backfill and restore excavated/disturbed surfaces.
	■ Implement institutional controls (governmental/property controls – environmental covenants, land use restrictions and soil management plans/requirements).	

Table 20

Description of Area C5 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Area C5 Remedial Alternatives		
C5-ALT-1	**C5-ALT-2**	**C5-ALT-3**
■ Maintain the existing 6-feet of clean soil cover that isolates soil contamination.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate in situ solidification/stabilization (S/S) of contaminated material.	■ Protect in place and/or temporarily disconnect, reroute and restore utilities as necessary to facilitate excavation of contaminated material.
■ Cut and cap (or backfill with grout slurry) underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3.	■ Cut and cap (or backfill with grout slurry) underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3.	■ Excavate overburden material as necessary to access contaminated material for removal. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.
■ Implement institutional controls (governmental/property controls – environmental covenants, land use restrictions and soil management plans/requirements).	■ Excavate overburden material as necessary to access contaminated material for in situ S/S. Dispose off-site and/or reuse overburden on site for backfilling as appropriate.	■ Perform verification soil sampling and analysis of indicator hazardous substances (IHSs) at the limits of excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
■ Perform long-term cap monitoring.	■ Perform in situ S/S of contaminated material. In situ S/S typically results in volume increase due to addition of reagents. Therefore, permitted off-site disposal of the volume increase may be required. ■ Restore disturbed surfaces. ■ Implement institutional controls (governmental/property controls – environmental covenants, land use restrictions and soil management plans/requirements).	■ Backfill and restore excavated/disturbed surfaces.

Table 21

Description of Area C6 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Area C6 Remedial Alternatives
C6-ALT-1
■ Complete 10-years of deep groundwater monitoring at the area to evaluate performance of groundwater natural attenuation processes and compliance with the cleanup standards. Use existing wells to the extent possible and/or install new wells to complete groundwater monitoring. and compliance with the cleanup standards.
■ Implement institutional controls (governmental/property controls – environmental covenants, groundwater use restrictions and groundwater management plans/requirements).

Table 22

Description of Areas D1, D2 and D3 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Areas D1, D2 and D3 Remedial Alternatives		
D1-ALT-1, D2-ALT-1 and D3-ALT-1	**D1-ALT-2, D2-ALT-2 and D3-ALT-2**	**D1-ALT-3, D2-ALT-3 and D3-ALT-3**
■ Complete 1-year of post-construction outfall-water monitoring at the area to evaluate performance of the remedies that are implemented at other upgradient areas (Areas B1, B2 and C5) to address potential sources of outfall-water contamination.	■ Place a thin layer of clean sand (approximately 10 cm [i.e. thickness of biologically active zone]) over the area of contaminated sediment to enhance natural recovery processes.	■ Dredge/excavate contaminated sediment and dispose at a permitted off-site disposal facility. Dredging/excavation activities will not be completed deeper than 3 feet below mudline. If contamination is observed at this depth, dredge/excavation area will be capped with appropriate material to mitigate exposure.
■ Complete 10-years of post-construction sediment monitoring at the area to assess natural recovery processes by periodically sampling and analyzing surface sediment (0 to 10 cm [i.e., thickness of biologically active zone]) for the indicator hazardous substances (IHSs).	■ Complete 1-year of post-construction outfall-water monitoring at the area to evaluate performance of the remedies that are implemented at other upgradient areas (Areas B1, B2 and C5) to address potential sources of outfall-water contamination.	■ Perform verification sediment sampling and analysis of indicator hazardous substances (IHSs) at the limits of dredging/excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place.
■ Implement institutional controls (governmental/property controls – environmental covenants, area use restrictions and sediment management plans/requirements).	■ Complete 10-years of post-construction sediment monitoring at the area to assess natural recovery processes by periodically sampling and analyzing surface sediment (0 to 10 cm [i.e., thickness of biologically active zone]) for the indicator hazardous substances (IHSs).	■ Backfill and restore dredged surfaces following construction.
	■ Implement institutional controls (governmental/property controls – environmental covenants, area use restrictions and sediment management plans/requirements).	■ Complete 1-year of post-construction outfall-water monitoring at the area to evaluate performance of the remedies that are implemented at other upgradient areas to address potential sources of outfall-water contamination.

Table 23

Description of Area D4 Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Area D4 Remedial Alternatives
D4-ALT-1
■ Complete 1-year of post-construction seep-water monitoring to assess performance of the remedies implemented at the upgradient Area B2 to address source of seep-water contamination.
■ Implement institutional controls (governmental/property controls – environmental covenants and water use restrictions).

Table 24

Area A1 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		A1-ALT-1	A1-ALT-2	A1-ALT-3			A1-ALT-1	A1-ALT-2	A1-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ 23,880	$ 112,314	$ 187,634	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital cost thereafter.
2	Abandonment of Monitoring Wells	1	1	1	$5,700	LS	$ 5,700	$ 5,700	$ 5,700	Decommission monitoring wells EV-13, EV-19B and EV-20B by a Washington State licensed well driller. Assumes drill-out and/or chip-in-place monitoring wells to decommission as applicable.
3	Utility protection and/or temporary reroute and restoration	0.5	1	1	$100,000	LS	$ 50,000	$ 100,000	$ 100,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
4	Demolition, Transportation and Off-Site Disposal of Demolition Debris		1,200	1,200	$14	SY	$ -	$ 16,800	$ 16,800	Includes demolition of existing paved (asphalt/concrete) surfaces in the area to assess contaminated material.
5	Capping - Low-Permeability Cap	170			$40	SY	$ 6,800	$ -	$ -	Assumes installation of asphalt/concrete cap over the existing unpaved surfaces in the area.
6	Containment along the Perimeter of the Area - Sheet Pile or Slurry Wall	320			$450	LF	$ 144,000	$ -	$ -	Includes purchase and placement of sheet pile wall along the entire perimeter of the area with the exception of the portions where placement of sheet pile wall is not possible due to underground obstructions such as utility corridor. Slurry wall approach will be used for these portions. Assumes average depth of containment to be approximately 15 feet.
7	Containment along the Perimeter of the Area - Slurry Wall	140			$240	LF	$ 33,600	$ -	$ -	Assumes construction of slurry wall in the portions where sheet pile wall cannot be installed due to underground obstructions such as utility corridor (assumes approximately 30% of the area perimeter contains such obstructions). Assumes 3-foot wide and on an average 15-foot deep slurry wall. Cost for excavation, transportation and disposal of material excavated for slurry trench are included as part of item 9.
8	In Situ Solidification/Stabilization (S/S)		6,800		$100	CY	$ -	$ 680,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
9	Hazardous Material Excavation, Transportation and Off-Site Disposal			2,500	$420	Ton	$ -	$ -	$ 1,050,000	Assumes 20% of the total contaminated material excavated from the area to be hazardous.
10	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal	410	2,500	9,700	$90	Ton	$ 36,900	$ 225,000	$ 873,000	For A1-ALT-1 includes excavation, transportation and disposal of material excavated for construction of slurry wall. For A1-ALT-2 includes excavation, transportation and disposal of the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For A1-ALT-3 includes excavation, transportation and disposal of remedial excavation material (assumes 80% of the total contaminated material excavated as non-hazardous).
11	Excavation Dewatering, Treatment (if necessary) and Disposal			1	$35,000	LS	$ -	$ -	$ 35,000	Perform dewatering, storage, treatment (if necessary) and permitted disposal of excavation water.
12	Temporary Shoring for Excavation and/or In Situ S/S		450	450	$1,500	LF	$ -	$ 675,000	$ 675,000	Construct shoring system to facilitate excavation/in situ S/S and keep portions of the East Marine View Drive operational during construction.
13	Disposal Characterization Sampling and Analysis	5	10	18	$140	Each	$ 700	$ 1,400	$ 2,520	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
14	Verification Sampling and Analysis			38	$60	Each	$ -	$ -	$ 2,280	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
15	Purchase and Placement of Backfill Material			6,800	$29	CY	$ -	$ -	$ 195,840	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
16	Restoration of Paved Surfaces	50	1,200	1,200	$40	SY	$ 2,000	$ 48,000	$ 48,000	Restoration of asphalt/concrete surfaces demolished or disturbed due to the remedy.
17	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)		170	170	$10	SY	$ -	$ 1,700	$ 1,700	Restoration of landscaped/unpaved surfaces.
18	Monitoring Well Installation	1	1	1	$14,500	LS	$ 14,500	$ 14,500	$ 14,500	Assumes the installation of 2 shallow and 2 deep monitoring wells.
19	Surveying (Pre-/Post-Construction)	1	1	1	$3,800	LS	$ 3,800	$ 3,800	$ 3,800	Perform site survey to document existing conditions and as-built conditions.
20	Surveying (Progress)			1	$3,100	LS	$ -	$ -	$ 3,100	Perform site survey to document excavation limits. Assumes 2 progress surveys.

Item No.	Item Description	Estimated Quantity[1] A1-ALT-1	A1-ALT-2	A1-ALT-3	Unit Cost[2]	Unit	Estimated Cost A1-ALT-1	A1-ALT-2	A1-ALT-3	Notes/Assumptions
21	1-Year of Post-Construction Shallow and Deep Groundwater Monitoring	4	4	4	$6,500	Event	$ 26,000	$ 26,000	$ 26,000	Monitor groundwater to evaluate natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 2 shallow and 2 deep wells will be monitored for IHSs on a quarterly basis for 1 year.
22	10-Years of Post-Construction Cap Monitoring	10			$2,000	Event	$ 20,000	$ -	$ -	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
	Direct Capital Cost				--	--	$ 321,880	$ 1,884,214	$ 3,214,874	Sum of line item 1 through 20. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
	Indirect Capital Cost				36	%	$ 115,877	$ 678,317	$ 1,157,355	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
	Direct O&M Cost				--	--	$ 46,000	$ 26,000	$ 26,000	Sum of line item 21 and 22. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost				15	%	$ 6,900	$ 3,900	$ 3,900	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency				30	%	$ 147,197	$ 777,729	$ 1,320,639	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:						$ 637,854	$ 3,370,160	$ 5,722,768	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

LS = lump sum

SY = square yard

LF = linear foot

CY = cubic yard

O&M = operation and maintenance

S/S = Solidification/Stabilization

IHS = indicator hazardous substance

Table 25

Area A2 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		A2-ALT-1	A2-ALT-2	A2-ALT-3			A2-ALT-1	A2-ALT-2	A2-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ 27,864	$ 35,951	$ 50,786	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital cost thereafter.
2	Abandonment of Monitoring Wells	1	1	1	$1,000	LS	$ 1,000	$ 1,000	$ 1,000	Decommission monitoring wells LLMW-08S/D by a Washington State licensed well driller. Assumes drill-out and/or chip-in-place monitoring wells to decommission as applicable.
3	Utility protection and/or temporary relocation and restoration	1	1	1	$20,000	LS	$ 20,000	$ 20,000	$ 20,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
4	Capping - Low-Permeability Cap	1,670			$40	SY	$ 66,800	$ -	$ -	Assumes asphalt/concrete cap over the existing unpaved surfaces in the area.
5	Containment along the Perimeter of the Area - Sheet Pile or Slurry Wall	620			$360	LF	$ 223,200	$ -	$ -	Includes purchase and placement of sheet pile wall along the entire perimeter of the area with the exception of the portions where placement of sheet pile wall is not possible due to underground obstructions such as utility corridor. Slurry wall approach will be used for these portions. Assumes average depth of containment to be approximately 12 feet.
6	In Situ Solidification/Stabilization (S/S)		3,400		$100	CY	$ -	$ 340,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
7	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal	450	1,200	6,000	$90	Ton	$ 40,500	$ 108,000	$ 540,000	For A1-ALT-1 includes excavation, transportation and disposal of material excavated for construction of slurry wall. For A1-ALT-2 includes excavation, transportation and disposal of the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For A1-ALT-3 includes excavation, transportation and disposal of remedial excavation material (assumes 100% of the total contaminated material excavated as non-hazardous).
8	Excavation Dewatering, Treatment (if necessary) and Disposal			1	$50,000	LS	$ -	$ -	$ 50,000	Perform dewatering, storage and treatment (if necessary) and permitted disposal of excavation water.
9	Disposal Characterization Sampling and Analysis	5	7	13	$140	Each	$ 700	$ 980	$ 1,820	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
10	Verification Sampling and Analysis			45	$60	Each	$ -	$ -	$ 2,700	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
11	Purchase and Placement of Backfill Material			3,400	$29	CY	$ -	$ -	$ 97,920	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
12	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)		1,700	1,700	$10	SY	$ -	$ 17,000	$ 17,000	Restoration of landscaped/unpaved surfaces.
13	Monitoring Well Installation	1	1	1	$7,500	LS	$ 7,500	$ 7,500	$ 7,500	Assumes the installation of 2 shallow monitoring wells.
14	Surveying (Pre-/Post-Construction)	1	1	1	$4,700	LS	$ 4,700	$ 4,700	$ 4,700	Perform site survey to document existing conditions and as-built conditions.
15	Surveying (Progress)			1	$3,800	LS	$ -	$ -	$ 3,800	Perform site survey to document excavation limits. Assume 2 progress surveys.
16	1-Year of Post-Construction Shallow Groundwater Monitoring	4	4	4	$5,300	Event	$ 21,200	$ 21,200	$ 21,200	Monitor groundwater to evaluate natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 2 shallow wells will be monitored for IHSs on a quarterly basis for 1 year.
17	10-Years of Post-Construction Cap Monitoring	10			$2,000	Event	$ 20,000	$ -	$ -	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
				Direct Capital Cost	--	--	$ 392,264	$ 535,131	$ 797,226	Sum of line item 1 through 15. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
				Indirect Capital Cost	36	%	$ 141,215	$ 192,647	$ 287,002	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, and other technical and professional services).

Item No.	Item Description	Estimated Quantity[1] A2-ALT-1	A2-ALT-2	A2-ALT-3	Unit Cost[2]	Unit	Estimated Cost A2-ALT-1	A2-ALT-2	A2-ALT-3	Notes/Assumptions
	Direct O&M Cost				–	–	$ 41,200	$ 21,200	$ 21,200	Sum of line item 16 and 17. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost				15	%	$ 6,180	$ 3,180	$ 3,180	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency				30	%	$ 174,258	$ 225,647	$ 332,582	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:						$ 755,117	$ 977,805	$ 1,441,190	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent
LS = lump sum
SY = square yard
LF = linear foot
CY = cubic yard
O&M = operation and maintenance
S/S = Solidification/Stabilization
IHS = indicator hazardous substance

Table 26

Area B1 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		B1-ALT-1	B1-ALT-2	B1-ALT-3			B1-ALT-1	B1-ALT-2	B1-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ 195,762	$ 2,406,755	$ 5,273,652	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital cost thereafter.
2	Abandonment of Monitoring Wells	1	1	1	$19,000	LS	$ 19,000	$ 19,000	$ 19,000	Decommission monitoring wells BP-02S/D, BP-04S/D/D2, BP-06S/D, BP-08S/D, BP-10S/D, EV-6A/B, EV-7B, EV-22A/B, LLMW-27S/D, LLMW-31D and LLMW-36D by a Washington State licensed well driller. Assumes drill-out and/or chip-in-place monitoring wells to decommission as applicable.
3	Utility protection and/or temporary relocation and restoration		1	1	$200,000	LS	$ -	$ 200,000	$ 200,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
4	Demolition, Transportation and Off-Site Disposal of Demolition Debris		8,300	8,300	$14	SY	$ -	$ 116,200	$ 116,200	Includes demolition of existing paved (asphalt/concrete) surfaces in the area to assess contaminated material. Paved surfaces of the Pacific Highway will be protected in place.
5	Clearing and Grubbing	8,900	8,900	8,900	$3	SY	$ 26,700	$ 26,700	$ 26,700	Includes clearing, grubbing and off-site disposal of cleared trees/vegetation.
6	Capping - Low-Permeability Cap	46,000			$40	SY	$ 1,839,999	$ -	$ -	Assumes installation of asphalt/concrete cap over the portions containing contaminated material.
7	Mitigation for the Impacts to Surface Water Features	1.2	1.2		$500,000	Acre	$ 600,000	$ 600,000	$ -	Mitigate impacts to surface water features at an off-site location as per the requirements of the project permit.
8	Overburden Material Excavation and Reuse		63,600	63,600	$10	CY	$ -	$ 636,000	$ 636,000	Includes excavation of overburden material to assess contaminated material. Assumes overburden material to be reused as backfill.
9	In Situ Solidification/Stabilization (S/S)		266,500		$100	CY	$ -	$ 26,650,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
10	Hazardous Material Excavation, Transportation and Off-Site Disposal			96,000	$420	Ton	$ -	$ -	$ 40,320,000	Assumes 20% of the total contaminated material excavated from the area to be hazardous.
11	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal		96,000	383,800	$90	Ton	$ -	$ 8,640,000	$ 34,542,000	For B1-ALT-2 includes excavation, transportation and disposal of the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For B1-ALT-3 includes excavation, transportation and disposal of remedial excavation material (assumes 80% of the total contaminated material excavated as non-hazardous).
12	Temporary Shoring for Excavation and/or In Situ S/S		2,800	2,800	$750	LF	$ -	$ 2,100,000	$ 2,100,000	Construct shoring system to facilitate excavation/in situ S/S and keep portions of the East Marine View Drive operational during construction.
13	Excavation Dewatering, Treatment (if necessary) and Disposal			1	850,000	LS	$ -	$ -	$ 850,000	Perform dewatering, storage, treatment (if necessary) and permitted disposal of excavation water.
14	Disposal Characterization Sampling and Analysis		112	555	$140	Each	$ -	$ 15,680	$ 77,700	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
15	Verification Sampling and Analysis			855	$60	Each	$ -	$ -	$ 51,300	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
16	Purchase and Placement of Backfill Material			266,500	$29	CY	$ -	$ -	$ 7,675,200	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
17	Restoration of Paved Surfaces		8,300	8,300	$40	SY	$ -	$ 332,000	$ 332,000	Restoration of asphalt/concrete surfaces.
18	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)	46,000	46,000	46,000	$10	SY	$ 460,000	$ 460,000	$ 460,000	For B1-ALT-1 includes landscaping of 6-foot of soil cap. For B1-ALT-2 and B1-ALT-3 includes restoration of landscaped/unpaved surfaces that were disturbed due to excavation/in situ S/S.
19	Re-Vegetation	2	2	2	$10,000	Acre	$ 20,000	$ 20,000	$ 20,000	Planting trees/shrubs within the existing area that was cleared and grubbed.
20	Restoration of Surface Water Features			1.2	$10,000	Acre	$ -	$ -	$ 12,000	Restore surface water features and plant trees/shrubs/hydroseed to restore habitat.
21	Surveying (Pre-/Post-Construction)	1	1	1	$197,000	LS	$ 197,000	$ 197,000	$ 197,000	Perform site survey to document existing conditions and as-built conditions.
22	Surveying (Progress)			1	$159,100	LS	$ -	$ -	$ 159,100	Perform site survey to document excavation limits. Assumes 2 progress surveys.

Item No.	Item Description	Estimated Quantity[1] B1-ALT-1	B1-ALT-2	B1-ALT-3	Unit Cost[2]	Unit	Estimated Cost B1-ALT-1	B1-ALT-2	B1-ALT-3	Notes/Assumptions
23	10-Years of Post-Construction Shallow and Deep Groundwater Monitoring	15			$9,500	Event	$ 142,500	$ -	$ -	Monitor groundwater to evaluate natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 5 existing shallow and 7 existing deep wells will be monitored for IHSs over a 10-year period with 1 year of quarterly monitoring, 2 years of semi-annual monitoring and 7 years of annual monitoring.
24	1-Year of Post-Construction Shallow and Deep Groundwater Monitoring		4	4	$0	Event	$ -	$ -	$ -	Monitor groundwater to evaluate natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 5 existing shallow and 7 existing deep wells will be monitored for IHSs on a quarterly basis for 1 year.
25	1-Year of Post-Construction Surface Water Quality Monitoring			4	$4,500	Event	$ -	$ -	$ 18,000	Monitor water quality of the restored surface water body following construction. For the purpose of cost estimating, it is assumed that 2 surface water samples will be collected on a quarterly basis for 1 year.
26	5-Years of Post-Construction Performance Monitoring of Restored Surface Water Features			5	$12,000	Event	$ -	$ -	$ 60,000	Restoration monitoring of reconstructed surface water features following construction. For the purpose of cost estimating, it is assumed that annually performance monitoring will be completed over a 5 year period.
27	10-Years of Post-Construction Cap Monitoring Throughout Area B1	10			$7,000	Event	$ 70,000	$ -	$ -	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
28	10-Years of Post-Construction Cap Monitoring for Pacific Hwy		10	10	$2,000	Event	$ -	$ 20,000	$ 20,000	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
	Direct Capital Cost				--	--	$ 3,358,461	$ 42,419,335	$ 93,067,852	Sum of line item 1 through 22. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
	Indirect Capital Cost				36	%	$ 1,209,046	$ 15,270,960	$ 33,504,427	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
	Direct O&M Cost				--	--	$ 212,500	$ 20,000	$ 98,000	Sum of line item 23 through 28. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost				15	%	$ 31,875	$ 3,000	$ 14,700	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency				30	%	$ 1,443,565	$ 17,313,989	$ 38,005,494	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:						$ 6,255,447	$ 75,027,284	$ 164,690,472	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent
LS = lump sum
SY = square yard
LF = linear foot
CY = cubic yard
O&M = operation and maintenance
S/S = Solidification/Stabilization
IHS = indicator hazardous substance

Table 27

Area B2 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		B2-ALT-1	B2-ALT-2	B2-ALT-3			B2-ALT-1	B2-ALT-2	B2-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ 119,982	$ 373,004	$ 503,259	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital cost thereafter.
2	Abandonment of Monitoring Wells	1	1	1	$4,400	LS	$ 4,400	$ 4,400	$ 4,400	Decommission monitoring wells LLMW-05S/D through LLMW-09S/D by a Washington State licensed well driller. Assumes drill-out and/or chip-in-place monitoring wells to decommission as applicable.
3	Utility protection and/or temporary relocation and restoration	0.1	1	1	$150,000	LS	$ 15,000	$ 150,000	$ 150,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
4	Demolition, Transportation and Off-Site Disposal of Demolition Debris		11,400	11,400	$14	SY	$ -	$ 159,600	$ 159,600	Includes demolition of existing paved (asphalt/concrete) surfaces in the area to assess contaminated material. Existing building and its surfaces will be protected in place.
5	Clearing and Grubbing	1,400	1,400	1,400	$3	SY	$ 4,200	$ 4,200	$ 4,200	Includes clearing, grubbing and off-site disposal of cleared trees/vegetation.
6	Capping - Low-Permeability Cap	16,900			$40	SY	$ 676,000	$ -	$ -	Includes purchase, placement, and compaction of 1-foot of soil cap with plastic (or similar) underliner.
7	Installation of Permeable Reactive Barrier (PRB)	1			$849,000	LS	$ 849,000	$ -	$ -	Includes purchase of reagents and installation of both pilot (30 feet long by 10 feet wide by 8 feet deep) and full-scale (130 feet long by 10 feet wide by 8 feet deep) shallow groundwater PRB along the shoreline of Area B2.
8	Stormwater Line Repair	1,600	1,600		$84	LF	$ 133,600	$ 133,600	$ -	Includes installation of slip liner, repairing and/or replacement of damaged stormwater pipes.
9	In Situ Solidification/Stabilization (S/S)		35,400		$100	CY	$ -	$ 3,540,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
10	Containment along the Perimeter of the Existing Building - Sheet Pile or Slurry Wall		800	800	$360	LF	$ -	$ 288,000	$ 288,000	Includes purchase and placement of sheet pile wall along the entire perimeter of the building with the exception of the portions where placement of sheet pile wall is not possible due to underground obstructions such as utility corridor. Slurry wall approach will be used for these portions. Assumes average depth of containment to be approximately 12 feet.
11	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal		13,310	64,210	$90	Ton	$ -	$ 1,197,900	$ 5,778,900	For B2-ALT-2 includes excavation, transportation and disposal of material excavated for construction of slurry wall and the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For B2-ALT-3 includes excavation, transportation and disposal of material excavated for construction of slurry wall and remedial excavation material (assumes 100% of the total contaminated material excavated as non-hazardous).
12	Excavation Dewatering, Treatment (if necessary) and Disposal			1	$120,000	LS	$ -	$ -	$ 120,000	Perform dewatering, storage and treatment and permitted disposal of excavation water.
13	Disposal Characterization Sampling and Analysis		16	78	$140	Each	$ -	$ 2,240	$ 10,920	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
14	Verification Sampling and Analysis			335	$60	Each	$ -	$ -	$ 20,100	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
15	Purchase and Placement of Backfill Material			35,400	$29	CY	$ -	$ -	$ 1,018,027	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
16	Restoration of Paved Surfaces	100	11,400	11,400	$40	SY	$ 4,000	$ 456,000	$ 456,000	For B2-ALT-1 includes restoration of asphalt/concrete surfaces disturbed due to construction of containment wall. For B2-ALT-2 and B2-ALT-3 includes restoration of asphalt/concrete surfaces disturbed due to excavation/in situ S/S.
17	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)	4,400	4,400	4,400	$10	SY	$ 44,000	$ 44,000	$ 44,000	For B2-ALT-1 includes landscaping of 1-foot of soil cap. For B2-ALT-2 and B2-ALT-3 includes restoration of landscaped/unpaved surfaces that were disturbed due to excavation/in situ S/S.
18	Monitoring Well Installation	1			$49,800	LS	$ 49,800	$ -	$ -	Assumes installation of 20 shallow and 2 deep monitoring wells for B2-ALT-1.
19	Monitoring Well Installation		1	1	$17,100	LS	$ -	$ 17,100	$ 17,100	Assumes installation of 4 shallow and 2 deep monitoring wells for B2-ALT-2 and B2-ALT-3.
20	Surveying (Pre-/Post-Construction)	1	1	1	$119,700	LS	$ 119,700	$ 119,700	$ 119,700	Perform site survey to document existing conditions and as-built conditions.
21	Surveying (Progress)			1	$96,700	LS	$ -	$ -	$ 96,700	Perform site survey to document excavation limits. Assumes 2 progress surveys.
22	10-Years of Post-Construction PRB Performance/Shallow Groundwater Monitoring	24			$14,300	Event	$ 343,200	$ -	$ -	Monitor groundwater to evaluate in situ groundwater treatment performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 20 new shallow wells will be monitored for IHSs over a period of 10 years with 2 years of quarterly monitoring and 8 years of semi-annual monitoring.

Item No.	Item Description	Estimated Quantity[1] B2-ALT-1	B2-ALT-2	B2-ALT-3	Unit Cost[2]	Unit	Estimated Cost B2-ALT-1	B2-ALT-2	B2-ALT-3	Notes/Assumptions
23	10-Years of Post-Construction Deep Groundwater Monitoring	15	15	15	$5,100	Event	$ 76,500	$ 76,500	$ 76,500	Monitor groundwater to evaluate groundwater natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 2 new deep wells will be monitored for IHSs over a 10-year period with 1 year of quarterly monitoring, 2 years of semi-annual monitoring and 7 years of annual monitoring.
24	1-Year of Post-Construction Shallow Groundwater Monitoring - B2-ALT-2 and B2-ALT-3		4	4	$6,800	Event	$ -	$ 27,200	$ 27,200	Monitor groundwater to evaluate natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 2 new deep wells will be monitored for IHSs on a quarterly basis for 1 year.
25	10-Years of Post-Construction Cap Monitoring Throughout Area B2	10			$6,000	Event	$ 60,000	$ -	$ -	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
26	10-Years of Post-Construction Cap Monitoring for the Existing Building		10	10	$2,000	Event	$ -	$ 20,000	$ 20,000	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
	Direct Capital Cost				–	–	$ 2,019,682	$ 6,489,744	$ 8,790,905	Sum of line item 1 through 21. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
	Indirect Capital Cost				36	%	$ 727,085	$ 2,336,308	$ 3,164,726	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
	Direct O&M Cost				–	–	$ 479,700	$ 123,700	$ 123,700	Sum of line item 22 through 26. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost				15	%	$ 71,955	$ 18,555	$ 18,555	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency				30	%	$ 989,527	$ 2,690,492	$ 3,629,366	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:						$ 4,287,949	$ 11,658,799	$ 15,727,252	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent
LS = lump sum
SY = square yard
LF = linear foot
CY = cubic yard
O&M = operation and maintenance
S/S = Solidification/Stabilization
IHS = indicator hazardous substance

Table 28

Area B3 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		B3-ALT-1	B3-ALT-2	B3-ALT-3			B3-ALT-1	B3-ALT-2	B3-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ -	$ 109,433	$ 151,963	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital cost thereafter.
2	Abandonment of Monitoring Wells		1	1	$2,800	LS	$ -	$ 2,800	$ 2,800	Decommission monitoring wells LLMW-14S/D and MW-109D by a Washington State licensed well driller. Assumes drill-out and/or chip-in-place monitoring wells to decommission as applicable.
3	Utility protection and/or temporary relocation and restoration		1	1	$5,000	LS	$ -	$ 5,000	$ 5,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
4	Demolition, Transportation and Off-Site Disposal of Demolition Debris		1,400	1,400	$14	SY	$ -	$ 19,600	$ 19,600	Includes demolition of existing paved (asphalt/concrete) surfaces in the area to assess contaminated material.
5	In Situ Solidification/Stabilization (S/S)		10,800		$100	CY	$ -	$ 1,080,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
6	Overburden Material Excavation and Reuse		12,900	12,900	$10	CY	$ -	$ 129,000	$ 129,000	Includes excavation of overburden material to assess contaminated material. Assumes overburden material to be reused as backfill.
7	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal		3,900	19,400	$90	Ton	$ -	$ 351,000	$ 1,746,000	For B3-ALT-2 includes excavation, transportation and disposal of the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For B3-ALT-3 includes excavation, transportation and disposal of remedial excavation material (assumes 100% of the total contaminated material excavated as non-hazardous).
8	Excavation Dewatering, Treatment (if necessary) and Disposal			1	$50,000	LS	$ -	$ -	$ 50,000	Perform dewatering, storage and treatment and permitted disposal of excavation water.
9	Disposal Characterization Sampling and Analysis		12	58	$140	Each	$ -	$ 1,680	$ 8,120	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
10	Verification Sampling and Analysis			166	$60	Each	$ -	$ -	$ 9,960	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
11	Purchase and Placement of Backfill Material			10,800	$29	CY	$ -	$ -	$ 311,040	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
12	Restoration of Paved Surfaces		1,400	1,400	$40	SY	$ -	$ 56,000	$ 56,000	Includes restoration of asphalt/concrete surfaces disturbed due to excavation/in situ S/S.
13	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)		5,100	5,100	$10	SY	$ -	$ 51,000	$ 51,000	For B3-ALT-1 includes landscaping of cap. For B2-ALT-2 and B2-ALT-3 includes restoration of landscaped/unpaved surfaces that were disturbed due to excavation/in situ S/S.
14	Monitoring Well Installation		1	1	$7,500	LS	$ -	$ 7,500	$ 7,500	Assumes the installation of 2 shallow monitoring wells.
15	Surveying (Pre-/Post-Construction)		1	1	$20,300	LS	$ -	$ 20,300	$ 20,300	Perform site survey to document existing conditions, excavation limits and as-built conditions.
16	Surveying (Progress)			1	$16,400	LS	$ -	$ -	$ 16,400	Perform site survey to document excavation limits. Assumes 2 progress surveys.
17	10-Years of Post-Construction Shallow Groundwater Monitoring	15			$5,300	Event	$ 79,500	$ -	$ -	Monitor groundwater following construction to evaluate groundwater natural attenuation processes and compliance with cleanup standards. For the purpose of cost estimating, it is assumed that wells 2 deep shallow wells will be monitored for IHSs over a 10-year period with 1 year of quarterly monitoring, 2 years of semi-annual monitoring and 7 years of annual monitoring.
18	1-Year of Post-Construction Shallow Groundwater Monitoring		4	4	$5,300	Event	$ -	$ 21,200	$ 21,200	Monitor groundwater following construction to evaluate natural attenuation performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 2 new shallow wells will be monitored for IHSs on a quarterly basis for 1 year.
19	10-Years of Post-Construction Cap Monitoring	10			$4,000	Event	$ 40,000	$ -	$ -	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
				Direct Capital Cost	--	--	$ -	$ 1,833,313	$ 2,584,683	Sum of line item 1 through 16. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
				Indirect Capital Cost	36	%	$ -	$ 659,993	$ 930,486	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).

Item No.	Item Description	Estimated Quantity[1] B3-ALT-1	B3-ALT-2	B3-ALT-3	Unit Cost[2]	Unit	Estimated Cost B3-ALT-1	B3-ALT-2	B3-ALT-3	Notes/Assumptions
	Direct O&M Cost				--	--	$ 40,000	$ 21,200	$ 21,200	Sum of line item 17 through 19. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost				15	%	$ 6,000	$ 3,180	$ 3,180	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency				30	%	$ 13,800.00	$ 755,306	$ 1,061,865	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:						$ 59,800	$ 3,272,991	$ 4,601,414	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent
LS = lump sum
SY = square yard
LF = linear foot
CY = cubic yard
O&M = operation and maintenance
S/S = Solidification/Stabilization
IHS = indicator hazardous substance

Table 29

Area C1 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1] C1-ALT-1	Estimated Quantity[1] C1-ALT-2	Unit Cost[2]	Unit	Estimated Cost C1-ALT-1	Estimated Cost C1-ALT-2	Notes/Assumptions
1	Mobilization/Site Controls/Demobilization		1	6 to 12	%	$ -	$ 50,712	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital costs thereafter.
2	Abandonment of Monitoring Wells		1	$5,300	LS	$ -	$ 5,300	Decommission monitoring wells LLMW-11S/D and LLMW-17S/D by a Washington State licensed well driller. Assumes drill-out and/or chip-in-place monitoring wells to decommission as applicable.
3	Utility protection and/or temporary relocation and restoration		1	$5,000	LS	$ -	$ 5,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
4	Installation of Permeable Reactive Barrier (PRB)		1	$687,000	LS	$ -	$ 687,000	Includes purchase of reagents and installation of both pilot (30 feet long by 10 feet wide by 30 feet deep) and full-scale (860 feet long by 10 feet wide by 30 feet deep) deep groundwater PRB along the shoreline of Area C1.
5	Monitoring Well Installation		1	$47,900	LS	$ -	$ 47,900	Assumes installation of 14 deep monitoring wells.
6	10-Years of Post-Construction Deep Groundwater Monitoring	15		$5,100	Event	$ 76,500	$ -	Monitor groundwater to evaluate natural attenuation performance and compliance with cleanup standards. For the purpose of cost estimating, it is assumed that wells 2 deep shallow wells will be monitored for IHSs over a 10-year period with 1 year of quarterly monitoring, 2 years of semi-annual monitoring and 7 years of annual monitoring.
7	10-Years of Post-Construction PRB Performance/Deep Groundwater Monitoring		24	$10,400	Event	$ -	$ 249,600	Monitor groundwater to evaluate in situ groundwater treatment performance and/or compliance with cleanup standards. For the purpose of cost estimating, it is assumed that 14 new deep wells will be monitored for IHSs over a period of 10 years with 2 years of quarterly monitoring and 8 years of semi-annual monitoring.
	Direct Capital Cost			--	--	$ -	$ 795,912	Sum of line items 1 through 5. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
	Indirect Capital Cost	36		%		$ -	$ 286,528.32	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
	Direct O&M Cost	--		--		$ 76,500	$ 249,600	Sum of line items 6 and 7. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost	15		%		$ 11,475	$ 37,440	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency	30		%		$ 26,392.50	$ 410,844.10	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:					$ 114,368	$ 1,780,324	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent
LS = lump sum
SY = square yard
LF = linear foot
CY = cubic yard
O&M = operation and maintenance
PRB = Permeable Reactive Barrier
IHS = indicator hazardous substance

Table 30

Areas C2 and C3 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1] C2-ALT-1/ C3-ALT-1	Estimated Quantity[1] C2-ALT-2/ C3-ALT-2	Unit Cost[2]	Unit	Estimated Cost C2-ALT-1/ C3-ALT-1	Estimated Cost C2-ALT-2/ C3-ALT-2	Notes/Assumptions
1	Mobilization/Site Controls/Demobilization	1	1	6 to 12	%	$ 15,000	$ 367,476	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital costs thereafter.
2	Utility protection and/or temporary relocation and restoration		1	50,000	LS	$ -	$ 50,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
3	Installation of Perimeter Fence	6,000		$25	LF	$ 150,000	$ -	Assumes 6-foot tall chain link fence.
4	Clearing and Grubbing		30,000	$3	SY	$ -	$ 90,000	Includes clearing, grubbing and off-site disposal of cleared trees/vegetation.
5	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal		53,900	$90	Ton	$ -	$ 4,851,000	Includes excavation, transportation and disposal of remedial excavation material (assumes 100% of the total contaminated material excavated as non-hazardous).
6	Disposal Characterization Sampling and Analysis		56	$140	Each	$ -	$ 7,840	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
7	Verification Sampling and Analysis		640	$60	Each	$ -	$ 38,400	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
8	Purchase and Placement of Backfill Material		30,000	$29	CY	$ -	$ 861,760	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
9	Re-Vegetation		7	$10,000	Acre	$ -	$ 70,000	Planting trees/shrubs within the existing area that was cleared and grubbed.
10	Surveying (Pre-/Post-Construction)		1	$75,200	LS	$ -	$ 75,200	Perform site survey to document existing conditions, excavation limits and as-built conditions.
11	Surveying (Progress)		1	$30,400	LS	$ -	$ 30,400	Perform site survey to document excavation limits. Assumes 2 progress surveys.
12	10-Years of Post-Construction Fence Monitoring	10		$3,000	Event	$ 30,000	$ -	Monitor fence conditions on an annual basis to assess long-term integrity of fence.
	Direct Capital Cost			--	--	$ 165,000	$ 6,442,076	Sum of line items 1 through 11. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
	Indirect Capital Cost			36	%	$ 59,400	$ 2,319,147	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
	Direct O&M Cost			--	--	$ 30,000	$ -	Includes line item 12. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost			15	%	$ 4,500	$ -	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency			30	%	$ 77,670	$ 2,628,367	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:					$ 336,570	$ 11,389,590	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

LS = lump sum

SY = square yard

LF = linear foot

CY = cubic yard

O&M = operation and maintenance

IHS = indicator hazardous substance

Table 31

Area C4 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		C4-ALT-1	C4-ALT-2	C4-ALT-3			C4-ALT-1	C4-ALT-2	C4-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ 1,176	$ 7,260	$ 9,014	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital cost thereafter.
2	Utility protection and/or temporary relocation and restoration		1	1	10,000	LS	$ -	$ 10,000	$ 10,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
3	Capping - Low-Permeability Cap	400			$12	SY	$ 4,800	$ -	$ -	Includes purchase, placement, and compaction of 1-foot of soil cap with plastic (or similar) underliner.
4	Overburden Material Excavation and Reuse		400	400	$10	CY	$ -	$ 4,000	$ 4,000	Includes excavation of overburden material to access contaminated material. Assumes overburden material to be reused as backfill.
5	In Situ Solidification/Stabilization (S/S)		400		$100	CY	$ -	$ 40,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
6	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal		120	600	$90	Ton	$ -	$ 10,800	$ 54,000	For C4-ALT-2 includes excavation, transportation and disposal of the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For C4-ALT-3 includes excavation, transportation and disposal of remedial excavation material (assumes 100% of the total contaminated material excavated as non-hazardous).
7	Disposal Characterization Sampling and Analysis		5	7	$140	Each	$ -	$ 700	$ 980	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
8	Verification Sampling and Analysis			14	$60	Each	$ -	$ -	$ 840	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
9	Purchase and Placement of Backfill Material			400	$29	CY	$ -	$ -	$ 9,600	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
10	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)	400	400	400	$10	SY	$ 4,000	$ 4,000	$ 4,000	For C4-ALT-1 includes landscaping of cap. For C4-ALT-2 and C4-ALT-3 includes restoration of landscaped/unpaved surfaces that were disturbed due to excavation/in situ S/S.
11	Surveying (Pre-/Post-Construction)	1	1	1	$1,000	LS	$ 1,000	$ 1,000	$ 1,000	Perform site survey to document existing conditions, excavation limits and as-built conditions.
12	Surveying (Progress)			1	$700	LS	$ -	$ -	$ 700	Perform site survey to document excavation limits. Assumes 2 progress surveys.
13	10-Years of Post-Construction Cap Monitoring	10			$3,000	Event	$ 30,000	$ -	$ -	Monitor cap conditions on an annual basis to access long-term integrity of cap.
	Direct Capital Cost				--	--	$ 10,976	$ 77,760	$ 94,134	Sum of line items 1 through 12. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
	Indirect Capital Cost				36	%	$ 3,951	$ 27,994	$ 33,888	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
	Direct O&M Cost				--	--	$ 30,000	$ -	$ -	Includes line item 13. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost				15	%	$ 4,500	$ -	$ -	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency				30	%	$ 14,828	$ 31,726	$ 38,407	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:						$ 64,256	$ 137,480	$ 166,430	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

LS = lump sum

SY = square yard

LF = linear foot

CY = cubic yard

O&M = operation and maintenance

S/S = Solidification/Stabilization

IHS = indicator hazardous substance

Table 32

Area C5 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1]			Unit Cost[2]	Unit	Estimated Cost			Notes/Assumptions
		C5-ALT-1	C5-ALT-2	C5-ALT-3			C5-ALT-1	C5-ALT-2	C5-ALT-3	
1	Mobilization/Site Controls/Demobilization	1	1	1	6 to 12	%	$ 2,880	$ 373,830	$ 507,187	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital costs thereafter.
2	Utility protection and/or temporary relocation and restoration		1	1	75,000	LS	$ -	$ 75,000	$ 75,000	Protect utilities and/or temporarily reroute and restore to facilitate remedial excavation activities.
3	Demolition, Transportation and Off-Site Disposal of Demolition Debris		5,600	5,600	$14	CY	$ -	$ 78,400	$ 78,400	Includes demolition of existing paved (asphalt/concrete) surfaces in the area to assess contaminated material.
4	Cut-Off Underdrains	1	1		$24,000	LS	$ 24,000	$ 24,000	$ -	Cut and cap underdrain pipe at the remedial area limit and backfill underdrains with grout slurry.
5	Overburden Material Excavation and Reuse		81,200	81,200	$10	CY	$ -	$ 812,000	$ 812,000	Includes excavation of overburden material to assess contaminated material. Assumes overburden material to be reused as backfill.
6	In Situ Solidification/Stabilization (S/S)		34,800		$100	CY	$ -	$ 3,480,000	$ -	Includes purchase of cementations (cement, lime, etc.) or chemical reagents and in situ mixing of reagents with contaminated material.
7	Non-Hazardous Material Excavation, Transportation and Off-Site Disposal		12,600	62,600	$90	Ton	$ -	$ 1,134,000	$ 5,634,000	For C5-ALT-2 includes excavation, transportation and disposal of the increase in the volume (assumes 20% of the total material treated) due to addition of reagents. For C5-ALT-3 includes excavation, transportation and disposal of remedial excavation material (assumes 100% of the total contaminated material excavated as non-hazardous).
8	Excavation Dewatering, Treatment (if necessary) and Disposal			1	$120,000	LS	$ -	$ -	$ 120,000	Perform dewatering, storage and treatment and permitted disposal of excavation water.
9	Disposal Characterization Sampling and Analysis		20	238	$140	Each	$ -	$ 2,800	$ 33,320	Obtain soil samples for chemical analysis of IHSs to support waste disposal characterization. Assumes minimum of 3 samples for up to 100 cy, 5 samples for up to 500 cy, 7 samples for up to 1,000 cy, 10 samples for up to 2,000 cy and 1 addition sample for every 500 cy over 2,000 cy.
10	Verification Sampling and Analysis			135	$60	Each	$ -	$ -	$ 8,100	Obtain soil samples for chemical analysis of IHSs to verify the limit of remedial excavation. Assumes 1 sample per 650 SF of remedial excavation base, 1 sample per 40 LF of remedial excavation sidewall and 10% duplicate samples.
11	Purchase and Placement of Backfill Material			34,800	$29	CY	$ -	$ -	$ 1,001,600	Includes purchase, placement and compaction of backfill material to fill remedial excavation.
12	Restoration of Paved Surfaces		5,600	5,600	$40	SY	$ -	$ 224,000	$ 224,000	Restoration of asphalt/concrete surfaces.
13	Landscaping (Placement of a Thin Layer of Top Soil and Hydroseeding)		29,300	29,300	$10	SY	$ -	$ 293,000	$ 293,000	Includes restoration of landscaped/unpaved surfaces that were disturbed due to excavation/in situ S/S.
14	Surveying (Pre-/Post-Construction)		1	1	$82,300	LS	$ -	$ 82,300	$ 82,300	Perform site survey to document existing conditions and as-built conditions.
15	Surveying (Progress)			1	$66,400	LS	$ -	$ -	$ 66,400	Perform site survey to document excavation limits. Assumes 2 progress surveys.
16	10-Years of Post-Construction Cap Monitoring	10			$3,000	Event	$ 30,000	$ -	$ -	Monitor cap conditions on an annual basis to assess long-term integrity of cap.
				Direct Capital Cost	--	--	$ 26,880	$ 6,579,330	$ 8,935,307	Sum of line items 1 through 15. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
				Indirect Capital Cost	36	%	$ 9,676.80	$ 2,368,559	$ 3,216,711	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
				Direct O&M Cost	--	--	$ 30,000	$ -	$ -	Includes line item 16. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
				Indirect O&M Cost	15	%	$ 4,500	$ -	$ -	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
				Contingency	30	%	$ 21,317.04	$ 2,684,367	$ 3,645,605	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
				Total Remedial Alternative Cost:			$ 92,374	$ 11,632,255	$ 15,797,623	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

LS = lump sum

SY = square yard

LF = linear foot

CY = cubic yard

O&M = operation and maintenance

S/S = Solidification/Stabilization

IHS = indicator hazardous substance

Table 33

Area C6 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Quantity[1] C6-ALT-1	Unit Cost[2]	Unit	Estimated Cost C6-ALT-1	Notes/Assumptions
1	10-Years of Post-Construction Deep Groundwater Monitoring	15	$5,200	Event	$ 78,000	Assumes collection of groundwater samples from existing wells at/downgradient of the area for chemical analysis of IHSs. Assumes a total of 10-years of monitoring including four quarters of monitoring for first year, semi-annual monitoring for second and third year, and annual monitoring thereafter.
	Direct Capital Cost	--	--		$ -	Not applicable.
	Indirect Capital Cost	36	%		$ -	Not applicable.
	Direct O&M Cost	--	--		$ 78,000	Includes line item 1. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost	15	%		$ 11,700	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency	30	%		$ 26,910	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:				$ 116,610	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

O&M = operation and maintenance

IHS = indicator hazardous substance

Table 34

Areas D1 Through D3 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Estimated Quantity[1] D1-ALT-1/ D2-ALT-1/ D3-ALT-1	Estimated Quantity[1] D1-ALT-2/ D2-ALT-2/ D3-ALT-2	Estimated Quantity[1] D1-ALT-3/ D2-ALT-3/ D3-ALT-3	Unit Cost[2]	Unit	Estimated Cost D1-ALT-1/ D2-ALT-1/ D3-ALT-1	Estimated Cost D1-ALT-2/ D2-ALT-2/ D3-ALT-2	Estimated Cost D1-ALT-3/ D2-ALT-3/ D3-ALT-3	Notes/Assumptions
1	Mobilization/Site Controls/Demobilization		1	1	6 to 12	%	$ 1,800	$ 155,400	$ 194,694	Includes mobilization to the site, installation of temporary site controls including temporary traffic, and erosion and sediment controls (as applicable), and demob from the site. Assumes 12% of the other direct capital costs for first $100,000 and 6% of the other direct capital costs thereafter. Additionally, $150,000 of mob/demob charges are added for ALT-2 and -3 for dredge/material barges.
2	Purchase and Place a Thin Layer of Sand to Enhance Natural Sediment Recovery (ENR)		500		$50	Ton	$ -	$ 25,000	$ -	Place thin layer of clean sand cap (approximately 10 cm [i.e., thickness of biologically active zone]) over the area of contaminated sediment to enhance natural attenuation processes
3	Non-Hazardous Sediment Dredging, Upland Offload, Transportation and Off-Site Upland Disposal			3,900	$110	Ton	$ -	$ -	$ 429,000	Dredge/excavate non-hazardous sediment, off-load at an upland facility, transport and dispose at a permitted off-site upland disposal facility. Depth of dredging is assumed to be 3 feet.
4	Purchase and Placement of Backfill Material			3,900	$50	Ton	$ -	$ -	$ 195,000	Includes purchase and placement of backfill material to fill dredge area.
5	Verification Sediment Sampling and Analysis			15	$60	Each	$ -	$ -	$ 900	Verification sampling and analysis of IHSs at the limits of dredging/excavation to monitor compliance with the cleanup standards and/or document contaminant concentrations that are left in-place. Assume 1 sample per 2,000 SF of remedial dredge/excavation base and 10% duplicate samples.
6	Bathymetric Surveying (Pre-/Post-Construction)	1	1	1	$15,000	LS	$ 15,000	$ 15,000	$ 15,000	Perform site survey to document existing conditions, excavation limits and as-built conditions.
7	Bathymetric Surveying (Progress)		1	1	$5,000	LS	$ -	$ 5,000	$ 5,000	Perform site survey to document excavation limits.
8	10-Years of Post-Construction Sediment Sampling and Analysis to assess Natural Sediment Recovery Processes	10	10		$7,200	Event	$ 72,000	$ 72,000	$ -	Sample and analyze surface sediment (0 to 10 cm; i.e., biologically active zone) for the IHSs. Assume 1 sample per remediation area per event.
9	1-Year of Post-Construction Stormwater Outfall Sampling and Analysis	4	4	4	$7,200	Event	$ 28,800	$ 28,800	$ 28,800	Sample stormwater outfalls for IHSs to assess the performance of remedies implemented in upgradient areas to address sources contamination.
					Direct Capital Cost	--	$ 16,800	$ 200,400	$ 839,594	Sum of line items 1 through 7. Consists of equipment, labor and material costs, including contractor markups such as overhead and profit, necessary to construct the remedial alternative.
					Indirect Capital Cost	36	%	$ 6,048	$ 72,144	$ 302,254	Assumes 36% of the direct capital cost. Consists of costs that are not part of the actual construction project but necessary to implement the remedial alternative (e.g., engineering, legal, construction management, reporting and other technical and professional services).
					Direct O&M Cost	--	--	$ 100,800	$ 100,800	$ 28,800	Sum of line items 8 and 9. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
					Indirect O&M Cost	15	%	$ 15,120	$ 15,120	$ 4,320	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
					Contingency	30	%	$ 41,630	$ 116,539	$ 352,490	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
					Total Remedial Alternative Cost:			$ 180,398	$ 505,003	$ 1,527,458	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

LS = lump sum

CY = cubic yard

O&M = operation and maintenance

IHS = indicator hazardous substance

Table 35

Area D4 Remedial Alternative Cost Estimate

Everett Smelter Site - Lowland Area

Everett, Washington

Item No.	Item Description	Quantity[1] D4-ALT-1	Unit Cost[2]	Unit	Estimated Cost D4-ALT-1	Notes/Assumptions
1	1-Year of Post-Construction Seep Sampling and Analysis	4	$6,900	Event	$ 27,600	Sample and analyze seep-water for IHSs. Assumes four quarters of monitoring with 1 sample per event.
	Direct Capital Cost		--	--	$ -	Not applicable.
	Indirect Capital Cost		36	%	$ -	Not applicable.
	Direct O&M Cost		--	--	$ 27,600	Includes line item 1. Consists of equipment, labor and material costs associated with activities necessary to ensure or verify the continued effectiveness of remedial alternative.
	Indirect O&M Cost		15	%	$ 4,140	Assumes 15% of the direct O&M cost. Consists of expenditures for professional and technical services including reporting necessary to support O&M activities.
	Contingency		30	%	$ 9,522	Covers unknowns, unforeseen circumstances, or unanticipated conditions associated with construction and O&M activities.
	Total Remedial Alternative Cost:				$ 41,262	Accuracy of the total remedial alternative cost is considered -30 to +50 % based on EPA's Guide to Developing and Documenting Cost Estimates During the Feasibility Study.

Notes:

[1] Concept design level.

[2] Unit costs based on a combination of published engineering reference manuals (i.e., RS Means Heavy Construction Cost Data Manual); construction cost estimates solicited from applicable vendors and contractors; review of actual costs incurred during similar, applicable projects; and professional judgment. Unit costs are based on 2015 rates.

% = percent

LS = lump sum

CY = cubic yard

O&M = operation and maintenance

IHS = indicator hazardous substance

Table 36

Site-Wide Remedial Alternatives 1(i) through 1(iii)[1]

Everett Smelter Site - Lowland Area

Everett, Washington

Area Group[2]	Area ID[2]	Site-Wide Remedial Alternative 1(i)	Site-Wide Remedial Alternative 1(ii)	Site-Wide Remedial Alternative 1(iii)	Status of Contaminated Media[3]
		Following are the Area Remedial Alternatives selected as part of the Site-Wide Remedial Alternatives 1(i) through 1(iii)			
A	A1	A1-ALT-1: CAP, CON, GWM, ICS	A1-ALT-2: ISS, GWM, ICS	A1-ALT-3: EXC, GWM	S, S/D, SG, DG
	A2	A2-ALT-1: CAP, CON, GWM, ICS	A2-ALT-2: ISS, GWM, ICS	A2-ALT-3: EXC, GWM	S, SG
B	B1	B1-ALT-1: CAP, 1FT, DWT, GWM, ICS			S, S/D, SG, DG, SW, SE
	B2	B2-ALT-1: CAP, 1FT, PRB, GNA, GWM, SWR, ICS			S, S/D, SG, DG
	B3	B3-ALT-1: 6FT, GNA, GWM, ICS			S, SG
C	C1	C1-ALT-2: PRB, GWM, ICS			DG
	C2	C2-ALT-1: FEN, ICS			S
	C3	C3-ALT-1: FEN, ICS			S
	C4	C4-ALT-1: 1FT, ICS			S
	C5	C5-ALT-1: 6FT, CUT, ICS			S
	C6	C6-ALT-1: GNA, GWM, ICS			DG
D	D1, D2 and D3	D1-ALT-1: D2-ALT-1: D3-ALT-1: MNA, OWM, ICS			SE, O → See Note 4
	D4	D4-ALT-1: SPM			SP → See Note 5

Notes:

[1] The site-wide Remedial Alternatives 1(i) through 1(iii) are identical to each other with the exception of the area remedial alternatives selected for Area Group A as shown. The area remedial alternatives selected for Area Groups B, C and D as part of the site-wide Remedial Alternative 1(i) through 1(iii) are the same.

[2] The descriptions of area groups and approximate location of each area are shown on Figure 1.

[3] The status of the contaminated media within each area is identified either as green which identifies that the media is addressed by the area remedial alternative or red which identifies that the media is not addressed by the area remedial alternative. The green arrows identify the area remedial alternatives that address the contaminated media that are red.

[4] The sources to outfall-water contamination at Areas D1, D2 and D3 are in Areas B1, B2 and C5, respectively. Remedial alternatives for Areas B1, B2 and C5 address outfall-water contamination.

[5] The source to seep-water contamination at Area D4 is contaminated groundwater at Area B2. The remedial alternative for Area B2 addresses seep-water contamination.

Table 37

Site-Wide Remedial Alternative 2

Everett Smelter Site - Lowland Area

Everett, Washington

Area Group[1]	Area ID[1]	Site-Wide Remedial Alternative 2 Following are the Area Remedial Alternatives selected as part of the Site-Wide Remedial Alternative 2	Status of Contaminated Media[2]
A	A1	A1-ALT-3: EXC, GWM	S, S/D, SG, DG
	A2	A2-ALT-3: EXC, GWM	S, SG
B	B1	B1-ALT-1: CAP, 1FT, DWT, GWM, ICS	S, S/D, SG, DG, SW, SE
	B2	B2-ALT-1: CAP, 1FT, PRB, GNA, GWM, SWR, ICS	S, S/D, SG, DG
	B3	B3-ALT-1: 6FT, GNA, GWM, ICS	S, SG
C	C1	C1-ALT-1: GNA, GWM, ICS	DG
	C2	C2-ALT-1: FEN, ICS	S
	C3	C3-ALT-1: FEN, ICS	S
	C4	C4-ALT-1: 1FT, ICS	S
	C5	C5-ALT-1: 6FT, CUT, ICS	S
	C6	C6-ALT-1: GNA, GWM, ICS	DG
D	D1, D2 and D3	D1-ALT-1: D2-ALT-1: D3-ALT-1: MNA, OWM, ICS	SE, O → See Note 3
	D4	D4-ALT-1: SPM	SP → See Note 4

Notes:

[1] The descriptions of area groups and approximate location of each area are shown on Figure 1.

[2] The status of the contaminated media within each area is identified either as green which identifies that the media is addressed by the area remedial alternative or red which identifies that the media is not addressed by the area remedial alternative. The green arrows identify the area remedial alternatives that address the contaminated media that are red.

[3] The sources to outfall-water contamination at Areas D1, D2 and D3 are in Areas B1, B2 and C5, respectively. Remedial alternatives for Areas B1, B2 and C5 address outfall-water contamination.

[4] The source to seep-water contamination at Area D4 is contaminated groundwater at Area B2. The remedial alternative for Area B2 addresses seep-water contamination.

Table 38

Site-Wide Remedial Alternatives 3(i) and 3(ii)[1]

Everett Smelter Site - Lowland Area

Everett, Washington

Area Group[2]	Area ID[2]	Site-Wide Remedial Alternative 3(i)	Site-Wide Remedial Alternative 3(ii)	Status of Contaminated Media[3]
		Following are the Area Remedial Alternatives selected as part of the Site-Wide Remedial Alternative 3(i) and 3(ii)		
A	A1	A1-ALT-2: ISS, GWM, ICS	A1-ALT-3: EXC, GWM	S, S/D, SG, DG
	A2	A2-ALT-2: ISS, GWM, ICS	A2-ALT-3: EXC, GWM	S, SG
B	B1	B1-ALT-2: ISS, CAP, DWT, GWM, ICS		S, S/D, SG, DG, SW, SE
	B2	B2-ALT-2: ISS, CON, GNA, GWM, SWR, ICS		S, S/D, SG, DG
	B3	B3-ALT-2: ISS, GWM, ICS		S, SG
C	C1	C1-ALT-1: GNA, GWM, ICS		DG
	C2	C2-ALT-1: FEN, ICS		S
	C3	C3-ALT-1: FEN, ICS		S
	C4	C4-ALT-2: ISS, ICS		S
	C5	C5-ALT-2: ISS, CUT, ICS		S
	C6	C6-ALT-1: GNA, GWM, ICS		DG
D	D1, D2 and D3	D1-ALT-2: D2-ALT-2: D3-ALT-2: ENA, OWM, ICS		SE, O → See Note 4
	D4	D4-ALT-1: SPM		SP → See Note 5

Notes:

[1] The Site-Wide Remedial Alternatives 3(i) and 3(ii) are identical to each other with the exception of the area remedial alternatives selected for Area Group A as shown. The area remedial alternatives selected for Area Groups B, C and D as part of the Site-Wide Remedial Alternative 3(i) and 3(ii) are the same.

[2] The descriptions of area groups and approximate location of each area are shown on Figure 1.

[3] The status of the contaminated media within each area is identified either as green which identifies that the media is addressed by the area remedial alternative or red which identifies that the media is not addressed by the area remedial alternative. The green arrows identify the area remedial alternatives that address the contaminated media that are red.

[4] The sources to outfall-water contamination at Areas D1, D2 and D3 are in Areas B1, B2 and C5, respectively. Remedial alternatives for Areas B1, B2 and C5 address outfall-water contamination.

[5] The source to seep-water contamination at Area D4 is contaminated groundwater at Area B2. The remedial alternative for Area B2 addresses seep-water contamination.

Table 39

Site-Wide Remedial Alternative 4

Everett Smelter Site - Lowland Area

Everett, Washington

Area Group[1]	Area ID[1]	Site-Wide Remedial Alternative 4 Following are the Area Remedial Alternatives selected as part of the Site-Wide Remedial Alternative 4	Status of Contaminated Media[2]
A	A1	A1-ALT-3: EXC, GWM	S, S/D, SG, DG
	A2	A2-ALT-3: EXC, GWM	S, SG
B	B1	B1-ALT-3: EXC, CAP, DWT, GWM, SWM, ICS	S, S/D, SG, DG, SW, SE
	B2	B2-ALT-3: EXC, CON, GNA, GWM, ICS	S, S/D, SG, DG
	B3	B3-ALT-3: EXC, GWM	S, SG
C	C1	C1-ALT-1: GNA, GWM, ICS	DG
	C2	C2-ALT-2: EXC	S
	C3	C3-ALT-2: EXC, CAP, ICS	S
	C4	C4-ALT-3: EXC	S
	C5	C5-ALT-3: EXC	S
	C6	C6-ALT-1: GNA, GWM, ICS	DG
D	D1, D2 and D3	D1-ALT-3: D2-ALT-3: D3-ALT-3: DRE, OWM	SE, O → See Note 3
	D4	D4-ALT-1: SPM	SP → See Note 4

Notes:

[1] The descriptions of area groups and approximate location of each area are shown on Figure 1.

[2] The status of the contaminated media within each area is identified either as green which identifies that the media is addressed by the area remedial alternative or red which identifies that the media is not addressed by the area remedial alternative. The green arrows identify the area remedial alternatives that address the contaminated media that are red.

[3] The sources to outfall-water contamination at Areas D1, D2 and D3 are in Areas B1, B2 and C5, respectively. The remedial alternatives for Areas B1, B2 and C5 address outfall-water contamination.

[4] The source to seep-water contamination at Area D4 is contaminated groundwater at Area B2. The remedial alternative for Area B2 addresses seep-water contamination.

Table 40

Evaluation of Site-Wide Remedial Alternatives[1]

Everett Smelter Site - Lowland Area
Everett, Washington

Evaluation Criteria	Site-Wide Remedial Alternative 1(i)	Site-Wide Remedial Alternative 1(ii)	Site-Wide Remedial Alternative 1(iii)	Site-Wide Remedial Alternative 2	Site-Wide Remedial Alternative 3(i)	Site-Wide Remedial Alternative 3(ii)	Site-Wide Remedial Alternative 4
Compliance with MTCA Threshold Criteria							
Protection of Human Health and the Environment	**Yes** - Alternative would protect human health and the environment primarily through capping and containment. This Alternative also utilizes in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to protect human health and the environment.	**Yes** - Alternative would protect human health and the environment primarily through in situ soil treatment (S/S) within the source area coupled with capping, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls.	**Yes** - Alternative would protect human health and the environment primarily through soil excavation within the source area coupled with capping, in situ groundwater treatment (shallow/deep PRB), stormwater conveyance system repairs, natural attenuation and institutional controls.	**Yes** - Alternative would protect human health and the environment primarily through soil excavation within the source area coupled with capping, in situ groundwater treatment (shallow PRB), stormwater conveyance system repairs, natural attenuation and institutional controls.	**Yes** - Alternative would protect human health and the environment primarily through site-wide in situ soil treatment (S/S) coupled with capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls.	**Yes** - Alternative would protect human health and the environment primarily through soil excavation within the source area coupled with site-wide in situ treatment (soil S/S), capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls.	**Yes** - Alternative would protect human health and the environment primarily through site-wide soil excavation coupled with capping, containment, natural attenuation and institutional controls.
Compliance With Cleanup Standards	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of these remedial technologies. Future development of property could potentially require additional environmental cleanup or special provisions.	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of in situ soil treatment (S/S), capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of these remedial technologies. Future development of property could potentially require additional environmental cleanup or special provisions.	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of soil excavation, capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of the remedial technologies that leave hazardous substances in place. Future development of property could potentially require additional environmental cleanup or special provisions.	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of soil excavation, capping, containment, in situ groundwater treatment (shallow PRB), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of the remedial technologies that leave hazardous substances in place. Future development of property could potentially require additional environmental cleanup or special provisions.	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of site-wide in situ soil treatment (S/S), capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of these remedial technologies. Future development of property could potentially require additional environmental cleanup or special provisions.	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of soil excavation, site-wide in situ soil treatment (S/S), capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of the remedial technologies that leave hazardous substances in place. Future development of property could potentially require additional environmental cleanup or special provisions.	**Yes -** Alternative is expected to comply with the cleanup standards. This alternative utilizes a combination of site-wide soil excavation, capping, containment, natural attenuation and institutional controls to prevent exposure. Compliance would rely on long-term monitoring and maintenance of the remedial technologies that leave hazardous substances in place. Future development of property could potentially require additional environmental cleanup or special provisions.
Compliance With Applicable State and Federal Regulations	**Yes -** Alternative complies with applicable state and federal regulations.	**Yes -** Alternative complies with applicable state and federal regulations.	**Yes -** Alternative complies with applicable state and federal regulations.	**Yes -** Alternative complies with applicable state and federal regulations.	**Yes -** Alternative complies with applicable state and federal regulations.	**Yes -** Alternative complies with applicable state and federal regulations.	**Yes -** Alternative complies with applicable state and federal regulations.
Provision for Compliance Monitoring	**Yes -** Alternative includes provisions for compliance monitoring.	**Yes -** Alternative includes provisions for compliance monitoring.	**Yes -** Alternative includes provisions for compliance monitoring.	**Yes -** Alternative includes provisions for compliance monitoring.	**Yes -** Alternative includes provisions for compliance monitoring.	**Yes -** Alternative includes provisions for compliance monitoring.	**Yes -** Alternative includes provisions for compliance monitoring.
Restoration Time Frame							
Restoration Time Frame	Restoration time frame is estimated to be on the order of 10 years, which includes implementation of the remedial technologies and performance monitoring for the PRB. Time frame for implementing the technologies is short. Potential future maintenance of the remedial technologies, additional PRB applications and monitoring may extend the restoration time frame of this alternative.	Restoration time frame is estimated to be on the order of 10 years, which includes implementation of the remedial technologies and performance monitoring for the PRB. Time frame for implementing the remedial technologies is short. Potential future maintenance of the remedial technologies, additional PRB applications and monitoring may extend the restoration time frame of this alternative.	Restoration time frame is estimated to be on the order of 10 years, which includes implementation of the remedial technologies and performance monitoring for the PRB. Time frame for implementing the remedial technologies is short. Potential future maintenance of the remedial technologies that leave hazardous substances in place, additional PRB applications and monitoring may extend the restoration time frame of this alternative.	Restoration time frame is estimated to be on the order of 10 years, which includes implementation of the remedial technologies and performance monitoring for the PRB. Time frame for implementing the remedial technologies is short. Potential future maintenance of the remedial technologies that leave hazardous substances in place, additional PRB applications and monitoring may extend the restoration time frame of this alternative.	Restoration time frame is estimated to be on the order of 3 years or less, which includes implementation of technologies followed by 1-year of performance groundwater monitoring. Time frame for implementing alternative 3(i) is relative longer than alternative 1 and 2 due to large scale in situ S/S. Potentially longer implementation time frame and potential future monitoring may extend the restoration time frame of this alternative.	Restoration time frame is estimated to be on the order of 3 years or less, which includes implementation of technologies followed by 1-year of performance groundwater monitoring. Time frame for implementing alternative 3(ii) is relative longer than alternative 1 and 2 due to large scale in situ S/S. Potentially longer implementation time frame and potential future monitoring may extend the restoration time frame of this alternative.	Restoration time frame is estimated to be on the order of 3 years or less, which includes implementation of technologies followed by 1-year of performance groundwater monitoring. Time frame for implementing alternative 4 is relative longer than alternative 1 and 2 due to large scale remedial excavation. Potentially longer implementation time frame and potential future monitoring may extend the restoration time frame of this alternative.

Evaluation Criteria	Site-Wide Remedial Alternative 1(i)	Site-Wide Remedial Alternative 1(ii)	Site-Wide Remedial Alternative 1(iii)	Site-Wide Remedial Alternative 2	Site-Wide Remedial Alternative 3(i)	Site-Wide Remedial Alternative 3(ii)	Site-Wide Remedial Alternative 4
Relative Benefits Ranking (Scored from 1-lowest to 10-highest)							
Protectiveness	**Score = 4** Achieves a medium level of overall protectiveness through the use of capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining these remedial technologies to prevent exposure.	**Score = 6** Achieves a medium level of overall protectiveness through the use of capping, containment, in situ soil and groundwater treatment (S/S and shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining these remedial technologies to prevent exposure.	**Score = 6** Achieves a medium level of overall protectiveness through the use of soil excavation, capping, containment, in situ soil and groundwater treatment (S/S and shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining the remedial technologies that leave hazardous substances in place to prevent exposure.	**Score = 5** Achieves a medium level of overall protectiveness through the use of soil excavation, capping, containment, in situ soil and groundwater treatment (S/S and shallow PRB), stormwater conveyance system repairs, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining the remedial technologies that leave hazardous substances in place to prevent exposure.	**Score = 7** Achieves a high level of overall protectiveness through the use of site-wide in situ soil treatment (S/S), capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining these remedial technologies to prevent exposure.	**Score = 7** Achieves a high level of overall protectiveness through the use of site-wide in situ soil treatment (S/S), soil excavation, capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining the remedial technologies that leave hazardous substances in place to prevent exposure.	**Score = 8** Achieves a high level of overall protectiveness through the use of site-wide soil excavation, capping, containment, natural attenuation and institutional controls. Long-term protectiveness would rely on maintaining the remedial technologies that leave hazardous substances in place to prevent exposure.
Permanence	**Score = 2** Achieves a low level of permanent reduction of mass and toxicity of hazardous substances at the Site. This alternative relies primarily on capping and containment to contain the mass and limit exposure to toxic materials while mobility is reduced through capping, containment, natural attenuation and in situ groundwater treatment (shallow/deep PRBs). Future development may require modification of the remedy.	**Score = 3** Achieves a medium-low level of permanent reduction of mass and toxicity of hazardous substances at the Site. This alternative relies primarily on capping, containment and in situ soil treatment (S/S) to contain the mass and limit exposure to toxic materials while mobility is reduced through capping, containment, in situ soil treatment (S/S), natural attenuation and in situ groundwater treatment (shallow/deep PRBs). Future development may require modification of the remedy.	**Score = 6** Achieves a medium level of permanent reduction of mass, toxicity, and mobility of hazardous substances at the Site. This alternative includes a reduction of mass through soil excavation and offsite disposal from Area A1 and A2. This alternative also relies primarily on capping, containment to contain the mass and limit exposure to toxic materials while mobility is reduced through capping, containment, soil excavation and offsite disposal, natural attenuation and in situ groundwater treatment (shallow/deep PRBs). Future development may require modification of the remedy.	**Score = 6** Achieves a medium level of permanent reduction of mass, toxicity, and mobility of hazardous substances at the Site. This alternative includes a reduction of mass through soil excavation and offsite disposal from Area A1 and A2. This alternative also relies primarily on capping, containment to contain the mass and limit exposure to toxic materials while mobility is reduced through capping, containment, soil excavation and offsite disposal, natural attenuation and in situ groundwater treatment (shallow PRB). Future development may require modification of the remedy.	**Score = 7** Achieves a medium-high level of permanent immobility of hazardous substances at the Site through site-wide in situ soil treatment (S/S). Future development may require modification of the remedy.	**Score = 8** Achieves a medium-high level of permanent immobility of hazardous substances at the Site through site-wide in situ soil treatment (S/S). This alternative also includes a reduction of mass through soil excavation and offsite disposal from Area A1 and A2. Future development may require modification of the remedy.	**Score = 9** Achieves a high level of permanent reduction of mass of hazardous substances at the Site through site-wide soil excavation and offsite disposal. Excavation and offsite disposal greatly reduces the amount of toxic material and material that may be mobilized at the Site.
Long-Term Effectiveness	**Score = 2** This alternative achieves a medium-low level of long-term effectiveness through capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure, but leaves hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining these remedial technologies. Future development may require modification of the remedy.	**Score = 3** This alternative achieves a medium-low level of long-term effectiveness through in situ soil treatment (S/S), capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure, but leaves hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining these remedial technologies. Future development may require modification of the remedy.	**Score = 4** This alternative achieves a medium-low level of long-term effectiveness through soil excavation, capping, containment, in situ groundwater treatment (shallow/deep PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure, but leaves hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining the remedial technologies that leave hazardous substances in place. Future development may require modification of the remedy.	**Score = 4** This alternative achieves a medium-low level of long-term effectiveness through soil excavation, capping, containment, in situ groundwater treatment (shallow PRBs), stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure, but leaves hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining the remedial technologies that leave hazardous substances in place. Future development may require modification of the remedy.	**Score = 7** This alternative achieves a medium level of long-term effectiveness through site-wide in situ soil treatment (S/S), capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure, but leaves hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining these remedial technologies. Future development may require modification of the remedy.	**Score = 8** This alternative achieves a medium level of long-term effectiveness through site-wide in situ soil treatment (S/S), capping, containment, stormwater conveyance system repairs, natural attenuation and institutional controls to prevent exposure, but leaves hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining the remedial technologies that leave hazardous substances in place. Future development may require modification of the remedy.	**Score = 9** This alternative achieves a high level of long-term effectiveness through site-wide soil excavation, capping, containment, natural attenuation and institutional controls to prevent exposure leaving limited hazardous substances in place. The long-term effectiveness of this alternative relies on maintaining the remedial technologies that leave hazardous substances in place. Future development may require modification of the remedy.

Evaluation Criteria	Site-Wide Remedial Alternative 1(i)	Site-Wide Remedial Alternative 1(ii)	Site-Wide Remedial Alternative 1(iii)	Site-Wide Remedial Alternative 2	Site-Wide Remedial Alternative 3(i)	Site-Wide Remedial Alternative 3(ii)	Site-Wide Remedial Alternative 4
Management of Short-Term Risks	**Score = 6** Short-term risks are moderate with this alternative. Capping, containment and institutional controls included with this alternative involves modification of selective surfaces and buried utilities to address hazardous substances. However, it is not expected to pose significant risks to the general public. Modification to surface water features will require mitigation.	**Score = 4** Short-term risks are moderate with this alternative. In situ soil treatment (S/S), capping, containment and institutional controls included with this alternative involves modification of selective surfaces and buried utilities to address hazardous substances. However, it is not expected to pose significant risks to the general public. In situ soil treatment (S/S) is expected to disrupt traffic flow during construction. Modification to surface water features will require mitigation.	**Score = 4** Short-term risks are moderate with this alternative. Soil excavation, capping, containment and institutional controls included with this alternative involves modification of selective surfaces and buried utilities to address hazardous substances. However, it is not expected to pose significant risks to the general public. Soil excavation is expected to disrupt traffic flow during construction. Modification to surface water features will require mitigation.	**Score = 5** Short-term risks are moderate with this alternative. Soil excavation, capping, containment and institutional controls included with this alternative involves modification of selective surfaces and buried utilities to address hazardous substances. However, it is not expected to pose significant risks to the general public. Soil excavation is expected to disrupt traffic flow during construction. Modification to surface water features will require mitigation.	**Score = 3** Short-term risks associated with this alternative would be moderately high. This alternative involves wide spread structure modification of the surface roads and buried utilities through site-wide in situ soil treatment (S/S) to address hazardous substances.	**Score = 3** Short-term risks associated with this alternative would be moderately high. This alternative involves wide spread structure modification of the surface roads and buried utilities through site-wide in situ soil treatment (S/S) and soil excavation to address hazardous substances.	**Score = 2** Short-term risks associated with this alternative would be moderately high. This alternative involves wide spread structure modification of the surface roads, buried utilities and the wetland area through site-wide in soil excavation to address hazardous substances.
Technical and Administrative Implementability	**Score = 8** Moderate challenge to implement. Implementation of remedial technologies utilizes standard construction methods. Administrative implementability of surface water features mitigation and institutional controls is high.	**Score = 6** Moderate challenge to implement. Implementation of remedial technologies generally utilizes standard construction methods, but will require specialty equipment for in situ soil treatment (S/S), rerouting of utilities in rights-of-ways and generate materials for off-site disposal. Administrative implementability of surface water features mitigation and institutional controls is high.	**Score = 7** Moderate challenge to implement. Implementation of remedial technologies utilizes standard construction methods, but will require rerouting of utilities in rights-of-ways and generate materials for off-site disposal. Administrative implementability of surface water features mitigation and institutional controls is high.	**Score = 7** Moderate challenge to implement. Implementation of remedial technologies utilizes standard construction methods, but will require rerouting of utilities in rights-of-ways and generate materials for off-site disposal. Administrative implementability of surface water features mitigation and institutional controls is high.	**Score = 4** Difficult to implement due to the design and coordination associated with shoring and rerouting of utilities in adjacent rights-of-way and use of specialty equipment for in situ soil treatment (S/S). Administrative implementability of institutional controls is high.	**Score = 4** Difficult to implement due to the design and coordination associated with shoring and rerouting of utilities in adjacent rights-of-way and utilizes specialty equipment for in situ soil treatment (S/S). Administrative implementability of institutional controls is high.	**Score = 5** Difficult to implement due to the design and coordination associated with shoring and rerouting of utilities in adjacent rights-of-way and will generate a significant volume of material for off-site disposal. Remedial alternative will require development of institutional controls in areas in which hazardous substances remain in place.
Consideration of Public Concerns	**Score = 3** Residual contamination remaining in place could result in concerns by the public and nearby property owners.	**Score = 3** Residual contamination remaining in place could result in concerns by the public and nearby property owners. In situ soil treatment (S/S) require rerouting of traffic.	**Score = 4** Residual contamination remaining in place could result in concerns by the public and nearby property owners. Soil excavation in right-of-ways will require rerouting of traffic. However, will result in the removal of the primary source areas to groundwater contamination.	**Score = 4** Residual contamination remaining in place could result in concerns by the public and nearby property owners. Soil excavation in right-of-ways will require rerouting of traffic. However, will result in the removal of the primary source areas to groundwater contamination.	**Score = 6** Residual contamination remaining in place could result in concerns by the public and nearby property owners. However, exposure risk is significantly reduced through in situ soil treatment (S/S). Soil treatment in right-of-ways will require rerouting of traffic. However, will result in the removal of the primary source areas to groundwater contamination.	**Score = 6** Residual contamination remaining in place could result in concerns by the public and nearby property owners. However, exposure risk is significantly reduced through in situ soil treatment (S/S) and source area removal. Soil excavation in right-of-ways will require rerouting of traffic. However, will result in the removal of the primary source areas to groundwater contamination.	**Score = 7** Soil excavation in right-of-ways will require rerouting of traffic, however, will result in a significant reduction in contaminant mass at the Site. Residual contamination remaining in isolated areas could result in concerns by the public and nearby property owners.

Notes:

[1] Detailed descriptions for Remedial Alternatives 1(i) through Remedial Alternative 4 are presented in Tables 11 through Table 23.

PRB = permeable reactive barrier

S/S = stabilization and solidification

Table 41

Summary of Evaluation and Ranking of Site-Wide Remedial Alternatives

Everett Smelter Site - Lowland Area

Everett, Washington

Remedial Alternative	Site-Wide Remedial Alternative 1(i)	Site-Wide Remedial Alternative 1(ii)	Site-Wide Remedial Alternative 1(iii)	Site-Wide Remedial Alternative 2	Site-Wide Remedial Alternative 3(i)	Site-Wide Remedial Alternative 3(ii)	Site-Wide Remedial Alternative 4
Evaluation							
Compliance with MTCA Threshold Criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Restoration Time Frame	5-10 years	5-10 years	5-10 years	5-10 years	2-3 years	2-3 years	1-2 years
Relative Benefits Ranking[1]							
Protectiveness (weighted as 30%)	1.2	1.8	1.8	1.5	2.1	2.1	2.4
Permanence (weighted as 20%)	0.4	0.6	1.2	1.2	1.4	1.6	1.8
Long-Term Effectiveness (weighted as 20%)	0.4	0.6	0.8	0.8	1.4	1.6	1.8
Management of Short-Term Risks (weighted as 10%)	0.6	0.4	0.4	0.5	0.3	0.3	0.2
Technical and Administrative Implementability (weighted as 10%)	0.8	0.6	0.7	0.7	0.4	0.4	0.5
Consideration of Public Concerns (weighted as 10%)	0.3	0.3	0.4	0.4	0.6	0.6	0.7
Total of Scores	**3.7**	**4.3**	**5.3**	**5.1**	**6.2**	**6.6**	**7.4**
Disproportionate Cost Analysis							
Probable Remedy Cost (+50%/-30%, rounded)	$14,700,000	$17,600,000	$20,400,000	$18,800,000	$107,200,000	$110,100,000	$221,400,000
Costs Disproportionate to Incremental Benefits	No	No	No	No	Yes	Yes	Yes
Practicability of Remedy	Practicable	Practicable	Practicable	Practicable	Not Practicable	Not Practicable	Not Practicable
Remedy Permanent to Maximum Extent Practicable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overall Alternative Ranking	**4th**	**3rd**	**2nd**	**1st**	**6th**	**5th**	**7th**

Note:

[1] Weightings were established by Ecology as referenced in Opinion Letter dated December 28, 2009.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Data Sources: ESRI Data & Maps

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Everett Smelter - Lowland Area

GeoEngineers

Figure 1

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Legend

- Everett Smelter Lowland Area
- Everett Smelter Upland Area
- Former Everett Smelter Facility Boundary

N
W E
S

700 0 700
Feet

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Everett Smelter Site	
Everett Smelter Site - Lowland Area	
GeoEngineers	Figure 2

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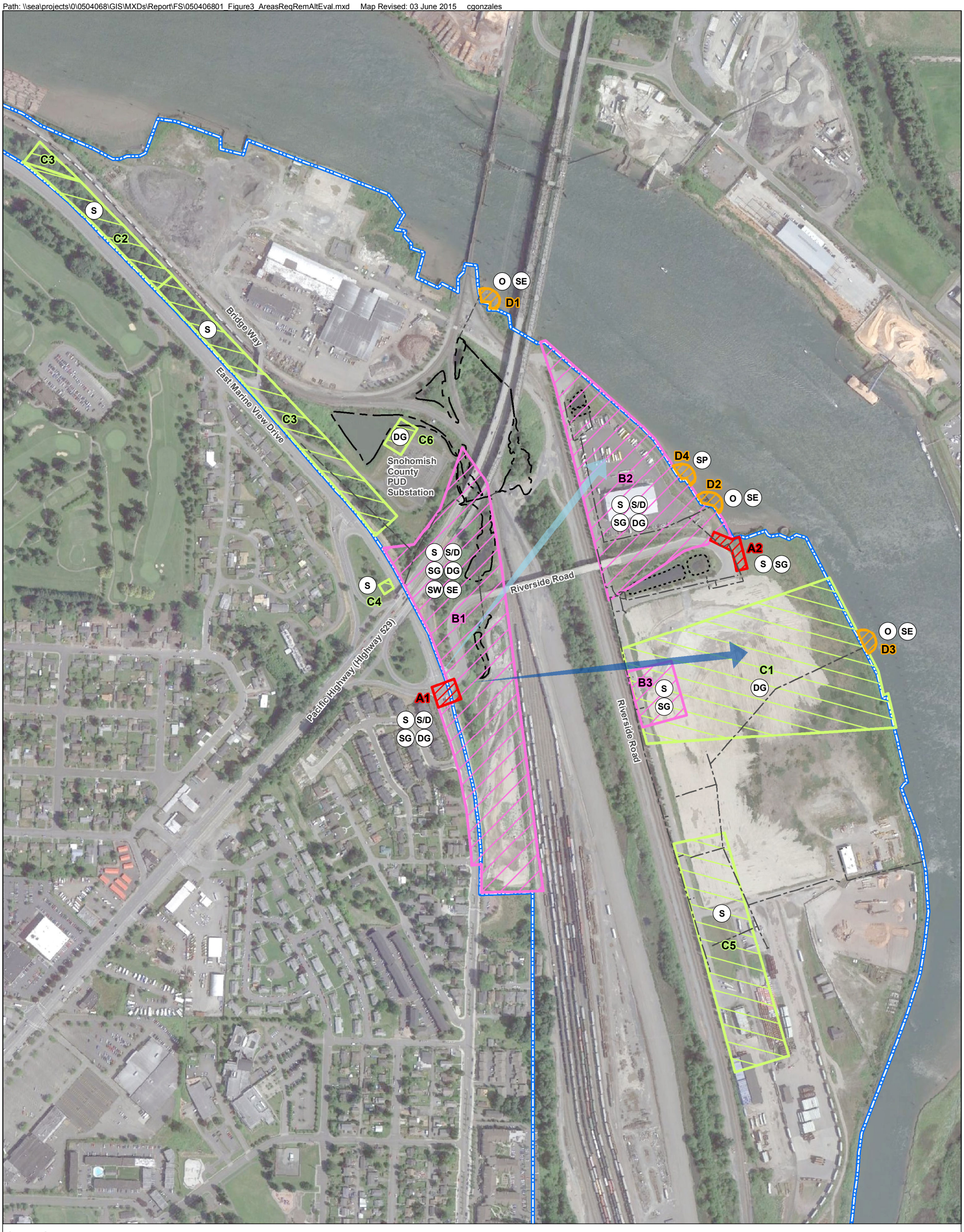

Legend

Areas Requiring Remedial Alternatives Evaluation

- Area Group "A" - Contaminated upland areas that are primary sources to groundwater contamination and contain multiple media requiring remedial alternative evaluation.
- Area Group "B" - Contaminated upland areas that are contributing sources to groundwater contamination and contain multiple media requiring remedial alternative evaluation.
- Area Group "C" - Contaminated upland areas that do not contain source material to groundwater contamination and contain only one media requiring remedial alternative evaluation.
- Area Group "D" - Contaminated marine areas.

- Lowland Area
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction

Contaminated Media

- S — Soil
- S/D — Slag or Debris
- SG — Shallow Groundwater
- DG — Deep Groundwater
- SW — Surface Water
- SP — Seep Water
- O — Outfall Water
- SE — Sediment

N W E S

450 0 450

Feet

Notes:
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Areas Requiring Remedial Alternatives Evaluation

Everett Smelter - Lowland Area

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Figure 3

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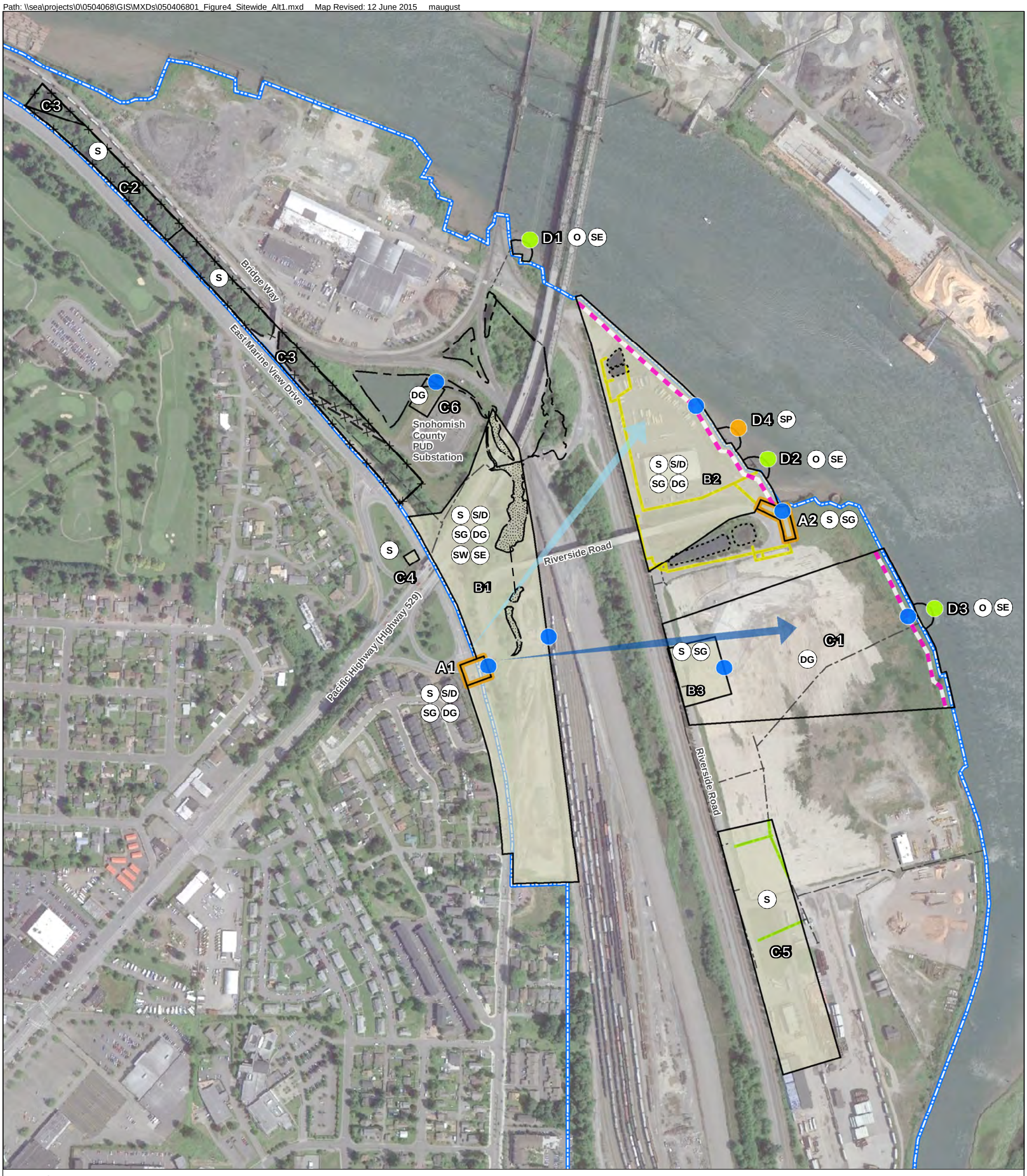

Legend

- Areas Requiring Remedial Alternatives Evaluation
- Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, a minimum of 1 foot of clean soil cover with underlying layer of plastic (or similar) or a minimum of 6-feet of clean soil cover.
- Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1
- Install fence
- Install physical vertical barrier (sheet pile and/or slurry wall) to contain contaminated material[1]
- Install permeable reactive barrier (PRB) to treat contaminated groundwater
- Cut and plug underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3
- Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2
- Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.
- Monitor outfall-water and sediment conditions at the area to evaluate performance of the remedies/natural recovery processes/compliance with the cleanup standards.
- Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction
- Lowland Area
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain

Contaminated Media

S	Soil	SW	Surface Water
S/D	Slag or Debris	SP	Seep Water
SG	Shallow Groundwater	O	Outfall Water
DG	Deep Groundwater	SE	Sediment

N W E S

450 0 450

Feet

Site-Wide Remedial Alternative 1(i)

Everett Smelter - Lowland Area

GeoEngineers

Figure 4

Notes:
1. Locations and depths of contamination at the Lowland Area are presented in the SRI Report (GeoEngineers, 2015). 2. The locations of all features shown are approximate.
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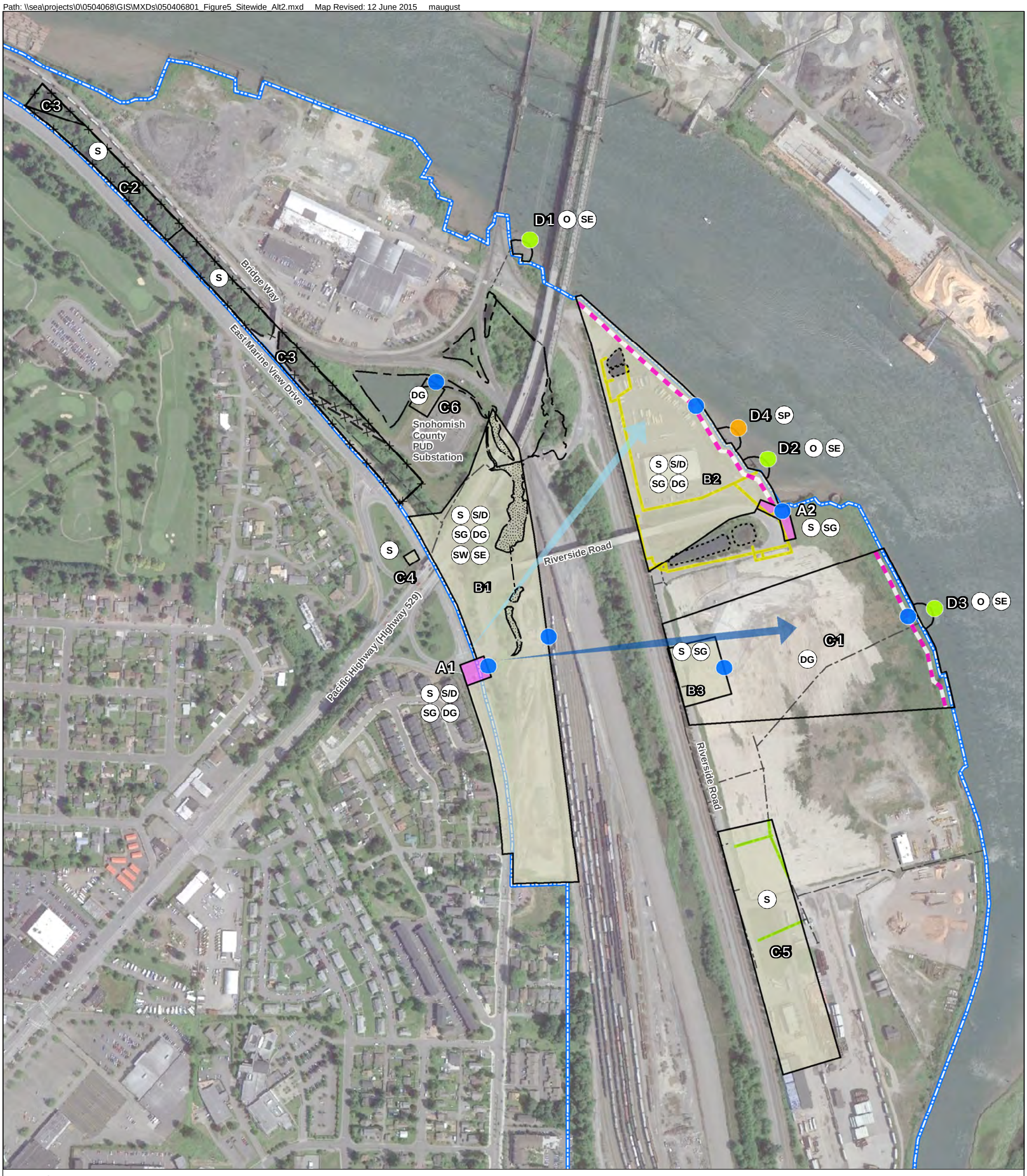

Legend

- Areas Requiring Remedial Alternatives Evaluation
- Perform in situ stabilization of contaminated material[1]
- Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, a minimum of 1 foot of clean soil cover with underlying layer of plastic (or similar) or a minimum of 6-feet of clean soil cover.
- Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1
- Install fence
- Install permeable reactive barrier (PRB) to treat contaminated groundwater
- Cut and plug underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3
- Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2
- Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.
- Monitor outfall-water and sediment conditions at the area to evaluate performance of the remedies/natural recovery processes/compliance with the cleanup standards.
- Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction
- Lowland
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain

Contaminated Media

S	Soil	SW	Surface Water
S/D	Slag or Debris	SP	Seep Water
SG	Shallow Groundwater	O	Outfall Water
DG	Deep Groundwater	SE	Sediment

N W E S

450 0 450

Feet

Site-Wide Remedial Alternative 1(ii)

Everett Smelter - Lowland Area

GeoEngineers

Figure 5

Notes:
1. Locations and depths of contamination at the Lowland Area are presented in the SRI Report (GeoEngineers, 2015). 2. The locations of all features shown are approximate.
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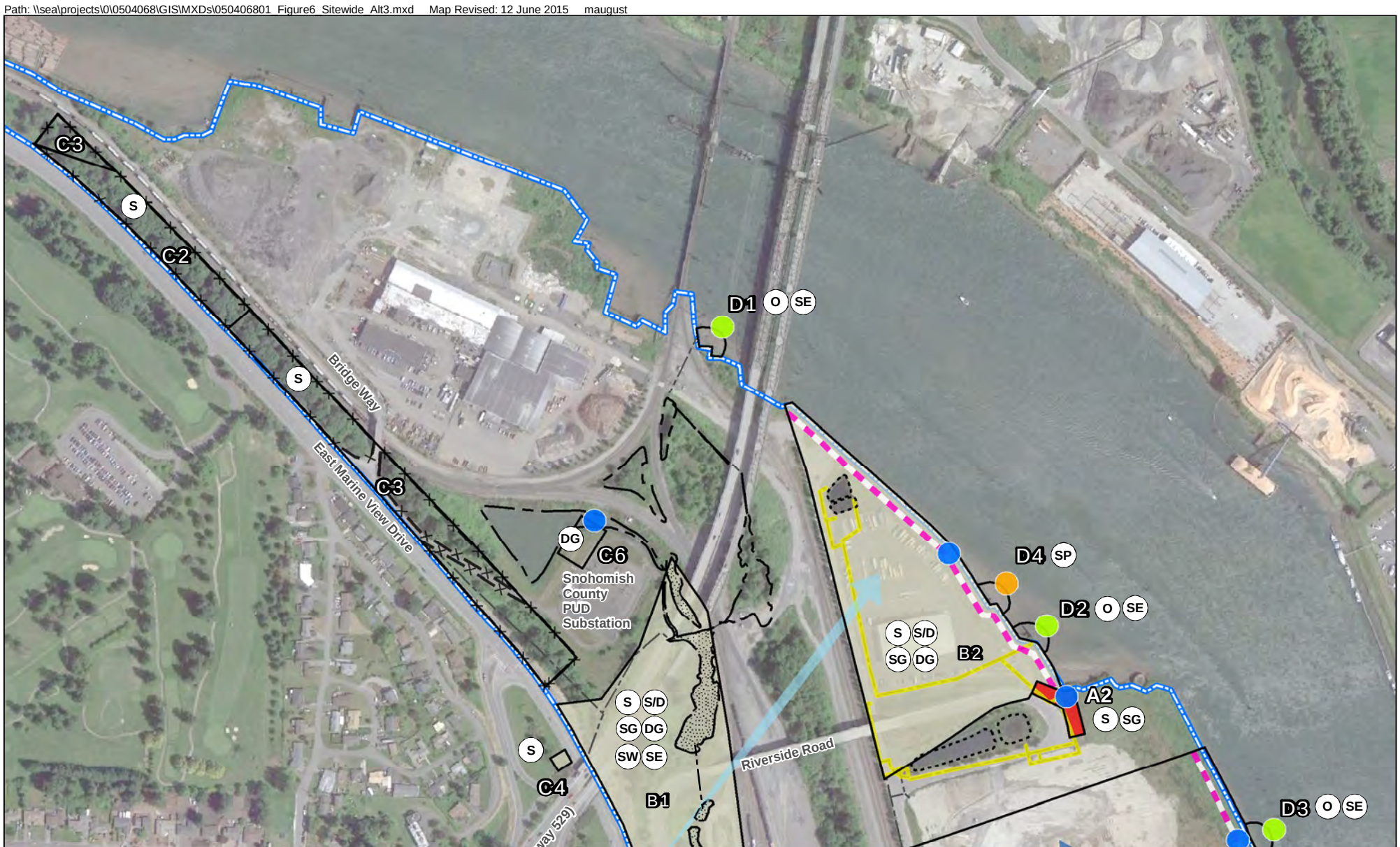

Legend

- Areas Requiring Remedial Alternatives Evaluation
- Perform excavation and off-site disposal of contaminated material[1]
- Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, a minimum of 1 foot of clean soil cover with underlying layer of plastic (or similar) or a minimum of 6-feet of clean soil cover.
- Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1
- Install fence
- Install permeable reactive barrier (PRB) to treat contaminated groundwater
- Cut and plug underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3
- Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2

Contaminated Media

S	Soil	SW	Surface Water
S/D	Slag or Debris	SP	Seep Water
SG	Shallow Groundwater	O	Outfall Water
DG	Deep Groundwater	SE	Sediment

- Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.
- Monitor outfall-water and sediment conditions at the area to evaluate performance of the remedies/natural recovery processes/compliance with the cleanup standards.
- Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction
- Lowland Area
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain

N W E S

450 0 450
Feet

Notes:
1. Locations and depths of contamination at the Lowland Area are presented in the SRI Report (GeoEngineers, 2015). 2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Site-Wide Remedial Alternative 1(iii)

Everett Smelter - Lowland Area

GeoEngineers

Figure 6

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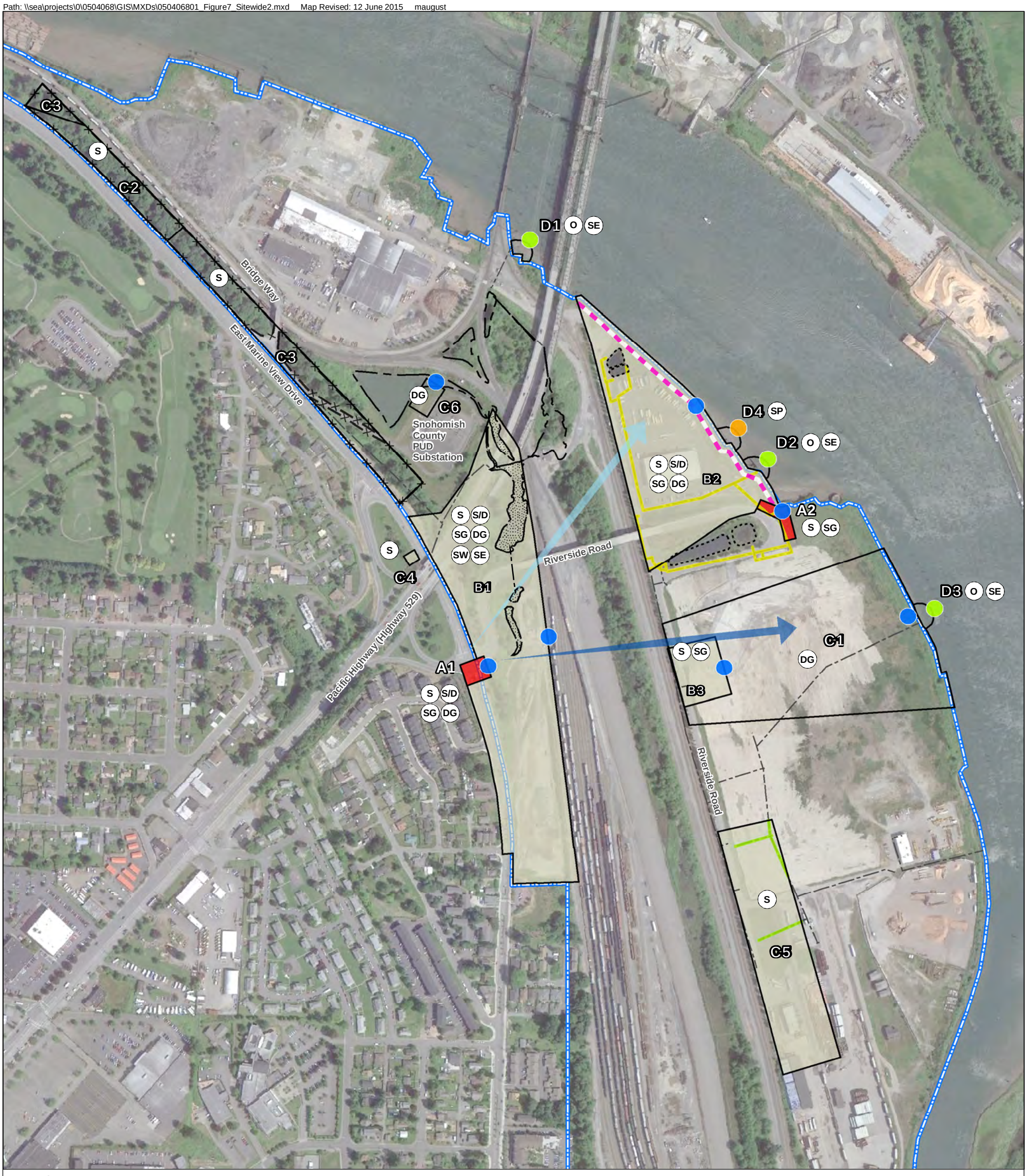

Legend

- Areas Requiring Remedial Alternatives Evaluation
- Perform excavation and off-site disposal of contaminated material[1]
- Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, a minimum of 1 foot of clean soil cover with underlying layer of plastic (or similar) or a minimum of 6-feet of clean soil cover.
- Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1
- Install fence
- Install permeable reactive barrier (PRB) to treat contaminated groundwater
- Cut and plug underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3
- Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2
- Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.
- Monitor outfall-water and sediment conditions at the area to evaluate performance of the remedies/natural recovery processes/compliance with the cleanup standards.
- Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction
- Lowland Area
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain

Contaminated Media

S Soil	SW Surface Water
S/D Slag or Debris	SP Seep Water
SG Shallow Groundwater	O Outfall Water
DG Deep Groundwater	SE Sediment

N W E S

450 0 450

Feet

Site-Wide Remedial Alternative 2

Everett Smelter - Lowland Area

GeoEngineers

Figure 7

Notes:
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Path: \\sea\projects\0\0504068\GIS\MXDs\050406801_Figure8_Sitewide3i.mxd Map Revised: 12 June 2015 maugust

Legend

- Areas Requiring Remedial Alternatives Evaluation
- Perform in situ stabilization of contaminated material[1]
- Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1
- Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, clean soil cover with underlying layer of plastic (or similar) or a 6-foot of clean soil cover.
- Place thin layer of clean sand (approximately 10 cm [i.e. thickness of biologically active zone]) to enhance natural sediment recovery
- Install fence
- Cut and plug underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3
- Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2
- Install physical vertical barrier (sheet pile and/or slurry wall) to contain contaminated material[1]
- Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.
- Monitor outfall-water and sediment conditions at the area to evaluate performance of the remedies/natural recovery processes/compliance with the cleanup standards.
- Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction
- Lowland Area
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain

Contaminated Media

S Soil	SW Surface Water
S/D Slag or Debris	SP Seep Water
SG Shallow Groundwater	O Outfall Water
DG Deep Groundwater	SE Sediment

N W E S

450 0 450

Feet

Site-Wide Remedial Alternative 3(i)

Everett Smelter - Lowland Area

GeoEngineers

Figure 8

Notes:
1. Locations and depths of contamination at the Lowland Area are presented in the SRI Report (GeoEngineers, 2015). 2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Source: GoogleEarth Pro, 2013. Snohomish County GIS, 2012. Washington State Department of Ecology

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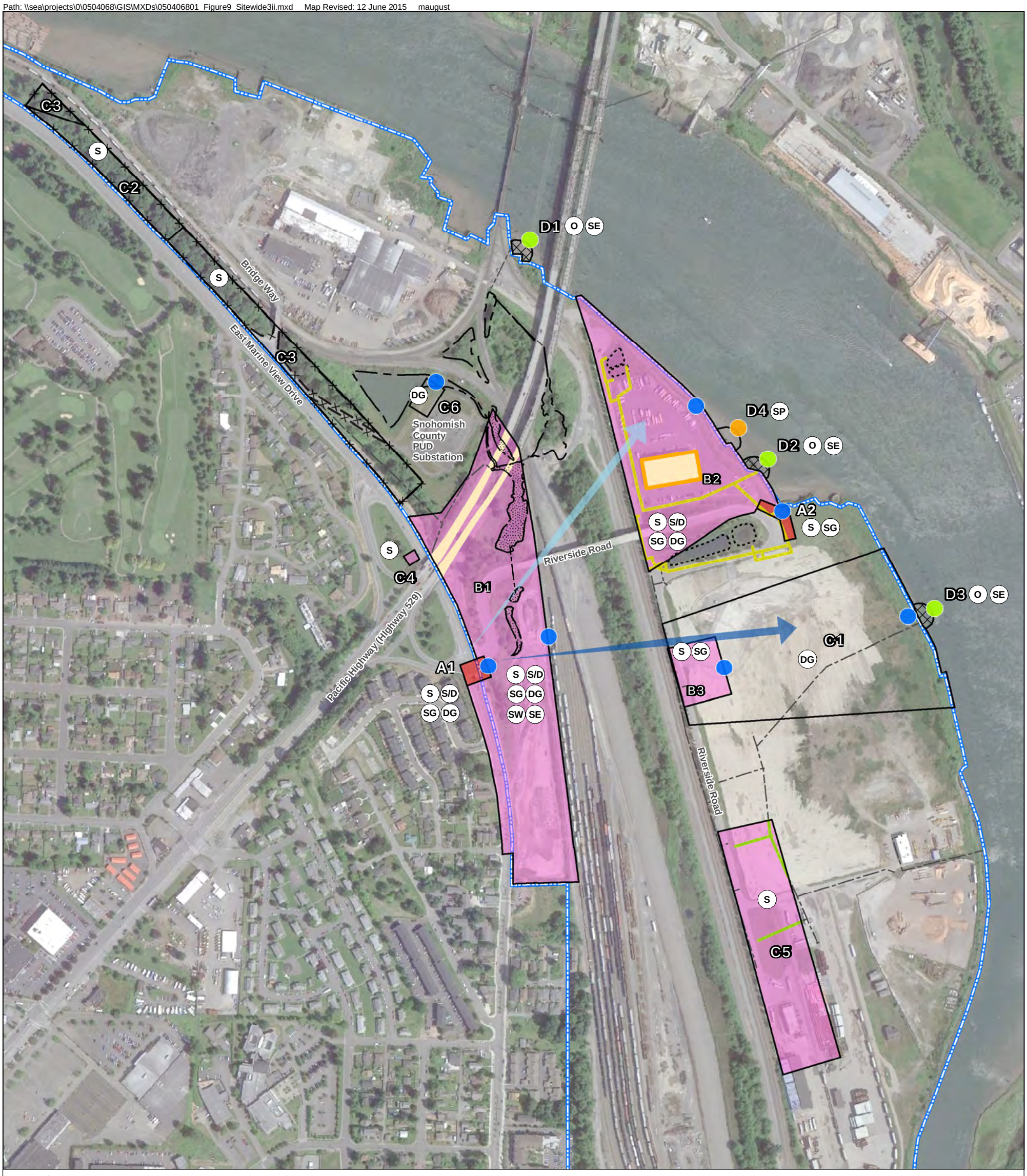

Legend

- Areas Requiring Remedial Alternatives Evaluation
- Perform in situ stabilization of contaminated material[1]
- Perform excavation and off-site disposal of contaminated material[1]
- Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1
- Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, clean soil cover with underlying layer of plastic (or similar) or a 6-foot of clean soil cover.
- Place thin layer of clean sand (approximately 10 cm [i.e. thickness of biologically active zone]) to enhance natural sediment recovery
- Install fence
- Cut and plug underdrains that are potentially responsible for transport of contaminants from Area C5 to the outfall at Area D3
- Repairs, lining or replacement of stormwater pipes that may allow infiltration and are potentially responsible for transport of contaminants from Area B2 to the outfall at Area D2
- Install physical vertical barrier (sheet pile and/or slurry wall) to contain contaminated material[1]
- Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.
- Monitor outfall-water and sediment conditions at the area to evaluate performance of the remedies/natural recovery processes/compliance with the cleanup standards.
- Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.
- Shallow Groundwater Flow Direction
- Deep Groundwater Flow Direction
- Lowland Area
- Surface Water Features (Wetland, Pond or Ditch)
- Stormwater Basin
- Stormwater Pipe, Culvert and/or Under Drain

Contaminated Media

S	Soil	SW	Surface Water
S/D	Slag or Debris	SP	Seep Water
SG	Shallow Groundwater	O	Outfall Water
DG	Deep Groundwater	SE	Sediment

N W E S

450 0 450

Feet

Site-Wide Remedial Alternative 3(ii)

Everett Smelter - Lowland Area

GeoEngineers

Figure 9

Notes:
1. Locations and depths of contamination at the Lowland Area are presented in the SRI Report (GeoEngineers, 2015). 2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Source: GoogleEarth Pro, 2013. Snohomish County GIS, 2012. Washington State Department of Ecology

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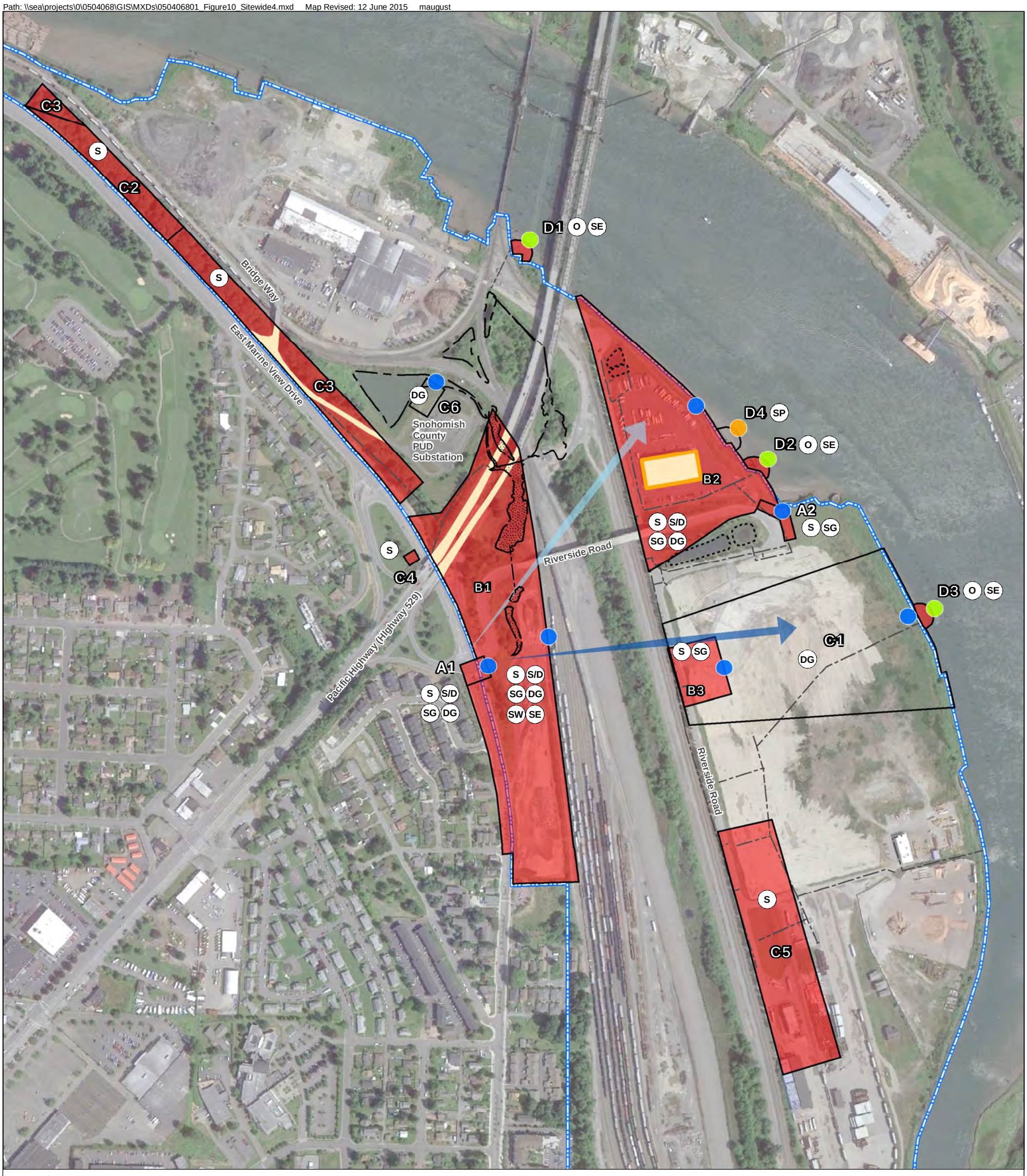

Legend

Areas Requiring Remedial Alternatives Evaluation

Perform excavation/dredging and off-site disposal of contaminated material[1]

Dewater, treat (if necessary) and dispose surface water that discharges as outfall-water at Area D1

Maintain existing pavement and construct (where necessary) cap over the portions that contain contaminated material[1]. Cap types include an asphalt/concrete cap, clean soil cover with underlying layer of plastic (or similar) or a 6-foot of clean soil cover.

Install physical vertical barrier (sheet pile and/or slurry wall) to contain contaminated material[1]

Contaminated Media

- S Soil
- S/D Slag or Debris
- SG Shallow Groundwater
- DG Deep Groundwater
- SW Surface Water
- SP Seep Water
- O Outfall Water
- SE Sediment

Monitor groundwater conditions at/downgradient of the area to evaluate performance of the remedies/natural attenuation processes/compliance with the cleanup standards.

Monitor outfall-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.

Monitor seep-water conditions at the area to evaluate performance of the remedies/compliance with the cleanup standards.

Shallow Groundwater Flow Direction

Deep Groundwater Flow Direction

Lowland Area

Surface Water Features (Wetland, Pond or Ditch)

Stormwater Basin

Stormwater Pipe, Culvert and/or Under Drain

N W E S

450 0 450

Feet

Site-Wide Remedial Alternative 4

Everett Smelter - Lowland Area

GeoEngineers

Figure 10

Notes:
1. Locations and depths of contamination at the Lowland Area are presented in the SRI Report (GeoEngineers, 2015). 2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Source: GoogleEarth Pro, 2013. Snohomish County GIS, 2012. Washington State Department of Ecology

APPENDIX A
Report Limitations and Guidelines for Use

APPENDIX A
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Environmental Services are Performed for Specific Purposes, Persons and Projects

GeoEngineers has performed this investigation of the Everett Smelter – Lowland Area in general accordance with the contract (Contract No.: C1100145AA) and scope and limitations of associated project proposals. This report has been prepared for the exclusive use of Washington State Department of Ecology, and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other properties.

GeoEngineers structures our services to meet the specific needs of our clients. For example, an ESA study conducted for a property owner may not fulfill the needs of a prospective purchaser of the same property. Because each environmental study is unique, each environmental report is unique, prepared solely for the specific client and property. No one except Washington State Department of Ecology should rely on this environmental report without first conferring with GeoEngineers. Use of this report is not recommended for any purpose or project except the one originally contemplated.

This Environmental Report is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Everett Smelter – Lowland Area. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

If important changes are made to the project or property after the date of this report, we recommend that GeoEngineers be given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Reliance Conditions for Third Parties

Our report was prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree to such reliance in advance and in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and

1 Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

budget, our services have been executed in accordance with our Agreement with the Client and generally accepted environmental practices in this area at the time this report was prepared.

Environmental Regulations are Always Evolving

Some substances may be present in the vicinity of the subject property in quantities or under conditions that may have led, or may lead, to contamination of the subject property, but are not included in current local, state or federal regulatory definitions of hazardous substances or do not otherwise present current potential liability. GeoEngineers cannot be responsible if the standards for appropriate inquiry, or regulatory definitions of hazardous substances, change or if more stringent environmental standards are developed in the future.

Conditions Can Change

This environmental report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the subject property, by new releases of hazardous substances, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Please contact GeoEngineers before applying this report for its intended purpose so that GeoEngineers may evaluate whether changed conditions affect the continued applicability of the report.

Most Environmental Findings are Professional Opinions

Our interpretations of site conditions are based on field observations and analytical data from widely spaced sampling locations at the subject property. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an informed opinion about subsurface conditions throughout the property. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) are less exact than other engineering and natural science disciplines. Without this understanding, there may be expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you need to know more about how these “Report Limitations and Guidelines for Use” apply to your project or property.