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# Supplemental Feasibility Study Report

## Glacier Park East Site
## Leavenworth, Washington

**Facility Site ID No. 349**
**Cleanup Site ID No. 4234**
**Agreed Order No. DE 16838**

**Prepared For:**

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## ABBREVIATIONS AND ACRONYMS

| Abbreviation/ Acronym | Definition |
|---|---|
| $\mu g/m^3$ | Micrograms per cubic meter |
| AO | Agreed Order |
| ARAR | Applicable or relevant and appropriate regulation |
| AST | Aboveground storage tank |
| bgs | Below ground surface |
| BTEX | Benzene, toluene, ethylbenzene, and total xylenes |
| CAP | Cleanup Action Plan |
| cfm | Cubic feet per minute |
| COC | Contaminant of concern |
| CSM | Conceptual site model |
| CUL | Cleanup level |
| DCA | Disproportionate cost analysis |
| DRO | Diesel-range organics |
| Ecology | Washington State Department of Ecology |
| EPA | United States Environmental Protection Agency |
| GRO | Gasoline-range organics |
| GWBU | Groundwater-bearing unit |
| LEL | Lower explosive limit |
| mg/kg | Milligrams per kilogram |
| MNA | Monitored natural attenuation |
| MTCA | Model Toxics Control Act |
| No. | Number |
| ORO | Oil-range organics |
| PID | Photoionization detector |
| ppm | Parts per million |
| RAO | Remedial action objective |
| REL | Remediation level |
| RTF | Restoration Time Frame |
| SFS | Supplemental Feasibility Study |
| SGC | Silica gel cleanup |
| SRI | Supplemental Remedial Investigation |
| SVE | Soil vapor extraction |
| TEE | Terrestrial Ecological Evaluation |
| TOC | Total organic carbon |
| TPH | Total petroleum hydrocarbons |
| TRC | TRC Environmental Corporation |
| WAC | Washington Administrative Code |

# 1.0 INTRODUCTION

On behalf of BNSF Railway Company (BNSF) and Chevron USA, Inc. (CUSA), TRC Environmental Corporation (TRC) is pleased to present this *Supplemental Feasibility Study* (SFS) with a disproportionate cost analysis (DCA) for the Glacier Park East (GPE) property located northeast of the intersection of U.S. Highway 2 and Chumstick Highway (formerly State Route 209) in Leavenworth, Washington (subject property). The location of the subject property is shown on Figure 1. The Site boundary lies within multiple parcels and is shown on Figure 2. The Site is currently under an Agreed Order (AO) with the Washington State Department of Ecology (Ecology), AO Number (No.) DE 16838 issued in 2020, and is assigned Cleanup Site No. 4234, and Facility Site No. 349.

This SFS has been prepared in general accordance with the Ecology Model Toxics Control Act and implementing regulations, collectively referred as "MTCA." The SFS includes a selection of cleanup actions consistent with the requirements of MTCA as indicated in Washington Administrative Code (WAC) 173-340-360 and includes both an evaluation of remedial alternatives and an evaluation of the cost and benefit of those cleanup alternatives that meet the threshold criteria for consideration.

This SFS is submitted under the requirements of the AO. If Ecology concurs with the selected remedial alternative, a *Cleanup Action Plan* (CAP), and other documents necessary to implement the selected remedial action(s) will be prepared.

# 2.0 BACKGROUND

## 2.1 Physical Description

The subject property is located northeast of the intersection of U.S. Highway 2 and Chumstick Highway (formerly State Route 209) in Leavenworth, Chelan County, Washington (Figure 1). Per AO No. DE 16838, the subject property is defined as the 1.72-acre area described in records maintained by the Chelan County Assessor's office, comprising of Chelan County Parcel Numbers 241701430700 and 241701430025. Portions of the subject property are located within the boundaries of the Site. As defined in MTCA, the Site comprises all locations where impacts have come to be located.

## 2.2 History

The subject property was first developed during the mid-1920s when Standard Oil Company of California (predecessor in interest to CUSA) leased the property from Great Northern Railroad to construct a bulk fuel storage facility. The bulk fuel storage facility consisted of one 20,000-gallon aboveground storage tank (AST), one 13,000-gallon AST, a pump house, a warehouse/office building, a truck loading rack, a drum storage facility, and an unloading rack for receiving product from rail tank cars. Two smaller ASTs (approximately 5,000 gallons each) were reportedly used to store gasoline for a short period. The structures were removed from the property in 1990. The locations of historical structures are shown on Figure 2.

In 1992, the property was temporarily used as a staging area for equipment and soil from the U.S. Highway 2 bridge construction over the Wenatchee River.

The County historically plows and places snow from Chumstick Highway and Highway 2 onto the subject property during winter months adjacent to the capped area.

### 2.3 Remedial Investigation Summary

Numerous environmental investigations have been completed at the Site. The assessments to date have satisfied the purpose of a remedial investigation (WAC 173-340-350(7)(a)):

> *"…collect data necessary to adequately characterize the site for the purpose of developing and evaluating cleanup action alternatives…"*

The totality of prior assessments and the *Supplemental Remedial Investigation Report* (SRI Report; July 2022) have met this objective. Each iterative phase of investigation has contributed to the characterization of the lateral and vertical extent of contaminant of concern (COC) impacts as well as historical sources of environmental impacts. These assessments have satisfied the requirements of WAC 173-340-350(7)(c)(iii)(B) and (C) for characterization of the extent of impacts and WAC 173-340-350(7)(c)(iii)(G) for identifying sources of impact. The historical reports are referenced in the SRI Report, which also includes summary tables of historical soil and groundwater data.

An initial SRI Report was submitted to Ecology on January 20, 2022. Ecology acknowledged review and receipt of the SRI Report and requested minor grammatical and administrative changes to be completed in correspondence dated May 12, 2022. Those changes were made and the final Revised SRI was resubmitted to Ecology on July 26, 2022.

### 2.4 Previous Remedial Actions

A CAP was implemented in 2003 under the previous AO. The selected cleanup action for the AO was soil isolation by capping and groundwater monitoring for a minimum of 5 years. The soil isolation cap consisted of approximately 10 to 15 feet of imported clean soil. The soil cap raised the elevation of the Site above the surrounding roadways and adjacent areas. A layer of asphaltic concrete was placed over the top of the soil and the western edge of the sloped soil cap where it meets Chumstick Highway. Surface slopes direct stormwater flow toward the catch basin on the cap and into the stormwater detention tank where sediment settles before water is discharged to the City of Leavenworth storm sewer system. The northern, eastern, and southern edges of the cap are surrounded and protected by a large rock barrier to prevent erosion and limit access to the surface of the cap.

During the 5-year review in 2008 Ecology concluded that continued impacts to groundwater following installation of the cap indicated that the remedial action was not sufficiently protective of human health and the environment. Ecology indicated an Environmental Covenant should be implemented. The required institutional controls included a long-term plan to monitor and document the integrity of the soil isolation cap and long-term groundwater monitoring.

An Environmental Covenant meeting the requirements of the Uniform Environmental Covenants Act (UECA) dated November 26, 2012 was filed with the Chelan County Recorder's office. The Environmental Covenant included restrictions on property use and soil disturbance.

## 3.0 NATURAL CONDITIONS

### 3.1 Physiographic Setting/Topography

The City of Leavenworth is in the upper reaches of the Wenatchee River Valley at an elevation of approximately 1,170 feet above mean sea level. The subject property is currently zoned as General Commercial per the City of Leavenworth's website. The subject property is bordered by Chelan County Public Utilities District property to the northeast, U.S. Highway 2 to the southeast, Chumstick Highway to the southwest, and BNSF right-of-way to the northwest. The subject property is presently vacant and partially vegetated, with a gravel-covered lot north of the asphaltic cap. The asphaltic cap is barricaded with closely spaced bollards to prevent vehicular traffic from entering. The subject property is located approximately 800 feet northwest of the Wenatchee River with a generally flat topography. Ponderosa pine trees cover most of the subject property east of the gravel lot. The Site is covered by clean fill material and an engineered and elevated asphaltic concrete cap, which is surrounded by sloped sidewalls and protected by boulders on three sides. The asphaltic concrete cap is shown on Figures 2 through 6.

### 3.2 Geology

The central portion of the subject property was filled with approximately 10 to 15 feet of clean imported soil prior to capping with asphaltic concrete. Native soils are laterally variable and the soil units present vary in thickness and extent. Based on the U.S. Geological Survey (USGS) geologic map, the subject property is underlain by Pleistocene glacial drift. Previous investigations indicate the native subsurface soil is primarily about 10 to 25 vertical feet of silty sand with 5 to 20 vertical feet of sandy silt beneath.

### 3.3 Surface Water

No surface water body is present at the subject property. The nearest body of water is the Wenatchee River, located about 800 feet southeast of the subject property and roughly 40 feet lower in elevation than the Site. The sloped asphaltic concrete cap includes a stormwater conveyance system designed to direct surface water away from the Site. Infiltration of stormwater and snowmelt is occurring around the periphery of the asphaltic cap and contributing to the presence of localized transient water in the vadose zone.

### 3.4 Groundwater

Groundwater at the subject property has been encountered in two separate zones: shallow transient water in the vadose zone and a deeper unconfined aquifer. Historically the shallow transient water has been encountered seasonally at a depth of about 15 feet below ground surface (bgs). It is typically encountered during spring, and is laterally discontinuous.

The deeper unconfined groundwater aquifer is laterally continuous and has been encountered at depths of approximately 50 to 75 feet bgs at multiple wells across the subject property. Based on piezometric measurements, groundwater at the subject property generally flows toward the north-northwest away from the Wenatchee River.

### 3.5 Natural Resources and Ecological Receptors

The Site is partially covered by an asphaltic concrete cap and crushed gravel. The property qualifies for a Terrestrial Ecological Evaluation (TEE) exclusion (see SRI TEE Evaluation form), based upon WAC 173-340-7491(1)(c)(i), which states that:

> *(c)(i) "For sites contaminated with hazardous substances other than those specified in (c)(ii), there is less than 1.5 acres of contiguous undeveloped land on the Site or within 500 feet of the area of the Site."*

As the Site does not contain any of the compounds listed in 173-340-7491(1)(c)(ii) which include chlorinated dioxins or furans, polychlorinated biphenyl (PCB) mixtures, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyldichloroethane (DDD), aldrin chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxophene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene, and there is not 1.5 acres of undeveloped land contiguous to the Site or within 500 feet of the site, it qualifies for the TEE exclusion.

Surface water and sediment are also not considered potential receptors because (1) the nearest surface water body (i.e., the Wenatchee River) is greater than 800 feet from the Site, and (2) a completed pathway of migration to surface water does not exist. In addition, storm sewer and other utility piping are completed above the seasonal high-water table of the deeper aquifer and do not serve as preferential pathways for migration of groundwater.

## 4.0 NATURE AND EXTENT OF CONTAMINANTS

A detailed discussion of the nature and extent of the impacts is presented in the SRI Report (TRC 2022). The subsections below provide a brief summary.

### 4.1 Sources and Contaminant Migration

The primary sources of petroleum-related impacts are the former 13,000-gallon AST, 20,000-gallon AST, and truck loading rack. Subsequent investigations in 1991 and 1995 further characterized the lateral and vertical extent of impacted soil beneath the Site and confirmed the depth of groundwater. Those investigations also confirmed the presence of impacts to groundwater.

Based on the location and extent of soil impacts, the primary release(s) were to the surface or near-surface from historical leaks in above-grade and below-grade product lines and/or releases during fuel transloading at the loading rack. Impacts from these surface and near-surface releases migrated vertically through preferential pathways to the deeper unconfined aquifer at depths between 50 to 60 feet bgs.

COCs are those compounds that were detected in soil and/or groundwater during the SRI at concentrations exceeding laboratory method detection limits and are potentially associated with release(s) from the fuel bulk storage and transloading operation. The COCs for the soils are diesel-range organics (DRO); oil-range organics (ORO); gasoline-range organics (GRO)' benzene, toluene, ethylbenzene, and total xylenes (BTEX), and naphthalene. The COCs for groundwater are DRO, ORO, GRO, and benzene.

### 4.2 Affected Soil

The extent of impacted soil defined in the Remedial Investigation and Feasibility Study (RI/FS) (GeoEngineers 1997) was capped beneath 10 to 15 feet of clean fill soil in 2003 as the approved remedy under the 2001 AO No. DE 01TCPCR3168. The SRI, completed in 2022, included sampling to further characterize the lateral limits of impacts to soil. This was performed by collecting and analyzing additional soil samples during drilling of SB-1 through SB-6 and GWB-1.

GRO was the only COC that exceeded the MTCA Method A soil cleanup level (CUL) during the SRI. GRO exceeded the CUL at four locations (SB-1, SB-2, SB-4, and SB-6). The maximum depth of impacts was 25 feet bgs at SB-6. Exceedances of the CUL at PZ-2 (completed in 2016), SB-1, and SB-2 indicate that GRO impacts extend beyond the footprint of the cap to the northeast in the top 10 feet of the soil column.

All other COCs are contained beneath the cap. DRO, ORO, and BTEX were not detected at concentrations exceeding the respective CULs in any of the additional samples. Naphthalene was detected in one location (PZ-2 at 7.5 feet bgs), but it is not present at 8 feet bgs. Additionally, the naphthalene detections in soil are not more than twice the CUL, and less than ten percent of the samples' exceeded the CUL for naphthalene. Therefore in accordance with WAC-340-740 (7)(d) and (e), naphthalene is not a COC.

Soil data from borings advanced through the cap (SB-4 and SB6) and data from shallow piezometer PZ-4 confirm the presence of GRO impacts to soil beneath the cap.

### 4.3 Groundwater

The shallow transient water is present only during brief periods of the year (primarily spring) and is not laterally continuous across the Site. The shallow transient water was observed in PZ-1 and PZ-3 between April and May 2017. No water has been observed in PZ-1 and PZ-3 during the monitoring events completed since May 2017. The shallow transient water has been observed in PZ-2 sporadically during spring and summer events from 2016 through 2021. The presence of shallow transient water beneath the cap was confirmed briefly with the installation of PZ-4 during the SRI in June 2021; however, the piezometers were dry during the latter half of 2021. Confirmation of shallow transient water beneath the cap during the SRI is consistent with findings in 2016 and 2017 when the presence of saturated conditions was identified in the three shallow piezometers (PZ-1, PZ-2, and PZ-3) installed around the perimeter of the cap. The shallow transient water is temporarily perched on less permeable soils, impeding vertical migration.

The source of the shallow transient water originates from accumulation of snow and resulting melt water and other surface water runoff and in low lying topographic areas of the subject property immediately adjacent to the cap. The deeper unconfined groundwater-bearing unit (GWBU) is impacted with GRO, DRO and ORO at concentrations exceeding the respective CULs. Following installation of the soil cap in 2003, groundwater COC concentrations generally declined in all monitoring wells and remained less than the respective CULs until approximately 2007. COC concentrations increased between 2007 and 2011, with a subsequent decline in concentrations in more recent years. Concentrations of GRO exceeding the CUL have been limited to well MW-3. Concentrations of DRO and ORO greater than the respective CULs in the deeper unconfined GWBU have been limited to wells MW-3 and MW-4 historically, with only sporadic detections in wells MW-1 and MW-2.

COCs have not been detected in downgradient well MW-5 or upgradient well MW-6. COCs in the deeper unconfined GWBU have continued to attenuate over time and their presence in groundwater at concentrations greater than the CULs is only reported in samples analyzed without silica gel cleanup (SGC). This finding strongly indicates that the petroleum present is highly degraded through environmental weathering and will continue to degrade over time.

## 5.0 CLEANUP STANDARDS

Cleanup standards include CULs, remediation levels (RELs), and action levels (ALs) that are adequately protective of human health and the environment at a specific point of compliance. The cleanup standards are used as the basis for developing media-specific remedial action objectives for the cleanup action.

### 5.1 Applicable Regulations

The work documented herein is intended to comply with the laws and regulations of the State of Washington. The work to be performed during implementation of the selected remedy will be performed under the AO and will comply with MTCA (70.105D RCW) and its implementing regulations (WAC 173-340). Applicable or Relevant and Appropriate Requirements (ARARs) for the selected remedy will be

MTCA, and all potential exposure pathways will be addressed. This SFS contains a fully MTCA-compliant CUL development. Therefore, further consideration of ARARs is not warranted and MTCA has been selected as the regulation with primacy for this project.

## 5.2 Development of Cleanup Levels

CULs for affected media were evaluated in accordance with MTCA and take into consideration exposure pathways to humans based on current and likely future uses. Final CULs and the potential use of RELs will be considered and developed in the CAP. As presented in Section 3.5 of this report, the Site qualifies for a TEE exclusion under WAC 173-340-7491(1)(c)(i).

Based on the identified current or potential future exposure pathways, MTCA is the primary regulation applicable to the Site. Based on the zoning and current and expected future use, MTCA Method A CULs for soil and groundwater are applicable.

The selected CULs must be protective of human health and the environment after completion of the selected remedial action and implementation of institutional and/or engineering controls (if any) and must consider the exposure pathways that remain after remedy implementation. Remedial objectives will be evaluated, at least in part, on the likely ability to attain CULs in all media, the ultimate objective of satisfying the AO and obtaining a No Further Action (NFA) determination.

Based on the conceptual site model (CSM) presented in Section 5.0 of the SRI Report, the environmental media of concern are soil and groundwater. Potential exposure pathways to humans include ingestion and dermal exposure from soil and groundwater, and inhalation from air. The reader is directed to the SRI Report for additional detail on the CSM and development of potential exposure pathways.

### 5.2.1 Soil

The MTCA Method A Soil CULs for Unrestricted Land Uses (WAC 173-340-900; Table 740-1) are the applicable CULs for soil. The selected soil CULs are protective of potential direct exposure to soils shallower than 15 feet and are generally accepted as being protective of groundwater to a drinking water standard. Potential soil exposures are limited by the existing cap. The cap was also designed to be protective of the soil-to-groundwater migration pathway by significantly reducing surface infiltration.

### 5.2.2 Groundwater

The MTCA Method A CULs for Groundwater (WAC 173-340-900; Table 720-1) are the applicable CULs for groundwater. The CULs for groundwater are summarized in Section 6.0.

### 5.3 Points of Compliance

A point of compliance is that point or location on a property where the CULs are attained. MTCA generally requires a standard point of compliance that is all media throughout a site. If a conditional point of compliance is appropriate, it must be established as close to the source of the release as practicable. A conditional point of compliance is appropriate based on the direct-contact soil CULs established herein. That point of compliance is all soil at depths between ground surface and 15 feet bgs.

For the purposes of this SFS, each remedial alternative will be evaluated based upon its likely ability to achieve the conditional point of compliance. Each alternative will also be evaluated based upon its ability to be protective of human health and the environment during implementation of the remedy, regardless of the point of compliance. Final points of compliance, including conditional points of compliance for soil, groundwater, and indoor air (if applicable), will be established in the CAP.

## 6.0 FINAL CONTAMINANTS OF CONCERN

Final COCs are those compounds in soil and groundwater that were detected at concentrations exceeding the Site-specific CULs presented below. COCs for soil include GRO, DRO and ORO. Soil borings that were advanced throughout the Site in 2016 were analyzed for all COCs. BTEX was not detected above CULs in any of the soil samples. BTEX is therefore excluded as a COC in soil. Although naphthalene was detected in one location (PZ-2 at 7.5 feet bgs), concentrations were not more than twice the CUL, and less than 10 percent of the samples' concentrations exceeded the CUL. Therefore, in accordance with WAC-340-740 (7)(d) and (e), naphthalene is not a COC in soil.

Final COCs for groundwater include GRO, DRO, and ORO.

The final COCs for affected media and the corresponding CULs are summarized below:

**Site-Specific Contaminants of Concern and Cleanup Levels**

| COC[a] | Soil | | Groundwater | |
|---|---|---|---|---|
| | Applicable CUL[b] (mg/kg) | Regulatory Basis | Applicable CUL[c] (µg/L) | Regulatory Basis |
| GRO | 100 / 30[d] | MTCA Method A | 1,000 / 800[d] | MTCA Method A |
| DRO | 2,000 | MTCA Method A | 500 | MTCA Method A |
| ORO | 2,000 | MTCA Method A | 500 | MTCA Method A |

Notes:

a COCs are based on those outlined in the Ecology-approved *Supplemental Remedial Investigation Work Plan* dated October 28, 2020.

b WAC 173-340-900, Table 740-1

c WAC 173-340-900, Table 720-1

d When benzene is also identified as a COC or when the sum of toluene, ethylbenzene, and total xylenes exceeds 1 percent of the GRO concentration

# 7.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) have been established to provide the technical basis for evaluating remedial alternatives that protect human health and the environment under the MTCA cleanup process (WAC 173-340-350). Based on the assessment of conditions and the applicable CULs presented in Section 6.0, the RAOs have been established as follows:

- Protect human receptors from exposure to soil outside of the currently capped area with COCs exceeding the Site-specific CULs to a depth of 15 feet bgs.
- Protect human receptors from direct contact with and ingestion of groundwater containing COCs at concentrations above CULs.
- Reduce concentrations of COCs in groundwater to levels protective of human health and the environment.
- Attain the standard point of compliance for all COCs in all media.

The RAOs are of primary importance to the evaluation of the general response actions, technologies, process options, and cleanup action alternatives presented in this SFS.

# 8.0 IDENTIFICATION AND SCREENING OF REMEDIATION TECHNOLOGIES

## 8.1 General Response Actions

General response actions are broad categories of remedial actions that can be combined to meet the RAOs for a site. The following are typical general response actions that are applicable to most impacted sites:

- No action
- Institutional controls
- Monitored natural attenuation (MNA)
- Containment
- Removal
- *Ex situ* treatment
- *In situ* treatment

Potentially applicable technologies associated with these general response actions have been identified and screened based on the COCs and affected media and take into consideration the current and future use of the property. An overview of those technologies is provided in the following section.

## 8.2 Identification and Screening of Applicable Technologies

Applicable technologies associated with the general response actions have been identified and screened for potential inclusion in the remediation alternatives. Each alternative meets the minimum threshold requirements that require that the action shall:

- protect human health and the environment;
- comply with cleanup standards (WAC 173-340-700 through 173-340-760);
- comply with applicable state and federal laws (WAC 173-340-710); and
- provide for compliance monitoring (WAC 173-340-410 and WAC 173-340-720 through 173-340-760).

Each identified technology was screened based on applicability to site conditions, overall effectiveness, implementability, and relative cost. The potentially applicable technologies considered are presented in Table 1, which provides a summary of the screening results. The alternatives considered using permanent solutions to the maximum extent practicable, provide for reasonable restoration time frames, and consider public concerns. The technologies that were retained for further consideration include a combination of continued containment and several in situ treatment options including bioventing, SVE and surface water diversion. Details of each technology are summarized below. The technologies determined to be appropriate are incorporated into potentially applicable remediation alternatives presented in Section 9.0.

### 8.2.1 Containment

Capping with an impervious surface is an appropriate technology for containment of impacts. The Site currently has a sloped asphaltic concrete cap that limits surface water from infiltrating through shallow contaminated soils. Capping is appropriate, as long as it prevents direct contact exposure to shallow soils and reduces infiltration of stormwater through impacted soil that could eventually migrate to deeper soils and groundwater.

### 8.2.2 Institutional Controls

If containment alone were to be implemented, institutional controls including an Environmental Covenant would be required to limit potential exposures to shallow soils and groundwater.

Institutional controls involve implementation of legal and/or physical restrictions on land use to limit exposure potential. Such restrictions may be implemented as a component of a remedial action, or they may be pre-existing restrictions. Land use restrictions might prohibit uses that would compromise the integrity of the existing surface cap of asphalt and concrete. The restrictions could also require that the cap is maintained as long as COC concentrations remain greater than the CUL in soil beneath the cap at depths up to 15 feet bgs. Implementation of institutional controls would be appropriate as a component of a remedial alternative to limit exposures. Land use restrictions would remain in place until COC concentrations in soil and groundwater decrease to less than the CUL.

### 8.2.3 *In Situ* Treatment

*In situ* treatment can be implemented as an alternative to, or in conjunction with, other treatment technologies. *In situ* treatment technologies are directly applied to subsurface soil and/or groundwater for removal or destruction of COCs. Given the subsurface conditions and presence of groundwater, the following technologies could be applicable as an *in situ* treatment:

- **Bioventing** – A bioventing system would be installed in the shallow vadose zone to facilitate the aerobic biodegradation of the shallow soil impacts and eliminate the soil-leaching-to-groundwater pathway.

- **Soil Vapor Extraction** – A soil vapor extraction (SVE) system would be installed in the shallow vadose zone to desorb and remove remaining COC concentrations to quickly mitigate the impacted soil-leaching-to-groundwater pathway.

- **Surface Water Diversion** – A hydraulic diversion trench (French drain) would be installed around the capped portions of the source area to intercept and re-route stormwater prior to infiltration.

### 8.2.4 Monitored Natural Attenuation

The natural attenuation processes can be classified as either physical (dispersion, dilution, and volatilization), chemical (sorption and chemical degradation), or biological (biodegradation). For petroleum hydrocarbons in the subsurface, biological degradation is often the most prominent destructive mechanism.

The effectiveness of these processes varies depending on the types and concentrations of contaminants and the physical, chemical, and biological characteristics. Natural attenuation should be evaluated as one potential remedial approach along with other cleanup action alternatives involving more active remedial technologies.

### 8.2.5 Removal (Soil Excavation)

Excavation of contaminated soil may be an effective method of reducing remaining impacted soil off-property. Excavated impacted soil would be transported for disposal at a permitted disposal facility.

## 9.0 SELECTION AND DESCRIPTION OF REMEDIAL ALTERNATIVES

Potential remedial alternatives are based on the response actions and technologies described in Section 8.0 and screened in Table 1. The proposed use of technologies within each alternative is based on professional judgment, experience, and the application of scientific principles. At a minimum, an alternative must meet MTCA's threshold requirements as specified in WAC 173-340-360(2)(a) before being considered for further evaluation.

## 9.1 MTCA Threshold Requirements

WAC 173-340-360(2)(a) specifies that cleanup actions shall:

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

WAC 173-340-360(2)(b) also mandates the other requirements that must be met by any remediation alternative:

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

## 9.2 Description of Remedial Alternatives

Based on the screening evaluation and MTCA's threshold and other requirements, the following remedial alternatives have been selected for evaluation and are described in detail in the subsequent subsections:

- Alternative 1 – Containment, Monitored Natural Attenuation (MNA), Removal, and Institutional Controls
- Alternative 2 – Containment, Bioventing, MNA, and Institutional Controls
- Alternative 3 – Containment, Soil Vapor Extraction, MNA, and Institutional Controls
- Alternative 4 – Containment, Surface Water Diversion (French Drain), MNA, and Institutional Controls

### 9.2.1 Alternative 1 – Containment, MNA, Removal, and Institutional Controls

Alternative 1 considers containment by maintaining the existing asphalt cap that diverts runoff and snow melt to the localized stormwater systems, and includes the removal of off-property soil impacts, monitoring the natural attenuation of groundwater, and placement of institutional controls on the property.

Currently, infiltration of snowmelt and rainwater may be occurring around the periphery of the cap in three directions that may be contributing to localized groundwater impacts through leaching. A natural depression in the underlying geologic strata is present beneath the cap that receives percolating rainwater and snowmelt, which is infiltrating around the periphery of the capped soil impacts. This transient groundwater leaches to the deeper groundwater resulting in COCs at concentrations greater than the applicable CULs in the deeper GWBU. The rate at which this is occurring, however, is slowing and groundwater conditions in the deeper groundwater unit are approaching MTCA Method A CULs under existing conditions. GRO has been intermittently detected in one deep well (MW-3) and was not detected when last sampled in 2021. DRO is the primary COC in groundwater.

Total organic carbon (TOC) testing was conducted during the SRI from Site groundwater samples. TOC concentrations in upgradient wells MW-3 (11,200 µg/L) and MW-4 (8,730 µg/L) are substantially higher than the wells located immediately downgradient such as MW-1 (4,820 µg/L, and the more distal wells such as at MW-5 (1,780 µg/L) and MW-6 (<1,000 µg/L). Samples were analyzed both with, and without SGC. Detections of DRO and ORO were present without SGC in the wells with high TOC. However, those detections were not observed when performing the SGC technique, demonstrating strong evidence of the breakdown of DRO and ORO that has occurred over time. The absence of detections of DRO and ORO when using SGC over the last several years indicates that current detections of DRO and ORO (without SGC) are biased high or are false positives due to the presence of polar metabolites resulting from the environmental breakdown of DRO and ORO in groundwater.

The monitoring of natural groundwater attenuation would include the collection of duplicate groundwater samples and the use of supplementary sample analysis using the SGC process. Biogenic interferences of polar organics are contributing to elevated concentrations of DRO and ORO, as evidenced in comparative analyses with and without using SGC process since 2016. An evaluation of the likely contributions of polar organics would be used in the continued evaluation of groundwater conditions.

Alternative 1 would further use institutional controls to limit the potential for direct contact, and would require regular inspections of the cap to ensure its intended functionality. Additional best management practices such as plowing winter snow into locations that will limit the volume of infiltration, should facilitate a shorter restoration time frame by reducing the mass of material leaching to groundwater.

Due to the presence of off-property impacts in the upper 15 feet in three locations to the northeast, a limited excavation of these remaining impacts would be performed to eliminate the direct contact exposure pathway. The removal of GRO impacts would require the removal of the top 5 feet of clean soil and stockpiling of these soils for future reuse as clean backfill. Soil impacts remaining in a thin zone of GRO impacts would be removed and the non-hazardous soils would be sent to the Wenatchee Regional Landfill for disposal. The excavated area would then be filled and compacted with structurally suitable backfill to grade (Figure 3).

This alternative assumes that the cap would remain in place and would require regular inspections, sealcoating as appropriate to maintain its functionality and repair costs to adequately maintain the cap. This alternative assumes that the impacted soil-leaching-to-groundwater pathway becomes insignificant in 15 years and may require four additional monitoring events to be conducted during future 5-Year Reviews by Ecology. Costs to implement Alternative 1 are $556,943 and can be found in Table 2.

#### 9.2.2 Alternative 2 – Containment, Bioventing, and Institutional Controls

Alternative 2 includes containment by maintaining the existing asphalt cap that diverts runoff and snow melt to the localized stormwater systems and includes the installation of a bioventing system in the shallow vadose zone to facilitate the aerobic biodegradation of the shallow soil impacts and eliminate the soil-leaching-to-groundwater pathway. The bioventing approach described in Alternative 2 focuses on enhancing natural attenuation through the introduction of additional available oxygen in the subsurface.

The bioventing alternative would include the installation of several bioventing wells set above the transiently present shallow groundwater. These wells would be evacuated using a vacuum blower to introduce atmospheric oxygen that would encourage and facilitate aerobic microbial growth at a rate that would reduce soil concentrations to the point that the soil-leaching-to-groundwater pathway becomes insignificant (i.e., no longer contributes contaminants to the lower GWBU).

A small-scale bioventing pilot test was conducted on October 4, 2022 to determine whether a bioventing strategy could be employed to stimulate aerobic bacterial populations and encourage the biotransformation of petroleum-impacted soil mass. The test consisted of a 3-hour bioventing study conducted at shallow well PZ-4, located within the core of the remaining impacts within the cap. The test used a vacuum blower to slowly pull soil gas out of the test well over a period of time to observe soil gas characteristics before and after low-flow bioventing was employed. The test was also intended to determine if air flow permeabilities and the responses are conducive to bioventing.

Baseline soil gas data was first gathered to determine the steady-state conditions of the soil gas, both in the shallow and deeper vadose zone soils. Steady-state baseline soil gas conditions were collected at shallow well PZ-4, advanced in the area of shallow soil impacts, and several shallow and deep monitoring wells around the cap including shallow wells PZ-1 and PZ-2, and deep wells MW-2 and MW-5. Baseline soil gas data from PZ-4 indicated depressed oxygen of 3.1 percent. Baseline carbon dioxide concentrations in the shallow vadose zone location PZ-4 were approximately 12.8 percent. Since atmospheric oxygen levels are generally present at 20.9 percent and atmospheric carbon dioxide concentrations are generally present at approximately 0.04 percent, moderate aerobic biotransformation appears to be occurring in the shallow capped portion of the Site.

Upon initiation of the test, oxygen in the shallow source-area test well PZ-4 remained depressed, exhibiting concentrations around 8.8 percent after approximately 2 hours of testing and ultimately dropping to 0.0 percent oxygen after an additional 45 minutes. Carbon dioxide concentrations in the test well ranged between approximately 6 percent and 10 percent throughout the test. These concentrations of carbon dioxide suggest that aerobic respiration is occurring at a moderate rate but may be limited in its generation rate(s) due to a depletion of available oxygen.

In addition to the aerobic processes identified, an abundance of carbon monoxide was detected during the bioventing test at PZ-4. The formation of carbon monoxide, and hydrogen sulfide to a lesser degree, suggest that anaerobic processes including methanogenesis are also occurring within the areas of impacts where oxygen is the most depleted. Very high lower explosive limits (LEL) conditions were observed at PZ-4, throughout the duration of the test. Ionizable hydrocarbons were reported at concentrations ranging from between approximately 544 to 680 parts per million (ppm), while LEL conditions remained high, ranging from 73 percent to 97 percent throughout the test. It is possible that anaerobically generated methane is contributing to the high sustained LEL conditions observed during the test.

Deeper soil gas data were also collected prior to and after the bioventing test performed at PZ-4. Soil gas results in deeper locations did not generally change, albeit a small increase in oxygen at well MW-5 was observed after the test. Deep soil gas concentrations prior to the test demonstrate very low oxygen at MW-2, located underneath the asphalt cap, throughout the test (0.0 percent) and low carbon dioxide concentrations (2.9 percent before to 1.7 percent after). Outside of the capped area, well MW-5 demonstrated moderate oxygen concentration of 12.8 percent before the test, to 14.1 percent, after 2 hours.

The first metric the U.S. Environmental Protection Agency (EPA) suggests to fully determine if bioventing is a recommended remedial alternative is whether the “Site” is oxygen deficient (less than 5 percent oxygen in soil gas), and therefore a potential candidate for bioventing. The baseline testing conducted within the core of the contaminated area demonstrated depleted oxygen (3.1 percent). Preliminary testing suggests that low-flow removal of soil gas can influence an increase in oxygen, which could be used by aerobes to metabolize total petroleum hydrocarbons (TPH). The degree to which the introduction of oxygen can be sufficiently utilized to mitigate the impacted soil-leaching-to-groundwater pathway may be tested in an expanded capacity to fully vet bioventing as a successful remedial alternative.

Small scale pre-remedial soil gas testing may provide additional information in determining the success of long-term bioventing. Oxygen utilization rates greater than 1.0 percent per day are a good indicator that bioventing may be feasible. Pre-remedial information such as soil oxygen demand (SOD) and soil moisture content information within the area of treatment may provide additional information regarding the natural oxygen scavenging capacity of the soils. Any additional oxygen consumption should be accounted for in the full-scale design.

This approach assumes that one or more bioventing wells are placed along the subject property line of the northeast portion of the Site to treat the off-property impacts in shallow soils. Pressure testing conducted during the pilot study suggest that a radius of 30 feet would facilitate the turnover of sufficient oxygen if implemented at a low vacuum and recovery rate. Approximately eight bioventing wells would be required to adequately allow for sufficient oxygen exchanges in the vadose zone. Figure 4 depicts the proposed locations for bioventing wells.

This SFS assumes that regular operations and maintenance will be required to optimize the oxygen supply rates and facilitate biological growth. A bioventing strategy may take as many as 7 years to complete the transformation of the remaining soil mass to the point that the soil-to-groundwater pathway becomes insignificant, and bioventing is no longer necessary to maintain that condition. Confirmation soil sampling would be performed off-property to the northeast following treatment to confirm that soil conditions have attenuated in that area.

Based on the current conditions, it is assumed that a bioventing program consisting of low-flow oxygen enrichment would be implemented for a period of 7 years. Alternative 2 assumes that 2 years of quarterly groundwater sampling would be required to demonstrate biological degradation of COCs, followed by 2 additional years of semi-annual groundwater sampling and 2 years of annual groundwater sampling to assess the potential for rebound conditions following the period of active bioventing. Subsequent 5-year Ecology reviews would require that four groundwater sampling events are conducted to assess the long-term effectiveness of the soil cap. Costs to implement Alternative 2 are $648,000 and can be found in Table 3.

#### 9.2.3 Alternative 3 – Containment, Soil Vapor Extraction, and Institutional Controls

Alternative 3 consists of containment by maintaining the existing asphalt cap that diverts runoff and snow melt to the localized stormwater systems and includes implementing SVE to physically remove remaining sorbed COC mass in the vadose zone and eliminate the soil leaching to groundwater pathway. SVE relies on physical mass removal rather than biodegradation, as applied during bioventing. The residual impacts within the capped area continues to slowly leach to the underlying GWBU. The application of SVE focused in the upper shallow soils with high residual impacts would quickly mitigate the impacted soil-leaching-to-groundwater pathway. The mitigation of that pathway will allow for the accelerated cleanup of groundwater conditions. Secondary mass removal efforts would be implemented in deeper portions of the source area, where soil gas concentrations remain high and continue to contribute to groundwater exceedances.

An SVE pilot test was conducted on October 5, 2022 to determine short-term air flow rates in the different geological zones, observe pneumatic response effects to SVE applications, and estimate mass recovery rates. The SVE pilot test was conducted in the shallow vadose zone, at location PZ-4, located within the area of impacts under the cap. In addition, a second SVE pilot test was conducted in the deeper soils, at location MW-4, which is screened across the GWBU.

The testing consisted of extracting soil gasses from MW-4 at a moderately low flow rate (3 to 5 cubic feet per minute [cfm]) using a regenerative vacuum blower. A vacuum of 40 to 50 inches of water column was required to facilitate this flow rate. The flow rate was lower than the flow rate tested at PZ-4 (described below) to more closely mimic the likely operational characteristics if implemented Site-wide. COC removal would be focused in the shallower zones with secondary lower-flow removal occurring in the deeper zones. Pneumatic responses to the applied vacuum were recorded in nearby shallow and deep observation wells to determine the radial effects of the propagated vacuum over time. In addition, an undiluted soil gas sample was collected from MW-4 prior to terminating the test to assess contaminant recovery estimates in the deeper vadose zone.

A second SVE pilot test was performed at shallow location PZ-4. Vacuum extraction at the test well consisted of the removal of soil gas from PZ-4 at a higher rate than that tested in the deeper vadose zone. A vacuum of approximately 36 inches of water column vacuum was applied to PZ-4, which yielded a flow rate of approximately 27 cfm. The discrepancies in flow rate versus applied vacuum in these two test wells may be predominantly explained by the differing geological properties and well-screen constructions. Deeper soils include finer-grained sands and silt compared with the shallow vadose zone soils that contain higher degrees of sands and gravel.

Findings from the SVE pilot test suggest that higher flow rates can be achieved in the shallower vadose zone soils compared with the deeper vadose zone soils. The construction of the wells additionally contributed to better flow rates due to the available unsaturated well-screen length. Approximately 10 feet of active well screen was available for recovery during the test at PZ-4, while only approximately 7 feet of well screen was available above the water table in MW-4 during testing. Pneumatic responses in surrounding observation wells during the pilot tests demonstrated that the effects of the vacuum propagation were primarily lateral, with the strongest vacuum effects observed in wells situated in similarly constructed depths and soil types.

A strong vacuum response greater than 1.5 percent of the applied vacuum at the test well was observed during testing at MW-3, located approximately 62 feet away. Vacuum responses in shallow wells during testing suggest that the vertical effects of the vacuum response were minimal. This finding implies that pneumatic communication occurs primarily in similarly constructed geological zones.

Soil gas testing was performed at the conclusion of the SVE tests by collecting soil gas samples from wells MW-4 and PZ-4. Soil gas samples were submitted to an accredited laboratory for analysis of GRO and DRO. GRO was detected in the shallow soil gas sample collected at PZ-4. A concentration of 1,000,000 micrograms per cubic meter ($\mu g/m^3$) was detected at PZ-4 after several hours of operation. This concentration suggests that this mass is recoverable in the capped portions of the source area. The testing performed at PZ-4 (including the bioventing test) included more than 5 hours of operation with PID concentrations remaining above 600 ppm for the duration of the testing. GRO in soil gas was detected at much higher concentrations than DRO in both tests.

GRO was detected in the deeper soil gas sample collected at MW-4 at concentrations of 230,000 $\mu g/m^3$, and DRO was detected at a concentration of 7,800 $\mu g/m^3$ at the end of the test. In this deeper vadose zone location, DRO comprised approximately 15 percent of the TPH at this location. DRO in shallower soil gas comprised approximately 30 percent of the TPH, indicating that higher concentration DRO remains in the shallow source area compared with the deeper soils.

The high concentration loadings captured during the pilot test indicate that SVE could provide suitable benefit if implemented full-scale to promote mass removal, particularly in the shallower source area and during drier months when transient water is not present. Conservative estimates of radial vacuum effects in the shallow zone are approximately 50 feet based on the pneumatic responses observed in nearby observation wells during the tests. SVE would be conducted in the upper vadose zone soils and would mitigate the soil-to-groundwater pathway and cause deeper soil gas to attenuate much more quickly following SVE application.

While the concentrations observed through testing demonstrate that high mass removal would be observed at the beginning of SVE application, concentrations and loadings are likely to drop off considerably after startup. Preferential geological pathways, diffusion kinetics and sorption capacities of the soils will dictate the degree to which SVE will be effective. SVE would be operated until a point at which the system reached asymptotic conditions. It is likely that soils will comply with direct contact CULs, or MTCA Method A CULs in the upper 15 feet after 3 years of operation.

This alternative considers that the radial effects of SVE would extend throughout the off-property soil impacts located to the northeast and would cause the impacts to attenuate to concentrations less than soil CULs. Approximately five SVE wells would be required to adequately allow for sufficient vapor extraction in the vadose zone (Figure 5). Confirmation soil sampling would be performed to confirm that soil conditions have attenuated in the area outside the cap.

Based on the current conditions, it is assumed that SVE would operate for a period of 3 years. Alternative 3 assumes that 2 years of quarterly groundwater sampling would be required to assess remedial conditions and demonstrate downward trends, followed by 2 additional years of semi-annual groundwater sampling and 2 years of annual groundwater sampling to assess the potential for rebound conditions following system shut down. Subsequent 5-year Ecology reviews would require that four groundwater sampling events are conducted to assess the long-term effectiveness of the soil cap. Costs to implement Alternative 3 are $793,000 and can be found in Table 4.

#### 9.2.4 Alternative 4 – Containment, Surface Water Diversion (French Drain), Removal, and Institutional Controls

Alternative 4 consists of containment by maintaining the existing asphalt cap that diverts runoff and snow melt to the localized stormwater systems and includes the installation of a hydraulic diversion trench (French drain) around the capped portions of the source area where rainwater and snowmelt are contributing to the infiltration of stormwater through impacted soils. Alternative 4 would require the installation of a shallow trench, constructed along the periphery of the existing asphalt cap to intercept and re-route the stormwater prior to infiltration.

By minimizing the volume of water that is currently infiltrating around the sides of the cap, the soil-leaching-to-groundwater pathway would be physically interrupted and prevent the continued migration of impacts to the GWBU. The French drain system would be constructed from ground surface to a total depth of 4 feet bgs to facilitate the collection of stormwater that sheet-flows off of the cap and the water that seeps under the cap from localized areas outside the cap. A trench depth of 4 feet would not require sidewall sloping or temporary shoring to install, per Occupational Safety and Health Administration's (OSHA's) shoring regulations and would be sufficiently deep to fully intercept localized infiltration.

The construction of an intercepting French drain would include the removal of existing clean soils along the terminus of the cap and the introduction of a gravel backfill to the trench. Clean excavated soils would be used to appropriately grade and berm areas as needed to either encourage migration to the French drain or flow around the cap. The gravel backfill will promote the collection of infiltrating water in the vicinity of the cap before it can infiltrate into the surrounding soils. The intercepting French drain would require the installation of geosynthetic materials around the gravel to prevent the plugging of pore spaces within the gravel from silt and other organic materials.

Localized surface water collection infrastructure would be required to capture and re-direct the water that is generated along the face of the cap and surrounding vicinity and into the French drain. The installation of localized catch basins would be required to adequately collect the surface water and route it accordingly to the City of Leavenworth's stormwater system.

Alternative 4 would require that routine cleaning and maintenance of the collection system be conducted periodically.

Due to the presence of off-property impacts in the upper 15 feet in three locations to the northeast, a limited excavation of these remaining impacts would be performed to eliminate the direct contact exposure pathway. This would require the removal and stockpiling of the top 5 feet of clean soil for future reuse as clean backfill. Soil impacts remaining in a thin zone would be removed and the non-hazardous soils would be sent to the Wenatchee Regional Landfill for disposal. The excavated area would then be filled and compacted with structurally suitable backfill to grade. Figure 6 depicts the proposed location for the French drain.

This alternative assumes groundwater compliance is achieved after 10 years and would require semi-annual monitoring during that period and assumes that four 5-year Ecology reviews may require additional sampling events. Costs to implement Alternative 4 are $692,000 and are provided in Table 5.

## 10.0 EVALUATION OF REMEDIAL ALTERNATIVES

### 10.1 Evaluation Framework

This section presents an evaluation and comparison of the proposed remedial alternatives for selecting the preferred cleanup action. In accordance with MTCA, the alternatives are evaluated relative to the criteria specified in WAC 173-340-360(3)(f) and WAC 173-340-360(4), which include the following:

- Protectiveness;
- Permanence;
- Effectiveness over the long term;
- Management of short-term risks;
- Technical and administrative implementability;
- Consideration of public concerns;
- Restoration time frame; and
- Cost.

A summary of the evaluation of the proposed alternatives is provided in Table 1 and summarized in Sections 10.3 through 10.10 for each of the criteria. The overall evaluation is then used to calculate the relative ranking of each alternative compared to the other alternatives.

Each alternative was assigned a score for each criterion ranging from 1 (worst) to 5 (best) based upon professional judgment and the application of engineering and scientific principles. Each score is based on the perceived degree to which that alternative meets the evaluation criteria and is included in Table 1.

For the Disproportionate Cost Analysis (DCA), the non-cost based criteria were analyzed using weighting factors established by Ecology. The weighted values were summed, and the summed scores are compared to the estimated cost of each alternative. The results of the DCA are presented in Section 10.11.

### 10.2 Evaluation of Remedial Alternatives

This section presents a summary of the evaluation and comparison of the proposed remedial alternatives for selecting the preferred cleanup action, based on the criteria contained within WAC 173-340-360 (3)(f) and (4). Each criterion also includes subcriteria as a component of the evaluation. The detailed numerical scores provided for each alternative for each evaluation criterion and subcriteria are summarized in Table 1.

Each of the alternatives are subjectively ranked between 1 and 5 for each of the subcriteria; 5 being the best and 1 being the worst. The subcriteria values are then averaged to provide the criterion score. The sum of the criterion scores is then used as a final score to rank each alternative.

The subjective rankings are based on professional judgment, the understanding and application of established scientific and engineering principles, experience with other sites and similar technologies, vendor information, and understanding of specific Site conditions that could affect each of the alternatives.

### 10.3 Protectiveness

Protectiveness is defined in WAC 173-340-360(3)(f)(i) as:

> *Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.*

All remedial alternatives are protective of human health and the environment. Two of the alternatives actively remediate soil beneath the Site (Alternatives 2 and 3), while the other two alternatives provide barriers to prevent exposures. Alternatives 2 and 3 would be the most protective if implemented properly by reducing concentrations of shallow soil impacts and ultimately, COCs in groundwater by actively removing contaminants. Alternative 3 reduces risks very quickly, and therefore scored slightly higher than Alternative 2. Alternatives 1 and 4 scored lower by a comparative lack of mass removal. Alternative 3 received the highest score followed by, in order, Alternatives 2, 4, and 1.

### 10.4 Permanence

Permanence is defined in WAC 173-340-360(3)(f)(ii) as:

> *The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and improvement of the overall environmental quality.*

Permanence includes the subcriteria of reduction in toxicity, degree of irreversibility, and the type and character of the waste streams generated during treatment. While all the technologies, if successfully implemented, would be permanent, the degree of certainty in the success of each technology varies due to the nature of the technologies.

Alternatives 2 and 3 are permanent remedial alternatives that would reduce toxicity through a reduction in COC concentrations in soil, immediately reduce mobility due to the *in situ* nature of remediation and reduce the volume of impacts. Alternatives 1 and 4 would not permanently treat the remaining contaminant mass and therefore, scored lower for permanence. Alternative 2 received the highest score followed by, in order, Alternatives 3, 4, and 1.

### 10.5 Effectiveness Over the Long Term

Effectiveness over the long term is defined in WAC 173-340-360(3)(f)(iv) as:

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

Long-term effectiveness includes the subcriteria of certainty, reliability, residual risk, and utilization of preferred remedies. Alternatives 2 and 3 are ranked highest for long-term effectiveness primarily because they remove or reduce impacts and provide a high level of effectiveness throughout implementation. These technologies also fall into the upper hierarchy of suggested alternatives and carry less residual risk based on their restoration time frames. While Alternative 3 (SVE) scores higher than Alternative 2 (bioventing) for its degree of certainty, SVE produces some waste that ranks it equally with bioventing for long-term effectiveness.

The presence of the asphalt cap will continue to protect the long-term conditions; however Alternatives 1 and 4 do not actively remove or reduce the volume of impacts and are appropriately ranked lower than Alternatives 2 and 3. Alternative 4 does reduce the mobility of impacts and therefore scores higher than Alternative 1. Alternatives 2 and 3 received similar scores, followed by, in order, Alternatives 4 and 1.

### 10.6 Management of Short-Term Risks

Management of short-term risks is defined in WAC 173-340-360(3)(f)(v):

> *The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*

The management of short-term risks require that the environmental benefit of the alternatives is weighed against the potential for risks associated with the necessary work to complete that alternative. Each of the alternatives has manageable short-term risks and effective measures for mitigating those risks. Alternative 1 has been ranked the highest for this criterion because it does not involve any intrusive work and, therefore, little to no short-term risks. Alternatives 2, 3, and 4 have moderate to high levels of short-term risks associated with implementation. Alternative 3 is ranked lower than Alternative 2 because it requires installation of substantial improvements with noxious emissions monitoring and on-site personnel for 6 to 8 weeks. Alternative 4 ranks lowest due to substantial on-site trenching, potential to generate sediment, and a risk of erosion during implementation. Alternative 1 received the highest score followed by, in order, Alternatives 2, 3, and 4.

### 10.7 Technical and Administrative Implementability

Technical and administrative implementability is defined in WAC 173-340-360(3)(f)(vi):

> *Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*

This criterion includes the concepts of technical possibility, access, necessary resources, monitoring requirements, and integration into existing facility features. All alternatives are technically possible to implement, but primarily vary based on their overall complexity. Alternative 1 received the highest implementability score because is the least complex of the alternatives to implement due its simplicity and overall lack of intrusive activities. Alternatives 3 and 4 received the same lowest score due to complexity of implementation (Alternative 3) and the uncertainty to adequately eliminate the surface-water-to-soil-pathway and to install in areas along the flanks of the cap (Alternative 4). Alternative 1 received the highest score followed by, in order, Alternatives 2, 3, and 4.

### 10.8 Consideration of Public Concerns

Consideration of public concerns is defined in WAC 173-340-360(3)(f)(vii):

> *Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.*

Integrating and addressing public concerns are integral in the success of implementing and maintaining the selected alternative. Alternatives 2 and 3 are ranked highest with the same score based on the moderate level of disruption to local businesses, impacts on traffic, and limited potential for major public concerns. Alternative 1 is ranked lower with excavation to address off-Site soil impacts on the northeast-adjacent property and restoration time frame will be longer without active remediation. Alternative 4 ranked the lowest with the most anticipated public concern with excavation of off-Site soil impacts, French drain installation, and transportation of impacted soil to the regional landfill. Based on a subjective evaluation of likely and perceived public concerns, Alternatives 2 and 3 are ranked highest, followed, in order, by Alternatives 1 and 4.

### 10.9 Restoration Time Frame

Restoration Time Frame (RTF) is evaluated using the following factors described in WAC 173-340-360(4)(b)(i through ix):

- Potential risks posed by the site to human health and the environment
- Practicability of achieving a shorter restoration time frame
- Current use of the site
- Potential future use of the site
- Availability of alternative water supplies
- Likely effectiveness and reliability of institutional controls
- Ability to monitor and control migration of hazardous substances from the site
- Toxicity of hazardous substances at the site
- Natural processes that reduce concentrations of hazardous substances at the site

Estimates of RTF are necessarily subjective. RTF was ranked based upon the general aggressiveness of each of the alternatives and their perceived certainty. Alternatives 2 and 3 are similarly ranked highest. They are judged to be most aggressive based on the highest quantity of contaminant mass removed in a short period of time. Alternative 4 is ranked lower because it does not actively remediate impacts or reduce their mobility, leaving them in place. Alternative 1 is ranked the lowest because it does not actively address the soil-leaching-to-groundwater pathway, will require the longest time frame to reach remedial cleanup goals, will rely on continued containment and the natural attenuation of groundwater through dispersion, dissolution, and biological breakdown over a period of 30 years. Based on these considerations, Alternatives 2 and 3 are ranked highest, followed, in order, by Alternatives 4 and 1.

### 10.10 Cost

Cost is defined in WAC 173-340-360(3)(f)(iii) as:

*The cost to implement the alternative, including the cost of construction, the net present value of any long-term costs, and agency oversight costs that are cost recoverable. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. Cost estimates for treatment technologies shall describe pretreatment, analytical, labor, and waste management costs. The design life of the cleanup action shall be estimated, and the cost of replacement or repair of major elements shall be included in the cost estimate.*

The order-of-magnitude remedial costs (i.e., ±30 to 50 percent) have been estimated for each of the remedial alternatives based on the descriptions presented in Section 9.2 and associated assumptions, and without engineering design or contractor bidding. The order-of-magnitude remedial costs are based on typical costs for Washington State and the current knowledge of the Site and are summarized in the following table. Because of the unstable and recently unpredictable economic rates of return on investments, the costs presented herein do not include a net present value analysis for several reasons. It is understood that longer-term costs such as groundwater monitoring that will be conducted will cost more in the future; however those tasks are common to all of the alternatives presented. Additionally, the common method for predicting future dollar costs is not a reasonable predictive model under the existing interest rate increases and economic climate. Lastly, the alternatives requiring capital investment costs mostly occur within the first year of operation and would not be substantially influenced using a net-present value evaluation.

Costs presented include estimates of pre-remedial agency and permitting requirements, remedial actions as applicable, monitoring and maintenance costs, and restoration and closure tasks. The following table summarizes these estimated costs, and a more detailed analysis of costs is provided in Tables 2 through 5. These costs are for comparison purposes only and actual implementation costs will vary from those provided below. These estimated costs incorporate a variety of necessary assumptions, and the validity of those assumptions cannot be fully known at this time.

**Remedial Alternatives Cost Summary**

| Remedial Alternative | Order-of-Magnitude Remediation Cost Estimate |
|---|---|
| 1. Containment, Monitored Natural Attenuation (MNA), Removal, and Institutional Controls | $ 556,943 |
| 2. Containment, Bioventing and Institutional Controls | $ 648,000 |
| 3. Containment, Soil Vapor Extraction (SVE) and Institutional Controls | $ 793,000 |
| 4. French Drain, Removal, and Institutional Controls | $ 692,000 |

### 10.11 Disproportionate Cost Analysis

Under WAC 173-340-360(3)(e), a cleanup action shall not be considered practicable "*if the incremental cost of the alternative over that of a lower cost alternative exceeds the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative*". The determination of practicability is made using an analysis of benefit versus cost. The DCA can be performed quantitatively using the judged scoring of the non-cost criteria as the net benefit.

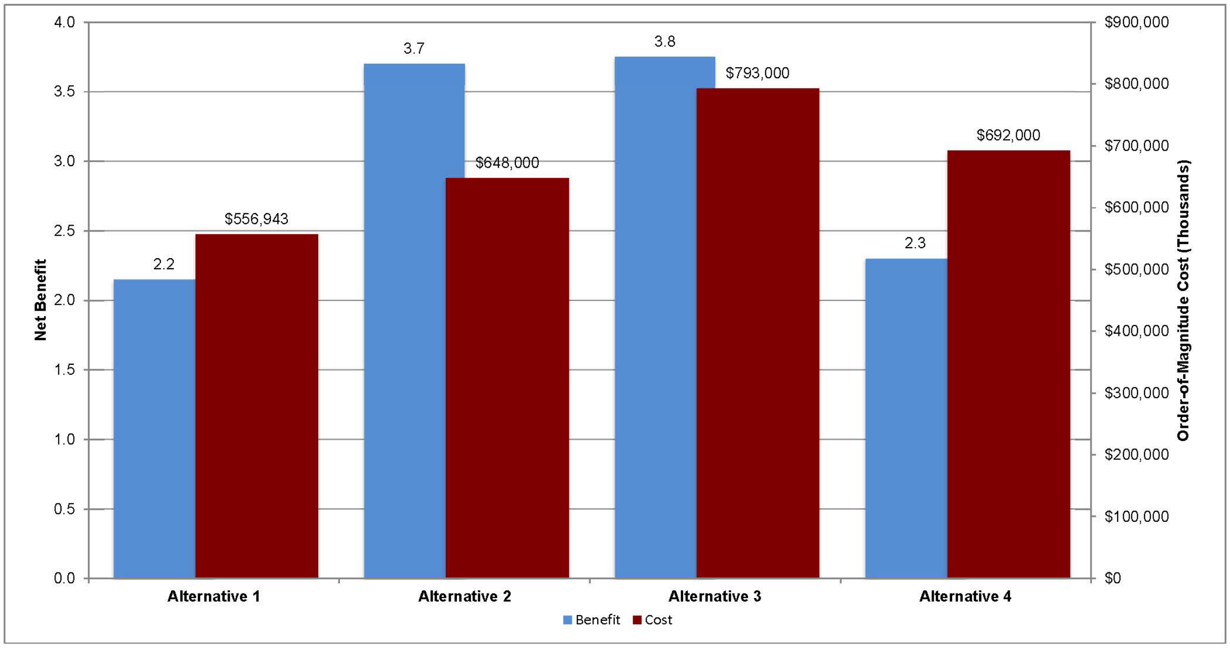
As previously discussed, each alternative was assigned a score for each of the non-cost evaluation criteria, with a score of 5 representing the highest overall perceived benefit and a score of 1 representing the lowest overall perceived benefit. The raw scores that were assigned in Table 1 are summarized below (rank) and are weighted for each criterion according to weighting factors established by Ecology (value). The sum of the individual weighted scores for each alternative represents a value of the overall benefit of the alternative.

**Remedial Alternatives Scoring Summary**

| **Criteria** *(Weighting Factor)* | **Alternative 1** | | **Alternative 2** | | **Alternative 3** | | **Alternative 4** | |
|---|---|---|---|---|---|---|---|---|
| | **Rank** | **Value** | **Rank** | **Value** | **Rank** | **Value** | **Rank** | **Value** |
| Protectiveness *(0.3)* | 1.0 | 0.30 | 3.3 | 1.00 | 4.0 | 1.20 | 2.2 | 0.65 |
| Permanence *(0.2)* | 2.3 | 0.47 | 4.3 | 0.87 | 4.0 | 0.80 | 3.0 | 0.60 |
| Long-Term Effectiveness *(0.2)* | 1.0 | 0.20 | 4.0 | 0.80 | 4.0 | 0.80 | 1.8 | 0.35 |
| Short-Term Risk *(0.1)* | 5.0 | 0.50 | 3.5 | 0.35 | 3.0 | 0.30 | 2.5 | 0.25 |
| Implementability *(0.1)* | 4.8 | 0.48 | 3.8 | 0.38 | 3.5 | 0.35 | 3.5 | 0.35 |
| Public Concerns *(0.1)* | 2.0 | 0.20 | 3.0 | 0.30 | 3.0 | 0.30 | 1.0 | 0.1 |
| **BENEFIT VALUE** | **2.2** | | **3.7** | | **3.8** | | **2.3** | |

The chart below presents the DCA using the estimated order-of-magnitude costs and quantitative net benefit values.

**Cost-to-Benefit Analysis**




## 11.0 RECOMMENDED REMEDIAL ALTERNATIVE

Alternative 2 – Containment, Bioventing, MNA, and Institutional Controls is the preferred remedial alternative based on the cost-to-benefit analysis. In consideration of the current concentrations of COCs in groundwater, impacts generally are between two to four times the CULs for DRO and ORO when analyzed without silica gel cleanup, and downgradient wells MW-5 and MW-6 demonstrate that off-property migration of these COCs is not currently occurring under the current conditions.

Containment of remaining soil impacts through the maintenance and monitoring of the asphalt cap will continue to limit the infiltration of rainwater and snowmelt through the shallow soils under the cap. As evidenced through pilot testing events, limited oxygen in the vadose zone is prohibiting the aerobic biological breakdown of petroleum hydrocarbons. Depleted oxygen conditions under the cap are currently limiting the potential for natural bacterial processes to occur. Providing sufficient oxygen to aerobes will promote increased cellular respiration, metabolize carbon-based petroleum and reduce groundwater concentrations within a reasonable RTF.

While SVE may restore the Site in a slightly shorter time frame, the substantial costs to implement, monitor, and maintain a more complex system far exceed the costs to implement bioventing. As shown in the DCA, the environmental benefits of bioventing and SVE are nearly the same, however, the costs to operate and maintain SVE compared with bioventing are approximately $145,000 more. Considering the current and future land uses for this subject property are not expected to change due to its location along Highway 2 and Chumstick Highway, Alternative 2 provides the highest environmental benefit for a reasonable cost. Alternatives 1 and 4 may provide some limited environmental benefit; however, they are much less certain that they will be successful within a reasonable RTF.

A bioventing program could be established and operated in a relatively short time frame and is readily implementable. The specific design and operation of the bioventing system will require the development of an *Engineering Design Report* (EDR) as a component of the CAP. The EDR and CAP will contain the specific design and operational criteria and will include a *Sampling and Analysis Plan* (SAP) that will include the specific soil gas, groundwater, and asphalt cap monitoring requirements. The SAP will additionally be included as a component of the *Compliance Monitoring Plan*, which would support any revised Environmental Covenant.

## 12.0 REFERENCES

GeoEngineers. 1997. *Remedial Investigation/Feasibility Study Report*, Glacier Park East Site, Leavenworth, Washington. Prepared for Burlington Northern Railroad and the TCLP Group. 27 February.

TRC Environmental Corporation (TRC). 2022. *Revised Supplemental Remedial Investigation Report, Glacier Park East Site, Leavenworth, Washington.* Prepared for BNSF Railway Company and Chevron USA, Inc. 25 July.

# Tables

**Table 1**
**Remedial Alternatives Evaluation**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | |
|---|---|---|---|---|---|---|---|---|
| **Criteria** | **Containment, Monitored Natural Attenuation, Removal, and Institutional Controls** | ***Score*** [a] | **Containment, Bioventing, and Institutional Controls** | ***Score*** [a] | **Containment, Soil Vapor Extraction (SVE), and Institutional Controls** | ***Score*** [a] | **Containment, Surface Water Diversion, Removal, and Institutional Controls** | ***Score*** [a] |
| **Description/Issues** | Implement institutional controls to maintain a surface cap and place a deed restriction on the impacted property. Requires limited off-property soil excavation. Will require implementation of institutional controls in soil and groundwater and long-term monitoring. | | Stimulate biodegradation through the addition of oxygen. Effectiveness limited to oxygen distribution. Will require continued institutional controls in soil and groundwater and long-term monitoring. Assumes 7 years of bioventing operation. | | Apply SVE technology to degrade soil impacts beneath the cap that may contribute to dissolved phase impacts in groundwater. Effectiveness limited to SVE radius of influence. Will require implementation of institutional controls in soil and groundwater and long-term monitoring. Assumes 3 years of SVE operation. | | Install a French Drain around the periphery of the soil isolation cap to divert surface water. Requires limited off-property soil excavation. Will require implementation of institutional controls in soil and groundwater and long-term monitoring. | |
| **Protectiveness** | Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality. | | | | | | | |
| **Overall Protectiveness** | *Protective if maintained* | *1* | *Protective when complete* | *3* | *Protective when complete* | *4* | *Protective if maintained* | *2* |
| **Reduces Existing Risks** | *Reduces risks when implemented* | *1* | *Reduces risks when implemented* | *4* | *Reduces risks when implemented* | *4* | *Reduces risks when implemented* | *3* |
| **Time Required to Reduce Risk** | *Longer duration to reduce risks* | *1* | *Shorter duration to reduce risks* | *3* | *Shortest duration to reduce risks* | *4* | *Longer duration to reduce risks* | *2* |
| **On-Site Risks** | *Reduces risks with lower level of certainty* | *1* | *Reduces risks with high level of certainty* | *4* | *Reduces risks with high level of certainty* | *4* | *Reduces risks with moderate to low level of certainty* | *3* |
| **Off-Site Risks** | *Reduces risks with lower level of certainty* | *1* | *Reduces risks with moderate level of certainty* | *3* | *Reduces risks with high level of certainty and eliminates vapor intrusion potential* | *4* | *Reduces risks with moderate to high level of certainty* | *1* |
| **Improvement in Environmental Quality** | *No immediate change in environmental quality* | *1* | *Moderate level of improvement* | *3* | *High level of improvement* | *4* | *Low level of improvement* | *2* |
| **Criterion Score** | | ***1.0*** | | ***3.3*** | | ***4.0*** | | ***2.2*** |
| **Permanence** | The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and improvement of the overall environmental quality. | | | | | | | |
| **Reduces Toxicity, Mobility, and Volume** | *Reduces toxicity, mobility, and volume slowly* | *1* | *Reduces toxicity, mobility, and volume* | *5* | *Reduces toxicity, mobility, and volume rapidly* | *5* | *Reduces toxicity, mobility and volume slowly* | *2* |
| **Degree of Irreversibility** | *Low degree of irreversibility* | *1* | *Largely Irreversible* | *4* | *Irreversible* | *5* | *Low degree of irreversibility* | *2* |
| **Waste Characteristics** | *No waste stream* | *5* | *Generates no air waste stream* | *4* | *Generates air waste stream* | *2* | *No waste stream* | *5* |
| **Criterion Score** | | ***2.3*** | | ***4.3*** | | ***4.0*** | | ***3.0*** |
| **Long-Term Effectiveness** | Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring. | | | | | | | |
| **Degree of Certainty** | *Relatively uncertain* | *1* | *Moderately to highly certain* | *4* | *Highly certain* | *5* | *Somewhat certain* | *2* |
| **Reliability** | *Moderately reliable* | *1* | *Moderately to highly reliable* | *4* | *Moderately to highly reliable* | *4* | *Somewhat reliable* | *2* |
| **Residual Risk** | *High* | *1* | *Moderate to low risk* | *4* | *Moderate, includes waste* | *3* | *High* | *1* |
| **Technology Hierarchy** | *Low* | *1* | *Moderate* | *4* | *Moderate to high* | *4* | *Low to Moderate* | *2* |
| **Criterion Score** | | ***1.0*** | | ***4.0*** | | ***4.0*** | | ***1.8*** |
| **Short-Term Risk Management** | The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks. | | | | | | | |
| **During Construction and Implementation** | *Low risks* | *5* | *Fewer risks* | *4* | *Moderate to low risks* | *3* | *Moderate risks associated with trenching* | *3* |
| **Effectiveness of Risk Management** | *Very Effective* | *5* | *Moderately effective* | *3* | *Moderately effective* | *3* | *Moderately effective* | *2* |
| **Criterion Score** | | ***5.0*** | | ***3.5*** | | ***3.0*** | | ***2.5*** |

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**Table 1**
**Remedial Alternatives Evaluation**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | |
|---|---|---|---|---|---|---|---|---|
| **Criteria** | **Containment, Monitored Natural Attenuation, Removal, and Institutional Controls** | *Score*[a] | **Containment, Bioventing, and Institutional Controls** | *Score*[a] | **Containment, Soil Vapor Extraction (SVE), and Institutional Controls** | *Score*[a] | **Containment, Surface Water Diversion, Removal, and Institutional Controls** | *Score*[a] |
| **Implementability** | Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions. | | | | | | | |
| **Technically Possible** | *Possible if property owner agrees to environmental covenant.* | *5* | *Possible, based on pilot testing and subsurface data.* | *4* | *Possible, based on pilot testing and subsurface data* | *4* | *Possible, but with some uncertainty associated with infiltration routes* | *2* |
| **Access** | *No issues related to access for implementing deed restrictions* | *5* | *No issues related to access* | *4* | *No issues related to access* | *4* | *Access off of capped area will be more challenging* | *3* |
| **Availability of Necessary Resources** | *Readily available* | *5* | *Available, possible delays with subcontractor* | *4* | *Available, possible delays with subcontractor* | *4* | *Readily Available* | *5* |
| **Scheduling, Size, and Complexity** | *Very low complexity; environmental covenant can be prepared within 2 to 4 weeks.* | *5* | *Moderate complexity and size; bioventing installation and startup can be completed within 6 to 8 weeks* | *4* | *Moderate complexity and size; AS/SVE installation and startup can be completed within 8 to 10 weeks* | *3* | *Moderate complexity and size; installation of French drain can be completed in ~4 weeks.* | *3* |
| **Monitoring Requirements** | *Moderate to low* | *4* | *Moderate* | *3* | *Higher* | *2* | *Moderate to low* | *4* |
| **Integration with Existing Features** | *High* | *5* | *Moderate* | *4* | *Moderate* | *4* | *Moderate* | *4* |
| **Criterion Score** | | ***4.8*** | | ***3.8*** | | ***3.5*** | | ***3.5*** |
| **Public Concerns** | Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site. | | | | | | | |
| **Concerns** | *Potential concerns regarding impacts remaining in soil and groundwater.* | ***2.0*** | *Potential concerns regarding equipment and noise, soil removal in close proximity to buried utilities and highway. Potential concerns regarding impacts remaining in groundwater and potentially necessary modification of the remedy if future development is desired. Possible if all property owner agree to environmental covenant. Cap is already in place, but will need to be maintained.* | ***3.0*** | *Potential concerns regarding equipment and noise, fugitive vapors. Potential concerns regarding impacts remaining in groundwater and potentially necessary modification of the remedy if future development is desired. Possible if all property owner agree to environmental covenant. Cap is already in place, but will need to be maintained.* | ***3.0*** | *Potential concerns regarding impacts remaining in soil and groundwater and potentially necessary modification of the remedy if future development is desired. Possible if all property owner agree to environmental covenant. Cap is already in place, but will need to be maintained.* | ***1.0*** |
| **Restoration Time Frame** | Determination of whether a cleanup action provides for a reasonable restoration time frame based on criteria in WAC 173-340-360(4)(b). | | | | | | | |
| **Time Frame** | *Longest time frame* | ***1.0*** | *Moderate time frame (7+ years)* | ***4.0*** | *Moderate time frame (3 - 5 years)* | ***4.0*** | *Longer time frame (10+ years)* | ***2.0*** |
| **TOTAL SCORE** | ***17.2*** | | ***26.0*** | | ***25.5*** | | ***15.9*** | |
| **Conceptual Level Cost** | **$556,943** | | **$648,000** | | **$793,000** | | **$692,000** | |

Note:
a Each sub-criterion is scored from 5 (best) to 1 (worst) based on the perceived benefit; the total criterion score is the average of the associated sub-criterion scores.

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**Table 1**
**Remedial Alternatives Evaluation**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | |
|---|---|---|---|---|---|---|---|---|
| **Criteria** | **Containment, Monitored Natural Attenuation, Removal, and Institutional Controls** | *Score* [a] | **Containment, Bioventing, and Institutional Controls** | *Score* [a] | **Containment, Soil Vapor Extraction (SVE), and Institutional Controls** | *Score* [a] | **Containment, Surface Water Diversion, Removal, and Institutional Controls** | *Score* [a] |
| **Implementability** | Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions. | | | | | | | |
| **Technically Possible** | *Possible if property owner agrees to environmental covenant.* | *5* | *Possible, based on pilot testing and subsurface data.* | *4* | *Possible, based on pilot testing and subsurface data* | *4* | *Possible, but with some uncertainty associated with infiltration routes* | *2* |
| **Access** | *No issues related to access for implementing deed restrictions* | *5* | *No issues related to access* | *4* | *No issues related to access* | *4* | *Access off of capped area will be more challenging* | *3* |
| **Availability of Necessary Resources** | *Readily available* | *5* | *Available, possible delays with subcontractor* | *4* | *Available, possible delays with subcontractor* | *4* | *Readily Available* | *5* |
| **Scheduling, Size, and Complexity** | *Very low complexity; environmental covenant can be prepared within 2 to 4 weeks.* | *5* | *Moderate complexity and size; bioventing installation and startup can be completed within 6 to 8 weeks.* | *4* | *Moderate complexity and size; AS/SVE installation and startup can be completed within 8 to 10 weeks.* | *3* | *Moderate complexity and size; installation of French drain can be completed in ~4 weeks.* | *3* |
| **Monitoring Requirements** | *Moderate to low* | *4* | *Moderate* | *3* | *Higher* | *2* | *Moderate to low* | *4* |
| **Integration with Existing Features** | *High* | *5* | *Moderate* | *4* | *Moderate* | *4* | *Moderate* | *4* |
| **Criterion Score** | | ***4.8*** | | ***3.8*** | | ***3.5*** | | ***3.5*** |
| **Public Concerns** | Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site. | | | | | | | |
| **Concerns** | *Potential concerns regarding impacts remaining in soil and groundwater.* | ***2.0*** | *Potential concerns regarding equipment and noise, soil removal in close proximity to buried utilities and highway. Potential concerns regarding impacts remaining in groundwater and potentially necessary modification of the remedy if future development is desired. Possible if all property owner agree to environmental covenant. Cap is already in place, but will need to be maintained.* | ***3.0*** | *Potential concerns regarding equipment and noise, fugitive vapors. Potential concerns regarding impacts remaining in groundwater and potentially necessary modification of the remedy if future development is desired. Possible if all property owner agree to environmental covenant. Cap is already in place, but will need to be maintained.* | ***3.0*** | *Potential concerns regarding impacts remaining in soil and groundwater and potentially necessary modification of the remedy if future development is desired. Possible if all property owner agree to environmental covenant. Cap is already in place, but will need to be maintained.* | ***1.0*** |
| **Restoration Time Frame** | Determination of whether a cleanup action provides for a reasonable restoration time frame based on criteria in WAC 173-340-360(4)(b). | | | | | | | |
| **Time Frame** | *Longest time frame* | ***1.0*** | *Moderate time frame (7 ± years)* | ***4.0*** | *Moderate time frame (3 - 5 years)* | ***4.0*** | *Longer time frame (10+ years)* | ***2.0*** |
| **TOTAL SCORE** | ***17.2*** | | ***26.0*** | | ***25.5*** | | ***15.9*** | |
| **Conceptual Level Cost** | **$556,943** | | **$648,000** | | **$793,000** | | **$692,000** | |

Note:
a Each sub-criterion is scored from 5 (best) to 1 (worst) based on the perceived benefit; the total criterion score is the average of the associated sub-criterion scores.

**Table 2**
**Order-of-Magnitude Cost Estimate**
**Alternative 1 – Containment, Monitored Natural Attenuation, Removal, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| Task / Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|
| **Implement Institutional Controls** | | | | | | | |
| Update Environmental Covenant | 1 | LS | | | $ 5,000 | $ 5,000 | |
| Cleanup Action Report | 1 | LS | | | $ 20,000 | $ 20,000 | ***$ 25,000*** |
| **Limited Off-Property Excavation** | | | | | | | |
| Access Agreement | 1 | LS | | | $ 3,000 | $ 3,000 | |
| Site Preparations | 1 | LS | $ 5,000 | $ 5,000 | $ 1,000 | $ 6,000 | |
| Tree and Stump Removal | 1 | LS | $ 7,500 | $ 7,500 | $ 1,500 | $ 9,000 | |
| Excavate and Stockpile Clean Overburden | 260 | CY | $ 50 | $ 13,000 | $ 2,000 | $ 15,000 | |
| Excavate and Load Impacted Soil | 105 | CY | $ 50 | $ 5,250 | $ 5,000 | $ 10,250 | |
| Trucking to Wenatchee Landfill 1-hr rd trip | 5 | hrs | $ 120 | $ 600 | | $ 600 | |
| Disposal of Impacted Soil | 160 | ton | $ 60 | $ 9,600 | | $ 9,600 | |
| Confirmation Soil Sampling & Analysis | 10 | sample | $ 250 | $ 2,500 | | $ 2,500 | |
| Import and Place Clean Backfill | 365 | CY | $ 37 | $ 13,505 | $ 2,500 | $ 16,005 | |
| Compaction and Site Restoration | 1 | LS | $ 15,000 | $ 15,000 | $ 1,500 | $ 16,500 | |
| Soil Removal and Closure Report | 1 | LS | $ 7,500 | | $ 7,500 | $ 7,500 | |
| Limited Off-Property Excavation Subtotal | | | | $ 71,955 | | $ 95,955 | |
| Tax on Contractor Services (8.6%) | | | | $ 6,188 | | $ 6,188 | ***$ 102,143*** |
| **Compliance Groundwater Sampling** | | | | | | | |
| Groundwater Monitoring | | | | | | | |
| Sampling Labor and Equipment | 1 | event | $ 6,500 | $ 6,500 | | *$ 6,500* | |
| Groundwater Analytical Costs | 1 | event | $ 1,500 | $ 1,500 | | *$ 1,500* | |
| *Subtotal per event* | | | | | | *$ 8,000* | |
| Semi-annual for 15 Years (30 events) Subtotal | | | | | | *$ 240,000* | |
| Five-Year Ecology Reviews (4 events) Subtotal | | | | | | *$ 32,000* | |
| Reporting | 19 | each | $ 4,500 | $ 85,500 | | *$ 85,500* | |
| *Groundwater Monitoring Subtotal* | | | | | | | ***$ 357,500*** |
| **Site Restoration and Closure** | | | | | | | |
| Well Closure (all MW wells) and decommissioning | 10 | well | $ 800 | $ 8,000 | $ 6,000 | $ 14,000 | |
| Final Closure Report | 1 | LS | $ 20,000 | | $ 20,000 | $ 20,000 | |
| Site Restoration and Closure Subtotal | | | | | | $ 34,000 | |
| Tax on Contractor Services (8.6%) | | | | $ 2,900 | | $ 2,900 | ***$ 36,900*** |
| **Maintain Surface Cap** | | | | | | | |
| Surface Cap Inspections (30 years) | | | | | | | |
| Annual Site Visits | 30 | visits | $ 1,000 | $ 30,000 | | $ 30,000 | |
| Asphalt Maintenance | | | | | | | |
| Asphalt Sealcoat (Years 10 and 20) | 2 | LS | $ 2,500 | $ 5,000 | | $ 5,000 | |
| *Maintain Surface Cap Subtotals* | | | | *$ 35,000* | *$ -* | *$ 35,000* | |
| *Tax on Contractor Services (8.6%)* | | | | *$ 400* | | *$ 400* | ***$ 35,400*** |
| **PROJECT TOTAL** | | | | | | | **$ 556,943** |

Notes:

CY Cubic yard
LS Lump sum
SF Square feet
ton tons

**Table 3**
**Order-of-Magnitude Cost Estimate**
**Alternative 2 – Containment, Bioventing, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| Task | Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|---|
| **Implement Institutional Controls** | | | | | | | | |
| | Update Environmental Covenant | 1 | LS | | | $ 5,000 | $ 5,000 | |
| | Cleanup Action Plan | 1 | LS | | | $ 30,000 | $ 30,000 | |
| | Engineering and Design Report | 1 | LS | | | $ 15,000 | $ 15,000 | ***$ 50,000*** |
| **Pre-Remedial Activities** | | | | | | | | |
| | Construction Permit | 1 | LS | | | $ 7,000 | $ 7,000 | |
| | Bid Solicitation | 1 | LS | | | $ 7,500 | $ 7,500 | |
| | Contracting | 1 | each | | | $ 2,500 | $ 2,500 | ***$ 17,000*** |
| **Bioventing Treatment System (Capital Cost)** | | | | | | | | |
| | Field Personnel | 20 | Days | $ 1,500 | | $ 30,000 | $ 30,000 | |
| | Mobilization and Site Prep. | 1 | LS | $ 8,500 | $ 8,500 | | $ 8,500 | |
| | Bioventing Wells (4" PVC to 25 ft bgs, HSA) | 8 | each | $ 2,500 | $ 20,000 | | $ 20,000 | |
| | Drill Cuttings Disposal | 16 | drums | $ 400 | $ 6,400 | | $ 6,400 | |
| | Asphalt saw-cutting | 600 | LF | $ 4 | $ 2,100 | | $ 2,100 | |
| | Asphalt removal for recycling | 3 | CY | $ 65 | $ 195 | | $ 195 | |
| | Trenching and stockpiling of re-usable backfill | 16 | CY | $ 100 | $ 1,600 | | $ 1,600 | |
| | Wellhead Connections/Vaults | 8 | each | $ 500 | $ 4,000 | | $ 4,000 | |
| | Installation of Conveyance Piping | 600 | LF | $ 5 | $ 3,000 | | $ 3,000 | |
| | Waste Disposal Profiling and Sampling | 1 | LS | $ 1,000 | $ 1,000 | | $ 1,000 | |
| | Bioventing Blower Package | 1 | LS | $ 10,000 | $ 10,000 | | $ 10,000 | |
| | Moisture Knockout Tank | 1 | each | $ 2,500 | $ 2,500 | | $ 2,500 | |
| | Vapor Phase Carbon (500-lb vessels) | 1 | each | $ 4,500 | $ 4,500 | | $ 4,500 | |
| | Misc. Plumbing/Piping | 50 | LF | $ 30 | $ 1,500 | | $ 1,500 | |
| | Instrumentation | 1 | LS | $ 2,500 | $ 2,500 | | $ 2,500 | |
| | Control Panel | 1 | LS | $ 3,000 | $ 3,000 | | $ 3,000 | |
| | Electrical Service | 1 | each | $ 10,000 | $ 10,000 | | $ 10,000 | |
| | Treatment System Enclosure | 1 | each | $ 12,000 | $ 12,000 | | $ 12,000 | |
| | Site Restoration and Demobilization | 1 | LS | $ 6,000 | $ 6,000 | | $ 6,000 | |
| | System Startup | 1 | LS | $ 2,500 | $ 2,500 | $ 5,000 | $ 7,500 | |
| | Bioventing System Installation Report | 1 | LS | | | $ 12,500 | $ 12,500 | |
| | *Category Subtotals* | | | | *$ 101,295* | *$ 17,500* | *$ 118,795* | |
| | Tax on Contractor Services/Capital Equipment (8.6%) | | | | $ 8,700 | | $ 8,700 | ***$ 127,495*** |
| **Bioventing System Operation and Maintenance (O&M)** | | | | | | | | |
| | Annual System O&M (7 Years) | | | | | | | |
| | Electrical Usage | 12 | months | $ 250 | $ 3,000 | | $ 3,000 | |
| | Site Visits (bi-monthly) | 6 | visits | $ 2,500 | | $ 15,000 | $ 15,000 | |
| | Annual O&M Subtotal | | | | | | $ 18,000 | |
| | 7-Year O&M Subtotal | | | | | | $ 126,000 | |
| | Periodic O&M Costs | | | | | | | |
| | Carbon Replacement (Year 1, and year 2, (2) events) | 500 | pounds | $ 4.00 | $ 2,000 | $ 2,000 | $ 4,000 | |
| | Other Equipment Maintenance or Repair | 1 | LS | $ 3,500 | $ 3,500 | $ 2,000 | $ 5,500 | |
| | Periodic O&M Costs Subtotal | | | | | | $ 9,500 | ***$ 135,500*** |
| **Compliance Sampling** | | | | | | | | |
| | Off-Property Compliance Soil Sampling | | | | | | | |
| | Soil Borings (12 ft bgs, direct push) | 5 | boring | $ 3,500 | $ 17,500 | $ 8,000 | $ 25,500 | |
| | Soil Analytical Cost | 10 | each | $ 250 | $ 2,500 | | $ 2,500 | |
| | Waste Disposal | 2 | drum | $ 350 | $ 700 | $ 1,000 | $ 1,700 | |
| | Compliance Soil Sampling Subtotal | | | | | | $ 29,700 | **$ 29,700** |

**Table 3**
**Order-of-Magnitude Cost Estimate**
**Alternative 2 – Containment, Bioventing, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| Task | Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|---|
| **Compliance Groundwater Sampling** | | | | | | | | |
| | Groundwater Monitoring | | | | | | | |
| | Sampling Labor and Equipment | 1 | event | $ 6,500 | | $ 6,500 | *$ 6,500* | |
| | Groundwater Analytical Costs | 1 | event | $ 1,500 | $ 1,500 | | *$ 1,500* | |
| | *Subtotal per Event* | | | | | | *$ 8,000* | |
| | Quarterly for 2 Years (8 events) Subtotal | | | | | | *$ 64,000* | |
| | Semiannual for 2 Years (4 events) Subtotal | | | | | | *$ 32,000* | |
| | Annual for 2 Years (2 events) Subtotal | | | | | | *$ 16,000* | |
| | Five-Year Ecology Reviews (4 events) Subtotal | | | | | | *$ 32,000* | |
| | Reporting (annual for 6 years, then (4) 5-yr reviews) | 10 | each | $ 6,500 | | $ 65,000 | *$ 65,000* | |
| | Groundwater Monitoring Subtotal | | | | | | | ***$ 209,000*** |
| **Site Restoration and Closure** | | | | | | | | |
| | Well Closure (all wells) and decommissioning | 18 | well | $ 800 | $ 14,400 | $ 6,000 | $ 20,400 | |
| | Final Closure Report | 1 | LS | $ 20,000 | | $ 20,000 | $ 20,000 | |
| | Site Restoration and Closure Subtotal | | | | | | $ 40,400 | |
| | Tax on Contractor Services (8.6%) | | | | $ 3,500 | | $ 3,500 | ***$ 43,900*** |
| **Maintain Surface Cap** | | | | | | | | |
| | Surface Cap Inspections (30 years) | | | | | | | |
| | Annual Site Visits | 30 | visits | $ 1,000 | $ 30,000 | | $ 30,000 | |
| | Asphalt Maintenance | | | | | | | |
| | Asphalt Sealcoat (Years 10 and 20) | 2 | LS | $ 2,500 | $ 5,000 | | $ 5,000 | |
| | *Maintain Surface Cap Subtotals* | | | | *$ 35,000* | *$ -* | *$ 35,000* | |
| | Tax on Contractor Services (8.6%) | | | | $ 400 | | $ 400 | ***35,400*** |
| **PROJECT TOTAL** | | | | | | | | **$ 648,000** |

Notes:

CY Cubic yards
LF Linear feet
LS Lump sum
SF Square feet

**Table 4**
**Order-of-Magnitude Cost Estimate**
**Alternative 3 – Containment, Soil Vapor Extraction, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| Task | Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|---|
| **Implement Institutional Controls** | | | | | | | | |
| | Update Environmental Covenant | 1 | LS | | | $ 5,000 | $ 5,000 | |
| | Cleanup Action Plan | 1 | LS | | | $ 30,000 | $ 30,000 | |
| | Engineering and Design Report | 1 | LS | | | $ 25,000 | $ 25,000 | ***$ 60,000*** |
| **Pre-Remedial Activities** | | | | | | | | |
| | Construction Permits | 1 | LS | | | $ 7,000 | $ 7,000 | |
| | Bid Solicitation | 1 | LS | | | $ 7,500 | $ 7,500 | |
| | Contracting | 1 | each | | | $ 2,500 | $ 2,500 | ***$ 17,000*** |
| **SVE Treatment System (Capital Cost)** | | | | | | | | |
| | Mobilization and Site Prep. | 1 | LS | $ 10,000 | $ 10,000 | $ 5,000 | $ 15,000 | |
| | Field Personnel | 30 | Days | $ 1,500 | $ 45,000 | | $ 45,000 | |
| | Shallow Vapor Extraction Wells (4" PVC to 25 ft bgs, HSA) | 5 | each | $ 2,500 | $ 12,500 | | $ 12,500 | |
| | Drill Cuttings Disposal | 10 | drums | $ 400 | $ 4,000 | | $ 4,000 | |
| | Asphalt saw-cutting | 375 | LF | $ 4 | $ 1,313 | | $ 1,313 | |
| | Asphalt removal for recycling | 2 | yds3 | $ 65 | $ 130 | | $ 130 | |
| | Trenching and stockpiling of re-usable backfill | 11 | yds3 | $ 100 | $ 1,100 | | $ 1,100 | |
| | SVE Wellhead Connections/Vaults | 5 | each | $ 500 | $ 2,500 | | $ 2,500 | |
| | Installation of Conveyance Piping | 375 | LF | $ 5 | $ 1,875 | | $ 1,875 | |
| | Waste Disposal Profiling and Sampling | 1 | LS | $ 1,000 | $ 1,000 | | $ 1,000 | |
| | SVE Blower Package | 1 | LS | $ 15,000 | $ 15,000 | | $ 15,000 | |
| | Moisture Knockout Tank | 1 | each | $ 3,500 | $ 3,500 | | $ 3,500 | |
| | Vapor Phase Carbon (1,000-lb vessels) | 2 | each | $ 8,400 | $ 16,800 | | $ 16,800 | |
| | Misc. Plumbing/Piping | 85 | LF | $ 30 | $ 2,550 | | $ 2,550 | |
| | Instrumentation | 1 | LS | $ 4,500 | $ 4,500 | | $ 4,500 | |
| | Control Panel | 1 | LS | $ 6,500 | $ 6,500 | | $ 6,500 | |
| | Electrical Service | 1 | each | $ 15,000 | $ 15,000 | | $ 15,000 | |
| | Treatment System Enclosure | 1 | each | $ 15,000 | $ 15,000 | | $ 15,000 | |
| | Site Restoration and Demobilization | 1 | LS | $ 7,500 | $ 7,500 | | $ 7,500 | |
| | System Startup | 1 | LS | $ 3,500 | $ 3,500 | $ 6,000 | $ 9,500 | |
| | Treatment System Installation Report | 1 | LS | | | $ 20,000 | $ 20,000 | |
| | *Category Subtotals* | | | | *$ 169,268* | *$ 31,000* | *$ 200,268* | |
| | Tax on Contractor Services/Capital Equipment (8.6%) | | | | $ 14,600 | | $ 14,600 | ***$ 214,900*** |
| **SVE System Operation and Maintenance (O&M)** | | | | | | | | |
| | Annual System O&M (3 Years) | | | | | | | |
| | Electrical Usage | 12 | months | $ 250 | $ 3,000 | | $ 3,000 | |
| | Air Influent and Effluent Sampling | 12 | months | $ 500 | $ 6,000 | | $ 6,000 | |
| | Site Optimization Visits (monthly) | 12 | visits | $ 3,500 | | $ 42,000 | $ 42,000 | |
| | Annual O&M Subtotal | | | | | | $ 51,000 | |
| | 3-Year O&M Subtotal | | | | | | $ 153,000 | |
| | Periodic O&M Costs | | | | | | | |
| | Carbon Replacement (Year 1, 2 and 3, (3) events) | 6,000 | pounds | $ 4.00 | $ 24,000 | $ 2,000 | $ 26,000 | |
| | Other Equipment Maintenance or Repair | 1 | LS | $ 5,000 | $ 5,000 | $ 2,000 | $ 7,000 | |
| | Periodic O&M Costs Subtotal | | | | | | $ 33,000 | ***$ 186,000*** |
| **Off-Property Compliance Soil Sampling** | | | | | | | | |
| | Compliance Soil Sampling | | | | | | | |
| | Soil Borings (12 ft bgs, direct push) | 5 | boring | $ 3,500 | $ 17,500 | $ 8,000 | $ 25,500 | |
| | Soil Analytical Cost | 10 | each | $ 250 | $ 2,500 | | $ 2,500 | |
| | Waste Disposal | 2 | drum | $ 350 | $ 700 | $ 1,000 | $ 1,700 | |
| | Compliance Soil Sampling Subtotal | | | | | | $ 29,700 | **$ 29,700** |

**Table 4**
**Order-of-Magnitude Cost Estimate**
**Alternative 3 – Containment, Soil Vapor Extraction, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| Task Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|
| **Compliance Groundwater Sampling** | | | | | | | |
| Groundwater Monitoring | | | | | | | |
| Sampling Labor and Equipment | 1 | event | $ 6,500 | | $ 6,500 | *$ 6,500* | |
| Groundwater Analytical Costs | 1 | event | $ 1,500 | $ 1,500 | | *$ 1,500* | |
| *Subtotal per Event* | | | | | | *$ 8,000* | |
| Quarterly for 2 Years (8 events) Subtotal | | | | | | *$ 64,000* | |
| Semiannual for 2 Years (4 events) Subtotal | | | | | | *$ 32,000* | |
| Annual for 2 Years (2 events) Subtotal | | | | | | *$ 16,000* | |
| Five-Year Ecology Reviews (4 events) Subtotal | | | | | | *$ 32,000* | |
| Reporting (annual for 6 years, then (4) 5-yr reviews) | 10 | each | $ 6,500 | | $ 65,000 | *$ 65,000* | |
| Groundwater Monitoring Subtotal | | | | | | | ***$ 209,000*** |
| **Site Restoration and Closure** | | | | | | | |
| Well Closure (all SVE and MW wells) and decommissioning | 15 | well | $ 800 | $ 12,000 | $ 6,000 | $ 18,000 | |
| Final Closure Report | 1 | LS | $ 20,000 | | $ 20,000 | $ 20,000 | |
| Site Restoration and Closure Subtotal | | | | | | $ 38,000 | |
| Tax on Contractor Services (8.6%) | | | | $ 3,300 | | $ 3,300 | ***$ 41,300*** |
| **Maintain Surface Cap** | | | | | | | |
| Surface Cap Inspections (30 years) | | | | | | | |
| Annual Site Visits | 30 | visits | $ 1,000 | $ 30,000 | | $ 30,000 | |
| Asphalt Maintenance | | | | | | | |
| Asphalt Sealcoat (Years 10 and 20) | 2 | LS | $ 2,500 | $ 5,000 | | $ 5,000 | |
| *Maintain Surface Cap Subtotals* | | | | *$ 35,000* | *$ -* | *$ 35,000* | |
| Tax on Contractor Services (8.6%) | | | | $ 400 | | $ 400 | ***35,400*** |
| **PROJECT TOTAL** | | | | | | | **$ 793,000** |

Notes:
- LS Lump sum
- SF Square feet
- CY Cubic yards
- LF Linear feet

TRC

**Table 5**
**Order-of-Magnitude Cost Estimate**
**Alternative 4 – Containment, French Drain, Removal, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

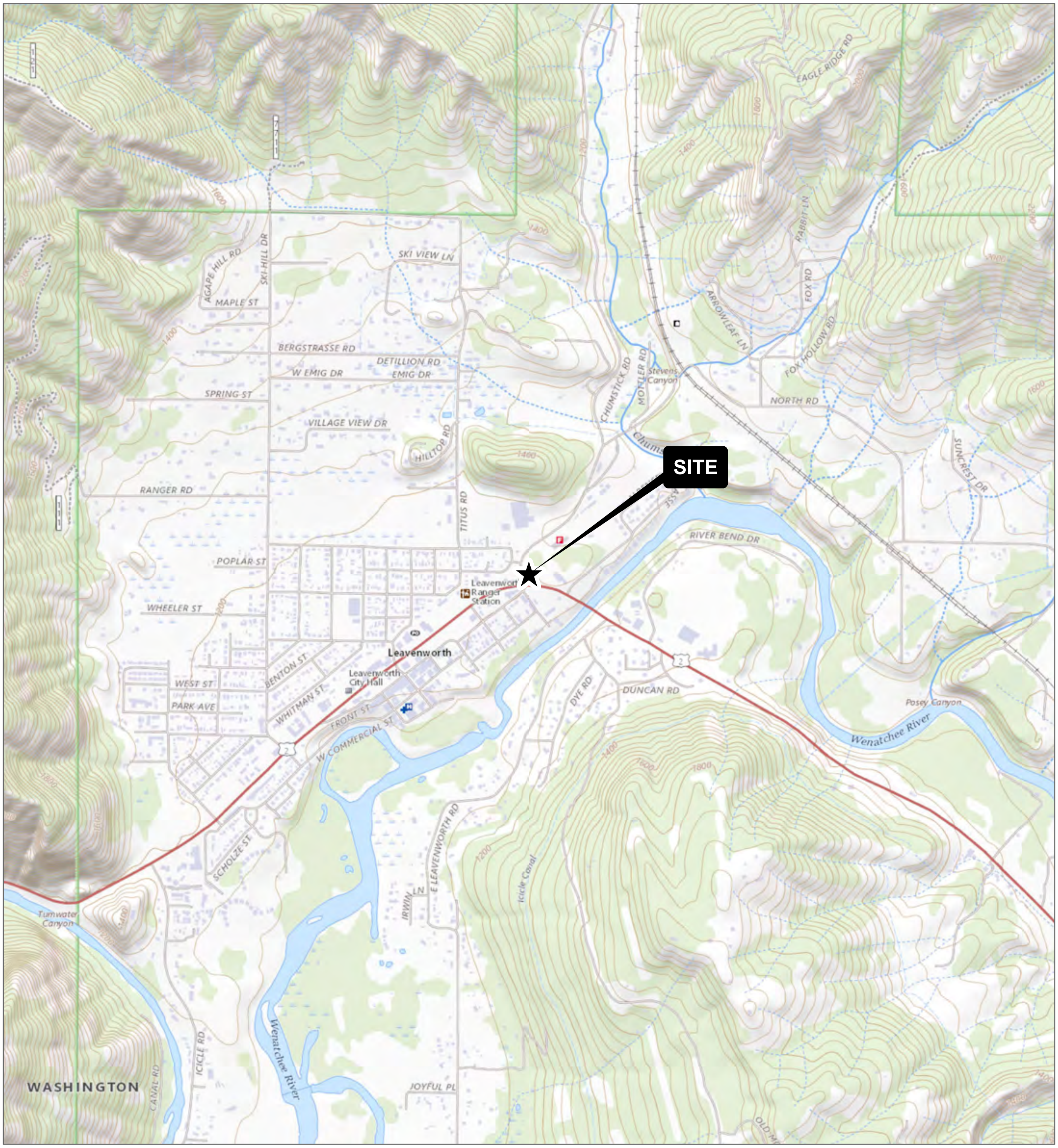
| Task | Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|---|
| **Implement Institutional Controls** | | | | | | | | |
| | Update Environmental Covenant | 1 | LS | | | $ 5,000 | $ 5,000 | |
| | Cleanup Action Plan | 1 | LS | | | $ 30,000 | $ 30,000 | |
| | Engineering and Design Report | 1 | LS | | | $ 25,000 | $ 25,000 | ***$ 60,000*** |
| **Pre-Remedial Activities** | | | | | | | | |
| | Engineering and Design | 1 | LS | | | $ 25,000 | $ 25,000 | |
| | Grading & Construction Permit | 1 | LS | | | $ 10,000 | $ 10,000 | |
| | Storm Water Connection Permit | 1 | LS | | | $ 10,000 | $ 10,000 | |
| | Civil Engineer Design of Storm System | 1 | LS | | | $ 15,000 | $ 15,000 | |
| | Bid Solicitation | 3 | each | | | $ 2,500 | $ 7,500 | |
| | Contracting | 1 | each | | | $ 5,000 | $ 5,000 | ***$ 72,500*** |
| **Limited Off-Property Excavation** | | | | | | | | |
| | Access Agreement | 1 | LS | | | $ 3,000 | $ 3,000 | |
| | Site Preparations | 1 | LS | $ 5,000 | $ 5,000 | $ 1,000 | $ 6,000 | |
| | Tree and Stump Removal | 1 | LS | $ 7,500 | $ 7,500 | $ 1,500 | $ 9,000 | |
| | Excavate and Stockpile Clean Overburden | 260 | CY | $ 50 | $ 13,000 | $ 2,000 | $ 15,000 | |
| | Excavate and Load Impacted Soil | 105 | CY | $ 50 | $ 5,250 | $ 5,000 | $ 10,250 | |
| | Trucking to Wenatchee Landfill 1-hr rd trip | 5 | hrs | $ 120 | $ 600 | | $ 600 | |
| | Disposal of Impacted Soil | 160 | ton | $ 60 | $ 9,600 | | $ 9,600 | |
| | Confirmation Soil Sampling & Analysis | 10 | sample | $ 250 | $ 2,500 | | $ 2,500 | |
| | Import and Place Clean Backfill | 365 | CY | $ 37 | $ 13,505 | $ 2,500 | $ 16,005 | |
| | Compaction and Site Restoration | 1 | LS | $ 15,000 | $ 15,000 | $ 1,500 | $ 16,500 | |
| | Soil Removal and Closure Report | 1 | LS | $ 7,500 | | $ 7,500 | $ 7,500 | |
| | Limited Off-Property Excavation Subtotal | | | | | | $ 95,955 | |
| | Tax on Contractor Services (8.6%) | | | | | | $ 8,252 | ***$ 104,207*** |
| **French Drain (5 feet depth on the NE and east sides of the property)** | | | | | | | | |
| | TRC Field Oversight | 10 | Days | | | $ 2,500 | $ 25,000 | |
| | Site Preparations | 1 | LS | $ 5,000 | $ 5,000 | | $ 5,000 | |
| | Excavate, Load, and Transport Clean Soil Off-Site | 75 | CY | $ 100 | $ 7,500 | | $ 7,500 | |
| | Gravel Backfill | 75 | CY | $ 150 | $ 11,250 | | $ 11,250 | |
| | Contractor French Drain Installation | 5 | Days | $ 6,000 | $ 30,000 | | $ 30,000 | |
| | French Drain Discharge Connection to Storm | 1 | LS | $ 15,000 | $ 15,000 | | $ 15,000 | |
| | Site Restoration | 1 | LS | $ 7,500 | $ 7,500 | | $ 7,500 | |
| | Closure Report | 1 | LS | $ 20,000 | | $ 20,000 | $ 20,000 | |
| | *Category Subtotals* | | | | $ 76,250 | | $ 121,250 | |
| | Tax on Contractor Services/Capital Equipment (8.6%) | | | | $ 6,600 | | $ 6,600 | ***$ 127,850*** |
| **Compliance Groundwater Sampling** | | | | | | | | |
| | Groundwater Monitoring | | | | | | | |
| | Sampling Labor and Equipment | 1 | event | $ 6,500 | $ 6,500 | | *$ 6,500* | |
| | Groundwater Analytical Costs | 1 | event | $ 1,500 | $ 1,500 | | *$ 1,500* | |
| | *Subtotal per event* | | | | | | *$ 8,000* | |
| | Semi-annual for 10 Years (20 events) Subtotal | | | | | | *$ 160,000* | |
| | Five-Year Ecology Reviews (4 events) Subtotal | | | | | | *$ 32,000* | |
| | Reporting | 14 | each | $ 4,500 | $ 63,000 | | *$ 63,000* | |
| | *Groundwater Monitoring Subtotal* | | | | | | | ***$ 255,000*** |

**Table 5**
**Order-of-Magnitude Cost Estimate**
**Alternative 4 – Containment, French Drain, Removal, and Institutional Controls**
**Supplemental Feasibility Study Report**
**Glacier Park East Site**
**Leavenworth, WA**

| Task | Component | Units | Basis | Unit Cost | Subtotal | Professional Labor | Component Subtotal | Task Subtotal |
|---|---|---|---|---|---|---|---|---|
| **Site Restoration and Closure** | | | | | | | | |
| | Well Closure (all MW wells) and decommissioning | 10 | well | $ 800 | $ 8,000 | $ 6,000 | $ 14,000 | |
| | Final Closure Report | 1 | LS | $ 20,000 | | $ 20,000 | $ 20,000 | |
| | Site Restoration and Closure Subtotal | | | | | | $ 34,000 | |
| | Tax on Contractor Services (8.6%) | | | | $ 2,900 | | $ 2,900 | ***$ 36,900*** |
| **Maintain Surface Cap** | | | | | | | | |
| | Surface Cap Inspections (30 years) | | | | | | | |
| | Annual Site Visits | 30 | visits | $ 1,000 | $ 30,000 | | $ 30,000 | |
| | Asphalt Maintenance | | | | | | | |
| | Asphalt Sealcoat (Years 10 and 20) | 2 | LS | $ 2,500 | $ 5,000 | | $ 5,000 | |
| | *Maintain Surface Cap Subtotals* | | | | *$ 35,000* | *$ -* | *$ 35,000* | |
| | *Tax on Contractor Services (8.6%)* | | | | *$ 400* | | *$ 400* | ***$ 35,400*** |
| **PROJECT TOTAL** | | | | | | | | **$692,000** |

Notes:
LS Lump sum
CY Cubic yards

# Figures




N

0 1,000 2,000

FEET

1:24,000 1" = 2,000'


BASE MAP: USGS COLOR ORTHO IMAGERY
DATA SOURCES: TRC

COORDINATE SYSTEM: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET; MAP ROTATION: 0
-- SAVED BY: SRAY ON 3/1/2023, 15:04:39 PM; FILE PATH: T:\BNSF\500438_SFS\2-APRX\SUPPLEMENTAL FEASIBILITY STUDY.APRX; LAYOUT NAME: FIG 1 - SITE VICINITY MAP

| | |
|---|---|
| PROJECT: | GLACIER PARK EAST SITE<br>CHUMSTICK HIGHWAY AND STATE HIGHWAY 2<br>LEAVENWORTH, WASHINGTON |
| TITLE: | GENERAL VICINITY MAP<br>SUPPLEMENTAL FEASIBILITY STUDY |

| | | | |
|---|---|---|---|
| DRAWN BY: | S. RAY | PROJ. NO.: | 500438.0000.0000 |
| CHECKED BY: | M. ESPARRA | FIGURE 1 | |
| APPROVED BY: | M. ESPARRA | | |
| DATE: | MARCH 2023 | | |

TRC

1180 NW MAPLE STREET, SUITE 310
ISSAQUAH, WA 98027
PHONE: 425.395.0010

FILE: SUPPLEMENTAL FEASIBILITY STUDY


CATCH BASIN

GROUNDWATER-BEARING ZONE MONITORING WELL

SOIL BORING

SHALLOW TRANSIENT WATER PIEZOMETER

INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED THE DLS, BUT LESS THAN THE CULS

INDICATES SAMPLE HAS NO CONSTITUENT CONCENTRATIONS EXCEEDING THE CULS OR DLS

INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED CULS

APPROXIMATE SITE BOUNDARY (INCLUDES IMPACT OF COCS ABOVE THEIR CULS)

EXISTING ASPHALT CAP

APPROXIMATE SUBJECT PROPERTY BOUNDARY

NOTES:
AST = ABOVEGROUND STORAGE TANK.
COCs = CONTAMINANTS OF CONCERN.
CUL = CLEANUP LEVEL.
DL = LABORATORY DETECTION LIMIT.
PROPERTY BOUNDARY EXTENDS FARTHER TO THE NORTHEAST.
WELLS AND PIEZOMETERS SURVEYED IN JUNE 2021 BY ERIANDSEN & ASSOCIATES, EAST WENATCHEE, WASHINGTON.

BASE MAP: GOOGLE EARTH AND THEIR DATA PARTNERS (2020).
DATA SOURCES: TRC, KENNEDY/JENKS CONSULTANTS (2013), GEO ENGINEERS (2002).

N

1:360
1" = 30'
0 30 60 FEET

PROJECT:
GLACIER PARK EAST SITE
CHUMSTICK HIGHWAY AND STATE HIGHWAY 2
LEAVENWORTH, WASHINGTON

TITLE:
SITE REPRESENTATION
SUPPLEMENTAL FEASIBILITY STUDY

| | | | |
|---|---|---|---|
| DRAWN BY: | S. RAY | PROJ. NO.: | 500438.0000.0000 |
| CHECKED BY: | M. ESPARRA | FIGURE 2 | |
| APPROVED BY: | M. ESPARRA | | |
| DATE: | MARCH 2023 | | |

TRC
1180 NW MAPLE STREET, SUITE 310
ISSAQUAH, WA 98027
PHONE: 425.395.0010

FILE: Supplemental Feasibility Study.aprx

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Map Rotation: 0
-- Saved By: SRAY on 3/17/2023, 13:13:30 PM; File Path: T:\BNSF\500438_SFS\2-APRX\Supplemental Feasibility Study.aprx; Layout Name: Fig 2 - Site Representation


CATCH BASIN

GROUNDWATER-BEARING ZONE MONITORING WELL

SOIL BORING

SHALLOW TRANSIENT WATER PIEZOMETER

INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED THE DLS, BUT LESS THAN THE CULS

INDICATES SAMPLE HAS NO CONSTITUENT CONCENTRATIONS EXCEEDING THE CULS OR DLS

INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED CULS

APPROXIMATE SITE BOUNDARY (INCLUDES IMPACT OF COCS ABOVE THEIR CULS)

EXISTING ASPHALT CAP

APPROXIMATE SUBJECT PROPERTY BOUNDARY

EXTENT OF OFF-PROPERTY EXCAVATION

NOTES:
AST = ABOVEGROUND STORAGE TANK.
COCs = CONTAMINANTS OF CONCERN.
CUL = CLEANUP LEVEL.
DL = LABORATORY DETECTION LIMIT.
PROPERTY BOUNDARY EXTENDS FARTHER TO THE NORTHEAST.
WELLS AND PIEZOMETERS SURVEYED IN JUNE 2021 BY ERIANDSEN & ASSOCIATES, EAST WENATCHEE, WASHINGTON.

BASE MAP: GOOGLE EARTH AND THEIR DATA PARTNERS (2020).
DATA SOURCES: TRC, KENNEDY/JENKS CONSULTANTS (2013), GEO ENGINEERS (2002).

N

1:360
1" = 30'
0 30 60 FEET

PROJECT: GLACIER PARK EAST SITE
CHUMSTICK HIGHWAY AND STATE HIGHWAY 2
LEAVENWORTH, WASHINGTON

TITLE: ALT. 1 - MNA AND OFF-PROPERTY REMOVAL
SUPPLEMENTAL FEASIBILITY STUDY

| DRAWN BY: | S. RAY | PROJ. NO.: | 500438.0000.0000 |
|---|---|---|---|
| CHECKED BY: | M. ESPARRA | FIGURE 3 | |
| APPROVED BY: | M. ESPARRA | | |
| DATE: | MARCH 2023 | | |

TRC
1180 NW MAPLE STREET, SUITE 310
ISSAQUAH, WA 98027
PHONE: 425.395.0010

FILE: Supplemental Feasibility Study.aprx

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Map Rotation: 0
-- Saved By: SRAY on 3/17/2023, 13:13:30 PM; File Path: T:\BNSF\500438_SFS\2-APRX\Supplemental Feasibility Study.aprx; Layout Name: Fig 3 - MNA Removal


CATCH BASIN
GROUNDWATER-BEARING ZONE MONITORING WELL
SOIL BORING
SHALLOW TRANSIENT WATER PIEZOMETER
INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED THE DLS, BUT LESS THAN THE CULS
INDICATES SAMPLE HAS NO CONSTITUENT CONCENTRATIONS EXCEEDING THE CULS OR DLS
INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED CULS
PROPOSED BIOVENTING WELL
PROPOSED BIOVENTING WELL 30-FOOT RADIUS OF INFLUENCE
APPROXIMATE SITE BOUNDARY (INCLUDES IMPACT OF COCS ABOVE THEIR CULS)
EXISTING ASPHALT CAP
APPROXIMATE SUBJECT PROPERTY BOUNDARY

NOTES:
AST = ABOVEGROUND STORAGE TANK.
COCs = CONTAMINANTS OF CONCERN.
CUL = CLEANUP LEVEL.
DL = LABORATORY DETECTION LIMIT.
PROPERTY BOUNDARY EXTENDS FARTHER TO THE NORTHEAST.
WELLS AND PIEZOMETERS SURVEYED IN JUNE 2021 BY ERIANDSEN & ASSOCIATES, EAST WENATCHEE, WASHINGTON.

BASE MAP: GOOGLE EARTH AND THEIR DATA PARTNERS (2020).
DATA SOURCES: TRC, KENNEDY/JENKS CONSULTANTS (2013), GEO ENGINEERS (2002).

N

1:360
1" = 30'
0 30 60 FEET

PROJECT: GLACIER PARK EAST SITE
CHUMSTICK HIGHWAY AND STATE HIGHWAY 2
LEAVENWORTH, WASHINGTON

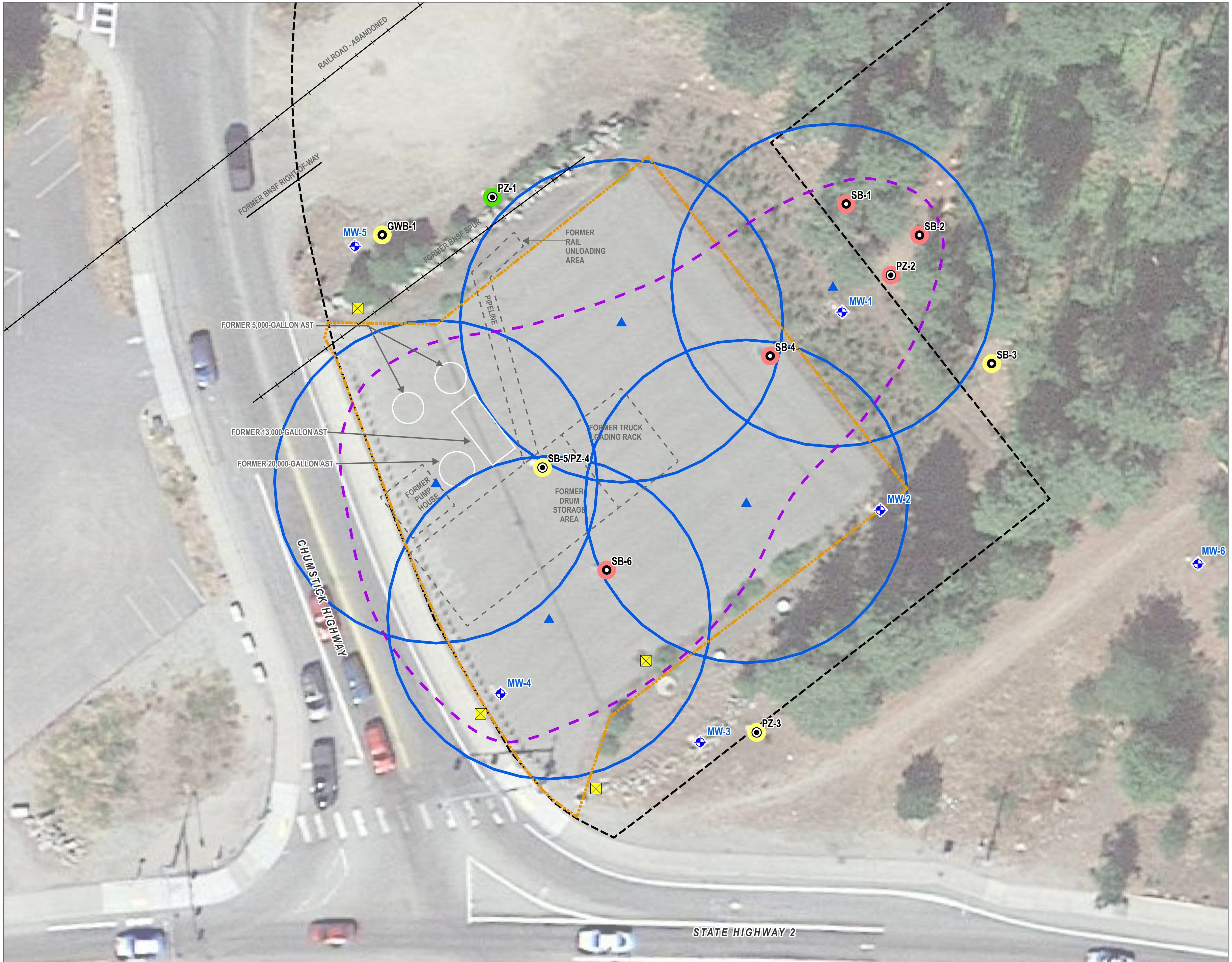
TITLE: ALT. 2 - PROPOSED BIOVENTING WELLS
SUPPLEMENTAL FEASIBILITY STUDY

| | | | |
|---|---|---|---|
| DRAWN BY: | S. RAY | PROJ. NO.: | 500438.0000.0000 |
| CHECKED BY: | M. ESPARRA | FIGURE 4 | |
| APPROVED BY: | M. ESPARRA | | |
| DATE: | MARCH 2023 | | |

TRC
1180 NW MAPLE STREET, SUITE 310
ISSAQUAH, WA 98027
PHONE: 425.395.0010

FILE: Supplemental Feasibility Study.aprx

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Map Rotation: 0
-- Saved By: SRAY on 3/17/2023, 13:13:30 PM; File Path: T:\BNSF\500438_SFS\2-APRX\Supplemental Feasibility Study.aprx; Layout Name: Fig 4 - Proposed Bioventing Wells




CATCH BASIN
GROUNDWATER-BEARING ZONE MONITORING WELL
SOIL BORING
SHALLOW TRANSIENT WATER PIEZOMETER
INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED THE DLS, BUT LESS THAN THE CULS
INDICATES SAMPLE HAS NO CONSTITUENT CONCENTRATIONS EXCEEDING THE CULS OR DLS
INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED CULS
PROPOSED SHALLOW SOIL VAPOR EXTRACTION WELL 50-FOOT RADIUS OF INFLUENCE
PROPOSED SHALLOW SOIL VAPOR EXTRACTION WELL
APPROXIMATE SITE BOUNDARY (INCLUDES IMPACT OF COCS ABOVE THEIR CULS)
EXISTING ASPHALT CAP
APPROXIMATE SUBJECT PROPERTY BOUNDARY

NOTES:
MG/KG - MILLIGRAMS PER KILOGRAM.
AST = ABOVEGROUND STORAGE TANK.
COC = CONTAMINANTS OF CONCERN.
CUL = CLEANUP LEVEL.
DL = LABORATORY DETECTION LIMIT.
PROPERTY BOUNDARY EXTENDS FARTHER TO THE NORTHEAST.
WELLS AND PIEZOMETERS SURVEYED IN JUNE 2021 BY ERIANDSEN & ASSOCIATES, EAST WENATCHEE, WASHINGTON.

BASE MAP: GOOGLE EARTH AND THEIR DATA PARTNERS (2020).
DATA SOURCES: TRC, KENNEDY/JENKS CONSULTANTS (2013), GEO ENGINEERS (2002).

N

1:360
1" = 30'
0 30 60 FEET

| | | | |
|---|---|---|---|
| PROJECT: | GLACIER PARK EAST SITE<br>CHUMSTICK HIGHWAY AND STATE HIGHWAY 2<br>LEAVENWORTH, WASHINGTON | | |
| TITLE: | **ALT. 3 - PROPOSED SVE WELLS<br>SUPPLEMENTAL FEASIBILITY STUDY** | | |
| DRAWN BY: | S. RAY | PROJ. NO.: | 500438.0000.0000 |
| CHECKED BY: | M. ESPARRA | **FIGURE 5** | |
| APPROVED BY: | M. ESPARRA | | |
| DATE: | MARCH 2023 | | |
| TRC | 1180 NW MAPLE STREET, SUITE 310<br>ISSAQUAH, WA 98027<br>PHONE: 425.395.0010 | | |
| FILE: | Supplemental Feasibility Study.aprx | | |

Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet; Map Rotation: 0
-- Saved By: SRAY on 3/17/2023, 13:13:30 PM; File Path: T:\BNSF\500438_SFS\2-APRX\Supplemental Feasibility Study.aprx; Layout Name: Fig 5 - Proposed SVE Wells


- CATCH BASIN
- MANHOLE
- GROUNDWATER-BEARING ZONE MONITORING WELL
- SOIL BORING
- SHALLOW TRANSIENT WATER PIEZOMETER
- INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED THE DLS, BUT LESS THAN THE CULS
- INDICATES SAMPLE HAS NO CONSTITUENT CONCENTRATIONS EXCEEDING THE CULS OR DLS
- INDICATES SAMPLE WHERE ONE OR MORE CONSTITUENT CONCENTRATIONS EXCEED CULS
- FRENCH DRAIN
- APPROXIMATE SITE BOUNDARY (INCLUDES IMPACT OF COCS ABOVE THEIR CULS)
- EXISTING ASPHALT CAP
- APPROXIMATE SUBJECT PROPERTY BOUNDARY
- EXTENT OF OFF-PROPERTY EXCAVATION

NOTES:
COCs = CONTAMINANTS OF CONCERN.
CUL = CLEANUP LEVEL.
DL = LABORATORY DETECTION LIMIT.
WELLS AND PIEZOMETERS SURVEYED IN JUNE 2021 BY ERIANDSEN & ASSOCIATES, EAST WENATCHEE, WASHINGTON.

BASE MAP: GOOGLE EARTH AND THEIR DATA PARTNERS (2020).
DATA SOURCES: TRC, KENNEDY/JENKS CONSULTANTS (2013), GEO ENGINEERS (2002).

N

1:360
1" = 30'
0 30 60 FEET

PROJECT: GLACIER PARK EAST SITE
CHUMSTICK HIGHWAY AND STATE HIGHWAY 2
LEAVENWORTH, WASHINGTON

TITLE: ALT. 4 - PROPOSED FRENCH DRAIN AND OFF-PROPERTY REMOVAL
SUPPLEMENTAL FEASIBILITY STUDY

| | | | |
|---|---|---|---|
| DRAWN BY: | S. RAY | PROJ. NO.: | 500438.0000.0000 |
| CHECKED BY: | M. ESPARRA | FIGURE 6 | |
| APPROVED BY: | M. ESPARRA | | |
| DATE: | MARCH 2023 | | |

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