Draft Final Focused Feasibility Study
West Bay Marina
Olympia, Washington

Prepared for the
Washington State
Department of Ecology

July 11, 2014
17800-45

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Prepared by
Hart Crowser, Inc.

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ACRONYMS AND ABBREVIATIONS

AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
BMP	best management practice
bgs	below ground surface
COC	constituent of concern
Corps	US Army Corps of Engineers
CRZ	critical root zone
CSM	conceptual site model
CUL	cleanup level
CY	cubic yards
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
FFS	focused feasibility study
HASP	health and safety plan
lb	pound
MSW	municipal solid waste
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OMC	Olympia Municipal Code
OHWM	ordinary high water mark
PCBs	polychlorinated biphenyls
pg/g	picograms per gram or parts per trillion
POCs	points of compliance
RI/FS	remedial investigation/feasibility study
SF	square foot
SWPPP	Stormwater Pollution Prevention Plan
TEQ	toxicity equivalency quotient
UST	underground storage tank
WAC	Washington Administrative Code
WBMA	West Bay Marina Associates

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EXECUTIVE SUMMARY

This report presents the results of a focused feasibility study (FFS) performed for the Washington State Department of Ecology (Ecology) for the West Bay Marina Site (site) in Olympia, Washington. The feasibility study focused on remediation of soil at the north end of the site, which contains dioxins/furans in exceedance of regulatory criteria. The FFS is limited to this area of concern and does not include adjacent properties or the aquatic environment.

The purpose of this FFS is to develop and evaluate remedial alternatives for the site and to recommend the most appropriate alternative based on site chemical and physical conditions, present and future land use, and the evaluation criteria specified in the Model Toxics Control Act (MTCA) regulations (Chapter 173-340 WAC). The primary objective for the FFS and cleanup action focuses on substantially eliminating, reducing, and/or controlling unacceptable risks to human health and the environment posed by the constituents of concern (COCs) to the greatest extent practicable.

The site was first developed as a lumber mill by Buchanan Lumber Company in 1919 (Hart Crowser 2011). Between 1919 and 1966, the site was used for various activities including a sawmill, veneer plant, and stud mill. These timber-related facilities also included a hog fuel burner near the northern property line. It is suspected that operation of the former hog fuel burner may be a potential source of the dioxin/furan contamination detected in near-surface soil at the northern end of the site. Between 1966 and 2002, the site operated as a boatyard and marina. West Bay Marina Associates (WBMA) has owned the West Bay Marina since 1990. In 2002, boat maintenance and repair activities ceased at the site, and it has operated solely as a marina since that time (Anchor 2009a).

The area of concern (AOC) that is the focus of this feasibility study is located at the northern end of the West Bay Marina site and is defined as the area of soil containing dioxin/furan toxicity equivalency quotients (TEQs) above the MTCA Method B soil cleanup level of 11 picograms per gram (pg/g). The exceedance locations are based on the results of remedial investigations conducted in 2010 and 2011 (Anchor 2010, Hart Crowser 2011), which identified four sample locations that exceeded the cleanup level. These sample locations are near the former hog fuel burner.

The options considered to develop remediation alternatives consist of accepted technologies for managing soil containing dioxins/furans, which include soil removal, off-site landfill disposal, incineration, and containment by capping.

Institutional controls are included in the alternatives where appropriate to further reduce risks to human health and the environment. The technologies considered in this FFS are assembled into the following six remediation alternatives:

- Alternative 1a – Soil excavation and off-site disposal. Includes tree removal within the AOC.

- Alternative 1b – Soil excavation and off-site incineration. Includes tree removal within the AOC.

- Alternative 1c – Same as Alternative 1a, but trees will be left in place within the AOC. Institutional controls may be included depending on the amount of contaminated soil remaining in protected tree areas.

- Alternative 1d – Same as Alternative 1b, but trees will be left in place within the AOC. Institutional controls may be included depending on the amount of contaminated soil remaining in protected tree areas.

- Alternative 2 – Capping and institutional controls.

- Alternative 3 – Combined excavation, off-site disposal, capping, and institutional controls.

The remediation alternatives are evaluated through comparative analysis, which assesses the relative capability of the alternatives, as applicable to the COCs identified for the site, to meet threshold requirements, to use permanent solutions to the maximum extent practicable, and to provide a reasonable restoration time frame. A disproportionate cost analysis is used to determine whether the cleanup action uses permanent solutions to the maximum practicable extent.

The remediation alternative that most closely satisfies the threshold criteria and other MTCA requirements is the preferred alternative for the site. Based on the evaluation of alternatives in this FFS, the preferred remediation alternative is Alternative 1a, which involves excavation of dioxin/furan-impacted soil and off-site disposal in a Subtitle D landfill facility. This alternative includes tree removal within the AOC to facilitate complete removal of contaminated soil and, thus, provides greater risk reduction. Appropriate site restoration measures will be implemented to compensate for the trees that are removed.

DRAFT FINAL FOCUSED FEASIBILITY STUDY
WEST BAY MARINA
OLYMPIA, WASHINGTON

1.0 INTRODUCTION

This report presents the results of a focused feasibility study (FFS) performed for the Washington State Department of Ecology (Ecology) for the West Bay Marina Site (site) in Olympia, Washington (Figure 1). The feasibility study focuses on remediation of soil at the north end of the site, which contains dioxins/furans in exceedance of regulatory criteria. The FFS is limited to this area of concern and does not include adjacent properties or the aquatic environment.

The work for this report follows the previous work conducted by Anchor QEA for West Bay Marina Associates (WBMA) under an existing Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Anchor 2009a) and investigative work conducted by Hart Crowser in 2011 and 2012 (Hart Crowser 2011 and 2012). Hart Crowser's work was conducted under contract to Ecology in partial fulfillment of the requirements of an Agreed Order (No. DE_5272) between Ecology and WBMA.

1.1 Purpose

The purpose of this FFS is to develop and evaluate remedial alternatives for the site and to recommend the most appropriate alternative based on site chemical and physical conditions, present and future land use, and the evaluation criteria listed below. According to the Model Toxics Control Act (MTCA) regulations, a cleanup alternative must satisfy all of the following threshold criteria as specified in Washington Administrative Code (WAC) 173-340-360(2):

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring.

While these criteria represent the minimum standards for an acceptable cleanup action, WAC 173-340-360(2)(b) also recommends that the selected cleanup action:

- Use permanent solutions to the maximum extent practicable;
- Provide for a reasonable restoration time frame; and
- Consider public concerns about the proposed cleanup action alternative.

1.2 Focused Feasibility Study Approach and Report Organization

The preparation of this FFS involved developing, evaluating, and recommending an appropriate remedial action for the area of concern (AOC) that would meet MTCA requirements specified in WAC 173-340-350(8). Specific tasks for this FFS included:

- Identifying the AOC for remediation;
- Reviewing existing site information to assess soil conditions in the AOC, interim actions completed at the site, and potential exposure pathways;
- Developing remedial action objectives and remediation goals based on the cleanup levels established for the site;
- Developing remediation alternatives for the AOC from applicable technologies;
- Evaluating alternatives following the criteria specified in WAC 173-340-360; and
- Recommending a cleanup alternative for the AOC.

This FFS report is organized into the following sections:

- **Section 2.0 – Site Description and History.** This section provides the general description of the site, its location, historical and current activities, and previous investigations.
- **Section 3.0 – Conceptual Site Model.** This section provides a conceptual understanding of the site derived primarily from the results of the historical research, subsurface investigations, and previous remedial activities at the site. Included is a discussion of the constituents and media of concern, the fate and transport characteristics of the constituents of concern, potential exposure pathways, and potential receptors at the site.

- **Section 4.0 – Cleanup Requirements.** This section identifies remedial action objectives and cleanup standards for the site. Together, the remedial action objectives and cleanup standards provide the framework for evaluating remediation alternatives described later in this FFS, and for selecting a preferred alternative.

- **Section 5.0 – Development of Remediation Alternatives.** This section describes the details of each remediation alternative. Candidate remedial technologies were identified to develop potential cleanup alternatives for further evaluation in this FFS.

- **Section 6.0 – MTCA Evaluation Criteria.** This section introduces and describes the MTCA criteria in WAC 173-340-360 that are evaluated in the selection of a remedial action. Disproportionate cost analysis methodology is described in this section.

- **Section 7.0 – Evaluation of Remediation Alternatives.** The evaluation of remediation alternatives is conducted in this section through comparative analysis of the alternatives. The comparative analysis assesses the relative capability of the alternatives to meet threshold requirements, to use permanent solutions to the maximum extent practicable, and to provide a reasonable restoration time frame. A disproportionate cost analysis is used to determine whether the cleanup action uses permanent solutions to the maximum practicable extent.

- **Section 8.0 – Preferred Alternative Recommendations.** This section summarizes the findings of the FFS and identifies the preferred cleanup alternative based on the results of the disproportionate cost analysis.

- **Section 9.0 – Limitations.**

- **Section 10.0 – References.** This section lists references cited in this document.

Supporting information is provided in the tables, figures, and appendices at the end of the FFS report text.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Location and Land Use

The site is located at 2100 West Bay Drive NW in Olympia, Washington, and is the location of a marina and restaurant. The site encompasses just over 3 acres of upland, which is predominantly paved and is used for parking and storage. The marina has about 400 slips that can accommodate boats up to 70 feet long, and is located on Budd Inlet under an Aquatic Land Lease (Lease No. 2618) from the Washington State Department of Natural Resources (DNR).

The site is bounded by a log sorting yard to the north (Dunlap Towing Company), Puget Sound (Budd Inlet) to the east, an abandoned lumber storage yard (Delson Lumber Company) to the south, and a steep hill and residences to the west. West Bay Drive NW and abandoned railroad tracks divide the property from north to south.

Currently, the harbor area leased by WBMA lies in front of Olympia Tidelands Blocks 385 to 388, inclusive, and comprises 13.6 acres of water-dependent use and 0.0495 acre of non-water-dependent use (Tugboat Annie's Restaurant building). The aquatic lands to the north are currently leased by Dunlap Towing, and those to the south are leased by Delson Lumber Company.

2.2 Historical Summary

The site was first developed as a lumber mill by Buchanan Lumber Company in 1919 (Hart Crowser 2011). Between 1919 and 1966, the site was used for various activities including a sawmill, veneer plant, and stud mill. These timber-related facilities also included a hog fuel burner near the northern property line. It is suspected that operation of the former hog fuel burner may be a potential source of the dioxin/furan contamination detected in near-surface soil at the northern end of the site. Historical maps and aerial photos show that most of the lumber mill operations were located off site to the north. The planing shed, mill office, and some lumber sheds were located on the site east of the Northern Pacific Railroad tracks. Additional lumber storage, motor vehicle parking, and an oil shed were located west of the tracks adjacent to the bluff. According to an interview with the former property owner, Mr. Buchanan, the site was filled with soil that sloughed off the steep bank to the west and with wood debris from mill operations. Mr. Buchanan also indicated that lumber was never treated at this location, and the closest lumber treating operation was located approximately one mile southeast of the site on the opposite side of Budd Inlet.

Between 1966 and 2002, the site operated as a boatyard and marina. WBMA has owned the West Bay Marina since 1990. In 2002, boat maintenance and repair activities ceased at the site, and it has operated solely as a marina since that time (Anchor 2009a). Before 2002, small boat maintenance activities included hydroblasting (using water jets to remove loose paint and marine growth from boat bottoms prior to scraping), scraping, sanding, and painting boats.

Tugs Restaurant was built on the site in 1984 or 1985 but was destroyed in a fire in 1993. Tugboat Annie's restaurant was built in 1995 at the same location and is currently in operation at the site.

2.3 Previous Investigation Activities and Cleanup Actions

Previous upland soil, groundwater, sediment, seep, and stream investigations were conducted at the West Bay Marina site in 1993, 1999, 2009, 2010, 2012, and 2014. These studies are listed below, the details of which are presented in the 2011 RI report and 2012 RI Addendum (Hart Crowser 2011 and 2012) and in Appendix A of this FFS.

- Preliminary Environmental Assessment and Soil Remediation (Hart Crowser 1993);
- Underground Storage Tank (UST) Removal Site Assessment (Stemen Environmental 1999a and 1999b);
- 2009/2010 Remedial Investigation (Anchor 2009b and 2010);
- 2011 Remedial Investigation (Hart Crowser 2011); and
- 2014 Stream Assessment (see Appendix A).

Two cleanup actions have been conducted at the site, which are described in detail in the 2011 RI report (Hart Crowser 2011). In 1993, Hart Crowser performed a cleanup of the soil in the southern ditch, removing the top 3 inches of soil, which contained elevated concentrations of copper. Additionally, approximately 55 tons of petroleum-impacted soil were removed from around an aboveground waste oil storage tank. In 1999, Stemen Environmental removed three USTs from the parking area at the site. Approximately 675 tons of petroleum-impacted soil, 56 tons of demolition debris, and an unreported volume of oily water were removed from the UST excavation.

3.0 CONCEPTUAL SITE MODEL

This section provides a conceptual understanding of the site derived primarily from the results of the historical research, subsurface investigations, and previous remedial actions performed at the site. The conceptual site model (CSM) described herein is limited to the AOC that is the focus of this FFS and serves as the basis for developing technically feasible cleanup alternatives and selecting a final cleanup action. The CSM is dynamic and may be refined throughout the cleanup action process as additional information becomes available.

3.1 Constituents of Concern and Affected Media

Soil, groundwater, and air are media within the AOC that could potentially be affected by the constituents of concern (COCs) identified at the site. The 2011 RI identified dioxin/furan congeners as COCs for soil in the AOC as a potential exposure risk to human receptors (Hart Crowser 2011). It is suspected that the soil dioxin/furan contamination potentially arose from operation of the former hog fuel burner at the north end of the site. The RI did not find groundwater to be a medium of concern. Based on the chemical and physical properties of the COCs, air is generally not considered to be a medium of concern. However, dust generated during soil remediation activities in the AOC may present a potential exposure pathway for COCs bound to dust particulates.

3.2 Release Mechanisms and Transport Processes

The primary release mechanisms and transport processes by which COCs can potentially migrate from sources to receptors are identified in this section.

3.2.1 Environmental Fate of Dioxins/Furans in the Subsurface

Dioxin/furan compounds can be persistent environmental pollutants that do not readily break down in the subsurface environment. The half-life of dioxins/furans in the subsurface is long, potentially on the order of decades (EPA 2014). Dioxins/furans exhibit low vapor pressure, low water solubility, and strong adsorption to organic matter, which generally ensure their immobility in soil and sediment (ATSDR 1998). Dioxins/furans bound to soil are unlikely to leach into groundwater, but may enter the atmosphere or surface water when the soil particulates to which they are bound are transported by erosion processes, such as wind or surface runoff.

3.2.2 Potential Exposure Pathways

As defined in WAC 173-340-200, an exposure pathway describes the mechanism by which a hazardous substance takes or could take from a source or contaminated medium to an exposed receptor.

Potential Soil Exposure Pathways

Direct ingestion of or dermal contact with soil containing dioxins/furans is considered a potential exposure pathway. The soil in the area of the four samples (HC-WB-US-001, HC-WB-US-002, WB017, and WB018) with elevated dioxin/furan detections identified in the 2011 RI is not screened or fenced to prevent human access (Hart Crowser 2011). This area is also not covered with a clean vegetated soil cap or an impervious covering such as asphalt or cement. Accordingly, soil containing dioxins/furans in the AOC remains available for potential direct contact or ingestion. It is also still susceptible to potential wind- or water-based erosion that could carry COCs to nearby marine sediment, freshwater runoff in the adjacent stream channel drainage, and marine water.

Potential Groundwater Exposure Pathways

As the RI did not identify groundwater to be a medium of concern, it is not considered an exposure pathway for dioxins/furans.

Potential Air Exposure Pathways

Air is not considered an exposure pathway from volatilization of dioxins/furans. Generation of airborne dust during cleanup activities or from soil that is not removed or otherwise contained could be an exposure pathway.

3.3 Potential Receptors

Human exposure to dioxin/furans in site soil is considered a risk; however, ecological receptors are not considered to be at risk, according to the results of the terrestrial ecological risk assessment for the site (Hart Crowser 2011). Potential human receptors include marina employees and residents, in addition to incidental receptors such as utility workers or site visitors who may be exposed to soil from the AOC.

3.4 Summary of Completed Exposure Pathways

For a COC to present a risk to human health and/or the environment, the pathway from the COC to the receptor must be completed. The COC-to-receptor pathways judged to be present at the site are summarized in this section, by medium.

3.4.1 Soil

The pathways judged to be present that may allow COCs in soil to reach receptors include direct contact with or ingestion of soil within 15 feet of the ground surface, which is the standard point of compliance for attaining cleanup standards for human receptors. However, it is anticipated that the COCs are confined to the uppermost portion of the soil column.

3.4.2 Groundwater

The groundwater exposure pathway is considered not to be present.

3.4.3 Air

The air exposure pathway from volatilization is considered not to be present. Airborne dust from the AOC, if present, presents a potential direct-contact exposure pathway.

4.0 CLEANUP REQUIREMENTS

The following sections identify remedial action objectives and preliminary cleanup standards for the AOC at the site, which were developed to address MTCA regulatory requirements for cleanup. These requirements address conditions relative to potential human receptor impacts. Together, the remedial action objectives and cleanup standards provide the framework for evaluating remedial alternatives described later in this FFS, and for selecting a preferred alternative.

4.1 Remedial Action Objectives

The primary objective for the FFS and cleanup action focuses on substantially eliminating, reducing, and/or controlling unacceptable risks to human health and the environment posed by the COCs to the greatest extent practicable.

4.2 Cleanup Standards

Cleanup standards include cleanup levels and points of compliance (POCs) as described in WAC 173-340-700 through WAC 173-340-760. Cleanup standards must also incorporate other state and federal regulatory requirements applicable to the cleanup action and/or its location as appropriate. The following sections summarize applicable cleanup standards for the site.

4.2.1 Cleanup Level

The soil cleanup level (CUL) for dioxins/furans will be based on human health exposure because the terrestrial ecological risk assessment in the RI demonstrated that residual contamination in site soil was minor or *de minimis* and did not pose an ecological risk to wildlife. For the cleanup action, Ecology has established the MTCA Method B soil cleanup level of 11 pg/g (picograms per gram or parts per trillion) for dioxins/furans for unrestricted land use.

4.2.2 Point of Compliance

For this FFS, it is assumed that the standard point of compliance will be applied to the cleanup action, which is defined to be throughout the AOC.

4.2.3 Applicable or Relevant and Appropriate Requirements

This section identifies potential applicable or relevant and appropriate requirements (ARARs) to be used in assessing and implementing remedial actions at the West Bay Marina site. The potential ARARs focus on federal or state statutes, regulations, criteria, and guidelines. The specific types of potential ARARs evaluated include contaminant-, location-, and action-specific ARARs. Each type of potential ARAR is evaluated for the site AOC and summarized in Table 1.

In general, only the substantive requirements of ARARs are applied to MTCA cleanup sites being conducted under a legally binding agreement with Ecology (WAC 173-340-710[9][b]). Thus, cleanup actions under a formal agreement with Ecology are exempt from the administrative and procedural requirements specified in state and federal laws. This exemption also applies to permits or approvals required by local governments.

Contaminant-Specific ARARs

Contaminant-specific ARARs are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical contaminant values that are generally recognized by the regulatory agencies as allowable to protect human health and the environment. As noted in Section 4.2.1, Ecology has established the MTCA Method B soil cleanup level of 11 pg/g for dioxins/furans for the site.

Action-Specific ARARs

Action-specific ARARs are pertinent to particular remediation methods and technologies, and to actions conducted to support cleanup. Action-specific ARARs are requirements that may need to be satisfied during the performance of specific remedial actions because they prescribe how certain activities (e.g., treatment and disposal practices, media monitoring programs) must occur. Typically, action-specific ARARs are not fully defined until a preferred response action has been selected and the corresponding remedial action can be more completely refined. However, preliminary consideration of the range of potential action-specific ARARs may help focus the process of selecting a preferred remedial action alternative.

Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of special locations include floodplains, wetlands, historic sites, and sensitive ecosystems or habitats.

4.3 Definition of the Area of Concern

The AOC is located at the northern end of the West Bay Marina property and is defined as the area of soil containing dioxin/furan toxicity equivalency quotients (TEQs) above the cleanup level selected for the site (Figure 2). The exceedance locations are based on the results of remedial investigations conducted in 2010 and 2011 (Anchor 2010, Hart Crowser 2011), which identified four sample locations (HC-WB-US-001, HC-WB-US-002, WB017, and WB018) that exceeded the cleanup level. As shown on Figure 2, these sample locations are in the vicinity of the former hog fuel burner.

Specifically, the AOC is limited to the upland area located north of the office/supply buildings at the northern end of the West Bay Marina property but does not extend beyond the property boundary (Figure 2). Assuming that the property boundary extends to the stream channel line between West Bay Marina and Dunlap Towing, the northern boundary of the AOC is limited by the stream line and trees located at the edge of the channel. The eastern boundary of the AOC is limited to the top of the slope before it descends to Budd Inlet. For the purposes of this FFS, it is assumed that the western boundary extends to half the distance between soil sample location HC-WB-US-002 (approximately 19 feet to the west of this sample location), which exceeds the cleanup level, and location HC-WB-US-003, which did not exceed the cleanup level. This FFS is limited to this AOC and does not include adjacent properties or the aquatic environment.

5.0 DEVELOPMENT OF REMEDIATION ALTERNATIVES

The remediation alternatives developed in this FFS combine technologies that are applicable to upland soil affected by dioxins/furans at the site. This section provides a general discussion of the technologies from which the remediation alternatives were developed, followed by detailed descriptions of the alternatives.

5.1 Remediation Technologies and Alternative Development

The options considered for development of remediation alternatives consist of accepted technologies for managing soil containing dioxins/furans, which include soil removal, off-site landfill disposal, incineration, and containment by capping. Institutional controls are included in the alternatives where appropriate to further reduce risk to human health and the environment.

Overall, effective remedial options are limited for cleanup of soil contaminated with dioxins/furans. Options are further limited when the specific conditions of the AOC are considered. The AOC is a relatively small area with dioxin/furan impacts residing in near-surface soil and is constrained by limited accessibility. To the greatest extent possible, while still meeting the MTCA threshold criteria, the remediation alternatives are to be developed to avoid the removal of or impediment to adjacent buildings, structures, or trees.

Many of the accepted treatment technologies for soil containing dioxins/furans consist of thermal methods for removal and destruction of the contaminants. However, considering the relatively small size of the AOC and volume of impacted soil, these methods may not be practicable. The FFS does consider off-site incineration as a treatment option in Alternatives 1b and 1d for the purpose of comparison to off-site landfill disposal.

Dechlorination technologies for treatment of dioxins/furans are in varying stages of development, and the applicability and effectiveness of bioremediation technologies are not well known at this point for dioxin/furan treatment. Because of their hydrophobicity and the strong affinity that dioxins/furans have for sorbing to soil, treatment technologies that rely on dissolution of the contaminants in water likely would not be effective.

The remediation technologies that have been retained for development of remediation alternatives include soil removal, off-site landfill disposal, off-site incineration, containment via capping, and institutional controls. The alternatives that involve soil removal consider both tree preservation and tree removal within the AOC as a comparison of options. Tree removal would allow for complete removal of contaminated soil from the AOC, which would otherwise be hindered. These technologies are assembled into the following six remediation alternatives:

- Alternative 1a – Soil excavation and off-site disposal. Includes removing trees within the AOC.

- Alternative 1b – Soil excavation and off-site incineration. Includes removing trees within the AOC.

- Alternative 1c – Soil excavation and off-site disposal. Trees within the AOC will remain in place. Institutional controls may be included depending on the amount of contaminated soil remaining in protected tree areas.

- Alternative 1d – Soil excavation and off-site incineration. Trees within the AOC will remain in place. Institutional controls may be included depending on the amount of contaminated soil remaining in protected tree areas.

- Alternative 2 – Capping and institutional controls.

- Alternative 3 – Combined excavation, off-site disposal, capping, and institutional controls.

These remediation alternatives are described in the following sections.

5.2 Remediation Alternative Descriptions

The components of remediation Alternatives 1a, 1b, 1c, 1d, 2, and 3 that have been developed for the AOC are described below. The conceptual layout and components of Alternatives 1 through 3 are depicted on Figures 3 through 5, respectively.

As described above in Section 4.3 and in Appendix A, the AOC resides in a stream buffer and, therefore, additional permitting and planning requirements apply to each remediation alternative. The buffer on the south side of the stream (where the AOC is located) is bounded by a building and gravel driveway; therefore, the buffer is defined as extending from the stream to the existing building and is approximately 17.5 feet wide.

For the purposes of this FFS, we assume that the stream buffer will be modified for the remediation, but that no excavation will occur below the ordinary high water mark (OHWM) of the stream; therefore, a US Army Corps of Engineers (Corps) Clean Water Act permit will not be required. However, the following City permits and planning measures may be required:

- Critical areas review and approval.
- Clearing and grading permit (including a grading plan and a drainage and erosion control plan).
- Once the concept of the design of the remediation has been determined, a pre-application meeting with the City of Olympia would be conducted to determine exactly what permits the City will require and what mitigation measures may be required.

5.2.1 Description of Alternative 1a

The components of Alternative 1a include removing trees in the AOC and excavating soil containing dioxin/furan TEQs above the CUL for off-site disposal. This alternative assumes that the vertical extent of the contaminated soil reaches 3 feet below ground surface (bgs). Surface soil samples HC-WB-US-001 and -002 collected during the RI were from the top 3 inches of soil material in the AOC. Deeper soil samples subsequently collected on the adjacent Dunlap Towing Company property (HC-WB-US-008 and -010) were collected from approximately 1.5 to 2 feet bgs. Both of these deeper samples contained dioxin/furan TEQs above the MTCA Method B CUL of 11 pg/g. Therefore, it is conservatively assumed that deeper soil in the AOC may also be contaminated and should be addressed. Since dioxins/furans are highly immobile in soil like polychlorinated biphenyls (PCBs), we assume that the vertical extent of impacted soil is 3 feet bgs or less for the purposes of this FFS.

Excavation. Soil would be excavated within the AOC to a depth of 3 feet bgs. Heavy equipment sized to accommodate the constraints and accessibility of the AOC would be used to excavate the soil. Based on the AOC delineation and approximate tree locations, approximately 144 cubic yards (CY) of impacted material (about 215 tons) would be excavated and disposed of in Alternative 1a. Excavation and staging of the soil would be conducted using best management practices (BMPs) including sedimentation control and erosion-prevention practices, such as installation of silt fences at the perimeter of the work area and using a stabilized construction entrance and exit. Additionally, dust suppression measures (such as wetting soil, etc.) would be implemented during construction activities to minimize any airborne transport of contaminated soil particulates from the site.

Performance monitoring would be conducted at the limits of excavation to verify that the contaminated material has been removed, which consists of soil sample collection and laboratory analysis for dioxins/furans.

Tree Removal. Six trees within the AOC would be removed in Alternative 1a to allow for complete removal of contaminated soil. These trees include two red alders and four larch conifers. For the purposes of this FFS, we have assumed that each tree would be removed and processed on site using chainsaws and a wood chipper. Stumps would be removed separately by a hydraulic backhoe. Again, BMPs including dust suppression measures would be employed to prevent migration of dust. We have assumed that the six trees are each approximately 30 feet tall and the trunks are 12 inches in diameter. Therefore, a total volume of about 5 CY (1.5 tons) of wood material would need to be disposed of. This processed wood material would be hauled and disposed of at a nearby composting facility (Silver Spring Organic, approximately 20 miles from the site). Any wood material containing residual dioxin/furan-impacted soil (such as the root ball of a tree) would be disposed of with the excavated soil at a Subtitle D landfill, as described below.

Off-Site Disposal. Excavated soil that is contaminated with dioxins/furans would be disposed of in a Subtitle D landfill as non-hazardous waste. The nearest Subtitle D municipal solid waste (MSW) disposal facility that accepts dioxin/furan-contaminated soil is the Roosevelt Regional Landfill, which is approximately 250 miles from the site in Roosevelt, Washington. However, contaminated materials would be hauled to a Centralia, Washington, waste yard (30 miles from the site), loaded onto railcars, and transported to Roosevelt.

Backfilling. Following excavation and verification soil sampling and analysis, the area would be backfilled with clean fill material. Once backfilled with clean material, the area would be restored as described below.

Site Restoration. Once excavation, verification soil sampling and analysis, and backfilling have been completed, site restoration and slope stabilization would be completed. This would include implementing temporary and long-term erosion control measures such as hydroseeding until the vegetative cover in the AOC is sufficiently established to control erosion. The AOC would be returned to a grade that is similar to current conditions. For the purposes of this FFS, we have assumed that six trees would be replanted at the site to mitigate for the removal of the six trees within the AOC.

Stormwater Management. The excavation work would be conducted in accordance with the substantive provisions of the National Pollutant Discharge Elimination System (NPDES) requirements for stormwater discharges from construction areas to minimize erosion and to prevent enhanced sediment loading to stream drainages or Budd Inlet. However, since the AOC is less than 1 acre, a NPDES Construction Surface Water General Permit would not be required. A stormwater pollution prevention plan (SWPPP) that stipulates erosion prevention, slope stabilization, and drainage collection measures would be developed and implemented. The SWPPP would also provide measures to protect the surface waters of Budd Inlet, and must be in place before construction begins.

Compliance Monitoring. Under MTCA, all cleanup actions require compliance monitoring. Compliance monitoring includes protection monitoring, performance monitoring, and confirmational monitoring.

Protection monitoring consists of monitoring to confirm that human health and the environment are protected during construction, operation, and maintenance, and would be addressed in a construction health and safety plan.

Performance monitoring would consist of documenting that the full extent of the impacted soil has been removed from the AOC. This would include inspecting and collecting samples at the limits of the excavation to verify that no impacted soil remains, and would include sampling the underlying soil to verify that the CUL has been met.

Confirmational monitoring, which consists of monitoring to confirm long-term effectiveness of the cleanup action once cleanup standards have been attained, would not be required for this alternative because all of the material exceeding the CUL would be removed from the AOC.

5.2.2 Description of Alternative 1b

Alternative 1b consists of the same on-site components as Alternative 1a but considers off-site incineration of the excavated soil rather than off-site landfill disposal. Alternative 1b also assumes removal of trees within the AOC and disposal at the nearby composting facility. Wood material containing residual dioxin/furan-impacted soil would be disposed of with the excavated soil, as described below.

Off-Site Incineration. Excavated soil that is contaminated with dioxins/furans would be transported to the nearest commercial waste incineration facility that accepts this type of waste. The nearest such incineration facility is the Clean

Harbors Aragonite LLC facility, which is located approximately 960 miles from the site in Aragonite, Utah. Under this alternative, 215 tons of non-hazardous contaminated soil would be transported to this facility following excavation as described above.

5.2.3 Description of Alternative 1c

Alternative 1c includes the elements of Alternative 1a except for tree removal within the AOC. Measures would be taken in Alternative 1c to preserve existing trees in and near the AOC during the construction work. Approximately 116 CY of impacted material (about 173 tons) would be excavated and disposed of off site in Alternative 1c. Since impacted soil may remain on site beneath the protected tree areas, it is assumed that institutional controls will likely be required.

Tree Preservation. To maintain healthy trees during construction, the tree roots would be protected from disturbance within the critical root zone (CRZ) of each tree. Each tree has a CRZ that varies by species and site conditions. A common rule of thumb is to use a tree's dripline to estimate the CRZ. The dripline is measured from the base of the tree trunk to the outer edge of the leaf canopy. For the purposes of this FFS, we have assumed that each tree has a dripline diameter of 8 feet. Therefore, each tree would have a protection area of 50.3 square feet (SF).

This alternative would involve excavating the soil within the AOC (to a depth of approximately 3 feet), except within each tree's CRZ. We assume that only limited construction disturbance will occur within the CRZ. Operation of heavy construction equipment and stockpiling of materials would be prohibited within the dripline areas of the trees. Excavation by hand may be required to remove accessible impacted soil from the CRZ areas, although other methods not causing root damage may be allowed (e.g., careful use of compressed air jet and vacuum). Again, BMPs including dust suppression measures would be employed to prevent the generation and migration of dust.

Institutional Controls. Because soil impacted by dioxins/furans may be left in place in the protected tree areas, institutional controls may also be required under this alternative. As described in the MTCA regulations (WAC 173-340-440), institutional controls are intended to limit or prohibit activities that may interfere with the integrity of a cleanup action that would result in risk of exposure to contaminated soil at the site. These institutional controls may include on-site features (such as fences), educational programs (such as signage and public notices), legal mechanisms (such as land use restrictions, environmental covenant, zoning designations, and building permit requirements), maintenance requirements for engineered controls (such as containment caps), and financial assurances.

Although actions would be taken to remove as much contaminated material from the protected tree areas, roots must be protected and maintained for tree survival. Therefore, some of the contaminated soil may remain in place around the tree roots. For costing purposes for this alternative, we assume that, since only a small amount of impacted material may remain in these areas, an environmental covenant would be a sufficient institutional control.

5.2.4 Description of Alternative 1d

Alternative 1d includes the elements of Alternative 1b except for the tree removal within the AOC. Similarly to Alternative 1c, each tree within the AOC would be protected during construction. Also similarly to Alternative 1c, approximately 116 CY of impacted material (about 173 tons) would be excavated and incinerated under Alternative 1d, and institutional controls would likely be required.

5.2.5 Description of Alternative 2

The components of Alternative 2 consist of containment via capping and institutional controls. It is assumed that little to no excavation of contaminated soil would be required under this alternative.

During the 2011 RI, the terrestrial ecological evaluation determined that residual contaminants in surface soil do not pose an ecological hazard to wildlife (Hart Crowser 2011) but that soil direct-contact risk to human receptors is a concern. The cap would prevent human exposure to contaminated soil, protect and prevent direct contact with rainfall runoff, and would not allow weathering or erosion of the contaminated soil beneath the cap.

Capping. The entire surface of the AOC (excluding tree areas) would be capped with asphalt pavement. The total cap thickness would be 9 inches and would be composed of a 3-inch aggregate base course layer, 2 inches of asphalt base layer, 2 inches of an intermediate asphalt layer, and 2 inches of an asphalt wearing layer. A sealant would be applied to the surface of the asphalt.

The cover would be designed such that all stormwater would run off the capped area rather than infiltrate. The top and sides of the capped area would be sloped to convey runoff water to the north of the AOC into the stream channel that drains to Budd Inlet.

Tree Preservation and Tree-Friendly Capping. As described under Alternative 1c, tree protection would be required in Alternative 2. This proposed alternative would extend up to the CRZ boundary of each tree within the AOC. For the purposes of this FFS, we assume that only limited construction disturbance will occur within the CRZ areas.

The CRZ area that surrounds each tree would not be capped with asphalt but would be covered with clean soil material that is not detrimental to the wellbeing of the tree or its roots. Since a tree's roots are critical to its survival, capping options are limited. The tree-friendly cover would be a maximum of 6 inches thick to allow transfer of oxygen beneath the ground. A weed-free topsoil mix would be used for this cover, which may include loam soil, compost, and sand. A thin continuous layer of coarser gravelly material may be placed beneath the topsoil to act as a demarcation layer above remaining contaminated soil.

This method of cover within the CRZ would still provide protection of human health while ensuring the tree's survival. However, regular inspection and maintenance would be required to repair or replace any tree-friendly cap material that is damaged or erodes away. If the coarser gravelly material becomes visible, it would indicate to the site owner or operator to replace the topsoil cap.

Institutional Controls. Because soil impacted by dioxins/furans would be left in place, institutional controls would also be required under this alternative. As described in Alternative 1c above, and in the MTCA regulations (WAC 173-340-440), institutional controls are intended to limit or prohibit activities that may interfere with the integrity of a cleanup action that would result in risk of exposure to contaminated soil at the site. These institutional controls may include on-site features (such as fences), educational programs (such as signage and public notices), legal mechanisms (such as land use restrictions, environmental covenant, zoning designations, and building permit requirements), maintenance requirements for engineered controls (for example, containment caps), and financial assurances. For costing purposes, we assume that an environmental covenant would be implemented and that a 6-foot-tall chain-link fence would be installed around the AOC, with two gates for access.

Compliance Monitoring and Maintenance. Under MTCA, all cleanup actions require compliance monitoring. Compliance monitoring includes protection monitoring, performance monitoring, and confirmational monitoring.

Confirmational monitoring would include monitoring the integrity of the cap with annual inspections. A long-term monitoring plan would be used to document long-term effectiveness and would conform to the general requirements of MTCA regulations (WAC 173-340-410). Maintenance and/or repairs would be conducted as necessary to maintain the integrity of the cap, as determined through the annual inspections.

5.2.6 Description of Alternative 3

The components of Alternative 3 include a combination of excavation and capping with institutional controls. As discussed in Section 2.2, operation of the former hog fuel burner is suspected as a potential dioxin/furan contaminant source for soil, which may have caused surface deposition of the contaminants from the emissions of the burning process. The soil samples collected at the site show that near-surface soil is contaminated within the AOC. However, the vertical extent of this contamination has not been delineated in this area. Additionally, since dioxins/furans are highly immobile in soil, we assume that it is primarily the near-surface soil that is contaminated (i.e., the top several inches) and that deeper soil layers would be less impacted or unaffected.

Following the above assumptions, Alternative 3 includes excavation of the surface soil layer (top 6 inches) in the AOC and then capping the area with an asphalt cap to contain any residual soil contamination. The combination of surface soil excavation and capping will prevent direct human contact and prevent surface water from infiltrating the site. Any residual dioxin/furan contamination not removed by excavation may slowly reduce over time beneath the cap, although the half-life of dioxins/furans in the subsurface is long, potentially on the order of decades (EPA 2014).

Excavation. The top 6 inches of soil would be excavated within the AOC in this alternative, except within tree dripline boundaries. For tree protection, the dripline areas may be excavated by hand or through careful use of a compressed air jet (air knife) and vacuum. Vacuum excavation and air knifing use high-pressure air to penetrate, expand, and break up soil from around a tree's roots. Loose soil and rocks can then be vacuumed directly into a drum without harming the roots. Excavation and dust suppression BMPs would be employed as described above in Alternative 1a. Alternative 3 would involve excavating approximately 24 CY of soil (this assumes the top 6 inches of soil in the AOC [18 CY] up to the CRZ areas at each tree, plus an additional 1 CY excavated within each CRZ by hand).

Tree Preservation and Tree-Friendly Capping. Tree preservation and a tree-friendly cap would be implemented as described in Alternatives 1c, 1d, and 2.

Off-Site Disposal. Excavated soil that is contaminated with dioxins/furans would be disposed of at a Subtitle D landfill facility. The approximately 36 tons of excavated material (24 CY) would be transported to the Centralia waste yard, as described in Section 5.2.1 for Alternative 1a, and disposed of at the Roosevelt Regional Landfill in Roosevelt, Washington.

Demarcation Layer. Following excavation of the AOC, a continuous demarcation layer would be placed over the excavation floor before capping. After excavation of surface contaminants, this alternative assumes that the contaminants in the sub-soil may be left in place without harm to the surrounding environment. However, to leave contaminated soil in place, a visual barrier should be installed to provide a warning to future workers that potentially contaminated soil remains beneath the barrier, in the event of work that requires penetration of the ground surface in the AOC. For the purposes of this FFS, we have assumed that an orange geotextile fabric would be an appropriate demarcation layer. The geotextile liner would allow for easy placement without installation damage by heavy equipment, and it is permeable.

Capping. Following excavation and placement of the demarcation layer, the entire AOC would be capped. Similar to Alternative 2, the AOC would be capped with an impermeable 9-inch-thick asphalt cap (6 inches of asphalt over a 3-inch-thick base course layer), except in the CRZ areas of the trees within the AOC. The CRZ areas would be capped with a 6-inch-thick, clean (tree-friendly) soil material. The tree-friendly cap material would be the same as the material described in Alternative 2. The AOC (excluding CRZ areas) would be graded following excavation to prepare the surface for base course and asphalt cap installation. Capping would be conducted as described in Alternative 2.

Institutional Controls. Like Alternative 2, Alternative 3 would also require institutional controls because a portion of potentially contaminated soil would be left in place. For costing purposes, we assume that these controls would include implementing an environmental covenant and installing a 6-foot-tall chain-link fence installed around the AOC, with two gates for access.

Compliance Monitoring and Maintenance. Under MTCA, all cleanup actions require compliance monitoring. Compliance monitoring includes protection monitoring, performance monitoring, and confirmational monitoring.

Confirmational monitoring would include monitoring the integrity of the cap with annual inspections. A long-term monitoring plan would be used to document the long-term effectiveness and would conform to the general requirements of MTCA (WAC 173-340-410). Regular inspections of the capped area would be made to assess the integrity of the cap. Maintenance and/or repairs would be conducted as necessary to maintain the integrity of the cap, as determined through the annual inspections.

6.0 MTCA EVALUATION CRITERIA

Ecology identified the criteria that should be used to evaluate remediation alternatives within the MTCA regulation (WAC 173-340-360). The purpose of the evaluation is to identify the advantages and disadvantages of each alternative and, thereby, assist in the decision-making process. The criteria are applied to Alternatives 1 through 3 in Section 7. The specific criteria are all considered important, but they are grouped into three sets of criteria in the decision-making process. These criteria are:

- Threshold requirements:
  - Protect human health and the environment.
  - Comply with cleanup standards (WAC 173-340-700 through 173-340-760).
  - Comply with applicable state and federal laws (WAC 173-340-710).
  - Provide for compliance monitoring (WAC 173-340-410 and 173-340-720 through 173-340-760).
- Other requirements:
  - Use permanent solutions to the maximum practicable extent. If a disproportionate cost analysis is used, then evaluate:
    - Protectiveness;
    - Permanence;
    - Cost;
    - Effectiveness over the long term;
    - Management of short-term risks; and
    - Technical and administrative implementability.
  - Consideration of public concerns.
- Restoration time frame.

Alternatives 1c, 1d, 2, and 3 include institutional controls and compliance monitoring. Institutional controls may include on-site features such as signs and fences, and legal mechanisms such as lease restrictions, deed restrictions, land use and zoning designations, and building permit requirements. Compliance monitoring is described in Section 6.1.

An alternative must meet the threshold criteria to be eligible for selection as a remedy. The expected performance of each alternative is assessed to identify its ability to comply with cleanup standards and applicable state and federal laws. If the alternative is deemed to comply, the subsequent evaluation of the alternative will be based on the remaining eight evaluation factors. The alternative that most closely satisfies these criteria will be the preferred alternative for the site.

6.1 Threshold Requirements

Overall Protection of Human Health and the Environment

This evaluation criterion (WAC 173-340-360[3][f][i]) assesses the degree to which existing risks are reduced, the time required to reduce risks at the site and attain cleanup standards, on- and off-site risks resulting from implementing the alternative, and improvement of overall environmental quality.

Comply with Cleanup Standards

The remediation alternatives presented in this FFS are assessed to determine whether they comply with MTCA cleanup standards (WAC 173-340-700 through WAC 173-340-760).

Comply with Applicable State and Federal Laws

The remediation alternatives presented herein are assessed to determine whether they comply with other applicable state and federal laws (WAC 173-340-710).

Provide for Compliance Monitoring

Compliance monitoring requirements are defined in WAC 173-340-410 and WAC 173-340-720 through WAC 173-340-760.

The institutional controls and long-term performance monitoring associated with each alternative vary slightly. As a result, the cost associated with institutional controls and compliance monitoring is included in the conceptual level cost estimate prepared for each alternative.

6.2 Other Requirements

Other requirements for remedial alternatives that must be evaluated once they meet threshold requirements are defined in WAC 173-340-360(2)(b) to include the use of permanent solutions to the maximum extent practicable (WAC 173-340-360[3]) and the provision of a reasonable restoration time frame WAC 173-340-360(4).

6.2.1 Use of Permanent Solutions to the Maximum Extent Practicable

The use of permanent solutions to the maximum extent practicable is a primary evaluation criterion for the remedial alternatives being considered for near-surface soil. The specific criteria that must be evaluated are specified in WAC 173-340-360(3)(f) and are discussed below.

Protectiveness. The overall protectiveness provided by the alternative to human health and the environment, including the degree to which existing risks are reduced, the time required to reduce risk at the site and attain cleanup standards, the on-site and off-site risks resulting from implementing the alternative, and the improvement of the overall environmental quality provided by the alternative, are evaluated by this criterion.

Permanence. This criterion evaluates the degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment processes, and the characteristics and quantity of treatment residuals generated.

Cost. This criterion evaluates the costs associated with the alternative, including direct capital costs (e.g., construction, equipment, land, services), indirect capital costs (e.g., engineering, supplies, contingency), long-term monitoring costs, O&M costs, and periodic costs. To evaluate the relative cost for the remedial alternatives, various cost estimating resources were used. This is necessary so that the relative cost of each alternative can be evaluated to help identify the most practicable cleanup alternative using the disproportionate cost analysis procedures presented in WAC 173-340-360(3)(e) and summarized below.

One of the primary goals in developing cost estimates for alternative evaluation is to ensure that costing procedures and assumptions are consistent between alternatives to reduce the potential for bias in one alternative assumption compared to other alternative assumptions. This approach presents a level playing field when evaluating the cost of one alternative versus costs for other alternatives. This cost estimating approach is appropriate for FFS costs. However, because of the conservative approach to estimating mass and area, FFS cost estimates are not appropriate for use in other applications. Cost estimates that are more accurate will be developed during remedial design as part of the bidding and contractor selection process.

Effectiveness over the Long Term. Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components can be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: reuse or recycling; destruction or detoxification; immobilization or stabilization; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.

Management of Short-Term Risks. This criterion evaluates the risk to human health and the environment associated with the alternative during construction and the effectiveness of measures taken to manage such risks.

Technical and Administrative Implementability. This criterion assesses the ability of the alternative to be implemented, including consideration of whether the alternative is technically possible; availability of necessary off-site facilities, services, and materials; administrative and regulatory requirements; scheduling; size; complexity; monitoring requirements; access for construction operations and monitoring; and integration with existing site operations and other current or potential remedial actions.

The Disproportionate Cost Analysis Procedure

Alternatives that meet threshold requirements for cleanup actions are assessed to determine which use permanent solutions to the maximum extent practicable per WAC 173-340-360(3). This assessment is conducted by performing a disproportionate cost analysis.

To conduct the disproportionate cost analysis, the alternatives are ranked from greatest to least degree of permanency. The cleanup action alternative evaluated in the feasibility study that provides the greatest degree of permanence shall be the baseline cleanup action alternative (WAC 173-340-360[3][e][ii][B]). For the purposes of this FFS, we have identified Alternative 1 as the cleanup action with the greatest degree of theoretical permanency (as defined in WAC 173-340-200 for permanent cleanup actions). Alternatives 3 and 2 have the next greatest degrees of permanency, in descending order.

The alternatives are compared by evaluating seven cost/benefit criteria: protectiveness, permanence, cost, effectiveness over the long term, management of short-term risks, and technical and administrative implementability. These evaluation criteria were defined in Section 6.2.1. The regulation gives a general discussion of the types of factors to consider when evaluating each criterion.

When assessing whether a cleanup action uses permanent solutions to the maximum extent practicable, the test used (WAC 173-340-360[3][e][i]) is as follows:

> *Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative.*

As stated in WAC 173-340-360(3)(3)(ii)(C):

> *The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, the department shall select the less costly alternative provided the requirements of subsection (2) of this section are met.*

Quantitative measures of costs and benefits, if performed, must be made in units that are common among the alternatives so that the comparison can be meaningful. It is best if the units of costs and the units of benefits can be the same, such as dollars. This is rarely possible at environmental cleanup sites. Costs are estimated in dollars, but quantitative measures of benefits are usually only available in terms of mass or volume of contaminant removed or some other physical, non-monetary measure.

One quantitative measure of benefits that can be assessed is the number of COC-receptor pathways that are present before and after a remedial alternative is implemented. Where benefits cannot be quantified in common units, they will be assessed qualitatively.

6.2.2 Restoration Time Frame

Cleanup actions must provide for a reasonable restoration time frame. The process used to determine whether an alternative provides for a reasonable restoration time frame is outlined in WAC 173-340-360(4). The factors that are considered include:

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

7.0 EVALUATION OF REMEDIATION ALTERNATIVES

The six remediation alternatives that are considered in this FFS are evaluated per MTCA criteria in this section. Descriptions of the evaluation criteria used to evaluate the alternatives are provided in Section 6. Subsequent sections present evaluations of the six remediation alternatives as follows:

- Alternative 1a – Soil excavation and off-site disposal. Trees within the AOC will be removed before excavation.
- Alternative 1b – Soil excavation and off-site incineration. Trees within the AOC will be removed before excavation.

- Alternative 1c – Soil excavation and off-site disposal. Trees will remain on-site. Institutional controls may also be included depending on the amount of contaminated soil remaining in protected tree areas.

- Alternative 1d – Soil excavation and off-site incineration. Trees will remain on-site. Institutional controls may also be included depending on the amount of contaminated soil remaining in protected tree areas.

- Alternative 2 – Capping and institutional controls.

- Alternative 3 – Combined excavation, off-site disposal, capping, and institutional controls.

The remediation alternatives are evaluated through comparative analysis in this section. The comparative analysis assesses the relative capability of the alternatives, as applicable to the COCs identified for the site, to meet threshold requirements, to use permanent solutions to the maximum extent practicable, and to provide a reasonable restoration time frame. A disproportionate cost analysis is used to determine whether the cleanup action uses permanent solutions to the maximum practicable extent. The procedure for disproportionate cost analysis is summarized in Section 6.2.1. The factors assessed to determine whether the restoration time frame is reasonable are summarized in Section 6.2.2. The outcome of this assessment is summarized in Tables 2 and 3.

7.1 Comparative Analysis of Alternatives

The relative capability of Alternatives 1a, 1b, 1c, 1d, 2, and 3 to meet threshold requirements, an assessment of whether they use permanent solutions to the maximum practicable extent (disproportionate cost analysis), and an assessment of whether the restoration time frames they achieve are reasonable are presented below as applicable to the site.

7.1.1 Threshold Requirements

Threshold requirements required for cleanup actions are defined in WAC 173-340-360(2). Requirements include protection of human health and the environment, compliance with MTCA cleanup standards and applicable state and federal laws, and provisions for compliance monitoring. Since protection and performance monitoring are a part of each of the alternatives in this FFS, they are equal in this regard, as shown below. For further discussion of threshold requirements, see Section 6.1.

Protect Human Health and the Environment

Alternatives 1a, 1b, 1c, 1d, 2, and 3 will eliminate or mitigate the risk associated with the direct contact of site workers and the public with COCs in near-surface soil in the AOC. The alternatives reduce this risk by removing contaminated soil through excavation and/or containing the contaminated area by capping. Alternative 2 does not include excavation of the contaminated soil, but rather places an engineered cap on the AOC. Based on the permanence of the removal of contaminated soil, Alternatives 1a and 1b (which aim to remove all contaminated soil from the AOC) are judged to be more protective of human health and the environment than Alternatives 1c, 1d, and 3, which are more protective than Alternative 2.

The six alternatives will cut the pathways by which COCs can reach human receptors. Based on the definition of a permanent cleanup action in WAC 173-340-200, Alternatives 1a and 1b are judged to provide a greater degree of theoretical permanence and a greater degree of protection of human health and the environment than the other four alternatives.

Comply with MTCA Cleanup Standards and Applicable State and Federal Laws

The CUL for the site is based on the requirements of MTCA Method B (see Section 4.2.1). This CUL is currently exceeded in the AOC (see Figure 2), which is defined in Section 4.3.

Alternatives 1a, 1b, 1c, and 1d include excavation of contaminated soil within the AOC to attain the CUL in this area. Alternatives 2 and 3 will break the exposure pathway in this area by capping the AOC and, since dioxins/furans are highly immobile in soil, COC concentrations are not expected to become an issue over time. Although Alternative 2 is not expected to directly reduce the concentration of COCs that are present, it provides the protection of containment as a risk-reduction measure. Alternative 3 will reduce some of the soil impacts that are present in the AOC by excavating the top 6 inches of soil and then capping the AOC.

Since Alternatives 1a and 1b are assumed to remove all of the contaminated soil in the AOC, these alternatives are expected to meet the CUL that has been established for site COCs in this area. Alternatives 1c and 1d may leave some contaminated material beneath the protected tree areas, but will remove most contaminated soil in the AOC. Additionally, Alternatives 2 and 3 include placing a cap over impacted soil above the CUL to eliminate the direct contact exposure pathway in this area location. All of the alternatives will employ institutional controls as needed to mitigate the risk from any contaminated soil remaining in place. Thus, the six alternatives comply with applicable laws.

7.1.2 Disproportionate Cost Analysis

The disproportionate cost analysis assesses whether Alternative 1a, 1b, 1c, 1d, 2, and 3 use permanent solutions to the maximum extent practicable.

Protectiveness

The alternatives each include physical and administrative controls and BMPs that will be used to reduce the potential for human exposure to COCs. Alternatives 1a and 1b break the direct-contact exposure pathway in the AOC through excavation and off-site management of impacted soil. Alternative 2 does not include excavation of contaminated soil, but rather places a cap on the AOC to break the direct-contact exposure pathway, and Alternatives 1c, 1d, and 3 combine variations of excavation and capping to achieve this reduction in risk. Alternatives 1a and 1b are judged to provide greater protectiveness than the other alternatives because they remove the direct-contact exposure risk within the AOC.

Permanence

Alternatives 1a and 1b will permanently reduce contaminant mass in the AOC by excavating impacted soil. Alternatives 1c and 1d will permanently reduce most of the contaminant mass in the AOC by excavating impacted soil, but may leave some impacted soil beneath the protected trees in the AOC. Capping will reduce the potential for workers or visitors to contact COCs in near-surface soil in Alternatives 2 and 3, but all or a portion of contaminant mass will remain in the AOC in these alternatives.

Alternatives 1a and 1b are judged to provide a greater degree of theoretical permanence than Alternatives 1c, 1d, 2, and 3, since they involve removal of contaminated soil from the AOC. Alternatives 1c and 1d are judged to be more permanent than Alternatives 2 and 3 since 1c and 1d excavate all impacted material except potentially impacted areas beneath protected trees within the AOC. Alternative 3 is judged to provide a greater degree of permanence for the contaminated soil than Alternative 2, since Alternative 3 includes excavation of contaminated soil to 6 inches bgs, and both Alternatives 2 and 3 are equivalent in regard to containment by capping.

Cost

The total cost of implementing Alternatives 1a, 1b, 1c, 1d, 2, and 3 (over a 10-year time period) is estimated to total approximately $111,000, $278,000, $106,000, $242,000, $107,000, and $112,000, respectively, assuming a feasibility study accuracy range of –35 to +50 percent (EPA 2000). The estimated cost of implementing Alternatives 1b or 1d are over twice the cost of Alternatives 1a and 1c. Alternatives 1a, 1c, 2, and 3 are relatively close in cost. The components of these costs and assumptions used in the estimates are provided in Appendix B.

Alternatives 1a, 1b, 1c, 1d, and 3 permanently remove contaminated soil within the AOC (although Alternative 3 only removes the upper 6 inches of contaminated soil), and the six alternatives prevent direct contact between contaminants and human receptors. However, Alternatives 1b and 1d are much more costly. Due to this large incremental cost difference with negligible increase in risk reduction benefit, and the fact that the six alternatives reduce risks to possible receptors, Alternatives 1a and 1c are judged to be more cost-effective than the other alternatives.

Cost Estimate Period of Analysis. The cost estimates assume a 10-year operation and maintenance (O&M) period for each alternative. Per EPA guidance, the period of analysis for a feasibility study cost estimate typically should be equivalent to the project duration for implementing the remedial action through project completion (commonly referred to as the project life cycle) (EPA 2000). For the most of the West Bay Marina remediation alternatives, however, the project duration necessary to reduce contaminant concentrations below the CUL, as represented by the restoration time frame (Section 7.1.3), is uncertain due to the persistent nature of dioxins/furans in the subsurface (Section 3.2.1). It is assumed that this uncertainty applies to all of the alternatives evaluated where some quantity of dioxin/furan-impacted soil may potentially remain in place (either under a containment cap or left in place to protect tree roots).

As a simplifying assumption, we assumed a 10-year O&M period to estimate costs for the remediation alternatives. The O&M period occurs after construction of the remedy and consists of monitoring and maintenance activities to ensure the integrity of the constructed remedy and institutional controls. The assumed 10-year O&M period represents one repeating cycle of annual and periodic costs in a potentially longer total project life cycle. This 10-year cycle is based on the occurrence of the least frequent periodic cost item (refurbishing/replacing asphalt caps every 10 years in Alternatives 2 and 3).

Since all of the alternatives involve long-term O&M activities, the 10-year O&M period was applied to each to facilitate an equal comparison of costs.

Effectiveness over the Long Term

Alternatives 1a, 1b, 1c, 1d, and 3 would provide for long-term COC concentration reduction by permanently removing COC mass in soil in the AOC, and the six remediation alternatives are effective over the long term in preventing human exposure by direct contact.

The six alternatives will protect workers from direct contact with COCs. Alternatives 1a and 1b will reach the CUL by excavating the contaminated soil within the AOC. Thus, Alternatives 1a and 1b are judged to be the most effective over the long term.

Management of Short-Term Risks

The six alternatives will use existing procedures to implement institutional controls and BMPs. Short-term risks to construction workers during the installation of the containment surfaces (capping) and performing the excavations could be reduced by adherence to a health and safety plan (HASP) prepared specifically for the planned work and expected conditions at the site. The procedures contained in a HASP have been shown to effectively manage the limited risk associated with these activities.

The remediation alternatives employ relatively common on-site construction activities with similar short-term risks. However, the handling and off-site transport of contaminated soil poses additional short-term risks, such as potential direct-contact exposure risk to the transport personnel and risk of cross-contamination in the event of material loss or spillage during transport. For these reasons, Alternatives 1a and 1b are judged to have greater short-term risks than Alternatives 1c, 1d, and 3, which also involves off-site transport of waste material but a lesser quantity. Alternative 2 presents the least short-term risk.

Technical and Administrative Implementability

The technologies employed by each of the alternatives are common to the construction industry, and, with controls in place to prevent worker exposure, can be readily implemented. The site is located in an urban waterfront area with a marina and nearby restaurant (Hart Crowser 2011). Nearby access to services, materials, supplies, and skilled labor should be readily available.

The excavation and hauling required for Alternatives 1a, 1b, 1c, 1d, and 3 may be staged to limit disruptions to the local infrastructure to the extent practicable, but some minor amount of business and traffic disruptions are likely to occur. Alternatives 1a, 1b, 1c, and 1d would have more disruptions than Alternative 3. Alternative 2 would likely present fewer disruptions due to construction.

Alternatives 1c, 1d, and 3 would need to overcome greater technical obstacles to avoid tree root impacts when conducting excavation activities within the AOC, in comparison to Alternatives 1a, 1b, and 2. Alternatives 1a, 1b, 1c, 1d, and 3 would require characterization and acceptance of the contaminated soil waste by the disposal facility. Alternatives 2 and 3, and potentially Alternatives 1c and 1d, would require obtaining an environmental covenant for the remaining COCs in the soil. Alternatives 1a and 1b would likely not require an environmental covenant since it is assumed that all of the contaminated soil within the AOC will be removed. The six alternatives are technically implementable, but Alternative 2 may be more implementable than the other alternatives since it requires less disturbance of the subsurface and is less constrained by the presence of tree roots. Alternatives 1a and 1b are judged to be equally administratively implementable as Alternative 2 and more administratively implementable than Alternatives 1c, 1d, and 3.

Summary of Disproportionate Cost Analysis

The total costs to implement Alternatives 1a, 1b, 1c, 1d, 2, and 3 are estimated to total approximately $111,000, $278,000, $106,000, $242,000, $107,000, and $112,000 (–35 to +50 percent), respectively. The alternatives assume a 10-year O&M period in estimating costs, as discussed above. Cost estimate details are provided in Appendix B.

Alternatives 1a and 1b are estimated to cost approximately $111,000 and $278,000, respectively. These costs do provide greater reduction in current risk (to human receptors) and potentially greater future risk reduction than Alternatives 1c, 1d, 2, and 3, which cost approximately $106,000, $242,000, $107,000, and $112,000, respectively. The six alternatives cut the exposure pathways by which COCs in contaminated soil can reach potential receptors. However, only Alternatives 1a and 1b will eliminate the majority of or all of the exposure risk posed by impacted near-surface soil to these receptors.

Alternatives 1a and 1b are judged to provide greater protectiveness, permanence, and long-term effectiveness than Alternatives 1c and 1d, which provide greater protectiveness, permanence, and long-term effectiveness than Alternatives 2 and 3. Alternatives 1a, 1b, 1c, and 1d have greater short-term risks than Alternative 3. Alternative 2 presents the fewest short-term risks. The alternatives have comparable overall implementability, although Alternative 2 is more technically implementable than Alternatives 1a, 1b, 1c, 1d, and 3, but Alternatives 1a and 1b present greater administrative implementability. According to this analysis, Alternatives 1a and 1b are judged to use permanent solutions to a greater extent than Alternatives 1c, 1d, 2, and 3. However, Alternative 1b is over twice the cost of Alternative 1a, which is an incremental cost difference of approximately $167,000. Thus, of the six remediation alternatives evaluated, Alternative 1a uses permanent solutions to the greatest practicable extent.

7.1.3 Restoration Time Frame Evaluation

Remedial alternatives must provide for a reasonable restoration time frame per WAC 173-340-360(2)(b)(ii). A number of factors are considered to determine whether an alternative provides for a reasonable restoration time frame (WAC 173-340-360[4][b]), as summarized in Section 6.2.2. This section evaluates the restoration time frames potentially achieved by Alternatives 1a, 1b, 1c, 1d, 2, and 3.

The six remediation alternatives can successfully address the exposure risk posed by the soil COCs in the AOC, although Alternatives 1a and 1b provide more permanent remedies than Alternatives 1c, 1d, 2, and 3, which leave some quantity of contaminated soil in place but contained beneath a cap (asphalt and soil caps). Alternatives 1a and 1b are assumed to remove all of the contaminated soil from the AOC. In Alternative 1a, the removed soil is contained off site in a controlled landfill facility. In Alternative 1b, the removed soil is thermally treated via incineration, which destroys contaminant mass. Alternative 1c and 1d remove the majority of impacted soil but may leave some in place beneath the protected trees within the AOC.

Alternative 2 does not directly reduce the toxicity or volume of the COCs contained in soil but does reduce potential migration of impacted soil from the AOC. The time needed for the low concentrations of dioxins/furans to fall below the CUL is expected to be much longer in Alternative 2 than in Alternatives 1a, 1b, 1c, and 1d, since there is no active removal occurring in this alternative, whereas Alternatives 1a and 1b remove all of the contaminated soil from the AOC. Some impacted soil beneath the protected tree areas may be left in place in the AOC under Alternatives 1c and 1d. A portion of the contaminated soil will be removed in Alternative 3, leaving less contaminant mass in place than in Alternative 2, which may require a shorter restoration time frame. However, the restoration time needed in Alternative 3 would still be much greater than in Alternatives 1a, 1b, 1c, and 1d. As discussed in Section 5.1, it would not be practicable to try to achieve a shorter restoration time frame in Alternatives 2 and 3 using *in situ* treatment technologies to destroy contaminant mass in place.

The construction work in the six alternatives may disrupt other site operations and potentially expose workers and site visitors to uncovered or excavated contaminated soil. However, such disruptions would be limited to the short construction period needed to implement the remediation alternatives. BMPs would be employed during construction to control potential risks and disruptions associated with the work.

The current and assumed future use of the property is as a marina and restaurant. Because of the limited extent and small amount of contamination in the AOC, there is little potential for surrounding areas and associated resources to be affected by releases at the site. In the six alternatives, future releases are prevented by either removing the contaminant mass from the AOC or containing it in place. Where contaminant mass is contained in place, institutional controls would be implemented, which would include the filing of an environmental covenant for the property, installing fencing around the AOC to limit access, and educating site personnel on the condition of the AOC and associated risks. These types of institutional controls are commonly applied and have been shown to be effective and reliable.

8.0 PREFERRED REMEDIATION ALTERNATIVE

The remediation alternative that most closely satisfies the threshold criteria and other MTCA requirements discussed in Sections 6.1 and 6.2 is the preferred alternative for the site. Based on the evaluation of alternatives presented in Section 7.0, the preferred remediation alternative is Alternative 1a, which involves removing the trees and excavating dioxin/furan-impacted soil for off-site disposal in a Subtitle D landfill facility. This section discusses the rationale for selecting the preferred alternative.

Alternatives 1a, 1b, 1c, and 1d comply with the MTCA threshold requirements for consideration as a cleanup action and provide for a reasonable restoration time frame. As described in Section 6.3, the main differences between the alternatives are how they fulfill the MTCA requirement that cleanup actions be permanent to the maximum extent practicable (that is, the tradeoffs between how they address the disproportionate cost analysis criteria). Under MTCA, the most practicable permanent solution is to be used as the baseline against which other alternatives are compared. Alternative 1a is the most permanent practicable solution and was, therefore, the baseline against which the other alternatives were compared.

Although Alternatives 1a and 1b are the most permanent, Alternative 1a is judged to use permanent solutions to the maximum extent practicable. Alternative 1b has significantly higher costs for minimal increase in protectiveness. Based on this large incremental cost difference, and the fact that both alternatives adequately address risks to possible receptors, Alternative 1a is the preferred alternative. Although Alternative 1a may present more short-term risks (from the off-site transport of contaminated soil) and potentially more technical challenges during implementation (to remove the existing trees in the AOC), when compared to the Alternatives 2 and 3, Alternative 1a is:

- Equally or more protective;
- Equally or more permanent;
- Equally or more effective over the long term; and
- More administratively implementable.

The conceptual-level (–35 to +50 percent) total cost for implementing Alternative 1a is estimated to be approximately $111,000.

9.0 LIMITATIONS

Work for this project was performed, and this report prepared, in general accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the Washington State Department of Ecology for specific application to the West Bay Marina Site. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

10.0 REFERENCES

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Table 1 – Potential Applicable or Relevant and Appropriate Requirements

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Contaminant-Specific ARARs				
State	Soil	Washington State Model Toxics Control Act [RCW 70.105D; Chapter 173-340 WAC]	Yes	The Model Toxics Control Act (MTCA) soil cleanup levels are applicable.
Action-Specific ARARs				
Federal/ State	Surface Water	Federal Water Pollution Control Act--National Pollution Discharge Elimination System [Clean Water Act; 33 USC § 1342, Section 402] and Implementing Regulations Washington State Construction Stormwater General Permit [RCW 90.48]	Yes	The NPDES program establishes requirements for point source discharges, including stormwater runoff. These requirements would be applicable for any point source discharge of stormwater during construction or following cleanup.
Federal	Surface Water	Federal Water Pollution Control Act--Water Quality Certification [Clean Water Act; 33 USC § 1341, Section 401] and Implementing Regulations	No	Section 401 of the CWA provides that applicants for a permit to conduct any activity involving potential discharges into waters or wetlands shall obtain certification from the state that discharges will comply with applicable water quality standards. No discharges are expected to waters or wetlands of the state.
State	Surface Water	Hydraulic Code [RCW 77.55; Chapter 220-110 WAC]	No	The Hydraulic Code requires that any construction activity that uses, diverts, obstructs, or changes the bed or flow of state waters must be done under the terms of a Hydraulics Project Approval permit issued by Washington State Department of Fish and Wildlife (WDFW). These activities are not expected for the proposed alternatives.
Federal	Surface Water and Wetlands	Federal Water Pollution Control Act--Discharge of Dredge and Fill Materials [Clean Water Act; 33 USC § 1344, Section 404] and Implementing Regulations	No	Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill materials into the waters of the United States, including wetlands. These activities are not expected for the proposed alternatives. It is assumed that the alternatives will be implemented upland of the ordinary high water mark and that a 404 permit through the U.S. Army Corps of Engineers will not be necessary.
Federal/ State	Solid Waste	Transportation of Hazardous Materials [49 CFR Parts 105 to 177] [Chapter 446-50 WAC]	Yes	Transportation of hazardous waste or materials is required to meet state and federal requirements. This requirement is potentially applicable to alternatives that involve the off-site transport of impacted soil.
Federal/ State	Solid waste	Resource Conservation and Recovery Act [42 USC § 6901 et seq.], Subtitle C – Hazardous Waste Management [40 CFR Parts 260 to 279] Dangerous Waste Regulations [Chapter 173-303 WAC]	No	Subtitle C of the Resource Conservation and Recovery Act (RCRA) pertains to the management of hazardous waste. Off-site disposal of impacted soil meeting hazardous waste criteria may require disposal at a Subtitle C landfill. It is not anticipated that the alternatives will generate soil that will require disposal as hazardous waste.

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Federal	Solid Waste	Resource Conservation and Recovery Act [42 USC § 6901 et seq.], Subtitle D – Managing Municipal and Solid Waste [40 CFR Parts 257 and 258]	Yes	Subtitle D of RCRA establishes a framework for management of non-hazardous solid waste. These regulations establish guidelines and criteria from which states develop solid waste regulations. These requirements are applicable to the remediation alternatives that involve off-site disposal of impacted soil.
State	Solid Waste	Washington State Solid Waste Handling Standards [RCW 70.95; Chapter 173-350 WAC]	Yes	Washington State Solid Waste Handling Standards apply to facilities and activities that manage solid waste. The regulations set minimum functional performance standards for proper handling and disposal of solid waste; describe responsibilities of various entities; and stipulate requirements for solid waste handling facility location, design, construction, operation, and closure. These requirements are applicable to remediation alternatives that involve off-site disposal of impacted soil.
Federal/ State	Solid Waste	Land Disposal Restrictions [40 CFR Part 268] [Chapter 173-303-140 WAC]	No	Best management practices for dangerous wastes are required to meet state and federal requirements. It is not anticipated that the remediation alternatives will generate waste that meets dangerous waste criteria.
Federal	Air	Clean Air Act [42 USC § 7401 et seq.; 40 CFR Part 50]	Yes	The federal Clean Air Act creates a national framework designed to protect ambient air quality by limiting air emissions.
State	Air	Washington Clean Air Act and Implementing Regulations [Chapter 173-400-040(8) WAC]	Yes	These regulations require the owner or operator of a source of fugitive dust to take reasonable precautions to prevent fugitive dust from becoming airborne and to maintain and operate the source to minimize emissions. These regulations are applicable to all alternatives during construction.
State	Groundwater	Minimum Standards for Construction and Maintenance of Water Wells [RCW 18.104; Chapter 173-160 WAC]	No	Washington State has developed minimum standards for constructing water and monitoring wells, and for the decommissioning of wells. Drilling or abandoning wells is not required in the alternatives.
Federal	Endangered Species, Critical Habitats	Endangered Species Act [16 USC §§ 1531 - 1544] and Implementing Regulations	No	The Endangered Species Act (ESA) protects species of fish, wildlife, and plants that are listed as threatened or endangered with extinction. It also protects designated critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, including consultation with resource agencies. No threatened or endangered species or habitat areas are expected to be impacted by the remediation alternatives.
State	Remedy Construction	Washington Industrial Safety and Health Act [RCW 49.17; Chapter 296-24 WAC]	Yes	Site worker and visitor health and safety requirements established by the Washington Industrial Safety and Health Act (WISHA) are to be met during implementation of the remedial action.
Local	Remedy Construction	Local Ordinances	Yes	Appropriate substantive requirements are to be met for implementation of the remedial action.

Table 1 – Potential Applicable or Relevant and Appropriate Requirements

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Location-Specific ARARs				
State	Aquatic Lands	Aquatic Lands Management – Washington State [RCW 79.90; Chapter 332-30 WAC]	No	The Aquatic Lands Management law develops criteria for managing state-owned aquatic lands. Aquatic lands are to be managed to promote uses and protect resources as specified in the regulations. The area of concern (AOC) to which the remediation alternatives apply is not on aquatic lands.
State	Public Lands	Public Lands Management [RCW 79.02]	No	Activities on public lands are restricted, regulated, or proscribed. The remediation alternatives do not occur on public lands.
Federal/ State	Historic Areas	Archaeological and Historic Preservation Act [16 USC § 469, 470 et seq.; 36 CFR Parts 65 and 800] [RCW 24.34, 27.44, 27.48, and 27.53; Chapters 25-46 and 25-48 WAC]	No	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeological properties and resources, and minimize harm to national landmarks. There are no known historic or archaeological sites in the vicinity of the AOC.
State	Shorelines and Surface Water	Shoreline Management Act of 1971 [RCW 90.58] and Implementing Regulations	Yes	Actions are prohibited within 200 feet of shorelines of statewide significance unless permitted. Remediation alternatives occur within 200 feet of Budd Inlet.
State	Wetlands	Shoreline Management Act of 1971 [RCW 90.58] and Implementing Regulations	No	The construction or management of property in wetlands is required to minimize potential harm, avoid adverse effects, and preserve and enhance wetlands. The remediation alternatives do not occur within delineated wetlands.
Local	Stream Buffer	Local Ordinance: Olympia Municipal Code, Streams and Important Riparian Areas [OMC 18.32.435]	Yes	The OMC requires 150-foot buffers for Type 4 and 5 streams, and 200-foot buffers for Type 3 streams. Remediation alternatives occur within this stream buffer.

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Selection Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Threshold Requirements: WAC 173-340-360(2)(a)						
Protect Human Health and the Environment	Protective. Removal of contaminated material eliminates direct-contact risk to human receptors. Approximately 144 CY of material will be removed under this alternative and disposed offsite at a Subtitle D landfill facility.	Protective. Removal of contaminated material eliminates direct-contact risk to human receptors. Approximately 144 CY of material will be removed under this alternative and incinerated off site.	Protective. Removal of contaminated material eliminates direct-contact risk to human receptors. Approximately 116 CY of material will be removed under this alternative and disposed offsite at a Subtitle D landfill facility.	Protective. Removal of contaminated material eliminates direct-contact risk to human receptors. Approximately 116 CY of material will be removed under this alternative and incinerated off site.	Protective. Capping prevents direct-contact risk to human receptors.	Protective. Removal of contaminated material in the upper 6 inches of soil eliminates direct-contact risk in the area of concern (AOC) and removes approximately 24 CY of impacted soil from the AOC. Following excavation, remaining impacted material in the AOC will be contained in place via capping.

Selection Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Comply with Cleanup Standards	Complies. Following removal, no contaminated soil exceeding the dioxin/furan cleanup level would remain in the AOC.	Complies. Following removal, no contaminated soil exceeding the dioxin/furan cleanup level would remain in the AOC.	Complies. Following removal, no contaminated soil exceeding the dioxin/furan cleanup level would remain in the AOC, except potentially in protected tree areas.	Complies. Following removal, no contaminated soil exceeding the dioxin/furan cleanup level would remain in the AOC, except potentially in protected tree areas.	Complies. The material left in place above the cleanup level will be contained via capping. Cleanup actions that involve containment can be deemed to meet cleanup standards if requirements set out in WAC 173-340-740(6)(f) are met (see Section 6.2.1).	Complies. The material left in place above the cleanup level will be contained via capping. Cleanup actions that involve containment can be deemed to meet cleanup standards if requirements set out in WAC 173-340-740(6)(f) are met (see Section 6.2.1).
Comply with Applicable State and Federal Laws	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 1).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 1).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 1).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 1).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 1).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 1).
Provide for Compliance Monitoring	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 5.2.1.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 5.2.2.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 5.2.3.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 5.2.4.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 5.2.5.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 5.2.6.

Selection Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Other Requirements: WAC 173-340-360(2)(b)						
Use Permanent Solutions to the Maximum Extent Practicable	Uses permanent solutions to the maximum extent practicable, as described in Section 6.2.1 and Table 3.	Uses permanent solutions but is not practicable, as described in Section 6.2.1 and Table 3.	Does not use permanent solutions to the extent provided in Alternatives 1a and 1b, as described in Section 6.2.1 and Table 3. Provides more permanence than Alternatives 2 and 3.	Does not use permanent solutions to the extent provided in Alternatives 1a and 1b, as described in Section 6.2.1 and Table 3. Also not practicable. Provides more permanence than Alternatives 2 and 3.	Does not use permanent solutions to the extent provided in Alternatives 1a and 1b, as described in Section 6.2.1 and Table 3.	Does not use permanent solutions to the extent provided in Alternatives 1a and 1b, as described in Section 6.2.1 and Table 3. Provides more permanence than Alternative 2.
Provide for a Reasonable Restoration Time Frame	Provides a reasonable restoration time frame. The work could be completed within one construction season.	Provides a reasonable restoration time frame. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate direct-contact exposure risk to receptors. However, some contaminated soil may remain contained within the AOC. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate direct-contact exposure risk to receptors. However, some contaminated soil may remain contained within the AOC. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate direct-contact exposure risk to receptors. However, contaminated soil will remain contained within the AOC. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate direct-contact exposure risk to receptors. However, contaminated soil will remain contained within the AOC. The work could be completed within one construction season.

Selection Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Consider Public Concerns	This criterion will be addressed during the public comment period for the FFS and Draft Cleanup Action Plan.					
Action-Specific Requirements: WAC 173-340-360(2)(c) through (h)						
Groundwater Cleanup Actions, WAC 173-340-360(2)(c)	Not applicable. There are no known dioxin/furan groundwater impacts at the site.					
Cleanup Actions for Soil at Current or Potential Future Residential Areas and for Soil at Schools and Child Care Centers, WAC 173-340-360(2)(d)	Complies. Alternative 1a meets the requirement because soil exceeding the cleanup level will be removed.	Complies. Alternative 1b meets the requirement because soil exceeding the cleanup level will be removed.	Complies. Alternative 1c meets the requirement because soil exceeding the cleanup level will be either removed or contained in place.	Complies. Alternative 1d meets the requirement because soil exceeding the cleanup level will be either removed or contained in place.	Complies. Alternative 2 meets the requirement because soil exceeding the cleanup level will be contained in place.	Complies. Alternative 3 meets the requirement because soil exceeding the cleanup level will be contained in place.

Selection Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Institutional Controls WAC 173-340-360(2)(e)	Complies. Alternative 1a does not rely primarily on institutional controls and monitoring.	Complies. Alternative 1b does not rely primarily on institutional controls and monitoring.	Complies. Alternative 1c may require institutional controls depending on the amount of contaminated soil remaining in protected tree areas; it does not rely primarily on institutional controls and monitoring.	Complies. Alternative 1d may require institutional controls depending on the amount of contaminated soil remaining in protected tree areas; it does not rely primarily on institutional controls and monitoring.	Complies. Alternative 2 uses institutional controls only to maintain the protectiveness of the cap; it does not rely primarily on institutional controls and monitoring.	Complies. Alternative 3 uses institutional controls only to maintain the protectiveness of the cap; it does not rely primarily on institutional controls and monitoring.
Releases and Migration WAC 173-340-360(2)(f)	Complies. Alternative 1a eliminates releases and migration of chemicals of concern (COCs) from the AOC by excavation and disposal.	Complies. Alternative 1b eliminates releases and migration of COCs from the AOC by excavation and disposal.	Complies. Alternative 1c minimizes releases and migration of COCs through the use of soil excavation to remove contaminated material and capping to contain remaining contaminated material in place.	Complies. Alternative 1d minimizes releases and migration of COCs through the use of soil excavation to remove contaminated material and capping to contain remaining contaminated material in place.	Complies. Alternative 2 contains COCs in place through capping. However, since dioxins/furans are relatively immobile in soil beneath the cap, their migration is not a concern.	Complies. Alternative 3 minimizes releases and migration of COCs through the use of surface soil excavation to remove contaminated material and capping to contain remaining contaminated material in place.
Dilution and Dispersion WAC 173-340-360(2)(g)	Complies. Alternative 1a does not rely on dilution and dispersion.	Complies. Alternative 1b does not rely on dilution and dispersion.	Complies. Alternative 1c does not rely on dilution and dispersion.	Complies. Alternative 1d does not rely on dilution and dispersion.	Complies. Alternative 2 does not rely on dilution and dispersion.	Complies. Alternative 3 does not rely on dilution and dispersion.

Table 2 – Remediation Alternative Evaluation

Selection Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Remediation Levels WAC 173-340-360(2)(h)	Not applicable. The alternatives do not involve remediation levels.					

Evaluation Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, Tree Protection, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, Tree Protection, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Protectiveness	Removal of hazardous substances would eliminate direct-contact risk to human receptors. Protectiveness would be achieved immediately upon completion of remedy. Alternatives 1a and 1b are judged to provide greater protectiveness than the other alternatives because they remove the contaminated material from the AOC.	Removal of hazardous substances would eliminate direct-contact risk to human receptors. Protectiveness would be achieved immediately upon completion of remedy. Alternatives 1a and 1b are judged to provide greater protectiveness than the other alternatives because they remove the contaminated material from the AOC.	Removal of hazardous substances in surface soil and capping would eliminate direct-contact risk to human receptors. Protectiveness would be achieved immediately upon completion of remedy. Alternatives 1c and 1d are considered more protective than Alternatives 2 and 3 but less protective than Alternatives 1a and 1b.	Removal of hazardous substances in surface soil and capping would eliminate direct-contact risk to human receptors. Protectiveness would be achieved immediately upon completion of remedy. Alternatives 1c and 1d are considered more protective than Alternatives 2 and 3 but less protective than Alternatives 1a and 1b.	Capping would prevent direct-contact risk to human receptors. Protectiveness would be achieved immediately upon completion of remedy. Alternative 2 is considered less protective than Alternatives 1a, 1b, 1c, 1d, and 3, since contaminated material will be contained in place in the AOC.	Removal of hazardous substances in surface soil and capping would eliminate direct-contact risk to human receptors. Protectiveness would be achieved immediately upon completion of remedy. Alternative 3 is considered more protective than Alternative 2 but less protective than Alternatives 1a, 1b, 1c, and 1d.
Permanence	Provides reduction in toxicity and volume of contaminants in the AOC. Risk of contaminant mobility would be eliminated by removing the contaminated soil and placing it in an off-site engineered, lined, and monitored landfill facility. For remediation of the areas of concern (AOC), Alternative 1a is considered more permanent than Alternatives 1c, 1d, 2, and 3, and as permanent as Alternative 1b.	Provides reduction in toxicity and volume of contaminants in the AOC. Risk of contaminant mobility would be eliminated by removing the contaminated soil and thermally treating it at a permitted incineration facility to achieve destruction of the contaminants. For remediation of the AOC, Alternative 1b is considered more permanent than Alternatives 1c, 1d, 2, and 3, and as permanent as Alternative 1a.	Provides reduction in toxicity and volume of contaminants in the AOC. Risk of contaminant mobility would be reduced by removing the contaminated soil and placing it in an off-site engineered, lined, and monitored landfill facility. Capping controls the mobility of contaminants remaining in place in the AOC. Long-term monitoring, maintenance, and institutional controls are required to maintain the integrity of the remedial action. For remediation of the AOC, Alternative 1c is considered less permanent than Alternatives 1a and 1b, but more permanent than Alternatives 2 and 3.	Provides reduction in toxicity and volume of contaminants in the AOC. Risk of contaminant mobility would be reduced removing the contaminated soil and thermally treating it at a permitted incineration facility to achieve destruction of the contaminants. Capping controls the mobility of contaminants remaining in place in the AOC. Long-term monitoring, maintenance, and institutional controls are required to maintain the integrity of the remedial action. For remediation of the AOC, Alternative 1d is considered less permanent than Alternatives 1a and 1b, but more permanent than Alternatives 2 and 3.	Capping provides less permanence than the soil removal alternatives but controls mobility of contaminants in the AOC. Long-term monitoring, maintenance, and institutional controls are required to maintain the integrity of the remedial action. Alternative 2 is considered the least permanent of the six alternatives.	Provides some reduction in toxicity and volume of contaminants. Risk of contaminant mobility would be greatly reduced by removing the surface layer of contaminated soil and placing it in an off-site engineered, lined, and monitored landfill facility. Capping controls the mobility of contaminants remaining in place in the AOC. Long-term monitoring, maintenance, and institutional controls are required to maintain the integrity of the remedial action. Alternative 3 is considered less permanent than Alternative 1a and 1b and more permanent than Alternative 2.
Cost	$111,000	$278,000	$106,000	$242,000	$107,000	$112,000
Effectiveness over the Long Term	Removal of contaminated soil from the AOC is very effective over the long term, since direct-contact exposure risk will be eliminated. Subtitle D landfills are proven and expected to be highly effective over the long term. Alternative 1a is	Removal of contaminated soil from the AOC is very effective over the long term, since direct-contact exposure risk will be eliminated. Incineration facilities are highly effective over the long term since contaminant mass will be destroyed.	Alternative 1c is considered more effective over the long term than Alternatives 2 and 3, but less effective than Alternatives 1a and 1b. Subtitle D landfills are proven and expected to be highly effective over the long term. Capping is a	Alternative 1d is considered more effective over the long term than Alternatives 2 and 3, but less effective than Alternatives 1a and 1b. Incineration facilities are highly effective over the long term since contaminant mass will be destroyed.	Capping is a proven technology that is expected to be effective over the long term for containing contaminated material in place. However, long-term effectiveness of the remedy relies on maintenance, monitoring, and institutional controls. Alternative 2 is	Alternative 3 is considered more effective over the long term than Alternative 2, but less effective than Alternatives 1a and 1b. Subtitle D landfills are proven and expected to be highly effective over the long term. Capping is a proven

Evaluation Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, Tree Protection, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, Tree Protection, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Effectiveness over the Long Term (continued)	considered equally effective over the long term for the AOC as Alternative 1b and more effective over the long term than the other alternatives.	Alternative 1b is considered equally effective over the long term for the AOC as Alternative 1a and more effective over the long term than the other alternatives.	proven technology that is expected to be effective over the long term for containing remaining contamination in place in the AOC. However, long-term effectiveness relies on maintenance, monitoring, and institutional controls.	Capping is a proven technology that is expected to be effective over the long term for containing remaining contamination in place in the AOC. However, long-term effectiveness relies on maintenance, monitoring, and institutional controls.	considered the least effective over the long term of the six remediation alternatives.	technology that is expected to be effective over the long term for containing remaining contamination in place in the AOC. However, long-term effectiveness relies on maintenance, monitoring, and institutional controls.
Management of Short-Term Risks	All of the remediation alternatives employ relatively common on-site construction activities with similar short-term risks. However, handling and off-site transport of contaminated soil pose additional short-term risks, such as potential direct-contact exposure risk to the transport personnel and risk of cross-contamination in the event of material loss or spillage during transport. For these reasons, Alternatives 1a and 1b are judged to have equivalent short-term risks, but greater short-term risks than Alternatives 1c, 1d, and 3, which also involves off-site transport of waste material but a lesser quantity. Alternative 2 presents the least short-term risk.	All of the remediation alternatives employ relatively common on-site construction activities with similar short-term risks. However, handling and off-site transport of contaminated soil pose additional short-term risks, such as potential direct-contact exposure risk to the transport personnel and risk of cross-contamination in the event of material loss or spillage during transport. For these reasons, Alternative 1b is judged to have equivalent short-term risks to Alternative 1a, and greater short-term risks than Alternative 3, which also involves off-site transport of waste material but a lesser quantity. Alternative 2 presents the least short-term risk.	All of the remediation alternatives employ relatively common on-site construction activities with similar short-term risks. Alternative 1c includes limited excavation and off-site transport and disposal, which pose additional short-term risks, but to a lesser extent than in Alternatives 1a and 1b and greater extent than Alternative 3. Alternatives 1a and 1b are judged to have greater short-term risks than Alternatives 1c, 1d, and 3. Alternative 2 presents the least short-term risk.	All of the remediation alternatives employ relatively common on-site construction activities with similar short-term risks. Alternative 1d includes limited excavation and off-site transport and disposal, which pose additional short-term risks, but to a lesser extent than in Alternatives 1a and 1b and greater extent than Alternative 3. Alternatives 1a and 1b are judged to have greater short-term risks than Alternatives 1c, 1d, and 3. Alternative 2 presents the least short-term risk.	All of the remediation alternatives employ relatively common on-site construction activities with similar short-term risks. However, in Alternative 2, contaminated soil will be contained in place, and no material will be removed and transported off site. For this reason, Alternative 2 presents the least short-term risk of the six remediation alternatives.	All of the remediation alternatives employ relatively common on-site construction activities with similar short-term risks. Alternative 3 includes limited excavation and off-site transport and disposal, which pose additional short-term risks, but to a lesser extent than in Alternatives 1a and 1b. Alternatives 1a and 1b are judged to have greater short-term risks than Alternatives 1c, 1d, and 3. Alternative 2 presents the least short-term risk.
Technical and Administrative Implementability	The excavation and hauling required for Alternative 1a may be staged to limit disruptions to the local infrastructure to the extent practicable, but some minor amount of business and traffic disruptions are likely to occur. Alternative 1a would have similar disruptions to Alternative 1b, but more disruptions than Alternative 3. Alternative 2 would likely present fewer disruptions during construction.	The excavation and hauling required for Alternative 1b may be staged to limit disruptions to the local infrastructure to the extent practicable, but some minor amount of business and traffic disruptions are likely to occur. Alternative 1b would have similar disruptions to Alternative 1a, but more disruptions than Alternative 3. Alternative 2 would likely present fewer disruptions during construction.	The excavation and hauling required for Alternative 1c may be staged to limit disruptions to the local infrastructure to the extent practicable, but some minor amount of business and traffic disruptions are likely to occur. Alternatives 1c and 1d would likely have more disruptions than the other four alternatives. Alternative 1c would need to	The excavation and hauling required for Alternative 1d may be staged to limit disruptions to the local infrastructure to the extent practicable, but some minor amount of business and traffic disruptions are likely to occur. Alternatives 1c and 1d would likely have more disruptions than the other four alternatives. Alternative 1d would need to	Alternative 2 would likely present fewer disruptions during construction than the other alternatives. Alternative 2 would need to overcome fewer technical obstacles during construction within the AOC, such as having to avoid subsurface impacts to tree roots. Alternative 2 would require obtaining an environmental covenant for the contaminated soil contained beneath the cap. The six alternatives	The excavation and hauling required for Alternative 3 may be staged to limit disruptions to the local infrastructure to the extent practicable, but some minor amount of business and traffic disruptions are likely to occur. Alternative 3 would have fewer disruptions than Alternatives 1a and 1b, but more than Alternative 2. Alternative 3 would need to

Evaluation Criteria	Alternative 1a: Excavation and Off-Site Disposal	Alternative 1b: Excavation and Off-Site Incineration	Alternative 1c: Excavation, Off-Site Disposal, Tree Protection, and Institutional Controls	Alternative 1d: Excavation, Off-Site Incineration, Tree Protection, and Institutional Controls	Alternative 2: Capping and Institutional Controls	Alternative 3: Limited Excavation, Capping, and Institutional Controls
Technical and Administrative Implementability (continued)	Alternative 1a would require characterization and acceptance of the contaminated soil waste by the disposal facility. Alternatives 1a and 1b are assumed to remove all of the contaminated soil within the AOC, and therefore an environmental covenant would not be required. The six alternatives are technically implementable, but Alternative 1a may pose greater technical challenges than Alternative 2, which requires less disturbance of the subsurface. Alternative 1a would have similar technical implementability compared to Alternatives 1b and 3. Alternatives 1a and 1b have similar administrative implementability and are judged to be equally administratively implementable as Alternative 2 and more administratively implementable than Alternatives 1c, 1d, and 3.	Alternatives 1b would require characterization and acceptance of the contaminated soil waste by the disposal facility. Alternatives 1a and 1b are assumed to remove all of the contaminated soil within the AOC, and therefore an environmental covenant would not be required. The six alternatives are technically implementable, but Alternative 1b may pose greater technical challenges than Alternative 2, which requires less disturbance of the subsurface. Alternative 1b would have similar technical implementability compared to Alternatives 1a and 3. Alternatives 1a and 1b have similar administrative implementability and are judged to be equally administratively implementable as Alternative 2 and more administratively implementable than Alternatives 1c, 1d, and 3.	overcome greater technical obstacles to avoid tree root impacts when conducting excavation activities within the AOC, in comparison to Alternative 2. Alternative 1c would require characterization and acceptance of the excavated contaminated soil waste by the disposal facility. Alternatives 1c, 1d, 2, and 3 would each require obtaining an environmental covenant for contaminated soil remaining in the AOC. The six alternatives are technically implementable, but Alternatives 1c, 1d, and 3 may pose greater technical challenges than Alternatives 1a, 1b, and 2. Alternatives 1c, 1d, and 3 are judged to be the least administratively implementable of the six alternatives, since they will require off-site waste management and the filing of an environmental covenant.	overcome greater technical obstacles to avoid tree root impacts when conducting excavation activities within the AOC, in comparison to Alternative 2. Alternative 1d would require characterization and acceptance of the excavated contaminated soil waste by the disposal facility. Alternatives 1c, 1d, 2, and 3 would each require obtaining an environmental covenant for the contaminated soil remaining in the AOC. The six alternatives are technically implementable, but Alternatives 1c, 1d, and 3 may pose greater technical challenges than Alternatives 1a, 1b, and 2. Alternatives 1c, 1d, and 3 are judged to be the least administratively implementable of the six alternatives, since they will require off-site waste management and the filing of an environmental covenant.	are technically implementable, but Alternative 2 may be more implementable than the other alternatives since it requires less disturbance of the subsurface and is less constrained by the presence of tree roots. Alternative 2 is judged to be equally administratively implementable as Alternatives 1a and 1b, but more administratively implementable than Alternative 3.	overcome greater technical obstacles to avoid tree root impacts when conducting excavation activities within the AOC, in comparison to Alternative 2. Alternative 3 would require characterization and acceptance of the excavated contaminated soil waste by the disposal facility. Both Alternatives 2 and 3 would require obtaining an environmental covenant for the contaminated soil contained beneath the cap. The six alternatives are technically implementable, but Alternative 3 may pose greater technical challenges than Alternative 2. Alternative 3 is judged to be the least administratively implementable of the four alternatives, since it will require off-site waste management and the filing of an environmental covenant.
Consideration of Public Concerns	This criterion will be addressed during the public comment period for the FFS and Cleanup Action Plan.					

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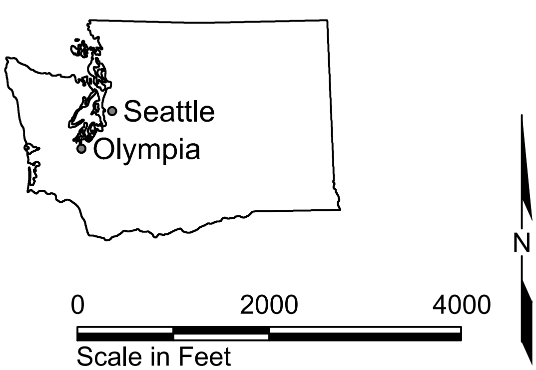
Source: Base map prepared from DeLorme Topo 7.0, 2007.



West Bay Marina
Olympia, Washington

Vicinity Map

17800-45 6/14

HARTCROWSER

Figure
1

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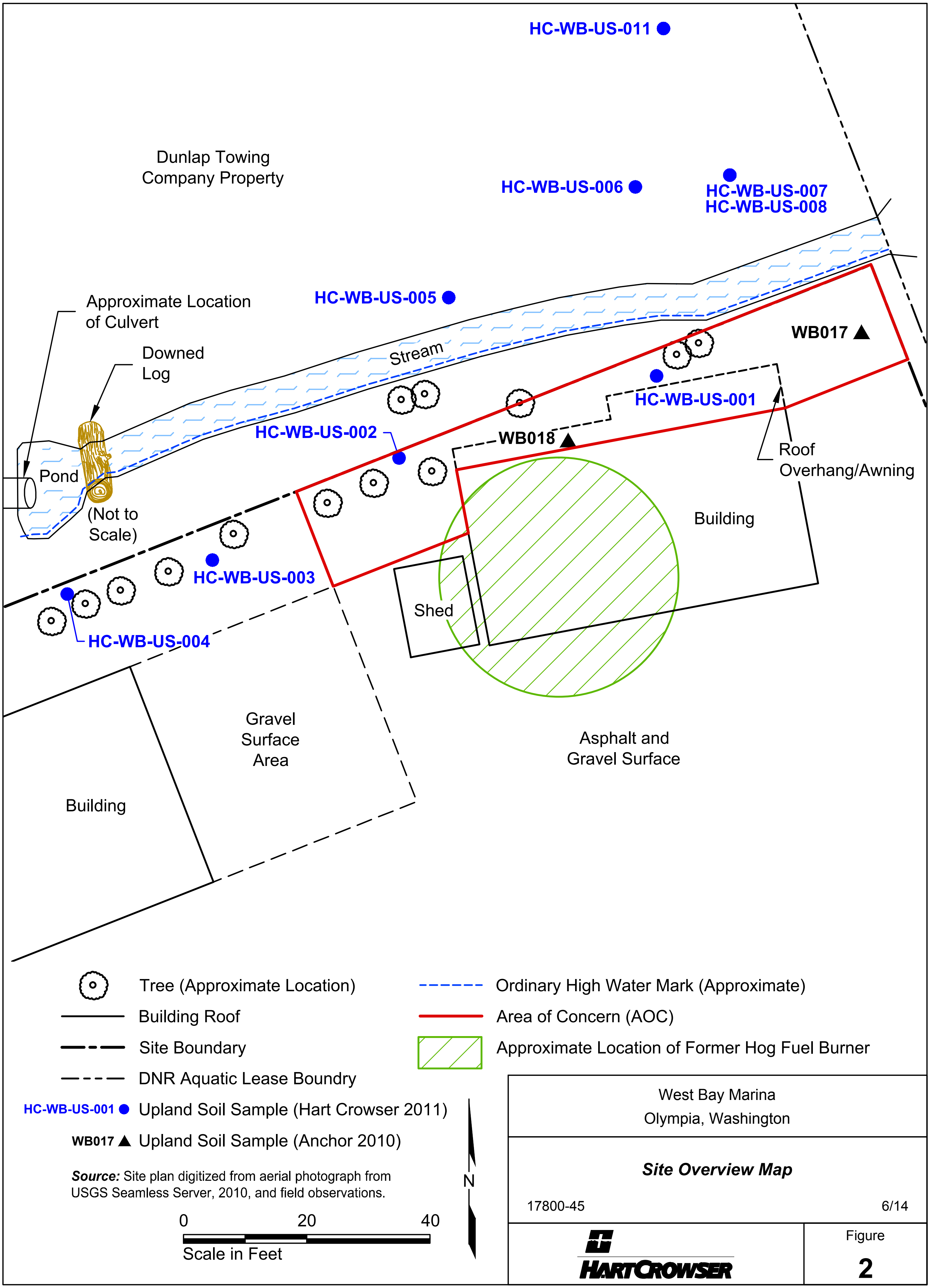

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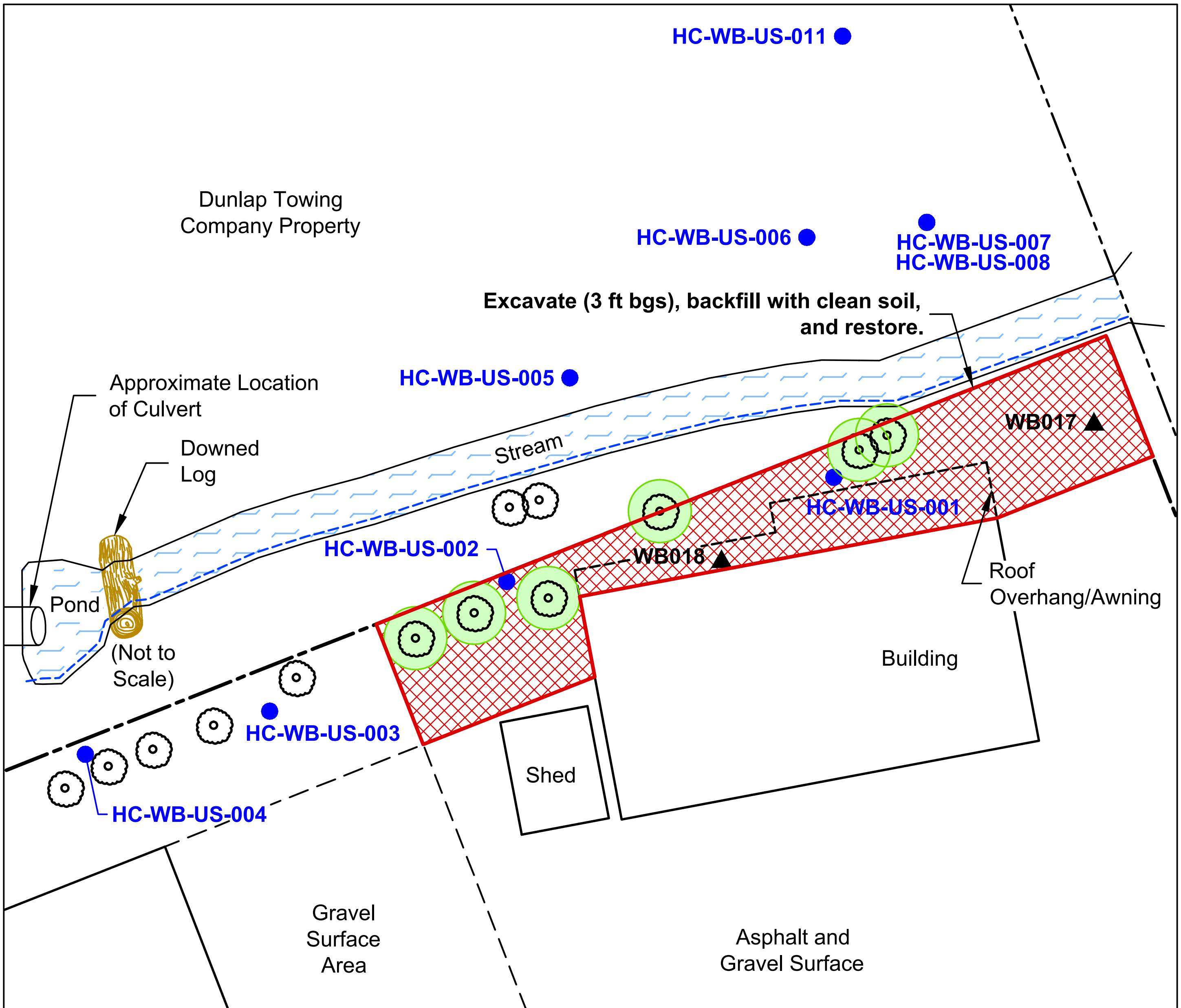

NOTES:

1. Alternatives 1a and 1b: Trees within the AOC will be removed and excavated beneath to 3 ft bgs.
2. Alternatives 1c and 1d: Trees will be protected within the critical root zone, as shown, and remain in place.

Tree (Approximate Location)

Critical Root Zone (Alts. 1b, 1d)

Building Roof

Site Boundary

DNR Aquatic Lease Boundry

HC-WB-US-001 ● Upland Soil Sample (Hart Crowser 2011)

WB017 ▲ Upland Soil Sample (Anchor 2010)

Ordinary High Water Mark (Approximate)

Area of Concern (AOC)

Source: Site plan digitized from aerial photograph from USGS Seamless Server, 2010, and field observations.

0 20 40

Scale in Feet

N

West Bay Marina
Olympia, Washington

FFS Alternatives 1a-1d

17800-45 6/14

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Figure

3

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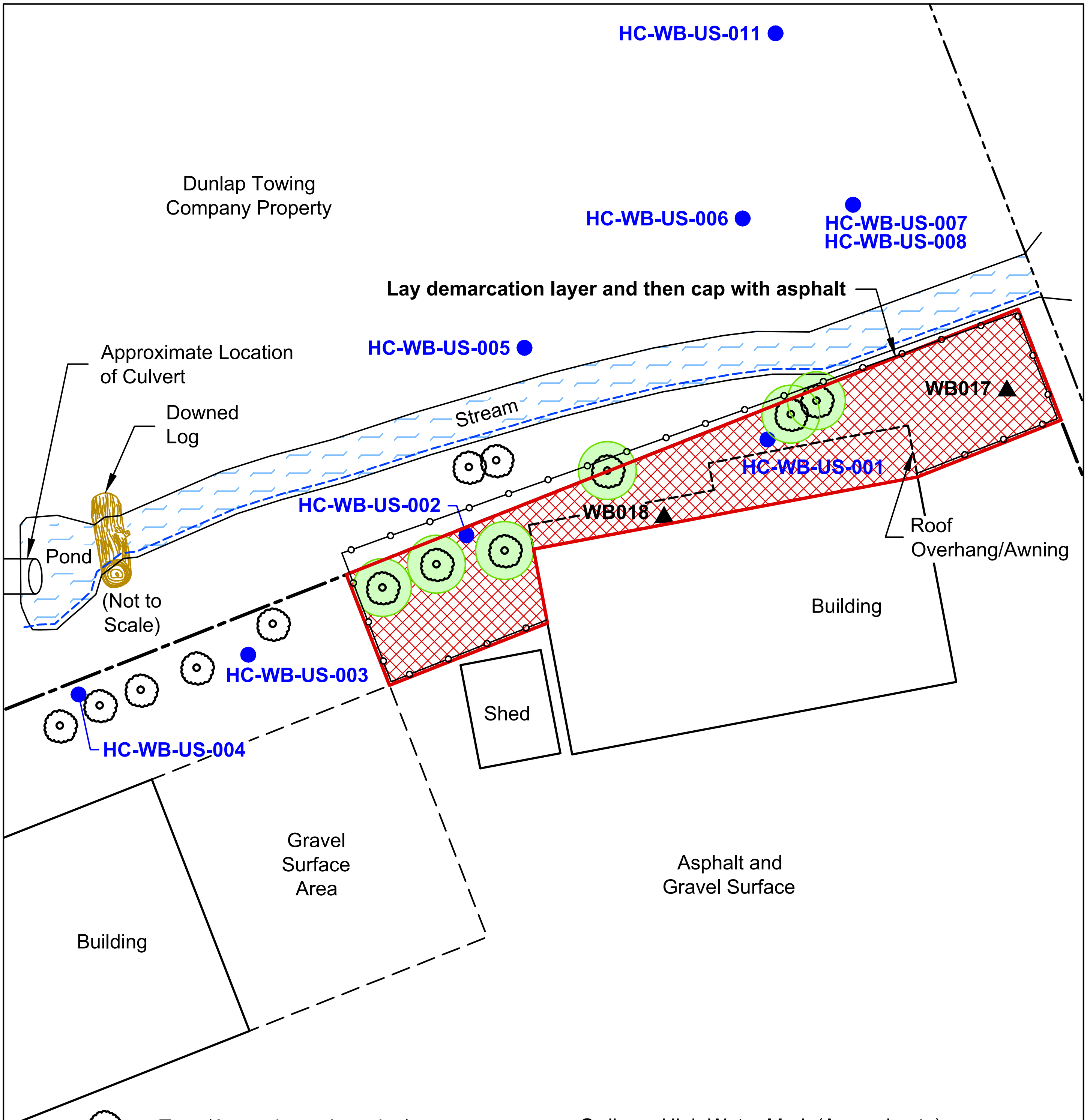

Tree (Approximate Location)

Critical Root Zone

6-Foot-High Fence

Building Roof

Site Boundary

DNR Aquatic Lease Boundry

HC-WB-US-001 Upland Soil Sample (Hart Crowser 2011)

WB017 Upland Soil Sample (Anchor 2010)

Ordinary High Water Mark (Approximate)

Area of Concern (AOC)

Source: Site plan digitized from aerial photograph from USGS Seamless Server, 2010, and field observations.

N

0 20 40

Scale in Feet

West Bay Marina
Olympia, Washington

FFS Alternative 2

17800-45 6/14

HARTCROWSER

Figure
4

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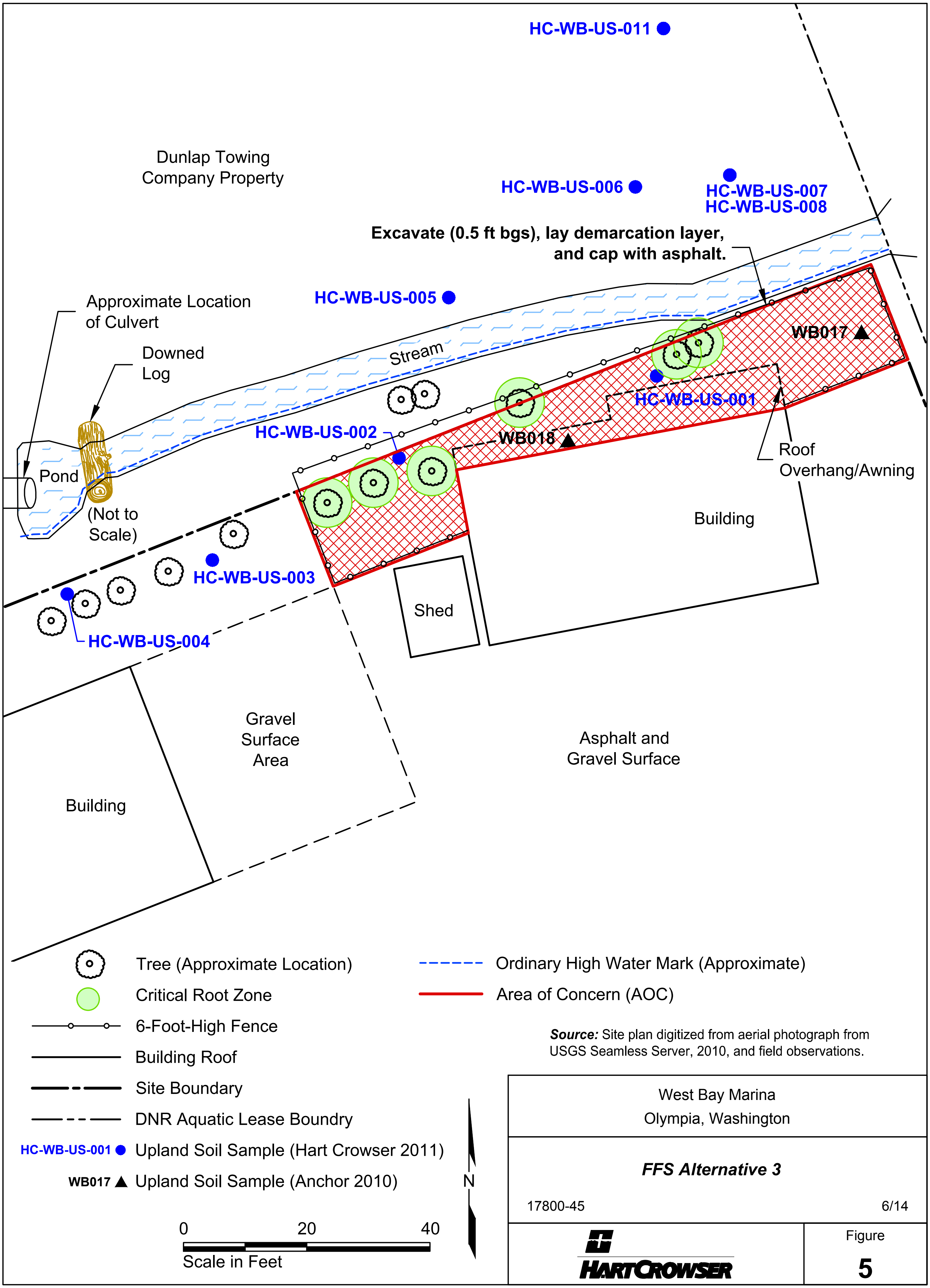

Source: Site plan digitized from aerial photograph from USGS Seamless Server, 2010, and field observations.

West Bay Marina
Olympia, Washington

FFS Alternative 3

17800-45

6/14

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APPENDIX A
STREAM ASSESSMENT

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APPENDIX A
STREAM ASSESSMENT

Hart Crowser visited the West Bay Marina project site on May 22, 2014, to conduct a stream assessment. The purpose was to investigate the drainage that is located to the north of the AOC and the vegetation within the drainage. The following is a summary of the findings:

- A drainage flows within a channel that appears to have been excavated due to the straight banks along the northern boundary of the AOC. The drainage contained running water at a depth between 2 to 4 inches deep. The water discharges from a culvert into the drainage at the western end of the site. A small pond (approximately 20 feet by 30 feet in size) is located between the discharge of the culvert and an impoundment of a log and debris that is located approximately 30 feet down the drainage. The pond was estimated to be 2 to 3 feet deep.

- Further investigation determined that the drainage is a stream that discharges from a slope located above and west of the log shipping yard to the west of the site. The stream enters a culvert under the shipping yard and then discharges at the western end of the site, where the driveway for the shipping yard is located. The stream appeared to be perennial, due to amount of scour within the channel and that it was running steadily even after there had been no precipitation for 5 days before the site visit. Also, an employee of Dunlap Towing to the north mentioned that the drainage runs all year round.

- The Washington Department of Natural Resources (WDNR) water-typing map (http://fortress.wa.gov/dnr/app1/fpars/viewer.htm) shows a stream at that location. The map indicates that the stream had not been surveyed for fish presence, so its type is unknown according to the WDNR. The stream has very poor habitat for fish but is perennial and does connect with Budd Inlet during high tides. The stream appears to be non-fish-bearing and is likely classified as an Np stream. If it is fish bearing, then it would be classified as an F stream.

- According to the Olympia Municipal Code (OMC) 18.32.435 (Streams and Important Riparian Areas – Buffers), Np streams are Type 4 streams, and small F streams are Type 3 streams. The OMC requires 150-foot buffers for Type 4 and 5 streams, and 200-foot buffers for Type 3 streams. Stream buffers are measured horizontally from the ordinary high water mark (OHWM) of the stream and do not include impervious structures or roads. The buffer on the south side of the stream (where the site is located) is bounded by a building and gravel driveway and thus is only approximately 17.5 feet wide.

- Typically, temporary disturbance of stream buffers must be restored to their original condition or better. Also, OMC 18.32.435.D requires that buffers that are inadequately vegetated to protect riparian functions must be "planted to a density of four hundred (400) tree units per acre..." with plants native to Thurston County.

- According to OMC 18.32.440.(A Streams and Important Riparian Areas – Special Reports), "Every application for development within a stream, or 'important riparian area' or their buffer shall include a drainage and erosion control plan and a grading plan."

- The trees in the buffer that may potentially be removed for the remedial action include red alder trees and four larch conifer trees.

- If the stream buffer will be modified for the remediation and no excavation below the OHWM of the stream will occur, the following City of Olympia permits are likely to be required (but may not be the only permits required):

  - Critical areas review and approval.

  - Clearing and grading permit (including a drainage and erosion control plan).

- If no impact occurs below the OHWM, then a Clean Water Act permit from the Army Corps of Engineers will not be required. Based on the data available and the FFS assumptions, the area of concern would only be excavated to approximately 3 feet below ground surface (which is above the OHWM); therefore, the Corps permit should not be needed.

- It is recommended that once the concept of the design of the remediation has been determined, a pre-application meeting with the City of Olympia be conducted to determine what permits the City will definitely require and what mitigation may be required.

APPENDIX B
REMEDIATION ALTERNATIVE COST ESTIMATE TABLES

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Table B-1 - Summary of Remediation Alternative Estimated Costs

Location:	West Bay Marina Olympia, WA
Phase:	Feasibility Study (-35% to +50%)
Base Year:	2013
Date:	July 2014

Description: Cost comparison of the total costs of Alternatives 1 through 3.

DESCRIPTION	TOTAL NET PRESENT VALUE	INCREMENTAL COST	COST TABLE REFERENCE
Alternative 1a	$111,000	Baseline Cost	Table B-2
Alternative 1b	$278,000	$167,000	Table B-3
Alternative 1c	$106,000	-$5,000	Table B-4
Alternative 1d	$242,000	$131,000	Table B-5
Alternative 2	$107,000	-$4,000	Table B-6
Alternative 3	$112,000	$1,000	Table B-7

Table B-2 - Remediation Alternative 1a Estimated Cost Summary

Location: West Bay Marina Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1a involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted, engineered, lined, and monitored landfill facility. This cost estimate assumes that the material will be disposed of at a Subtitle D landfill. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be removed to facilitate complete removal of contaminated soil. It is assumed that an environmental covenant will not be required for this alternative.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Excavation and Disposal					
Mobilization/Demobilization	1	LS	$ 5,000	$ 5,000	Engineer's estimate.
Temp. Erosion & Sedimentation Control Measures	1	LS	$ 3,000	$ 3,000	Engineer's estimate.
Excavation and Loading	144	CY	$ 31	$ 4,394	Hydraulic backhoe, 0.5 CY bucket. 2010 RSMeans 31 23 16.16 6030 and 9024.
Tree and Stump Removal	6	EA	$ 494	$ 2,964	Remove selected trees in AOC using chainsaw and chipper. Stump removal by hydraulic backhoe 2010 RSMeans 31 13 13.20 3050 and 2040.
Waste Transportation and Disposal	215	ton	$ 47	$ 10,121	Roosevelt Regional Landfill, Subtitle D MSW facility. Vendor quote.
Performance Sampling and Analysis	1	LS	$ 9,750	$ 9,750	Analytical cost only, labor assumed to be part of construction management, 1 sample per 100 SF.
Tree and Stump Material Disposal	1	LS	$ 335	$ 335	Haul material and disposal fee for compost facility. See Table B-8.
Excavation and Disposal Subtotal				**$ 35,563**	
Restoration and Revegetation					
Backfilling	144	CY	$ 36	$ 5,204	Includes compaction in 12" layers, vibrating plate. 2010 RSMeans 31 23 23.13 1100.
Grading & Seeding	144	SY	$ 3.70	$ 532	Fine grading and seeding, incl. lime, fertilizer & seed, with equipment. 2010 RSMeans 32 91 19.13 1000.
Planting Trees	6	EA	$ 67	$ 402	Planting trees, medium soil, bagged and burlapped, 12"diameter ball, by hand. 2010 RSMeans 32 93 43.10 0600.
Restoration and Revegetation Subtotal				**$ 6,138**	
Contingency	15%	--	--	**$ 6,255**	Scope and bid contingency. Percentage of capital costs.
Permitting					
Pre-Application Meeting with City of Olympia	1	LS	$ 240	$ 240	City of Olympia 2014 land use planning application fees, pre-submission conference.
Critical Areas Review Permit Application	1	LS	$ 2,534	$ 2,534	Thurston County application and review fees.
Clearing and Grading Permit Application	1	LS	$ 500	$ 500	Engineer's estiamte.
Planning Documents	1	LS	$ 9,000	$ 9,000	Drainage/erosion control plans, mitigation planting plan, monitoring plan. Engineer's estiamte.
Permitting Subtotal				**$ 12,274**	

Table B-2 - Remediation Alternative 1a Estimated Cost Summary

Location: West Bay Marina, Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1a involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted, engineered, lined, and monitored landfill facility. This cost estimate assumes that the material will be disposed of at a Subtitle D landfill. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be removed to facilitate complete removal of contaminated soil. It is assumed that an environmental covenant will not be required for this alternative.

Professional/Technical Services					
Project Management	10%	--	--	$ 4,796	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial Design	20%	--	--	$ 9,591	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction Management	15%	--	--	$ 7,193	Percentage of capital cost + contingency. EPA 540-R-00-002.
Professional/Technical Services Subtotal				**$ 21,580**	
TOTAL CAPITAL COST				**$ 81,809**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Restoration Monitoring					
Site Inspections	1	YR	$ 500	$ 500	Engineer's estimate.
Site Restoration Monitoring Subtotal				**$ 500**	
Contingency	10%	--	--	**$ 50**	Scope and bid contingency. Percentage of annual costs.
Professional/Technical Services					
Project Management	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical Support	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	EA	$ 500	$ 500	Engineer's estimate.
Professional/Technical Services Subtotal				**$ 610**	
TOTAL ANNUAL O&M COST				**$ 1,160**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Maintenance					
Site Maintenance	1	YR	$ 1,534	$ 1,534	25% of restoration and revegetation costs, every 2 years.
Contingency	10%	--	--	$ 153	Scope and bid contingency. Percentage of periodic cost.
Project Management	10%	--	--	$ 169	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Site Maintenance Subtotal				**$ 1,857**	
Professional/Technical Services					
5-Year Reviews & Reporting	1	EA	$ 5,000	$ 5,000	Engineer's estimate. Years 5 and 10.
Professional/Technical Services Subtotal				**$ 5,000**	

Table B-2 - Remediation Alternative 1a Estimated Cost Summary

Location: West Bay Marina, Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1a involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted, engineered, lined, and monitored landfill facility. This cost estimate assumes that the material will be disposed of at a Subtitle D landfill. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be removed to facilitate complete removal of contaminated soil. It is assumed that an environmental covenant will not be required for this alternative.

PRESENT VALUE ANALYSIS

Discount Rate 1.0%
Total Years 10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 81,809	$ 81,809	1.000	$ 81,809	
Annual O&M	1 - 10	$ 11,600	$ 1,160	9.471	$ 10,987	
Periodic	2	$ 1,857	$ 1,857	0.980	$ 1,820	
Periodic	4	$ 1,857	$ 1,857	0.961	$ 1,784	
Periodic	5	$ 5,000	$ 5,000	0.951	$ 4,757	
Periodic	6	$ 1,857	$ 1,857	0.942	$ 1,749	
Periodic	8	$ 1,857	$ 1,857	0.923	$ 1,715	
Periodic	10	$ 6,857	$ 6,857	0.905	$ 6,207	
		$ 112,693			$ 110,829	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 1A					**$ 110,829**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 10-year discount rate of 1.0 percent (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table B-3 - Remediation Alternative 1b Estimated Cost Summary

Location: West Bay Marina Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1b involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted waste incineration facility. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be removed to facilitate complete removal of contaminated soil. It is assumed that an environmental covenant will not be required for this alternative.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Excavation and Disposal					
Mobilization/Demobilization	1	LS	$ 5,000	$ 5,000	Engineer's estimate.
Temp. Erosion & Sedimentation Control Measures	1	LS	$ 3,000	$ 3,000	Engineer's estimate.
Excavation and Loading	144	CY	$ 31	$ 4,394	Hydraulic backhoe, 0.5 CY bucket. 2010 RSMeans 31 23 16.16 6030 and 9024.
Tree and Stump Removal	6	EA	$ 494	$ 2,964	Remove selected trees in AOC using chainsaw and chipper. Stump removal by hydraulic backhoe 2010 RSMeans 31 13 13.20 3050 and 2040.
Waste Transportation and Incineration	215	ton	$ 520	$ 111,911	Clean Harbors Aragonite LLC facility, Aragonite, UT (960 miles from site). See cost backup (Table B-8).
Performance Sampling and Analysis	1	LS	$ 9,750	$ 9,750	Analytical cost only, labor assumed to be part of construction management, 1 sample per 100 SF.
Tree and Stump Material Disposal	1	LS	$ 335	$ 335	Haul material and disposal fee for compost facility. See Table B-8.
Excavation and Disposal Subtotal				**$ 137,353**	
Restoration and Revegetation					
Backfilling	144	CY	$ 36	$ 5,204	Includes compaction in 12" layers, vibrating plate. 2010 RSMeans 31 23 23.13 1100.
Grading & Seeding	144	SY	$ 3.70	$ 532	Fine grading and seeding, incl. lime, fertilizer & seed, with equipment. 2010 RSMeans 32 91 19.13 1000.
Planting Trees	6	EA	$ 67	$ 402	Planting trees, medium soil, bagged and burlapped, 12"diameter ball, by hand. 2010 RSMeans 32 93 43.10 0600.
Restoration and Revegetation Subtotal				**$ 5,735**	
Contingency	15%	--	--	**$ 21,463**	Scope and bid contingency. Percentage of capital costs.
Permitting					
Pre-Application Meeting with City of Olympia	1	LS	$ 240	$ 240	City of Olympia 2014 land use planning application fees, pre-submission conference.
Critical Areas Review Permit Application	1	LS	$ 2,534	$ 2,534	Thurston County application and review fees.
Clearing and Grading Permit Application	1	LS	$ 500	$ 500	Engineer's estiamte.
Planning Documents	1	LS	$ 9,000	$ 9,000	Drainage/erosion control plans, mitigation planting plan, monitoring plan. Engineer's estiamte.
Permitting Subtotal				**$ 12,274**	

Table B-3 - Remediation Alternative 1b Estimated Cost Summary

Location: West Bay Marina, Olympia, WA
Phase: Feasibility Study (-35% to +50%)
Base Year: 2013
Date: July 2014

Description: Alternative 1b involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted waste incineration facility. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be removed to facilitate complete removal of contaminated soil. It is assumed that an environmental covenant will not be required for this alternative.

Professional/Technical Services					
Project Management	10%	--	--	$ 16,455	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial Design	20%	--	--	$ 32,910	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction Management	15%	--	--	$ 24,683	Percentage of capital cost + contingency. EPA 540-R-00-002.
Professional/Technical Services Subtotal				**$ 74,048**	
TOTAL CAPITAL COST				**$ 250,874**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Restoration Monitoring					
Site Inspections	1	YR	$ 500	$ 500	Engineer's estimate.
Site Restoration Monitoring Subtotal				**$ 500**	
Contingency	10%	--	--	**$ 50**	Scope and bid contingency. Percentage of annual costs.
Professional/Technical Services					
Project Management	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical Support	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	EA	$ 500	$ 500	Engineer's estimate.
Professional/Technical Services Subtotal				**$ 610**	
TOTAL ANNUAL O&M COST				**$ 1,160**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Maintenance					
Site Maintenance	1	YR	$ 1,434	$ 1,434	25% of restoration and revegetation costs, every 2 years.
Contingency	10%	--	--	$ 143.39	Scope and bid contingency. Percentage of periodic cost.
Project Management	10%	--	--	$ 157.72	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Site Maintenance Subtotal				**$ 1,735**	
Professional/Technical Services					
5-Year Reviews & Reporting	1	EA	$ 5,000	$ 5,000	Engineer's estimate. Years 5 and 10.
Professional/Technical Services Subtotal				**$ 5,000**	

Table B-3 - Remediation Alternative 1b Estimated Cost Summary

Location: West Bay Marina
Olympia, WA
Phase: Feasibility Study (-35% to +50%)
Base Year: 2013
Date: July 2014

Description: Alternative 1b involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted waste incineration facility. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be removed to facilitate complete removal of contaminated soil. It is assumed that an environmental covenant will not be required for this alternative.

PRESENT VALUE ANALYSIS

Discount Rate 1.0%
Total Years 10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 250,874	$ 250,874	1.000	$ 250,874	
Annual O&M	1 - 10	$ 11,600	$ 1,160	9.471	$ 10,987	
Periodic	2	$ 1,434	$ 1,434	0.980	$ 1,406	
Periodic	4	$ 1,434	$ 1,434	0.961	$ 1,378	
Periodic	5	$ 5,000	$ 5,000	0.951	$ 4,757	
Periodic	6	$ 1,434	$ 1,434	0.942	$ 1,351	
Periodic	8	$ 1,434	$ 1,434	0.923	$ 1,324	
Periodic	10	$ 6,735	$ 6,735	0.905	$ 6,097	
		$ 279,945			$ 278,174	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 1B					**$ 278,174**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 10-year discount rate of 1.0 percent (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table B-4 - Remediation Alternative 1c Estimated Cost Summary

Location: West Bay Marina Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1c involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted, engineered, lined, and monitored landfill facility. This cost estimate assumes that the material will be disposed of at a Subtitle D landfill. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be protected and will remain. An environmental covenant may be required if impacted material remains in the AOC.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Excavation and Disposal					
Mobilization/Demobilization	1	LS	$ 5,000	$ 5,000	Engineer's estimate.
Temp. Erosion & Sedimentation Control Measures	1	LS	$ 3,000	$ 3,000	Engineer's estimate.
Excavation and Loading	110	CY	$ 31	$ 3,368	Hydraulic backhoe, 0.5 CY bucket. 2010 RSMeans 31 23 16.16 6030 and 9024.
Excavation from Tree Areas	6	CY	$ 92	$ 511	Hand excavation around trees with pick and shovel, 0.5 ft deep. 2010 RSMeans 31 23 16.16 0200.
Waste Transportation and Disposal	173	ton	$ 47	$ 8,152	Roosevelt Regional Landfill, Subtitle D MSW facility. Vendor quote.
Performance Sampling and Analysis	1	LS	$ 9,750	$ 9,750	Analytical cost only, labor assumed to be part of construction management, 1 sample per 100 SF.
Excavation and Disposal Subtotal				**$ 29,781**	
Restoration and Revegetation					
Backfilling	110	CY	$ 36	$ 3,989	Includes compaction in 12" layers, vibrating plate. 2010 RSMeans 31 23 23.13 1100.
Place Soil Cover Material	6	CY	$ 31	$ 172	Place soil cover in tree areas by hand, no compaction, light soil. 2010 RSMeans 31 23 23.13 0015.
Grading & Seeding	110	SY	$ 3.70	$ 408	Fine grading and seeding, incl. lime, fertilizer & seed, with equipment. 2010 RSMeans 32 91 19.13 1000.
Restoration and Revegetation Subtotal				**$ 4,569**	
Contingency	15%	--	--	**$ 5,153**	Scope and bid contingency. Percentage of capital costs.
Permitting					
Pre-Application Meeting with City of Olympia	1	LS	$ 240	$ 240	City of Olympia 2014 land use planning application fees, pre-submission conference.
Critical Areas Review Permit Application	1	LS	$ 2,534	$ 2,534	Thurston County application and review fees.
Clearing and Grading Permit Application	1	LS	$ 500	$ 500	Engineer's estiamte.
Planning Documents	1	LS	$ 9,000	$ 9,000	Drainage/erosion control plans, mitigation planting plan, monitoring plan. Engineer's estiamte.
Permitting Subtotal				**$ 12,274**	
Professional/Technical Services					
Project Management	10%	--	--	$ 3,950	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial Design	20%	--	--	$ 7,901	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction Management	15%	--	--	$ 5,925	Percentage of capital cost + contingency. EPA 540-R-00-002.
Professional/Technical Services Subtotal				**$ 17,776**	

Table B-4 - Remediation Alternative 1c Estimated Cost Summary

Location: West Bay Marina, Olympia, WA
Phase: Feasibility Study (-35% to +50%)
Base Year: 2013
Date: July 2014

Description: Alternative 1c involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted, engineered, lined, and monitored landfill facility. This cost estimate assumes that the material will be disposed of at a Subtitle D landfill. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be protected and will remain. An environmental covenant may be required if impacted material remains in the AOC.

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls					
Preparation of Environmental Covenant	1	EA	$ 10,000	$ 10,000	Engineer's estimate.
Institutional Controls Subtotal				**$10,000**	
TOTAL CAPITAL COST				**$ 79,553**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Restoration Monitoring					
Site Inspections	1	YR	$ 500	$ 500	Engineer's estimate.
Site Restoration Monitoring Subtotal				**$ 500**	
Contingency	10%	--	--	**$ 50**	Scope and bid contingency. Percentage of annual costs.
Professional/Technical Services					
Project Management	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical Support	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	EA	$ 500	$ 500	Engineer's estimate.
Professional/Technical Services Subtotal				**$ 610**	
TOTAL ANNUAL O&M COST				**$ 1,160**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Maintenance					
Site Maintenance	1	YR	$ 1,142	$ 1,142	25% of restoration and revegetation costs, every 2 years.
Contingency	10%	--	--	$ 114	Scope and bid contingency. Percentage of periodic cost.
Project Management	10%	--	--	$ 126	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Site Maintenance Subtotal				**$ 1,382**	
Professional/Technical Services					
5-Year Reviews & Reporting	1	EA	$ 5,000	$ 5,000	Engineer's estimate. Years 5 and 10.
Professional/Technical Services Subtotal				**$ 5,000**	

Table B-4 - Remediation Alternative 1c Estimated Cost Summary

Location: West Bay Marina Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1c involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted, engineered, lined, and monitored landfill facility. This cost estimate assumes that the material will be disposed of at a Subtitle D landfill. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be protected and will remain. An environmental covenant may be required if impacted material remains in the AOC.

PRESENT VALUE ANALYSIS

Discount Rate 1.0%
Total Years 10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 79,553	$ 79,553	1.000	$ 79,553	
Annual O&M	1 - 10	$ 11,600	$ 1,160	9.471	$ 10,987	
Periodic	2	$ 1,382	$ 1,382	0.980	$ 1,355	
Periodic	4	$ 1,382	$ 1,382	0.961	$ 1,328	
Periodic	5	$ 5,000	$ 5,000	0.951	$ 4,757	
Periodic	6	$ 1,382	$ 1,382	0.942	$ 1,302	
Periodic	8	$ 1,382	$ 1,382	0.923	$ 1,276	
Periodic	10	$ 6,382	$ 6,382	0.905	$ 5,778	
		$ 108,064			$ 106,336	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 1C					**$ 106,336**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 10-year discount rate of 1.0 percent (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table B-5 - Remediation Alternative 1d Estimated Cost Summary

Location: West Bay Marina Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1d involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted waste incineration facility. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be protected and will remain. An environmental covenant may be required if impacted material remains in the AOC.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Excavation and Disposal					
Mobilization/Demobilization	1	LS	$ 5,000	$ 5,000	Engineer's estimate.
Temp. Erosion & Sedimentation Control Measures	1	LS	$ 3,000	$ 3,000	Engineer's estimate.
Excavation and Loading	110	CY	$ 31	$ 3,368	Hydraulic backhoe, 0.5 CY bucket. 2010 RSMeans 31 23 16.16 6030 and 9024.
Excavation from Tree Areas	6	CY	$ 92	$ 511	Hand excavation around trees with pick and shovel, 0.5 ft deep. 2010 RSMeans 31 23 16.16 0200.
Waste Transportation and Incineration	173	ton	$ 520	$ 90,142	Clean Harbors Aragonite LLC facility, Aragonite, UT (960 miles from site). See cost backup (Table B-8).
Performance Sampling and Analysis	1	LS	$ 9,750	$ 9,750	Analytical cost only, labor assumed to be part of construction management, 1 sample per 100 SF.
Excavation and Disposal Subtotal				**$ 111,771**	
Restoration and Revegetation					
Backfilling	110	CY	$ 36	$ 3,989	Includes compaction in 12" layers, vibrating plate. 2010 RSMeans 31 23 23.13 1100.
Place Soil Cover Material	6	CY	$ 31	$ 172	Place soil cover in tree areas by hand, no compaction, light soil. 2010 RSMeans 31 23 23.13 0015.
Grading & Seeding	110	SY	$ 3.70	$ 408	Fine grading and seeding, incl. lime, fertilizer & seed, with equipment. 2010 RSMeans 32 91 19.13 1000.
Restoration and Revegetation Subtotal				**$ 4,569**	
Contingency	15%	--	--	**$ 17,451**	Scope and bid contingency. Percentage of capital costs.
Permitting					
Pre-Application Meeting with City of Olympia	1	LS	$ 240	$ 240	City of Olympia 2014 land use planning application fees, pre-submission conference.
Critical Areas Review Permit Application	1	LS	$ 2,534	$ 2,534	Thurston County application and review fees.
Clearing and Grading Permit Application	1	LS	$ 500	$ 500	Engineer's estiamte.
Planning Documents	1	LS	$ 9,000	$ 9,000	Drainage/erosion control plans, mitigation planting plan, monitoring plan. Engineer's estiamte.
Permitting Subtotal				**$ 12,274**	
Professional/Technical Services					
Project Management	10%	--	--	$ 13,379	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial Design	20%	--	--	$ 26,758	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction Management	15%	--	--	$ 20,069	Percentage of capital cost + contingency. EPA 540-R-00-002.
Professional/Technical Services Subtotal				**$ 60,206**	

Table B-5 - Remediation Alternative 1d Estimated Cost Summary

Location: West Bay Marina, Olympia, WA
Phase: Feasibility Study (-35% to +50%)
Base Year: 2013
Date: July 2014

Description: Alternative 1d involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted waste incineration facility. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be protected and will remain. An environmental covenant may be required if impacted material remains in the AOC.

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls					
Preparation of Environmental Covenant	1	EA	$ 10,000	$ 10,000	Engineer's estimate.
Institutional Controls Subtotal				**$10,000**	
TOTAL CAPITAL COST				**$ 216,271**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Restoration Monitoring					
Site Inspections	1	YR	$ 500	$ 500	Engineer's estimate.
Site Restoration Monitoring Subtotal				**$ 500**	
Contingency	10%	--	--	**$ 50**	Scope and bid contingency. Percentage of annual costs.
Professional/Technical Services					
Project Management	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical Support	10%	--	--	$ 55	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	EA	$ 500	$ 500	Engineer's estimate.
Professional/Technical Services Subtotal				**$ 610**	
TOTAL ANNUAL O&M COST				**$ 1,160**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Maintenance					
Site Maintenance	1	YR	$ 1,142	$ 1,142	25% of restoration and revegetation costs, every 2 years.
Contingency	10%	--	--	$ 114.23	Scope and bid contingency. Percentage of periodic cost.
Project Management	10%	--	--	$ 125.65	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Site Maintenance Subtotal				**$ 1,382**	
Professional/Technical Services					
5-Year Reviews & Reporting	1	EA	$ 5,000	$ 5,000	Engineer's estimate. Years 5 and 10.
Professional/Technical Services Subtotal				**$ 5,000**	

Table B-5 - Remediation Alternative 1d Estimated Cost Summary

Location: West Bay Marina, Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 1d involves excavation and off-site disposal of soil containing COCs above the cleanup level at a permitted waste incineration facility. Following excavation, the AOC will be backfilled to grade with clean fill material. Trees within the AOC will be protected and will remain. An environmental covenant may be required if impacted material remains in the AOC.

PRESENT VALUE ANALYSIS

Discount Rate 1.0%
Total Years 10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 216,271	$ 216,271	1.000	$ 216,271	
Annual O&M	1 - 10	$ 11,600	$ 1,160	9.471	$ 10,987	
Periodic	2	$ 1,142	$ 1,142	0.980	$ 1,120	
Periodic	4	$ 1,142	$ 1,142	0.961	$ 1,098	
Periodic	5	$ 5,000	$ 5,000	0.951	$ 4,757	
Periodic	6	$ 1,142	$ 1,142	0.942	$ 1,076	
Periodic	8	$ 1,142	$ 1,142	0.923	$ 1,055	
Periodic	10	$ 6,382	$ 6,382	0.905	$ 5,778	
		$ 243,822			$ 242,141	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 1D					**$ 242,141**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 10-year discount rate of 1.0 percent (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table B-6 - Remediation Alternative 2 Estimated Cost Summary

Location:	West Bay Marina Olympia, WA	**Description:** Alternative 2 involves containment of contaminated soil via capping and institutional controls. Little excavation is required under this alternative (some soil removal may occur accommodate cap installation). The entire AOC (excluding tree areas) will be capped with asphalt. The critical root zone areas for trees within the AOC will be capped with "tree-friendly" cap material. The cap will be monitored and maintained for the length of the remedy (10 years). The AOC will be enclosed by a fence with two gates for access. This alternative assumes that an environmental covenant will be implemented.
Phase:	Feasibility Study (-35% to +50%)	
Base Year:	2013	
Date:	July 2014	

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Excavation and Site Preparation					
Mobilization/Demobilization	1	LS	$ 5,000	$ 5,000	Engineer's estimate.
Temp. Erosion & Sedimentation Control Measures	1	LS	$ 3,000	$ 3,000	Engineer's estimate.
Excavation from Tree Areas	6	CY	$ 92	$ 511	Hand excavation around trees with pick and shovel, 0.5 ft deep. 2010 RSMeans 31 23 16.16 0200.
Waste Transportation and Disposal	8	ton	$ 47	$ 394	Roosevelt Regional Landfill, Subtitle D MSW facility. See cost backup (Table B-8).
Clearing and Grading Cap Area	144	SY	$ 4.67	$ 671	Grade subgrade for base course, small irregular areas. 2010 RSMeans 31 22 16.10 1050.
Demarcation Layer	110	SY	$ 2.80	$ 308	Orange, non-woven geotextile. See cost backup (Table B-8).
Fence	185	LF	$ 14	$ 2,590	Schedule 20, 11 ga, 1-5/8" posts, 6' high fence. 2010 RSMeans 32 31 13.25 0100.
Gates	2	EA	$ 286	$ 572	4' wide, 6' high gate, 1-3/8" frame. 2010 RSMeans 32 31 13.25 0190.
Excavation Subtotal				**$ 13,046**	
Capping					
Asphalt Cover	110	SY	$ 44	$ 4,884	See cost backup (Table B-8).
Soil Cover (Tree Areas)	6	CY	$ 26	$ 145	Pacific Topsoil, weed-free topsoil for tree-friendly cap material.
Haul Soil Material	2	HR	$ 113	$ 226	From Pacific Topsoils in Maple Valley, WA. Hauling, 8 CY truck, small project hourly rate. 2010 RSMeans 31 23 23.20 2000.
Place Soil Cover Material	6	CY	$ 31	$ 172	Place soil cover in tree areas by hand, no compaction, light soil. 2010 RSMeans 31 23 23.13 0015.
Capping Subtotal				**$ 5,427**	
Contingency	15%	--	--	**$ 2,771**	Scope and bid contingency. Percentage of capital costs.
Permitting					
Pre-Application Meeting with City of Olympia	1	LS	$ 240	$ 240	City of Olympia 2014 land use planning application fees, pre-submission conference.
Critical Areas Review Permit Application	1	LS	$ 2,534	$ 2,534	Thurston County application and review fees.
Clearing and Grading Permit Application	1	LS	$ 500	$ 500	Engineer's estiamte.
Planning Documents	1	LS	$ 9,000	$ 9,000	Drainage/erosion control plans, mitigation planting plan, monitoring plan. Engineer's estiamte.
Permitting Subtotal				**$ 12,274**	

Table B-6 - Remediation Alternative 2 Estimated Cost Summary

Location: West Bay Marina, Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 2 involves containment of contaminated soil via capping and institutional controls. Little excavation is required under this alternative (some soil removal may occur accommodate cap installation). The entire AOC (excluding tree areas) will be capped with asphalt. The critical root zone areas for trees within the AOC will be capped with "tree-friendly" cap material. The cap will be monitored and maintained for the length of the remedy (10 years). The AOC will be enclosed by a fence with two gates for access. This alternative assumes that an environmental covenant will be implemented.

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Professional/Technical Services					
Project Management	10%	--	--	$ 2,124	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial Design	20%	--	--	$ 4,249	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction Management	15%	--	--	$ 3,187	Percentage of capital cost + contingency. EPA 540-R-00-002.
Professional/Technical Services Subtotal				**$ 9,560**	
Institutional Controls					
Preparation of Environmental Covenant	1	EA	$ 10,000	$ 10,000	Engineer's estimate.
Institutional Controls Subtotal				**$10,000**	
TOTAL CAPITAL COST				**$ 53,078**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Annual O&M					
Site Inspections	1	YR	$ 500	$ 500	Engineer's estimate.
Site Maintenance	1	YR	$ 1,847	$ 1,847	10% of construction costs.
Annual O&M Subtotal				**$ 2,347**	
Contingency	15%	--	--	**$ 352**	Scope and bid contingency. Percentage of periodic costs.
Professional/Technical Services					
Project Management	10%	--	--	$ 270	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical Support	10%	--	--	$ 270	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	YR	$ 1,000	$ 1,000	Engineer's estimate.
Professional/Technical Services Subtotal				**$ 1,540**	
TOTAL ANNUAL O&M COST				**$ 4,239**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Maintenance					
Cap Replacement/Repair	1	EA	$ 5,427	$ 5,427	100% of capping capital costs. Year 10.
Site Maintenance Subtotal				**$ 5,427**	
Professional/Technical Services					
5-Year Reviews & Reporting	1	EA	$ 5,000	$ 5,000	Engineer's estimate. Years 5 and 10.
Professional/Technical Services Subtotal				**$ 5,000**	

Table B-6 - Remediation Alternative 2 Estimated Cost Summary

Location: West Bay Marina, Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 2 involves containment of contaminated soil via capping and institutional controls. Little excavation is required under this alternative (some soil removal may occur accommodate cap installation). The entire AOC (excluding tree areas) will be capped with asphalt. The critical root zone areas for trees within the AOC will be capped with "tree-friendly" cap material. The cap will be monitored and maintained for the length of the remedy (10 years). The AOC will be enclosed by a fence with two gates for access. This alternative assumes that an environmental covenant will be implemented.

PRESENT VALUE ANALYSIS

Discount Rate 1.0%
Total Years 10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 53,078	$ 53,078	1.000	$ 53,078	
Annual O&M	1 - 10	$ 42,393	$ 4,239	9.471	$ 40,151	
Periodic	5	$ 5,000	$ 5,000	0.951	$ 4,757	
Periodic	10	$ 10,427	$ 10,427	0.905	$ 9,439	
		$ 110,897			$ 107,426	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 2					**$ 107,426**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 10-year discount rate of 1.0 percent (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table B-7 - Remediation Alternative 3 Estimated Cost Summary

Location: West Bay Marina Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 3 involves a combination of excavation and capping with institutional controls. The top 6 inches of soil within the AOC will be excavated, except for within the critical root zone of trees in the AOC. To protect the trees, the critical root zone areas will be excavated by hand or vacuum. Following excavation, a demarcation layer will be placed and the entire AOC will be capped. The cap will be monitored for the length of the remedy (10 years). The AOC will be enclosed by a fence with two gates for access. This alternative assumes that an environmental covenant will be implemented.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Excavation and Site Preparation					
Mobilization/Demobilization	1	LS	$ 5,000	$ 5,000	Engineer's estimate.
Temp. Erosion & Sedimentation Control Measures	1	LS	$ 3,000	$ 3,000	Engineer's estimate.
Excavation and Loading	18	CY	$ 31	$ 561	Hydraulic backhoe, 0.5 CY bucket. 2010 RSMeans 31 23 16.16 6030 and 9024.
Excavation from Tree Areas	6	CY	$ 92	$ 511	Hand excavation around trees with pick and shovel, 0.5 ft deep. 2010 RSMeans 31 23 16.16 0200.
Waste Transportation and Disposal	36	ton	$ 47	$ 1,687	Roosevelt Regional Landfill, Subtitle D MSW facility. Vendor quote.
Grading	144	SY	$ 2.69	$ 387	Grade subgrade for base course, small irregular areas. 2010 RSMeans 31 22 16.10 1050.
Demarcation Layer	110	SY	$ 2.80	$ 308	Orange, non-woven geotextile. See cost backup (Table B-8).
Fence	185	LF	$ 14	$ 2,590	Schedule 20, 11 ga, 1-5/8" posts, 6' high fence. 2010 RSMeans 32 31 13.25 0100
Gates	2	EA	$ 286	$ 572	4' wide, 6' high gate, 1-3/8" frame. 2010 RSMeans 32 31 13.25 0190
Excavation Subtotal				**$ 14,616**	
Capping					
Asphalt Cover	110	SY	$ 44	$ 4,884	See cost backup (Table B-8).
Soil Cover (Tree Areas)	6	CY	$ 26	$ 145	Pacific Topsoil, weed-free topsoil for tree-friendly cap material.
Haul soil material	2	HR	$ 113	$ 226	From Pacific Topsoils in Maple Valley, WA. Hauling, 8 CY truck, small project hourly rate. 2010 RSMeans 31 23 23.20 2000.
Place Soil Cover Material	6	CY	$ 31	$ 172	Place soil cover in tree areas by hand, no compaction, light soil. 2010 RSMeans 31 23 23.13 0015.
Capping Subtotal				**$ 5,427**	
Contingency	15%	--	--	**$ 3,006**	Scope and bid contingency. Percentage of capital costs.
Permitting					
Pre-Application Meeting with City of Olympia	1	LS	$ 240	$ 240	City of Olympia 2014 land use planning application fees, pre-submission conference.
Critical Areas Review Permit Application	1	LS	$ 2,534	$ 2,534	Thurston County application and review fees.
Clearing and Grading Permit Application	1	LS	$ 500	$ 500	Engineer's estiamte.
Planning Documents	1	LS	$ 9,000	$ 9,000	Drainage/erosion control plans, mitigation planting plan, monitoring plan. Engineer's estiamte.
Permitting Subtotal				**$ 12,274**	

Table B-7 - Remediation Alternative 3 Estimated Cost Summary

Location: West Bay Marina, Olympia, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2013 **Date:** July 2014	**Description:** Alternative 3 involves a combination of excavation and capping with institutional controls. The top 6 inches of soil within the AOC will be excavated, except for within the critical root zone of trees in the AOC. To protect the trees, the critical root zone areas will be excavated by hand or vacuum. Following excavation, a demarcation layer will be placed and the entire AOC will be capped. The cap will be monitored for the length of the remedy (10 years). The AOC will be enclosed by a fence with two gates for access. This alternative assumes that an environmental covenant will be implemented.

Professional/Technical Services					
Project Management	10%	--	--	$ 2,305	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial Design	20%	--	--	$ 4,610	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction Management	15%	--	--	$ 3,457	Percentage of capital cost + contingency. EPA 540-R-00-002.
Professional/Technical Services Subtotal				**$ 10,372**	
Institutional Controls					
Preparation of restrictive covenant	1	EA	$ 10,000	$ 10,000	Engineer's estimate.
Institutional Controls Subtotal				**$10,000**	
TOTAL CAPITAL COST				**$ 55,696**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Annual O&M					
Site Inspections	1	YR	$ 500	$ 500	Engineer's estimate.
Site Maintenance	1	YR	$ 2,004	$ 2,004	10% of construction costs.
Annual O&M Subtotal				**$ 2,504**	
Contingency	15%	--	--	**$ 376**	Scope and bid contingency. Percentage of periodic costs.
Professional/Technical Services					
Project Management	10%	--	--	$ 288	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical Support	10%	--	--	$ 288	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	YR	$ 1,000	$ 1,000	Engineer's estimate.
Professional/Technical Services Subtotal				**$ 1,576**	
TOTAL ANNUAL O&M COST				**$ 4,456**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Maintenance					
Cap Replacement/Repair	1	EA	$ 5,427	$ 5,427	100% of capping capital costs. Year 10.
Site Maintenance Subtotal				**$ 5,427**	
Professional/Technical Services					
5-Year Reviews & Reporting	1	EA	$ 5,000	$ 5,000	Engineer's estimate. Years 5 and 10.
Professional/Technical Services Subtotal				**$ 5,000**	

Table B-7 - Remediation Alternative 3 Estimated Cost Summary

Location:	West Bay Marina Olympia, WA	**Description:** Alternative 3 involves a combination of excavation and capping with institutional controls. The top 6 inches of soil within the AOC will be excavated, except for within the critical root zone of trees in the AOC. To protect the trees, the critical root zone areas will be excavated by hand or vacuum. Following excavation, a demarcation layer will be placed and the entire AOC will be capped. The cap will be monitored for the length of the remedy (10 years). The AOC will be enclosed by a fence with two gates for access. This alternative assumes that an environmental covenant will be implemented.
Phase:	Feasibility Study (-35% to +50%)	
Base Year:	2013	
Date:	July 2014	

PRESENT VALUE ANALYSIS

Discount Rate 1.0%
Total Years 10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 55,696	$ 55,696	1.000	$ 55,696	
Annual O&M	1 - 10	$ 44,559.35	$ 4,456	9.471	$ 42,204	
Periodic	5	$ 5,000	$ 5,000	0.951	$ 4,757	
Periodic	10	$ 10,427	$ 10,427	0.905	$ 9,439	
		$ 115,682			$ 112,096	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 3					**$ 112,096**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 10-year discount rate of 1.0 percent (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table B-8 - Cost Backup and Calculations

AOC Information		ALT 1a	ALT 1b	ALT 1c	ALT 1d	ALT 2	ALT 3
Area	SY	143.6	143.6	143.6	143.6	143.6	143.6
Tree area	SY	0.0	0.0	33.5	33.5	33.5	33.5
Area less trees	SY	143.6	143.6	110.0	110.0	110.0	110.0
Exc. Volume	CY	143.6	143.6	110.0	110.0	0.0	18.3
Loose Volume	CY	165.1	165.1	126.6	126.6	0.0	21.1
Density	tons/CY	1.5	1.5	1.5	1.5	1.5	1.5
Weight	tons	215.3	215.3	165.1	165.1	8.4	35.9

Restoration and Revegetation		ALT 1	ALT 2	ALT 3		Notes
Area	SY	110.0	0.0	0.0		Fine grading and seeding, including lime, fertilizer and seed. With equip., 2010 RSMeans 32 91 19.13 1000.

Tree Removal		ALT 1	ALT 2	ALT 3		Notes
Trees	EA	6.0	0.0	0.0	$ 345	Remove selected trees in AOC using chain saw and chipper, not including stumps, up to 12" diameter. 2010 RSMeans 31 13 13.20 3100.
Stumps	EA	6.0	0.0	0.0	$ 119	Stump removal by hydraulic backhoe, 1-1/2 CY, 8-12" diameter. 2010 RSMeans 31 13 13.20 2050.

Tree/Stump Material Hauling & Disposal

					Notes
Tree Volume	6 trees		CY	5.2	Silver Spring Organic13835 Military Rd SERainier, WA 98576
Wood chip density			tons/CY	0.29	Chipped/Ground Wood $49.00 /TON
Weight			tons	1.5	20 miles from Site
Transportation to disposal site	$	5.91	per mile		Per truck average of min/max cost per mile, 2010 RSMeans 02 81 20.10 1220.
Total			$	335	

Permitting Costs - All Alternatives

A pre-application meeting with the City of Olympia	$ 240	City of Olympia 2014 land use planning application fees.
Critical areas review permit application	$ 2,534	Application fees and review fees.
Clearing and grading permit application	$ 500	Engineer's estimate.
Developing drainage/erosion control plans, mitigation planting plan and monitoring plan	$ 9,000	Engineer's estimate.

Incineration

Transportation cost per ton	$	20	per ton	Engineer's estimate.
Disposal costs	$	500	per ton	Quote from vendor (Clean Harbors disposal by incineration), $0.25/lb, assumes material is non haz.
Total transport and disposal cost	$	520	per ton	

Sampling 1 sample per 100 SF

					Analysis	
ALT 1	13	samples	$ 750	$ 9,750	dioxins/furans	Source: ARI labs price list for dioxins/furans in soil,
ALT 2	13	samples	$ 750	$ 9,750	dioxins/furans	method 1613/8290A HR-GC/MS.
ALT 3	13	samples	$ 750	$ 9,750	dioxins/furans	

Table B-8 - Cost Backup and Calculations

Demarcation Layer $ 2.80 per SY — RSMeans Heavy Construction 2340-300-1550, geotextile, non-woven 120 lb tensile strength (2006 unit price converted to 2013) .

		ALT 1	ALT 2	ALT 3
Area req'd	SY	0.0	110.0	110.0
Total Demarcation Layer Costs		$0	$308	$308

Asphalt Cap	Quantity	Unit	Unit Cost	Total	
ALT 1	--	--	--	--	
ALT 2					
Asphalt Cap Installation					
Subgrade preparation	110.0	SY	$ 2.00	$ 220	Prepare and roll. 2010 RSMeans 32 11 23.23 7000.
Paving materials hauling	27.5	LCY	$ 5.31	$ 146	12 CY trucks, 25 MPH ave., cycle 4 mi. 2010 RSMeans 31 23 23.20 1040.
Aggregate base course	110.0	SY	$ 5.28	$ 581	Crushed 3/4-in. stone, compacted, 3 in. deep. 2010 RSMeans 32 11 23.23 0050.
Asphalt base layer	110.0	SY	$ 9.58	$ 1,054	Binder course, 2-in. thick. 2010 RSMeans 32 12 16.13 0120.
Asphalt intermediate layer	110.0	SY	$ 9.58	$ 1,054	Binder course, 2-in. thick. 2010 RSMeans 32 12 16.13 0120.
Asphalt wearing layer	110.0	SY	$ 10.70	$ 1,177	Wearing course, 2-in. thick. 2010 RSMeans 32 12 16.13 0380.
Sealing	110.0	SY	$ 1.87	$ 206	Tack coat, emulsion 0.10 gal. per SY. 2010 RSMeans 32 01 13.62 3270.
Subtotal				$ 4,440	
Cap installation quality control	10%	--	--	$ 444	Assume QC conducted to ensure appropriate impermeability.
Total				$ 4,884	
Total unit cost		SY	$ 44.38		
ALT 3					
Asphalt Cap Installation					
Subgrade preparation	110.0	SY	$ 2.00	$ 220	Prepare and roll. 2010 RSMeans 32 11 23.23 7000.
Paving materials hauling	27.5	LCY	$ 5.31	$ 146	12 CY trucks, 25 MPH ave., cycle 4 mi. 2010 RSMeans 31 23 23.20 1040.
Aggregate base course	110.0	SY	$ 5.28	$ 581	Crushed 3/4-in. stone, compacted, 3 in. deep. 2010 RSMeans 32 11 23.23 0050.
Asphalt base layer	110.0	SY	$ 9.58	$ 1,054	Binder course, 2-in. thick. 2010 RSMeans 32 12 16.13 0120.
Asphalt intermediate layer	110.0	SY	$ 9.58	$ 1,054	Binder course, 2-in. thick. 2010 RSMeans 32 12 16.13 0120.
Asphalt wearing layer	110.0	SY	$ 10.70	$ 1,177	Wearing course, 2-in. thick. 2010 RSMeans 32 12 16.13 0380.
Sealing	110.0	SY	$ 1.87	$ 206	Tack coat, emulsion 0.10 gal. per SY. 2010 RSMeans 32 01 13.62 3270.
Subtotal				$ 4,440	
Cap installation quality control	10%	--	--	$ 444	Assume QC conducted to ensure appropriate impermeability.
Total				$ 4,884	
Total unit cost		SY	$ 44.38		

Monitoring

All alternatives require an annual inspection. This is assumed to cost approximately $500 per year.

Table B-8 - Cost Backup and Calculations

Institutional Controls

ALT 1a/b

No environmental covenant

ALT 1c/d

Preparation of environmental covenant	$ 10,000	Engineer's estimate.	

ALTs 2/3

Preparation of environmental covenant	$ 10,000	Engineer's estimate.	
6' high fence around capped area (approx. 185 ft)	$14	per LF	2010 RSMeans 32 31 13.25 0100
2 gates for fence	$286	per gate, 6' high	2010 RSMeans 32 31 13.25 0190