REVISED ANALYSIS OF BROWNFIELD CLEANUP ALTERNATIVES

Former Frontier Leather Tannery Property

1210 SW Oregon Street

Sherwood, Oregon

Cooperative Agreement BF-00J93201

Prepared for:

City of Sherwood
22580 SW Pine Street
Sherwood, OR 97140

Prepared by:

Wood Environment & Infrastructure Solutions, Inc.
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July 2018

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wood.

July 23, 2018
Project No. 5-61M-130820

City of Sherwood
22580 SW Pine Street
Sherwood, Oregon 97140

Attention: Ms. Julia Hajduk

Subject: Revised Analysis of Brownfield Cleanup Alternatives – Draft
Former Frontier Leather Tannery Property
1210 SW Oregon Street – Sherwood, Oregon
Cooperative Agreement BF-00J93201

Dear Julia:

Wood Environment & Infrastructure Solutions, Inc. (Wood) is pleased to submit this Revised Analysis of Brownfield Cleanup Alternatives (ABCA) for the above-referenced property in Sherwood, Oregon. The ABCA was revised to address comments received from the Oregon Department of Environmental Quality (DEQ) dated October 24 and 30, 2017, and February 22, 2018. The United States Environmental Protection Agency did not provide comments. Responses to DEQ comments are presented in Appendix A.

We appreciate the opportunity to serve you on this project. If you have any questions or require further information, please feel free to contact us at (503) 639-3400.

Sincerely,

Wood Environment & Infrastructure Solutions, Inc.

Michelle Peterson, RG
Project Manager

Russ Bunker, RG
Associate Geologist

Attachments

GT/CE/MLP/ay

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Former Frontier Leather Tannery Property
Sherwood, Oregon

1.0 INTRODUCTION

On behalf of the City of Sherwood (City), Wood Environment & Infrastructure Solutions, Inc. (Wood, formerly Amec Foster Wheeler Environment & Infrastructure, Inc. [Amec Foster Wheeler]) has prepared this Analysis of Brownfield Cleanup Alternatives (ABCA) for the Former Frontier Leather Property located at 1210 SW Oregon Street in Sherwood, Oregon. The City was awarded a United States Environmental Protection Agency (EPA) Site-Specific Brownfields Assessment Grant in 2014 to conduct assessment and cleanup planning for Tax Lots 600 and 602, collectively referred to as the Former Frontier Leather Property and the Site. All grant work performed by the City and its contractors was performed in accordance with the Cooperative Agreement (BF-00J93201) executed by the United States Environmental Protection Agency (EPA) and the City.

This ABCA was originally submitted to the DEQ and the EPA on October 5, 2017. EPA did not provide comments on the ABCA. DEQ provided comments dated October 24 and 30, 2017, and February 22, 2018. Responses to DEQ comments were provided in two memorandums on February 6, 2018, and July 13, 2018. The Revised ABCA incorporates the responses to DEQ's comments. Responses to DEQ are presented in a comment response table provided in Appendix A. DEQ comments letters and response memoranda are also provided in Appendix A.

2.0 PROJECT BACKGROUND

This section provides a summary of the Site history, a site description, the proposed development plan, a summary of previous investigations, and the project objectives.

2.1 SITE LOCATION AND DESCRIPTION

The Site is located in Washington County, in Township 2 South, Range 1 West of the Willamette Meridian at the southwest corner of Section 29 (Figure 1). The Site consists of two vacant tax lots (Tax Lots 600 and 602) covering approximately 24 acres located in an industrially-zoned area of Sherwood, Oregon along SW Oregon Street (Figure 2). The Site is surrounded by industrially zoned land on the west, north, and east. A railroad right-of-way borders the Site on the north. A residential neighborhood is located south of the Site, across SW Oregon Street. The Site contains

17.36 acres of wetland areas (Amec Foster Wheeler, 2016a; Amec Foster Wheeler 2017) and is identified as part of the Rock Creek Unit of the Tualatin River National Wildlife Refuge. Rock Creek crosses the northeastern most tip of Tax Lot 600. Washington County currently owns the property as a result of property tax foreclosure.

Current Site features from historical operations include one small shed, two former sedimentation lagoons and their associated bermed perimeters, two shallow depressions from historical aeration ponds used to treat tanning wastes before they were discharged to the bermed sedimentation lagoons, an access road that enters the property from the west, extending to the east between the two aeration ponds, a surficial drainage ditch that runs parallel to the railroad tracks along the northern property boundary, and seven monitoring wells (installed during the Oregon Department of Environmental Quality [DEQ's] Remedial Investigation [RI] in 2003). Prior investigations also identified a hide-split landfill along the western edge of Tax Lot 600.

2.2 SITE HISTORY

The two tax lots that comprise the Site were historically part of a large tannery operation that existed from the late 1940s through the early 1990s and covered approximately 33 acres on six tax lots. The portion of the Site being evaluated for cleanup under this grant consists of two tax lots (600 and 602) used for landfilling of hide-splits (the non-valued part of the hide) and for processing various tannery wastes. These historical uses impacted soil, sediment, and shallow groundwater from a variety of contaminants associated with the tanning process and waste treatment.

2.3 ASSESSMENT SUMMARY

The Oregon Department of Environmental Quality conducted a Remedial Investigation (RI) of Tax Lot 600 in 2003 and 2004 (GeoEngineers, 2004). Groundwater monitoring was conducted at the Site by DEQ between 2005 and 2007 (DEQ, 2015b). Wood conducted a Supplemental Remedial Investigation (Amec Foster Wheeler, 2016b) of Tax Lot 602 in 2015. The scope and findings of the investigations are summarized below, with additional details presented in the project Quality Assurance Project Plan & Sampling and Analysis Plan (QAPP-SAP) (Amec Foster Wheeler, 2015). Additional information for each is also available in the relevant DEQ environmental cleanup file. The DEQ Environmental Cleanup Site Information Database (ECSI) file number for the sedimentation lagoon portion of the Former Frontier Leather Property is #2638.

Additional information pertaining to the nature of potential impacts at the Site are included in a Staff Report prepared by DEQ for the Ken Foster Farms Site (DEQ, 2015a), which is located approximately 0.5 miles south of the Site. The Ken Foster Farms Site is related because it also received tannery wastes generated at the Former Frontier Leather Tannery property. The DEQ file number for the Ken Foster Farms Site is #2516.

2.3.1 Remedial Investigation, GeoEngineers, 2004

The RI was conducted in 2003 and 2004 to evaluate potential impacts on Tax Lot 400 and Tax Lot 600 from historical tannery operations. Tax Lot 400 is not part of the current Site, while Tax Lot 600 is and contains the sedimentation lagoons and wetland areas extending east to Rock Creek. Tax Lot 602 was not included in the RI completed in 2004, because DEQ was not able to secure access to conduct the investigation at that time.

The RI evaluated the vertical and horizontal extent of hide-splits, and the potential impacts in soil, sediment, groundwater, and surface water. The field investigation included the completion of 24 test pits, 63 hand auger borings, and installation of 7 monitoring wells, which resulted in the sampling and analysis of more than 150 soil samples, 9 sediment samples, 23 groundwater samples, 19 surface water samples from upland seeps, and 8 samples of surface water from Rock Creek.

2.3.2 Groundwater and Surface Water Assessment, DEQ, 2005-2007

After the RI was completed, DEQ collected and analyzed groundwater from four monitoring wells and surface water from five locations, between 2005 and 2007. Groundwater samples were analyzed for dissolved chromium and manganese. Surface water samples were analyzed for total chromium and manganese. Results from the sampling were consistent with results from samples collected in 2003 and 2004.

2.3.3 Supplemental Remedial Investigation – Amec Foster Wheeler, 2015

The Site investigation to support the Supplemental RI was conducted in November 2015 to assess the nature and extent of contamination on Tax Lot 602. The investigation included a geophysical survey to map the extent of the hide-split landfill on Tax Lot 602. A subsurface investigation was conducted and was comprised of 24 subsurface borings installed to a maximum depth of 20 feet below ground surface (bgs). Seven borings were installed within the northern aeration pond footprint; four borings were installed within the southern aeration pond footprint; and the remaining borings were spatially distributed throughout Tax Lot 602. Groundwater samples were collected from five borings.

2.3.4 Wetland Delineation – Amec Foster Wheeler, 2017

A wetland delineation was conducted in May 2016 and March 2017 to determine the extent of wetland areas at the Site (Amec Foster Wheeler, 2016; Amec Foster Wheeler 2017). Approximately 17.36 acres were identified as wetland, in one of the following categories:

1. Palustrine emergent wetland habitat/waterway (Rock Creek and the 100-year floodplain)
2. Palustrine emergent wetland (Rock Creek floodplain outside the 100-year boundary, portions of the sedimentation lagoon interiors, within the aeration ponds, and on the terrace above south sedimentation lagoon)
3. Palustrian forested habitat (forested portion of the sedimentation lagoon interiors)
4. Palustrine forested habitat/waterway (forested area of stormwater drainage along railroad at the northern property boundary)
5. Open water/stormwater ditch (stormwater drainage under SW Oregon Street near the southeastern corner of the Site)

The Oregon Department of State Lands (DSL) concurred with the wetland delineation in May 2017 (DSL, 2017). Areas of the Site delineated as wetland are illustrated on Figure 2.

2.4 SUBSURFACE CONDITIONS

The descriptions provided in this section are based on regional geologic and hydrogeologic reference documents, logs of the subsurface conditions observed during field activities from the assessment conducted in November 2015 and the previous RI conducted in 2003-2004, and logs of surrounding wells which were identified during the beneficial water use determination.

2.4.1 Soils & Geology

The Site is located within the Tualatin Valley. Fine alluvium from channels and floodplains of the Tualatin River overlies the Missoula Flood deposits (~65 to 80 feet thick), which consist of heterogeneous layers of silts, sands and/or gravels (The Oregon Department of Geology and Mineral Industries [DOGAMI], 2012). The entire area is underlain by the basalts of the Columbia River Basalt Group, which erupted 14 to 16 million years ago, from fissure volcanoes near the border of Idaho. Bedrock is exposed at Bull Mountain, north of the site, and Pleasant Hill, south of the site (DOGAMI, 2012).

The National Resources Conservation Service maps the site soils as Quatama loam, Aloha silt loam, and Cove clay. The Quatama loam soil series is characterized by moderately well drained loam and clay loam, and a depth to water from 2 to 3 feet bgs. The Aloha silt loam soil series is mapped in the southwest portion of the site and characterized by somewhat poorly drained silt loam from 0 to 65 inches, and a depth to water from 1.5 to 2 feet bgs. The Cove clay soil series is mapped in the east portion of the site, near Rock Creek, and is characterized by poorly drained clay, and a depth to water from 0 to 1 foot bgs.

2.4.2 Groundwater & Hydrogeology

Based on local topography and the location relative to the Rock Creek, groundwater flow appears to be northeast. Well logs on file with the Oregon Water Resources Department (OWRD) indicate a shallow groundwater layer with significant seasonal variation from 2 to 30 feet bgs and a deeper aquifer 75 to 200 feet bgs. This is consistent with the findings of the previous RI which indicates depths to water ranging from approximately 1.5 feet bgs to greater than 15 feet bgs.

3.0 NATURE AND EXTENT OF CONTAMINATION

The investigations completed to date have defined the nature and extent of potential impacts in soil, groundwater, sediment, and surface water from historical operations that treated and disposed of tannery wastes on Site. The areas of contamination associated with site-related activities were defined based on the 2004 RI (GeoEngineers, 2004) and 2016 Supplemental RI (Amec Foster Wheeler, 2016b) to be within the following historical Site features: a) the footprint of the hide-split landfill, b) within the two aeration ponds, c) within the two sedimentation lagoons, d) downgradient of the breaches in the berms of each sediment lagoon, and e) in one small segment of Rock Creek downgradient of the breach in the north sedimentation lagoon. The nature and extent of contamination associated with these features is presented by media in the remainder of this section.

3.1 HIDE-SPLIT LANDFILL

A test pit investigation was conducted in 2004 and a geophysical investigation was conducted in 2015 to identify the extent of the hide-split landfill on Tax Lot 600 and Tax Lot 602, respectively. Hide splits were encountered up to 10 bgs in test pits, but the thickness was noted to decrease along the edges of the landfill and adjacent to roadways.

A limited amount of soil was encountered within the hide-split landfill so most soil sampling was focused on the surface soils (upper 3 feet) and soils immediately below encountered hides. Twenty-nine samples were collected from the test pits to characterize soil within the hide-split landfill area. All 29 samples were analyzed for the ten project-specific metals. Three samples were also analyzed for hexavalent chromium, semivolatile organic compound (SVOCs), organochlorine insecticide (OCIs), and polychlorinated biphenyls (PCBs).

Arsenic, cadmium, copper, manganese, nickel, and zinc were detected at concentrations that are largely consistent with naturally occurring background levels for the Portland area (DEQ, 2013). Antimony, chromium, lead, and mercury were each detected at concentrations greater than background levels, and are likely associated with the hide-splits. Chromium concentrations were the highest, with a maximum concentration of 21,000 milligrams per kilogram (mg/kg) detected in TP-3 at 4 feet bgs. Hexavalent chromium was detected in one sample at a concentration of 0.28 mg/kg, more than an order of magnitude below the site-specific risk-based concentration of 6.3 mg/kg. No SVOCs, OCIs, or PCBs were detected.

3.2 SOIL IMPACT

Approximately 128 soil exploration locations (direct push borings, test pits, and hand auger borings) were completed at the Site during various investigations. Samples from those explorations were tested for metals, including hexavalent chromium. Select samples were also tested for SVOCs, PCBs, and OCIs and leachable metals.

Arsenic, copper, lead, nickel, and zinc were found primarily at background levels, except at a few locations each associated with hide-splits. Antimony, cadmium, chromium, manganese, and mercury were detected at concentrations greater than background levels. Hexavalent chromium was detected in twelve of nineteen samples, and at a maximum concentration of 6.43 mg/kg. One of the twelve detections slightly exceeded the site-specific risk-based concentration of 6.3 mg/kg, but the 90% upper confidence limits used in the human health risk assessment were less than 6.3 mg/kg (2.5 mg/kg for 0 to 5 feet and 3.35 mg/kg for 0 to 15 feet).

Four OCIs (4,4'-DDD; 4,4'-DDE; 4,4'-DDT; and chlordane) were detected in seven samples collected from the shallow railroad drainage ditch, the sedimentation lagoons, and in the wetland area adjacent to Rock Creek. OCIs were not found in the hide-split landfill, and thus are not considered to be site-related. As stated in the RI report, detected OCIs are believed to be representative of regional soil conditions (GeoEngineers, 2004). One SVOC (phenol) was detected in 1 of 13 samples. Phenol was detected at concentrations just above the detection limit in a sample collected within the footprint of the hide-split landfill. No other SVOCs were detected. No PCBs were detected.

3.3 GROUNDWATER IMPACT

Water level measurements and groundwater samples were collected from the seven monitoring wells (MW-1 through MW-7) installed between June 2003 and March 2004. The depth to groundwater is shallow and varies from just a few feet bgs (MW-1) to greater than 15 feet bgs (MW-4). Water levels at MW-3 and MW-5 appear very deep, but these wells are completed on the lagoon berms and thus their surface elevation is artificially high as compared to surrounding ground surface elevations. In general, groundwater elevations follow topography, and groundwater flows northeast toward Rock Creek. The groundwater gradient is approximately 0.04 feet per foot across the Site.

Groundwater samples were collected during seven events. Three events occurred during the RI in 2003 and 2004, and included testing of groundwater samples from monitoring wells and two hand auger borings for ten project-specific dissolved metals. In addition, selected groundwater samples from one of the RI groundwater sampling events were also analyzed for volatile organic compounds (VOCs), SVOCs, PCBs, OCIs, chloride, nitrate, nitrite, and sulfate. Three events occurred after the RI in 2005, 2006, and 2007, and included testing of groundwater samples from monitoring wells for dissolved chromium and manganese.

Total and or dissolved metals were detected above laboratory reporting limits at least once, except for mercury which wasn’t detected any sample. Dissolved metals detected infrequently were antimony, arsenic, cadmium, and zinc. Chromium and manganese were detected the most frequently and at the highest concentrations.

In addition to metals, three VOCs (1,2-dichlorobenzene; 1,4-dichlorobenzene; and chlorobenzene) and one OCI (lindane) were detected in one monitoring well (MW-4). Detected concentrations were low at 10 micrograms per liter (µg/L) or less. No other VOCs or OCIs were detected in groundwater. No SVOCs (other than 1,2-dichlorobenzene, as mentioned above) or PCBs were detected. Chloride, nitrate, and sulfate were each detected, while nitrate was not.

3.4 Surface Water Impact

Surface water samples were collected from a wide range of locations, including: seven upland seeps, two locations within the northern sedimentation lagoon, two locations within the southern sedimentation lagoon, four locations from standing water in the wetland area adjacent to Rock Creek and four locations within Rock Creek (one upstream location and three downstream locations). Sampling events occurred between June 2003 and March 2004. In all, 27 surface water samples were collected from the Site. All samples were analyzed for 7 of the 10 project-specific dissolved metals (antimony, cadmium, chromium, copper, manganese, and zinc. Selected surface water samples were analyzed for dissolved arsenic, lead, nickel and hexavalent chromium. Two surface water samples (one from the railroad ditch and one from Rock Creek) were also analyzed for SVOCs, OCIs, and PCBs.

Chromium and manganese were the mostly commonly detected metals. No SVOCs, OCIs, or PCBs were detected.

3.5 SEDIMENT IMPACT

Nine samples were collected from Rock Creek in the upper 12 inches of sediment. All nine samples were analyzed for a suite of ten project-specific metals. Six samples were also analyzed for hexavalent chromium, SVOCs, OCIs, and PCBs.

All metals, except for chromium and manganese, were detected at concentrations consistent with naturally occurring background levels. Chromium and manganese were each detected in one sample at a concentration greater than its background level. The samples were located near the railroad drainage ditch, which appears to have been a historical transport pathway to Rock Creek. These samples are also located downgradient of the breach in the north sedimentation lagoon.

Two OCIs (4,4’-DDD and 4,4’-DDE) were detected in 4 of 6 samples, but are interpreted to be representative of regional OCI levels since no on-site source was identified in upland media. No SVOCs or PCBs were detected in sediment samples.

3.6 NATURE & EXTENT SUMMARY

Metals were widely detected in all media as summarized below:

- Soil – Metals concentrations are the highest within the hide-split landfill, within the sedimentation lagoons, and downstream of the breaches in each lagoon berm. All metals were found at concentrations greater than naturally occurring levels in at least a few samples, but arsenic, copper, lead, nickel, and zinc were found primarily at background levels, except at a few locations associated with hide-splits. Chromium concentrations were the highest of the metals most commonly exceeding background levels, with two greatest concentrations occurring within the footprint of the hide-split land fill (21,000 mg/kg in TP-3 at 4 feet bgs and 32,300 mg/kg in DP-15 at 5 feet bgs).
- Sediment – Metals were found at concentrations consistent with naturally occurring background levels, with the exception of chromium and manganese which were each detected in one sample near the railroad drainage ditch and downgradient of the breach in the north sedimentation lagoon at concentrations above the background level. The railroad drainage ditch appears to have been a historical transport pathway to Rock Creek.
- Groundwater and surface water – All metals but mercury were detected in groundwater or surface water at least once, with chromium and manganese being the mostly frequently detected in both media.

Other analytes from the VOC, SVOC, OCI, and PCB compound classes were largely not detected in the media where they were analyzed. Detections of 1,2-dichlorobenzene; 1,4-dichlorobenzene; chlorobenzene, and phenol were limited to one or two samples and all concentrations were low. Detections of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, chlordane are believed to be representative of regional conditions (GeoEngineers, 2004). PCBs were not detected in soil, sediment, surface water, or groundwater.

4.0 CONCEPTUAL SITE MODEL

The Conceptual Site Model (CSM) describes the potentially complete exposure pathways through which receptors can come into contact with site-related contamination. The CSM is developed through a review of land and water use records to determine the reasonably likely current and future site uses. The CSM describes the potential for migration away from source areas to other media where receptor exposures could occur.

4.1 LAND USE ZONING

The Site is located in an area of industrially zoned land and is zoned for light industrial use according to the City of Sherwood Plan and Zone Map accessed in August 2017. The Site is partially fenced, but access is not controlled nor monitored. The City is considering use of the upland portion of the Site to relocate the City's public works facility out of its downtown core. This future land use would be consistent with the current and reasonably likely future zoning.

The Site is also part of the Rock Creek Unit of the Tualatin River National Wildlife Refuge, and the lower elevation portions of the Site may not be suitable for industrial development. The City envisions preserving those portions of the Site that are not suitable for development to provide open space or overlook access to the Tualatin River National Wildlife Refuge, and thus protecting Rock Creek as a Goal 5 resource (a Goal 5 resource includes natural resources, scenic and historic areas, and open spaces, as defined in Oregon Administrative Rules 660-015-0000(5)). This is consistent with the Site's location within the Tualatin River National Wildlife Refuge and the City's Parks and Recreation Master Plan (City of Sherwood, 2006). It also would provide improved access to the natural undeveloped areas for residential developments located south of the Site.

Based on current zoning and potential future use, the potential human receptors at the Site are a current trespasser, and future occupational/industrial workers, future construction and excavation workers, and future recreational users. Future occupational/industrial workers are not anticipated to use the lower elevation areas of the Site where industrial development would not occur. Future construction and excavation workers could be exposed across the entirety of the Site during remediation and redevelopment activities. Future recreational users could potentially be exposed across the lower elevation portion of the Site if trails or other park uses are incorporated into future uses.

4.2 BENEFICIAL WATER USE

No drinking water wells are located at the Site. There is no known use of shallow groundwater (above the first layer of basalt) for domestic purposes within 1 mile of the Site. The closest wells to the Site are two industrial wells, both of which are completed on the opposite side of Rock Creek from the Site, and at depths below the first layer of basalt. Shallow groundwater does discharge to wetland areas and to Rock Creek at the Site.

As reported in the 2004 RI (GeoEngineers, 2004), a 30-foot-deep well (now abandoned) was located at the former tannery on Tax Lot 400, which is west of the Site. The well was uncased and extended approximately 20 feet into the basalt. The Prospective Purchaser's Agreement (PPA) for tax lots 400, 403, 500 and 501 serves as an institutional control that prohibits groundwater extraction for uses other than construction dewatering (DEQ, 2001). Groundwater wells on file with OWRD for the areas included in the well search are summarized in Appendix B of the 2004 RI.

There is a surface water point of diversion for irrigation and livestock use associated with the Site, but there is no evidence of recent use. Therefore, the reasonably likely future beneficial water uses at the Site are determined to include irrigation, livestock, and to support wildlife and aquatic habitat.

4.3 EXPOSURE PATHWAYS

Based on the land use and beneficial water use identified for the Site, potentially complete exposure pathways for human receptors include:

- Direct contact with surface soil by occupational workers, construction and excavation workers, and trespasser/recreational users.
- Direct contact with subsurface soil by construction and excavation workers.
- Direct contact with sediment by trespassers/recreational users.
- Direct contact with groundwater in excavations by construction and excavation workers.

The results of the Level 1 ecological risk evaluation identified that a variety of aquatic and terrestrial species could be exposed to site-related contamination through ingestion, inhalation, dermal contact and root contact with surface soils and shallow groundwater, as well as from exposure to sediment and surface water within Rock Creek.

5.0 RISK ASSESSMENT SUMMARY

5.1 HUMAN HEALTH RISK

A human health risk assessment (HHRA) was conducted using all available sampling results to evaluate potential human health risks from exposure to analytes in soil and groundwater for the complete exposure pathways defined by the human health CSM. The HHRA evaluated three exposure units (EUs): 1) Upland EU soils (all receptors), 2) Wetland EU soils (all receptors except occupational workers), and 3) Groundwater EU, Site-wide, (construction worker and excavation worker only). All metals results for soil and groundwater were conservatively evaluated to ensure all potential constituents of potential concern (COPCs) were identified for further evaluation. The COPCs identified for each EU were:

- Upland EU soils – Arsenic, copper, lead, and hexavalent chromium.
- Wetland EU soils – Arsenic.
- Groundwater EU (site-wide) – None.

Of the COPCs evaluated, unacceptable human health risks were identified for only two constituents: 1) arsenic and 2) lead. The effected receptors include the occupational worker exposed to arsenic in the upper 5 feet of soil in the Upland EU, and the excavation worker exposed to lead in the upper 5 feet of soil, and down to 15 feet, in the Upland EU. In both cases, the predicted health risks were driven by a single elevated detection of arsenic or lead that was found within the footprint of the hide-split landfill. In addition, arsenic was detected in two samples at concentrations just above background and the screening level for a recreational user/trespasser. All other detections of arsenic in the wetland EU are consistent with background levels of arsenic at concentrations less than background (DEQ, 2013). No unacceptable human health risks were identified for copper or hexavalent chromium.

The HHRA concluded that unacceptable risk to human health is isolated to direct contact with contaminant concentrations associated with the hide-split landfill only.

5.2 ECOLOGICAL RISK ASSESSMENT SUMMARY

An Ecological Risk Assessment (ERA) was prepared for Tax Lots 400 and 600 in 2004 and presented in the 2004 RI. The ERA evaluated exposure from soil, sediment, groundwater, and surface water in Rock Creek for metals, VOCs, SVOCs, OCIs, and PCBs. The 2004 ERA included evaluation of threatened & endangered (T&E) species, based on the T&E listings at that time, but no T&E species are known to be at the Site today, and thus the results for T&E species are no longer relevant.

VOCs, SVOCs, PCBs, and OCIs were not retained as constituents of potential ecological concern (CPECs) based on their limited detection or lack of detection, and in the case of OCIs because they are not site-related. Metals concentrations in groundwater and surface water were found below levels of concern. Metals in soil and sediment were found at levels of concern as summarized below:

- Soil – antimony, chromium, lead, manganese, and mercury
- Sediment – antimony, cadmium, chromium, copper, manganese, and zinc

Additional evaluation of potential ecological risks from chromium in soil was conducted by evaluating the American Robin consuming worms as the representative specie using all habitat types at the Site. The site-specific risk-based concentration developed for non-T&E species was 280 mg/kg. Based on this concentration, unacceptable risks were identified in portions of the north sedimentation lagoon, the majority of the south sedimentation lagoon, areas downstream of the breaches in each sedimentation lagoon, areas of the Rock Creek floodplain downgradient of the lagoon breaches, and the hide-split landfill area. Elevated concentration of other metals of concern were largely found to be co-located with elevated chromium concentrations, with only a few isolated locations as exceptions.

Ecological hot spots for chromium based on a 10-fold multiplier of the risk-based concentration, were identified in a small portion of the northern sedimentation lagoon, the southern sedimentation lagoon, outside of the breach in the south sedimentation lagoon, one area within the Rock Creek floodplain, and the entire area of the hide-split landfill. The ERA identified that concentrations of the metals remaining after soil removal should be reevaluated to determine if remaining concentrations pose an unacceptable risk to ecological receptors.

The ERA prepared in 2004 was not updated during the Supplemental RI in 2015 because no new data were generated in areas of ecological exposure and the assumptions and approach used to evaluate potential ecological risks in 2004 were still considered valid.

6.0 SUMMARY OF ISSUES IDENTIFIED BY THE RI

The RIs completed in 2003-2004 and 2015 identified the following issues for which environmental cleanup is required to address unacceptable risks:

1. Chromium concentrations greater than the site-specific risk-based concentration of 280 mg/kg for ecological receptors are widespread in soil and in sediment within the sedimentation lagoons, localized in sediment downstream of the railroad ditch and breach in the northern sedimentation lagoon, and assumed to be present throughout the hide-split landfill.
2. Other metals of potential concern found at concentrations in soil and sediment greater than background levels (antimony, manganese, and mercury) are generally co-located with the areas of highest chromium concentrations.

Human health risks were identified only for the occupational worker exposed to arsenic in the upper 5 feet of soil in the Upland EU, and the excavation worker exposed to lead in the upper 5 feet of soil, and down to 15 feet, in the Upland EU. In both cases, the predicted health risks were driven by a single elevated detection of arsenic or lead that was found within the footprint of the hide-split landfill and that will be addressed by the remedy that addresses the risks to ecological receptors from the hide-splits. No unacceptable human health risks were identified for other metals, though the data set for hexavalent chromium is small and one detection was very close to the site-specific risk-based concentration for one sample within the hide-split landfill. Potential risks from hexavalent chromium will be addressed by the remedy that addresses the risk to ecological receptors from the hide-splits.

7.0 REMEDIAL ACTION OBJECTIVES AND APPLICABLE REGULATIONS

Remedial action objectives (RAOs) are written statements that guide how cleanup alternatives are developed because they define what requires remediation using the outcome of the RI. Four RAOs were developed to support cleanup alternative development for this Site. The first two RAOs were developed during the 2004 Focused Feasibility Study prepared for Tax Lot 600 by GeoEngineers on behalf of DEQ and are still relevant to the Site. The third and fourth RAOs were developed by Wood to address the additional issues identified on Tax Lot 602, and focus the City’s resources on the areas of greatest contamination.

1. RAO #1 – Prevent ecological receptors from exposure to soil or sediments containing chromium, or other metals, at concentrations in excess of appropriate cleanup levels determined to be protective of sensitive Site receptors.
2. RAO #2 – Prevent migration of soil or sediments in stormwater or surface water runoff that could result in an adverse effect to the beneficial water uses of Rock Creek for aquatic life.

3. RAO #3 – Source control of materials in historical features that are not being addressed by RAO #1 or RAO #2 (i.e. the two aeration ponds, hides on the ground surface outside the footprint of the hide-split landfill).
4. RAO #4 - Remediate soil or sediment hot spots of contamination to the extent feasible.

The proposed cleanup levels are presented in the next section.

In addition to the DEQ environmental cleanup regulations, approval to conduct a remedial action is anticipated to be required from a number of other state or local agencies through a permitting process. The following list of permits are likely to be required to implement a cleanup at the Site:

1. Joint Permit Application (JPA) submitted to the Oregon Division of State Lands (to comply with Oregon's Removal Fill Law [Oregon Revised Statute 196.795-990]) and to the United States Army Corps of Engineers (USACE) to comply with Section 404 of the Clean Water Act.
2. Water Quality Certification issued by DEQ under Section 401 of the Clean Water Act, including a land use compatibility statement (processed based on information provided in the JPA).
3. National Pollution Discharge Elimination System (NPDES) 1200-C for management of stormwater during construction and issued by DEQ.
4. Clean Water Service permits for grading and stormwater control.
5. City of Sherwood permits covering grading and erosion control.

This is not an exhaustive list of permits and additional evaluation of applicable permits should be conducted in consultation with permitting agencies prior to implementing any cleanup activities. Permits and certifications are also discussed in Section 9.2 of the ABCA where major assumptions used in development of the ABCA are addressed.

8.0 SITE-SPECIFIC CLEANUP LEVELS

Prior assessments proposed the use of a site-specific cleanup level for chromium that was developed for the American Robin as a representative but sensitive receptor using all habitat types at the Site. DEQ was consulted to determine if the previously established value of 280 mg/kg would still be considered appropriate for use in identifying areas of the site requiring remediation. DEQ approved use of 280 mg/kg for defining areas of soil remediation, but not for sediment (DEQ, 2017). Instead, DEQ recommended use of the probable effect concentration (PEC) for chromium at a concentration of 111 mg/kg established by MacDonald, et al., in a paper titled *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater*

Ecosystems (2000) as the proposed cleanup level. The PEC, as described by McDonald, et al., is the concentration above which adverse effects are expected to occur more often than not in ecological receptors.

Chromium concentrations in Site soils, including within the hide-split landfill and sediment within the Wetland EU, exceed the proposed cleanup levels of 111 mg/kg and of 280 mg/kg, leading to a significant volume of soil and sediment requiring remediation that would translate into a significant cost. Therefore, hot spot concentrations were developed for soil and sediment for use in evaluating remedial alternatives so that a smaller volume of soil could be considered. The calculation of hot spot levels for ecological receptors is based on a 10-fold multiplier of the acceptable risk level, which set the proposed cleanup levels at 1,110 mg/kg and 2,800 mg/kg. DEQ has the ability to approve remedial actions requiring treatment of hot spots to the extent treatment is feasible, as specified in Oregon Administrative Rules (OAR) 340-122-090(4), which says that the treatment requirement for hot spots is subject to the remedy selection balancing factors and criteria listed in OAR 340-122-090(4) and specifies that a higher threshold be applied in evaluating the reasonableness of costs for treating hot spots of contamination.

In DEQ comments on the ABCA (DEQ, 2017; DEQ, 2018), DEQ requested an evaluation of protectiveness for terrestrial and benthic receptors assuming the remedy would be based on a hotspot cleanup level. The protectiveness evaluation demonstrated that a hot spot cleanup would be protective of terrestrial receptors in the Wetland EU, but that it would not be protective for immobile benthic communities in the Wetland EU. This is due to locations with demonstrated chromium concentrations between the PEC of 111 mg/kg and the hot spot cleanup level of 1,110 mg/kg (Amec Foster Wheeler, 2018). The outcome of the protectiveness evaluation was to select the PEC as the cleanup level for use in the Wetland EU to increase protectiveness of the proposed cleanup for benthic receptors (Wood, 2018). The DEQ comment letters and protectiveness evaluation memoranda documenting this decision are presented in Appendix A.

The next sections present the selected cleanup levels for the Upland EU and Wetland EU.

8.1.1 Upland Exposure Unit Selected Cleanup Level

DEQ's comment letter on the ABCA indicated that a residual risk evaluation would not be required because Site development is anticipated to be consistent with current zoning (which is industrial). Therefore, the hot spot cleanup level of 2,800 mg/kg was selected as the Site cleanup goal for the Upland EU. No areas of soil contamination outside the footprint of the hide-split landfill in the upland portion of the Site exceeded the hot spot level of 2,800 mg/kg, and therefore no soil remediation areas separate from the hide-split landfill were identified.

Conducting a cleanup of soil with concentrations above hot spot levels meets the requirements of OAR 340-122-090(4) because it is a) considered to be protective of present and future ecological receptors, b) is based on balancing of remedy selection factors which includes consideration of reasonableness of cost and that the costs of the remedy are proportionate to the benefits created through risk reduction or management, and c) recognizes the preference for treatment of hot spots.

8.1.2 Wetland Exposure Unit Selected Cleanup Level

As discussed earlier, the protectiveness evaluation requested by DEQ indicated that using the hot spot cleanup level of 1,110 mg/kg for chromium was not sufficiently protective of immobile benthic receptors, which are the most sensitive receptors in the Wetland EU. Therefore, the selected cleanup level for the Wetland EU is the PEC of 111 mg/kg for chromium. The areas of soil/sediment contamination exceeding the cleanup level of 111 mg/kg for chromium are illustrated on Figures 2 and 3. Remediation of these areas is evaluated in the next section.

9.0 ANALYSIS OF BROWNFIELD CLEANUP ALTERNATIVES

The purpose of this ABCA is to define and evaluate cleanup alternatives that meet or exceed the RAOs identified in Section 7. This can be accomplished by either decreasing contaminant concentrations to levels that are protective of human health and the environment or breaking the exposure route between the potential receptor and the chemical. The ABCA contains the following elements:

1. Considerations for developing sustainable cleanup alternatives;
2. Discussion of major assumptions;
3. Description of proposed remedial action alternatives; and,
4. Recommendation of the preferred alternative.

This ABCA presents seven cleanup alternatives. The ABCA assesses the protectiveness of each alternative by considering the present and future public health, safety, and welfare, and the environment. RAOs must achieve the standards of protectiveness stipulated in OAR 340-122-0040. The ABCA also evaluates each cleanup alternative according to seven balancing factors to establish a rank for each alternative. The balancing factors are defined below (as summarized from DEQ's environmental cleanup rules presented in OAR 340-122-0090 and EPA Brownfield guidance):

1. Effectiveness – Measures the performance of the technology in achieving protectiveness up to the time when RAOs are achieved and remedy implementation is complete.

2. Long-Term Reliability – A remedy's long-term reliability is based on the reliability of treatment technology to remain protective and, if using engineering or institutional controls, on its reliability in managing residual risks. Long-term reliability also is influenced by uncertainties associated with potential long-term risk management.
3. Implementability – Measures whether it is easy or difficult to implement a remedy considering practical, technical, or legal difficulties that may be associated with construction and implementation, including scheduling delays. Implementability also depends on the ability to measure the effectiveness of the remedy and its consistency with regulatory requirements.
4. Implementation risk – Implementation risk evaluates the risk posed by the remedy during implementation (including construction and operation), based on potential impacts to the community, workers, and the environment. Implementation risk also considers the time needed to implement the remedy and the impact to the environment from use of fossil.
5. Sustainability – Elements of the remedial alternatives that increase or decrease sustainability, such as fuel consumption and emissions from truck traffic, provide an additional ranking factor that can be used in the comparative analysis for remedy selection.
6. Climate change concerns – The impact of reasonably foreseeable changing climate conditions on the remedial alternatives is ranked if there are site-specific risk factors associated with the remedy.
7. Reasonableness of cost – A remedy's reasonableness of cost is based on the following, as appropriate:
   - Cost of remedial action, including capital cost, and annual operation and maintenance (O&M) cost;
   - The degree to which the costs are proportionate to the benefits to human health and the environment created by risk reduction;
   - The degree of sensitivity and uncertainty of the costs; and
   - Any other information relevant to cost reasonableness.

The cleanup alternatives were developed within the context of redevelopment of the Site as the future location for the City's public works facility and possibly with open space and/or park space to provide access to the Tualatin River National Wildlife Refuge. Re-locating the public works facilities to the Site puts out-of-use industrial land back into productive service for the community while moving the facility away from the downtown core where public works activities conflict with desired downtown development. The seven cleanup alternatives are:

- Alternative 1 – No Action,
- Alternative 2 – Removal and Disposal of Contaminated Sediments and Hide Splits,
- Alternative 3 – Placement of Contaminated Sediments and Hide Splits Within High-Density Polyethylene (HDPE)-Lined On-Site Containment Cell,
- Alternative 4 – Placement of Contaminated Sediments and Hide Splits Within Chemically Stabilized On-Site Containment Cell,
- Alternative 5 – Placement of Contaminated Sediments Within Chemically Stabilized On-Site Containment Cell; Removal and Disposal of Hide Splits,
- Alternative 6 – Placement of Contaminated Sediments Within Chemically Stabilized On-Site Containment Cell; Hide-Split Landfill Managed in Place,
- Alternative 7 – Removal and Disposal of Contaminated Sediments; Hide-Split Landfill Managed In-Place.

9.1 SUSTAINABILITY CONSIDERATIONS

Sustainability has been considered in the design and selection of a cleanup plan for the Site so that the sustainable elements of each alternative are accounted for in the ranking of each alternative and in the comparative analysis. Sustainability considerations included in the evaluation are:

- Materials management and waste reduction – Disposal alternatives for contaminated soil, sediment, and waste animal hides have been evaluated and onsite containment options have been considered to limit the amount of material transported to a landfill. Also, berm material surrounding the sedimentation lagoons will be considered for reuse for soil cover. After the berms are removed this could increase the amount of wetland area at the Site further promoting project sustainability through enhancements to the wetland environment.
- Greenhouse gas emissions and fuel consumption – Estimates for greenhouse gas emissions from off-Site trucking for material disposal for each cleanup alternative were calculated and are presented in Appendix B.
- Trucking contractors hired to transport material to and from the Site will be encouraged to use diesel fuel blended with 10% biofuel.
- The number of miles driven for off-Site transportation to a landfill will be considered when evaluating the sustainability of each alternative.

9.1.1 Changing Climate Considerations

As part of the ABCA, the resilience of proposed remedial alternatives will be evaluated in regards to reasonably foreseeable changing climate conditions and associated site-specific risk factors.

This includes the increased potential for flooding from extreme weather events and a higher wet-season water table.

9.1.2 Green Infrastructure

Climate change impacts along with land use changes can affect the amount of stormwater runoff that needs to be managed by stormwater infrastructure. Green infrastructure reduces the burden of storm events on local stormwater infrastructure. It uses landscape features to store, infiltrate and evaporate stormwater to reduce the amount of water entering sewers, reducing the discharge of pollutants into water bodies. Green infrastructure can also provide a number of important environmental and socio-economic benefits to communities, including preserving and restoring natural landscape features such as forests, floodplains and wetlands, and reducing the amount of land covered by impermeable surfaces.

9.1.3 Site Specific Weather Conditions

Due to the site's configuration and location, current and forecasted climate changes could impact the long-term reliability of certain remedial alternatives. For example, rises in the water table and increased flooding at the Site could compromise an engineered cap and expose underlying contamination.

9.2 MAJOR ASSUMPTIONS

The ABCA evaluates six remedial alternatives (excluding Alternative 1 which is "no action") within the context of the following six major assumptions:

1. Wastes are Classified as Non-Hazardous – Three alternatives include off-site disposal as part of the remedy, and assume contaminated materials are non-hazardous, based on assessment data. The costs for remediation for these three alternatives would increase if some or all of the contaminated materials must be handled as hazardous waste.
2. An On-Site Containment Cell Can be Constructed in a Wetland – Four of the six remedial alternatives rely on construction of an on-site containment cell in a wetland area (in the south sedimentation lagoon), where the water table is above the ground surface during the wet season. These four alternatives assume that major reconstruction of the sedimentation lagoon would not be required (other than addition of an engineered floor and cap) and that the regulatory agencies governing environmental cleanup and wetland areas will approve this approach. The potential effects of constructing a containment cell with an engineered floor (either a plastic liner or a chemically-stabilized floor) are not expected to adversely impact native vegetation

because the floor of the containment cell will be entirely covered by the engineered cap where native wetland plant restoration activities are not planned. Additional planning and engineering design beyond that presented in this ABCA will be required if the selected alternative includes construction of an on-site containment cell.

3. 100-Year Floodplain – According to the November 4, 2016, National Flood Insurance Program Flood Insurance Rate Map for Washington County, portions of the Site are within the 100-year floodplain. These portions include the entire Rock Creek floodplain (up to the sedimentation lagoon berms), and approximately half of the southern sedimentation lagoon. The 100-year floodplain does not extend inside the northern sedimentation lagoon. Four of the six remedial alternatives rely on construction of a containment cell within the southern sedimentation lagoon and would be impacted by regulatory requirements associated with construction within the 100-year floodplain. A number of modifications to the remedial alternatives that rely on a containment cell are possible, such as: 1) moving the containment cell to the northern sedimentation lagoon because both lagoons are of similar size; 2) resizing the footprint of the containment cell in the southern sedimentation lagoon so that it is not within the 100-year floodplain; 3) conducting a survey to verify and/or refine the 100-year floodplain map specific to the Site; or 4) having a qualified engineer evaluate storability options within the floodway at the Site and prepare a No-Rise Certification to support placement of the containment cell within the southern sedimentation lagoon. No modifications were made to the four remedial alternatives relying on construction of a containment cell in the southern sedimentation lagoon at this time to allow the City to complete its visioning process and create a site redevelopment plan which may determine a preference for containment cell size and location. A change in location or footprint is not considered to change the evaluation of remedial alternatives because the sedimentation lagoons are of similar size and addressing the difference in size of the remediation areas within each lagoon is not expected to significantly change the cost of implementation.
4. Preservation of Upland Area for Redevelopment – Construction of an engineered on-Site containment cell in the upland portion of the Site was not evaluated to preserve the upland portion of the Site for future redevelopment. Managing the hides in place where they currently exist, however, is evaluated in two alternatives to provide a simplified evaluation of an upland management strategy.
5. Wetland Mitigation – Five of the six remedial alternatives will impact wetland areas, including elimination of 3.9 acres of wetland in the south sedimentation lagoon. Loss of wetlands will require permitting and mitigation, so the ABCA incorporates a simplified assessment of the requirements for mitigation to capture estimated costs for this element of a cleanup. The simplified assessment assumes that the City will pay into a

wetland bank for two alternatives (increases remedy cost) and assumes the City would be willing to open and manage a wetland mitigation bank at the Site for three alternatives (decreases remedy cost). However, there could be a variety of other solutions that will meet mitigation requirements, so additional planning and negotiations with key regulatory agencies will be required to design a final wetland mitigation plan that integrates with the selected remedy.

6. Operations and maintenance (O&M) – Each of the alternatives, except for alternatives 1 and 2, will require long-term monitoring to ensure the cleanup remains protective. For the purposes of estimating O&M costs, it is assumed that alternatives proposing to maintain hides or contaminated soil/sediment on-Site would require annual monitoring for 5 years. O&M activities include annual inspection and reporting of the containment cell and soil cap conditions. Repair costs are excluded.

The cost estimates presented in the ABCA are planning-level engineering cost estimates with a precision of +50% / -30%, and include a 10% contingency. They do not account for site preparation costs associated with redevelopment, which could include a geotechnical suitability analysis. They also don’t account for the cost to open and manage a wetland bank. Additional work will be needed for remedial planning and design to refine the selected remedy to take the outcome of the ABCA from planning level information to detailed design and construction level documents.

Other assumptions made in the development of remedial alternatives and costs are listed below:

- Backfill material for Site excavations can be taken from the berms surrounding the north and south sedimentation lagoons. Berm materials are described in logs for MW-3 and MW-5 as silts with varying amounts of clay. They are assumed to be suitable for use as backfill, though additional testing of berm materials should be considered during subsequent remedial planning efforts prior to conducting cleanup activities. The removed berms would be graded and restored as wetland habitat. It is assumed that adequate general fill materials are available on the Site for various excavation and fill activities. The berm material is estimated to be 13,000 cubic yards (estimated area of the berms [58,400 square feet] multiplied by an average height of six feet).
- The thickness of the hide-split landfill is estimated with an average based on data collected during the hide-split landfill assessment. The actual thickness of the landfill could be larger or smaller.
- Residential use will not occur.
- All costs are presented as 2017 dollars, with no discounting.

9.3 ALTERNATIVE 1 – NO ACTION

9.3.1 Alternative 1 Description

Alternative 1 is the baseline against which all other alternatives are compared. Under this alternative, contaminated sediments and the hide-split landfill would be left in place in their current configuration.

9.3.2 Alternative 1 Evaluation

Protectiveness: Alternative 1 is not protective of current or future receptors at the Site.

Effectiveness: Alternative 1 has low effectiveness since there is no action implemented and thus no protection to ecological receptors is provided.

Long-term Reliability: Alternative 1 has low long-term reliability because it does not remove contamination or eliminate ecological exposure pathways.

Implementability: This alternative is easy to implement because no action is required.

Implementation Risk: There is low implementation risk associated with this alternative because no activities would be conducted.

Sustainability: Alternative 1 is moderately sustainable. No greenhouse gas emissions would be produced by this alternative however the Site would remain impacted by metals.

Reasonableness of Cost: There is no cost to implement this alternative.

Climate Change Concerns: No Site-specific risk factors were identified under this alternative with respect to climate change considerations.

9.4 ALTERNATIVE 2 – REMOVAL AND DISPOSAL OF CONTAMINATED SEDIMENTS AND HIDES

9.4.1 Alternative 2 Description

Contaminated sediments above the cleanup level would be excavated and transported off site for disposal. Sampling data results indicate that sediments are not anticipated to be a Resource Conservation and Recovery Act (RCRA) hazardous waste. Correspondence with DEQ indicates that hides are not considered a RCRA hazardous waste. Therefore, the contaminated materials can be disposed at a Subtitle D (non-hazardous) waste landfill.

Approximately 17,000 cubic yards of contaminated sediments from the north and south sedimentation lagoons and 2,725 cubic yards of sediments outside the lagoons in the Rock Creek floodplain would be excavated and transported to the Waste Management landfill in Hillsboro, Oregon. Approximately 25,300 cubic yards of hide splits from the hide-split landfill and co-mingled soil would be excavated from the upland portion of the Site and transported to the Waste Management landfill in McMinnville, Oregon. Volume information is presented in Appendix C.

Excavation areas would be backfilled with suitable fill taken from the berms of the existing sedimentation lagoons or imported from a local source and compacted back to the existing grade.

Excavated areas inside the north and south sedimentation lagoons and the excavation areas in the Rock Creek floodplain are located within designated wetland areas and would require restoration measures. Under this alternative, it is estimated that 3.9 acres of wetland credits would be sold into a wetland mitigation bank by the City after remedial action. This includes wetland enhancement of the north and south sedimentation lagoons, and wetland conversion of the sedimentation lagoon berm areas.

9.4.2 Alternative 2 Evaluation

Protectiveness: Alternative 2 is considered protective because it removes contaminated material with concentrations above the established cleanup levels from the Site.

Effectiveness: Alternative 2 eliminates the potential for direct contact with contaminated materials (sediment and hide splits) above established cleanup levels by removing the material from the Site. It also reduces a long-term potential secondary source of contamination from stormwater runoff. Therefore, this alternative is highly effective.

Long-term Reliability: Alternative 2 permanently removes the most contaminated material identified at the Site, and therefore is highly reliable over the long-term. Although the material would not be destroyed, it would be placed into a permitted solid waste landfill designed for controlled long-term storage. Compacted soils used to fill the excavations should be suitable for long-term use. Restored wetland areas would require long-term monitoring and maintenance to assure viability.

Implementability: Alternative 2 would require readily available equipment, materials, and services and would consist of unrestricted excavation, loading, and shipment of impacted sediment by covered dump truck to the landfill. Excavations would be backfilled and compacted with clean, suitable fill. Restored wetland areas would require a site-specific design, construction oversight, monitoring, and maintenance. This alternative is considered easy to implement.

Implementation Risk: Alternative 2 would have a high implementation risk due to the location, size, and depth of the excavations, as well as from the length of time required to complete the work (13 weeks) and the number of miles traveled for off-site disposal. Subcontractors hired to conduct the contaminated material removal would be current with Occupational Safety and Health Administration (OSHA) 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training and all work would be performed under a site-specific Health and Safety Plan (HASP). This alterative includes additional risks of further exposure to surrounding residents, drivers, and landfill workers due to transportation and off-site disposal. The exposure risk due to transportation, road accidents, and landfill placement are moderate to high due to the estimated number of trips (1,728) required to execute this alternative.

Sustainability: Transport of all sediments described under Alternative 2 would consume the largest amount of fuel of any of the alternatives and is therefore has a higher carbon footprint. The estimated fuel usage (11,596 gallons of diesel) and associated emissions of carbon dioxide (118,395 kilograms) and methane gas (532 grams) would be considerable (refer to calculation provided in Appendix B). Additional fuel may be expended for an unknown quantity of backfill material that may need to be brought in, thus increasing the carbon emissions. In contrast, this alternative would allow for the greatest area of wetland reconstruction, thereby contributing to clean air and water initiatives in accordance with the Clean Water Act. Alternative 2 therefore is considered to be slightly to moderately sustainable.

Reasonableness of Cost: The cost estimate to implement Alternative 2 is the second highest of the evaluated alternatives at approximately $3.85 million (M) and is primarily based on 1) the volume of excavated material; 2) transport and disposal of excavated material, and 3) selling of wetland credit to a wetland bank which reduces the total cost of this alternative. Tasks associated with this alternative are expected to be eligible for funding under an EPA multi-purpose brownfield cleanup grant.

Climate Change Concerns: No Site-specific risk factors were identified for the Site under this alternative. This alternative would allow for the greatest amount of wetland reconstruction and would also contribute to enhanced flood control along Rock Creek.

9.5 ALTERNATIVE 3 – PLACEMENT OF CONTAMINATED SEDIMENTS AND HIDES WITHIN HDPE-LINED ON-SITE CONTAINMENT CELL

9.5.1 Alternative 3 Description

Under this alternative, sediments above the cleanup level and the hide-split landfill would be excavated and placed into an engineered containment cell constructed within the south sedimentation lagoon. The south sedimentation lagoon is selected because it contains more contaminated sediments than the northern sedimentation lagoon.

Approximately 11,600 cubic yards of contaminated sediments from the south sedimentation lagoon would be excavated and temporarily stored on-site, before constructing an engineered containment cell with a HDPE liner placed across the bottom of the excavated area inside the lagoon. Once constructed, sediments would be placed into the south sedimentation lagoon containment cell over the new HDPE liner. Approximately 5,500 cubic yards of contaminated sediments from the north sedimentation lagoon, 2,725 cubic yards of contaminated sediment within the Rock Creek floodplain, and approximately 25,300 cubic yards of hide splits from the hide-split landfill would be excavated and placed into the south sedimentation lagoon containment cell. Volume information is presented in Appendix C.

Once filled, the containment cell would be capped with a HDPE cover, which would be sealed with the underlying liner, and then covered with approximately 25,900 cubic yards of sand and organic soil fill (total cap thickness of 3 feet). To prevent erosion, the cap would be graded to direct stormwater away from the containment cell and vegetative cover would be planted on the cap. Excavation areas would be backfilled and compacted with suitable fill taken from the berms of the existing sedimentation lagoons or imported from a local source.

Because contaminated material would be contained on the Site, institutional and engineering controls would be used to mitigate residual risk. An institutional control in the form of an Easement and Equitable Servitude (EES), or deed restriction, may be required. Long-term operation and maintenance in the form of routine inspection to document conditions would also be required. Repairs would need to be implemented when issues are identified during inspections.

Excavated areas inside the north and south sedimentation lagoons and the excavation areas in the Rock Creek floodplain are located within designated wetland areas and would require restoration measures. Under this alternative, it is estimated that 1.2 acres of wetland credits would be purchased from a wetland mitigation bank after remedial action. This includes filling of the south sedimentation lagoon with the containment cell, wetland enhancement of the north sedimentation lagoon, and wetland conversion of the sedimentation lagoon berm areas.

9.5.2 Alterative 3 Evaluation

Protectiveness: Alternative 3 is considered protective because it breaks the exposure pathway for current and future receptors at the Site by placing contaminated material with concentrations above the established cleanup levels within an engineered HDPE-lined containment cell.

Effectiveness: Alternative 3 eliminates the potential for direct contact with the most contaminated materials (sediment and hide splits) and it reduces a potential secondary source of stormwater runoff. Residual risk of excavated contaminated material would be managed by the engineered containment cell with protective cap and HDPE bottom liner. This alternative is considered highly effective.

Long-term Reliability: Alternative 3 relocates contaminated material on the Site from an uncontrolled condition into an engineered containment cell, designed for long-term reliability. Compacted, suitable fill used to backfill the excavations should be suitable for long-term use. Restored or created wetland areas would require long-term monitoring and maintenance to assure viability. The bottom of the containment cell would be constructed at the base of the sedimentation lagoon. Based on groundwater elevation data, the sedimentation lagoon is expected to be regularly inundated with three feet of water during the wet season (a minimum of six months each year). Hydrostatic pressure could be placed on the HDPE liner potentially causing liner failure. Hides will decompose over time and could contribute to settlement in the containment cell. Hides could also contribute to generation of methane gas. Testing for methane gas generation in the existing hide-split landfills should be conducted to determine if this is a significant issue. The long-term reliability of this alternative is considered low.

Implementability: Alternative 3 is the most difficult alternative to implement because of the need to create a temporary sediment pile somewhere on Site before installing the HDPE liner. This alternative would require readily available equipment, materials, and services. Excavation of contaminated materials and placement into the on-Site containment cell is straightforward. Likewise, backfilling and compaction of clean, suitable fill in the cavities will entail basic construction activities. Construction of the on-Site containment cell would require engineering design and field oversight, and is expected to take twelve weeks to implement in the field. Permitting of the containment cell and long-term periodic inspections of the containment cell and cap would be required. Filling a wetland would require permitting. Restored and created wetland areas would require a site-specific design, construction oversight, monitoring, and maintenance. The implementability of this alternative is considered relatively difficult.

Implementation Risk: Alternative 3 would have a moderate implementation risk due to the length of time (12 weeks) to complete excavation activities and onsite construction of the containment cell. Obtaining a permit to fill a wetland could take six months to a year. Subcontractors hired to conduct the contaminated material removal would need to be current with OSHA 40-Hour HAZWOPER training. Work would be performed under a site-specific HASP.

Sustainability: Alternative 3 would have a relatively low carbon foot print as all the contaminated materials would remain onsite. It is anticipated that fuel usage from off-site trucking would be zero for this alternative. A large amount of resources would be required in the form of a plastic liner for the top and the bottom of the containment cell, so the overall sustainability of this alternative is considered moderate.

Reasonableness of Cost: The cost estimate to implement Alternative 3 would be approximately $3.71M and is primarily based on 1) volume of material excavated and graded, 2) containment cell construction, and 3) Site restoration, including purchase of wetland credits from wetland bank. Tasks associated with this alternative are expected to be eligible for funding under an EPA multi-purpose brownfield cleanup grant.

Climate Change Concerns: The construction of a containment cell located within the Rock Creek floodplain has the potential to be impacted by flood damage and therefore erosion. These risks are considered low, however, because the cell will be located an estimated 10 feet above and 375 feet away from Rock Creek. The climate change concerns for this alternative are considered moderate because of the presence of an on-site containment cell in the floodplain.

9.6 Alternative 4 – Placement of Contaminated Sediments and Hides Within Chemically Stabilized On-Site Containment Cell

9.6.1 Alterative 4 Description

Under this alternative, sediments above the cleanup level and the hide-split landfill would be excavated and placed into an engineered containment cell constructed within the south sedimentation lagoon. Before material placement, the base of the engineered containment cell would be amended with a blended phosphate-based material or other chemical mixture to fixate the metals to reduce their leachability and mobilization to groundwater.

Sediment in the bottom of the south sedimentation lagoon would be mixed with a suitable chemical admixture to stabilize metals of concern that may potentially migrate downward through the containment cell inside the lagoon and into groundwater. The estimated costs included in this ABCA are based on a single application of solid phosphate blend amendment to establish a competent base layer approximately 18 inches thick. Treatability testing would be required before remedy implementation to determine the most appropriate chemical admixture for stabilizing metals by creating insoluble compounds, creating a preference for metals compounds to sorb to sediment particles, or through encapsulation, as well as for creating a sufficiently strong base to support the weight of contaminated materials placed in the containment cell.

Approximately 5,500 cubic yards of contaminated sediments from the north sedimentation lagoon, 2,725 cubic yards of contaminated sediment from the Rock Creek floodplain, and 25,300 cubic yards of hide splits from the hide-split landfill would be excavated and placed into the south sedimentation lagoon containment cell above the amended floor. Once filled, the containment cell would be capped with a HDPE liner and covered with approximately 25,900 cubic yards of sand and organic soil fill as a cap (total cap thickness of three feet). To prevent erosion, the cap would be graded to direct stormwater away from the containment cell and a vegetative cover would be planted on the cap. Excavation areas would be backfilled and compacted with suitable fill taken from the berms of the existing sedimentation lagoons or imported from a local source. Volume information is presented in Appendix C.

Because contaminated material would be contained on the Site, institutional and engineering controls would be used to mitigate residual risk. An institutional control in the form of an EES, or deed restriction, may be required. Long-term O&M in the form of routine inspection to document condition would also be required. Repairs would need to be implemented when issues are identified during inspections.

Excavated areas inside the north and south sedimentation lagoons and the excavation areas in the Rock Creek floodplain are located within designated wetland areas and would require restoration measures. Under this alternative, it is estimated that 1.2 acres of wetland credits would be purchased from a wetland mitigation bank after remedial action. This includes filling of the south sedimentation lagoon with the containment cell, wetland enhancement of the north sedimentation lagoon, and wetland conversion of the sedimentation lagoon berm areas.

9.6.2 Alterative 4 Evaluation

Protectiveness: Alternative 4 is considered protective because it breaks the exposure pathway for current and future receptors at the Site by placing contaminated material with concentrations above the established cleanup levels within a containment cell. However, leaching of Site contaminants could occur if the chemically stabilized floor is not installed properly, uniformly, or in inadequate quantity, or if the groundwater table rises significantly during the annual wet season and changes the hydraulic gradient within the containment cell.

Effectiveness: Alternative 4 eliminates the potential for direct contact with the most contaminated materials at the Site (sediment and hide splits) and reduces a potential secondary source of stormwater and shallow groundwater contamination. Residual risk of excavated contaminated material would be managed by the designed containment cell with protective cap and stabilized floor. The effectiveness of Alternative 4 is considered high.

Long-term Reliability: Alternative 4 relocates the most contaminated material on the Site from an uncontrolled condition into an engineered containment cell, designed for long-term reliability. Permitting of the containment cell and long-term periodic inspections of the containment cell and cap would be required. Compacted, clean fill used to backfill the excavations should be suitable for long-term use. Restored or created wetland areas would require long-term monitoring and maintenance to assure viability. The potential for failure of the engineered elements is considered low because a treatability study would have been conducted to determine the most suitable chemical admixture to stabilize the containment cell floor. The bottom of the containment cell would be constructed at the bottom of the sedimentation lagoon. Based on groundwater elevation data, the sedimentation lagoon is expected to be regularly inundated with three feet of water during the wet season. Regular groundwater flushing of the containment cell could create migratory pathways for contained contaminants and will require long-term monitoring. Hides will decompose over time and could contribute to settlement in the containment cell. Hides could also contribute to generation of methane gas. Testing for methane gas generation in the existing hide-split landfills should be conducted to determine if this is a significant issue. The overall long-term reliability for this alternative is considered moderate.

Implementability: Alternative 4 is easy to implement and would require readily available equipment, materials, and services. Excavation of contaminated materials and its placement into the on-site containment cell is not complicated. Likewise, backfilling and compaction of clean, suitable fill in the cavities will entail basic construction activities. Construction of the onsite containment cell would require engineering design and field oversight and is expected to take ten weeks to implement in the field. Filling a wetland would require permitting. Restored and created wetland areas would require a site-specific design, construction oversight, monitoring, and maintenance.

Implementation Risk: Alternative 4 would have moderate implementation risk due to the length of time (ten weeks) required to complete excavation activities and onsite construction of the containment cell. Obtaining a permitting to fill a wetland could require up to one year. Subcontractors hired to conduct the contaminated material removal would need to be current with OSHA 40-Hour HAZWOPER training. Work would be performed under a site-specific HASP. The exposure risk is contained on the site in a limited area and the risk of an accident from off Site disposal would not be present because all materials would be contained on Site.

Sustainability: Alternative 4 would have a relatively low carbon foot print because all the contaminated materials would remain on-site. It is anticipated that fuel usage for off-Site trucking would be zero for this alternative, and fewer resources would be required in the form of plastic because only the top of the containment cell would have an HDPE liner. The sustainability of this alternative is considered high.

Reasonableness of Cost: The cost estimate to implement Alternative 4 would be approximately $3.28M and is largely based on 1) volume of excavated material, 2) containment cell construction, and 3) Site restoration, including purchase of wetland credits from wetland bank. Tasks associated with this alternative are expected to be eligible for funding under an EPA multi-purpose brownfield cleanup grant.

Climate Change Concerns: The construction of a containment cell located nearby the Rock Creek lowland areas has the potential to be impacted by flood damage and therefore erosion. However, these risks are considered low as the cell will be located an estimated 10 feet above and 375 away from Rock Creek. The climate change concerns for this alternative are considered moderate because of the presence of an on-site containment cell in the floodplain.

9.7 Alternative 5 – Placement of Contaminated Sediments Within On-Site Phosphate-Amended Containment Cell; Removal and Disposal of Hides

9.7.1 Alterative 5 Description

Under this alternative, sediments above the cleanup level would be excavated and placed into an engineered containment cell constructed within the south sedimentation lagoon. The hide-split landfill would be excavated and transported for off-site for disposal. Sampling results indicate the hide splits are not a RCRA hazardous waste; therefore, they can be disposed at a Subtitle D (non-hazardous) waste landfill.

Sediment in the bottom of the south sedimentation lagoon would be mixed with a suitable chemical admixture to stabilize metals of concern that may potentially migrate downward through the containment cell inside the lagoon and into groundwater. The estimated costs included in this ABCA are based on a single application of solid phosphate blend amendment to establish a competent base layer approximately 18 inches thick. Treatability testing would be required before remedy implementation to determine the most appropriate chemical admixture for stabilizing metals by creating insoluble compounds, creating a preference for metals compounds to sorb to sediment particles, or through encapsulation, as well as for creating a sufficiently strong base to support the weight of contaminated materials placed in the containment cell.

Approximately 5,500 cubic yards of contaminated sediments from the north sedimentation lagoon and 2,725 cubic yards of contaminated sediment from the Rock Creek floodplain would be excavated and placed into the south sedimentation lagoon containment cell above the phosphate-amended floor. Approximately 25,300 cubic yards of hide splits from the hide-split landfill and comingled soil would be excavated from the upland portion of the Site and transported to the

Waste Management landfill in McMinnville, Oregon. Volume information is presented in Appendix C.

Once filled, the containment cell would be capped with a HDPE liner and covered with approximately 25,900 cubic yards of sand and organic soil fill as a cap (total cap thickness of three feet). To prevent erosion, the cap would be graded to direct stormwater away from the containment cell and a vegetative cover would be planted on the cap. Excavation areas would be backfilled and compacted with suitable fill taken from the berms of the existing sedimentation lagoons or imported from a local source.

Because contaminated sediment would be contained on the Site, institutional and engineering controls would be used to mitigate residual risk. An institutional control in the form of an EES, or deed restriction, may be required. Long-term operation & maintenance in the form of routine inspection to document condition would also be required. Repairs would need to be implemented when issues are identified during inspections.

Excavated areas inside the north and south sedimentation lagoons and the excavation areas in the Rock Creek floodplain are located within designated wetland areas and would require restoration measures. Under this alternative, it is estimated that 1.3 acres of wetland credits would be sold into a wetland mitigation bank after remedial action. This includes filling of a portion of the south sedimentation lagoon with the containment cell, wetland enhancement of the north sedimentation lagoon and a portion of the south sedimentation lagoon, and wetland conversion of the sedimentation lagoon berm areas.

9.7.2 Alterative 5 Evaluation

Protectiveness: Alternative 5 is considered protective because it breaks the exposure pathway for current and future receptors at the Site by placing contaminated material with concentrations above the established cleanup levels within a containment cell. Some leaching of Site contaminants could, however, occur if the chemically stabilized floor is not installed properly, uniformly, or in inadequate quantity; or if the groundwater table rises significantly during the annual wet season and changes the hydraulic gradient within the containment cell.

Effectiveness: Alternative 5 eliminates the potential for direct contact with the most contaminated materials (sediment and hide splits) on the Site and reduces a potential secondary source of stormwater runoff. Residual risk of excavated contaminated sediment would be managed by the designed containment cell with protective cap and stabilized floor. The effectiveness of this alternative is considered high.

Long-term Reliability: Alternative 5 relocates the most-contaminated material from an uncontrolled access condition and places it into either an on-Site containment cell (contaminated sediment) or off-Site landfill (hide splits). Both locations are designed for long-term reliability. Permitting of the containment cell and long-term periodic inspections of the containment cell and cap would be required. Compacted, suitable fill used to backfill the excavations should be suitable for long-term use. The potential for failure of the engineered elements is considered low because a treatability study would have been conducted to determine the most suitable chemical admixture to stabilize the containment cell floor. Restored or created wetland areas would require long-term monitoring and maintenance to assure viability. The bottom of the containment cell would be constructed at the bottom of the sedimentation lagoon. Based on groundwater elevation data, the sedimentation lagoon is expected to be regularly inundated with three feet of water during the wet season. Regular groundwater flushing of the containment cell could create migratory pathways for contained contaminants and will require long-term monitoring. Hides will decompose over time and could contribute to settlement in the containment cell. Hides could also contribute to generation of methane gas. Testing for methane gas generation in the existing hide-split landfills should be conducted to determine if this is a significant issue. Overall, the long-term reliability of this alternative is considered moderate.

Implementability: Alternative 5 is easy to implement and would require readily available equipment, materials, and services. Excavation of contaminated materials and placement into the on-Site containment cell is straightforward, as is excavation and transportation of hide-splits for off-Site disposal. Likewise, the backfilling and compaction of clean, suitable fill in the cavities will entail basic construction activities. Construction of the on-Site containment cell would require engineering design and field oversight and is expected to take nine weeks to implement in the field. Filling a wetland would require permitting. Restored and created wetland areas would require a site-specific design, construction oversight, monitoring and maintenance. Obtaining a permitting to fill a wetland could take six to twelve months.

Implementation Risk: Alternative 5 would have a moderate implementation risk due to the length of time (nine weeks) to complete excavation activities and onsite construction of the containment cell, combined with the additional risks from off-site trucking. This alterative includes additional risks of further exposure to surrounding residents, drivers, and landfill workers due to transportation and off-site disposal. The exposure risk due to transportation, road accidents, and landfill placement are moderate to high due to the estimated number of trips (1,728) required to execute this alternative.

Sustainability: Alternative 5 would have a high carbon foot print as a portion of the contaminated materials would remain on site. It is anticipated that approximately 7,871 gallons of diesel fuel would be used for trucking the hide splits to the landfill. The associated emissions of carbon dioxide (80,836 kilograms) and methane gas (361 grams) are considered moderate. The overall sustainability of this alternative is considered moderate.

Reasonableness of Cost: The cost estimate to implement Alternative 5 would be approximately $4.31M and is largely based on 1) volume of excavated material, 2) containment cell construction, 3) source and volume of clean fill, and 4) restoration, including selling of wetland credits by the City to a wetland bank which reduces the total cost of this alternative. Tasks associated with this alternative are expected to be eligible for funding under an EPA multi-purpose brownfield cleanup grant.

Climate Change Concerns: The construction of a containment cell located nearby the Rock Creek lowland areas has the potential to be impacted by flood damage and therefore erosion. However, these risks are considered low as the cell will be located an estimated 10 feet above and 375 feet away from Rock Creek. The climate change concerns for this alternative are considered moderate because of the presence of an on-site containment cell in the floodplain.

9.8 Alternative 6 – Placement of Contaminated Sediments Within Phosphate-Amended Containment Cell; Hide-Split Landfill Managed In Place

9.8.1 Alterative 6 Description

This alternative was included in the ABCA because managing the hide-split landfill in place was previously evaluated in the 2004 Focused Feasibility Study and this evaluation provides a current assessment of the benefits and drawbacks to leaving the hides in place. Under this alternative, contaminated sediments above the cleanup level would be excavated and placed into an engineered containment cell constructed within the south sedimentation lagoon. Hide splits in the upland areas would be covered with suitable fill and managed in-place.

Sediment in the bottom of the south sedimentation lagoon would be mixed with a suitable chemical admixture to stabilize metals of concern that may potentially migrate downward through the containment cell inside the former lagoon and into groundwater. The estimated costs included in this ABCA are based on a single application of solid phosphate blend amendment to establish a competent base layer that is approximately 18 inches thick. Treatability testing would be required before remedy implementation to determine the most appropriate chemical admixture for stabilizing metals by creating insoluble compounds, creating a preference for metals compounds to sorb to sediment particles, or through encapsulation; as well as for creating a sufficiently strong base to support the weight of contaminated materials placed in the containment cell.

Approximately 5,500 cubic yards of contaminated sediments from the north sedimentation lagoon and 2,725 cubic yards of contaminated sediment from the Rock Creek floodplain would be excavated and placed into the south sedimentation lagoon containment cell above the chemically stabilized floor. Volume information is presented in Appendix C.

Once filled, the containment cell would be capped with a HDPE liner and covered with approximately 25,900 cubic yards of sand and organic soil fill (total cap thickness of three feet). To prevent erosion, the cap would be graded to direct stormwater away from the containment cell and a vegetative cover would be planted on the cap. Excavation areas would be backfilled and compacted with suitable fill taken from the berms of the existing sedimentation lagoons or imported from a local source.

The surface of the hide-split landfill would be graded so that when covered it would approximate the desired grade for planned development. The hide-split landfill would be covered with a minimum of three feet of suitable soil cover taken from the berms of the existing sedimentation lagoons, or imported from a local source, and managed in-place.

Because contaminated sediment and hide splits would be contained on the Site, institutional and engineering controls would be used to mitigate residual risk. An institutional control in the form of an EES, or deed restriction, may be required. Long-term operation & maintenance in the form of routine inspection to document condition would also be required. Repairs would need to be implemented when issues are identified during inspections.

Excavated areas inside the north and south sedimentation lagoons and the excavation areas in the Rock Creek floodplain are located within designated wetland areas and would require restoration measures. Under this alternative, it is estimated that 1.3 acres of wetland credits would be sold into a wetland mitigation bank after remedial action. This includes filling of a portion of the south sedimentation lagoon with the containment cell, wetland enhancement of the north sedimentation lagoon and a portion of the south sedimentation lagoon, and wetland conversion of the sedimentation lagoon berm areas.

9.8.2 Alterative 6 Evaluation

Protectiveness: Alternative 6 is considered protective because it breaks the exposure pathway for current and future receptors at the Site by placing contaminated material with concentrations above the established cleanup levels within a containment cell. Some leaching of Site contaminants could, however, occur if the chemically stabilized floor is not installed properly, uniformly, or in inadequate quantity; or if the groundwater table rises significantly during the annual wet season and changes the hydraulic gradient within the containment cell. In addition, managing the hide-split landfill in place allows for potential exposure to future receptors if erosion occurs or if future excavation is required. The overall protectiveness of this alternative is considered moderate.

Effectiveness: Alternative 6 eliminates the potential for direct contact with the most contaminated materials (sediment and hide splits) managed on the Site and reduces a potential secondary source of stormwater runoff. Residual risk of excavated contaminated sediment would be managed by the engineered containment cell with protective cap and stabilized floor. Soil cover would mitigate in-place the direct exposure risk posed by the hide-split landfill. The overall effectiveness of this alternative is considered high.

Long-term Reliability: Alternative 6 relocates the most contaminated sediment from an uncontrolled condition by placing it into an on-site containment cell. The hide-split landfill would be capped with soil to eliminate the direct exposure pathway. Both relocating the contaminated sediment and capping the hide-split landfill in-place would provide relative long-term reliability. Permitting of the containment cell and long-term periodic inspections of the containment cell and cap would be required. The potential for failure of the engineered elements is considered low because a treatability study would have been conducted to determine the most suitable chemical admixture to stabilize the containment cell floor. Compacted, suitable fill used to backfill the excavations should be suitable for long-term use. Restored or created wetland areas would require long-term monitoring and maintenance to assure viability. The likelihood of having to mitigate or remove the hides from this location in the future is moderate to high because hides are located in an area considered developable. The bottom of the containment cell would be constructed at the bottom of the sedimentation lagoon. Based on groundwater elevation data, the sedimentation lagoon is expected to be regularly inundated with three feet of water during the wet season. Regular groundwater flushing of the containment cell could create migratory pathways for contained contaminants and will require long-term monitoring. The containment cell in this alternative would be considerably smaller than the containment cell in Alternative 4 and would therefore be less impacted by inundation. Hides will decompose over time and could contribute to settlement in the containment cell. Hides could also contribute to generation of methane gas. Testing for methane gas generation in the existing hide-split landfills should be conducted to determine if this is a significant issue. The overall long-term reliability of this alternative is considered low to moderate.

Implementability: Alternative 6 is considered relatively easy to implement. Excavation of contaminated materials and placing into an on-site containment cell (sediment) or capping with clean soil (hide splits) is not complicated. Likewise, the backfilling and compaction of clean, suitable fill in the cavities will entail basic construction activities. Construction of the on-Site containment cell would require engineering design and field oversight and is expected to take eight weeks to implement in the field. Filling a wetland would require permitting. Restored and created wetland areas would require a site-specific design, construction oversight, monitoring and maintenance. The placement of hide splits on the upland portion of the Site may restrict future redevelopment activities.

Implementation Risk: Alternative 6 would have a low implementation risk due to straightforward excavation activities and onsite construction of the containment cell that are anticipated to take less than ten weeks to complete. Subcontractors hired to conduct contaminated material removal would need to be current with OSHA 40-Hour HAZWOPER training. Work would be performed under a site-specific HASP.

Sustainability: Alternative 6 would have a small carbon foot print because all of the contaminated materials would remain on-Site. It is anticipated that fuel usage from trucking would be zero for this alternative. Capping the hides in place is a poor use of usable upland property and could degrade the value and future uses of the Site. Therefore, this alternative is considered to have low sustainability.

Reasonableness of Cost: The cost estimate to implement Alternative 6 would be approximately $3.26M and is largely based on 1) volume of excavated sediment, 2) containment cell construction, 3) covering the hide-split landfill, and 4) restoration, including purchase of wetland credits from wetland bank. Tasks associated with this alternative are expected to be eligible for funding under an EPA multi-purpose brownfield cleanup grant.

Climate Change Concerns: The construction of a containment cell located nearby the Rock Creek lowland areas has the potential to be impacted by flood damage and therefore erosion. However, these risks are considered low because the cell will be located an estimated 10 feet above and 375 feet away from Rock Creek. The climate change concerns for this alternative are considered moderate because of the presence of an on-site containment cell in the floodplain.

9.9 ALTERNATIVE 7 – REMOVAL AND DISPOSAL OF CONTAMINATED SEDIMENTS; HIDE-SPLIT LANDFILL MANAGED IN-PLACE

9.9.1 Alterative 7 Description

This alternative was included in the ABCA because managing the hide-split landfill in place was previously evaluated in the 2004 Focused Feasibility Study and this evaluation provides a current assessment of the benefits and drawbacks to leaving the hides in place. Under this alternative, contaminated sediments above the cleanup level would be excavated and transported off-Site for disposal. Sampling results indicate that sediments are not anticipated to be a RCRA hazardous waste. Therefore, they can be disposed at a Subtitle D (non-hazardous) waste landfill. Hide splits in the upland areas would be covered with clean, suitable fill and managed in-place.

Approximately 5,500 cubic yards of contaminated sediments from the north sedimentation lagoon, approximately 11,600 cubic yards from south sedimentation lagoon, and approximately 2,725 cubic yards from the Rock Creek floodplain would be excavated and transported the Waste Management landfills in Hillsboro, Oregon. Volume information is presented in Appendix C.

The surface of the hide-split landfill would be graded so that when covered it would match the necessary grade for desired development. The hide-split landfill would be covered with a minimum of three feet of suitable soil cover taken from the berms of the existing sedimentation lagoons or imported from a local source and managed in-place.

Because contaminated hide splits would be contained on the Site, institutional and engineering controls would be used to mitigate residual risk. An institutional control in the form of an EES, or deed restriction, may be required. Long-term operation & maintenance in the form of routine inspection to document condition would also be required. Repairs would need to be implemented when issues are identified during inspections.

Excavated areas inside the north and south sedimentation lagoons and the excavation areas in the Rock Creek floodplain are located within designated wetland areas and would require restoration measures. Under this alternative, it is estimated that 3.9 acres of wetland credits would be sold into a wetland mitigation bank by the City after remedial action. This includes wetland enhancement of the north and south sedimentation lagoons, and wetland conversion of the sedimentation lagoon berm areas.

9.9.2 Alterative 7 Evaluation

Protectiveness: Alternative 7 is considered protective because it breaks the exposure pathway for current and future receptors at the Site by removing or managing in place contaminated material with concentrations above the established cleanup levels at the Site. Managing the hide-split landfill in place could allow for potential exposure to future receptors if erosion occurs or if future excavation is required in the landfill.

Effectiveness: Alternative 7 eliminates the potential for direct contact with the most-contaminated materials (sediment and hide splits) located on the Site and reduces a potential secondary source of stormwater runoff. Residual risk from the contaminated sediment would be eliminated by removing it from the Site and placing it into a permitted landfill. Clean soil cover would mitigate in-place the direct exposure risk posed by the hide splits. The overall effectiveness of this alternative is considered high.

Long-term Reliability: Alternative 7 permanently removes the most-contaminated sediment identified at the Site. The hide-split landfill would be capped with soil to eliminate the direct exposure pathway to associated contamination. Both removing the contaminated material and capping the hide-split landfill in-place would provide relative long-term reliability. The likelihood of having to mitigate or remove the hides from this location in the future is moderate to high because hides are located in an area considered developable. Minor permitting and long-term periodic inspection and reporting would be required for the capped area. Compacted, clean fill used to backfill the excavations or should be suitable for long-term use. Hides will decompose over time and could contribute to settlement in the containment cell. Hides could also contribute to generation of methane gas. Testing for methane gas generation in the existing hide-split landfills should be conducted to determine if this is a significant issue. The overall long-term reliability of this alternative is considered moderate.

Implementability: Alternative 7 is easy to implement. Excavation of contaminated materials and transporting off-site or placing clean fill over the existing hide-split landfill area is not complicated. Likewise, the backfilling and compaction of clean, suitable fill in the cavities will entail basic construction activities. Capping the hide splits would require an implementation plan and field oversight and is estimated to take nine weeks to implement. Restored and created wetland areas would require a site-specific design, construction oversight, monitoring and maintenance. The placement of hide splits on the upland portion of the Site may restrict future redevelopment activities. Restored or created wetland areas would require long-term monitoring and maintenance to assure viability.

Implementation Risk: Alternative 7 would have a low implementation risk because the straightforward excavation activities and onsite construction of the hide split capping area are anticipated to take less than ten weeks to complete. Subcontractors hired to conduct contaminated material removal would need to be current with OSHA 40-Hour HAZWOPER training. Work would be performed under a site-specific HASP. The exposure risk due to transportation, road accidents, and landfill placement is considered moderate due to the estimated number of trips (464) for this alternative. Overall, the implementation risk for this alternative is considered low.

Sustainability: Alternative 7 would have a moderate carbon footprint as a portion of the contaminated materials would remain on-Site. It is anticipated that approximately 3,725 gallons of diesel fuel would be used for trucking contaminated sediment to the landfill. The associated emissions of carbon dioxide (38,255 kilograms) and methane gas (171 grams) are considered moderate for this alternative. This alternative would allow for the greatest area of wetland conversion thereby contributing to clean air and water initiatives in accordance with the Clean Water Act. Capping the hides in place is a poor use of usable upland property and could degrade the value and future uses of the site. The overall sustainability of this alternative is considered moderate.

Reasonableness of Cost: The cost estimate to implement Alternative 7 would be approximately $2.63M and is largely based on 1) volume of excavated material, 2) covering the hide-split landfill, and 4) restoration, including selling of wetland credits by the City to a wetland bank which reduces the total cost of this alternative. Tasks associated with this alternative are expected to be eligible for funding under an EPA multi-purpose brownfield cleanup grant. If portions of the Site were converted to wetlands the resultant area could offset the proposed upland development in the wetlands area of could be sold into a mitigation bank for a profit.

Climate Change Concerns: Major risk factors have not been identified under this alternative as the hide split capping areas would be located on the upland portion of the Site. This alternative would allow for the greatest amount of wetland reconstruction and would also contribute to enhanced flood control along Rock Creek.

9.10 SELECTION OF PREFERRED REMEDIAL ALTERNATIVE

The seven remedial alternatives were evaluated using the balancing factors required by DEQ, as well as evaluating sustainability and climate change concerns as required by the Brownfield program. Table 1 summarizes cleanup alternatives compared to the evaluation criteria. Table 2 presents a summary of costs for each alternative.

Alternatives 2 and 7 ranked the highest, followed by Alternatives 4, 5, and 6 which were closely ranked.

When cost is considered, Alternatives 4 and 6 are the lowest, with both being estimated at approximately $3.3M (Table 2 – Summary of Costs). However, Alternative 6 leaves hides in place in the upland portion of the Site, which is not a desired attribute for putting the property back into productive use. Therefore, Alternative 4 – *Placement of Contaminated Soils and Hides in Chemically Stabilized On-Site Containment Cell* – is selected as the most appropriate cleanup action for the Site. The primary components of Alternative 4 are depicted on Figure 4, including proposed excavation areas and the proposed location of the chemically-stabilized containment cell.

10.0 CONCLUSIONS

This ABCA has summarized the assessment activities conducted to date, the issues identified by the assessment, the remedial action objectives designed to address these issues, the proposed cleanup levels, and an evaluation of seven remedial alternatives using DEQ's balance factors and considering sustainability and climate change concerns. Alternative 4 (Placement of Contaminated Sediments and Hides Within Phosphate-Amended Containment Cell) was selected as the proposed remedial alternative based on balancing factors demonstrating overall benefits for the estimated costs. This alternative was selected within the context of six major assumptions that cover disposing of wastes as nonhazardous, construction of the on-Site containment cell in a wetland (i.e. south sedimentation lagoon), consideration of the 100-year floodplain (a portion of the south sedimentation lagoon is within the 100-year floodplain), preserving the upland area for redevelopment, using wetland banking as a mitigation strategy, and five years of O&M inspection. Additional remedial design work and planning work, in consultation with the City, will be needed to take the outcome of the ABCA from planning level information to detailed design and construction level documents, so that future redevelopment meets City needs.

We appreciate the opportunity to be of service to the City of Sherwood on this project. If you have any questions or comments regarding this report, please contact the undersigned at (503) 639-3400.

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LIMITATIONS

This report was prepared exclusively for the City of Sherwood by Wood Environment & Infrastructure Solutions, Inc. The quality of information, conclusions, and estimates contained herein is consistent with the level of effort involved in Wood services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions, and qualifications set forth in this report. This Analysis of Brownfield Cleanup Alternatives is intended to be used by the City of Sherwood for the Former Frontier Leather Property located at 1210 SW Oregon Street in Sherwood, Oregon only, subject to the terms and conditions of its contract with Wood. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

The findings contained herein are relevant to the dates of the Wood Site visit and should not be relied upon to represent conditions at later dates. In the event that changes in the nature, usage, or layout of the property or nearby properties are made, the conclusions and recommendations contained in this report may not be valid. If additional information becomes available, it should be provided to Wood so the original conclusions and recommendations can be modified as necessary.

TABLES

TABLE 1
Summary of Cleanup Alternatives Compared to Evaluation Criteria
Former Frontier Leather Tannery Property
Sherwood, Oregon

Alternative No. and Title	Protectiveness	Effectiveness		Long-term Reliability		Implementability		Implementation Risk			Sustainability		Climate Change Concerns		Rank (higher score = more desirable)	Cost
		Scoring		Scoring		Scoring		Scoring			Scoring		Scoring			
	Pass / Fail	None Low Moderate High	0 1 2 3	None Low Moderate High	0 1 2 3	NA Difficult Moderate Easy	 1 2 3	None High Moderate Low	0 1 2 3	No. of Weeks	NA Low Moderate High	 1 2 3	None Low Moderate High	4 3 2 1		
Alternative 1 No Action	Fail	None	0	None	0	Easy	3	None	0	0	Moderate	2	None	4	9	$0
Alternative 2 Removal and Disposal of Contaminated Soils and Hide	Pass	High	3	High	3	Easy	3	High	1	16	Moderate	2	None	4	16	$3,850,000
Alternative 3 Placement of Contaminated Soils and Hides in (HDPE)-Lined On-Site Containment Cell	Pass	High	3	Low	1	Difficult	1	Moderate	2	15	Moderate	2	Moderate	2	11	$3,710,000
Alternative 4 Placement of Contaminated Soils and Hides in Chemically Stabilized On-Site Containment Cell	Pass	High	3	Moderate	2	Easy	3	Moderate	2	13	High	3	Moderate	2	15	$3,280,000
Alternative 5 Placement of Contaminated Soils in Chemically-Stabilized On-Site Containment Cell; Removal and Disposal of Hides	Pass	High	3	Moderate	2	Easy	3	Moderate	2	12	Moderate	2	Moderate	2	14	$4,310,000
Alternative 6 Placement of Contaminated Soils in Chemically-Stabilized On-Site Containment Cell; Hides Managed In Place	Pass	High	3	Low to Moderate	2	Easy	3	Low	3	10	Low	1	Moderate	2	14	$3,260,000
Alternative 7 Removal and Disposal of Contaminated Soils; Hides Managed In-Place	Pass	High	3	Moderate	2	Easy	3	Moderate	2	11	High	3	None	4	17	$2,630,000

Notes:
No. of weeks - total weeks estimated for construction
Green highlight identifies the remedial alternatives with the highest rank
Yellow highlight identifies the alternatives of similar score below the highest ranked alternatives

TABLE 2
Summary of Costs for Each Remedial Alternative
Former Frontier Leather Tannery Property
Sherwood, Oregon

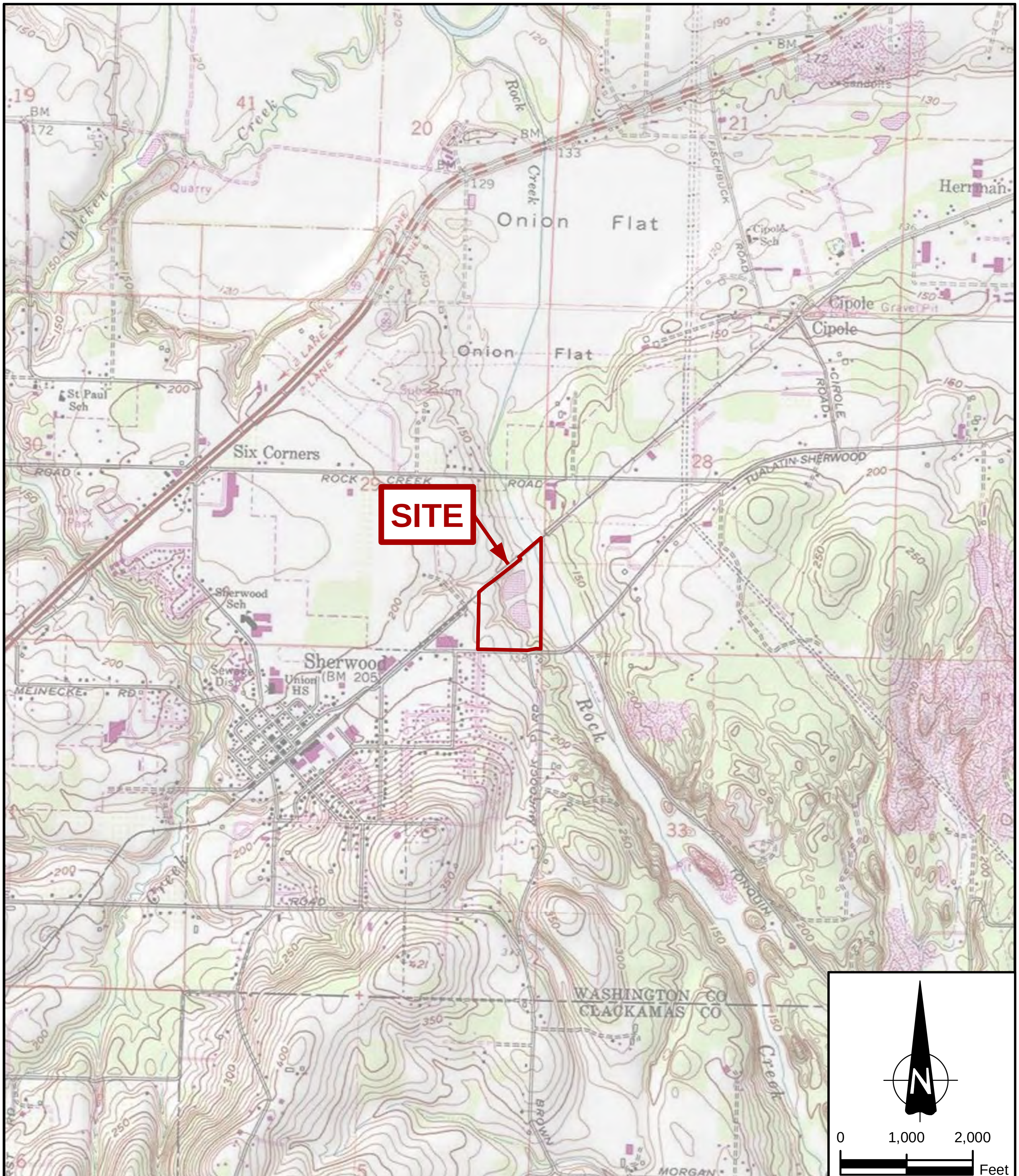
Cost Categories	Rate	Units	Alternative 1 No Action		Alternative 2 Removal and Disposal of Contaminated Soils and Hides		Alternative 3 Placement of Contaminated Soils and Hides in HDPE-Lined On-Site Containment Cell		Alternative 4 Placement of Contaminated Soils and Hides in Chemically Stabilized On-Site Containment Cell		Alternative 5 Placement of Contaminated Soils in Chemically-Stabilized On-Site Containment Cell; Removal and Disposal of Hides		Alternative 6 Placement of Contaminated Soils in Chemically-Stabilized On-Site Containment Cell; Hides Managed In Place		Alternative 7 Removal and Disposal of Contaminated Soils; Hides Managed In-Place		Explanation
			Quantity	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	
CONSULTANT COST																	
Workplan/Design (subtotal)			0	$0	216	$31,600	248	$35,840	234	$34,060	244	$35,710	214	$31,110	214	$31,110	
Sr. Engineer	$165	Per Hour	0	$0	80	$13,200	80	$13,200	80	$13,200	90	$14,850	70	$11,550	70	$11,550	Estimated LOE in 2017 dollars
Jr. Engineer	$120	Per Hour	0	$0	48	$5,760	40	$4,800	36	$4,320	36	$4,320	36	$4,320	36	$4,320	Estimated LOE in 2017 dollars
PM - Geologist	$155	Per Hour	0	$0	48	$7,440	48	$7,440	48	$7,440	48	$7,440	48	$7,440	48	$7,440	Estimated LOE in 2017 dollars
CAD	$130	Per Hour	0	$0	40	$5,200	80	$10,400	70	$9,100	70	$9,100	60	$7,800	60	$7,800	Estimated LOE in 2017 dollars
Permitting (subtotal)			0	$0	200	$24,000	200	$24,000	200	$24,000	200	$24,000	200	$24,000	200	$24,000	
Permit Specialist	$120	Per Hour	0	$0	200	$24,000	200	$24,000	200	$24,000	200	$24,000	200	$24,000	200	$24,000	Estimated LOE in 2017 dollars
Bid Support			0	$0	60	$9,000	64	$9,480	64	$9,480	64	$9,480	64	$9,480	64	$9,480	
Sr. Engineer	$165	Per Hour	0	$0	40	$6,600	40	$6,600	40	$6,600	40	$6,600	40	$6,600	40	$6,600	Estimated LOE in 2017 dollars
Jr. Engineer	$120	Per Hour	0	$0	20	$2,400	24	$2,880	24	$2,880	24	$2,880	24	$2,880	24	$2,880	Estimated LOE in 2017 dollars
Construction Oversight (subtotal)			0	$0	1148	$115,980	1078	$108,880	938	$94,680	868	$87,580	728	$73,380	798	$80,480	
Sr. Engineer	$165	Per Hour	0	$0	160	$26,400	150	$24,750	130	$21,450	120	$19,800	100	$16,500	110	$18,150	Estimated LOE in 2017 dollars based on schedule
Jr. Engineer	$120	Per Hour	0	$0	160	$19,200	150	$18,000	130	$15,600	120	$14,400	100	$12,000	110	$13,200	Estimated LOE in 2017 dollars based on schedule
Env. Tech	$85	Per Hour	0	$0	828	$70,380	778	$66,130	678	$57,630	628	$53,380	528	$44,880	578	$49,130	Estimated LOE in 2017 dollars based on schedule
Construction Report (subtotal)			0	$0	208	$30,060	220	$31,500	220	$31,500	230	$33,150	230	$33,150	230	$33,150	
Sr. Engineer	$165	Per Hour	0	$0	100	$16,500	100	$16,500	100	$16,500	110	$18,150	110	$18,150	110	$18,150	Estimated LOE in 2017 dollars
Jr. Engineer	$120	Per Hour	0	$0	48	$5,760	60	$7,200	60	$7,200	60	$7,200	60	$7,200	60	$7,200	Estimated LOE in 2017 dollars
CAD Specialist	$130	Per Hour	0	$0	60	$7,800	60	$7,800	60	$7,800	60	$7,800	60	$7,800	60	$7,800	Estimated LOE in 2017 dollars
5-Year Operations & Maintenance (subtotal)			0	$0	0	$0	160	$21,200	160	$21,200	160	$21,200	280	$36,150	135	$17,250	
Sr. Engineer	$165	Per Hour	0	$0	0	$0	40	$6,600	40	$6,600	40	$6,600	50	$8,250	20	$3,300	Estimated LOE in 2017 dollars covering a 5-year period
Jr. Engineer	$120	Per Hour	0	$0	0	$0	100	$12,000	100	$12,000	100	$12,000	200	$24,000	100	$12,000	Estimated LOE in 2017 dollars covering a 5-year period
CAD Specialist	$130	Per Hour	0	$0	0	$0	20	$2,600	20	$2,600	20	$2,600	30	$3,900	15	$1,950	Estimated LOE in 2017 dollars covering a 5-year period
Project Mgmt/Communication (subtotal)			0	$0	384	$56,360	364	$53,540	332	$48,420	316	$45,860	284	$40,740	300	$43,300	
PM - Geologist	$155	Per Hour	0	$0	256	$39,680	244	$37,820	220	$34,100	208	$32,240	184	$28,520	196	$30,380	Estimated LOE in 2017 dollars based on schedule plus pre- and post-construction communications
Admin/WP Support	$65	Per Hour	0	$0	52	$3,380	48	$3,120	48	$3,120	48	$3,120	48	$3,120	48	$3,120	Estimated LOE in 2017 dollars
Principal Review	$175	Per Hour	0	$0	76	$13,300	72	$12,600	64	$11,200	60	$10,500	52	$9,100	56	$9,800	Estimated LOE in 2017 dollars plus pre-construction communications
Labor Markup	6	%		$0		$16,020		$17,066		$15,800		$15,419		$14,881		$14,326	
TOTAL CONSULTANT LABOR COST				**$0**		**$283,020**		**$301,506**		**$279,140**		**$272,399**		**$262,891**		**$253,096**	
Expenses (subtotal)			0	$0	2748	$49,077	2443	$43,473	2153	$42,291	2008	$41,700	1574	$38,358	1866	$41,154	
Mileage	$0.65	Per Mile	0	$0	2240	$1,456	2100	$1,365	1820	$1,183	1680	$1,092	1400	$910	1540	$1,001	No. of weeks * 5 days/week * roundtrip miles
Van	$216	Per Week	0	$0	16	$3,456	3	$648	3	$648	3	$648	3	$648	3	$648	No. of weeks * cost/week
Analytical - Total Chromium	$15	Per Sample	0	$0	411	$6,165	264	$3,960	264	$3,960	264	$3,960	120	$1,800	267	$4,005	Variable per alternative based on 1 bottom sample per 1,000SF and 1 sidewall sample per 100LF
Permitting	$30,000	Lump Sum	0	$0	1	$30,000	1	$30,000	1	$30,000	1	$30,000	1	$30,000	1	$30,000	Professional judgement (may change based on future dialouge with permitting agencies)
Other	$100	Lump Sum	0	$0	80	$8,000	75	$7,500	65	$6,500	60	$6,000	50	$5,000	55	$5,500	Other direct costs proportional to scale of each alternative
Expense Markup	15	%		$0		$7,362		$6,521		$6,344		$6,255		$5,754		$6,173	
TOTAL CONSULTANT EXPENSE COST				**$0**		**$56,439**		**$49,994**		**$48,635**		**$47,955**		**$44,112**		**$47,327**	
TOTAL CONSULTANT COST (LABOR + EXPENSE)				*$0*		*$339,459*		*$351,500*		*$327,775*		*$320,354*		*$307,002*		*$300,423*	
CONTRACTOR COST																	
Site Prep/Mob/Demob	$1,000	Lump Sum	0	$0	64	$64,000	60	$60,000	52	$52,000	48	$48,000	40	$40,000	44	$44,000	Proportional to equipment and manpower requirements to complete each alternative
Grubbing/Tree Removal	$2,000	Per Acre	0	$0	17.3	$34,676	17.3	$34,676	17.3	$34,676	17.3	$34,676	17.3	$34,676	17.3	$34,676	Total acres (10.2) * 1.7 to cover equipment and disposal costs (engineer's experience)
Excavation/Grading	$14.00	Per CY	0	$0	50,352	$704,932	50,352	$704,932	50,352	$704,932	50,352	$704,932	38,974	$545,631	38,974	$545,631	Total CY to be moved
Transport to Hillsboro (soil)	$9.00	Per Ton	0	$0	27,595	$248,356	0	$0	0	$0	0.0	$0	0.0	$0	27,595	$248,356	Total tons to be transported to Hillboro Landfill
Disposal Hillsboro	$33.32	Per Ton	0	$0	27,595	$919,467	0	$0	0	$0	0	$0	0.0	$0	27,595	$919,467	Total tons to be disposed at Hillsboro Landfill
Transport to Riverbend (hides)	$15.30	Per CY	0	$0	22,757	$348,185	0	$0	0	$0	22,757	$348,185	0.0	$0	0.0	$0	Total CY to be transported to Riverbend Landfill
Disposal (hide splits only) Riverbend	$38.20	Per CY	0	$0	22,757	$869,325	0	$0	0	$0	22,757	$869,325	0.0	$0	0.0	$0	Total CY to be disposed at Riverbend Landfill
Liner Installation	$1.85	Per SF	0	$0	0	$0	398,861	$737,892	199,430	$368,946	199,430	$368,946	199,430	$368,946	0.0	$0	SF of South lagoon * 1.2 to account for topography
CAP Cover/Backfill	$32.00	Per CY	0	$0	0	$0	25,852	$827,267	25,852	$827,267	25,852	$827,267	43,552	$1,393,668	17,700	$566,401	CY of cap * 1.4 to account for compaction
Phosphate Mixing	$1,200	Per Ton	0	$0	0	$0	0	$0	48.5	$58,210	48.5	$58,210	48.5	$58,210	0.0	$0	No. tons * mixing ratio of 0.003 per ton
Wetlands Mitigation [1]	$155,000	Per Acre	0	$0	-3.9	-$599,756	1.2	$188,728	1.2	$188,728	-1.3	-$205,514	-1.3	-$205,514	-3.9	-$599,756	See note at bottom of table
Wetlands Restoration	$0.25	Per SF	0	$0	544,895	$136,224	136,773	$34,193	136,773	$34,193	136,773	$34,193	136,773	$34,193	136,773	$34,193	SF of wetland area * 1.5 for to meet state restoration requirements
Upland Hydroseeding	$4,356	Per Acre	0	$0	4	$17,068	8.1	$35,240	8.1	$35,240	8.1	$35,240	8.1	$35,240	4	$17,068	$0.10 per SF for 1-acre or more; no. of acres * 1.5 to account for topography
Contractor Markup	15	%		$0		$411,372		$393,439		$345,629		$468,519		$345,758		$271,506	
TOTAL CONTRACTOR COST				*$0*		*$3,153,849*		*$3,016,368*		*$2,649,821*		*$3,591,980*		*$2,650,809*		*$2,081,543*	
TOTAL PROJECT COST																	
CONSULTANT + CONTRACTOR COST (INCL O&M)				*$0*		*$3,493,307*		*$3,367,868*		*$2,977,596*		*$3,912,334*		*$2,957,812*		*$2,381,967*	
Contingency	*10*	*%*		*$0*		*$349,331*		*$336,787*		*$297,760*		*$391,233*		*$295,781*		*$238,197*	*Accounts for unknown conditions and volumes. Applied to consultant and contractor costs.*
TOTAL PROJECT COST (CAPITAL COST + O&M)				*$0*		*$3,842,638*		*$3,704,655*		*$3,275,356*		*$4,303,567*		*$3,253,593*		*$2,620,163*	
TOTAL PROJECT COST (CAPITAL COST + O&M) - ROUNDED						*$3,850,000*		*$3,710,000*		*$3,280,000*		*$4,310,000*		*$3,260,000*		*$2,630,000*	*For use in comparative evaluation*
Schedule (weeks) [2] =				**0**		**16**		**15**		**13**		**12**		**10**		**11**	See note at bottom of table

Notes:

[1] The wetland mitigation unit cost is derived from estimated costs, as of 2017, for credits available from wetland mitigation banks within the designated watershed of the site. This unit rate cost is subject to change. Costs for wetland mitigation reflect the requirement for the purchase or sale of wetland credits depending upon the overall impact or restoration of site wetlands as proposed in each alternative. A negative quantity and cost for wetland mitigation indicates that a wetland mitigation bank would be established at the site and banked credits would be sold over time. A positive quantity and cost indicates that banked credits would be purchased from an established mitigation bank within the watershed to offset the estimated impact to site wetlands.

[2] Schedule is based on the number of weeks for on-site or off-site transport of contaminated materials, plus 2 weeks for mob/demob, plus between 1 and 5 additional weeks not covered by transport time.

FIGURES



CITY OF SHERWOOD

Amec Foster Wheeler
Environment & Infrastructure, Inc.
7376 S.W. Durham Road
Portland, OR 97224

amec foster wheeler

FORMER FRONTIER LEATHER PROPERTY
SHERWOOD, OREGON

SITE LOCATION MAP

DATE	JUNE 2018
SCALE	1 " = 2,000 '
PROJECT NO.	5-61M-130820-03
FIGURE	1

DRAWN BY: SD CHECKED BY: GT

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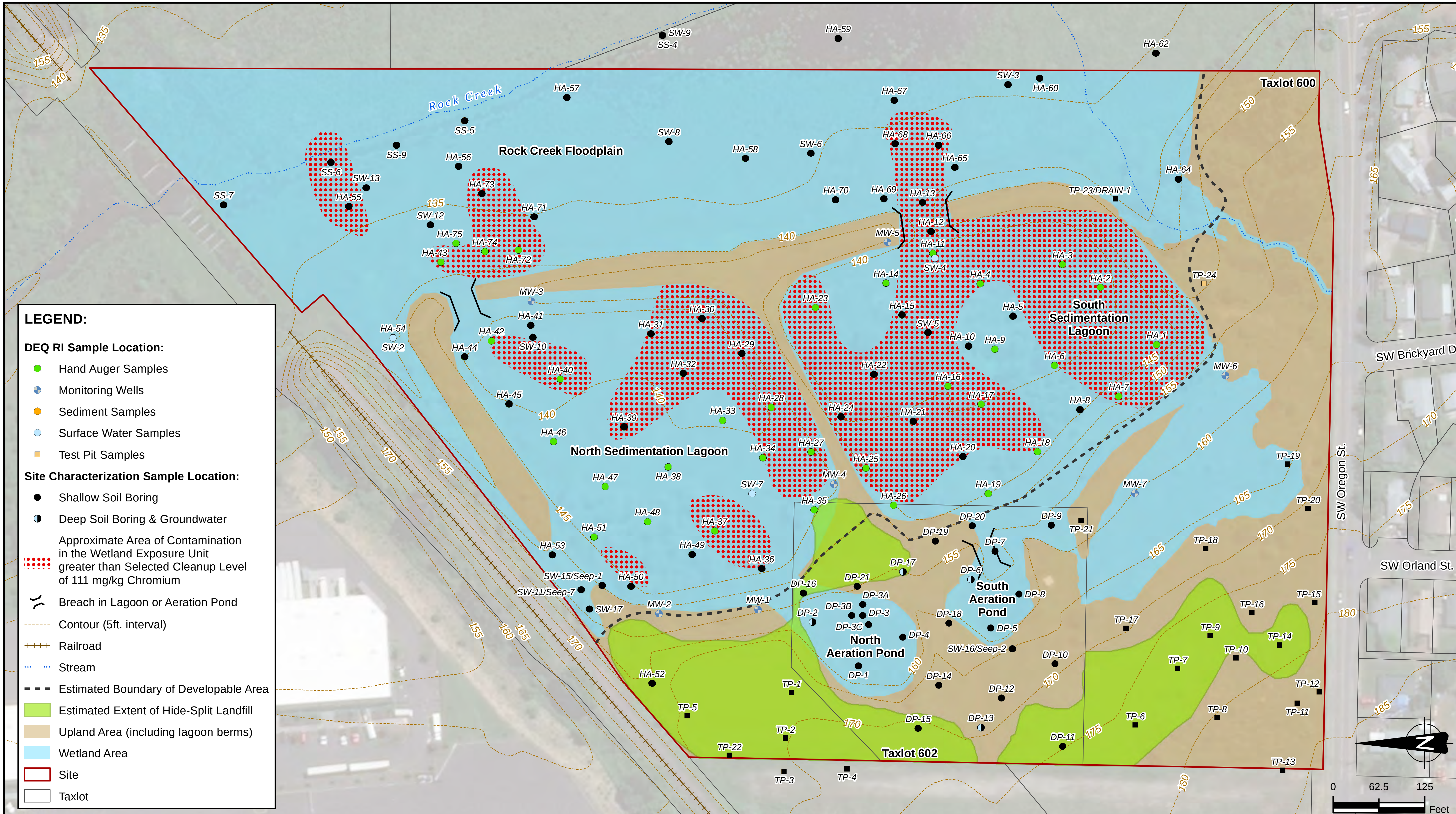

	CITY OF SHERWOOD	FORMER FRONTIER LEATHER PROPERTY SHERWOOD, OREGON	DATE JULY 2018
			SCALE 1 " = 125 '
DRAWN BY: SD CHECKED BY: GT	Amec Foster Wheeler Environment & Infrastructure, Inc. 7376 S.W. Durham Road Portland, OR 97224	CLEANUP PLANNING MAP	PROJECT NO. 5-61M-130820-03
			FIGURE 2

amec foster wheeler

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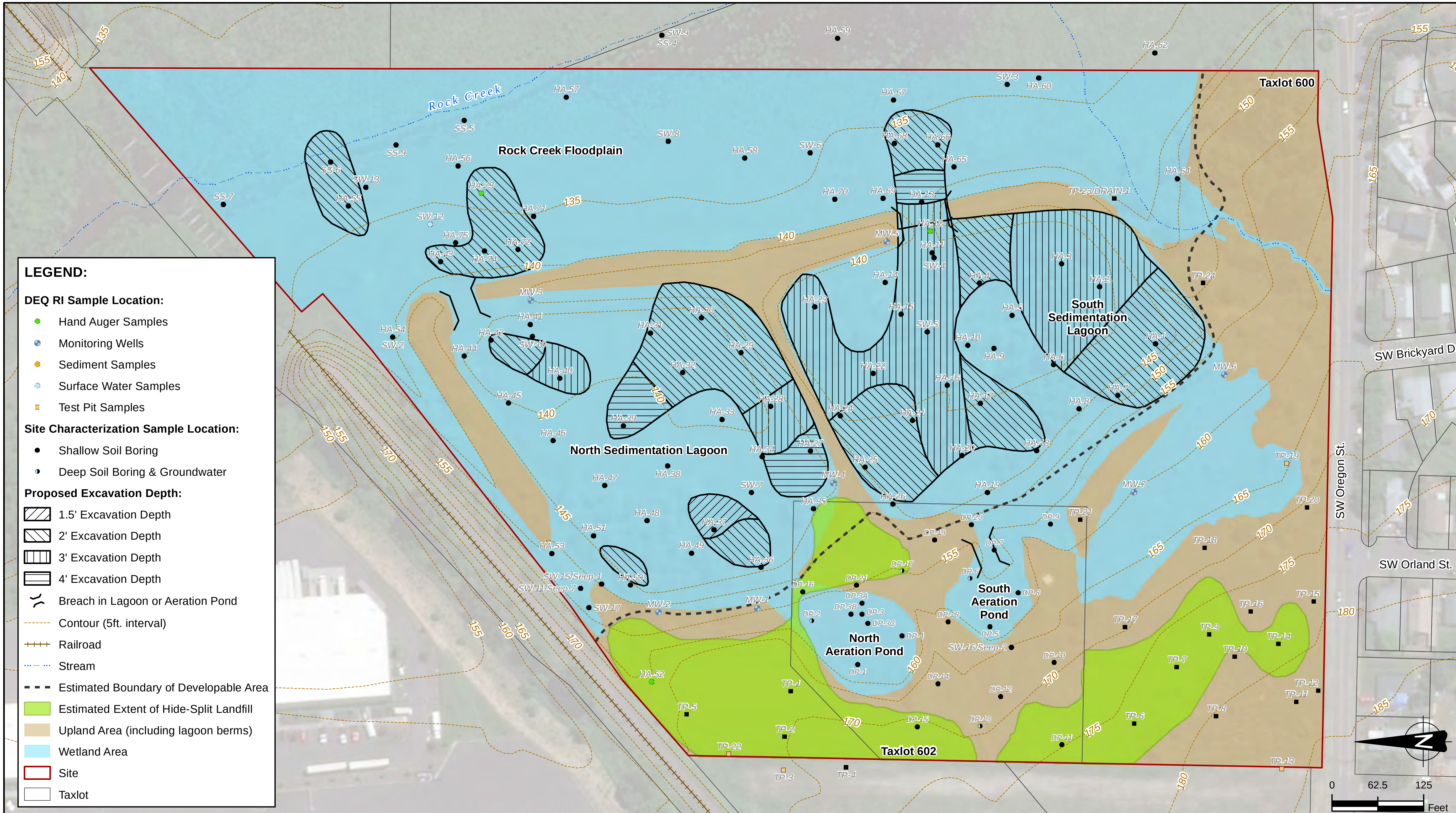

CITY OF SHERWOOD

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amec foster wheeler

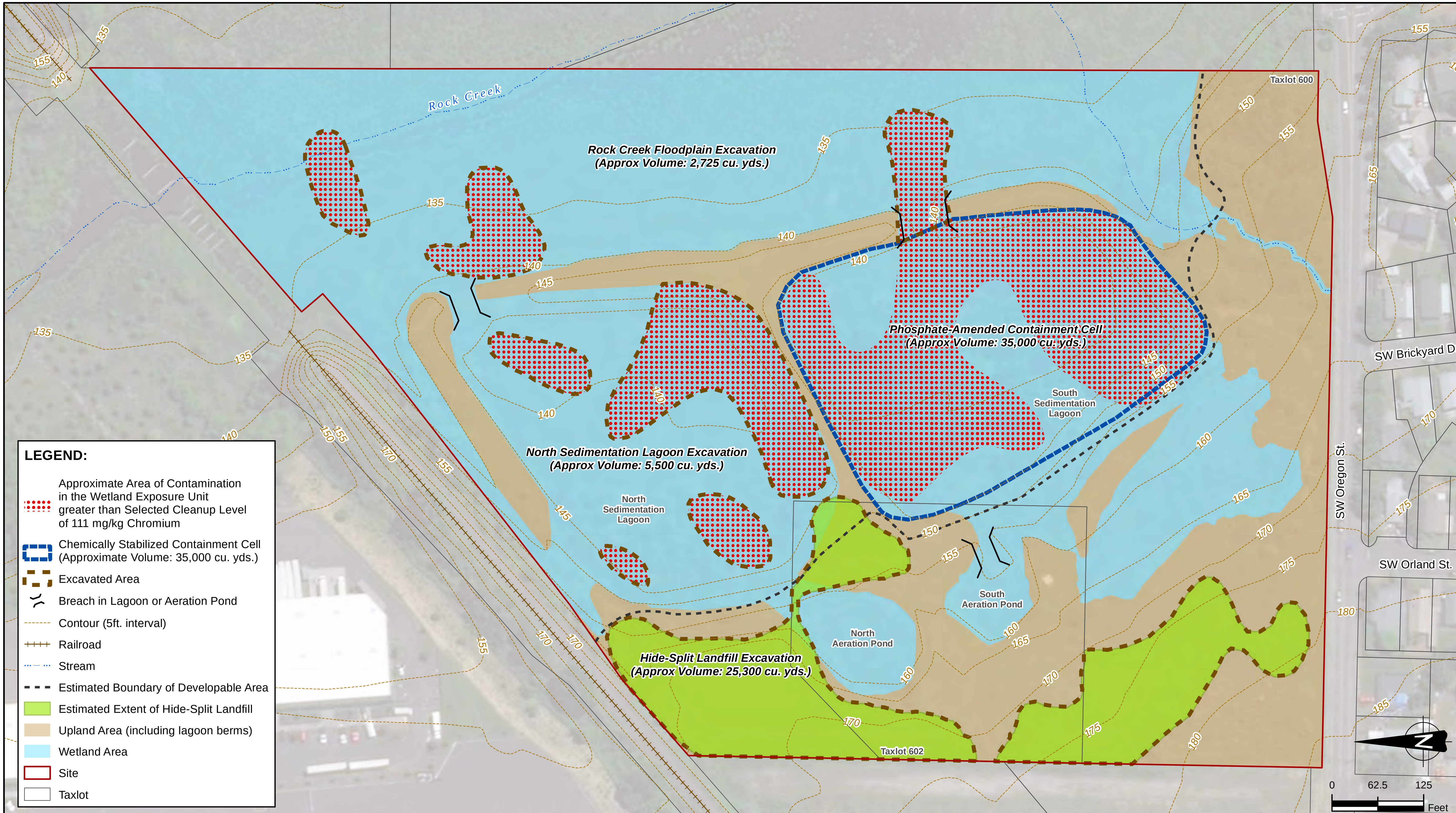
FORMER FRONTIER LEATHER PROPERTY
SHERWOOD, OREGON

CLEANUP PLANNING MAP
WITH EXCAVATION DEPTHS

DATE	JULY 2018
SCALE	1 " = 125 '
PROJECT NO.	5-61M-130820-03
FIGURE	3

DRAWN BY: SD CHECKED BY: GT

K:\13000\13000\13082\DWG_ABCA_Revised_2018\Figure 3 - Cleanup Planning Map.mxd - stephane.descombes - 7/3/2018 - 9:48:19 AM



CITY OF SHERWOOD

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FORMER FRONTIER LEATHER PROPERTY
SHERWOOD, OREGON

SELECTED REMEDIAL ALTERNATIVE MAP

DATE	JULY 2018
SCALE	1 " = 125 '
PROJECT NO.	5-61M-130820-03
FIGURE	4

DRAWN BY: SD CHECKED BY: GT

K:\13000\13000\13082\DWG_ABCA_Revised_2018\Figure 4 - Selected Remedial Alternative Map.mxd - stephane.descombes - 7/3/2018 - 1:13:49 PM

APPENDIX A

Response to DEQ Comments and Protectiveness Evaluation Memoranda

APPENDIX A-1

Response to Comments Table: Draft Analysis of Brownfield Alternatives (dated October 5, 2017)

APPENDIX A
Response to Comments
Draft Analysis of Brownfield Alternatives (dated October 5, 2017)
Former Frontier Leather Tannery Property
Cooperative Agreement BF-00J93201

Reviewer	Reviewer Title	Comment #	Comment	Response
DEQ comments received via letter dated 10/24/17				
Mark Pugh	DEQ Project Manager	1	**Section 3.1 and 3.2** touch on contaminant detections for most analytes, but not Cr(VI).	A sentence was added to Section 3.1 that indicates hexavalent chromium was detected in one sample collected from the hidesplit landfill. A sentence was added to Section 3.2 that indicates hexavalent chromium was detected in five of thirteen samples.
Mark Pugh	DEQ Project Manager	2	**3.3 Groundwater Impact** The last sentence of the second paragraph is incomplete.	The missing information was added to the end of the sentence.
Mark Pugh	DEQ Project Manager	3	**4.2 Beneficial Water Use** The former on-site industrial use well on the adjacent tax lot to the west should be discussed in this section. From the DEQ RI Report: "*A 30-foot-deep well (now abandoned) was located at the former tannery on Tax Lot 400. The well was uncased and extended approximately 20 feet into the basalt. Future use of groundwater at the facility is restricted. The PPA for tax lot 400, 403, 500 and 501 serves as an institutional control that prohibits groundwater extraction for uses other than construction dewatering (DEQ, 2001). Groundwater wells on file with OWRD for the areas included in the well search are summarized in Appendix B.*"	The details provided by DEQ from the DEQ RI report were added as the second paragraph of the presentation of Beneficial Water Use in Section 4.2 of the ABCA.
Mark Pugh	DEQ Project Manager	4	**9.0 Analysis of Brownfield Cleanup Alternatives** Under DEQ's comparative analysis protocol, "Protectiveness" is not a balancing factor, and is not quantified, but is rated as pass/fail. Per DEQ's feasibility study guidance, "Oregon's cleanup law requires that all remedies be protective of human health and the environment as demonstrated through a residual risk assessment" (see OAR 340-122-0040(2)(a)). See additional comments under Section 9.10 below. Costing information presented for each alternative on Table 2 is presented in summary form and does not contain units or unit rate/cost used in estimating costs. It is stated in the ABCA that cost estimates are +50%/-30%, but there is no contingencies indicated in the cost table that would account for or reflect this cost estimate range. Under the descriptions for alternatives involving capping, it would be informative to include the thickness of cap components and/or the total nominal cap thickness.	The text of Section 9.0 was revised to discuss protectiveness separately from the balancing factors. Table 1 was also revised so that protectiveness was indicated as "pass" or "fail". Table 2 was revised to show unit rates/costs. A contingency of 10 percent was included and is applied to total cost of each alternative. The cap thickness is estimated at three feet where capping was included as a cleanup element. The written description of each alternative that includes capping now indicates the total cap thickness will be three feet.
Mark Pugh	DEQ Project Manager	5	**9.2 Major Assumptions** The estimated areal extent, volume or mass of affected media, and the basis for calculating the estimated values should be provided in the report text, or on a table. Only the mass of berm soil is provided in the ABCA text. There are a number of permitting requirements identified under item 4. DEQ agrees that these add uncertainty to the implementability of most alternatives. Coordination with permitting agencies (especially Oregon Division of State Lands [DSL]) will be needed before selecting a final remedial alternative. With regard to DSL, they may require compensation and/or easements if State lands are to be used as a permanent disposal cell, and this would increase the cost for alternatives with this remedial component. A consultation with DSL in the near future is recommended to assess potential additional costs for incorporation into the comparative analysis of each remedial alternative as appropriate. Given that permitting will play an important part in the project, DEQ suggests renaming Section 7 to "Applicable Regulations and Remedial Action Objectives" and adding local state and federal laws applicable to the cleanup, and permits that may be required. This would also be consistent with national guidelines for ABCA structure. The following permit information was included in the prior DEQ FS: *Section 7.1 (PERMITTING)* *The recommended remedial action would likely require the following permits:* • *National Pollution Discharge Elimination System (NPDES) 1200-C for management of stormwater during construction;* • *DEQ 401 certification, including a land use compatibility statement;* • *Washington County development permit; and* • *Combined Oregon Division of State Lands (DSL) Removal Fill Permit/Army Corps Section 404 permit.* *The combined DSL/Corps permit is mandated under Section 404 of the clean water act. Section 404 of the Clean Water Act requires approval prior to discharging dredged or fill material into the "waters of the United States". Typical activities requiring Section 404 permits are:* • *Depositing of fill or dredged material in waters of the U.S. or adjacent wetlands;* • *Site development fill for residential, commercial, or recreational developments; and/or* • *The landward regulatory limit for non-tidal waters (in the absence of adjacent wetlands) is the "ordinary high water mark". The ordinary high water mark is the line on the shores established by the fluctuations of water and indicated by physical characteristics.*	The estimated areal extent of affected media is shown on Figure 2. The estimated depth of affected media is shown on Figure 3. The volumes of affected media are presented in Appendix C. The text also provides a description of the affected media and the associated volumes for the alternatives that include a removal component. Section 7 was re-titled to be "Remedial Action Objectives and Applicable Regulations". The list of permits provided in the 2004 FS is included in Section 7 and was updated to reflect current agency terminology and requirements. Section 7 also points the reader to Section 9.2 (Major Assumptions) where permits are further discussed.

Reviewer	Reviewer Title	Comment #	Comment	Response
Mark Pugh	DEQ Project Manager	5 (continued)	As indicted in this section, the costs associated with long term O&M are not included where applicable. This would increase the cost of most alternatives, with higher costs associated with alternatives that call for larger capping areas such as the recommended remedial alternative #4. By omitting these costs the estimated costs for alternatives with areas of larger capping areas (alternatives #3, #4 and #6) are disproportionately lower compared to alternatives with off-site disposal components that require smaller capping areas (e.g., alternatives #2, #5 and #7). The ABCA does not discuss the quality of the berm soil, so it is not clear that it is appropriate for backfilling or capping. Berm soil quality is not discussed in DEQ's Focused Feasibility Study even though it was identified as a borrow source. The suitability of the berm soil to be used for capping should be included as an assumption in this section. Potential effects, if any, on local hydrology or native wetland plant restoration, from constructing a phosphate treatment cell with a potential thickness of 2 feet, should be discussed.	O&M costs were added to Table 2 and are included in Section 9.2 as a major assumption. O&M costs cover annual inspection of the containment cell and soil caps for a period of 5 years in alternatives where those elements are part of the proposed cleanup. Inspection effort is less for alternatives that have smaller cap areas. The quality of the berm material is assumed to be suitable as backfill material. Section 9.2 has been revised to indicate that berm materials are described as silts with varying amount of clay in the logs for MW-3 and MW-5. Additional testing of berm materials is suggested as part of subsequent remedial planning. A discussion of the potential effects on native wetland plant restoration was added to bullet 2 in Section 9.2 (Major Assumptions), and indicates that an engineered floor is not expected to adversely impact native plant restoration because the liner will be entirely covered by the cap where native plant restoration is not planned. The potential effects on local hydrology are addressed in the third bullet in Section 9.2 that discussions the 100-year floodplain, as well as being discussed under the "Long-Term Reliability" portion of the evaluation of each alternative.
Mark Pugh	DEQ Project Manager	6	**9.10 Selection of Preferred Remedial Alternative** It would be helpful to identify whether samples on data tables represent areas that will be capped, excavated, or left exposed. Under preferred remedial Alternative #4, the northern sedimentation lagoon and upland hide removal area apparently would not be capped. Because there will be residual contamination above ecological RBCs (but below HS levels based on 10 times the applicable RBC) in the northern sedimentation lagoon and the Rock Creek floodplain east of the sedimentation lagoons, there should be a discussion of residual contamination, including leave surfaces of excavated areas, and also residual risk to benthic and terrestrial receptors. For the upland area that is likely to be developed consistent with current zoning, DEQ will not require a residual risk assessment. DEQ made a similar determination with regard to ecological risk for upland areas at the Ken Foster Farm Site that are reasonably likely to be developed for residential use. To support the residual risk assessment it will be necessary to reduce the data set to eliminate sampling results for areas that will be capped or otherwise remediated and to identify sample results appropriate for each decision unit defined in the risk evaluation.	The samples on data tables are now shown on Figures 2 and 3 so that it is easier to correlate sample locations with areas that would be capped, excavated, or left exposed under the selected alternative. A memorandum presenting an evaluation of protectiveness of the selected remedy was submitted to DEQ on February 6, 2018. A teleconference with DEQ was held on February 15, 2018 to discuss the memorandum. DEQ provided additional comments on February 22, 2018 based on the February 15, 2018 discussion. An additional teleconference with DEQ was held on April 23, 2018 to discuss how the City would respond. A memorandum providing that response is included in Appendix A of the Revised ABCA. The response indicates that to increase the protectiveness of the remedy for benthic receptors, the ABCA was revised to reflect a greater level of cleanup in the wetland exposure unit. This was accomplished by using the selected cleanup level of 111 mg/kg of chromium, instead of the hotspot cleanup level of 1,110 mg/kg, to define the areas of soil and sediment that will be removed off-site for disposal or that will be placed into an on-site containment cell from the wetland exposure unit. Each remedial alternative in the ABCA that includes cleanup in the wetland exposure unit was revised, and those revisions were incorporated into the text, tables, figures, and appendices of the ABCA. The data set used in the evaluation of protectiveness excluded sampling results for areas that are planned for capping or that will be otherwise remediated during remedy implementation.
DEQ comments received via e-mail dated 10/30/17				
Mark Pugh	DEQ Project Manager	1	Under Section 4.1, Land Use Zoning mentions a "Goal 5 resource", but that term is not defined. Please consider adding a definition/ brief explanation of why this is relevant.	A parenthetical was added to Section 4.1, following reference to Rock Creek as a Goal 5 resource. The parenthetical states: "(a Goal 5 resource includes natural resources, scenic and historic areas, and open spaces, as defined in Oregon Administrative Rules 660-015-0000(5))".
EPA comments received via e-mail on October 30, 2017				
B Perkins	EPA Project Officer	None	No comments provided.	No response needed.

APPENDIX A-2

Comment letter from DEQ regarding: Analysis of Brownfield Cleanup Alternatives (Draft), dated October 24, 2017

Oregon
Kate Brown, Governor

Department of Environmental Quality
Northwest Region
700 NE Multnomah Street, Suite 600
Portland, OR 97232
(503) 229-5263
FAX (503) 229-6945
TTY 711

October 24, 2017

Michelle Peterson RG, LG
Associate Geologist
Amec Foster Wheeler
7376 SW Durham Road
Portland, OR 97224

Sent via e-mail
michelle.peterson@amecfw.com

Re: Analysis of Brownfield Cleanup Alternatives (Draft)
Former Frontier Leather Property
1210 SW Oregon Street
Sherwood, Oregon
ECSI #2638

Dear Michelle:

The Oregon Department of Environmental Quality (DEQ) reviewed the above-referenced report, prepared on behalf of the City of Sherwood by Amec Foster Wheeler Environment and Infrastructure, Inc. and dated October 2017. DEQ has the following comments:

DEQ Comments

Section 3.1 and 3.2 touch on contaminant detections for most analytes, but not Cr(VI).

3.3 Groundwater Impact
The last sentence of the second paragraph is incomplete.

4.2 Beneficial Water Use
The former on-site industrial use well on the adjacent tax lot to the west should be discussed in this section.

From the DEQ RI Report:

"A 30-foot-deep well (now abandoned) was located at the former tannery on Tax Lot 400. The well was uncased and extended approximately 20 feet into the basalt. Future use of groundwater at the facility is restricted. The PPA for tax lot 400, 403, 500 and 501 serves as an institutional control that prohibits groundwater extraction for uses other than construction dewatering (DEQ, 2001). Groundwater wells on file with OWRD for the areas included in the well search are summarized in Appendix B"

9.0 Analysis of Brownfield Cleanup Alternatives
Under DEQ's comparative analysis protocol, "Protectiveness" is not a balancing factor, and is not quantified, but is rated as pass/fail. Per DEQ's feasibility study guidance, "Oregon's cleanup law

requires that all remedies be protective of human health and the environment as demonstrated through a residual risk assessment" (see OAR 340-122-0040(2)(a)). See additional comments under Section 9.10 below.

Costing information presented for each alternative on Table 2 is presented in summary form and does not contain units or unit rate/cost used in estimating costs. It is stated in the ABCA that cost estimates are +50%/-30%, but there is no contingencies indicated in the cost table that would account for or reflect this cost estimate range.

Under the descriptions for alternatives involving capping, it would be informative to include the thickness of cap components and/or the total nominal cap thickness.

9.2 Major Assumptions

The estimated areal extent, volume or mass of affected media, and the basis for calculating the estimated values should be provided in the report text, or on a table. Only the mass of berm soil is provided in the ABCA text.

There are a number of permitting requirements identified under item 4. DEQ agrees that these add uncertainty to the implementability of most alternatives. Coordination with permitting agencies (especially Oregon Division of State Lands [DSL]) will be needed before selecting a final remedial alternative. With regard to DSL, they may require compensation and/or easements if State lands are to be used as a permanent disposal cell, and this would increase the cost for alternatives with this remedial component. A consultation with DSL in the near future is recommended to assess potential additional costs for incorporation into the comparative analysis of each remedial alternative as appropriate. Given that permitting will play an important part in the project, DEQ suggests renaming Section 7 to "Applicable Regulations and Remedial Action Objectives" and adding local state and federal laws applicable to the cleanup, and permits that may be required. This would also be consistent with national guidelines for ABCA structure.

The following permit information was included in the prior DEQ FS:

7.1 PERMITTING

The recommended remedial action would likely require the following permits:

- *National Pollution Discharge Elimination System (NPDES) 1200-C for management of stormwater during construction;*
- *DEQ 401 certification, including a land use compatibility statement;*
- *Washington County development permit; and*
- *Combined Oregon Division of State Lands (DSL) Removal Fill Permit/Army Corps Section 404 permit.*

The combined DSL/Corps permit is mandated under Section 404 of the clean water act. Section 404 of the Clean Water Act requires approval prior to discharging dredged or fill material into the "waters of the United States". Typical activities requiring Section 404 permits are:

• Depositing of fill or dredged material in waters of the U.S. or adjacent wetlands;
• Site development fill for residential, commercial, or recreational developments; and/or
• The landward regulatory limit for non-tidal waters (in the absence of adjacent wetlands) is the "ordinary high water mark". The ordinary high water mark is the line on the shores established by the fluctuations of water and indicated by physical characteristics.

As indicted in this section, the costs associated with long term O&M are not included where applicable. This would increase the cost of most alternatives, with higher costs associated with alternatives that call for larger capping areas such as the recommended remedial alternative #4. By omitting these costs the estimated costs for alternatives with areas of larger capping areas (alternatives #3, #4 and #6) are disproportionately lower compared to alternatives with off-site disposal components that require smaller capping areas (e.g., alternatives #2, #5 and #7).

The ABCA does not discuss the quality of the berm soil, so it is not clear that it is appropriate for backfilling or capping. Berm soil quality is not discussed in DEQ's Focused Feasibility Study even though it was identified as a borrow source. The suitability of the berm soil to be used for capping should be included as an assumption in this section.

Potential effects, if any, on local hydrology or native wetland plant restoration, from constructing a phosphate treatment cell with a potential thickness of 2 feet, should be discussed.

9.10 Selection of Preferred Remedial Alternative
It would be helpful to identify whether samples on data tables represent areas that will be capped, excavated, or left exposed.

Under preferred remedial Alternative #4, the northern sedimentation lagoon and upland hide removal area apparently would not be capped. Because there will be residual contamination above ecological RBCs (but below HS levels based on 10 times the applicable RBC) in the northern sedimentation lagoon and the Rock Creek floodplain east of the sedimentation lagoons, there should be a discussion of residual contamination, including leave surfaces of excavated areas, and also residual risk to benthic and terrestrial receptors. For the upland area that is likely to be developed consistent with current zoning, DEQ will not require a residual risk assessment. DEQ made a similar determination with regard to ecological risk for upland areas at the Ken Foster Farm Site that are reasonably likely to be developed for residential use.

To support the residual risk assessment it will be necessary to reduce the data set to eliminate sampling results for areas that will be capped or otherwise remediated and to identify sample results appropriate for each decision unit defined in the risk evaluation.

Closing
Please consider these comments during preparation of the revised ABCA report. DEQ suggests AMEC submit a memorandum outlining residual risk assessment methodology for DEQ review. Should you have any questions or comments, please contact me at (503) 229-5587 or via e-mail at mailto:pugh.mark@deq.state.or.us.

Sincerely,

Mark Pugh, R.G.
Project Manager
Northwest Region Cleanup Section

ec: Julia Hadjuk, City of Sherwood (hajdukj@sherwoodoregon.gov)
Brandon Perkins, EPA (Perkins.Brandon@epamail.epa.gov)
Jenn Peterson, DEQ (mailto:Peterson.Jennifer@deq.state.or.us)
Rebecca Wells-Albers (mailto:wells-albers.rebecca@deq.state.or.us)

APPENDIX A-3

Amec Foster Wheeler Memorandum, dated February 6, 2018: *Protectiveness Evaluation and Justification for Confirmation Sample Surrogate Concentrations*

Memorandum

To	Mark Pugh, RG Project Manager Oregon Department of Environmental Quality Northwest Region Cleanup Section	File no.:	5-61M-130820
From	Michelle Peterson RG, LG Project Manager Amec Foster Wheeler Environment & Infrastructure, Inc.	c:	Julia Hajduk, City of Sherwood
Date	February 6, 2018		
Subject	Former Frontier Leather Tannery Property Analysis of Brownfield Cleanup Alternatives Protectiveness Evaluation and Justification for Confirmation Sample Surrogate Concentrations		

INTRODUCTION

This memorandum is written in response to comments received from the Oregon Department of Environmental Quality (DEQ) regarding the *Draft Analysis of Brownfield Cleanup Alternatives* (ABCA) report for the Former Frontier Leather Tannery Property in Sherwood, Oregon (Site). The Site location is depicted on Figure 1. The Draft ABCA was dated October 2017 and the DEQ comment letter was dated October 24, 2017.

In their comment letter, the DEQ requested evaluation of the protectiveness of the selected remedy presented in the ABCA (comment 9.10), to determine if residual contamination that will be left in place after remedy implementation has the potential to present unacceptable risk to terrestrial and benthic receptors. This memorandum presents that evaluation and its outcome for DEQ consideration in advance of revising and resubmitting the ABCA. The remainder of the DEQ comments not related to the protectiveness evaluation will be addressed in the revised ABCA.

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OVERVIEW OF THE SELECTED REMEDY

The selected remedy for managing contaminated soil, sediment, and the hide-split landfill at the Site, as presented in the ABCA, involves excavation of sediments exceeding the hot spot cleanup level for total chromium (1,110 milligrams per kilogram [mg/kg]), and removal of the hide-split landfill. This material would be placed into an engineered containment cell constructed within either the north or south sedimentation lagoon, depending on site development plans. Confirmation samples would be collected from the excavation footprint to determine residual concentrations of chemicals of potential ecological concern (CPECs).

The base of the engineered containment cell would be amended with a blended phosphate-based material or other chemical mixture to fixate metals to reduce their leachability and mobilization to groundwater. The containment cell would be capped with high density polyethylene (HDPE) sheeting and at least three feet of clean fill material. The cap would be graded so that water runs away from the containment cell and does not create significant erosion. The Cleanup Planning Map and Selected Remedial Alternative Map from the Draft ABCA that illustrate remediation areas are provided as Figure 2 and Figure 3, respectively.

Because specific Site development plans are not yet complete, the selected remedy could be implemented in one of two scenarios as defined below and referenced in this memo hereafter:

- **Remedy Scenario 1 (South Lagoon Containment Cell) –** This scenario involves constructing the containment cell in the south sedimentation lagoon. Sediment exceeding the hot spot cleanup value in the north sedimentation lagoon and Rock Creek floodplain would be excavated and placed in the containment cell along with material from the hide split landfill (located in the upland areas of the Site). Confirmation samples would be collected from the sidewalls and bottom of the excavations in the north sedimentation lagoon and Rock Creek floodplain.
- **Remedy Scenario 2 (North Lagoon Containment Cell) –** This scenario involves constructing the containment cell in the north sedimentation lagoon. Sediment exceeding the hot spot cleanup value in the south sedimentation lagoon and Rock Creek floodplain would be excavated and placed in the containment cell along with material from the hide split landfill (located in the upland areas of the Site). Confirmation samples would be collected from the sidewalls and bottom of the excavations in the south sedimentation lagoon and Rock Creek floodplain.

EVALUATION OF PROTECTIVENESS FOR TERRESTRIAL RECEPTORS

A protectiveness evaluation was conducted for the selected remedy. Both Remedy Scenarios 1 and 2 were evaluated. The primary CPEC for terrestrial receptors at the Site is chromium so the evaluation of protectiveness is focused on chromium. Two cleanup levels were identified as relevant in the ABCA. The sediment cleanup level was selected in collaboration with the DEQ, and is the Probable Effect Concentration (PEC) of 111 mg/kg. The soil cleanup level was also selected in collaboration with DEQ, and is the previously established Site-specific ecological cleanup value for threatened and endangered (T&E) species of 280 mg/kg[1]. No T&E species are known to be present at the Site. The selected remedy is considered protective of ecological receptors at the Site if the average chromium concentration remaining in the soil/sediment of the Rock Creek floodplain and sedimentation lagoons after remedial action is within the range of selected cleanup levels, or is less.

Inputs to the evaluation to represent the level of residential chromium contamination include two data sets:

1. Existing Site data from areas that are outside of the excavation footprints. Two distinct data sets were developed; one for Remedy Scenario 1 and a separate data set for Remedy Scenario 2. The data sets were evaluated separately.
2. A calculated surrogate value (described below) that will represent the concentration of chromium for confirmation samples collected from inside the areas of excavation, after excavation is complete.

To estimate the average chromium concentration remaining in soil/sediment following excavation, the 90 percent (%) upper confidence limit (UCL) was calculated using both data sets described above (existing Site data and the calculated surrogate value). The 90% UCL was then compared to the cleanup levels. This analysis was done for each remedy scenario.

The following sections present the approach used to calculate a surrogate value for the chromium concentration in confirmation samples, and the outcome of the protectiveness evaluation for terrestrial receptors.

CONFIRMATION SAMPLE SURROGATE CONCENTRATION CALCULATION

As part of the selected remedy, confirmation samples will be collected after the removal action to document remaining metals concentrations. Confirmation samples would be collected from the sidewalls and floor of each excavation, with the number of confirmation samples dependent on the remedy scenario implemented and the frequency of collection. For this evaluation, we assumed one confirmation sample would be collected from sidewalls every 100 linear feet, and one confirmation sample would be collected from the base of the excavation per every 1,000 square

[1] Previous Site-specific risk-based concentrations for ecological receptors were discussed in detail in Section 6.4 of the 2004 Remedial Investigation Report for the DEQ Frontier Leather Site prepared by GeoEngineers.

feet. Given these rates of sample collection, a total of 63 confirmation samples would be collected for Remedy Scenario 1 and a total of 115 confirmation samples would be collected for Remedy Scenario 2.

To estimate the residual concentration in each of the confirmation samples, a surrogate concentration was assumed. The surrogate concentration used in this evaluation is the calculated average chromium concentration from the existing Site data set that are comprised of the following:

1. Samples collected during the 2004 Remedial Investigation (RI) in the north and south sedimentation lagoons and in the Rock Creek Floodplain that are outside of the proposed excavation areas illustrated on Figures 2 and 3; and,
2. Samples collected within the upper 24 inches (burrowing mammal zone).

EVALUATION PROCESS

The protectiveness evaluation was conducted for two possible remedy implementation scenarios to determine if the selected remedy could be implemented in either the north or the south sedimentation lagoon and still be considered protective. A 90% UCL was calculated to represent the average concentration for residual chromium contamination remaining after remedy implementation for each scenario.

For Remedy Scenario 1 (South Lagoon Containment Cell), the estimated post-remedy residual concentration for chromium in the north sedimentation lagoon was calculated using the following data sets:

- Existing Site data set – 57 sample results from the 2004 RI collected from less than 24 inches in the north sedimentation lagoon and the Rock Creek floodplain.
- Surrogate confirmation sample data set – 63 surrogate concentrations for chromium were used to represent confirmation samples.

For Remedy Scenario 2 (North Lagoon Containment Cell), the estimated post-remedy residual concentration for chromium in the south sedimentation lagoon was calculated using the following data sets:

- Existing Site data set – 45 sample results from the 2004 RI collected from less than 24 inches in the south sedimentation lagoon and the Rock Creek floodplain.
- Surrogate confirmation sample data set – 115 surrogate concentrations for chromium were used to represent confirmation samples.

The 90% UCL for each remedy implementation scenario was compared to the selected cleanup level. The chromium input data sets are presented in Attachment A. The outcome of the protectiveness evaluation presented in the next section.

OUTCOMES

The protectiveness evaluation identified two key outcomes. First, the preliminary evaluation of Remedy Scenarios 1 and 2 determined that the remedy would not be protective enough for terrestrial ecological receptors unless the excavation area was modified because the average chromium concentration used as the surrogate confirmation sample concentration was too high. Specifically, the chromium concentrations from samples HA-66 (890 mg/kg) and HA-68 (260 mg/kg) contributed to an average concentration of 109.9 mg/kg, which in turn led to 90% UCLs that were greater than the sediment cleanup level of 111 mg/kg. Therefore, a modification of the selected remedy is required to expand the excavation area at the south sedimentation lagoon to include soil represented by samples HA-66 and HA-68. This modification would expand the excavation footprint by an estimated 8,052 square feet at a depth of 1.5 feet below ground surface, and is illustrated on Figure 4. The estimated increase in excavated soil was therefore calculated at 447 cubic yards. This estimated increase in excavated volume will be included in the revised alternatives analysis for all remedial alternatives presented in the ABCA.

The surrogate confirmation sample concentration was recalculated after removing the results from HA-66 and HA-68. The refined surrogate confirmation sample concentration for chromium is 97.5 mg/kg. The confirmation surrogate concentration should be considered a conservative estimate considering that the background concentration for chromium in the Portland basin is 76 mg/kg[2].

The protectiveness evaluation was refined using the modified excavation area (which excludes HA-66 and HA-68 from the existing Site data set), and using the refined surrogate confirmation sample concentration of 97.5 mg/kg. The refined 90% UCL calculated for each remedy scenario is presented in Table 1, along with the selected cleanup levels. ProUCL output is presented in Attachment B.

The 90% UCL for residual chromium concentration is 105 mg/kg for Remedy Scenario 1, and is 120 mg/kg for Remedy Scenario 2. These chromium concentrations are within the range of selected cleanup levels, or less. This comparison provides the second key outcome of the protectiveness evaluation, which is that the residual concentrations of chromium fall within the range of cleanup levels relevant to the Site and are sufficiently protective of terrestrial receptors.

---

[2] March 2013, Development of Oregon Background Metals Concentrations in Soil.

Therefore, the selected remedy that incorporates the expanded excavation area to remove soil from samples locations HA-66 and HA-68 is considered protective.

EVALUATION OF PROTECTIVENESS FOR BENTHIC RECEPTORS

DEQ's comment on Section 9.10 of the ABCA also requested an evaluation of the protectiveness of the selected remedy for benthic receptors, which are organisms without backbones that generally reside in bottom sediment or on the surface of sediment found within surface water bodies. The evaluation presents the results from the existing Site data set for samples collected within the upper twelve inches (biologically active zone) and that are outside the footprint of the excavation areas, and compares them to the selected cleanup levels to identify locations where the residual chromium concentration exceeds one or both of the cleanup levels. The evaluation closes with a discussion of the suitability of the habitat present at the Site to support a benthic community.

Tables 2 and 3 present the existing Site data set for each remedy scenario (excluding samples collected below 12 inches), and identify those sample locations that exceed one or both of the selected cleanup levels for chromium. Eleven samples in each remedy scenario have chromium concentrations greater than 111 mg/kg, but only two to four samples (depending on the remedy scenario) have chromium concentrations greater than 280 mg/kg. Additionally, the confirmation samples that will be collected from inside excavation areas after excavation is complete are estimated to have an average concentration of 97.5 mg/kg, which is less than the lowest cleanup level of 111 mg/kg. Given these data, the locations of the samples having chromium concentrations that exceed the selected cleanup levels after excavation represent a relatively small portion of the wetland areas where benthic communities could exist.

The comparison of the chemical data to the selected cleanup levels (which are the PEC and the site-specific RBC) as presented above assumes that the wetland areas in the Rock Creek flood plain and sedimentation lagoons provide suitable habitat for benthic organisms to exist. However, the following two lines of evidence present the reasons why the Rock Creek flood plain and sedimentation lagoons may not provide suitable habitat:

1. **Seasonality of the wetland areas** – The Rock Creek floodplain and sedimentation lagoons are not continuously wet, particularly with increasing distance from Rock Creek. This statement is supported by the wetland delineation conducted as part of the Brownfield Assessment Grant (Amec Foster Wheeler, 2016; Amec Foster Wheeler, 2017; Oregon Department of State Lands, 2017). Soil plot data collected in the flood plain and sedimentation lagoon indicate a lack of surface water, water table, and saturation, with soil cracks identified at some locations. These soil plot data indicate that a benthic community is likely only supported on a short-term, seasonal basis when standing water returns after the dry season ends, or when sufficient seasonal flooding occurs. During the dry season, the wetland body would lose whatever benthic community it supported when inundated, due to desiccation.

2. **Site disturbance** – Seasonal benthic communities have been disturbed by historical activities at the Site that include construction of the sedimentation lagoons and creation of the lagoon breaches that prevent the lagoons from holding standing water when they were taken out of service. Seasonal benthic communities have also been disturbed by man-made fires, the most recent of which occurred in 2015, and which burned an estimated 75% of the wetland area.

The seasonal nature of the wetland area and the history of disturbance at the Site demonstrate that the Site likely does not provide suitable habitat for a benthic community. The limited areas of the Site where chromium concentrations will exceed selected cleanup levels after excavation demonstrate that the selected remedy to address hot spots of chromium will be protective of the overall integrity of seasonal benthic communities, if present.

REFERENCES

Amec Foster Wheeler, 2016. Wetland and Other Waters Determination and Delineation Report dated September 8, 2016.

Amec Foster Wheeler, 2017. Addendum to Wetland and Other Waters Determination and Delineation Report, dated May 2, 2017.

Oregon Department of State Lands, 2017. WD #2016-0405 Wetland Delineation Report for The Former Frontier Leather Property, Washington County; T2S R1W Sec. 29D Tax Lots 600 and 602, City of Sherwood Local Wetlands Inventory, Wetland R5, R7, R8. May 3, 2017.

ATTACHMENTS:

Table 1 – Comparison of 90% UCLs to Selected Cleanup Levels
Table 2 – Remedy Scenario 1 (South Lagoon Containment Cell), Chromium Concentrations in the Biologically Active Zone in the North Sedimentation Lagoon and Rock Creek Flood Plain
Table 3 – Remedy Scenario 2 (North Lagoon Containment Cell), Chromium Concentrations in the Biologically Active Zone in the South Sedimentation Lagoon and Rock Creek Flood Plain

Figure 1 – Site Location Map
Figure 2 – Cleanup Planning Map – Original
Figure 3 – Selected Remedial Alternative Map – Original
Figure 4 – Selected Remedial Alternative Map – Revised

Attachment A – Chromium Input Data Sets Used in the Terrestrial Evaluation
Attachment B – ProUCL Output

TABLES

TABLE 1
Comparison of 90% UCLs to Selected Cleanup Levels

Protectiveness Evaluation (Terrestrial Receptors)	Chromium Concentration (mg/kg)
Selected Cleanup Levels	
PEC	111
Site-specific RBC (non-T&E)	280
Background Level for the Portland Basin and Surrogate Confirmation Sample Concentration	
Background	76
Surrogate Concentration	97.5
90% Upper Confidence Limit of Residual Chromium Concentration	
Remedy Scenario 1 (South Lagoon Containment Cell)	105
Remedy Scenario 2 (North Lagoon Containment Cell)	120

Notes:
mg/kg = miligrams per kilogram
UCL = Upper conficence limit
RBC = Risk-based concentration
T&E = Threatened and endangered
PEC = Probable effect concentration

TABLE 2
Remedy Scenario 1 (South Lagoon Containment Cell)
Chromium Concentrations in the Biologically Active Zone in the North Sedimentation Lagoon and Rock Creek Flood Plain

Sample Count	Boring Location	Position Relative to Excavation Area	Lagoon or Floodplain?	Sample ID	Sample Date	Depth (ft bgs)	Chromium
1	HA-43	Outside	Floodplain	HA-43-1.0	6/6/2003	1	180
2	HA-55	Outside	Floodplain	HA-55-0.5	6/11/2003	0.5	150
3	HA-56	Outside	Floodplain	HA-56-0.5	6/11/2003	0.5	26
4	HA-57	Outside	Floodplain	HA-57-0.5	6/11/2003	0.5	24
5	HA-58	Outside	Floodplain	HA-58-1.0	6/11/2003	1	29
6	HA-59	Outside	Floodplain	HA-59-0.5	6/11/2003	0.5	26
7	HA-60	Outside	Floodplain	HA-60-0.5	6/11/2003	0.5	28
8	HA-61	Outside	Floodplain	HA-61-0.5	6/11/2003	0.5	30
9	HA-64	Outside	Floodplain	HA-64-0.5	6/11/2003	0.5	18
10	HA-64	Outside	Floodplain	HA-64-1.0	6/11/2003	1	18
11	HA-65	Outside	Floodplain	HA-65(0-0.5)	12/19/2003	0 - 0.5	24
12	HA-67	Outside	Floodplain	HA-67(0-0.5)	12/19/2003	0 - 0.5	24
13	HA-69	Outside	Floodplain	HA-69(0-0.5)	12/19/2003	0 - 0.5	23
14	HA-70	Outside	Floodplain	HA-70(0-0.5)	12/19/2003	0 - 0.5	21
15	HA-71	Outside	Floodplain	HA-71(0-0.5)	12/19/2003	0 - 0.5	65
16	HA-72	Outside	Floodplain	HA-72(0-0.5)	12/19/2003	0 - 0.5	160
17	HA-73	Outside	Floodplain	HA-73(0-0.5)	12/19/2003	0 - 0.5	250
18	HA-74	Outside	Floodplain	HA-74(0-0.5)	12/19/2003	0 - 0.5	480
19	HA-75	Outside	Floodplain	HA-75(0-0.5)	12/19/2003	0 - 0.5	68
20	SS-2	Outside	Floodplain	SS-2	6/12/2003	0 - 0.5	39
21	SS-3	Outside	Floodplain	SS-3	6/12/2003	0 - 0.5	22
22	SS-4	Outside	Floodplain	SS-4	6/12/2003	0 - 0.5	55
23	SS-5	Outside	Floodplain	SS-5	6/11/2003	0 - 0.5	37
24	SS-7	Outside	Floodplain	SS-7	12/19/2003	0 - 0.5	23
25	SS-9	Outside	Floodplain	SS-9	12/19/2003	0 - 0.5	5.8
26	HA-28	Outside	N Lagoon	HA-28-0.5	6/4/2003	0.5	220
27	HA-29	Outside	N Lagoon	HA-29-0.8	6/4/2003	0.8	220
28	HA-31	Outside	N Lagoon	HA-31-0.7	6/4/2003	0.7	120
29	HA-32	Outside	N Lagoon	HA-32-0.5	6/4/2003	0.5	130
30	HA-33	Outside	N Lagoon	HA-33-1.0	6/4/2003	1	45
31	HA-34	Outside	N Lagoon	HA-34-0.5	6/4/2003	0.5	20
32	HA-37	Outside	N Lagoon	HA-37-0.5	6/4/2003	0.5	170
33	HA-38	Outside	N Lagoon	HA-38-0.5	6/4/2003	0.5	22
34	HA-39	Outside	N Lagoon	HA-39-0.5	6/6/2003	0.5	53
35	HA-41	Outside	N Lagoon	HA-41-1.0	6/6/2003	1	30
36	HA-44	Outside	N Lagoon	HA-44-0.5	6/6/2003	0.5	80
37	HA-45	Outside	N Lagoon	HA-45-1.0	6/5/2003	1	60
38	HA-46	Outside	N Lagoon	HA-46-0.5	6/6/2003	0.5	44
39	HA-47	Outside	N Lagoon	HA-47-0.5	6/5/2003	0.5	44
40	HA-48	Outside	N Lagoon	HA-48-0.5	6/5/2003	0.5	41
41	HA-48	Outside	N Lagoon	HA-48-1.0	6/5/2003	1	27
42	HA-49	Outside	N Lagoon	HA-49-0.5	6/5/2003	0.5	71
43	HA-49	Outside	N Lagoon	HA-49-1.0	6/5/2003	1	15
44	HA-50	Outside	N Lagoon	HA-50-0.5	6/5/2003	0.5	500
45	HA-51	Outside	N Lagoon	HA-51-0.5	6/5/2003	0.5	82
46	HA-53	Outside	N Lagoon	HA-53-1.0	6/6/2003	1	29

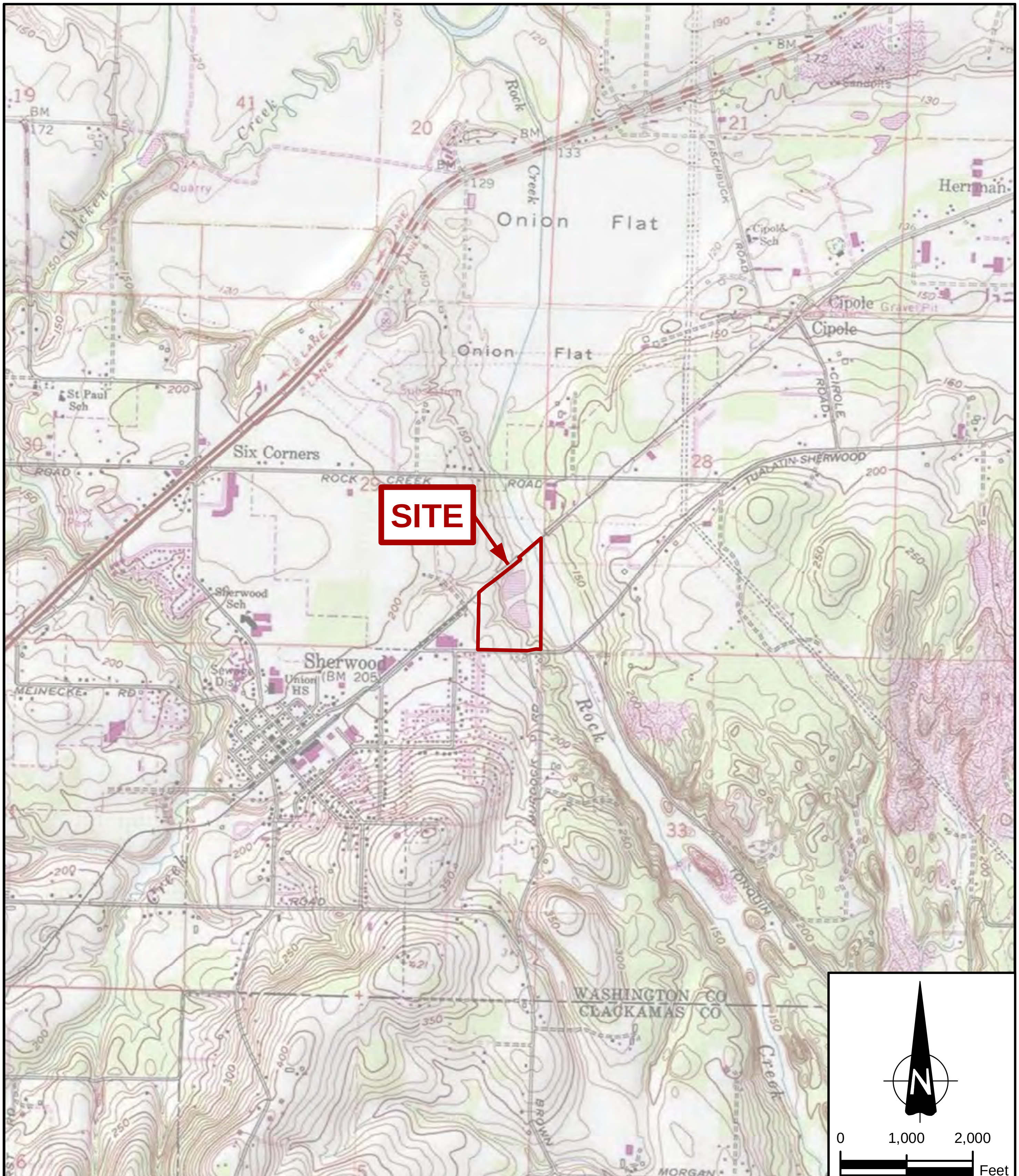
Notes:
Lines shaded in grey identify sample locations with a chromium concentration greater than 111 mg/kg.
Text in red identifies sample locations with a chromium concentration greater than 280 mg/kg.

TABLE 3
Remedy Scenario 2 (North Lagoon Containment Cell)
Chromium Concentrations in the Biologically Active Zone in the South Sedimentation Lagoon and Rock Creek Flood Plain

Sample Count	Boring Location	Lagoon or Floodplain?	Lagoon or Floodplain?	Sample ID	Sample Date	Depth (ft bgs)	Chromium
1	HA-43	Outside	Floodplain	HA-43-1.0	6/6/2003	1	180
2	HA-55	Outside	Floodplain	HA-55-0.5	6/11/2003	0.5	150
3	HA-56	Outside	Floodplain	HA-56-0.5	6/11/2003	0.5	26
4	HA-57	Outside	Floodplain	HA-57-0.5	6/11/2003	0.5	24
5	HA-58	Outside	Floodplain	HA-58-1.0	6/11/2003	1	29
6	HA-59	Outside	Floodplain	HA-59-0.5	6/11/2003	0.5	26
7	HA-60	Outside	Floodplain	HA-60-0.5	6/11/2003	0.5	28
8	HA-61	Outside	Floodplain	HA-61-0.5	6/11/2003	0.5	30
9	HA-64	Outside	Floodplain	HA-64-0.5	6/11/2003	0.5	18
10	HA-64	Outside	Floodplain	HA-64-1.0	6/11/2003	1	18
11	HA-65	Outside	Floodplain	HA-65(0-0.5)	12/19/2003	0 - 0.5	24
12	HA-67	Outside	Floodplain	HA-67(0-0.5)	12/19/2003	0 - 0.5	24
13	HA-69	Outside	Floodplain	HA-69(0-0.5)	12/19/2003	0 - 0.5	23
14	HA-70	Outside	Floodplain	HA-70(0-0.5)	12/19/2003	0 - 0.5	21
15	HA-71	Outside	Floodplain	HA-71(0-0.5)	12/19/2003	0 - 0.5	65
16	HA-72	Outside	Floodplain	HA-72(0-0.5)	12/19/2003	0 - 0.5	160
17	HA-73	Outside	Floodplain	HA-73(0-0.5)	12/19/2003	0 - 0.5	250
18	HA-74	Outside	Floodplain	HA-74(0-0.5)	12/19/2003	0 - 0.5	480
19	HA-75	Outside	Floodplain	HA-75(0-0.5)	12/19/2003	0 - 0.5	68
20	SS-2	Outside	Floodplain	SS-2	6/12/2003	0 - 0.5	39
21	SS-3	Outside	Floodplain	SS-3	6/12/2003	0 - 0.5	22
22	SS-4	Outside	Floodplain	SS-4	6/12/2003	0 - 0.5	55
23	SS-5	Outside	Floodplain	SS-5	6/11/2003	0 - 0.5	37
24	SS-7	Outside	Floodplain	SS-7	12/19/2003	0 - 0.5	23
25	SS-9	Outside	Floodplain	SS-9	12/19/2003	0 - 0.5	5.8
26	HA-10	Outside	S Lagoon	HA-10-0.5	6/9/2003	0.5	190
27	HA-14	Outside	S Lagoon	HA-14-1.0	6/9/2003	1	21
28	HA-18	Outside	S Lagoon	HA-18-0.5	6/10/2003	0.5	550
29	HA-19	Outside	S Lagoon	HA-19-1.0	6/9/2003	1	95
30	HA-2	Outside	S Lagoon	HA-2-0.5	6/10/2003	0.5	380
31	HA-22	Outside	S Lagoon	HA-22-1.0	6/6/2003	1	42
32	HA-23	Outside	S Lagoon	HA-23-0.5	6/6/2003	0.5	220
33	HA-24	Outside	S Lagoon	HA-24-0.5	6/9/2003	0.5	71
34	HA-25	Outside	S Lagoon	HA-25-0.5	6/9/2003	0.5	420
35	HA-5	Outside	S Lagoon	HA-5-0.5	6/10/2003	0.5	45
36	HA-6	Outside	S Lagoon	HA-6-0.5	6/10/2003	0.5	240
37	HA-8	Outside	S Lagoon	HA-8-0.5	6/10/2003	0.5	63
38	HA-9	Outside	S Lagoon	HA-9-0.5	6/10/2003	0.5	52

Notes:
Lines shaded in grey identify sample locations with a chromium concentration greater than 111 mg/kg.
Text in red identifies sample locations with a chromium concentration greater than 280 mg/kg.

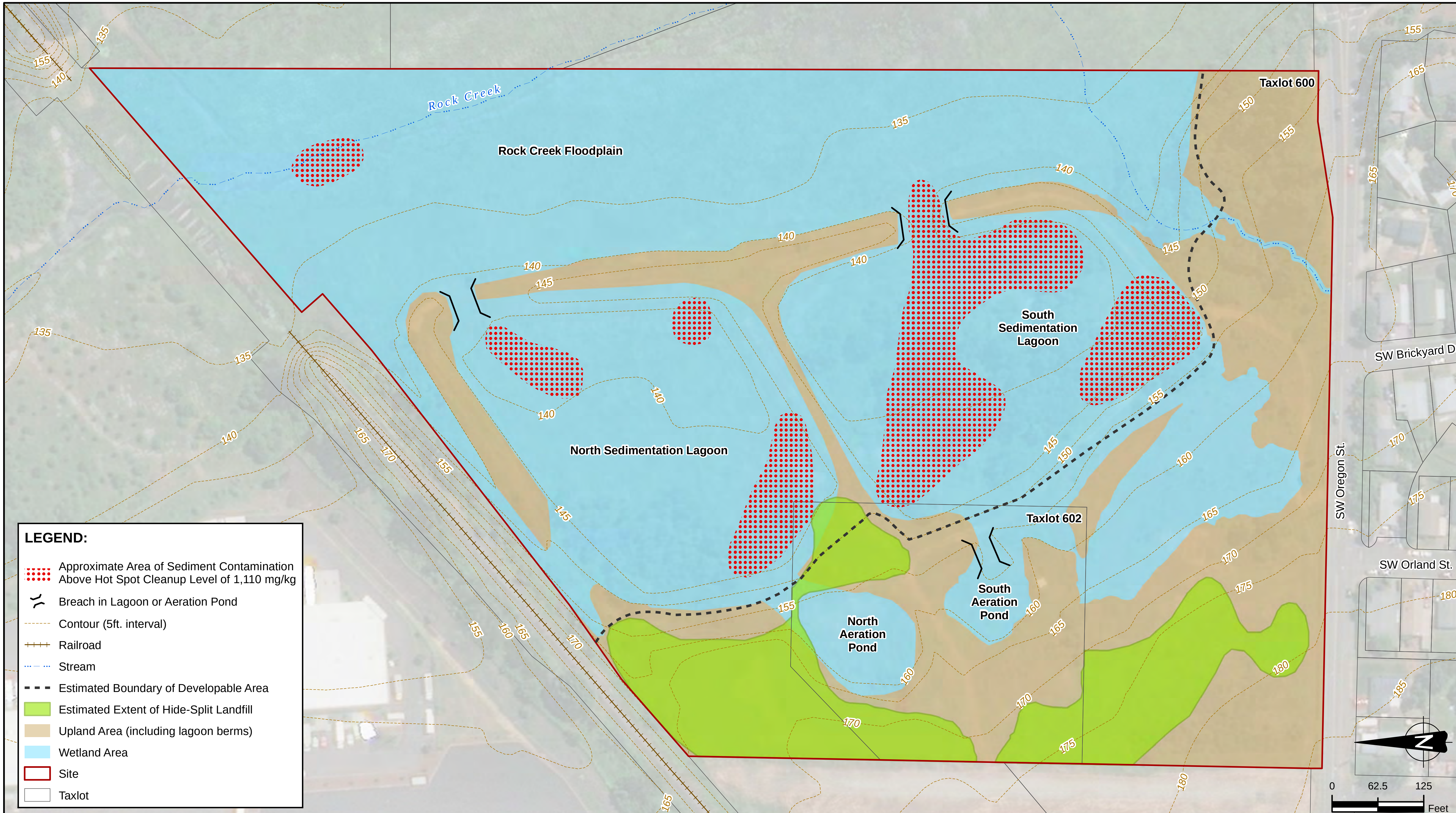
FIGURES



CITY OF SHERWOOD		FORMER FRONTIER LEATHER PROPERTY SHERWOOD, OREGON	DATE JANUARY 2018
			SCALE 1 " = 2,000 '
Amec Foster Wheeler Environment & Infrastructure, Inc. 7376 S.W. Durham Road Portland, OR 97224	amec foster wheeler	SITE LOCATION MAP	PROJECT NO. 5-61M-130820-03
			FIGURE 1

DRAWN BY: SD CHECKED BY: EH

K:\13000\13000\13082\DWG_Protectiveness_Memo\Figure 1 - Site Location Map.mxd - stephane.descombes - 1/22/2018 - 10:48:30 AM



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7376 S.W. Durham Road
Portland, OR 97224

amec foster wheeler

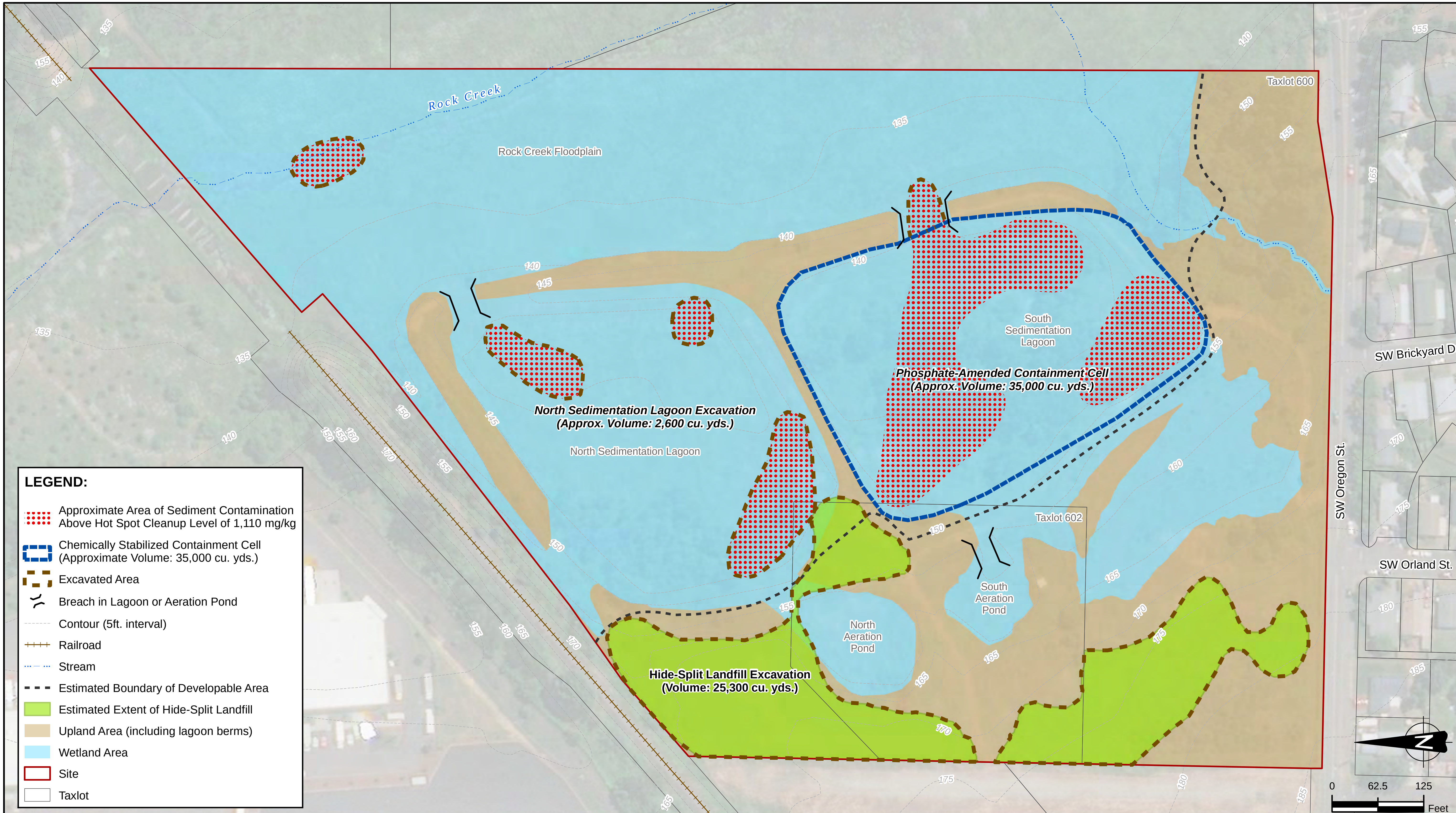
FORMER FRONTIER LEATHER PROPERTY
SHERWOOD, OREGON

CLEANUP PLANNING MAP

DATE	JANUARY 2018
SCALE	1 " = 125 '
PROJECT NO.	5-61M-130820-03
FIGURE	2

DRAWN BY: SD CHECKED BY: EH

K:\13000\13000\13082\DWG_Protectiveness_Memo\Figure 2 - Cleanup Planning Map.mxd - stephane.descombes - 1/31/2018 - 11:26:03 AM



NOTE: Containment cell would be capped with 3 feet of suitable fill.

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Portland, OR 97224

amec foster wheeler

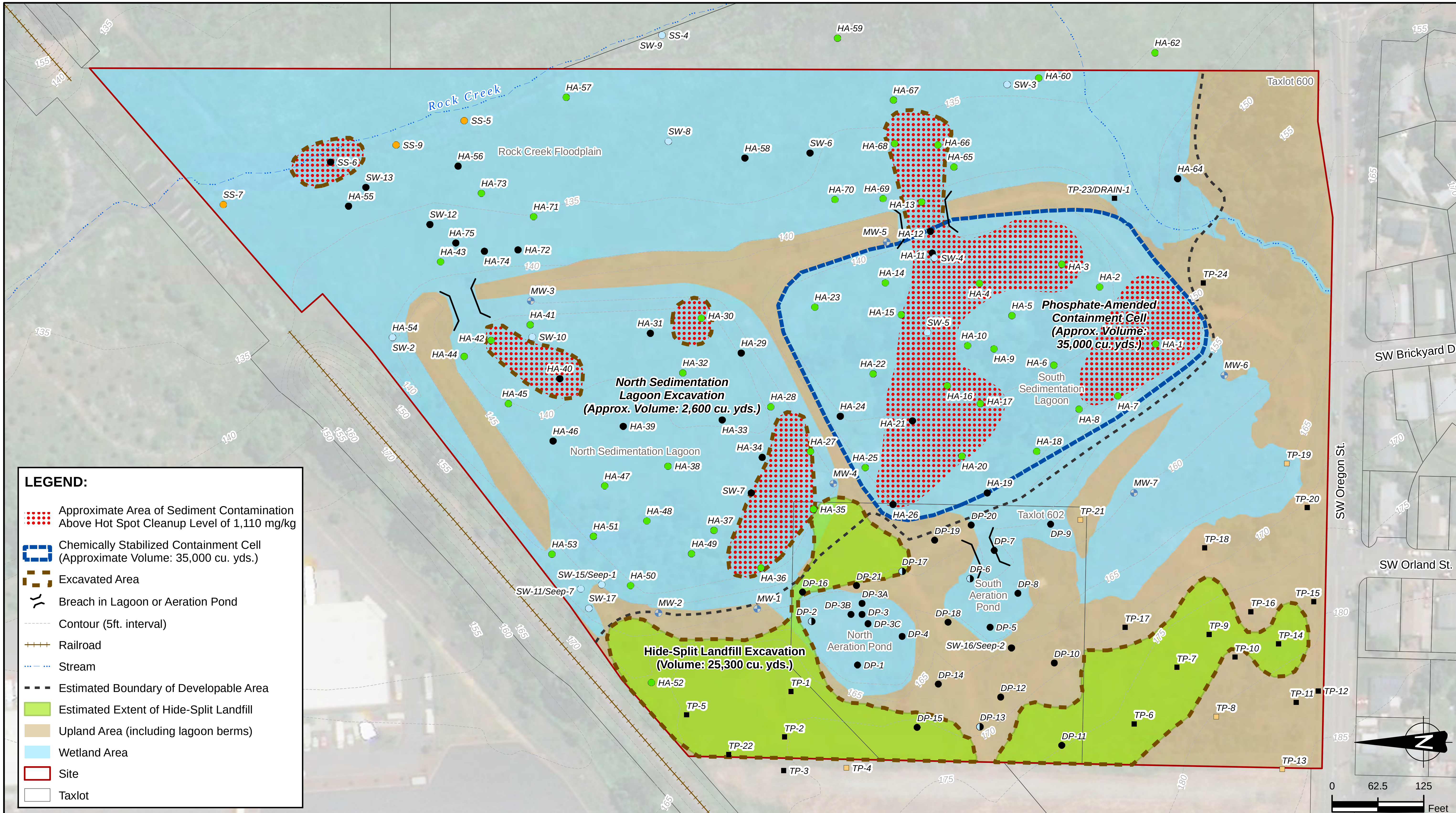
FORMER FRONTIER LEATHER PROPERTY
SHERWOOD, OREGON

SELECTED REMEDIAL ALTERNATIVE MAP
ORIGINAL

DATE	JANUARY 2018
SCALE	1 " = 125 '
PROJECT NO.	5-61M-130820-03
FIGURE	3

DRAWN BY: SD CHECKED BY: EH

K:\13000\13000\13082\DWG_Protectiveness_Memo\Figure 3 - Selected Cleanup Alternative Map.mxd - stephane.descombes - 1/31/2018 - 11:25:56 AM



NOTE: Containment cell would be capped with 3 feet of suitable fill.

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CITY OF SHERWOOD

Amec Foster Wheeler
Environment & Infrastructure, Inc.
7376 S.W. Durham Road
Portland, OR 97224

amec foster wheeler

FORMER FRONTIER LEATHER PROPERTY
SHERWOOD, OREGON

SELECTED REMEDIAL ALTERNATIVE MAP
REVISED

DATE	JANUARY 2018
SCALE	1 " = 125 '
PROJECT NO.	5-61M-130820-03
FIGURE	4

DRAWN BY: SD CHECKED BY: EH

K:\13000\13000\13082\DWG_Protectiveness_Memo\Figure 4 - Selected Cleanup Alternative Map - Sample Locations.mxd - stephane.descombes - 1/31/2018 - 11:26:37 AM

ATTACHMENT A

Chromium Input Data Sets Used in the Terrestrial Evaluation

ATTACHMENT A-1
Remedy Scenario 1 (South Lagoon Containment Cell)
Chromium Input Data Set for North Sedimentation Lagoon, Rock Creek Floodplain, and Surrogate Concentration (listed once to save space for presentation)

Location	Area	Inside or outside excavation area	Sample ID	Sample Date	Depth (ft bgs)	Chromium	d_Chromium
Surrogate Concentration (used 63 times)						**97.5**	**1**
HA-50	N Lagoon	Outside	HA-50-0.5	6/5/2003	0.5	500	1
HA-74	Floodplain	Outside	HA-74(0-0.5)	12/19/2003	0 - 0.5	480	1
HA-73	Floodplain	Outside	HA-73(0-0.5)	12/19/2003	0 - 0.5	250	1
HA-28	N Lagoon	Outside	HA-28-0.5	6/4/2003	0.5	220	1
HA-29	N Lagoon	Outside	HA-29-0.8	6/4/2003	0.8	220	1
HA-43	Floodplain	Outside	HA-43-1.0	6/6/2003	1	180	1
HA-37	N Lagoon	Outside	HA-37-0.5	6/4/2003	0.5	170	1
HA-72	Floodplain	Outside	HA-72(0-0.5)	12/19/2003	0 - 0.5	160	1
HA-55	Floodplain	Outside	HA-55-0.5	6/11/2003	0.5	150	1
HA-32	N Lagoon	Outside	HA-32-0.5	6/4/2003	0.5	130	1
HA-31	N Lagoon	Outside	HA-31-0.7	6/4/2003	0.7	120	1
HA-51	N Lagoon	Outside	HA-51-0.5	6/5/2003	0.5	82	1
HA-44	N Lagoon	Outside	HA-44-0.5	6/6/2003	0.5	80	1
HA-31	N Lagoon	Outside	HA-31-2.0	6/4/2003	2	80	1
HA-49	N Lagoon	Outside	HA-49-0.5	6/5/2003	0.5	71	1
HA-75	Floodplain	Outside	HA-75(0-0.5)	12/19/2003	0 - 0.5	68	1
HA-71	Floodplain	Outside	HA-71(0-0.5)	12/19/2003	0 - 0.5	65	1
HA-45	N Lagoon	Outside	HA-45-1.0	6/5/2003	1	60	1
SS-4	Floodplain	Outside	SS-4	6/12/2003	0 - 0.5	55	1
HA-39	N Lagoon	Outside	HA-39-0.5	6/6/2003	0.5	53	1
HA-34	N Lagoon	Outside	HA-34-2.0	6/4/2003	2	50	1
HA-33	N Lagoon	Outside	HA-33-1.0	6/4/2003	1	45	1
HA-46	N Lagoon	Outside	HA-46-0.5	6/6/2003	0.5	44	1
HA-47	N Lagoon	Outside	HA-47-0.5	6/5/2003	0.5	44	1
HA-48	N Lagoon	Outside	HA-48-0.5	6/5/2003	0.5	41	1
SS-2	Floodplain	Outside	SS-2	6/12/2003	0 - 0.5	39	1
SS-5	Floodplain	Outside	SS-5	6/11/2003	0 - 0.5	37	1
HA-32	N Lagoon	Outside	HA-32-2.0	6/4/2003	2	32	1
HA-61	Floodplain	Outside	HA-61-0.5	6/11/2003	0.5	30	1
HA-41	N Lagoon	Outside	HA-41-1.0	6/6/2003	1	30	1
HA-53	N Lagoon	Outside	HA-53-1.0	6/6/2003	1	29	1
HA-58	Floodplain	Outside	HA-58-1.0	6/11/2003	1	29	1
HA-60	Floodplain	Outside	HA-60-0.5	6/11/2003	0.5	28	1
HA-48	N Lagoon	Outside	HA-48-1.0	6/5/2003	1	27	1
HA-56	Floodplain	Outside	HA-56-0.5	6/11/2003	0.5	26	1
HA-59	Floodplain	Outside	HA-59-0.5	6/11/2003	0.5	26	1
HA-54	Floodplain	Outside	HA-54-1.5	6/6/2003	1.5	25	1
HA-65	Floodplain	Outside	HA-65(0-0.5)	12/19/2003	0 - 0.5	24	1
HA-67	Floodplain	Outside	HA-67(0-0.5)	12/19/2003	0 - 0.5	24	1
HA-57	Floodplain	Outside	HA-57-0.5	6/11/2003	0.5	24	1
HA-69	Floodplain	Outside	HA-69(0-0.5)	12/19/2003	0 - 0.5	23	1
HA-46	N Lagoon	Outside	HA-46-1.5	6/6/2003	1.5	23	1
SS-7	Floodplain	Outside	SS-7	12/19/2003	0 - 0.5	23	1
HA-38	N Lagoon	Outside	HA-38-0.5	6/4/2003	0.5	22	1
SS-3	Floodplain	Outside	SS-3	6/12/2003	0 - 0.5	22	1
HA-70	Floodplain	Outside	HA-70(0-0.5)	12/19/2003	0 - 0.5	21	1
HA-47	N Lagoon	Outside	HA-47-1.5	6/5/2003	1.5	21	1
HA-34	N Lagoon	Outside	HA-34-0.5	6/4/2003	0.5	20	1

ATTACHMENT A-1

Remedy Scenario 1 (South Lagoon Containment Cell)

Chromium Input Data Set for North Sedimentation Lagoon, Rock Creek Floodplain, and Surrogate Concentration (listed once to save space for presentation)

Location	Area	Inside or outside excavation area	Sample ID	Sample Date	Depth (ft bgs)	Chromium	d_Chromium
HA-38	N Lagoon	Outside	HA-38-1.5	6/4/2003	1.5	20	1
HA-51	N Lagoon	Outside	HA-51-2.0	6/5/2003	2	20	1
HA-37	N Lagoon	Outside	HA-37-1.5	6/4/2003	1.5	19	1
HA-64	Floodplain	Outside	HA-64-0.5	6/11/2003	0.5	18	1
HA-64	Floodplain	Outside	HA-64-1.0	6/11/2003	1	18	1
HA-58	Floodplain	Outside	HA-58-2.0	6/11/2003	2	17	1
HA-49	N Lagoon	Outside	HA-49-1.0	6/5/2003	1	15	1
HA-50	N Lagoon	Outside	HA-50-2.0	6/5/2003	2	15	1
SS-9	Floodplain	Outside	SS-9	12/19/2003	0 - 0.5	5.8	1

ATTACHMENT A-2
Remedy Scenario 2 (North Lagoon Containment Cell)
Chromium Input Data Set for South Sedimentation Lagoon, Rock Creek Floodplain, and Surrogate Concentration (listed once to save space for presentation)

Location	Area	Inside or outside excavation area	Sample ID	Sample Date	Depth (ft bgs)	Chromium	d_Chromium
Surrogate Concentration (used 115 times)						**97.5**	**1**
HA-18	S Lagoon	Outside	HA-18-0.5	6/10/2003	0.5	550	1
HA-2	S Lagoon	Outside	HA-2-2.0	6/10/2003	2	510	1
HA-74	Floodplain	Outside	HA-74(0-0.5)	12/19/2003	0 - 0.5	480	1
HA-25	S Lagoon	Outside	HA-25-0.5	6/9/2003	0.5	420	1
HA-2	S Lagoon	Outside	HA-2-0.5	6/10/2003	0.5	380	1
HA-73	Floodplain	Outside	HA-73(0-0.5)	12/19/2003	0 - 0.5	250	1
HA-6	S Lagoon	Outside	HA-6-0.5	6/10/2003	0.5	240	1
HA-23	S Lagoon	Outside	HA-23-0.5	6/6/2003	0.5	220	1
HA-10	S Lagoon	Outside	HA-10-0.5	6/9/2003	0.5	190	1
HA-24	S Lagoon	Outside	HA-24-2.0	6/9/2003	2	190	1
HA-43	Floodplain	Outside	HA-43-1.0	6/6/2003	1	180	1
HA-72	Floodplain	Outside	HA-72(0-0.5)	12/19/2003	0 - 0.5	160	1
HA-55	Floodplain	Outside	HA-55-0.5	6/11/2003	0.5	150	1
HA-19	S Lagoon	Outside	HA-19-1.0	6/9/2003	1	95	1
HA-24	S Lagoon	Outside	HA-24-0.5	6/9/2003	0.5	71	1
HA-75	Floodplain	Outside	HA-75(0-0.5)	12/19/2003	0 - 0.5	68	1
HA-71	Floodplain	Outside	HA-71(0-0.5)	12/19/2003	0 - 0.5	65	1
HA-8	S Lagoon	Outside	HA-8-0.5	6/10/2003	0.5	63	1
SS-4	Floodplain	Outside	SS-4	6/12/2003	0 - 0.5	55	1
HA-9	S Lagoon	Outside	HA-9-0.5	6/10/2003	0.5	52	1
HA-5	S Lagoon	Outside	HA-5-0.5	6/10/2003	0.5	45	1
HA-22	S Lagoon	Outside	HA-22-1.0	6/6/2003	1	42	1
SS-2	Floodplain	Outside	SS-2	6/12/2003	0 - 0.5	39	1
SS-5	Floodplain	Outside	SS-5	6/11/2003	0 - 0.5	37	1
HA-61	Floodplain	Outside	HA-61-0.5	6/11/2003	0.5	30	1
HA-58	Floodplain	Outside	HA-58-1.0	6/11/2003	1	29	1
HA-60	Floodplain	Outside	HA-60-0.5	6/11/2003	0.5	28	1
HA-56	Floodplain	Outside	HA-56-0.5	6/11/2003	0.5	26	1
HA-59	Floodplain	Outside	HA-59-0.5	6/11/2003	0.5	26	1
HA-54	Floodplain	Outside	HA-54-1.5	6/6/2003	1.5	25	1
HA-65	Floodplain	Outside	HA-65(0-0.5)	12/19/2003	0 - 0.5	24	1
HA-67	Floodplain	Outside	HA-67(0-0.5)	12/19/2003	0 - 0.5	24	1
HA-57	Floodplain	Outside	HA-57-0.5	6/11/2003	0.5	24	1
HA-69	Floodplain	Outside	HA-69(0-0.5)	12/19/2003	0 - 0.5	23	1
SS-7	Floodplain	Outside	SS-7	12/19/2003	0 - 0.5	23	1
SS-3	Floodplain	Outside	SS-3	6/12/2003	0 - 0.5	22	1
HA-70	Floodplain	Outside	HA-70(0-0.5)	12/19/2003	0 - 0.5	21	1
HA-14	S Lagoon	Outside	HA-14-1.0	6/9/2003	1	21	1
HA-10	S Lagoon	Outside	HA-10-1.5	6/9/2003	1.5	21	1
HA-8	S Lagoon	Outside	HA-8-1.5	6/10/2003	1.5	19	1
HA-64	Floodplain	Outside	HA-64-0.5	6/11/2003	0.5	18	1
HA-64	Floodplain	Outside	HA-64-1.0	6/11/2003	1	18	1
HA-58	Floodplain	Outside	HA-58-2.0	6/11/2003	2	17	1
HA-19	S Lagoon	Outside	HA-19-2.0	6/9/2003	2	12	1
SS-9	Floodplain	Outside	SS-9	12/19/2003	0 - 0.5	5.8	1

ATTACHMENT B

ProUCL Output

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/1/2018 7:06:14 PM
From File	N Lag and Floodplain with surrogates no HA-66 and HA-68_v2.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Total Number of Observations	120	Number of Distinct Observations	42
		Number of Missing Observations	0
Minimum	5.8	Mean	85.94
Maximum	500	Median	97.5
SD	68.9	Std. Error of Mean	6.289
Coefficient of Variation	0.802	Skewness	3.534

Normal GOF Test

Shapiro Wilk Test Statistic	0.643	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.342	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0812	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	96.37	95% Adjusted-CLT UCL (Chen-1995)	98.46
		95% Modified-t UCL (Johnson-1978)	96.71

Gamma GOF Test

A-D Test Statistic	8.503	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.765	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.278	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0853	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.108	k star (bias corrected MLE)	2.06
Theta hat (MLE)	40.78	Theta star (bias corrected MLE)	41.71
nu hat (MLE)	505.8	nu star (bias corrected)	494.5
MLE Mean (bias corrected)	85.94	MLE Sd (bias corrected)	59.87
		Approximate Chi Square Value (0.05)	443.9
Adjusted Level of Significance	0.048	Adjusted Chi Square Value	443.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	95.73	95% Adjusted Gamma UCL (use when n<50)	95.86

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.31	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0812	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.758	Mean of logged Data	4.198
Maximum of Logged Data	6.215	SD of logged Data	0.757

Assuming Lognormal Distribution

95% H-UCL	102	90% Chebyshev (MVUE) UCL	109
95% Chebyshev (MVUE) UCL	118.3	97.5% Chebyshev (MVUE) UCL	131.2
99% Chebyshev (MVUE) UCL	156.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	96.29	95% Jackknife UCL	96.37
95% Standard Bootstrap UCL	96.32	95% Bootstrap-t UCL	99.31
95% Hall's Bootstrap UCL	102.4	95% Percentile Bootstrap UCL	96.57
95% BCA Bootstrap UCL	99.41		
90% Chebyshev(Mean, Sd) UCL	104.8	95% Chebyshev(Mean, Sd) UCL	113.4
97.5% Chebyshev(Mean, Sd) UCL	125.2	99% Chebyshev(Mean, Sd) UCL	148.5

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	113.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/1/2018 7:08:47 PM
From File	N Lag and Floodplain with surrogates no HA-66 and HA-68_v2.xls
Full Precision	OFF
Confidence Coefficient	90%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Total Number of Observations	120	Number of Distinct Observations	42
		Number of Missing Observations	0
Minimum	5.8	Mean	85.94
Maximum	500	Median	97.5
SD	68.9	Std. Error of Mean	6.289
Coefficient of Variation	0.802	Skewness	3.534

Normal GOF Test

Shapiro Wilk Test Statistic	0.643	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.342	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0812	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

90% Normal UCL		**90% UCLs (Adjusted for Skewness)**	
90% Student's-t UCL	94.05	90% Adjusted-CLT UCL (Chen-1995)	95.45
		90% Modified-t UCL (Johnson-1978)	94.39

Gamma GOF Test

A-D Test Statistic	8.503	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.765	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.278	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0853	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.108	k star (bias corrected MLE)	2.06
Theta hat (MLE)	40.78	Theta star (bias corrected MLE)	41.71
nu hat (MLE)	505.8	nu star (bias corrected)	494.5
MLE Mean (bias corrected)	85.94	MLE Sd (bias corrected)	59.87
		Approximate Chi Square Value (0.1)	454.6
Adjusted Level of Significance	0.0978	Adjusted Chi Square Value	454.3

Assuming Gamma Distribution

90% Approximate Gamma UCL (use when n>=50))	93.48	90% Adjusted Gamma UCL (use when n<50)	93.55

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.855	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.31	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.0812	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.758	Mean of logged Data	4.198
Maximum of Logged Data	6.215	SD of logged Data	0.757

Assuming Lognormal Distribution

90% H-UCL	98.66	90% Chebyshev (MVUE) UCL	109
95% Chebyshev (MVUE) UCL	118.3	97.5% Chebyshev (MVUE) UCL	131.2
99% Chebyshev (MVUE) UCL	156.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

90% CLT UCL	94	90% Jackknife UCL	94.05
90% Standard Bootstrap UCL	94.2	90% Bootstrap-t UCL	95.91
90% Hall's Bootstrap UCL	97.97	90% Percentile Bootstrap UCL	94.06
90% BCA Bootstrap UCL	95.1		
90% Chebyshev(Mean, Sd) UCL	104.8	95% Chebyshev(Mean, Sd) UCL	113.4
97.5% Chebyshev(Mean, Sd) UCL	125.2	99% Chebyshev(Mean, Sd) UCL	148.5

Suggested UCL to Use

Recommendation Provided only for 95% Confidence Coefficient

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/1/2018 7:13:40 PM
From File	S Lagoon and Floodplain with surrogates no HA-66 and HA-68_v2.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Total Number of Observations	160	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	5.8	Mean	101.4
Maximum	550	Median	97.49
SD	76.62	Std. Error of Mean	6.058
Coefficient of Variation	0.756	Skewness	3.745

Normal GOF Test

Shapiro Wilk Test Statistic	0.519	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.439	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0704	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	111.4	95% Adjusted-CLT UCL (Chen-1995)	113.3
		95% Modified-t UCL (Johnson-1978)	111.7

Gamma GOF Test

A-D Test Statistic	23.51	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.362	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0746	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.68	k star (bias corrected MLE)	2.634
Theta hat (MLE)	37.82	Theta star (bias corrected MLE)	38.48
nu hat (MLE)	857.7	nu star (bias corrected)	843
MLE Mean (bias corrected)	101.4	MLE Sd (bias corrected)	62.46
		Approximate Chi Square Value (0.05)	776.6
Adjusted Level of Significance	0.0485	Adjusted Chi Square Value	776

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	110	95% Adjusted Gamma UCL (use when n<50)	110.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.722	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.395	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0704	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.758	Mean of logged Data	4.421
Maximum of Logged Data	6.31	SD of logged Data	0.661

Assuming Lognormal Distribution

95% H-UCL	114.6	90% Chebyshev (MVUE) UCL	121.1
95% Chebyshev (MVUE) UCL	129.2	97.5% Chebyshev (MVUE) UCL	140.4
99% Chebyshev (MVUE) UCL	162.4		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	111.3	95% Jackknife UCL	111.4
95% Standard Bootstrap UCL	111.3	95% Bootstrap-t UCL	114.7
95% Hall's Bootstrap UCL	113.6	95% Percentile Bootstrap UCL	112
95% BCA Bootstrap UCL	113.2		
90% Chebyshev(Mean, Sd) UCL	119.5	95% Chebyshev(Mean, Sd) UCL	127.8
97.5% Chebyshev(Mean, Sd) UCL	139.2	99% Chebyshev(Mean, Sd) UCL	161.6

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	127.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.12/1/2018 7:12:40 PM
From File	S Lagoon and Floodplain with surrogates no HA-66 and HA-68_v2.xls
Full Precision	OFF
Confidence Coefficient	90%
Number of Bootstrap Operations	2000

Chromium

General Statistics

Total Number of Observations	160	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	5.8	Mean	101.4
Maximum	550	Median	97.49
SD	76.62	Std. Error of Mean	6.058
Coefficient of Variation	0.756	Skewness	3.745

Normal GOF Test

Shapiro Wilk Test Statistic	0.519	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.439	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0704	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

90% Normal UCL		90% UCLs (Adjusted for Skewness)	
90% Student's-t UCL	109.2	90% Adjusted-CLT UCL (Chen-1995)	110.4
		90% Modified-t UCL (Johnson-1978)	109.5

Gamma GOF Test

A-D Test Statistic	23.51	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.362	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0746	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.68	k star (bias corrected MLE)	2.634
Theta hat (MLE)	37.82	Theta star (bias corrected MLE)	38.48
nu hat (MLE)	857.7	nu star (bias corrected)	843
MLE Mean (bias corrected)	101.4	MLE Sd (bias corrected)	62.46
		Approximate Chi Square Value (0.1)	790.8
Adjusted Level of Significance	0.0984	Adjusted Chi Square Value	790.4

Assuming Gamma Distribution

90% Approximate Gamma UCL (use when n>=50))	108.1	90% Adjusted Gamma UCL (use when n<50)	108.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.722	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.395	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0704	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.758	Mean of logged Data	4.421
Maximum of Logged Data	6.31	SD of logged Data	0.661

Assuming Lognormal Distribution

90% H-UCL	111.9	90% Chebyshev (MVUE) UCL	121.1
95% Chebyshev (MVUE) UCL	129.2	97.5% Chebyshev (MVUE) UCL	140.4
99% Chebyshev (MVUE) UCL	162.4		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

90% CLT UCL	109.1	90% Jackknife UCL	109.2
90% Standard Bootstrap UCL	109.3	90% Bootstrap-t UCL	111.1
90% Hall's Bootstrap UCL	110.4	90% Percentile Bootstrap UCL	109.4
90% BCA Bootstrap UCL	111		
90% Chebyshev(Mean, Sd) UCL	119.5	95% Chebyshev(Mean, Sd) UCL	127.8
97.5% Chebyshev(Mean, Sd) UCL	139.2	99% Chebyshev(Mean, Sd) UCL	161.6

Suggested UCL to Use

Recommendation Provided only for 95% Confidence Coefficient

APPENDIX A-4

DEQ letter dated February 22. 2018: *Protectiveness Evaluation and Justification for Confirmation Sample Surrogate Concentrations.*

Oregon
Kate Brown, Governor

Department of Environmental Quality
Northwest Region Portland Office
700 NE Multnomah Street, Ste 600
Portland, OR 97232-4100
(503) 229-5263

February 22, 2018

Michelle Peterson RG, LG
Associate Geologist
Amec Foster Wheeler
7376 SW Durham Road
Portland, OR 97224

Sent via e-mail
michelle.peterson@amecfw.com

Re: Former Frontier Leather Tannery Property Analysis of Brownfield Cleanup Alternatives Protectiveness Evaluation and Justification for Confirmation Sample Surrogate Concentrations ECSI #2638

Dear Michelle:

The Oregon Department of Environmental Quality (DEQ) reviewed the above-referenced document, prepared on behalf of the City of Sherwood by Amec Foster Wheeler Environment and Infrastructure, Inc. (AMEC) and dated February 6, 2018. DEQ and AMEC staff had a teleconference on February 15, 2018 to discuss the document. Based on our review, and teleconference with AMEC, DEQ has the following comments and recommendations:

General Comments

1. The document presented a method to evaluate residual risk following a proposed remedial action to demonstrate it is protective, which DEQ considers a requisite for an acceptable remedy.

2. The method assigned surrogate chromium concentrations in remedial areas to be included in statistical analysis to calculate a predicted exposure point concentration (EPC) following remediation.

   The average of existing total chromium concentrations in the upper 24 inches of soil and sediment outside the remedial areas was identified as the surrogate concentration.

3. The predicted EPC, based on the 90% upper confidence limit of the mean total chromium concentration, calculated using existing and surrogate concentrations, was compared to terrestrial soil and benthic sediment cleanup criteria (280 mg/kg, 111 mg/kg, respectively) to assess residual risk. Although a number of individual concentrations were above one or both cleanup criteria, the predicted average EPCs were below both cleanup criteria, and on this basis an alternative was deemed protective. For the prediction to be reliable the confirmation sample concentrations must be at or below the surrogate concentration.

4. DEQ concurs with the residual risk assessment conclusions regarding terrestrial receptors, but not for benthic organisms. Benthic organisms have limited mobility, and thus predicted exposure based on an average concentration would underestimate exposure at specific locations above the cleanup level. The method for evaluating exposure to immobile or nearly immobile aquatic and benthic invertebrate receptors is point by point (ODEQ *Guidance for Ecological Risk Assessment*, 2001).

5. The cleanup level for sediment is based on probable effects to the receptor. The concentrations above the sediment cleanup level outside of the remedial area should be identified as likely having an adverse effect on benthic receptors.

Specific Comments

Page 3, First Paragraph.
The site-specific ecological cleanup value of 280 mg/kg is for non-threatened and endangered (T&E) species, not T&E species.

Page 7, 2. Site Disturbance
DEQ does not agree with the broad characterization that the Site does not provide suitable benthic habitat. Areas of the site are designated as surface water and emergent wetlands under the United States Fish and Wildlife National Wetlands Inventory, categorized as freshwater pond and emergent wetland. It is also adjacent to USFW managed lands. The lagoon area has been reclaimed by local vegetation, and aside from contamination most of the lagoon area provides habitat similar to adjacent "non-disturbed" areas. Fires can be beneficial in many habitats, including grass and marshland. Impacts from the August 2015 fire were localized in the northernmost Site area. Testing showed it did not result in significant contamination, and thus the fire was not necessarily detrimental to the wetland.

Please revise this section as appropriate.

Next Steps

DEQ recommends revising the protectiveness evaluation for benthic risk, to include a point by point evaluation to identify areas that exceed screening criteria. A more robust remedial action that incorporates more of the affected areas would provide a better demonstration of protectiveness. To that end, DEQ and AMEC discussed the following to be considered in the revision:

- Expand the proposed remedial scenarios to incorporate some or all of the outlying samples above cleanup levels and re-assess residual risk under each scenario using a point by point comparison.
- Discuss to what extent increasing the size of the remedial area reduces benthic risk, and whether the risk reduction is cost reasonable.
- For the various scenarios estimate what percent or portion of the entire site area may contain residual concentrations above site- specific cleanup levels for benthic organisms.
- Expand on discussion of existing benthic habitat quality, including surface water and wetland designations, and how the remedial action would affect existing habitat.

In addition, please address the two specific comments listed above.

Should you have any questions or comments please contact me at (503) 229-5587 or via e-mail at mailto:pugh.mark@deq.state.or.us.

Sincerely,

Mark Pugh, R.G.
Project Manager
Northwest Region Cleanup Section

e-copy: Jennifer Peterson, (Peterson.Jennifer@deq.state.or.us)
Julia Hadjuk, City of Sherwood (hajdukj@sherwoodoregon.gov)
Brandon Perkins, EPA (Perkins.Brandon@epamail.epa.gov)

APPENDIX A-5

Wood Memorandum dated July 23, 2018: *Response to DEQ's Comment on the Protectiveness Evaluation*

Memorandum

To	Mark Pugh, RG Project Manager Oregon Department of Environmental Quality Northwest Region Cleanup Section	File no.:5-61M-130820
From	Michelle Peterson RG, LG Project Manager Wood Environment & Infrastructure Solutions, Inc.	c:Julia Hajduk, City of Sherwood
Date	July 23, 2018	
Subject	Former Frontier Leather Tannery Property, Analysis of Brownfield Cleanup Alternatives (ABCA), Response to DEQ's Comment on the Protectiveness Evaluation Memorandum	

INTRODUCTION

This memorandum is written in response to comments received from the Oregon Department of Environmental Quality (DEQ) regarding the *Protectiveness Evaluation and Justification for Confirmation Sample Surrogate Concentrations* memorandum (Protectiveness Memo) for the Former Frontier Leather Tannery Property in Sherwood, Oregon (Site). The Protectiveness Memo is dated February 6, 2018. The DEQ comment letter is dated February 22, 2018.

The DEQ comment letter reflects the discussion held between Amec Foster Wheeler, now Wood, and DEQ on February 15, 2018. In that discussion, DEQ concurred with the protectiveness evaluation for terrestrial receptors, but not for benthic receptors because benthic receptors are not mobile and, therefore, could be adversely affected by chromium concentrations greater than 111 mg/kg.

To increase the protectiveness of the remedy for benthic receptors, Wood indicated during a follow-up teleconference with DEQ on April 23, 2018 that the ABCA would be revised to reflect a greater level of cleanup in the wetland exposure unit. This will be accomplished by using the selected cleanup level of 111 mg/kg of chromium, instead of the hotspot cleanup level of 1,110 mg/kg, to define the areas of soil and sediment that will be removed off-site for disposal or that will be placed into an on-site containment cell. Each remedial alternative in the ABCA that includes cleanup in the wetland exposure unit was revised, and those revisions were incorporated into the text, tables, figures, and appendices of the ABCA.

Wood Environment & Infrastructure Solutions, Inc.
7376 SW Durham Road
Portland, Oregon
USA 97224
Tel+1 (503) 639-3400
Fax+1 (503) 620-7892
www.woodplc.com

In addition, this memorandum addresses two specific comments in the February 22 DEQ comment letter as follows:

- Page 3, First Paragraph – DEQ correctly identified that the site-specific ecological cleanup value of 280 mg/kg is for non-threatened & endangered (T&E) species. The Protectiveness Memo inadvertently indicated the 280 mg/kg was for T&E species.
- Page 7, 2. Site Disturbance – Wood acknowledges the potential for benthic receptors to be present throughout the wetland exposure unit, and as discussed above, will revise the remedial alternatives that include cleanup in the wetland exposure unit to remove sediment containing chromium concentrations greater than 111 mg/kg. The ABCA currently incorporates wetland mitigation for each remedial alternative that includes cleanup in the wetland exposure unit. A detailed plan for wetland mitigation was not developed at this time because the City is still undertaking a visioning process for how it would use the site, and this information will feed into a future task to discuss the process of permitting and mitigating the proposed environmental cleanup with the appropriate regulatory agencies. The revised ABCA identifies the types of permits that are likely to be required, so at a minimum, the agencies responsible for issuing those permits could be included in future discussions regarding permitting the proposed cleanup.

Revision of the ABCA was performed as discussed with DEQ on April 23, 2018, and as reflected in this memorandum.

APPENDIX B

Greenhouse Gas Emissions Calculations for Remedial Alternatives

APPENDIX B
Greenhouse Gas Emissions Calculations for Remedial Alternatives
Former Frontier Leather Tannery Property
Sherwood, Oregon

Alternative Number	Alternative Description	Material Transported from Site (CY)	Estimated Number of Truck Trips [1]	Estimated Miles per Round Trip [2]	Estimated Total Mileage	Estimated MPG [3]	Estimated Total Fuel Consumption (gallons)	Estimated CO_2-Equivalent Emissions (kilograms) [4]	Estimated CO_2-Equivalent Emissions (pounds)	Estimated Methane Emissions (grams) [4]
1	No Action	--	--	--	--	--	--	--	--	--
2	Removal and Disposal of Contaminated Soils and Hide Splits	44,997	2,250	56 or 34	104,364	9	11,596	118,395	261,061	532
3	Placement of Contaminated Soils and Hide Splits Within High-Density Polyethylene (HDPE)-Lined Containment Cell	--	--	--	--	--	--	--	--	--
4	Placement of Contaminated Soils and Hide Splits Within Phosphate-Amended Containment Cell	--	--	--	--	--	--	--	--	--
5	Placement of Contaminated Soils Within On-Site Phosphate-Amended Containment Cell and Removal and Disposal of Hide Splits	25,286	1,265	56	70,840	9	7,871	80,836	178,244	361
6	Placement of Contaminated Soils Within Phosphate-Amended Containment Cell and Hide Split Landfill Managed In Place	--	--	--	--	--	--	--	--	--
7	Removal and Disposal of Contaminated Soils and Hide Split Landfill Managed In-Place	19,711	986	34	33,524	9	3,725	38,255	84,351	171

Notes:

[1] Assume 20 cubic yards per truck; number of trucks rounded up.

[2] Mileage assumes one round-trip per truck from Sherwood to landfills.

[3] Source: Oak Ridge National Laboratory (http://cta.ornl.gov/vtmarketreport/pdf/chapter3_heavy_trucks.pdf)

[4] Source: EPA Center for Corporate Climate Leadership Simplified GHG Emissions Calculator (SGEC) Version 3.2 January 2017

CY = Cubic Yards

CO_2 = Carbon dioxide

MPG = miles per gallon

Roundtrip mileage to Riverbend Landfill (McMinnville) is 56 miles.

Roundtrip mileage to Hillsboro Landfill is 34 miles.

APPENDIX C

Summary Volumes of Impacted Materials and Schedule Breakdown

APPENDIX C
Summary Volumes of Impacted Materials and Schedule Breakdown
Former Frontier Leather Tannery Property
Sherwood, Oregon

Dimensions of Key Site Features		
Feature Name	**Square Feet**	**Acres**
North Sedimentation Lagoon	164,287	3.8
South Sedimentation Lagoon	166,192	3.8
Hide Split Landfill	113,786	2.6
Total	444,265	10.2

Areas / Volumes of Impact Areas
(soil/sediment with concentrations above cleanup levels and the hide-split landfill)

Depth	North Sed. Lagoon Impact Area		South Sed. Lagoon Impact Area		Rock Creek Floodplain Impact Area		Hide-Split Landfill Impact Area		Total Soil/Sediment Impact Area		Total Soil/Sediment + Hides Impact Area	
(ft)	Area (sf)	Volume (cy)	Area (sf)	Volume (cy)	Area (sf)	Volume (cy)	Area (sf)	Volume (cy)	Area (sf)	Volume (cy)	Area (sf)	Volume (cy)
1.5	3,505	195	0	0	0	0	0	0	3,505	195	3,505	195
2.0	34,103	2,526	51,605	3,823	27,726	2,054	0	0	113,434	8,403	113,434	8,403
3.0	9,843	1,094	69,543	7,727	2,113	235	0	0	81,499	9,055	81,499	9,055
4.0	10,947	1,622	0	0	2,945	436	0	0	13,892	2,058	13,892	2,058
6.0	0	0	0	0	0	0	113,786	25,286	0	0	113,786	25,286
Totals	58,398	5,436	121,148	11,550	32,784	2,725	113,786	25,286	212,330	19,711	326,116	44,997
Tons	7,611		16,169		3,815		22,757		27,595		50,352	

Notes:
ft = feet   sf = square feet   cy = cubic yards

Schedule Breakdown

Inputs	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Total tons	50,352	50,352	34,183	34,183	11,426	27,595
Tons per day [1]	840	840	840	840	840	840
Number of Days	60	60	41	41	14	33
Days/week	5	5	5	5	5	5
Number of Transport Weeks (rounded up)	12	12	9	9	3	7
Number of Mob/Demob/Setup Weeks	2	2	2	2	2	2
Number of Weeks of Onsite Work not including Transport Weeks	2	1	2	1	5	2
Total weeks (Schedule)	16	15	13	12	10	11

Assumptions:
[1] Transport - Assume 10 trucks taking 20CY per load at 3 trips per day. This production rate equals 840 tons per day