FFP Project 101, LLC

Remedial Investigation / Feasibility Study Rev 2

Goldendale Energy Storage Project, FERC No. 14861

November 2024

Project No.: 0743146

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Danielle Foss
Project Manager

Erik Ipsen
Partner-in-Charge

Environmental Resources Management, Inc.
1050 SW 6th Avenue
Suite 1650
Portland, OR 97204

T: +1 503 488 5282
F: +1 503 488 5142

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Acronyms and Abbreviations

Name	**Description**
°F	degrees Fahrenheit
µg/L	micrograms per liter
AGO	Washington Attorney General’s Office
AMSL	above mean sea level
AOC	area of concern
Applicant	FFP Project 101, LLC
ARAR	Applicable or Relevant and Appropriate Requirement
BAL	Basalt Aquifer Lower Zone
BAU	Basalt Aquifer Upper Zone
BMP	best management practice
CAP	Cleanup Action Plan
CGA	Columbia Gorge Aluminum
CGA Smelter Site	Former Columbia Gorge Aluminum Site in its entirety
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic poly aromatic hydrocarbons
CUL	cleanup levels
DCA	disproportionate cost analysis
Detailed Proposal	Prospective Purchaser Agreement Detailed Proposal
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ERM	Environmental Resources Management, Inc.
FERC	Federal Energy Regulatory Commission
FERC Property Boundary	652 acres on the western side of the CGA Smelter Site
GW	groundwater
GWET	groundwater extraction and treatment
HMW	high molecular weight
ISS	In-situ soil stabilization
Kd	partition coefficient
LMCO	Lockheed Martin Corporation
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
NSC	NSC Smelter, LLC
Order	Agreed Order No. DE 10483
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PLPs	potentially liable parties/persons
PPA	Prospective Purchaser Agreement
PPCD	Prospective Purchaser Consent Decree
Project	Goldendale Energy Storage Project
Project Area	area of the site to be developed for the Project
Property Boundary	529.6 acres currently owned by NSC Smelter, LLC
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington

Name	**Description**
RI/FS	Remedial Investigation / Feasibility Study
SMS	Sediment Management Standards
SWMU	Solid Waste Management Unit
TEE	Terrestrial Ecological Evaluation
TPH	total petroleum hydrocarbons
TTEC	total toxicity equivalent concentration
UA	Unconsolidated Aquifer Zone
UTL	Upper Threshold Limit
VOC	volatile organic compound
WAC	Washington Administrative Code
West SPL	West Spent Pot Liner
West SPL Ditch	drainage ditch south of the West Spent Pot Liner
WPA	Work Plan Addendum
WSI	West Surface Impoundment

EXECUTIVE SUMMARY

The Goldendale Energy Storage Project (Project) is a proposed closed-loop, pumped-storage energy generation facility currently in a permitting process administered by the Federal Energy Regulatory Commission (FERC). FFP Project 101, LLC (the Applicant) proposes to construct the Project on property currently occupied by the closed Columbia Gorge Aluminum (CGA) aluminum smelter, located north of the Columbia River and south of the city of Goldendale, Klickitat County, Washington.

The current property owner, NSC Smelter, LLC (NSC), has been decommissioning and removing buildings and other structures since 2011. NSC and Lockheed Martin Corporation (collectively the potentially liable parties/persons), a former owner/operator, have been assessing soil and groundwater conditions at the CGA Smelter Site in accordance with the 2014 Agreed Order No. DE 10483 (Ecology 2014).

The Applicant holds an option with NSC to purchase 652 acres of the closed smelter property to develop the Project and intends to exercise the option after receiving an applicable license from FERC. The major components of the Project include the Upper Reservoir, the Lower Reservoir, a powerhouse, tunnels/penstocks, transmission lines, substation, and conveyance lines connecting those features within a 283-acre limit of disturbance. The proposed location of the Lower Reservoir overlaps a closed landfill, referred to as the West Surface Impoundment (WSI) that was formerly operated by the smelter. The WSI was closed in 2004 in accordance with applicable regulatory criteria under review and approval of the Washington State Department of Ecology (Ecology).

The closed WSI (classified as industrial waste) is geotechnically incompatible with construction of the Lower Reservoir and must be removed. To construct the Project, the contents of the WSI will be excavated and disposed of off-site at an appropriate disposal facility, in accordance with applicable regulations. Contaminated soils underneath the WSI have not yet been investigated and will be addressed will the selected remedial alternative in this Remedial Investigation / Feasibility Study. A plan will be devised in the Draft Cleanup Action Plan (CAP) for appropriately designating wastes as they are removed from the WSI.

The network of monitoring wells in the Project Area provides groundwater characterization and monitoring of the WSI and adjacent Solid Waste Management Unit identified as the West Spent Pot Liner Storage Area. Groundwater monitoring at well locations within the Project Area is intended to continue for 30 years from the time of the WSI closure (i.e., in 2004) or until contaminant concentrations are below screening levels in accordance with Goldendale Aluminum WSI Closure Plan (Parametrix 2004). To build the Project, monitoring wells within the Lower Reservoir footprint will be abandoned. The Applicant proposes to replace selected groundwater monitoring wells, as necessary for groundwater monitoring of the former WSI. Details will be provided in the Compliance Monitoring Plan and/or CAP.

The Applicant prepared an Initial Application for a Prospective Purchaser Agreement (PPA) in accordance with Washington Administrative Code 173-340-520 and Ecology's Toxics Cleanup Program Policy 520B and submitted the Initial Application to Ecology and the Washington Attorney General's Office in December 2019. The Initial Application describes the rationale and general plan to remove the former WSI landfill and modify the landfill groundwater monitoring systems before constructing the Lower Reservoir.

A 28 April 2020 letter from Ecology (Ecology 2020) to the Applicant stated, "it is in the public interest and consistent with RCW [Revised Code of Washington] 70.105D.040(5) to begin work with the applicant toward development" of a Prospective Purchaser Consent Decree for the Project. Ecology's letter also stated, "the proposed project is not likely to contribute to a release or interfere with necessary cleanup actions" ongoing on the former CGA Smelter Site.

On 25 June 2021, the Applicant submitted the PPA Detailed Proposal to Ecology, consistent with WAC 173-30-520, to provide a detailed description of the Applicant's activities that are to be covered by the PPA (ERM 2021). In accordance with Ecology's comments on the PPA Detailed Proposal, Environmental Resources Management, Inc., has prepared this Revised Remedial Investigation / Feasibility Study report on behalf of the Applicant to define and describe the nature and extent of contamination in the former WSI landfill and evaluate cleanup alternatives for the areas and/or media exceeding the applicable cleanup levels in the Project Area (i.e., the former WSI landfill and contaminated soil within the WSI footprint located within the property to be acquired by the Project). The recommended alternative in the FS proposes excavation and off-site disposal of the WSI, excavation of contaminated soil within the WSI footprint, and monitored natural attenuation with contingency. This Revised Remedial Investigation / Feasibility Study is a precursor document to a Draft CAP and will provide Ecology information for remedy selection in the Project CAP.

FERC's decision to grant a license depends on definition and resolution of waste issues to the satisfaction of the State of Washington. The Applicant, upon receipt of the FERC license for the Project, will exercise its option to purchase the 652 acres to develop the Project.

1. INTRODUCTION

The Goldendale Energy Storage Project (Project) is a proposed closed-loop, pumped-storage energy generation facility currently in the licensing process administered by the Federal Energy Regulatory Commission (FERC). FFP Project 101, LLC (the Applicant), holds an option to develop the Project on 652 acres (the FERC Property Boundary) on the western side of the approximately 7,000-acre former Columbia Gorge Aluminum (CGA) Plant property (the CGA Smelter Site) near Goldendale, Klickitat County, Washington (Figure 1-1). The Project will be constructed on a 529.6-acre tract of land currently owned by NSC Smelter, LLC (NSC; the Property Boundary). A portion of the Project (i.e., the Lower Reservoir) will be constructed over the West Surface Impoundment (WSI), an area formerly used for waste disposal and impacted by contamination from past smelter operations) associated with the CGA Smelter Site.

The WSI was closed by the smelter potentially liable parties/persons (PLPs) in 2004 under Dangerous Waste requirements per WAC 173-303 and the federal the Resource Conservation and Recovery Act (RCRA). The WSI is currently in a long-term post-closure monitoring program as a condition of closure. The WSI (also known as Solid Waste Management Unit [SWMU] 4) consists of an engineered liner, the WSI wastes, and an approved RCRA engineered cover (see Appendix A). The Project Area includes portions of a groundwater monitoring network maintained by the PLPs to monitor groundwater impacts attributable to the CGA Smelter Site.

The CGA Smelter Site is a RCRA corrective action site being managed by the Washington State Department of Ecology (Ecology) as an active cleanup site under Agreed Order No. DE 10483 (the Order) with Lockheed Martin Corporation (LMCO) and the current owner, NSC. LMCO and NSC, collectively the Smelter PLPs, are conducting investigation and cleanup under the Order and pursuant to Chapter 70.105D Revised Code of Washington (RCW), Model Toxics Control Act (MTCA).

In order to develop the Project within the CGA Smelter Site, the Applicant began a process to obtain a Prospective Purchaser Agreement (PPA) in accordance with Washington Administrative Code (WAC) 173-340-520 and Ecology's Toxics Cleanup Program Policy 520B and submitted the Initial Application to Ecology and the Washington Attorney General's Office (AGO) on 4 December 2019. The Initial Application describes the rationale and general plan to address the CGA Smelter Site environmental impacts within the Project Area before constructing the Lower Reservoir.

The Applicant met with representatives of the Washington AGO and Ecology on 29 January 2020 to discuss the Initial Application. The Applicant held follow-up telephone conferences to review the Initial Application with the Washington AGO and Ecology staff on 19 February 2020, and with Ecology environmental staff, Washington Governor's staff representing the Executive Advisor for Tribal Affairs, and the Clean Tech section leader for the Washington Governor's office on 21 April 2020. The Applicant received a letter from Ecology dated 28 April 2020 (Ecology 2020) stating that “it is in the public interest and consistent with RCW 70.105D.040(5) to begin work with the applicant toward development” of a Prospective Purchaser Consent Decree (PPCD) for the Project.

Environmental Resources Management, Inc. (ERM), on behalf of the Applicant, submitted a PPA Detailed Proposal (the Detailed Proposal) on 25 June 2021 (ERM 2021). The Detailed Proposal describes the Project Area intended to be subject to the PPA. In accordance with Ecology's comments on the Detailed Proposal, ERM prepared a Remedial Investigation / Feasibility Study (RI/FS) report on 24 November 2021 on behalf of the Applicant to characterize the nature and extent of contamination in the former WSI landfill and proposed cleanup alternatives for the former WSI landfill located within the Project Area. Ecology and Yakima Nation provided comments for the initial RI/FS in late January 2022. ERM has collaborated with Ecology, the Yakima Nation, and Smelter PLPs to revise this RI/FS in accordance with the comments received and the Smelter PLP's FS.

The Project provides a unique opportunity to reuse a decommissioned industrial facility; and proximity to the John Day Dam, Bonneville Power Administration transmission lines, and nearby wind farms makes the site ideal for a closed-loop, pumped-storage facility.

1.1 Scope of the Project Remedial Investigation / Feasibility Study

This RI/FS report characterizes the nature and extent of CGA Smelter Site contamination within the Project Area and evaluates cleanup alternatives for impacted media. This RI/FS also proposes delineation of responsibility among and between the Applicant and Smelter PLPs for remedial action within the Project Area and further supports development of a CAP and PPCD for the Project Area.

The FS describes cleanup action alternatives for environmental media (e.g., soil and groundwater) in the Project Area that are compatible with constructing the Project and the Smelter PLPs remedy for the site-wide CGA Smelter Site. This RI/FS is based entirely on information provided by others on behalf of the Smelter PLPs pursuant to the Order and focuses on contamination within the Project Area. The Smelter PLPs are investigating the broader CGA Smelter Site and assessing cleanup actions under the Order. The Applicant is not a PLP under the Order.

The Smelter PLPs will implement all remedial actions which are outside the Project Area and all remedial actions associated with groundwater contamination at the CGA Smelter Site, including the Project Area, pursuant to the Order. The Applicant will implement the remaining remedial actions within the Project Area including installation of replacement monitoring wells that will be decommissioned for construction activities in the Project Area. Accordingly, while this RI/FS identifies remedial actions for the Project Area, including the western groundwater area of concern (GW AOC; i.e., groundwater contamination associated with the WSI and West Spent Pot Liner Storage Area [West SPL]), the Smelter PLP’s will implement all groundwater remediation.,

1.2 Report Organization

This report is organized into the following major sections:

- Section 1 Introduction
- Section 2 Background
- Section 3 Conceptual Site Model
- Section 4 Regulatory Framework
- Section 5 Investigation Approach
- Section 6 Investigation Summary
- Section 7 Nature and Extent of Contamination Within the Project Area
- Section 8 Remedial Action Objectives
- Section 9 Technology Screening
- Section 10 Description of Remedial Action Alternatives
- Section 11 Screening of Remedial Alternatives
- Section 12 Recommended Alternative
- Section 13 References

2. BACKGROUND

2.1 Site Description

2.1.1 Location

The former CGA Smelter facility is located at 85 John Day Dam Road, Goldendale, Washington (Figure 1-1). The CGA Smelter Site is located north of the Columbia River approximately 9 miles southeast of the city of Goldendale in Klickitat County. The CGA Smelter Site includes portions of Sections 20 and 21 in T3N, R17E, Willamette Meridian.

2.1.2 Site History

Harvey Aluminum Company built the CGA Smelter in 1969 and 1970. There was one major expansion in 1971. Martin Marietta (later LMCO) owned the Facility from 1971 to 1985. Other owners included Commonwealth Aluminum from 1985 through 1987, Columbia Aluminum from 1987 through 1996, and Goldendale Aluminum from 1996 through closure in 2003.

The smelter operated as a primary aluminum smelter from approximately 1970 until 2003, when smelting ceased. Since 2003, the site owners have demolished structures, except for a few office and storage buildings and a small active wastewater treatment plant permitted under the National Pollutant Discharge Elimination System (NPDES) permit WA0000540. NSC is the current owner of the CGA Smelter Site and surrounding land.

2.1.3 Site Setting

The CGA Smelter Site is in the southern margin of the Columbia Hills near the Columbia River within the Columbia Plateau physiographic province. The Columbia Plateau covers an area of approximately 63,000 square miles, within which the ground surface ranges in elevation from approximately 200 to 3,000 feet. Mountains surround the plateau: the Cascade Range to the west, the Okanogan Highlands to the north, the Clearwater Range to the east, and the Blue Mountains to the south (Shannon & Wilson, Inc. 2002).

Figure 2-1 shows the topography of the Project Area. The southern portion of the Project site is a relatively flat bench extending from the Columbia River northward to the base of steep bluffs. The bluffs rise steeply (approximately 2,300 feet of relief) from the bench. The northern portion of the Project site is a gentle, northward sloping surface extending from the bluff edge to the northern boundary of the Project Area.

2.2 Proposed Project Description

The Applicant proposes to build a pumped-storage hydroelectric facility comprised of an off-stream, closed-loop pumped-storage Project with an upper and lower reservoir with 2,400 feet maximum gross head that involves no river or stream impoundments. Other features include an underground water conveyance tunnel, underground powerhouse, substation/switchyard, 500-kilovolt transmission line(s), and other appurtenant facilities (HDR 2020). The Project is a “closed-loop” system and use water supplied by Klickitat Public Utility District for initial fill and periodic makeup water. The Project will provide critical electricity balancing capacity and carbon-free renewable energy to utilities in the Pacific Northwest and potentially California. FERC has the exclusive authority to license most non-federal hydropower projects. A FERC Preliminary Permit for the Project was issued March 2018. A Final License Application for the Project was filed with FERC March 2020. A Project Arrangement Plan detailing preliminary design of the Project is included as Appendix B.

The Project includes the following major elements:

- Upper and Lower reservoirs, sized to provide approximately 7,100 acre-feet of usable storage volume by combination of limited excavation of the reservoirs and construction of concrete faced rockfill dams.
- Concrete horizontal intake structure at the Lower Reservoir, including vertical steel slide gates to allow isolation of the tailrace tunnel from the Lower Reservoir.
- Water conveyance system, including:
  - One 29-foot diameter concrete-lined vertical shaft
  - One 29-foot diameter concrete-lined headrace tunnel
  - One 22-foot diameter concrete-lined high-pressure manifold tunnel
  - Three 15-foot diameter steel/concrete-lined penstock tunnels
  - Three 20-foot diameter steel-lined draft tube tunnels, each including a bonneted slide gate to allow isolation of pump-turbines from Lower Reservoir
  - One 26-foot diameter concrete-lined low-pressure tunnel
  - One 30-foot diameter concrete-lined tailrace tunnel
- Underground powerhouse and appurtenant equipment.
- Transmission interconnection to the Bonneville Power Administration’s John Day Substation.

2.3 Environmental Setting

2.3.1 Topography

The CGA Smelter Site (including the Project Area) is located on a topographic bench at about 450 to 540 feet in elevation, and approximately 0.5 mile from the Columbia River south of CGA Smelter Site. The bench terminates at cliffs above the Columbia River. The Columbia River surface water elevation near the CGA Smelter Site is about 268 feet mean sea level in the Lake Umatilla pool upstream of the John Day Dam. North of the CGA Smelter Site, the Columbia Hills form a steep ridge with about 2,500 feet of relief with a talus slope extending down slope onto the CGA Smelter Site. Three natural seasonal drainages to the south of the former smelter and north of the Columbia River drain to the river. To construct the smelter, one of these drainages was modified into a series of settling ponds called the NPDES Ponds A through D. The topographic relief to support the Upper and Lower Reservoirs of the proposed Project is shown on Figure 2-1.

2.3.2 Climate

The CGA Smelter Site is located in the eastern portion of the Columbia River Gorge in a semi-arid region. Average annual rainfall ranges from 9.4 to 24.2 inches per year with the driest periods occurring during summer through early fall according to the Western Region Climate Center [WRCC] at Goldendale, Washington Station 453226 for the period of record between 1972 to 1995. The CGA Smelter Site is characterized by hot and dry conditions in the summer (daytime high temperature of 107 degrees Fahrenheit [°F] in July) and relatively cold conditions in the winter (daytime high temperatures of 60°F in January). Locally, most precipitation occurs in November through February; the wettest months are December and January with an average rainfall of about 2.4 to 2.7 inches per month.

2.3.3 Geohydrology

2.3.3.1 Geology

The CGA Smelter Site is located on the Columbia River Plateau where the bedrock is composed of the Miocene Columbia River Basalt Group (Bela 1982; USGS 2014). The rocks of the Columbia Plateau are primarily accumulations of successive lava flows that erupted during the Miocene epoch. Figure 2-2 is a geologic map of the Project Area.

Bedrock in the Project are members of the Columbia River Basalt Group. These lava flows are several thousand feet thick across most of the Columbia Plateau area and are the result of numerous eruptions of basaltic lavas from vents in what is now northeast Oregon and southeast Washington. In many places, sedimentary units of variable thickness are present between the flows, marking quiescent periods between eruptions that allowed lacustrine and fluvial sediments to accumulate as the regional surface water flow adjusted to the new topography and drainage conditions resulting from each lava flow.

There is suspected Quaternary movement along some of the northwest/southeast trending fault sections (USGS 2014). An east-west trending thrust fault is present near the base of the Columbia Hills to the north of the site based upon a repeated section within the Grande Ronde Basalt (Bela 1982). Two generally northwest-southeast trending faults have been previously mapped near CGA Smelter Site one named Goldendale strike-slip fault and the other a combination strike-slip and normal fault, that intersect the thrust fault in the site vicinity (KPUD 2014)The Goldendale fault is inferred to be west of the WSI and about 1 mile downstream of John Day Dam. The second fault passes under the former location of the CGA Smelter Site with the fault trace appearing to coincide with the western gulley that leads from the western end of a boat basin up to the western end of the former CGA Facility. According to the John Day Pool pumped-storage pre-application document (KPUD 2014), it is unlikely that the faults beneath the CGA Smelter Site are active or have the potential to produce earthquakes.

The bench area represents an erosional feature formed by erosional scour during the Pleistocene Missoula Floods (Bela 1982). Unconsolidated deposits near the CGA Smelter Site consist of glacial fluvial sediments, alluvium, colluvium shed from the ridge to the north, potential localized aeolian deposits, and manufactured fill associated with highway construction, dam construction, and smelter construction and operations. The unconsolidated deposits in the Project Area are a discrete stratigraphic unit ranging from a few feet to about 60 feet thick in localized areas within flood-scoured depressions on the basalt bench surface.

2.3.3.2 Groundwater

Groundwater beneath the CGA Smelter Site is first encountered in an unconsolidated alluvial/colluvial aquifer underlain by a series of basalt bedrock aquifers that represent the more permeable zones within the basalts and typically correspond to lava flow tops. Groundwater underlying the Project Area of the CGA Smelter Site is encountered in three water-bearing aquifers zones, which are defined in the CGA Smelter Site RI reports (Tetra Tech 2015, 2019, and 2022) as follows:

- Unconsolidated Aquifer Zone (UA)—shallow water in the colluvium, alluvium fill that overlies basalt bedrock. Groundwater occurs locally within the upper 2 to 3 feet of fractured basalt. The top of the UA occurs 14 to 28 feet below ground surface and is 38 to 70 feet thick (Appendix C).
- Basalt Aquifer Upper Zone (BAU)—groundwater occurs within the basalt flow sequences. The BAU is approximately 50 feet thick and occurs from elevation 400 to 350 feet above mean sea level (AMSL; Appendix C).
- Basalt Aquifer Lower Zone (BAL)—underlies saturated zones beneath the BAU. The BAL is approximately 85 feet thick and occurs from elevation 350 to 265 feet AMSL (Appendix C).

Groundwater elevations in the BAL zone are lower than the shallower UA and BAU zones. The BAL zone appears to have up to three water-bearing zone in some areas (i.e., BAL1 and BAL2, and potentially a third zone) (Tetra Tech 2022). The BAL1 water-bearing zone occurs at an elevation just above or slightly below the elevation of the Columbia River (Lake Umatilla Pool). The BAL2 water-bearing zone occurs at an elevation about 40 feet below the elevation of the Columbia River. A low permeability flow interior appears to be separating the two BAL water-bearing zones. The vertical gradient between the water-bearing zones is downward; however, significant groundwater flow has not been observed (Tetra Tech 2022).

Groundwater beneath the CGA Smelter Site flows southwestward toward the Columbia River. Hydrographs developed from a water-level characterization study and cross sections indicate that the BAL water-bearing zones have negligible discharge to the Columbia River (Tetra Tech 2022). The surface water elevation of Lake Umatilla Reservoir is slightly higher than the groundwater elevations for most of the year, suggesting limited discharge in the vicinity of well RI-MW18-BAL and well RI-MW19-BAL. Slug tests conducted during the lag and dampening of the shoreline wells and the Lake Umatilla Reservoir evaluation suggest that the aquifer is more permeable in the immediate area of the shoreline wells (Section 2.4.4 of the Final Draft RI [Tetra Tech 2022]). Additionally, relatively small responses were observed at these wells after fluctuations in river stage, indicating minimal river connectivity. These findings suggest limited groundwater discharge to Columbia River sediment and surface water.

Volume 4 for the Final Draft RI notes that groundwater elevations converge on the fault/fracture zones which are also topographic lows within the BAU; however, these fault locations are outside of the Project Area (Appendix C). Groundwater monitoring wells screened within the UA, BAU, and BAL which are located within and adjacent to the Project Area are detailed on Figure 2-3.

2.3.4 Surface Water and Sediments

The Columbia River is the major water body near CGA Smelter Site. The John Day River flows from Oregon into the Columbia River about 1 mile upstream of the former smelter. The John Day Dam spans the Columbia River and is equipped with fish passages used by various runs of salmon and steelhead.

Seven springs are present on-site; however, only two (i.e., Springs 6 and 7) are located adjacent to the Project Area (Figure 2-3; Appendix D). Spring 6, a modified spring, is present at the southwestern margin of a historical wetland (i.e., Wetland D; Section 2.3.5, Wetlands and Historical Wetlands). It discharges from the UA Zone into a small pond, and then flows westward through a roadway culvert that pools in an open area to the west where it infiltrates into the ground. This modified spring appears to be perennial and used for cattle watering.

Spring 7 is a perennial spring at the top of basalt cliffs near the former Cliffs community (Appendix D). A shallow-dug well and associated drainpipe is also located at the spring location. The spring currently appears to be used for livestock watering. The spring appears to be recharged from a shallow interval within the basalts that correlates to the elevation the BAU zone. However, this water-bearing zone was not encountered when nearby BAL well (i.e., RI-MW20-BAL) was installed, suggesting a potential incomplete connection between the BAU and Spring 7 (Appendix C).

The springs are present as surface water for a short distance and are not connected to fish-bearing waters, including the Columbia River

2.3.5 Wetlands and Historical Wetlands

Historic wetlands delineated in the CGA Smelter Site RI (Tetra Tech 2019) consist primarily of Category III and IV palustrine emergent and/or palustrine scrub/shrub wetlands. Category III and Category IV wetlands are those with a moderate- to low-level function that have been disturbed (e.g., grazing, historical grading activities, etc.). Historical wetland delineations found Wetland D to be the main wetland close to the Project Area; other wetlands in the vicinity are upgradient (Wetland A) or are small and do not consistently contain water (Wetlands B, C, and H; Appendix E). Based on a review of historical aerial photographs, it appears that Wetland D was created during plant construction and historical operations and does not appear to represent natural features that pre-date the period of plant operations (Tetra Tech 2022).

ERM prepared the Wetlands and Waters Delineation Report Rev 3 based on new field surveys within the Project Area in May 2019 and April 2022. ERM identified one palustrine, emergent wetland (W6) associated with a seep on a hillslope road cut along Highway 14, north of the WSI and outside the Project footprint for the Lower Reservoir (ERM 2023, Appendix F). ERM's 2022 field investigation led to the reclassification of historic Wetlands A, B, C, D, and H as non-wetland areas primarily due to their absence of hydric soils (Appendix F).

2.3.6 Ecology

Previous reports describe the ecology of the area (PGG 2014; FFP Project 101 2020; Tetra Tech 2015, 2019, and 2021). The CGA Smelter Site is part of eastern Washington shrub-steppe community that includes sagebrush, bunch grass, rabbitbrush, intermixed with talus slopes and patches of forest. Trees are uncommon, except near water, such as wetlands, ponds, streams, and rivers. In wetter areas, common tree species include oak, pine, willow, and Russian olive. In areas suitable for agriculture, the native vegetation has been replaced with grain (in wetter areas) or other row crops (including grapes) that may require irrigation.

The habitat near CGA Smelter Site is commonly referred to as "scablands" that includes sagebrush and grasses between areas of exposed bedrock with a hummocky topography. The basalt forms cliffs in areas along the Columbia River and steep talus slopes north of CGA Smelter Site along the base of the Columbia Hills.

The Project FERC Final License Application (FFP Project 101 2020, Section 3) lists species and maps habitat areas. The area of the CGA Smelter Site, overall, provides habitat for bird species such as sparrows, chukar, quail, turkeys, crows, and raptors including the red-tailed hawk, and golden eagle. Ponds and wetland areas provide habitat for ducks, geese, and other water birds. Mammals may include mice and other rodents, rabbits, raccoons, skunks, foxes, coyotes, and deer. A few reptile species including rattlesnakes are present near of the CGA Smelter Site.

Tetra Tech (2021) identifies state or federally designated threatened and endangered species that may be present near the CGA Smelter Site, and in the nearby Columbia River. Listed species include the western gray squirrel (state listing as threatened) and various federally listed threatened fish including particular bull trout, steelhead, Chinook salmon, and chum salmon runs. The Snake River sockeye salmon is federally listed as endangered (Tetra Tech 2022).

2.4 Current and Future Land Use

The Project Area is zoned industrial as is most of the surrounding CGA Smelter property. The Project Area is within an energy overlay zone (FFP Project 101 2020). The current owner of the CGA Smelter Site and adjacent property (NSC) plans to sell its land and other assets for commercial and industrial purposes. Land use surrounding the CGA Smelter property has been limited to livestock grazing, primarily cattle, in the sagebrush/grassland habitat.

Access to CGA Smelter Site and the Project Area (including the WSI) is restricted, with most of the former CGA Smelter facility fenced and locked. Some areas east of the former CGA Smelter facility (e.g., SWMU

31, Smelter Sign Area) are located outside the existing perimeter fencing; however, a full-time site manager is responsible for site security.

2.5 Previous Investigations

The CGA Smelter Site has a long history of environmental investigation, cleanup, and site closure performed in association with environmental permits and regulations. The Smelter PLPs have completed a Final Draft RI (Tetra Tech 2022) and Final Draft Feasibility Study (Weston 2024) to address the requirements of the 2014 Agreed Order No. DE 10483 issued by Washington State Department of Ecology (Ecology) and dated 1 May 2014. Primary features of the CGA Smelter Site as identified in the Final Draft RI are detailed in Appendix G.

The Agreed Order required two phases of RI Work Plan preparation (Phase 1 and Phase 2) that were prepared as two separate volumes. The Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) summarized available information and data regarding 32 SWMUs and 5 Areas of Concern (AOCs) identified in the Agreed Order, screened each SWMU and AOC to determine if they require further investigation, and identified data gaps and data needs for each SWMU and AOC. The Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) defined the specific investigation and evaluation activities for each SWMU and AOC that required further investigation to characterize the nature and extent of contamination. Ecology formally approved the Final RI Phase 1 and Phase 2 Work Plans in correspondence dated 14 August 2015 (Ecology 2015). A supplemental Work Plan for the Plant Area AOC (PGG 2017) and a Bioassay Sampling and Analysis Plan (Tetra Tech 2018) were also submitted to and approved by Ecology to address data needs identified during the course of the field investigation.

The initial RI field program was implemented from September 2015 through August 2018. A Draft RI Report was submitted to Ecology on 24 January 2019 (Tetra Tech et al. 2019a). Ecology provided comments, including Yakama Nation Comments, on the Draft RI Report on 26 June 2019 (Ecology and Yakama Nation 2019). The Draft RI Report Comments (Ecology and Yakama Nation 2019) stated that additional characterization work was required to adequately define the nature and extent of contamination at the site, and that the preparation of a Work Plan Addendum (WPA) would be required to address data gaps identified in the comments submitted on 26 June 2019.

The Draft WPA was submitted for Ecology and Yakama Nation review on 18 November 2019 (Tetra Tech et al. 2019b). Ecology and Yakama Nation submitted comments on the Draft WPA on 20 March 2020 (Ecology and Yakama Nation 2020a) and comment responses were submitted to Ecology on 13 May 2020 (Tetra Tech et al. 2020a). The Final WPA was submitted for Ecology and Yakama Nation review on 24 July 2020 and comments were received on 26 August 2020 (Ecology and Yakama Nation 2020b). The Final WPA, Revision 1 was submitted to Ecology on 18 September 2020 (Tetra Tech et al. 2020b).

The WPA field program was implemented in two phases: a fall 2020 mobilization and a spring 2021 mobilization. The findings of the WPA are provided in the Smelter PLPs Final Draft RI Report dated 14 June 2022.

The Applicant’s approach for using these previous investigations to complete this RI/FS, a summary of environmental data collected, and a description of nature and extent of contamination within the Project Area are provided in Section 5, Investigation Approach; Section 6, Investigation Summary; and Section 7, Nature and Extent of Contamination Within the Project Area, of this RI/FS, respectively.

2.6 Project Construction Environmental Considerations

Environmental considerations for construction of the Project within the described environmental setting are addressed through this RI/FS, a 401 Water Quality Certification with the State of Washington, by the pending FERC license to construct and operate a hydroelectric facility, and associated plans and permits.

This section identifies CGA Smelter Site features within and adjacent to the Project Area, Project construction activities with potential to impact these features, and where applicable, plans and permits in addition to the pending PPCD which address those considerations.

The footprint of the Lower Reservoir partially overlaps the historic WSI. The Project design includes removal of all the WSI (liners and contents of the WSI) because they are unsuitable for reservoir construction. Removal of the WSI will occur prior to reservoir construction. Directly adjacent to the WSI is the West SPL and a drainage ditch south of the West SPL (the West SPL Ditch). The CGA Smelter Site groundwater monitoring well network within the Project Area (i.e., the WSI monitoring well network) consists of 14 monitoring wells, of which 11 wells are within the Project footprint (i.e., the Lower Reservoir) and must be decommissioned. Previous investigations by the Smelter PLPs have identified environmental impacts associated with these features (see Figure 2-3).

Project construction and operation activities with potential to disturb these environmental impacts include site access, land disturbance activities, and groundwater dewatering. In addition to this RI/FS, the Applicant has developed a draft Stormwater Pollution Prevention Plan and Dewatering Plan to identify control measures for prevention of releases of contaminants associated with the CGA Smelter Site during Project construction activities. These activities are summarized as follows:

- Access to the WSI and lower reservoir site is planned from the existing John Day Dam Road using approximately 0.7 miles of existing access roads to the aluminum smelter. Access to the Upper Reservoir site is planned from Hoctor Road, using approximately 8.6 miles of the existing access roads for the existing TWPA wind farm (HDR 2020).
- The existing elevations in the vicinity of the Lower Reservoir range from 400 to 600 feet AMSL. The proposed bottom of the reservoir is 420 feet AMSL and the proposed top of dam is 500 feet AMSL. Both reservoirs will be constructed by a combination of excavation and construction of dams and embankments, balancing the excavated volumes with the volumes needed for the embankments. The material for the dams and embankments will be sourced primarily from the processing of excavated materials from the construction of the reservoirs and tunnels.
- Dewatering is expected during the construction of the Lower Reservoir. Only a portion of the Lower Reservoir where the bottom elevation (420 feet AMSL) intersects the water table (northeastern corner) will likely require dewatering during construction. Dewatering rates necessary for the construction of the Lower Reservoir are estimated to be between 15 and 25 gallons per minute on average. DRAFT Goldendale Lower Reservoir Dewatering Simulations are presented in Appendix H. ERM will coordinate with the design engineer to develop solutions that do not exacerbate existing groundwater impacts or impeded the selected remedy. Water generated from dewatering will be managed using typical large-construction best management practices (BMPs), including potential use of mobile treatment plants.

These construction and dewatering activities will be carried out separately from the proposed remedial actions described in this RI/FS. The costs for these activities are not included in cost estimates for the remedial alternatives because the cost for these activities will be the same for each of the remedial alternatives.

3. CONCEPTUAL SITE MODEL

A site conceptual model integrates understanding of sources, nature, and extent of contamination; fate and transport mechanisms; and potential receptors and exposure pathways to environmental contamination. Figures 3-1 and 3-2 present the conceptual site model schematic for the Project Area. This CSM is adapted from the Final Draft RI (Tetra Tech 2022) to be focused on the Project Area.

3.1 Potential Sources and Release Mechanisms

The predominant mechanisms for historical contaminant releases in the Project Area vicinity are from former CGA Smelter waste management activities and facilities (i.e., WSI, West SPL, and West SPL Ditch; Figure 2-4).

The WSI is lined with a geomembrane and soil as detailed in the Previous Investigations Section. Emission control wastewater was concentrated to sludge by evaporation in this facility. Contaminants of interest associated with sludge include alumina, dust and particulates from the reduction operation, and sulfate and fluoride precipitates from the treatment system. Investigations during closure of the WSI (Parametrix 2004) found that portions of the engineered lining system were degraded.

Given the degraded state of the liner, the lining system may be compromised, resulting in releases and impacts to soil and groundwater below the WSI. Groundwater concentration trend analysis suggest that the source/releases related to MW-3B and MW-14A may be diminishing (GeoPro 2021) as these locations show statistically significant decreasing trends. Concentrations of sulfate, fluoride, and cyanide at MW-10A and cyanide at MW-18 appear to be trending upward which could suggest a newer/continued releases (Appendix I).

The West SPL is a concrete pad with containment wall used to store spent pot liner generated by the facility. Waste was moved beyond the original footprint during closure; however, these areas were lined with a 50-mil high density polyethylene geomembrane in accordance with Washington State Solid Waste regulations, as detailed in the Investigation Summary Section. Fluoride was present in the cryolite bath. Sulfur was present in the coke and pitch used in the manufacturing of briquettes used to line the pots. The West SPL itself may not a contributing source considering the structure of the containment area. However, polyaromatic hydrocarbons (PAHs), fluoride, arsenic, cadmium, and selenium were detected above screening levels in the West SPL Ditch soil samples (Appendix J) that formerly contained the scrubber slurry line to the WSI and the drain from the West SPL. Additionally, groundwater concentration spikes of total cyanide, fluoride, and sulfate observed in 1996 after the West SPL cap and closure suggest potential leaching of fluoride from the West SPL Ditch adjacent to the West SPL and not the West SPL itself (CH2MHill 1996).

3.2 Exposure Media and Transport Pathways

Potentially impacted environmental media on and adjacent to the Project Area resulting from historical operations at the CGA Smelter Site included the following:

- Soil (i.e., surface soil in the West SPL Ditch and underlying the WSI)
- Surface water (Springs 6 and 7)
- Groundwater

Remedial Investigations and Feasibility Studies typically assess potential contaminant transport mechanisms in the context of cleanup technologies and source control. The transport mechanisms identified in the CGA Smelter Site RI (Tetra Tech 2022) that apply to the Project Area are as follows:

- **Infiltration and Leaching.** Infiltration of precipitation on the WSI could leach contaminants from shallow soils to groundwater.
- **Groundwater Flow.** Transport of dissolved chemicals of concern (COCs) in groundwater could result in exposure at exposure points.
- **Air Dispersion.** Wind-driven soil from surface sources could deposit contaminated soil down wind.
- **Erosion and Runoff.** Transport of soil from surface sources could deposit contaminated soil to surface water (i.e., spring discharge points).
- **Wildfire Transport.** Wildfires can potentially generate contaminants by burning on the CGA Smelter Site or nearby and with subsequent aeolian transport and deposition. Wildfires may also result in increased erosion and runoff in the fire areas.

This RI/FS for the Project Area considers possible transport mechanisms and COCs associated the WSI and underlying impacted soils and/or groundwater. The site-wide FS completed by the Smelter PLPs will consider other CGA Smelter Site sources, COCs, and transport mechanisms.

3.3 Chemicals of Potential Concern

Chemicals of potential concern (COPCs) in the Project Area, as identified in the CGA Smelter Site Final Draft RI, include chemicals associated with the former aluminum reduction facility and wastes formerly disposed of in the WSI. These COPCs include cyanide, fluoride, sulfate, and PAHs. In addition, polychlorinated biphenyls (PCBs), some metals (e.g., arsenic, cadmium, nickel, and lead), volatile organic compounds (VOCs) related to fuels and solvents, and total petroleum hydrocarbons (TPH) represent COPC for some areas and media at the CGA Smelter Site.

Cyanide, fluoride, and sulfate are related to smelter operations and used pot liners at the site. Fluoride is present in the cryolite bath material, in spent pot liners, and air pollution control byproducts. PAHs and sulfates are present in the coke and pitch for the manufacture of briquettes used to line the pots. Cyanide is produced in trace amounts within spent pot liner during the aluminum reduction process. PCBs were historically used in oils in the capacitors and transformers at the site.

PAH particulates from the aluminum processing cells became entrained in gaseous emissions and removed by the scrubber air pollution control system (in particular the wet air scrubber system), which then generated a PAH-containing wastewater stream and sludges.

3.4 Contaminant Fate and Transport

This section briefly summarizes fate and transport properties for some of the main COPCs at the site from the Smelter PLPs Final Draft RI (Tetra Tech 2022).

3.4.1 Fluoride

In general, fluoride is more soluble in alkaline soils than in acidic soils (with lower Kd values for alkaline soils). Groundwater pH at the site typically ranges from 6.5 to 8.0 pH units. Fluoride-containing wastes present at the site include cryolite as the dominant form, which was used in the electrolytic refining process, and spent pot liner (K088 waste). Cryolite (Na3AlF6) is slightly soluble in water, with literature values indicating a solubility of 420 milligrams per liter (mg/L; 228 mg/L fluoride). The principal minerals present in the spent pot liner include cryolite, fluorite (CaF2), and sodium fluoride (NaF). Fluorite has very low solubility, while sodium fluoride is extremely soluble in water. The fluoride ion will sorb or participate in exchange reactions with clays, alumina, and iron oxides. Based on geologic logging and chemistry data collected during the RI, colluvial soils at the site are frequently clay-rich and iron-rich given their derivation from the Columbia River Basalts.

3.4.2 Sulfate

Sulfates commonly occur naturally as the mineral gypsum, epsomite, and barite. High concentrations of naturally occurring sulfates have been reported for groundwater within the Columbia River Basalt Group, although elevated sulfate concentrations were not detected in the RI background well data set. Sulfate ion is the second most abundant ion in seawater and freshwater.

Sulfate and sulfuric acid products are used in the production of fertilizers, chemicals, dyes, glass, paper, soaps, textiles, fungicides, and insecticides. They are also used in mining, wood pulp, metal and plating industries and industrial operations of smelters, pulp and paper mills, textile mills, and tanneries. Sodium, potassium, and magnesium sulfates are all highly soluble in water, while calcium and barium sulfates, and many heavy metal sulfates are less soluble. Atmospheric sulfur dioxide formed by combustion of fossil fuels and various metallurgical processes may contribute to the sulfate content of surface waters as well as acid rain (WHO 2004; Encyclopedia of Toxicology 2014).

Sulfate is part of the biologically mediated sulfur cycle in which the sulfate ion is biologically reduced to sulfide through a multi-step process. This bacterially driven cycle is important to the biodegradation of petroleum hydrocarbons under anaerobic conditions, where sulfate acts as the terminal electron acceptor for the microbial metabolism of petroleum hydrocarbons (Encyclopedia of Ecology 2008).

3.4.3 Metals

Various metals (As, Al, Cd, Cr, Cu, Ni, Pb, Se, and Zn) have been detected in smelter wastes, soils, and or groundwater above natural background concentrations and screening levels in at least a few locations.

The most important factors controlling metal fate and transport are solubility, redox behavior, aqueous speciation, and sorption behavior, all of which are functions of the ambient geochemical environment. For metals, volatilization and photolysis are of limited importance. Biotransformation processes can be important for some metals (e.g., Cu, As, and Pb) under certain environmental conditions. All metals are, to variable extents, subject to cation-exchange reactions with minerals present in the environment. This does not include anionic metal species, such as oxyanions of metals in certain oxidations states. The extent to which cation-exchange occurs is dependent on the mineral species present and on pH, as well as on the characteristics of the individual metals.

The mobility of metals within environmental matrices depends upon numerous factors such as the relative stabilities of individual valence states (which are element-specific), oxygen content, pH and Eh conditions, and the presence of available complexing agent.

In general, metals have a high adsorptive affinity for inorganic mineral surfaces and organic matter. Adsorption, for most metals, is highly pH-dependent, with desorption generally more favored at low pH and sorption mechanisms dominating at higher pH conditions for cationic metals. However, the types of clays and their surface charges in relation to soil pH values, dictate whether sorption or desorption will occur. Additionally, chemical speciation determines the relative degree of adsorption among different species of a particular metal. Based on the data available for site soils, sorption is most probably a significant fate process for metals. The aerobic conditions in the surface water and shallow groundwater are likely to promote the precipitation of ferromanganese oxides and oxyhydroxides (probably nucleating on sand and soil grains) to which other metals will readily adsorb.

3.4.4 Polynuclear Aromatic Hydrocarbons

PAHs are among the most widespread COCs at the site and are present at elevated concentrations in soils and wastes at the site. PAHs are persistent and generally immobile in soil matrices under normal environmental conditions. This is primarily due to their low aqueous solubility and resistance to photolytic, oxidative, and hydrolytic degradation, and their high affinity for adsorption to organic matter and soil particles. However, in the presence of highly mobile organic compounds (i.e., VOCs, phenolic compounds, ethers and/or nitrobenzene) which can act as co-solvents, the mobility of PAHs in soils and/or aqueous matrices can be greatly enhanced which would facilitate the transport of PAHs to groundwater. These highly mobile organic compounds acting as co-solvents can also greatly enhance the transport of PAHs within groundwater and/or surface water. However, other highly mobile organic compounds such as VOCs do not represent COPCs at this site.

PAHs can be degraded by microbial populations; however, this is generally a slow process in the environment. Among PAHs, naphthalene is relatively mobile in the environment due to its lower adsorptive affinity and higher aqueous solubility in comparison to most PAHs. The carcinogenic PAHs tend to be high molecular weight compounds that are less mobile in the environment and more likely to bind to soil particles. Some of the PAHs may exhibit substantial bioaccumulation (i.e., phenanthrene); however, this is usually a transitory effect (i.e., depuration typically occurs within several weeks or months) since most organisms have the ability to metabolize these compounds.

3.5 Ecological and Human Receptors

Potential exposure to COCs in soil and/or groundwater and/or physical stresses (e.g., destruction of habitat and disturbance) during the proposed Project construction and operation represent the primary effects to potential ecological and human receptors in the Project Area.

3.5.1 Ecological Receptors

Ecological exposure to COCs within the WSI is unlikely given the location of soil impacts are limited to the WSI which is capped, a low-quality habitat, and secured with fencing. Wildlife is not considered a potential receptor. The WSI is a landfill with an engineered RCRA cap consisting of soil and geosynthetic materials. Quarterly inspections and maintenance are completed to maintain integrity of the cap including removal of rodent holes and vegetation clearance (GeoPro 2021). According to MTCA WAC 173-340-7491(b), the WSI is exempted from Terrestrial Ecological Evaluation requirements as it was closed under RCRA program requirements and is undergoing long-term post-closure groundwater monitoring.

There is potential for ecological exposure to livestock and terrestrial wildlife at Spring 6 and 7 as it is suspected they are connected to the groundwater adjacent to the Project Area. These locations do not exceed the protective of livestock screening levels for sulfate (500 mg/L) and fluoride (2 mg/L) and there is no established terrestrial wildlife screening level (Weston 2024). Additionally, both springs appear to be at the leading edge of the plume for their respective aquifers where COPCs have primarily attenuated (i.e., low concentrations relative to the groundwater immediately downgradient from the WSI).

3.5.2 Human Receptors

The majority of the CGA Smelter Site is currently zoned for industrial use. In the eastern portion of the CGA Smelter Site an area zoned for extensive agriculture is present. In addition, south of main plant area there is an area zoned as Open Space. Land use surrounding the CGA Smelter Site includes livestock grazing, primarily cattle, in the sagebrush/grassland habitat (Tetra Tech 2022). Access to CGA Smelter Site and the Project Area is restricted, with most of the area fenced with locked gates.

Exposures by humans could occur through contact, ingestion, or inhalation of contaminated subsurface soil, dust entrained in air during construction, or use of contaminated groundwater. The Weston Final Draft Feasibility Study describes possible exposure to CGA Smelter Site related contaminants (Weston 2024). Potential human receptors at the cap area include current and future users of the area, potential trespassers, and potential future users of groundwater. Current water rights identify drinking water as a possible beneficial use (PGG 2014); however, there are currently no drinking water wells located in the Project Area.

There are potential human receptors at Spring 6 and 7 as it is suspected they are connected to groundwater through the UA and BAU, respectively. However, these locations are primarily used for livestock watering (cattle) and human exposure can be eliminated/reduced through institutional controls.

4. REGULATORY FRAMEWORK

This section summarizes the regulatory framework for cleanup actions described within this RI/FS.

4.1 Permitting and Regulatory Overview

Key environmental permitting and orders pertaining to the Project are detailed below.

4.1.1 State Environmental Policy Act

Ecology has completed an Environmental Impact Statement for the Project. The Environmental Impact Statement will help Washington State make decisions related to the Project based on environmental impacts and inform Ecology's consideration of impacts that may be provisioned in permits and approval, including the PPCD.

4.1.2 Resource Conservation and Recovery Act

4.1.2.1 Current Permit Status

The Project will be constructed on part of the CGA Smelter Site identified as a RCRA site in 1981, identification number WAD990828642. The WSI (SWMU 4) received state-only dangerous wastes based on bioassay criteria in place and regulated under the RCRA permit. The RCRA closure process for the WSI began in 2004. A revised RCRA Part B application was submitted in August 2004 (Golder 2004) to reflect closure of the WSI. Ecology approved the WSI Closure Plan in October 2004, and the WSI was closed in November 2005. A final status permit has not been issued and the smelter CGA Smelter Site continues as a RCRA interim-status facility.

The WSI waste will be excavated, profiled, manifested, and transported to an off-site landfill that is licensed to accept both solid and hazardous wastes at an approved RCRA-permitted treatment storage and disposal facility.

4.1.2.2 Proposed Status

The Environmental Protection Agency's (EPA's) Post-Closure Care Final Rule provides the regulatory agency discretion to impose alternative requirements developed for corrective action in lieu of the requirements of 40 CFR Parts 264 and 265, Subparts F, G, and H, where a regulated unit and another unregulated solid waste unit have contributed to the same release (Section 6). The alternative requirements for corrective action for this facility would be those developed in accordance with MTCA under Washington's authorized program.

If approved as part of an authorized program, Ecology may use enforceable documents developed under MTCA as an alternate administrative mechanism to require corrective action and implementation of ongoing controls/requirements in lieu of the RCRA post-closure permit for the WSI. The Applicant and Smelter PLPs propose to use the PPCD for this Project to serve this function for the WSI. The current Agreed Order together with the pending site-wide consent decree could serve this function for the remainder of the Project Area.

The Applicant proposes to use the Cleanup Action Plan for the Project implemented under the PPCD as an amended closure plan for the WSI, specifying the removal of wastes, liners and impacted soils above applicable, risk-based cleanup levels. Public notice requirements for closure plan amendment would be incorporated in the administrative process for the PPCD.

4.1.3 Model Toxics Control Act

The Smelter PLPs have investigated the CGA Smelter Site under the Order, including the SWMUs and AOCs within the Project Area. The Applicant proposes that remedial action occur within the Project Area to address SWMU 4 (i.e., the WSI) in accordance with MTCA under a CAP incorporated into a PPCD. The PPCD will identify responsible parties for addressing cleanup actions identified in this RI/FS. The Smelter PLPs will implement all remedial actions which are outside the Project Area and all remedial actions associated with groundwater contamination at the CGA Smelter Site, including the Project Area, pursuant to the Order. The Applicant will implement the remaining remedial actions within the Project Area including installation of replacement monitoring wells that will be decommissioned for construction activities in the Project Area.

When finalized, the PPCD will be filed at the appropriate superior court having jurisdiction.

As described above, the alternative requirements for corrective action for the WSI will be developed in accordance with MTCA under Washington’s authorized program in accordance with EPA’s Post-Closure Care Final Rule (40 CFR Parts 264 and 265, Subparts F, G, and H).

4.1.4 Local Review

Consultation with local government may be needed to define substantive permit requirements in the event that state and local permits are exempted under the PPCD.

4.2 Screening Levels

The primary screening levels identified for use in the RI/FS are MTCA Method A, B, and C Cleanup Levels (WAC 173-340). Method A, B, and C Cleanup Levels are summarized below.

- Method A provides tables of cleanup levels that are protective of human health for the 25 to 30 most common hazardous substances for soil and groundwater and including petroleum hydrocarbons. Method A is designed for cleanups that are relatively straightforward or involve only a few hazardous substances. Use of Method A may be appropriate for some specific-SWMUs at the CGA Smelter Site.
- Method B is the universal method under MTCA with cleanup levels acceptable for unrestricted (all) land uses and consistent with state and federal requirements. Human health levels for individual carcinogens cannot exceed one-in-a-million and cumulative site cancer-risk levels may not exceed 1 in 100,000. Levels of non-carcinogens cannot exceed the point at which a substance may cause illness in humans (that is the hazard quotient must be less than 1).
- Method C is a conditional method that is commonly used to set soil cleanup levels at qualifying industrial sites and for groundwater in some specific circumstances. Method C is based on less stringent exposure assumptions and higher lifetime cancer-risk thresholds than Method B. All practical methods of treatment must be used, and institutional controls must be implemented and maintained as part of site cleanup actions in which Method C cleanup levels are adopted.

The screening levels in this section of the RI/FS are summarized from the Smelter PLPs' Final Draft RI (Tetra Tech 2022). These were used as an initial site screening, to identify locations needing further investigation, and to determine data needs for the CGA Smelter Site RI. Proposed cleanup levels are presented in Section 8, Remedial Action Objectives, based on the remedial investigation results consistent with MTCA requirements.

Soil screening levels, groundwater screening levels, surface water screening levels, and sediment screening levels from the Smelter PLPs' Final Draft RI are provided in Appendix K.

Screening levels for specific medias within and adjacent to the Project Area are described in the following sections.

4.2.1 Soil

MTCA Methods A, B, C, MTCA soil screening levels for protections of groundwater, and MTCA terrestrial ecologic soil screening levels have been adopted for screening purposes in this RI Report. Soil screening levels for site COPC are summarized in Appendix K.

4.2.1.1 MTCA Method A, B, and C

MTCA Method A, B, and C soil cleanup levels have been included in Appendix K for screening comparison purposes in the RI. Method A Cleanup Levels for both Unrestricted Land Use and Industrial properties are included. Note that for some chemicals, the Method A soil cleanup level is based on protection of groundwater.

MTCA Method C Industrial Cleanup Levels are appropriate for cleanup of soils at the site in areas owned by NSC Smelter LLC and zoned as industrial (Tetra Tech 2022). Method C soil cleanup levels may only be established where the parties conducting the cleanup action can demonstrate requirements of WAC 173-340-745).

4.2.1.2 Human Health

MTCA soil cleanup levels for unrestricted land use (i.e., MTCA Method A and B) are protective of Treaty-Protected Tribal Uses based on their residential exposure assumptions (e.g., exposure frequency, average body weight, soil ingestion rate and risk levels).

4.2.1.3 Protection of Groundwater

Soil screening levels protective of groundwater from CLARC have been included where available as calculated with the fixed parameter three-phase partitioning model [as described in WAC 173- 340-747(4) and based on MTCA Equation 747-1]. For three aluminum smelter-related chemicals lacking CLARC values (i.e., fluoride, cyanide, and sulfate), soil screening levels were determined consistent with MTCA. For sulfate and cyanide, the fixed parameter three-phase partitioning model was used in conjunction with MTCA and MCL groundwater screening levels, and literature Kd values as input values. For fluoride, an empirical demonstration has been used to establish soil screening levels protective of groundwater consistent with WAC 173- 340-747(9) (Tetra Tech 2022).

The screening level for carcinogenic PAH compounds is based on the calculated total toxicity equivalent concentration (TTEC) value, which represents the equivalent benzo(a)pyrene concentration using methods in WAC 173-340-708(8) and Table 708-2 of MTCA.

4.2.1.4 Terrestrial Ecological Evaluation

MTCA (WAC 1173-340-7490) defines procedures for determining whether a release of hazardous substances to soil may pose a threat to terrestrial ecologic receptors. A site-specific Terrestrial Ecological Evaluation (TEE) is necessary for the CGA Smelter Site and MTCA Table 749-3 Indicator Concentrations for three receptor categories (soil, biota, plants) were used for screening in accordance with Ecology guidance (Ecology 2017a). Soils in areas which are both owned by NSC and zoned for industrial use may be screened using only the wildlife values for TEE. All other areas of the CGA Smelter Site should be screened using appropriate values for all three eco-risk receptor categories (Tetra Tech 2022).

In addition to the screening levels included by rule in MTCA Table 749-3, screening levels for additional chemicals have been provided by Ecology. These recommended screening levels are based on best available science. For PAHs, The PAH values in the Ecology-supplied table are based on EPA guidance "Ecological Soil Screening Levels for PAHs, Interim Final" (EPA 2007). These TEE screening values with associated laboratory reporting limits and method detection limits are included in Appendix K (i.e., Table 5-1 from the Final Draft RI).

4.2.2 Groundwater

Appendix K (i.e., Table 5-2 from the Final Draft RI) summarizes groundwater screening levels considered for use in support of this RI/FS. Based on review of water rights and groundwater use, MTCA Method A and Method B groundwater cleanup levels are appropriate. Groundwater at this site is considered to represent a potential source of drinking water that represents its highest beneficial use consistent with MTCA requirements and given the recent change of groundwater rights for the former plant production wells to municipal use.

For screening purposes, groundwater results have been primarily compared against groundwater protection standards. Spring water results are considered to represent discharging groundwater.

For a few chemicals (i.e., fluoride, free cyanide), groundwater federal primary MCLs, which also represent Washington State Primary MCLs in WAC 246-290-310 were also included as appropriate groundwater screening levels. In the case of sulfate, the secondary MCL of 250 mg/L was used for screening purposes because no risk-based concentration or reference dose was found.

4.2.2.1 Fluoride

Applicable screening levels for fluoride include the MCL of 4.0 mg/L and the MTCA Method B formula value is 0.96 mg/L. Based on review, most aluminum smelter groundwater cleanups in Washington have adopted the MCL for fluoride as the site groundwater cleanup level. The fluoride cleanup level is calculated with the standard MTCA equations and using the Integrated Risk Information System reference dose of 6.00E-2 milligrams per kilogram (mg/kg) per day.

4.2.2.2 Cyanide

For cyanide (as free cyanide), the MCL is 0.2 mg/L and the MTCA Method B formula value is 0.010 mg/L. Both of the screening levels are based on free cyanide, and not metal-complexed cyanides. The RI groundwater results show that all forms of cyanide are infrequently detected in groundwater. Where cyanide is detected, it appears to predominately occur in the metal-complexed form. Total cyanide concentrations significantly exceed free cyanide concentrations in all wells with positive cyanide detections. Based on review of the RI groundwater data set, it does not appear that cyanide represents a significant risk-driver for groundwater based on its infrequency of detection and metal-complexed form at the site.

4.2.2.3 Sulfate

For sulfate, the screening level is the secondary MCL of 250 mg/L, which is deemed non-mandatory by EPA, because secondary MCL are established for "nuisance" chemicals on aesthetic qualities as opposed to human health effects. According to EPA, contaminants are not considered to present a risk to human health at the secondary MCL. However, Ecology has explained that the secondary MCL for sulfate represents a likely Applicable or Relevant and Appropriate Requirement (ARAR) for the Project. Washington State drinking water regulations (WAC 246-290-310) include a secondary MCL for sulfate of 250 mg/L and drinking water system purveyors must monitor for and comply with this secondary standard.

4.2.3 Sediment

Appendix K (i.e., Table 5-3 from the Final Draft RI) summarizes sediment screening levels considered for use in support of this RI Report. The Washington State Sediment Management Standards (SMS) represent the main regulations for conducting sediment cleanups in the State of Washington (WAC 173-204). The Ecology sediment cleanup user's manual (SCUM II; Ecology 2017b, 2019) was used as the source of the screening levels in this RI Report. The goal of the SMS is to reduce and ultimately eliminate adverse effects on biological resources and threats to human health from surface sediment contamination. The SMS, in conjunction with MTCA, governs the process of how sediment sites are identified, investigated, cleaned up, and monitored in Washington State.

SMS criteria are applicable for use in areas that are inundated with water for periods of more than 6 consecutive weeks. There are no locations within the Project Area which meet this criteria.

Appendix K (i.e., Table 5-3 from the Final Draft RI) also summarizes current freshwater sediment screening criteria and includes maximum and 90 Upper Threshold Limit (UTL) reference station concentrations which have been updated to include carcinogenic PAHs.

4.2.4 Surface Water

Appendix K (i.e., Table 5-4 from the Final Draft RI) summarizes surface water screening levels considered for use in support of this RI Report. The draft RI Report summarized chemical-specific screening levels for surface water including: MTCA Method B Surface Water Cleanup Levels, Washington State (WAC 340-201A) and Federal Ambient Water Criteria (acute and chronic freshwater values). The MTCA Method B formula values incorporate human health water quality criteria in the National Toxics Rule (40 CFR 131.36) and the Clean Water Act 304 (a) human criteria for water and organisms.

The principal issue related to default surface cleanup levels is associated with carcinogenic PAH compounds represented as equivalent benzo[a]pyrene. Ecology has approved a method detection limit of 1.1x10-2 micrograms per liter (µg/L) and a method reporting limit of 1.0x10-1 µg/L for benzo[a]pyrene in the Final WPA. The RI laboratories achieved a method detection limit of 1.1x10-3 µg/L and a method reporting limit of 2.0x10-2 µg/L, which are orders of magnitude higher than the default ARAR value of 1.6x10-5 µg/L.

If there is a completed pathway to a fish-bearing surface water for carcinogenic PAHs, then values established under 40 CFR 131.45 40 and CFR 131.45 should be used but adjusted upward to an appropriate practical quantitation limit consistent with MTCA requirements (WAC 173-340-7006[d]) (Ecology 2022). Ecology noted that the springs represent a special case since they are seasonal and do not provide fish habitat. Ecology also stated that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs.

4.2.5 Background Concentrations

This section summarizes where media-specific background concentrations (e.g., arsenic) are consistently higher than the screening levels as evaluated by the Smelter PLPs in the Final Draft RI (Tetra Tech 2022). In these cases, the screening levels have been adjusted to background concentrations consistent with MTCA requirements. Screening levels were adjusted for the following media and analytes (Appendix K):

- Soil: Aluminum, Arsenic, Cadmium, Chromium, Copper, Fluoride, Lead, Mercury, Nickel, Selenium, and Zinc
- Groundwater: Aluminum, Arsenic, Chromium, Fluoride, Iron, Lead, Nickel, and Sulfate

- Sediment: Aluminum, Arsenic, Cadmium, Chromium, Copper, Fluoride, Lead, Mercury, Nickel, Polycyclic Aromatic Hydrocarbons, Sulfate, TPH-Residual, and Zinc

5. INVESTIGATION APPROACH

This RI/FS is based entirely on information obtained over the history of investigations completed by the Smelter PLPs for the CGA Smelter Site. The Applicant has utilized this information to evaluate the extent of contamination within the Project Area. The Smelter PLPs are investigating the broader CGA Smelter Site and assessing cleanup actions under the Order for the CGA Smelter Site. The Applicant is not a PLP under the Order.

A detailed description of SWMUs and AOCs, including a summary operational history and past investigations for the CGA Smelter Site is provided in the Ecology-approved Final RI Phase 1 and 2 Work Plans (Tetra Tech et al. 2015a,b), Final Work Plan Addendum (Tetra Tech et al. 2020b), and the Final Draft RI (Tetra Tech 2022). The list of SWMUs and AOCs to be evaluated in the original RI are summarized in the May 2014 Agreed Order (Ecology 2014). The Agreed Order includes 32 SWMUs and 4 AOCs. A fifth AOC (the Plant Area AOC) was identified by the Project team during work plan preparation and included additional areas of the former plant that may have released COPCs. An additional area of investigation was identified to include the West SPL Ditch near the West SPL (SWMU 13). The locations of the SWMUs listed in the Agreed Order as shown in Appendix G.

A detailed description of SWMUs and AOCs, including a summary operational history and past investigations is provided in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a). Brief background summaries are included for individual SWMUs and AOCs located within or adjacent to the Project Area.

6. INVESTIGATION SUMMARY

Investigations have been completed within and adjacent to the Project Area between 1988 and 2019 to characterize the site media and understand the nature and extent of contamination related to the CGA Smelter Operations.

6.1 Solid Waste Management Units

Field investigations for the 32 SWMUs and additional investigation areas on-site are summarized in Volume 2 for the Final Draft RI (Tetra Tech 2022). The WSI (SWMU 4) is within the Project Area and the West SPL (SWMU 13) is immediately adjacent to WSI, outside of the Project Area. Field investigations were not conducted for the WSI and West SPL as part of the Final Draft RI since both had previously been investigated and closed under RCRA and Washington Solid Waste regulations (Parametrix 2004; CH2MHill 1988).

6.1.1 West Surface Impoundment

The WSI is an SWMU containing industrial wastes produced by historical operations of the smelter (Appendix A). When operating, the WSI was an approximately 10-acre earthen impoundment with a maximum depth of approximately 18 feet. The smelter operators constructed the WSI by expanding naturally occurring landscape features and installing a 30-millimeter thick Hypalon geomembrane that was covered with 6 inches of protective soil (Parametrix 2004). The WSI concentrated emission control wastewater to sludge by evaporation. The WSI was constructed in 1981 and began receiving waste in 1982. According to the West Parametrix Closure and Post-Closure Plan, the WSI contains approximately 89,000 cubic yards of the following sludge types:

- Sludge from plant process, as designed, included:
    - Tertiary plant waste solids underflow
    - Sulfur dioxide scrubbers underflow
    - Thickener and reaction clarifier filter press cake
- Basement cleanup and cell line sweepings
- Dormer dust
- Paving cleanup
- Sludge from auto shop wash station
- Sludge from paste plant cooling water
- Cleanup soil from paste plant
- Filter cake

The WSI historically received state-only dangerous wastes. These wastes were later designated as WT02 (toxic dangerous waste) through a fish bioassay test performed by Martin Marietta Corporation. Martin Marietta Corporation reported this designation in its Part A permit application submitted on 6 August 1982. In November of 1995, Ecology revised WAC 173-303, and changed the bioassay criteria. Under the new criteria, the WSI wastes did not designate as dangerous.

At the time of closure, the side slopes of the WSI no longer had the protective soil layer over the membrane and oxidation was visible in those areas. Many oxidation-related rips and tears were observed in the geomembrane; however, no repairs were recommended at the time of closure (Parametrix 2004).

Contaminants of interest associated with the solid waste materials include alumina, dust, and particulates from the reduction operation, and sulfate and fluoride precipitates from the treatment system.

A RCRA Part B application was submitted by the Smelter PLPs in August 2004 to reflect closure of the WSI. Ecology approved the WSI Closure Plan in October 2004, and the WSI was closed on 30 November 2005. The WSI was closed in place under RCRA and is currently in long-term post-closure monitoring.

Closure of the WSI included the following elements:

- Blending site borrow material with the landfill contents such that they would support construction equipment and consolidation of the landfill contents to reduce the impoundment footprint.
- Installing a ventilation system consisting of 12-inch wide strip drains, below the liner system that leads to three vertical ventilation pipes.
- Covering the landfill contents with an engineered RCRA cap that consists of geosynthetic clay liner, 30-millimeter thick polyvinyl chloride geomembrane, and an 8-ounce nonwoven geotextile.
- Placing a 2-foot thick layer of cover soil consisting of soil from the on-site borrow pit and soils from the existing south berm road.
- Hydroseeding the final cover system.

Appendix A includes details of the approximate location of each type of waste within the WSI at the time of closure (see Figure A1 adapted from Parametrix [2004]); figures showing the final grading plan for the WSI after closure (Figure A2); a recent aerial photograph (Figure A3); plan view maps with cross section locations (A4 and A5), and geologic cross sections of the WSI (Figures A6–A8).

Soil samples has not been collected from beneath the WSI to delineate the potential soil contamination for WSI leaching. However, historical groundwater monitoring associated with the WSI has included some or all of the following: analysis of pH, conductivity, total organic carbon, sulfate, fluoride, chloride, sodium, iron, manganese, free cyanide, total cyanide, and total phenols. The Closure and Post-Closure Plan monitoring well locations include MW-8A, MW-10A, MW-12A, MW-14A, MW-3B, and MW-18. Sample results identified fluoride, chloride, sulfate, and cyanide as chemicals that had affected groundwater in the area of the WSI and thus became the main analytes monitored since closure. Groundwater characterization is discussed in Section 3.2, Exposure Media and Transport Pathways.

6.1.2 West Spent Pot Liner Storage Area (SWMU 14)

The West SPL, located immediately east of the WSI, was constructed in 1984 and consisted of a 6-inch concreate pad with containment walls (Figure 2-4). A drainage system was installed on the southern edge of the pad. Additional construction details are presented in the closure plan (CH2MHill 1988). The West SPL was used for all spent pot liner generated by the facility during its 4 years of use. Spent pot liner waste typically have high pH and contain fluoride and cyanide.

In 1988, the West SPL was closed in accordance with Washington State Solid Waste Regulations per an Ecology approved closure plan (CH2MHill 1988). The spent pot liner stockpile was regraded for closure, increasing the footprint outside of the concrete pad. Areas outside of the pad were lined with a 50 mil high density polyethylene geomembrane liner and protective soil. The enlarged footprint was capped with bedding material, a 50 mil high density polyethylene geomembrane, drains, and crushed rock. Groundwater monitoring around the West SPL commenced in 1990 per Ecology request (Tetra Tech 2015). Design drawing of the original construction are not available.

Closure monitoring consisted of samples collected at MW-6B, MW-11A, MW-16A, and MW-17A. Wells MW-6B and MW-11A for the following analytes: free cyanide, total cyanide, fluoride, sulfate, chloride, and sodium. Monitoring was conducted until 2008. During this time, total cyanide, free cyanide, fluoride and/or sulfate were detected at concentrations above MTCA Method B and maximum contaminant load (MCL) screening levels. Groundwater concentration spikes of total cyanide, fluoride, and sulfate in monitoring wells near the capped area were found in 1996. These observed increases were thought to be ponded water and potential leaching from the West SPL Ditch (CH2MHill 1996; Tetra Tech 2015). Further characterization of the groundwater is discussed in Section 6.2, Groundwater.

6.1.3 West Spent Pot Liner Ditch

In 2015, Ecology requested characterization of the ditch south of the West SPL (i.e., the West SPL Ditch) as it formerly contained a WSI scrubber slurry line (i.e., there is potential for historical piping that connects with the WSI) and there was some historical evidence of releases (Tetra Tech 2015) (Appendix J). Soil samples were collected in June 2016, November 2020, and May 2021 to determine if releases had occurred from the West SPL Ditch.

Soil sample results as detailed in the Final Draft RI are as follows (Tetra Tech 2022):

- Concentrations of carcinogenic poly aromatic hydrocarbons (cPAHs) exceed MTCA-derived soil screening level for protection of groundwater of 3.9 mg/kg as TTEC cPAH in 7 of 12 samples collected (Appendix J). PAHs exceeded terrestrial ecological screening levels for wildlife protection (1.1 mg/kg as high molecular weight [HMW] PAH) in 11 of 12 samples. Concentrations of HMW PAH (11.23 mg/kg) were detected above terrestrial ecologic screening levels in one of two samples collected beneath the West SPL Ditch liner (WSPLD-WP-SS01-BL). No samples exceeded MTCA Method C screening levels.
- Fluoride was detected above the soil screening level for protection of groundwater of 147.6 mg/kg in 5 of 12 samples collected from the West SPL Ditch including the furthest downstream samples.
- Arsenic (15 mg/kg) and cadmium (2.5 J mg/kg) were detected above MTCA-derived soil screening levels for protection of groundwater and soil background concentrations in the initial RI sample collected from the mouth of the West SPL Ditch (AIA-Ditch-HA-0.5). Selenium (maximum of 1.6 J mg/kg) was detected above terrestrial ecological screening levels for wildlife protection in 3 of 12 samples.
- PCBs, specifically Aroclor 1254, were detected below MTCA screening levels at a concentration of 0.014 mg/kg.
- Residual-range organics were detected at or above the MTCA Method A Industrial total petroleum hydrocarbon-screening level of 2,000 mg/kg in 2 of 10 samples.

6.2 Groundwater

The Smelter PLPs completed quarterly groundwater sampling as part of the site-wide RI in 2017 for sulfate, fluoride, cyanide, PAHs, VOCs, petroleum hydrocarbons, and metals. Investigation results are in Appendix I and the key findings within the vicinity of the are summarized below.

- Fluoride, sulfate, and/or cyanide were detected at concentrations above screening levels in monitoring wells within and adjacent to the Project Area during all four quarters of sampling in 2017 as follows:
    - UA wells with fluoride concentrations above screening levels in all four quarters of 2017: MW-12A, MW-17A.
    - UA wells with sulfate concentrations above screening levels in all four quarters of 2017: MW-14A, RI-GW1, MW-12A, MW-10A.

  - UA wells with Cyanide concentrations above screening levels in all four quarters of 2017: MW-6B, MW-15A.
  - BAU wells with sulfate concentrations above screening levels in all four quarters of 2017: MW-3B, MW-18, RI-MW3-BAL.
  - BAL wells with sulfate concentrations above screening levels in all four quarters of 2017: RI-MW20-BAL.

- VOCs, PAHs, and petroleum hydrocarbons were not detected above screening levels in these same monitoring wells.
- Arsenic (both total and dissolved fractions) was detected at MW-14A above the MCL (i.e., 0.01 mg/L) during all four quarters of sampling. The MCL is above the site-specific groundwater background for arsenic that was calculated at 0.0069 mg/L.
- Aluminum was detected at well RI-MW20-BAL (29 mg/L) above the MTCA Method B groundwater screening levels in the total fraction during the baseline sampling round. Aluminum was not detected in the dissolved fraction. During subsequent sampling rounds, aluminum was not detected above screening levels.
- Lead was detected at well RI-MW20-BAL (maximum of 0.048 mg/L) above the MTCA Method A screening level in the total fraction during the first and second quarters. Lead was not detected above screening levels in the dissolved (field-filtered) fraction.

These groundwater monitoring results indicate that VOCs, PAHs, and petroleum hydrocarbons are not a concern for the groundwater. Currently, in accordance with the WSI Closure Plan (Parametrix 2004), the Smelter PLPs monitor wells associated with the WSI (MW-8A, MW-3B, MW-10A, MW-12A, MW-14A, MW-18) through annual sampling for sulfate, fluoride, chloride, and total cyanide.

6.3 Columbia River Sediments

The Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) includes a detailed summary of background information about the Columbia River Sediments AOC, past environmental sediment studies, and investigations. The Columbia River Sediments AOC field investigation was conducted in April 2016 in accordance with the Ecology-approved Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Additional bioassay sampling was conducted in August 2018 to address Yakima Nation and Ecology comments.

Investigation results are present in Appendix L and the key findings are summarized below (Tetra Tech 2022):

- No organics, including total PAHs, total PCBs, or TPHs were detected in sediments above available Washington State SMS screening levels.
- Although no SMS freshwater criteria are available specifically for cPAHs, Ecology requested additional consideration of these compounds to better assess potential human health concerns. As such, total cPAH concentrations were screened directly against associated 90/90 UTL reference values.
- No detections of any chemicals above the SMS cleanup screening level were reported.
- Only cadmium at three locations slightly exceeded the SMS sediment cleanup objective and associated 90/90 UTL reference concentration. It is noted that cadmium is not uniquely related to smelter plant operations. Tier 2 sampling locations successfully bounded the area potentially related to the exceedances.

- Cyanide was detected in one sample, SED15, at 11 mg/kg. Cyanide was not detected in any of the reference sample locations or any of the other sediment sampling locations.
- Fluoride was detected above the 90/90 UTL reference concentration of 7.7 mg/kg at six locations, with the highest concentration of 12 mg/kg at SED18.
- Sulfate was detected above the 90/90 UTL reference concentration of 278 mg/kg at 10 locations with the highest concentrations of 4,700 and 1,900 mg/kg at SED17 and SED18.
- Many detections above screening criteria are adjacent to or within the Boat Basin. Also, many of these detections were from stations characterized by finer grained silty sands and elevated total organic carbon percentages.
- The area surrounding the NPDES outfall and associated diffuser showed limited impacts to sediment, with only a few relatively low-level detections of cPAHs above the associated 90/90 UTL reference concentration.

A summary of the 2018 bioassay testing results includes:

- Overall, for all three tests, the laboratory sand control samples met the control performance standards for each of the tests and end-point measurements (mortality and growth).
- The reference sediment samples submitted for testing met the reference performance standard for each of the tests and end-point measurements.
- All the sediment samples submitted for the three bioassay tests passed their respective criteria for each end-point compared to the reference samples.

Additional information supporting these results are in Volume 5, Appendix C-4 of the Final Draft RI (Tetra Tech 2022).

The Final Draft RI results for the Columbia River Sediments AOC suggests that sediment quality has not been significantly impacted above relevant screening levels from past aluminum smelter operations, or from other potential non-site related historical or ongoing sources. These findings are generally consistent with results from past investigations of sediments in the Columbia River and Boat Basin near the subject site (Tetra Tech et al. 2015a).

The bioassay test results indicate that the Columbia River sediments adjacent to the site met the SMS sediment cleanup objective and cleanup screening level criteria for acute and chronic survival and chronic sub-lethal biological assessments and do not exhibit a toxic response for fresh water benthic organisms. The results of the sediment chemistry testing combined with the results of the bioassay testing for the Columbia River Sediments AOC indicate that no further investigation or cleanup action is warranted for sediment.

6.4 Historical Wetlands

The overall objective of the wetland’s sampling program was to characterize the nature and extent of surface soil contamination in wetland designated areas (Tetra Tech 2022). In addition to historical smelter emissions, surface soil in the wetland’s areas could also potentially have been impacted by runoff or groundwater discharges (Tetra Tech 2022).

Four wetland investigations were previously performed at the site. In 2013, the Smelter PLP’s completed field classification of the wetland areas, was an investigation of soil types and groundwater conditions at the largest wetland (Wetland D) located west of former production area of the plant, and characterization of wetland water quality (PGG 2013). In 2019 and 2022, ERM completed delineation of wetlands in the Project Area and in locations adjacent to the Lower Reservoir that lead to reclassification of historic wetlands (i.e., identified in the Smelter PLP's 2013 field classification) A, B, C, D, and H as non-wetland areas (ERM 2023; see Appendix H).

PAH concentrations exceeded the ecological soil screening level for wildlife protection of 1.1 mg/kg as total HMW PAHs at several wetland locations. At Wetland K[1], soil samples exceed MTCA Method B screening levels of 0.1 mg/kg for TTEC cPAHs that were used for screening levels in this open-space zoned area.

The wetland's AOC will be included in the CGA FS based the soil chemical results from Wetlands D, E, G, H, I, J, K, and L. Investigation results are present in Appendix E and the key findings are summarized below.

- Off-site contaminants, only low concentrations selenium (maximum of 1.4 mg/kg) that exceeded terrestrial ecological soil screening level for wildlife protection of 0.3 mg/kg were detected in soils at Wetlands F and M.
- At historical Wetland D, elevated PAH, arsenic, and sulfate soil concentrations in soil coincide with former location of the Duck Pond on the eastern side of the wetland (Tetra Tech 2022).

The wetland sediments will be addressed with the wetland AOC as part of the CGA FS. The spring on the western edge of historical Wetland D, Spring 6, is considered connected with groundwater and is discussed in the following section.

6.5 Springs

The objective of the spring sampling was to identify potential pathways between the groundwater, wetlands/historical wetlands, and springs through spring contaminant characterization. The springs were sampled during WPA field mobilization in early April 2021 as well as RI sample results collected at Spring 1 and the North of the East Surface Impoundment wetland during initial RI investigation (Appendix F). Springs 6 and 7 appear to be associated with the groundwater and Project Area (Figure 2-4); Spring 6 is considered connected with the UA and Spring 7 is considered to be connected with the BAL (Appendix C). Previous investigation results for Spring 6 and 7 are summarized below (Tetra Tech 2022).

- Fluoride was detected above groundwater screening levels at Spring 6 (Appendix F). Concentrations of fluoride were of similar magnitude as detections in the UA monitoring wells upgradient of the spring (Appendix I).
- Sulfate exceeded the secondary MCL of 250 mg/L only at Spring 7, the spring/dug well near the former Cliffs town site (Spring 7). The sulfate concentration did not exceed the screening level for adverse health effects for cattle (calves) of 500 mg/L. Concentrations of sulfate in the spring are of similar magnitude to those concentrations detected in BAL monitoring well RI-MW20-BAL (Appendix I).
- Arsenic exceeded the MTCA Method B groundwater screening at Springs 6 and 7 in both total and field-filtered samples. At the Cliffs spring (Spring 7), total arsenic concentrations (maximum of 0.00443 mg/L) exceeded both the MTCA Method C and site-specific background concentrations; however, the dissolved (field-filtered) sample of similar concentration did not exceed the site groundwater background concentration for dissolved arsenic. The sample was also below the MTCA Method A groundwater screening level for arsenic of 0.005 mg/L that takes into account state groundwater background arsenic concentrations.

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[1] Wetland K was not included in the additional study area evaluated by ERM in 2022.

- The PAH spring results do not exceed the MTCA Method B surface water screening level of 3.5°x°10-2 micrograms per liter benzo(a)pyrene equivalent concentration.
- PCBs were not detected in spring samples collected from Wetland K (not in the Project Area), historic Wetland D, or the North of the East Surface Impoundment wetland.
- Diesel-range organics and residual-range organics were not detected in the eight spring samples analyzed for petroleum hydrocarbons.

These results indicate that PAHs, PCBs, and petroleum hydrocarbons are not a concern for the springs. Spring 6 and 7 are considered part of the groundwater and will be addressed accordingly with the selected remedy.

6.6 Data Quality

The Smelter PLPs conducted soil and groundwater investigations, as described in the CGA Smelter Site Final Draft RI (Tetra Tech 2022). A Field Sampling Plan and Quality Assurance Plan were included in the Final RI Phase 2 Work Plan that described sampling procedures and data quality assurance (Tetra Tech 2015). Sufficient data has been collected to move forward with characterization of the contamination within and related to the Project Area.

7. NATURE AND EXTENT OF CONTAMINATION WITHIN THE PROJECT AREA

The WSI is the only SWMU that is within the Project Area; however, the West SPL and West SPL Ditch are immediately adjacent to the east (Figure 7-1). Other components for the Project will not be located on the CGA Smelter Site historical operation areas or SWMUs.

The following sections describe the contaminated media within and associated to the Project Area.

7.1 Soil

There is a potential soil-to-groundwater pathway for aluminum, arsenic, cyanide, fluoride, lead, and sulfate on the downgradient side of the WSI, considering the known groundwater contamination in the vicinity of the WSI and the history of the area (i.e., the WSI is a former source to groundwater prior to its closure). The groundwater monitoring results indicate that VOCs, PAHs, and petroleum hydrocarbons are not a concern for the soil-to-groundwater pathway as they have not been observed in the groundwater. However, the soil COC list was expanded beyond the known groundwater contamination analytes since samples have not yet been collected beneath the WSI (Table 5-1 from the Final Draft RI).

There are no known areas of contaminated soil associated with the CGA Smelter Site within the Project Area outside of the WSI footprint. Analytical soil samples were not taken during the 1988 well installation. If there is soil contamination outside of the WSI but within the Project Area, it is minimal (i.e., expected below the cleanup levels protective of groundwater) since separate plumes have not been observed nor are there any additional know sources. This serves as a line of evidence that potential soil contamination is associated with the WSI and/or West SPL.

The West SPL Ditch was modified, lined, and repaired in 1996 and 1997 (CH2MHill 1996, 1997) (Figure 7-1; Appendix J). There is potential that the WSI slurry lines released to the unlined West SPL Ditch during earlier operations. Soil contamination identified in the West SPL Ditch (i.e., outside of the Project Area) will be addressed with the site-wide remedy by verifying what portion of the West SPL Ditch is lined and determining the amount of potentially impacted soil in the area. Fluoride and PAHs were the constituents most frequently over the screening levels in the West SPL Ditch soil samples. Groundwater results in the area indicate that fluoride may have leached into the groundwater near the West SPL Ditch, but not PAHs. The West SPL Ditch will be addressed by the Smelter PLPs in the site-wide FS.

7.2 Groundwater

The CGA Smelter Site groundwater monitoring well network within and adjacent to the Project Area consists of 14 monitoring wells. Nine of the WSI monitoring wells within the Project Area are screened in the UA (Section 2.5.3.2 for description of groundwater zones). Two wells (MW 2B and MW-7B) are screened in the BAU (Figure 7-1). MW-18 is screened in the BAU downgradient of WSI and outside the Project Area. The West SPL monitoring network has four wells (MW-6B, MW-11A, MW-16A, and MW-17A). Historically the WSI GW monitoring network has consisted of six monitoring wells (MW-12A, MW-14A, MW-18, MW-8A, MW-3B, and MW-10A) with additional wells (RI-GW1, RI-MW-BAL, and RI-MW20-BAL) added during the remedial investigation to supplement the dataset.

The typical depth to groundwater in the Project Area is 14 to 28 feet below the ground surface, depending on the well locations and seasonal fluctuations (i.e., approximately 2 feet). The depth to groundwater beneath the WSI varies by area of the WSI. The WSI does not penetrate the groundwater table. As shown on Figure A4 of Appendix A, the base of the WSI was approximately 10 to 15 feet above the water table in the unconsolidated deposits.

Groundwater flow in the uppermost aquifer in the Project Area is generally southwestward toward the Columbia River. Appendix I, show groundwater elevations in the unconsolidated deposits and the upper basalt in the Project Area, as measured in 2018.

As previously mentioned, monitoring data reported in the RI prepared by the Smelter PLPs (Tetra Tech 2019) and recent monitoring data (GeoPro 2021) indicate groundwater concentrations of fluoride and sulfate are consistently above screening levels in downgradient of the WSI (Appendix J). Aluminum, arsenic, cyanide, and lead have been detected at concentrations above screening levels but below cleanup levels (CULs) with limited frequency at select monitoring wells in this same area. VOCs, PAHs, and petroleum hydrocarbons have not been detected in this area.

The CGA Smelter Site western plume (i.e., comprising groundwater within and adjacent to the Project Area) within and downgradient of the WSI, was split out from the larger groundwater AOC to focus on the groundwater impacted within and downgradient of the Project Area and (the Western Groundwater Area of Concern [GW AOC]; Figure 7-1).The western GW AOC was delineated based on detections of sulfate and fluoride at concentrations that exceed proposed CULs in the UA, BAU, and BAL downgradient of the WSI. Figure 7-1 delineates the known or projected extents of the following:

- Fluoride/sulfate in the UA
- Sulfate in the BAU and BAL
- Fluoride in Spring 6 / Wetland D and sulfate in Spring 7

Site contaminants have migrated downward from the UA to the BAU and BAL. Migration is attributed to the interconnectedness of the UA and BAU and the vertical gradient (Section 2.3.3, Geohydrology). In the Final Draft RI (Tetra Tech 2022), migration of contaminates along faulting was not noted in the western GW AOC (e.g., Spring 1, Wetland F).

7.3 Summary

Contamination within and adjacent to the Project Area is related to the historical SWMUs and conveyance features (WSI, West SPL, and the West SPL Ditch). The surface and subsurface soil contaminants have contributed to groundwater contamination and associated impacts to Springs 6 and 7. Accordingly, remedial actions evaluated in the sections below are focused on identifying appropriate technology combinations to address residual soil contamination such that there is no longer a source to groundwater and consequently the springs.

8. REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) have been developed to address contamination within the Project Area as detailed in the following sections.

8.1 Applicable Relevant and Appropriate Requirements

WAC 173-340-710 provides that MTCA cleanup actions must comply with applicable state and federal laws. Potentially applicable federal, state, and local laws that may apply during the implementation of remedial actions at the site are summarized in Table 8-1. Ecology will confirm the listed applicable relevant and appropriate requirements and/or amend if needed.

8.2 Constituents of Concern

The selection of COCs was based on the evaluation of the nature and extent of contamination data presented in the Final Draft RI (Tetra Tech 2022), potential risks to human health and the environment (identified in the Final Draft RI), and ARARs. COCs are detailed in Tables 8-2 and 8-3 and summarized in the following sections.

8.3 Proposed Cleanup Levels

Remedial actions must comply with cleanup standards set forth in WAC 173-340-700 through 173-340-760. Cleanup standards include CULs for site COCs, the point of compliance (i.e., location where these CULs must be met), and other regulatory requirements that potentially apply to the site due to the remedial action type and/or site location. Cleanup standards are based on federal and state primary or secondary MCLs. Detailed rationales for the selection of COCs and CULs are presented in the Data Assessment Memorandum (Weston 2022a) and the Final Draft Feasibility Study (Weston 2024) and summaries are presented in the sections below.

8.3.1 Soil Cleanup Levels

Soil CULs are protective of groundwater, human health, surface water and consistent with MTCA. Protection of groundwater is a level calculated to protect groundwater from the soil-to-groundwater leaching pathway. Protection of human health CULs are based on MTCA Method B direct contact cleanup levels (for unrestricted use), and MTCA Method C cleanup levels (for industrial use). For the site contaminants that pose a potential for impacts to ecological receptors, soil concentrations were established to protect wildlife, as appropriate, for SWMUs and AOCs not meeting criteria (Weston 2024).

- Proposed Cleanup Levels: Soil CULs protective of groundwater and human direct contact consistent with the Final Draft RI (Table 8-2). The lowest soil CUL (most protective) will be used.
- Soil COCs beneath the WSI are based on groundwater results: Aluminum, arsenic, cyanide, fluoride, lead, and sulfate.
  - The cleanup level of 2,150 mg/kg for sulfate is proposed for protection of groundwater (Tetra Tech 2022).
  - The cleanup level of 148 mg/kg for fluoride is proposed for the protection of groundwater based on the screening level calculated in the Final Draft RI (Tetra Tech 2022) for the protection of groundwater using site-specific data. The protective soil concentration was derived based on the groundwater screening level concentration of 0.96 mg/L, a soil/water Kd value of 153 liters per kilogram, and a dilution factor of 1 (Tetra Tech 2022).

  - TTEC PAHs did not exceed the state and federal primary MCL of 0.2 microgram per liter in wells sampled during the RI (Tetra Tech 2022). Because the groundwater data for TTEC PAHs do not indicate significant impacts at the site, PAHs are not selected as soil COCs based on the protection of groundwater (Weston 2024).

8.3.2 Groundwater Cleanup Levels

The Weston Draft Feasibility Study identified groundwater screening levels as drinking water MCLs, MTCA Method A formula values, or secondary MCLs (Weston 2024). Groundwater at this site is considered a potential source of drinking water in this RI/FS as that represents its highest beneficial use consistent with MTCA requirements.

- Groundwater COCs for the Western AOC: fluoride and sulfate.
- Proposed CULs:
  - The cleanup level for fluoride is set at the MTCA Method B CUL of 0.96 mg/L (Table 8-3).
  - The cleanup level for sulfate is set at the secondary MCL of 250 mg/L (Table 8-3).

Groundwater COCs may be added pending results of soil samples beneath the WSI (e.g., multiple detections of a constituent in soil samples that is above the soil CULs from beneath the WSI may warrant addition to the COC list). Soil results will be shared with Ecology and the PLPs with recommendations for additional groundwater COCs following completion of WSI excavation and confirmation sampling.

8.4 Identify Remedial Action Objectives

The RAOs are the primary objectives for selecting a site-specific cleanup action consistent with MTCA. These objectives are identified according to the following requirements:

1. Select a remedial alternative that is compatible with constructing the Project, consistent with the Detailed Proposal, and meets the requirements of the Order and the Smelter PLPs.
2. Project construction is not negatively impacting the plume and facilitates successful implementation of the remedial alternative.
3. Comply with applicable state and federal regulation for site cleanup, health and safety, and waste management.
4. Ensure that the remedial designs and actions comply with state and federal solid waste and hazardous waste management, closure, and post-closure requirements.
5. Protect human health and the environment from risks related to COCs in soil and groundwater at SWMUs and AOCs.
6. Attain cleanup standards meeting the requirements specified in MTCA.
7. Reduce or eliminate migration and discharge of groundwater COCs to the springs and wetlands.
8. Reduce or eliminate potential leaching of constituents in soil-to-groundwater at concentrations that would exceed groundwater CULs.
9. Reduce concentrations of WSI-related constituents in groundwater to risk-based concentrations in the western GW AOC and at the point of compliance over time.

The RAOs for the CGA Smelter Site environmental impacts within the Project Area are provided in the following sections. The Smelter PLPs are conducting an FS to assess remedial actions for the remaining areas with contaminated media at the CGA Smelter Site.

8.4.1 Soil Remedial Action Objectives

Based on the COCs, potential migration and exposure pathways, and potential risks to human health and the environment, the following RAOs were developed for soil within the Project Area:

- Human Health—Industrial Reuse
  - Limit contact (i.e., dermal contact, inhalation, ingestion) with the COCs exceeding CULs in soil, sediments, and wastes for potential industrial receptors (for areas with continued industrial use; the Projects lower reservoir falls within this category).
- Human Health—Unrestricted Reuse
  - Limit contact (i.e., dermal contact, inhalation, ingestion) with the COCs exceeding CULs for potential residential receptors (for areas zoned for open-space owned by other parties).
  - Attain CULs protective of unrestricted land use for areas with extensive agriculture and open-space zoning owned by other parties (e.g., US Army Corps of Engineers lands).
- Groundwater Protection
  - Reduce or eliminate potential sources of groundwater contamination.

8.4.2 Groundwater Remedial Action Objectives

Based on the COCs, potential migration and exposure pathways, and potential risks to human health and the environment, the following RAOs were developed for groundwater within the western GW AOC:

- Limit contact of potential industrial users with the groundwater COCs exceeding CULs, including ingestion and direct contact.
- Prevent groundwater COCs exceeding CULs for surface water protection from impacting the springs.

The Weston Final Draft Feasibility study identifies the groundwater RAOs (Weston 2024).

9. TECHNOLOGY SCREENING

Technologies were identified based on the impacted soil and groundwater within the Project Area and western GW AOC. These technologies are identified and evaluated in Table 9-1 according to the following criteria:

- Effectiveness—The ability to contain and control or treat the site contaminants and meet RAOs.
- Implementability—The relative complexity (technical and administrative feasibility) of implementing the technology.
- Relative Cost—General estimate (low, moderate, and high) of capital and operations and maintenance cost based on vendors, cost-estimating guides, and prior projects.
- Compatibility with the Project—The technology's compatibility with constructing the Project.

Technologies retained from Table 9-1 are as follows:

- Institutional controls
- Excavation and off-site disposal of WSI waste and impacted soil beneath in the WSI
- In-situ soil stabilization (ISS) of impacted soil beneath the WSI
- Monitored natural attenuation (MNA) with contingency
- Groundwater Extraction and Treatment
    - Ex-situ Groundwater Treatment (ion exchange or reserve osmosis)
    - Discharge of Treated Water to NPDES Ponds

These retained technologies were combined to develop remedial action alternatives as described in the following sections.

10. DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES

Section 10, Description of Remedial Action Alternatives, and Section 11, Screening of Remedial Alternatives, of this report describe remedial action alternatives for removing the WSI and addressing underlying impacted soil and impacted groundwater in the GW AOC where COC concentrations are greater than the proposed CULs (Tables 8-2 and 8-3).

10.1 Approach to Remedial Action Alternatives

This section describes remedial actions applicable to the Project Area. As agreed by Ecology in its comments on the Detailed Proposal, this FS focuses on remedial alternatives within the Project Area that are compatible with the Project and necessary to address wastes in the WSI, underlying soils in the Project Area, the western GW AOC.

The Applicant coordinated with the Smelter PLPs on the screening and evaluation of remedial alternatives for soil and groundwater in the Project Area. The western plume was split out from the larger GW AOC to focus on the groundwater impacted within and downgradient of the Project Area. Groundwater impacts at Spring 6 and Spring 7 are assumed to be connected to this plume and are addressed by the alternatives in this FS. The Smelter PLPs are conducting a site-wide FS to assess remedial actions for site-wide groundwater as detailed the Weston Final Draft Feasibility Study (Weston 2024). It should be noted that managing the risks associated with groundwater and Springs 6 and 7 is outside of the Applicant's scope of responsibility. Remedial actions being considered for groundwater and Springs 6 and 7 are presented in the site-wide FS (Weston 2024). This documents presents the current understandings of the site-wide FS, as requested by Ecology.

10.2 Remedial Action Alternatives

The contents of the WSI, the bottom liner, the RCRA cover system, and the landfill ventilation system are incompatible with the Project. Therefore, the Applicant intends to remove the WSI contents and piping systems in order to safely construct the Lower Reservoir. Furthermore, the Final License Application for the Project (FFP 2020) indicated that the base of the Lower Reservoir would be at an elevation that is at or near the water table of the uppermost groundwater aquifer in the Lower Reservoir footprint. Therefore, construction of the Lower Reservoir will require removal and off-site disposal of the WSI in its entirety, as well as remediation of some potentially impacted soils in the vadose zone beneath the bottom liner of the WSI. As explained in Section 2.6, Project Construction Environmental Considerations, the costs for removing soils beneath the WSI for constructing the Lower Reservoir and associated dewatering are not included in the costs for any of the remedial alternatives. The remedial alternatives focus on the activities for addressing contaminated media.

Remedial action alternatives considered for the Project Area are combinations of institutional controls, excavation and off-site disposal of waste in the WSI and impacted soil beneath the WSI, ISS of impacted soil beneath the WSI, groundwater extraction, and MNA with contingency. All alternatives will include routine monitoring that demonstrate concentration trends and/or system performance. Remedial alternatives are summarized in Table 10-1 and described below:

- Alternative 1: Excavation of WSI, MNA with Contingency, and Institutional Controls
- Alternative 2: Excavation of WSI, Groundwater Extraction and Treatment, Institutional Controls
- Alternative 3: Excavation of WSI and soil below WSI liner with concentrations of COCs above CULs, MNA, and Institutional Controls

- Alternative 4: Excavation of WSI and soil below WSI liner with concentrations of COCs above CULs, Groundwater Extraction and Treatment, Institutional Controls
- Alternative 5: ISS, MNA, and Institutional Controls
- Alternative 6: ISS, Groundwater Extraction and Treatment, Institutional Controls

All alternatives include excavation of the WSI and decommissioning and replacement of groundwater monitoring wells in the Project Area (Section 6.2). Replacement wells will be downgradient of the Lower Reservoir and the former WSI. The Applicant will develop a plan to decommission and replace groundwater monitoring wells. The number and location of replacement wells will be determined in consultation with Ecology and the Smelter PLPs to meet the requirements of a CAP for the CGA Smelter Site.

10.2.1 Alternative 1: Excavation of WSI, MNA with Contingency, and Institutional Controls

Alternative 1 consists of excavating the WSI, groundwater MNA, and application of institutional controls to groundwater use and springs. All excavated materials will be sampled for waste designation purposes and transported to an off-site landfill for disposal in accordance with applicable state and federal regulations.

10.2.1.1 WSI Excavation

As described in Section 6.1.1, West Surface Impoundment, the capped WSI consists of a landfill ventilation system, a bottom liner of two layers of 15-millimeter thick Hypalon, waste materials from the WSI, an engineered RCRA cap, and a 2-foot thick layer of cover soil.

Excavation of WSI consists of excavating the WSI and components. Excavated materials will be sampled for waste designation purposes and transported to an off-site landfill for disposal in accordance with applicable state and federal regulations. Confirmation soil sampling will be conducted below the WSI bottom liner, and/or other soil in the immediately adjacent area to the WSI to support assessment of potential for residual impacts of COCs to be managed via a groundwater monitoring program and institutional controls as described in the section below. If historical piping connecting the WSI to the West SPL Ditch is discovered during excavation activities, the piping will be capped and surveyed. Observations of contamination outside the Project Area will be disclosed to Ecology and the Smelter PLPs.

The following earthwork quantities were estimated based on the available information on the cap and liner systems (Parametrix 2004).

- Engineered RCRA cover system: 32,300 in-place cubic yards
- Waste material disposed in the WSI: 89,000 in-place cubic yards
- Bottom liner system: 16,100 cubic yards

To the extent practicable, the vegetative cover material component of the RCRA cover system will be removed and staged for reuse since those materials were not in direct contact with the WSI contents. The proposed excavation depth is to elevation 420 feet AMSL within the reservoir footprint. It is assumed that all of the soil between the bottom liner and the proposed excavation depth is contaminated and must be disposed of off-site. The WSI excavation is not expected to penetrate groundwater or encounter bedrock, as interpreted from Appendix A and summarized in Section 6.1.1.

10.2.1.2 MNA with Contingency

WAC 173-340-200 defines natural attenuation as “a variety of physical, chemical or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of hazardous substances in the environment. These in-situ processes include: natural biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of hazardous substances.”

As discussed in Section 6.2, the lining system may be compromised, resulting in releases and impacts to soil and groundwater below the WSI. Groundwater monitoring results downgradient of the WSI indicate that concentrations in most wells are decreasing or stable despite the presence of the WSI (Appendix J). Effects of natural attenuation (i.e., decreased concentrations) are anticipated to be more prevalent after removal of the WSI which is a potential ongoing source to groundwater contamination. The Weston Final Draft Feasibility Study identifies proposed points of compliance for groundwater, included select springs (Weston, 2024). Groundwater monitoring for COCs (fluoride and sulfate) in the western GW AOC will be conducted to confirm concentration reductions following WSI source removal. Conditional groundwater Points of Compliance will be at Spring 6 and Spring 7.

A long-term monitoring plan will be developed in conjunction with the Cleanup Action Plan when the basis, scope, and frequency of monitoring will be determined. Remedial actions being considered in the site-wide FS (Weston 2024) include establishing a monitoring well network. The monitoring plan will be reassessed and updated as necessary in conjunction with five-year reviews. During each five-year review, trend analysis will be performed for fluoride and sulfate in groundwater and assess the remedy effectiveness. If necessary to achieve groundwater RAOs, evaluation of contingency measures will be triggered. It is expected than a minimum of 10 years of data collection after remedy implementation will be required to evaluate trends and remedy effectiveness. (Weston 2024).

The Weston Draft Final Feasibility Study states that post-remedy implementation activities will include reporting the findings to Ecology and if necessary, a focused feasibility study will be performed to evaluate appropriate additional remedial actions at the site. Potential additional remedial actions that would be considered include refined stormwater management, additional soil removal, and hydraulic containment.

10.2.1.3 Institutional Controls

WAC 173-340-440 defines institutional controls as “measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or cleanup action or that may result in exposure to hazardous substances at a site.” By this definition, institutional controls are applicable only at sites and under conditions where residual contamination remains and where exposure is possible. Such non-engineered measures may include fences, use restrictions, environmental covenant, or signage.

Institutional controls would include restrictions (e.g., restrict livestock watering and/or human consumption at springs) or procedures to limit exposure to residual contaminated soil or groundwater after the WSI is removed. For example, the institutional controls at the springs would eliminate exposure to ecological (cattle) and human receptors at those locations. The covenant would be executed by the property owner and recorded with the register of deeds for Klickitat County.

10.2.2 Alternative 2: Excavation of WSI, Groundwater Extraction and Treatment, and Institutional Controls

Alternative 2 consists of excavation of the WSI, groundwater extraction and treatment (GWET), and the same institutional controls described in Alternative 1.

10.2.2.1 Groundwater Extraction and Treatment

The groundwater extraction and treatment program will use existing wells to extract and/or contain impacted groundwater at locations with elevated COC concentrations (see Figure 10-1). The six proposed extraction well locations in the western GW AOC are anticipated to produce up to 60 gallons per minute, on average 10 gallons per minute per well. Extracted groundwater will be directed to an on-site groundwater treatment plant to be constructed in the main plant area. This groundwater treatment plant would be sized to treat the groundwater extracted site-wide and not solely from the western GW AOC.

As described in the Final Draft Feasibility Study (Weston 2024), the groundwater treatment plant would consist of the following: an aeration tank to oxidize scaling chemicals, disinfection to inhibit bacteria growth using sodium hypochlorite, ultrafiltration membrane to remove suspended solids and reduce sulfate concentration, and nanofiltration (used in costing) or reverse osmosis. A treatability study would be performed to determine selection of the membrane system and the design parameters. Treated water would be discharged to the NPDES Ponds. It is estimate that the groundwater extraction system would need to operate for up to 10 years.

Approximately 20 percent to 40 percent of the influent volume would result in reject liquid. This liquid would be collected, characterized, and transported off-site for disposal. For FS costing purposes, it was assumed that 40 percent reject liquid would be generated and sent to a Subtitle D landfill for disposal.

10.2.3 Alternative 3: Excavation of WSI and Soil above CULs, MNA with Contingency, and Institutional Controls

Alternative 3 consists of excavating the WSI and assumed over-excavation of 15-feet or to the groundwater table beneath 20 percent of the WSI footprint. This alternative assumes that soil borings will be installed following excavation of the WSI and liner to determine the remaining extent of COCs in soil with concentrations above the proposed CUL (i.e., soil-to-groundwater pathway). All excavated materials will be sampled for waste designation purposes and transported to an off-site landfill for disposal in accordance with applicable state and federal regulations. The groundwater remediation in Alternative 3 consists of MNA with contingency and institutional controls as described in Alternative 1.

10.2.3.1 WSI Excavation and Over-excavation

This excavation consists of excavating the WSI and removing all impacted soil beneath the WSI with concentrations higher than soil CULs below the WSI liner. For costing purposes, this excavation assumes that concentrations of COCs are above the soil CULs in an area of 20 percent the WSI footprint to a depth of 15 feet below the WSI liner. Excavated materials will be sampled for waste designation purposes and transported to an off-site landfill for disposal in accordance with applicable state and federal regulations. Confirmation soil sampling will be conducted below the WSI bottom liner to support assessment of locations where soil is remaining above CULs to determine where additional excavation is required.

The following earthwork quantities were estimated based on the available information on the cap and liner systems (Parametrix 2004).

- Engineered RCRA cover system: 32,300 in-place cubic yards
- Waste material disposed in the WSI: 89,000 in-place cubic yards
- Bottom liner system: 16,100 cubic yards
- Over-excavation: 48,400 cubic yards

To the extent practicable, the vegetative cover material component of the RCRA cover system will be removed and staged for reuse since those materials were not in direct contact with the WSI contents. The proposed excavation depth is 2 feet below the bottom of the WSI waste and liner system. It is assumed that all of the soil between the bottom liner and the proposed excavation depth is contaminated and must be disposed of off-site. The excavation is not expected to penetrate groundwater or encounter bedrock, as interpreted from Appendix A and summarized in Section 6.1.1; however, if either bedrock or groundwater is encountered, excavation will stop. If historical piping connecting the WSI to the West SPL Ditch is discovered during excavation activities, the piping will be capped and surveyed. Observations of contamination outside the Project Area will be disclosed to Ecology and the Smelter PLPs.

The cost estimate for Alternative 3 is based on the volumes and depths listed above.

10.2.4 Alternative 4: Excavation of WSI and Soil above CULs, Groundwater Extraction, Treatment and Discharge, and Institutional Controls

Alternative 4 consists of the excavation presented in Alternative 3 (i.e., Excavation of WSI and Soil above CULs). The groundwater remediation in Alternative 4 consists of groundwater extraction, treatment, and discharge as described for Alternative 2, and the same institutional controls as described for Alternative 1.

10.2.5 Alternative 5: In-situ Stabilization, MNA with Contingency, and Institutional Controls

Alternative 5 consists of excavating the WSI and assumed in-situ stabilization of impacted soil beneath the WSI with COC concentrations higher than the CULs protective of groundwater to an assumed depth of 15 feet beneath 20 percent of the WSI footprint (Table 5-1 from the Final Draft RI). Excavated materials will be sampled for waste designation purposes and transported to an off-site landfill for disposal in accordance with applicable state and federal regulations. The groundwater remediation in Alternative 5 consists of MNA with contingency and institutional controls as described in Alternative 1.

10.2.5.1 In-situ Stabilization

Excavation will be completed using standard excavation and earth-moving equipment. In-situ stabilization will be completed using bucket or auger mixing. The following earthwork quantities were estimated based on the available information on the cap and liner systems (Parametrix 2004).

- Engineered RCRA cover system: 32,300 in-place cubic yards
- Waste material disposed in the WSI: 89,000 in-place cubic yards
- Bottom liner system: 16,100 in-place cubic yards
- In-situ stabilization: 48,400 in-place cubic yards

To the extent practicable, the vegetative cover material component of the RCRA cover system will be removed and staged for reuse since those materials were not in direct contact with the WSI contents. The proposed stabilization depth is 15 feet below the bottom of the WSI waste and liner system. It is assumed that up to 20 percent of the soil below the bottom liner is contaminated and must be stabilized. The remaining 80 percent of soil will remain in place without stabilization.

10.2.6 Alternative 6: In-situ Stabilization, Groundwater Extraction, Treatment and Discharge, and Institutional Controls

Alternative 6 consists of the ISS approach presented in Alternative 5 and groundwater extraction and treatment as described for Alternative 2. and the same institutional controls as described for Alternative 1.

11. SCREENING OF REMEDIAL ALTERNATIVES

This section summarizes the evaluation of the remedial alternatives described in the above section. MTCA identifies specific criteria against which alternatives are to be evaluated and categorizes them as "threshold" or "other" requirements. Remedial actions must at a minimum meet the threshold requirements. The other MTCA requirements are considered when selecting from the alternatives that fulfill the threshold requirements. If an alternative does not meet these criteria, it should be eliminated from further consideration according to WAC 173-340-360(2).

Alternatives that meet the threshold and other requirements are further assessed using the disproportionate cost analysis (DCA) criteria to determine the most permanent solution that is cost effective (i.e., maximum feasible permanence).

11.1 Threshold Requirements

Threshold requirements required for cleanup actions are defined in WAC 173-340-360(2)(a). Requirements include protection of human health and the environment, compliance with MTCA cleanup standards and applicable state and federal laws, and provisions for compliance monitoring. Alternatives 3 through 6 meet the MTCA threshold requirements as described in the following sections.

11.1.1 Protect Human Health and the Environment

Protectiveness is defined as the degree to which human health and the environment are protected by a given alternative, including risk reduction and the length of time required to meet cleanup standards.

Alternatives 2 through 6 eliminate or reduce the human and groundwater exposure pathways by removing and transporting off-site waste in the WSI and by preventing exposure to soil and groundwater with COC concentrations above the CULs. Alternative 1 does not address groundwater due to potentially leaving soil in place above CULs and not implementing active groundwater treatment (i.e., there may be a remaining source to groundwater that limits effectiveness of MNA).

11.1.2 Comply with Cleanup Standards

Cleanup standards, CULs, and the points of compliance, are established in WAC 173-340-700 through 173-340-760.

Alternatives 3 through 6 comply with soil cleanup standards by removing and permanently disposing of and/or stabilizing with ISS for soil with COC concentrations above the CULs. These alternatives comply with groundwater cleanup standards by treating (through MNA, groundwater extraction and treatment and/or containment) groundwater with COC concentrations above the CULs (Tables 8-2 and 8-3). Alternatives 1 and 2 do not meet these criteria as they potentially leave soil in place above CULs.

11.1.3 Comply with Applicable State and Federal Laws

Applicable or relevant and appropriate requirements are defined in WAC 173-340-710. Local, state, and federal laws related to environmental protection, health and safety, transportation, and disposal apply.

The alternatives will comply with all applicable relevant and appropriate requirements, which are summarized in Table 8-1.

11.1.4 Provide for Compliance Monitoring

The alternative must provide for compliance monitoring, as established under WAC 173-340-410 and WAC 173-340-720 through 173-340-760. There are three types of compliance monitoring: protection, performance, and confirmational. Protection monitoring is designed to protect human health and the environment during the construction and operations and maintenance phases of the cleanup action. Performance monitoring confirms that the cleanup action has met cleanup and/or performance standards. Confirmational monitoring confirms the long-term effectiveness of the cleanup action once cleanup standards have been met or other performance standards have been attained.

All alternatives would meet requirements for compliance monitoring, as they require varying levels of all three types of compliance monitoring as described in Section 10.2, Remedial Action Alternatives.

The Applicant will prepare a compliance monitoring plan to describe confirmation sampling of the WSI excavation to document that the excavation achieves the soil CULs. The Smelter PLPs will develop and implement groundwater compliance monitoring at the CGA Smelter Site, including the western GW AOC, in accordance with requirements of the Order.

11.2 Other Requirements

11.2.1 Provide for a Reasonable Restoration Timeframe

The restoration timeframe analysis can consist of qualitative estimates of the restoration timeframe for alternatives. Under MTCA, evaluation of a reasonable restoration timeframe considers potential implementation risks, practicality of a reduced restoration time, current and future land use, and likely effectiveness of institutional controls, among other factors (WAC 173-340-360(4)).

The timeframe for mitigating direct contact exposure and groundwater pathway from impacted soil is up to 2 years as the WSI excavation, excavation of soil above CULs, and/or ISS will occur in a continuous sequence.

For groundwater, the groundwater restoration timeframes for Alternatives1, 3, and 5 are anticipated to be longer than Alternatives 2, 4, and 6 since active groundwater remediation is not included in Alternatives 1, 3, and 5. However, the restoration timeframes for Alternative 3 and 5 will be shorter than Alternative 1 since the potential source material will be removed and/or stabilized.

11.2.2 Use of Permanent Solutions to the Maximum Extent Practicable

When selecting a remedial action, preference shall be given to permanent solutions to the maximum extent practicable. To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, the DCA shall be used. The analysis shall compare the costs and benefits of the cleanup action alternatives evaluated in the Feasibility Study (WAC 173-340-360(3)).

This requirement is addressed by assessing cost and benefits of each alternative through the DCA evaluation as described in Section 11.5, DCA Alternatives Evaluation.

11.2.3 Consider Public Concerns

Provide a narrative regarding whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns (WAC 173-340-360(2)(b)(iii)).

This requirement is assessed as part of the DCA evaluation in Section 11.5.

11.3 Alternatives Retained for Detailed Evaluation

Based on the screening results from the initial media-specific alternatives (focused on soil/waste and groundwater), alternatives retained for detailed analysis are summarized in Table 11-1 and detailed below:

- Alternative 3: Excavation of WSI and Soil above CULs, MNA, and Institutional Controls
- Alternative 4: Excavation of WSI and Soil above CULs, GWET, and Institutional Controls
- Alternative 5: ISS, MNA, and Institutional Controls
- Alternative 6: ISS, GWET, and Institutional Controls

Alternatives 1 and 2 did not meet threshold and/or other requirements and were not retained for detailed analysis.

11.4 Evaluation Criteria for Remedial Alternatives

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

A DCA was conducted for alternatives that meet the threshold requirements (i.e., Alternatives 3 through 6) as described in Section 11.1, Threshold Requirements. The alternatives are compared by evaluating the following criteria: protectiveness, permanence, cost, effectiveness over the long-term, management of short-term risks, technical and administrative implementability, and consideration of public concerns. These evaluation criteria are defined below.

- Protectiveness: Overall protectiveness of human health and the environment.
- Permanence: The permanence of a cleanup action is measured by the degree to which it permanently reduces the toxicity, mobility, or volume of hazardous substances.
- Cost: The cost to implement the alternative. Includes present capital costs, future capital costs, indirect costs, and operation and maintenance costs.
- Effectiveness over the long-term: Effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the restoration timeframe, the magnitude of residual risk with the alternate.
- Management of short-term risks: Short-term risks consider the degree to which human health and the environment are protected during construction and implementation of an alternative. Standard BMPs are expected to be implemented to manage potential risks to human health and the environment.
- Technical and administrative implementability: An alternative’s technical and administrative implementability includes the following considerations:
  - Whether the alternative is technically possible
  - Availability of necessary facilities, services, and materials
  - Administrative and regulatory requirements
  - Scheduling
  - Size and complexity of the alternative
  - Monitoring requirements
  - Access for construction and monitoring
  - Integration of existing operations with the cleanup action
- Consider public concerns: Provide a narrative regarding whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns.

The cost and benefits of the retained alternatives were evaluated using the DCA criteria in the following section.

11.5 DCA Alternatives Evaluation

The alternatives evaluated in this RI/FS are ranked from most to least permanent, based on the evaluation of the alternatives under WAC 173-340-360(3)(f) and the definition of permanent solution in WAC 173-340-360(3)(c) (Table 10-2). Some estimates were quantitative (e.g., cost); however, most were qualitative (i.e., ranked on a scale of 1 to 10) and required the use of best professional judgment.

An initial baseline alternative, which is the alternative with highest degree of permeance, was first identified (i.e., Alternative 4). Each alternative was then compared stepwise to the baseline (e.g., baseline compared to next most permanent, next most permanent compared to the second most permanent, etc.).

A total weighted benefits score is obtained for each alternative by multiplying the six non-cost scores by their corresponding weighting factors (i.e., 30 percent protectiveness, 20 percent permanence, 20 percent effectiveness over the long-term, 10 percent management of short-term risks, 10 percent technical and administrative implementability, and 10 percent consideration of public concerns) and summing the weighted values. The total weighted benefits score of each alternative is divided by the alternative’s estimated cost to obtain a benefit/cost ratio, which is a relative measure of the cost effectiveness of the alternative.

The alternative with the highest benefit/cost ratio is considered permanent to the maximum extent practicable and is selected as the preferred cleanup action alternative. The DCA is summarized in Table 11-6 and detailed in the following sections.

11.5.1 Protectiveness

All alternatives include removing waste in the WSI. The WSI removal will be protective of human health and the environment since WSI waste will be excavated and transported for off-site disposal. The waste removal will eliminate a potential source of impacts to groundwater. Each of the alternatives incorporate institutional controls, if required by the presence of residual contamination, to protect human health and the environment by restricting property access and requiring actions to be implemented for future construction activities.

Excavation of the WSI and soil above CULs (Alternatives 3 and 4) includes excavation beneath the WSI bottom liner to remove soil with COCs exceeding CULs. This alternative is protective of human health and the environment since the likely source of impacts to groundwater (the WSI) will be removed along with likely contaminated soil beneath the liner. The excavation aims to remove all contaminated soil beneath the WSI to the extent practical and includes confirmation sampling. Removal of the additional soil will prevent further leaching of contaminates through stormwater infiltration or contact with the groundwater. Additionally, the future use of the site includes a concrete-lined reservoir, providing further protection to human health and the environment through protection from direct contact and inhalation within the footprint of the Lower Reservoir.

The ISS alternatives (Alternatives 5 and 6) include stabilization of soil beneath the WSI bottom liner that has concentrations of COCs above CULs. These alternatives are considered less protective relative to the excavation alternatives since the contamination is not removed rather stabilized in place. ISS is expected to have slightly longer durations to achieve CULs (i.e., potential for some continued leaching in short-term).

Alternatives with MNA (Alternatives 1, 3 and 5) are considered to be less protective than alternatives with GWET due to the expected longer time to achieve CULs in groundwater and at the springs.

11.5.2 Permanence

Excavation and off-site disposal will permanently remove the WSI source, thereby removing associated toxicity and the leachability transport as a contamination source to groundwater. Implementation of GWET will remove COCs in groundwater and promote desorption from saturated soil thereby reducing potential for future rebound of dissolved concentrations of COCs (i.e., relative to MNA). Accordingly, Alternative 4 is considered the most permanent remedial alternative. Alternatives with ISS were scored lower than alternatives with excavation due to the soil COCs remaining in place (although being rendered insoluble).

11.5.3 Cost

Cost estimates for alternatives retained for detailed analysis are provided in Tables 11-2 through 11-5. The cost estimates include costs for remedial alternative design, construction, and operations and maintenance through the expected duration of the alternative. The cost estimate does not include past costs (e.g., to develop the RI/FS), costs for confirmation sampling, Ecology oversight costs, or legal costs. The costs presented reflect feasibility study-level estimates and assume a range of uncertainty of -30 percent to +50 percent. Cost estimates ranged from $27.5 to $32.8 million in 2023 Net Present Value.

11.5.4 Effectiveness over the Long-Term

Alternative 4 was scored most effective over the long-term due to the combination of removal of soil with concentrations above CULs and GWET. ISS options were scored lower than excavation due to contaminants remaining in place.

11.5.5 Management of Short-term Risks

Standard BMPs are expected to be implemented to manage potential short-term risks to human health and the environment.

Excavation and off-site disposal present short-term risks, due to material handling, high volumes of off-site truck traffic, and potential for transport of contaminants via erosion during rain events. The short-term risks are manageable by implementing safe work practices, a transportation plan, and an erosion and sediment control plan. To satisfy WAC 173-340-520(1)(h)(iii), excavation work will be monitored as required by Ecology and dictated by best practices for minimizing generation of dust and in protecting the public and environment during the excavation and load-out process. The specific suite of BMPs addressing short-term risks will be developed and submitted to Ecology for review as part the Remedial Design documents.

Short-term risks associated with ISS include worker safety/potential exposure to contaminated media, dust and erosion control, and ISS equipment operation. Alternatives with ISS were scored similar to alternatives with excavation for short-term risks.

GWET is expected to have higher short-term risks relative to MNA due to the need for installation of conveyance and treatment infrastructure.

11.5.6 Technical and Administrative Implementability

Excavation and off-site disposal are technically feasible. Commonly used construction and excavation equipment and well drilling services are readily available. A permitted landfill that will accept the WSI waste is located nearby. The excavation and disposal will be conducted in accordance with local, state MTCA, and federal RCRA regulatory requirements and applicable or relevant and appropriate requirements.

The proposed excavation process is not expected to be complex. Existing access roads will accommodate equipment required for excavation, construction, drilling, and transportation. Access to the WSI and Lower Reservoir site is planned from the existing John Day Dam Road using approximately 0.7 mile of existing access roads to the aluminum smelter. Access to the Upper Reservoir site is planned from Hoctor Road, using approximately 8.6 miles the existing access roads for the existing Tuolome Wind Project Authority wind farm (HDR 2020). There are no ongoing operations at the Facility. The Applicant will coordinate fieldwork with the Smelter PLPs and regulatory agencies.

Alternatives with ISS and GWET are considered to be less implementable than alternatives with excavation and MNA due to those options requiring additional technical design elements and permitting.

11.5.7 Consider Public Concerns

Ecology considers public concerns by making draft copies of RI/FS and remedial decision documents available for review and comment and by evaluating and responding to comments received on the remedial alternatives (WAC 173-340-360). Previous comments received by Yakama Nation on the draft RI/FS and public comments received on the Applicants 401 Water Quality Certification Application indicate there is general concern over groundwater, nearby drainages, and soil contamination remaining in place. Accordingly, there was little variation between alternatives with alternatives which treat groundwater being scored slightly higher than those with MNA (i.e., while groundwater is extracted and treated, there is expected to be concern over discharge). Additionally, while ISS immobilizes contaminants in the subsurface, higher concern is expected for these alternatives relative to excavation, which removes contaminants.

11.5.8 DCA Summary

As detailed in Table 11-6, the total weighted benefit score ranged from 6.3 for Alternative 5 to 8.5 for Alternative 4. The benefit/cost ratios for the cleanup action alternatives are presented at the far right column and on Figure 11-1. Alternative 3 has the highest benefit/cost ratio (0.26), followed by Alternative 5 (0.24), and Alternative 4 (0.23).

12. RECOMMENDED ALTERNATIVE

The recommended alternative is Alternative 3 because it is permanent to the maximum extent practicable, as determined by the DCA. Alternative 3 consists of (1) excavation and off-site disposal of the waste in the WSI and soil below the liner, (2) implementing MNA, (3) implementing institutional controls, and (4) performing compliance monitoring. Implementation of this remedial action alternative will address the RAOs for the Project Area.

Additionally, the contents of the WSI, the liner, the RCRA cover system, and the gas venting system are incompatible with engineering requirements to construct the Lower Reservoir of the Project. The selected remedial action alternative will be further documented in the forthcoming CAP and PPCD.

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TABLES

Table 8-1

Applicable or Relevant and Appropriate Requirements (ARARs)
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Jurisdiction	Summary of ARARs	
State of Washington Regulations	Ch. 173- 340 WAC	MTCA soil and groundwater cleanup levels and cleanup levels based on estimates of the reasonable maximum exposure.
	Ch. 18.104 RCW & Ch. 173-160 WAC	Establishes minimum standards for the construction and decommissioning of all wells in the state of Washington.
	Ch. 173-162 WAC	Rules & Regulations Governing the Licensing of Well Contractors & Operators
	Ch. 173-303 WAC	Dangerous Waste Management
	Ch. 173-304 WAC	Solid Waste Handling Standards
	Ch. 70A.300 RCW	Establishes framework for planning, regulation, control, and management of hazardous waste.
	Ch. 70.105D RCW	Hazardous Waste Cleanup Model Toxics Control Act.
	Ch. 173-340 WAC	MTCA Cleanup Regulation
	Ch. 70A.205 RCW	Solid Waste Management - Reduction and Recycling
	Ch. 173-350 WAC	Solid Waste Handling Standards
	Ch. 43.21C RCW	State Environmental Policy Act
	Ch. 49.17 RCW	Washington Industrial Safety and Health Act requires employers to maintain work practices and work environments which do not endanger health and safety of employees.
	Ch. 197-11 WAC	SEPA Rules
	Ch. 70.94 RCW and Ch. 70A.15 RCW	Washington Clean Air Act - Regulates Air Emissions and Fugitive Dust
	Ch. 70.119A RCW & Ch. 246-290 WAC	Establishes MCLs for drinking water
	Ch. 43.21A RCW	General Regulations for Air Pollution
	Ch. 90.48 RCW	Establishes NPDES permit requirements for discharging pollutants into water of the United States
	Ch. 173-400 WAC	General Regulations for Air Pollution Sources
	Ch. 173-460 WAC	Controls for New Sources of Air Pollution
	Ch. 173-470 WAC	Ambient Air Quality Standards for Particulate Matter
Federal Regulations	29 CFR 1910	Occupational Safety and Health Act
	36 CFR 800	National Historic Preservation Act
	42 USC 6921-22	Identification and Listing of Hazardous Waste
	42 USC 7401	Clean Air Act of 1977
	40 CFR 50	National Ambient Air Quality Standards
	40 CFR 141	Drinking Water Regulations
	40 CFR 260-268	Hazardous Waste Regulations (RCRA)
	50 CFR Part 17	Endangered Species Act
County Regulations	KCMC, Title 8, Chapter 8.14	Solid Waste Handling
	KCMC, Title 15, Chapter 15.04	State Building Code - Establishes Building Demolition Requirements

Notes:
ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act
RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
TESC = Temporary Erosion and Sediment Control
USC = U.S. Code
WAC = Washington Administrative Code
NPDES = National Pollutant Discharge Elimination System
KCMC = Klickitat County Municipal Code

Table 8-2

Proposed Soil Cleanup Levels
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Analyte	Proposed Cleanup Level (mg/kg)	Basis for Cleanup Level	Risk to Construction Workers (mg/kg)	Basis for Cleanup Level
Aluminum	480,000	Protection of Groundwater	3,500,000	MTCA Method C
Arsenic	0.67	Protection of Groundwater	88	MTCA Method B
Cyanide (Free)[a]	5.9	Protection of Groundwater	2,100	MTCA Method C
Fluoride[b]	148	Protection of Groundwater	210,000	MTCA Method C
Sulfate[c]	2,150	Protection of Groundwater	NE	MTCA Method B
Lead	3,000	Protection of Groundwater	NE	MTCA Method C
Total TEC cPAH (calc)	0.2	Protection of Groundwater	130	MTCA Method C
Cadmium	0.69	Protection of Groundwater	3,500	MTCA Method C
Selenium	5.2	Protection of Groundwater	18,000	MTCA Method C

Notes:
mg/kg = milligrams per kilogram
MTCA = Model Toxics Control Act
WAC = Washington Administrative Code
TEC cPAH = Toxicity Equivalent Concentration Carcinogenic Polycyclic Aromatic Hydrocarbon
NE = Not established
a = Cyanide soil screening levels for protection of groundwater based on literature distribution coefficient, MTCA Method B groundwater
b = Fluoride soil screening level for protection of groundwater based on empirical demonstration consistent with WAC 173-340-747.

c = Sulfate screening level for protection of groundwater based on literature distribution coefficient, secondary MCL, and fixed parameter three-phase partitioning model

Table 8-3
Proposed Groundwater Cleanup Levels
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Analyte	Proposed Cleanup Level (mg/L)	Basis for Cleanup Level
Fluoride	0.96	MTCA Method B
Sulfate	250	WA MCL

Notes:
mg /L = micrograms per liter
MTCA = Model Toxics Control Act
WA MCL = Washington Maximum Contaminant Level

Table 9-1
Technology Screening Table
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Remediation Technology	Description	Implementability	Effectiveness	Relative Cost	Compatible with Project?	Screening Comments	Technology Retained?
Soil[1]							
Institutional Controls	Physical or legal restriction that limit exposure or interference with cleanup.	Technically implementable.	Reliable administrative measures.	Negligible capital cost. Low O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Soil Removal[1]	Removal of impacted soil using excavation techniques. Excavated soil will be treated on site or sent off site for disposal.	Technically implementable.	Effective as contaminated soil would be removed and disposed of off site.	Moderate to high capital cost. No O&M cost.	Yes	Compatible with the Project because the WSI waste will be removed. Cost highly dependent on excavation depth. Multiple depths will be proposed.	Yes
Offsite Disposal	Disposal of impacted soil at an offsite, lined, permitted landfill.	Technically implementable. Impacted soil requires profiling and meet land disposal requirements.	Effective for contaminants in/around WSI.	Moderate to high capital cost. No O&M cost.	Yes	Effective for contaminants in/around WSI.	Yes
Ex Situ Treatment	Treatment of excavated soil by enhancing biodegradation through modification of soil conditions (e.g., heat, surfactants, microbes).	Limit space in Project Area for ex situ treatment. May require leachate or off-gas collection and treatment.	Effective for most contaminants (i.e., not fluoride) in/around WSI.	Moderate to high capital cost and O&M cost.	No	Limit space in Project Area for ex situ treatment. Incompatible with Project as removed soil would need to be replaced in a shorter time frame than available from technology	No
Horizontal Barrier	Low permeability barriers meant to reduce infiltration and downward contaminant migration.	Difficult to implement. Not implementable in BAU.	Possibly effective for portions of the UA outside of the Lower Reservoir footprint. However, does not provide treatment.	Moderate to High capital cost. High O&M cost.	Possibly in the UA, outside of Project Area	Difficult to implement. Possibly feasible in portions of the UA outside of the Lower Reservoir footprint, not feasible in the BAU.	No
Capping	Installation of a surface cap over impacted groundwater areas to minimize water infiltration and mobilization of contaminants.	NA. Already implemented. Soil alternatives assume WSI removal has already occurred; capping would not be implementable.	NA	NA	No	Already implemented and incompatible with Project as WSI needs to be removed for construction.	No
In-situ Solidification/Stabilization	Mix soil with binding agent to turn soil into low-permeability blocks. Stabilization also causes chemical reactions to transform contaminants into less-mobile forms.	Technically implementable	Effective as contaminants will be immobilized.	Moderate to high capital cost. No O&M cost.	Yes	Stabilization would occur primarily below the reservoir. Coordination with geotechnical engineers for reservoir design would be necessary. Bench test would be needed before implementation.	Yes
Groundwater							
Institutional Controls	Physical or legal restriction that limit exposure or interference with cleanup.	Technically implementable.	Reliable administrative measures.	Negligible capital cost. Low O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Monitored Natural Attenuation with Contingency[2]	Naturally occurring physical, chemical, and biological processes that reduce contaminant mobility or concentration. Groundwater monitoring will demonstrate COC concentration reductions in groundwater over time after removal of potential source area (i.e., WSI). Includes contingent hydraulic containment at Springs 6 and 7 if elevated concentrations presist. CAP will outline this process in detail.	Technically implementable. Cleanup time may be longer than other remediation technologies.	Effective for contaminants amenable to the natural attenuation process (i.e., fluoride). Attenuation for sulfate would be dilution/dispersion only (i.e., not chemical or biological).	Negligible capital cost. Low O&M cost.	Yes	Additional monitoring and modeling may be required to demonstrate mechanism of attenuation. Applicable in combination with other technologies.	Yes
Vertical Barrier Wall	Low permeability barriers meant to retard groundwater flow and reduce contaminant migration.	Technically implementable; however, difficult due to basalt, hill slope, and reservoir foot print (i.e., barrier wall height of < 40 feet and 100 to 400 ft upgradient of the WSI). Requires management of groundwater upgradient of and inside barrier.	Established technology for reducing contaminant migration. However, does not provide treatment.	Moderate to High capital cost.	No	Does not provide treatment. Not compatible with reservoir project because the tunnels would need to penetrate the barrier wall. Difficult to implement due to basalt, hill slope, and reservoir foot print (i.e., barrier wall height of < 40 feet and 100 to 400 ft upgradient of the WSI).	No
Permeable Reactive Barriers	Permeable reactive barriers remove contaminants from groundwater through chemical and biological means as groundwater flows through the barriers.	Technically implementable. Adequate hydraulic characterization would be necessary. Installation into the basalt interflow would be challenging.	Established technology for in-situ treatment of groundwater. However, treatment Moderate for some of the COCs is not well established. For example, bench and pilot testing of zero-valent iron (ZVI) for sulfate treatment would be necessary.	High capital cost. Low to Moderate O&M cost.	Yes	Substantial additional hydraulic characterization and bench testing would be necessary to develop a remedy. Installation in basalt interflow is cost prohibitive.	No
Groundwater Extraction / Hydraulic Containment	Extracting contaminated groundwater through wells for ex-situ treatment and/or provide hydraulic containment of contaminant plume.	Technically implementable.	Established technology for controlling contaminant migration and removing contaminants from groundwater.	High capital cost and high O&M cost.	Yes	Established technology. Potentially high cost.	Yes

Ex-situ Treatment - Electrocoagulation	Treatment of groundwater through contaminated groundwater flows through an electrolytic cell containing aluminum or iron/aluminum anodes after it is extracted prior to reinjection/discharge.	Technically implementable. Pilot testing may be necessary as it is a relatively new technology. Sludge created from treatment process would require disposal.	Relatively new technology but has been shown to be effective for fluoride and sulfate through recent studies (Maleki et al., 2015; Mamelkina et al. 2019). Selected interim action for treating arsenic and fluoride at Kaiser Mead (Kaiser Mead 2019).	Moderate capital cost. Moderate to High O&M cost.	Yes	Technically implementable. Pilot testing will be necessary as it is a relatively new technology.	No
Remediation Technology	**Description**	**Implementability**	**Effectiveness**	**Relative Cost**	**Compatible with Project?**	**Screening Comments**	**Technology Retained?**
Groundwater							
Ex-situ Treatment - Ion Exchange	Treatment of groundwater through a resin bed after it is extracted prior to reinjection/discharge.	Technically implementable. Different resins may be required for each COC. Groundwater pH adjustments may be required prior to treatment. Disposal of concentrate will be required.	Effective for sulfate and fluoride.	Moderate capital cost. Moderate to High O&M cost.	Yes	Established technology.	No
Ex-situ Treatment - Reverse Osmosis	Treatment of groundwater through membrane vessels.	Technically implementable. Disposal of concentrate will be required.	Effective for sulfate and fluoride	Moderate capital cost. Moderate to High O&M cost.	Yes	Established technology.	Yes
Ex-situ Treatment - Bioremediation	Treatment of groundwater through a biological vessels.	Technically implementable. Disposal of sludge and frequent O&M would be required.	Effective for sulfate. However, effectiveness varies as treatment is microbial dependent. Microbes and vessel conditions can easily fluctuate.	Moderate capital cost. Moderate to High O&M cost.	Yes	Frequent O&M difficult for a more remote location.	No
Ex-situ Treatment - Pond Evaporation	Evaporation of extracted groundwater using passive solar ponds.	Technically implementable. Limited space in Project Area. Disposal of concentrate will be required.	Effective for treatment of sulfate.	Low to moderate capital cost. Low O&M cost.	No	Established technology. Typically less concreate than reserve osmosis.	No
Ex-situ Treatment - Nanofiltration	Treatment of groundwater through film composite membranes.	Technically implementable. Concentrated COCs from treatment process would require disposal.	Effective for sulfate and fluoride.	Moderate capital cost. Moderate to High O&M cost.	Yes	Established technology.	Yes
Discharge Treated Water to NPDES Ponds	Discharging treated water to the NPDES Pond in plant area.	Technically implementable. Current NPDES permit already associated with ponds.	Effective for disposal of treated groundwater.	Low capital cost. Low O&M cost.	Yes	Established technology.	Yes
Reinjection of Treated Water	Reinjecting treated water upgradient of the groundwater extraction wells or trenches.	Technically implementable.	Effective and established technology. Reinjection of treated groundwater may mobilize precipitated fluoride.	Moderate capital cost. Low O&M cost.	Yes	Established technology. Reinjection of treated groundwater may mobilize precipitated fluoride.	No
Discharge Treated Water to Columbia River	Discharging treated water to the Columbia River.	Technically implementable. Would require NPDES permit and conveyance to river.	Effective for disposal of treated groundwater.	Low capital cost. Low O&M cost.	Yes	Will require a NPDES permit. Potential water quality concerns.	No

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Maleki et al., 2015. Influence of selected anions on Fluoride removal in electrocoagulation/ electroflotation. Research Report, Fluoride 48(1)23–33, January-March 2015

Mamelkina et al. 2019. Systematic study on sulfate removal from mining waters by electrocoagulation, Separation and Purification Technology, Volume 219. Pages 43-50.

1 = Soil Remediation technologies assume that WSI waste has already been removed. Removal of the WSI waste is mandatory for construction of the lower reservoir.

2 = Hydraulic containment would be considered as a contingency measure only if spring water samples continueto show elevated concentrations (compared to the ecological threshold) in 5 years afterimplementing the associated alternative. Additional details provided in report text.

Notes:
CAP = Cleanup Action Plan
COC = constituent of concern
NPDES = National Pollutant Discharge Elimination System
O & M = operation and maintenance
WSI = West Surface Impoundment

Table 10-1
Alternatives Summary
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Remedial Alternative	Excavation of WSI[1]	Excavation of Soil below WSI[2]	ISS[3]	MNA[4]	GWET[5]	Institutional Controls[6]
1	X			X		X
2	X				X	X
3	X	X		X		X
4	X	X			X	X
5	X		X	X		X
6	X		X		X	X

Notes:

[1] = Consists of excavating the WSI.

[2] = Consists of excavating the WSI and assumed over-excavation of 15-feet or to the groundwater table beneath 20 percent of the WSI footprint to remove all soil above CULs.

[3] = Alternative 5 consists of excavating the WSI and assumed in-situ stabilization of impacted soil beneath the WSI with COC concentrations higher than the CULs protective of groundwater to an assumed depth of 15 feet beneath 20 percent of the WSI footprint.

[4] = Groundwater monitoring for COCs (fluoride and sulfate) in the western GW AOC will be conducted to confirm concentration reductions following excavation. Conditional groundwater POCs will be at Springs 6 and 7. Hydraulic containment will be considered upgradient of the springs as a contingency measure only if spring water samples continue to show elevated fluoride and sulfate concentrations in 5 years after implementing the remedy.

[5] = The groundwater extraction and treatment program will use existing wells to extract and/or contain impacted groundwater at locations with elevated COC concentrations. Extracted groundwater will be directed to an on-site groundwater treatment plant to be constructed in the main plant area.

[6] = Institutional controls would include restrictions (e.g., restrict livestock watering and/or human consumption at springs) or procedures to limit exposure to residual contaminated soil or groundwater after the WSI is removed.

GWET = Groundwater Extraction and Treatment
ISS = in situ stabilization
MNA = monitored natural attenuation
WSI = West Surface Impoundment

Table 11-1
Retained Alternatives
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Remedial Alternative		**Threshold Requirements**				**Other Requirements**			
		Overall Protection of Human Health and the Environment	**Compliance with Clean up Standards**	**Compliance with ARARs**	**Provide for Compliance Monitoring**	**Provide a Reasonable Restoration Timeframe**	**Use of Permanent Solutions**	**Consider Public Concerns**	**Alternative Retained for Detailed Analysis**
1	**Excavation Option 1, MNA with Contingency, and Institutional Controls**	**No** Does not address groundwater	**No** Does not address soil above CULs	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	**No** Does not address groundwater	**No**
2	**Excavation Option 1, Groundwater Extraction and Treatment, Institutional Controls**	Yes Meets Threshold Criteria	**No** Does not address soil above CULs	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	**No**
3	**Excavation Option 2, MNA with Contingency, and Institutional Controls**	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes
4	**Excavation Option 2, Groundwater Extraction and Treatment, Institutional Controls**	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes
5	**In-situ Stabilization (ISS), MNA with Contingency, and Institutional Controls**	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes
6	**ISS, Groundwater Extraction, Treatment and Reinjection, and Institutional Controls**	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes Meets Threshold Criteria	Yes

Notes:

▨ Shaded cells are not retained for detailed analysis.
WSI = West Surface Impoundment
ISS = in situ stabilization
MNA = monitored natural attenuation

Table 11-2

Alternative 3: Excavation Option 2, MNA with Contingency, and Institutional Controls
Goldendale Aluminum West Surface Impoundment Excavation
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Line Item	Unit	Quantity	Unit Price	Total Cost
Excavation (WSI and soil below liner)				
Pre-construction Items				
Work plans, regulatory negotiation, design	EA	1	$200,000	$200,000
Site Preparation				
Mobilization	LS	1	$400,000	$400,000
Health and Safety	LS	1	$120,000	$120,000
Erosion and Sediment Control	LS	1	$50,000	$50,000
Dust and Odor Control	LS	1	$400,000	$400,000
Development of Contractor Staging Area	LS	1	$100,000	$100,000
Abandonments of Existing Groundwater Monitoring Wells	EA	15	$4,000	$60,000
Temporary Facilities	LS	1	$50,000	$50,000
Pre-Construction Survey	Ac	10	$15,000	$150,000
Impoundment Excavation and Restoration				
Excavation and Stockpiling of Cover System	CY	32300	$5	$162,000
Excavation and Stockpiling of Waste	CY	89000	$5	$445,000
Excavation and Stockpiling of Liner System	CY	16100	$5	$81,000
Over-excavation Beneath Liner System	CY	48400	$5	$242,000
Waste Classification	EA	307	$2,000	$614,000
Transport of Excavated Material to Commercial Landfill	Ton	199550	$35	$6,984,000
Disposal of Excavated Material in Commercial Landfill	Ton	199550	$65	$12,971,000
Replacement of Cover Soils within Excavation	CY	32300	$5	$162,000
Grading and Stabilization of Excavation Area	Ac	10	$2,000	$20,000
Post-Construction Survey	Ac	10	$15,000	$150,000
Groundwater Monitoring Well Abandonment and Replacement				
Replace Groundwater Monitoring wells	EA	15	$20,000	$300,000
Construction Completion Report				
Construction Completion Reporting	EA	1	$50,000	$50,000
			Excavation Subtotal	***$23,711,000***
Monitored Natural Attenuation				
Compliance Monitoring and Reporting				
Semi-Annual Groundwater Monitoring	YR	10	$100,000	$1,000,000
Reporting	YR	10	$25,000	$250,000
			MNA Subtotal	***$1,250,000***
			Alternative 3 Subtotal	***$24,961,000***
			Management and administration (10%)	$501,000
			Contingency (15%)	$3,745,000
			Alternative 3 Total Cost	**$29,207,000**

Notes:

Ac = Acre

CY = Cubic Yard

EA= Each

LS = Lump Sum

MNA = monitored natural attenuation

Ton = Short Ton (2,000 pounds)

WSI = West Surface Impoundment

YR = Yearly

Table 11-3

Alternative 4: Excavation Option 2, Groundwater Extraction, Treatment and Discharge, and Institutional Controls
Goldendale Aluminum West Surface Impoundment Excavation
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Line Item	Unit	Quantity	Unit Price	Total Cost
Excavation (WSI and soil below liner)				
Work plans, regulatory negotiation, design	EA	1	$200,000	$200,000
Site Preparation				
Mobilization	LS	1	$400,000	$400,000
Health and Safety	LS	1	$120,000	$120,000
Erosion and Sediment Control	LS	1	$50,000	$50,000
Dust and Odor Control	LS	1	$400,000	$400,000
Development of Contractor Staging Area	LS	1	$100,000	$100,000
Abandonments of Existing Groundwater Monitoring Wells	EA	15	$4,000	$60,000
Temporary Facilities	LS	1	$50,000	$50,000
Pre-Construction Survey	Ac	10	$15,000	$150,000
Impoundment Excavation and Restoration				
Excavation and Stockpiling of Cover System	CY	32300	$5	$162,000
Excavation and Stockpiling of Waste	CY	89000	$5	$445,000
Excavation and Stockpiling of Liner System	CY	16100	$5	$81,000
Over-excavation Beneath Liner System	CY	48400	$5	$242,000
Waste Classification	EA	307	$2,000	$614,000
Transport of Excavated Material to Commercial Landfill	Ton	199550	$35	$6,984,000
Disposal of Excavated Material in Commercial Landfill	Ton	199550	$65	$12,971,000
Replacement of Cover Soils within Excavation	CY	32300	$5	$162,000
Grading and Stabilization of Excavation Area	Ac	10	$2,000	$20,000
Post-Construction Survey	Ac	10	$15,000	$150,000
Groundwater Monitoring Well Abandonment and Replacement				
Replace Groundwater Monitoring wells	EA	15	$20,000	$300,000
Construction Completion Report				
Reporting	EA	1	$50,000	$50,000
			Excavation Subtotal	***$23,711,000***
Groundwater Extraction and Treatment				
Installation				
Installation of Extraction Wells and Vaults	LS	3	$25,000	$75,000
Installation Wellheads, Programming/controls, Electrical	LS	3	$50,000	$150,000
Furnish and Place Piping	LF	6000	$1,000	$6,000,000
Treatment System	LS	1	$250,000	$250,000
Start up	LS	1	$25,000	$25,000
GWET O&M and Compliance Monitoring				
Groundwater Extraction System O&M	/year	5	$200,000	$1,000,000
Monthly Discharge Monitoring and Reporting (12 months)	/year	5	$60,000	$300,000
			GWET Subtotal	***$7,800,000***
Monitored Natural Attenuation				
Compliance Monitoring and Reporting				
Semi-Annual Groundwater Monitoring	YR	5	$100,000	$500,000
Reporting	YR	5	$25,000	$125,000
			MNA Subtotal	***$625,000***
			Alternative 4 Subtotal	***$32,136,000***
			Engineering, management, and administration (10%)	$3,214,000
			Contingency (15%)	$4,821,000
			Alternative 4 Total Cost	**$40,171,000**

Notes:
Ac = Acre
CY = Cubic Yard
EA= Each
LS = Lump Sum
MNA = monitored natural attenuation
Ton = Short Ton (2,000 pounds)
WSI = West Surface Impoundment
YR = Yearly

Table 11-4

Alternative 5: In-situ Stabilization, MNA with Contingency, and Institutional Controls
Goldendale Aluminum West Surface Impoundment Excavation
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

West Surface Impoundment Excavation and Stabilization

Line Item	Unit	Quantity	Unit Price	Total Cost
Excavation (WSI)				
Pre-construction Items				
Work plans, regulatory negotiation, design	EA	1	$200,000	$200,000
Site Preparation				
Mobilization	LS	1	$400,000	$400,000
Health and Safety	LS	1	$120,000	$120,000
Erosion and Sediment Control	LS	1	$50,000	$50,000
Dust and Odor Control	LS	1	$400,000	$400,000
Development of Contractor Staging Area	LS	1	$100,000	$100,000
Abandonments of Existing Groundwater Monitoring Wells	EA	15	$4,000	$60,000
Temporary Facilities	LS	1	$50,000	$50,000
Pre-Construction Survey	Ac	10	$15,000	$150,000
Impoundment Excavation and Restoration				
Excavation and Stockpiling of Cover System	CY	32300	$5	$162,000
Excavation and Stockpiling of Waste	CY	89000	$5	$445,000
Excavation and Stockpiling of Liner System	CY	16100	$5	$81,000
Waste Classification	EA	210	$2,000	$420,000
Transport of Excavated Material to Commercial Landfill	Ton	136630	$35	$4,782,000
Disposal of Excavated Material in Commercial Landfill	Ton	136630	$65	$8,881,000
Replacement of Cover Soils within Excavation	CY	32300	$5	$162,000
Grading and Stabilization of Excavation Area	Ac	10	$2,000	$20,000
Post-Construction Survey	Ac	10	$15,000	$150,000
Groundwater Monitoring Well Abandonment and Replacement				
Replace Groundwater Monitoring wells	EA	15	$20,000	$300,000
Construction Completion Report				
Report	EA	1	$50,000	$50,000
			WSI Excavation Subtotal	***$16,983,000***
In Situ Stabilization (ISS)				
ISS Implementation				
Material Ammendment Storage System	LS	1	$1,050,000	$1,050,000
InSitu Reagent Mixing	CY	48400	$35	$1,694,000
Ammendment: Cement (5% by Weight)	Ton	3146	$250	$787,000
			ISS Subtotal	***$3,531,000***
Monitored Natural Attenuation				
Compliance Monitoring and Reporting				
Semi-Annual Groundwater Monitoring	YR	10	$100,000	$1,000,000
Reporting	YR	10	$25,000	$250,000
			MNA Subtotal	***$1,250,000***
			Alternative 5 Subtotal	***$21,764,000***
			Management and administration (10%)	$1,657,000
			Contingency (15%)	$3,265,000
			Alternative 5 Total Cost	**$26,686,000**

Notes:

Ac = Acre
CY = Cubic Yard
EA= Each
LS = Lump Sum
MNA = monitored natural attenuation
Ton = Short Ton (2,000 pounds)
WSI = West Surface Impoundment
YR = Yearly

Table 11-5

Alternative 6: In-situ Stabilization, MNA with Contingency, and Institutional Controls
Goldendale Aluminum West Surface Impoundment Excavation
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Line Item	Unit	Quantity	Unit Price	Total Cost
Excavation (WSI)				
Work plans, regulatory negotiation, design	EA	1	$200,000	$200,000
Site Preparation				
Mobilization	LS	1	$400,000	$400,000
Health and Safety	LS	1	$120,000	$120,000
Erosion and Sediment Control	LS	1	$50,000	$50,000
Dust and Odor Control	LS	1	$400,000	$400,000
Development of Contractor Staging Area	LS	1	$100,000	$100,000
Abandonments of Existing Groundwater Monitoring Wells	EA	15	$4,000	$60,000
Temporary Facilities	LS	1	$50,000	$50,000
Pre-Construction Survey	Ac	10	$15,000	$150,000
Impoundment Excavation and Restoration				
Excavation and Stockpiling of Cover System	CY	32300	$5	$162,000
Excavation and Stockpiling of Waste	CY	89000	$5	$445,000
Excavation and Stockpiling of Liner System	CY	16100	$5	$81,000
Waste Classification	EA	210	$2,000	$420,000
Transport of Excavated Material to Commercial Landfill	Ton	136630	$35	$4,782,000
Disposal of Excavated Material in Commercial Landfill	Ton	136630	$65	$8,881,000
Replacement of Cover Soils within Excavation	CY	32300	$5	$162,000
Grading and Stabilization of Excavation Area	Ac	10	$2,000	$20,000
Post-Construction Survey	Ac	10	$15,000	$150,000
Groundwater Monitoring Well Abandonment and Replacement				
Replace Groundwater Monitoring wells	EA	15	$20,000	$300,000
Construction Completion Report				
Report	EA	1	$50,000	$50,000
			WSI Excavation Subtotal	***$16,983,000***
InSitu Stabilization				
ISS Implementation				
Material Ammendment Storage System	LS	1	$1,050,000	$1,050,000
InSitu Reagent Mixing	CY	48400	$35	$1,694,000
Ammendment: Cement (5% by Weight)	Ton	3146	$250	$787,000
			ISS Subtotal	***$3,531,000***
Groundwater Extraction and Treatment				
Installation				
Installation of Extraction Wells and Vaults	LS	3	$25,000	$75,000
Installation Wellheads, Programming/controls, Electrical	LS	3	$50,000	$150,000
Furnish and Place Piping	LF	6000	$1,000	$6,000,000
Treatment System	LS	1	$250,000	$250,000
Start up	LS	1	$25,000	$25,000
GWET O&M and Compliance Monitoring				
Groundwater Extraction System O&M	/year	5	$200,000	$1,000,000
Monthly Discharge Monitoring and Reporting (12 months)	/year	5	$60,000	$300,000
			GWET Subtotal	***$7,800,000***
Monitored Natural Attenuation				
Compliance Monitoring and Reporting				
Semi-Annual Groundwater Monitoring	YR	5	$100,000	$500,000
Reporting	YR	5	$25,000	$125,000
			MNA Subtotal	***$625,000***
			Alternative 6 Subtotal	***$28,939,000***
			Engineering, management, and administration (10%)	$2,894,000
			Contingency (15%)	$4,341,000
			Alternative 6 Total Cost	**$36,174,000**

Notes:

Ac = Acre

CY = Cubic Yard

EA= Each

LS = Lump Sum

MNA = monitored natural attenuation

Ton = Short Ton (2,000 pounds)

WSI = West Surface Impoundment

YR = Yearly

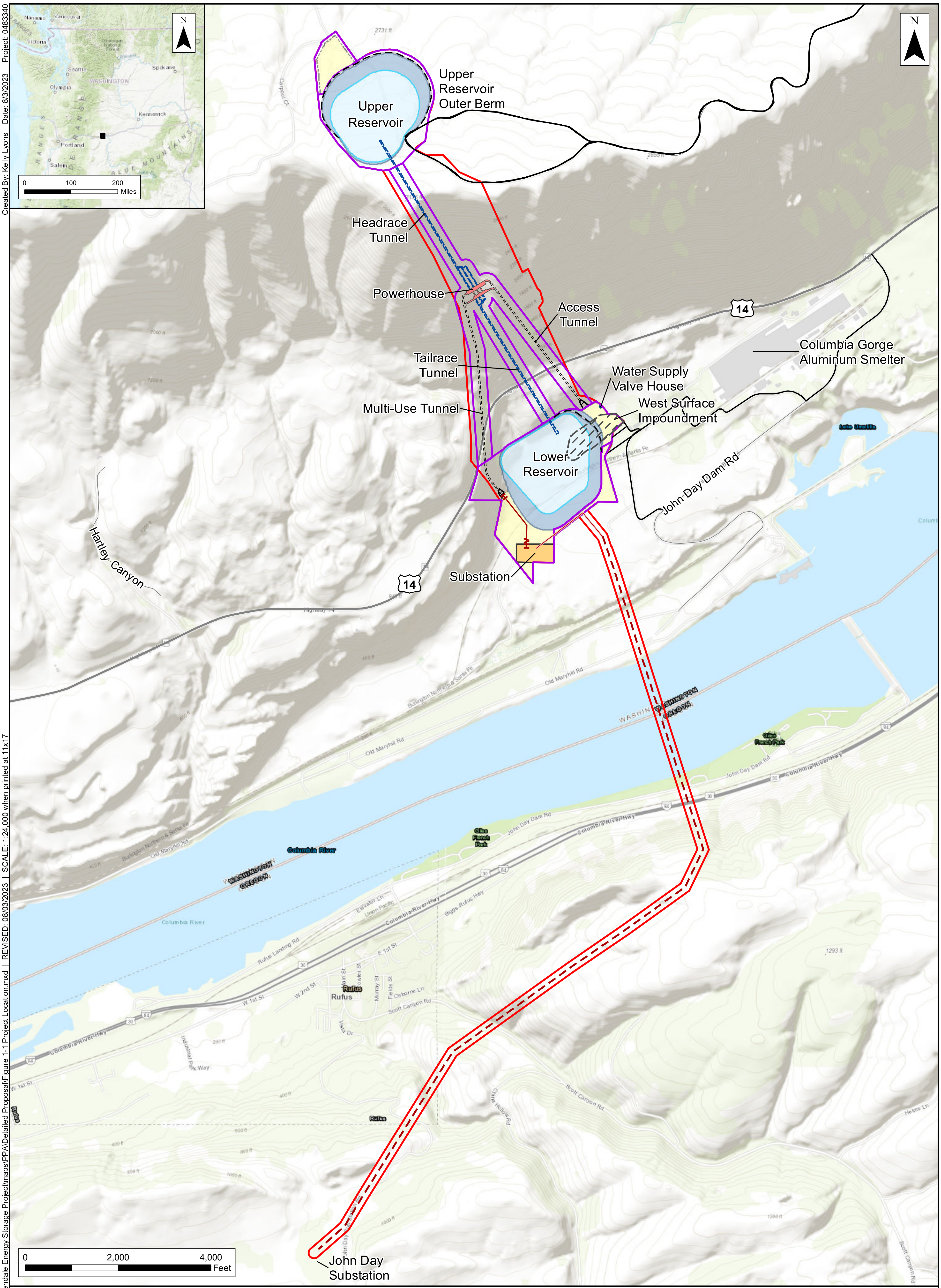
Table 11-6
Disproportional Cost Analysis
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, WA

Remedial Alternative		Criteria and Weighting[1,2]						Total Weighted Score[4]	Estimated Cost[5]	Benefit / Cost Ratio[6]
		Protectiveness (30%)	Permanence (20%)	Effectiveness over the Long Term (20%)	Management of Short-Term Risks (10%)	Technical and Administration Implementability (10%)	Consideration of Public Concerns			
		30%	20%	20%	10%	10%	10%			
3	**Excavation Option 2, MNA with Contingency, and Institutional Controls**	7	8	8	7	9	8	7.7	$29,207,000	0.26
		Protectiveness less than Alternative 4 because attaining groundwater cleanup levels will be incrementally slower without GWET that is included in Alternative 4. However, institutional controls will restrict use of groundwater rand springs to maintain protectiveness. It will attain soil cleanup levels in the same way (i.e., same excavation extent and soil removal offsite).	Similar permanence as Alternative 4 dude to full removal of soil above CULs and therefore no continuing source to groundwater. Less permanence than Alternative 4 due to potential for remaining groundwater concentrations above CULs.	Similar long-term effectiveness as Alternative 4; however, lower score due to application of MNA for groundwater relative to GWET.	Moderate but manageable short term risks associated with the deep soil excavation (e.g., worker safety/potential exposure to contaminated media, dust and erosion control, dewatering, etc.). Low short-term risk associated with MNA.	Most difficult to implement for soil since this Alternative requires the deepest excavation (i.e., to the water table) and potential multiple rounds of soil sampling below greater up to 15 ft below the WSI liner. May require additional shoring and/or ramps at greater depths. Potential excavation delays while waiting for confirmation sampling results may create cost and scheduling issues. MNA is easily implementable for groundwater and much of the required infrastructure for it already exists. Additionally, MNA is more implementable than Alternatives with GWET since it has less regulatory requirements, less scheduling and access issues, and is less complex than GWET.	Anticipated to meet public concerns similar to Alternative 4 since soil excavation is to the maximum extent practicable (i.e., complete cleanup; attains soil cleanup levels quickest). While relative to GWET alternatives, reaching groundwater cleanup levels will be incrementally slower, there are no additional permitting requirements associated with GWET.			
4	**Excavation Option 2, Groundwater Extraction and Treatment, Institutional Controls**	9	10	9	5	6	9	8.5	$40,171,000	0.21
		Most protective to human health and the environment since most contaminant mass will be removed (i.e., excavation to the maximum extent practicable/water table) and soil CULs will be achieved the quickest. Anticipate groundwater CULs will be attained incrementally quicker with GWET than MNA. GWET is expected to discharge under a NPDES Permit.	This alternative is considered the most permanent as all soil above CULs is excavated offsite and thereby removing any known source to groundwater. Includes extraction and treatment of groundwater with COC concentrations above the CULs. Most permanent due to the excavation extent, removal of contaminated soil off Site, and treatment of groundwater.	Most effective option over long-term as all soil above CULs will be removed and disposed of offsite. Additionally, GWET will will result in high pore water flushes and resulting higher removal of COCs from the saturated zone (i.e., there will be less chance of a future rebound relative to MNA).	Moderate but manageable short term risks associated with the deep soil excavation (e.g., worker safety/potential exposure to contaminated media, dust and erosion control, etc.). Moderate but manageable short-term risk associated with GWET system construction and startup (e.g., worker safety, potential exposure to contaminated media).	Higher implementability score relative to Alternative 6 due to excavation compared to ISS.	Anticipated to meet public concerns the most since soil excavation is to the maximum extent practicable (i.e., complete cleanup; quickly attains soil cleanup levels) and includes active remediation for groundwater (i.e., incremental decrease in duration to attain groundwater cleanup levels). Additionally, the Yakima Nation has been included in the RIFS revision review process with Ecology. Some anticipated public concern with discharge of treated groundwater.			
5	**In-situ Stabilization, MNA with Contingency, and Institutional Controls**	6	6	6	7	7	7	6.3	$26,686,000	0.24
		Alternative 5 will achieve soil and groundwater CULs across a similar extent and timeframe as Alternative 3 because stabilized extent would be the same as the excavation extent; however, contaminants will remain in place under stabilization. Stabilization of the soil will prevent further leaching of contaminates through stormwater infiltration or contact with the groundwater.	Lower permanence score relative to excavation as impacted soil will remain on site, in-place, following stabilization.	Less effective over long-term relative to Alternative 6 due to application of MNA instead of GWET.	Moderate but manageable short term risks associated with the WSI removal (e.g., worker safety/potential exposure to contaminated media, dust and erosion control, etc.) and ISS. Low short-term risk associated with MNA.	Higher implementability score relative to Alternative 6 due to application of MNA instead of GWET. MNA is easily implementable for groundwater and much of the required infrastructure for it already exists. Additionally, MNA is more implementable than GWET since it has less regulatory requirements, less scheduling and access issues, and is less complex than GWET.	Slightly lowered score than Alternative 3 since soil contamination will be stabilized in place. Additionally, higher technical nature of ISS is expected to result in greater public concern.			
6	**ISS, Groundwater Extraction and Treatment, and Institutional Controls**	8	8	7	5	4	8	7.1	$36,174,000	0.20
		Similarly protective (i.e., achieve soil and groundwater CULs similarly, extent and timeframe) as Alternative 4 because stabilized extent would be the same as the excavation Option 2 extent. Stabilization of the soil will prevent further leaching of contaminates through stormwater infiltration or contact with the groundwater. GWET will result in similar timeframe as Alternative 4.	Higher permanence relative to Alternative 5 because this includes extraction and treatment of groundwater with COC concentrations above the CULs.	Similar effectivness over long term to Alternative 4 by stabilizing soil with COCs above CULs in place; however, impacted soil is not being removed and will remain onsite.	Moderate but manageable short term risks associated with the WSI (e.g., worker safety/potential exposure to contaminated media, dust and erosion control, etc.) and ISS. Moderate but manageable short-term risk associated with P&T system construction and startup (e.g., worker safety, potential exposure to contaminated media).	Alternative 6 is the most technically and administratively challenging alternative to implement due combination of ISS and GWET. Technical aspects of ISS will include depth and lithology to achieve appropriate mixing as well as consideration of potential for impacts on adjacent structures (i.e., (West SPL). Potential implementability challenges for GWET with regulatory requirements for treated groundwater and operations & maintenance/access/scheduling as the site is relatively remote. However, GWET process equipment are reliable and technologies well-documented. Services, materials, and expertise widely available.	Slightly lowered score than Alternative 4 since soil contamination will be stabilized in place. Additionally, higher technical nature of ISS is expected to result in greater public concern.			

Notes:

[1] = Ranking score based on relative ability to achieve criteria on 1 (lowest) to 10 (highest) scale.
[2] = Weighting factors based on professional judgement. See justification described in Section 11.5.
[3] = Ecology considers and responds to all public comments received on the DCAP and PPCD as part of the cleanup process under MTCA. Because public comments have not yet been received, consideration of public concerns regarding the cleanup action alternatives is preliminarily included in this document.
[4] = Total weighted benefit score is obtained by multiplying the rating for each criterion by its weighting factor, and summing the results for the six criteria.
[5] = Net present value costs are estimated in 2023 dollars, and were calculated using a two percent discount rate. Itemized estimates are provided in Tables 11- through 11-6.
[6] = The benefit/cost ratio is obtained by dividing the alternative's total weighted benefit score by its estimated cost (in $million).
COC = constituent of concern
CUL = clean up level
GWET = groundwater extraction and treatment
ISS = in situ stabilization
MNA = monitored natural attenuation
NPDES = National Pollutant Discharge Elimination System
WSI = West Surface Impoundment

FIGURES



Legend

- ▨ West Surface Impoundment (WSI)
- 🟥 FERC Project Boundary
- 🟪 Property Boundary
- 🟦 Reservoir
- 🟦 Reservoir Berm Outer Slope
- 🟨 Laydown Area
- 🟥 Powerhouse
- 🟧 Substation
- 🟦 Water Supply Valve House
- ☐ Access Tunnel
- ▩ Access Tunnel Portal
- ☐ Headrace/Tailrace Tunnel

Figure 1-1
Project Location
Draft Cleanup Action Plan
Goldendale Energy Storage Project
at the Former Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
www.erm.com
ERM

Source: Esri - World Topographic Map; NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Created By: Kelly Lyons Date: 8/3/2023 Project: 0483340

FILE: M:\US\Projects\A-C\Copenhagen Infra\Goldendale Energy Storage Project\maps\PPA\Detailed Proposal\Figure 1-1 Project Location.mxd | REVISED: 08/03/2023 | SCALE: 1:24,000 when printed at 11x17

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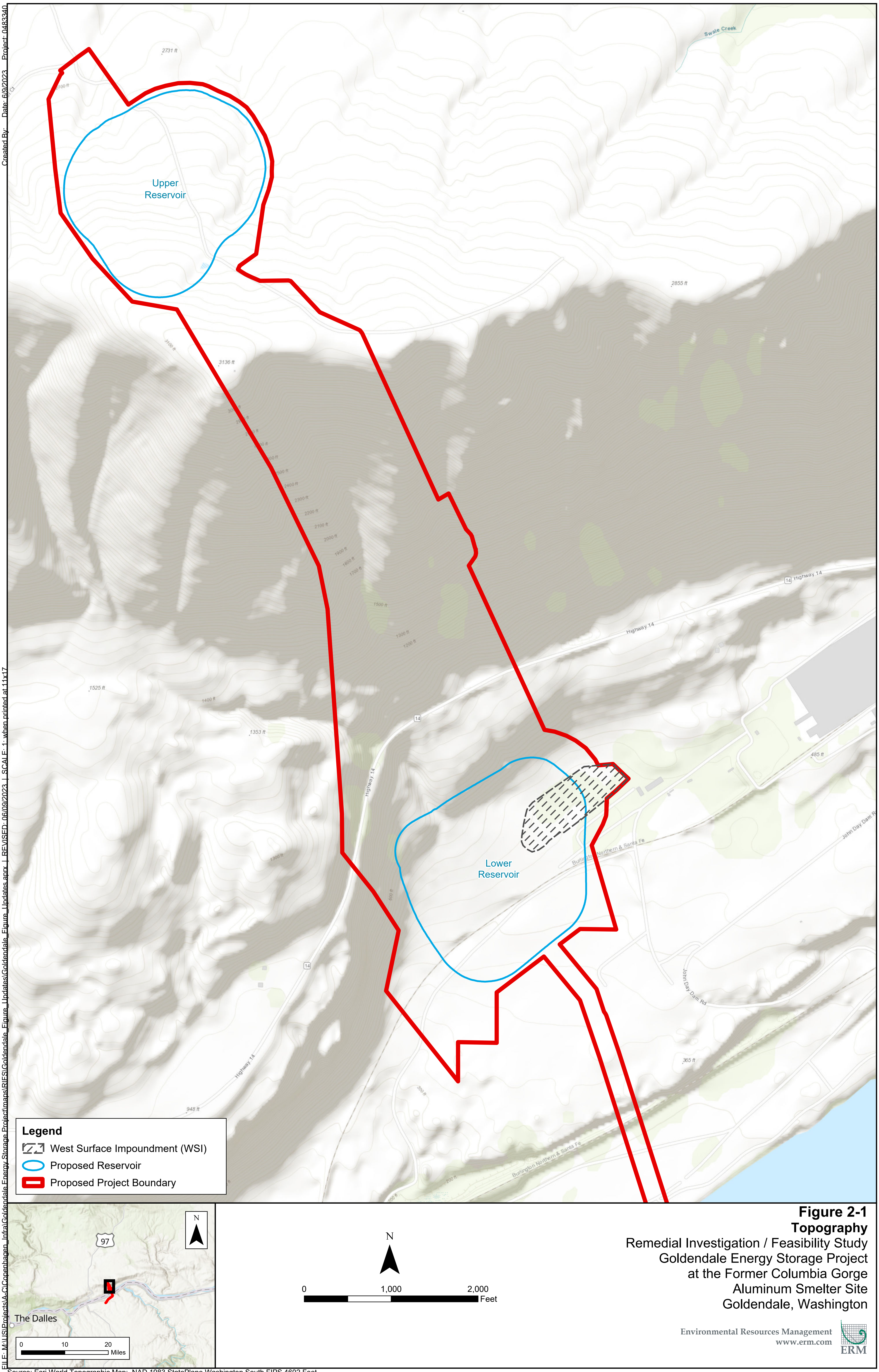

Figure 2-1
Topography
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
at the Former Columbia Gorge
Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
www.erm.com
ERM

Source: Esri World Topographic Map; NAD 1983 StatePlane Washington South FIPS 4602 Feet

Created By: Date: 6/9/2023   Project: 0483340

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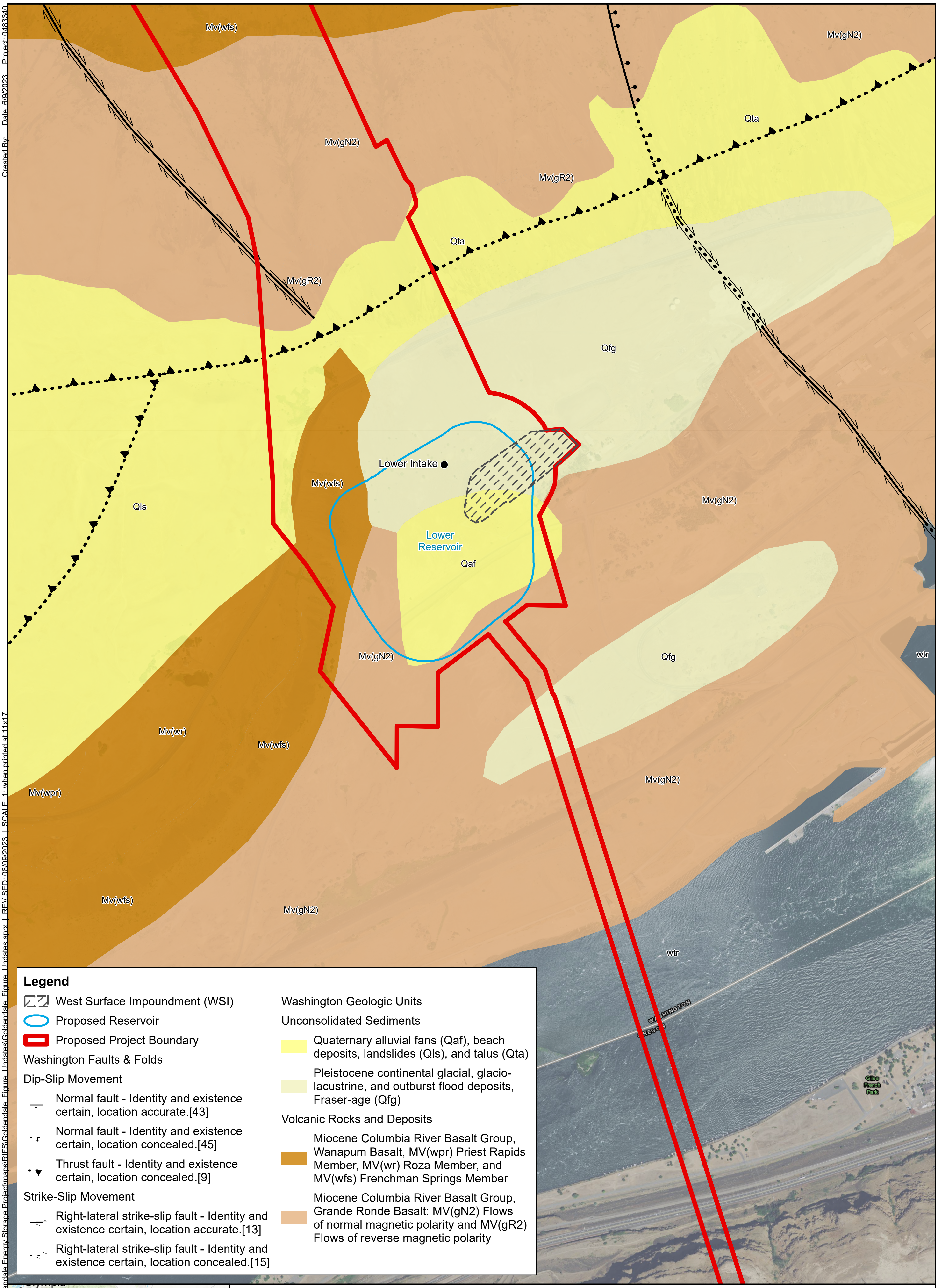


Legend

⧄ West Surface Impoundment (WSI)

○ Proposed Reservoir

▭ Proposed Project Boundary

Washington Faults & Folds

Dip-Slip Movement

- Normal fault - Identity and existence certain, location accurate.[43]
- Normal fault - Identity and existence certain, location concealed.[45]
- Thrust fault - Identity and existence certain, location concealed.[9]

Strike-Slip Movement

- Right-lateral strike-slip fault - Identity and existence certain, location accurate.[13]
- Right-lateral strike-slip fault - Identity and existence certain, location concealed.[15]

Washington Geologic Units

Unconsolidated Sediments

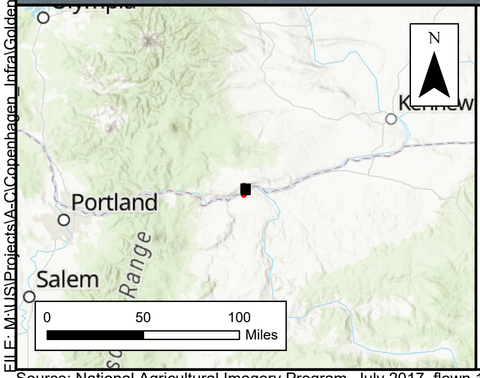
🟨 Quaternary alluvial fans (Qaf), beach deposits, landslides (Qls), and talus (Qta)

▨ Pleistocene continental glacial, glacio-lacustrine, and outburst flood deposits, Fraser-age (Qfg)

Volcanic Rocks and Deposits

🟧 Miocene Columbia River Basalt Group, Wanapum Basalt, MV(wpr) Priest Rapids Member, MV(wr) Roza Member, and MV(wfs) Frenchman Springs Member

🟫 Miocene Columbia River Basalt Group, Grande Ronde Basalt: MV(gN2) Flows of normal magnetic polarity and MV(gR2) Flows of reverse magnetic polarity



N

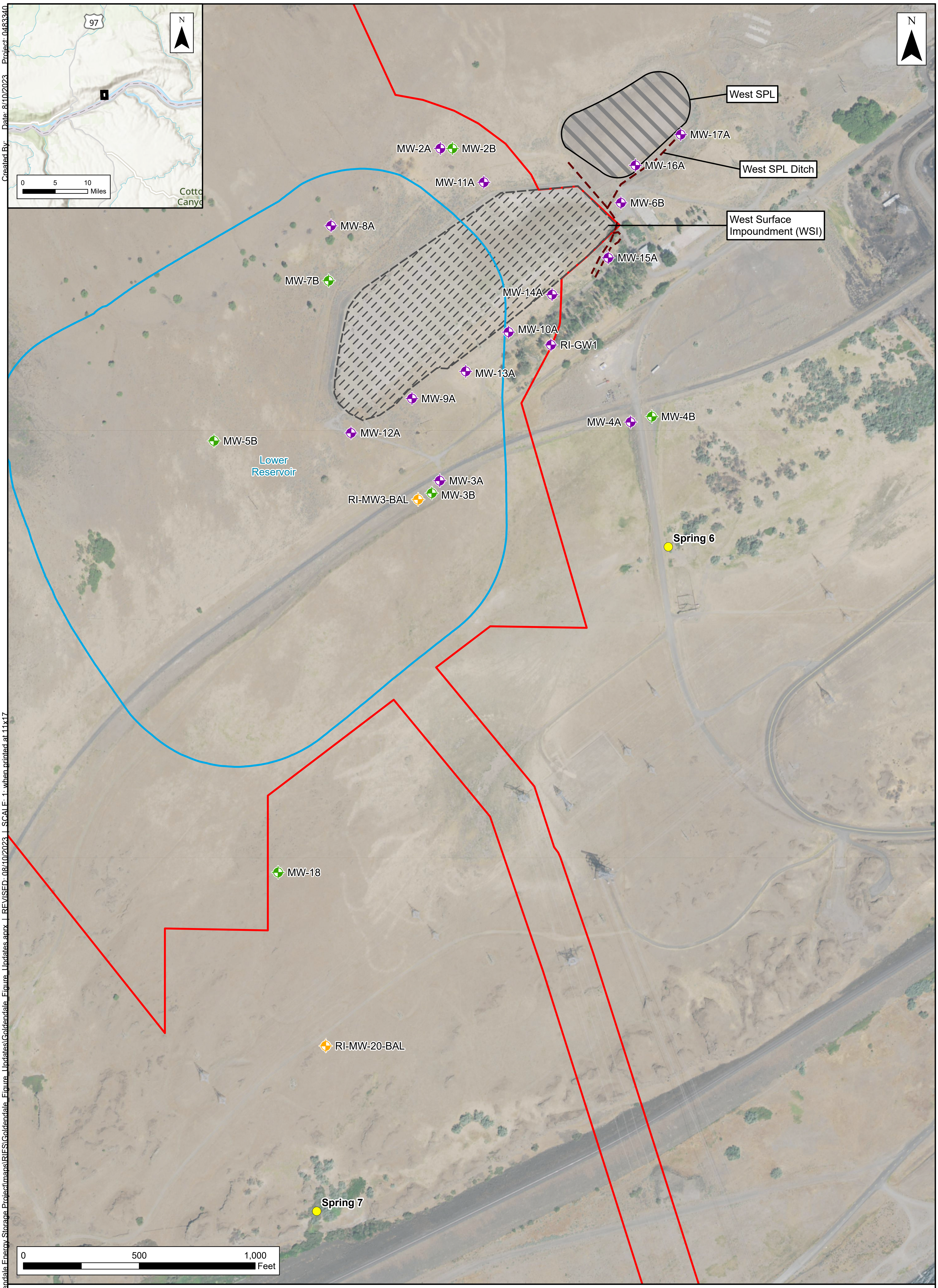
0 1,000 2,000 Feet

Figure 2-2
Site Geology
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
at the Former Columbia Gorge
Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
www.erm.com
ERM

Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 StatePlane Washington South FIPS 4602 Feet

Created By: Date: 8/10/2023 Project: 0483340



Legend

- Unconsolidated Aquifer Well
- Uppermost Basalt Aquifer Well
- Deep Well with Coring (BAL)
- ● Springs
- ▨ West SPL
- ▨ West Surface Impoundment (WSI)
- Proposed Reservoir
- 🟥 Project Boundary

Notes:
Extent lines dashed where inferred.
UA = Unconsolidated Aquifer
BAU = Basalt Aquifer - Upper Zone
BAL = Basalt Aquifer - Lower Zone
MCL = Maximum Contaminant Load
SPL = Spent Pot Liner
WSI = West Surface Impoundment

Figure 2-3
Project Area Groundwater Monitoring Wells

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
at the Former Columbia Gorge
Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
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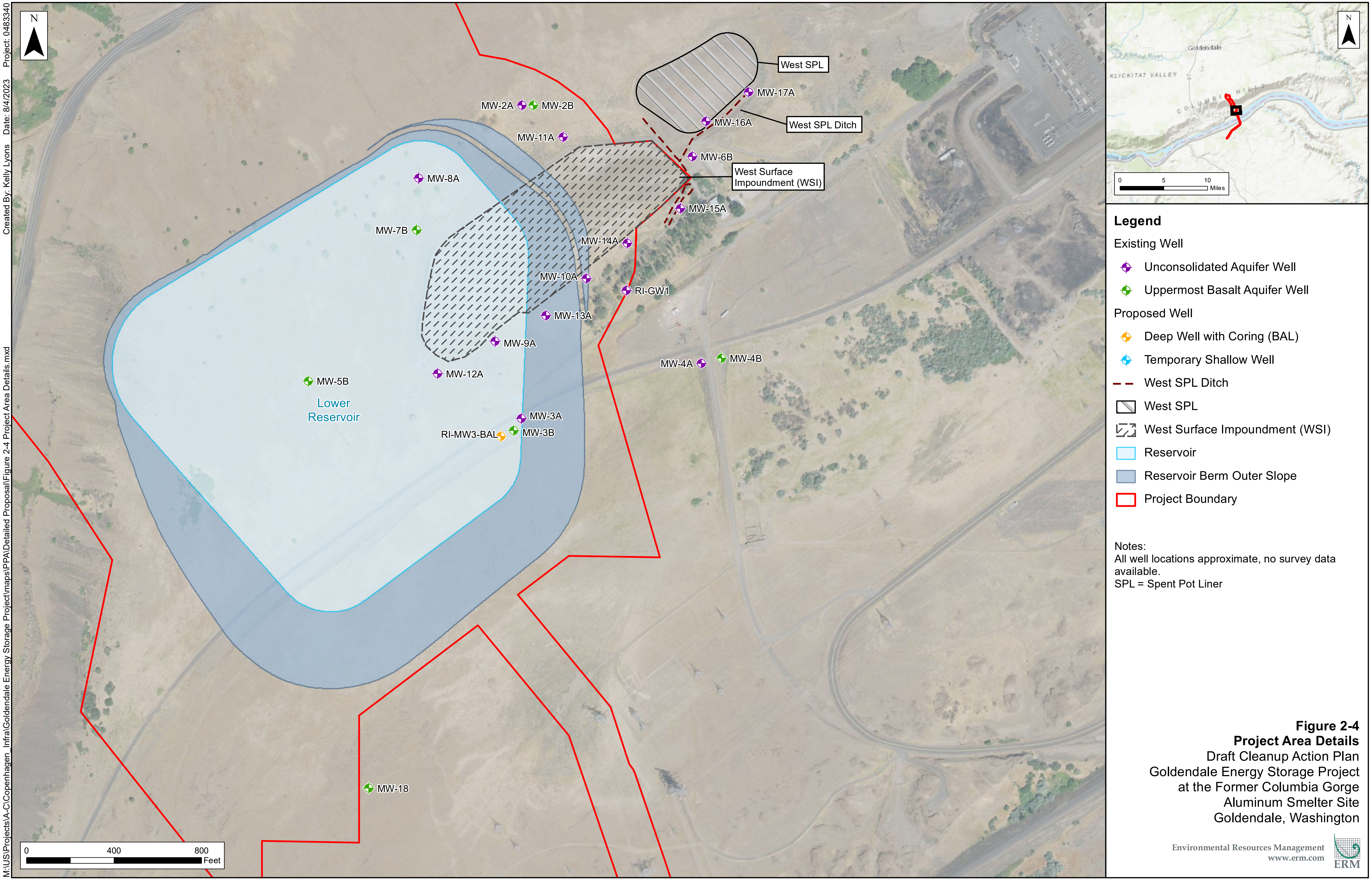
FILE: M:\US\Projects\A-C\Copenhagen_Infra\Goldendale_Energy_Storage_Project\maps\RIFS\Goldendale_Figure_Updates\Goldendale_Figure_Updates.aprx | REVISED: 08/10/2023 | SCALE: 1: when printed at 11x17

Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

M:\US\Projects\A-C\Copenhagen_Infra\Goldendale Energy Storage Project\PPA\Detailed Proposal\Figure 2-4 Project Area Details.mxd Created By: Kelly Lyons Date: 8/4/2023 Project: 0483340



Legend

Existing Well

- ✚ Unconsolidated Aquifer Well
- ✚ Uppermost Basalt Aquifer Well

Proposed Well

- ✚ Deep Well with Coring (BAL)
- ✚ Temporary Shallow Well
- - - West SPL Ditch
- ▨ West SPL
- ▨ West Surface Impoundment (WSI)
- ☐ Reservoir
- ☐ Reservoir Berm Outer Slope
- ☐ Project Boundary

Notes:
All well locations approximate, no survey data available.
SPL = Spent Pot Liner

Figure 2-4
Project Area Details
Draft Cleanup Action Plan
Goldendale Energy Storage Project
at the Former Columbia Gorge
Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
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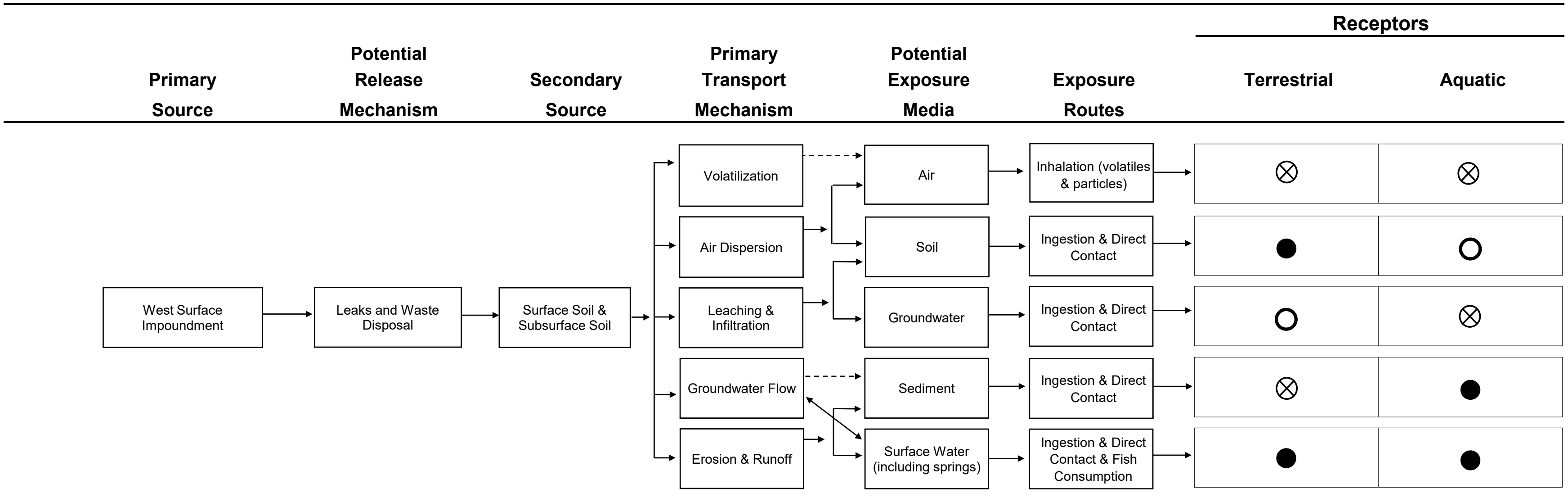
Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend
- ● = Complete Exposure
- ⊗ = Potentially Complete but Insignificant/Indirect Exposure
- ○ = Incomplete Exposure
- ⟶ = Complete Pathway or Medium
- - - - -► = Incomplete or Insignificant Pathway or Medium

Figure 3-1
Conceptual Ecological Exposure Site Model
Ecological Risk Assessment
Remedial Investigation/Feasibility Study
Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
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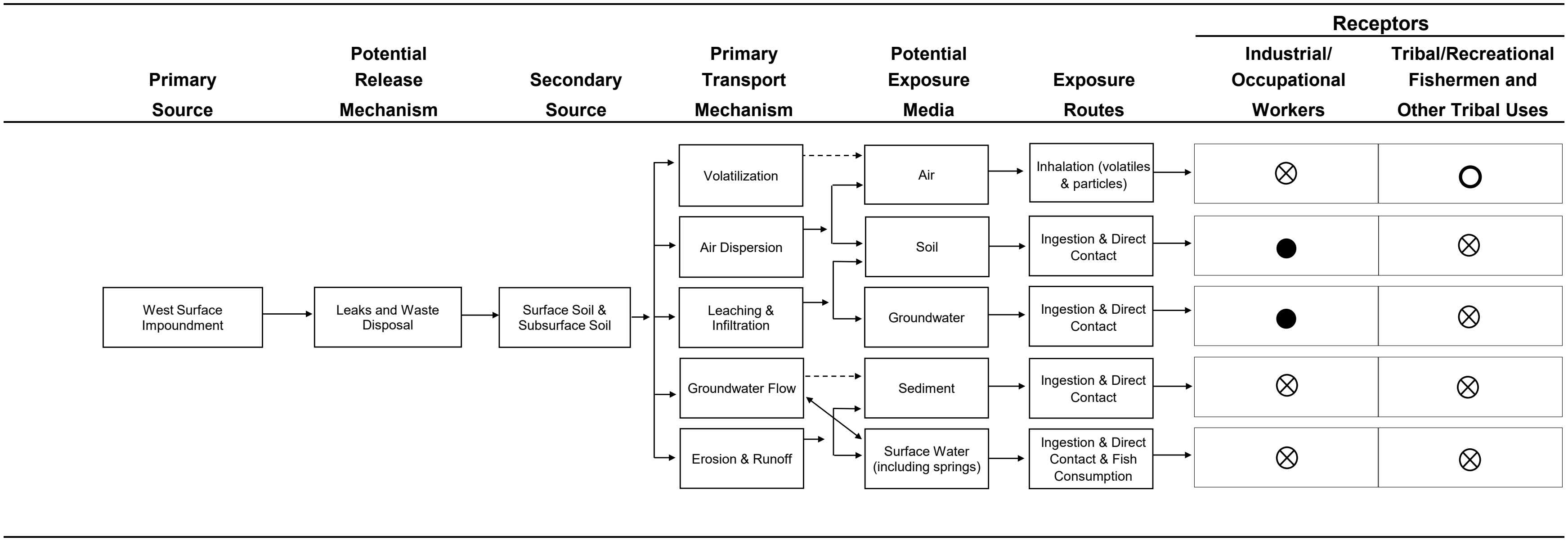

Potential Exposure Media	Exposure Routes	Industrial/ Occupational Workers	Tribal/Recreational Fishermen and Other Tribal Uses
Air	Inhalation (volatiles & particles)	⊗	○
Soil	Ingestion & Direct Contact	●	⊗
Groundwater	Ingestion & Direct Contact	●	⊗
Sediment	Ingestion & Direct Contact	⊗	⊗
Surface Water (including springs)	Ingestion & Direct Contact & Fish Consumption	⊗	⊗

Legend

● = Complete Exposure
⊗ = Potentially Complete but Insignificant/Indirect Exposure
○ = Incomplete Exposure
⟶ = Complete Pathway or Medium
- - - -› = Incomplete or Insignificant Pathway or Medium

Note: This exposure model does not include potential municipal water use considerations for surface water and groundwater exposure media.

Figure 3-2

Conceptual Human Health Exposure Model

Human Health Risk Assessment

Remedial Investigation/Feasibility Study
Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

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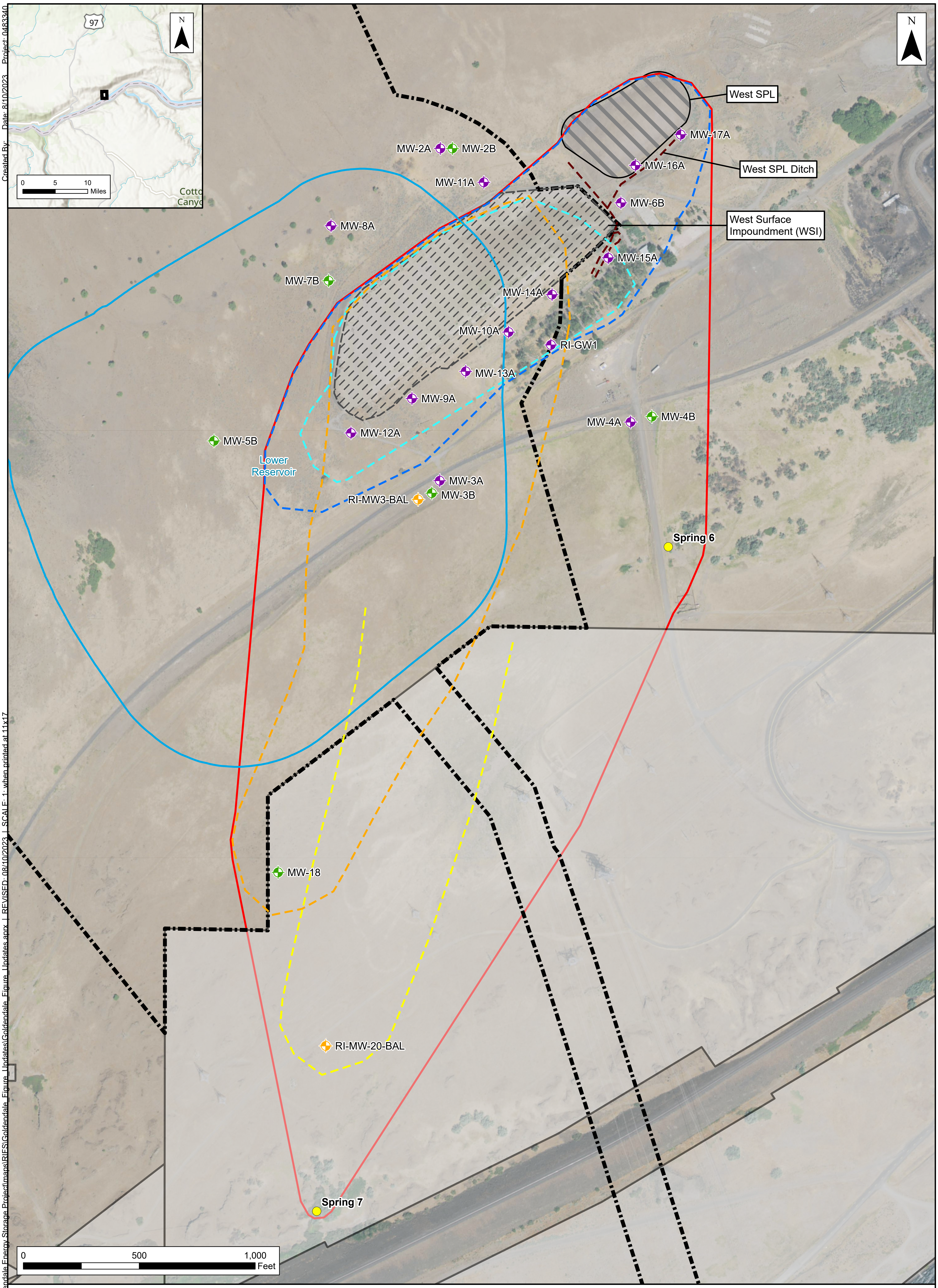
FILE: M:\US\Projects\A-C\Copenhagen_Infra\Goldendale Energy Storage Project\maps\RIFS\Goldendale_Figure_Updates\Goldendale_Figure_Updates.aprx | REVISED: 08/10/2023 | SCALE: 1: when printed at 11x17

Created By: Date: 8/10/2023 Project: 0483340



Legend

- Unconsolidated Aquifer Well
- Uppermost Basalt Aquifer Well
- Deep Well with Coring (BAL)
- Springs
- Extent of Fluoride UA
- Extent of Sulfate UA
- Extent of Sulfate BAU
- Extent of Sulfate BAL
- West SPL Discharge Ditch
- West SPL
- West Surface Impoundment (WSI)
- Western GW AOC
- Non NSC Smelter LLC Property
- Lower Reservoir
- Project Boundary

Notes:
Extent lines dashed where inferred.
UA = Unconsolidated Aquifer
BAU = Basalt Aquifer - Upper Zone
BAL = Basalt Aquifer - Lower Zone
MCL = Maximum Contaminant Load
SPL = Spent Pot Liner
WSI = West Surface Impoundment

Western GW AOC extent is based on locations that exceed the Fluoride MTCA Method B Screening Level (0.96 mg/L) and/or the Sulfate Secondary MCL Screening Level (250 mg/L).

Fluoride and Sulfate extents, springs, and wetlands are based on data/figures presented in the CGA Smelter Revised RI (Tetra Tech 2021).

Springs with exceedance of at least one COC are included in the GW AOC due to potential connections with water bearing units.

Figure 7-1
Project Area SWMUs and GW AOC

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
at the Former Columbia Gorge
Aluminum Smelter Site
Goldendale, Washington

Environmental Resources Management
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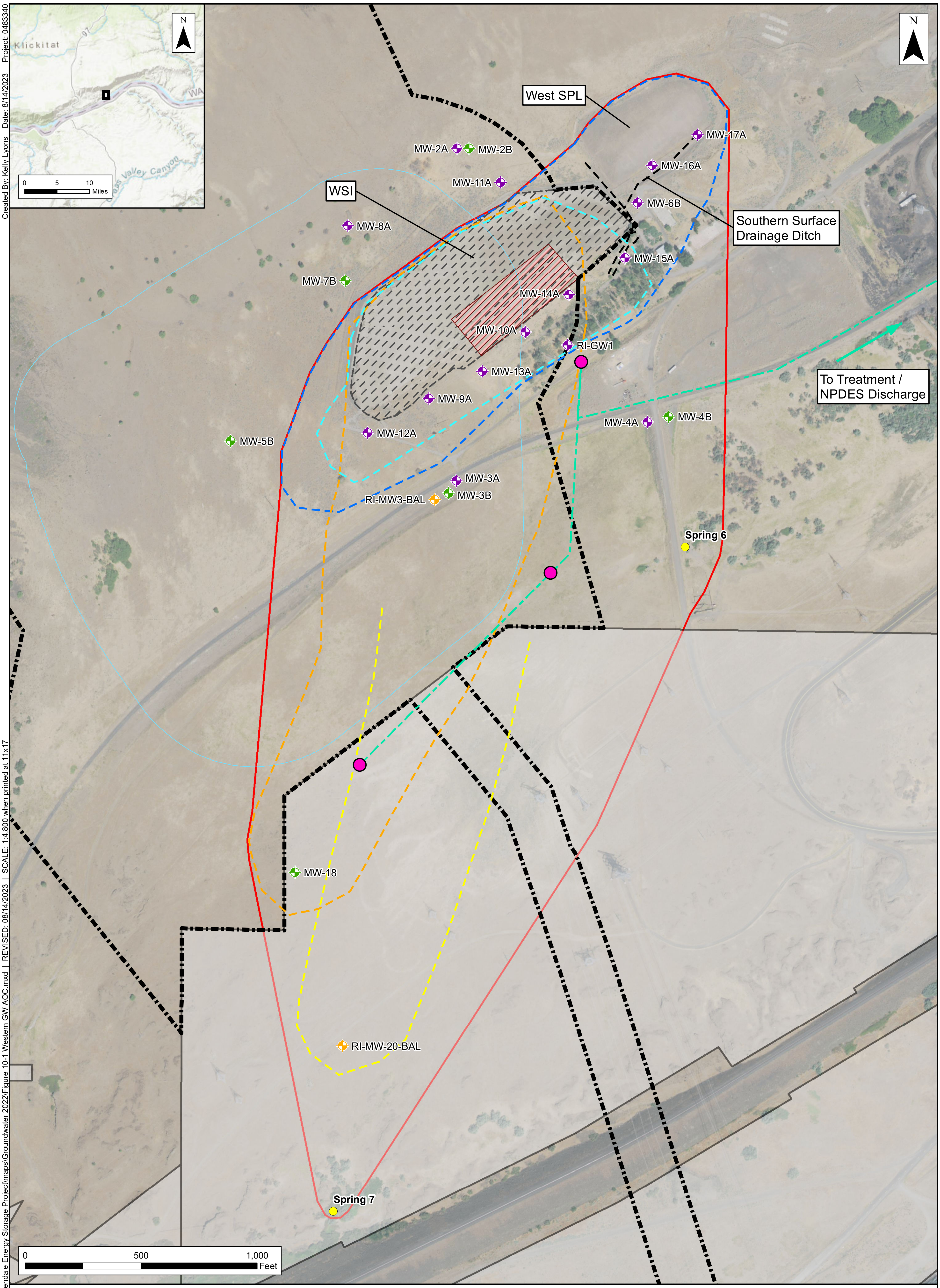
Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Created By: Kelly Lyons Date: 8/14/2023 Project: 0483340

FILE: M:\US\Projects\A-C\Copenhagen Infra\Goldendale Energy Storage Project\maps\Groundwater 2022\Figure 10-1 Western GW AOC.mxd | REVISED: 08/14/2023 | SCALE: 1:4,800 when printed at 11x17



Legend

- ⊕ Unconsolidated Aquifer Well
- ⊕ Uppermost Basalt Aquifer Well
- ⊕ Deep Well with Coring (BAL)
- ⊕ Temporary Shallow Well
- ● Extraction Well
- ● Springs
- - - Extent of Fluoride UA
- - - Extent of Sulfate UA
- - - Extent of Sulfate BAU
- - - Extent of Sulfate BAL
- - - GWET Conveyance Piping
- ☐ Western GW AOC
- ☐ Non NSC Smelter LLC Property
- ☐ Project Boundary
- ☐ Lower Reservoir
- ▨ Area of Excavation (Excavation to immediately beneath liner)
- ▨ Over-Excavation or ISS Area

Western GW AOC extent is based on locations that exceed the Fluoride MTCA Method B Screening Level (0.96 mg/L) and/or the Sulfate Secondary MCL Screening Level (250 mg/L).

Fluoride and Sulfate extents, springs, and wetlands are based on data/figures presented in the CGA Smelter Revised RI (Tetra Tech 2021).

Springs with exceedance of at least one COC are included in the GW AOC due to potential connection with water bearing units.

Over-excavation or ISS Area to be determined following confirmation sampling after WSI excavation.

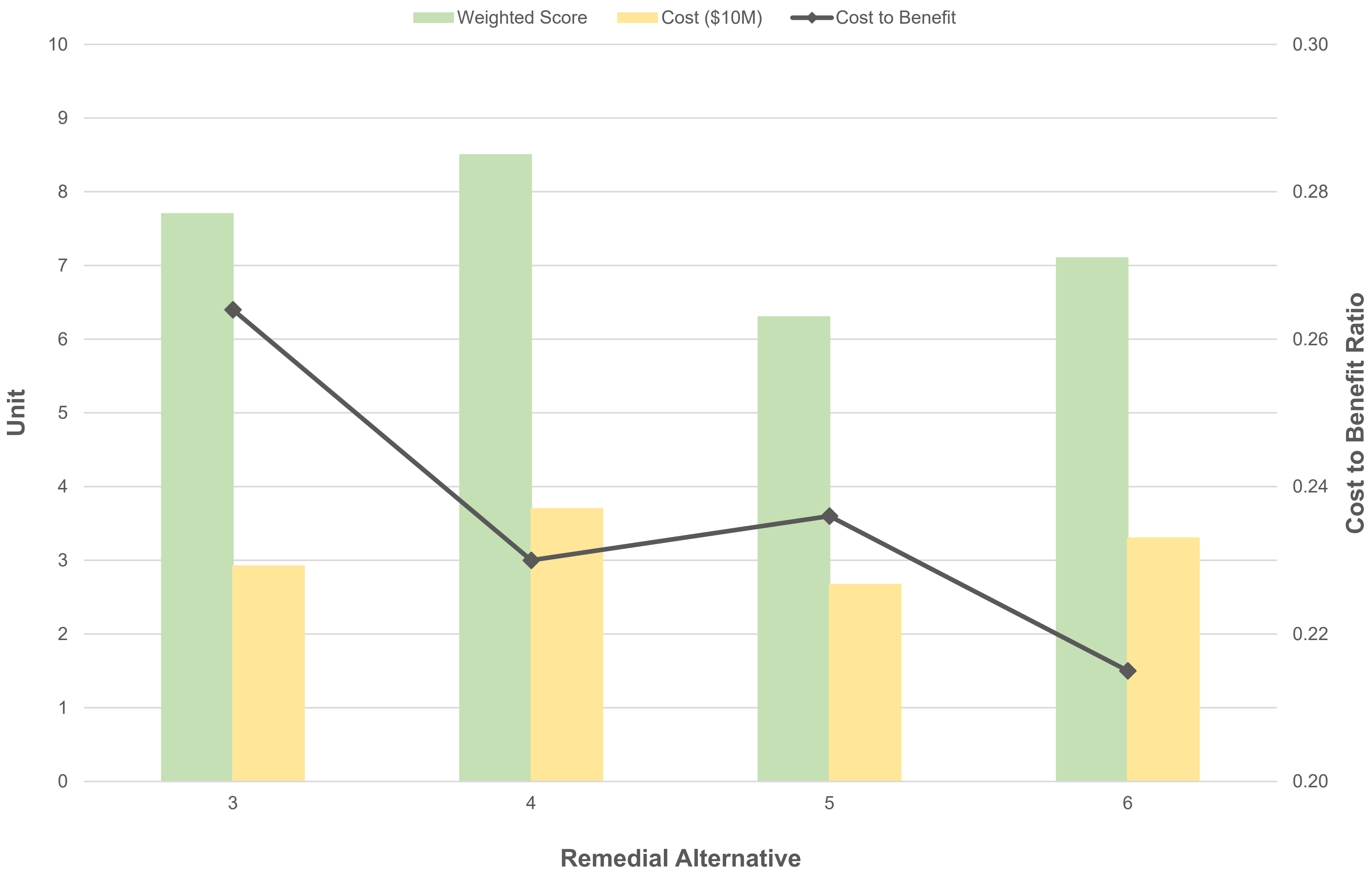
Extent lines dashed where inferred.
GW = Groundwater
AOC = Area of Concern
UA = Unconsolidated Aquifer
BAU = Basalt Aquifer - Upper Zone
BAL = Basalt Aquifer - Lower Zone
GWET = Groundwater extraction and treatment
ISS = In situ stabilization
MCL = Maximum Contaminant Load MTCA = Model Toxics Control Act

Figure 10-1
Conceptual Layout
Goldendale Energy Storage Project
Goldendale, WA

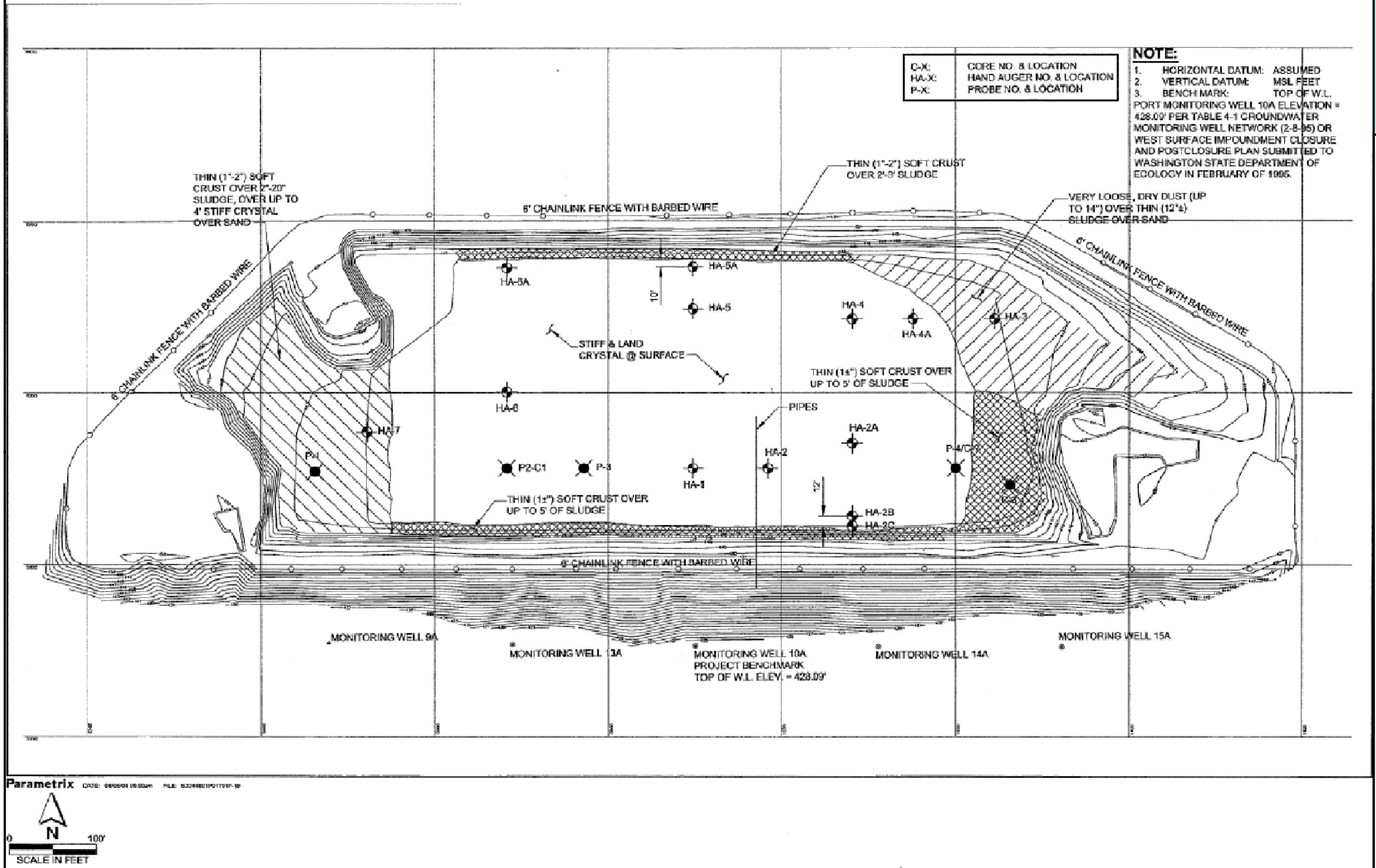
Environmental Resources Management
www.erm.com
ERM

Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Figure 11-1 Cost to Benefit Ratio



APPENDIX A WSI DETAIL



NOTE:

1. HORIZONTAL DATUM: ASSUMED
2. VERTICAL DATUM: MSL FEET
3. BENCH MARK: TOP OF W.L.

PORT MONITORING WELL 10A ELEVATION = 428.09' PER TABLE 4-1 GROUNDWATER MONITORING WELL NETWORK (2-8-95) OR WEST SURFACE IMPOUNDMENT CLOSURE AND POSTCLOSURE PLAN SUBMITTED TO WASHINGTON STATE DEPARTMENT OF ECOLOGY IN FEBRUARY OF 1995.

Source:
Parametrix
Construction Quality
Assurance Report
2004

Figure A1
Waste Types and Locations
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage
Project
Goldendale, Washington

Environmental Resources
Management
www.erm.com
ERM

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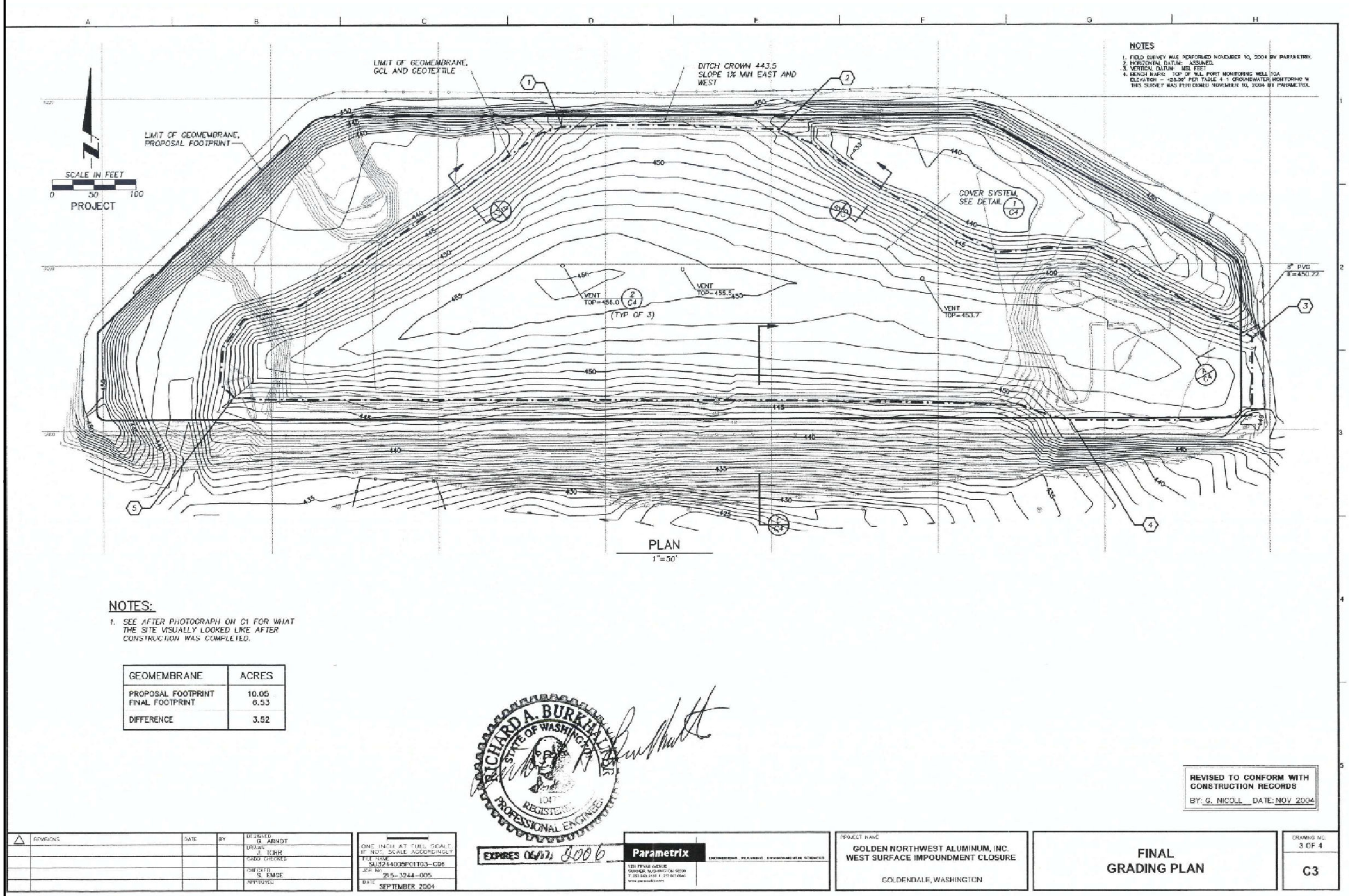

NOTES

1. FIELD SURVEY WAS PERFORMED NOVEMBER 10, 2004 BY PARAMETRIX.
2. HORIZONTAL DATUM: ASSUMED.
3. VERTICAL DATUM: MSL FEET
4. BENCH MARK: TOP OF W.L. PORT MONITORING WELL 10A ELEVATION = 423.92' PER TABLE 4-1 GROUNDWATER MONITORING W THIS SURVEY WAS PERFORMED NOVEMBER 10, 2004 BY PARAMETRIX.

NOTES:

1. SEE AFTER PHOTOGRAPH ON C1 FOR WHAT THE SITE VISUALLY LOOKED LIKE AFTER CONSTRUCTION WAS COMPLETED.

GEOMEMBRANE	ACRES
PROPOSAL FOOTPRINT FINAL FOOTPRINT	10.05 6.53
DIFFERENCE	3.52

RICHARD A. BURKHALTER
EXPIRES 06/07/ 2006

REVISED TO CONFORM WITH CONSTRUCTION RECORDS
BY: G. NICOLL DATE: NOV 2004

REVISIONS	DATE	BY	
			DESIGNED G. ARNDT
			DRAWN J. IDRR
			CADD CHECKED
			CHECKED S. EMGE
			APPROVED

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY
FILE NAME SU3244005P01T03-C06
JOB No. 215-3244-005
DATE SEPTEMBER 2004

Parametrix

PROJECT NAME
GOLDEN NORTHWEST ALUMINUM, INC.
WEST SURFACE IMPOUNDMENT CLOSURE
GOLDENDALE, WASHINGTON

FINAL
GRADING PLAN

DRAWING NO.
3 OF 4
C3

Source:
Parametrix
Construction Quality
Assurance Report
2004

Figure A2
WSI 2004 Final Grading Plan
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage
Project
Goldendale, Washington

Environmental Resources
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Figure A3
WSI Aerial Photography
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 StatePlane Washington South FIPS 4602 Feet

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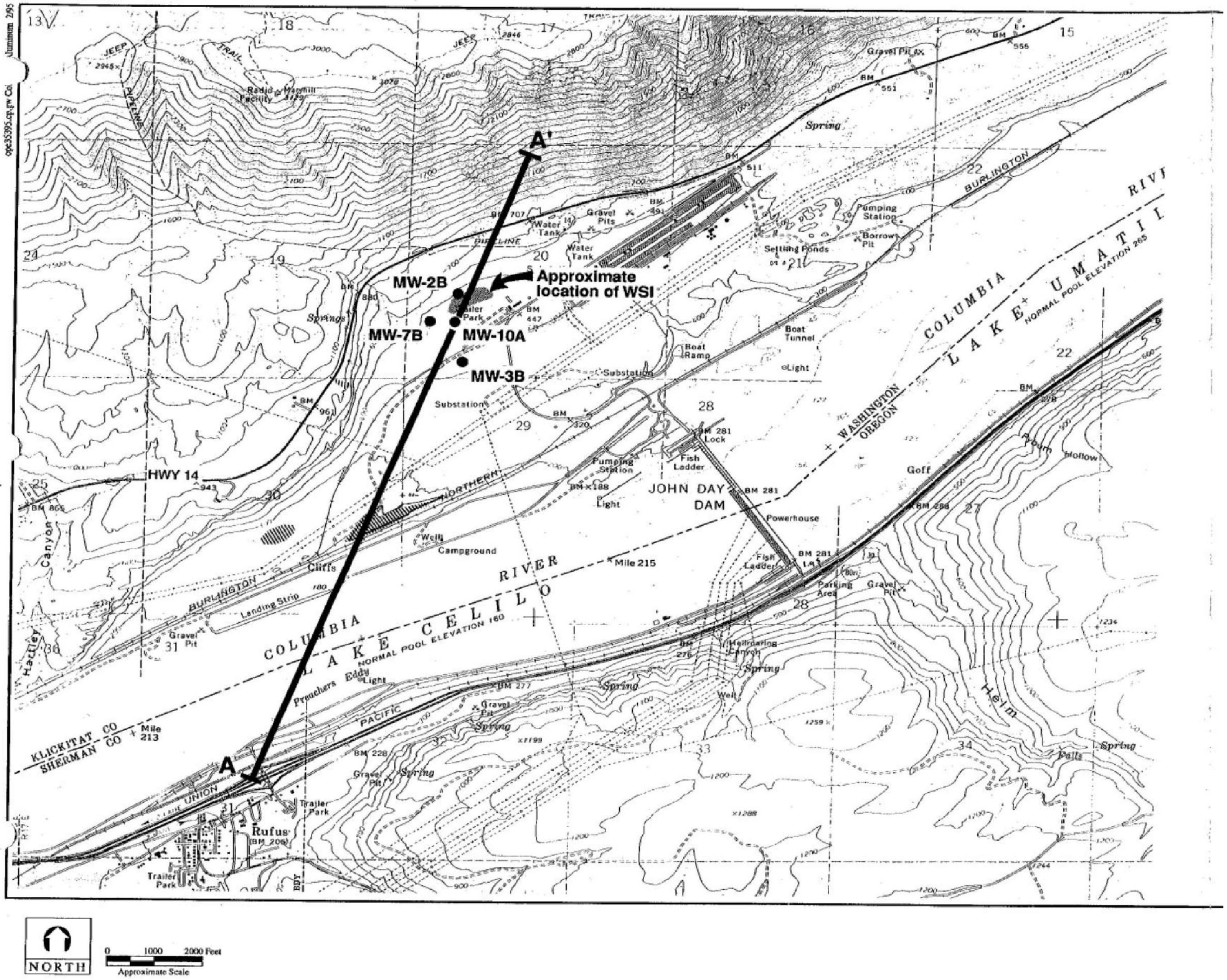

LEGEND

MW-10A ● Approximate well locations

A — A' Cross section location

▨ Wetland areas

OREGON

QUADRANGLE LOCATION

Contour interval = 20 feet
Datum is mean sea level

Source: U.S. Geological Survey Rufus 7.5-Minute Quadrangle, Oregon-Washington. 1971.

Source:
Tetra Tech
Final Remedial Investigation Work Plan
Volume 1: Phase 1 Work Plan
Columbia Gorge Aluminum Smelter Site
2015

Figure A4
Regional Cross Section A-A' Map

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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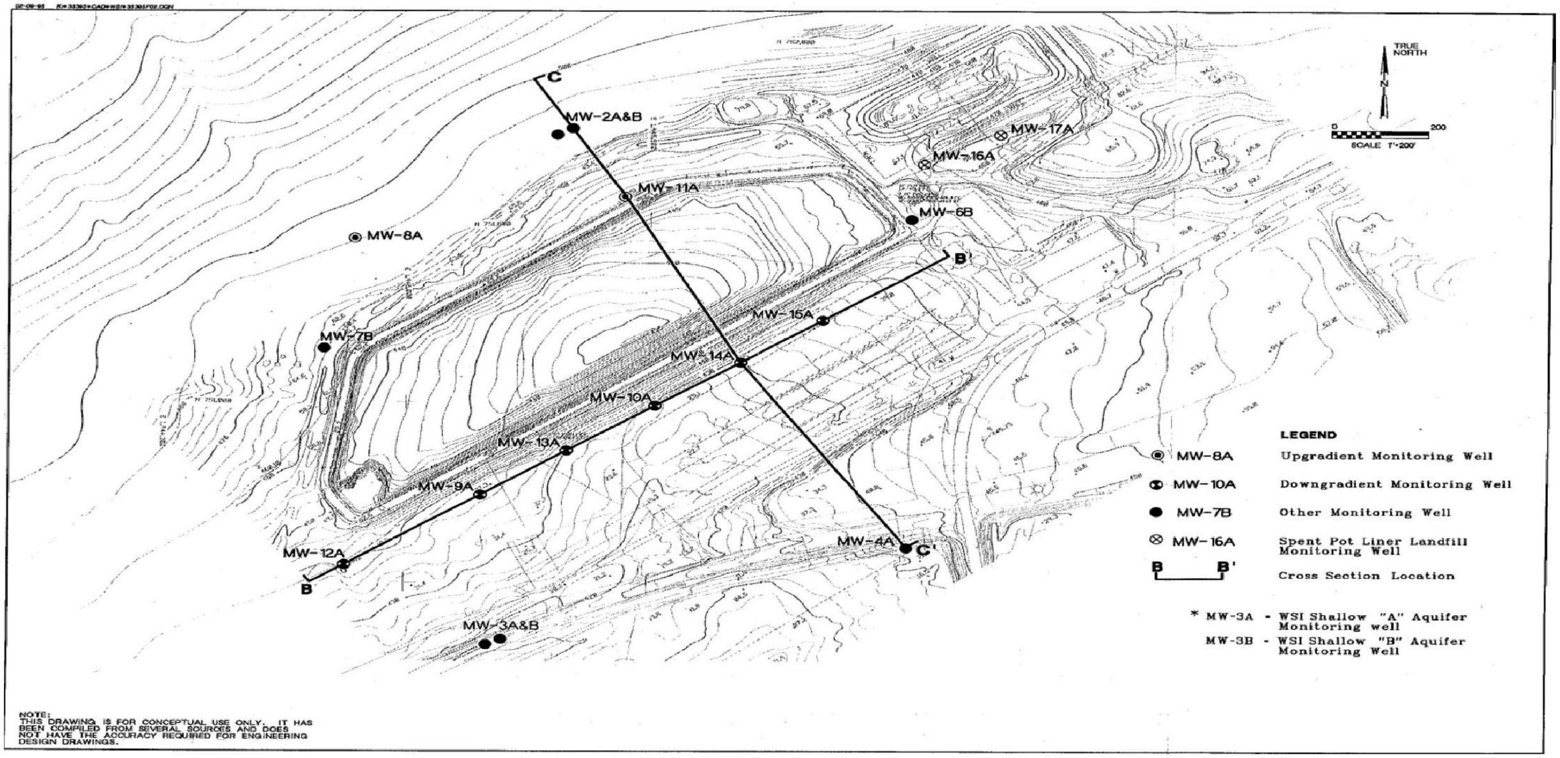

NOTE:
THIS DRAWING IS FOR CONCEPTUAL USE ONLY. IT HAS BEEN COMPILED FROM SEVERAL SOURCES AND DOES NOT HAVE THE ACCURACY REQUIRED FOR ENGINEERING DESIGN DRAWINGS.

Source:
Tetra Tech
Final Remedial Investigation
Work Plan, Volume 1: Phase 1
Work Plan Columbia Gorge
Aluminum Smelter Site
2015

Figure A5
Cross Section Location Map for B-B' and C-C'

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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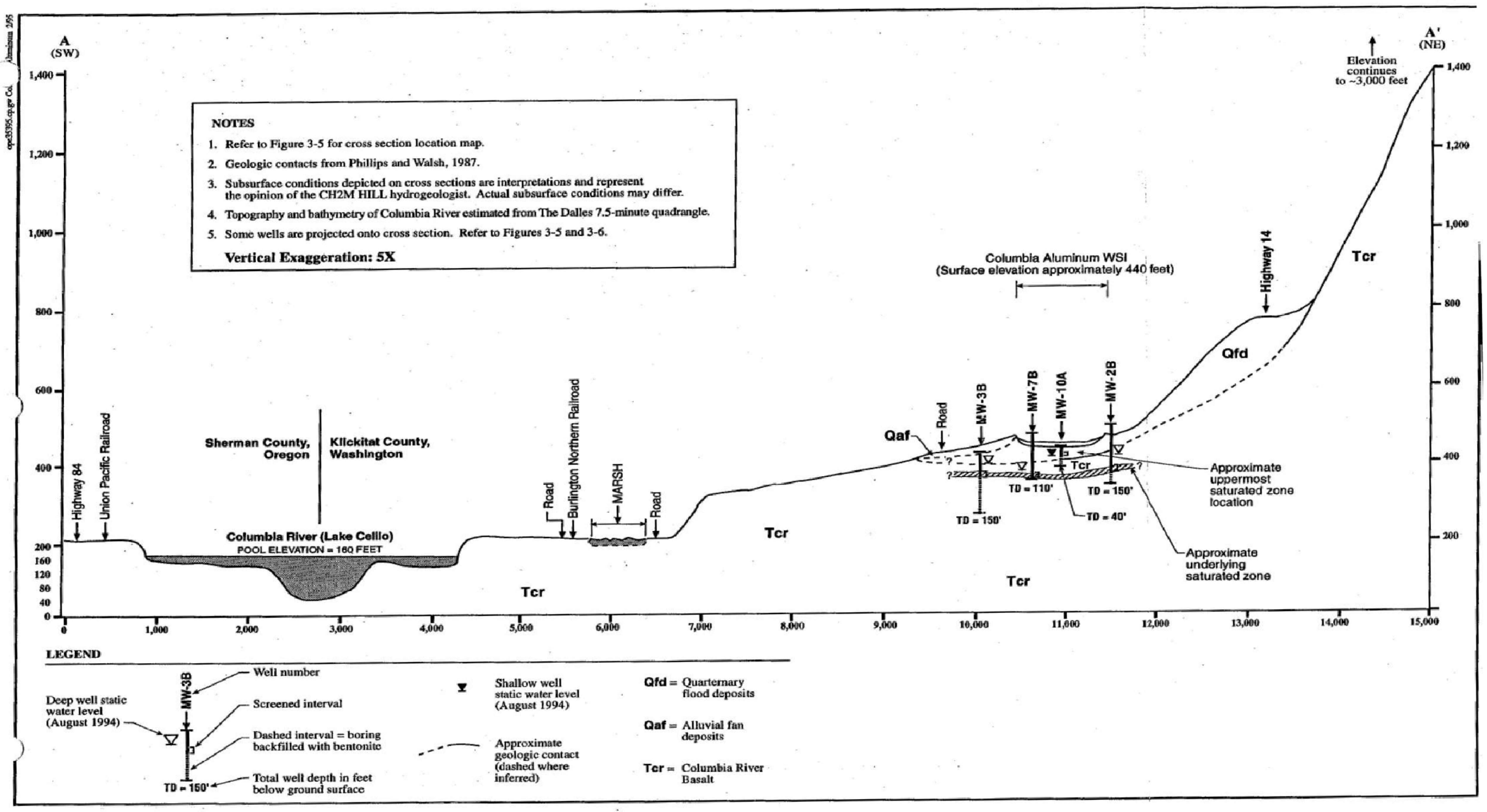
ERM



NOTES

1. Refer to Figure 3-5 for cross section location map.
2. Geologic contacts from Phillips and Walsh, 1987.
3. Subsurface conditions depicted on cross sections are interpretations and represent the opinion of the CH2M HILL hydrogeologist. Actual subsurface conditions may differ.
4. Topography and bathymetry of Columbia River estimated from The Dalles 7.5-minute quadrangle.
5. Some wells are projected onto cross section. Refer to Figures 3-5 and 3-6.

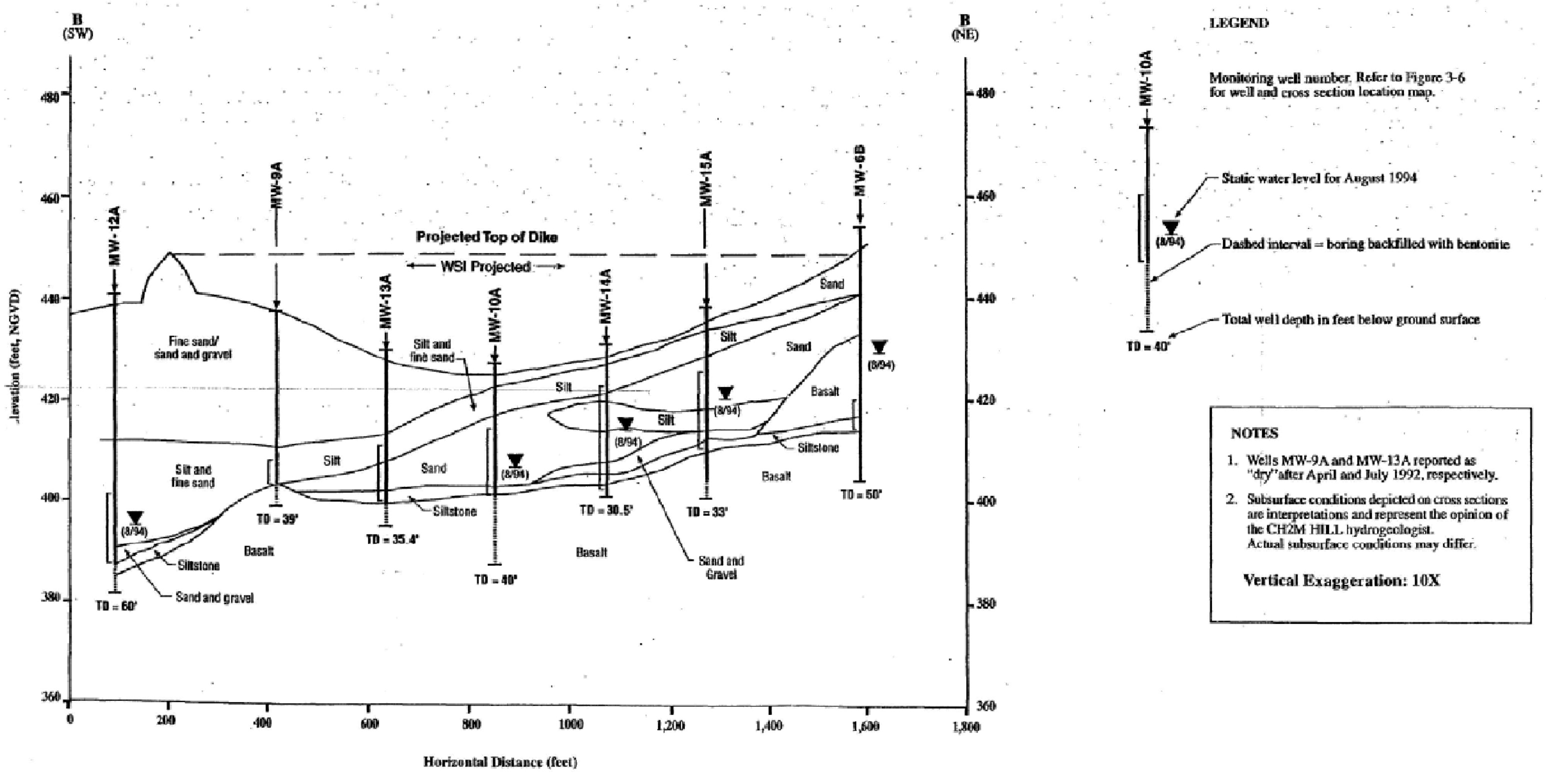
Vertical Exaggeration: 5X

Source:
Tetra Tech
Final Remedial Investigation
Work Plan, Volume 1: Phase 1
Work Plan Columbia Gorge
Aluminum Smelter Site
2015

Figure A6
Regional Hydrogeologic Cross Section A-A'

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
www.erm.com



NOTES

1. Wells MW-9A and MW-13A reported as "dry" after April and July 1992, respectively.
2. Subsurface conditions depicted on cross sections are interpretations and represent the opinion of the CH2M HILL hydrogeologist. Actual subsurface conditions may differ.

Vertical Exaggeration: 10X

Source:
Tetra Tech
Final Remedial Investigation
Work Plan, Volume 1: Phase 1
Work Plan Columbia Gorge
Aluminum Smelter Site
2015

Figure A7
West Surface Impoundment Cross Section

Remedial Investigation /
Feasibility Study
Goldendale Energy Storage
Project
Goldendale, Washington

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Management
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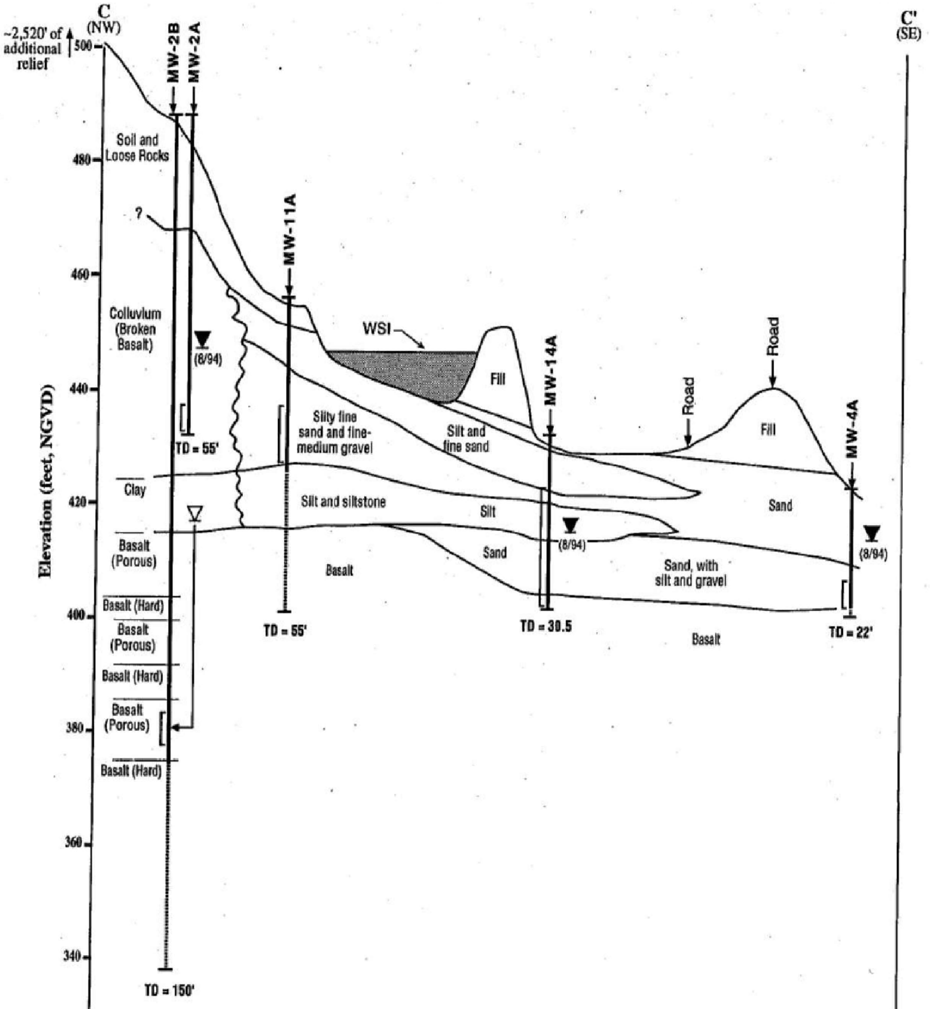
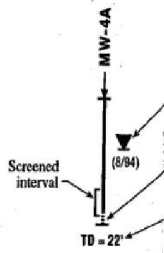


LEGEND



Monitoring well number. Refer to Figure 3-6 for well and cross section location map.

Static water level for August 1994

Dashed interval = boring backfilled with bentonite

Total well depth in feet below ground surface

▽ Water level in underlying saturated zone for August 1994

NOTES

1. Wells MW-9A and MW-13A reported as "dry" after April and July 1992, respectively.
2. Subsurface conditions depicted on cross sections are interpretations and represent the opinion of the CH2M HILL hydrogeologist. Actual subsurface conditions may differ.
3. WSI inserted for graphical purposes only; elevations are schematic and are not necessarily representative of this feature.

Vertical Exaggeration: 10X

Source:
Tetra Tech
Final Remedial Investigation
Work Plan, Volume 1: Phase 1
Work Plan Columbia Gorge
Aluminum Smelter Site
2015

Figure A8
Hydrogeologic Cross Section C-C'

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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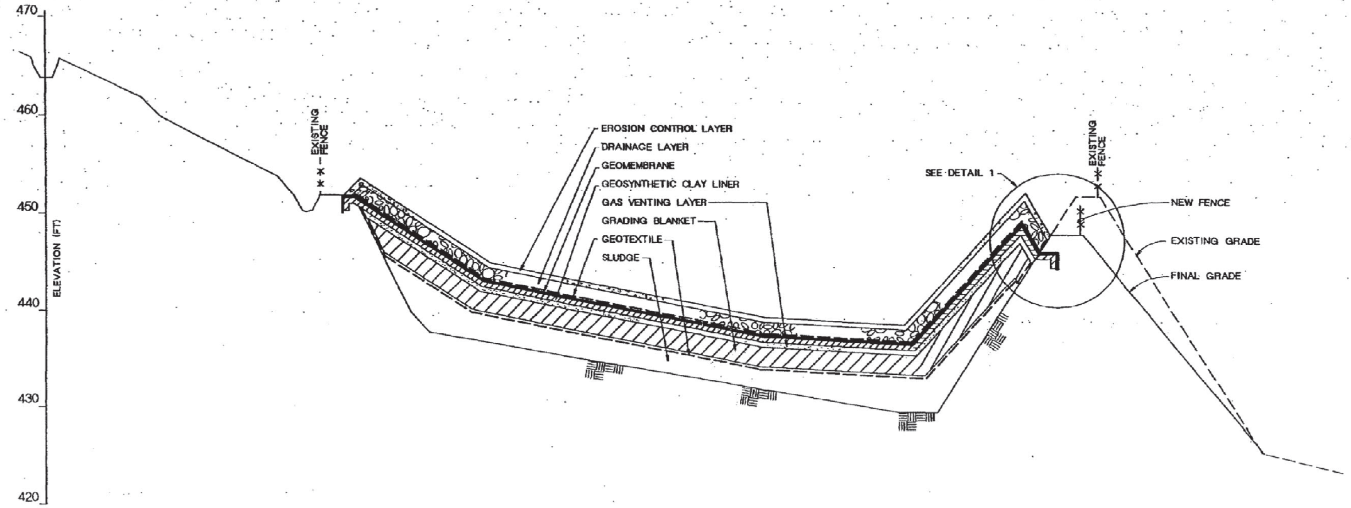

SECTION A
SCALE : HORIZ 1"=50'
VERT 1"=10'

Source:
Parametrix
West Surface Impoundment
Closure and Postclosure Plan
2004

Figure A9
Typical Cross Section through Constructed Cover

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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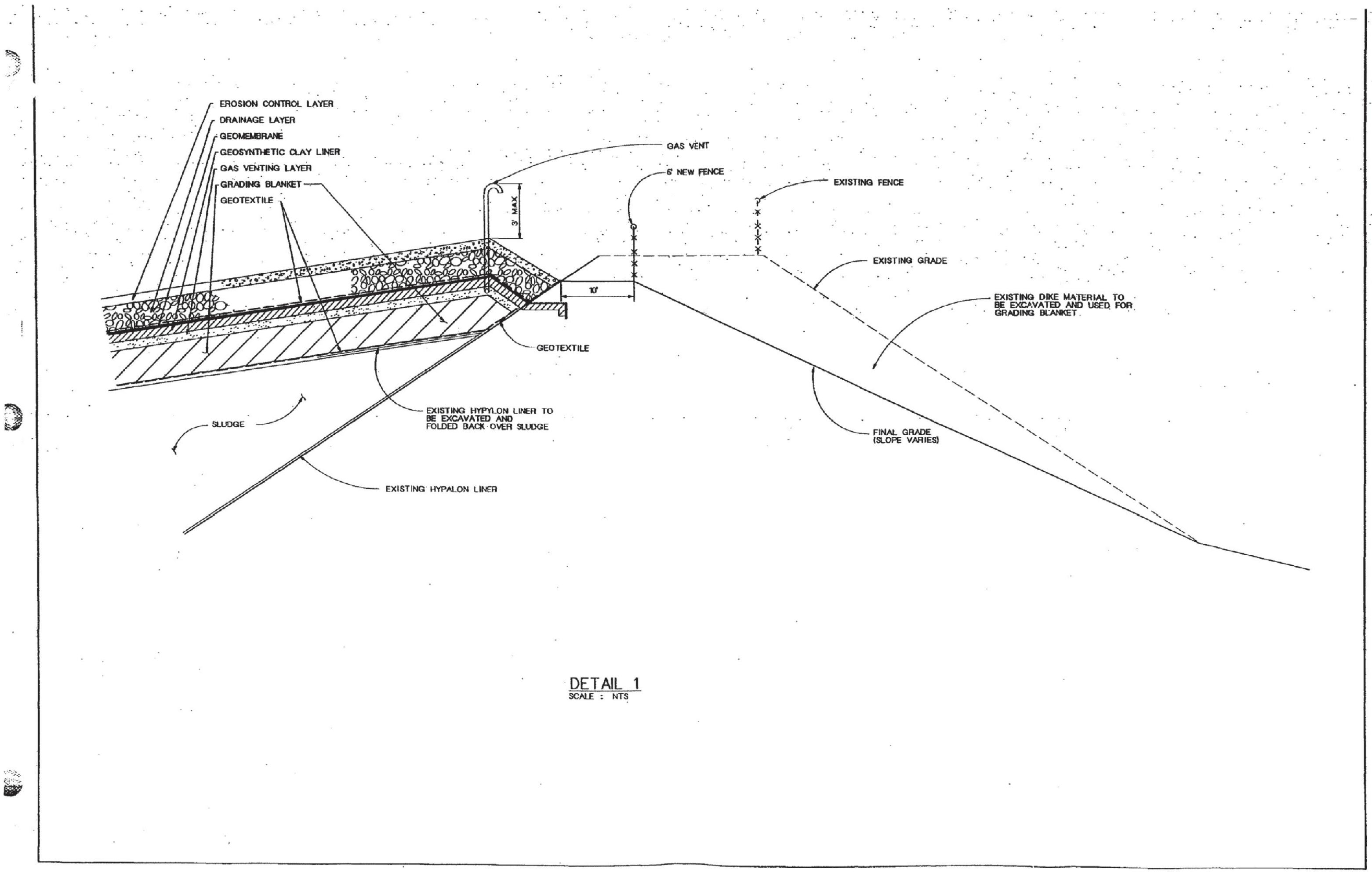

DETAIL 1
SCALE : NTS

Source:
Parametrix
West Surface Impoundment
Closure and Postclosure Plan
2004

Figure A10
Typical Cover Perimeter Details at South Dike

Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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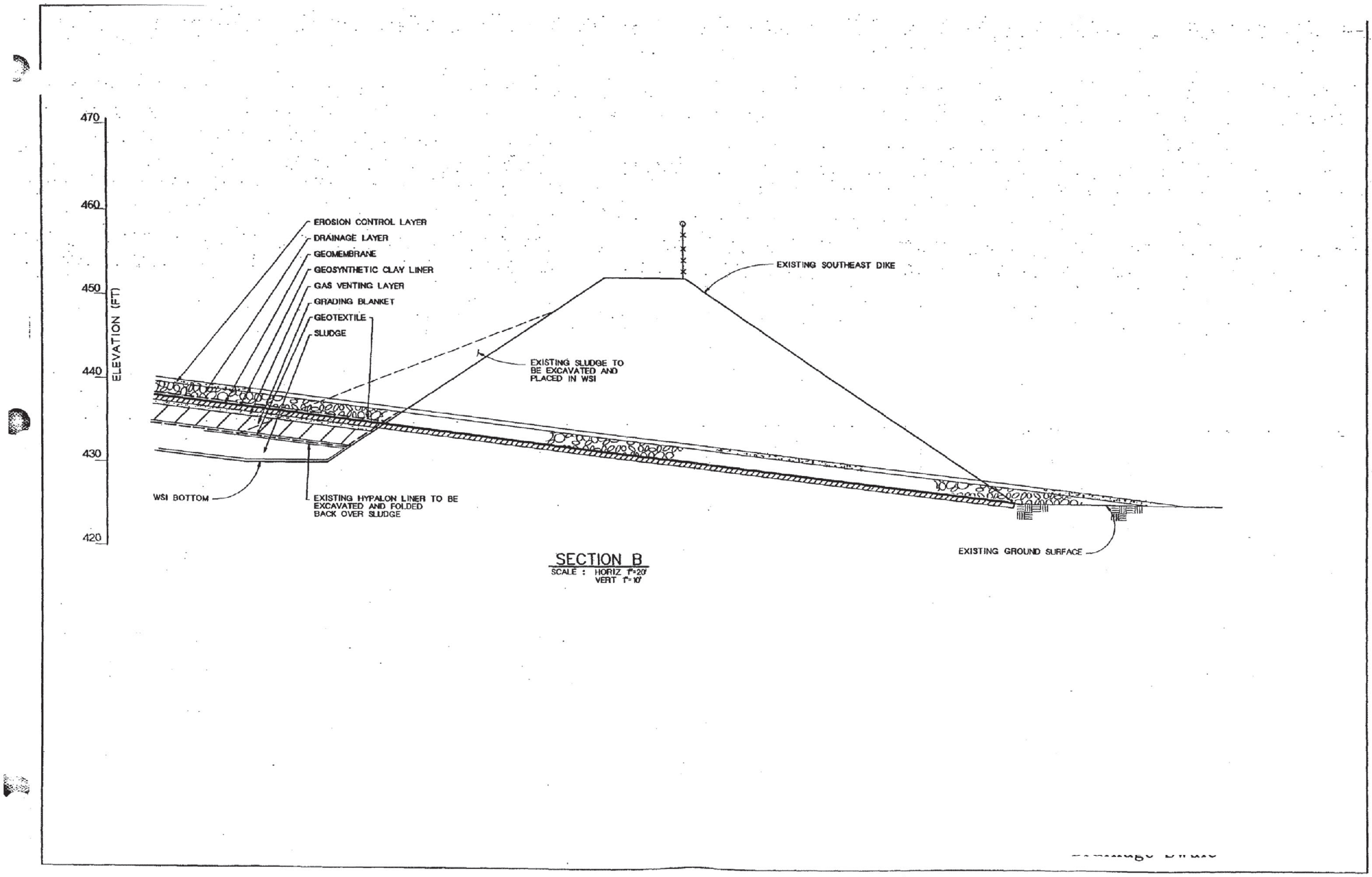

Source:
Parametrix
West Surface Impoundment Closure and Postclosure Plan
2004

Figure A11

Section Through Drainage Swale

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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APPENDIX B LOWER RESERVOIRE PRELIMINARY DESIGN DETAILS

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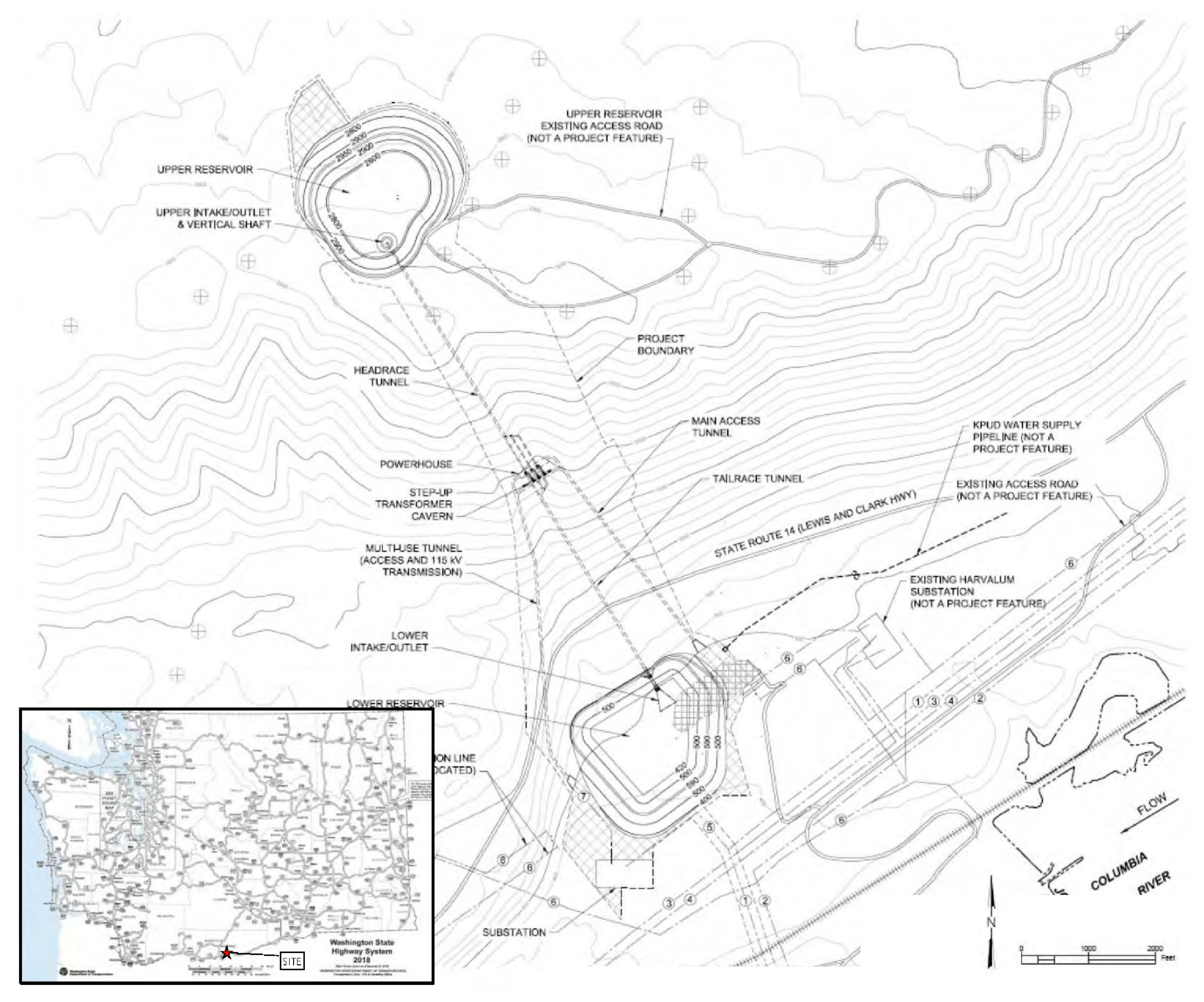


LEGEND:

- ⊠ CONSTRUCTION LAYDOWN AND PARKING AREA
- ▦ WEST SURFACE IMPOUNDMENT
- ① EXISTING ROCK CREEK-JOHN DAY NO.1 500 KV TRANSMISSION LINE
- ② EXISTING HARVALUM-JOHN DAY NO.2 500 KV TRANSMISSION LINE
- ③ EXISTING MCNARY-ROSS NO.1 345 KV TRANSMISSION LINE
- ④ EXISTING HARVALUM-BIG EDDY NO.1 230 KV TRANSMISSION LINE
- ⑤ NEW 500 KV TRANSMISSION LINE
- ⑥ EXISTING DISTRIBUTION LINE (NOT A PROJECT FEATURE)
- ⊕ WIND TURBINE (EXISTING, NOT A PROJECT FEATURE)
- ⑦ NEW 115 KV PROJECT TRANSMISSION LINE

NOTES:

1. HORIZONTAL DATUM = NAD83; VERTICAL DATUM = NAVD88 (ELEVATIONS IN FT)
2. SOURCE OF DEM: U.S. GEOLOGICAL SURVEY, 20180501, USGS NED $\frac{1}{3}$ ARC-SECOND N46W121 1X1 DEGREE ARCGRID 2018; U.S. GEOLOGICAL SURVEY
3. TUNNELS NECESSARY FOR CONSTRUCTION OF UNDERGROUND FACILITIES NOT SHOWN

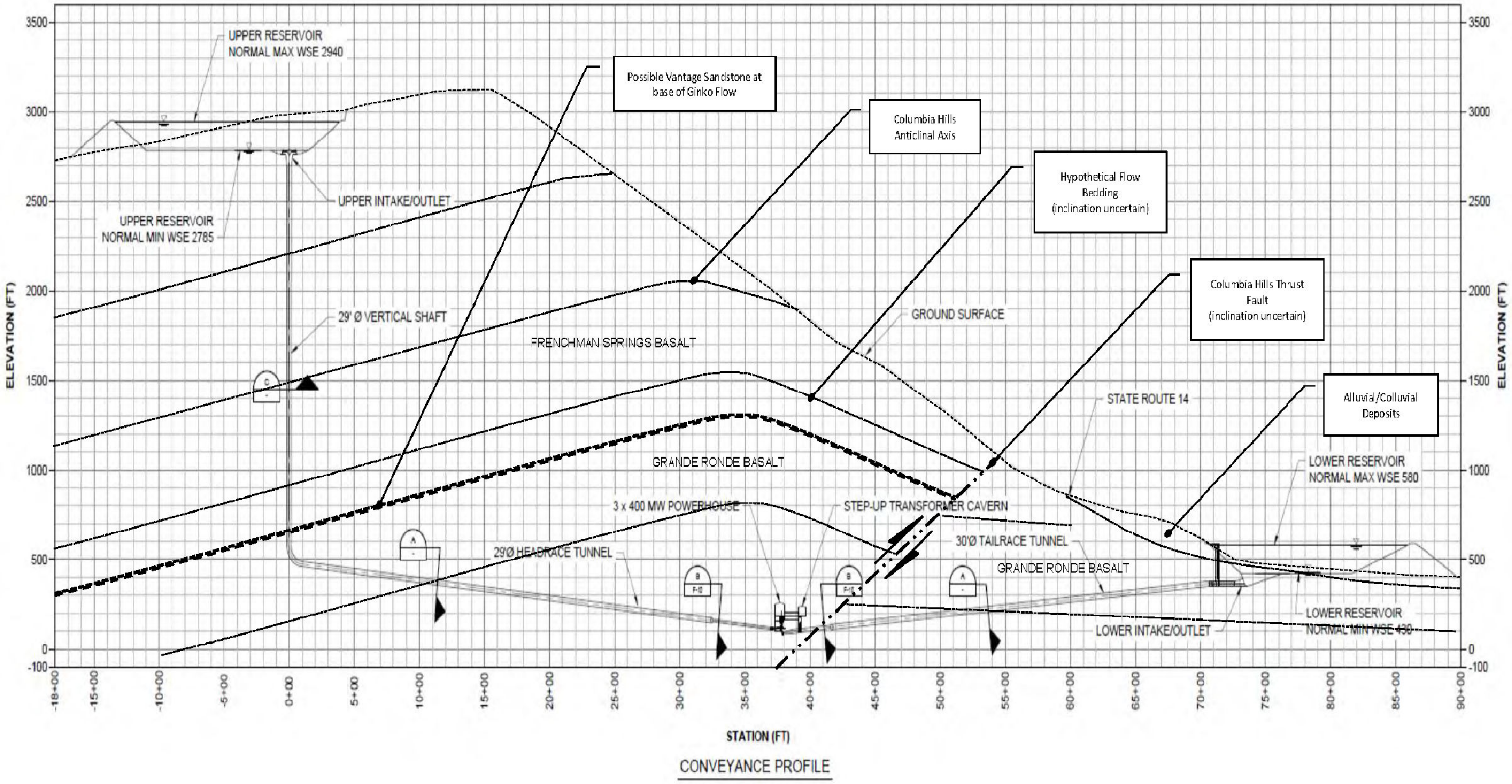
Source: HDR. 2017. *JD Pool Pumped Storage Hydropower Project Conceptual Study Klickitat County, Washington.* June 9.

Figure B1

Site Location and Conceptual Project Plan

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
www.erm.com



Source: HDR. 2017. *JD Pool Pumped Storage Hydropower Project Conceptual Study Klickitat County, Washington.* June 9.

Figure B2
Project Profile - Conceptual
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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APPENDIX C CROSS SECTIONS

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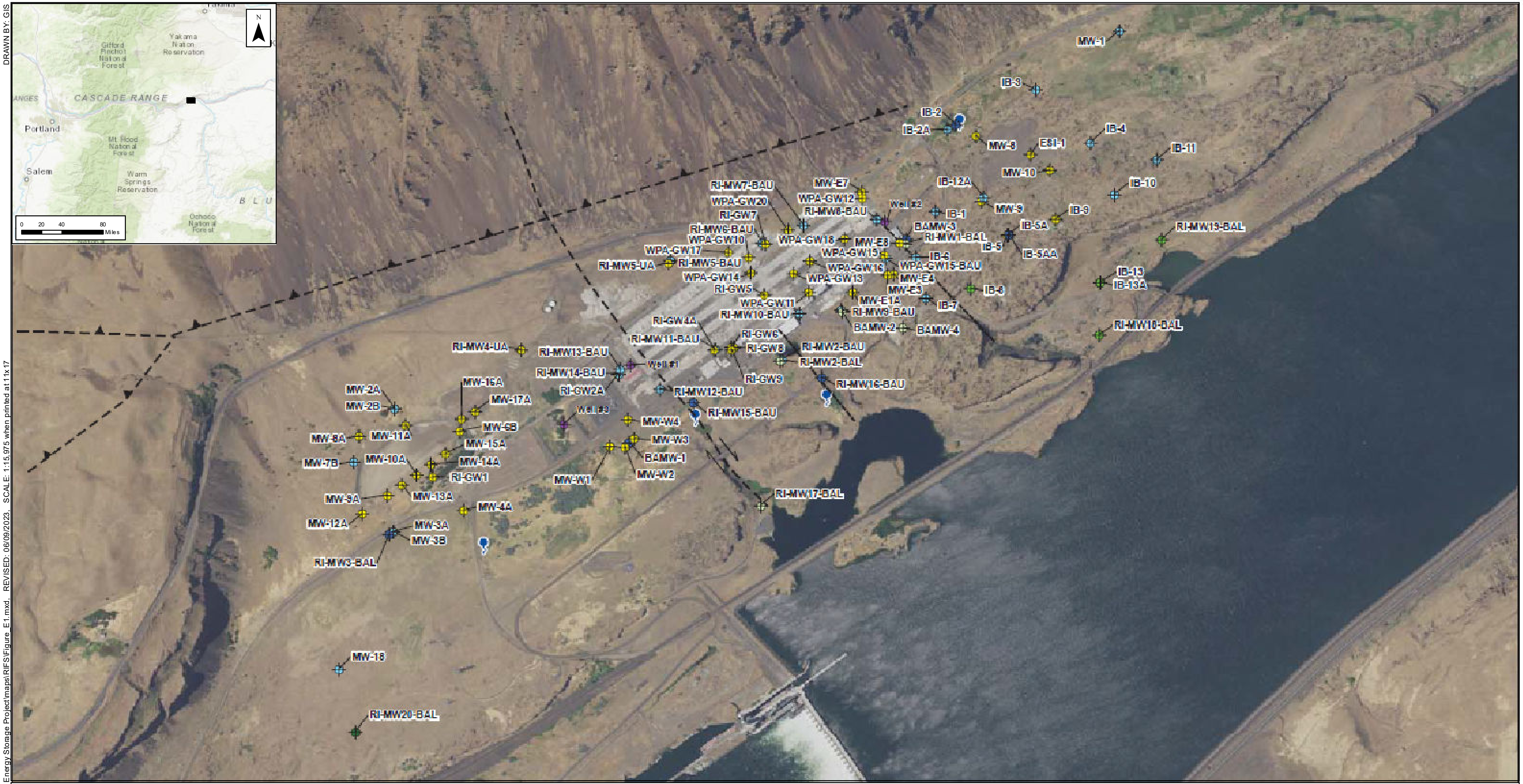

Legend

- ✚ Production Well
- ✚ Unconsolidated Aquifer Well (UA)

Uppermost Basalt Aquifer Well (BAU)

- ✚ BAU_1 - Shallower Water-bearing Zone
- ✚ BAU_2 - Deeper Water-bearing Zone

Lower Basalt Aquifer Well (BAL)

- ✚ BAL_1 - Shallower Water-bearing Zone
- ✚ BAL_2 - Deeper Water-bearing Zone
- ✚ BAL_3 - Deepest Water-bearing Zone

- Spring
- Thrust Fault
- Strike Slip Fault
- Fault Displacement and Location Uncertain

Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure C1
Monitoring Well Network and Site Faults
emedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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Source: Esri - World Topographic Map; NAD 1983 UTM Zone 10N

DRAWN BY: GIS

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Source: Esri - World Topographic Map; NAD 1983 UTM Zone 10N

Legend

- ✛ Production Well
- ✛ Unconsolidated Aquifer Well (UA)

Uppermost Basalt Aquifer Well (BAU)

- ✛ BAU_1 - Shallower Water-bearing Zone
- ✛ BAU_2 - Deeper Water-bearing Zone

Lower Basalt Aquifer Well (BAL)

- ✛ BAL_1 - Shallower Water-bearing Zone
- ✛ BAL_2 - Deeper Water-bearing Zone
- ✛ BAL_3 - Deepest Water-bearing Zone

A ●—● A' Cross-Section

📍 Spring

Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure C2

Plan View of Cross-Sections

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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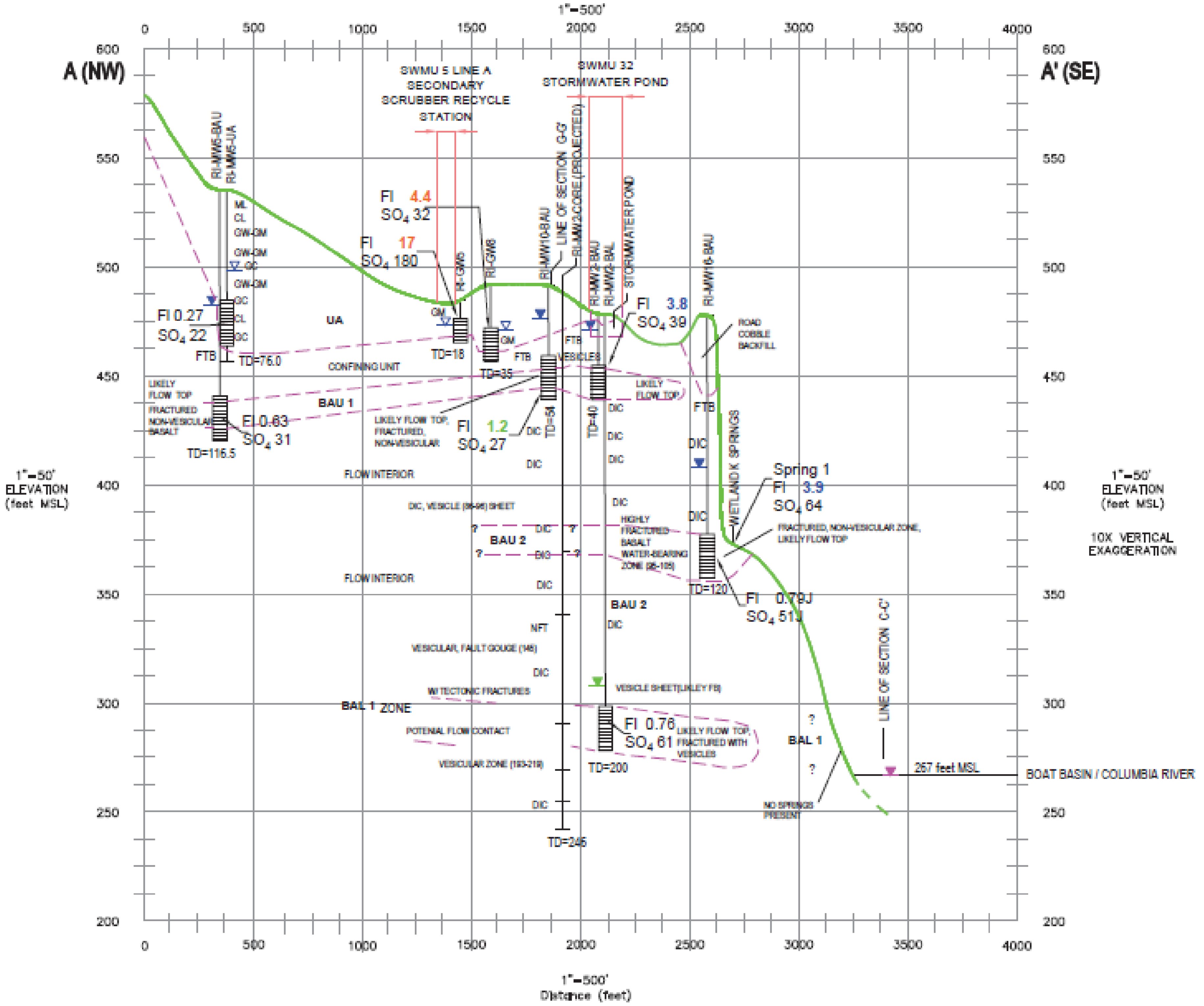

Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
FB	Flow Bottom
FTB	Flow-top breccia
IVZ	Internal vesicular zone
NFT	Normal Flow Top
Wx	Weathered

Unified Soil Classification System

CL	Clay
ML	Silt
GC	Clayey Gravel
GM	Silty Gravel
GP	Poorly Graded Gravel
GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen Interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI	4.5	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

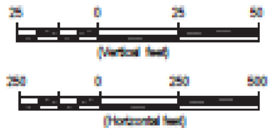

Figure C3
Cross Section A-A'
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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Source: Esri - World Topoographic Map; NAD 1983 UTM Zone 10N

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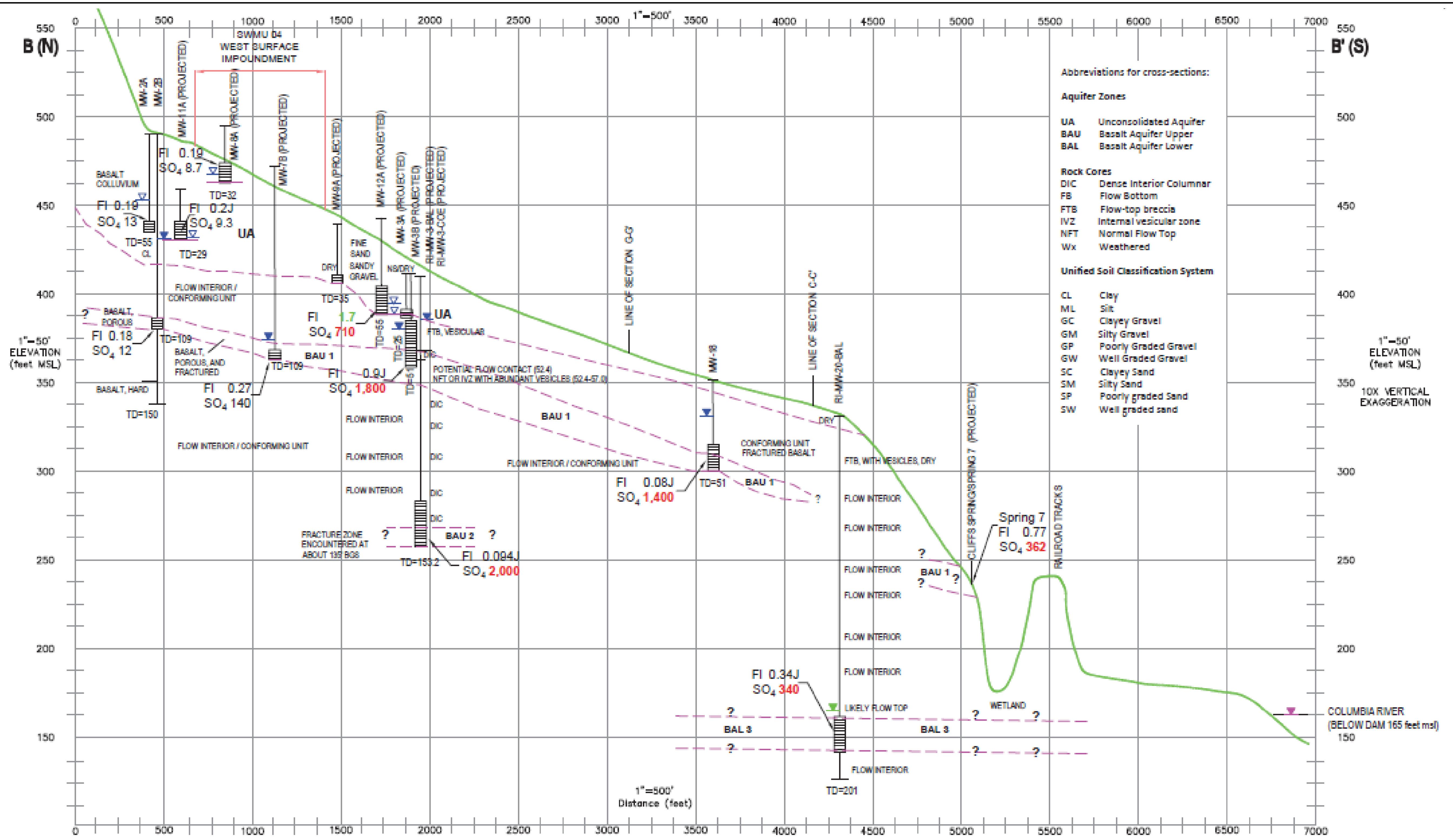

Abbreviations for cross-sections:

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BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
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IVZ	Internal vesicular zone
NFT	Normal Flow Top
Wx	Weathered

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GW	Well Graded Gravel
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SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

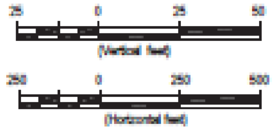
▤ Well Screen Interval

Legend

- ▼ Surface Water-Level Elevation, During Baseline Round
- ▽ UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- ▼ BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- ▼ BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- --- Lithologic Contact

FI	4.6	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.



Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

Figure C4
Cross Section B-B'
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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Source: Esri - World Topoographic Map; NAD 1983 UTM Zone 10N

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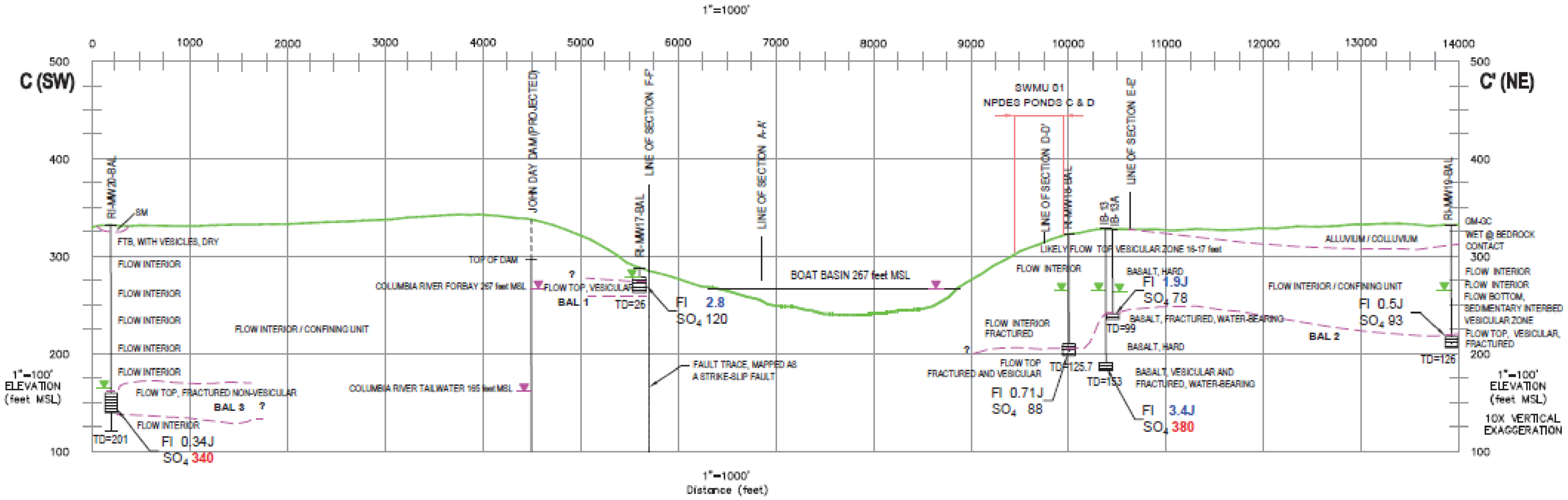

Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
FB	Flow Bottom
FTB	Flow-top breccia
IVZ	Internal vesicular zone
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GM	Silty Gravel
GP	Poorly Graded Gravel
GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

▤ Well Screen Interval

Legend

▼	Surface Water-Level Elevation, During Baseline Round
▽	UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
▼	BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
▼	BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- - -	Lithologic Contact

FI	4.6	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
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SO_4	300	Exceeds Secondary MCL of 250 mg/L

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Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

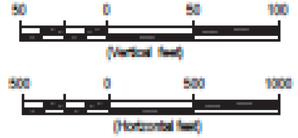

Figure C5
Cross Section C-C'
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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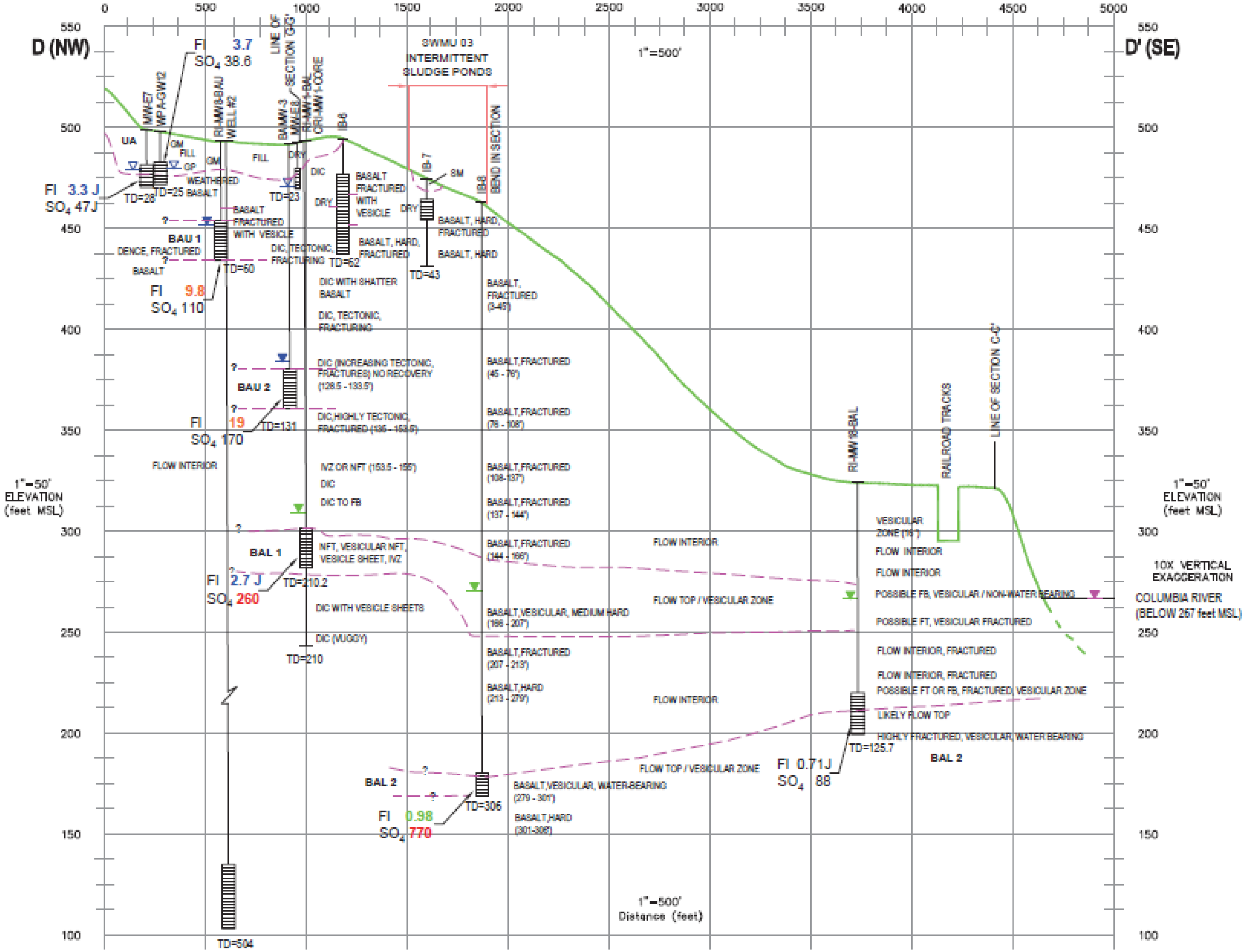
Source: Esri - World Topoographic Map; NAD 1983 UTM Zone 10N



Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
FB	Flow Bottom
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GC	Clayey Gravel
GM	Silty Gravel
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GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen Interval

Legend

- ▼ Surface Water-Level Elevation, During Baseline Round
- ▽ UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- ▼ BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- ▼ BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- --- Lithologic Contact

FI	4.5	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

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Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

25 0 25 50
(Vertical feet)

250 0 250 500
(Horizontal feet)

Figure C6
Cross Section D-D'

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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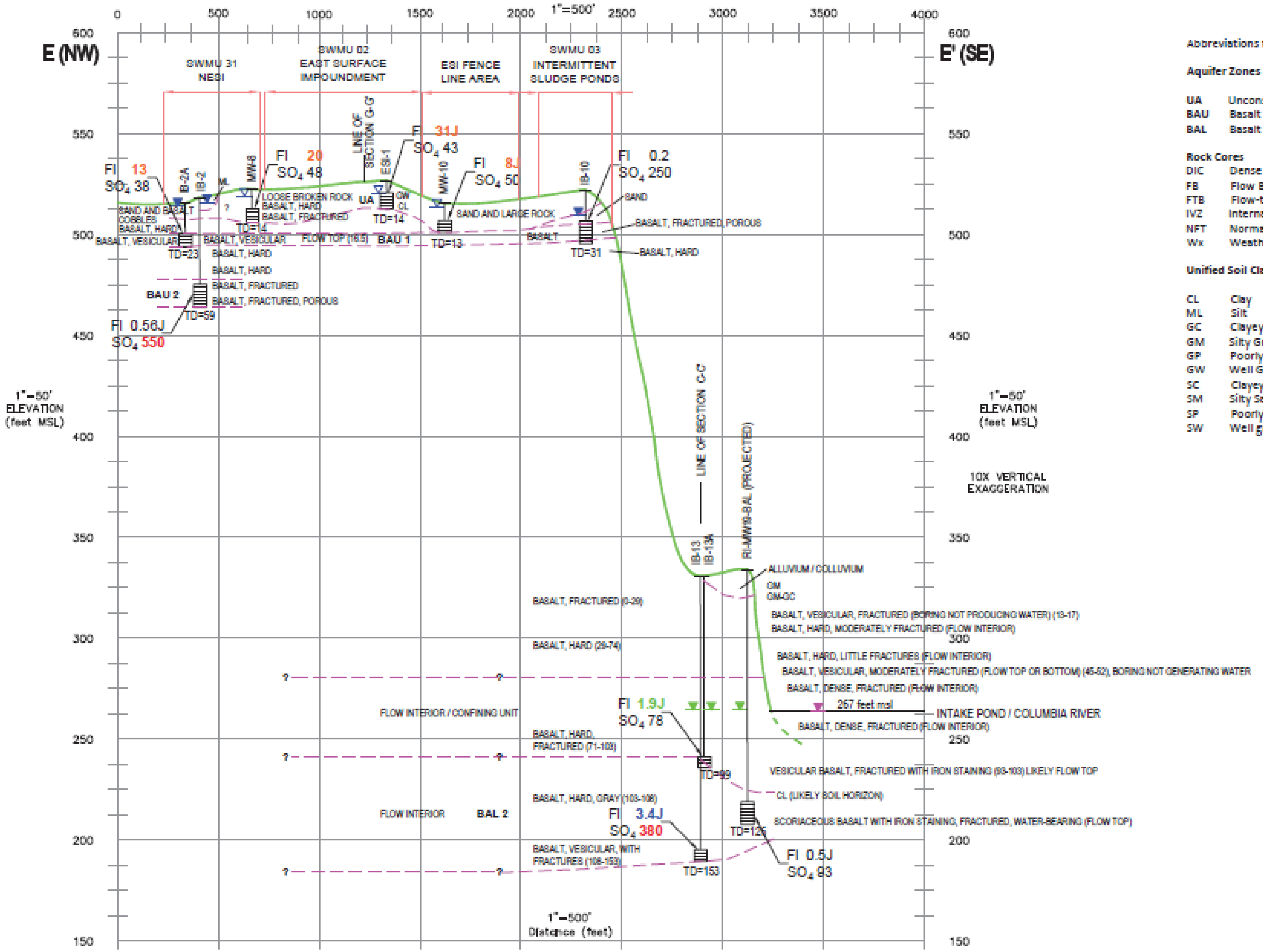

Abbreviations for cross-sections:

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BAL	Basalt Aquifer Lower

Rock Cores

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SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level
Well Screen Interval

Legend
- ▼ Surface Water-Level Elevation, During Baseline Round
- ▽ UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- ▼ BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- ▼ BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- --- Lithologic Contact

FI	4.6	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

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Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

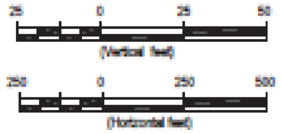

Figure C7
Cross Section E-E'
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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Source: Esri - World Topoographic Map; NAD 1983 UTM Zone 10N

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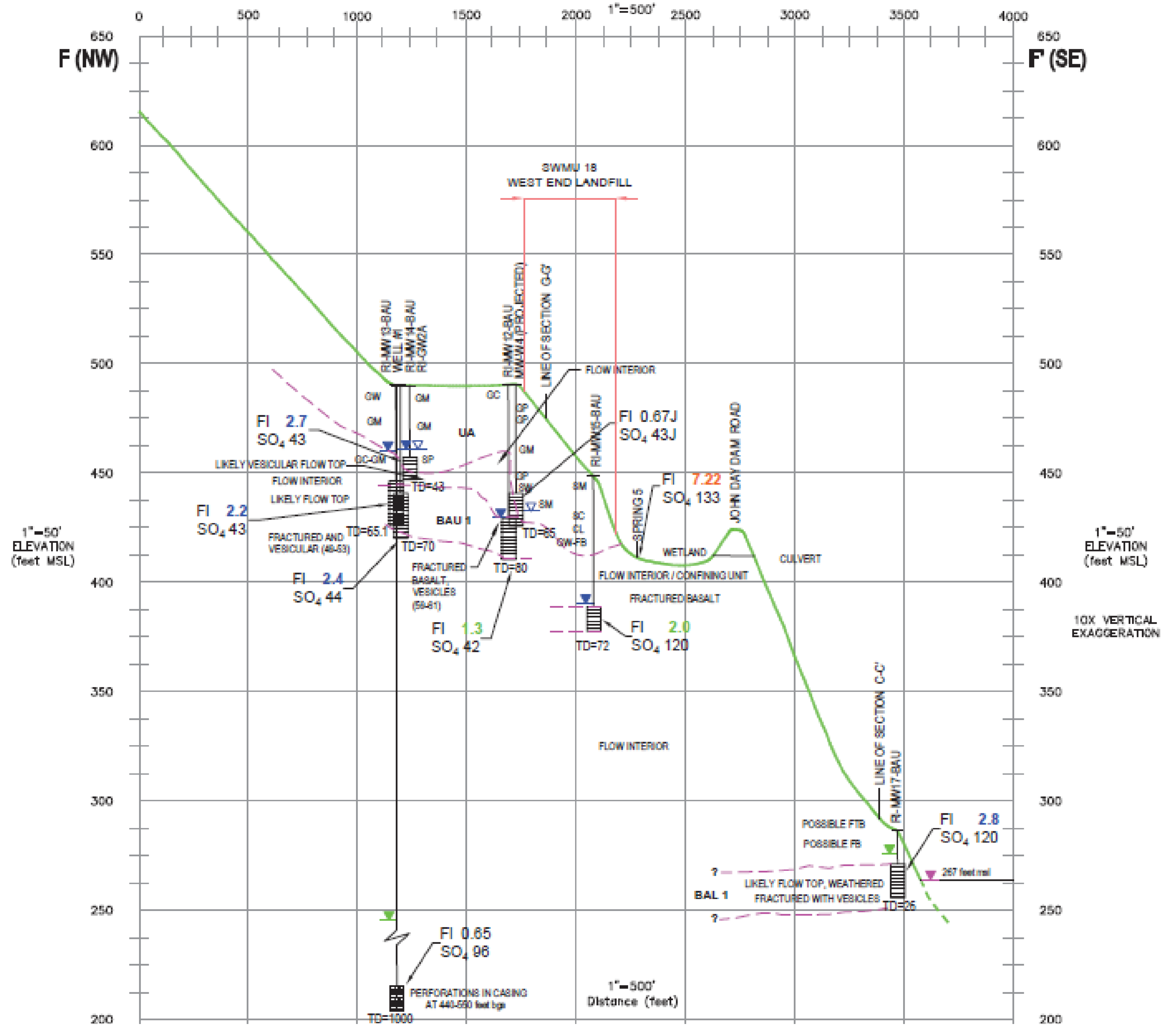

Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
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FTB	Flow-top breccia
IVZ	Internal vesicular zone
NFT	Normal Flow Top
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Unified Soil Classification System

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GC	Clayey Gravel
GM	Silty Gravel
GP	Poorly Graded Gravel
GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen Interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI	4.6	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
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Source:
Tetra Tech Revised Remedial
Investigation Report Vol. 4, 2021

25 0 25 50
(Vertical feet)

250 0 250 500
(Horizontal feet)

Figure C8

Cross Section F-F'

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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Source: Esri - World Topoographic Map; NAD 1983 UTM Zone 10N

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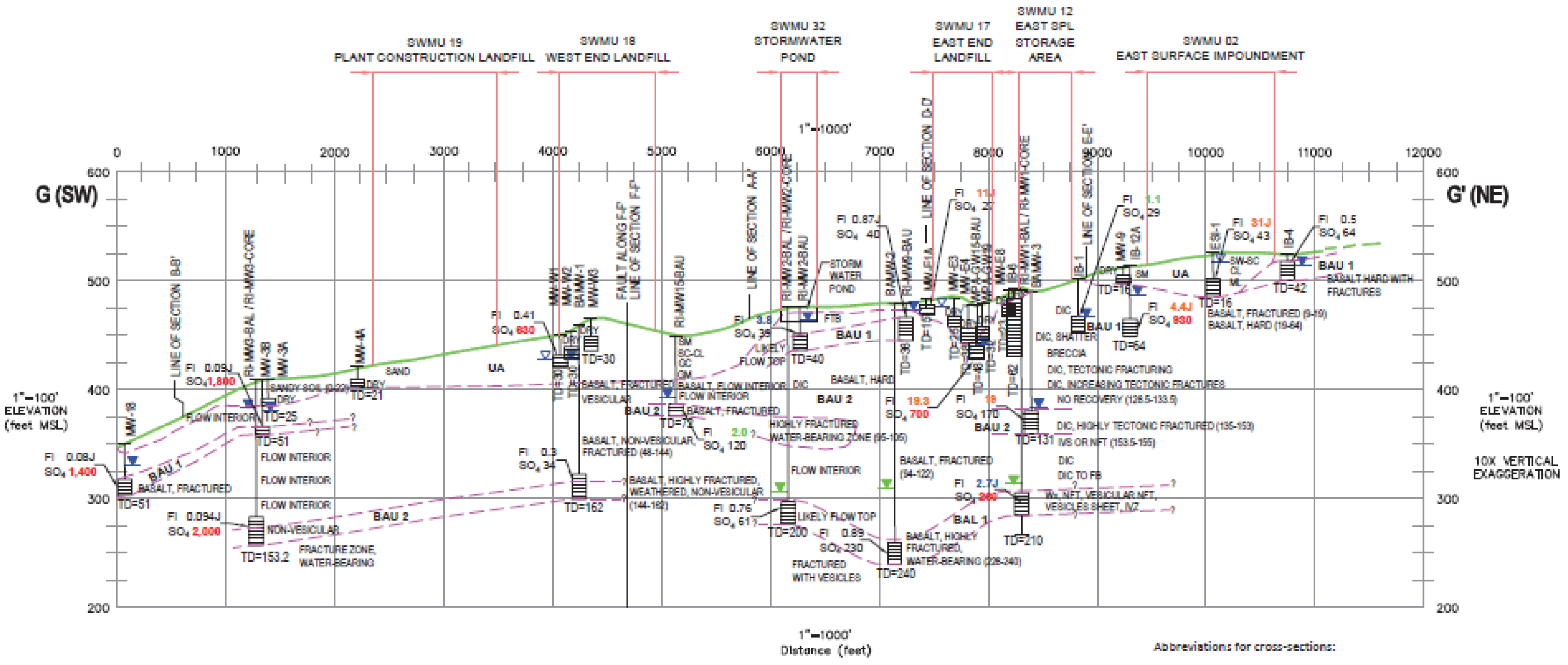

Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
FB	Flow Bottom
FTB	Flow-top breccia
IVZ	Internal vesicular zone
NFT	Normal Flow Top
Wx	Weathered

ESI - East Surface Impoundment
WELF - West End Landfill

Unified Soil Classification System

CL	Clay
ML	Silt
GC	Clayey Gravel
GM	Silty Gravel
GP	Poorly Graded Gravel
GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen Interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

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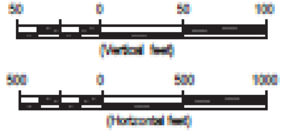

Figure C9

Cross Section G-G'

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
www.erm.com

Source: Esri - World Topoographic Map; NAD 1983 UTM Zone 10N

APPENDIX D SAMPLE RESULTS AT SPRINGS

Table 3-4
Wetlands AOC - Spring Water Results - RI and WPA Results
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
2017 and Spring 2021
(Page 1 of 2)

									Analytical Results												
									NESI Wetland			Wetland F	Wetland D	Cliffs	Wetland K						
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Site Background	Selected Screening Level	Fraction Analyzed	NESI Wetland-01 3/2/2017	SWMU31-WPA-NESI-Spring4 4/1/2021	SWMU31-WPA-NESI-Spring11 (Duplicate of SWMU31-WPA-NESI-Spring4) 4/1/2021	WLAOC-WPA-WTLF-Spring5 4/1/2021	WLAOC-WPA-WTLD-Spring6 4/1/2021	WPA-CliffsSpring7 4/1/2021	Spring1-01 2/25/2017	Spring1-02 5/4/2017	Spring1-03 8/24/2017	Spring1-04 11/7/2017	WLAOC-WPA-WTLK-Spring1 4/1/2021	WLAOC-WPA-WTLK-Spring2 4/1/2021	WLAOC-WPA-WTLK-Spring3 4/1/2021
Aluminum Smelter																					
Cyanide[a]	mg/L	NA	0.01	0.022	0.2	NE	0.01	Total	0.06 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.06 U	0.06 U	0.06 U	0.06 U	0.0005 U	0.0005 U	0.0005 U
Cyanide, Free	mg/L	NA	0.01	0.022	0.2	NE	0.01	Total	1.5 U	NA	NA	NA	NA	NA	0.0015 U	NA	NA	NA	NA	NA	NA
Cyanide, Weak Acid Dissociable	mg/L	NA	NE	NE	NE	NE	NE	Total	0.06 U	NA	NA	NA	NA	NA	0.06 U	0.06 U	0.06 U	0.06 U	NA	NA	NA
Fluoride	mg/L	NA	0.96	2.1	4.0	0.72	0.96	Total	**20 J**	**16.8**	**17.3**	**7.22**	**1**	0.77	**3.9**	**3.5 J**	**3.8**	**3.7**	**3.31**	**3.43**	**3.05**
Sulfate	mg/L	NA	NE	NE	250	32	250	Total	120	31.7	32.2	133	22.1	**362**	64	60	40	32	31.2	32.1	34.5
Polycyclic Aromatic Hydrocarbons (PAHs)																					
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	NE	1.5	Total	0.0068 U	NA	NA	NA	NA	NA	0.006 U	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	µg/L	NL	32	70	NE	NE	32	Total	0.01 U	0.0013 U	0.0013 U	0.0018 B	0.0013 U	0.0013 U	0.009 U	NA	NA	NA	0.0013 U	0.0013 U	0.0017 B
Acenaphthene	µg/L	NA	960	2,100	NE	NE	960	Total	0.0023 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.002 U	NA	NA	NA	0.0012 U	0.0016 J	0.0012 U
Acenaphthylene	µg/L	NA	NE	NE	NE	NE	NE	Total	0.0023 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.002 U	NA	NA	NA	0.0011 U	0.0011 U	0.0011 U
Anthracene	µg/L	NA	4,800	11,000	NE	NE	4,800	Total	0.01 J	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.003 U	NA	NA	NA	0.0013 J	0.0015 J	0.0014 J
Benzo(a)anthracene	µg/L	NA	NL	NL	NE	NE	NE	Total	0.0023 U	0.002 B	0.0017 B	0.0023 B	0.0016 B	0.0016 B	0.0043 J	NA	NA	NA	0.0047 B	0.0092 J	0.0045 B
Benzo(a)pyrene	µg/L	NL	NL	NL	NL	NE	NL	Total	0.0034 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0057 J	NA	NA	NA	0.0041 J	0.012 J	0.0033 J
Benzo(b)fluoranthene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0091 U	0.00083 U	0.00083 U	0.00083 U	0.00083 U	0.00083 U	0.012 J	NA	NA	NA	0.005 J	0.014 J	0.0045 J
Benzo(ghi)perylene	µg/L	NA	NE	NE	NE	NE	NE	Total	0.0034 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.0051 J	NA	NA	NA	0.0032 J	0.008 J	0.0027 J
Benzo(k)fluoranthene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.01 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.009 U	NA	NA	NA	0.0018 J	0.0047 J	0.0014 J
Chrysene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0068 U	0.00076 U	0.00076 U	0.00076 U	0.00076 U	0.00076 U	0.0072 J	NA	NA	NA	0.0029 J	0.0095 J	0.0028 J
Dibenzo(a,h)anthracene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0023 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.002 U	NA	NA	NA	0.0013 U	0.0022 J	0.0013 U
Fluoranthene	µg/L	NA	640	1,400	NE	NE	640	Total	0.0023 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.0083 J	NA	NA	NA	0.0036 J	0.014 J	0.0033 J
Fluorene	µg/L	NA	640	1,400	NE	NE	640	Total	0.0034 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.003 U	NA	NA	NA	0.0089 J	0.0011 U	0.0011 U
Indeno(1,2,3-cd)pyrene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0079 U	0.00000089 U	0.00000089 U	0.00000089 U	0.00000089 U	0.00000089 U	0.007 U	NA	NA	NA	0.0000033 J	0.0000083 J	0.0000026 J
Naphthalene	µg/L	160	160	350	NE	NE	160	Total	0.015 U	0.0024 B	0.0016 B	0.0042 B	0.0014 U	0.0028 B	0.013 U	NA	NA	NA	0.002 B	0.0028 B	0.0025 B
Phenanthrene	µg/L	NA	NE	NE	NE	NE	NE	Total	0.0083 B	0.0019 B	0.0012 B	0.0011 U	0.0011 U	0.0011 U	0.005 B	NA	NA	NA	0.0029 B	0.007 B	0.0026 B
Pyrene	µg/L	NA	480	1,100	NE	NE	480	Total	0.0045 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0093 J	NA	NA	NA	0.0052 J	0.013 J	0.0039 J
Dibenzofuran	µg/L	NA	16	35	NE	NE	16	Total	NA	0.0012 B	0.00096 U	0.00096 U	0.00096 U	0.00096 U	NA	NA	NA	NA	0.00096 U	0.0012 B	0.0019 B
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	NE	0.2	Total	0.003314	0.0009518	0.0009218	0.0009818	NA	NA	0.008302	NA	NA	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)																					
PCB-aroclor 1016	µg/L	NA	1.1	2.5	NE	NE	1.1	Total	0.022 U	NA	NA	NA	NA	NA	0.021 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	µg/L	NA	NE	NE	NE	NE	NE	Total	0.032 U	NA	NA	NA	NA	NA	0.03 UJ	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	µg/L	NA	NE	NE	NE	NE	NE	Total	0.029 U	NA	NA	NA	NA	NA	0.027 UJ	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	µg/L	NA	NE	NE	NE	NE	NE	Total	0.03 U	NA	NA	NA	NA	NA	0.028 UJ	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	µg/L	NA	NE	NE	NE	NE	NE	Total	0.022 U	NA	NA	NA	NA	NA	0.021 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	µg/L	NA	0.044	0.44	NE	NE	0.044	Total	0.021 U	NA	NA	NA	NA	NA	0.02 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	µg/L	NA	0.044	0.44	NE	NE	0.044	Total	0.027 U	NA	NA	NA	NA	NA	0.026 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	µg/L	NA	NE	NE	NE	NE	NE	Total	0.033 U	NA	NA	NA	NA	NA	0.031 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	µg/L	NA	NE	NE	NE	NE	NE	Total	0.026 U	NA	NA	NA	NA	NA	0.025 U	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	NE	0.044	Total	0.021 U	NA	NA	NA	NA	NA	0.02 U	NA	NA	NA	NA	NA	NA

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

Appendix D

Table 3-4 Wetlands AOC - Spring Water Results

Remedial Investigation / Feasibility Study

Goldendale Energy Storage Project

Goldendale, Washington

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Table 3-4
Wetlands AOC - Spring Water Results - RI and WPA Results
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
2017 and Spring 2021
(Page 2 of 2)

									Analytical Results												
									NESI Wetland			Wetland F	Wetland D	Cliffs	Wetland K						
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Site Background	Selected Screening Level	Fraction Analyzed	NESI Wetland-01 3/2/2017	SWMU31-WPA-NESI-Spring4 4/1/2021	SWMU31-WPA-NESI-Spring11 (Duplicate of SWMU31-WPA-NESI-Spring4) 4/1/2021	WLAOC-WPA-WTLF-Spring5 4/1/2021	WLAOC-WPA-WTLD-Spring6 4/1/2021	WPA-CliffsSpring7 4/1/2021	Spring1-01 2/25/2017	Spring1-02 5/4/2017	Spring1-03 8/24/2017	Spring1-04 11/7/2017	WLAOC-WPA-WTLK-Spring1 4/1/2021	WLAOC-WPA-WTLK-Spring2 4/1/2021	WLAOC-WPA-WTLK-Spring3 4/1/2021
Metals																					
Aluminum	mg/L	NA	16	35	NE	1.14	16	Dissolved	0.89	0.783	0.765	0.0122	0.0034 J	0.0047	0.1 U	NA	NA	NA	0.0036 J	0.0027 J	0.0055
Aluminum	mg/L	NA	16	35	NE	0.433	16	Total	1.1	0.83	0.835	0.0922	0.0029 B	0.0031 B	0.1 U	NA	NA	NA	0.0513	0.256	0.539
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.002	0.00051	0.00058	0.00105	0.00315	0.00453	0.0022	0.0015	0.0017	0.0015	0.00157	0.00159	0.00152
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.0014	0.00059	0.00063	0.00105	0.00324	**0.00443**	0.002	0.0015	0.0018	0.0015	0.00162	0.0016	0.00171
Cadmium	mg/L	0.005	0.008	0.018	0.005	NE	0.005	Dissolved	0.000028 U	0.000008 U	0.000008 U	0.000008 U	0.000008 U	0.000008 U	0.000028 U	NA	NA	NA	0.000008 U	0.000008 U	0.000008 U
Cadmium	mg/L	0.005	0.008	0.018	0.005	NE	0.005	Total	0.000028 U	0.000013 J	0.000009 J	0.000008 U	0.000008 U	0.000008 U	0.000028 U	NA	NA	NA	0.000008 U	0.000011 J	0.000017 J
Chromium	mg/L	0.05	24	53	0.1	0.03	0.05	Dissolved	0.00032 J	0.00013 J	0.00013 J	0.00082	0.00033	0.00045	0.00039 J	NA	NA	NA	0.00013 J	0.00017 J	0.00009 J
Chromium	mg/L	0.05	24	53	0.1	0.055	0.05	Total	0.00026 J	0.00019 B	0.0002 B	0.00085	0.00029	0.00034	0.0003 J	NA	NA	NA	0.00013 B	0.00034	0.00058
Copper	mg/L	NA	0.64	1.4	1.3	NE	0.64	Dissolved	0.0015 J	0.00093	0.00083	0.00037	0.00033	0.00057	0.00097 J	NA	NA	NA	0.00038	0.00037	0.00065
Copper	mg/L	NA	0.64	1.4	1.3	NE	0.64	Total	0.0023	0.00101	0.00103	0.0004	0.00016	0.00029	0.0017 J	NA	NA	NA	0.0007	0.00109	0.00227
Iron	mg/L	NA	11	25	0.3	13	13	Dissolved	0.081	0.000006 J	0.000007 J	0.000015 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	mg/L	NA	11	25	0.3	1.361	1.361	Total	0.16	0.000017 J	0.000016 J	0.000048	NA	NA	0.18 U	NA	NA	NA	NA	NA	NA
Lead	mg/L	0.015	NE	NE	0.015	0.00046	0.015	Dissolved	0.00011 J	0.00002 U	0.00002 U	0.00002 U	0.000014 J	0.000021	0.000059 B	NA	NA	NA	0.000006 U	0.000007 J	0.000021
Lead	mg/L	0.015	NE	NE	0.015	0.00046	0.015	Total	0.00061	0.00002 U	0.00002 U	0.00002 U	0.000006 U	0.000006 U	0.0002 J	NA	NA	NA	0.000028	0.000137	0.00029
Mercury	mg/L	0.002	NE	NE	0.002	NE	0.002	Dissolved	0.000047 B	0.00104	0.00097	0.00018 J	0.00002 U	0.00002 U	0.000083 B	NA	NA	NA	0.00002 U	0.00002 U	0.00002 U
Mercury	mg/L	0.002	NE	NE	0.002	NE	0.002	Total	0.00006 B	0.00111	0.00107	0.00024	0.00002 U	0.00002 U	0.000081 B	NA	NA	NA	0.00002 U	0.00002 U	0.00002 U
Nickel	mg/L	NA	0.000096	0.00096	0.1	0.0065	0.0065	Dissolved	0.0021 J	0.0002 U	0.0002 U	0.0012	0.00011 J	0.0002 J	0.0004 U	NA	NA	NA	0.00012 J	0.00013 J	0.00017 J
Nickel	mg/L	NA	0.000096	0.00096	0.1	0.0038	0.0038	Total	0.0021 J	0.0002 U	0.0002 U	0.0011	0.00009 J	0.00008 J	0.0004 U	NA	NA	NA	0.00019 J	0.00031	0.00072
Selenium	mg/L	NA	0.08	0.18	0.05	NE	0.05	Dissolved	0.00064 J	0.0021	0.0017 J	0.0007 J	0.0006 J	0.001	0.0011	NA	NA	NA	0.0004 J	0.0004 J	0.0006 J
Selenium	mg/L	NA	0.08	0.18	0.05	NE	0.05	Total	0.00055 J	0.003	0.0024	0.0024	0.0006 J	0.0009 J	0.0014 B	NA	NA	NA	0.0004 J	0.0004 J	0.0007 J
Zinc	mg/L	NA	4.8	11	NE	NE	4.8	Dissolved	0.0024 J	NA	NA	NA	0.0018 J	0.0033	0.0019 U	NA	NA	NA	0.0005 J	0.0008 J	0.0011 J
Zinc	mg/L	NA	4.8	11	NE	NE	4.8	Total	0.0033 J	NA	NA	NA	0.0005 U	0.0005 U	0.0024 J	NA	NA	NA	0.0008 J	0.0014 J	0.0029
Total Petroleum Hydrocarbons (TPHs)																					
Diesel Range Organics	mg/L	0.5	NE	NE	NE	NE	0.5	Total	NA	0.054 B	0.069 B	0.024 B	0.015 B	0.019 B	NA	NA	NA	NA	0.018 B	0.022 B	0.017 B
Residual Range Organics	mg/L	0.5	NE	NE	NE	NE	0.5	Total	NA	0.065 B	0.058 B	0.048 B	0.02 B	0.039 B	NA	NA	NA	NA	0.031 B	0.039 B	0.029 B
General Chemistry																					
Calcium	mg/L	NA	NE	NE	NE	NE	NE	Total	38	NA	NA	NA	NA	NA	30	NA	NA	NA	NA	NA	NA
Magnesium	mg/L	NA	NE	NE	NE	NE	NE	Total	23	NA	NA	NA	NA	NA	17	NA	NA	NA	NA	NA	NA
Potassium	mg/L	NA	NE	NE	NE	NE	NE	Total	7.5	NA	NA	NA	NA	NA	5.8	NA	NA	NA	NA	NA	NA
Sodium	mg/L	NA	NE	NE	NE	NE	NE	Total	86	NA	NA	NA	NA	NA	26	NA	NA	NA	NA	NA	NA
Chloride	mg/L	NA	NE	NE	NE	NE	NE	Total	15	NA	NA	NA	NA	NA	14	NA	NA	NA	NA	NA	NA
Calcium	mg/L	NA	NE	NE	NE	NE	NE	Total	38	NA	NA	NA	NA	NA	30	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	mg/L	NA	NE	NE	NE	NE	NE	Total	490	NA	NA	NA	NA	NA	280	NA	NA	NA	NA	NA	NA
Magnesium	mg/L	NA	NE	NE	NE	NE	NE	Total	23	NA	NA	NA	NA	NA	17	NA	NA	NA	NA	NA	NA
Alkalinity, Total	mg/L	NA	NE	NE	NE	NE	NE	Total	200	NA	NA	NA	NA	NA	110	NA	NA	NA	NA	NA	NA
Bicarbonate Alkalinity as CaCO3	mg/L	NA	NE	NE	NE	NE	NE	Total	200	NA	NA	NA	NA	NA	110	NA	NA	NA	NA	NA	NA
Carbonate Alkalinity as CaC03	mg/L	NA	NE	NE	NE	NE	NE	Total	5 U	NA	NA	NA	NA	NA	5 U	NA	NA	NA	NA	NA	NA
Hydroxide Alalinity as CaCO3	mg/L	NA	NE	NE	NE	NE	NE	Total	5 U	NA	NA	NA	NA	NA	5 U	NA	NA	NA	NA	NA	NA
Hardness as calcium carbonate	mg/L	NA	NE	NE	NE	NE	NE	Total	3,200	NA	NA	NA	NA	NA	150	NA	NA	NA	NA	NA	NA

Notes:
Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.
B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected.
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.

cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
µg/L = micrograms per liter
mg/L = milligrams per liter
MCL = Maximum Contaminant Level Goal
MTCA = Model Toxics Control Act
NA = Not Applicable
NE = Not Established

NL = Not Listed
PAHs = Polycyclic Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyls
SSL = Soil Screening Level
Total TEC = Total Toxicity Equivalent Concentration
TPH = Total Petroleum Hydrocarbons

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

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DRAWN BY: GIS

Spring 4	3/2/2017	4/1/2021	4/1/2021 Duplicate
Fluoride	20 J	16.8	17.3
Sulfate	120	31.7	32.2

Spring 3	4/1/2021
Fluoride	3.05
Sulfate	34.5

Spring 5	4/1/2021
Fluoride	7.22
Sulfate	133

Spring 1	2/25/2017	5/4/2017	8/24/2017	11/7/2017	4/1/2021
Fluoride	3.9	3.5 J	3.8	3.7	3.31
Sulfate	64	60	40	32	31.2

Spring 2	4/1/2021
Fluoride	3.43
Sulfate	32.1

Spring 6	4/1/2021
Fluoride	1
Sulfate	22.1

Spring 7	4/1/2021
Fluoride	0.77
Sulfate	362
Metals (mg/L)	
Arsenic	0.00443
Total Dissolved Arsenic	0.00453

N
W E
S

0 500 1,000 2,000
Feet

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

Legend

● Spring Sample Location

▨ Wetland Area

orange: Exceeds MCL Screening Level
red: Exceeds MTCA Method C
green: Exceeds MTCA Method B
black: Below Screening Levels

Sulfate MCL represents a secondary MCL and does not represent a health-based criteria.
Total Arsenic exceeds screening level and site background groundwater concentration.

Figure D1

Sample Results at Springs

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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APPENDIX E SAMPLE RESULTS AT HISTORICAL WETLANDS (RI)

Table 3-1
Wetlands AOC - Wetland D RI and WPA Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
Spring 2016 and Winter 2020
(Page 1 of 2)

				Ecological Indicator				Analytical Results														
Parameter Name	Units	MTCA Method A Industrial	MTCA Method C	Eco-SSL Wildlife	Protection of Groundwater[a]	Selected Screening Level	Natural Background	WLAOC-SS12 5/4/2016	WLAOC-SS13 5/4/2016	WLAOC-SS14 5/4/2016	WLAOC-SS15 5/4/2016	WLAOC-SS16 5/4/2016	WLAOC-SS17 5/4/2016	WLAOC-SS18 5/4/2016	WLAOC-SS40 (Duplicate of WLAOC-SS18) 5/4/2016	WLAOC-SS19 5/4/2016	WLAOC-WPA-WTLD-SS-1 12/9/2020	WLAOC-WPA-WTLD-SS-2 12/9/2020	WLAOC-WPA-WTLD-SS-3 12/9/2020	WLAOC-WPA-WTLD-SS-57 Duplicate of WLAOC-WPA-WTLD-SS-3) 12/9/2020	WLAOC-WPA-WTLD-SS-4 12/9/2020	WLAOC-WPA-WTLD-SS-5 12/9/2020
Aluminum Smelter																						
Cyanide[b]	mg/Kg	NA	2,200	5.0	1.9	1.9	NE	2.2 UJ	1.9 UJ	2.1 UJ	1.8 UJ	1.9 UJ	2 UJ	2 UJ	2.2 UJ	**5.4 J**	0.09 J	0.12 J	0.21 J	0.62 J	0.12 J	0.82
Fluoride	mg/Kg	NA	210,000	NE	147.6[c]	147.6	14.11	5.5 J	2.8 J	3.5 J	4.8 J	2.4 J	5.6 J	0.33 U	0.69 J	2.3 J	3.7 J	1.1 J	2.7 J	1.9 J	1.5 J	5.2 J
Sulfate	mg/Kg	NA	NE	NE	2,150[c]	2,150	NE	**7,700 J**	58 J	11 B	7.8 B	7.3 B	12 B	420 J	380 J	78 J	16.6	1.1 J	28.2 J	34.8 J	1.8 J	37.8
Polycyclic Aromatic Hydrocarbons (PAHs)																						
1-Methylnaphthalene	mg/Kg	NL	4,500	NL	0.082	0.082	NE	0.028 J	0.0006 U	0.0006 U	0.00054 U	0.0019 J	0.001 J	0.00068 U	0.0023 J	0.0058 U	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	mg/Kg	NL	14,000	NL	1.7	1.7	NE	0.042 J	0.00094 J	0.00043 U	0.00038 U	0.002 J	0.0011 J	0.00049 U	0.0026 J	0.0041 U	0.00099 J	0.0004 U	0.0004 U	0.00069 J	0.00054 J	0.001 J
Acenaphthene	mg/Kg	NA	210,000	NL	98	98	NE	0.32	0.0067	0.0016 J	0.0024 J	0.0057	0.0055	0.0029 J	0.0048 J	0.0055 U	0.0077	0.00047 J	0.00033 U	0.0015 J	0.00033 U	0.0047 J
Acenaphthylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.0057 U	0.00048 U	0.00048 U	0.00043 U	0.00044 U	0.00051 U	0.00054 U	0.00057 U	0.0046 U	0.00032 U	0.00031 U	0.00031 U	0.00031 U	0.00031 U	0.00066 J
Anthracene	mg/Kg	NA	NE	NL	2,300	2300	NE	0.25	0.0049	0.0012 J	0.0011 J	0.0045	0.0028 J	0.0045 J	0.0078	0.0055 U	0.0085	0.00073 J	0.00077 J	0.0017 J	0.00066 J	0.0051 J
Benz[a]anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	2.4	0.077	0.014	0.019	0.075	0.035	0.05	0.072	0.03 J	0.055	0.0068	0.015 J	0.03 J	0.0097	0.12
Benzo(a)pyrene	mg/Kg	2.0	NL	NL	NL	NL	NE	2.7	0.078	0.016	0.024	0.1	0.044	0.056	0.079	0.037 J	0.086	0.012	0.021 J	0.055 J	0.016	0.2
Benzo(b)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	4.4	0.12	0.031	0.041	0.18	0.062	0.11	0.14	0.069	0.11	0.019	0.038 J	0.096 J	0.032	0.53
Benzo(ghi)perylene	mg/Kg	NA	NE	NL	NE	NL	NE	2.2	0.071	0.014	0.021	0.1	0.03	0.063	0.075	0.036 J	0.061	0.012	0.019 J	0.053 J	0.017	0.26
Benzo(k)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	1.2	0.034	0.0084	0.013	0.059	0.02	0.033	0.042	0.027 J	0.037	0.0057	0.013 J	0.03 J	0.0091	0.15
Chrysene	mg/Kg	NL	NL	NL	NL	NL	NE	3.4	0.095	0.02	0.028	0.13	0.047	0.12	0.11	0.054	0.07	0.013	0.023 J	0.059 J	0.019	0.21
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.43	0.013	0.0025 J	0.0037 J	0.025 J	0.0054	0.0099	0.013	0.0066 U	0.015	0.0026 J	0.0046 J	0.013 J	0.0039 J	0.069
Fluoranthene	mg/Kg	NA	140,000	NL	630	630	NE	4.2	0.11	0.027	0.031	0.12	0.066	0.091	0.12	0.061	0.087	0.012	0.023 J	0.046 J	0.015	0.13
Fluorene	mg/Kg	NA	140,000	NL	100	100	NE	0.16	0.0031 J	0.00048 U	0.00043 U	0.0034 J	0.00051 U	0.004 J	0.0063	0.0046 U	0.0041 J	0.00062 U	0.00062 U	0.001 J	0.00063 U	0.0025 J
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NL	NL	NL	NE	2.6	0.076	0.016	0.026	0.1	0.038	0.066	0.083	0.039 J	0.068	0.012	0.02 J	0.057 J	0.017	0.27
Naphthalene	mg/Kg	5.0	70	NL	4.5	4.5	NE	0.068	0.0017 J	0.00076 U	0.00068 U	0.0042 J	0.0017 J	0.0033 J	0.0082	0.0073 U	0.0029 J	0.00063 J	0.00075 J	0.0016 J	0.0015 J	0.0022 J
Phenanthrene	mg/Kg	NA	NE	NL	NE	NL	NE	1.6	0.039	0.0095	0.0099	0.038	0.025	0.027 J	0.054 J	0.019 J	0.041	0.0044 J	0.0069 J	0.014 J	0.0046 J	0.035
Pyrene	mg/Kg	NA	110,000	NL	650	650	NE	3.5	0.098	0.02	0.028	0.1	0.054	0.077	0.1	0.053	0.075	0.011	0.017 J	0.04 J	0.013	0.097
Dibenzofuran	mg/Kg	NA	NL	NL	NL	NL	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0021 J	0.00065 U	0.00065 U	0.0011 J	0.00066 U	0.0019 J
Total TEC cPAH (calc)	mg/Kg	2.0	130	NE	3.9	3.9	NE	3.837	0.11095	0.02339	0.03455	0.1452	0.06051	0.08409	0.1151	0.05437	0.1152	0.01674	0.03029	0.07819	0.02336	0.316
LMW PAH	mg/Kg	NA	NE	100	NE	100	NE	6.668	0.16634	0.0393	0.0444	0.1797	0.1031	0.1327	0.206	0.08	0.15219	0.01823	0.03142	0.06649	0.0223	0.18116
HMW PAH	mg/Kg	NA	NE	1.1	NE	1.1	NE	**22.83**	0.662	0.1419	0.2037	0.869	0.3354	0.5849	0.714	0.345	0.577	0.0941	0.1706	0.433	0.1367	**1.906**
Polychlorinated Biphenyls (PCBs)																						
PCB-aroclor 1016	mg/Kg	NA	250	NE	NE	250	NE	NA	NA	NA	NA	NA	NA	0.0078 U	0.0079 U	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0044 U	0.0045 U	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0052 U	0.0052 U	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0017 UJ	0.0017 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0031 UJ	0.0031 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	mg/Kg	NA	66	NE	0.71	0.71	NE	NA	NA	NA	NA	NA	NA	0.0016 UJ	0.0016 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	mg/Kg	NA	66	NE	NE	66	NE	NA	NA	NA	NA	NA	NA	0.002 UJ	0.002 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.00053 UJ	0.00053 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.00095 UJ	0.00096 UJ	NA	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	mg/kg	10	66	0.65	NE	0.65	NE	NA	NA	NA	NA	NA	NA	0.00053 U	0.00053 U	NA	NA	NA	NA	NA	NA	NA
Metals																						
Aluminum	mg/Kg	NA	3,500,000	NE	480,000	480,000	28,299	5,900	5,200	6,200	6,300	5,400	6,200	6,300	5,400	5,900	6,660	6,080	5,540	5,700	6,070	7,030
Arsenic	mg/Kg	20	88	132	2.9	7.61	7.61	**16**	1.9	2	2.7	3	3.8	2.3	2.8	4.4	5.16	3.12	2.67	2.63	3.23	5.29
Cadmium	mg/Kg	2.0	3,500	14	0.69	0.81	0.81	0.13	0.081 J	0.092 J	0.11	0.12	0.11	0.11	0.1	0.16	0.108	0.105	0.078	0.092	0.088	0.124
Chromium	mg/Kg	2,000	5,300,000	67	490,000	67	31.88	15 J	9.7 J	11 J	10 J	8.8 J	9.8 J	10 J	9.1 J	9.5 J	9.85	9.54	8.5	9.38	9.41	15.8
Copper	mg/Kg	NA	140,000	217	280	217	28.4	22	7.4	8.3	8.7	9.2	11	11	10	9.9	9.64	8.85	8.78	9.36	8.63	16.6
Lead	mg/Kg	1,000	NE	118	3,000	118	13.1	9.9	3.2	4.2	4.5	5.4	6.3	6.5 J	4.8 J	5.8	6.57	5.28	3.53	3.78	5.24	7.86
Mercury	mg/Kg	2.0	NE	5.5	2.1	2.1	0.04	0.049	0.0054 U	0.006 U	0.0055 U	0.0062 U	0.0093 J	0.0068 U	0.0064 U	0.007 J	0.006 J	0.006 J	0.005 J	0.008 J	0.009 J	0.015 J
Nickel	mg/Kg	NA	70,000	980	130	130	24.54	13	8	9.2	11	9.3	9.6	10	9.3	9	10.9	9.64	8.98	9.15	9.22	11.4
Selenium	mg/Kg	NA	18,000	0.3	5.2	0.3	0.29	**3**	**0.56**	**0.77**	**0.69**	**0.63**	**0.82**	**1.1**	**1.3**	**0.91**	0.1 J	0.1 J	0.09 U	0.1 U	0.1 U	**0.6 J**
Zinc	mg/Kg	NA	1,100,000	360	6,000	360	80.91	81	30	35	35	36	38	40	37	110	47	39.4	34.5	37.3	38.3	62.4
Total Petroleum Hydrocarbons (TPHs)																						
Diesel Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	NA	NA	NA	NA	NA	NA	60	69	NA	42	83	9.2 J	21 J	41	33 J
Residual Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	NA	NA	NA	NA	NA	NA	220	260	NA	98 J	130	28 J	68 J	81 J	240

Notes:

Bold and shaded values denote exceedances of one or more screening levels and background concentrations.

a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted.

b Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.

c Soil screening levels for protection of groundwater derived from literature or empirical demonstration (refer to Volume 1 for discussion).

B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected. J = The result is an estimated value.

U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable

NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbon
PCBs = Polychlorinated Biphenols
SSL = Soil Screening Level
TPH = Total Petroleum Hydrocarbons
Total TEC = Total Toxicity Equivalent Concentration

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

Appendix E

Table 3-1 Wetlands AOC - Wetlands D RI and WPA Soil Results Summary

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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Table 3-1
Wetlands AOC - Wetland D RI and WPA Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
Spring 2016 and Winter 2020
(Page 2 of 2)

Parameter Name	Units	MTCA Method A Industrial	MTCA Method C	Ecological Indicator	Protection of Groundwater[a]	Selected Screening Level	Natural Background	Analytical Results												
				Eco-SSL Wildlife				WLAOC-WPA-WTLD-SS-6 12/9/2020	WLAOC-WPA-WTLD-SS-7 12/9/2020	WLAOC-WPA-WTLD-SS-8 12/9/2020	WLAOC-WPA-WTLD-SS-9 12/9/2020	WLAOC-WPA-WTLD-SS-10 12/10/2020	WLAOC-WPA-WTLD-SS-11 12/10/2020	WLAOC-WPA-WTLD-SS-12 12/10/2020	WLAOC-WPA-WTLD-SS-58 (Duplicate of WLAOC-WPA-WTLD-SS-12) 12/10/2020	WLAOC-WPA-WTLD-SS-13 12/10/2020	WLAOC-WPA-WTLD-SS-14 12/10/2020	WLAOC-WPA-WTLD-SS-15 12/10/2020	WLAOC-WPA-WTLD-SS-16 12/10/2020	WLAOC-WPA-WTLD-SS-59 (Duplicate of WLAOC-WPA-WTLD-SS-16) 12/10/2020
Aluminum Smelter																				
Cyanide[b]	mg/Kg	NA	2,200	5.0	1.9	1.9	NE	0.24	0.22 J	0.07 U	0.5	0.17 J	0.71	0.2 J	0.2 J	0.17 J	0.3	0.07 U	0.28 J	0.47 J
Fluoride	mg/Kg	NA	210,000	NE	147.6[c]	147.6	14.11	3.8 J	8.8	5.3	3.5 J	2.3 J	0.6 U	2.8 J	1.4 J	3 U	3.1 J	1.6 J	2.6 J	2.1 J
Sulfate	mg/Kg	NA	NE	NE	2,150[c]	2,150	NE	70.1	**26,200**	53.1	19.9	4.4	139	1.2 J	1.3 J	662	48.1	1.1 U	38.6 J	24.8 J
Polycyclic Aromatic Hydrocarbons (PAHs)																				
1-Methylnaphthalene	mg/Kg	NL	4,500	NL	0.082	0.082	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	mg/Kg	NL	14,000	NL	1.7	1.7	NE	0.0071	0.0066 J	0.00079 J	0.0017 J	0.001 J	0.0077	0.00052 J	0.00067 J	0.00062 J	0.0026 J	0.0018 J	0.00043 J	0.00091 J
Acenaphthene	mg/Kg	NA	210,000	NL	98	98	NE	0.071	0.054	0.0024 J	0.013	0.0036 J	0.059	0.0017 J	0.0026 J	0.0067	0.029 J	0.0064	0.0015 J	0.00066 J
Acenaphthylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.0014 J	0.00081 J	0.00032 U	0.00037 J	0.00042 J	0.0021 J	0.00032 U	0.00031 U	0.00043 J	0.0011 J	0.00032 U	0.00032 U	0.00035 U
Anthracene	mg/Kg	NA	NE	NL	2,300	2300	NE	0.055	0.046	0.0024 J	0.012	0.0034 J	0.056	0.002 J	0.0031 J	0.008	0.026 J	0.006	0.001 J	0.00054 J
Benz[a]anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.73	0.44	0.025	0.13	0.046	0.57	0.023 J	0.044 J	0.12	0.36 J	0.058	0.019 J	0.012 J
Benzo(a)pyrene	mg/Kg	2.0	NL	NL	NL	NL	NE	0.94	0.57	0.032	0.22	0.062	0.71	0.036 J	0.074 J	0.18	0.48 J	0.083	0.027	0.021
Benzo(b)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	1.4	0.84	0.05	0.32	0.098	1.1	0.065 J	0.13 J	0.29	0.75 J	0.12	0.052	0.045
Benzo(ghi)perylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.69	0.41	0.027	0.19	0.057	0.55	0.036 J	0.071 J	0.16	0.39 J	0.066	0.028	0.025
Benzo(k)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	0.49	0.28	0.016	0.1	0.033	0.38	0.02 J	0.04 J	0.094	0.23	0.04	0.016	0.012
Chrysene	mg/Kg	NL	NL	NL	NL	NL	NE	0.96	0.6	0.035	0.19	0.067	0.8	0.038 J	0.068 J	0.17	0.51	0.1	0.032	0.025
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.19	0.11	0.0071	0.045	0.014	0.15	0.0091 J	0.018 J	0.04	0.1	0.017	0.0071	0.0058 J
Fluoranthene	mg/Kg	NA	140,000	NL	630	630	NE	1.1	0.7	0.044	0.2	0.075	0.92	0.036 J	0.063 J	0.18	0.55	0.091	0.026 J	0.015 J
Fluorene	mg/Kg	NA	140,000	NL	100	100	NE	0.03	0.029	0.002 J	0.0072	0.0027 J	0.036	0.00099 J	0.0014 J	0.0034 J	0.014	0.0039 J	0.0007 J	0.00072 J
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NL	NL	NL	NE	0.73	0.44	0.027	0.19	0.058	0.59	0.036 J	0.073 J	0.16	0.4	0.071	0.026	0.025
Naphthalene	mg/Kg	5.0	70	NL	4.5	4.5	NE	0.0081	0.01	0.0013 J	0.0032 J	0.0014 J	0.011	0.0011 J	0.0013 J	0.0016 J	0.0038 J	0.0042 J	0.0011 J	0.0018 J
Phenanthrene	mg/Kg	NA	NE	NL	NE	NL	NE	0.41	0.29	0.019	0.082	0.03	0.36	0.012 J	0.02 J	0.051 J	0.18	0.039	0.0083	0.0064
Pyrene	mg/Kg	NA	110,000	NL	650	650	NE	0.88	0.58	0.033	0.17	0.059	0.74	0.031 J	0.054 J	0.14 J	0.46	0.076	0.023 J	0.013 J
Dibenzofuran	mg/Kg	NA	NL	NL	NL	NL	NE	0.014	0.015	0.0014 J	0.0041 J	0.0017 J	0.019	0.00072 J	0.00087 J	0.0014 J	0.0061 J	0.0021 J	0.00067 U	0.00092 J
Total TEC cPAH (calc)	mg/Kg	2.0	130	NE	3.9	3.9	NE	1.3036	0.787	0.04486	0.3004	0.08757	0.997	0.05169	0.10518	0.2521	0.6691	0.1146	0.03933	0.03123
LMW PAH	mg/Kg	NA	NE	100	NE	100	NE	1.6826	1.13641	0.07189	0.31947	0.11752	1.4518	0.05431	0.09207	0.25175	0.8065	0.1523	0.03903	0.02603
HMW PAH	mg/Kg	NA	NE	1.1	NE	1.1	NE	**7.01**	**4.27**	0.2521	**1.555**	0.494	**5.59**	0.2941	0.572	**1.354**	**3.68**	0.631	0.2301	0.1838
Polychlorinated Biphenyls (PCBs)																				
PCB-aroclor 1016	mg/Kg	NA	250	NE	NE	250	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	mg/Kg	NA	66	NE	0.71	0.71	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	mg/Kg	NA	66	NE	NE	66	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	mg/kg	10	66	0.65	NE	0.65	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals																				
Aluminum	mg/Kg	NA	3,500,000	NE	480,000	480,000	28,299	7,130	7,360	5,160	5,030	5,710	5,980	5,880	5,640	4,810	6,260	4,630	6,320	6,320
Arsenic	mg/Kg	20	88	132	2.9	7.61	7.61	7.02	6.9	1.77	2.12	2.19	6.64	1.98	2.18	**9.38**	5.58	1.39	3.52	2.94
Cadmium	mg/Kg	2.0	3,500	14	0.69	0.81	0.81	0.084	0.067	0.051	0.102	0.08	0.191	0.127	0.154	0.097	0.102	0.053	0.092	0.077
Chromium	mg/Kg	2,000	5,300,000	67	490,000	67	31.88	15.3	16.6	8.51	7.49	8.94	12.5	10.5	9.95	11	13.4	8.6	12.4	11.7
Copper	mg/Kg	NA	140,000	217	280	217	28.4	15.6	18	6.93	9.42	8.36	14.8	9.19	8.95	12.3	14.4	5.26	10.5	10.1
Lead	mg/Kg	1,000	NE	118	3,000	118	13.1	8.11	7.86	2.8	3.22	3.67	6.95	4.31	4.95	6.45	7.73	2.5	5.7	4.64
Mercury	mg/Kg	2.0	NE	5.5	2.1	2.1	0.04	0.021 J	0.017 J	0.005 J	0.016 J	0.007 J	0.027	0.01 J	0.011 J	0.02 J	0.02 J	0.013 J	0.02 J	0.014 J
Nickel	mg/Kg	NA	70,000	980	130	130	24.54	10.3	10.4	7.09	7.76	8.33	10.1	8.92	8.57	8.23	8.82	6.32	8.8	8.82
Selenium	mg/Kg	NA	18,000	0.3	5.2	0.3	0.29	**0.8 J**	**0.8 J**	0.1 J	**0.4 J**	0.1 J	**1.1 J**	0.2 J	0.2 J	**1.8**	**0.6 J**	0.1 J	**0.4 J**	0.3 J
Zinc	mg/Kg	NA	1,100,000	360	6,000	360	80.91	68.9	104	37.7	38.7	32.6	83.9	83.5	97.5	33.4	63.7	28	43.1	41
Total Petroleum Hydrocarbons (TPHs)																				
Diesel Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	33	41	6.7 J	43	19 J	59	7.1 J	11 J	27 J	43	6.7 J	7.3 J	8.4 J
Residual Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	160	220	27 J	230	47 J	370	43 J	64 J	160	240	35 J	34 J	42 J

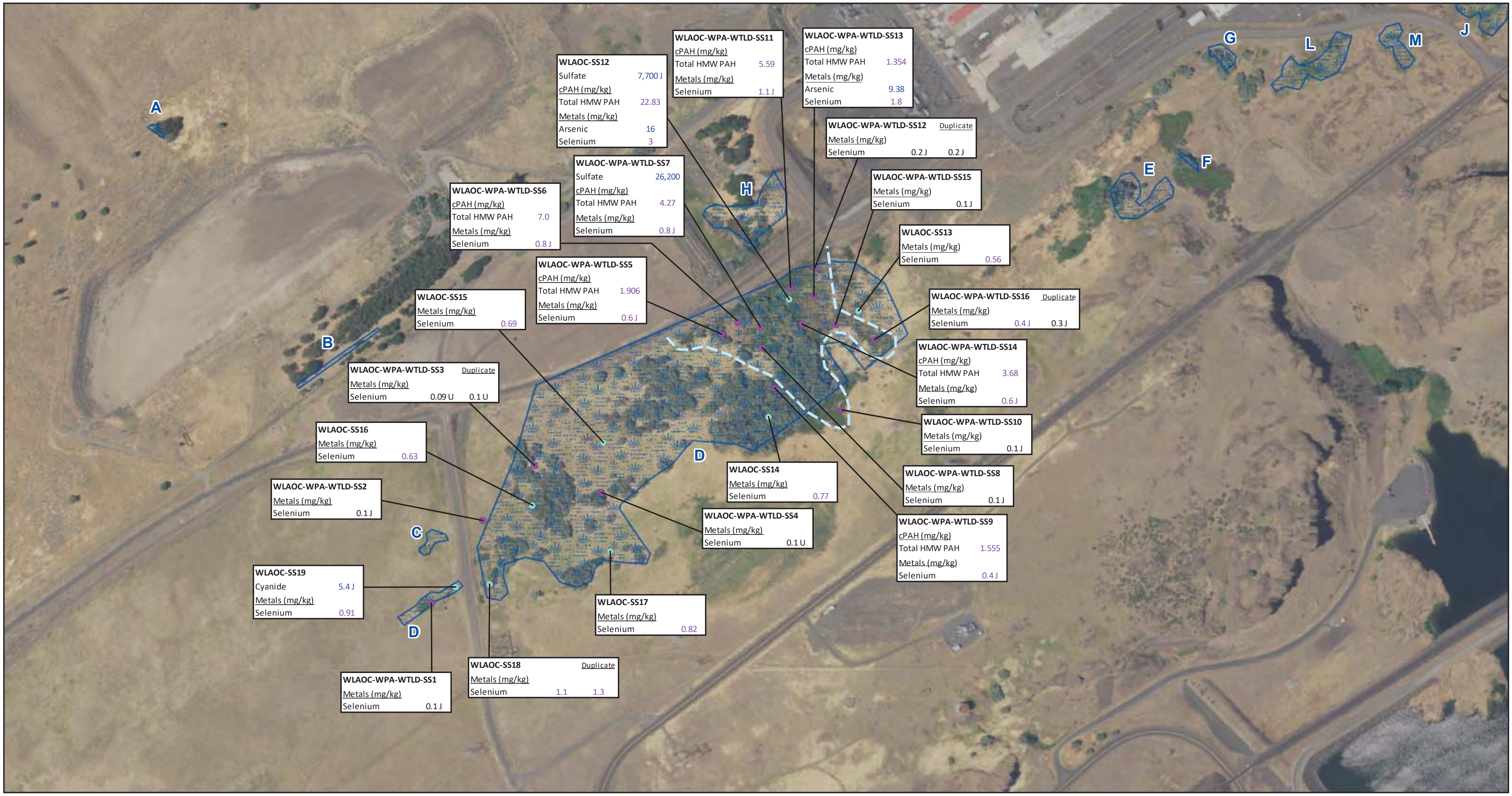
Notes:

Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted. b
Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically n c
Soil screening levels for protection of groundwater derived from literature or empirical demonstration (refer to Volum B
= The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-cont J =
The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable

NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbon
PCBs = Polychlorinated Biphenyls
SSL = Soil Screening Level
TPH = Total Petroleum Hydrocarbons
Total TEC = Total Toxicity Equivalent Concentration

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.



Legend

- ● RI Surface Soil Sample Location
- ● WPA Soil Sample Location
- Spring
- Former "Duck Pond" Area
- A Wetland Area Name

purple: Exceeds Terrestrial Ecological Soil Screening Level
blue: Exceeds MTCA Soil Screening Level for Protection of Groundwater
black: Below Screening Levels

cPAH - Polycyclic Aromatic Hydrocarbon
HMW - High Molecular Weight
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)

N
W E
S

0 125 250 500
Feet

Figure E1

Wetlands AOC - Wetland D Soil Sample Locations and Results Above Screening Levels

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4, Columbia Gorge Aluminum Smelter Site Revision 0*, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

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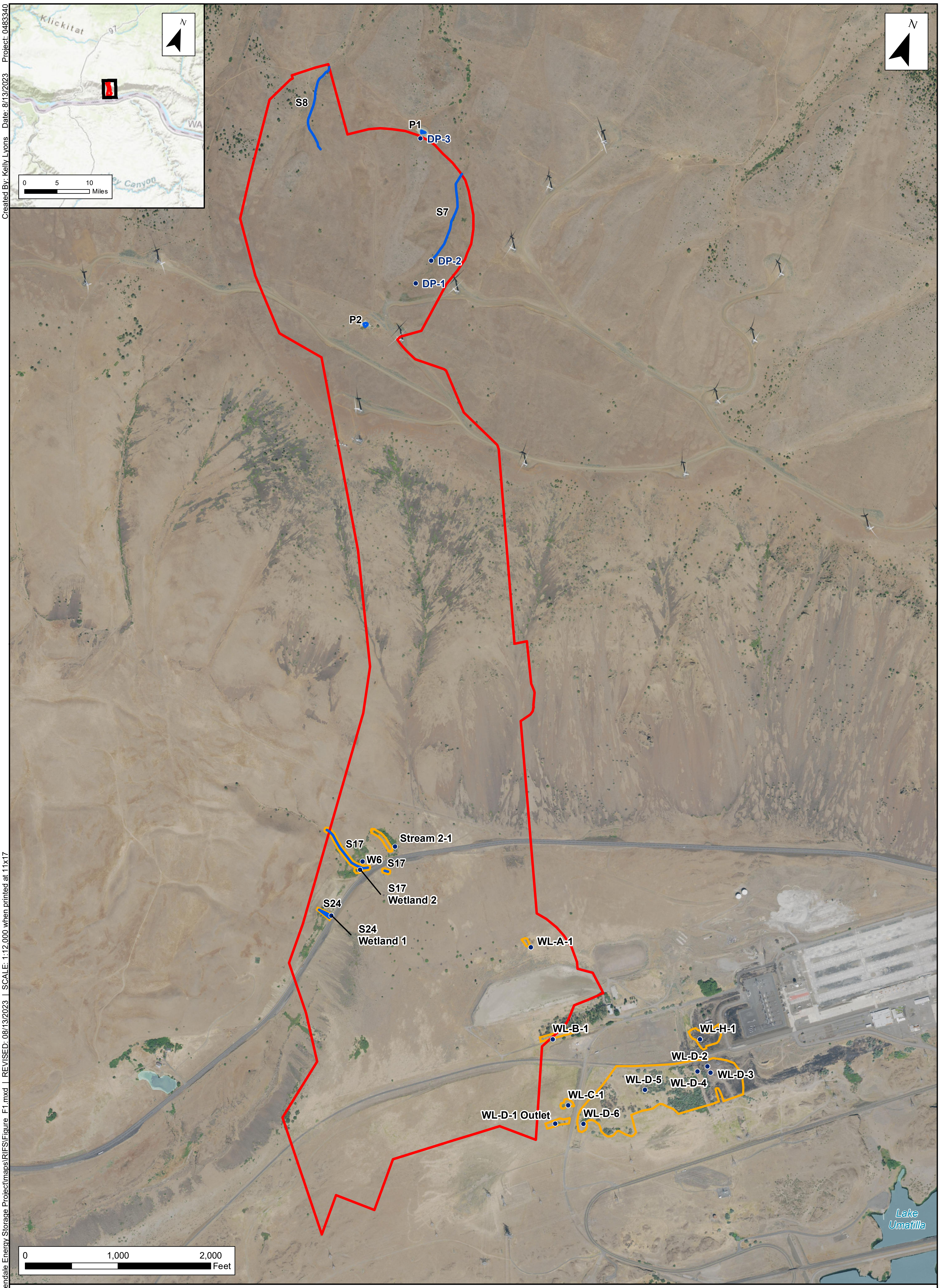
APPENDIX F WETLANDS AND WATERS (ERM)

Created By: Kelly Lyons   Date: 8/13/2023   Project: 0483340



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Legend

- ● Wetland Determination Points
- 🟥 Study Area
- 🟧 Additional Study Areas
- — Delineated Wetland/Waterbody

Notes:
NHD: National Hydrography Dataset
NHD credit: US Geological Survey
NWI: National Wetlands Inventory.
NWI credit: US Fish and Wildlife Service

Figure F1
Wetland and Waters Delineation
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage
Project
Goldendale, Washington

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ERM

Source: National Agricultural Imagery Program, July 2017, flown 1m per pixel; NAD 1983 StatePlane Washington South FIPS 4602 Feet

Appendix F

Table F-1 Wetland and Water Features Confirmed in 2019 and 2022 Delineation in the Study Area and in Additional Study Areas

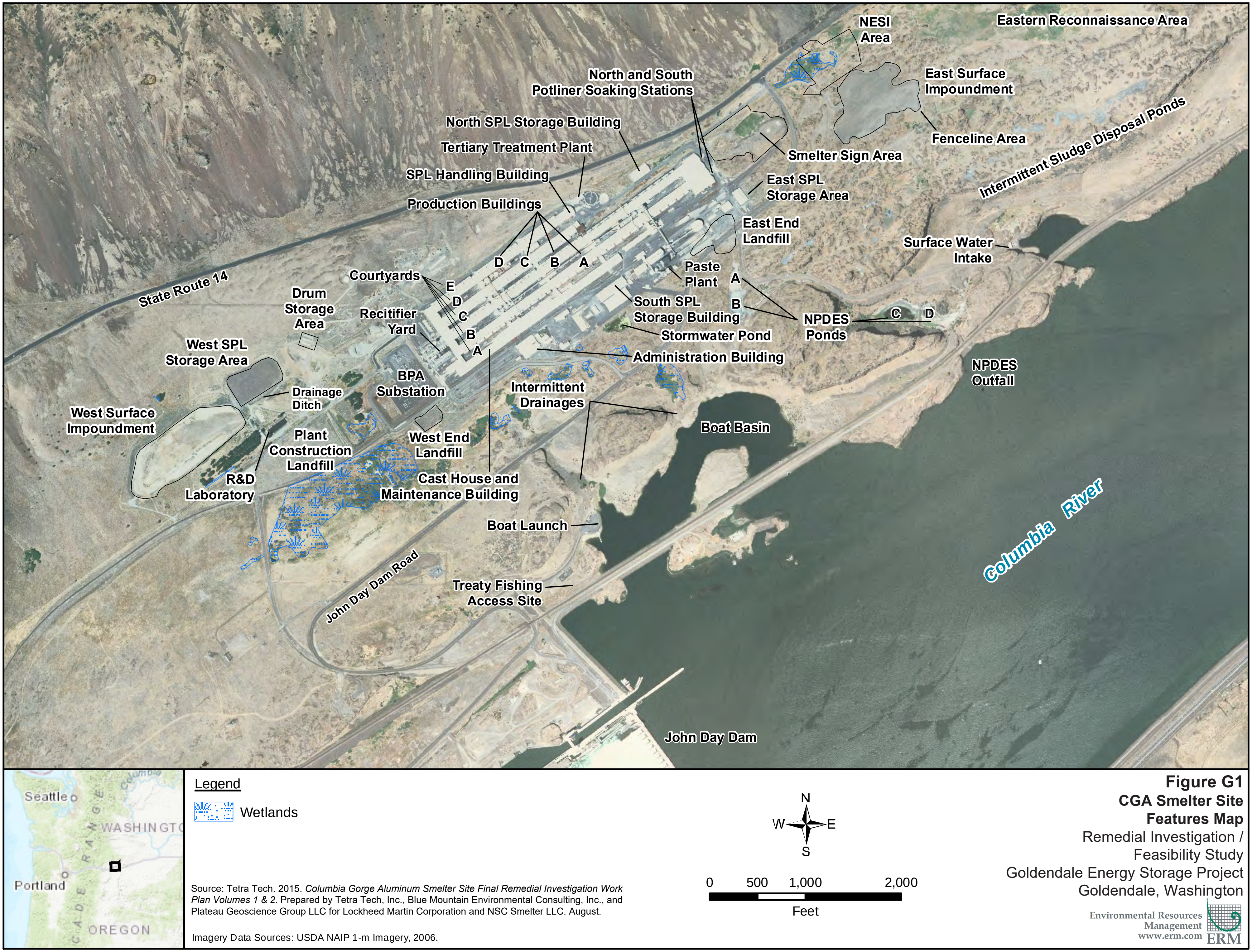
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

ID	Wetland Present	Waters Present	Wetland Determination Point(s)	Investigation Date(s)	NWI	NHD	Clean Water Act Jurisdiction (2019 and 2022 Field Confirmation)
S7	No	Yes	DP-1, DP-2	ERM 2019	R5UBH	Perennial	USACE determined jurisdictional waterbody in 2022. Intermittent stream connects to Swale Creek, a perennial tributary of the Klickitat River, approximately 2.4 miles north of the survey area.
S8	No	Yes	Photos and notes only	ERM 2019	R5UBH	Perennial	USACE determined jurisdictional waterbody in 2022. Intermittent stream connects to Swale Creek, a perennial tributary of the Klickitat River, approximately 2.4 miles north of the survey area.
P1	Yes	No	DP-3	ERM 2019	PUBHx	Perennial	Not evaluated in the 2022 USACE jurisdictional determination. Likely not jurisdictional. Pond is artificially created in uplands and appears to be isolated as it does not have an outlet or surface connection to feature S7.
P2	Yes	No	Photos and notes only	ERM 2019	Not mapped	Perennial	USACE determined not jurisdictional in 2022. Pond is artificially created in uplands and appears to be isolated as it does not have an outlet or surface connection to feature S7.
S17 / Wetland 2	Yes, Assumed Presence	Yes	Stream-17-1	ERM 2019, Ecology 2022, ERM 2022	R4SBC, PSS1A	Intermittent	Likely not jurisdictional. Stream lacks a surface connection to the Columbia River as most of the stream flow goes subsurface near Highway 14.
S24 / Wetland 1	Yes, Assumed Presence	Yes	Stream-24-1	ERM 2019, Ecology 2022, ERM 2022	Not mapped	Not mapped	Likely not jurisdictional. Spring lacks a surface connection to the Columbia River as most of the flow goes subsurface near Highway 14.
W6	Yes	No	DP-4	ERM 2019	Not Mapped	Not mapped	Likely not jurisdictional. Wetland appears to be isolated and does not have a surface connection to S17.

ID	Wetland Present	Waters Present	Wetland Determination Point(s)	Investigation Date(s)	NWI	NHD	Clean Water Act Jurisdiction (2019 and 2022 Field Confirmation)
Wetland A	No	No	WL-A-1	PGG 2013, ERM 2022	Not mapped	Not mapped	No wetland present, not jurisdictional.
Wetland B	No	No	WL-B-1	PGG 2013, ERM 2022	Not mapped	Not mapped	No wetland present, not jurisdictional.
Wetland C	No	No	WL-C-1	PGG 2013, ERM 2022	Not mapped	Not mapped	No wetland present, not jurisdictional.
Wetland D	No	No	WL-D-1 Outlet, WL-D-2, WL-D-3, WL-D-4, WL-D-5, WL-D-6	PGG 2013, ERM 2022	PUBFx, PUBFh, PEM1Ch	Not mapped	No wetland present, not jurisdictional.
Wetland H	No	No	WL-H-1	PGG 2013, ERM 2022	Not mapped	Not mapped	No wetland present, not jurisdictional.
Stream 2	No	No	Stream-2-1	Ecology 2021, ERM 2022	PSS1A	Not mapped	No stream present, not jurisdictional.

PEM1Ch = Palustrine, emergent, persistent, seasonally flooded, diked/impounded wetland; PSS1A = Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded wetland; PUBFh = Palustrine, unconsolidated bottom, semi permanently flooded, diked/impounded wetland; PUBFx = Palustrine, unconsolidated bottom, semi permanently flooded, excavated wetland; PUBHx = Palustrine, unconsolidated bottom, permanently flooded, excavated stream; R4SBC = Riverine, intermittent, streambed, seasonally flooded stream; R5UBH = Riverine, unknown perennial, unconsolidated bottom, permanently flooded stream

APPENDIX G SMELTER FEATERES



Legend

▨ Wetlands

Source: Tetra Tech. 2015. *Columbia Gorge Aluminum Smelter Site Final Remedial Investigation Work Plan Volumes 1 & 2*. Prepared by Tetra Tech, Inc., Blue Mountain Environmental Consulting, Inc., and Plateau Geoscience Group LLC for Lockheed Martin Corporation and NSC Smelter LLC. August.

Imagery Data Sources: USDA NAIP 1-m Imagery, 2006.

Figure G1
CGA Smelter Site
Features Map
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
www.erm.com
ERM

APPENDIX H DRAFT DEWATERING SIMULATION (HDR-ERM)

Goldendale Lower Reservoir Dewatering and Contaminate Fate and Transport Simulations

HDR

April 28, 2023

1. Introduction

A proposed pump and storage facility is being contemplated at a location along the Columbia River in southern Washington State near Goldendale. Figure 1 shows the location of the planned facility. Part of the facility is a Lower Reservoir that will receive water from and pump water to an upper reservoir through a tunnel that passes through a chamber equipped with energy generation and pumping. During construction, a portion of the Lower Reservoir excavation may require dewatering. Once constructed, although the reservoir will be double lined with a water return system in the lower liner, some water may seep through liner to the underlying geologic material. Washington State Department of Ecology (Ecology) has asked for additional information regarding the effects of dewatering and seepage through the liner on previously mapped wetlands and an existing plume of sulfate and fluoride associated with a closed surface impoundment (the West Surface Impoundment), which was part of a former aluminum smelter adjacent to the planned reservoir. The generalized "sandbox" groundwater flow model[1] described below was developed to predict the impacts of dewatering and operating the Lower Reservoir. This model was developed as a sand box model with upgradient and downgradient heads assigned and the material and conditions in between approximated from existing studies. Such models are useful to answer generalized questions especially if sensitivity analyses can bound the range of possible conditions and if they can be shown to match observed conditions.

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[1] While this is considered a sandbox model due to necessary generalization, every attempt was made to accurately simulate site conditions given the available subsurface and hydrogeologic data. The model predict groundwater levels were compared to observed water levels as described in Section 4.4 Model Calibration below and the comparison shows that they fall within the observed ranges and industry standards for model calibration.

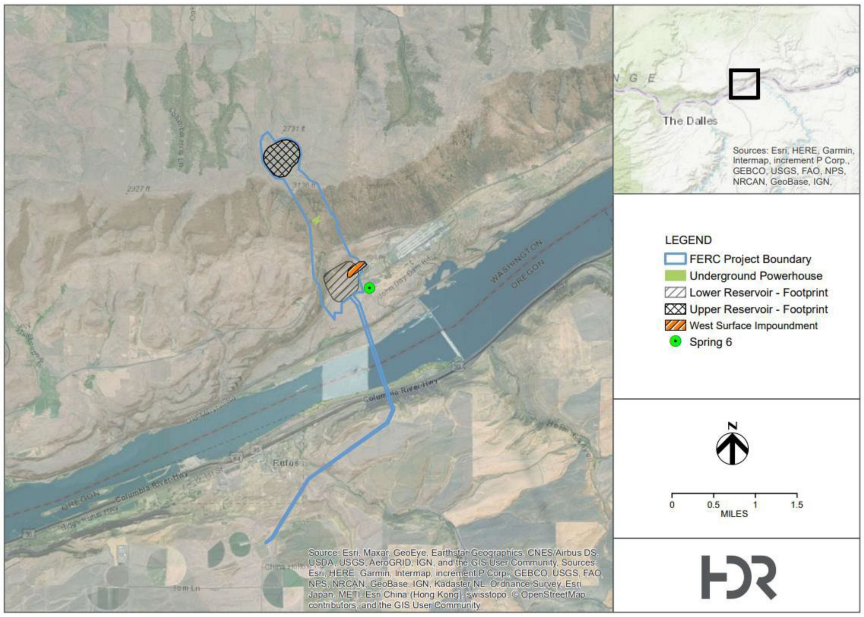


Figure 1. Location of the planned facility

2. Setting

2.1. Geology

The planned Lower Reservoir will be constructed on a basalt terrace above the Columbia River and at the Base of the Columbia Hills. The Columbia River left alluvium on the basalt terrace during the Pleistocene Missoula Floods and alluvial fans and land slide deposits have also developed on the basalt terrace. The unconsolidated deposits (flood deposits, alluvial fans, and land slide deposits) and fill used in the construction of the aluminum smelter coalesce to form a limited area of overburden at the base of the Columbia Hills. The overburden does not extend as a single unit to the edge of the terrace but may fill in topographic lows in the basalt. The basalt terrace and the Columbia Hills are comprised of different flows of the Middle Miocene Grande Ronde Basalt Formation of the Columbia River Basalt Group. The Columbia Hills are an approximately 3000-feet high ridge created by folding and faulting of the Columbia River Basalts. Local to the site there are thrust faults and strike slip faults. The escarpment above the Lower Reservoir is the result of both an anticline and faulting. Figure 2 is a generalized map of the geology near the Lower Reservoir.

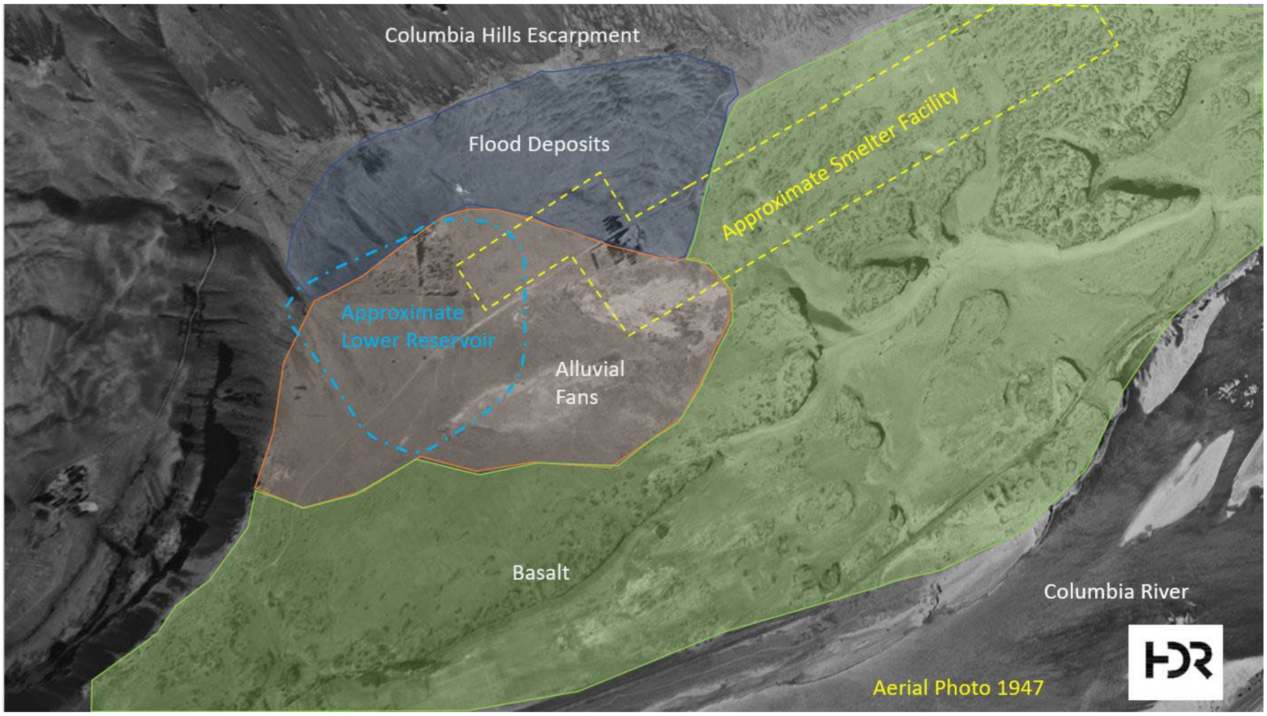
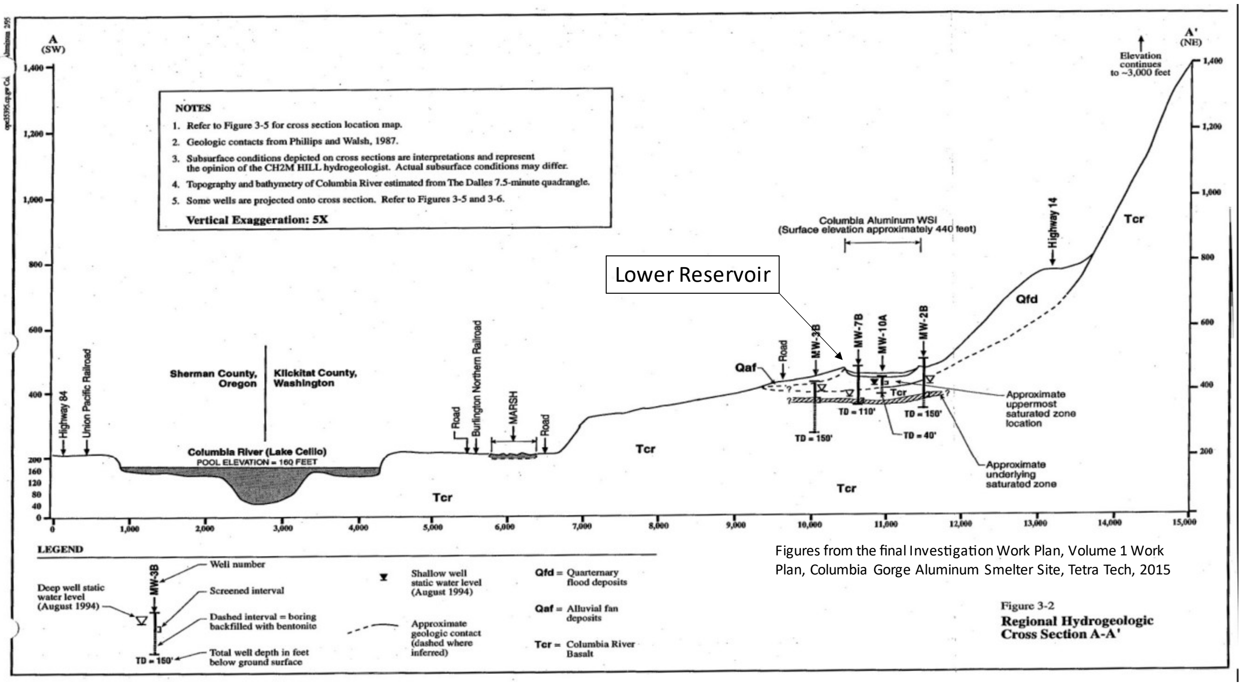


Figure 2. Geology of the Lower Reservoir area and model domain

2.2. Hydrogeology

The overburden is a thin and limited extent surficial aquifer identified as the Unconsolidated Aquifer (UA) (TetraTech, 2021). The upgradient extent of the UA is the basalt escarpment of the Columbia Hills and the down gradient edge is where the deposits thin to only occupying topographic lows in the underlying basalt. Permeable interflow zones in the underlying basalt where the basalt is vesicular or brecciated can be productive aquifers. Two basalt aquifers have been identified at the site, the Basalt Aquifer Upper (BAU) and the Basalt Aquifer Lower (BAL). Both the BAU and the BAL are identified in multiple transmissive zones (TetraTech, 2021). Based on water level measurements in the UA and both the BAU and the BAL, the UA has higher head than the BAU, and the BAU has higher head than the BAL. Both the BAU and the BAL have locations where they outcrop and create springs along the edge and base of the basalt terrace. While these aquifers are separated by massive basalts, sulfate and fluoride which likely originated in the UA can be found in in the BAU and the BAL. This indicates that there is some hydraulic connection between these water bearing zones. Figure 3 shows a cross section through the Lower Reservoir footprint and extending down to the Columbia River. Tcr is the basalt and the Qfd is the alluvium.



Figures from the final Investigation Work Plan, Volume 1 Work Plan, Columbia Gorge Aluminum Smelter Site, Tetra Tech, 2015

Figure 3. Geological cross section

2.3. Wetland D and Spring 6

One of the concerns with dewatering is the potential effects on a wetland and associated spring south the Lower Reservoir. Wetland D and Spring 6 were identified in the Remedial Investigation (RI) for the former aluminum smelter located to the east of the Lower Reservoir (TetraTech, 2021). The RI indicated that neither the wetland nor the spring existed before the smelter was constructed. Review of aerial photograph confirm that Wetland D and Spring 6 did not exist until the smelter was in operation and seemed to be associated with the "Duck Pond" a temporary surface water feature that appeared at the upgradient end of Wetland D once the smelter was constructed. When the smelter was razed, the Duck Pond dried up and then shortly afterwards Wetland D appeared to dry up as well. At the same time, Spring 6 begins to diminish in size and to migrate westward. In April 2022, ERM sent a wetland biologist to confirm the existence of Wetland D and Spring 6. They found that Wetland D no longer exists as a wetland and Spring 6 has been modified for cattle watering (buried lateral collectors focus water to two watering troughs).

2.4. Upgradient Conditions at MW-8A

MW-8 is a monitoring well immediately upgradient of the planned Lower Reservoir that was installed for a remedial investigation of the aluminum smelter. The well screen for MW-08A was constructed bridging from the overburden 6 feet into the underlying basalt. Water levels have been measured in MW-08A approximately quarterly since 2004. Figure 3 is box and whisker plot of the water level elevations measured in MW-08A.

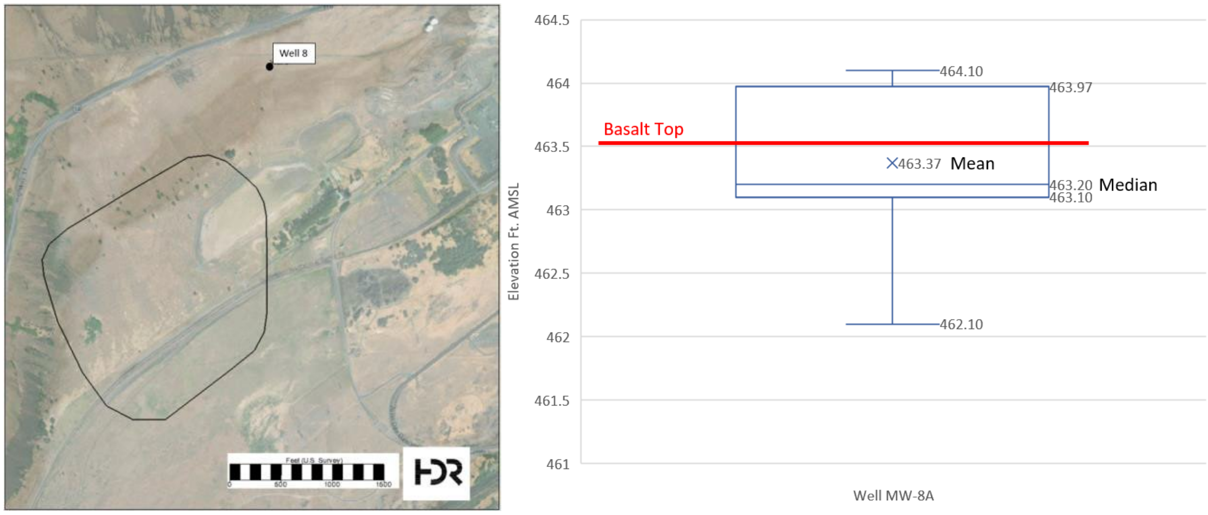


Figure 3. Water Elevations (Ft AMSL) in MW-8A between 2004 and 2021 (right) and the location of well 8 to the location of the lower impoundment (left)

The elevation where the well screen passes into the basalt is 465.5 feet above mean sea level (Ft AMSL). Water levels in the well are most frequently within the basalt and were not observed to be more than about half a foot above the basalt into the overburden. The range of water levels suggest that there is a thin veneer of water that moves down the basalt surface in the overburden and maintains the water level in the basalt portion of the well. Water levels in MW-8A appear to define the location and elevation of the upgradient edge of the saturated UA.

3. Conceptual Site Model

The conceptual site model (CSM) domain is the area that can potentially affect the groundwater system around the Lower Reservoir and was chosen based on natural boundary conditions. Figure 4 shows the model domain, western surface impoundment, proposed Lower Reservoir, former smelting facility and the location of Spring 6. The domain falls within the Middle Columbia-Lake Wallula watershed and the Middle Columbia-Hood watershed and is in Klickitat County.

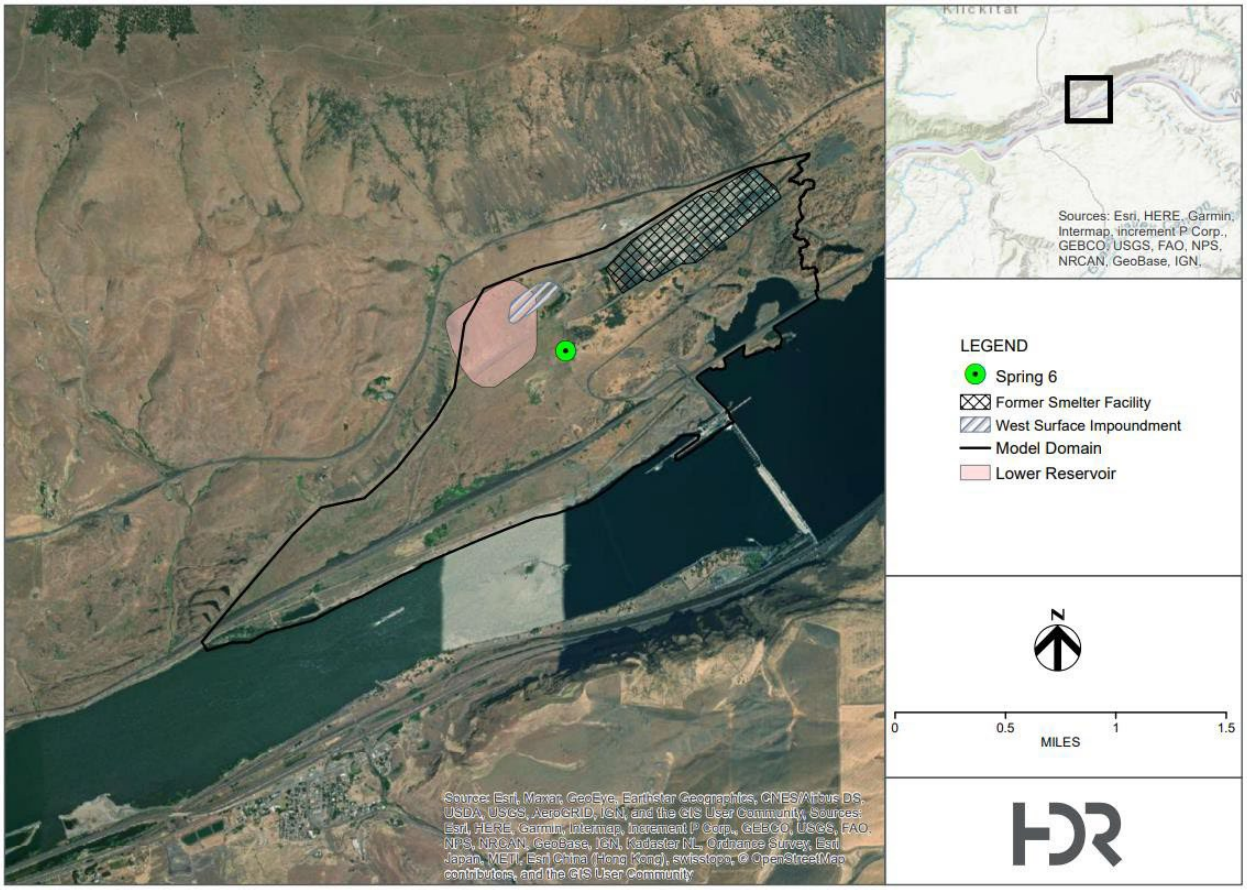


Figure 4. Model domain, West Surface Impoundment, proposed Lower Reservoir, Former Smelter and Spring 6

Average annual recharge from precipitation is estimated to be about 3.85 inch per year (Aspect Consulting, 2007). On the northern model boundary and near the former smelting facility, recharge is increased to just over 4 inches per year to account for run-off arriving from the escarpment to the north. Recharge to the aquifer comes from precipitation as snow and rainfall and is the sum of total precipitation minus losses for evapotranspiration and run off.

Recharging water percolates into the subsurface where it reaches saturated geologic material at the water table. From there it flows through the geologic material, first the overburden (where present) and then the basalt aquifers, to discharge points where it discharges to surface water (wetlands, springs, and the Columbia River). Flow in overburden mainly occurs in coarse-grained material such as sand and gravel. Flow in basalt mainly occurs in the permeable interflow zones.

4. Model Development and Calibration

The groundwater model was developed using the groundwater modeling pre- and post- processing software Groundwater Modeling Systems (GMS) 10.5 (Aquaveo; https://www.aquaveo.com/software/gms-groundwater-modeling-system-introduction). The groundwater flow model, MODFLOW-2005 (Harbaugh et al. 2005) was used to solve the groundwater-flow equations. The U.S. Geological Survey's mode in program MODFLOW solves the system of equations that quantify the flow of groundwater in three dimensions. Steady-state and transient flow conditions can be simulated with MODFLOW, as can confined and water-table conditions. Additional components of the hydrological cycle affecting groundwater can be considered including pumping wells, recharge, evapotranspiration, rivers, streams, wetlands, springs, seeps, and lakes among others.

Information compiled in the site model framework in GMS is translated into its numerical equivalent to generate inputs for MODFLOW. MODFLOW uses a numerical finite difference solution to iteratively estimate 3-dimensinal (3-D) groundwater hydraulic head and groundwater movement within the model domain, while conserving the mass of water. The MODFLOW output is read into GMS for post-processing includes creating contour and color-flood maps, comparing output to calibration targets, particle tracking, and contaminate fate and transport modeling.

Contaminant fate and transport modeling uses known or assumed processes to estimate the movement of chemical constituents in groundwater in response to hydraulic forcing based on the flow model. The U.S. Army Corps of Engineers contaminant fate and transport modeling software MT3DMS (Zheng and Wang 1999) was used to simulate the transport of fluoride and sulfate originating in the vicinity of the Lower Reservoir.

4.1. Model Discretization

The model domain is approximately 2.1 square miles. The domain was divided into two layers with the grid oriented at a 65-degree angle to align the grid orientation with the perspective Lower Reservoir and Columbia River orientation. Rows and columns are variable in width and length ranging from 50 by 50 feet around the Lower Reservoir and former western surface impoundment, expanding to 250 by 250 feet farther away from the site. The resulting grid has 8,152 active grid cells. Figure 5 shows the active model grid.

Figure 5. Active model grid

4.2. Layering and Hydrogeologic Parameters

The model was simulated using 2 layers. The hydrogeological materials simulated for each layer include:

- Layer 1 - Alluvium with a horizontal hydraulic conductivity simulated at 1.75 ft/d and a horizontal to vertical anisotropy ratio of 3.
- Layer 2 – Basalt with a horizontal hydraulic conductivity simulated at 0.35 ft/d and a horizontal to vertical anisotropy ratio of 3.[2]

These hydraulic properties are within the ranges determined from testing during the RI (Tetra Tech, 2021). Based on the geological map (Figure 2), the alluvium extends across only a portion of the site and model domain with the rest of the area having basalt at the surface. In the area of the West Surface Impoundment the boring logs show an approximate depth 50 feet for alluvium. The alluvium thickness gets thinner as it approaches where the basalt is at the ground surface. The alluvium geometry approximately represents the tapering off the alluvium by decreasing the thickness in increments from 50 feet near the West Surface Impoundment down to 5 feet at the southern and southwestern edges of the alluvium. All cells outside of the area with alluvium were inactive in layer 1 and the surface of layer 2 in areas outside the alluvium were given a surface elevation based on the DEM (USGS 2021). Figure 6 shows layer 1 and layer 2 of the model.

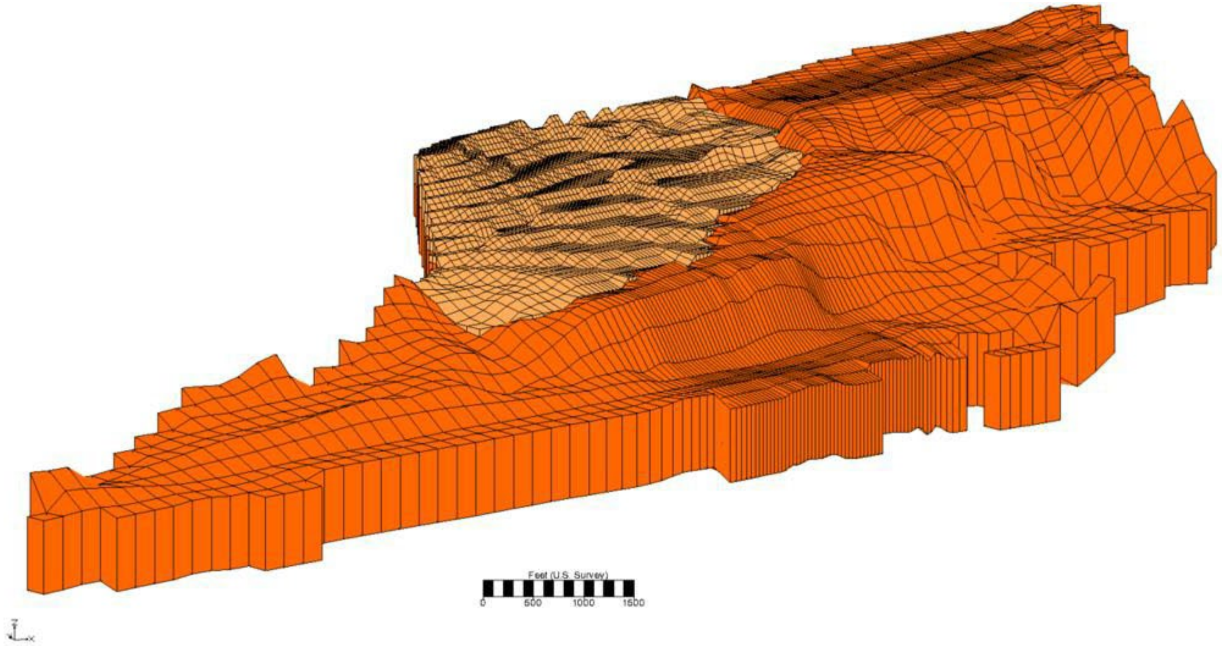


Figure 6. Layer 1 and layer 2 of the model. Tan is alluvium, and orange is basalt.

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[2] Layer 2 combines both the BAU and the BAL as well as fractures in the massive basalt in between as one generalized layer. The geometry and detail of these individual hydrostratigraphic units is not important to the understanding of the impacts of dewatering in the overburden. However, it is important that water from the overburden leave layer 1 vertically into layer 2.

4.3. Boundary Conditions

The southern boundary of the model is simulated using the MODFLOW river package to represent the Columbia River. The northern boundary is simulated using a MODFLOW general head boundary to account for groundwater entering from the escarpment. The rest of the model boundary is simulated as a no-flow boundary. Figure 7 shows the location of the boundary conditions within the model domain.

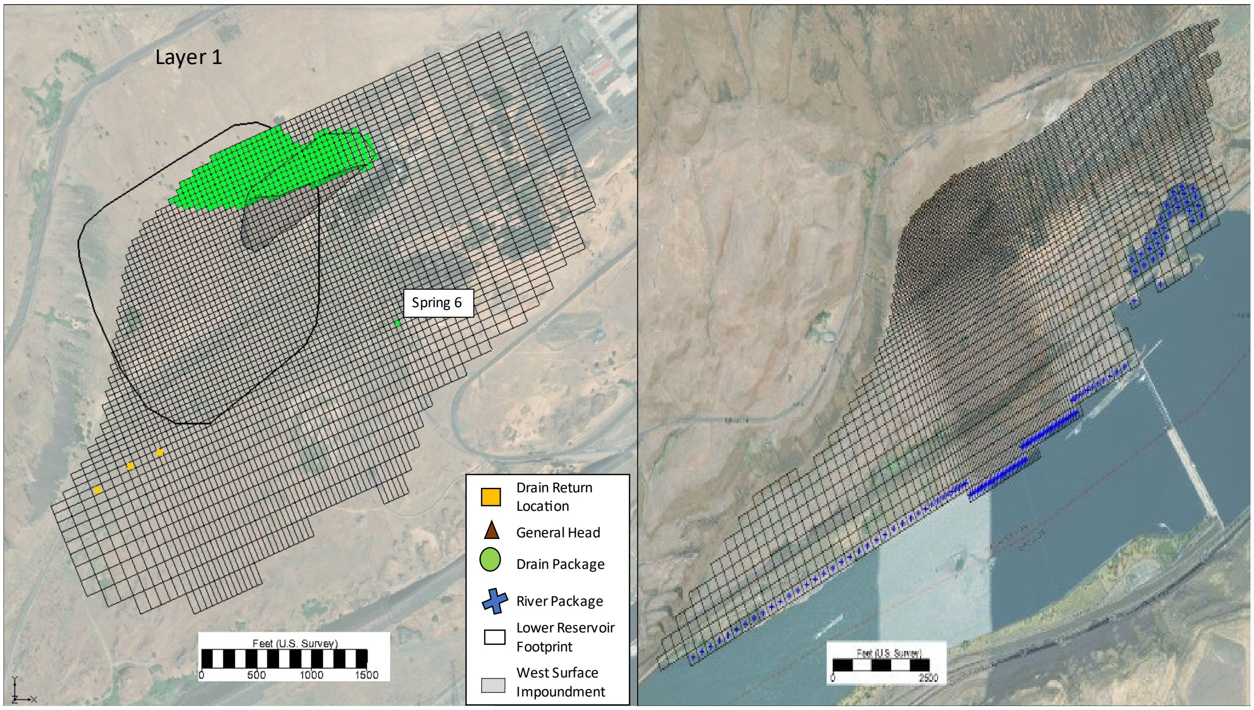

Figure 7. Boundary conditions within the model domain.

4.3.1. Columbia River

The Columbia River is simulated in the model using the MODFLOW river package as a head-dependent flux boundary in layer 2. The boundary condition is given a bottom and surface elevation and a conductance. The surface elevation is based on the river's surface from the USGS DEM (USGS, 2021) and the bottom elevation is 10 feet below the surface. The river located downstream of the John Day dam has a surface elevation of 164 feet and the river located upstream has a surface elevation of 267 feet. A conductance value of 1 ft^2/d was used to simulate restriction of flow by the sediment bed. This boundary condition allows for water to be exchanged between the river and the groundwater.

4.3.2. Spring 6

Spring 6 is located just south of the Lower Reservoir and is simulated using the MODFLOW drain package. This package removes water from the domain at a specific elevation at a rate limited by a specified conductance. An elevation was chosen based on the DEM (USGS, 2021). It was given a low conductance of 0.5 ft^2/d.

4.3.3. Recharge

Recharge is generally simulated in a groundwater model as an aerially specified water source that is applied as either a constant flux or a transiently varied flux. Groundwater recharge is simulated after calibration at 1 inch per year throughout most of the domain except along the northern boundary near the Lower Reservoir where recharge was increased to 4 inches per year to account for runoff from the escarpment and near the former smelting facility where recharge was increased to 4.4 inches per year to account for the extra water added to the system there (e.g., the duck pond). Both of these values are similar to the local recharge estimate of 3.85 found in Aspect, 2007. The recharge simulated to the duck pond was simulated during the calibration and used for the start of the transient model. Once the model was converted to a transient simulation the recharge was adjusted to the 1 inch per year used throughout the model domain. Figure 8 shows the areas of the model with increased recharge (orange).

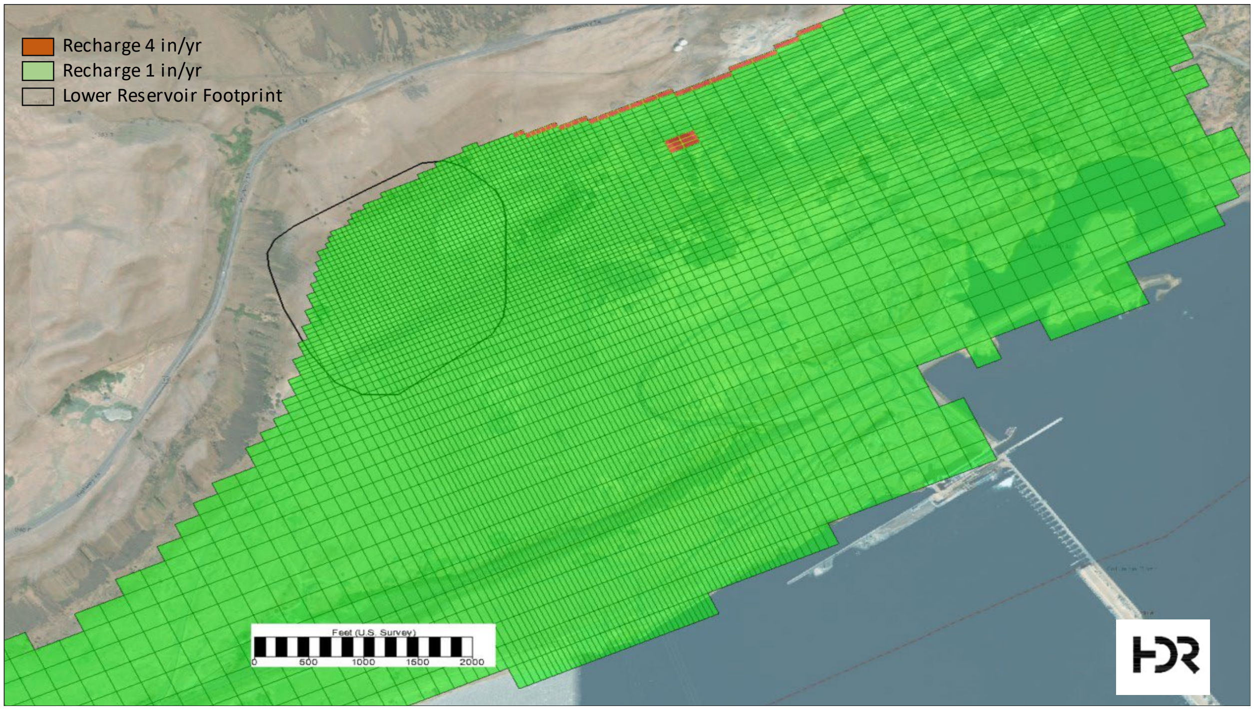

Figure 8. Recharge zones

4.3.4. General Head

General head boundary was placed along the northern boundary of layer 1 to account for additional flow into the model from landslide material and runoff. The general head package is similar to the drain and river packages in that flow in or out of a cell is proportional to a difference in head. A specified head and conductance value is assigned.

4.4. Model Calibration

Model calibration is the process of adjusting hydraulic parameters, hydrologic stresses, and boundary conditions within reasonable ranges to achieve an acceptable match between the modeled and observed calibration targets (groundwater levels). The hydraulic conductivity, vertical anisotropy, recharge values and conductance values on the river, drain and general heads were used to perform the calibration. The flow model was calibrated to the mean water levels measured during four sampling events in 2017 for 10 monitoring wells. Calibrating to mean water levels instead of to water levels measured on a specific date creates a model that simulates the mean condition of the aquifer, providing an estimated (simulated) quantitative representation of the most common groundwater flow pattern and water budget. Table 1 shows the observed head, simulated head, and residual for each well. Figure 9 shows the predicted compared to the observed heads (r^2 = 0.9794)

Table 1. Model calibration

Well	Obs. Head	Sim. Head	Residual
MW-12A	394.1	396.1	-1.9
MW-10A	409.8	411.4	-1.7
MW-14A	416.4	415.6	0.8
MW-3A	389.1	388.0	1.1
MW-11A	431.1	432.3	-1.1
MW-15A	420.0	419.4	0.6
MW-6B	431.4	425.0	6.4
MW-16A	436.1	434.9	1.2
MW-17A	441.2	443.4	-2.2
RI-GW1	411.6	410.9	0.7

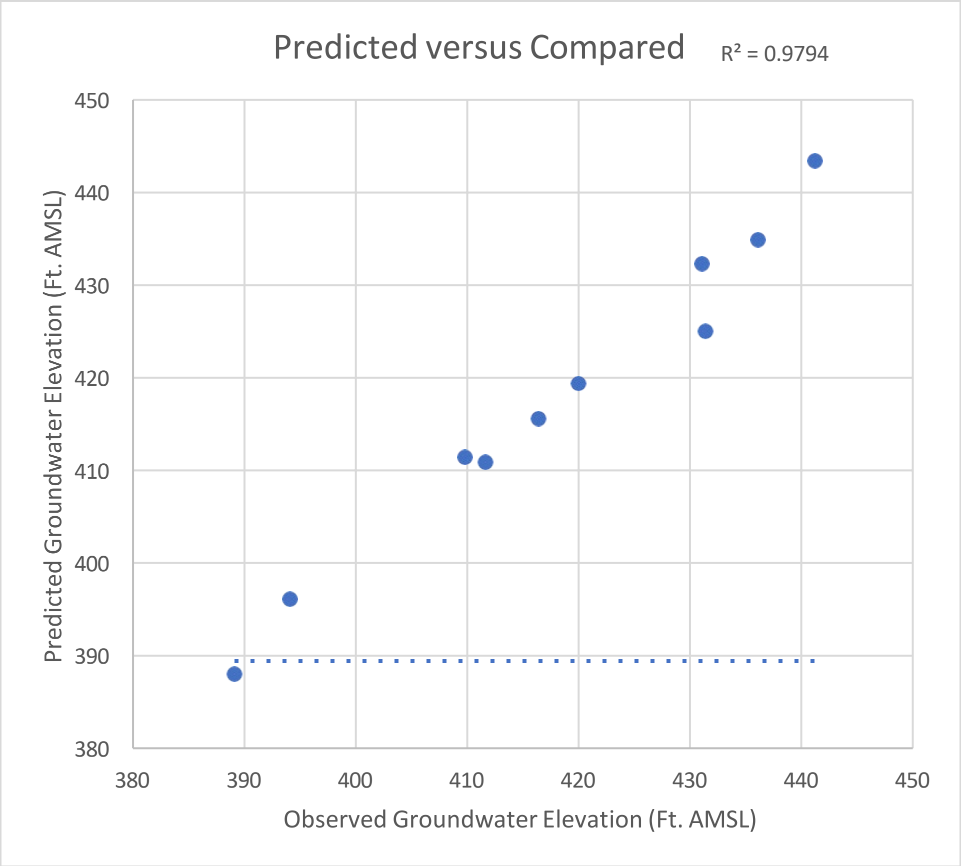

Figure 9. Observed versus Predicted Heads

The observed groundwater fluctuation was approximately 2 feet. Eight of the 10 wells are within the range of 2 feet fluctuation. The exceptions are MW-17A with a residual -2.2 feet (overprediction) and MW-6B with a residual of 6.4 feet (underprediction).

The overall mean residual was -0.29 feet. The absolute residual and root mean squared error (RMSE) are 1.26 and 1.37, respectively. The root mean squared of the individual standard deviations of water levels measured at each monitoring well is 2.64 feet which represents the variability within the observed water levels. This indicates that the calibrated model is within the variability of the observed dataset and is approaching the mean condition and is sufficiently calibrated for the purposes of this basic sandbox model. In addition, the RMSE should be less than 10 percent of the total head loss across the model domain (less than 12 feet, based on an estimated 120 feet of head loss across the AU (Anderson and Woessner, 1992). Figure 10 is a map of the calibrated water levels showing the error associated with each measurement point (the whiskers indicate a 95 percent confidence interval, or about 2 standard deviations around the mean.) A green bar means the computed is within the 95 percent confidence interval of the observed target, a yellow bar means the error > 100 percent and a red bar means the error > 200 percent of the 95 percent confidence interval.

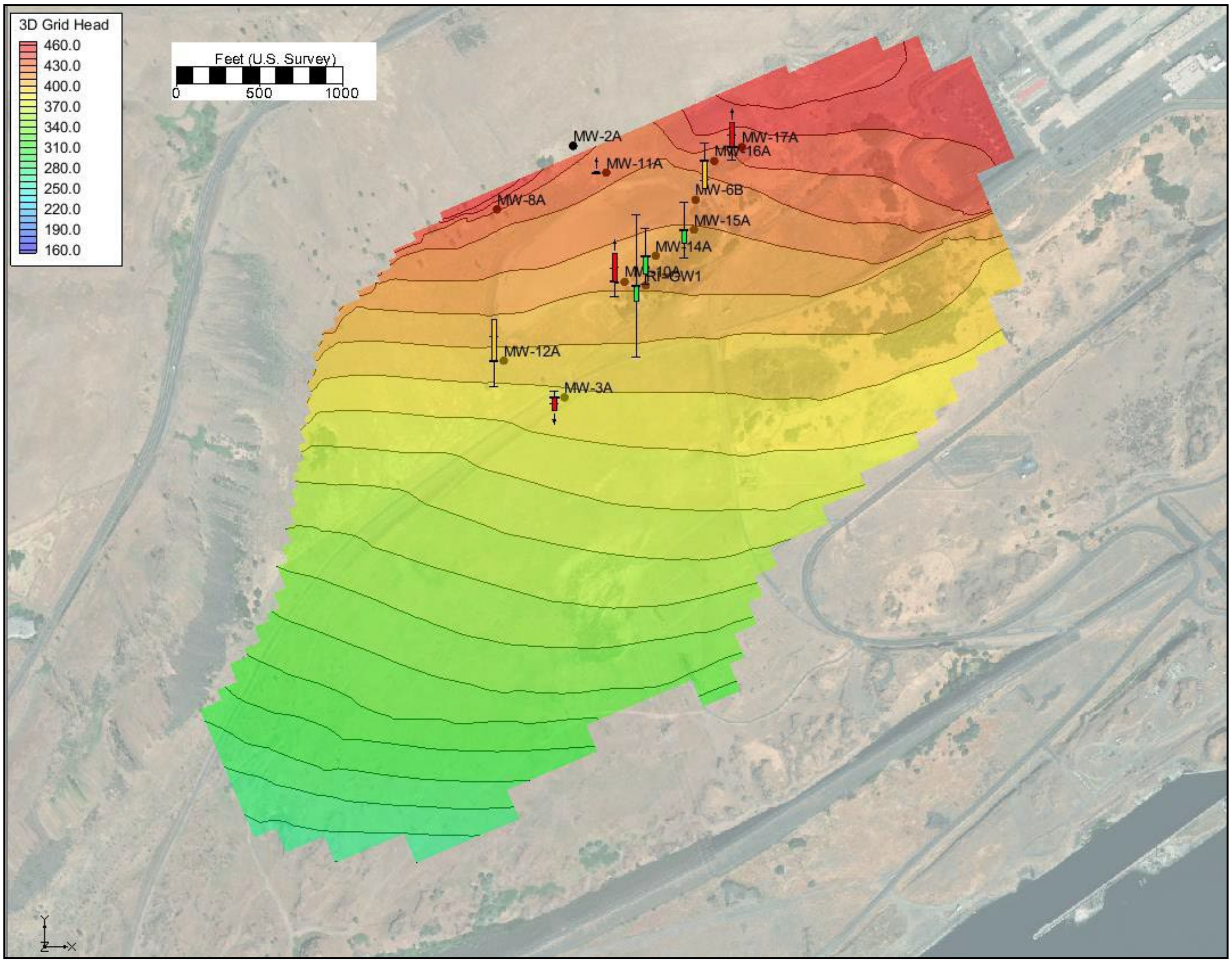

Figure 10. Calibrated water levels in the alluvium.

The model was converted to transient for the simulations of dewatering and contaminate fate and transport (MT3DMS) for evaluation of operations of the Lower Reservoir. To convert the model to transient, specific yield was set to 0.1 for the over burden and specific storage was set to 10^{-5} for the basalt. These values were based on reasonable values for the material. The porosity for the fate and transport simulations was set to 0.3 for the alluvium and to 0.1 for the basalt.

5. Dewatering Simulations

The dewatering was simulated in the area of the Lower Reservoir. The location of dewatering was chosen based on initial design documents and geologic cross-sections. The initial designs indicate the Lower Reservoir will be excavated to an elevation of 420 feet above mean sea level (AMSL) and will require dewatering where the groundwater elevation is above 420 feet AMSL. Most groundwater beneath the planned excavation is already below that elevation, so dewatering will only be necessary in the northeastern portion of the excavation. Drain cells were placed in the area of the excavation where the water table is above 420 feet AMSL. The MODFLOW drain return package was used to simulate a bottom drain elevation at 420 feet AMSL. As the design of the reservoir progresses, the elevation and extent of the drain used in the model for dewatering may need to be adjusted. The drain return package controls the elevation of the groundwater in specific cells by calculating how much groundwater to withdraw to achieve the prescribed elevation needed for dewatering and then estimating the drawdown in adjacent aquifer caused by the removal of the water. The drain return package also allows the simulated withdrawn groundwater to be returned to the aquifer system at specified locations. As noted, only a portion the Lower Reservoir where the bottom elevation (420 Ft. AMSL) intersects the water table (northeastern corner) will likely require dewatering during construction. Figure 7 shows the location where the drain package was assigned (green circles) within the West Surface Impoundment and the Lower Reservoir where the predicted ambient groundwater elevation is above 420 feet AMSL. The dewatering was originally simulated as steady state and then adjusted to transient. For the steady state simulation, the simulated flow rate from the drain return package was 23 gpm.

Since dewatering will be necessary for an extended time, a transient model was used to estimate the effect of dewatering over time on the aquifer (*i.e.,* will include the removal of storage). The transient simulation was set up with the simulated calibrated model heads as the starting heads and three main stress periods (6 stress periods in total). The first stress period is 40 year a lead up for the fate and transport simulation to create the fluoride and sulfate plumes and has no dewatering. The second stress period is 6 months and starts the dewatering. This initial dewatering stress period is further broken down into 4 stress periods to simulate the progression of excavation and dewatering more accurately. The last stress period extends 4.5 years to simulate entire excavation. The excavation of the Lower Reservoir is not expected to take 5 years but for the purpose of the modeling an arbitrary length of time was needed to create the simulation simulates, so the model simulates 5 years of dewatering. The dewatering stress period starts after a 40-year stress period needed to set up the progression of the sulfate and fluoride plume in the fate and transport modeling. The dewatering stress period was broken down into 4 smaller stress periods to more gradually dewater from the maximum elevation of 480 feet AMSL in the northern portion of the boundary down to the required 420 feet AMSL in steps. The initial dewatering rate is simulated at approximately 70 gpm. Within a few days it drops to 30 gpm and then to less than 20 gpm. The initial increased 70 gpm is a result of the transient model time-steps and the model instantaneously reaching the dewatering elevation. In reality, the dewatering would happen on a more gradual scale which would require a smaller initial pumping rate.

The drain return package allows the simulated groundwater being removed from the system to be returned at a different specified location. Figure 7 shows the 3 cells (yellow squares) where the groundwater removed from the aquifer system was returned to the model. The drain return package varies the rate being returned based on the simulated dewatering rate at any specific time. **Figure 11** shows the simulated dewatering rate over time, which is directly related to the amount of water being returned to the system.

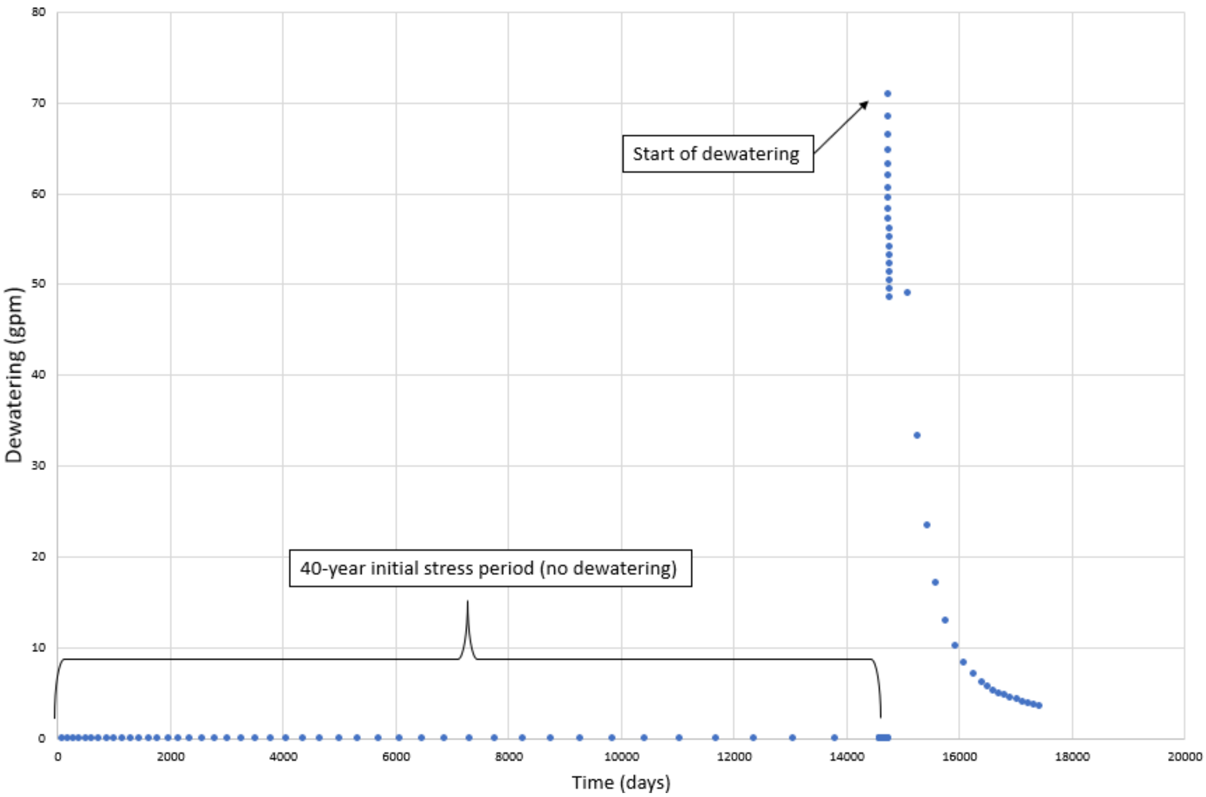

Figure 11. Simulated dewatering rate over time

Table 2 shows the predicted dewatering rate during the initial 6-month dewatering, after 2.5 years of dewatering and after 5 years of dewatering. The initial 6 months of dewatering has a model estimated dewatering rate of 70 gpm. This value is an overestimation caused by model limitations resulting from the model instantaneously reaching the simulated dewatering elevation rather than more gradually drawing down which would be more realistic and result in lower estimated dewatering rates. The model simulates dropping groundwater levels to an elevation of 420 feet within the first six months. In reality, the progression of dewatering will likely happen more gradually during the excavation of the Lower Reservoir, especially if a sump in the excavation is used to control water inflow. Simulating the progressive excavation at that time scale (sub 6-months) would require finer temporal discretization than accounted for in the model. This can be refined further for future simulations to simulate the initial dewatering more realistically as part of the final design. The actual schedule for excavation will be refined/designed as part of the final design. After 2.5 years of dewatering the model predicts the dewatering rate to be approximately 20 gpm and after 5 years of dewatering the model predicts 5 gpm.

Table 2. Simulated transient dewatering rates.

Time	Dewatering Rate (gpm)
Initial 6 month	70
After 2.5 Years	20
After 5 years	5

Figure 12 shows the simulated drawdown from dewatering after the 5 years of dewatering. After 5 years

of pumping the area of 0.5 feet drawdown or greater will be almost entirely inside the area of the Lower Reservoir to the south and just outside the Lower Reservoir to the north. Measurable drawdown from the dewatering does not reach Spring 6 during the simulated 5 years of dewatering.

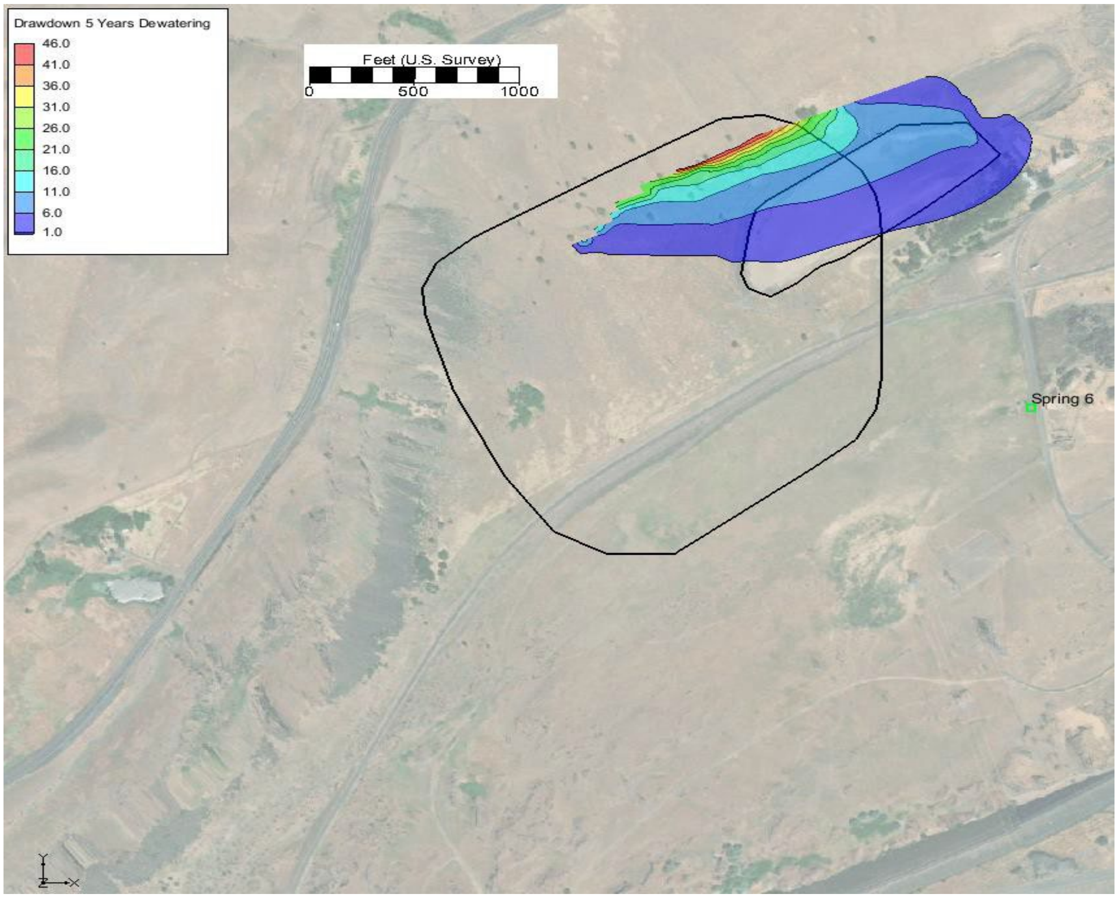

Figure 12. Drawdown after 5 years of dewatering.

5.1. Sensitivity Analyses

A sensitivity analysis was performed to determine the effect of hydraulic conductivity on the system during dewatering. Table 3 shows the simulations that were run for the sensitivity analysis. The final hydraulic conductivity of 1.75 was multiplied by 2, 10 and 0.5 and the resulting drawdown in Spring 6 for 6 months and 5 years of dewatering was recorded. For all sensitivity simulations adjusting hydraulic conductivity there was no effect to spring 6 after 6 months and negligible effects after 5 years.

Table 3. Sensitivity analysis

Simulations	Spring 6 Drawdown (ft)	
	6 Months	5 Years
Calibrated	0	0.0002
HK x 2	0	0.004
HK x 10	0	0
HK x 0.5	0	0

Table 4. Predicted flow rates for dewatering

Hydraulic Conductivity	Flow Rate (gpm)
Calibrated	24
HK x 2	23
HK x10	21
HK x 0.5	23

The flow rates needed for dewatering are estimated by the flow budget calculated by MODFLOW. Table 4 shows the average flow rates in gallons per minute for each sensitivity in the steady state model. This provides a range of expected pumping rates for the dewatering to an elevation of 420 feet in the Lower Reservoir. All predicted flow rates based on the sensitivity analysis (calibrated, hydraulic conductivity (HK) x2, HK x 10, and the HK x 0.5), have similar predictive flow rates ranging from 21 gpm to 24 gpm.

6. MT3DMS Simulations

Contaminant fate and transport modeling uses known or assumed processes to estimate the movement of chemical constituents in groundwater in response to hydraulic forcing on the flow model. The U.S. Army Corps of Engineers contaminant fate and transport modeling software MT3DMS (Zheng and Wang 1999) was used to simulate the transport of fluoride and sulfate originating at the West Surface Impoundment that overlaps the Lower Reservoir.

There are three main stress periods applied to the model:

- 40 years in length – Fluoride and sulfate source is applied to the model with a source term at the West Surface Impoundment. The starting heads are the simulated ambient heads from the calibrated model.
- 6 months in length – Dewatering in the Lower Reservoir begins in the area where the groundwater elevation is above 420 feet AMSL. The fluoride and sulfate source is still simulated in the vicinity of the West Surface Impoundment. The dewatering water is returned to the model as treated with constituents removed using the drain return package at three locations (see figure 7).
- 4.5 years in length – The fluoride and sulfate source is assumed removed due to excavation and therefore turned off. The dewatering continues and fluoride and sulfate mass in the aquifer continues to be transported downgradient.

The fluoride and sulfate source is applied as a constant concentration within the West Surface Impoundment and is assumed to be a conservative tracer with minimal interactions with the aquifer matrix. Figure 13 shows the location of the fluoride and sulfate source within the model. The blue circles represent the grid cells where the fluoride and sulfate source are applied. The concentrations used for the source were the maximum concentrations detected in groundwater for both fluoride and sulfate, 46 mg/l and 8600 mg/l, respectively (Tetra Tech, 2021). The values are uniformly applied across the source area.

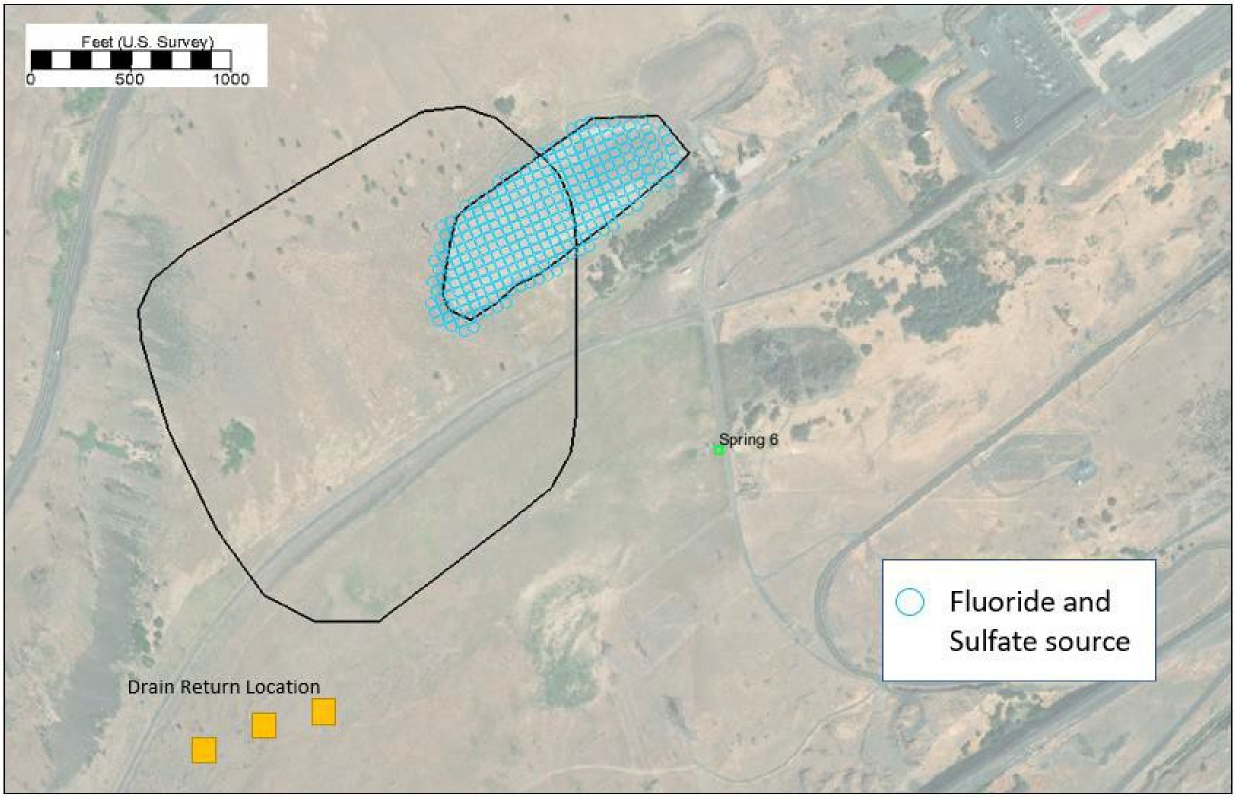

Figure 13. Location of the Fluoride and Sulfate source

Three cells were used for the drain return package once the dewatering began. The dewatering area was evenly divided into three parts with each part getting assigned to one of the drain return cells. This allows the dewatering to be returned to the aquifer system at the same rate as the dewatering. **Figure 13** shows the location of the drain return locations within the model (yellow square).

Figure 14 (at the end of the report) shows the fluoride plume and **Figure 15** (at the end of the report) shows the sulfate plume at year 1, year 40, 6 months after dewatering and 5 years after dewatering. The red contours show the highest concentrations (46 mg/l for fluoride and 8600 mg/l for sulfate), and the blue contours show the most protective cleanup levels and/or treatment standards (0.96 mg/l for fluoride and 250 mg/l for sulfate). The darker areas in the contours (shadows) show where some of the plume has migrated into layer 2 of the model. For the purposes of this evaluation both fluoride and sulfate can be considered conservative tracers in the groundwater and have limited interaction with the aquifer matrix, so only advection and dispersion were used in the simulation. For advection the Modified Method of Characteristics (MMOC) was used. The injection wells create a slight depression inward on the plumes as can be seen in both the fluoride and sulfate 5-year dewatering maps.

Figures 14 and 15 both show that after 1 year of simulating the fluoride and sulfate plumes there is only a slight migration from the original source south toward the Columbia River. After 40 years of simulating the two plumes they have migrated approximately 2,500 feet south toward the Columbia River. After 6 months of dewatering the overall plumes have not changed much but the source area has decreased. For the next 4.5 years of the transient model, the model simulates the removal of the source at the West Surface Impoundment by turning off the simulated continuous dissolved sulfate and fluoride concentrations. The blue contours left in that area for both the fluoride and sulfate show the low concentrations of the plume that have migrated into layer 2. In addition to the removal of the plume the drain return cells are active and the dewatered groundwater was returned back into the system. After 6 months of the drain return being on there is only a slight indentation in the contours representing the two plumes.

After 5 years of dewatering the maximum concentration for both the sulfate and fluoride plumes have migrated to the south and decreased in area. Both plumes are migrating away from the West Surface Impoundment and Lower Reservoir and appear to be decreasing in size. The drain return cells have made a slightly larger depression inward on the plumes but still have a minimal effect on the plumes and aquifer.

7. Model Assumptions and Limitations

The model assumptions include the following:

- The steady-state flow model was calibrated to hydraulic heads measured at monitoring wells at discrete moments in time that may not represent the entire variability of the groundwater levels.
- Heterogeneity in the subsurface conditions may not be fully captured by the geologic data used to create the model and is necessarily generalized in the model. Such varying conditions result in uncertainty in the model outcome.
- The uncertainty in model parameters and predictions has not been quantified; therefore, the error in the model predictions is not known. It is assumed the model results are suitable for a relative comparison of closure scenario options.
- The conditions simulated are based on a preliminary design of the Lower Reservoir and are subject to change as designs are finalized and dewatering needs defined.
- Aerial photographs and site visits indicate that the state of the UA has been changing since operations at the former aluminum smelter ceased. Specifically, Wetland D no longer exists as a wetland and Spring 6 has migrated westward and is shrinking. Similarly, some of the monitoring wells near the western surface impoundment have gone dry. It is likely that the smelter and the western surface impoundment added water to the UA which stopped after the smelter ceased operations and the impoundment was closed. For these reasons, the conditions are likely in a state of flux and it is possible that even more limited or no dewatering will be required by the time the Lower Reservoir is constructed. The model did not consider such changes in the flow system over time.
- Dewatering simulation occurs relatively instantaneously and do not capture a more realistic gradual removal of groundwater.
- The dewatering water is simulated to be reinjected as treated groundwater. The fluoride and sulfate are assumed to be completely removed by the treatment.
- For the purposes of this evaluation both fluoride and sulfate can be considered conservative tracers in the groundwater and have limited interaction with the aquifer matrix, so only advection and dispersion were used in the simulation.

This is a description of the assumptions and limitations of the modeling effort. Part of the process of performing applied modeling will include assessment of uncertainty, both in the model simulation results and in the data that are used to develop the calibrated model. Since this was intended as a generalized model to assess impacts of a not-yet-fully designed system, the level of uncertainty analysis was kept to the sensitivity analyses described above. Other factors may influence the uncertainty that were not tested for during this modeling effort.

8. Findings

- The calibrated steady-state groundwater model was used in a transient simulation to predict the effects of dewatering rates necessary to dewater the Lower Reservoir to 420 ft AMSL. The simulated steady states dewatering rate is 23 gpm. The transient dewatering rate ranges from 70 gpm at the initial dewatering down to 5 gpm after 5 years of dewatering. The 70-gpm initial flow is not expected during actual construction because the excavation will progress more slowly than simulated by the model.
- The resulting drawdown from dewatering at Spring 6 after 5 years of pumping is not measurable (0.0002 feet based on the calibrated model). Note that Wetland D was found to no longer exist in 2022 and Spring 6 has diminished in size and has been modified for cattle watering.
- A sensitivity analysis was done to determine how sensitive the model and aquifer is to changes in hydraulic conductivity. The result of the sensitivity analysis showed after 1 and 5 years of dewatering there is no to negligible drawdown at Spring 6 regardless of the hydraulic conductivity and the model is not very sensitive to hydraulic conductivity changes in the alluvium.
- The initial concentration of fluoride and sulfate were set at 46 mg/l and 8600 mg/l, respectively based on the maximum concentration of both constituents detected in the field. The plumes generated from this source roughly matches the distribution of fluoride and sulfate found in the RI (Tetra Tech, 2021). Based on the maximum concentrations (values taken from the RI) and time weighted average simulated steady state dewatering rate the daily load of fluoride and sulfate being removed from the system will average 5 kg/d and 100 kg/d, respectively.
- The injection wells were placed just southwest of the Lower Reservoir boundary. It simulated returning between 5 and 70 gpm to the aquifer. The return causes a slight local movement of the fluoride and sulfate plume to the east and has a minimal effect on the overall aquifer system.
- Note that the source of fluoride and sulfate will be removed by the Lower Reservoir excavation.
- Steady state model-estimated dewatering rates necessary for the construction of the Lower Reservoir were between around 25 gpm under average annual conditions. Pumping rates during the high-recharge season, if the Lower Reservoir is constructed during those times, could be expected to increase.

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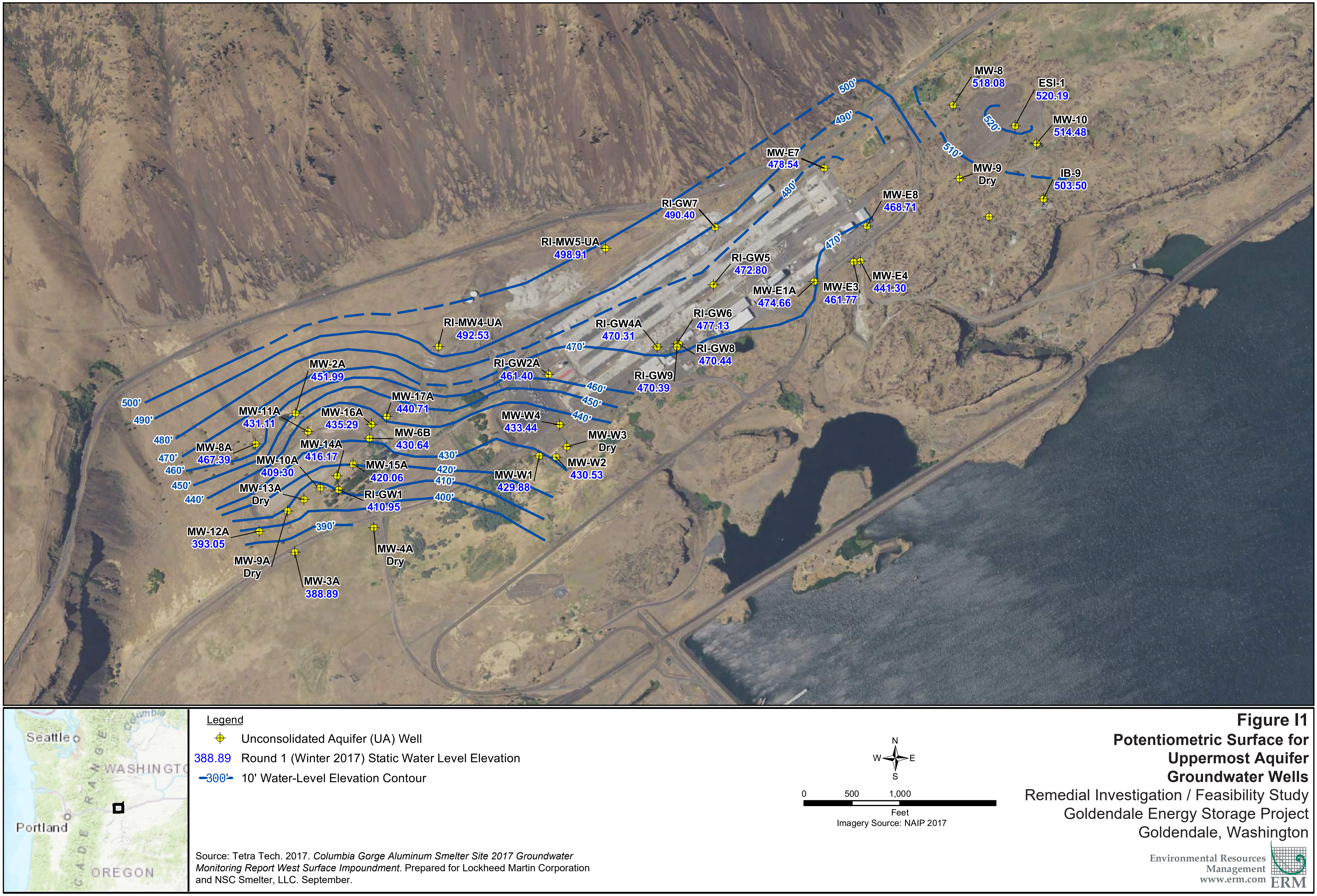
USGS, 2021; USGS 1/3 Arc Second n46w121 20211129: U.S. Geological Survey.

APPENDIX I GROUNDWATER CONDITIONS



Imagery Source: NAIP 2017

Legend

- ⊕ Unconsolidated Aquifer (UA) Well
- 388.89 Round 1 (Winter 2017) Static Water Level Elevation
- —300'— 10' Water-Level Elevation Contour

Source: Tetra Tech. 2017. *Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment.* Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.

Figure I1

Potentiometric Surface for Uppermost Aquifer Groundwater Wells

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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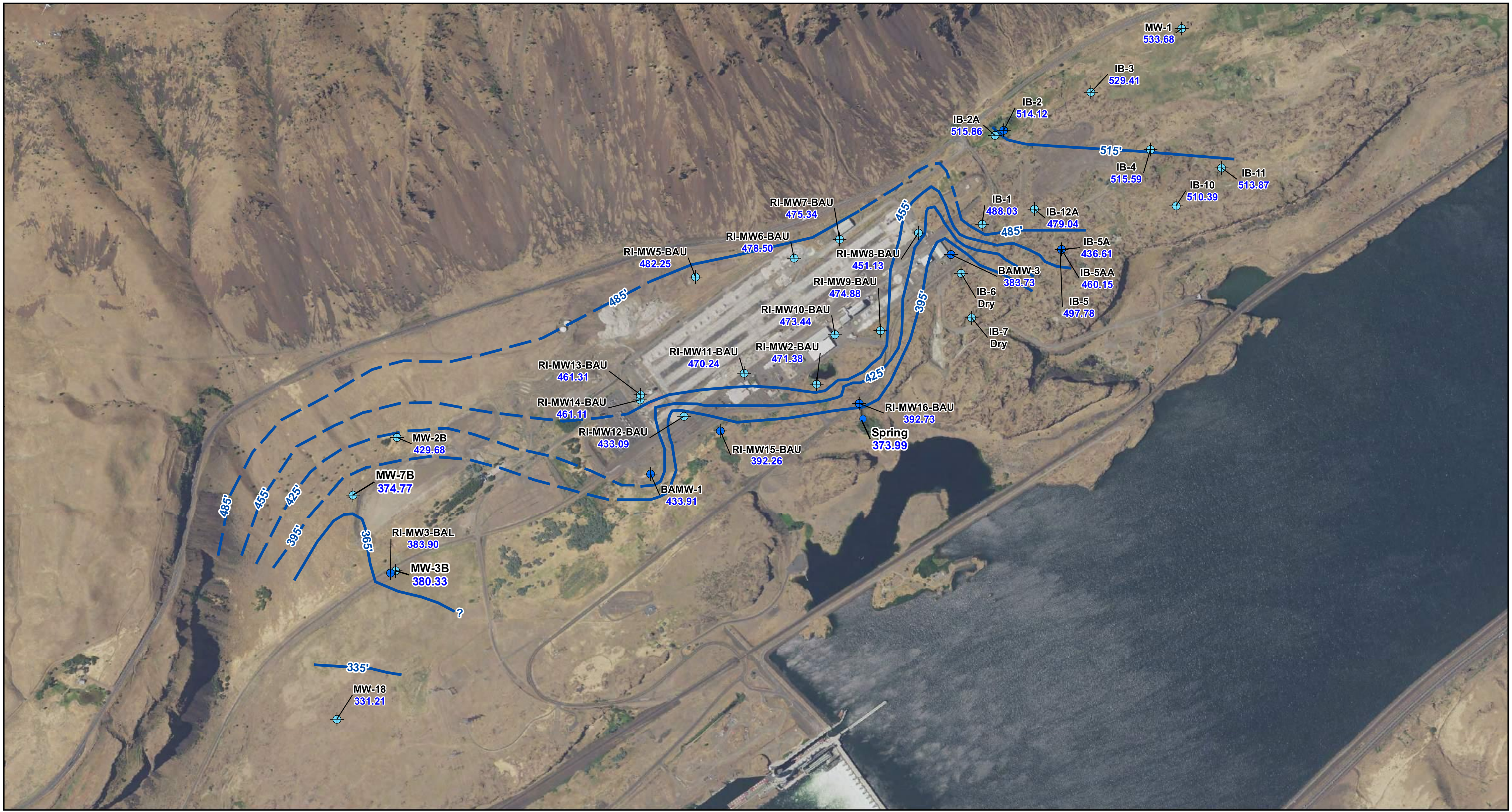

Legend

Uppermost Basalt Aquifer Well (BAU)

- ⊕ BAU_1 - Shallower Water-bearing Zon
- ⊕ BAU_2 - Deeper Water-bearing Zone

331.21 Round 1 (Winter 2017) Water-Level Elevation

-515'- 30' Water-Level Elevation Contour

● Spring

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Source: Tetra Tech. 2017. *Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment*. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.

Figure I2

Potentiometric Surface for Uppermost Basalt Aquifer Groundwater Wells

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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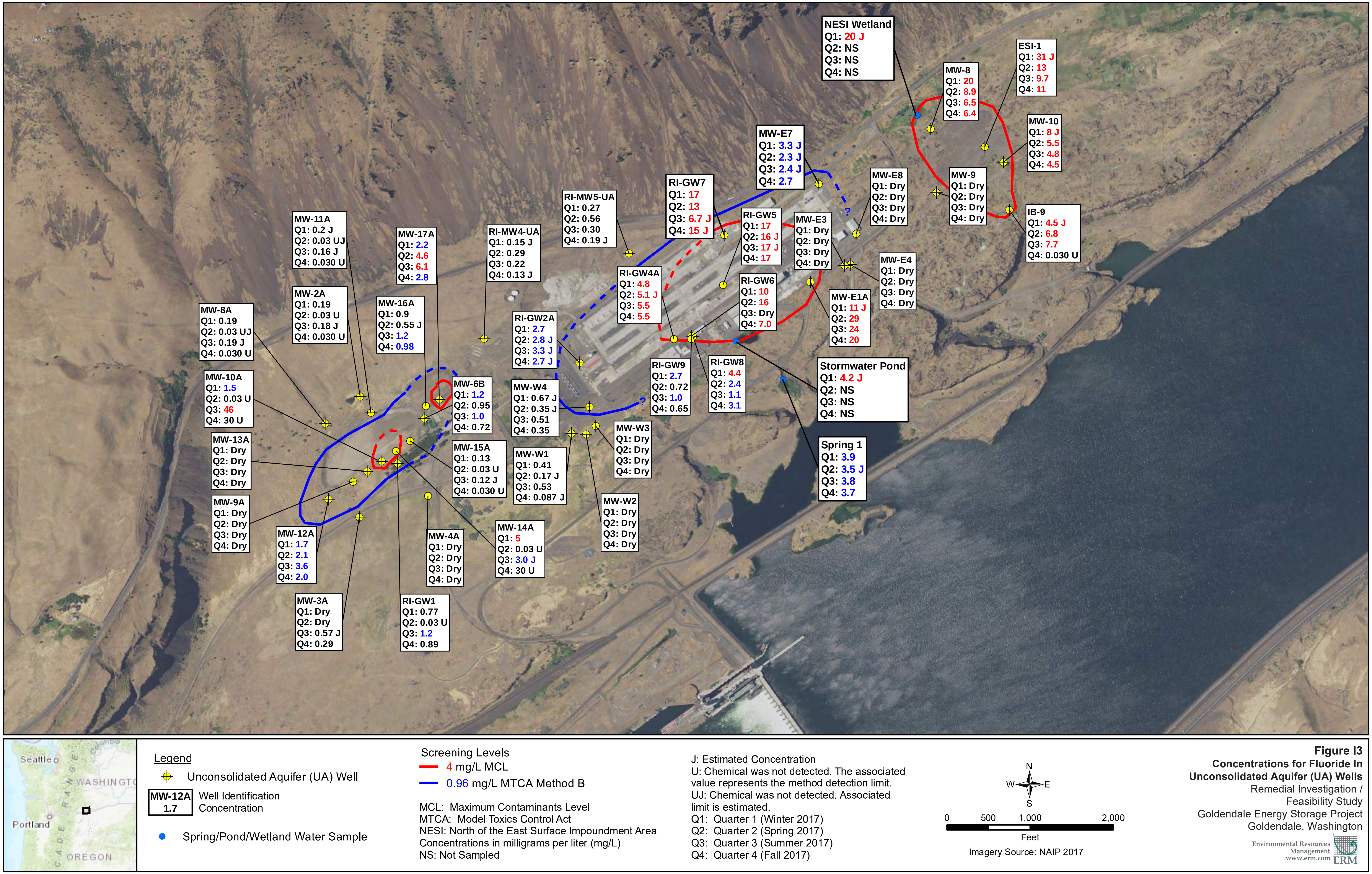

Legend

⊕ Unconsolidated Aquifer (UA) Well

MW-12A 1.7	Well Identification Concentration

● Spring/Pond/Wetland Water Sample

Screening Levels

4 mg/L MCL

0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NESI: North of the East Surface Impoundment Area
Concentrations in milligrams per liter (mg/L)
NS: Not Sampled

J: Estimated Concentration
U: Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

Imagery Source: NAIP 2017

Figure I3
Concentrations for Fluoride In Unconsolidated Aquifer (UA) Wells
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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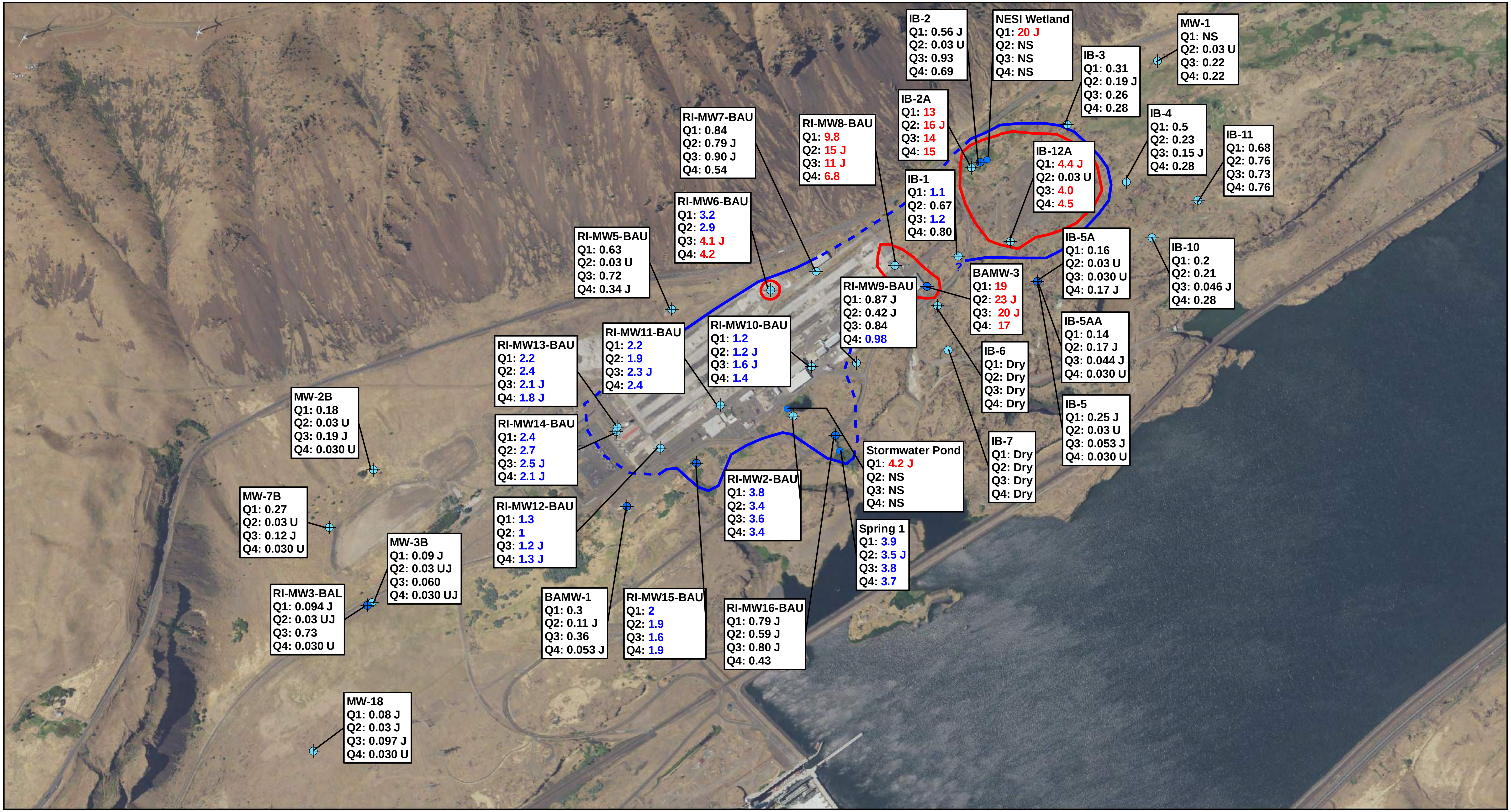
ERM

Source: Tetra Tech. 2017. Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.



Legend

Uppermost Basalt Aquifer Well (BAU)

- ⌖ BAU_1 - Shallower Water-bearing Zone
- ⌖ BAU_2 - Deeper Water-bearing Zone
- MW-12A 1.7 Well Identification Concentration
- ● Spring/Pond/Wetland Water Sample

Screening Levels

- 🟥 4 mg/L MCL
- 🟦 0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NESI: North of the East Surface Impoundment Area
Concentrations in milligrams per liter (mg/L)
NS: Not Sampled

J: Estimated Concentration
U: Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet

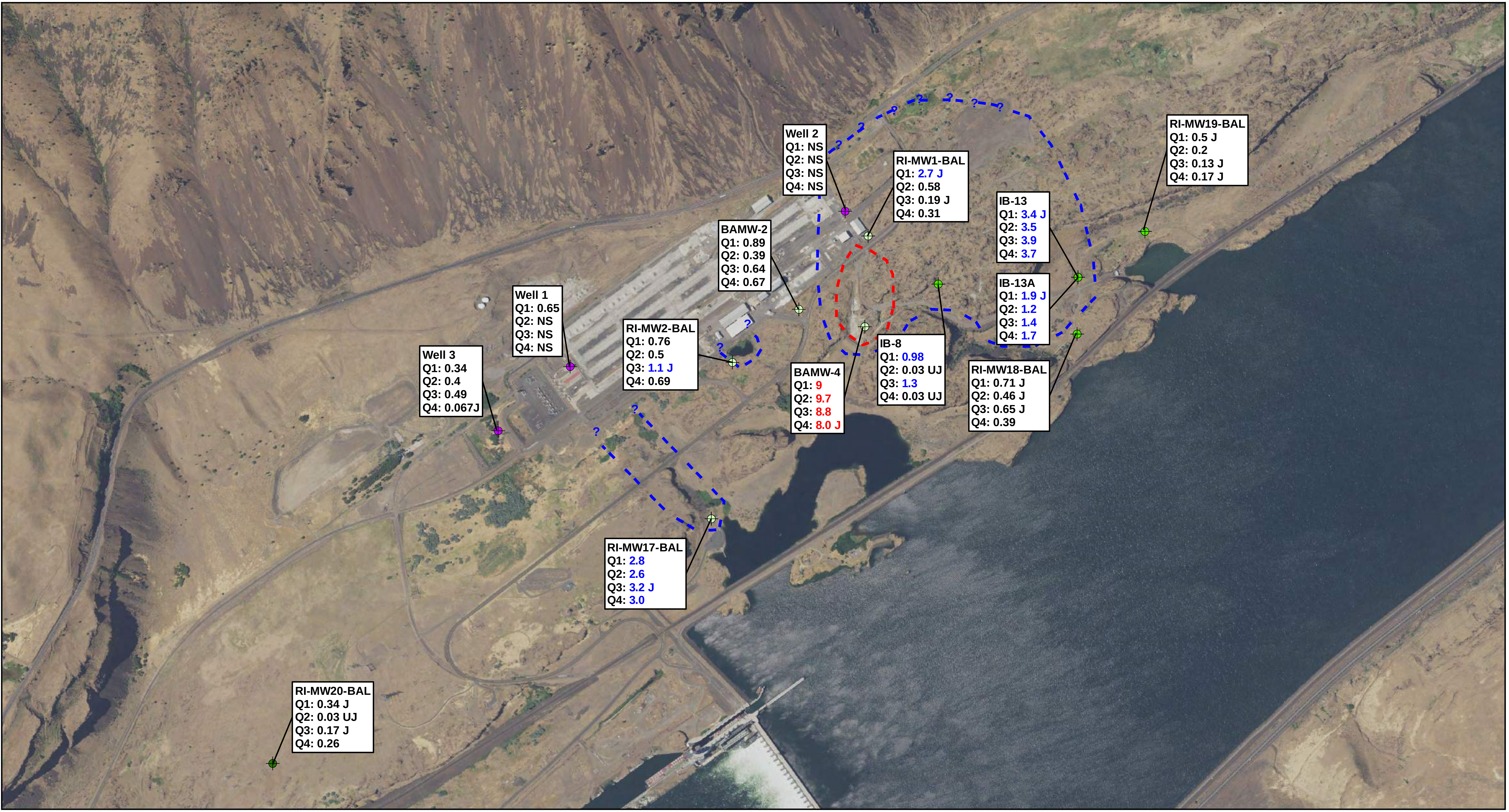
Imagery Source: NAIP 2017

Figure I4
Concentrations for Fluoride In Uppermost Basalt Aquifer (BAU) Wells
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
www.erm.com ERM

Source: Tetra Tech. 2017. Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.

R:\projects_2011\LockheedMartin_GoldendaleSiteInvestig\maps\2018_Reporting\Figure_2-28_Monitoring_Wells_Fluoride_Q1-4_BAL.mxd



Legend

Lower Basalt Aquifer Well (BAL)

⊕ BAL₁ - Shallower Water-bearing Zone
⊕ BAL₂ - Deeper Water-bearing Zone
⊕ BAL₃ - Deepest Water-bearing Zone

RI-MW20-BAL 0.34 J	Well Identification Concentration

⊕ Production Well

Screening Levels

— 4 mg/L MCL
— 0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
Concentrations in milligrams per liter (mg/L)
NS: Not Sampled

J: Estimated Concentration
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure I5
Concentrations for Fluoride In Lower Basalt Aquifer (BAL) Wells

Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
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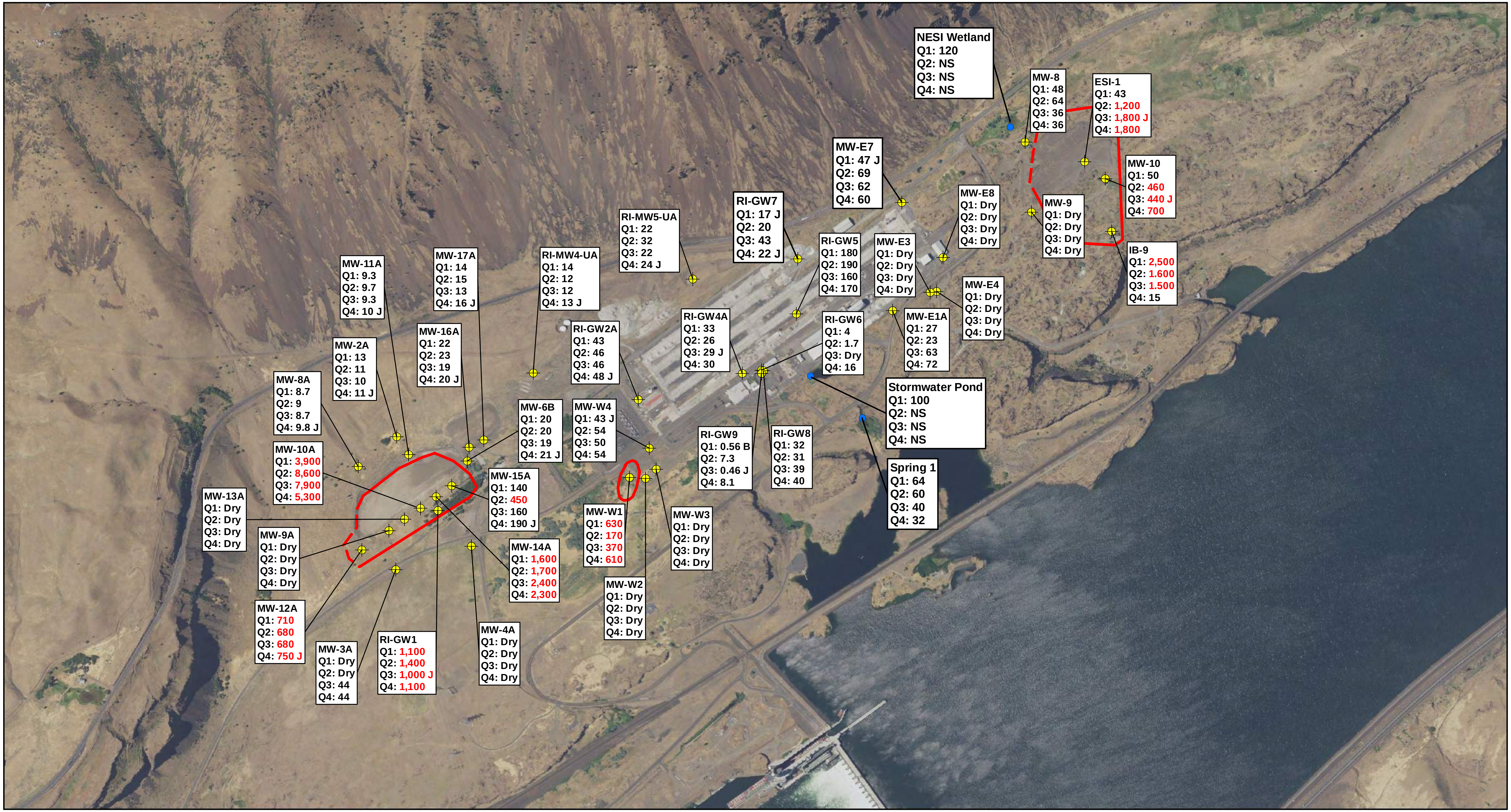
Source: Tetra Tech. 2017. Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.



Legend

⊕ Unconsolidated Aquifer (UA) Well

MW-12A 710	Well Identification Concentration

● Spring/Pond/Wetland Water Sample

Screening Levels
250 mg/L Secondary MCL

MCL: Maximum Contaminants Level
J: Estimated Concentration
Concentrations in milligrams per liter (mg/L)

NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure I6
Concentrations for Sulfate In
Unconsolidated Aquifer (UA) Wells
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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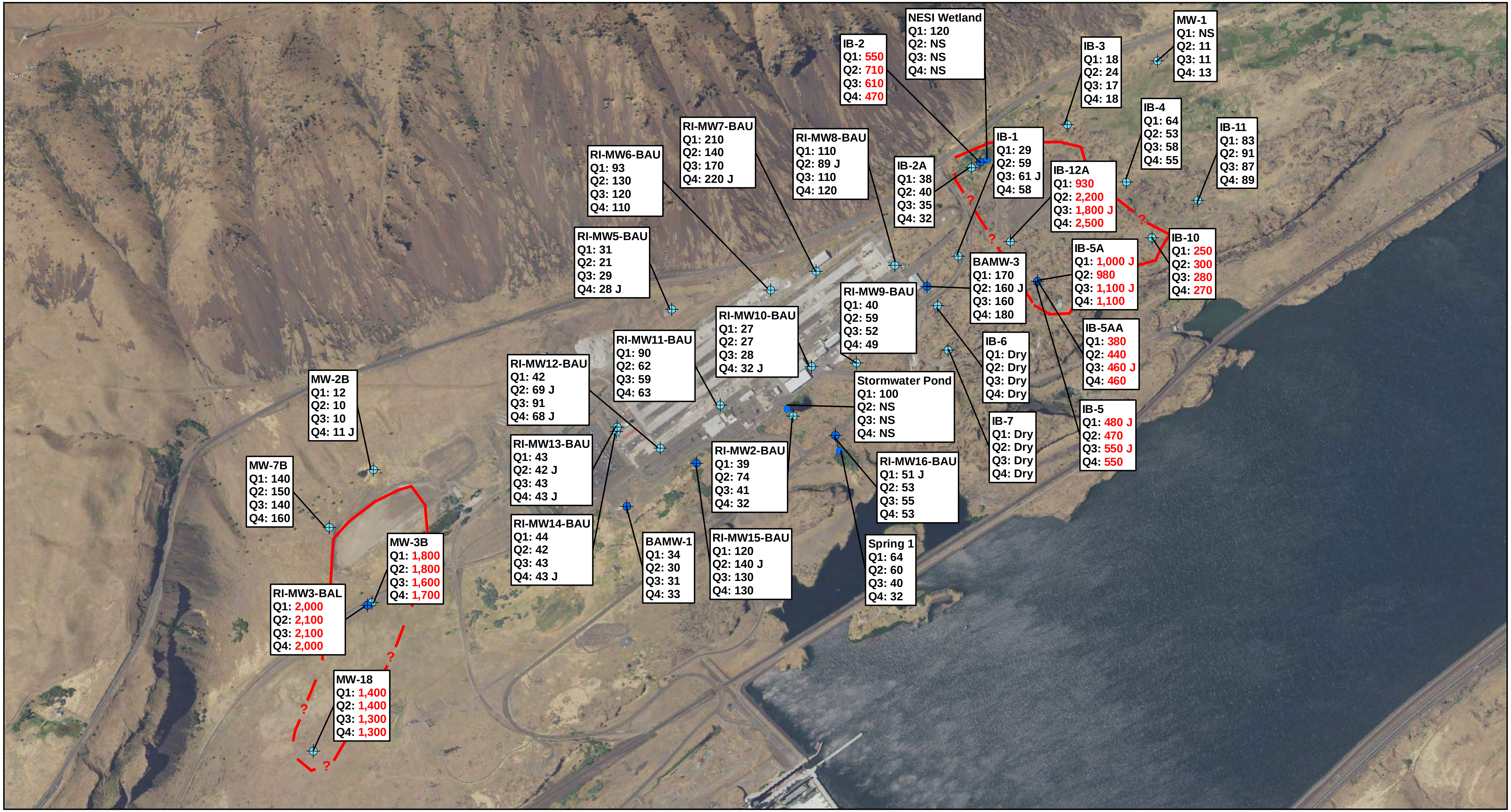
Source: Tetra Tech. 2017. Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.



Legend

Uppermost Basalt Aquifer Well (BAU)

- BAU₁ - Shallower Water-bearing Zone
- BAU₂ - Deeper Water-bearing Zone

MW-18
1,400
Well Identification
Concentration

● Spring/Pond/Wetland Water Sample

Screening Levels
250 mg/L Secondary MCL

MCL: Maximum Contaminants Level
J: Estimated Concentration
Concentrations in milligrams per liter (mg/L)

NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure I7
Concentrations for Sulfate In
Uppermost Basalt Aquifer (BAU) Wells
Remedial Investigation /
Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources
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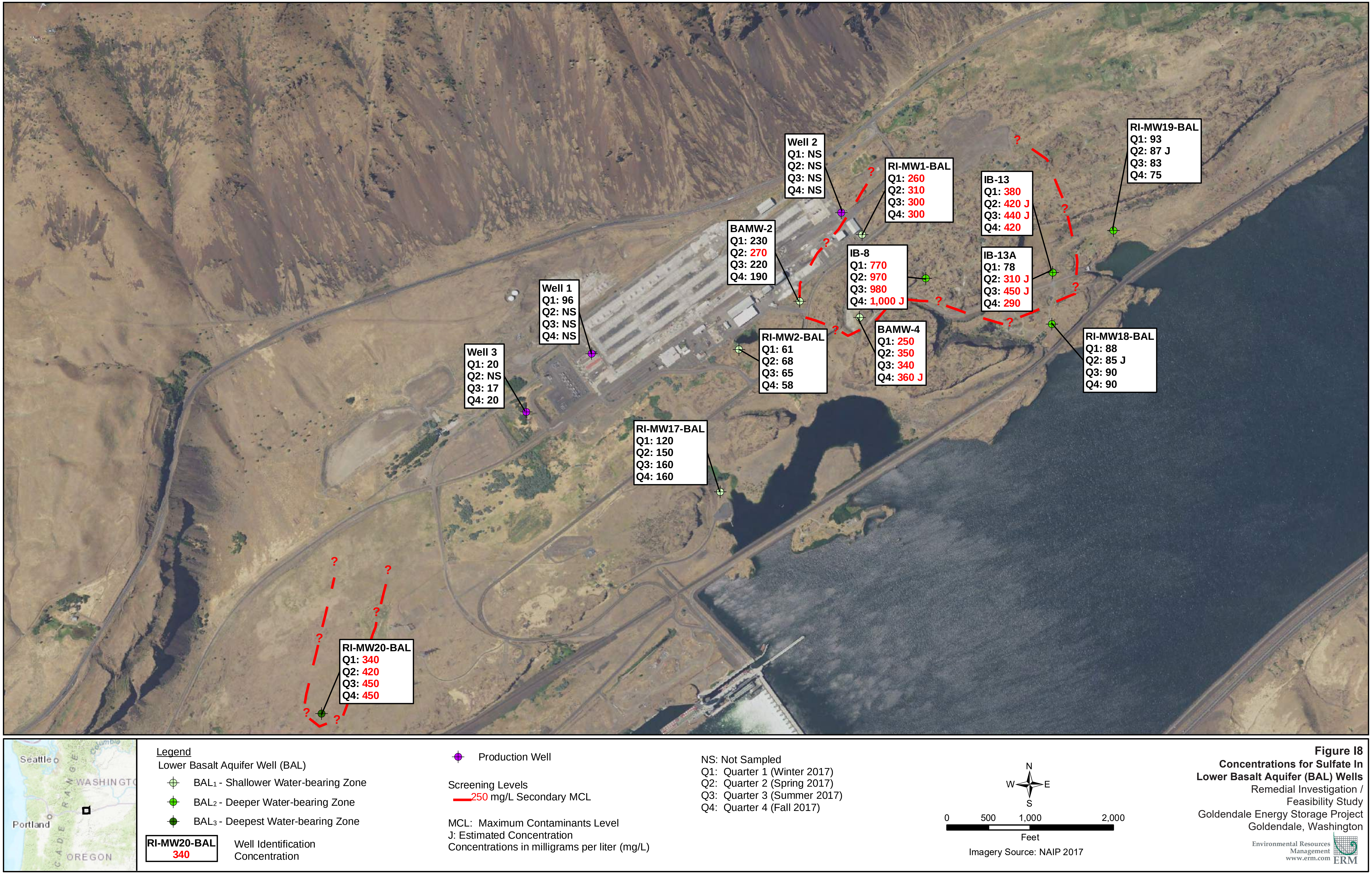
Source: Tetra Tech. 2017. Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.



Legend

Lower Basalt Aquifer Well (BAL)

- BAL_1 - Shallower Water-bearing Zone
- BAL_2 - Deeper Water-bearing Zone
- BAL_3 - Deepest Water-bearing Zone

RI-MW20-BAL
340 — Well Identification Concentration

Production Well

Screening Levels
250 mg/L Secondary MCL

MCL: Maximum Contaminants Level
J: Estimated Concentration
Concentrations in milligrams per liter (mg/L)

NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

Imagery Source: NAIP 2017

Figure I8
Concentrations for Sulfate In Lower Basalt Aquifer (BAL) Wells
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Environmental Resources Management
www.erm.com
ERM

Source: Tetra Tech. 2017. Columbia Gorge Aluminum Smelter Site 2017 Groundwater Monitoring Report West Surface Impoundment. Prepared for Lockheed Martin Corporation and NSC Smelter, LLC. September.

Appendix I - TABLES

Table I1. Monitoring Well Construction Information

Table I2. Summary of Groundwater Monitoring Results at WSI

Well ID	Construction Date	Well Material	Well Diameter (in)	Screen Interval (ft bgs)	Total Depth of Well (ft bgs)
MW-02A	4/5/1984	PVC Schedule 40	2	50 - 55	55
MW-02B	4/5/1984	PVC Schedule 40	4	104 - 109	109
MW-03A	4/13/1984	PVC Schedule 40	2	19.5 - 24.5	24.5
MW-03B	4/7/1984	PVC Schedule 40	4	46 - 51	51
MW-04A	4/17/1984	PVC Schedule 40	4	16 - 21	21
MW-04B	NA	NA	4	35 - 40	50
MW-05B	NA	NA	4	97 - 102	110
MW-06B	4/20/1984	PVC Schedule 40	4	35 - 40	50
MW-07B	4/25/1984	PVC Schedule 40	2	104 - 109	109
MW-08A	5/7/1989	PVC Schedule 40	4	21.5 - 31.5	32
MW-09A	4/18/1989	PVC Schedule 40	4	30.5 - 35.5	35.5
MW-10A	4/20/1989	PVC Schedule 40	4	13 - 25.5	26
MW-11A	4/28/1989	PVC Schedule 40	4	19 - 29	29.5
MW-12A	5/2/1989	PVC Schedule 40	4	40 - 54	55
MW-13A	5/4/1989	PVC Schedule 40	4	18.5 - 30.5	31
MW-14A	5/6/1989	PVC Schedule 40	4	8.5 - 29.5	30.5
MW-15A	5/6/1989	PVC Schedule 40	4	12.5 - 28	29
MW-16A	1/10/1990	PVC Schedule 40	4	22 - 42	43
MW-17A	1/10/1990	PVC Schedule 40	4	15 - 35	35
MW-18	10/1/2004	NA	4	35 - 50	51

Notes:
in = inches
ft = ft
bgs = below ground surface
NA = Not available.
MW-4B and MW-5B were abandoned in 1989.

Table I2
Summary of WSI Groundwater Monitoring Data
Remedial Investigation / Feasibility Study Rev 1
Goldendale Energy Storage Project, Goldendale, WA

	Location ID	Upgradient Well MW-8A		Downgradient Well MW-3B		Downgradient Well MW-10A		Downgradient Well MW-12A		Downgradient Well MW-14A		Downgradient Well MW-18	
	Analyte	Sulfate	Fluoride	Sulfate	Fluoride	Sulfate	Fluoride	Sulfate	Fluoride	Sulfate	Fluoride	Sulfate	Fluoride
Lowest Groundwater Protection Standard		250	0.96	250	0.96	250	0.96	250	0.96	250	0.96	250	0.96
Sample Date	Unit												
2/16/2005	mg/L	10	0.9	2300	0.6	940	1.8	*Dry*	*Dry*	4000	9.6	1500	0.6
5/11/2005	mg/L	9.8	0.3	2500	0.4	910	1.5	*Dry*	*Dry*	3500	8.6	1300	0.4
8/29/2005	mg/L	8.9	0.4	2700	0.6	670	1.2	*Dry*	*Dry*	3600	30	1500	0.4
11/1/2005	mg/L	9.6	0.9	2600	0.9	670	2.7	*Dry*	*Dry*	2800	25	1300	1.8
2/27/2006	mg/L	9.27	2.8	2610	0.7	1570	2.3	*Dry*	*Dry*	2170	31	1520	0.9
6/5/2006	mg/L	9.8	0.2	2220	0.2	1650	3.2	*Dry*	*Dry*	2380	27	1490	0.2
7/31/2006	mg/L	9.8	0.1	2000	3.7	860	2.3	*Dry*	*Dry*	3300	30	1500	2.6
10/9/2006	mg/L	9.7	*<0.2*	2500	3.8	850	1.9	*Dry*	*Dry*	3900	24	1600	2.4
3/13/2007	mg/L	10	*<0.1*	2500	3.8	1100	3.4	1800	6.3	4400	16	1600	2.6
6/22/2007	mg/L	1	*<10*	2500	<10	1100	*<10*	*Dry*	*Dry*	7900	19	1700	*<1*
9/24/2007	mg/L	10	*<1*	2200	<1	760	1.2	*Dry*	*Dry*	6400	*<50*	1400	*<50*
11/14/2007	mg/L	--	--	--	--	--	--	*Dry*	*Dry*	--	--	--	--
5/8/2008	mg/L	10	*<1*	2200	<50	2700	*<50*	*Dry*	*Dry*	5500	*<50*	1300	*<50*
10/14/2008	mg/L	10	0.1	2600	<10	860	*<10*	*Dry*	*Dry*	6500	20	1600	*<1*
5/29/2009	mg/L	9	*<1*	2200	<1	2000	2	*Dry*	*Dry*	7000	30	1500	1
10/27/2009	mg/L	10	*<1*	2606	<1	760	<1	*Dry*	*Dry*	5900	24	1200	<1
5/26/2010	mg/L	9.3	*<1*	2300	2.3	2200	4.4	*Dry*	*Dry*	5200	32	1500	2
10/6/2010	mg/L	8.9	*<1*	2400	<1	710	1	*Dry*	*Dry*	4000	18	1600	*<1*
7/26/2011	mg/L	7.8	*<1*	2000	<1	1800	3.3	*Dry*	*Dry*	3900	23	1600	*<1*
4/19/2012	mg/L	10	0.18	2200	0.16	5800	1.9	*Dry*	*Dry*	*Dry*	*Dry*	1700	0.2
6/20/2013	mg/L	9.4	0.16	1900	0.16	4700	3.1	*Dry*	*Dry*	2300	17	1500	0.13
4/25/2014	mg/L	9.5	0.19	2000	0.18	6100	2	*Dry*	*Dry*	2100	18	1700	0.12
7/20/2015	mg/L	9.5	0.16	1900	0.14	1900	2	*Dry*	*Dry*	1100	6.8	1300	0.11
8/2/2016	mg/L	9.3	0.13	1900	0.12	3500	2.1	*Dry*	*Dry*	1400	3.5	1700	0.12
8/9/2017	mg/L	9.6	0.15	1700	0.15	2900	3.2	*Dry*	*Dry*	1700	2.5	1300	0.11
7/26/2018	mg/L	9.5	0.15	1800	0.16	4800	4.1	*Dry*	*Dry*	1800	3.6	1400	0.11
7/24/2019	mg/L	5.4	0.14	1500	0.15	4000	3.7	*Dry*	*Dry*	1700	2.8	1200	0.12
6/20/2020	mg/L	11	0.16	1700	0.14	5700	4.4	*Dry*	*Dry*	2000	7	1400	0.13
7/29/2021	mg/L	9	0.15	1500	0.17	*Dry*	*Dry*			1100	7.8	1200	0.11

Notes:

Data compiled from the *2021 Annual Groundwater Monitoring Report and Surface Maintenance Report. September 20, 2021, Appendix A*

< = Compound not detected at concentrations above the laboratory reporting detection limit. The laboratory reporting detection limit is shown.

Bold are detected results

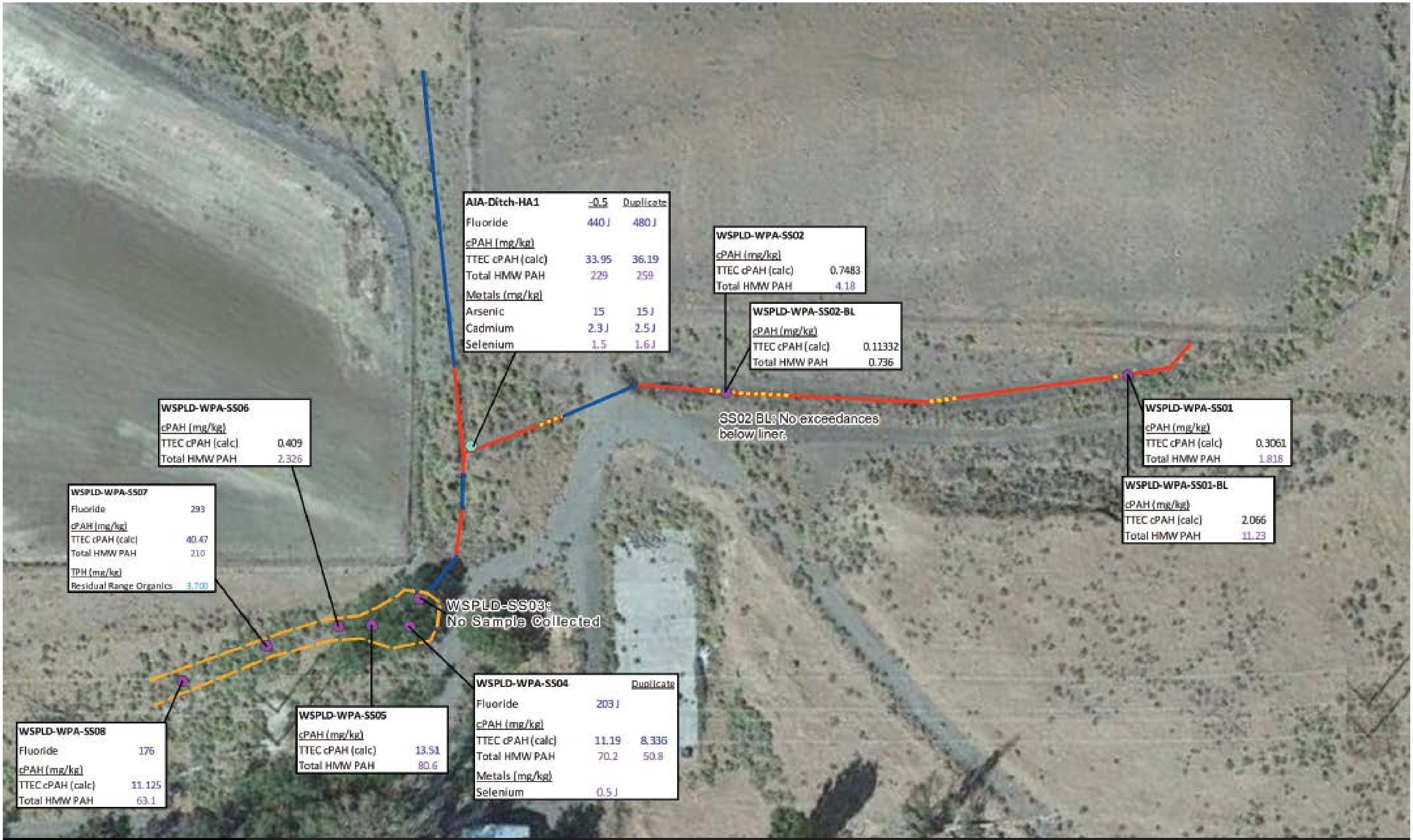
Grey shaded cells = results exceed lowest groundwater protection standard

Empty cells = Data not available from GeoPro LLC 2021 Annual Groundwater Monitoring Report

-- = Data not available from GeoPro LLC 2021 Annual Groundwater Monitoring Report

mg/L = Milligrams per liter

APPENDIX J SAMPLE RESULTS WEST SPL DITCH



AIA-Ditch-HA1	-0.5	Duplicate
Fluoride	440 J	480 J
cPAH (mg/kg)		
TTEC cPAH (calc)	33.95	36.19
Total HMW PAH	229	259
Metals (mg/kg)		
Arsenic	15	15 J
Cadmium	2.3 J	2.5 J
Selenium	1.5	1.6 J

WSPLD-WPA-SS02	
cPAH (mg/kg)	
TTEC cPAH (calc)	0.7483
Total HMW PAH	4.18

WSPLD-WPA-SS02-BL	
cPAH (mg/kg)	
TTEC cPAH (calc)	0.11332
Total HMW PAH	0.736

WSPLD-WPA-SS06	
cPAH (mg/kg)	
TTEC cPAH (calc)	0.409
Total HMW PAH	2.326

WSPLD-WPA-SS01	
cPAH (mg/kg)	
TTEC cPAH (calc)	0.3061
Total HMW PAH	1.818

WSPLD-WPA-SS01-BL	
cPAH (mg/kg)	
TTEC cPAH (calc)	2.066
Total HMW PAH	11.23

WSPLD-WPA-SS07	
Fluoride	293
cPAH (mg/kg)	
TTEC cPAH (calc)	40.47
Total HMW PAH	210
TPH (mg/kg)	
Residual Range Organics	3,700

WSPLD-WPA-SS04		Duplicate
Fluoride	203 J	
cPAH (mg/kg)		
TTEC cPAH (calc)	11.19	8.336
Total HMW PAH	70.2	50.8
Metals (mg/kg)		
Selenium	0.5 J	

WSPLD-WPA-SS05	
cPAH (mg/kg)	
TTEC cPAH (calc)	13.51
Total HMW PAH	80.6

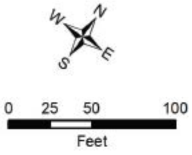
WSPLD-WPA-SS08	
Fluoride	176
cPAH (mg/kg)	
TTEC cPAH (calc)	11.125
Total HMW PAH	63.1

Legend

- ● RI Sample Location
- ● WPA Sample Location
- — Armored Ditch
- — Culvert
- ···· Area of Minor Sediment and Vegetation
- – – Approximated Lateral Extent of Soil Screening Level Exceedances

red: Exceeds MTCA Method C Soil Screening Level
cyan: Exceeds MTCA Method A Soil Screening Level (TPH Only)
blue: Exceeds MTCA Soil Screening Level for Protection of Groundwater
purple: Exceeds Terrestrial Ecological Soil Screening Level
black: Below Screening Levels

cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
HMW = High Molecular Weight
LMW = Low Molecular Weight
PAH = Polycyclic Aromatic Hydrocarbon
TTEC (calc) = Total Toxicity Equivalent Concentration (calculated)



Source: Tetra Tech. 2021. Revised Remedial Investigation Report Volumes 1 through 4, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

Figure J1

West SPL Ditch Sampling Locations and Soil Screening Level Exceedance Summary

Remedial Investigation /Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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Table 33-1
West SPL Ditch RI Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
June 2016
(Page 1 of 2)

Parameter Name	Units	MTCA Method A Industrial	MTCA Method C	Ecological Indicator	Protection of Groundwater Vadose Zone[a]	Selected Screening Level	Natural Background	Analytical Results	
				Eco-SSL Wildlife				AIA-Ditch-HA1-0.5 6/30/2016	AIA-Ditch-HA40-0.5 (Duplicate of AIA-Ditch-HA1-0.5) 6/30/2016
Aluminum Smelter									
Cyanide[b]	mg/Kg	NA	2,200	5.0	1.9	1.9	NE	2 U	2 U
Fluoride	mg/Kg	NA	210,000	NE	147.6[c]	147.6	14.11	**440 J**	**480 J**
Sulfate	mg/Kg	NA	NE	NE	2,150[c]	2,150	NE	28 J	28 J
Polycyclic Aromatic Hydrocarbons (PAHs)									
1-Methylnaphthalene	mg/Kg	NL	4,500	NL	0.082	0.082	NE	0.022 J	0.023 J
2-Methylnaphthalene	mg/Kg	NL	14,000	NL	1.7	1.7	NE	0.029	0.029
Acenaphthene	mg/Kg	NA	210,000	NL	98	98	NE	0.39	0.38
Acenaphthylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.021 J	0.023 J
Anthracene	mg/Kg	NA	NE	NL	2,300	2,300	NE	0.65	0.68
Benzo(a)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	11	11
Benzo(a)pyrene	mg/Kg	2.0	NL	NL	NL	NL	NE	21	21
Benzo(b)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	47	57
Benzo(ghi)perylene	mg/Kg	NA	NE	NL	NE	NL	NE	39	47
Benzo(k)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	15	17
Chrysene	mg/Kg	NL	NL	NL	NL	NL	NE	20	20
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	5.5	5.9
Fluoranthene	mg/Kg	NA	140,000	NL	630	630	NE	16	16
Fluorene	mg/Kg	NA	140,000	NL	100	100	NE	0.18	0.18
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NL	NL	NL	NE	49	59
Naphthalene	mg/Kg	5.0	70	NL	4.5	4.5	NE	0.052	0.05
Phenanthrene	mg/Kg	NA	NE	NL	NE	NL	NE	3.2	3.1
Pyrene	mg/Kg	NA	110,000	NL	650	650	NE	21	21
Total TEC cPAH (calc)	mg/Kg	2.0	130	NE	3.9	3.9	NE	**33.95**	**36.19**
LMW PAH	mg/Kg	NA	NE	100	NE	100	NE	20.544	20.465
HMW PAH	mg/Kg	NA	NE	1.1	NE	1.1	NE	**229**	**259**
Polychlorinated Biphenyls (PCBs)									
PCB-aroclor 1016	mg/Kg	NA	250	NE	NE	250	NE	0.0072 U	0.0073 U
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	0.0041 U	0.0042 U
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	0.0047 U	0.0048 U
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	0.0015 U	0.0016 U
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	0.0028 U	0.0029 U
PCB-aroclor 1254	mg/Kg	NA	66	NE	0.71	66	NE	0.0098	0.014
PCB-aroclor 1260	mg/Kg	NA	66	NE	NE	66	NE	0.0018 U	0.0019 U
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	0.00048 UJ	0.00049 UJ
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	0.00087 U	0.00089 U
Total PCB Aroclor (calc)	mg/Kg	10	66	0.65	NE	0.65	NE	0.0098	0.014
Metals									
Aluminum	mg/Kg	NA	3,500,000	NE	480,000	480,000	28,299	43,000	45,000
Arsenic	mg/Kg	20	88	132	2.9	7.61	7.61	**15**	**15 J**
Cadmium	mg/Kg	2.0	3,500	14	0.69	0.81	0.81	**2.3 J**	**2.5 J**
Chromium	mg/Kg	2,000	5,300,000	67	490,000	67	31.88	22	22
Copper	mg/Kg	NA	140,000	217	280	217	28.4	18	19 J
Lead	mg/Kg	1,000	NE	118	3,000	118	13.1	20	21
Mercury	mg/Kg	2.0	NE	5.5	2.1	2.1	0.04	0.02	0.019
Nickel	mg/Kg	NA	70,000	980	130	130	24.54	120	130 J
Selenium	mg/Kg	NA	18,000	0.3	5.2	0.3	0.29	**1.5**	**1.6 J**
Zinc	mg/Kg	NA	1,100,000	360	6,000	360	80.91	130	140 J
Total Petroleum Hydrocarbons (TPHs)									
Diesel Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NA	120	130
Residual Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NA	1,100	1,200

Source: Tetra Tech. 2021. *Revised Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order DE 10483. November 30.

Appendix J

Table 33-1 West SPL Ditch RI Soil Results Summary (June 2016)
Remedial Investigation /Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Table 33-1
West SPL Ditch RI Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
June 2016
(Page 2 of 2)

Notes:

Bold and shaded values denote exceedances of one or more screening levels and background concentrations.

a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted.

b Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.

c Soil screening levels for protection of groundwater derived from literature or empirical demonstration (refer to Volume 1 for discussion).

B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected.
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable
NE = Not Established
NL = Not Listed
PAHs = Polycyclic Aromatic Hydrocarbon
SSL = Soil Screening Level
Total TEC = Total Toxicity Equivalent Concentration
TPH = Total Petroleum Hydrocarbons

APPENDIX K SCREENING LEVELS

Table 5-1
Soil Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 3)

Chemicals of Potential Concern	MTCA Screening Levels											Range of Background Concentrations	Laboratory Reporting Limit / Method Detection Limit
	Method A				Protection of Groundwater		Protection of Surface Water		Site-Specific TEE [d,e]				
	Unrestricted Land Use	Industrial	Method B	Method C	Vadose Zone	Saturated Zone	Vadose Zone	Saturated Zone	Ecological Indicator-Plants	Ecological Indicator-Soil Biota	Ecological Indicator-Wildlife		
Aluminum Smelting (mg/kg)													
Cyanide	NA	NA	50	2,200	140.4/1.9 [i]	0.1	1.0	0.041	NE	NE	5	NE	2.0 / 0.51
Fluoride	NA	NA	4,800	210,000	615/147.6 [j]	140	NE	NE	NE	NE	NE	14.11 [h]	8.0 / 2.41
Sulfate	NA	NA	NE	NE	2,150 [m]	2,150 [m]	NE	NE	NE	NE	NE	NE	20.0 / 7.75
Polynuclear Aromatic Hydrocarbons (PAHs) (mg/kg)													
1-Methylnaphthalene	NL [a]	NL [a]	34	4,500	0.082	0.0042	NE	NE	NE	NL	NL	NE	0.005 / 0.00063
2-Methylnaphthalene	NL[a]	NL [a]	320	14,000	1.7	0.088	NE	NE	NE	NL	NL	NE	0.005/ 0.000205
Acenaphthene	NA	NA	4,800	210,000	98	5	3.1	0.16	NL	NL	NL	NE	0.005 / 0.0006
Acenaphthylene	NA	NA	NE	NE	NE	NE	NE	NE	NE	NL	NL	NE	0.005 / 0.0005
Anthracene	NA	NA	NE	NE	2,300	110	47	2.4	NE	NL	NL	NE	0.005 / 0.0006
Benzo(a)anthracene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 / 0.00076
Benzo(a)pyrene	0.1 [b]	2.0[b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 / 0.00084
Benzo(b)fluoranthene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005/ 0.00059
Benzo(g,h,i)perylene	NA	NA	NE	NE	NE	NE	NE	NE	NE	NL	NL	NE	0.005 / 0.0005
Benzo(k)fluoranthene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005/ 0.00060
Chrysene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 /0.0015
Dibenzo(a,h)anthracene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005/ 0.00072
Fluoranthene	NA	NA	3,200	140,000	630	32	5.9	0.3	NE	NL	NL	NE	0.005 / 0.0014
Fluorene	NA	NA	3,200	140,000	100	5.1	1.6	0.08	NE	NL	NL	NE	0.005/ 0.0005
Indeno(1,2,3-cd)pyrene	NL [b]	NL [b]	NL	NL	NL	NL	NL	NL	NE	NL	NL	NE	0.005 / 0.00060
Naphthalene	5.0 [a]	5.0 [a]	1.6	70	4.5	240	NE	NE	NE	NL	NL	NE	0.005 / 0.00162
Phenanthrene	NA	NA	NE	NE	NE	NE	NE	NE	NE	NL	NL	NE	0.005/ 0.00163
Pyrene	NA	NA	2,400	110,000	650	33	11.0	0.55	NE	NL	NL	NE	0.005/ 0.00097
Total TTEC cPAH (calc)	0.1[b]	2.0 [b]	0.19 [b]	130 [b]	3.9[b]	0.19	0.00031	0.000016	NE	NE	NE	NE	0.005 / 0.00084
Total LMW PAH	NA	NA	NE	NE	NE	NE	NE	NE	NE	29	100	NE	0.005 / 0.0005
Total HMW PAH	NA	NA	NE	NE	NE	NE	NE	NE	NE	18	1.1	NE	0.005 / 0.00084
Polychlorinated Biphenyls (PCBs) (mg/kg)													
Total PCBs	1.0	10.0	0.5	66	NE	0.14	NE	0.0000022	40	NE	0.65	NE	0.02 / 0.0074
Aroclors													
1016	NA	NA	5.6	250	NE	0.12	NE	0.00032	NE	NE	NE	NE	0.02 / 0.0074
1221	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0042
1232	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0049
1242	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0035
1248	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.02 / 0.0029
1254	NA	NA	0.5	66	0.71	0.035	0.0017	0.000084	40	NE	NE	NE	0.02 / 0.0037
1260	NA	NA	0.5	66	NE	0.036	NE	NE	NE	NE	NE	NE	0.02 / 0.0074

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Table 5-1
Soil Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 3)

	MTCA Screening Levels												
	Method A				Protection of Groundwater		Protection of Surface Water		Site-Specific TEE [d,e]				
Chemicals of Potential Concern	Unrestricted Land Use	Industrial	Method B	Method C	Vadose Zone	Saturated Zone	Vadose Zone	Saturated Zone	Ecological Indicator-Plants	Ecological Indicator-Soil Biota	Ecological Indicator-Wildlife	Range of Background Concentrations	Laboratory Reporting Limit / Method Detection Limit
Metals (mg/kg)													
Aluminum	NA	NA	80,000	3,500,000	480,000	24,000	NE	NE	50	NE	NE	12,692 [h] / 28,299 [g]	15.0 / 3.3
Arsenic	20 [m]	20 [m]	0.67	88	2.9	0.15	2.9	0.15	10	60	132	1.9 [h] / 7.61 [g]	0.5 / 0.1
Cadmium	2 [f]	2 [f]	80	3,500	0.69	0.035	0.099	0.055	4	20	14	0.07 [h] / 0.81 [g]	0.4 / 0.07
Chromium [l]	2,000	2,000	120,000	5,300,000	490,000	24,000	1,500	74	42	42	67	12.37 [h] / 31.88 [g]	0.5 / 0.06
Copper	NA	NA	3,200	140,000	280	14	4.9	0.25	100	50	217	28.4 [g]	1.0 / 0.22
Lead	250	1,000	NE	NE	3,000	150	500	25	50	500	118	5.19 [h] / 13.1 [g]	0.5 / 0.05
Mercury	2 [f]	2 [f]	24	NE	2.10	0.10	0.013	0.00063	0.3	0.1	5.5	0.0015 [h] / 0.04 [g]	0.03 / 0.009
Nickel [c]	NA	NA	880	70,000	130	6.5	68	3.4	30	200	980	24.54 [g]	0.5 / 0.19
Selenium	NA	NA	400	18,000	5.2	0.26	0.52	0.026	1	70	0.3	0.29 [h]	1.5 / 0.28
Zinc	NA	NA	24,000	1,100,000	6,000	300	120	6.2	86	200	360	80.91 [g]	5.5 / 1.61
Total Petroleum Hydrocarbons (TPHs) (mg/kg)													
TPH-Gx (gasoline-extended range)	100 [n] 30	100 [n] 30	NE	NE	NA	NA	NA	NA	120	120	1,000	NA	5.0 / 2.30
TPH-Dx (diesel and heavy-oil ranges)	2,000	2,000	NE	NE	NA	NA	NA	NA	1,600	260	2,000	NA	50 / 12.3
Volatile Organic Compounds (VOCs) (mg/kg)													
Fuel-Related													
Benzene	0.03	0.03	18	2,400	0.027	0.0017	0.0024	0.00015	NE	NE	0.255	NA	0.030 / 0.0038
Toluene	7.0	7.0	6,400	280,000	4.5	0.27	0.4	0.024	200	NE	5.45	NA	0.15 / 0.0135
Ethyl benzene	6.0	6.0	8,000	350,000	5.9	0.34	0.24	0.014	NE	NE	5.16	NA	0.040/0.0091
Xylenes	9.0	9.0	16,000	700,000	14	0.83	NE	NE	NE	NE	10.0	NA	0.2 / 0.0149
Solvents													
Tetrachloroethene (PCE)	0.05 [f]	0.05 [f]	480 [j]	21,000 [j]	0.05	0/0028	0.024	0.0013	NE	NE	9.92	NA	0.002/ 0.0004
Trichloroethene (TCE)	0.03 [f]	0.03 [f]	12	1,800	0.025	0.0015	0.0019	0.00011	NE	NE	12.4	NA	0.002 / 0.0003
1,1,1-Trichloroethane (1,1,1-TCA)	2.0[f]	2 [f]	160,000	7,000,000	1.5	0.084	74	4.2	NE	NE	29.8	NA	0.002 / 0.0003
1,2,-Dichloroethane (1,2-DCA)	NE	NE	11	1,400	0.023	0.0016	0.043	0.0029	NE	NE	21.2	NA	0.001 / 0.0002
cis-1,2-Dichlorothene (cis-1,2-DCE)	NE	NE	160	7,000	0.078	0.0052	NE	NE	NE	NE	30.2	NA	0.003 / 0.0006
Vinyl chloride	NE	NE	0.67	88	0.0017	0.000089	0.00012	0.0000061	NE	NE	6.46	NA	0.002/ 0.0003

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Table 5-1
Soil Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 3 of 3)

Notes:

Cleanup Level and Risk Calculations Summary Tables accessed online during June 2021 and incorporate the February 2021 CLARC Update (Ecology 2021b).

a Method A level includes sum of 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene.
b MTCA cleanup levels for carcinogenic PAHs are based on toxicity equivalency factor summation approach specified in WAC 173-340-708(8) and Table 708-2 of MTCA.
c CLARC value for nickel refinery dusts adopted for human-health screening purposes. Soil screening values for protection of groundwater based on soluble salt-physical properties.
d Ecological indicator soil concentration for plants, soil biota, and wildlife exposure categories (Table 749-3, WAC 173-340-7493, MTCA).
e Additional ecological indicator soil screening values provided by Ecology and based on Ecology Implementation Memorandum # 19 for TPH and EPA ecological soil screening level guidance for low molecular-weight (LMW) and high molecular-weight (HMW) PAHs (EPA 2007a). For PAHs, total LMW and HMW PAH concentrations will be used for screening purposes. Individual PAH levels are provided for completeness.
f Method A soil level is designed to be protective of groundwater drinking water use.
g Natural background based on Ecology (1994) soil natural background concentration study. Value represents 90th percentile of eastern Washington data set.
h Site-specific background value from PGG (2013a) site investigation.
i Cyanide soil screening levels for protection of groundwater based on free cyanide form, literature distribution coefficient, MTCA Method B groundwater formula value/MCL, and fixed parameter three phase partitioning mode.
j Fluoride soil screening level for protection of groundwater based on MCL and empirical demonstration consistent with WAC 173-340-747.
k Sulfate screening level for protection of groundwater based on literature distribution coefficient, Secondary MCL, and fixed parameter there-phase partitioning model.
l Chromium screening levels are based on chromium (III) as the dominant form.
m Method A Cleanup Level for arsenic based on protection of groundwater adjusted for soil natural background.
n Method A Cleanup Level of 100 mg/kg if benzene is not detected and the sum of BTEX is less than 1 percent). Otherwise, the MTCA Method A Cleanup Level is 30 mg/kg.

mg/kg = Milligrams per kilogram
µg/kg = Micrograms per kilogram
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
CLARC = Cleanup Level and Risk Calculations Summary Tables and guidance accessed online during April 2018.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbons
HMW = High Molecular-Weight
LMW = Low Molecular-Weight
MTCA = Model Toxics Control Act
MCL = Maximum Contaminant Level
NA = Not applicable
NE = Not established in look-up Tables.
NL = Not listed. Screening level for specific chemical is not listed but is accounted for by summation process. Refer to footnotes.
NPDES = National Pollutant Discharge Elimination System
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TEE = Terrestrial Ecological Evaluation
Total TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
TPH-Dx = Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx = Total Petroleum Hydrocarbons – Gasoline-extended range
VOCs = Volatile Organic Compounds

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Table 5-2
Groundwater Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Chemicals of Potential Concern	MTCA Screening Levels			Natural Background	WA MCL	Laboratory Reporting Limit / Method Detection Limit
	Method A	Method B	Method C			
Aluminum Smelting (mg/L)						
Cyanide (Free)	NE	0.01	0.022	NE	0.2	0.005 / 0.0015
Fluoride	NE	0.96	2.1	0.72	4.0	0.20 / 0.030
Sulfate	NE	NE	NE	32	250 (also federal secondary)	1.20 / 0.260
Polynuclear Aromatic Hydrocarbons (PAHs) (µg/L)						
Acenaphthene	NA	960	2,100	NE	NE	0.020 / 0.0013
Acenaphthylene	NA	NE	NE	NE	NE	0.020 / 0.0011
Anthracene	NA	4,800	11,000	NE	NE	0.020 / 0.00082
Benzo(g,h,i)perylene	NA	NE	NE	NE	NE	0.0020 / 0.00086
Fluoranthene	NA	640	1,400	NE	NE	0.020 / 0.00082
Fluorene	NA	640	1,400	NE	NE	0.020 / 0.0011
1-Methylnaphthalene	NL [a]	1.5	15	NE	NE	0.020/ 0.0013
2-Methylnaphthalene	NL [a]	32	70	NE	NE	0.020 / 0.0013
Naphthalene	160 [a]	160	350	NE	NE	0.020/ 0.0014
Phenanthrene	NA	NE	NE	NE	NE	0.020 / 0.0011
Pyrene	NA	480	1,100	NE	NE	0.020 / 0.0010
Carcinogenic PAHs (µg/L)						
Total Toxicity Equivalent Concentration (TTEC)	0.1	0.2 [d]	0.2 [d]	NE	0.2	0.020 / 0.0011
Benzo(a)pyrene	0.1 [b]	0.023	0.88	NE	0.2	0.020 / 0.0011
Benz(a)anthracene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.000097
Benzo(b)fluoranthene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.00083
Benzo(k)fluoranthene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.00094
Chrysene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.00076
Dibenz(a,h)anthracene	NL [b]	NL [b]	NL [b]	NE	NE	0.020 / 0.0013
Indeno(1,2,3-cd)pyrene	NL [b]	NL [b]	NL [b]	NE	NE	0.05020 / 0.00089
Polychlorinated Biphenyls (PCBs) (µg/L)						
Total PCBs	0.1	0.044	0.44	ND	0.5	0.621/0.022
1016	NA	1.1	2.5	ND	NE	0.621/0.022
1221	NA	NE	NE	ND	NE	0.621/0.022
1232	NA	NE	NE	ND	NE	0.621/0.022
1242	NA	NE	NE	ND	NE	0.621/0.022
1248	NA	NE	NE	ND	NE	0.621/0.022
1254	NA	0.044	0.44	ND	NE	0.621/0.022
1260	NA	0.044	0.44	ND	NE	0.621/0.022
Metals (mg/L)						
Aluminum	NE	16	35	1.14	NE	0.1 / 0.0126
Arsenic	0.005	0.000058	0.00058	0.0069	0.01	0.001 / 0.0002
Cadmium	0.005	0.008	0.018	NE	0.005	0.0004 / 0.0001
Chromium (total)	0.05	24 (Cr III)	53 (Cr III)	0.03	0.1	0.0004 / 0.0002
Copper	NE	0.64	1.4	NE	1.3	0.002 / 0.0006
Iron	NA	11	25	13	0.3 (Secondary MCL)	0.5/0.18
Lead	0.015	NE	NE	0.00046	0.015	0.0008 / 0.0002
Mercury	0.002	NE	NE	NE	0.002	0.0003 / 0.0002
Nickel [c]	NA	0.000096	0.00096	0.0065	0.1	0.0003 / 0.0001
Selenium	NA	0.08	0.18	NE	0.050	0.0008 / 0.0020
Silver	NA	0.08	0.18	NE	NE	0.0004 / 0.0005
Zinc	NA	4.8	11	NE	NE	0.007 / 0.0019

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Table 5-2
Groundwater Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Chemicals of Potential Concern	MTCA Screening Levels			Natural Background	WA MCL	Laboratory Reporting Limit / Method Detection Limit
	Method A	Method B	Method C			
Total Petroleum Hydrocarbons (TPH) (mg/L)						
TPH-Gx (gasoline-extended range)	1.0 (no benzene) 0.80 (benzene present)	NE	NE	NE	NE	0.250 / 0.10
TPH-Dx (diesel and heavy-oil ranges)	0.5	NE	NE	NE	NE	0.110 / 0.065
Volatile Organic Compounds (VOCs) (µg/L)						
Fuel-Related						
Benzene	5.0	0.8	8.0	NE	5.0	0.20 / 0.03
Toluene	1,000	640	1,400	NE	1,000	0.20 / 0.05
Ethyl benzene	700	800	1,800	NE	700	0.20 / 0.05
Xylenes	1,000	1,600	3,500	NE	10,000	0.50 / 0.115
Solvent-Related						
Tetrachloroethene (PCE)	5.0	21	110	NE	5.0	0.50 / 0.084
Trichloroethene (TCE)	5.0	0.54	8.8	NE	5.0	0.20 / 0.066
1,1,1-Trichloroethane (1,1,1-TCA)	200	16,000	35,000	NE	200	0.20 / 0.025
1,2,-Dichloroethane (1,2-DCA)	5.0	0.48	4.8	NE	5.0	0.20 / 0.043
cis-1,2-Dichlorothene (cis-1,2-DCE)	NE	16	35	NE	70	0.20 / 0.055
Vinyl chloride	0.2	0.029	0.29	NE	2.0	0.02 / 0.013

Notes:

Cleanup Level and Risk Calculations Summary Tables accessed online during June 2021 and incorporate February 2021 CLARC Update (Ecology 2021b).

Based on the conceptual model of the site presented in this Final Draft RI Report, Ecology (2022) comments state that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs. The springs represent a special case since they are largely seasonal and do not provide fish habitat. Accordingly, spring data have been compared with groundwater screening levels.

a Method A level includes sum of 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene.

b MTCA cleanup levels for carcinogenic PAHs are based on toxicity equivalency factor summation approach specified in WAC 173-340-708(8) and Table 708-2 of MTCA.

c CLARC Method B and C values for nickel refinery dusts or nickel soluble salts depending on available values.

d MTCA Method B and C Cleanup Levels for carcinogenic PAHs represent the MCL consistent with Ecology (2021b) February 2021 CLARC modification.

mg/L = Milligrams per Liter
µg/L = Micrograms per Liter
CLARC = Cleanup Level and Risk Calculations Summary Tables accessed online during April 2018.
MCL = Maximum Contaminant Level
MTCA = Model Toxics Control Act
ND = Chemical was not detected
NE = Not established in look-up Tables
NL = Not listed. Screening level for specific chemical is not listed but is accounted for by summation process. Refer to footnotes.
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TPHs = Total Petroleum Hydrocarbons
TPH-Dx = Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx = Total Petroleum Hydrocarbons – Gasoline-extended range
VOCs = Volatile Organic Compounds
WA = Washington
Xylenes = Represents the total of m-, o-, and p-xylene isomers.

Table 5-3
Sediment Freshwater Screening Level Summary
Columbia Gorge Aluminum Smelter Site
Goldendale, Washington
(Concentrations in mg/kg dry weight unless otherwise indicated)

Chemical	Washington SMS Freshwater		Reference Station Concentrations		Laboratory Reporting Limit / Method Detection Limit
	Sediment Cleanup Objective	Cleanup Screening Level	Maximum	90/90 UTL	
Aluminum Smelter (mg/kg)					
Total Cyanide	NE	NE	ND	NC	2.0 / 0.51
Fluoride	NE	NE	7.8	7.7	8.0 / 2.41
Sulfate	NE	NE	290	278	20 / 7.75
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)					
1-Methylnaphthalene	NA	NA	28	NC	5.0 / 0.63
2-Methylnaphthalene	NA	NA	30	NC	5.0 / 2.05
Acenaphthene	NA	NA	24	NC	5.0 / 0.60
Acenaphthylene	NA	NA	28	NC	5.0 / 0.50
Anthracene	NA	NA	29	NC	5.0 / 0.60
Benz[a]anthracene	NA	NA	83	NC	5.0 / 0.76
Benzo(a)pyrene	NA	NA	140	41	5.0 / 0.84
Benzo(b)fluoranthene	NA	NA	150	NC	5.0 / 0.59
Benzo(ghi)perylene	NA	NA	190	NC	5.0 / 0.50
Benzo(k)fluoranthene	NA	NA	43	NC	5.0 / 0.60
Chrysene	NA	NA	120	NC	5.0 / 1.50
Dibenzo(a,h)anthracene	NA	NA	26	NC	5.0 / 0.72
Fluoranthene	NA	NA	210	NC	5.0 / 1.40
Fluorene	NA	NA	27	NC	5.0 / 0.50
Indeno(1,2,3-cd)pyrene	NA	NA	150	NC	5.0 / 0.60
Naphthalene	NA	NA	100	NC	5.0 / 1.62
Phenanthrene	NA	NA	100	NC	5.0 / 1.63
Pyrene	NA	NA	260	NC	5.0 / 0.97
Total cPAH BaPeq (calc)	NA	NA	185	57	5.0 / 0.97
Total PAHs	17,000	30,000	1,516	NC	5.0 / 0.84
Polychlorinated Biphenyls (PCBs) (mg/kg)					
Total Aroclors	0.110	2.5	ND	NC	0.02 / 0.0074
Metals (mg/kg)					
Aluminum	NA	NA	21,000	NC	15.0 / 3.3
Arsenic	14	120	20	18	0.5 / 0.1
Cadmium	2.1	5.4	1.5	1.3	0.4 / 0.07
Chromium	72	88	32	NC	0.5 / 0.06
Copper	400	1,200	54	NC	1.0 / 0.22
Lead	360	>1,300	35.8	128	0.5 / 0.05
Mercury (inorganic)	0.66	0.8	0.18	1.06	0.03 / 0.009
Nickel	26	110	22.7	48.6	0.5 / 0.19
Selenium	11	>20	NE	NE	1.5 / 0.28
Zinc	3,200	>4,200	121	459	5.5 / 1.61
Bulk Petroleum Hydrocarbons (mg/kg)					
TPH-Diesel	340	510	ND	NC	50 / 12.3
TPH-Residual	3,600	4,400	61	NC	50 / 17.5

Notes:

The list of chemicals is limited to chemicals of potential concern for freshwater sediment. There are no SMS Standards for individual PAHs. Volatile Organic Compounds (VOCs) do not represent chemicals of potential concern for sediments.

mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram
BaPeq = Benzo(a)pyrene equivalent
cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons
NA = Not Applicable
NC = Not Calculated
ND = Not Detected
NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
SMS = Washington State Sediment Management Standard
TPH = Total Petroleum Hydrocarbon
UTL = Upper Threshold Limit

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Appendix K
Table 5-3 Sediment Freshwater Screening Level Summary
Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Table 5-4
Surface Water Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 3)

Chemical	MTCA Human Health		Human Health			Aquatic Life		Drinking Water WA MCL	Other Screening Levels to Be Considered	Laboratory Reporting Limit/Method Detection Limit
			Freshwater							
	Method B	Method C	WAC 173-201A (Washington State Surface Water Criteria)	40 CFR 131.45 Water Quality Criteria	Clean Water Act Section 304 National Recommended Water Quality Criteria – Water + Organisms	National Recommended Water Quality Criteria – Freshwater Acute (CMC)	National Recommended Water Quality Criteria – Freshwater Chronic (CCC)			
Aluminum Smelting (mg/L)										
Cyanide (Free)	1.6	4.1	0.019	0.009	0.004	0.022	0.0052	0.2	NE	0.005 / 0.0015
Fluoride	NE	NE	NE	NE	NE	NE	NE	4.0	2.0[d]	0.20 / 0.030
Sulfate	NE	NE	NE	NE	NE	NE	NE	250[f]	500[e]	1.20 / 0.260
Polynuclear Aromatic Hydrocarbons (PAHs) (μg/L)										
Acenaphthene	640	1,600	110	30	70	NE	NE	NE	NE	0.020 / 0.0013
Acenaphthylene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0011
Anthracene	26,000	65,000	3,100	100	300	NE	NE	NE	NE	0.020 / 0.00082
Benzo(g,h,i)perylene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.0020 / 0.00086
Fluoranthene	90	230	16	6	20	NE	NE	NE	NE	0.020 / 0.00082
Fluorene	3,500	8,600	420	10	50	NE	NE	NE	NE	0.020 / 0.0011
1-Methylnaphthalene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020/ 0.0013
2-Methylnaphthalene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0013
Naphthalene	4,900	12,000	NE	NE	NE	NE	NE	NE	NE	0.020/ 0.0014
Phenanthrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0011
Pyrene	2,600	6,500	310	8	20	NE	NE	NE	NE	0.020 / 0.0010
Carcinogenic PAHs (μg/L)										
Total Toxicity Equivalent Concentration (TTEC)	0.035/0.000016[b]	5.4/0.000016 [b]	NE	NE	NE	NE	NE	NE	NE	0.020 / 0.0011
Benzo(a)pyrene	0.035/0.000016 [b]	5.4/0.000016 [b]	0.0014	0.000016	0.00012	NE	NE	0.2	NE	0.020 / 0.0011
Benzo(a)anthracene	NE	NE	0.014	0.00016	0.0012	NE	NE	NE	NE	0.020 / 0.000097
Benzo(b)fluoranthene	NE	NE	0.014	0.00016	0.0012	NE	NE	NE	NE	0.020 / 0.00083
Benzo(k)fluoranthene	NE	NE	0.014	0.0016	0.012	NE	NE	NE	NE	0.020 / 0.00094
Chrysene	NE	NE	1.4	0.016	0.12	NE	NE	NE	NE	0.020 / 0.00076
Dibenz(a,h)anthracene	NE	NE	0.0014	0.000016	0.00012	NE	NE	NE	NE	0.020 / 0.0013
Indeno(1,2,3-cd)pyrene	NE	NE	0.014	0.00016	0.0012	NE	NE	NE	NE	0.05020 / 0.00089
Polychlorinated Biphenyls (PCBs) (μg/L)										
Total PCBs	0.0001	0.0026	0.00017	0.000007	0.000064	2	0.014	0.5	NE	0.621/0.022
Aroclors (μg/L)										
1016	0.0058	0.015	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1221	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1232	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1242	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1248	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1254	0.0017	0.0026	NE	NE	NE	NE	NE	NE	NE	0.621/0.022
1260	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.621/0.022

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Table 5-4
Surface Water Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 3)

Chemical	MTCA Human Health		Human Health			Aquatic Life		Drinking Water WA MCL	Other Screening Levels to Be Considered	Laboratory Reporting Limit/Method Detection Limit
			Freshwater							
	Method B	Method C	WAC 173-201A (Washington State Surface Water Criteria)	40 CFR 131.45 Water Quality Criteria	Clean Water Act Section 304 National Recommended Water Quality Criteria – Water + Organisms	National Recommended Water Quality Criteria – Freshwater Acute (CMC)	National Recommended Water Quality Criteria – Freshwater Chronic (CCC)			
Metals (mg/L)										
Aluminum [a]	NE	NE	NE	NE	NE	1.3[c]	0.480[c]	NE	NE	0.1 / 0.0126
Arsenic	0.000098	0.0025	0.001	0.000018	0.000018	0.34	0.15	0.010	NE	0.001 / 0.0002
Cadmium [a]	NE	NE	NE	NE	NE	0.0026[h]	0.0010[h]	0.05	NE	0.0004 / 0.0001
Chromium (III)	240	610	NE	NE	NE	0.79[h]	0.010[h]	0.1	NE	0.0004 / 0.0002
Copper [a]	2.9	7.2	1.3	NE	1.3	NE[i]	NE[i]	13	NE	0.002 / 0.0006
Lead [a]	NE	NE	NE	NE	NE	0.10[h]	0.0039[h]	0.015	NE	0.0008 / 0.0002
Mercury	NE	NE	NE	NE	NE	0.0014	0.00077	0.002	NE	0.0003 / 0.0002
Nickel (soluble salts)[a]	1.1	2.8	0.15	0.08	0.06	0.66[h]	0.073[h]	0.1	NE	0.003 / 0.0001
Selenium	2.7	6.8	0.12	0.06	0.17	NE	NE	0.050	NE	0.008 / 0.0020
Zinc[a]	17	41	2.3	1	7.4	0.12[h]	0.01[h]	NE	NE	0.007 / 0.0019
Total Petroleum Hydrocarbons (TPHs) (mg/L)										
TPH-Gx (gasoline-extended range)	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.250 / 0.10
TPH-Dx (diesel and heavy-oil ranges)	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.110 / 0.065
Volatile Organic Compounds (VOCs) (µg/L)										
Fuel-Related										
Benzene	23	570	0.44	NE	0.58	NE	NE	5	NE	0.20 / 0.03
Toluene	19,000	48,000	180	72	57	NE	NE	1,000	NE	0.20 / 0.05
Ethyl benzene	6,900	17,000	200	29	68	NE	NE	700	NE	0.20 / 0.05
Xylenes	NE	NE	NE	NE	NE	NE	NE	10,000	NE	0.50 / 0.115
Solvent-Related										
Tetrachloroethene (PCE)	100	1,300	4.9	2.4	10	NE	NE	5	NE	0.50 / 0.084
Trichloroethene (TCE)	13	290	0.38	0.3	0.6	NE	NE	5	NE	0.20 / 0.066
1,1,1-Trichloroethane (1,1,1-TCA)	930,000	2,300,000	47,000	20,000	10,000	NE	NE	200	NE	0.20 / 0.025
1,2-Dichloroethane (1,2-DCA)	59	1,500	9.3	8.9	9.9	NE	NE	5	NE	0.20 / 0.043
cis-1,2-Dichlorothene (cis-1,2-DCE)	NE	NE	NE	NE	NE	NE	NE	70	NE	0.20 / 0.055
Vinyl chloride	3.7	92	0.02	NE	0.022	NE	NE	2	NE	0.02 / 0.013

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Table 5-4
Surface Water Screening Level Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
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Notes:

Cleanup Level and Risk Calculations Summary Tables accessed online during June 2021 and incorporate February 2021 CLARC Update (Ecology 2021b).

a Hardness and/or pH dependent criteria.

b Ecology has proposed to adopt the EPA 40 CFR 131.45 criteria as the MTCA Method B and C Surface Water Cleanup Level (Ecology 2019b, 2021a) pending ongoing litigation between the State of Washington and EPA for surface waters that provide fish habitat. Based on the conceptual model of the site presented in this Final Draft RI Report, Ecology (2022) comments state that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs. The springs represent a special case since they are largely seasonal and do not provide fish habitat.

c Aluminum criteria calculated using EPA (2018) guidance and associated calculator spreadsheet. Values used to determine the screening levels included: dissolved organic carbon of 1.0 mg/L, pH of 7.19, and total hardness of 150 mg/L. Hardness and pH based on the Wetland K Spring 01 RI data set. Dissolved organic carbon based on the typical range for groundwater. Aluminum ambient water quality criteria are based on total recoverable fraction.

d Fluoride value represents the Federal EPA Secondary MCL as well as screening level protective of livestock (cattle) (NDSU Extension 2021, UK Cooperative Extension 2008).

e Sulfate value represents screening level protective of livestock (cattle) (NDSU Extension 2021, UK Cooperative Extension 2008).

f Criteria represents Federal EPA Secondary MCL.

g Criteria based of dissolved (field-filtered) fraction that will be used for comparison.

h Hardness dependent criteria that has been adjusted using a hardness value of 150 mg/L from the RI Wetland K Spring 01 data set. The ambient water criteria values were adjusted using the equation and conversion factors on the EPA (2021) National Recommended Water Quality Criteria-Aquatic Life Criteria Table, Appendix B.

i Calculation of ambient water quality criteria value for copper requires use of Biologic Ligand Model and sampling and analysis for development of appropriate input parameters has not been performed. For this reason, the Washington 173-201A freshwater chronic aquatic copper value will be used for screening purposes for this exposure pathway.

mg/L = Milligrams per Liter
µg/L = Micrograms per Liter
CCC = Criterion Continuous Concentration
CFR = Code of Federal Regulations
Cleanup Level and Risk Calculations Summary Tables accessed online during August 2019 (May 2019 CLARC Update)
CMC = Criterion Maximum Concentration
MTCA = Model Toxics Control Act
NE = Not established in look-up Tables
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TPHs = Total Petroleum Hydrocarbons
TPH-Dx = Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx = Total Petroleum Hydrocarbons – Gasoline-extended range
VOCs = Volatile Organic Compounds
WAC = Washington Administrative Code

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

APPENDIX L SEDIMENT SAMPLE RESULTS

Table 1-4
Columbia River Sediments AOC - Reference Station Sample Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Parameter_Name	Units	Freshwater SMS Screening Levels		Analytical Results												
		SCO	CSL	CRSAOC-BKG01 4/27/2016	CRSAOC-BKG02 4/27/2016	CRSAOC-BKG03 4/27/2016	CRSAOC-BKG04 4/27/2016	CRSAOC-BKG05 4/27/2016	CRSAOC-BKG06 4/27/2016	CRSAOC-BKG07 4/27/2016	CRSAOC-BKG08 4/27/2016	CRSAOC-BKG09 4/27/2016	CRSAOC-BKG10 4/25/2016	CRSAOC-BKG11 4/25/2016	CRSAOC-BKG12 4/27/2016	CRSAOC-BKG40 (Dup of BKG05) 4/27/2016
Grain Size/Total Organic Carbon																
Particle/Grain Size, Clay	%	NA	NA	12.1	24.5	5.1	7.4	28.8	23.8	4.5	27.1	12.1	28.4	25.8	21.2	28.6
Particle/Grain Size, Gravel	%	NA	NA	0.7	37.2	7.5	0	0	0	0	3.5	0	0	0	0	0
Particle/Grain Size, Sand	%	NA	NA	36.3	6.8	65.4	65.6	6.4	1.9	83.4	9.9	39.5	1.5	0.1	1.2	6.5
Particle/Grain Size, Silt	%	NA	NA	50.9	31.5	22	27.1	64.8	74.3	12.1	59.5	48.4	70.1	74.1	77.6	64.9
Total Organic Carbon	%	NA	NA	1.1	2	0.63	0.66	2	2.1	0.29	1.8	0.95	1.9	1.2	0.99	1.8
Metals																
Aluminum	mg/Kg	NA	NA	9,000	8,900	16,000	17,000	19,000 J	13,000	7,100	15,000	10,000	20,000	16,000	21,000	15,000 J
Arsenic	mg/Kg	14	120	4.4	4.1	**20**	9.6	10	6.9	4	6.5	5.7	7.7	4.7	4.5	8.2
Cadmium	mg/Kg	2.1	5.54	0.64	0.72	1.2	1	1.5 J	1.3	0.36	1.3	0.8	1.1	0.47	0.41	1.2 J
Chromium	mg/Kg	72	88	16 J	13 J	31 J	32 J	29 J	21 J	15 J	22 J	19 J	29 J	23 J	27	23 J
Copper	mg/Kg	400	1,200	17 J	16 J	31 J	27 J	37 J	29 J	14 J	27 J	19 J	54 J	45 J	50	29 J
Lead	mg/Kg	360	1,300	13	12	26	22	28 J	21	13	21	14	19	10	8.7	22 J
Mercury	mg/Kg	1	1	0.044	0.058	0.067	0.073	0.11 J	0.099	0.026 J	0.096	0.065	0.093	0.037 J	0.039	0.15 J
Nickel	mg/Kg	26	110	15	13	**29**	**29**	**28 J**	21	13	22	18	**31 J**	25 J	**28**	22 J
Selenium	mg/Kg	NA	NA	1.1	1.1	2.4	2	2.2	1.6	0.78	1.8	1.2	2.1	1.6	1.3	1.9
Zinc	mg/Kg	3,200	4,200	130	120	280	230	250 J	190	140	200	140	170	90	85	190 J
Inorganics																
Total Cyanide	mg/Kg	NA	NA	3.2 UJ	3.2 UJ	6 UJ	5.8 UJ	5.7 UJ	4.3 UJ	2.6 UJ	5.6 UJ	4.1 UJ	6.1 U	3.7 U	3.7 U	4.9 UJ
Fluoride	mg/Kg	NA	NA	3.2 J	7.3 J	5.9 J	4.6 J	6.6 J	3.4	0.84 B	6	2.9	5.3	2.4 B	2.7	7.8 J
Sulfate	mg/Kg	NA	NA	28	62	41	62	110	130	25 B	230	71	290	220	110	110
Polychlorinated Biphenyls (PCBs)																
Total PCB Aroclor	µg/Kg	110	2,500	0.84 U	0.81 U	1.4 U	1.4 U	1.5 U	0.99 U	0.66 U	1.4 U	0.93 U	1.3 U	0.77 U	0.91 U	1.3 U
Total PCB Congener	µg/Kg	110	2,500	1.36	1.45	1.40	5.16	2.64	2.26	0.349	3.22	2.31	2.11	0.923	0.619	2.04
Polycyclic Aromatic Hydrocarbons (PAHs)																
1-Methylnaphthalene	µg/Kg	NA	NA	7	8.7 J	2 U	3.3 J	13 J	9.3 J	0.85 U	1.7 U	1.2 U	9 J	1.7 J	1.1 U	28 J
2-Methylnaphthalene	µg/Kg	NA	NA	7.6	15	3.1 J	4.3 J	13 J	5.7 J	0.61 U	3.1 J	3.9 J	12 J	5 J	0.76 U	30 J
Acenaphthene	µg/Kg	NA	NA	3.1 J	7.3 J	4.5 J	3 J	3.5 J	1.2 U	1.9 J	1.6 U	1.2 J	1.5 U	1.1 U	1 U	24 J
Acenaphthylene	µg/Kg	NA	NA	0.68 U	0.88 U	22	1.5 U	1.3 UJ	1 U	0.68 U	1.3 U	0.96 U	1.3 U	0.91 U	0.84 U	28 J
Anthracene	µg/Kg	NA	NA	8.1	4.2 J	11 J	5.1 J	7.1 J	2.9 J	1.7 J	1.6 U	2.1 J	3.1 J	1.2 J	1 U	29 J
Benz[a]anthracene	µg/Kg	NA	NA	32	3.7 J	83	34	11 J	3.8 J	16	4.6 J	8.4 J	8.9 J	4.6 J	4.7 J	38 J
Benzo(a)pyrene	µg/Kg	NA	NA	35	3.8 J	140	41	11 J	0.82 U	21	5.1 J	8.2 J	8.2 J	4.5 J	4.9 J	30 J
Benzo(b)fluoranthene	µg/Kg	NA	NA	46	7.3 J	150	59	19 J	8.7 J	29	12 J	14	16	9.7	7.7 J	40 J
Benzo(ghi)perylene	µg/Kg	NA	NA	27	4.4 J	190	37	10 J	4.5 J	16	6.4 J	7 J	8.7 J	5.4 J	3.8 J	31 J
Benzo(k)fluoranthene	µg/Kg	NA	NA	14	2.2 J	43	17	6.2 J	2.4 J	13	4.6 J	4 J	4.6 J	2.6 J	3 J	32 J
Chrysene	µg/Kg	NA	NA	44	6.6 J	120	46	19 J	8 J	21	12 J	11	14	9 J	6.3 J	49 J
Dibenzo(a,h)anthracene	µg/Kg	NA	NA	5.7 J	1.3 U	16	7.1 J	3.2 J	1.5 U	3 J	1.9 U	2.1 J	1.9 U	1.3 U	1.2 U	26 J
Fluoranthene	µg/Kg	NA	NA	55	15	210	57	30 J	14	23	16	17	24	14	9	46 J
Fluorene	µg/Kg	NA	NA	2.9 J	7.6 J	5.6 J	3.4 J	8.8 J	4.7 J	0.68 U	1.3 U	2.5 J	7.4 J	6.5 J	0.84 U	27 J
Indeno(1,2,3-cd)pyrene	µg/Kg	NA	NA	30	4.6 J	150	39	11 J	3.7 J	17	4.7 J	7.9 J	8 J	4.6 J	4.2 J	32 J
Naphthalene	µg/Kg	NA	NA	11	100	7.4 J	5.4 J	11 J	6.9 J	1.1 U	5.6 J	4.2 J	15	6.6 J	2 J	30 J
Phenanthrene	µg/Kg	NA	NA	33	20	100	27	21 J	9.3 J	11	9.9 J	9.5 J	15	8.9 J	3.2 J	34 J
Pyrene	µg/Kg	NA	NA	50	9.8	260	46	21 J	9.5 J	21	12 J	13	17	9.9	8.4	40 J
Total cPAH BaPeq (calc)	µg/Kg	NA	NA	48.2	5.71	185	57.1	16.2	2.43	29.0	7.91	12.0	12.2	6.81	6.98	47.3
Total PAHs	µg/Kg	17,000	30,000	411	220	1,516	435	219	93	195	96	116	171	94	57	594
Petroleum Range Organics																
#2 Diesel	mg/Kg	NA	NA	18 U	19 U	31 U	31 U	29 U	24 U	15 U	33 U	22 U	29 U	22 U	19 U	27 U
Motor Oil	mg/Kg	NA	NA	15 U	16 U	26 U	26 U	24 U	29 J	13 U	27 U	18 U	35 J	26 J	61 J	61 J

Notes:

B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample because cross-contamination is suspected.

Bold = Sample result > SCO screening level.

CSL = Cleanup Screening Level
J = Estimated concentration
NA = Not applicable
nc = Not calculated

SCO = Sediment Cleanup Objective
SMS = Sediment Management Standards
U = Chemical was not detected at or above the associated method detection limit.
UTL = Upper Threshold Limit

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Appendix L

Table 1-4 Columbia River Sediments AOC - Reference Station Sample Results Summary

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

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Table 1-5
Columbia River Sediments AOC - Project (Study Area) Sample Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Parameter Name	Units	Sediment Screening Levels				Analytical Results																		
		Freshwater SMS Criteria		Reference Concentrations [a]		CRSAOC-SED01 4/30/2016	CRSAOC-SED02 4/30/2016	CRSAOC-SED40 (Dup of SED02) 4/30/2016	CRSAOC-SED03 4/30/2016	CRSAOC-SED04 5/1/2016	CRSAOC-SED41 (Dup of SED04) 5/1/2016	CRSAOC-SED05 5/2/2016	CRSAOC-SED06 5/1/2016	CRSAOC-SED07 5/1/2016	CRSAOC-SED42 (Dup of SED07) 5/1/2016	CRSAOC-SED08 5/1/2016	CRSAOC-SED09 5/1/2016	CRSAOC-SED10 5/1/2016	CRSAOC-SED11 5/1/2016	CRSAOC-SED12 5/1/2016	CRSAOC-SED13 5/1/2016	CRSAOC-SED14 5/1/2016	CRSAOC-SED15 5/1/2016	CRSAOC-SED43 (Dup of SED15) 5/1/2016
		SCO	CSL	Maximum	90/90 UTL																			
Grain Size/Total Organic Carbon																								
Particle/Grain Size, Clay	%	NA	NA	NA	NA	8.9	15.8	24.4	20.4	27.9	28.4	3.6	7	10.5	8.2	24.4	3.1	4.8	3.1	6.4	26.5	23	14.8	14.3
Particle/Grain Size, Gravel	%	NA	NA	NA	NA	0	0	0	0	0	0	4	0	1.4	0	0	0	0	0	3.9	0	0	0	0
Particle/Grain Size, Sand	%	NA	NA	NA	NA	62.6	36	11.5	9.9	2.2	2.2	62.8	63.3	74.6	70.4	9.2	89.4	77	91.1	61	7.4	5.4	10	7.9
Particle/Grain Size, Silt	%	NA	NA	NA	NA	28.5	48.2	64.1	69.7	69.9	69.4	29.6	29.7	13.5	21.4	66.4	7.5	18.2	5.8	28.7	66.1	71.6	75.2	77.8
Total Organic Carbon	%	NA	NA	2.1	nc	0.74	1.6	1.5	1.7	2.1	2.2	1.1	0.7	0.62	0.65	1.7	0.27	0.43	0.23	0.52	1.6	1.7	3	3.1
Metals																								
Aluminum	mg/Kg	NA	NA	21,000	23000[b]	11,000	17,000	15,000	19,000	21,000	20,000	7,100	9,500	9,000	9,800	19,000	7,500	9,300	5,800	10,000	21,000	21,000	18,000	17,000
Arsenic	mg/Kg	14	120	20	11[c]	4.7	7.6	7.1	8.3	9.4	9.3	3	4.6	4.5	4.8	8.5	5.1	4.5	3.8	4.8	8.7	9.4	9.1	8.8
Cadmium	mg/Kg	2.1	5.54	1.5	1.7[b]	0.6	1.2	1	1.5	1.6	1.6	0.56	0.65	0.51	0.57	1.5	0.4	0.32	0.28	0.48	1.7	2.3	2.5	2.4
Chromium	mg/Kg	72	88	32	35[b]	18 J	25 J	23 J	27 J	29 J	29 J	11	15 J	14 J	15 J	27 J	13 J	17 J	10 J	17 J	29 J	29 J	27 J	26 J
Copper	mg/Kg	400	1,200	54	55[b]	16	28	26	31	38 J	37 J	16	14 J	13 J	15 J	32 J	8.8 J	12 J	7.5 J	14 J	36 J	37 J	39 J	36 J
Lead	mg/Kg	360	1,300	28	30[b]	11	20	18	23	27	27	6.7	10	9.2	10	23	8.1	7	6.4	8.6	23	26	24	25
Mercury	mg/Kg	1	1	0.15	0.14[b]	0.036	0.076	0.082	0.11	0.12	0.12	0.029 J	0.041	0.033	0.037	0.14	0.016 J	0.02 J	0.017 J	0.03	0.11	0.12	0.13	0.12
Nickel	mg/Kg	26	110	31	35b	16	24	22	26	29 J	28 J	10	14 J	13 J	14 J	26 J	11 J	14 J	9.1 J	14 J	26 J	27 J	26 J	25 J
Selenium	mg/Kg	NA	NA	2.4	2.6[b]	0.96	1.5	1.3	1.7	2.1	1.9	0.95	0.81	0.84	0.88	1.8	0.68	0.75	0.52	0.83	1.6	1.8	2	1.9
Zinc	mg/Kg	3,200	4,200	280	290[b]	120	190	170	210	240 J	230 J	83	110 J	96 J	100 J	210 J	95 J	75 J	67 J	95 J	220 J	250 J	270 J	260 J
Inorganics																								
Total Cyanide	mg/Kg	NA	NA	ND	nc	2.9 UJ	5.1 UJ	4.7 UJ	5.3 UJ	5.7 UJ	5.7 UJ	3.6 R	3 UJ	2.7 UJ	3 UJ	5.4 UJ	2.6 UJ	2.7 UJ	2.3 UJ	2.8 UJ	4.7 UJ	5.1 UJ	**11 J**	5.4 UJ
Fluoride	mg/Kg	NA	NA	7.8	7.7[b]	0.47 U	1.6 B	1.2 B	1.5 B	**9 J**	4.4 J	0.62 B	0.48 U	2.4 B	1.9 B	2.7 J	0.82 B	1.2 B	0.36 U	1.6 B	3.1	6.2	5 J	1.7 B
Sulfate	mg/Kg	NA	NA	290	278[b]	39	81 J	62 J	88	**380**	**410**	**380 J**	71	59	64	120	14 B	19 B	11 B	24 B	**390**	**430**	**460 J**	**670 J**
Polychlorinated Biphenyls (PCBs)																								
Total PCB Aroclor	µg/Kg	110	2,500	ND	nc	0.7 U	1.2 U	1.0 U	1.5 U	1.5 U	1.6 U	0.75 U	0.84 U	0.76 U	0.74 U	1.2 U	0.59 U	0.65 U	0.6 U	0.71 U	1.1 U	1.3 U	1.3 U	1.4 U
Total PCB Congener	µg/Kg	110	2,500	5.16	4.4[b]							1.08		1.03			0.196		0.136				2.41	2.79
Polycyclic Aromatic Hydrocarbons (PAHs)																								
1-Methylnaphthalene	µg/Kg	NA	NA	28	nc	2.7 J	9.9 J	8.2 J	2.4 J	1.9 U	1.9 U	2.2 J	0.95 U	0.96 U	0.83 U	1.7 U	0.69 U	0.69 U	0.68 U	0.8 UJ	4 J	8.3 J	3.7 J	9.2 J
2-Methylnaphthalene	µg/Kg	NA	NA	30	nc	5.1 J	12	14	3.5 J	1.4 U	1.3 U	5.8 J	0.68 U	0.69 U	2.4 J	1.2 U	0.49 U	0.49 U	1.2 J	0.57 J	4.7 J	18	9.4 J	12 J
Acenaphthene	µg/Kg	NA	NA	24	nc	2.3 J	1.4 U	12	1.8 U	1.8 U	1.8 U	30	3.4 J	1.4 J	1.6 J	1.6 U	2.3 J	0.65 U	11	5.7 J	5.7 J	60	9.3 J	11 J
Acenaphthylene	µg/Kg	NA	NA	28	nc	0.76 U	1.1 U	2.6 J	1.5 U	1.5 U	1.5 U	0.85 U	0.75 U	0.76 U	0.66 U	1.4 U	0.55 U	0.55 U	0.54 U	0.63 UJ	1.3 UJ	1.2 U	1.4 U	1.4 U
Anthracene	µg/Kg	NA	NA	29	nc	4.6 J	5.6 J	9.5 J	3.6 J	2.8 J	4 J	37	3.1 J	2.2 J	3.2 J	3 J	2.7 J	4.1 J	11	5.7 J	7.6 J	79	12 J	16
Benz[a]anthracene	µg/Kg	NA	NA	83	nc	21	24	36	9.3 J	20	14 J	280	32	14	16	11 J	24	44	90	51 J	52 J	800	72	98
Benzo(a)pyrene	µg/Kg	NA	NA	140	41[c]	20	22 J	38 J	9.3 J	19	18	**310**	36	21	23	12 J	32	**120**	**100**	**64 J**	**70 J**	**810**	**92**	**120**
Benzo(b)fluoranthene	µg/Kg	NA	NA	150	nc	34	42	57	17	30	29	470	50	40	36	18	47	230	140	84 J	100 J	1200	140	180
Benzo(ghi)perylene	µg/Kg	NA	NA	190	nc	18	23	26	8.9 J	14 J	15	280	30	37 J	22 J	9.2 J	28	140	83	52 J	59 J	710	77	95
Benzo(k)fluoranthene	µg/Kg	NA	NA	43	nc	12	16	21	5.9 J	8.6 J	9.2 J	190	19	12	12	5.4 J	16	67	45	33 J	39 J	410	49	63
Chrysene	µg/Kg	NA	NA	120	nc	37	38 J	59 J	14 J	24	25	400	39	21	25	13 J	35	250	100	63 J	86 J	1100	110	140
Dibenzo(a,h)anthracene	µg/Kg	NA	NA	26	nc	3.2 J	3.5 J	5.1 J	2.1 U	2.2 U	3.6 J	41	5.3 J	5.4 J	3.8 J	2 U	4.9 J	21	13	8.6 J	9.9 J	130	15	17
Fluoranthene	µg/Kg	NA	NA	210	nc	36	49	66	24	36	37	410	48	27	29	21	39	20	130	75 J	93 J	1200	130	180
Fluorene	µg/Kg	NA	NA	27	nc	0.76 U	1.1 U	11	1.5 U	3.6 J	5.8 J	15	2.3 J	0.76 U	0.66 U	1.4 U	1.6 J	0.55 U	5.7	2.9 J	5.1 J	45	14	12 J
Indeno(1,2,3-cd)pyrene	µg/Kg	NA	NA	150	nc	19	24	28	12 J	15	17	300	32	38 J	24 J	10 J	30	130	88	51 J	62 J	720	83	100
Naphthalene	µg/Kg	NA	NA	100	nc	7 J	13 J	99 J	6.2 J	4.2 J	7.9 J	7.7 J	7.2 J	1.2 U	2.6 J	3 J	1.1 J	0.87 U	2.9 J	2.3 J	6.6 J	16	8.6 J	13 J
Phenanthrene	µg/Kg	NA	NA	100	nc	26	26 J	44 J	12 J	16	20	180	21	10	13	9.4 J	16	10	61	33 J	39 J	400	57	81
Pyrene	µg/Kg	NA	NA	260	nc	35	38	51	17	31	29	360	44	23	25	19	34	17	120	64 J	81 J	950	110	150
Total cPAH BaPeq (calc)	µg/Kg	NA	NA	185	57.1[d]	29.3	33.3	53.3	14.0	26.7	25.5	**442.1**	50.2	32.2	32.4	16.7	44.5	**171.7**	**138.6**	**87.4**	**97.2**	**1147.0**	**129.0**	**167.2**
Total PAHs	µg/Kg	17,000	30,000	1,516	nc	283	346	587	145	224	235	3,319	372	252	239	134	314	1,053	1,002	596	725	8,656	992	1,297
Petroleum Range Organics																								
#2 Diesel	mg/Kg	NA	NA	ND	nc	16 J	27 U	24 U	32 U	30 U	33 U	19 U	18 U	17 U	17 U	29 U	13 U	15 U	13 U	15 U	25 U	24 U	29 U	29 J
Motor Oil	mg/Kg	NA	NA	61	nc	36 J	30 J	20 U	140 J	25 U	30 J	43 J	15 U	14 U	14 U	24 U	11 U	12 U	10 U	12 U	100 J	73 J	33 J	55 J

Notes:

a) Reference concentrations developed from the collected samples BKG01 - BKG12

b) 90/90 UTL - normal distribution value

c) 90/90 UTL - normal distribution value with outlier removed

d) 90/90 UTL - nonparametric distribution value with outlier removed

B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample because cross-contamination is suspected.

Yellow shading = Sample result > SCO screening level and > 90/90 UTL.

Bold = Sample result > 90/90 UTL of the reference sample results where no SCO criteria available.

BaPeq = Benzo(a)pyrene equivalent

CSL = Cleanup Screening Level

J = Estimated concentration

NA = Not applicable

nc = Not calculated

R = rejected result

SCO = Sediment Cleanup Objective

SMS = Sediment Management Standards

U = Chemical was not detected at or above the associated method detection limit.

UTL = Upper Threshold Limit

Source: Tetra Tech. 2022. *Final Draft Remedial Investigation Report Volumes 1 through 4*, Columbia Gorge Aluminum Smelter Site, Revision 0, Goldendale, WA. Facility Site Id #95415874, Agreed Order De 10483. June 14.

Appendix L

Table 1-5 Columbia River Sediments AOC - Project (Study Area) Sample Results Summary

Remedial Investigation / Feasibility Study
Goldendale Energy Storage Project
Goldendale, Washington

Table 1-5
Columbia River Sediments AOC - Project (Study Area) Sample Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

		Sediment Screening Levels				Analytical Results																			
		Freshwater SMS Criteria		Reference Concentrations [a]		CRSAOC-SED16	CRSAOC-SED17	CRSAOC-SED18	CRSAOC-SED19	CRSAOC-SED20	CRSAOC-SED21	CRSAOC-SED22	CRSAOC-SED23	CRSAOC-SED24	CRSAOC-SED25	CRSAOC-SED26	CRSAOC-SED27	CRSAOC-SED28	CRSAOC-SED29	CRSAOC-SED30	CRSAOC-SED31	CRSAOC-SED32	CRSAOC-SED33	CRSAOC-SED34	CRSAOC-SED35
Parameter Name	Units	SCO	CSL	Maximum	90/90 UTL	5/2/2016	5/2/2016	5/2/2016	4/29/2016	4/29/2016	5/2/2016	4/26/2016	4/26/2016	4/26/2016	4/26/2016	4/26/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016
Grain Size/Total Organic Carbon																									
Particle/Grain Size, Clay	%	NA	NA	NA	NA	1.5	40	37.3	1.2	2	0.2	42	22.3	23.6											
Particle/Grain Size, Gravel	%	NA	NA	NA	NA	0.4	0	0	6.3	0	4.5	0	0	0											
Particle/Grain Size, Sand	%	NA	NA	NA	NA	93.2	5.7	9.7	85.5	68.4	89.9	7.1	3.6	4											
Particle/Grain Size, Silt	%	NA	NA	NA	NA	4.9	54.3	53	6.9	29.6	5.3	50.9	74.1	72.4											
Total Organic Carbon	%	NA	NA	2.1	nc	0.24	3.9	3.7	0.22	0.67	1	1.7	2	1.7											
Metals																									
Aluminum	mg/Kg	NA	NA	21,000	23000[b]	6,000	19,000	16,000	6,300	1,500	4,500	23,000	21,000	20,000											
Arsenic	mg/Kg	14	120	20	11[c]	2.7	9.9	8.2	2.9	0.52	3.3	13	10	9.3											
Cadmium	mg/Kg	2.1	5.54	1.5	1.7[b]	0.21	1.2	1.3	0.23	0.081	0.16	3.3	2	1.9	1.3	1.9	1.4								
Chromium	mg/Kg	72	88	32	35[b]	9.5	24	20	11	2.9	5.4	31 J	30 J	28 J											
Copper	mg/Kg	400	1,200	54	55[b]	7.8	45	42	8.7	2.3	11	43 J	40 J	36 J											
Lead	mg/Kg	360	1,300	28	30[b]	5.4	22	19	5.1	1.2	3.9	51	28	26											
Mercury	mg/Kg	1	1	0.15	0.14[b]	0.012 J	0.085 J	0.079 J	0.013 J	0.022 J	0.0082 J	0.2	0.11	0.13											
Nickel	mg/Kg	26	110	31	35b	9.4	21	19	9.9	2.5	7	29 J	29 J	27 J											
Selenium	mg/Kg	NA	NA	2.4	2.6[b]	0.66 J	2.6 J	2	0.68	0.15	0.82	2.2	2.5	2.2											
Zinc	mg/Kg	3,200	4,200	280	290[b]	74	180	170	74	17	51	410	260	240											
Inorganics																									
Total Cyanide	mg/Kg	NA	NA	ND	nc	2.6 R	12 R	9.2 R	2.4 U	3.1 U	2.5 R	4.5 U	6.2 U	5.8 U	4.6 U	6.0 U	5.4 U	5.1 U	5.9 U	5.3 U	5.4 U	5.1 U	5.3 U	6.1 U	4.6 U
Fluoride	mg/Kg	NA	NA	7.8	7.7[b]	0.44 U	1.9 U	**12**	0.41 J	0.5 U	0.38 U	**8.4**	**8.9**	**9.1**	5.2	**8.1**	1.1 J	**8.9**	2.0 J	1.5 J	1.6 J	1.7 J	1.5 J	1.6 J	1.3 J
Sulfate	mg/Kg	NA	NA	290	278[b]	23 B	**4,700 J**	**1,900 J**	20	32	12 B	220	**300**	**350**	260	220	**320**	240	77	110	**290**	96	110	130	120
Polychlorinated Biphenyls (PCBs)																									
Total PCB Aroclor	µg/Kg	110	2,500	ND	nc	0.56 U	3.1 U	2.2 U	0.58 U	0.7 U	0.62 U	1.2 U	1.3 U	1.4 U											
Total PCB Congener	µg/Kg	110	2,500	5.16	4.4[b]						0.057	15.8													
Polycyclic Aromatic Hydrocarbons (PAHs)																									
1-Methylnaphthalene	µg/Kg	NA	NA	28	nc	2 J	4 UJ	11 J	4 J	0.85 U	0.73 U	3.4 J	6.1 J	3.2 J											
2-Methylnaphthalene	µg/Kg	NA	NA	30	nc	2.5 J	2.9 UJ	16 J	7.5	2.4 J	0.52 U	3.8 J	4.3 J	9 J											
Acenaphthene	µg/Kg	NA	NA	24	nc	21	59 J	63	21	15	0.69 U	5.1 J	2.1 J	1.9 J											
Acenaphthylene	µg/Kg	NA	NA	28	nc	0.73 U	3.2 UJ	2.3 U	0.65 U	0.68 U	0.58 U	1.1 U	1.5 U	1.5 U											
Anthracene	µg/Kg	NA	NA	29	nc	20	70 J	65	20	17	0.69 U	38	5.1 J	5.5 J											
Benz[a]anthracene	µg/Kg	NA	NA	83	nc	200	520 J	450	170	160	2.2 J	240	22	20											
Benzo(a)pyrene	µg/Kg	NA	NA	140	41[c]	**250**	**620 J**	**560**	**180**	**180**	3.1 J	**190**	24	22											
Benzo(b)fluoranthene	µg/Kg	NA	NA	150	nc	360	990 J	830	250	240	5.9	410	40	36											
Benzo(ghi)perylene	µg/Kg	NA	NA	190	nc	220	550 J	460	150	150	3.1 J	130	22	20											
Benzo(k)fluoranthene	µg/Kg	NA	NA	43	nc	140	350 J	280	86	82	2.2 J	110	11 J	10 J											
Chrysene	µg/Kg	NA	NA	120	nc	250	890 J	710	200	190	3.9 J	220	33	30											
Dibenzo(a,h)anthracene	µg/Kg	NA	NA	26	nc	33	77 J	72	23	24	0.83 U	26	4.7 J	4.4 J											
Fluoranthene	µg/Kg	NA	NA	210	nc	300	1000 J	870	260	240	4.5 J	130	47	41											
Fluorene	µg/Kg	NA	NA	27	nc	10	39 J	38	12	9.5	0.58 U	8.9 J	5.8 J	6.1 J											
Indeno(1,2,3-cd)pyrene	µg/Kg	NA	NA	150	nc	230	550 J	480	150	170	3.7 J	130	22	21											
Naphthalene	µg/Kg	NA	NA	100	nc	5 J	18 J	21 J	5.3 J	4 J	0.93 U	7.5 J	6.7 J	6.6 J											
Phenanthrene	µg/Kg	NA	NA	100	nc	120	370 J	350	110	88	1.6 J	44	20	18											
Pyrene	µg/Kg	NA	NA	260	nc	270	880 J	730	230	210	4 J	250	36	33											
Total cPAH BaPeq (calc)	µg/Kg	NA	NA	185	57.1[d]	**348.8**	**877.6**	**778.3**	**249.9**	**249.5**	4.6	**283.8**	34.3	31.4											
Total PAHs	µg/Kg	17,000	30,000	1,516	nc	2,434	6,983	6,006	1,879	1,782	34	1,947	312	288											
Petroleum Range Organics																									
#2 Diesel	mg/Kg	NA	NA	ND	nc	13 U	68 U	51 U	14 J	22 J	12 U	24 U	33 U	29 U											
Motor Oil	mg/Kg	NA	NA	61	nc	18 J	64 J	76 J	32 J	80 J	10 J	20 U	29 J	24 U											

Notes:

a) Reference concentrations developed from the collected samples BKG01 - BKG12

b) 90/90 UTL - normal distribution value

c) 90/90 UTL - normal distribution value with outlier removed

d) 90/90 UTL - nonparametric distribution value with outlier removed

B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample because cross-contamination is suspected.

Yellow shading = Sample result > SCO screening level and > 90/90 UTL.

Bold = Sample result > 90/90 UTL of the reference sample results where no SCO criteria available.

BaPeq = Benzo(a)pyrene equivalent

CSL = Cleanup Screening Level

J = Estimated concentration

NA = Not applicable

nc = Not calculated

R = rejected result

SCO = Sediment Cleanup Objective

SMS = Sediment Management Standards

U = Chemical was not detected at or above the associated method detection limit.

UTL = Upper Threshold Limit

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ERM's Portland Office
1050 SW 6th Avenue
Suite 1650
Portland, OR 97204

T: +1 503 488 5282
F: +1 503 488 5142

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