

Revised Focused Feasibility Study

Bolon Island Graving Dock

Reedsport, Oregon

ECSI File #5361

Prepared by:

Alpine Environmental Consultants, LLC

Mr. Jonathan Williams, R.G.

12210 Antioch Road

White City, Oregon 97503

541.944.4685

jwilliams@alpine-env-llc.com

Prepared for:

Knife River Materials

Mr. Tom Gruszczenski, P.E.

P.O. Box 1145

Medford, Oregon 97501

August 2, 2023



ALPINE ENVIRONMENTAL CONSULTANTS, LLC

TABLE OF CONTENTS

1	EXECUTIVE SUMMARY	1
2	INTRODUCTION	4
2.1	Administrative Requirements	4
2.2	Report Organization	4
3	SITE DESCRIPTION AND HISTORY	6
3.1	Site Description	6
3.2	Site Background	6
3.2.1	Historic Site Development and Usage	6
3.2.2	Site Ownership History	7
4	PREVIOUS ENVIRONMENTAL INVESTIGATIONS AND FINDINGS	8
4.1	Previous Environmental Investigations	8
4.2	Findings of Previous Environmental Investigations	10
4.3	Hot Spot Determination	11
4.4	Groundwater Beneficial Use Determination	11
4.5	Conceptual Site Model	11
4.5.1	Sources	12
4.5.2	Chemical Fate and Transport	12
4.5.3	Potential Human Health Exposure Scenarios	12
4.5.4	Potential Ecological Exposure Scenarios	13
5	REMEDIAL ACTION OBJECTIVES	15
5.1	Site Remedial Action Objectives	15
5.2	Soil Hot Spot Determination	15
5.3	Area/Volume	15
6	IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES	16
6.1	General Response Actions	16
6.2	Technology Descriptions	16
6.2.1	No Action	16
6.2.2	Institutional Controls	16
6.2.3	Engineering Controls	17
6.2.4	Treatment	17
6.2.5	Excavation and Off-Site Disposal	18
6.3	Technology Screening	18
6.4	Screening Results	18



6.5	Alternative Descriptions and Conceptual Design	19
6.5.1	Alternative 1 – No Action	19
6.5.2	Alternative 2 – Excavation and Off-Site Disposal	19
6.5.3	Alternative 3 – Aggregate Capping with Institutional Controls	19
6.5.4	Alternative 4 – Asphalt Capping with Institutional Controls	20
7	COMPARATIVE ANALYSIS OF ALTERNATIVES	21
7.1	Evaluation Criteria	21
7.1.1	Protectiveness	21
7.1.2	Balancing Factors	22
7.1.2.1	Effectiveness	22
7.1.2.2	Long-term Reliability	22
7.1.2.3	Implementability	23
7.1.2.4	Implementation Risk	24
7.1.2.5	Reasonableness of Cost	25
8	CONCLUSIONS	26
9	REFERENCES	28
10	QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONAL	30



ATTACHMENTS

LIST OF FIGURES

Figure 1 – Site Location Map

Figure 2 – Site Map with Property Boundary

Figure 3 – Alternatives 2 and 3 – General Layout Map

Figure 4 – Alternatives 2 and 3 - Details

LIST OF TABLES

Table 1 – Oregon Administrative Rules Pertinent to the Feasibility Study

Table 2 – Technology Screening Results Summary

Table 3 – Ranking of Remedy Alternatives

Table 4 – Alternatives Cost Details

LIST OF APPENDICES

Appendix 1 – Analytical Results Tables from the 2018 Phase II Report

Appendix 2 – Figures from the 2018 Phase II Report

Appendix 3 – Groundwater Beneficial Use Determination Results

Appendix 4 – Conceptual Site Model Figures for Sediment, Soil, and Groundwater



1 EXECUTIVE SUMMARY

This revised Focused Feasibility Study (FFS) report summarizes an evaluation of remedial action alternatives for the Bolon Island Graving Dock located in Douglas County immediately north of Reedsport, Oregon (the Site) and incorporates responses to comments received in a letter from the Oregon Department of Environmental Quality (DEQ) dated June 17, 2022. The graving dock was constructed sometime between 1945 and 1954 by Umpqua River Navigation (URN) and acquired in May 2000 by LTM Incorporated dba Knife River Materials (KRM). The graving dock was exclusively operated by URN and subsequently KRM for the maintenance of URN's River Mining Equipment (dredges and barges). The dredges and barges were used to mine the Umpqua River upstream of the Site for sand and gravel under the Oregon Department of State Lands (DSL) Royalty License SG-43 App #16097 which expired on April 30, 2010, and was not renewed. The river mining equipment was maintained as needed in the graving dock. The river mining equipment was all sold by circa 2011.

The Site is listed under the Oregon Department of Environmental Quality's (DEQ's) Environmental Cleanup Site Information (ESCI) Database as File #5361. On August 3, 2010, KRM submitted an application for the Site to enter DEQ's Voluntary Cleanup Pathway (VCP) through the Independent Cleanup Pathway (ICP), and a Phase II Environmental Investigation, human health risk assessment, and ecological risk assessments were completed under DEQ oversight.

The results of the Phase II Environmental Investigation involving the collection and laboratory analyses of soil and samples in upland areas and surface and subsurface sediment samples in both upland areas and the Umpqua River estuary were evaluated to determine if Site-related contamination posed unacceptable risks to human and ecological receptors in both the upland and estuary areas. Based on this evaluation, the following conclusions were made:

- Benzo(a)pyrene in five of 11 samples in upland soil and sediment was reported at concentrations that exceed the respective generic risk-based concentration (RBC) for the *soil ingestion, dermal contact, and inhalation exposure pathway* for occupational receptors.
- Lead in 10 of 33 samples and naphthalene in one of 11 samples in upland soil and sediment were reported at concentrations that exceed the generic RBC for the *leaching to groundwater exposure pathway* for occupational receptors. However, there are no wells on the Site and the Site is provided with municipal water.
- No other constituents were reported in upland soil and sediment at concentrations that exceed relevant generic RBCs.
- The results of a Level I Ecological Scoping Assessment indicated no further ecological evaluations are needed for upland soil. However, benthic and aquatic species in the estuary have the potential to contact Site-related chemicals in sediment and surface water and a Level II Ecological Screening Assessment was warranted.



- The results of a Level II Ecological Screening Assessment, including the development of Site-specific screening level values (SLVs) for tri-butyl-tin (TBT) in estuary sediment, indicate there are no unacceptable risks to ecological receptors or recreational fishers.

Remedial technologies were screened for effectiveness, long-term reliability, ease of implementation, and relative cost. The remedial technologies retained after screening were used to assemble remedial alternatives. These alternatives were then further evaluated against DEQ balancing factors.

Remedial action objectives (RAOs) for the Site are the following:

- Reduce human exposure to benzo(a)pyrene in upland soil reported at concentrations that exceed respective generic RBC for the *soil ingestion, dermal contact, and inhalation exposure pathway* in five of 11 samples for occupational receptors to achieve acceptable risk levels for current and reasonably likely future land use conditions.
- Because lead at 10 of 33 sample locations and naphthalene at one of 11 sample locations in upland soil and sediment were reported at concentrations that exceed the generic RBC for the *leaching to groundwater exposure pathway* for occupational receptors, reduce human exposure to groundwater that might contain elevated levels of lead and naphthalene to achieve acceptable risk levels for current and reasonably likely future land use conditions.
- While reported concentrations of TBT in estuary sediment do not pose unacceptable risks to ecological receptors and recreational fishers, minimize or eliminate the migration through wind and water erosional processes of upland soil containing TBT into estuary sediment. Minimizing or eliminating this potential source of TBT to estuary sediment will maintain protectiveness of estuarine ecological receptors and recreational fishers in the future.

Remedial action alternatives evaluated included excavation and off-Site disposal, on-Site engineering controls, and implementing administrative controls. A no-action alternative was also evaluated against remedial action objectives. Conclusions drawn from the evaluation include the following:

- Excavation and off-Site disposal provide a permanent, protective remedial action according to Oregon Administrative Rule (OAR) 340-122-0040. This option prevents the threat of release of hazardous substances in a manner that assures protection of present and future public health, safety, and welfare. However, the relative cost of excavation and off-Site disposal is high.
- Backfilling of the graving dock area below the mean high water line with clean fill and capping with aggregate or asphalt of the entire former graving dock work area, including ancillary upland features such as maintenance buildings and spoil piles, is considered protective because it eliminates exposure pathways under current and future anticipated commercial use scenarios. In conjunction with regular inspection and cap maintenance, capping with aggregate or asphalt will meet the RAOs at a relatively low cost. Capping



with aggregate has a lower cost than capping with asphalt so capping with aggregate is recommended as the final remedy to be implemented.

- The no-action alternative will not result in acceptable risk levels as defined in OAR 340-122-0115(1), so was not retained even though the cost was relatively low.



2 INTRODUCTION

The purpose of this revised FFS report is to develop sufficient information to facilitate the selection and recommendation of a remedial action alternative. This revised FFS report includes a screening evaluation of available technologies and a comparative evaluation of applicable technologies that could achieve the remedial action objectives for the Site. Based on these evaluations, remedial action alternatives that would be protective of human health and the environment are presented. This revised FFS report builds upon the original FFS report dated October 15, 2021 (AEC, 2021), and incorporates responses to comments documented in a letter from AEC to DEQ dated February 14, 2022 (AEC, 2022), a letter from DEQ dated June 17, 2022 (DEQ, 2022), and in an email from DEQ dated April 3, 2023 (DEQ, 2023).

2.1 Administrative Requirements

This FFS was completed in accordance with the OARs relative to hazardous substance remedial action (OARs 340 122 010 through 140), feasibility studies (OAR 340-122-085), and remedy selection (OAR 340-122-090).

Some of the key requirements for feasibility studies are listed in **Table 1**. The OAR section numbers have been provided for reference; however, for the purposes of brevity, not all information under each section has been included. The term “hot spot” is used in a manner consistent with DEQ’s definition in OAR 340 122 115(32).

2.2 Report Organization

This report is organized as follows:

Section 1 – Executive Summary

Section 2 – Introduction, explains the purpose of this FFS and provides the reader with an overview of the administrative requirements and the report organization.

Section 3 – Site Description and History, provides a brief overview of the Site background and history.

Section 4 – Previous Environmental Investigations and Findings, includes information regarding on-Site investigations and risk assessments.

Section 5 – Remedial Action Objectives, describes the soil remedial action objectives and target remedial action area for the Site.

Section 6 – Identification and Screening of Remedial Technologies, describes the general response actions and the technologies that were evaluated for their potential applicability to the Site. Describes the evaluation of the technologies retained from the preliminary screening process and presents a screening of the remedial alternatives based on OAR criteria.

Section 7 – Comparative Analysis of Alternatives, is a detailed qualitative comparative evaluation of the remedial alternatives.



Section 8 – Conclusions, presents the recommended remedial alternatives and the rationale for their selection.

Section 9 – References, includes the references used in assembling this report.



3.1 Site Description

The Site is located on Bolon Island in Section 35 of Township 21 South, Range 12 West and occupies a single tax lot (Tax Lot 402) covering a total of approximately 15 acres. The location of the Site is shown on **Figure 1** and **Figure 2**. The City of Reedsport is located south of the Site across the Umpqua River. The Site is located in Douglas County and is zoned Heavy Industrial. Approximately 2.2 acres of the Site are relatively flat and developed, while the remaining acreage is currently undeveloped and heavily vegetated. The Site does not have a mailing address but is proximal to Highway 101 to the northwest and is accessed from Lower Smith River Road. The Site is bounded by the Umpqua River to the south and southwest, a railroad to the east and southeast, the Umpqua River to northeast, and undeveloped property to the north and west.

The primary feature of the Site is the graving dock, or dry dock, which covers an area approximately 100 feet by 300 feet. The graving dock can be seen on **Figure 2**. To the southwest of the graving dock between the Umpqua River and the graving dock is a gate. The graving dock was operated by opening the gate during high tide so that barges could enter the graving dock. The gate was then closed and water pumped out of the graving dock to facilitate maintenance and repair work on barges. Ancillary support structures associated with the graving dock include the gate, two sheds, a work shop, and two blast grit hoppers for holding sandblasting media.

3.2 Site Background

3.2.1 Historic Site Development and Usage

The following discussion is based on a review of the Phase I Environmental Site Assessment (ESA) report prepared for the Site by Land and Water Environmental Services, Inc. (LWES) in 2000 (LWES, 2000a). Based on a review of historical aerial photographs, the Site was developed from vacant land into a graving dock with associated support structures sometime between 1945 and 1954. Changes to the Site since initial development have been minimal. The graving dock was used for maintenance and repair work on barges that were primarily used to transport sand and gravel. Maintenance and repair work included sandblasting, painting, and welding of barges and other equipment. From the time of the graving dock's construction sometime between 1945 and 1954 to approximately 2001, the base of the graving dock consisted of natural materials (i.e. soil or sediment consisting of clay, silt, sand, and/or gravel). In approximately 2001, the natural material base of the graving dock was paved with concrete.

Limited information is available on the number or frequency of barges worked on historically at the Site prior to 2000. Since the purchase of URN by KRM in May 2000 the Site was used exclusively by URN for the maintenance of its' River Mining Equipment (Dredge and barges). URN dredged the Umpqua River upstream of the Site for sand and gravel under DSL Royalty License SG-43 App #16097, which expired on April 30, 2010, and was not renewed. The river mining



equipment consisted of up to 5 work barges that were maintained as needed in the graving dock. The river mining equipment was all sold by circa 2011.

While no details regarding the maintenance of these five barges are available, it is likely these five barges were intermittently present in the graving dock for maintenance during the period from 2000 until they were sold. The Site was not used by others, and it was not operated as ship/barge repair facility for others. Maintenance included the sandblasting of barges which were painted with anti-fouling paint that contained various metals, including TBT.

3.2.2 Site Ownership History

Based on a review of the Phase I ESA report (LWES, 2000a) and discussions with Mr. Tom Gruszczenski of KRM, the history of Site ownership can be summarized as follows:

- Prior to 1991 and to some unknown earlier date, the Site was owned by Bohemia, Inc.
- On April 30, 1991, URN entered into a lease with Bohemia, Inc. to use the Site. The lease was set to expire on April 30, 2021. The lease applied to the developed portion (approximately 2.2 acres) of what was then Tax Lot 300, which totaled 21.87 acres.
- On March 1, 2000, Douglas County purchased the property from Bohemia, Inc. and continued the lease with URN.
- On May 16, 2000, Morse Bros, Inc. (MBI) purchased URN. MBI subsequently transferred URN to LTM, Inc. At that time both MBI and LTM, Inc. (now doing business as KRM) were subsidiaries of MDU Resources Group, Inc. (MDU).
- On October 29, 2014, KRM purchased the Site from Douglas County so it could better manage the environmental outcome.



4.1 Previous Environmental Investigations

Based on a review of the available records, the following environmental investigations have been performed at the Site:

- In 1989, Sweet-Edwards/EMCON, Inc. collected soil samples from six borings located beneath the graving dock (EMCON, 1989). Soil samples were submitted for analyses of various metals using the U.S. Environmental Protection Agency (USEPA) Extraction Procedure Toxicity Method 1310 and benzene, toluene, ethylbenzene, and xylenes (BTEX) by USEPA Method 8020. Barium, chromium, and zinc were detected in extracts of the soil samples, but at concentrations below applicable U.S. Environmental Protection Agency (USEPA) action levels to be considered hazardous materials. For the BTEX analyses, only ethylbenzene and xylene were detected at relatively low concentrations.
- A Phase I ESA was performed by LWSE, which is documented in a report dated March 17, 2000 (LWSE, 2000b). LWSE identified seven recognized environmental conditions associated with the Site.
- A Phase II ESA was performed by LWSE, which is documented in a report dated May 1, 2000 (LWSE, 2000a). Of the seven recognized environmental conditions identified in the Phase I ESA report (LWSE, 2000b), four of the recognized environmental conditions were eliminated and three of the recognized environmental conditions were confirmed. These three recognized environmental conditions included the following: 1) a detection of TBT, a metal associated with anti-fouling paints, was observed in pore water from a sediment sample collected in the graving dock; 2) soil beneath the oil stove in the lunch room (i.e. the larger shed on the northwest side of graving dock) had been Impacted by petroleum hydrocarbons; and 3) stressed vegetation along the eastern side of the Site appears to be the result of periodic leachate emanating from the spoils piles. The original source/s of materials in the spoils piles is unknown, but the spoils piles appear to consist of soil, vegetation, and some building debris.
- On June 17, 2010, DEQ personnel visited the Site while responding to a complaint regarding a ruptured public sewer main northeast of the Site. The ruptured sewer main is accessed via the same access road leading to the Site. While responding to the sewer main complaint, DEQ personnel visited the Site and observed sand blast grit from ship maintenance activities on the land surface. Based on this observation, DEQ added the Site to the ESCI Database as File #5361.
- On August 3, 2010, KRM submitted an application for the Site to enter DEQ's VCP through the ICP. KRM was subsequently accepted into the ICP, and on October 12, 2010, DEQ personnel performed a Site walk with personnel from KRM, Douglas County, and JBR. During the Site meeting, personnel from all parties observed Site conditions, discussed historical Site activities, and discussed Site characterization objectives and strategies.



- In a letter from KRM to DEQ dated November 18, 2010, KRM transmitted copies of the three aforementioned reports documenting previous environmental investigations completed at the Site. Subsequent to this submittal of reports from KRM to DEQ, personnel from JBR Environmental, Inc. (JBR), KRM, and SLR International Corporation (SLR) have held numerous discussions with DEQ to develop the scope of work pursued under a subsequent Phase II ESA. A detailed Work Plan describing proposed Phase II Environmental Investigation activities was prepared by JBR and submitted to DEQ on February 11, 2011 (JBR, 2011). This Work Plan was subsequently approved by DEQ, with comments, in a letter dated March 4, 2011 (DEQ, 2011). Comments from DEQ included a request of additional metals analyses, PCBs analyses, analyses of polycyclic aromatic hydrocarbons (PAHs), and preparation of a Level I Ecological Scoping Assessment.
- On August 10, 2012, the Level I Ecological Scoping Assessment prepared by SLR was submitted to DEQ (SLR, 2012). The findings of the Level I Ecological Scoping Assessment were that no further ecological evaluations were recommended for upland soil. However, because the Umpqua River estuary near the Site supports a variety of benthic and aquatic species and because ecological receptors in the estuary have the potential to contact chemicals in sediment and groundwater, an ecological screening assessment was pursued consistent with DEQ's Level II Ecological Screening Assessment guidance (DEQ, 2011) for portions of the estuary with Site-related contamination.
- In May 2014, AEC succeeded JBR as the environmental consultant for the project, though no changes in key personnel familiar with the Site occurred. Based on the initial analytical results for soil and sediment samples collected in 2011 and 2012, and numerous meetings and telephone discussions held between personnel from DEQ, KRM, AEC, and SLR, supplemental characterization work of Umpqua River sediment proximal to the Site was pursued in February 2017 to more thoroughly characterize the spatial extent of Site-related impacts in the estuary.
- The investigation scope of upland soil and sediment and sediment in the Umpqua River estuary was collaboratively developed by DEQ, KRM, JBR, AEC, and SLR. Soil and sediment samples were collected under direction of the ICP in 2011, 2012, and 2017. All sampling and analyses work was completed generally consistent with DEQ-approved work plans prepared by JBR (JBR, 2011) and AEC (AEC, 2016). During numerous meetings and telephone discussions held during the period 2010 through 2017, specific methods on how to evaluate potential risks to human and ecological receptors were also presented and refined.
- The results of the Phase II Environmental Investigation and Risk Evaluation completed under the direction of the ICP in 2011, 2012, and 2017 are documented in a report prepared by AEC and dated September 17, 2018 (AEC, 2018). Copies of the analytical results tables from this report, including corrections to generic RBCs for PAHs reflected in DEQ's updated May 2018 Risk-Based Decision Making Guidance, are included as **Appendix 1**. Copies of the figures from this report are included as **Appendix 2**.



4.2 Findings of Previous Environmental Investigations

It should be noted the use of the terms “upland soils” and “upland sediments” is confusing. For the purposes of risk evaluation, “sediment” is considered the organic/inorganic particulate matter on the bottom of an aquatic system. Sediment is capable of supporting aquatic organisms, while soil can support terrestrial organisms. As discussed during a Site meeting held between DEQ, AEC, and KRM personnel on December 8, 2021, the sediments beneath the concrete floor of the graving dock and the swale to the west of the graving dock were described as upland soils to differentiate them from estuary sediment. As observed during the December 2021 Site visit, the swale to west of the graving dock is ephemeral and above mean high water. The swale does not host aquatic receptors and should more accurately be defined as soil.

In a letter to KRM from the U.S. Army Corps of Engineers dated January 16, 2020, the area within the graving dock inland from the gate is not defined as waters of the U.S. As described above, all of the Alternatives besides the No Action Alternative involve filling the graving dock in conjunction with permanent closure of the graving dock gate. The concrete floor of the graving dock will remain in place prior to the permanent placement of fill. Accordingly, the material beneath the graving dock should more accurately be defined as upland soil after the final remedy has been implemented and the discussion below refers to all of the “upland soil” and “upland sediments” samples collected in the upland area as “upland soil” samples.

Based on the analytical results for soil and sediment samples collected at the Site and based on the findings of human health and ecological risk assessments, the following conclusions were made (AEC, 2018):

- Benzo(a)pyrene in upland soil was reported at concentrations that exceed the respective generic risk-based concentration (RBC) for the *soil ingestion, dermal contact, and inhalation exposure pathway* for occupational receptors.
- Lead and naphthalene in upland soil were reported at concentrations that exceed the generic RBC for the *leaching to groundwater exposure pathway* for occupational receptors. However, there are no wells on the Site and the Site is provided with municipal water.
- No other constituents were reported in upland soil sediment at concentrations that exceed relevant generic RBCs.
- The results of a Level I Ecological Scoping Assessment indicated no further ecological evaluations are needed for upland soil.
- The results of a Level II Ecological Screening Assessment, including the development of Site-specific SLVs for TBT in estuary sediment, indicate there are no unacceptable risks to ecological receptors or recreational fishers. This lack of unacceptable risks to ecological receptors or recreational fishers is in part due to documentation in the scientific literature that while bioaccumulation of organotins in biota occurs (i.e. the accumulation over time of a substance and especially a contaminant in a living organism, biomagnification of organotins (i.e. the process by which a compound increases its concentrations in the tissues of organisms as it travels up the food chain) does not occur. This issue is discussed



in more detail in AEC's comment response letter to DEQ dated February 14, 2022 (AEC, 2022).

- The results of a Level II Ecological Screening Assessment, including the development of Site-specific SLVs for TBT in estuary sediment, also indicate there are no unacceptable risks to subsistence/tribal fishers. While the Site and proximal area is not a location where special tribal fishing rights can be legally exercised, AEC incorporated conservative assumptions into a followup evaluation of risks to subsistence/tribal fishers and determined there are no risks to hypothetical subsistence/tribal fishers. This issue is discussed in more detail in AEC's comment response letter to DEQ dated February 14, 2022 (AEC, 2022).

4.3 Hot Spot Determination

Based on the analytical results presented in the Phase II Environmental Investigation and Risk Evaluation (AEC, 2018), no hot spots were identified based on the concepts of being *highly concentrated*, *highly mobile*, or *not reliably contained*. No constituents were reported at concentrations above hot spot thresholds (i.e. above a hazard quotient of 10 for non-carcinogens or 100 for carcinogens). The sandy soils at the Site appear to have remained intact since work was initiated at the Site in 2011. On August 18, 2018, a composite soil sample from the spoils piles at the Site was collected in the area where the higher concentrations of TBT were reported at the Site. This composite soil sample was analyzed for both total TBT and soluble TBT using the Synthetic Precipitation Leaching Procedure (SPLP). The total TBT concentration was 2,060 micrograms per kilogram and the SPLP result for TBT was non-detect using a method reporting limit of 0.193 micrograms per liter. Accordingly, the soils are reliably contained and not highly mobile.

4.4 Groundwater Beneficial Use Determination

Per DEQ's request, AEC completed a groundwater beneficial use determination to evaluate whether Site-related contamination in upland soil that might subsequently leach to groundwater could adversely impact domestic well users at the Site or proximal properties on Bolon Island. The groundwater beneficial use survey was completed on August 29, 2022, by reviewing Oregon Water Resources (WRD) well logs on the entirety of Bolon Island. This task was accomplished using WRD's online mapping tool. Based on a review of the readily available well logs in WRD records, no domestic water supply wells are located on Bolon Island, including the Site. Records available from WRD indicate a total of 28 geotechnical holes and monitoring wells have been drilled on Bolon Island. A summary table of these 28 geotechnical holes and monitoring wells is presented in **Appendix 3**.

4.5 Conceptual Site Model

Per DEQ's request, AEC has incorporated a conceptual site model (CSM) into the revised FFS report. A CSM summarizes known or suspected sources of contamination, fate and transport processes that affect the distribution of contamination, and mechanisms by which human and ecological receptors may contact impacted environmental media. Four elements are required to



establish a complete exposure pathway: 1) a source and mechanism of chemical release to the environment, 2) a retention or environmental transport medium for a released chemical, 3) a point of potential contact with the impacted medium (referred to as the exposure point), and 4) an exposure route (e.g., sediment ingestion) at the exposure point. The human health and ecological CSMs are shown in **Appendix 4** as **Figure A4-1** and **Figure A4-2**, respectively. Elements of the CSMs are discussed below.

4.5.1 Sources

The Site, including graving dock, was used to repair and maintain barges. Barge maintenance and repair work included sandblasting, painting, and welding. It appears that there were releases of sandblasting grit and paint chips to both soil and sediment. Also, there appears to have been releases of petroleum products to soil. The primary chemicals of interest include metals associated with paints, particularly anti-fouling paints. Various petroleum hydrocarbons are also chemicals of interest.

4.5.2 Chemical Fate and Transport

The primary mechanisms that may influence the fate and transport of chemicals in soil include leaching to groundwater, wind-mediated erosion of surface soil, and perhaps historic soil erosion by stormwater flow. Mechanisms that affect fate and transport of chemicals in sediment include leaching to porewater, migration from porewater to surface water, advection and dispersion in surface water, sorption to the sediment matrix, and erosion. The relative importance of these processes in structuring the dynamics of contaminant fate and transport varies depending on the chemical and physical properties of a released contaminant, physical properties of soil and sediment, and the dynamics of wind and water flow. Several other fate and transport mechanisms are possible, but are expected to be minor.

4.5.3 Potential Human Health Exposure Scenarios

The Site is located along the north bank of the Umpqua River and comprises a 2.2-acre portion of tax lot 300. Development of the property into a maintenance facility with a graving dock started sometime between 1945 and 1954. The Site was used to maintain and repair barges until approximately 2010 when operations ceased. The property is zoned Heavy Industrial. Given historical uses the Site, the current zoning, and current planned uses, it is likely the Site will remain an industrial facility for the foreseeable future. There are no residential properties on Bolon Island. As a result, people with the greatest potential to have significant exposure to soil at the Site are future occupational workers.

Shallow groundwater at the Site is not used for drinking or irrigation. The Site is supplied with municipal water. Given the relatively low cost and high reliability of municipal water and the potential for salt-water intrusion into groundwater, it is unlikely that water supply wells for drinking will be developed at the Site in the foreseeable future. Future workers at the Site are unlikely to have significant exposure to groundwater. The results of the beneficial groundwater use determination indicate there are no water supply wells on the entirety of Bolon Island (see **Section 4.4**).



Future occupational workers at the Site are unlikely to have significant exposure to sediment in the Umpqua River estuary. The graving dock is in disrepair and is planned for decommissioning, and future occupational workers are unlikely to perform operations in or near the estuary that could result in significant sediment contact. Worker exposure to sediments in the estuary is considered an insignificant potential exposure scenario.

Recreationists such as fishers and boaters are unlikely to have significant exposure to sediment at the Site. The Site is private property with restricted land access to the shoreline. Shallow water in the mudflats adjacent to the Site limits access to the shoreline by boaters. Also, the muddy bottom in the intertidal and subtidal zones makes it very difficult to walk the shoreline below the typical high tide zone.

No significant recreational clamming is expected to take place at the Site. None of the primary clam beds in the estuary are located immediately adjacent to the Site, although there are clam beds on the western end of Bolon Island and north of the island (ODFW, 2014).

People with the greatest potential to be exposed to chemicals in sediment near the Site are recreational fishers. TBT may accumulate in the tissues of fish that are exposed to impacted sediment. If recreational fishers were to catch and consume fish at the Site that had long-term exposure to sediment, fishers could be exposed to TBT in fish tissues.

The Site is located in the ancestral lands of the Lower Umpqua tribe, which is a member of the federally-recognized Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (<https://ctclusi.org/history>). The Umpqua River near the Site is not part of a tribal reservation or trust. Also, the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians do not currently have treaty fishing rights on the Umpqua River; <https://oregonhistoryproject.org/narratives/this-land-oregon/resettlement-and-the-new-economy/treaties-and-reservations/#.W5FpulpKiUk>; http://www.westcoast.fisheries.noaa.gov/fisheries/salmon_steelhead/united_states_v_oregon.html). Therefore, all fishers near the Site are subject to State of Oregon fishing laws and it is reasonable and likely to assume this situation will continue into the future. Under this legal framework, it is unlikely that fishers at the Site could catch a sufficient amount of local fish to support a subsistence lifestyle, and the subsistence fisher exposure scenario is considered incomplete.

4.5.4 Potential Ecological Exposure Scenarios

The Oregon cleanup rules (Oregon Administrative Rules [OAR] 340-122-115) specify the protection of individuals of species listed as threatened or endangered (T&E) under state or federal laws established to protect T&E species and their habitat (e.g., Endangered Species Acts) from adverse effects resulting from exposure to hazardous substances. For species not listed as T&E species, populations, not necessarily each individual, must be protected.

As described in the Level I Ecological Scoping Assessment, no amphibian, reptile, or mammal species that have been classified as threatened or endangered reside in the area (SLR, 2012). The



Umpqua River near the Site has been designated as critical habitat for two anadromous fish species listed as threatened by National Marine Fisheries Service (NMFS):

Coho Salmon (*Oncorhynchus kisutch*): The Oregon Coast Evolutionary Significant Unit (ESU) of the coho salmon has been listed as threatened by the NMFS. This ESU includes fish that naturally breed in the Umpqua River system. Much of the Umpqua River, including the estuary, has been designated as critical habitat for coho.

Eulachon (*Thaleichthys pacificus*): The southern Distinct Population Segment (DPS) of the eulachon, also known commonly as smelt, has been designated as threatened by the NMFS. The lower Umpqua River up to the confluence with Mill Creek near Scottsburg has been designated as critical habitat for eulachon in the southern DPS.

Neither coho nor eulachon are expected to have significant exposure to chemicals in sediment near the Site. Both fish are anadromous that spawn in freshwater, but spend the majority of their lives in the ocean.

Sediment-dwelling invertebrates can potentially have direct contact with chemicals in sediment. Similarly, demersal fish (fish that live near the river bottom) may also contact chemicals in sediment. Fish will likely have lower exposures to sediment than sediment-dwelling invertebrates. Routes by which fish and invertebrates may contact chemicals in sediment include gill uptake, sediment ingestion, and dermal contact. In general, chemicals that partition from sediment to surrounding pore water pose the greatest risk to benthic and aquatic organisms. Dissolved chemicals in sediment pore water are typically more bioavailable to aquatic and benthic organisms than chemicals bound to sediment solids.

Chemicals in sediment of the estuary may partition into sediment porewater, and this porewater could migrate to overlying surface water. If this were to happen, aquatic and benthic organisms in surface water of the estuary could contact waterborne chemicals through gill uptake and incidental ingestion. Chemical migration from sediment is not expected to cause significant contamination of surface water. Instead, it is likely that the flux of ambient river water over the nearshore estuary is many orders of magnitude greater than the flux of sediment pore water to surface water. Upon chemical migration from sediment to surface water, mixing with ambient water is likely to substantially reduce waterborne concentrations within a small distance of the discharge boundary.

Fish-eating (piscivorous) wildlife that may be present near the Site include osprey (*Pandion haliaetus*), great blue heron (*Ardea herodias*), mink (*Neovision vison*), and a number of other species. Piscivorous birds and mammals could be indirectly exposed to chemicals in sediment if they consume fish or other aquatic organisms that have accumulated site-related chemicals in tissues.



5 REMEDIAL ACTION OBJECTIVES

5.1 Site Remedial Action Objectives

OAR 340-122-040 requires that remedial actions shall be implemented to achieve acceptable risk levels. Acceptable risk levels, defined in OAR 340-122-0115(1), are excess lifetime cancer risk less than or equal to 1.0×10^{-6} for individual carcinogens (1.0×10^{-5} for multiple carcinogens), or a hazard index of one for non-carcinogens. However, OAR-340-122-0040(2)(d) specifies that, for areas where hazardous substances occur naturally above acceptable risk levels, the background level is the target remedial action level.

RAOs for the Site are the following:

- Reduce human exposure to benzo(a)pyrene in upland soil reported in five of 11 samples at concentrations that exceed the respective generic risk-based concentration (RBC) for the *soil ingestion, dermal contact, and inhalation exposure pathway* for occupational receptors to achieve acceptable risk levels for current and reasonably likely future land use conditions.
- Because lead 10 in 33 samples and naphthalene in one of 11 samples in upland soil and sediment were reported at concentrations that exceed the generic RBC for the *leaching to groundwater exposure pathway* for occupational receptors, reduce human exposure to groundwater that might contain elevated levels of lead and naphthalene to achieve acceptable risk levels for current and reasonably likely future land use conditions.
- While reported concentrations of TBT in estuary sediment do not pose unacceptable risks to ecological receptors and recreational fishers, minimize or eliminate the migration through wind and water erosional processes of upland soil containing TBT into estuary sediment. Minimizing or eliminating this potential source of TBT to estuary sediment will maintain protectiveness of estuarine ecological receptors and recreational fishers in the future.

5.2 Soil Hot Spot Determination

As discussed in Section 4.3, no hot spots were identified because no constituents are *highly concentrated, highly mobile, or not reliably contained*.

5.3 Area/Volume

Approximately 2.2 acres of the Site are relatively flat and developed, and this is the area where historical graving dock activities occurred. Conservatively assuming the upper 2 feet of upland soil in this approximately 2.2-acre area is impacted with Site-related contamination yields an estimated volume of impacted soil of approximately 7,100 cubic yards. This volume is considered conservative because the graving dock footprint covering approximately 100 feet by 300 feet is covered in concrete and not soil.



6.1 General Response Actions

General response actions describe actions that will satisfy the RAOs. The general response actions to be considered in the feasibility study are defined in OAR 340-122-085. These response actions include the following:

- No Action – serves as a baseline.
- Institutional Controls – legal or administrative actions that prevent or minimize exposure to Site soils. This action can include posting signs, public education, and deed restrictions.
- Engineering Controls – physical actions that prevent or minimize exposure to Site soils. This action can include capping or other containment such as fencing and/or vegetative covers.
- Treatment – permanent reduction in toxicity or volume of Site soil with the use of in-situ or ex-situ remedial technologies.
- Excavation and Off-Site Disposal – Site soils would be excavated and disposed at an off-Site permitted disposal facility.
- Any combination of the above.

OAR 340-122-085 specifies that remedial action alternatives that are not protective, feasible, or appropriate for the Site may be eliminated from development or evaluation in the feasibility study.

6.2 Technology Descriptions

This section provides general descriptions of the technologies and supporting process options identified from the technology search.

6.2.1 No Action

The “no action” response assumes that areas of soil contamination are not remediated using conventional engineering technologies.

6.2.2 Institutional Controls

Institutional controls are a type of land use control that consists of legal or administrative mechanisms imposed to ensure the effectiveness of land use restrictions on a property to advise current and prospective future users about soil contamination.

Administrative controls involve limiting land use and activities or managing Site activities. Administrative controls may be implemented by a deed restriction. Examples include limiting or placing restrictions on-Site activities such as construction and excavation that would cause disturbance of soil, providing for maintenance of caps that serve as protective barriers, limiting



the use of groundwater by prohibiting the installation of water supply well, or establishing and implementing work practice controls for Site workers.

An environmental notice is a legal document recorded with property records that provides information as to confirmed environmental facts.

6.2.3 Engineering Controls

Engineering controls are physical actions that prevent or minimize exposure to Site soil. Engineering controls generally require institutional controls, such as a deed restriction, so that the technology is maintained and continues to meet the RAO.

Capping. Capping involves constructing a physical barrier over areas of Site soil. This technology reduces the potential exposure to Site soil from direct contact, ingestion, and dust inhalation.

Aggregate Cap. This technology provides a durable barrier from Site soil. An aggregate cap is suitable for areas of light to moderate vehicular traffic and pedestrian use. An aggregate cap would be pervious and not likely increase surface water runoff.

Asphalt Cap. This technology provides a durable barrier from Site soil. Compared with a gravel or vegetative cap, an asphalt cap would be relatively impervious and would increase surface water runoff. An asphalt cap is suitable for high vehicular traffic areas.

Vegetative Cover. Vegetative covers generally consist of planting erosion-resistant vegetation or maintaining existing vegetation. For certain conditions, this technology reduces the potential for direct contact with Site soil and dispersion of dust. This technology would be appropriate at the Site under current conditions where there is almost no vehicular and pedestrian traffic. The vegetation would provide aesthetic and habitat benefits.

Topsoil and Vegetative Cover. Topsoil and vegetative covers generally consist of planting erosion-resistant vegetation over a layer of imported topsoil. This technology reduces the potential for direct contact with Site soil and dispersion of dust. This technology is suitable for pedestrian use and occasional vehicular traffic. The vegetation would provide recreational/aesthetic and habitat benefits.

6.2.4 Treatment

In a presentation at the 22nd International Petroleum Environmental Conference of November 2015, Ivey International presented a paper on *Innovative Chemical Treatment of TBT-Impacted Marine Sediments: A Bench Scale Study* (Ivey International, 2015). In this study, a 3 kilogram sample of marine impacted sediment was successfully treated to chemically degrade TBT to trace detections. However, the study was only bench scale and no costs were provided. Other treatment technologies for TBT, benzo(a)pyrene, naphthalene, and lead in soil that involve vitrification, flushing, or washing of soils may also be possible, but these would be costly and/or unproven technologies that are not considered appropriate for the Site. Furthermore, because



TBT is a listed hazardous waste, additional permitting would be required to pursue treatment and recovered TBT would have to be disposed of at the Arlington Landfill.

6.2.5 Excavation and Off-Site Disposal

Landfill disposal is a conventional technology involving excavation of contaminated soil and transport to a permitted landfill. Because TBT is state-listed hazardous waste, TBT-impacted soil at the Site would need to be disposed of at a Subtitle C landfill permitted to accept hazardous waste (e.g. the Arlington Landfill in Arlington, Oregon).

6.3 Technology Screening

A list of potentially feasible remedial technologies was developed for the Site and evaluated against the following screening criteria:

Effectiveness – the likelihood of the technology to meet RAOs.

Implementability – the technical and logistical feasibility of applying the technology.

Cost – the relative capital and operations and maintenance (O&M) expenses of a technology.

6.4 Screening Results

The results of the technology screening evaluation are presented in **Table 2**. The table includes the general rationale for retaining or excluding a technology from future consideration in the assembly of remedial alternatives.

The technologies that were retained for further evaluation as part of a remedial alternative for the Site include the following:

- No Action
- Engineering Controls: Aggregate and Asphalt Caps
- Excavation and off-Site disposal

The vegetative cover and the topsoil and vegetative cover options were not retained because while the costs of these cover options are lower, the long-term effectiveness and O&M requirements introduce undesired uncertainty. While there are no current or future plans for Site use, an aggregate cap and an asphalt cap would permit future uses involving vehicular traffic without compromising the effectiveness of the cap. Treatment was not retained because of the high cost and uncertainties associated with implementation relative to the benefits. Institutional controls were not retained as a stand-alone technology because while the cost is relatively low, implementation may be difficult and the effectiveness is low. However, institutional controls were combined with the engineering control alternatives so that RAOs are achieved over time.



6.5 Alternative Descriptions and Conceptual Design

6.5.1 Alternative 1 – No Action

No action was retained as an alternative for a baseline comparison.

6.5.2 Alternative 2 – Excavation and Off-Site Disposal

This technology provides a high-cost, highly effective, permanent method of meeting the remedial action objectives. Site soils would be excavated and disposed of at the only Subtitle C landfill in Oregon (i.e. Chemical Waste Management's landfill in Arlington, Oregon). Prior to removal, the single lane access road to the Site would need to be improved to facilitate heavy truck traffic and existing structures would need to be removed. Subsequent to removal of the upper 2 feet of soil, the remaining surface would be graded level with clean fill and/or topsoil. Post-excavation soil confirmation sampling would be required. Excavation and off-Site disposal will also minimize or eliminate the potential for TBT to migrate from upland soil into estuary sediment and maintain protectiveness of estuarine ecological receptors and recreational fishers in the future. This alternative would take approximately 3 years to implement accounting for the availability of equipment, labor, and clean fill material.

6.5.3 Alternative 3 – Aggregate Capping with Institutional Controls

This alternative can serve as an effective barrier to prevent occupational receptors from coming into contact with Site soil and provide an acceptable reduction in risk. The aggregate cap will consist of approximately 6 inches of clean aggregate overlying geotextile fabric. The geotextile fabric will maintain separation of the aggregate and concurrently demarcate that separation between the overlying clean aggregate and the underlying impacted soil. Prior to installation of the aggregate cap, improvements to the single lane access road to the Site would be made to facilitate heavy truck traffic. In addition, existing structures within the approximately 2.2-acre developed area would be demolished and the existing spoils piles at the Site would be graded flat. Clean fill would be placed within the footprint of the graving dock to an elevation above the mean high water line that is sufficient to accommodate the 6 inches of impacted soil from outside the graving dock area and the 6 inches of imported capping aggregate. When finalizing and implementing the final remedial design, an effort will be made to maximize the vertical separation between impacted Site soil and the mean high water line. This separation will be achieved by placing the clean fill as high as possible while only leaving enough room for the impacted soils placement and imported capping aggregate. If the impacted soil is placed in the northern half of the dry dock area then the base of the impacted soil will be about 2 to 3 feet below the finished grade. Placement in the northern half of the dry dock area would result in the impacted soil placement being over 100 feet north of the existing dry dock gate/shoreline. This approach should reduce contact between tidally-influenced groundwater in the future due to climate change that could potentially increase mean high water line elevations assuming the sea level rises.

Institutional controls would include provisions for long-term maintenance of the aggregate cap, a requirement to leave the concrete floor within the graving dock in place, and a deed restriction



prohibiting the installation of a water supply well at the Site. Aggregate capping will also minimize or eliminate the potential for TBT to migrate from upland soil into estuary sediment and maintain protectiveness of estuarine ecological receptors and recreational fishers in the future. This alternative would take approximately 3 years to implement accounting for the availability of equipment, labor, clean fill material, and aggregate.

6.5.4 Alternative 4 – Asphalt Capping with Institutional Controls

This alternative can serve as an effective barrier to prevent occupational receptors from coming into contact with Site soil and provide an acceptable reduction in risk. The asphalt cap will consist of approximately 2 inches of compacted asphalt placed over approximately 1 inch of aggregate base rock. Prior to installation of the asphalt cap, improvements to the single lane access road to the Site would be made to facilitate heavy truck traffic. In addition, existing structures within the approximately 2.2-acre developed area would be demolished and the existing spoils piles at the Site would be graded flat. Clean fill would be placed within the footprint of the mean high water line of the dry dock footprint and brought to grade. During grading activities, impacted Site soil would be kept outside of the footprint of the mean high water line. Institutional controls would include provisions for long-term maintenance of the asphalt cap and a deed restriction prohibiting the installation of a water supply well at the Site. Asphalt capping will also minimize or eliminate the potential for TBT to migrate from upland soil into estuary sediment and maintain protectiveness of estuarine ecological receptors and recreational fishers in the future. This alternative would take approximately 3 years to implement accounting for the availability of equipment, labor, clean fill material, and asphalt.



7 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents an evaluation of the remedial alternatives using criteria in OAR 340-122-085 that specify the requirements for the feasibility study and those in OAR 340-122-090 regarding the selection of a remedial action. The OAR evaluation criteria are briefly summarized below, followed by a detailed evaluation of each alternative against the criteria.

7.1 Evaluation Criteria

The OARs require that feasibility studies include evaluations of the following three criteria:

- The protectiveness of the alternative based on the standards set forth in OAR 340-122-0040.
- The feasibility of the alternative based on balancing the remedy selection factors set forth in OAR 340-122-090(3) and (4). These factors include effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost.
- The extent to which the remedial action alternative treats hot spots of contamination based on the criteria set forth in sections (5) and (6) of this rule and OAR 340 122 090(4). This criterion is not applicable to the Site because no hot spots were identified as defined in OAR 340-122-0115(32).

The protectiveness and remedy selection factors were evaluated and are summarized in the following subsections and in **Table 3**.

7.1.1 Protectiveness

Remedial alternatives are required to be evaluated with respect to the degree that they are protective of human health and the environment as demonstrated through a residual risk assessment.

Alternative 1. No action does not reduce exposure to Site soil and is not considered protective.

Alternative 2. Excavation and off-Site disposal is considered protective for present and future occupational receptors because it removes the potential for exposure. Excavation and off-Site disposal will also minimize or eliminate the potential for TBT to migrate from upland soil into estuary sediment and maintain protectiveness of estuarine ecological receptors and recreational fishers in the future so long as the concrete floor of the graving dock is left in place prior to placement of fill.

Alternative 3. An aggregate cap is considered protective because it eliminates all exposure pathways. Institutional controls will be required to provide for regular inspection and maintenance of the aggregate cap. An aggregate cap will also minimize or eliminate the potential for TBT to migrate from upland soil into estuary sediment and maintain protectiveness of



estuarine ecological receptors and recreational fishers in the future so long as the concrete floor of the graving dock is left in place prior to placement of fill.

Alternative 4. An asphalt cap is considered protective because it eliminates all exposure pathways. An asphalt cap will also minimize or eliminate the potential for TBT to migrate from upland soil into estuary sediment and maintain protectiveness of estuarine ecological receptors and recreational fishers in the future so long as the concrete floor of the graving dock is left in place prior to placement of fill. Institutional controls will be required to provide for regular inspection and maintenance of the asphalt cap.

7.1.2 Balancing Factors

The balancing factors that must be considered include effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost.

7.1.2.1 Effectiveness

Each remedial action alternative is to be assessed for its effectiveness in achieving protection by considering the following factors, as appropriate:

- Magnitude of risk from untreated waste or treatment residuals remaining at the Site considering the degree they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bioaccumulate, and propensity to degrade.
- Adequacy of any engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances remaining at the Site.
- Time until the RAOs would be achieved.

Alternative 1. No action would not be effective at meeting RAOs because potential human exposure to Site soil and the potential for TBT in Site soil to migrate into the estuary would not be reduced.

Alternative 2. Removal of impacted Site soil by excavation and off-Site disposal would be a highly effective solution. This alternative could be implemented in a relatively short time period.

Alternative 3. Aggregate capping would be highly effective because it would provide a physical barrier to Site soil, thus reducing potential exposure risks for occupational and ecological receptors. This alternative could be implemented within a relatively short time period.

Alternative 4. Asphalt capping would be highly effective because it would provide a physical barrier to Site soil, thus reducing potential exposure risks for occupational and ecological receptors. This alternative could be implemented within a relatively short time period.

7.1.2.2 Long-term Reliability

Each remedial action alternative is to be assessed for its long-term reliability by considering the following factors, as appropriate:



- Reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances, taking into consideration the characteristics of the hazardous substances to be managed and the effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure.
- Nature, degree, and certainties or uncertainties of any necessary long-term management (for example, O&M and monitoring).

Alternative 1. There is no long-term reliability for the no action alternative.

Alternative 2. The long-term reliability of the excavation and disposal alternative is ranked as high. Removal of Site soil is permanent, and future maintenance would not be required to manage risks associated with potential exposure.

Alternatives 3. The long-term reliability of the aggregate cap is ranked as moderately high. Institutional controls consisting of inspection and maintenance would be necessary to provide for long-term reliability.

Alternatives 4. The long-term reliability of the asphalt cap is ranked as moderately high. Institutional controls consisting of inspection and maintenance would be necessary to provide for long-term reliability.

7.1.2.3 Implementability

Each remedial action alternative is to be assessed for the ease or difficulty of its implementation by considering the following factors, as appropriate:

- Practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays.
- Ability to monitor the effectiveness of the remedy.
- Consistency with federal, state, and local requirements; activities needed to coordinate with other agencies; and the ability and time required to obtain any necessary authorization from other governmental bodies.
- Availability of necessary services, materials, equipment, and specialists, including the availability of adequate off-Site treatment, storage, and disposal capacity and services, and the availability of prospective technologies.

Alternative 1. No action is the easiest alternative to implement.

Alternative 2. The implementability of excavation and disposal is high. Monitoring effectiveness of excavation and disposal would be accomplished by visual inspection and post-excavation confirmation soil sampling to confirm Site-related contamination has been removed. This



alternative will require a National Pollutant Discharge and Elimination System (NPDES) 1200-C construction permit because the area of disturbance would exceed 1 acre.

Alternative 3. The implementability of aggregate capping with institutional controls is moderately high. Maintenance would be required to maintain the effectiveness of this remedy through inspection and repairs. This alternative will involve filling of the graving dock. In a letter to KRM from the U.S. Army Corps of Engineers (Corps) dated January 16, 2020 (Corps, 2020), the Corps issued an Approved Jurisdictional Determination documenting that the area of the graving dock inland from the gate is not waters of the U.S. This alternative will require an NPDES 1200-C construction permit because the area of disturbance would exceed 1 acre. Monitoring the integrity and effectiveness of the aggregate cap would be accomplished through periodic visual inspection and repairs as necessary.

Alternative 4. The implementability of asphalt capping with institutional controls is moderately high. Maintenance would be required to maintain the effectiveness of this remedy through inspection and repairs. This alternative will involve filling of the graving dock. In a letter to KRM from the Corps dated January 16, 2020 (Corps, 2020), the Corps issued an Approved Jurisdictional Determination documenting that the area of the graving dock inland from the gate is not waters of the U.S. This alternative will require an NPDES 1200-C construction permit because the area of disturbance would exceed 1 acre. Monitoring the integrity and effectiveness of the asphalt would be accomplished through periodic visual inspection and repairs as necessary.

7.1.2.4 Implementation Risk

Each remedial action alternative is to be assessed for the risk posed during implementation by considering the following factors, as appropriate:

- Potential impacts during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures on the community, on workers, and on the environment.
- Time until the remedial action is completed.

Alternative 1. There is no risk because no action is implemented. No increase or decrease in risk to human and ecological receptors would result from this action.

Alternative 2. The implementation risks during excavation and off-Site disposal are low. The primary risks would be related to workers during structure demolition and construction activities and while hauling soil from the Site to the Subtitle C landfill in Arlington, Oregon. Construction worker exposure to impacted Site soil can be minimized using wet dust suppression methods. These alternatives call for common construction methods with demonstrated low risk. These risks can be controlled by implementing construction safety and safe driving practices.

Alternative 3. The implementation risks during demolition of existing structures, importing and placing clean fill, Site grading, and installation of an aggregate cap would be relatively low. Construction worker exposure to impacted Site soil can be minimized using wet dust suppression



methods. These alternatives call for common construction methods with demonstrated low risk. These risks can be controlled by implementing construction safety and safe driving practices.

Alternative 4. The implementation risks during demolition of existing structures, importing and placing clean fill, Site grading, and installation of an asphalt cap would be relatively low. Construction worker exposure to impacted Site soil can be minimized using wet dust suppression methods. These alternatives call for common construction methods with demonstrated low risk. These risks can be controlled by implementing construction safety and safe driving practices.

7.1.2.5 Reasonableness of Cost

Each remedial action alternative is to be assessed for the reasonableness of the cost of the remedial action, by considering the following factors, as appropriate:

- Cost of the remedial action, including capital costs (both direct and indirect costs), annual O&M costs, costs of any periodic review requirements, and the net present value (NPV) of all project costs.
- Degree to which the costs of the remedial action are proportionate to the benefits to human health and the environment created through risk reduction or risk management.
- The degree of sensitivity and uncertainty of the costs.

Alternatives 2, 3, and 4 could be implemented over a 3-year period, so the NPV was applied to a 3-year period, though the inspection and maintenance of the aggregate or asphalt cap will continue past 3 years. Estimated costs for the four alternatives, including line item details, are included in **Table 4**.

Alternative 1. There are no costs associated with the no action alternative.

Alternative 2. The capital cost for excavation and off-Site disposal is high, primarily due to the long distance between the Site and the Subtitle C landfill, as well as the tipping fees for hazardous waste disposal. However, there are no O&M costs associated with this option.

Alternative 3. The cost for the aggregate cap is moderate. However, the costs are relatively low for the risk reduction benefit that is provided. The maintenance costs are expected to be moderately low, but will increase if there is an increase in vehicle traffic in the future. The cost for institutional controls is considered to be relatively low for the risk reduction benefit.

Alternative 4. The cost for the asphalt cap is moderately high. However, the costs are relatively low for the risk reduction benefit that is provided. The maintenance costs are expected to be moderately low, but will increase if there is an increase in vehicle traffic in the future. The cost for institutional controls is considered to be relatively low for the risk reduction benefit.



8 CONCLUSIONS

The Bolon Island Graving Dock is located in Douglas County and is zoned Heavy Industrial. Approximately 2.2 acres of the Site are relatively flat and developed, while the remaining acreage is currently undeveloped and heavily vegetated. The graving dock was used to maintain dredges and barges, including sand blasting of hulls painted with anti-fouling paint containing various metals including TBT. Human health risks at the Site are associated with potential exposure to benzo(a)pyrene in soil and potential exposure to groundwater that might contain naphthalene and lead that leached from soil. It should be noted there are no water supply wells at the Site and the Site is provided with municipal water. While reported concentrations of TBT in estuary sediment do not pose unacceptable risks to ecological receptors and recreational fishers, minimizing or eliminating the potential for future migration of upland soil containing TBT into estuary sediment will maintain protectiveness of estuarine ecological receptors and recreational fishers in the future.

RAOs were developed for the Site. Remedial technologies were screened for effectiveness, long-term reliability, ease of implementation, and relative cost. Technologies retained after screening and assembled into remedial alternatives for further evaluation include no action, excavation and off-Site disposal, an aggregate cap, and an asphalt cap.

Remedial alternatives were evaluated for protectiveness and against the DEQ balancing factors. The results of the FFS indicate the following:

- Alternative 3, the aggregate cap alternative with institutional controls, would be protective, highly effective, have high long-term reliability, be easy to implement, and has a moderate cost. For these reasons, implementation of the aggregate cap with institutional controls is the recommended option.
- Alternative 4, the asphalt cap alternative with institutional controls, is very similar to Alternative 3 in that it would be protective, highly effective, have high long-term reliability, and be easy to implement. However, relative to Alternative 3, Alternative 4 has a moderately high cost and so was not selected.
- Alternative 2, the excavation and off-Site disposal alternative, would be highly effective, have high long-term reliability, and be easy to implement. However, relative to Alternative 3, Alternative 2 has a high cost and so was not selected.
- Alternative 1, the no action alternative, would be easy to implement and have no cost. However, it would not be protective, effective, or provide long-term reliability. Accordingly, Alternative 1 was not selected.



Placing an aggregate cap in conjunction with institutional controls requiring cap inspections/maintenance, a requirement to leave the concrete floor within the graving dock in place, and a deed restriction prohibiting the installation of a water supply well at the Site would achieve the RAOs. This remedial action will provide a permanent, protective remedial action according to OAR 340-122-0040. It will eliminate human exposure to impacted Site soil and minimize or eliminate the potential for future migration of upland soil impacted by TBT into estuary sediment to maintain protectiveness of estuarine ecological receptors and recreational fishers in the future.

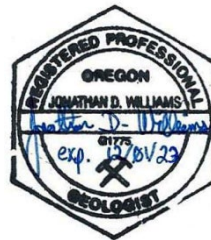
Please feel free to contact Jonathan Williams at 541-944-4685 or jwilliams@alpine-env-llc.com if you have any questions about this revised FFS report.

Sincerely,

Alpine Environmental Consultants, LLC



Jonathan D. Williams, R.G.
Senior Hydrogeologist



9 REFERENCES

- Alpine Environmental Consultants, LLC (AEC). 2016. Bolon Island – Proposed Supplemental Estuary Sampling Approach – DEQ File #5361. Email from Mr. Jonathan Williams of AEC to Mr. Norman Read of the Oregon Department of Environmental Quality (DEQ). September 7.
- AEC. 2018. Phase II Environmental Investigation, Risk Evaluation, and Remedial Action Plan; Bolon Island Graving Dock; Reedsport, Oregon; ECSI File #5361. September 17.
- AEC. 2021. Focused Feasibility Study; Bolon Island Graving Dock; Reedsport, Oregon; ECSI File #5361. October 15.
- AEC. 2022. Response to Comments on Phase II Environmental Investigation and Risk Evaluation for the Bolon Island Graving Dock; Reedsport, Oregon; ECSI File #5361. February 14.
- Oregon Department of Environmental Quality (DEQ). 2011. Response to Site Characterization Work Plan, Bolon Island Graving Dock, Douglas County, Oregon, ECSI File #5361. Letter from Mr. Greg Aitken of DEQ to Mr. Tom Gruszczenski of Knife River Materials. March 4.
- DEQ. 2022. DEQ Comments on Focused Feasibility Study; Bolon Island Graving Dock; Reedsport, Oregon; ECSI File #5361. June 17.
- DEQ. 2023. DEQ Comments on Focused Feasibility Study; Bolon Island Graving Dock; Reedsport, Oregon; ECSI File #5361. Email from Ms. Margaret Oscilia of DEQ to Mr. Jonathan Williams of AEC. April 3.
- EMCON, Inc. 1989. Letter report entitled *Bohemia Reedsport Sampling*. March 6.
- Ivey International, Inc. 2015. Innovative Chemical Treatment of TBT (Tributyltin)-Impacted Marine Sediments: A Bench Scale Study. 22nd International Petroleum Environmental Conference; November 17 to 19, 2015; Denver, Colorado.
- JBR Environmental Consultants, Inc. (JBR). 2011. Site Characterization Work Plan, Bolon Island Graving Dock, Douglas County, Oregon, ECSI File #5361. Prepared by JBR Environmental Consultants, Inc. February.
- Land and Water Environmental Services, Inc. (LWES), 2000a. *Phase II Environmental Site Assessment of the Property Located at the Southeast Portion of Bolon Island, Douglas County, Oregon*. May 1.
- LWES, 2000b. *Phase I Environmental Site Assessment of the Property Located at the Southeast Portion of Bolon Island, Douglas County, Oregon*. March 17.



ODFW. 2014. Winchester Bay / Umpqua River Shellfish Areas. Oregon Department of Fish and Wildlife. <http://www.dfw.state.or.us/MRP/shellfish/maps/Umpqua.asp>

SLR. 2012. Level I Ecological Scoping Assessment, Bolon Island, Douglas County, Oregon. Prepared for Knife River Materials. SLR International Corporation (SLR). August.

U.S. Army Corps of Engineers (Corps). 2020. Letter from Mr. William Abadie of the Corps to Mr. Tom Gruszczenski of Knife River Materials regarding the Approved Jurisdictional Determination for the Bolon Island Dry Dock. January 16.



10 QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONAL

Mr. Jonathan Williams received a Bachelor of Science degree in Geology, with honors, from Duke University in 1987. He has over 28 years of experience working with geologic and environmental projects throughout the United States, including Phase I and Phase II Environmental Site Assessments, Remedial Investigations, Human Health and Ecological Risk Assessments, Feasibility Studies, hydrogeologic characterization, groundwater flow modeling, and contaminant transport modeling. Mr. Williams has been a Registered Geologist in the State of Oregon since 1996 and has 40-hour HAZWOPER training.



TABLES

Table 1
Oregon Administrative Rules Pertinent to the Feasibility Study (OAR 340-120-085)
Focused Feasibility Study
Bolon Island Graving Dock in Reedsport, Oregon
ECSI #5361

Administrative Rule	Requirement	Section of This Report in Which Rule Is
OAR 340-122-085 (2)	(2) A feasibility study shall develop and evaluate a range of	Sections 6 and 7
	(a) No action;	
	(b) Remedial action utilizing engineering and/or institutional	
	(c) Remedial action utilizing treatment;	
	(d) Remedial action utilizing excavation and offsite	
	(e) Any combination of the above, as appropriate.	
OAR 340-122-085 (3)	(3) Remedial action alternatives may be eliminated from development or evaluation in the feasibility study if, based on the remedial investigation and consideration of factors specified in OAR 340-122-090, the Department determines one or more remedial action alternatives are not protective, feasible or appropriate for the facility.	Sections 6 and 7
OAR 340-122-085 (4)	(4) For each remedial action option developed under section (2) of this rule, the feasibility study shall evaluate:	Section 7
	(a) The protectiveness of the alternative based upon the standards set forth in OAR 340-122-040;	
	(b) The feasibility of the alternative based upon a balancing of the remedy selection factors set forth in OAR 340-122-090(3) and (4); and	
	(c) The extent to which the remedial action alternative treats hot spots of contamination based upon the criteria set forth in sections (5) and (6) of this rule and OAR 340- 122-090(4).	Not applicable
OAR 340-122-085 (6)	(6) For contamination of media other than groundwater or surface water, the feasibility study shall evaluate the extent to which the hazardous substances cannot be reliably contained.	Section 7
OAR 340-122-085 (8)	(8) For contaminant concentrations in media other than water that would remain after treatment or excavation and off-site disposal pursuant to section (7) of this rule, the feasibility study shall evaluate the feasibility of a range of remedial action alternatives to achieve the acceptable risk level. The evaluation shall be based upon a balancing of the remedy selection factors in OAR 340-122-090 without application of the higher thresholds, under section (7), for reasonableness of the cost of the treatment and excavation and offsite disposal of hot spots of contamination.	Section 7
OAR 340-122-085 (9)	(9) The feasibility study should recommend a protective and feasible remedial action from the remedial action alternatives developed and evaluated in the feasibility study.	Sections 1 and 8

Table 2
Technology Screening Results Summary
Focused Feasibility Study
Bolon Island Graving Dock in Reedsport, Oregon
ECSI #5361

Remedial Technologies	Effectiveness	Ease of Implementation	Relative Cost	Comments	Technology Retained?
(1) No Action	Low	High	Low	Technology retained to compare with other technologies.	Retained
(2) Institutional Controls					
Administrative Controls	High	Very High	Low	In conjunction with engineering controls, implementing a deed restriction or deed notice prohibiting the installation of a water supply well would be low cost, effective, and very easy to implement. Implementing a cap inspection and maintenance plan would also be low cost, highly effective, and easy to implement.	Not Retained
(3) Engineering Controls					
Aggregate Cap	High	Moderate	Moderate	Reduces potential for direct contact with impacted soil and reduces or eliminates the potential for TBT in upland soil to migrate through erosional processes into estuary sediment. Suitable for light to moderate traffic and pedestrian use. Would be pervious and not likely increase surface water runoff. Institutional controls (inspections and repairs) required to provide long-term effectiveness.	Retained
Asphalt Cap	High	Moderate	Moderately High	Reduces potential for direct contact with impacted soil and reduces or eliminates the potential for TBT in upland soil to migrate through erosional processes into estuary sediment. Suitable for high vehicular traffic and pedestrian use. Would be impervious and likely increase surface water runoff. Institutional controls (inspections and repairs) required to provide long-term effectiveness.	Retained
Vegetative Cover	Moderate	Moderate	Low	Reduces potential for direct contact with surface soil and dust generation. Best for low-use areas with pedestrian use and occasional vehicle traffic. Might limit future uses of the Site, which is zone Heavy Industrial. Institutional controls (inspections and maintenance of vegetation) required to provide long-term effectiveness.	Not Retained
Topsoil and Vegetative Cover	Moderate	Moderate	Moderate	Reduces potential for direct contact with surface soil and dust generation. Best for low-use areas with pedestrian use and occasional vehicle traffic. Might limit future uses of the Site, which is zone Heavy Industrial. Institutional controls (inspections and maintenance of vegetation) required to provide long-term effectiveness.	Not Retained
(4) Treatment					
Chemical Treatment, Soil Washing	Moderate	Low	High	Only bench scale studies have been completed, so uncertainty remains with effectiveness and cost of this unproven technology. Treatment of hazardous waste would require additional permitting, and recovered TBT would be a hazardous waste.	Not Retained
(5) Excavation and Off-Site Disposal					
Excavation and Offsite Disposal	High	Moderate	High	Removes impacted soil. This is the only remedial technology that is permanent and will not require long term monitoring. Resulting surface would require backfilling with clean fill to make the Site suitable for vehicular traffic. Cost would be high because the impacted soil contains TBT and would have to be disposed of at the hazardous waste landfill in Arlington.	Retained

Table 3
Ranking of Remedy Alternatives
Focused Feasibility Study
Bolon Island Graving Dock in Reedsport, Oregon
ECSI #5361

Alternative Number	Remedial Alternative	Overall Protectiveness	Effectiveness	Long-Term Reliability	Implementability	Reasonableness of Cost ^a	Overall Rank based on combined balancing factors
1	No Action	Not Protective	Low	Low	High	No Cost	4
2	Excavation and Off-Site Disposal	Protective	High	High	High	High	3
3	Aggregate Cap	Protective	High	High	High	Moderate	1
4	Asphalt Cap	Protective	High	High	High	Moderately High	2

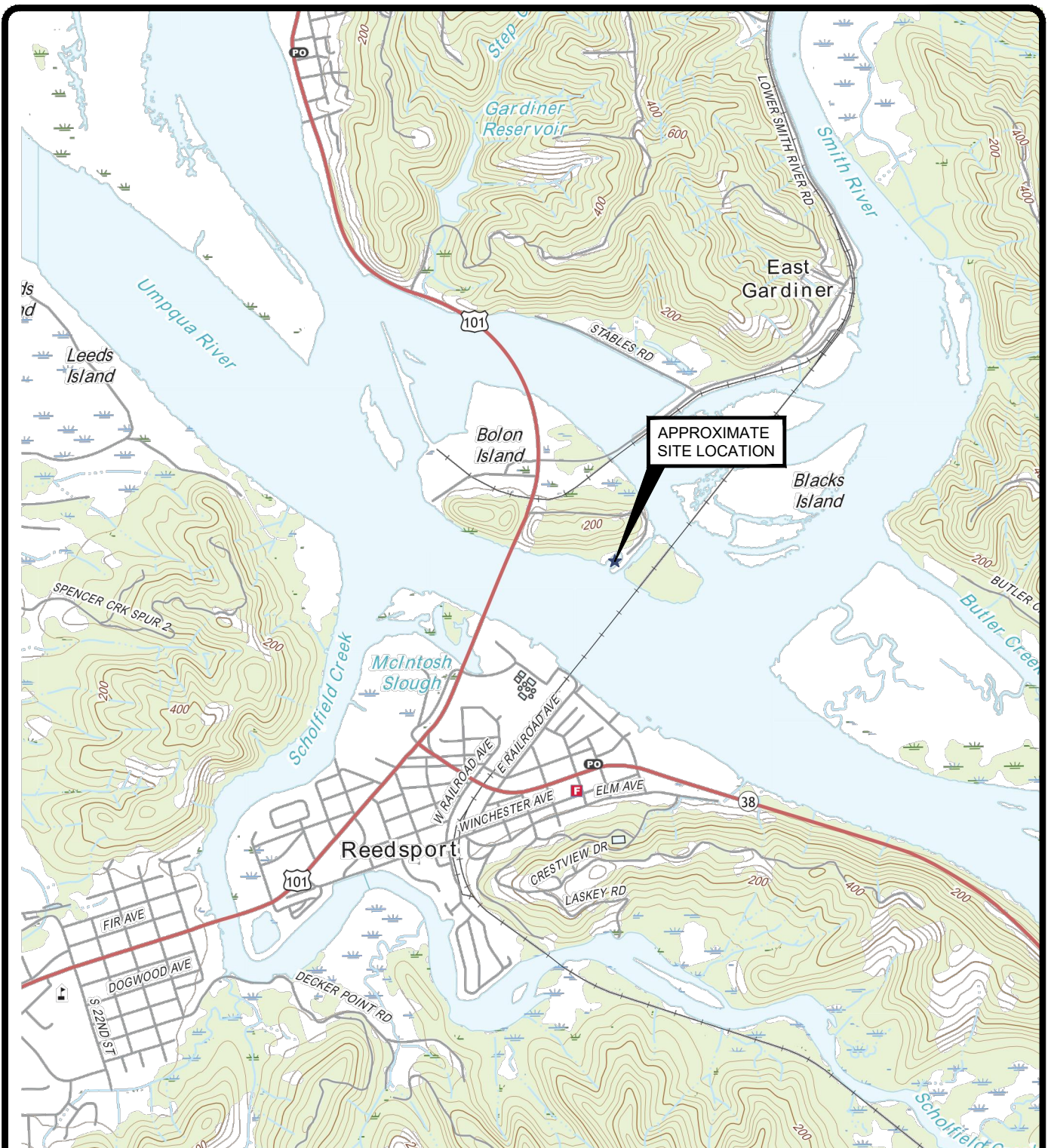
Notes: ^a See Table 4

Table 4
Estimated Remedial Alternatives Costs Details
Focused Feasibility Study
Bolon Island Graving Dock in Reedsport, Oregon
ECSI #5361

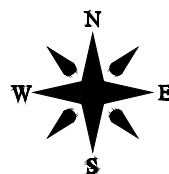
Alternative Number	Remedial Alternative	Line Items	Line Item Cost	Total Cost (1)
1	No Action	None	None	\$0
2	Excavation and Off-Site Disposal	Mobilization	\$3,500	
		Entrance Road Improvements	\$86,000	
		Demolition and Disposal of Structures / Strip	\$8,500	
		Excavation of Approximately 9,000 Tons, Hauling to Arlington Landfill, Labor and Equipment	\$830,500	
		Tipping Fees for Arlington Landfill	\$1,419,000	
		Confirmation Sampling, Labor, and Analytical	\$50,000	
		Import and Place Approximately 18,500 cubic yards of Clean Fill; Labor, Equipment, and Material	\$150,000	
				\$2,547,500
3	Aggregate Cap	Mobilization	\$3,500	
		Entrance Road Improvements	\$86,000	
		Demolition and Disposal of Structures / Strip	\$8,500	
		Import and Place Approximately 12,500 cubic yards of Clean Fill in dry dock area; Labor, Equipment, and	\$95,000	
		Geotextile	\$13,500	
		Import and Place Approximately 3,000 tons of Clean Aggregate over 2.2 acres; Labor, Equipment, and Ma	\$110,000	
		Annual Aggregate Cap Inspection and Repairs Over 30 Years	\$15,000	
				\$331,500
4	Asphalt Cap	Mobilization	\$3,500	
		Entrance Road Improvements	\$86,000	
		Demolition and Disposal of Structures / Strip	\$8,500	
		Import and Place 12,500 cubic yards of Clean Fill in dry dock area; Labor, Equipment, and Material	\$95,000	
		Import and Place Approximately 600 tons of Clean Aggregate over dry dock and fine grade 2.2 acres; Labor, Equipment, and Material	\$25,000	
		Asphalt Paving, 2 inches over 2.2 acres	\$215,000	
		Annual Asphalt Cap Inspection and Repairs Over 30 Years	\$20,000	
				\$453,000

Note: (1) The selected remedial alternative can be implemented within 3 years with the exception of cap inspection and maintenance, if selected. Costs reflect net present value over 3 years.

FIGURES



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC QUADRANGLE
REEDSPORT, OR (2017)



ALPINE ENVIRONMENTAL CONSULTANTS, LLC

DATE: 8/20/21

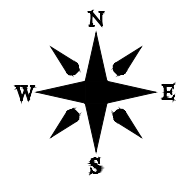
DRAWN BY: SRM

APPROVED BY: JDW

Figure 1
Site Location Map
Focused Feasibility Study
Bolon Island Graving Dock
Reedsport, Oregon



SOURCE: GOOGLE EARTH (7/22/2012)



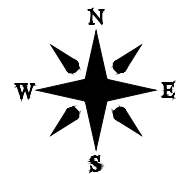
ALPINE ENVIRONMENTAL CONSULTANTS, LLC

DATE: 8/20/21	DRAWN BY: SRM	APPROVED BY: JDW
---------------	---------------	------------------

Figure 2
Site Map with Property Boundary
Focused Feasibility Study
Bolon Island Graving Dock
Reedsport, Oregon



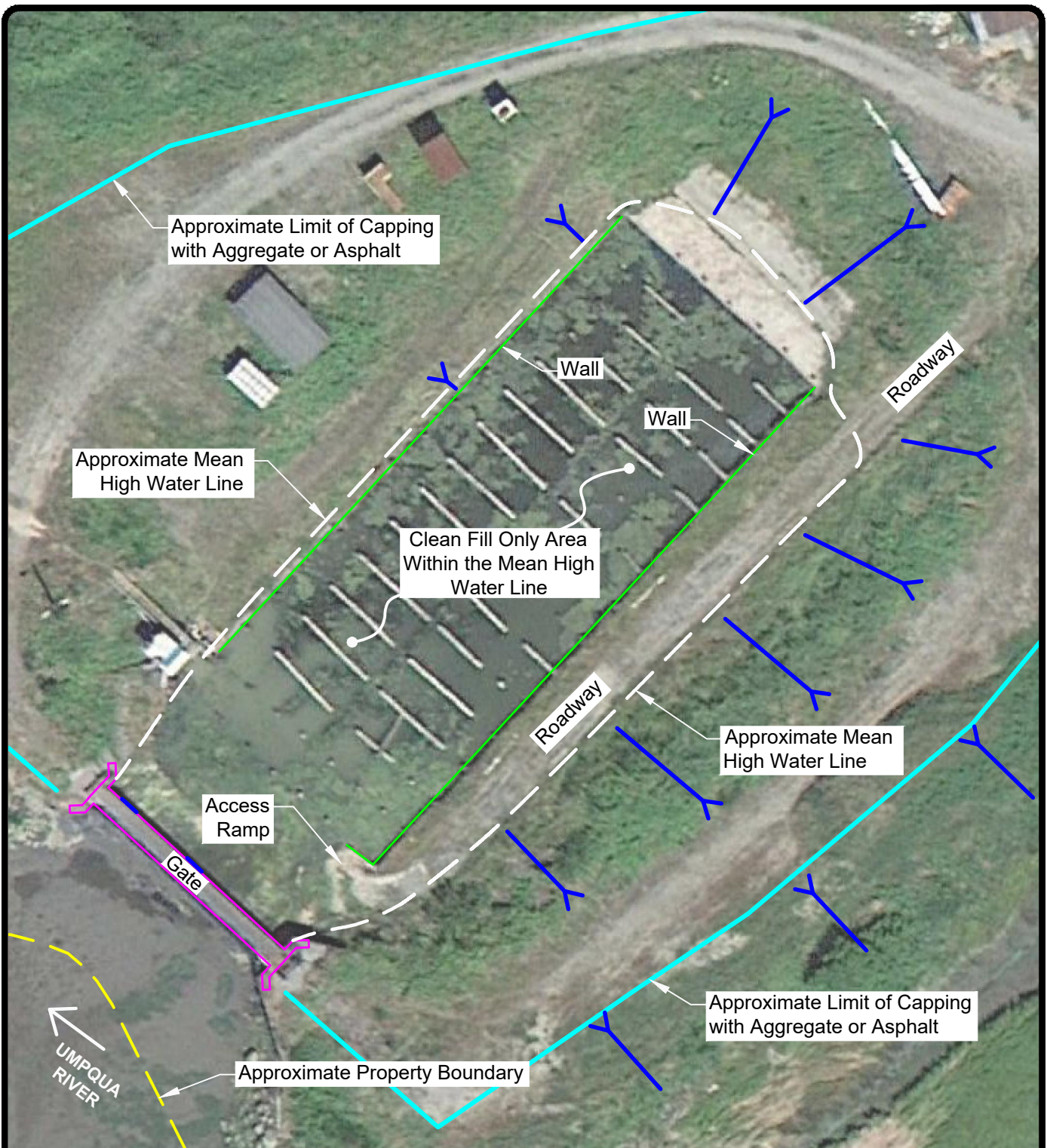
SOURCE: GOOGLE EARTH (7/22/2012)



ALPINE ENVIRONMENTAL CONSULTANTS, LLC

DATE: 9/3/21	DRAWN BY: SRM	APPROVED BY: JDW
--------------	---------------	------------------

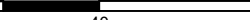
Figure 3
 Alternatives 2 and 3 - General Layout Map
 Focused Feasibility Study
 Bolon Island Graving Dock
 Reedsport, Oregon



SOURCE: GOOGLE EARTH (7/22/2012)

LEGEND

 Existing Slope

SCALE  FEET
0 40 80

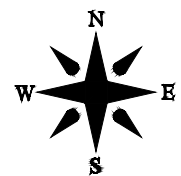


Figure 4
Alternatives 2 and 3 - Details
Focused Feasibility Study
Bolon Island Graving Dock
Reedsport, Oregon

APPENDIX 1

Analytical Results Tables from the 2018 Phase II Report

**Table 1. Soil and Sediment Analytical Results - Total Petroleum Hydrocarbons (TPHs)
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon**

			Total Petroleum Hydrocarbons (TPHs)		
			DEQ Method HCID and if detected, DEQ Method NWTPH-Dx		
			(mg/kg)		
Sample Name	Depth (ft bgs)	Date Collected	Diesel-range (TPH-D)	Oil-range (TPH-O)	Gasoline-range (TPH-G)
SED-15	0.0-1.0	2/22/2012	58.9U	118U	23.6U
SED-16	0.0-1.0	2/22/2012	70.4U	141U	28.2U
TP-1	0.0-1.0	2/22/2012	67.6	222	22.9U
TP-2	0.0-1.0	2/22/2012	38.7	124	23.2U
FSP-1	0.0-0.5	2/22/2012	73.5	204	21.5U
FSP-2	0.0-0.5	2/22/2012	56.7	160	24.9U
FSP-3	0.0-0.5	2/22/2012	41.8	113	22.8U
S1	0.0-1.0	2/22/2012	427U	1,360	99.2U
S2	0.0-1.0	2/22/2012	41.8U	83.6U	16.7U
LR-South	0.0-1.0	2/22/2012	87.5	240	23.7U
DEQ Risk-Based Concentrations for Soil (a)					
Occupational Soil Ingestion, Dermal Contact, and Inhalation (b)			14,000	14,000	20,000
Construction Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			4,600	4,600	9,700
Excavation Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			>Max	>Max	>Max
Occupational Volatilization to Outdoor Air (c)			>Max	>Max	69,000
Occupational Vapor Intrusion into Buildings (d)			>Max	>Max	>Max
Occupational Leaching to Groundwater (e)			>Max	>Max	130

See notes on next page.

**Table 1. Soil and Sediment Analytical Results - Total Petroleum Hydrocarbons (TPHs)
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon**

Notes:

Analytical data in bold font indicates that the value exceeds the laboratory's method reporting limit.

Data Qualifiers:

U - The analyte was analyzed for, but was not detected above the analytical laboratory's limit of quantitation.

Footnotes:

(a) Risk-Based Concentrations are referenced from the May 2018 update to the DEQ's Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites guidance document dated September 2003.

(b) This pathway is applicable anytime someone is likely to come into contact with contaminated soil. For the occupational scenario, exposure to contaminated soils should be considered for all contaminants found in the top three feet of soil.

(c) This pathway is applicable whenever vadose zone soils are contaminated with volatile compounds.

(d) This pathway is applicable whenever vadose zone soils contaminated with volatile compounds are located beneath or within 10 feet of a commercial building or beneath or within 50 feet of a residential building.

(e) This pathway is applicable whenever vadose zone contamination is found overlying an aquifer that is currently used or is reasonably likely to be used in the future for drinking water.

Symbols/Acronyms:

bgs - below ground surface

>Csat - The soil RBC exceeds the limit of three-phase equilibrium partitioning. Soil concentrations in excess of this value indicate free product might be present.

DEQ - Department of Environmental Quality

ft - feet

>Max - The constituent RBC for this pathway is greater than 1,000,000 mg/Kg or 1,000,000 mg/L. Therefore, these substances are not expected to pose risks in the scenario shown.

mg/kg - milligrams per kilogram

NA - Sample was not analyzed for this analyte.

HCID = Hydrocarbon identification

TPH-D = Total petroleum hydrocarbons in the diesel range

TPH-O = Total petroleum hydrocarbons in the oil range

TPH-G = Total petroleum hydrocarbons in the gasoline range

RBC - risk-based concentration

Table 2. Soil and Sediment Analytical Results - Polycyclic Aromatic Hydrocarbons (PAHs)
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon

			Polycyclic Aromatic Hydrocarbons (PAHs)																	
			USEPA Method 8270D SIM																	
			(mg/kg)																	
Sample Name	Depth (feet bgs or feet below bottom of concrete)	Date Collected	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b+k)fluoranthene(s)	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	1-Methylnaphthalene	2-Methylnaphthalene	Naphthalene	Phenanthrene	Pyrene
TP-1	0.0-1.0	2/22/2012	0.307	0.0491U	0.677	2.92	3.15	5.51	2.04	3.50	0.475	0.133	6.48	0.231	2.07	0.0981U	0.0981U	0.147	3.04	5.60
TP-2	0.0-1.0	2/22/2012	0.190	0.0456U	0.555	2.44	2.72	4.70	1.76	2.85	0.409	0.0793	4.76	0.154	1.81	0.0912U	0.0912U	0.0912U	1.96	4.22
FSP-1	0.0-0.5	2/22/2012	0.381	0.0235U	0.878	3.90	4.30	7.32	2.81	4.53	0.667	0.177	7.92	0.337	2.85	0.0637	0.0776	0.111	3.71	6.80
FSP-2	0.0-0.5	2/22/2012	1.14	0.0426U	1.70	6.86	6.29	11.7	3.49	7.99	0.866	1.07	18.7	1.22	3.70	0.315	0.504	2.15	11.8	14.4
FSP-3	0.0-0.5	2/22/2012	0.180	0.0216U	0.358	2.07	2.41	4.31	1.60	2.51	0.377	0.0950	4.30	0.159	1.63	0.0433U	0.0436	0.0783	2.02	3.58
S1	0.0-1.0	2/22/2012	0.185U	0.185U	0.185U	0.455	0.577	1.03	0.478	0.640	0.185U	0.185U	0.746	0.185U	0.445	0.369U	0.369U	0.369U	0.231	0.741
LR-South	0.0-1.0	2/22/2012	0.0629	0.0454U	0.130	0.574	0.620	1.14	0.420	0.702	0.0964	0.0454U	1.23	0.0495	0.437	0.0908U	0.0908U	0.0908U	0.525	1.04
SED-11-2	1.75-2.25	10/12/11	0.0165U	0.0165U	0.0165U	0.0569	0.0560	0.103, Q-26	0.0372	0.0745	0.0165U	NA	0.124	0.0165U	0.0370	NA	NA	0.0331U	0.100	0.118
SED-11-4	3.75-4.25	10/12/11	0.0195U	0.0195U	0.0238	0.0886	0.0989	0.181, Q-26	0.0597	0.119	0.0195U	NA	0.190	0.0195U	0.0695	NA	NA	0.0390U	0.109	0.177
SED-14-2	1.75-2.25	10/12/11	0.0322U	0.0322U	0.0322U	0.0855	0.0888	0.147, Q-26	0.0623	0.0920	0.0322U	NA	0.139	0.0322U	0.0627	NA	NA	0.0645U	0.0576	0.155
SED-14-4	3.75-4.25	10/12/11	0.804U	0.804U	0.804U	1.39	1.38	2.43, Q-26	0.949	1.50	0.804U	NA	2.27	0.804U	1.03	NA	NA	0.804U	0.972	2.46
DEQ Risk-Based Concentrations for Soil (a)																				
Occupational Soil Ingestion, Dermal Contact, and Inhalation (b)			70,000	NE	350,000	21	2.1	21	NE	2,100	2.1	NE	30,000	47,000	21	NE	NE	23	NE	23,000
Construction Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			21,000	NE	110,000	170	170	170	NE	17,000	17	NE	10,000	14,000	170	NE	NE	580	NE	7,500
Excavation Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			590,000	NE	>Max	4,800	4,900	4,900	NE	490,000	490	NE	280,000	390,000	4,900	NE	NE	16,000	NE	210,000
Occupational Volatilization to Outdoor Air (c)			>Max	NE	>Max	>Csat	NV	NV	NE	NV	NV	NE	NV	>Max	NV	NE	NE	83	NE	>Csat
Occupational Vapor Intrusion into Buildings (d)			>Max	NE	>Max	>Csat	NV	NV	NE	NV	NV	NE	NV	>Max	NV	NE	NE	83	NE	>Csat
Occupational Leaching to Groundwater (e)			>Csat	NE	>Csat	8.8	>Csat	>Csat	NE	>Csat	>Csat	NE	>Csat	>Csat	>Csat	NE	NE	0.34	NE	>Csat

See notes on next page.

**Table 2. Soil and Sediment Analytical Results - Polycyclic Aromatic Hydrocarbons (PAHs)
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon**

Notes:

Analytical data in bold font indicates that the value exceeds the laboratory's method reporting limit.

Analytical data highlighted in yellow indicates the value exceeded a generic RBC.

The laboratory method reporting limits that exceed one or more RBCs are indicated with bold blue font.

Data Qualifiers:

U - The analyte was analyzed for, but was not detected above the analytical laboratory method reporting limit.

Q-26 - Peak separation for Benzo(b) and Benzo(k)fluoranthenes does not meet method specified criteria. Reported result includes the combined area of the two isomers and should be considered the total of Benzo(b+k)Fluoranthenes.

Footnotes:

(a) Risk-Based Concentrations are referenced from the May 2018 update to the DEQ's Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites guidance document dated September 2003.

(b) This pathway is applicable anytime someone is likely to come into contact with contaminated soil. For the occupational scenario, exposure to contaminated soils should be considered for all contaminants found in the top three feet of soil.

(c) This pathway is applicable whenever vadose zone soils are contaminated with volatile compounds.

(d) This pathway is applicable whenever vadose zone soils contaminated with volatile compounds are located beneath or within 10 feet of a commercial building or beneath or within 50 feet of a residential building.

(e) This pathway is applicable whenever vadose zone contamination is found overlying an aquifer that is currently used or is reasonably likely to be used in the future for drinking water.

Symbols/Acronyms:

bgs - below ground surface

>Csat - The soil RBC exceeds the limit of three-phase equilibrium partitioning. Soil concentrations in excess of this value indicate free product might be present.

DEQ - Department of Environmental Quality

ft - feet

>Max - The constituent RBC for this pathway is greater than 1,000,000 mg/Kg or 1,000,000 mg/L. Therefore, these substances are not expected to pose risks in the scenario shown.

mg/kg - milligrams per kilogram

NE - No RBC levels are established for this chemical.

RBC - risk-based concentration

USEPA - United States Environmental Protection Agency

Table 3. Soil and Sediment Analytical Results - Polychlorinated Biphenyls (PCBs)
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon

Sample Name			Polychlorinated Biphenyls (PCBs)						
			USEPA Method 8082A						
			(mg/kg)						
			Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
SED-11-2	1.75-2.25	10/12/11	0.00416U	0.00416U	0.00416U	0.00416U	0.00416U	0.00416U	0.00416U
SED-11-4	3.75-4.25	10/12/11	0.00470U	0.00470U	0.00470U	0.00470U	0.00470U	0.00470U	0.00470U
SED-14-2	1.75-2.25	10/12/11	0.00423U	0.00423U	0.00423U	0.00423U	0.00423U	0.00423U	0.00423U
SED-14-4	3.75-4.25	10/12/11	0.00531U	0.00531U	0.00531U	0.00531U	0.00531U	0.132, A-01	0.00531U
DEQ Risk-Based Concentrations for Soil (a)									
Occupational Soil Ingestion, Dermal Contact, and Inhalation (b)			0.59 (f)	0.59 (f)	0.59 (f)	0.59 (f)	0.59 (f)	0.59 (f)	0.59 (f)
Construction Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			4.9 (f)	4.9 (f)	4.9 (f)	4.9 (f)	4.9 (f)	4.9 (f)	4.9 (f)
Excavation Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			140 (f)	140 (f)	140 (f)	140 (f)	140 (f)	140 (f)	140 (f)
Occupational Volatilization to Outdoor Air (c)			>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)
Occupational Vapor Intrusion into Buildings (d)			>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)	>Csat (f)
Occupational Leaching to Groundwater (e)			1.1 (f)	1.1 (f)	1.1 (f)	1.1 (f)	1.1 (f)	1.1 (f)	1.1 (f)

See notes on next page.

**Table 3. Soil and Sediment Analytical Results - Polychlorinated Biphenyls (PCBs)
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon**

Notes:

Analytical data in bold font indicates that the value exceeds the laboratory's method reporting limit.

Data Qualifiers:

A-01 - Sample was used as a source for the duplicate. The duplicate final result was 430.916 microgram/kilogram. Sample is non-homogenous.

U - The analyte was analyzed for, but was not detected above the analytical laboratory's method reporting limit.

Footnotes:

(a) Risk-Based Concentrations are referenced from the May 2018 update to the DEQ's Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites guidance document dated September 2003.

(b) This pathway is applicable anytime someone is likely to come into contact with contaminated soil. For the occupational scenario, exposure to contaminated soils should be considered for all contaminants found in the top three feet of soil.

(c) This pathway is applicable whenever vadose zone soils are contaminated with volatile compounds.

(d) This pathway is applicable whenever vadose zone soils contaminated with volatile compounds are located beneath or within 10 feet of a commercial building or beneath or within 50 feet of a residential building.

(e) This pathway is applicable whenever vadose zone contamination is found overlying an aquifer that is currently used or is reasonably likely to be used in the future for drinking water.

(f) RBCs are for total of PCBs Aroclors.

Symbols/Acronyms:

bgs - below ground surface

>C_{sat} - The soil RBC exceeds the limit of three-phase equilibrium partitioning. Soil concentrations in excess of this value indicate free product might be present.

DEQ - Department of Environmental Quality

ft - feet

>Max - The constituent RBC for this pathway is greater than 1,000,000 mg/Kg or 1,000,000 mg/L. Therefore, these substances are not expected to pose risks in the scenario shown.

mg/kg - milligrams per kilogram

NE - No RBC levels are established for this chemical.

RBC - risk-based concentration

USEPA - United States Environmental Protection Agency

Table 4. Soil and Sediment Analytical Results - Total Metals and TOC
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon

Parameter			Total Metals					Tributyltin (as TBT ion)	Total Organic Carbon
			USEPA 6020 (ICPMS)					Krone-1988 SIM (GC/MS)	By PSEP/SM 5310B MOD
			(mg/kg)					(µg/kg)	(% by Weight)
Sample Name	Depth (feet bgs or feet below bottom of concrete)	Date Collected	Cadmium	Chromium (III)	Copper	Lead	Zinc	Tributyltin	Total Organic Carbon
SED-1-0-6	0.0-0.5	2/22/2012	0.797U	33.2	15.1	8.11	48.7	23	0.85
SED-1-6-12	0.5-1.0	2/22/2012	0.635U	46.2	19.2	45.8	63.5	190	0.88
SED-2-0-6	0.0-0.5	2/22/2012	0.868U	35.7	16.4	5.84	53.0	3.2, J	1.4
SED-2-6-12	0.5-1.0	2/22/2012	0.870U	38.4	20.2	5.96	55.8	55	1.5
SED-3-0-6	0.0-0.5	2/22/2012	0.918U	46.4	22.9	6.71	63.9	61	2.0
SED-3-6-12	0.5-1.0	2/22/2012	0.865U	51.3	30.4	7.58	67.3	10	2.0
SED-4-0-6	0.0-0.5	2/23/2012	0.929U	46.3	25.1	6.68	65.5	51	2.1
SED-4-6-12	0.5-1.0	2/23/2012	0.827U	54.1	31.9	8.15	68.6	41	2.1
SED-5-0-6	0.0-1.0	2/23/2012	0.954U	48.3	26.0	7.19	65.9	8.2	2.0
SED-5-6-12	0.5-1.0	2/23/2012	0.942U	53.5	28.2	31.6	67.4	43	1.9
SED-6-0-6	0.5-1.0	2/23/2012	0.861U	42.9	19.8	7.51	57.4	77	1.4
SED-6-6-12	0.5-1.0	2/23/2012	0.696U	57.0	21.9	211	55.5	58	1.3
SED-7-0-6	0.0-0.5	2/23/2012	0.885U	33.8	16.8	5.88	50.1	2.2, J	1.5
SED-7-6-12	0.5-1.0	2/23/2012	0.755U	48.8	23.1	10.8	56.7	66	1.4
SED-8-0-6	0.0-0.5	2/23/2012	0.776U	37.0	19.9	5.55	53.1	3.6U	1.0
SED-8-6-12	0.5-1.0	2/23/2012	0.779U	40.2	22.1	5.68	53.5	3.7U	0.67
SED-9-0-6	0.0-0.5	2/22/2012	1.38U	57.7	37.1	9.70	83.7	180	1.9
SED-9-6-12	0.5-1.0	2/22/2012	1.09U	55.7	36.5	9.31	75.7	160	2.8
SED-10-0-6	0.0-0.5	2/22/2012	1.53U	56.0	37.3	9.16	81.3	2.2, J	4.0
SED-10-6-12	0.5-1.0	2/22/2012	0.992U	50.6	32.1	7.91	70.4	24	2.6
Potentially Applicable Screening Criteria									
DEQ Soil: Occupational Soil Ingestion, Dermal Contact, and Inhalation (a),(b)			1,100	>Max	47,000	800	NE	NE	NE
DEQ Soil: Construction Worker Soil Ingestion, Dermal Contact, and Inhalation (a),(b)			350	530,000	14,000	800	NE	NE	NE
DEQ Soil: Excavation Worker Soil Ingestion, Dermal Contact, and Inhalation (a),(b)			9,700	>Max	390,000	800	NE	NE	NE
DEQ Soil: Occupational Volatilization to Outdoor Air (a),(c)			NV	NV	NV	NV	NE	NE	NE
DEQ DEQ Soil: Occupational Vapor Intrusion into Buildings (a),(d)			NV	NV	NV	NV	NE	NE	NE
DEQ Soil: Occupational Leaching to Groundwater (a),(e)			*	*	*	30	NE	NE	NE
DEQ Freshwater Sediment SLVs			0.6	37(total)	36	35	123	NE	NE
DEQ Marine Sediment SLVs			0.7	52(total)	19	30	124	3,000	NE
Freshwater Sediment TEC			0.99	43.4(total)	31.6	35.8	121	NE	NE
Freshwater Sediment PEC			4.98	111(total)	149	128	459	NE	NE
DEQ Sediment SLVs - Bird Populations			NE	NE	NE	NE	NE	4,100	NE
DEQ Sediment SLVs - Mammal Populations			NE	NE	NE	NE	NE	1,100	NE
DEQ Sediment SLVs - Fish			NE	NE	NE	NE	NE	2.3	NE
DEQ Sediment Background Concentrations			<0.5	30	12	2	53	NE	NE
DEQ Soil SLVs - Bird Populations			30	20(III)	950	80	300	NE	NE
DEQ Soil SLVs - Mammal Populations			625	2050(VI)	1950	20000	100000	NE	NE
DEQ Soil SLVs - Plants			4	1(III)	100	50	50	NE	NE
DEQ Soil SLVs - Invertebrates			20	0.4(III)	50	500	200	NE	NE
DEQ Soil Background Concentrations (f)			0.54	240	100	34	140	NE	NE
USEPA Regional Screening Level - Human Receptors, Industrial Soil (g)								35,000	
USEPA Soil Screening Levels for Mammals			0.36	34(III)	49	56	79	NE	NE
USEPA Soil Screening Levels for Birds (h)			0.77	26(III)	28	11	46	NE	NE

Table 4. Soil and Sediment Analytical Results - Total Metals and TOC
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon

Parameter			Total Metals					Tributyltin (as TBT ion)	Total Organic Carbon
			USEPA 6020 (ICPMS)					Krone-1988 SIM (GC/MS)	By PSEP/SM 5310B MOD
			(mg/kg)					(µg/kg)	(% by Weight)
Sample Name	Depth (feet bgs or feet below bottom of concrete)	Date Collected	Cadmium	Chromium (III)	Copper	Lead	Zinc	Tributyltin	Total Organic Carbon
SED-15	0.0-1.0	2/22/2012	0.639U	92.4	92.5	33.6	124	450	NA
SED-16	0.0-1.0	2/22/2012	0.642U	40.6	18.6	11.7	70.3	170	NA
TP-1	0.0-1.0	2/22/2012	0.639U	614	99.0	143	228	4,500	NA
TP-2	0.0-1.0	2/22/2012	0.685	382	73.1	86.6	170	6,400	NA
FSP-1	0.0-0.5	2/22/2012	0.727U	527	102	268	275	6,500	NA
FSP-2	0.0-0.5	2/22/2012	0.671U	782	82.1	115	265	8,600	NA
FSP-3	0.0-0.5	2/22/2012	0.600U	425	52.8	92.2	394	3,200	NA
S1	0.0-1.0	2/22/2012	0.578U	114	32.8	49.0	97.4	1,100	NA
S2	0.0-1.0	2/22/2012	0.559U	59.4	24.5	11.4	46.7	190	NA
SED-11-2	1.75-2.25	10/12/11	0.617U	22.8	14.7	4.88	39.5	NA	NA
SED-11-4	3.75-4.25	10/12/11	0.561U	38.8	12.8	4.15	32.7	NA	NA
SED-14-2	1.75-2.25	10/12/11	0.589U	15.1	7.21	2.98	24.1	NA	NA
SED-14-4	3.75-4.25	10/12/11	0.752U	218	31.2	47.8	129	NA	NA
SED-17-0-6	0.0-0.5	02/07/17	NA	NA	NA	NA	NA	3.74U	1.06
SED-17-6-12	0.5-1.0	02/07/17	NA	NA	NA	NA	NA	3.82U	1.39
SED-18-0-6	0.0-0.5	02/07/17	NA	NA	NA	NA	NA	7.52	0.99
SED-18-6-12	0.5-1.0	02/07/17	NA	NA	NA	NA	NA	3.57U	1.20
SED-19-0-6	0.0-0.5	02/07/17	NA	NA	NA	NA	NA	3.72U	1.67
SED-19-6-12	0.5-1.0	02/07/17	NA	NA	NA	NA	NA	4.55	1.00
Potentially Applicable Screening Criteria									
DEQ Soil: Occupational Soil Ingestion, Dermal Contact, and Inhalation (b)			1,100	>Max	47,000	800	NE	NE	NE
DEQ Soil: Construction Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			350	530,000	14,000	800	NE	NE	NE
DEQ Soil: Excavation Worker Soil Ingestion, Dermal Contact, and Inhalation (b)			9,700	>Max	390,000	800	NE	NE	NE
DEQ Soil: Occupational Volatilization to Outdoor Air (c)			NV	NV	NV	NV	NE	NE	NE
DEQ DEQ Soil: Occupational Vapor Intrusion into Buildings (d)			NV	NV	NV	NV	NE	NE	NE
DEQ Soil: Occupational Leaching to Groundwater (e)			*	*	*	30	NE	NE	NE
DEQ Freshwater Sediment SLVs			0.6	37(total)	36	35	123	NE	NE
DEQ Marine Sediment SLVs			0.7	52(total)	19	30	124	3,000	NE
Freshwater Sediment TEC			0.99	43.4(total)	31.6	35.8	121	NE	NE
Freshwater Sediment PEC			4.98	111(total)	149	128	459	NE	NE
DEQ Sediment SLVs - Bird Populations			NE	NE	NE	NE	NE	4,100	NE
DEQ Sediment SLVs - Mammal Populations			NE	NE	NE	NE	NE	1,100	NE
DEQ Sediment SLVs - Fish			NE	NE	NE	NE	NE	2.3	NE
DEQ Sediment Background Concentrations			<0.5	30	12	2	53	NE	NE
DEQ Soil SLVs - Bird Populations			30	20(III)	950	80	300	NE	NE
DEQ Soil SLVs - Mammal Populations			625	2050(VI)	1950	20000	100000	NE	NE
DEQ Soil SLVs - Plants			4	1(III)	100	50	50	NE	NE
DEQ Soil SLVs - Invertebrates			20	0.4(III)	50	500	200	NE	NE
DEQ Soil Background Concentrations (f)			0.54	240	100	34	140	NE	NE
USEPA Regional Screening Level - Human Receptors, Industrial Soil (g)								35,000	
USEPA Soil Screening Levels for Mammals			0.36	34(III)	49	56	79	NE	NE
USEPA Soil Screening Levels for Birds (h)			0.77	26(III)	28	11	46	NE	NE

See notes on next page.

Table 4. Soil and Sediment Analytical Results - Total Metals and TOC
Phase II Environmental Investigation - Bolon Island Graving Dock, Reedsport, Oregon

Notes:

Analytical data in bold font indicates that the value exceeds the laboratory's method reporting limit.

Analytical data highlighted in yellow indicates the value exceeded a generic RBC.

Analytical data, DEQ Background Concentrations, or USEPA Soil Screening Levels for Birds highlighted in yellow indicates the value exceeded a generic RBC.

* - Leaching to groundwater RBCs are not provided for inorganic chemicals. If this pathway is of concern, then site-specific leaching tests must be performed.

According to Analytical Resources, Incorporated regarding the Trubutyl analysis, several samples required an additional analytical run at a dilution in order to properly quantify "E" qualified values within a reportable range. In these instances, both runs have been reported in the complete laboratory report and only the highest value was reported in Table 4.

Data Qualifiers:

E - Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

J - Estimated concentration when the value is less than Analytical Resources, Incorporated's established reporting limits.

U - The analyte was analyzed for, but was not detected above the analytical laboratory's method reporting limit.

Footnotes:

(a) Risk-Based Concentrations are referenced from the May 2018 update to the DEQ's Risk-Based Decision Making (RBDM) for the Remediation of Petroleum-Contaminated Sites guidance document dated September 2003.

(b) This pathway is applicable anytime someone is likely to come into contact with contaminated soil. For the occupational scenario, exposure to contaminated soils should be considered for all contaminants found in the top three feet of soil.

(c) This pathway is applicable whenever vadose zone soils are contaminated with volatile compounds.

(d) This pathway is applicable whenever vadose zone soils contaminated with volatile compounds are located beneath or within 10 feet of a commercial building or beneath or within 50 feet of a residential building.

(e) This pathway is applicable whenever vadose zone contamination is found overlying an aquifer that is currently used or is reasonably likely to be used in the future for drinking water.

(f) DEQ's Background Concentrations in Soil are referenced from the DEQ's Development of Oregon Background Metals Concentrations in Soil technical report dated March 2013. The background concentrations included in this table are 95% Upper Prediction Limit (UPL) for the Coast Range region, which includes the Reedsport area and the Site.

(g) From USEPA Regional Screening Levels, May 2018, Target Hazard Quotient = 0.1

(h) From USEPA Interim Final Table 1 of 2007. Source: <http://www.epa.gov/ecotox/index.html>.

Symbols/Acronyms:

bgs - below ground surface

DEQ - Department of Environmental Quality

ft - feet

>Max - The constituent RBC for this pathway is greater than 1,000,000 mg/Kg or 1,000,000 mg/L. Therefore, these substances are not expected to pose risks in the scenario shown.

mg/kg - milligrams per kilogram

µg/kg - micrograms per kilogram

NE - No RBC levels are established for this chemical.

NV - The chemical is considered "nonvolatile" for the purposes of the exposure calculations.

RBC - risk-based concentration

TOC - Total Organic Carbon

USEPA - United States Environmental Protection Agency

Table 5
Estuary Sediment Samples Analytical Results for Metals and TOC
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

Sample Name	Total Metals USEPA 6020 (ICPMS) (mg/kg)					Tributyltin (as TBT ion) Krone-1988 SIM (GC/MS) (µg/kg)	Total Organic Carbon By PSEP/SM 5310B MOD
	Cadmium	Chromium (III)	Copper	Lead	Zinc	Tributyltin (TBT)	Total Organic Carbon (% by Weight)
SED-1-0-6	<0.797	33.2	15.1	8.11	48.7	23	0.85
SED-1-6-12	<0.635	46.2	19.2	45.8	63.5	190	0.88
SED-2-0-6	<0.868	35.7	16.4	5.84	53	3.2	1.4
SED-2-6-12	<0.87	38.4	20.2	5.96	55.8	55	1.5
SED-3-0-6	<0.918	46.4	22.9	6.71	63.9	61	2
SED-3-6-12	<0.865	51.3	30.4	7.58	67.3	10	2
SED-4-0-6	<0.929	46.3	25.1	6.68	65.5	51	2.1
SED-4-6-12	<0.827	54.1	31.9	8.15	68.6	41	2.1
SED-5-0-6	<0.954	48.3	26	7.19	65.9	8.2	2
SED-5-6-12	<0.942	53.5	28.2	31.6	67.4	43	1.9
SED-6-0-6	<0.861	42.9	19.8	7.51	57.4	77	1.4
SED-6-6-12	<0.696	57	21.9	211	55.5	58	1.3
SED-7-0-6	<0.885	33.8	16.8	5.88	50.1	2.2	1.5
SED-7-6-12	<0.755	48.8	23.1	10.8	56.7	66	1.4
SED-8-0-6	<0.776	37	19.9	5.55	53.1	3.6 U	1
SED-8-6-12	<0.779	40.2	22.1	5.68	53.5	3.7 U	0.67
SED-9-0-6	<1.38	57.7	37.1	9.7	83.7	180	1.9
SED-9-6-12	<1.09	55.7	36.5	9.31	75.7	160	2.8
SED-10-0-6	<1.53	56	37.3	9.16	81.3	2.2	4
SED-10-6-12	<0.992	50.6	32.1	7.91	70.4	24	2.6
SED-17-0-6						3.74 U	1.06
SED-17-6-12						3.82 U	1.39
SED-18-0-6						7.52	0.99
SED-18-6-12						3.57 U	1.2
SED-19-0-6						3.72 U	1.67
SED-19-6-12						4.55	1
Mean		46.7	25.1	20.8	62.9	41.9	1.64
Standard Deviation		8.0	7.0	45.9	10.0	55.3	0.72
Coefficient of Variation		0.2	0.3	2.2	0.2	1.3	0.44
Screening Criteria							
DEQ Soil Background Concentrations ^a	0.54	240	100	34	140	NA	NA
Benthic Invertebrate SL1 ^b	2.1	72	400	360	3200	47	NA
Benthic Invertebrate SL2 ^c	5.4	88	1200	>1,300	>4,200	320	NA
DEQ Sediment SLV - Bird Population ^d	NA	NA	NA	NA	NA	4100	NA
DEQ Sediment SLV - Mammal Population ^d	NA	NA	NA	NA	NA	1100	NA
DEQ Sediment SLV - Freshwater Fish ^d	NA	NA	NA	NA	NA	2.3	NA
DEQ Sediment SLV - General Fisher ^d	NA	NA	NA	NA	NA	85	NA

Notes:

USEPA - United States Environmental Protection Agency
DEQ - Oregon Department of Environmental Quality
NA - Not Available
SL - Screening Level
SLV - Screening Level Value
mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram

^a - DEQ default background concentrations in soil of the Coast Range (DEQ, 2013).

DEQ, 2013. *Development of Oregon Background Metals Concentrations in Soil, Technical Report*.

^b - Concentration below which adverse effects to benthic communities would not be expected (RSET, 2016).

^c - Concentration above which more than minor adverse effects may be observed in benthic organisms (RSET, 2016).
Northwest Regional Sediment Evaluation Team (RSET), 2016. *Sediment Evaluation Framework*

^d - DEQ sediment bioaccumulation SLV (DEQ, 2007).

DEQ, 2007. *Bioaccumulative Chemicals of Concern in Sediment*.

Table 6
Recreational Fisher Screening Level Value
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

Symbol	Definition	Value	Units	Comment
<i>Acceptable Tissue Level</i>				
RfD	Reference dose	0.0003	mg/kg ww*d	TBT reference dose from DEQ
FIR	Fish ingestion rate	0.0175	kg ww/d	DEQ (2007) fish ingestion rate for recreational fisher
BW	Body weight	80	kg	Updated default body weight
AR _{nc}	Non-cancer acceptable risk level	1	unitless	DEQ acceptable risk level for noncarcinogens
ATL	Acceptable tissue level (ww)	1.37	mg/kg ww	Wet weight ATL for recreational fisher calculated as follows: $ATL = RfD * BW * AR_{nc} / FIR$
ATL	Acceptable tissue level (dw)	4.57	mg/kg dw	Dry weight ATL converted from wet weight value assuming fish have water content of 0.7 (70%) using following equation: $C_{wet\ wt} = C_{dry\ wt} * (1 - \text{proportion water})$.
BSAF	Biota-sediment accumulation factor	4.7	kg oc dw/kg lipid dw	BSAF based on dry weight of sediment, tissue, oc, and lipid. DEQ (2007) default value with correct units.
f _{oc}	Fraction organic carbon	0.0164	kg oc dw/kg sed dw	Mean dry weight fraction organic carbon for sediment at the Site.
f _L	Fraction lipid	0.03	kg lipid dw/kg body wt dw	DEQ (2007) default value for fraction lipid content of a fish fillet.
<i>Recreational Fisher SLV</i>				
SLV	Screening level value (ppm)	0.532	mg/kg dw	Recreational fisher SLV assuming all consumed fish are from the Site calculated as follows: $SLV_{dw} = (f_{oc} * ATL_{dw}) / (BSAF_{dw} * f_L)$
SLV	Screening level value (ppb)	532	ug/kg dw	Same as above in units of ug/kg
Notes: dw = dry weight ww = wet weight oc = organic carbon mg = milligram kg = kilogram ug = microgram DEQ. 2007. Bioaccumulative chemicals of concern in sediment. Final January 31, 2007; updated April 3, 2007				

Table 7
Home Range Size of Fish
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

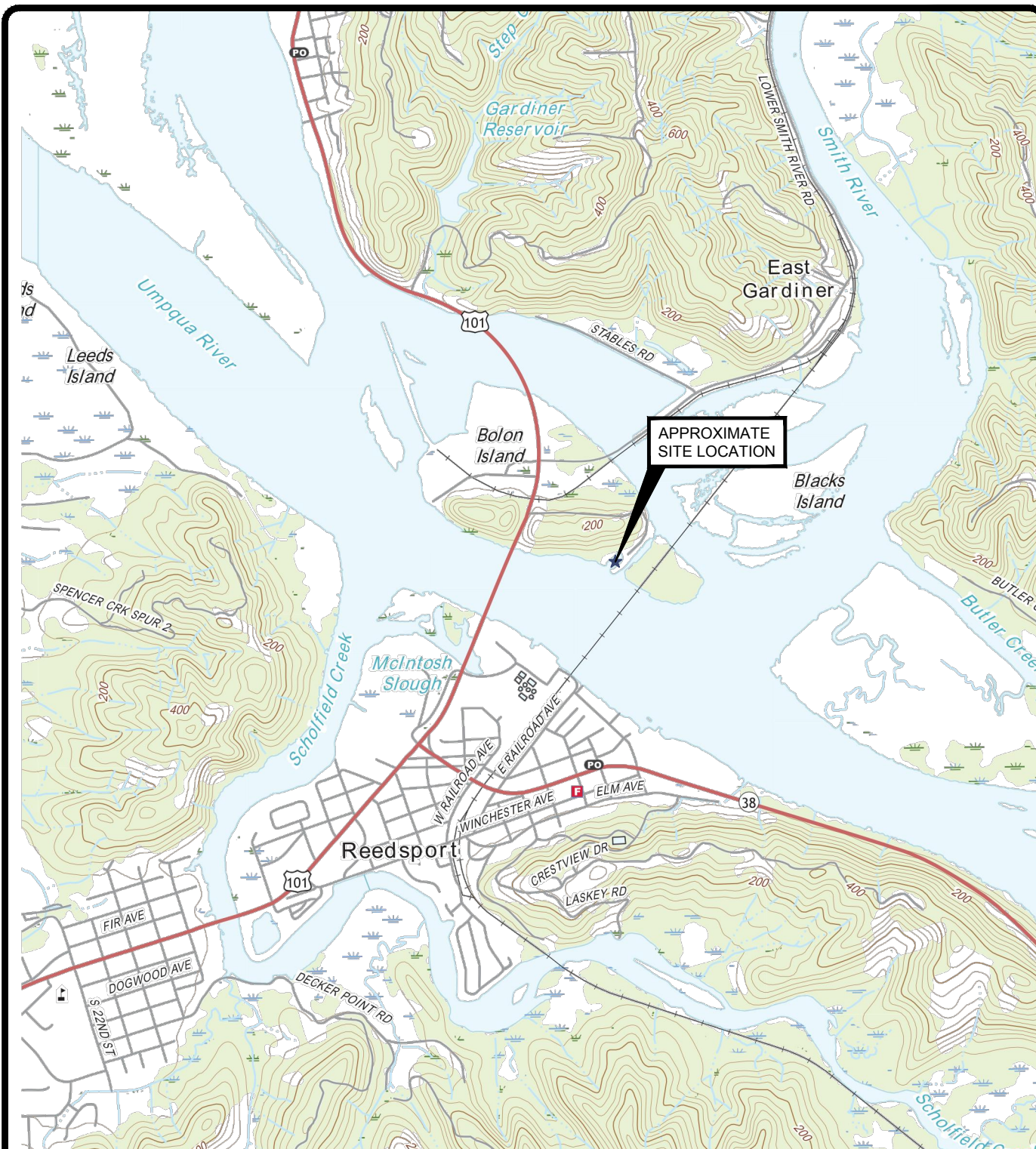
Symbol	Definition	Value	Units	Comment
FL	Fish length	10	cm	Length of typical small fish found near the Site.
BS	Body size	1000	cm ³	Body size approximated as cubic fish length (BS = FL ³)
log BS	Log body size	3	cm ³	Log of approximate fish body size
RL	River length	160000	m	Approximate length of Umpqua River
log RL	Log river length	5.20	m	Log of approximate length of Umpqua River
log HR	Log home range size	2.0	lineal m	Log of fish home range (lineal m) = (0.3788*log river length) + (0.3617 * log body size) - 1.03. Based on Woolnough et al (2008).
HR	Home range size	106	lineal m	Fish home range size in lineal meters along shore.
Notes: cm = centimeter cm ³ = cubic centimeter m = meter Woolnough, D.A., J.A. Downing, and T.J. Newton. 2009. Fish movement and habitat use depends on water body size and shape. Ecology of Freshwater Fish, Vol 18, pp. 83-91				

Table 8
Fish Screening Level Value
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

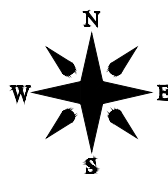
Symbol	Definition	Value	Units	Comment
BSAF	Biota-sediment accumulation factor	4.7	kg oc dw/kg lipid dw	BSAF based on dry weight of sediment, tissue, oc, and lipid. DEQ (2007) default value with correct units.
f _{oc}	Fraction organic carbon	0.0164	kg oc dw/kg sed dw	Mean dry weight fraction organic carbon for sediment at the Site.
f _L	Fraction lipid	0.05	kg lipid dw/kg body wt dw	DEQ (2007) default value for fraction lipid content of whole fish or invertebrates.
SUF	Site use factor	1	unitless	Proportion of total fish exposure from the Site. Assumes all fish exposures are from the Site.
CTL 1	Critical tissue level 1	3.0	mg/kg dw	Critical tissue level in dry weight from Meador et al (2000).
CTL 2	Critical tissue level 2	1.0	mg/kg dw	CTL used at Astoria Marine site based on low-effect level from Meador (2011). Converted from wet weight value of 0.3 mg/kg to dry weight assuming fish have water content of 0.7 (70%) using following equation: C wet wt = C dry wt * (1 - proportion water).
<i>Fish SLV</i>				
SLV 1	Screening level value 1 (ppm)	0.209	mg/kg dw	Dry weight SLV based on Meador (2000) CTL calculated as follows: $SLV\ dw = (f_{oc} * CTL\ dw) / (BSAF\ dw * f_L * SUF)$
SLV 2	Screening level value 2 (ppm)	0.070	mg/kg dw	Dry weight SLV based on Meador (2011) CTL calculated as follows: $SLV\ dw = (f_{oc} * CTL\ dw) / (BSAF\ dw * f_L * SUF)$
SLV 1	Screening level value 1 (ppb)	209	ug/kg dw	Same as above in units of ug/kg
SLV 2	Screening level value 2 (ppb)	70	ug/kg dw	Same as above in units of ug/kg
Notes: dw = dry weight ww = wet weight oc = organic carbon mg = milligram kg = kilogram ppm = parts per million ppb = parts per billion DEQ. 2007. Bioaccumulative chemicals of concern in sediment. Final January 31, 2007; updated April 3, 2007 Meador, J.P., T.K. Collier, and J.E. Stein. 2002. Determination of a tissue and sediment threshold for tributyltin to protect prey species of juvenile salmonids listed under the US Endangered Species Act. Aquatic Conserv: Mar. Freshw. Ecosyst., 12: 539–551 Meador, J.P. 2011. Organotins in aquatic biota: Occurrence in tissue and toxicological significance. In: Environmental Contaminants in Biota: Interpreting Tissue Concentrations. Beyer WN and Meador JP (eds).				

APPENDIX 2

Figures from the 2018 Phase II Report



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC QUADRANGLE
REEDSPORT, OR (2017)



ALPINE ENVIRONMENTAL CONSULTANTS, LLC

DATE: 6/21/18

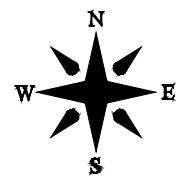
DRAWN BY: SRM

APPROVED BY: JDW

Figure 1
Site Location Map
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon



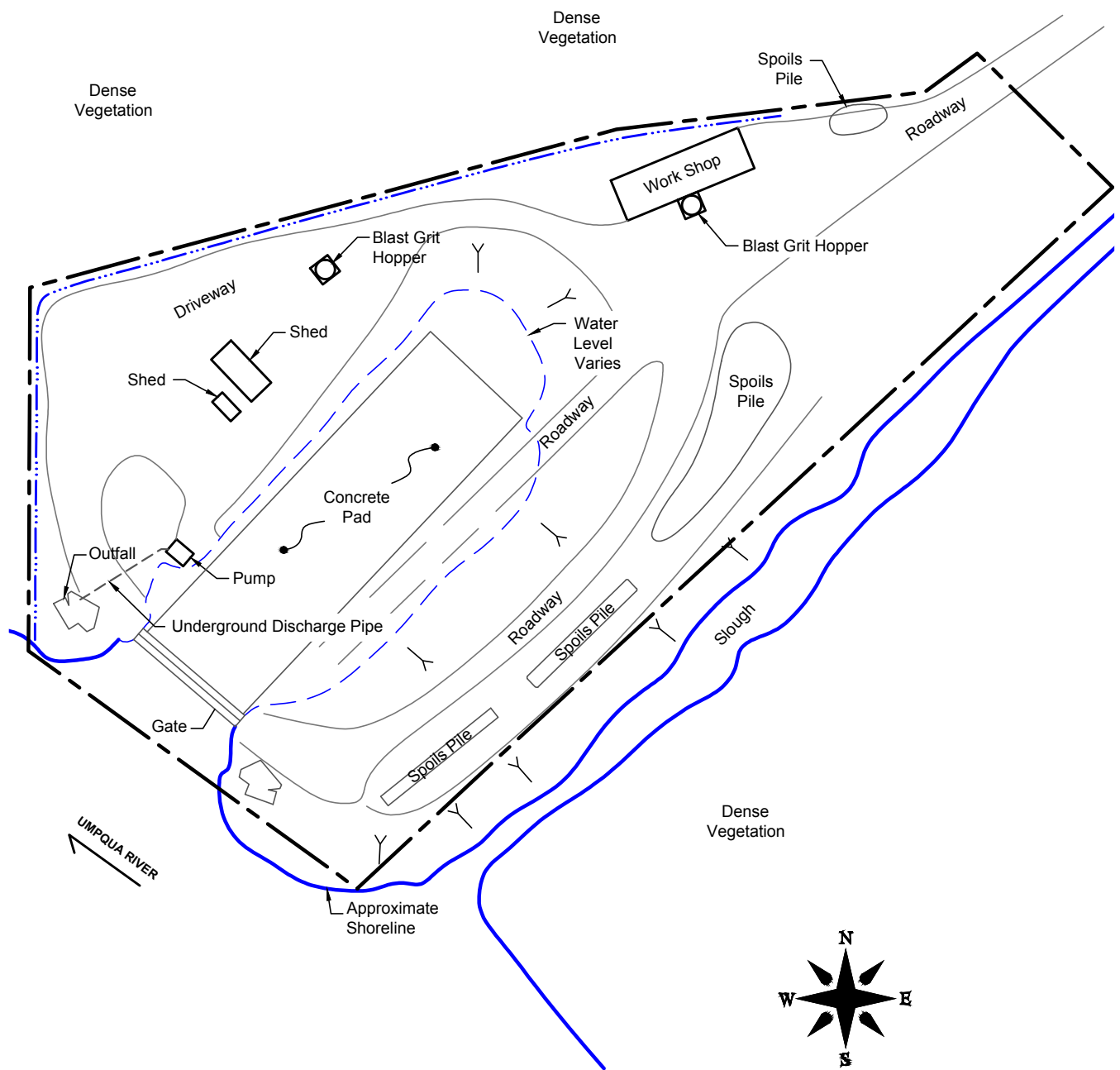
SOURCE: GOOGLE EARTH (7/22/2012)



ALPINE ENVIRONMENTAL CONSULTANTS, LLC

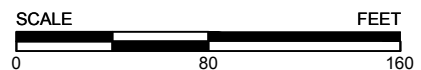
DATE: 6/21/18	DRAWN BY: SRM	APPROVED BY: JDW
---------------	---------------	------------------

Figure 2
Site Map with Property Boundary
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon



LEGEND

- Approximate Historical Lease Property Boundary
- Approximate Location of Drainage Ditch



SOURCE: JBR ENVIRONMENTAL (1/24/2011)



Figure 3
Site Map Infrastructure Schematic
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

	PR-2-1-15	PR-2-2-16
Gasoline	--	--
Mineral Spirits	--	--
Kerosene	--	--
Diesel	--	--
Oil	--	--
Carbon Disulfide	<10.0	11.9
Chloroform	<10.0	<10.0
Methylene Chloride	<50.0	<50.0
o-Xylene	<10.0	<10.0
Arsenic	--	--
Barium	--	--
Cadmium	--	--
Chromium	--	--
Lead	--	--
Selenium	--	--
Silver	--	--
Mercury	--	--
Chromium TCLP	--	--
Lead TCLP	--	--
Tributyltin	--	--

	SUR-06-20
Gasoline	--
Mineral Spirits	--
Kerosene	--
Diesel	--
Oil	--
Carbon Disulfide	--
Chloroform	--
Methylene Chloride	--
o-Xylene	--
Arsenic	3.19
Barium	30.3
Cadmium	1.60
Chromium	30.9
Lead	<1.06
Selenium	<1.06
Silver	<1.06
Mercury	<0.0200
Chromium TCLP	--
Lead TCLP	--
Tributyltin	--

	DOCK-2-1-21
Gasoline	--
Mineral Spirits	--
Kerosene	--
Diesel	--
Oil	--
Carbon Disulfide	--
Chloroform	--
Methylene Chloride	--
o-Xylene	--
Arsenic	2.56
Barium	38.9
Cadmium	2.56
Chromium	35.9
Lead	2.99
Selenium	1.28
Silver	<0.855
Mercury	<0.0226
Chromium TCLP	--
Lead TCLP	--
Tributyltin	--

	DOCK-1-1-17	DOCK-1-2PW-18	DOCK-1-3-19
Gasoline	--	--	--
Mineral Spirits	--	--	--
Kerosene	--	--	--
Diesel	--	--	--
Oil	--	--	--
Carbon Disulfide	--	--	--
Chloroform	--	--	--
Methylene Chloride	--	--	--
o-Xylene	--	--	--
Arsenic	<0.952	--	2.91
Barium	30.0	--	38.3
Cadmium	5.71	--	1.94
Chromium	45.7	--	29.1
Lead	3.33	--	11.6
Selenium	1.43	--	<0.971
Silver	<0.952	--	<0.971
Mercury	<0.0200	--	0.988
Chromium TCLP	<0.00500	--	--
Lead TCLP	--	--	0.0300
Tributyltin	--	0.00010	--

	SUR-05-11
Gasoline	--
Mineral Spirits	--
Kerosene	--
Diesel	--
Oil	--
Carbon Disulfide	--
Chloroform	--
Methylene Chloride	--
o-Xylene	--
Arsenic	1.55
Barium	34.5
Cadmium	5.67
Chromium	912
Lead	1.55
Selenium	<1.03
Silver	<1.03
Mercury	<0.0200
Chromium TCLP	0.00527
Lead TCLP	--
Tributyltin	--

	EB-1-1-14
Gasoline	--
Mineral Spirits	--
Kerosene	--
Diesel	--
Oil	--
Carbon Disulfide	--
Chloroform	--
Methylene Chloride	--
o-Xylene	--
Arsenic	2.60
Barium	40.6
Cadmium	3.12
Chromium	323
Lead	80.2
Selenium	1.04
Silver	<1.04
Mercury	0.532
Chromium TCLP	0.00500
Lead TCLP	0.0200
Tributyltin	--

LEGEND

DOCK-01 ✕ 2000 surface sample location

EB-02 ☐ 2000 test pit

mg/kg Milligrams per kilograms

µg/L Micrograms per liter

< Not reported at or above the laboratory method reporting limit

-- Not analyzed

RED Bold, red text indicate analytical results which exceed DEQ RBDM levels

0.0300 Shaded result is in mg/L. All other results in mg/kg.

--- Approximate lease property boundary

--- Approximate location of drainage ditch

Note: VOC analysis included 65 separate analytes. This table displays only the four analytes with one or more results at, or above, the laboratory method reporting limit. All Locations are approximate.

SOURCE: JBR ENVIRONMENTAL (4/8/2011)

Locations and results from Phase II Report prepared by Land and Water Environmental Services, Inc. report dated March 17, 2000.



Figure 4
Soil and Sediment Analytical Results
from 2000 Phase II Investigation
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

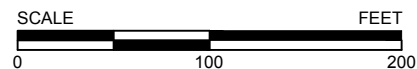
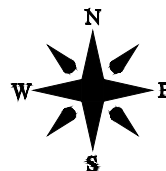
BOLON ISLAND



SOURCE: JBR ENVIRONMENTAL (3/14/12)

LEGEND

- Discrete Sample location
- ▲ Composite Sample location

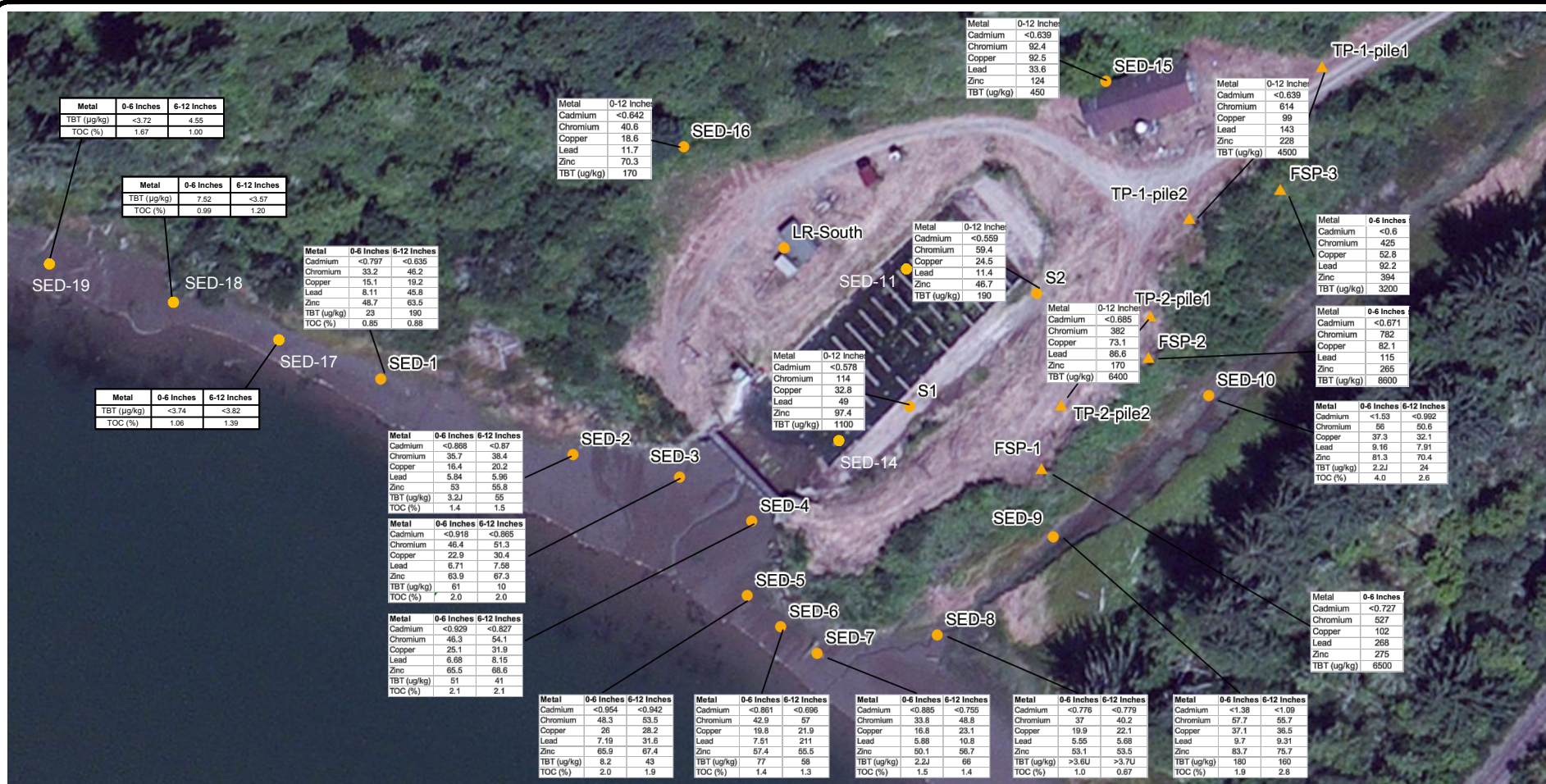


Note:

- Hydrocarbon concentrations in milligrams per kilogram
- Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.
- < = indicates that the target analyte was not detected at the reported concentration.



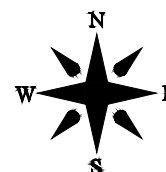
Figure 5
Hydrocarbons in Soil and Sediment
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon



SOURCE: JBR ENVIRONMENTAL (3/14/12)

LEGEND

- Discrete Sample location
- ▲ Composite Sample location



Note:

- Metals concentrations in milligrams per kilogram, except for TBT as noted.
- Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.
- 0-6 inches = sample depth below grade, land surface on land, sediment surface in estuary.
- < = indicates that the target analyte was not detected at the reported concentration.
- TOC = total organic carbon, percent by weight.



Figure 6
Total Metals in Soil and Sediment
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

Figure 7
Human Health Conceptual Site Model
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon

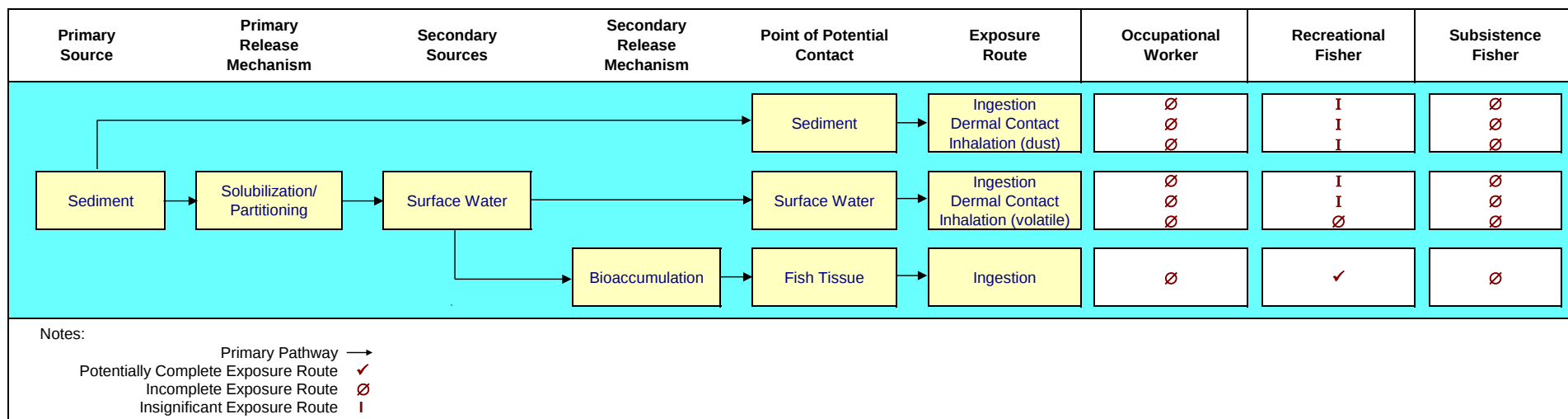
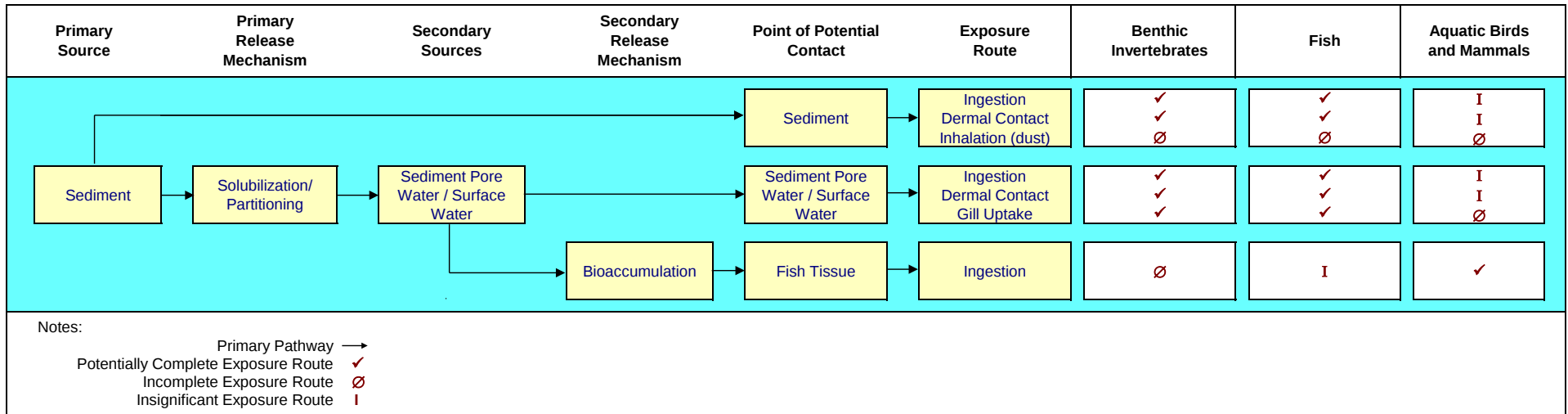


Figure 8
Ecological Conceptual Site Model
Phase II Environmental Investigation
Bolon Island Graving Dock
Reedsport, Oregon



APPENDIX 3

Groundwater Beneficial Use Determination Results

APPENDIX 4

Conceptual Site Model Figures for Sediment, Soil, and Groundwater

**Figure A4-1
Human Receptor Conceptual Site Model
Bolon Island, Oregon**

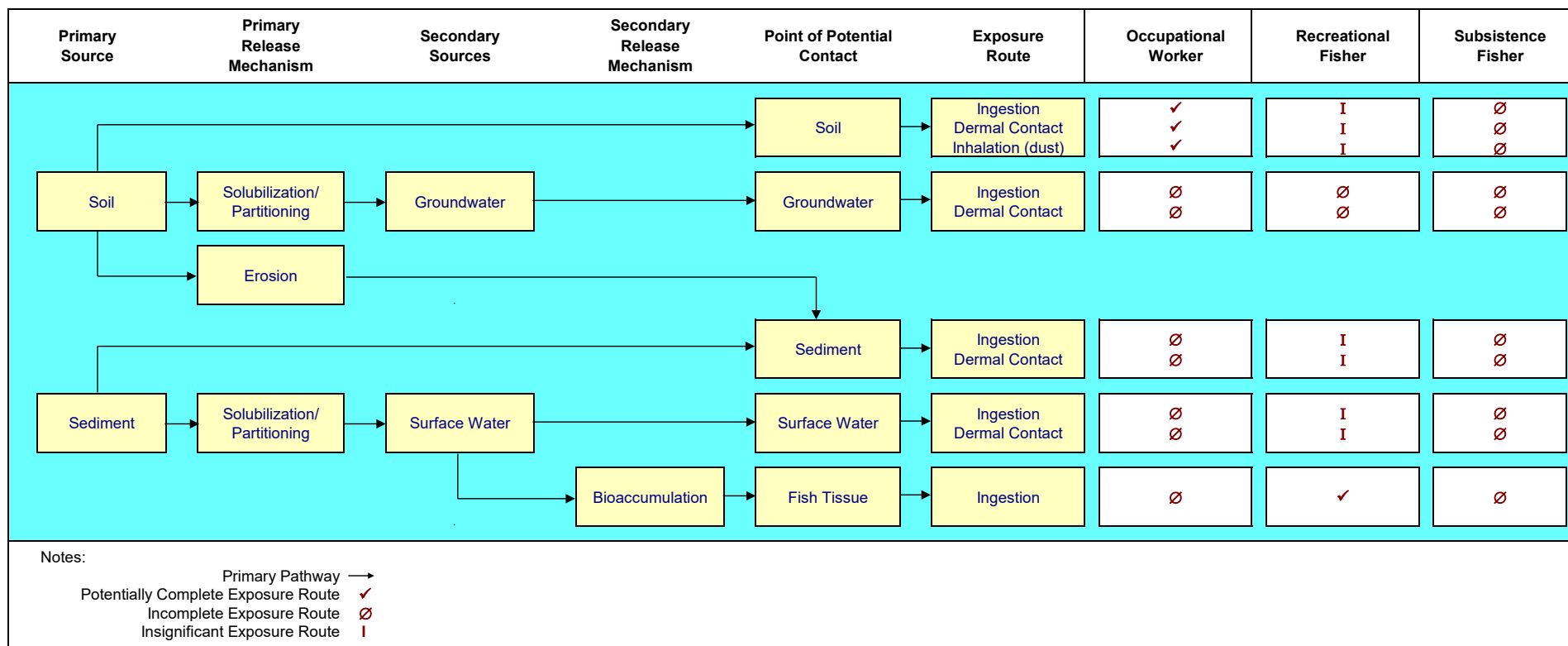


Figure A4-2
Ecological Receptor Conceptual Site Model
Bolon Island, Oregon

