Cleanup Action Plan

Parcel 15 (Portac) - Port of Tacoma

July 6, 2021

Prepared by:

Washington State Department of Ecology

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Contents

Tables

Figures

Appendix

Abbreviations and Acronyms

μg/L	microgram per liter
ARAR	applicable, relevant and appropriate requirement
bgs	below ground surface
CAP	Cleanup Action Plan
CMCRP	Compliance Monitoring and Contingency Response Plan
CMMP	contaminated media management plan
CUL	cleanup levels
CWA	Clean Water Act
DCA	disproportionate cost analysis
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FRTR	Federal Remediation Technologies Roundtable
FS	feasibility study
GCL	geosynthetic clay liner
GSI	GSI Water Solutions, Inc.
HMA	hot mix asphalt
IC	institutional control
LEL	lower explosive limit
LLC	limited liability company
Log Yard	former log yard area at the Site
mg/kg	milligram per kilogram
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NPV	net present value
OMMP	operations maintenance and monitoring plan
Order	Agreed Order
PCP	pentachlorophenol
pH	negative log of the hydrogen ion concentration in solution
POC	point of compliance
Port	Port of Tacoma
Portac	Portac, LLC
PQL	practical quantification limits
PRB	permeable reactive barrier
RCC	roller-compacted concrete
RCW	Revised Code of Washington
REL	remediation level
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
Sawmill	former sawmill area at the Site
Site	Parcel 15 – Former Portac sawmill and log yard
SR	State Route
SVOC	semivolatile organic compound
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
WAC	Washington Administrative Code
ZVI	zero valent iron

Executive Summary

This document presents the Cleanup Action Plan (CAP) for the Port of Tacoma (Port) Parcel 15 Site (Site) near Tacoma, Washington. The CAP, prepared by the Washington State Department of Ecology (Ecology) in collaboration with the Port, meets the requirements of the Model Toxics Control Cleanup Act (MTCA) and implementing regulations Chapter 70.105D RCW; WAC Chapter 173-340WAC. The CAP describes Ecology's proposed cleanup action for this site and sets forth the requirements for the cleanup.

Background: The Site is an approximately 52-acre triangular parcel near the Blair Waterway owned by the Port of Tacoma. Figure 1 shows the location of the Site. The Site consists of two functionally distinct historical use areas: the former sawmill area (Sawmill) in the southwestern part of the property; and the former log yard area (Log Yard) occupying the remainder of the Site, as shown on Figure 1.

- **Log Yard:** Slag from the former ASARCO smelter was used as a road base to stabilize surface soils in the Log Yard. Studies showed that metals (e.g., arsenic, copper, lead, and zinc) were leaching from the slag and being discharged into Wapato Creek in surface water and groundwater. The Log Yard was capped in 1988 to prevent runoff of contaminated surface water from flowing into Wapato Creek. Groundwater monitoring and maintenance of the cap has been conducted over the ensuing years.
- **Sawmill:** The sawmill operated from 1974 to 2009 and used pentachlorophenol (PCP) to prevent sap staining on the cut wood. Contaminated soil was removed from the sawmill area in the early 2000s. Groundwater contaminated with PCP remains at one location near Wapato Creek.

Evaluation of Alternatives: A comprehensive remedial investigation (RI) and feasibility study (FS) were initiated in 2016. The RI documented current environmental conditions throughout the Site, assessed contaminant fate and transport properties, and provided the information needed to develop the FS. The FS defined applicable Site cleanup standards, screened potentially viable cleanup technologies, and evaluated a range of cleanup alternatives. Five cleanup alternatives were evaluated for the Log Yard, and three were evaluated for the Sawmill. A sixth cleanup alternative was later evaluated for the Log Yard in an FS Addendum. Preferred cleanup alternatives were identified after evaluation against MTCA threshold criteria, evaluation of restoration time frame and completion of a disproportionate cost analysis.

Ecology's Cleanup Decision: The FS and FS Addendum identified **Alternative 3A** for the Log Yard and **Alternative 1** for the Sawmill as preferred remedial alternatives. Ecology concurs with the findings of the alternatives evaluation as contained in those documents, and has selected these two cleanup alternatives for implementation at the Site. These alternatives comply with MTCA remedy selection criteria, and also comply with Ecology's expectations for cleanup remedies as defined in WAC 173-340-370.

The selected cleanup remedies include the following components:

- **Log Yard Remedy:** The selected Log Yard remedy uses a two-phased approach. The first phase of cleanup (Figure 6) will be implemented following finalization of this CAP and will include maintenance of the existing cap, improvements to the stormwater conveyance system, installation and operation of a permeable reactive barrier (PRB) along Wapato Creek, environmental monitoring, and implementation of institutional controls (ICs). The second phase of cleanup will be implemented following completion of land use planning and in parallel with future Site redevelopment. The second phase (Figure 6) includes replacement of the existing cap with a low-permeability geosynthetic clay liner (GCL) cap or an alternate cap achieving the same or better infiltration control performance. The remedy also includes contingent remedial actions to be used in the event that Site remediation levels are not met.

- **Sawmill Remedy:** The selected remedy for the Sawmill uses natural attenuation processes to treat residual PCP in groundwater, within the former dip tank area. The remedy incorporates natural attenuation monitoring, institutional controls, and contingent remedial actions.

The cleanup will be implemented in two phases. Compliance monitoring will ensure that cleanup standards are met.

SECTION 1

Introduction

1.1 Purpose

This document presents the Cleanup Action Plan (CAP) for the Port of Tacoma (Port) Parcel 15 Site (Site) near Tacoma, Washington. Site details are shown in Figure 1. A CAP is required as part of the site cleanup process under Washington Administrative Code (WAC) Chapter 173-340. The CAP identifies the proposed cleanup action for the Site and provides an explanatory document for public review. More specifically, this plan:

- Describes the Site
- Summarizes current Site conditions
- Identifies site-specific cleanup levels and points of compliance for each hazardous substance and medium of concern for the proposed cleanup action
- Summarizes the cleanup action alternatives considered during the feasibility study (FS) and the remedy selection process
- Describes the cleanup action selected by Washington State Department of Ecology (Ecology) for the Site and the basis for remedy selection
- Summarizes the compliance monitoring framework for the site;
- Identifies applicable state and federal laws for the proposed cleanup action
- Identifies residual contamination remaining on the site after cleanup
- Presents the schedule for implementing the CAP

Ecology has made a preliminary determination that a cleanup conducted in conformance with this CAP will comply with the requirements for selection of a remedy under WAC 173-340-360.

1.2 Previous Studies

A comprehensive summary of previous environmental investigations prior to the remedial investigation (RI) (GSI 2017) is provided in the RI. Table 1 provides a summary of documents representing the primary investigations and evaluations.

RI activities were conducted during 2016 and 2017 consistent with an Ecology-approved RI Work Plan (GSI, 2016; Ecology, 2016). The investigation approach for the RI entailed testing for arsenic concentrations and redox chemistry across the Site, with additional testing near Wapato Creek for geochemical conditions affecting arsenic mobility and attenuation. Additional constituents, such as pentachlorophenol (PCP), were analyzed in historical source areas in the Sawmill. Data collection included groundwater sampling, soil sampling, test pit explorations, porewater sampling, surface water sampling, outfall discharge sampling, sediment sampling, and a tidal study in the adjacent Wapato Creek. In addition, the following Ecology-approved activities were conducted beyond the scope of work described in the RI work plan:

- Conducted a video survey of stormwater lines.
- Visually inspected and surveyed the invert elevations in the spill containment vaults located adjacent to Manholes #1 and #6.
- Installed transducers to evaluate water level fluctuations in response to precipitation seepage through the cap.
- Abandoned monitoring well HC-1 to prevent it from acting as a potential conduit for rainwater to migrate into the underlying fill containing slag.

Post-RI studies conducted have included the following:

- Preparing a MTCA feasibility study (FS) (GSI, 2018) that screened potentially viable remedial technologies; considered potential effects of climate change; analyzed different remedial alternatives, including five for the Log Yard and three for the Sawmill; and identified preferred remedial alternatives for each area following completion of a disproportionate cost analysis.
- Preparing a FS addendum (GSI, 2019a) that evaluated a refined remedial alternative for the Log Yard.
- Performing additional groundwater monitoring in February 2019 (GSI 2019b), with a second event in August 2019.

1.3 Regulatory Framework

The proposed cleanup action complies with the MTCA provisions for selecting a cleanup action as listed in WAC 173-340-360. Specifically, the proposed cleanup action will:

1. Protect human health and the environment. The cleanup action will mitigate potential risks associated with impacted groundwater at the Site, which will protect human or ecological receptors where groundwater discharges to surface water.

2. Comply with cleanup standards. Groundwater cleanup standards are established to address all potential exposure pathways. The cleanup action will meet those cleanup standards, or a series of contingency measures will be implemented until standards are achieved at points of compliance.

3. Comply with applicable state and federal laws. The cleanup action will comply with requirements of the state cleanup regulation (MTCA), as well as other applicable laws and regulations. All required permits will be obtained during cleanup implementation.

4. Provide for compliance monitoring. A performance groundwater quality monitoring plan will be developed to document performance monitoring and evaluation, and attainment of groundwater cleanup standards. Contingent remedial actions are included and will be implemented if cleanup levels (CULs) established by MTCA are not met and remediation levels (RELs) are exceeded.

5. Use permanent solutions to the maximum extent practicable. The proposed cleanup action was evaluated in the FS and FS Addendum and was determined to be permanent to the maximum extent practicable. The selected remedy includes source control measures (capping and drainage system improvements within the Log Yard) to limit contaminant leaching and transport, uses treatment measures (including a permeable reactive barrier [PRB] within the Log Yard and biological degradation of contaminants in the Sawmill) to control groundwater contaminants, and incorporates applicable institutional controls.

6. Provide for a reasonable restoration time frame. The proposed cleanup action provides for a reasonable restoration time frame, with contingency actions included, as necessary, to achieve cleanup goals.

7. Consider public concerns. Ecology is making the draft CAP available for public review during a formal public comment period in accordance with the Amendment to Agreed Order No. DE-11237. Ecology will respond to public comments and concerns on the draft CAP received during the public comment period, prior to preparing the final CAP.

SECTION 2

Site Description

2.1 Site Location

Parcel 15 consists of an approximately triangular parcel of about 52 acres of land owned by the Port. The Site is located at 4215 State Route (SR) 509 – North Frontage Road in an industrial area between Interstate 5 and Commencement Bay, in Tacoma, Washington, as shown in Figure 1. The Site is bounded by East 4th Street (northern boundary), Alexander Avenue East (western boundary), and North Frontage Road (SR 509) (southeastern boundary). Wapato Creek is situated between Alexander Avenue East and the western edge of the property, and empties into the Blair Waterway through a culvert under East 4th Street. The Blair Waterway is in the southern portion of Commencement Bay, one of multiple industrial waterways developed in the 1900s to support international commerce.

2.2 Site History

Portac, LLC (Portac) and its predecessors leased the Site from the Port beginning in 1974 and vacated the Site in 2009. The Site consists of two functionally distinct historical use areas: the former sawmill area (Sawmill) in the southwestern part of the property, and the former log yard (Log Yard) occupying the remainder of the Site.

Historical industrial activities conducted on the Site adversely impacted upland soil, groundwater, and surface water in the adjacent Wapato Creek. Environmental investigations and cleanup under Ecology oversight have been ongoing since the late 1980s.

Like other milling and log storage operations in the Tacoma area, slag from the former ASARCO smelter was used as road base to stabilize surface soil in the Log Yard. During Log Yard operations the slag was pulverized by operating equipment and mixed with wood waste, which produced a slightly acidic and reduced environment that leached heavy metals, principally arsenic, from the slag. Historical analysis of upland soil and fill containing slag indicated that metals (i.e., arsenic) were present at concentrations that would exceed current MTCA soil cleanup levels (CULs).

Pursuant to the 1988 Order on Consent, State of Washington Department of Ecology Docket No. DE 88-S326 under RCW 90.48 (Order on Consent), Portac and the Port agreed to cap the Log Yard to abate metals contamination of surface water runoff discharging to the adjacent Wapato Creek. Although the primary purpose for capping the Log Yard was to mitigate surface water impacts, the action also was expected to mitigate groundwater contamination by preventing stormwater infiltration through the slag/wood waste fill, which was linked to leaching of metals. The Site was capped between late 1988 and early 1989, and inspection and maintenance of the cap have been ongoing under the 1988 Order on Consent, Section VI (4).

In 2009, Portac entered into Ecology's Voluntary Cleanup Program (VCP) to address the presence of contaminants (e.g., PCP) in soil and groundwater in the Sawmill. As described in the RI report, Portac implemented soil removal to address areas of identified contaminants. Approximately 4,950 tons of soil were removed as part of the combined VCP soil cleanup activities.

The Port and the former site tenant initiated a site-wide RI/FS in 2016 under Agreed Order No. DE 11237 with Ecology. That work resulted in production of site-wide RI and FS reports, and an FS addendum as described in Section 1.2.

2.3 Human Health and Environmental Concerns

Currently, the Log Yard is capped with roller-compacted concrete (RCC), installed as part of a remedial action, with two subsurface stormwater conveyance lines serving as Log Yard stormwater drainage (Figure 1). Currently, the Sawmill is partially paved; however, the particular area of interest (the area near the former dip tank, as shown in Figure 1) remains unpaved.

2.3.1 Log Yard

Before installation of the cap, infiltration or precipitation through the fill containing slag, and subsequent discharge of stormwater to Wapato Creek (via the former central drainage ditch, subsurface drains, and direct overland flow), served as a direct pathway for metals migration to surface water and potentially groundwater. The cap in the Log Yard was installed between late 1988 and early 1989 with the intention of cutting off surficial and shallow subsurface stormwater drainage through the fill containing slag. However, observations of ongoing perched water in a number of wells confirmed that there are portions of the Site where fill containing slag is still saturated, and thus leaching of metals from the slag still serves as an ongoing source of arsenic to groundwater (Figure 2). Although the cap significantly reduced infiltration and groundwater flux to the creek, seepage of ponded stormwater through the cap appears to be the primary source of the ongoing perched water.

Arsenic in groundwater has the potential to be transported toward Wapato Creek via either the groundwater-to-porewater-to-surface water pathway, or through infiltration into the storm drain system. Because the Log Yard has been capped, surface soil migration through water and wind erosion is not a significant release mechanism in the Log Yard portion of the Site. Further details on these pathway mechanisms are provided in the RI report (GSI, 2017).

Methane, a naturally occurring gas, is present below the Log Yard cap as a result of decomposition of the wood waste associated with the fill containing slag.

2.3.2 Sawmill

PCP was used historically at the former sawmill to prevent sap stain, applied in a water-based solution using spray booths and a dip tank. In previous remedial actions, PCP sources and contaminated soil were removed. Some PCP contamination persists in groundwater in the immediate vicinity of the former dip tank (Figure 3), although it has not migrated to porewater or surface water at concentrations above screening levels. Decreases in PCP concentration have been observed over time due to natural degradation. However, elevated pH values in groundwater have been observed at the same well as the highest PCP detections (well MW-2R). The alkaline conditions in groundwater in the former dip tank excavation area are likely the result of the recycled concrete aggregate that was used for backfill (University of Wisconsin-Madison, 2012). The alkaline groundwater conditions are considered to be localized in the concrete aggregate backfill, given that a high pH was not observed in the three wells (MW-1, MW-3, and MW-4) located adjacent to the former dip tank excavation area.

Alkaline groundwater conditions can inhibit biological activity and reduce the adsorptive capacity of PCP, resulting in a localized increase in PCP mobility. However, PCP concentrations have continued to naturally attenuate over time, as shown in the trend plot in Appendix A.

In addition, two wells north of the former dip tank area (MW-1 and MW-3) have arsenic concentrations above the natural background concentrations. Groundwater arsenic concentrations in this range are likely caused by arsenic desorption from naturally occurring minerals, a process promoted under the reducing geochemical conditions and the nearby alkaline conditions in the former dip tank area (see the RI report for further details). Methane gas is also present in those wells.

2.4. Contaminants of Concern

The site-associated contaminants identified for cleanup are arsenic and PCP, with arsenic the primary driver in the Log Yard, and PCP the primary driver in the Sawmill. In addition, methane gas is identified as a site-associated contaminant in the Log Yard and portions of the Sawmill that will be managed through institutional controls (IC)s.

2.5 Cleanup Standards

Cleanup standards include cleanup levels, points of compliance (POCs), and remediation levels (RELs).

2.5.1 Cleanup Levels

MTCA's CULs are risk-based concentrations that are protective of generic exposure scenarios for a given site use. The RI report (GSI, 2017) summarizes potentially relevant human health and ecological screening criteria by medium. These screening criteria were derived from a variety of pertinent sources. The CUL for each medium is selected as the most stringent of the MTCA or applicable or relevant and appropriate requirement (ARAR) concentration, unless the natural background concentration is higher than that criterion. Because MTCA states that CULs should not be lower than natural background concentrations, CULs default up to the natural background concentration (or analytical testing limitations defined by the practical quantitation limit [PQL] where background concentrations are not available). CULs and the associated protection basis are provided in Table 2 and described below

Soil

The lowest screening level for soil was selected as the CUL for the two site-associated contaminants as follows:

- **Arsenic CUL = 20 milligrams per kilogram (mg/kg),** based on the MTCA Method A industrial cleanup level. Note that the MTCA Method A criterion of 20 mg/kg was developed to be protective of groundwater at a concentration of 5 micrograms per liter (µg/L), which is based on natural background levels in groundwater.
- **PCP CUL = 328 mg/kg,** based on the MTCA Method C cancer screening value.

Groundwater and Surface Water

As discussed in the RI report, groundwater at the Site is nonpotable, and current and future Site use will be industrial. The highest beneficial use of groundwater at the Site is discharge to marine waters:

- **Arsenic CUL = 5 µg/L,** based on the MTCA Method A groundwater cleanup level, which in turn is based on the natural background level of arsenic in groundwater.
- **PCP CUL = 1 µg/L,** based on the PQL.

Air

Methane gas in soil at the Site poses a potential risk for indoor air quality for potential future use scenarios at the Site. As such, the MTCA Air Quality Guidance (WAC 173-340) sets a standard of 10 percent of the lower explosive limit (LEL) for all volatile organic compounds (VOCs). Therefore, the CUL for methane is:

- **Methane CUL = 0.5 percent by volume,** based on an LEL of 5 percent.

2.5.2 Points of Compliance

The POCs also are included in Table 2 for each media and Site area. POCs are the locations within the site where the cleanup standards must be met. Site POCs are discussed further in Section 4.3.

2.5.3 Remediation Levels

RELs are also shown in Table 2 where applicable. The RELs are used to determine when contingent remedial actions must be implemented. Site RELs are discussed further in Section 4.3.

SECTION 3

Evaluation of Cleanup Alternatives

This section provides a summary of key information provided in the FS and FS Addendum (GSI, 2018 and GSI, 2019a), including a detailed screening of remedial technologies, evaluation of cleanup alternatives, and identification of preferred remedial alternatives for each Site area. These technology screening and alternatives evaluation steps were conducted separately for each Site area, because the occurrence of the two primary site-associated contaminants (PCP and arsenic) differed for each portion of the Site.

3.1 Initial Screening of Technologies

3.1.1 Screening Approach

Potentially applicable remedial technologies were identified and screened employing available published resources and industry common practice. Two primary contaminants of interest are considered throughout this evaluation, PCP and arsenic; the treatment of both focuses on contamination in soil and water. The following sources of information were used to screen these technologies relative to the pertinent media:

- The Federal Remediation Technologies Roundtable (FRTR) screening matrix (http://www.frtr.gov)
- Federal (U.S. Environmental Protection Agency [EPA], U.S. Navy, U.S. Air Force, and U.S. Army Corps of Engineers) documents available online (https://cluin.org/databases/#67; http://www.epa.gov/remedytech/publicationsremediation-technologies-cleaning-contaminated-sites)
- Regional industry common practices for soil and water treatment

3.1.2 Preliminary Identification of Technologies

The FRTR screening matrix provides an overall rating of a technology group or process (e.g., In Situ Biological Treatment) with respect to broad chemical types such as "Inorganics." "Inorganics" is understood to include metals, such as arsenic, and "Halogenated SVOCs" (semivolatile organic compounds) is understood to include PCP. The FRTR rating system is structured as "Above Average," "Average," or "Below Average." As a result, the preliminary identification was performed in the following steps:

- All technologies rated "Above Average" for "Inorganics" or "Halogenated SVOCs" were determined to be applicable.
- Technologies that were rated "Average," "Below Average," or "Site Dependent" for "Inorganics" and "Halogenated SVOCs," but were known to be applicable, were added to the list of identified technologies.

The results of the preliminary technology identification screening for PCP and arsenic in soil are provided in the FS and FS Addendum.

3.1.3 Technology Evaluation

Available information in literature was reviewed to determine site-specific applicability of each technology identified in the preliminary screening. Each technology was screened for effectiveness and implementability. Technologies determined to be effective and implementable were retained for further consideration. Technologies deemed ineffective or not implementable at the Site were eliminated from further consideration.

3.1.4 Development of Remedial Alternatives

Six remedial alternatives for the Log Yard were assembled from the remedial technologies presented in the FS and FS Addendum. Table 3 summarizes the components of the remedial alternatives considered.

Three remedial alternatives for the Sawmill were assembled from the remedial technologies presented in the FS. Table 4 summarizes the components of the remedial alternatives considered.

3.2 Detailed Evaluation of Alternatives

This section summarizes the evaluations of remedial alternatives as conducted during the FS and FS Addendum.

3.2.1 Threshold Requirements

Remedial actions performed under MTCA must meet a set of minimum requirements or threshold requirements. Per WAC 173-340-360(2)(a), alternatives that do not meet the threshold requirements are not considered viable remedial alternatives under MTCA. Each of the six evaluated Log Yard alternatives and the three Sawmill alternatives were determined to comply with threshold requirements, which are to:

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

3.2.2 Other MTCA Requirements

A preferred remedial alternative for each Site area was defined after evaluating other MTCA requirements. These additional requirements included the following:

- Use permanent solutions to the maximum extent possible
- Provide for a reasonable restoration time frame

- Consider public concerns

3.2.3 Restoration Time Frame

The restoration time for each alternative was evaluated during the FS and FS Addendum. A summary of those evaluations is provided below:

Log Yard

All evaluated remedial alternatives in the Log Yard are expected to achieve cleanup objectives within a similar time frame. That time varies as described below:

- **Groundwater restoration time frame:** Residual groundwater contamination is expected to remain within the Site under all Log Yard alternatives. Following remedial actions (capping or soil removal), residual groundwater contamination is expected to attenuate as a result of ongoing geochemical processes that sequester arsenic. However, this is expected to require many decades under all alternatives. No practicable alternatives were defined that could result in a more rapid groundwater restoration time frame. Given the extended restoration time frames for Site groundwater, all FS and FS Addendum cleanup alternatives include contingent remedial actions for arsenic in groundwater. The schedule for installation of a PRB along Wapato Creek is expedited in Alternative 3A to optimize groundwater restoration time frames. Remediation levels will be used to determine whether contingent remedial actions should be undertaken at the Site.

- **Restoration time frame for benthic receptors, sediments and surface water:** Despite the extended groundwater restoration time frame, RI monitoring documented that concentrations of arsenic in Wapato Creek surface water were below levels protective of aquatic organisms and groundwater background levels, the levels in sediments were below natural background, and arsenic concentrations in porewater were below those protective of benthic organisms. Therefore, aquatic and benthic receptors are expected to remain protected throughout the groundwater restoration time frame.

- **Termination of stormwater migration pathway:** Groundwater infiltration to the stormwater system currently serves as a preferential pathway for arsenic migration to Wapato Creek. Stormwater conveyance system repair or replacement is proposed in all Log Yard remedial alternatives and is considered to be a priority action. Implementation of stormwater system repair is expected to occur in year one following regulatory approval. Reduction of seepage in the stormwater conveyance system is expected to occur immediately following system repair.

Sawmill

As evaluated in the FS, all three remedial alternatives in the Sawmill are expected to achieve cleanup objectives within a reasonable time frame. Ongoing natural attenuation of the primary contaminant, PCP, is an element of all three alternatives and is the primary treatment in Alternative 1. Based on existing data, residual PCP in the Sawmill is expected to achieve cleanup standards through natural attenuation within approximately 12 to 16 years. The baseline alternative, Alternative 3, which proposes excavation, offsite disposal, temporary groundwater treatment, and monitored natural attenuation (MNA), anticipates a shorter restoration time frame of 4 to 6 years with performance monitoring. Alternative 2, an enhanced MNA or biodegradation alternative, anticipates an enhanced restoration time frame of 6 to 8 years with performance monitoring.

3.2.4 Disproportionate Cost Analysis

The MTCA disproportionate cost analysis (DCA) is used to determine which alternative is permanent to the maximum extent practicable. The DCA does this by comparing the relative costs and benefits of the different alternatives.

The evaluation criteria for the DCA are specified at WAC 173-340-360((3)(e), and include protectiveness, permanence, cost, long-term effectiveness, management of short-term risks, implementability, and consideration of public concerns.

In the FS and FS Addendum and Cleanup Action Plan, the individual criterion scores were weighted to emphasize protectiveness, permanence, and long-term effectiveness. The weighting factors used in the evaluation of Sawmill and Log Yard alternatives are as follows:

- Protectiveness: 25 percent
- Permanence: 20 percent
- Long-term effectiveness: 20 percent
- Management of short-term risks: 15 percent
- Technical and administrative implementability: 10 percent
- Consideration of public concerns: 10 percent

For each criterion, the benefits of the alternative were scored on a scale of 1 to 10 based on the degree to which the alternative meets that criterion. A score of 1 indicates that the alternative poorly meets the criterion and a score of 10 indicates that the alternative provides the highest benefit for that criterion. Overall benefits of the alternative are represented by the sum of the individual benefits scores, multiplied by the weighting factors. Tables 5 and 6 show this overall score in the "Environmental Benefit Score" column.

The preferred alternative for each Site area was identified by evaluating which alternatives were the most permanent without triggering disproportionate costs. As specified at WAC 173-340-360(3)(e), the alternatives were ranked from most permanent to least permanent using the benefits scores and the MTCA definition of permanent solution. Then the alternatives were evaluated to determine the relationship between remedy benefits and incremental costs of each alternative. As defined in MTCA, "costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower-cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower-cost alternative."

Log Yard DCA

A DCA was performed for five Log Yard alternatives in the FS. It was then updated for a sixth alternative (Alternative 3A) in the FS Addendum. The findings of the Log Yard DCA as presented in the FS Addendum are summarized below and in Table 5:

- **Protectiveness:** All proposed remedial alternatives meet the protectiveness threshold criteria and would be protective of human health and environment. However, significant differences in protectiveness were identified among the alternatives. Alternative 3 and 3A were the highest-ranked capping alternatives because both use a low-permeability cap expected to protectively address the source of perched water and reduce groundwater flux to Wapato Creek. The cap also separates the infiltration-control layer from the working surface, providing better protection of cap performance over the long term in comparison to other alternatives. Alternative 3 addresses the stormwater pathway through raising and replacing the stormwater system and Alternative 3A addresses the stormwater pathway through a combination of draining the perched water zone and stormwater system repairs. Because the replacement of the stormwater system in Alternative 3 occurs earlier than in Alternative 3A, Alternative 3 provides a more robust barrier to the stormwater pathway earlier than the stormwater system repairs of Alternative 3A. However, the contingent placement of the drainage system in Alternative 3A within the perched water zone provides more direct source reduction. Consequently, each alternative was awarded the same ranking score for protectiveness.

- **Permanence:** Scores for remedy permanence generally follow those for protectiveness. Among the capping alternatives, Alternatives 3 and 3A both received the highest score for permanence because of their use of the low-permeability cap, separation of the cap working surface from the infiltration-control layer, and stormwater system replacement.

- **Long-Term Effectiveness:** Scores for long-term effectiveness were highest for those alternatives expected to require the least active maintenance to protect remedy performance for the long term. Among the capping alternatives, long-term effectiveness scores were highest for Alternative 3 and 3A. Initial investments in a low-permeability cap under Alternative 3 or the perched groundwater treatment and PRB in Alternative 3A are expected to control the high-arsenic concentrations in perched groundwater and reduce arsenic flux toward Wapato Creek most effectively, enhancing the performance of natural attenuation processes. The separation of the cap working surface from the infiltration-control layer enhances the long-term performance of the cap and makes the remedy less dependent on active cap inspections and maintenance in comparison to Alternatives 1, 2, and 4. The remedies for Alternatives 3 and 3A do not require long-term active groundwater extraction, treatment, and monitoring, as required under Alternative 4. Alternative 5 received a high score for long-term effectiveness because of its use of offsite disposal in a commercial landfill for management of contaminated soils, rather than onsite containment beneath a cap.

- **Management of Short-Term Risks:** Scores for short-term risk-management varied significantly among the alternatives. Those alternatives that require the greatest exposure of contaminated materials during remedy implementation (i.e., Alternatives 4 and 5) received the lowest scores. Alternatives 1, 2, and 3 received higher scores because those alternatives require little or no exposure of contaminated soils or groundwater during remedy implementation. Alternative 3A received the same score ad Alternative 4, a higher score than Alternatives 5 but lower than other alternatives as it requires more direct exposure to contaminated soils via the early implementation of the perched groundwater treatment and PRB, but less exposure than Alternatives 4 and 5.
- **Technical and Administrative Implementability:** All Log Yard alternatives are considered to be sufficiently implementable to be evaluated in the FS. However, the complexity of implementation requirements varies significantly among the alternatives. Alternative 3A is considered to be the highly implementable because the primary remedial technologies, the perched groundwater treatment and PRB, can be implemented most easily with current facility use. Alternatives 1 and 2 are considered the most implementable because these alternatives use relatively simple construction methods not requiring exposure of contaminated soils or groundwater, and do not require additional permitting as do Alternatives 3, 4, or 5. Alternatives 3 and 3A require more regrading of the Site during cap construction, and will require issuance of a construction stormwater permit not required under Alternatives 1 and 2 because of the rubblization of the RCC cap. Implementation requirements for Alternatives 4 and 5 are much greater, resulting in lower scores for implementability. To be protective, Alternative 4 requires the use of short-term and long-term management methods for extracted groundwater. This would include development and maintenance of an individual NPDES permit, and performance of active groundwater treatment, monitoring, and reporting throughout the life cycle of the remedy. Alternative 5 requires implementation of the largest construction effort, use of management practices to prevent contaminant releases via stormwater, and implementation of measures to ensure safety during offsite transportation and disposal of contaminated soils removed from the Site.
- **Consideration of Public Concerns:** Public concerns will be evaluated after the public comment period, and alternative scoring will be altered as appropriate.
- **Environmental Benefit Score:** The derivation of this score is described above in Section 3.2.4. See Table 5 for the score for each alternative.
- **Probable Cost:** Cost estimates for each alternative are provided in Appendix A of the FS Addendum. The costs were evaluated on a 100-year timescale to fully capture the expected long-term care costs of the proposed remedies. Because of the areal extent of the Site and quantity of contaminated media present, remedies are material sensitive. Alternative 5, which proposes Site-wide excavation and offsite disposal, was estimated to have the highest cost (approximately $31 million). Alternatives 1 through 4 vary in initial construction cost, driven primarily by cap material quantities and significance of existing cap alteration. In terms of net present value

(NPV), Alternatives 1 through 4 have similar overall cost, ranging from $9.5 to $12.2 million.

DCA results are presented in Figure 4 for the Log Yard. Environmental benefit scores rank in the following order: Alternative 1 (lowest), 4, 2, 3, 3A, and 5 (highest). The incremental benefit increases in rough proportion with cost from Alternatives 1 through 3A. However, a large (more than twofold) cost increase occurs between Alternatives 3A and 5 without a corresponding increase in environmental benefits. Environmental benefits increase only 6 percent in contrast to a 190 percent increase in costs. Based on the disproportionate increase in costs for Alternative 5, Alternative 3A is identified as the preferred remedial alternative. Alternative 3A is permanent to the maximum extent practicable.

Sawmill DCA

Comparative analysis used to determine the benefit scoring and overall ranking of proposed remedial alternatives in the Sawmill are detailed below. The individual benefit scores and rankings are provided in Table 6.

- **Protectiveness:** The three Sawmill alternatives were evaluated for protectiveness relative to the expected timeline to reach CULs in all Site wells. Scores for Alternatives 3 and 2 were higher than for Alternative 1, given the longer restoration time frame for that alternative. However, all alternatives are expected to achieve compliance with Site CULs and protect human health and the environment.

- **Permanence:** All alternatives propose permanent remedies that would result in permanent reduction of contaminant mass and toxicity. PCP degrades naturally in aerobic and anaerobic groundwater conditions, ultimately to innocuous by-products. Differences among the alternatives were associated with the expected time to reach CULs in all Site wells. Alternative 3 had the highest score and Alternative 1 had the lowest score.

- **Long-Term Effectiveness:** All alternatives propose permanent remedies that would result in permanent reduction of contaminant mass and toxicity. PCP degrades naturally in aerobic and anaerobic groundwater conditions, ultimately to innocuous by-products. Alternative 1 scored lower than Alternatives 2 and 3 because of the longer time frame required to reach CULs in all wells, and the longer time frame required for implementation of interim environmental covenants at the Site.

- **Management of Short-Term Risks:** Each alternative was ranked relative to the significance of expected interaction and handling of contaminated media during implementation of the respective remedy. Alternative 3, which proposes excavation and temporary groundwater treatment, received the lowest relative ranking because it poses the greatest short-term exposure risks to workers during material removal and offsite transportation and disposal.

- **Technical and Administrative Implementability:** All Sawmill alternatives use commercially available construction methods. Alternative 3 received the lowest score because of its greater relative complexity in handling excavated materials and coordinating offsite disposal. Alternative 1 received the highest implementability score because the treatment mechanism is ongoing and requires minimal infrastructure changes for long-term monitoring.

- **Consideration of Public Concerns:** Public concerns will be evaluated after the conclusion of the public comment period, and alternative scoring will be altered as appropriate.

- **Environmental Benefit Score:** The derivation of this score is described above in Section 3.2.4. See Table 6 for the score for each alternative.

- **Cost:** Each alternative includes provisions for compliance and confirmation monitoring, and cost estimates for the monitoring program are included in each alternative. Alternative 3, which proposes excavation and offsite disposal with temporary groundwater treatment, poses the greatest cost at an NPV of approximately $740,000; landfill disposal fees represent the greatest unit cost. Alternatives 1 and 2 had a similar NPV cost of approximately $500,000 to $540,000, despite initial capital expenditures in Alternative 2, because of expected savings in long-term monitoring costs.

Benefits and costs of remediation alternatives for the Sawmill are presented in Figure 5. Environmental benefit scores increase from Alternatives 1 to 2, but decrease between Alternatives 2 and 3. Remedy costs increase slightly between Alternatives 1 and 2. However, they increase substantially between Alternatives 2 and 3, without a corresponding increase in environmental benefit. Based on the disproportionate increase in costs for Alternative 3, Alternative 2 is identified as the preferred remedial alternative. Alternative 2 is permanent to the maximum extent practicable.

3.3 Optimization and Modification of Alternatives

3.3.1 Log Yard Alternative 3A Optimization

Additional evaluations were completed for the alternative that scored highest in the DCA for the Log Yard, Alternative 3A, to optimize the environmental benefit score versus probable cost. Based on these evaluations, sequencing of the elements of the alternative were revised as follows:

- Installation of the PRB earlier in the implementation of the remedy, in conjunction with the conveyance system improvements. The DCA evaluation called for the PRB installation later in the remedial action implementation, after conveyance system improvements and perched groundwater treatment actions were completed.

- Installation of the perched groundwater treatment system will be contingent on the performance of the PRB and conveyance system improvements, and would occur later in the implementation of the remedy. The DCA evaluation included the perched groundwater treatment system installation early in the remedial action implementation, before the PRB installation.

The probable cost, and environmental benefit score were recalculated based on these changes in sequencing. The revised tables and DCA figure from the FS Addendum are provided in Appendix B. Installing the PRB earlier and delaying the installation of the perched groundwater treatment system increases the probably cost from $11.4 million to $11.5 million while also increasing the environmental benefit score from 7.0 to 7.3. This revises the environmental benefit to probable cost ratio from 0.61 of 0.63. Alternative 3A is identified as the preferred remedial alternative. Alternative 3A is permanent to the maximum extent practicable.

3.3.2 Sawmill Alternative Modification

Additional evaluation of the source of alkalinity in groundwater in the former dip tank area was conducted following approval of the FS and FS addendum. It was determined that alkaline conditions are likely the result of the recycled concrete aggregate that was used for backfill (University of Wisconsin-Madison, 2012). The alkaline groundwater conditions are localized in the concrete aggregate backfill, given that a high pH was not observed in the three wells (MW-1, MW-3, and MW-4) located adjacent to the former dip tank excavation area. Alkaline groundwater conditions can inhibit biological activity and reduce the adsorptive capacity of PCP, resulting in a localized increase in PCP mobility. However, PCP concentrations have continued to naturally attenuate over time, as shown in the trend plot in Appendix A. Alternative 2 was selected in the FS based on the assumption that the pH could be modified by injecting amendments to enhance biodegradation. Given that the excavation in the dip tank area is backfilled with concrete aggregate, it is expected that injection of amendments would not provide the pH adjustment needed to enhance biodegradation.

The environmental benefit scores were recalculated based on these considerations. The revised DCA evaluation table and DCA figure from the FS are provided in Appendix C. This revises the environmental benefit to probable cost ratio for Alternative 2 from 1.34 to 1.09. Based on these revisions, Alternative 1 has the highest environmental benefit to cost ratio and Alternative 1 is selected as the preferred remedial alternative. Alternative 1 is permanent to the maximum extent practicable.

SECTION 4

Description of Selected Remedy

4.1 Basis for Remedy Selection

Ecology has selected the proposed remedy for the Site based on the alternatives evaluation conducted in the FS Report and the FS Addendum, and as described in Sections 3.2 and 3.3 of this CAP:

- **Alternative 3A** was selected as the preferred remedial alternative for the **Log Yard** and
- **Alternative 1** was selected as the preferred remedial alternative for the **Sawmill**.

These alternatives meet all of the threshold requirements under MTCA and provide a reasonable restoration time frame (see Section 3.2.3), and have been determined to be permanent to the maximum extent practicable as defined in WAC 173-340-360(3)(e) following completion of a disproportionate cost analysis (see Section 3.2.4). These alternatives also comply with Ecology's expectations for cleanup remedies as defined in WAC 173-340-370.

4.2 Description of the Cleanup Action

4.2.1 Log Yard

The selected alternative (Alternative 3A) is illustrated in Figures 6 and 7. Figure 8 details the implementation phasing for remedial actions and includes a time frame for completion. The remedy includes the following components, with planned remedial actions to be implemented in two discrete phases of construction (Phase 1 and Phase 2):

Planned Remedial Actions

- **Conveyance System Improvements (Phase 1):** Elements of the conveyance system improvements include the installation of tide gates, removal of the spill containment vaults, and installation of slip lining or other trenchless pipe. The goal of these actions are to eliminate preferential pathways between site groundwater and Wapato Creek. This work will include the following actions:
    - Tide gates will be installed at outfalls OF-2 and OF-3 to prevent tidal backflow from Wapato Creek.
    - Significant accumulated debris in the stormwater system will be removed.
    - Removal of the spill containment vaults and slip lining the conveyance pipes (or other trenchless pipe repair) between Wapato Creek and the

removed vaults will be completed. A section of pipe or stormwater vault would then be installed in place of each of the existing vaults.

- Performance monitoring will then be conducted for conveyance system improvements.

- **Permeable Reactive Barrier (Phase 1):** The PRB will be installed in conjunction with the conveyance system improvements to serve as the primary remedy. The goal of the PRB is to control and reduce the concentration of the arsenic in groundwater at the downgradient side of the PRB. The PRB will be installed parallel to Wapato Creek along the westernmost boundary of the cap and along a portion of the northwestern boundary (Figure 6). The PRB will extend to below the streambed of Wapato Creek. It will be backfilled with reactive media (e.g., iron filing or zero valent iron) to treat dissolved arsenic in the groundwater passing through the PRB. Based on preliminary analysis (to be confirmed with a design study), the PRB will extend to a depth of approximately 25 feet below ground surface (bgs), with reactive media placed between the interval of 10 and 25 feet bgs to intercept impacted groundwater (Figure 7). A low-permeability material to inhibit surface water infiltration and provide structural strength, such as a low-strength concrete, will be placed atop the reactive media to restore the grade to pre-excavation conditions. The PRB performance will be monitored to assess whether the PRB is achieving its goals. Monitoring wells installed downgradient of the PRB will be used to assess the effectiveness of the PRB.

- **Enhanced (Low-Permeability) Cap (Rubblize RCC and Install Clay Liner; Phase 2):** During Phase 2 of Site cleanup, a low-permeability GCL or cap of equivalent infiltration-control performance, will be constructed within the Log Yard at the time the Site undergoes redevelopment. The goal for this component of the cleanup is to (1) significantly reduce vertical seepage of stormwater through the cap and underlying fill containing slag, (2) significantly reduce seepage with elevated arsenic concentrations into the conveyance system, and (3) lower the perched groundwater level in the vicinity of monitoring wells HC-2, MW-10, and MW-13 to below the fill containing slag. The timing of the construction of the low-permeability cap will be determined by completion of land use planning efforts for the site and the timing for development at the site. This coordination of remediation and land use planning efforts is required to optimize cap and associated drainage performance. The conceptual implementation approach for the cap is as follows:
    - The RCC cap will be rubblized and the underlying gravel course removed to install a low-permeability GCL atop the fill containing slag. The cap will be sloped to subsurface drain structures.
    - A working surface will be constructed atop the GCL and the Site will be restored for ongoing uses. The working surface is expected to be composed sequentially of a geogrid, gravel, and standard hot mix asphalt surface. A schematic is shown in the inset in Figure 6.

    - In parallel with capping, the existing stormwater conveyance system will be abandoned and a replacement system installed at the same or higher grade with watertight seals and joints. The existing system will be abandoned by either complete removal or plugging with low-permeability material (e.g., low-strength concrete) at multiple stations throughout the system.

- **Remedy Maintenance Activities:**
    - The remedy includes planned maintenance activities for the PRB, the existing RCC cap, and the future low-permeability cap (following its installation). These activities will be defined for each phase of remedial action in operations maintenance and monitoring plans (OMMPs) to be prepared during remedial design. The first OMMP will address maintenance of the PRB and RCC cap. The second OMMP will address maintenance of the low-permeability cap.
    - The remedy also includes development of a contaminated media management plan (CMMP). The CMMP will define the method to be used to manage contaminated soil or groundwater that may be generated in the future during remedy maintenance or site development activities. The CMMP will be developed during remedial design.
- **Environmental Monitoring:** The planned remedy includes a comprehensive environmental monitoring program to document that cleanup standards are met and determine whether contingent remedial actions must be implemented. The details of the environmental monitoring program will be defined in a Compliance Monitoring and Contingency Response Plan (CMCRP). That document will be prepared during environmental design for the first phase of remedy implementation. Additional details regarding monitoring activities are described in Section 4.3.
- **Institutional Controls:** A restrictive covenant will be placed on the property to restrict the land use at the site to industrial uses, prohibit consumptive use of site groundwater, restrict activities that would compromise the remedial actions, and require a contingent soil gas evaluation should enclosed structures be constructed in the Log Yard.

Contingent Remedial Actions

Groundwater monitoring will be performed as described in the CMCRP to document compliance with cleanup standards. In the event that remediation levels are not met following implementation of the remedial action and environmental monitoring, contingent remedial actions will be implemented to ensure protection of human health and the environment. The remedy includes one defined contingent remedial action for groundwater and one for soil vapors as contemplated during development of the FS and this CAP:

- **Contingent Conveyance System Improvements:** If performance monitoring indicates that base flow discharges from the Log Yard outfalls with elevated arsenic concentrations continue after the Log Yard conveyance system improvements described above, then additional sections of pipe will be slip lined or sealed via other trenchless pipe technologies upstream of the removed vaults.

- **Contingent Perched Groundwater Treatment:** Groundwater evaluations performed during the FS demonstrated that elevated arsenic levels in perched groundwater within the Log Yard can be reduced rapidly by treating the water with zero valent iron. If remediation levels for groundwater are not met downgradient of the PRB or arsenic concentrations in discharges from the Log Yard outfalls are not reduced, collection and treatment of perched groundwater may be implemented to reduce the flux of arsenic toward the PRB and into the stormwater conveyance system. This contingent treatment remedy would capture perched water with a French drain type collection system (see Figure 9). Perched water would be treated in situ (i.e., in collector vaults) and then re-infiltrated within the groundwater plume area at or upgradient of the PRB.

- **Contingent Management of Soil Vapors:** The RI confirmed that methane levels in soil gas are elevated within the Log Yard and portions of the Sawmill. These soil vapors are primarily associated with decomposition of wood waste present in the Log Yard area. There may also be contributions from natural organic matter deposits in site soils. Under current land uses, no management controls are required. However, in the event that buildings or other enclosed structures are constructed at the Site, an evaluation will be required to define soil gas management methods to prevent gas accumulation in the new structures.

4.2.2 Sawmill

The selected remedy for the Sawmill is Alternative 1 (Figure 10), with revisions as described below. The alternative includes the following components:

- **Natural Attenuation:** The PCP concentration in groundwater within the former dip tank area has been decreasing over time, confirming that natural attenuation of the PCP is occurring (Appendix A). This alternative will employ natural attenuation and monitoring in the former dip tank area to achieve compliance with groundwater cleanup standards. PCP concentrations in nearby wells (MW-1, MW-3, and MW-4) are already below site CULs.

- **Environmental Monitoring:** Groundwater monitoring will be performed to verify that natural attenuation of the remaining PCP contamination achieves groundwater cleanup standards. The groundwater program will be defined in the site CMCRP, which is to be developed during remedial design. Current monitoring expectations are described in Section 4.3.

- **Institutional Controls:** A restrictive covenant will be recorded for the Sawmill to document the cleanup as performed, restrict land uses to industrial use, restrict consumptive use of site groundwater in the former dip tank area pending compliance with cleanup standards, and require a contingent soil gas evaluation should enclosed structures be constructed in the Sawmill.

- **Contingent Management of Soil Vapors:** The RI confirmed that methane levels in soil gas are elevated within the Log Yard and portions of the Sawmill. These soil vapors are primarily associated with decomposition of wood waste present in the Log Yard. There may also be contributions from natural organic matter deposits in site soils. Under current land uses, no management controls are required. However, in the event that buildings or other enclosed structures are constructed at the Site, an evaluation will be required to define soil gas management methods to prevent gas accumulation in the new structures.

4.3 Compliance Monitoring Framework

This section describes the compliance monitoring framework considered by Ecology during selection of the remedy.

Compliance monitoring activities associated with the cleanup include three types of monitoring:

- **Protection monitoring:** Includes monitoring during implementation of an active remedy to ensure continued protection of remediation workers and the environment. Projection monitoring requirements will be defined during remedial design for each phase of remedy construction.
- **Performance monitoring:** Includes monitoring activities to confirm that the cleanup action has attained cleanup standards and other performance requirements.
    - Performance monitoring requirements for soil capping activities will be defined during remedial design.
    - Performance monitoring requirements for groundwater monitoring will be defined in the CMCRP.
- **Confirmational monitoring:** Includes monitoring activities to confirm the long-term effectiveness of the cleanup action once performance standards have been attained. Confirmational monitoring requirements for groundwater monitoring will be defined in the CMCRP.

4.3.1 Groundwater POCs and RELs

The groundwater monitoring framework assumes the use of both conditional (arsenic) and standard (PCP) POCs, and the use of RELs for arsenic.

Arsenic Conditional POC

The remedial actions for the Log Yard include a conditional POC located along the shoreline of Wapato Creek. This POC meets the tests for a conditional point of compliance as defined in WAC 173-340-720(8)(c), including requirements for providing a reasonable restoration time frame (see Section 3.2.3) and for providing all practicable methods of treatment (i.e., inclusion of the PRB and contingent perched water treatment).

Arsenic concentrations throughout the Log Yard exceed the CUL, with the highest concentrations observed within and below the perched water zone located in the central portion of the Log Yard. As described in the FS and RI Reports, arsenic transport is limited by the fine-grained nature of the native alluvial deposits, and by the groundwater and soil conditions that promote arsenic precipitation and adsorption.

None of the Log Yard FS alternatives evaluated potentially could achieve groundwater CULs at the standard POC within a relatively short time frame. Integral to the selected remedy is the use of a conditional POC established along the eastern shoreline of Wapato Creek, as shown in Figure 11. Conditional POC wells in this location are located as close as practicable downgradient from the source areas and before discharge to surface water, in accordance with WAC 173-340-720(8)(c). Wells in this location will be located downgradient of containment (capping) and treatment structures (i.e., PRB and contingent perched groundwater treatment structures if required) installed as part of the remedy, and upgradient of Wapato Creek.

Additional sentinel wells or piezometers may be included in the groundwater monitoring framework to monitor groundwater elevations or groundwater quality within the Log Yard and upgradient of the POC. Evaluation against CULs will not be performed at such sentinel wells.

Arsenic RELs

The compliance monitoring framework for the Log Yard includes the use of arsenic RELs. These arsenic RELs will be used to trigger additional contingent remedy evaluations in the event that groundwater remedial actions do not perform as anticipated. Compliance with RELs will be evaluated at the conditional POC wells and supplemented with additional PRB groundwater monitoring points.

The combination of cap maintenance/replacement and PRB installation is expected to control and ultimately reduce groundwater arsenic concentrations at the POC wells in comparison to baseline groundwater quality at these locations. Baseline groundwater quality will be defined for each well during the first eight groundwater monitoring events (including existing data available from the RI/FS and post-FS sampling events where applicable).

A REL exceedance is defined as a sustained flat or increasing trend in groundwater arsenic concentrations measured at one or more POC wells that is not associated with recent construction activities (e.g., soil disturbance during PRB installation) Trend analysis will be performed periodically on each well using the Theil-Sen trend analysis method or similar statistical methods to be defined in the CMCRP. The Theil-Sen trend method is capable of differentiating between increasing and decreasing trends and random water quality variation.

If a REL exceedance is noted, a contingent remedy evaluation will be initiated. That evaluation may include additional groundwater, surface water, or porewater testing as necessary to assess the significance of the groundwater quality changes. An evaluation report will be prepared documenting the conclusions of the evaluation and recommending a contingent remedial action if necessary.

PCP POC

PCP is consistently elevated only in a single well in the Sawmill (MW-2R), which sits within the former dip tank excavation. Two other wells (MW-5R and MW-6R) in the Sawmill have had intermittent exceedances of the PCP PQL but are located approximately 550 feet from Wapato Creek. Wells nearest to Wapato Creek in the Sawmill (MW-1, MW-3 and MW-4) exhibit PCP concentrations consistently below the PCP CUL.

A standard POC (i.e., site-wide) for groundwater will be applied to PCP in the Sawmill.

Groundwater monitoring activities at the Sawmill are expected to include periodic monitoring of wells MW-2R, MW-5R, and MW-6R (see Figure 11) until PCP cleanup levels are consistently maintained.

4.3.2 Soil POC

Soil cleanup levels at the Log Yard and Sawmill are applied at the standard MTCA POC, throughout the site and between 0 and 15 feet below ground surface.

Ongoing soil testing is not anticipated following implementation of the remedy, unless the cap is disturbed (e.g., during cap maintenance or redevelopment activities).

4.3.3 Surface Water POC

Compliance with surface water will be measured using a standard POC located within the surface water discharging from Log Yard outfalls (OF-2 and OF-3) into of Wapato Creek.

Log Yard outfall monitoring is anticipated during cleanup implementation to verify protectiveness of the Log Yard conveyance system upgrades. Log Yard outfall monitoring is anticipated following implementation of the remedy. Log Yard outfall monitoring may also be performed as part of contingent remedy evaluations where appropriate.

Sediment porewater is not surface water. Porewater monitoring provides an indication of contaminant transport and attenuation processes occurring between the groundwater POC and the surface water POC. Porewater monitoring may be performed as part of contingent remedy evaluations but is not anticipated as a regular part of the compliance monitoring program for the Site.

4.3.4 Groundwater Monitoring Expectations

This section describes groundwater monitoring expectations for the selected remedy. The detailed expectations will be defined in the CMCRP, to be developed during remedial design.

Log Yard Monitoring

Log Yard monitoring activities are to include periodic monitoring of POC wells, as well as periodic monitoring of selected sentinel wells and piezometers located within the Log Yard.

- Monitoring is to be performed on a semi-annual basis during the year preceding (Year 0) and the five years following (Year 1 through Year 5) Phase 1 construction (construction of the PRB and completion of the storm drain upgrades).

- Provided that groundwater RELs are met, the frequency may then be reduced to annual measurements (Year 6 forward).
- Following five years of annual monitoring (Year 6 through Year 10), and provided that groundwater RELs have not been exceeded, the frequency of monitoring may be reduced to 2.5-year intervals for long-term monitoring. Statistical evaluations over the long term may be conducted to determine if five year monitoring intervals will adequately characterize groundwater conditions.

Sawmill Monitoring

Sawmill monitoring will include periodic monitoring of the three wells that have had detectable PCP (MW-2R, MW-5R, and MW-6R). Monitoring will be performed semi-annually during the first two years, unless cleanup levels have been met (in which case groundwater monitoring will terminate at that well). Groundwater cleanup levels will be considered to have been met when the results in a given well remain below the PCP cleanup level for four consecutive monitoring events.

After two years, and assuming there is not an upward trend in groundwater PCP concentrations, the frequency of monitoring may be reduced to annual.

Soil Gas Monitoring

Routine soil gas monitoring is not warranted. Soil gas monitoring will be performed as part of contingent evaluations should construction of enclosed or occupied spaces be proposed at the Site. These data would be used to determine what types of controls may be necessary to protect indoor air quality.

4.4 Compliance with ARARs

In accordance with WAC 173-340-710, applicable, relevant and appropriate requirements (ARARs) were considered during development of corrective actions and proposed CULs. Although a cleanup action performed under formal MTCA authorities (e.g., a consent decree) would be exempt from the procedural requirements of certain state and local environmental laws, the action nevertheless must comply with the substantive requirements of such laws (RCW 70.105D.090; WAC 173-340-710).

Potentially applicable federal laws and regulations that may impact the implementation of remedial actions at the Site are shown in Table 7. The list of applicable ARARs may be refined during remedial design.

4.5 Schedule for Implementation

The final remedy will be implemented in two discrete phases.

- **Phase 1 Cleanup:** Phase 1 implementation will be initiated following finalization of the CAP and execution of an Agreed Order (AO). This work will include the following:
    - Development of an engineering design report, including supporting plans (CMCRP, CMMP, and an OMMP for the existing cap)
    - Design and permitting for the Phase 1 cleanup
    - Construction of the Phase 1 cleanup, including construction of the PRB and storm drain improvements
    - Development of a Completion Report for Phase 1 construction
    - Implementation of ongoing cap maintenance activities as defined in the OMMP
    - Groundwater monitoring and data evaluation as defined in the CMCRP (including, if applicable, the implementation of a contingent remedy [conveyance system improvements and perched groundwater treatment]).
- **Phase 2 Cleanup:** Construction of the future low-permeability cap requires verification of land use planning assumptions and coordination with future redevelopment activities. This work will be implemented under a separate future AO Amendment or Consent Decree, and will include the following:
    - Development of a Phase 2 engineering design report, including supporting plans (Phase 2 OMMP for the upgraded cap)
    - Design and permitting for the Phase 2 cleanup
    - Construction of the Phase 2 cleanup, including construction of the low-permeability cap
    - Development of a Completion Report for Phase 2 construction
    - Implementation of cap maintenance activities as defined in the Phase 2 OMMP
    - Ongoing groundwater monitoring and data evaluation as defined in the CMCRP

SECTION 5

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Tables

Year	Author	Document Title
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1988	Rittenhouse-Zeman & Associates, Inc.	Memorandum by Rittenhouse-Zeman & Associates, Inc., for Portac, Inc., to C.C. Pittman. Regarding Results of Soil Sampling and Analytical Results Following Partial Soil Removal in the Central Ditch Area of the Portac Site. August 23, 1988.
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1988	Rittenhouse-Zeman & Associates, Inc.	Letter by Daniel Whitman, Rittenhouse-Zeman & Associates, Inc., to C. Pittman, Portac, Inc. Subject: Wapato Creek Sediment Sampling and Analytical Results. September 8, 1988.
1988	Rittenhouse-Zeman & Associates, Inc.	Memorandum by Rittenhouse-Zeman & Associates, Inc., for Portac, Inc., to C.C. Pittman. Regarding Results of Soil Sampling and Analytical Results following Soil Removal in the Central Ditch Area of the Portac Site. September 23, 1988.
1989	PTI Environmental Services	Background Concentrations of Selected Chemicals in Water, Soil, Sediments, and Air of Washington State
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2009	Whitman Environmental Services	Log Yard Ramp Demolition - Portac, Inc. - 4215 N. Frontage Road, Tacoma, WA. (Draft)
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Site-Associated Contaminant	Cleanup Level (CUL)	CUL Units	Protection Basis	Point of Compliance or Measuring Point	Remediation Level (REL)	Nature and Extent and Remedial Action Summary
Soil						
Arsenic	20	mg/kg	MTCA Method A (Industrial)	Site-wide soil (to 15 ft bgs)		Soils in and below the fill containing slag exceed the MTCA A CUL throughout much of the capped Log Yard area. One exceedance in a shallow fill sample from the former dip tank excavation (Sawmill) was observed but no active remediation is anticipated in that area.
Pentachlorophenol	328	mg/kg	MTCA Method C (Cancer)	Site-wide soil (to 15 ft bgs)		No exceedances of CULs (see RI Report for further details). No active remediation or monitoring anticipated.
Methane (as vapor)	0.5	% by Volume	MTCA Air Quality Guidance	Site-wide soil (to the water table)		Present at concentrations above CULs throughout the capped Log Yard and in the area around the former dip tank on the Sawmill.
Groundwater						
Arsenic	5.0	µg/L	MTCA Method A, Adjusted for Background	Conditional POC in nearshore groundwater monitoring wells	A REL exceedance is defined as a sustained flat or increasing trend in groundwater arsenic concentrations measured at POC wells that is not associated with recent construction activities (e.g., soil disturbance during PRB installation)	Groundwater throughout most of the Log Yard and a portion of the Sawmill exceeds the CUL for arsenic. Because none of the FS alternatives could achieve groundwater CULs at the standard POC within a relatively short time frame, a conditional POC is proposed at nearshore groundwater monitoring wells located at the top of the bank, in accordance with WAC 173-340-720(8)(c).
Pentachlorophenol	1.0	µg/L	PQL	Well MW-2R to be used as POC at dip tank area		All groundwater from top of bank monitoring wells had PCP concentrations that were below CULs. Consistent exceedances of CULs were observed only at MW-2R, within the former dip tank excavation area. Concentrations are decreasing over time.

Notes

µg/L = micrograms per liter
bgs = below ground surface
CAP = corrective action plan
CUL = cleanup level
FS = feasibility study
ft = feet or foot
mg/kg = miilligrams per kilogram
MTCA = Model Toxics Control Act
MW = monitoring well
N/A = not applicable
PCP = pentachlorophenol
POC = point of compliance
PQL = practical quantitation limit
REL = remediation level
RI = remedial investigation
WAC = Washington Administrative Code

Remedial Technology	Alternative 1	Alternative 2	Alternative 3	Alternative 3A	Alternative 4	Alternative 5	Remedy Detail
Log Yard Cap/Soil							
Existing Cap Maintenance and Monitoring	X			X	X		Maintenance activities includes regular inspections and periodic crack repair and resurfacing using a suitable overlay.
Cap Enhancement (Geogrid and Gravel)		X					Cap enhancement includes cap upgrades to reduce (1) the effects of cracking and (2) effective cap permeability to precipitation. The infiltration-control layer is considered to be the asphalt concrete working surface. On-going monitoring and maintenance of the cap will also be required and includes regular inspections and periodic repair and maintenance of infiltration control layer.
Cap Enhancement (Low Permeability)			X	X			Includes the rubbilization of the existing roller-compacted concrete (RCC) cap and installation of a low-permeability infiltration-control layer that is separate from the working surface. For costing purposes, the preliminary design used included a geosynthetic clay liner (GCL) that would be installed atop the rubbilized RCC, with subsequent layers of recycled gravel base coarse, geogrid, new gravel base coarse, and a asphalt concrete working surface. The asphalt concrete working surface is considered separate from maintenance and monitoring following installation as the infiltration control layer would subsequently be separate. Ongoing monitoring and maintenance of the GCL will be required and will include regular inspections and periodic repair and maintenance.
Source Removal (Excavation and Disposal)						X	Fill containing slag will be removed and disposed offsite. RCC and cap subgrade materials overlaying the source material are assumed to be clean and will be stockpiled on-site during removal for subsequent use as fill material. Existing stormwater conveyance system reconstruction and usable surface restoration will be required.
Institutional Controls	X	X	X	X	X		Periodic inspection and/or repair of the engineered system or barrier while contamination remains. A notification of potential exposure for workers handling impacted soils will be attached to the property deed.
Stormwater							
Conveyance System Interim Repair			X			X	This remedy is the same approach as conveyance system repair detailed below; however, this remedy does not include slip lining. This remedy is considered to be an interim action to reduce groundwater seepage prior to a full conveyance system replacement.
Conveyance System Repair	X	X		X	X		Conveyance system repair incorporates slip lining the existing system (pipes, manholes, and spill-containment vessels) to significantly reduce leakage where joints and cracks are observed, as well as slip lining sections at the lowest elevations. It is assumed that an investigation and incremental repair approach will be adopted. Installation of tide gates at outfalls OF 2 and OF 3 is part of this work. Slip lining is assumed to extend from OF 2 and OF 3 to the respective spill containment vessels, approximately 300 ft upstream. Replacement of vaults is assumed for Alternative 3A. Periodic maintenance, monitoring, and repair of the improved conveyance system will be conducted to prevent groundwater seepage.
Conveyance System Replacement			X	X		X	A replacement system will incorporate the abandonment of the existing system and construction of a shallower, watertight system. Portions of the abandoned system will be removed and replaced with low permeability backfill to limit perched water and groundwater migration along the pipe and bedding. This alternative would require periodic monitoring, maintenance, and repair of the improved conveyance system will be needed to prevent groundwater infiltration.
Institutional Controls	X	X	X	X	X		Periodic inspection and/or repair of engineered system or barrier while contamination remains. A notification of potential exposure for workers handling stormwater with site-related contaminants will be attached to the property deed.
Groundwater							
Monitored Natural Attenuation	X	X	X	X	X	X	Periodic monitoring will be conducted to ensure cleanup goals are met.
Permeable Reactive Barrier	X	X	X	X	X	X	A permeable reactive barrier will be installed parallel to Wapato Creek inside the fence line and running along the full extent of the westernmost boundary of the cap and along the northwestern boundary near identified perched water areas. The barrier will extend to below the streambed of Wapato Creek and be backfilled with reactive media (such as iron filings or zero-valent iron [ZVI]) to treat dissolved arsenic in the groundwater flux.
Perched Groundwater Treatment				X			A French drain or similar groundwater collection system will be designed to remove accumulated water in perched groundwater zones. The system will likely require the use of several laterals spanning the north/south extent of the Log Yard. Accumulating perched water will be treated in situ in the collector vaults that infiltrate water downward into a more permeable layer. Overflow from the collector vaults will flow to a trench in the Sawmill Area where it will be treated in situ and infiltrated. Treatment will be provided by a reactive medium (e.g., ZVI).
Extraction and Ex Situ Treatment					X		Areas of perched groundwater will be extracted via sumps, shallow wells, or French drains to minimized areas of perched groundwater in contact with the fill containing slag. Ex-situ treatment may include precipitation and separation media (e.g., filters, iron reactive media). Separated arsenic will be disposed offsite and the treated groundwater will be discharged to surface water.
Institutional Controls	X	X	X	X	X	X	Periodic inspection and/or repair of engineered system or barrier while contamination remains. A notification of potential exposure for workers handling impacted groundwater will be attached to the property deed.
Soil Gas							
Institutional Controls	X	X	X	X	X	X	Methane gas does not present an imminent hazard under existing site conditions. A notification of potential hazardous conditions for trench workers or vapor intrusion to enclosed structures would be attached to the property deed.

Notes

ft = feet or foot
GCL = geosynthetic clay liner
RCC = roller-compacted concrete
ZVI = zero-valent iron

Table 4. Sawmill Remedial Alternatives

Remedial Technology	Alternative 1	Alternative 2	Alternative 3	Remedy Detail
Groundwater				
Natural Attenuation	x	x	x	Periodic monitoring would be conducted to ensure cleanup goals are met.
Enhanced Bioremediation		x		Groundwater conditions in the dip tank area indicate a high-pH environment that does not provide an optimal environment for biological activity. Enhanced biodegradation would include the injection of amendments to create a more neutral pH for improved biological activity. Amendment selection could incorporate a bench-scale analysis to determine the optimal application to degrade residual PCP. *(Note that the PCP concentrations have been observed to be generally decreasing over time, suggesting that attenuation is occurring.)*
Extraction and Ex-Situ Treatment (During Soil Removal)			x	Removal of vadose-zone and upper saturated-zone soils would target areas outside the limits of the historical excavation. Excavated soil would be disposed off-site and replaced with clean fill. Groundwater extracted, as needed, to dewater the soil excavation, would be treated ex situ using chemically or biologically destructive means, or through physical media filtration. Treatment could be conducted on- or off-site.
Institutional Controls	x	x		A notification of potential exposure for excavation workers would be attached to the property deed until cleanup levels have been met.
Soil Gas				
Institutional Controls	x	x	x	Methane gas does not present an imminent hazard under existing site conditions. A notification of potential hazardous conditions for trench workers or vapor intrusion to enclosed structures would be attached to the property deed.

Notes
PCP = pentachlorophenol

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								
Alternative 1 - Cap Overlay - Conveyance System Repair - Permeable Reactive Barrier -Monitored Natural Attenuation - Institutional Controls	Achieves a score for protectiveness that is lower than protectiveness for other alternatives. However, the capping approach is less protective than those under Alternatives 2 and 3. Frequent inspections and sealing of cracks will be required to maintain cap performance. The stormwater repairs are less robust than the system replacement conducted under Alternatives 3 and 5. Protectiveness is enhanced with the use of a contingent PRB.	Achieves a low-medium score for permanence. Permanence under this alternative is lower than under Alternatives 2 and 3, because the capping approach does less to reduce the production of arsenic-contaminated perched groundwater than other alternatives, and no treatment of this water is provided as under Alternative 4. The alternative also uses stormwater line repairs rather than replacing the system. Together these factors result in a greater risk of arsenic migration toward Wapato Creek, and a greater likelihood that contingent groundwater treatment will be required.	Alternative 1 achieves a low-medium score for long-term effectiveness. Unlike Alternative 3, the permeability of the cap is not reduced, and arsenic-contaminated perched water will continue to be generated at significant rates. The cap performance will also require frequent inspections and sealing of cracks that are expected to occur at higher rates than under Alternative 2. Repair in place of the stormwater system has a higher likelihood of failure over the long term in comparison to the system raising and replacement as performed under Alternative 3. Groundwater flux rates will be higher than under Alternatives 2 or 3, placing higher demands on natural attenuation processes and increasing the likelihood that a contingent PRB will be required.	This alternative has a medium-high score for short-term risk management. It involves construction activities that are less extensive than those under any other alternatives, and requires no exposure of arsenic-contaminated soils. The alternative uses routine construction methods (asphalt overlay placement) for capping. Stormwater management risks are minimized by keeping the existing RCC cap in place.	Alternative 1 has a medium-high score for implementability. The requirements for initial design and construction are lower than those under any other alternatives. The alternative uses standard construction methods for capping. It will not require a construction stormwater permit and will not expose contaminated soils. However, this alternative will require more frequent inspections and cap maintenance activities over the long term.	Evaluation pending public comment.	4.2	$9.5M	0.44
	3	**3**	**4**	**8**	**8**	**--**			
Alternative 2 - Enhanced Cap - Conveyance System Repair - Permeable Reactive Barrier -Monitored Natural Attenuation - Institutional Controls	Achieves a medium score for protectiveness. Protectiveness of Alternative 2 is higher than for Alternative 1, because measures are taken to reduce ongoing crack formation within the cap surface layer. However, the capping approach is less protective than Alternative 3. Frequent inspections and sealing of cracks will be required to maintain cap performance. The stormwater repairs are less robust than the system replacement conducted under Alternatives 3 and 5. Protectiveness is enhanced with the use of a contingent PRB.	Achieves a medium score for permanence. Permanence under this alternative is better than under Alternative 1 but lower than under Alternative 3. The capping approach reduces anticipated infiltration in comparison to Alternative 1; however, the capping approach does less to address the generation of perched groundwater than the approach in Alternative 3. This alternative also uses stormwater line repairs rather than replacing the system. Together these factors result in a an intermediate risk of arsenic migration toward Wapato Creek, and an intermediate risk that contingent groundwater treatment will be required.	Alternative 2 achieves a medium score for long-term effectiveness. The long-term cap performance is expected to be better than cap performance under Alternative 1, with reduced surface cracking. However, the permeability of the cap is not reduced as much as under Alternative 3. The cap performance will also require more frequent inspections and maintenance in comparison to those activities for Alternative 3. Repair in place of the stormwater system has a higher likelihood of failure over the long term in comparison to the system raising and replacement as performed under Alternative 3. Groundwater flux rates will be higher than under Alternative 3, placing higher demands on natural attenuation processes, and increasing the likelihood that a contingent PRB will be required.	This alternative has a medium-high score for short-term risk management. It involves construction activities that are less extensive than those under Alternatives 3, 4, or 5. The alternative does not requires exposure of arsenic-contaminated soils and uses routine construction methods (gravel placement and asphalt paving) for capping. Stormwater management risks are minimized by keeping the existing RCC cap in place.	Alternative 2 has a medium-high score for implementability. The requirements for initial design and construction are lower than those under Alternatives 3, 4, or 5. The alternative uses standard construction methods for capping. It will not require a construction stormwater permit and will not expose contaminated soils. However, this alternative will require more frequent inspections and cap maintenance activities over the long term than for Alternative 3.	Evaluation pending public comment.	5.5	$10.5M	0.52
	5	**5**	**6**	**8**	**8**	**--**			

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								
Alternative 3 - Low-Permeability Cap - Conveyance System Replacement - Permeable Reactive Barrier - MNA - Institutional Controls	Achieves a high level of overall protectiveness through the use of a low-permeability composite cap to reduce infiltration through source material and prevent accumulation of perched water. The infiltration control layer is separated from the cap working surface to minimize the risks of cap damage during long-term maintenance. The stormwater conveyance system will be replaced and raised to prevent groundwater infiltration. Protectiveness is enhanced with the use of a contingent PRB. Given the anticipated reduction in infiltration and groundwater flux, the need for the PRB is less likely than under Alternatives 1, 2, or 4.	Achieves a medium-high score for permanence by including both a more robust cap and a new stormwater system. The cap design is expected to reduce the generation of high-arsenic perched water in comparison to Alternatives 1, 2, and 4. The stormwater system replacement will also prevent future seepage of arsenic-containing groundwater into the storm drainage system.	Achieves a high level of long-term effectiveness through the use of a low-permeability composite cap to reduce infiltration through source material and prevent accumulation of arsenic-contaminated perched water. The infiltration control layer is separated from the cap working surface to maximize long-term cap performance and minimize dependence on ongoing cap inspections and maintenance. The stormwater conveyance system will be replaced and raised, rather than being repaired in place, eliminating risks that leaks would recur over the long term. The reduction in infiltration and groundwater flux under this alternative optimizes conditions for ongoing natural attenuation of arsenic, reducing the likelihood that the contingent PRB will be required. If the PRB is required, the lifespan of the treatment media will be improved relative to other the lifespan of alternatives with higher groundwater flux rates.	This alternative has a medium-high score for short-term risk management. It involves more extensive construction activities during initial cap installation than under Alternatives 1, 2, or 4. However, this initial work is offset over the long term by fewer requirements for on-site inspections and cap maintenance actions. Construction-related risks are lower than risks for Alternative 5, because the arsenic-contaminated soils will not be exposed to workers or to stormwater during cap installation. The alternative includes significant on-site construction activities, but does not involve extensive off-site transportation of contaminated soils as is the case under Alternative 5.	Alternative 3 has a lower score for implementability than Alternatives 1 or 2 because initial design and construction requirements are greater. Though the alternative doesn't require exposure of contaminated soils, it will involve removal of the RCC cap and re-grading of cap materials. A construction stormwater permit will be required. However, this alternative will require less-frequent inspections and cap maintenance activities over the long term than activities necessary for Alternatives 1, 2, and 4.	Evaluation pending public comment.	6.8	$12.3M	0.55
	8	**7**	**8**	**7**	**7**	**--**			
Alternative 3A - Conveyance System Repair - Perched Groundwater Treatment - Permeable Reactive Barrier -Monitored Natural Attenuation - Low Permeability Cap Contingency - Institutional Controls	Achieves a high level of overall protectiveness through the use of a perched groundwater treatment system and a contingent PRB. The stormwater conveyance system will be slip lined in areas affected by groundwater infiltration and replaced when the property is developed or contigency low permeability cap implemented. Protectiveness is enhanced by directly removing perched water and reducing arsenic flux to groundwater and Wapato creek. A contigent PRB near Wapato Creek and a low permeability cap would be implemented if criteria conditions are exceeded. With this tiered approach, the overall protectiveness of the remedy is enhanced.	Achieves a high score for permanence. Permanence under this alternative is enhanced by directly removing perched groundwater. This alternative is more permanent than Alternative 4, as it integrates better with Port land use planning and employs a more robust contigent cap design. The cap design is expected to reduce the generation of high-arsenic perched water in comparison to Alternatives 1, 2, 3, and 4. The stormwater system repair (slip line) and eventual replacement will also prevent future seepage of arsenic-containing groundwater into the storm drainage system.	Achieves a high level of long-term effectiveness through the use of perched groundwater treatment, stormwater system improvements, a PRB, and a contingent low-permeability cap to reduce perched water in source material and subsequent migration pathways. At the time of property development or implementation of the contingent low-permeability cap, the stormwater conveyance system will be replaced, eliminating risks that leaks would recur over the long term. The reduction in infiltration and groundwater flux under this alternative optimizes conditions for ongoing natural attenuation of arsenic, reducing the likelihood that the contingent PRB will be required. If the PRB is required, the lifespan of the treatment media will be improved relative to other alternatives with higher groundwater flux rates.	This alternative has a medium score for short-term risk management. It involves more extensive construction activities during the perched water drain installation and initally during cap installation than under activites in these phases for Alternatives 1, 2, 3, or 4. Construction-related risks are lower than risks under Alternative 5, because the quantity of arsenic-contaminated soils to which workers would be exposed would be much less. The alternative includes significant on-site construction activities, but does not involve extensive off-site transportation of contaminated soils, as needed under Alternative 5.	Alternative 3A has the highest score for implementability because it integrates best with property development planning and current uses. Implementation of the perched water treatment in this alternative is expected to be less complex and requiring less long-term maintenance than for other alternatives, as it is expected to discharge in situ.	Evaluation pending public comment.	7.0	$11.4M	0.61
	8	**9**	**8**	**6**	**7**	**--**			

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								
Alternative 4 - Cap Overlay - Conveyance System Repair - Perched Water Ex Situ Treatment - Permeable Reactive Barrier -Monitored Natural Attenuation - Institutional Controls	Achieves a medium score for overall protectiveness through the continued use and maintenance of a surface cap to reduce infiltration through source material, stormwater conveyance system repairs, natural attenuation and institutional controls. Perched water is actively addressed through extraction, ex situ treatment, and discharge to Wapato Creek. Protectiveness is enhanced with the use of a contingent PRB. However, the capping approach is less protective than the approaches for Alternatives 2 and 3 because more cracking and infiltration will likely occur under Alternative 1.	Achieves a medium score for permanence. Like Alternative 1, the capping approach of this alernative does less to address the production than Alternatives 2 or 3. The active extraction and treatment of this water will require extensive ongoing operation and maintenance in order to remain effective. Repair in place of the stormwater system has a higher likelihood of failure over the long term than the system raising and replacement under Alternative 3.	Alternative 4 achieves a medium level of long-term effectiveness. Unlike Alternative 3, the permeability of the cap is not reduced, and arsenic-contaminated perched water will continue to be generated at significant rates. Although the perched water is managed through extraction and treatment, these measures will require extensive ongoing operation, monitoring, and maintenance to prevent inadvertent discharge of contaminated groundwater. The cap performance will also require frequent inspections and sealing cracks that are expected to occur at higher rates than would be expected under Alternative 2. Repair in place of the stormwater system has a higher likelihood of failure over the long term than the likelihood of failure for system raising and replacement under Alternative 3.	This alternative has a medium score for short-term risk management. It involves more extensive construction activities during initial cap installation than under Alternatives 1 or 2, including installation of drains and sumps for extraction of groundwater. Appropriate methods will be required to prevent discharge of contaminated groundwater during treatment system startup and initial operation. Construction-related risks are lower than construction-related risks under Alternative 5, because the arsenic-contaminated soils will not be exposed to workers or to stormwater during cap installation. The alternative includes significant on-site construction activities, but does not involve extensive off-site transportation of contaminated soils as is proposed under Alternative 5.	Alternative 4 has a lower score for implementability than Alternatives 1, 2, or 3. This reduction in score reflects the increased complexity of construction associated with installation of the perched water extraction and treatment system. Alternative 4 uses standard construction methods for capping, will not require a construction stormwater permit, and will not expose contaminated soils. However, this alternative will require more frequent inspections and cap maintenance activities over the long term than are needed for Alternative 3. Alternative 4 also require long-term operation and maintenance of the water treatment system, including procurement and periodic renewal of a NPDES permit.	Evaluation pending public comment.	5.1	$10.9M[5]	0.47
	6	**5**	**6**	**6**	**5**	**--**			
Alternative 5 - Conveyance System Repair - Excavation and Disposal -Conveyance System Replacement - Permeable Reactive Barrier -Monitored Natural Attenuation - Institutional Controls	Achieves a high level of overall protectiveness through excavation and off-site disposal of arsenic-contaminated soils. Residual groundwater contamination will remain and will be managed by stormwater system replacement, monitored natural attenuation, and institutional controls. Given the presence of residual groundwater contamination and potential increases in groundwater infiltration and flux after cap removal, this alternative includes a contingent PRB to ensure protectiveness.	Achieves a higher score for permanence than other alternatives by removing slag and contaminated soils that are a potential ongoing source of groundwater contamination. Residual groundwater contamination will remain. That contamination is managed through institutional controls, stormwater system replacement, and a contingent groundwater PRB.	Achieves a high score for long-term effectiveness through excavation and offsite disposal of arsenic contaminated soils. These soils will be transferred to an off-site commercial landfill, rather than contained on-site beneath an environmental cap. Residual groundwater contamination will remain and will be managed by stormwater system replacement, monitored natural attenuation, and institutional controls. Given the presence of residual groundwater contamination and potential increases in groundwater infiltration and flux after cap removal, this alternative includes a contingent PRB to ensure the long-term effectiveness of groundwater controls.	Alternative 5 has a low-medium score for short-term risk management. Short-term risks associated with this alternative would be moderately high. The work includes extensive construction activities to remove, transport, and safely manage contaminated soils without exposing workers to contaminant-related risks. Stormwater and dust will need to be appropriately managed during construction activities. This alternative also involves significant modifications to existing site conditions, with the removal of the existing cap and changes to groundwater control measures. These changes could affect existing groundwater attenuation processes (this risk is managed with the contingent PRB).	This alternative has a medium score for implementability. The project will require a construction general stormwater permit and additional control measures to manage construction-related stormwater containing arsenic. The project will require extensive off-site transportation of contaminated soils. The duration of the construction project is longer than for any of the other aternatives, impacting ongoing site uses to a greater degree.	Evaluation pending public comment.	7.2	$31.0M	0.23
	9	**10**	**9**	**4**	**5**	**--**			

Notes

[1] Consideration of public concerns is not addressed in this table because the public has not yet had an opportunity to provide comments.
[2] Each of the DCA criteria listed were weighted, so the overall DCA score would be influenced by criteria directly relating to protectiveness and effectiveness. A score of 10 represents an alternative that satisfies the criteria to the highest degree.
[3] Probable cost reflects the total estimated cost including applicable contingencies (see cost detail in Appendix A).
[4] Probable costs were evaluated in increments of $1 million for comparison to benefit scoring.
[5] A formula error in the original FS cost estimating tables for Alternative 4 was corrected as part of this FS Addendum effort, correspondingly, the Alternative 4 cost has been updated.
DCA = disproportionate cost analysis
FS = feasiblity study M = million MNA = monitored natural attenuation NPDES = National Pollutant Discharge Elimination System PRB = permeable reactive barrier

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								
Alternative 1 - Monitored Natural Attenuation - Institutional Controls	Achieves a medium score for overall protectiveness through ongoing monitored natural attenuation.	Residual contamination can be permanently detoxified through natural processes. This alternative receives a medium-high score for permanent reduction of mass and toxicity of hazardous substances at the Site.	This alternative receives a medium score for effectiveness, as the time to complete the cleanup is longer than the time to complete under the other alternatives. The long-term effectiveness of this alternative depends upon maintaining institutional controls until contaminants attenuate and degrade.	This alternative was scored high for short-term risk management. This alternative does not require any ex situ handling of residual contamination, as treatment would occur in situ. There are no additional construction-related risks requiring management.	This alternative is scored high for implementability. This alternative requires only routine site monitoring.	Evaluation pending public comment.	6.2	$495K	1.24
	6	**6**	**6**	**9**	**9**	**--**			
Alternative 2 - Enhanced Bioremediation - Monitored Natural Attenuation - Institutional Controls	Achieves a medium-high score for overall protectiveness through accelerated in situ biodegradation and monitored natural attenuation, reducing the expected amount of time necessary until residual contamination is below cleanup levels in all wells.	This alternative receives a high score for permanent reduction of mass and toxicity of hazardous substances at the Site. This alternative will be effective at a faster rate than Alternative 1. Residual contamination can be permanently detoxified through natural processes.	This alternative receives a medium-high score for effectiveness because the time required to complete the cleanup is less than the time required under Alternative 1. Long-term effectiveness of this alternative depends on maintaining institutional controls until contaminants attenuate and degrade.	This alternative was scored medium-high for short term-risk management. This alternative does not require any ex situ handling of residual contamination, as treatment would occur in situ. However, some handling of corrosive chemicals would be required during amendment injection.	This alternative is scored high for implementability. Neutralization agents and injection mechanisms are well-developed technologies that could be rapidly procured and implemented.	Evaluation pending public comment.	7.2	$539K	1.34
	8	**8**	**8**	**8**	**8**	**--**			
Alternative 3 - Expanded Excavation and Off-Site Disposal - Temporary Groundwater Extraction and Treatment - Monitored Natural Attenuation - Institutional Controls	Achieves a high score for overall protectiveness by reducing residual contaminant mass through excavation and temporary groundwater treatment, reducing the expected amount of time necessary until residual contamination is below cleanup levels in all wells.	This alternative receives a high score for rapid removal of remaining groundwater contamination at the Site, relative to Alternatives 1 or 2.	This alternative receives a high score for long-term effectiveness because it has shortest restoration time frame and interim institutional controls are not likely required for groundwater.	This alternative was score medium for short-term risk management. Excavation and ex situ treatment are included as remedial elements in this alternative. Ex situ handling of contaminated media creates the potential for short-term exposure for site workers or fugitive emissions.	This alternative is scored medium for implementability. The alternative will require management of stormwater and extracted groundwater during construction as well as off-site management of excavated soils.	Evaluation pending public comment.	7.1	$742K	0.96
	9	**9**	**9**	**5**	**5**	**--**			

Notes

[1] Consideration of public concerns is not addressed in this table because the public has not yet had an opportunity to provide comments.
[2] Each of the DCA criteria listed were weighted, so the overall DCA score would be influenced by criteria directly relating to protectiveness and effectiveness. A score of 10 represents an alternative that satisfies the criteria to the highest degree.
[3] Probable cost reflects the total estimated cost including applicable contingencies (see cost detail in Appendix C).
[4] Probable costs were evaluated in $100,000 increments for comparison to benefit scoring.

DCA = disproportionate cost analysis
FS = feasiblity study
K = thousand
MNA = monitored natural attenuation
PRB = permeable reactive barrier

Medium	Standard / Criterion	Citation
All media	Federal requirements for proper management of contaminants encountered at concentrations that fall under the Toxic Substances Control Act (TSCA) requirements	Toxic Substances Control Act (15 USC §§2601 et seq. [1976])
All media	Federal and State of Washington requirements for proper management of hazardous wastes "from cradle to grave."	Federal Resource Conservation and Recovery Act (40 CFR 261 et seq.), Washington Hazardous Waste Management Act (including Dangerous Waste Regulations, RCW 70.105)
All media	Federal requirements for conservation of threatened and endangered plants and animals and the habitats in which they are found.	Federal Endangered Species Act (16 USC §§1531 et seq. [1973])
Air	Federal requirements regulating air emissions from stationary and mobile sources. Applicable mainly during active construction periods. Methane soil gas concentrations will be a consideration during future building construction for indoor air and during open-excavation activities.	Federal Clean Air Act (42 USC §§7401 et seq.)
Soil	State of Washington requirements for establishing numeric or risk-based goals and selecting cleanup actions.	MTCA (WAC 173-340, §§740, 745, 747)
Soil	Federal requirements for preservation of historic artifacts encountered during soil disturbance activities	National Historic Preservation Act (36 CFR 63 et seq.)
Soil / Surface Water	Federal and State of Washington requirements for controlling construction-related runoff.	Washington WPCA - State Water Quality Standards for Surface Water (RCW 90.48), federal WPCA / CWA (33 USC 1251 et. seq.)
Surface Water / Groundwater	State of Washington requirements for protecting state water resources including surface water and groundwater.	Washington Water Resource Act (RCW 90.54)
Stormwater (Surface Water) / Groundwater (Protection of Sediment)	Federal and State of Washington requirements for controlling discharge of pollutants in stormwater from industrial facilities. State water quality standards; conventional water quality parameters and toxic criteria.	Washington WPCA - State Water Quality Standards for Surface Water (RCW 90.48), federal WPCA / CWA (33 USC 1251 et. seq.)
Groundwater / Surface Water	State of Washington requirements for establishing numeric or risk-based goals and selecting cleanup actions.	MTCA (WAC 173-340, §§720, 730)
Surface Water / Groundwater (Protection of Sediment)	Ambient water quality criteria for the protection of aquatic organisms and human health.	Federal Water Pollution Control Act/ Clean Water Act (CWA) §304 (33 USC 1251B1376, 40 CFR 100B149), National Toxics Rule 40 CFR 131
Groundwater (Protection of Drinking Water)	SDWA National Primary Drinking Water Standards: maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), Proposed MCLs and MCLGs.	MTCA (WAC 173-340, §§720, 730)
Sediment	State of Washington standards to reduce and ultimately eliminate adverse effects on biological resources and significant threats to human health from surface sediment contamination	Washington State Sediment Management Standards (WAC 173-204)

Notes

CFR = Code of Federal Regulations
CWA = Clean Water Act of 1972
et seq. = and following
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
MTCA = Model Toxics Control Act
RCW = Revised Code of Washington
SDWA = Safe Drinking Water Act
TSCA = Toxic Substances Control Act
USC = Code of Laws of the United States of America
WAC = Washington Administrative Code
WPCA = Water Pollution Control Act

Figures

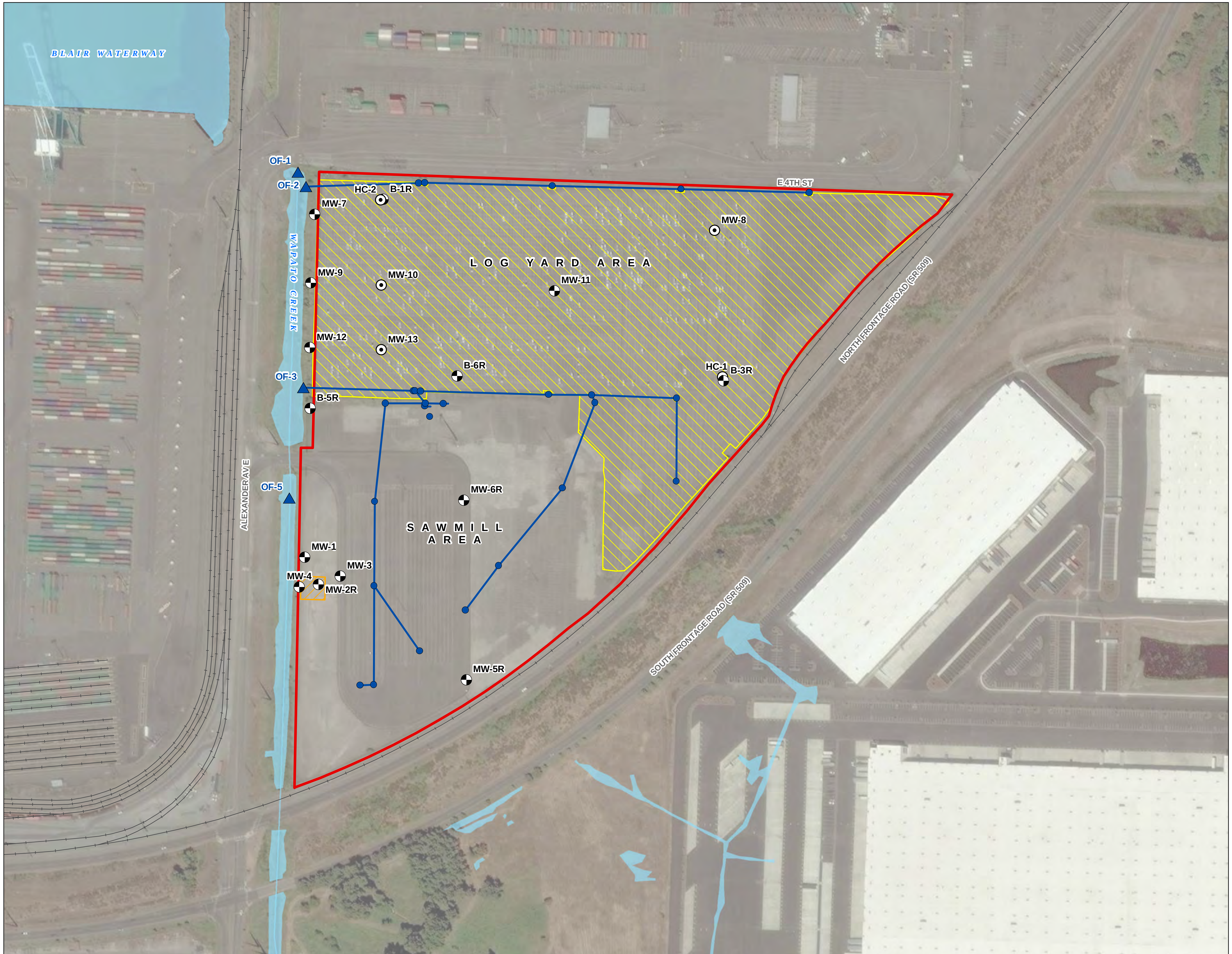

FIGURE 1

Site Map

Cleanup Action Plan
Parcel 15
Tacoma, WA

LEGEND

- Monitoring Well
- Perched Monitoring Well
- Outfall
- Vault
- Stormwater Conveyance Pipe
- Site Boundary
- Site Area
- Former Dip Tank
- Fill Containing Slag
- Railroad
- Watercourse
- Waterbody

NOTE:
Site boundary defined in Exhibit A of the Draft Agreed Order No. DE 11237 (Ecology, 2015).

N

0 150 300 450
Feet

Date: April 7, 2020
Data Sources: PORTAC, Aerial from METRO 2018

GSI Water Solutions, Inc.

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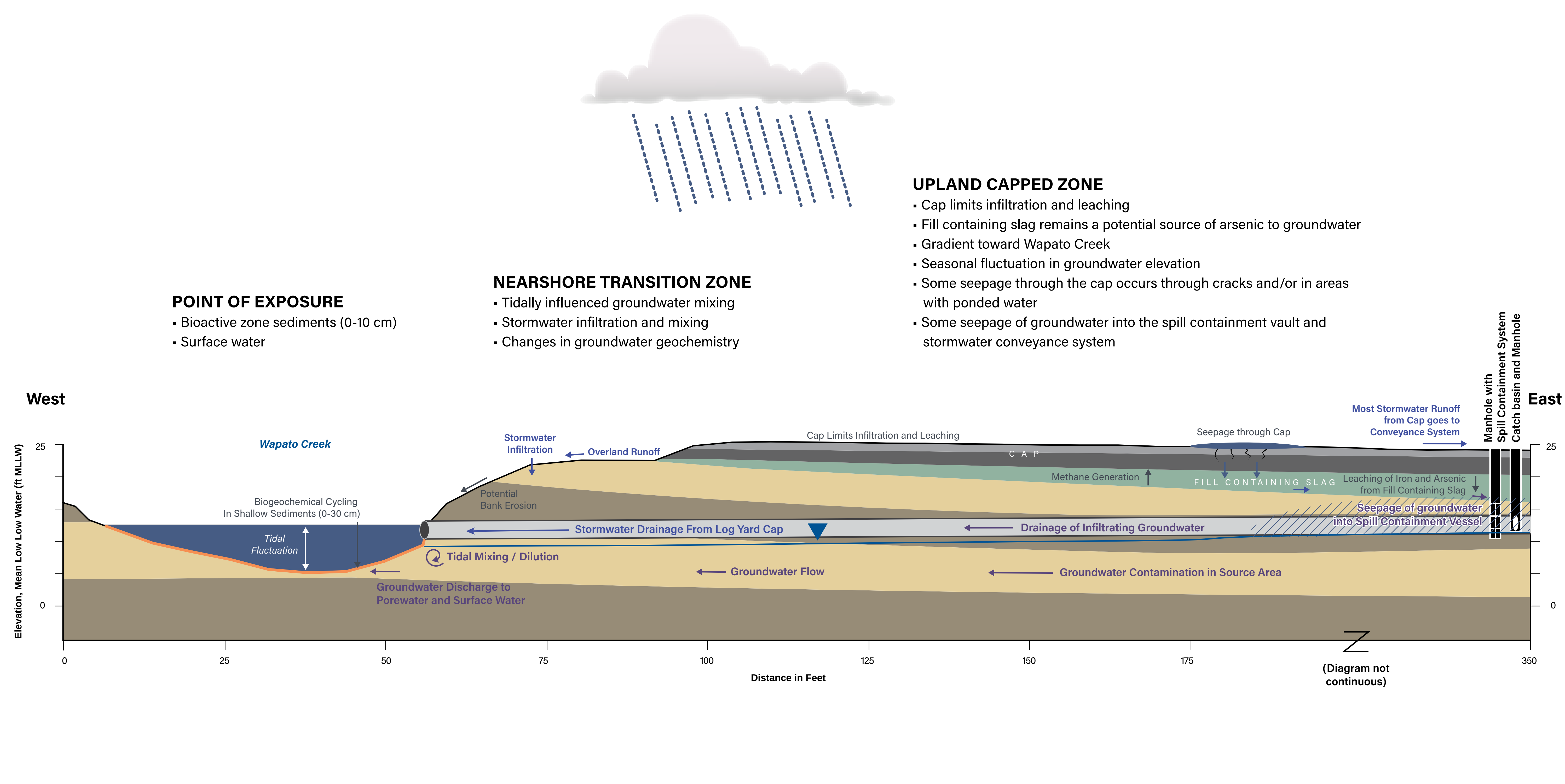

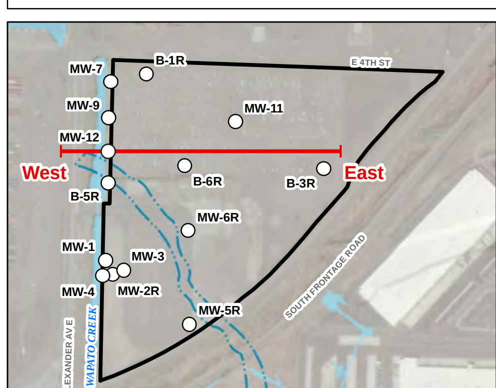

LEGEND
- Stormwater Pipe
- Catch Basin/Manhole
- Spill Containment System
- May 2016 Water Level
- Perched Groundwater

NOTE
Vertical Exaggeration = 1X
ft = feet
cm = centimeters

Geology
- Roller-Compacted Concrete
- Gravel Base Course
- Fill Containing Slag
- Silty Sand
- Fine-Grained Deposits (Silt and Clay)
- Bioactive Zone Sediments

FIGURE 2

Conceptual Site Model - Current Conditions - Log Yard

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

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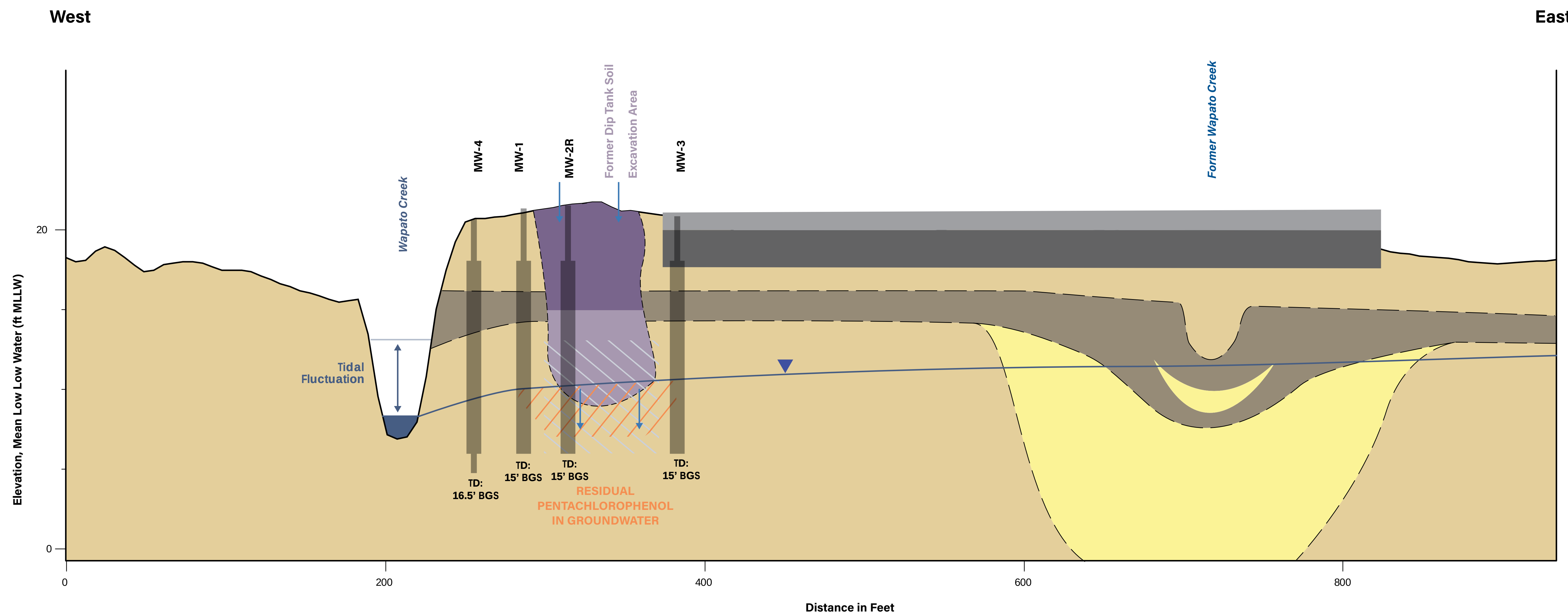

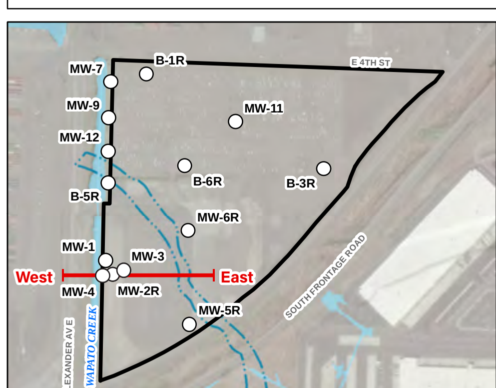

LEGEND

- Groundwater Surface
- May 2016, Estimated Water Level
- Precipitation Infiltration
- Residual Pentachlorophenol
- Groundwater with Elevated pH

Geology

- Asphalt Concrete
- Gravel Base Coarse
- Crushed Concrete Fill
- Sand FIll (Soil Excavation Area)
- Silty Sand
- Fine-Grained Deposits (Silt and Clay)
- Sand

NOTES

Vertical Exaggeration = 10X
Lidar data is from 2010 from Puget Sound Lidar Consortium's website (http://pugetsoundlidar.ess.washington.edu/lidardata/). Data converted from NAVD88 to MLLW by adding 2.67', made by GSI.

FIGURE 3

Conceptual Site Model - Sawmill

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

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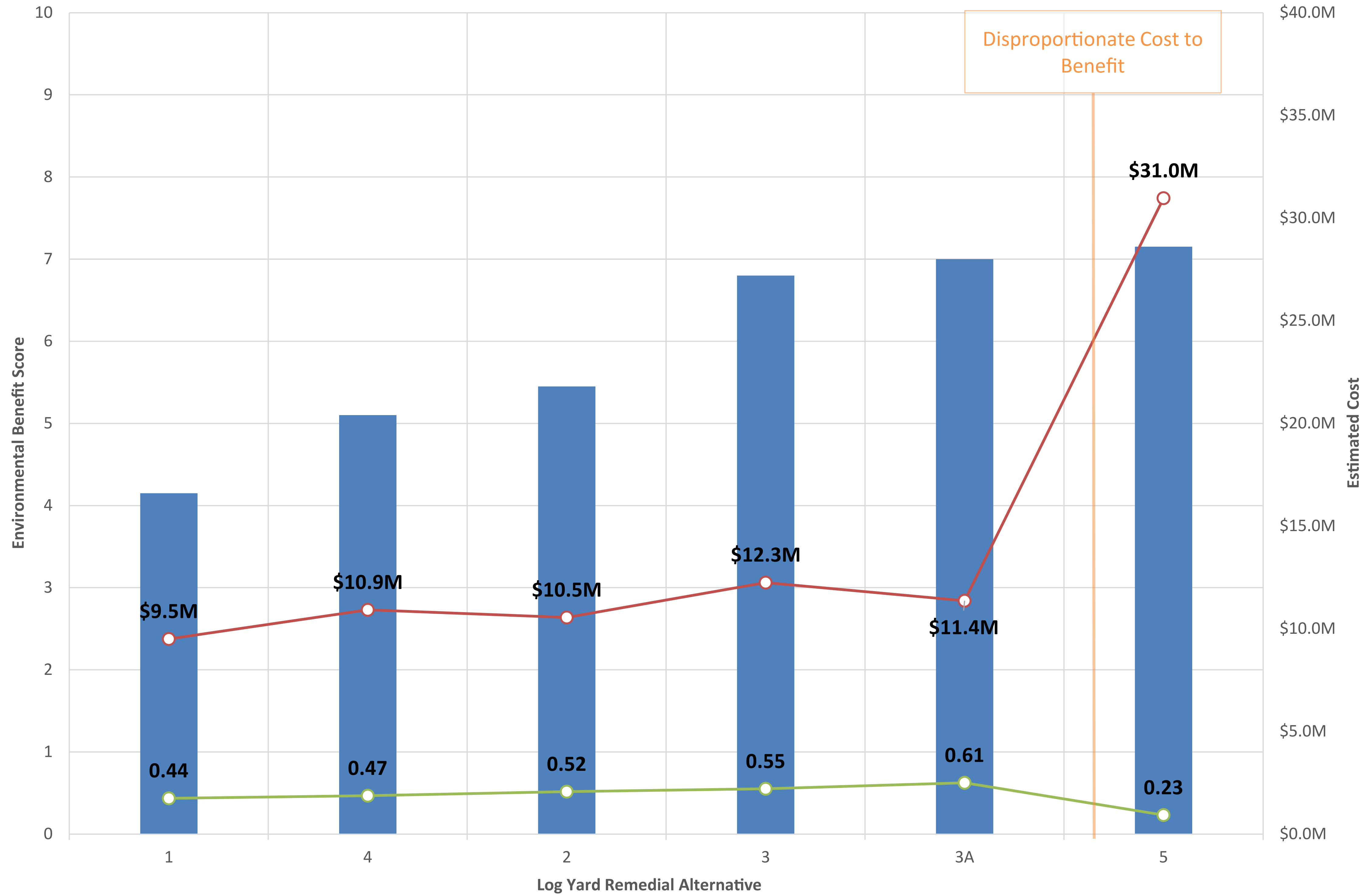

LEGEND

Environmental Benefit Score
Relative Benefit / Cost ($M)
Estimated Cost

NOTE
M = Millions

FIGURE 4

Log Yard Disproportionate Cost Analysis

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

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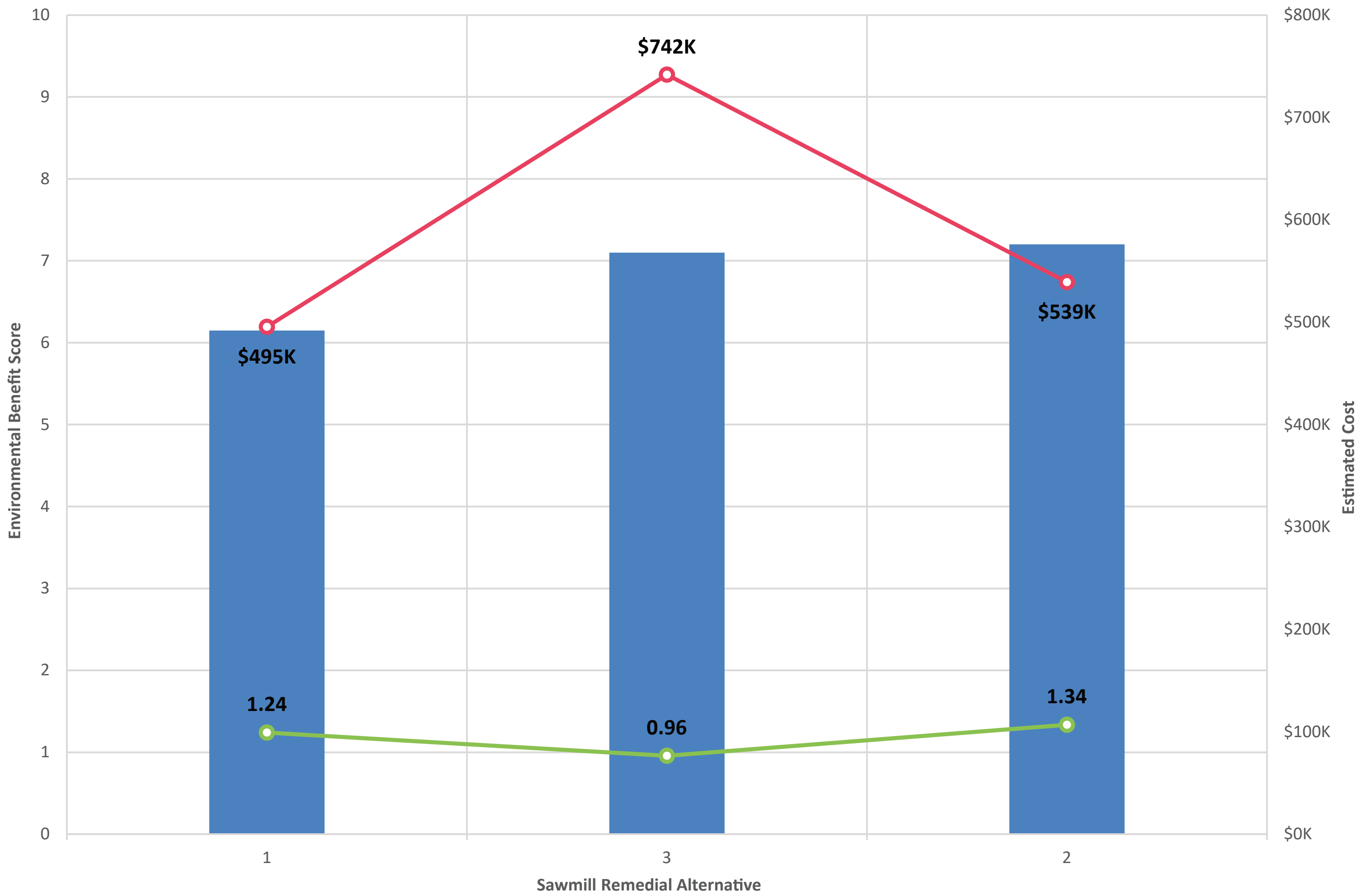

FIGURE 5

Sawmill Disproportionate Cost Analysis

Cleanup Action Plan
Parcel 15
Tacoma, WA

LEGEND

- Environmental Benefit Score
- Relative Benefit / Cost ($100K)
- Estimated Cost

NOTE

K = Thousands

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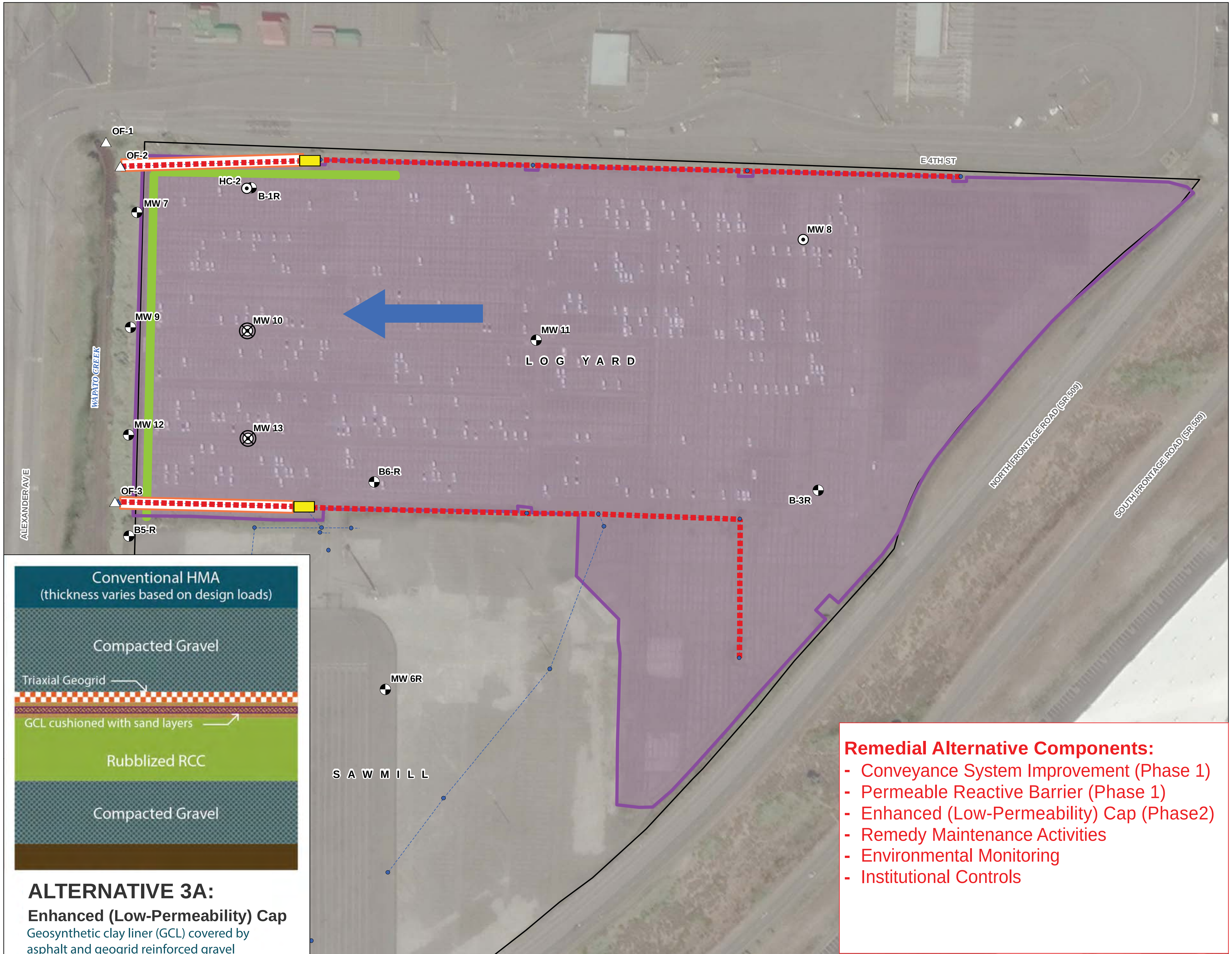
FIGURE 6

Log Yard Remedial Alternative 3A

Cleanup Action Plan
Parcel 15
Tacoma, WA



LEGEND

Site Features[1]
- Monitoring Well
- Perched Monitoring Well
- Stormwater Outfall

Site Storm Features
- Outfall
- Vault
- Storm Line

Remedial Alternative Features
- Well to be Abandoned and Replaced
- Replace Stormwater Vault
- Slip Line Stormwater Pipe
- Permeable Reactive Barrier[4]
- Enhanced Cap
- Replace Stormwater System

All Other Features
- Site Boundary[2]
- Groundwater Flow Direction

NOTES

1. Locations surveyed May 2016.
2. Site boundary defined in Exhibit A of the Draft Agreed Order No. DE 11237 (Ecology, 2015).
3. Cap extent defined on Figure 2 of the Former Portac Inc. Site (AQEA, 2014).
4. Permeable reactive barrier dimensions and extent are subject to change during remedial design.

HMA: Hot Mix Asphalt
RCC: Roller-Compacted Concrete
GCL: Geosynthetic Clay Liner

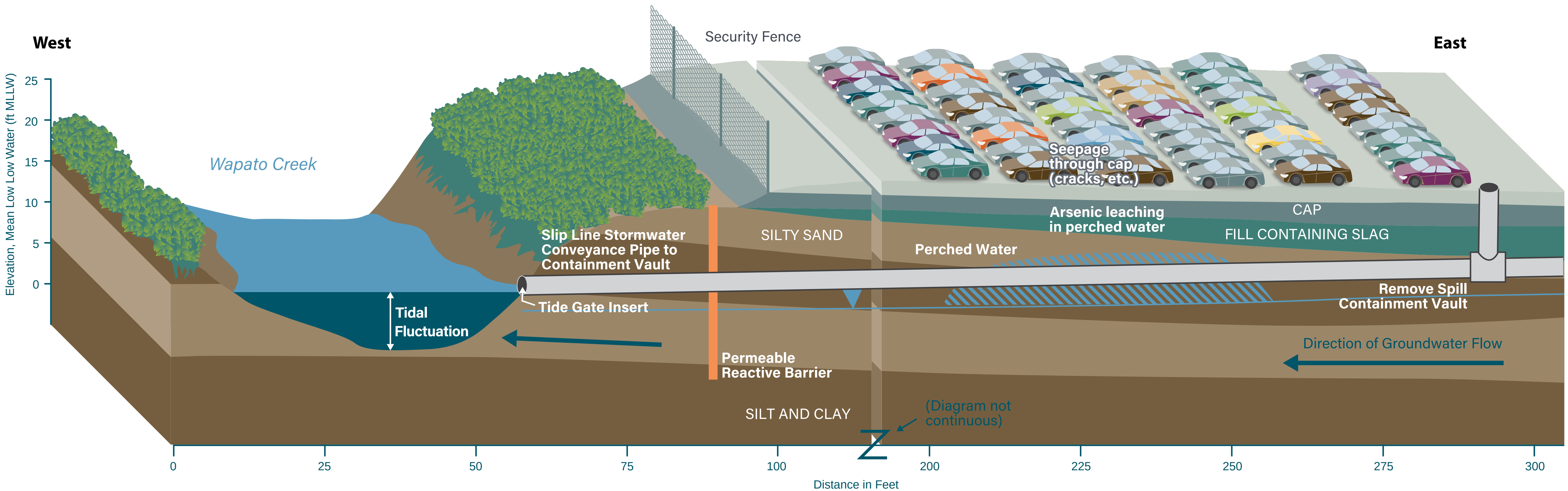
N

0 90 180 270
Feet

Date: April 13, 2020
Data Sources: PORTAC, Aerial photo taken September 2018 by Metro

GSI Water Solutions, Inc.

Document Path: Y:\0603_Port_Tacoma\Source_Figures\Cleanup_Action_Plan\2020_Update\Figure2_LY_Remedial_Alt3a.mxd



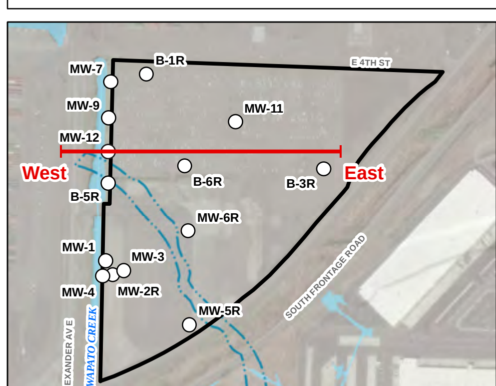


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FIGURE 7

Log Yard Remedial Alternative 3A Cross Section

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

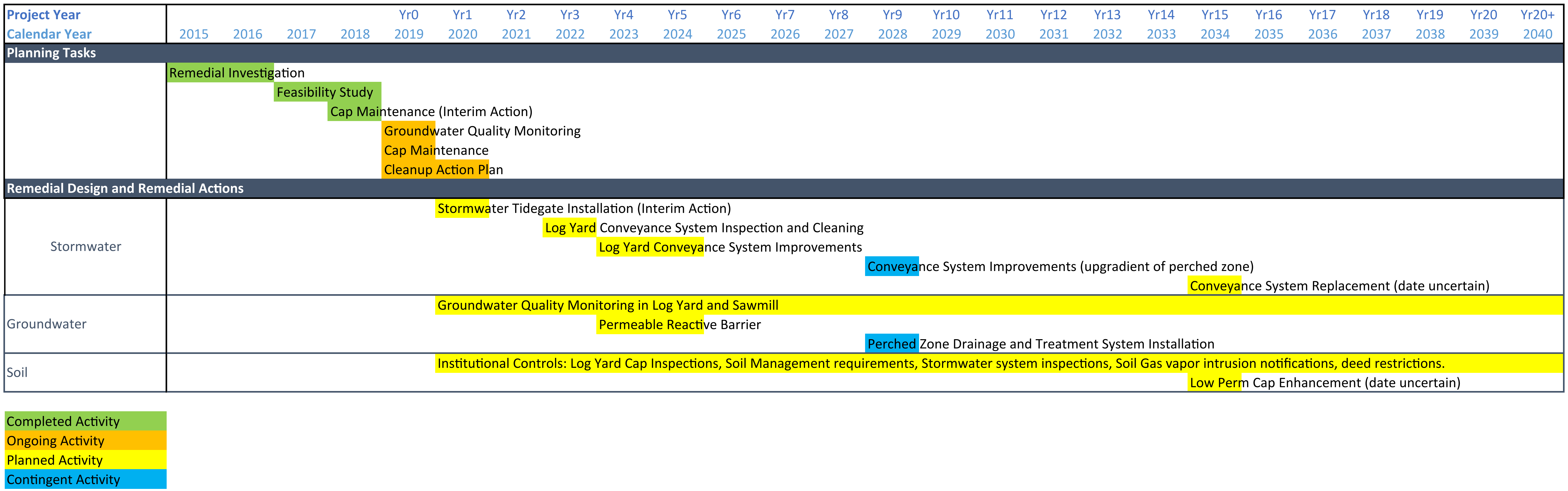

FIGURE 8

Log Yard Estimated Cleanup Action Timeline

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

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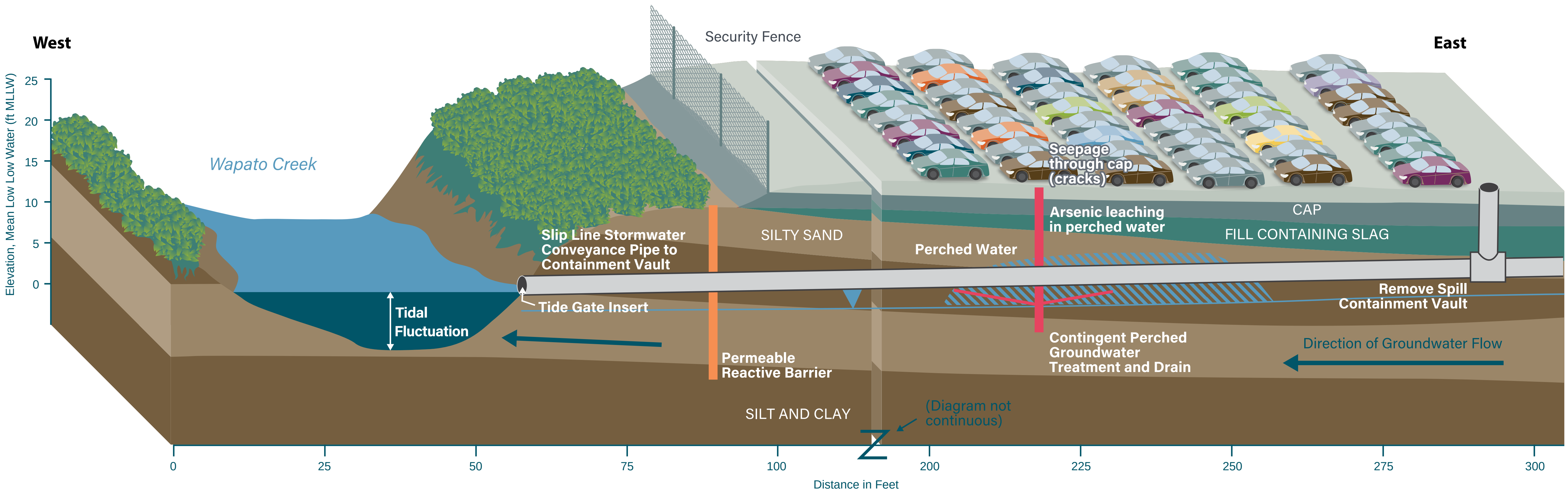

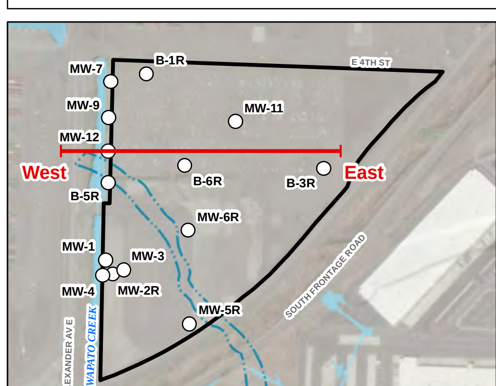

FIGURE 9

Log Yard Remedial Alternative 3A Contingent Perched Groundwater Trearment

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

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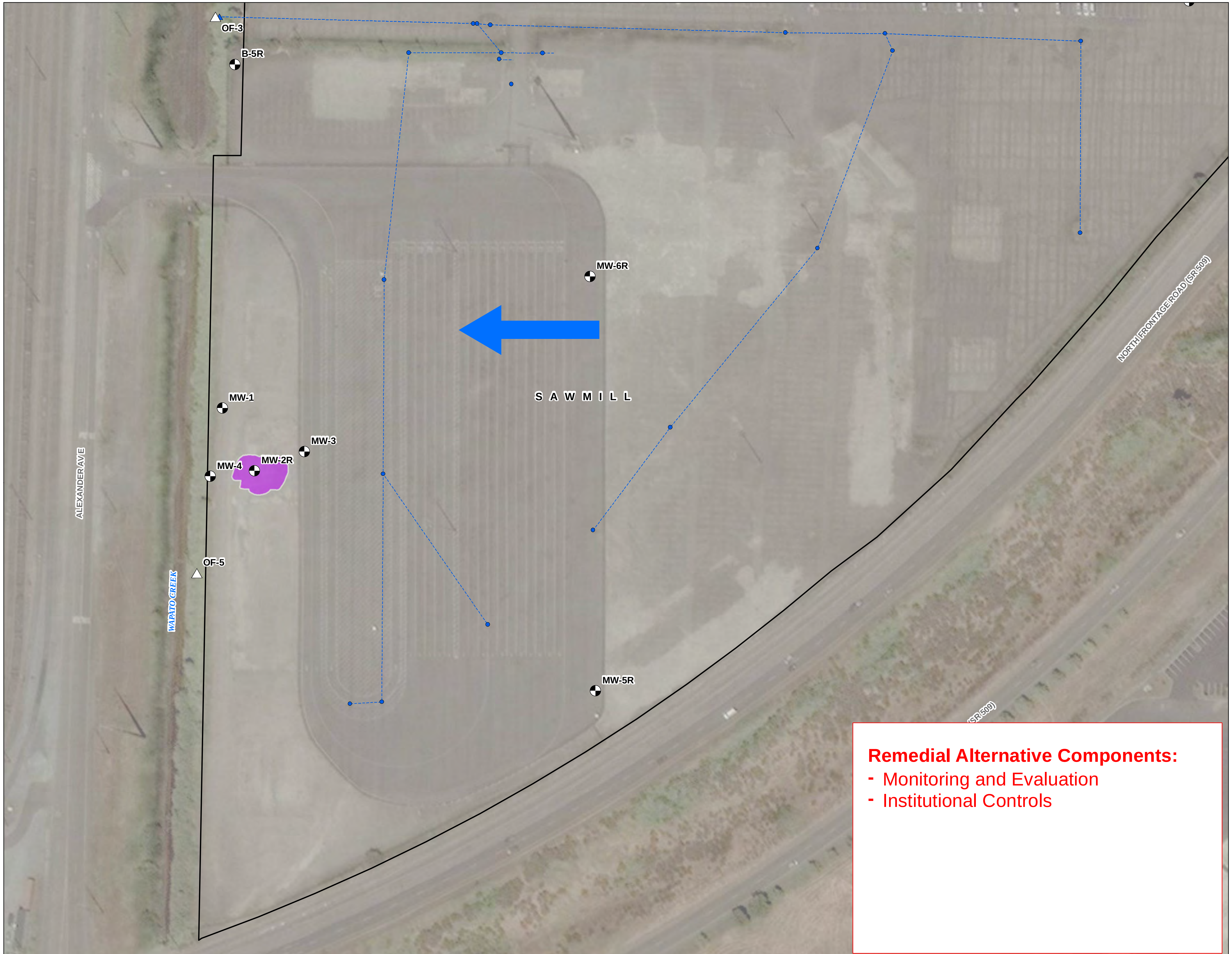

Remedial Alternative Components:
- Monitoring and Evaluation
- Institutional Controls

FIGURE 10

Sawmill Remedial Alternative 1

Cleanup Action Plan
Parcel 15
Tacoma, WA

LEGEND

Site Features[1]
- Monitoring Well
- Stormwater Outfall

Storm Features
- Outfall
- Vault
- Stormwater Conveyance Pipe

Remedial Alternative Features
- Former Dip Tank Excavation/Fill Extent (Approximate)

All Other Features
- Site Boundary[2]
- Groundwater Flow Direction

NOTES
1. Locations have been surveyed, May 2016.
2. Site boundary defined in Exhibit A of the Draft Agreed Order No. DE 11237 (Ecology, 2015).

N

0 65 130 195
Feet

GSI Water Solutions, Inc.

Date: April 13, 2020
Data Sources: PORTAC, Aerial photo taken September 2018 by Metro

Document Path: Y:\0603_Port_Tacoma\Source_Figures\Cleanup_Action_Plan\2020_Update\Figure10_SM_Remedial_Alt2.mxd

FIGURE 11

Point of Compliance Locations

Cleanup Action Plan
Parcel 15
Tacoma, WA

LEGEND

Point of Compliance Location

- Monitoring Well
- Surface Water

All Other Features

- Vault
- Stormwater Conveyance Pipe
- Former Dip Tank
- Site Boundary[1]
- Railroad
- Watercourse
- Waterbody

NOTE

1. Site boundary defined in Exhibit A of the Draft Agreed Order No. DE 11237 (Ecology, 2015).

N

0 150 300 450
Feet

Date: April 9, 2020
Data Sources: PORTAC, Aerial photo taken September 2018 by Metro

GSI Water Solutions, Inc.

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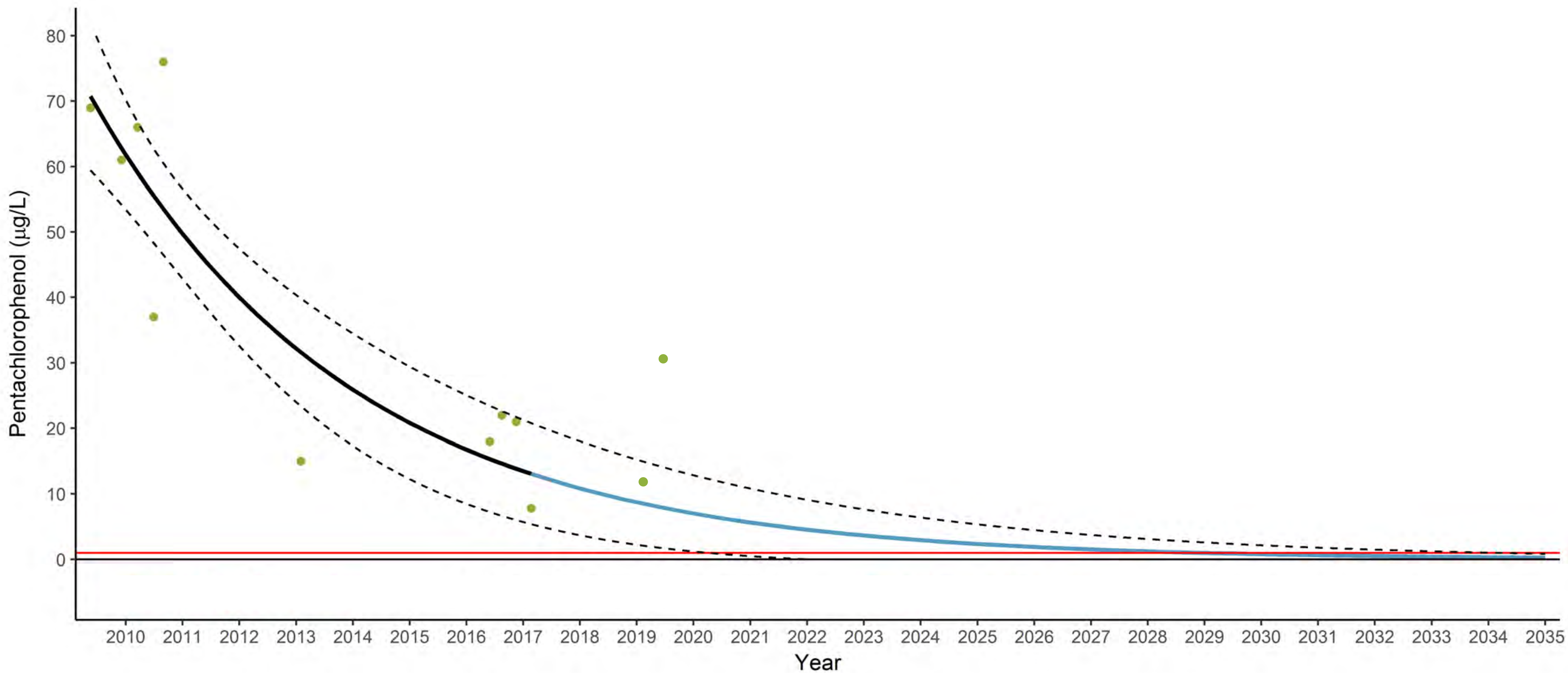
Appendix A

PCP Concentrations at Site Well MW-2R



LEGEND

- Target Concentration
- Log Regression of Available Data
- Predicted Decay Values
- Upper and Lower 85% Confidence Limit

NOTE:
Half-life is 3.19 years, calculated based on modeled decay constat
Decay prediction equation, y=exp(6.30-0.217*(x)); where x is the decimal year

MW-2R DATA

EVENT	PCP (ug/kg)	pH
1	18	12.01
2	22	11.72
3	21	11.21
4	7.8	11.84
5	12	11.85
6	31	11.02

APPENDIX A

PCP Concentrations at Site Well MW-2R

Cleanup Action Plan
Parcel 15
Tacoma, WA

GSI Water Solutions, Inc.

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Appendix B

Revised Environmental Benefit and Probable Cost Tables and DCA Figure

COST ESTIMATE
SUMMARY TABLE

Remedial Alternatives		Net Present Value[2]
Log Yard		
Alternative 1	Asphalt Overlay, Stormwater System Repair, MNA, PRB Contingency	$9,505,000
Alternative 2	Enhanced Cap, Stormwater System Repair, MNA, PRB Contingency	$10,549,000
Alternative 3	Low Permeability Cap, Stormwater System Replacement, MNA, PRB Contingency	$12,254,000
Alternative 3A	Perched Zone Treatment, PRB, Stormwater System Repair, MNA, Low Permeability Cap Contingency	$11,507,000
Alternative 4	Asphalt Overlay, Stormwater System Repair, Ex Situ Treatment, MNA, PRB Contingency	$10,921,000
Alternative 5	Excavation & Off-site Disposal, Stormwater System Replacement, MNA, PRB Contingency	$30,964,000

Notes:
1. Estimated costs are in 2017 dollars
2. Net present value (NPV) based on reasonable return on investment (ROI) estimate (5.5%) subtracted from average City of Tacoma consumer price index (CPI) between 1998 and 2016 (2.4%) for a discount rate of (3.1%).

Initial and Annual Costs[1]

Item	Quantity	Unit	Rate/ %	Total
Initial (Year 1) Costs				
Mobilization			6%	$4,000
Stormwater System Repair	1	LS	$58,500	$58,500
Design and Permitting			15%	$9,000
Construction Management			10%	$6,000
Project Management			8%	$5,000
Ecology Review/Oversight for Implementation			2%	$1,000
Sales Tax (City of Tacoma)			10.1%	$6,000
			Year 1 Costs Subtotal	**$89,500**
Stormwater System Slip Lining (Year 2) Costs				
Mobilization			6%	$23,000
Stormwater System Repair (Slip Line)	1	LS	$270,000	$270,000
Stormwater System Repair (Vault Replacement)	1	LS	$107,000	$107,000
Design and Permitting			8%	$30,000
Construction Management			4%	$15,000
Project Management			3%	$11,000
Ecology Review/Oversight for Implementation			1%	$4,000
Sales Tax (City of Tacoma)			10.1%	$40,000
			Year 2 Costs Subtotal	**$500,000**
Perched Zone Treatment and Drain (Year 5) Costs				
Mobilization			8%	$27,000
Perched Zone Treatment and Drain Installation (8- 12' bgs, ZVI sumps 12-18'bgs)	1	LS	$342,000	$342,000
Design and Permitting			12%	$41,000
Construction Management			8%	$27,000
Project Management			5%	$17,000
Ecology Review/Oversight for Implementation			2%	$7,000
Sales Tax (City of Tacoma)			10.1%	$37,000
			Year 5 Costs Subtotal	**$498,000**
PRB (Year 10) Costs				
Mobilization			6%	$60,000
PRB Installation (10% ZVI @ 25'-10'bgs)	1,000	LF	$1,000	$1,000,000
Design and Permitting			8%	$80,000
Construction Management			4%	$40,000
Project Management			3%	$30,000
Ecology Review/Oversight for Implementation			1%	$10,000
Sales Tax (City of Tacoma)			10.1%	$107,000
			Year 10 Costs Subtotal	**$1,327,000**
Cap Improvement Contingency (Year 15) Costs				
Mobilization			4%	$283,000
Low Permeability Cap (GCL, 5" HMA cover)	1	LS	$6,360,000	$6,360,000
Stormwater System Replacement	1	LS	$672,000	$672,000
Monitoring well repairs/replacement	18	EA	$2,500	$45,000
Design and Permitting			4%	$281,000
Construction Management			3%	$211,000
Project Management			2%	$141,000
Ecology Review/Oversight for Implementation			1%	$70,000
Sales Tax (City of Tacoma)			10.1%	$743,000
			Year 15 Costs Subtotal	**$8,806,000**
Initial Other Costs				
Institutional controls	1	LS	$10,000	$10,000
			Initial Construction and Other Costs Subtotal	**$9,403,500**
			Initial Construction Costs Contingency[2] (20%)	**$1,880,700**
			Total Initial Construction and Other Costs	**$11,284,200**

Annual Long Term Costs	No. of Events	Unit	Rate/ %	Annual Total	Years	Total
Annual Costs - Yr 1-5						
Maintain Inst. Controls	1	LS	$1,000	$1,000	5	$5,000
Cap Inspections	1	LS	$8,500	$8,500	5	$42,500
Cap Repairs	1	LS	$54,000	$54,000	5	$270,000
Ground/Surface Water Sampling & Annual Reporting (YR 1)	4	LS	$11,500	$46,000	1	$46,000
Ground/Surface Water Sampling & Annual Reporting	2	LS	$14,500	$29,000	4	$116,000
Porewater Sampling (YR 4)	2	LS	$14,500	$29,000	1	$29,000
Ecology Review/Oversight for annual events		5%	$5,500	$5,500	5	$27,500
Annual Costs - Yrs 6-15						
Maintain Inst. Controls	1	LS	$1,000	$1,000	10	$10,000
Cap Repairs	1	LS	$54,000	$54,000	5	$270,000
Cap Inspections	1	LS	$8,500	$8,500	10	$85,000
Groundwater Sampling and Annual Reporting	2	LS	$13,500	$27,000	10	$270,000
Porewater Sampling (YR 9)	2	LS	$14,500	$29,000	1	$29,000
Ecology Review/Oversight for annual events		5%	$6,000	$6,000	10	$60,000
Annual Costs - Yrs 16-100						
Maintain Inst. Controls	1	LS	$1,000	$1,000	85	$85,000
Cap Inspections	1	LS	$8,500	$8,500	85	$722,500
Reduced Groundwater Sampling & Reporting (YRs 16-21)	1	LS	$17,000	$17,000	5	$85,000
Reduced Groundwater Sampling & Reporting (Twice/5YR)	0.4	LS	$17,000	$6,800	85	$578,000
Ecology Review/Oversight for annual events		5%	$1,700	$1,700	85	$144,500
Other Periodic Costs						
GCL Liner Repair		3%	$190,800	$190,800	yr 25, 50, 80	$572,400
PRB Maintenance/Repair		25%	$331,750	$331,750	yr 45	$331,750
Perched Zone PRB Maintenance/Repair		10%	$49,800	$49,800	yr 20, 50, 80	$149,400
Abandon wells	12	EA	$1,500	$18,000	yr 100	$18,000

Net Present Value Calculation

Year	Initial/One Time Costs	Annual	Contingency (20%)	Total	Inflated Cost (2.4%)	NPV Cost (ROI 5.5%)	Year	Initial/One Time Costs	Annual	Contingency (20%)	Total	Inflated Cost (2.4%)	NPV Cost (ROI 5.5%)
1	$89,500	$115,000	$40,900	$245,400	$251,290	$238,189	51	$0	$18,000	$3,600	$21,600	$72,402	$4,719
2	$500,000	$98,000	$119,600	$717,600	$752,458	$676,048	52	$0	$18,000	$3,600	$21,600	$74,140	$4,581
3	$0	$98,000	$19,600	$117,600	$126,272	$107,535	53	$0	$18,000	$3,600	$21,600	$75,919	$4,446
4	$0	$127,000	$25,400	$152,400	$167,566	$135,262	54	$0	$18,000	$3,600	$21,600	$77,741	$4,315
5	$1,327,000	$98,000	$285,000	$1,710,000	$1,925,289	$1,473,105	55	$0	$18,000	$3,600	$21,600	$79,607	$4,189
6	$0	$96,500	$19,300	$115,800	$133,508	$96,826	56	$0	$18,000	$3,600	$21,600	$81,518	$4,065
7	$0	$96,500	$19,300	$115,800	$136,713	$93,981	57	$0	$18,000	$3,600	$21,600	$83,474	$3,946
8	$0	$96,500	$19,300	$115,800	$139,994	$91,220	58	$0	$18,000	$3,600	$21,600	$85,477	$3,830
9	$0	$125,500	$25,100	$150,600	$186,434	$115,147	59	$0	$18,000	$3,600	$21,600	$87,529	$3,718
10	$498,000	$96,500	$118,900	$713,400	$904,342	$529,429	60	$0	$18,000	$3,600	$21,600	$89,630	$3,608
11	$0	$96,500	$19,300	$115,800	$150,317	$83,412	61	$0	$18,000	$3,600	$21,600	$91,781	$3,502
12	$0	$96,500	$19,300	$115,800	$153,925	$80,961	62	$0	$18,000	$3,600	$21,600	$93,983	$3,399
13	$0	$96,500	$19,300	$115,800	$157,619	$78,583	63	$0	$18,000	$3,600	$21,600	$96,239	$3,299
14	$0	$96,500	$19,300	$115,800	$161,402	$76,273	64	$0	$18,000	$3,600	$21,600	$98,549	$3,203
15	$8,816,000	$96,500	$1,782,500	$10,695,000	$15,264,414	$6,837,436	65	$0	$18,000	$3,600	$21,600	$100,914	$3,108
16	$0	$28,200	$5,640	$33,840	$49,457	$20,999	66	$0	$18,000	$3,600	$21,600	$103,336	$3,017
17	$0	$28,200	$5,640	$33,840	$50,644	$20,382	67	$0	$18,000	$3,600	$21,600	$105,816	$2,928
18	$0	$28,200	$5,640	$33,840	$51,860	$19,783	68	$0	$18,000	$3,600	$21,600	$108,355	$2,842
19	$0	$28,200	$5,640	$33,840	$53,104	$19,201	69	$0	$18,000	$3,600	$21,600	$110,956	$2,759
20	$49,800	$28,200	$15,600	$93,600	$150,409	$51,550	70	$0	$18,000	$3,600	$21,600	$113,619	$2,678
21	$0	$18,000	$3,600	$21,600	$35,543	$11,547	71	$0	$18,000	$3,600	$21,600	$116,346	$2,599
22	$0	$18,000	$3,600	$21,600	$36,396	$11,207	72	$0	$18,000	$3,600	$21,600	$119,138	$2,523
23	$0	$18,000	$3,600	$21,600	$37,269	$10,878	73	$0	$18,000	$3,600	$21,600	$121,997	$2,449
24	$0	$18,000	$3,600	$21,600	$38,164	$10,558	74	$0	$18,000	$3,600	$21,600	$124,925	$2,377
25	$190,800	$18,000	$41,760	$250,560	$453,326	$118,877	75	$0	$18,000	$3,600	$21,600	$127,924	$2,307
26	$0	$18,000	$3,600	$21,600	$40,018	$9,947	76	$0	$18,000	$3,600	$21,600	$130,994	$2,239
27	$0	$18,000	$3,600	$21,600	$40,978	$9,655	77	$0	$18,000	$3,600	$21,600	$134,138	$2,173
28	$0	$18,000	$3,600	$21,600	$41,962	$9,371	78	$0	$18,000	$3,600	$21,600	$137,357	$2,109
29	$0	$18,000	$3,600	$21,600	$42,969	$9,096	79	$0	$18,000	$3,600	$21,600	$140,653	$2,047
30	$0	$18,000	$3,600	$21,600	$44,000	$8,828	80	$240,600	$18,000	$51,720	$310,320	$2,069,218	$28,550
31	$0	$18,000	$3,600	$21,600	$45,056	$8,569	81	$0	$18,000	$3,600	$21,600	$147,486	$1,929
32	$0	$18,000	$3,600	$21,600	$46,137	$8,317	82	$0	$18,000	$3,600	$21,600	$151,025	$1,872
33	$0	$18,000	$3,600	$21,600	$47,245	$8,073	83	$0	$18,000	$3,600	$21,600	$154,650	$1,817
34	$0	$18,000	$3,600	$21,600	$48,378	$7,836	84	$0	$18,000	$3,600	$21,600	$158,362	$1,764
35	$0	$18,000	$3,600	$21,600	$49,540	$7,605	85	$0	$18,000	$3,600	$21,600	$162,162	$1,712
36	$0	$18,000	$3,600	$21,600	$50,729	$7,382	86	$0	$18,000	$3,600	$21,600	$166,054	$1,662
37	$0	$18,000	$3,600	$21,600	$51,946	$7,165	87	$0	$18,000	$3,600	$21,600	$170,040	$1,613
38	$0	$18,000	$3,600	$21,600	$53,193	$6,954	88	$0	$18,000	$3,600	$21,600	$174,121	$1,565
39	$0	$18,000	$3,600	$21,600	$54,469	$6,750	89	$0	$18,000	$3,600	$21,600	$178,299	$1,519
40	$0	$18,000	$3,600	$21,600	$55,777	$6,552	90	$0	$18,000	$3,600	$21,600	$182,579	$1,475
41	$0	$18,000	$3,600	$21,600	$57,115	$6,359	91	$0	$18,000	$3,600	$21,600	$186,960	$1,431
42	$0	$18,000	$3,600	$21,600	$58,486	$6,172	92	$0	$18,000	$3,600	$21,600	$191,448	$1,389
43	$0	$18,000	$3,600	$21,600	$59,890	$5,991	93	$0	$18,000	$3,600	$21,600	$196,042	$1,349
44	$0	$18,000	$3,600	$21,600	$61,327	$5,815	94	$0	$18,000	$3,600	$21,600	$200,747	$1,309
45	$331,750	$18,000	$69,950	$419,700	$1,220,217	$109,667	95	$0	$18,000	$3,600	$21,600	$205,565	$1,270
46	$0	$18,000	$3,600	$21,600	$64,306	$5,478	96	$0	$18,000	$3,600	$21,600	$210,499	$1,233
47	$0	$18,000	$3,600	$21,600	$65,849	$5,317	97	$0	$18,000	$3,600	$21,600	$215,551	$1,197
48	$0	$18,000	$3,600	$21,600	$67,430	$5,161	98	$0	$18,000	$3,600	$21,600	$220,724	$1,162
49	$0	$18,000	$3,600	$21,600	$69,048	$5,009	99	$0	$18,000	$3,600	$21,600	$226,021	$1,128
50	$240,600	$18,000	$51,720	$310,320	$1,015,799	$69,853	100	$18,000	$18,000	$7,200	$43,200	$462,892	$2,189
												Net Present Value[3]	$11,507,000

Table 2. Log Yard DCA Evaluation (revisions show in red font)

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								
Alternative 3	8	7	8	7	7	--			
Alternative 3A - Conveyance System Repair - Permeable Reactive Barrier - Perched Groundwater Treatment -MNA - Low Permeability Cap Contingency - Institutional Controls	Achieves a high level of overall protectiveness through the use of a PRB with a contingent perched groundwater treatment system. The stormwater conveyance system will be sliplined in areas affected by groundwater infiltration and replaced when the property is developed or contigency low permeability cap implemented. Protectiveness is enhanced by installing a PRB near Wapato Creek. A contingent action will directly remove perched water groundwater and reduce arsenic flux to groundwater and Wapato Creek. A contigent low permeability cap would be implemented if criteria conditions are exceeded. With this tiered approach the overall protectiveness of the remedy is enhanced.	Achieves a high score for permanence. Permanence under this alternative is enhanced over Alternatives 1, 2 and 3 by directly removing perched groundwater. This alternative is more permanent than Alternative 4 as it integrates better with Port land use planning and employs a more robust contigent cap design. The cap design is expected to reduce the generation of high-arsenic perched water in comparison to Alternatives 1, 2 3, and 4. The stormwater system repair (slipline) and eventual replacement will also prevent future seepage of arsenic-containing groundwater into the storm drainage system.	Achieves a high level of long-term effectiveness through the use of perched groundwater treatment, stormwater system improvements, a PRB, and a contingent low-permeability cap to reduce perched water in source material and subsequent migration pathways. At the time of property development or implementation of the contingent low permeability cap, the stormwater conveyance system will be replaced eliminating risks that leaks would recur over the long-term. The reduction in infiltration and groundwater flux under this alternative optimizes conditions for ongoing natural attenuation of arsenic, reducing the likelihood that the contingent PRB will be required. If the PRB is required, the lifespan of the treatment media will be improved relative to other alternatives with higher groundwater flux rates.	This alternative has a medium score for short-term risk management. It involves more extensive construction activities during the perched water drain installation and initally during cap installation than under Alternatives 1, 2, 3, or 4. Construction-related risks are lower than under Alternative 5, because the quantity of arsenic-contaminated soils workers will be exposed to will be much less. The alternative includes significant on-site construction activities, but does not involve extensive off-site transportation of contaminated soils as under Alternative 5.	Alternative 3A has the highest score for implementability because it integrates best with property development planning and current uses. Implementation of the perched water treatment in this alternative is expected to be less complex and requiring less long term maintenance as it is expected to discharge in situ.	Evaluation pending public comment.	7.3	$11.5M	0.63
	9	9	8	6	7	--			

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								

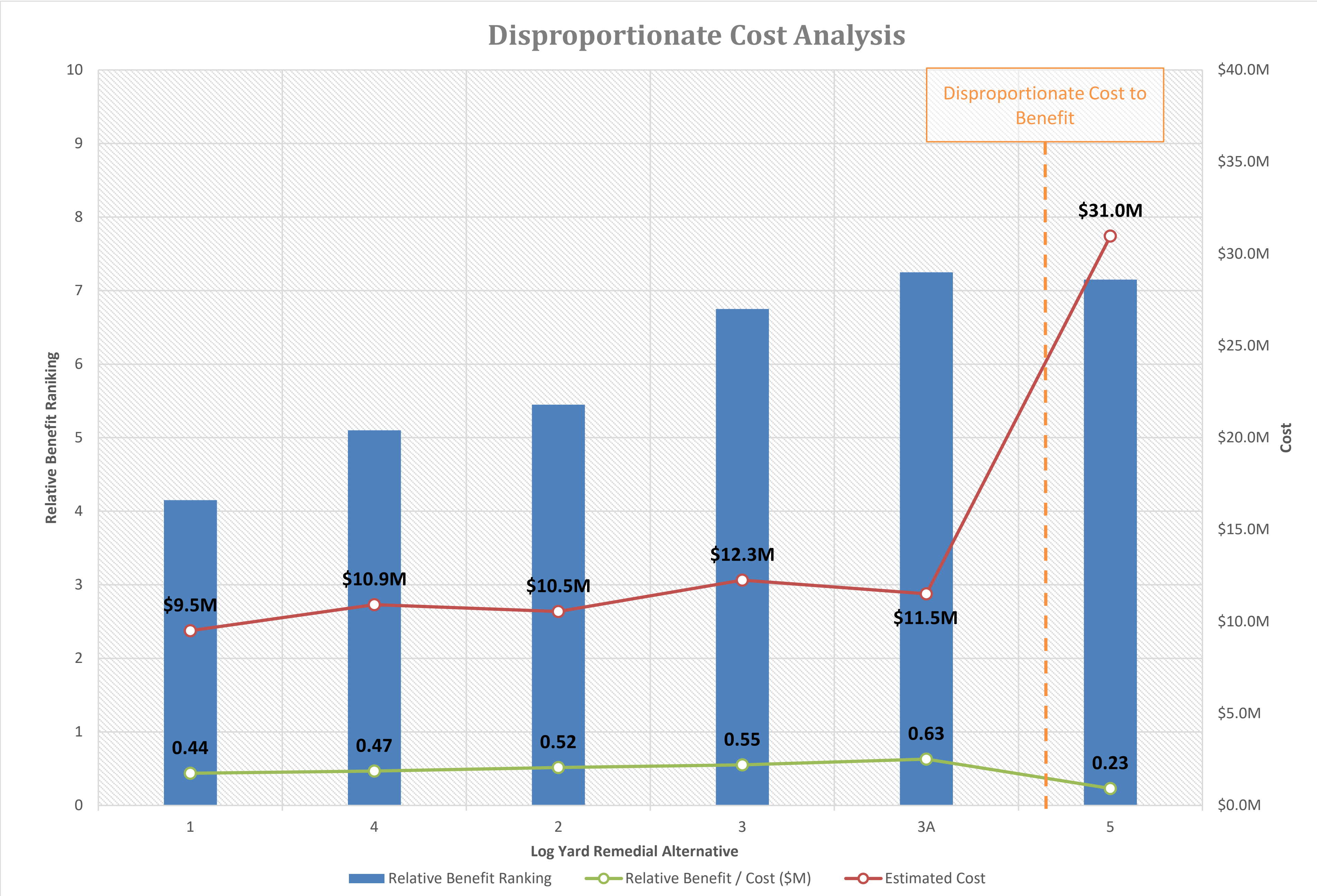
Notes:

1. Consideration of public concerns is not addressed in this table because the public has not yet had an opportunity to provide comments.
2. Each of the DCA criteria listed were weighted, so the overall DCA score would be influenced by criteria directly relating to protectiveness and effectiveness. A score of 10 represents an alternative that satisfies the criteria to the highest degree.
3. Probable cost reflects the total estimated cost including applicable contingencies (see cost detail in Appendix A).
4. Probable costs were evaluated in increments of $1 million for comparison to benefit scoring.
5. A formula error in the orginal FS cost estimating tables for Alternative 4 was corrected as part of this FS Addendum effort, correspondingly Alternative 4's cost has been updated.

PRB = permeable reactive barrier

MNA = monitored natural attenuation

Revised Figure 6 from FS Addendum



Appendix C

Revised Environmental Benefit Table and DCA Figure

Table 8. Sawmill DCA Evaluation (revisions shown in red font)

Remedial Alternative[1]	Protectiveness (25%)[2]	Permanence (20%)	Long-Term Effectiveness (20%)	Short-Term Risk Management (15%)	Technical and Administrative Implementability (10%)	Public Concerns (10%)	Environmental Benefit Score	Probable Cost[3]	Benefit Score / Probable Cost[4]
	Relative Ranking - Scored from 1 (lowest) to 10 (highest)								
Alternative 1 - MNA - Institutional Controls	Achieves a medium score for overall protectiveness through ongoing monitored natural attenuation. **6**	Residual contamination can be permanently detoxified through natural processes. This alternative receives a medium-high score for permanent reduction of mass and toxicity of hazardous substances at the Site. **6**	This alternative receives a medium score for effectiveness as the time to complete the cleanup is longer than under the other alternatives. Long term effectiveness of this alternative depends upon maintaining institutional controls until contaminants attenuate and degrade. **6**	This alternative was scored high for short term risk management. This alternative does not require any ex situ handling of residual contamination as treatment would occur in situ. There are no additional construction-related risks requiring management. **9**	This alternative is scored high for implementability. This alternative requires only routine site monitoring. **9**	Evaluation pending public comment. **--**	6.2	$495K	1.24
Alternative 2 - Enhanced Bioremediation - MNA - Institutional Controls	Achieves a medium score for overall protectiveness because injection of amendments is not expected to accelerate in situ biodegradation and natural attenuation great than would occur for Alternative 1. **6**	This alternative receives a medium score for permanent reduction of mass and toxicity of hazardous substances at the Site. Injection of amendments is not expected to result in a faster rate than under Alternative 1. **6**	This alternative receives a medium score for effectiveness because the time required to complete the cleanup is expected to be the same as Alternative 1. Long term effectiveness of this alternative depends upon maintaining institutional controls until contaminants attenuate and degrade. **6**	This alternative was scored medium-high for short term risk management. This alternative does not require any ex situ handling of residual contamination as treatment would occur in situ. However, some handling of corrosive chemicals would be required during amendment injection. **8**	This alternative is scored high for implementability. Neutralization agents and injection mechanisms are well-developed technologies that could be rapidly procured and implemented. **8**	Evaluation pending public comment. **--**	5.9	$539K	1.09
Alternative 3 - Expanded Excavation and Off-Site Disposal - Temporary Groundwater Extraction and Treatment - MNA - Institutional Controls	Achieves a high score for overall protectiveness by reducing residual contaminant mass through excavation and temporary groundwater treatment, reducing the expected timeline until residual contamination is below cleanup levels in all wells. **9**	This alternative receives a high score for rapid removal of remaining groundwater contamination at the Site, relative to Alternatives 1 or 2. **9**	This alternative receives a high score for long-term effectiveness because it has shortest restoration time-frame and interim institutional controls are not likely required for groundwater. **9**	This alternative was score medium for short term risk management. Excavation and ex situ treatment are included as remedial elements in this alternative. Ex situ handling of contaminated media creates short term exposure potential for site workers or fugitive emissions. **5**	This alternative is scored medium for implementability. The alternative will require management of stormwater and extracted groundwater during construction, and off-site management of excavated soils. **5**	Evaluation pending public comment. **--**	7.1	$742K	0.96

Notes:
1. Consideration of public concerns is not addressed in this table because the public has not yet had an opportunity to provide comments.
2. Each of the DCA criteria listed were weighted, so the overall DCA score would be influenced by criteria directly relating to protectiveness and effectiveness. A score of 10 represents an alternative that satisfies the criteria to the highest degree.
3. Probable cost reflects the total estimated cost including applicable contingencies (see cost detail in Appendix C).
4. Probable costs were evaluated in $100,000 increments for comparison to benefit scoring.
MNA = monitored natural attenuation

Revised Figure 14 from Feasibility Study