STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

In the Matter of Remedial Action by:	FIRST AMENDMENT TO AGREED ORDER
City of Bothell at Bothell Riverside MTCA Site - HVOC Area	No. DE 21531

TO: Kyle Stannert
City Manager
City of Bothell
18415 101st Avenue NE
Bothell, WA 98011

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I. INTRODUCTION

The mutual objective of the State of Washington, Department of Ecology (Ecology) and the City of Bothell (the City) under this Agreed Order (Order) is to provide for remedial action at a facility where there has been a release or threatened release of hazardous substances. This Order requires the City to implement the Cleanup Action Plan (Exhibit B) and Cleanup Action Plan Addendum (Exhibit E). Ecology believes the actions required by this Order are in the public interest.

II. JURISDICTION

This Order is issued pursuant to the Model Toxics Control Act (MTCA), RCW 70A.305.050(1).

III. PARTIES BOUND

This Agreed Order shall apply to and be binding upon the Parties to this Order, their successors and assigns. The undersigned representative of each Party hereby certifies that he or she is fully authorized to enter into this Order and to execute and legally bind such Party to comply with this Order. The City agrees to undertake all actions required by the terms and conditions of this Order. No change in ownership or corporate status shall alter the City's responsibility under this Order. The City shall provide a copy of this Order to all agents, contractors, and subcontractors retained to perform work required by this Order, and shall ensure that all work undertaken by such agents, contractors, and subcontractors complies with this Order.

IV. DEFINITIONS

Unless otherwise specified herein, the definitions set forth in RCW 70A.305, WAC 173-204 and WAC 173-340 shall control the meanings of the terms in this Order.

A. Site: The Site is referred to as Bothell Riverside-HVOC Site. The Site constitutes a facility under RCW 70A.305.020(8). The Site is defined by where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located. Based upon factors currently known to Ecology, the Remedial Action Location Diagram (Exhibit A) shows where the remedial action will be implemented. The

Site description and remedial action are more fully described in the Cleanup Action Plan (Exhibit B) and Cleanup Action Plan Addendum (Exhibit E).

B. Parties: Refers to the State of Washington, Department of Ecology and the City.

C. Potentially Liable Persons (PLP(s)): Refers to the City.

D. Agreed Order or Order: Refers to this Order and each of the exhibits to this Order. All exhibits are integral and enforceable parts of this Order.

V. FINDINGS OF FACT

Ecology makes the following findings of fact, without any express or implied admissions of such facts by the City:

A. Based upon factors currently known to Ecology, the Site is generally located at Woodinville Drive (SR 522) and NE 180th Street, Bothell, WA. The anticipated location of the remedial action is shown on the Remedial Action Location Diagram (Exhibit A). The location is contaminated by halogenated volatile organic compounds in soil and groundwater. The Site description and remedial action are more fully described in the Cleanup Action Plan (Exhibit B) and Cleanup Action Plan Addendum (Exhibit E).

B. The City acquired the property in 1990. The Site is now part of King County Tax Parcel No. 0826059120.

C. The Site is currently used for parking and access to a public park and the Burke-Gilman Trail.

D. Ecology entered into Agreed Order No. DE 6295 with the City, effective February 3, 2009, to address concentrations of TPH and HVOC at the Site. Under Agreed Order No. DE 6295 and Agreed Order No. DE 16541, the City was to perform a Remedial Investigation, Feasibility Study, Interim Actions, and complete a preliminary draft Cleanup Action Plan.

E. The City has completed several studies of the Site under Agreed Order No. DE 6295 and Agreed Order No. DE 16541 that document the release of hazardous substances which present a threat to human health or the environment. These documents, and other reports related to the Site, are available at Ecology's Northwest Regional Office and include: HWA Geosciences, *Final Remedial Investigation Report, Bothell Riverside Site, Bothell, WA* (Oct. 9, 2015), HWA Geosciences, *Ground Water Monitoring Results Year 4, Quarter 1 - April 2017, Riverside HVOC Site, Bothell, WA* (May 8, 2017), Kane Environmental, *Supplemental Remedial Investigation and Feasibility Study, Riverside HVOC Site, Bothell, WA* (February 2, 2022), and Floyd|Snider, *Pre-Engineering Design Investigation Data Report, Riverside HVOC Site* (December 17, 2024).

F. Under Agreed Order No. DE 6295 Amendments No. 1 and 2, the City conducted interim actions at the Site. Under Agreed Order No. DE 6295, Amendment No. 1, the City excavated TPH soil contamination. Under Agreed Order No. DE 6295, Amendment No. 2, the City installed wells to control the groundwater gradient where groundwater is contaminated by HVOCs. The groundwater pumping system is intended to prevent HVOCs in groundwater from discharging to the Sammamish River. Pumped water continues to be discharged to the King County sanitary sewer system for treatment pursuant to King County Wastewater Discharge Authorization No. 4268-02 (expires Oct. 9, 2023).

G. In 2019, Ecology and the City split the Riverside Site into two Sites: the Riverside-TPH Site and the Riverside-HVOC Site. Ecology removed the Riverside-TPH Site from the Hazardous Sites List in December 2019 and issued a determination that no further remedial action is necessary to clean up contamination at the Riverside-TPH Site.

H. On December 5, 2019, Ecology and the City entered into Agreed Order 16541, to provide for a Supplemental Remedial Investigation, Feasibility Study, Draft Cleanup Action Plan, and continued groundwater pumping at the remaining Riverside-HVOC Site.

I. Under Agreed Order No. DE 16541, the City continued the groundwater pumping interim action to address HVOCs at the Riverside-HVOC Site. The City performed a Remedial Investigation and Feasibility Study, and prepared a preliminary draft Cleanup Action Plan and draft Cleanup Action Plan Addendum to address the remaining HVOC contamination.

VI. ECOLOGY DETERMINATIONS

Ecology makes the following determinations, without any express or implied admissions of such determinations (and underlying facts) by the City.

A. The City is an "owner or operator" as defined in RCW 70A.305.020(22) of a "facility" as defined in RCW 70A.305.020(8).

B. Based upon all factors known to Ecology, a "release" or "threatened release" of "hazardous substance(s)" as defined in RCW 70A.305.020(32), (13), respectively, has occurred at the Site.

C. Based upon credible evidence, Ecology issued a PLP status letter to the City dated November 20, 2008, pursuant to RCW 70A.305.040, .020(26), and WAC 173-340-500. By letter dated November 25, 2008, the City voluntarily waived its rights to notice and comment and accepted Ecology's determination that the City is a PLP under RCW 70.105D.040.

D. Pursuant to RCW 70A.305.030(1), .050(1), Ecology may require PLPs to investigate or conduct other remedial actions with respect to any release or threatened release of hazardous substances, whenever it believes such action to be in the public interest. Based on the foregoing facts, Ecology believes the remedial actions required by this Order are in the public interest.

E. Ecology has determined that it is appropriate to address the release of TPH and the release of HVOC at the property under separate administrative orders. This Agreed Order will address the release of HVOC at the Site. Agreed Order No. 16541 is deemed satisfied and terminated upon the effective date of this Order.

F. As documented in the Cleanup Action Plan (CAP) (Exhibit B) and Cleanup Action Plan Addendum (CAP Addendum) (Exhibit E), Ecology has chosen a final cleanup action to be implemented at the Riverside-HVOC Site.

VII. WORK TO BE PERFORMED

Based on the Findings of Fact and Ecology Determinations, it is hereby ordered that the City take the following remedial actions at the Site. The area within the Site where remedial action is necessary under RCW 70A.305 is described in the Remedial Action Location Diagram (Exhibit A). These remedial actions must be conducted in accordance with WAC 173-340:

A. The City will implement the Cleanup Action Plan (Exhibit B) and Cleanup Action Plan Addendum (Exhibit E) and Schedule (Exhibit C), and all other requirements of this Order.

B. If the City learns of a significant change in conditions at the Site, including but not limited to a statistically significant increase in contaminant and/or chemical concentrations in any media, the City, within seven (7) days of learning of the change in condition, shall notify Ecology in writing of said change and provide Ecology with any reports or records (including laboratory analyses, sampling results) relating to the change in conditions.

C. The City shall submit to Ecology written quarterly Progress Reports that describe the actions taken during the previous quarter to implement the requirements of this Order. All Progress Reports shall be submitted by the tenth (10th) day of the month in which they are due after the effective date of this Order. Unless otherwise specified by Ecology, Progress Reports and any other documents submitted pursuant to this Order shall be sent by certified mail, return receipt requested, to Ecology's project coordinator. The Progress Reports shall include the following:

1. A list of on-site activities that have taken place during the quarter.
2. Detailed description of any deviations from required tasks not otherwise documented in project plans or amendment requests.
3. Description of all deviations from the Scope of Work and Schedule (Exhibit C) during the current quarter and any planned deviations in the upcoming quarter.
4. For any deviations in schedule, a plan for recovering lost time and maintaining compliance with the schedule.
5. All raw data (including laboratory analyses) received during the previous quarter (if not previously submitted to Ecology), together with a detailed description of the underlying samples collected.
6. A list of deliverables for the upcoming quarter.

D. Pursuant to WAC 173-340-440(11), the City shall maintain sufficient and adequate financial assurance mechanisms to cover all costs associated with the operation and maintenance of the remedial action at the Site, including institutional controls, compliance monitoring, and corrective measures.

1. Within sixty (60) days of the effective date of this Order, the City shall submit to Ecology for review and approval an estimate of the costs under this Order for operation and maintenance of the remedial actions at the Site, including institutional controls, compliance monitoring and corrective measures. Within sixty (60) days after Ecology approves the aforementioned cost estimate, the City shall provide proof of financial assurances sufficient to cover all such costs in a form acceptable to Ecology.
2. The City shall adjust the financial assurance coverage and provide Ecology's project coordinator with documentation of the updated financial assurance for:
    a. Inflation, annually, within thirty (30) days of the anniversary date of the entry of this Order; or if applicable, the modified anniversary date established in accordance with this section, or if applicable, ninety (90) days after the close of the City's fiscal year if the financial test or corporate guarantee is used.
    b. Changes in cost estimates, within thirty (30) days of issuance of Ecology's approval of a modification or revision to the Cleanup Action Plan (Exhibit B) (CAP) or Cleanup Action Plan Addendum (Exhibit E) (CAP Addendum) that result in increases to the cost or expected duration of remedial actions. Any adjustments for inflation since the most recent preceding anniversary date shall be made concurrent with adjustments for changes in cost estimates. The issuance of Ecology's approval of a revised or modified CAP or CAP Addendum will revise the anniversary date established under this section to become the date of issuance of such revised or modified CAP or CAP Addendum.

E. As detailed in the CAP and CAP Addendum, institutional controls are required at the Site. Environmental (Restrictive) Covenants will be used to implement the institutional controls.

1. In consultation with the City, Ecology will prepare the Environmental (Restrictive) Covenants consistent with WAC 173-340-440, RCW 64.70, and any policies or procedures specified by Ecology. The Environmental (Restrictive) Covenants shall restrict future activities and uses of the Site as agreed to by Ecology and the City.
2. After approval by Ecology, the City shall record the Environmental (Restrictive) Covenant for affected properties it owns with the office of the King County Auditor as detailed in the Schedule (Exhibit C). The City shall provide Ecology with the original recorded Environmental (Restrictive) Covenants within thirty (30) days of the recording date.

F. All plans or other deliverables submitted by the City for Ecology's review and approval under the Cleanup Action Plan (Exhibit B), Cleanup Action Plan Addendum (Exhibit E), and Schedule (Exhibit C) shall, upon Ecology's approval, become integral and enforceable parts of this Order. The City shall take any action required by such deliverable.

G. If Ecology determines that the City has failed to make sufficient progress or failed to implement the remedial action, in whole or in part, Ecology may, after notice to the City, perform any or all portions of the remedial action or at Ecology's discretion allow the City opportunity to correct. In an emergency, Ecology is not required to provide notice to the City, or an opportunity for dispute resolution. The City shall reimburse Ecology for the costs of doing such work in accordance with Section VIII.A (Payment of Remedial Action Costs). Ecology reserves the right to enforce requirements of this Order under Section X (Enforcement).

H. Except where necessary to abate an emergency situation or where required by law, the City shall not perform any remedial actions at the Site outside those remedial actions required by this Order to address the contamination that is the subject of this Order, unless Ecology concurs, in writing, with such additional remedial actions pursuant to Section VIII.J. (Amendment of Order). In the event of an emergency, or where actions are taken as required by law, the City must notify Ecology in writing of the event and remedial action(s) planned or taken as soon as practical but no later than within twenty-four (24) hours of the discovery of the event.

I. Ecology hereby incorporates into this Order the previous remedial actions described in Section V (Findings of Fact). Reimbursement for specific project tasks under a grant agreement with Ecology is contingent upon a determination by Ecology's Toxics Cleanup Program that the retroactive costs are eligible under WAC 173-322A-320(6), the work performed complies with the substantive requirements of WAC 173-340, and the work is consistent with the remedial actions required under this Order. The costs associated with Ecology's determination on the past independent remedial actions described in Section V (Findings of Fact), are recoverable under this Order.

VIII. TERMS AND CONDITIONS

A. Payment of Remedial Action Costs

The City shall pay to Ecology costs incurred by Ecology pursuant to this Order and consistent with WAC 173-340-550(2). These costs shall include work performed by Ecology or its contractors for, or on, the Site under RCW 70A.305, including remedial actions and Order preparation, negotiation, oversight, and administration. These costs shall include work performed both prior to and subsequent to the issuance of this Order. Ecology's costs shall include costs of direct activities and support costs of direct activities as defined in WAC 173-340-550(2). For all Ecology costs incurred, the City shall pay the required amount within thirty (30) days of receiving from Ecology an itemized statement of costs that includes a summary of costs incurred, an identification of involved staff, and the amount of time spent by involved staff members on the project. A general statement of work performed will be provided upon request. Itemized statements shall be prepared quarterly. Pursuant to WAC 173-340-550(4), failure to pay Ecology's costs within ninety (90) days of receipt of the itemized statement of costs will result in interest charges at the rate of twelve percent (12%) per annum, compounded monthly.

In addition to other available relief, pursuant to RCW 19.16.500, Ecology may utilize a collection agency and/or, pursuant to RCW 70A.305.060, file a lien against real property subject to the remedial actions to recover unreimbursed remedial action costs.

B. Designated Project Coordinators

The project coordinator for Ecology is:

Sunny Becker
Department of Ecology
PO Box 330316
Shoreline, WA 98133-9716
Phone: (206) 594-0107
Email: sunny.becker@ecy.wa.gov

The project coordinator for the City is:

Ryan Roberts
Supervising Civil Engineer
City of Bothell, Public Works Department
18415 - 101st Avenue NE
Bothell, WA 98011
Phone: (425) 806-6823
Email: Ryan.Roberts@bothellwa.gov

Each project coordinator shall be responsible for overseeing the implementation of this Order. Ecology's project coordinator will be Ecology's designated representative for the Site. To the maximum extent possible, communications between Ecology and the City, and all documents, including reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Order shall be directed through the project coordinators. The project coordinators may designate, in writing, working level staff contacts for all or portions of the implementation of the work to be performed required by this Order.

Any Party may change its respective project coordinator. Written notification shall be given to the other Party at least ten (10) calendar days prior to the change.

C. Performance

All geologic and hydrogeologic work performed pursuant to this Order shall be under the supervision and direction of a geologist or hydrogeologist licensed by the State of Washington or under the direct supervision of an engineer registered by the State of Washington, except as otherwise provided for by RCW 18.43 and 18.220.

All engineering work performed pursuant to this Order shall be under the direct supervision of a professional engineer registered by the State of Washington, except as otherwise provided for by RCW 18.43.130.

All construction work performed pursuant to this Order shall be under the direct supervision of a professional engineer or a qualified technician under the direct supervision of a professional engineer. The professional engineer must be registered by the State of Washington, except as otherwise provided for by RCW 18.43.130.

Any documents submitted containing geologic, hydrogeologic, or engineering work shall be under the seal of an appropriately licensed professional as required by RCW 18.43 and 18.220.

The City shall notify Ecology in writing of the identity of any engineer(s) and geologist(s), contractor(s), subcontractor(s), and other key personnel to be used in carrying out the terms of this Order, in advance of their involvement at the Site.

D. Access

Ecology or any Ecology authorized representative shall have access to enter and freely move about all property at the Site that the City either owns, controls, or has access rights to at all reasonable times for the purposes of, *inter alia*: inspecting records, operation logs, and contracts related to the work being performed pursuant to this Order; reviewing the City's progress in carrying out the terms of this Order; conducting such tests or collecting such samples as Ecology may deem necessary; using a camera, sound recording, or other documentary type equipment to record work done pursuant to this Order; and verifying the data submitted to Ecology by the City. Ecology or any Ecology authorized representative shall give reasonable notice before entering any Site property owned or controlled by the City unless an emergency prevents such notice. All persons who access the Site pursuant to this section shall comply with any applicable health and safety plan(s). Ecology employees and their representatives shall not be required to sign any liability release or waiver as a condition of Site property access.

The City shall make best efforts to secure access rights for those properties within the Site not owned or controlled by the City where remedial activities or investigations will be performed pursuant to this Order. As used in this Section, "best efforts" means the efforts that a reasonable person in the position of the City would use so as to achieve the goal in a timely manner, including the cost of employing professional assistance and the payment of reasonable sums of money to secure access and/or use restriction agreements, as required by this Section. If, within 60 days after the effective date of this Order, the City is unable to accomplish what is required through "best efforts," the City shall notify Ecology, and include a description of the steps taken to comply with the requirements. If Ecology deems it appropriate, it may assist the City, or take independent action, in obtaining such access and/or use restrictions. Ecology reserves the right to seek payment from the City for all costs, including cost of attorneys' time, incurred by Ecology in obtaining such access or agreements to restrict land, water, or other resource use.

E. Sampling, Data Submittal, and Availability

With respect to the implementation of this Order, the City shall make the results of all sampling, laboratory reports, and/or test results generated by it or on its behalf available to Ecology. Pursuant to WAC 173-340-840(5), all sampling data shall be submitted to Ecology in both printed and electronic formats in accordance with Section VII (Work to be Performed), Ecology's Toxics Cleanup Program Policy 840 (Data Submittal Requirements), and/or any subsequent procedures specified by Ecology for data submittal.

If requested by Ecology, the City shall allow Ecology and/or its authorized representative to take split or duplicate samples of any samples collected by the City pursuant to implementation of this Order. the City shall notify Ecology seven (7) days in advance of any sample collection or work activity at the Site. Ecology shall, upon request, allow the City and/or its authorized representative to take split or duplicate samples of any samples collected by Ecology pursuant to the implementation of this Order, provided that doing so does not interfere with Ecology's sampling. Without limitation on Ecology's rights under Section VIII.D (Access), Ecology shall notify the City prior to any sample collection activity unless an emergency prevents such notice.

In accordance with WAC 173-340-830(2)(a), all hazardous substance analyses shall be conducted by a laboratory accredited under WAC 173-50 for the specific analyses to be conducted, unless otherwise approved by Ecology.

F. Public Participation

Ecology shall maintain the responsibility for public participation at the Site. However, the City shall cooperate with Ecology, and shall:

1. If agreed to by Ecology, develop appropriate mailing lists and prepare drafts of public notices and fact sheets at important stages of the remedial action, such as the submission of work plans, remedial investigation/feasibility study reports, cleanup action plans, and engineering design reports. As appropriate, Ecology will edit, finalize, and distribute such fact sheets and prepare and distribute public notices of Ecology's presentations and meetings.

2. Notify Ecology's project coordinator prior to the preparation of all press releases and fact sheets, and before meetings related to remedial action work to be performed at the Site with the interested public and/or local governments. Likewise, Ecology shall notify the City prior to the issuance of all press releases and fact sheets related to the Site, and before meetings related to the Site with the interested public and local governments. For all press releases, fact sheets, meetings, and other outreach efforts by the City that do not receive prior Ecology approval, the City shall clearly indicate to its audience that the press release, fact sheet, meeting, or other outreach effort was not sponsored or endorsed by Ecology.

3. When requested by Ecology, participate in public presentations on the progress of the remedial action at the Site. Participation may be through attendance at public meetings to assist in answering questions or as a presenter.

4. When requested by Ecology, arrange and maintain a repository to be located at:

a. King County Bothell Library
18215 98th Ave. NE
Bothell, WA 98011

b. Ecology's Northwest Regional Office
Washington Department of Ecology
15700 Dayton Ave N
Shoreline, WA 98133

Call for an appointment:
Sally Perkins
E-mail: nwro_public_request@ecy.wa.gov

c. City of Bothell – City Hall
18415 – 101st Ave NE
Bothell, WA 98011
Phone: (425) 486-7811

At a minimum, copies of all public notices, fact sheets, and documents relating to public comment periods shall be promptly placed in these repositories. A copy of all documents related to this Site shall be maintained in the repository at Ecology's Northwest Regional Office in Shoreline, Washington.

G. Access to Information

The City shall provide to Ecology, upon request, copies of all records, reports, documents, and other information (including records, reports, documents, and other information in electronic form) (hereinafter referred to as "Records") within the City's possession or control or that of their contractors or agents relating to activities at the Site or to the implementation of this Order, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information regarding the work. The City shall also make available to Ecology, for purposes of investigation, information gathering, or testimony, their employees, agents, or representatives with knowledge of relevant facts concerning the performance of the work.

Nothing in this Order is intended to waive any right the City may have under applicable law to limit disclosure of Records protected by the attorney work-product privilege and/or the attorney-client privilege. If the City withholds any requested Records based on an assertion of privilege, the City shall provide Ecology with a privilege log specifying the Records withheld and the applicable privilege. No Site-related data collected pursuant to this Order shall be considered privileged, including: (1) any data regarding the Site, including, but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, radiological, biological, or engineering data, or the portion of any other record that evidences conditions at or around the Site; or (2) the portion of any Record that Respondents are required to create or generate pursuant to this Order.

Notwithstanding any provision of this Order, Ecology retains all of its information gathering and inspection authorities and rights, including enforcement actions related thereto, under any other applicable statutes or regulations.

H. Retention of Records

During the pendency of this Order, and for ten (10) years from the date of completion of the work performed pursuant to this Order, the City shall preserve all records, reports, documents, and underlying data in its possession relevant to the implementation of this Order and shall insert a similar record retention requirement into all contracts with project contractors and subcontractors.

I. Resolution of Disputes

1. In the event that the City elects to invoke dispute resolution the City must utilize the procedure set forth below.

a. Upon the triggering event (receipt of Ecology's project coordinator's written decision or an itemized billing statement), the City has fourteen (14) calendar days within which to notify Ecology's project coordinator in writing of its dispute (Informal Dispute Notice).

b. The Parties' project coordinators shall then confer in an effort to resolve the dispute informally. The Parties shall informally confer for up to fourteen (14) calendar days from receipt of the Informal Dispute Notice. If the project coordinators cannot resolve the dispute within those fourteen (14) calendar days, then within seven (7) calendar days Ecology's project coordinator shall issue a written decision (Informal Dispute Decision) stating: the nature of the dispute; the City's position with regards to the dispute; Ecology's position with regards to the dispute; and the extent of resolution reached by informal discussion.

c. The City may then request regional management review of the dispute. The City must submit this request (Formal Dispute Notice) in writing to the Northwest Region Toxics Cleanup Section Manager within seven (7) calendar days of receipt of Ecology's Informal Dispute Decision. The Formal Dispute Notice shall include a written statement of dispute setting forth: the nature of the dispute; the City's position with respect to the dispute; and the information relied upon to support its position.

d. The Section Manager shall conduct a review of the dispute and shall endeavor to issue a written decision regarding the dispute (Decision on Dispute) within thirty (30) calendar days of receipt of the Formal Dispute Notice. The Decision on Dispute shall be Ecology's final decision on the disputed matter.

2. The Parties agree to only utilize the dispute resolution process in good faith and agree to expedite, to the extent possible, the dispute resolution process whenever it is used.

3. Implementation of these dispute resolution procedures shall not provide a basis for delay of any activities required in this Order, unless Ecology agrees in writing to a schedule extension.

4. In case of a dispute, failure to either proceed with the work required by this Order or timely invoke dispute resolution may result in Ecology's determination that insufficient progress is being made in preparation of a deliverable, and may result in Ecology undertaking the work under Section VII.I (Work to be Performed) or initiating enforcement under Section X (Enforcement).

J. Extension of Schedule

1. The City's request for an extension of schedule shall be granted only when a request for an extension is submitted in a timely fashion, generally at least thirty (30) days prior to

expiration of the deadline for which the extension is requested, and good cause exists for granting the extension. All extensions shall be requested in writing. The request shall specify:

a. The deadline that is sought to be extended.

b. The length of the extension sought.

c. The reason(s) for the extension.

d. Any related deadline or schedule that would be affected if the extension were granted.

2. The burden shall be on the City to demonstrate to the satisfaction of Ecology that the request for such extension has been submitted in a timely fashion and that good cause exists for granting the extension. Good cause may include, but may not be limited to:

a. Circumstances beyond the reasonable control and despite the due diligence of the City including delays caused by unrelated third parties or Ecology, such as (but not limited to) delays by Ecology in reviewing, approving, or modifying documents submitted by the City.

b. A shelter in place or work stoppage mandated by state or local government order due to public health and safety emergencies.

c. Acts of God, including fire, flood, blizzard, extreme temperatures, storm, or other unavoidable casualty.

d. Endangerment as described in Section VIII.K (Endangerment).

However, neither increased costs of performance of the terms of this Order nor changed economic circumstances shall be considered circumstances beyond the reasonable control of the City.

3. Ecology shall act upon the City’s written request for extension in a timely fashion. Ecology shall give the City written notification of any extensions granted pursuant to this Order. A requested extension shall not be effective until approved by Ecology. Unless the extension is a substantial change, it shall not be necessary to amend this Order pursuant to Section VIII.J (Amendment of Order) when a schedule extension is granted.

4. At the City's request, an extension shall only be granted for such period of time as Ecology determines is reasonable under the circumstances. Ecology may grant schedule extensions exceeding ninety (90) days only as a result of one of the following:

a. Delays in the issuance of a necessary permit which was applied for in a timely manner.

b. Other circumstances deemed exceptional or extraordinary by Ecology.

c. Endangerment as described in Section VIII.K (Endangerment).

K. Amendment of Order

The project coordinators may verbally agree to minor changes to the work to be performed without formally amending this Order. Minor changes will be documented in writing by Ecology within seven (7) days of verbal agreement.

Except as provided in Section VIII.L (Reservation of Rights), substantial changes to the work to be performed shall require formal amendment of this Order. This Order may only be formally amended by the written consent of both Ecology and the City. Ecology will provide its written consent to a formal amendment only after public notice and opportunity to comment on the formal amendment.

When requesting a change to the Order, the City shall submit a written request to Ecology for approval. Ecology shall indicate its approval or disapproval in writing and in a timely manner after the written request is received. If Ecology determines that the change is substantial, then the Order must be formally amended. Reasons for the disapproval of a proposed change to this Order shall be stated in writing. If Ecology does not agree to a proposed change, the disagreement may be addressed through the dispute resolution procedures described in Section VIII.H (Resolution of Disputes).

L. Endangerment

In the event Ecology determines that any activity being performed at the Site under this Order is creating or has the potential to create a danger to human health or the environment on or surrounding the Site, Ecology may direct the City to cease such activities for such period of time as it deems necessary to abate the danger. The City shall immediately comply with such direction.

In the event the City determines that any activity being performed at the Site under this Order is creating or has the potential to create a danger to human health or the environment, the City may cease such activities. The City shall notify Ecology's project coordinator as soon as possible, but no later than twenty-four (24) hours after making such determination or ceasing such activities. Upon Ecology's direction, the City shall provide Ecology with documentation of the basis for the determination or cessation of such activities. If Ecology disagrees with the City's cessation of activities, it may direct the City to resume such activities.

If Ecology concurs with or orders a work stoppage pursuant to this section, the City's obligations with respect to the ceased activities shall be suspended until Ecology determines the danger is abated, and the time for performance of such activities, as well as the time for any other work dependent upon such activities, shall be extended in accordance with Section VIII.I (Extension of Schedule) for such period of time as Ecology determines is reasonable under the circumstances.

Nothing in this Order shall limit the authority of Ecology, its employees, agents, or contractors to take or require appropriate action in the event of an emergency.

M. Reservation of Rights

This Order is not a settlement under RCW 70A.305. Ecology's signature on this Order in no way constitutes a covenant not to sue or a compromise of any of Ecology's rights or authority. Ecology will not, however, bring an action against the City to recover remedial action costs paid to and received by Ecology under this Order. In addition, Ecology will not take additional enforcement actions against the City regarding remedial actions required by this Order, provided the City complies with this Order.

Ecology nevertheless reserves its rights under RCW70A.305, including the right to require additional or different remedial actions at the Site should it deem such actions necessary to protect human health or the environment, and to issue orders requiring such remedial actions. Ecology also reserves all rights regarding the injury to, destruction of, or loss of natural resources resulting from the release or threatened release of hazardous substances at the Site.

By entering into this Order, the City does not admit to any liability for the Site. Although the City is committing to conducting the work required by this Order under the terms of this Order, the City expressly reserves all rights available under law, including but not limited to the right to seek cost recovery or contribution against third parties, and the right to assert any defenses to liability in the event of enforcement.

N. Transfer of Interest in Property

No voluntary conveyance or relinquishment of title, easement, leasehold, or other interest in any portion of the Site shall be consummated by the City without provision for continued implementation of all requirements of this Order and implementation of any remedial actions found to be necessary as a result of this Order.

Prior to the City's transfer of any interest in all or any portion of the Site, and during the effective period of this Order, the City shall provide a copy of this Order to any prospective purchaser, lessee, transferee, assignee, or other successor in said interest; and, at least thirty (30) days prior to any transfer, the City shall notify Ecology of said transfer. Upon transfer of any interest, the City shall notify all transferees of the restrictions on the activities and uses of the property under this Order and incorporate any such use restrictions into the transfer documents.

O. Compliance with Applicable Laws

1. *Applicable Laws.* All actions carried out by the City pursuant to this Order shall be done in accordance with all applicable federal, state, and local requirements, including requirements to obtain necessary permits or approvals, except as provided in RCW 70A.305.090. The permits or specific federal, state, or local requirements that the agency has determined are applicable and that are known at the time of the execution of this Order have been identified in Exhibit _D_. The City has a continuing obligation to identify additional applicable federal, state, and local requirements which apply to actions carried out pursuant to this Order, and to comply with those requirements. As additional federal, state, and local requirements are identified by

Ecology or the City, Ecology will document in writing if they are applicable to actions carried out pursuant to this Order, and the City must implement those requirements.

2. *Relevant and Appropriate Requirements.* All actions carried out by the City pursuant to this Order shall be done in accordance with relevant and appropriate requirements identified by Ecology. The relevant and appropriate requirements that Ecology has determined apply have been identified in Exhibit D. If additional relevant and appropriate requirements are identified by Ecology or the City, Ecology will document in writing if they are applicable to actions carried out pursuant to this Order and the City must implement those requirements.

3. Pursuant to RCW 70A.305.090(1), the City may be exempt from the procedural requirements of RCW 70A.15, 70A.205, 70A.300, 77.55, 90.48, and 90.58 and of any laws requiring or authorizing local government permits or approvals. However, the City shall comply with the substantive requirements of such permits or approvals. For permits and approvals covered under RCW 70A.305.090(1) that have been issued by local government, the Parties agree that Ecology has the non-exclusive ability under this Order to enforce those local government permits and/or approvals. The exempt permits or approvals and the applicable substantive requirements of those permits or approvals, as they are known at the time of the execution of this Order, have been identified in Exhibit D.

4. The City has a continuing obligation to determine whether additional permits or approvals addressed in RCW 70A.305.090(1) would otherwise be required for the remedial action under this Order. In the event either Ecology or the City determines that additional permits or approvals addressed in RCW 70A.305.090(1) would otherwise be required for the remedial action under this Order, it shall promptly notify the other Party of its determination. Ecology shall determine whether Ecology or the City shall be responsible to contact the appropriate state and/or local agencies. If Ecology so requires, the City shall promptly consult with the appropriate state and/or local agencies and provide Ecology with written documentation from those agencies of the substantive requirements those agencies believe are applicable to the remedial action. Ecology shall make the final determination on the additional substantive requirements that must be met by

the City and on how the City must meet those requirements. Ecology shall inform the City in writing of these requirements. Once established by Ecology, the additional requirements shall be enforceable requirements of this Order. The City shall not begin or continue the remedial action potentially subject to the additional requirements until Ecology makes its final determination.

Pursuant to RCW 70A.305.090(2), in the event Ecology determines that the exemption from complying with the procedural requirements of the laws referenced in RCW 70A.305.090(1) would result in the loss of approval from a federal agency that is necessary for the state to administer any federal law, the exemption shall not apply and the City shall comply with both the procedural and substantive requirements of the laws referenced in RCW 70A.305.090(1), including any requirements to obtain permits or approvals.

P. Periodic Review

So long as remedial action continues at the Site, the Parties agree to review the progress of remedial action at the Site, and to review the data accumulated as a result of monitoring the Site as often as is necessary and appropriate under the circumstances. Unless otherwise agreed to by Ecology, at least every five (5) years after the initiation of cleanup action at the Site the Parties shall confer regarding the status of the Site and the need, if any, for further remedial action at the Site. At least ninety (90) days prior to each periodic review, the City shall submit a report to Ecology that documents whether human health and the environment are being protected based on the factors set forth in WAC 173-340-420(4). Ecology reserves the right to require further remedial action at the Site under appropriate circumstances. This provision shall remain in effect for the duration of this Order.

Q. Indemnification

The City agrees to indemnify and save and hold the State of Washington, its employees, and agents harmless from any and all claims or causes of action (1) for death or injuries to persons, or (2) for loss or damage to property, to the extent arising from or on account of acts or omissions of the City, its officers, employees, agents, or contractors in entering into and implementing this Order. However, the City shall not indemnify the State of Washington nor save nor hold its employees and agents harmless from any claims or causes of action to the extent arising out of the negligent acts or omissions of the State of Washington, or the employees or agents of the State, in entering into or implementing this Order.

IX. SATISFACTION OF ORDER

The provisions of this Order shall be deemed satisfied upon the City's receipt of written notification from Ecology that the City has completed the remedial activity required by this Order, as amended by any modifications, and that the City has complied with all other provisions of this Agreed Order.

X. ENFORCEMENT

Pursuant to RCW 70A.305.050, this Order may be enforced as follows:

A. The Attorney General may bring an action to enforce this Order in a state or federal court.

B. The Attorney General may seek, by filing an action, if necessary, to recover amounts spent by Ecology for investigative and remedial actions and orders related to the Site.

C. A liable party who refuses, without sufficient cause, to comply with any term of this Order will be liable for:

1. Up to three (3) times the amount of any costs incurred by the State of Washington as a result of its refusal to comply.

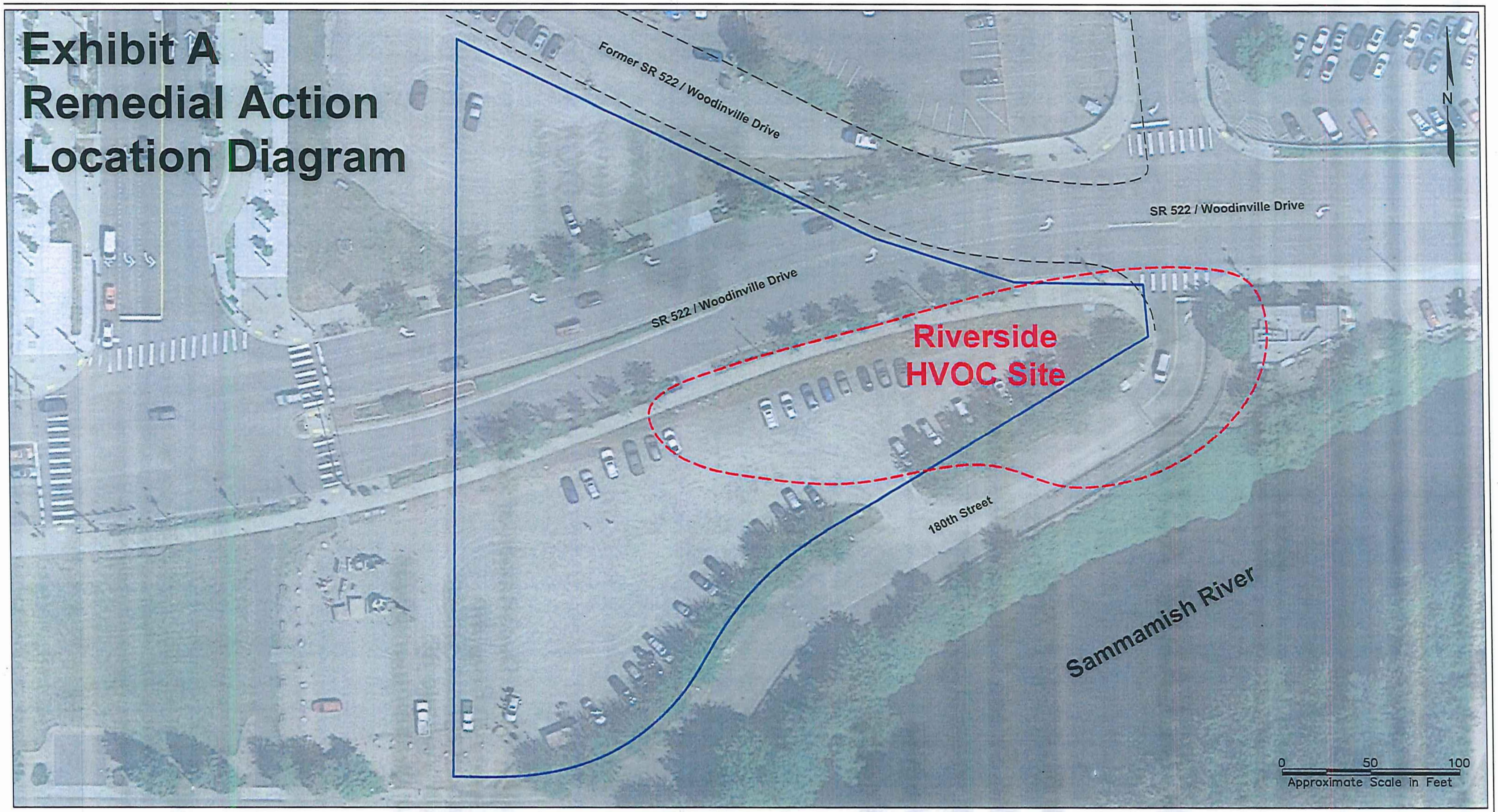
2. Civil penalties of up to twenty-five thousand dollars ($25,000) per day for each day it refuses to comply.

D. This Order is not appealable to the Washington Pollution Control Hearings Board. This Order may be reviewed only as provided under RCW 70A.305.070.

Effective date of this Order: August 8, 2025

CITY OF BOTHELL	STATE OF WASHINGTON DEPARTMENT OF ECOLOGY
DocuSigned by: Kyle Stannert 8/8/2025 896E5F0D91104B1...	DocuSigned by: Kim Wooten 8/8/2025 653809364CCA4ED...

Kyle Stannert City Manager City off Bothell	Kimberly Wooten Section Manager Toxics Cleanup Program Northwest Regional Office



LEGEND

Approximate location of historical Riverside property

Approximate location of Riverside HVOC Site Boundary

EXHIBIT B

FINAL CLEANUP ACTION PLAN

Bothell Riverside HVOC
NE 180th Street & Woodinville Drive
Bothell, Washington 98011
FSID # 93061
CSID # 14970

DEPARTMENT OF ECOLOGY
State of Washington

Issued By:

Washington State Department of Ecology
Toxics Cleanup Program
Northwest Regional Office
3190 160th Avenue SE
Bellevue, Washington 98008

March 2023

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1.0 INTRODUCTION

This Cleanup Action Plan (CAP) report was prepared by Kane Environmental, Inc., (Kane Environmental) on behalf of the City of Bothell (the City) for submission to the Washington State Department of Ecology (Ecology) to clean up the area of soil and groundwater contamination associated with releases of solvents at the contaminated site known as the Bothell Riverside Halogenated Volatile Organic Compounds (HVOC) Site located in Bothell, Washington (herein referred to as Riverside HVOC; Site). A vicinity map is shown as Figure 1. This CAP has been prepared to meet the requirements of the Model Toxics Control Cleanup Act (MTCA) administered by Ecology under Chapter 173-340 of the Washington Administrative Code (WAC). This CAP describes Ecology's proposed cleanup action for this site and sets forth the requirements that the cleanup must meet.

The Riverside HVOC Site is located on the eastern end of King County Assessor's parcel, 082605-9120, which is presently owned by the City of Bothell. The parcel containing the Site is currently vacant and utilized as a City of Bothell Park and as a public gravel parking lot. The Site is bounded to the north by State Route (SR) 522 and bounded to the south by the Sammamish River. See Figure 2 for an area Site plan, showing the Site boundaries with respect to the surrounding properties.

Kane Environmental completed a Draft Supplemental Remedial Investigation and Feasibility Study (RI/FS) for the Site dated February 22, 2022. The Remedial Investigation (RI) delineated the extent of HVOC impacts to both soil and groundwater at the Site. The primary source of current HVOC contamination on the Site is most likely associated with releases from historical machine shop operations on the Site. The Contaminants of Concern (COCs) in soil and groundwater are: Tetrachloroethene (PCE), Trichloroethene (TCE), (cis)-1,2 Dichloroethene (DCE) and Vinyl Chloride (VC).

Five remedial alternatives were evaluated in the draft Feasibility Study (FS) and are summarized below:

Alternative 1 – Alternative 1 – Limited Source Soil Excavation and EOS® Bioremediation

Alternative 1 includes excavation and off-site disposal of contaminated soils followed by supplemental bioremediation injection. The proposed excavation area for Alternative 1, which is the contaminant source area, is shown in the Supplemental RI/FS Figure 11. Prior to excavation, a geotechnical soldier pile wall, or similar, will be installed on the Riverside HVOC Site along the sidewalk of Highway 522 to provide structural support on the northern side of the excavation. Excavation to the east, south and west can be completed using a 1:1 excavation slope. Excavation activities will focus on vadose zone soils and will extend to approximately 15 feet below ground surface (bgs). Soil will be disposed of at an appropriate licensed landfill and clean imported fill material will be placed on the Site.

Following source soil removal activity, an array of groundwater injection wells at varying depths from 10 feet to 30 feet bgs, will be installed on the Riverside HVOC Site. An emulsified oil product, EOS©, which is an emulsion of lactate, soybean oil and nutrients that stimulates the growth of anaerobic bacteria to treat the groundwater plume through reductive dechlorination, will be injected into the groundwater. EOS© will be injected into wells at the source area and in downgradient wells. During bacterial respiration, electrons from the EOS® are transferred to the chlorinated compounds via the bacteria, releasing chlorine ions and eventually degrading to ethane and hydrogen gas.

Alternative 2 – Alternative 2 – Bioremediation with Carbstrate© and Groundwater Recirculation

This alternative involves the pumping of groundwater from existing and new extraction wells located at the Site, treatment of this water with a bioremediation product, and reinjection of this treated groundwater into the Site subsurface via injection wells. Proposed well locations associated with this alternative are shown in Figure 12 of the Supplemental RI/FS.

Currently, an array of six (6) 4-inch diameter groundwater extraction wells, are present at the Riverside HVOC Site. Several of these wells will be utilized to continue extraction while at least two new extraction wells will be installed on the site. These extraction wells will provide hydraulic control of the contaminant plume.

Extracted groundwater pumped from the extraction wells will be amended with a bioremediation product, Carbstrate©, or similar bioremediation product, a nutrient-amended electron donor substrate, pH adjusted if necessary, and then re-injected into the aquifer through vertical injection wells, to stimulate anaerobic bioremediation of PCE and its' breakdown products. Injection wells would need to be placed at different depths, and over a large area to cover the entire plume. Injection wells would be installed with a rotosonic drill rig to reduce smearing of fine grained material if possible. This will reduce the chance of the injection wells being biofouled. Two of the existing extraction wells and one existing monitoring well will be converted to injection wells.

Alternative 3 – Air Sparging and Soil Vapor Extraction (AS/SVE)

Alternative 3 includes a combination of air sparging and soil vapor extraction throughout the Site. See Figure 13 of the Supplemental RI/FS for the proposed air sparge and soil vapor extraction well location. Air sparging involves introducing compressed air into the groundwater. The introduction of air below the groundwater table enhances volatilization of contaminants dissolved in groundwater and sorbed onto saturated soils. Volatilized contaminants are then recovered via vapor extraction of the overlying vadose zone. Low molecular weight, volatile compounds such as PCE, TCE, DCE and vinyl chloride are generally amenable to air sparging. Air sparging would be combined with soil vapor extraction to remove the contaminants. Soil vapor extraction is the process of removing contaminants from the soil in the vapor phase, usually by applying a vacuum to the subsurface. This is done through the use of a series of wells which are placed throughout the area of contamination and screened above the groundwater table. The wells are connected to an air blower, which draws a vacuum. With the reduced pressure, air begins to move through the subsurface drawing out the contaminant vapors. The withdrawn air will likely require treatment, depending on contaminant concentrations. Common processes for remediating this air include vapor phase carbon adsorption, catalytic converters, or thermal converters (oxidizers).

The vapors are run through a remediation system, and then discharged into the atmosphere under state and local permit requirements. This action is enhanced when the surface is covered by a cap of asphalt and/or concrete, minimizing the amount of ambient air drawn into the system.

Alternative 4 – Excavation and Monitored Natural Attenuation (MNA)

Alternative 4 includes excavation and off-site disposal of all contaminated soils followed by monitored natural attenuation (MNA). The proposed excavation areas are the contaminant source areas in the northern and southern portions of the Site down to its furthest vertical extent of 30 feet bgs near RMW-12 and 25 feet bgs near RMW-14 as depicted in the Supplemental RI/FS Figure 14. Prior to excavation, a geotechnical soldier pile wall, or similar, will be installed on the entire excavation boundary due to the depth of excavation.

Soil will be excavated up to 30 feet bgs and disposed of at an appropriate licensed landfill. Clean, compacted imported fill material will replace the excavated contaminated soil. Following source soil removal activity, MNA would be implemented. MNA is the practice of allowing natural (physical, chemical and biological) processes in soil and groundwater to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in those media. MNA requires first establishing that conditions are favorable for those processes and monitoring to ensure they are occurring.

MNA processes include biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants. MNA is a viable approach where dissolved contaminant concentrations in groundwater are low, potential receptors are not in danger of being affected, and natural attenuation of contaminants is known or likely.

Alternative 5 – Bioremediation with Carbstrate© and Groundwater Recirculation Combined with Soil Vapor Extraction

This alternative combines elements of Alternative 2 and Alternative 3. Soil vapor extraction (SVE) is the process of removing contaminants from the soil in the vapor phase, by applying a vacuum to the subsurface. An SVE system consisting of a network of shallow wells connected to an air blower will be installed on the Site. The SVE system and associated wells will specifically target the vadose zone soil in the northern portion of the Site. Well spacings for an SVE system are typically 15-25 feet for the subsurface conditions found at the Site.

Groundwater treatment will be accomplished through bioremediation with Carbstrate© or similar bioremediation product, and groundwater recirculation. This alternative involves the pumping of groundwater from existing and new extraction wells at the Site, treatment of this water with a bioremediation product, and reinjection of this treated groundwater into the Site subsurface via injection wells. This method will also serve as the treatment of saturated soils which extend down to a depth of approximately 30 feet bgs. Proposed well locations associated with this alternative are shown in Supplemental RI/FS Figure 15.

Extracted groundwater pumped from the extraction wells will be amended with a bioremediation product, Carbstrate©, a nutrient-amended electron donor substrate, pH adjusted if necessary, and then re-injected into the aquifer through vertical injection wells, to stimulate anaerobic bioremediation of PCE and its' breakdown products. Injection wells would need to be placed at different depths, and over a large area to cover the entire plume. Injection wells would be installed with a rotosonic drill rig to reduce smearing of fine grained material if possible. This will reduce the chance of the injection wells being biofouled. Two of the existing extraction wells and one existing monitoring well will be converted to injection wells

Preferred Alternative

Alternative 5 – Bioremediation with Carbstrate© and Groundwater Recirculation Combined with Soil Vapor Extraction.

Based on the results of the Remedial Investigation and Feasibility Study conducted under MTCA and the application of the selection of remedy criteria, the Preferred Alternative chosen is Alternative 5, Bioremediation with Carbstrate© or similar bioremediation product, and Groundwater Recirculation Combined with Soil Vapor Extraction, developed in accordance with WAC 173-340-350 through 173-340-390.

1.1 Purpose

This document is the Cleanup Action Plan (CAP) for the Riverside HVOC Site located in Bothell, Washington. The general location of the Site is shown in Figures 1 and 2. A CAP is required as part of the site cleanup process under Chapter 173-340 WAC, Model Toxics Control Act (MTCA) Cleanup Regulations. The purpose of the CAP is to describe the preferred cleanup alternative for the Site determined from the Supplemental RI/FS. More specifically, this plan:

- Describes the Site;
- Summarizes current site conditions;
- Summarizes the cleanup action alternatives considered in the remedy selection process;
- Describes the selected cleanup action for the Site and the rational for selecting this alternative;
- Identifies site-specific cleanup levels and points of compliance for each hazardous substance and medium of concern for the proposed cleanup action;
- Identifies applicable state and federal laws for the proposed cleanup action;
- Identify residual petroleum contamination remaining on the Site after cleanup, if present and potential restrictions on future uses and activities to ensure continued protection of human health and the environment;
- Discusses performance and compliance monitoring requirements and plans; and
- Presents the schedule for implementing the CAP.

Under the terms of the Agreed Order with Ecology and the City of Bothell, a preliminary determination that a cleanup conducted in conformance with this CAP will comply with the requirements for selection of a remedy under WAC 173-340-360.

1.2 Previous Studies

This section contains summaries of previous environmental investigations conducted at the Riverside HVOC Site.

Years 1990-2009

During initial investigations on the Riverside property conducted in the early 1990s, petroleum contamination was discovered in the northwestern portions of the Riverside property, reportedly associated with historical gas station operations in this area (SEACOR, 1990; SEACOR 1991). Remedial excavations were conducted throughout the early 1990s which removed approximately 4,700 cubic yards of petroleum contaminated soil (RZA AGRA, 1992; GTI, 1993a; GTI, 1993b). Petroleum contaminated soils were treated on property using a bioremediation cell, and post-treatment soils were used to backfill the remedial excavation.

During 2008 site investigation activities, HWA discovered the presence of halogenated volatile organic compounds (HVOCs), specifically tetrachloroethylene (PCE), trichloroethylene (TCE), (cis) 1,2-dichloroethylene ((cis) 1,2-DCE), and vinyl chloride (VC) in groundwater above their respective Model Toxics Control Act (MTCA) Method A or Method B cleanup levels (HWA, 2008).

PCE was also detected in soils from location BC-3 at a concentration of 5.9 parts per million (ppm) and at location R-4 at a concentration of 9 ppm (see Figure 3 for locations of borings). The MTCA Method A cleanup level for PCE in soil is 0.05 ppm. HWA noted that these detections were collected from saturated soils and attributed the detections to groundwater contamination. HWA also stated that the HVOC contaminated groundwater was most likely migrating from an upgradient source.

An investigation was conducted by CDM in 2009 to assess soil and groundwater conditions along the former State Route (SR) 522, which at the time, bounded the Riverside property to the north-northeast. Groundwater samples collected north and northwest of the Riverside property along the former SR 522 reported concentrations of HVOCs in groundwater above their respective state cleanup levels (MTCA Method A cleanup levels). However, the CDM report noted that these detections were several orders of magnitude less than the HVOC contamination on the Riverside HVOC Site. CDM determined that the source of the HVOC contamination was associated with an unknown source located on-property and not associated with upgradient sources (CDM, 2009).

Supplemental groundwater sampling confirmed the presence of HVOC contamination in groundwater (Parametrix, 2009).

<u>Years 2013-2018</u>

A groundwater extraction/treatment system was installed and activated in January of 2013. The system originally consisted of four groundwater extraction wells (EW-1 through EW-4), screened over intervals ranging from 11 to 35 feet bgs. Two additional extraction wells were added in December 2016 (EW-5 and EW-6). Extraction wells were installed with approximately 40 foot spacing, dedicated submersible pumps, and connected to an enclosure via sub-grade piping within the Riverside HVOC Site. The extracted groundwater was then discharged to sanitary sewer. HWA noted that the total discharge is sampled quarterly prior to entering the sanitary sewer system to ensure that the effluent meets the King County sanitary sewer discharge limits for HVOCs and settleable solids.

Quarterly groundwater monitoring on the Riverside HVOC Site was resumed in 2014 following the installation of the groundwater treatment system and included sampling of the extraction wells in addition to the monitoring wells. Groundwater HVOC concentrations reportedly decreased over time although there were seasonal fluctuations noted as well.

HWA performed a Remedial Investigation (RI) report for the Riverside HVOC Site dated December 18, 2017 (HWA, 2017b) in which the original "Riverside Site", which encompassed the Riverside property, was delineated into two areas: the Riverside TPH Site and the Riverside HVOC Site. The report detailed the supplemental groundwater sampling as well as the implementation of a groundwater extraction system acting as an interim measure to prevent HVOC contaminated groundwater from entering the Sammamish River to the southeast. HWA also reportedly conducted a passive soil gas survey (HWA, 2016) in which a concentrated area of PCE was detected in the vicinity of RMW-12. The results suggested that there was potentially a source located near RMW-12.

HWA conducted a reconnaissance groundwater sampling study in 2017 to delineate the extent of the Ultra Custom Cleaners (an up-gradient cleanup site) HVOC groundwater plume (HWA, 2017a). One of the goals of the study was to determine if the Ultra Custom Cleaners site was a potential source for HVOC groundwater contamination on the Riverside HVOC Site. Ten borings were reportedly advanced to depths ranging between 40 and 45.5 feet bgs. Groundwater samples were collected from shallow (1-20 feet bgs), intermediate (18-34 feet bgs), and deep (35-45 feet bgs) intervals from each boring. Results indicated that the Ultra Custom Cleaners groundwater HVOC plume extended further southeast than expected, but concluded that it was unlikely to be the source of the HVOC groundwater contamination on the Riverside HVOC Site. The RI concluded that due to the absence of HVOCs detected above their respective cleanup levels in unsaturated soils, that there were no contaminants of concern (COCs) for Riverside HVOC Site soils.

However, the RI report confirmed the presence of PCE, TCE, (cis) 1,2-DCE, and vinyl chloride as COCs in groundwater, and stated that the "impacts are being addressed by the on-going second interim action (pump and treat)". While not explicitly explained in the text, the groundwater analytical tables listed Riverside HVOC Site specific cleanup levels for the groundwater COCs. The cleanup levels used were 0.69 parts per billion (ppb) for PCE, 2.5 ppb for TCE, 16 ppb for (cis) 1,2-DCE, and 0.2 ppb for vinyl chloride.

HWA completed a Draft Feasibility Study Report (dFS) for the Riverside HVOC Site dated February 7, 2018 (HWA, 2018a). The report outlined the primary source of contamination as a "small release of PCE to the ground somewhere at the north (upgradient) end of the Riverside HVOC area". The report stated that the primary exposure route was HVOC contaminated groundwater migrating into the Sammamish River (surface water), where pathways included dermal contact and ingestion of water or ingestion of aquatic species by both human (recreational users) and ecological (aquatic species) receptors. Soil was not considered as a potential exposure pathway due to the absence of any soils detected above applicable cleanup levels and vapor was not considered due to the absence of present or planned buildings in the area.

According to the dFS report, due to the proximity of the HVOC contaminated groundwater to the Sammamish River, surface water cleanup levels were proposed by HWA. The dFS report also noted that the surface water MTCA Method B cleanup level for human health of 0.69 ppb was listed for PCE, per the U.S. EPA Clean Water Act §304 Federal Ambient Water Quality Criteria applicable or relevant and appropriate requirements (ARARs). For TCE, the surface water MTCA Method B cleanup level for human health – fresh water of 2.5 ppb was listed, also per the U.S. EPA Clean Water Act §304 Federal Ambient Water Quality Criteria ARARs. The groundwater MTCA Method B non-carcinogen cleanup level of 16 ppb was listed for (cis) 1,2-DCE. For vinyl chloride, HWA selected 0.2 ppb as the cleanup level due to the value being the "practical quantitation limit / reporting limits achievable by local accredited labs".

The dFS report also evaluated several remedial alternatives. In-situ groundwater treatment technologies evaluated included chemical oxidation, chemical reduction, bioremediation, air sparging, and soil vapor extraction. Pump and treat alternatives were also considered with various treatment methods including carbon adsorption, air stripping, and discharge to sanitary sewer, and the concepts of recirculating extracted groundwater versus discharge were also considered. Permeable reactive barriers were considered as was monitored natural attenuation. Ultimately, HWA determined that the recommended remedial alternative was to pump and treat groundwater with discharge to sanitary sewer. The proposed final cleanup action would be to continue the interim action which began in 2014.

Additional Soil and Groundwater Sampling – HWA November 9, 2018

Following the RI and Draft FS, HWA completed an *Additional Soil and Groundwater Sampling* report dated November 9, 2018 (HWA, 2018b). In October of 2018, HWA advanced eight borings on the Riverside HVOC Site for collection of soil and groundwater samples. Each boring location was also surveyed so that groundwater elevation could be calculated, and hydraulic control of the groundwater treatment system could be assessed across the Site.

At boring location RB-25, PCE and TCE were detected in a soil sample collected at 13 feet bgs at concentrations (0.46 ppm and 0.052 ppm, respectively) above their MTCA Method A cleanup levels (0.05 ppm and 0.03 ppm, respectively). The sample was reportedly collected in unsaturated soils which were identified as "fill material". Temporary groundwater samples collected from the boring locations reported relatively high concentrations of HVOCs in groundwater with PCE detections ranging between 200 ppb to

0.56 ppb. The PCE groundwater cleanup level proposed by HWA in this report was 0.69 ppb and the proposed TCE groundwater cleanup level was 2.5 ppb.

The highest concentration of PCE in groundwater was collected from RB-25 (where soil exceedances were noted) with a reported concentration of 200 ppb. Elevated concentrations of PCE in groundwater were also noted at RB-32 (110 ppb) and the highest concentration of vinyl chloride was reported at RB-31 (13 ppb) both located just down gradient (southeast) of EW-2. Groundwater results are included in Table 2. Boring locations were surveyed, and a groundwater gradient was calculated to flow generally to the southeast. The water elevation survey also noted groundwater drawdown around the extraction wells EW-1 through EW-4, and EW-6. The report stated that this suggested that "from somewhere east of EW-1 to RMW-6 (west of EW-4), which encompasses the east-west extents of the HVOC plume is effectively captured by pumping wells."

Interim Action Report – Kane Environmental December 31, 2019

Kane Environmental completed an *Interim Action Report* for the Site dated December 31, 2019. The report reviewed additional historical information regarding potential source areas on the Site, summarized soil and groundwater data, responded to Ecology comments, and evaluated the effectiveness of the pump and treat system operating on the Site.

The report stated that a structure was constructed on the eastern end of Riverside HVOC Site in 1944 for use as a machine shop, pump repair, and "fixit" shop, and operated through at least 1960. The report concluded that the former machine shop located on the Riverside HVOC Site represented a potential source for the HVOC contamination in both soil and groundwater at the Site.

Groundwater samples were also collected from all monitoring wells and operational extraction wells located on the Site. Detectable concentrations of PCE ranged from 16 ppb to 0.51 ppb, detectable concentrations of TCE ranged between 4.7 ppb and 0.39 ppb, detectable concentrations of (cis) 1,2-DCE ranged between 33 ppb to 0.22 ppb, and detectable concentrations of vinyl chloride ranged between 27 ppb and 0.57 ppb. Based on these results, and after a review of historical groundwater results for the Site, the report determined that the pump and treat system on the Site was "not an effective remedial strategy to consider moving forward". Kane Environmental recommended evaluating other remedial strategies in a Supplemental FS

The report also evaluated the cleanup levels proposed for Site groundwater in the 2018 dFS following comments from Ecology. The report concluded that several updates to federal and state Applicable or Relevant and Appropriate Requirements (ARARs) had not been considered by the 2018 dFS, and therefore the cleanup levels proposed were not valid. Kane Environmental recommended revaluating the federal and state ARARs in a Supplemental FS.

1.3 Regulatory Framework

The Riverside HVOC Site is currently listed in Ecology's database as Facility Number 93061 and CSID # 14970. The Site is currently listed as Agreed Order site DE 16541. However, a new Agreed Order will be completed for the Site following the completion of the CAP.

2.0 SITE DESCRIPTION

2.1 Site History

The City acquired a two-acre property (historical Riverside property) in 1990 which included King County Assessor tax parcels 082605-9120, 082605-0284, and 082605-0031. Following the relocation of SR 522, the area was re-parceled. The Site is located on the eastern portion of parcel 082605-9120 which is currently utilized as a vacant gravel parking lot and City of Bothell park.

Based on the available information, a structure was constructed on the eastern end of Riverside HVOC Site in 1944 for use as a machine shop, pump repair, and "fixit" shop, and operated through at least 1960. Due to the operations conducted during that time period, it is possible that halogenated solvents were used on the Riverside HVOC Site and over time, releases may have occurred, adversely impacting the subsurface. The historical presence of a machine shop on the Riverside HVOC Site represents a potential source for the HVOC contamination in both soil and groundwater at the Riverside HVOC Site (Kane Environmental, 2019).

2.2 Human Health and Environmental Concerns

The Supplemental RI/FS identified exposure pathways of contaminants of concern (COCs) at the Site. Based on the nature and the extent of contamination, the likely greatest potential risks to human receptors are dermal contact of soil and/or groundwater to construction workers during soil-disturbing activities and dermal contact of surface water to recreational users. Another most likely exposure risk is inhalation of vapors during soil-disturbing activities or by commercial workers and/or residents.

These risks can be mitigated under a cleanup action that either removes the contaminants to levels that are protective to receptors which is preferred by the MTCA, or that places institutional or engineering controls to prevent exposure, following MTCA requirements.

Based on the nature and extent of contamination, the likely greatest potential risk to ecological receptors include incidental soil ingestion and dermal contact, as well as ingestion and direct contact with groundwater and surface water. Based on the exposure pathways analysis, the land use on the Site and the surrounding area make wildlife exposure possible, so a Simplified Terrestrial Ecological Evaluation (TEE) was completed for the Riverside HVOC Site. Based on the results of the Simplified TEE, the Riverside HVOC Site does not require a site-specific ecological evaluation.

See Figures 4 and 5 for the human health and ecological exposure Conceptual Site Models.

2.3 Cleanup Standards

The COCs in soil and groundwater for Riverside HVOC are described below.

The selected cleanup levels for the identified Contaminants of Concern in soil are as follows:

MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses (WAC 173-340-900, Table 740-1) and MTCA Method B (WAC 173-340-900, Equations 740-1 and 740-2):

- PCE 0.05 mg/kg
- TCE 0.03 mg/kg
- (cis) 1,2-DCE 160 mg/kg (Method B)
- VC 0.67 mg/kg (Method B)

Due to the proximity of the Site to the Sammamish River, the groundwater cleanup levels selected for Site COCs are protective of surface water, where applicable. The selected cleanup levels for the identified Constituents of Concern in groundwater are as follows:

MTCA Cleanup Levels for Groundwater based on Surface Water Standards– Human Health Fresh Water (WAC 173-201A) and MTCA Method B Noncancer (WAC 173-340-900, Equation 720-1):

- PCE 4.9 ug/L
- TCE 0.38 ug/L
- (cis) 1,2-DCE 16 ug/L (Method B, no surface water cleanup level)
- VC 0.02 ug/L

The points of compliance are the locations at which cleanup levels for the Contaminants of Concern (COCs) must be attained to meet the requirements of MTCA and support issuance of an NFA determination for the

Site. In accordance with WAC 173-340-740(6), the point of compliance for soil is all vadose zone soil within the boundaries of the Site. In accordance with WAC 173-340-720(8), the point of compliance for groundwater is all groundwater within the boundaries of the Site. The point of compliance for saturated soils is all groundwater within the boundaries of the site.

3.0 DESCRIPTION OF SELECTED REMEDY

3.1 General Description of the Cleanup Action

Based on the results of the Supplemental Remedial Investigation and Feasibility Study conducted under MTCA (Kane Environmental, 2022) and the application of the selection of remedy criteria, the Preferred Alternative is Alternative 5 (Bioremediation with Carbstrate© and Groundwater Recirculation Combined with Soil Vapor Extraction), developed in accordance with WAC 173-340-350 through 173-340-390. Alternative 5 will be implemented as the primary alternative for source control and plume remediation. Alternative 5 was chosen because it is an active remedial action by 24/7 dosing of remediation product through injection wells directly into the groundwater, resulting in reduction of COC concentrations within months of project startup. Furthermore, the active groundwater recirculation system will maintain hydraulic control of the existing contaminant plume within its current extent, while over time reducing its size through active bioremediation.

3.2 Bioremediation with Carbstrate© and Groundwater Recirculation Combined with Soil Vapor Extraction

This alternative combines SVE with bioremediation to effectively remediate HVOC contamination in soil and groundwater.

The Site currently contains an interim action groundwater pump and treat system where groundwater is pumped from several extraction wells and discharged to sanitary sewer. During the implementation of the preferred remedial action, infrastructure associated with this system will either be decommissioned or retrofitted for use in the preferred remedial action described below.

3.2.1 Soil Vapor Extraction

Soil vapor extraction (SVE) is the process of removing contaminants from the soil in the vapor phase, by applying a vacuum to the subsurface. This is done through the use of a series of wells which are placed throughout the area of contamination and screened in unsaturated soils (vadose zone) above the groundwater table. The SVE system will specifically target the vadose zone soil contamination in the northern portion of the Site.

SVE wells will be installed to depths of approximately 15 feet bgs throughout the northern portion of the Site. Screened intervals will vary depending on subsurface conditions. Proposed locations of SVE wells associated with this alternative are shown in Figure 6. Well spacings for an SVE system are typically 15-25 feet for the subsurface conditions found at the Site. Any investigation derived waste (IDW) generated during the installation of the SVE wells will be contained in 55-gallon steel drums and disposed of off-Site at an appropriate licensed disposal facility.

The SVE wells are connected via subsurface conveyance lines to an air blower, which draws a vacuum. With the reduced pressure, air begins to move through the subsurface drawing out the contaminant vapors. Based on the known concentrations of COCs in soil and groundwater, the withdrawn air will not require an air discharge permit. The vapors are run through a remediation system, and then discharged into the atmosphere under state and local permit requirements. The process of soil vapor extraction is enhanced when the surface is covered by a cap of asphalt and/or concrete, minimizing the amount of ambient air drawn into the system. Due to the elevation change in the northern portion of the Site and its current use as a gravel parking lot, installation of a concrete or asphalt cap may be infeasible. The SVE system including the blower, air treatment, and discharge, will be located near or within the remedial enclosure currently located on the Site.

The SVE system will be monitored throughout operation. Periodically, influent vapor samples will be collected from the SVE combined extraction inlet. Samples will be collected using a photoionization detector (PID) or using tedlar bags for laboratory analysis. Performance air sampling will be conducted on a monthly basis until concentrations have achieved asymptotic conditions. Once air concentrations have stabilized, confirmation soil sampling will be conducted on the Site using a drill rig. Detailed engineering specifications will be provided in the Engineering Design Report.

The estimated restoration timeframe for the SVE component of this alternative is two to three years.

3.2.2 Bioremediation with Carbstrate© and Groundwater Recirculation

Groundwater treatment will be accomplished through bioremediation with Carbstrate© or similar bioremediation product, and groundwater recirculation. This alternative involves the pumping of groundwater from existing and new extraction wells at the Site, treatment of this water with a bioremediation product, and reinjection of this treated groundwater into the Site subsurface via injection wells. This method will also serve as the treatment of saturated soils which extend down to a depth of approximately 30 feet bgs. Proposed well locations associated with this alternative are shown in Figure 6.

Extracted groundwater pumped from the extraction wells will be amended with a bioremediation product, Carbstrate©, or similar bioremediation product, a nutrient-amended electron donor substrate, pH adjusted if necessary, and then re-injected into the aquifer through vertical injection wells, to stimulate anaerobic bioremediation of PCE and its' breakdown products. Figure 6 depicts a simplified injection path from the proposed injection wells, along with the approximate capture radius of the proposed extraction wells.

Injection and extraction wells will need to be placed at different depths, and over a large area to cover the entire plume. The proposed bioremediation and groundwater recirculation well network will consist of approximately nine total injection wells and four total extraction wells. Of the nine injection wells, six will be newly installed, two will be former extraction wells (EW-3 and EW-1) converted into injection wells, and one will be the former monitoring well RMW-14, converted into an injection well. Of the four extraction wells, two will be newly installed in the area to the southeast of current extraction wells EW-5 and EW-6 (which will be repurposed as monitoring wells), and two will be the existing extraction wells EW-2 and EW-4. All new and existing injection and extraction wells will be 4-inch diameter PVC wells, variously screened between 10 and 35 feet bgs. Any IDW generated during the installation of the injection or extraction wells will be contained in 55-gallon steel drums and disposed of off-Site at an appropriate licensed disposal facility.

The groundwater recirculation system will be operated using aboveground equipment housed either in the current remediation enclosure located on Site or a separate secure weatherproof enclosure. Equipment contained within this enclosure will include: a 200-gallon poly tank to contain the concentrated Substrate injection solution ("solution tank"); an air compressor; a programmable logic controller (PLC) system; and injection and extraction manifolds, with their respective pressure gauges, ball valves, flow meters and sampling ports. In addition, two 500-gallon polyethylene tanks to hold the extracted groundwater ("holding tanks") and a 150-gallon activated carbon drum will be located immediately outside the enclosure. Groundwater extracted through the extraction wells will be pumped through underground conveyance lines to the pre-treatment holding tank. The pre-treatment holding tank will contain a high/high, high, and low float for logic control.. A transfer pump will pump the groundwater from the pre-treatment tank through a GAC vessel, and into the post-treatment holding tank (also containing three floats for logic control). The in-situ delivery (ISD) system will pull treated groundwater from the post-treatment holding tank, and amend it automatically using a metering peristaltic pump connected to a small substrate solution/mixing tank located inside the remediation enclosure. The concentrated substrate solution will be metered into the injection header at a specified rate when the system is in the injection mode. The ISD system will inject the groundwater containing the substrate to the desired injection wells via subsurface conveyance lines, based on set times and rates dictated by the operator. The proposed injection schedule, and the performance and confirmation monitoring plans will be included in the Engineering Design Report. Weekly visits to the Site to monitor flow rates, pump operation, and add substrate material to the solution tank will be required.

Prior to activation of the bioremediation and groundwater recirculation system, the quantification of Dehalococcoides, the only known bacterial group capable of complete reductive dechlorination of PCE to ethene, will be conducted. This is an important component of assessment, remedy selection, and performance monitoring at sites impacted by chlorinated solvents. Kane Environmental proposes to sample up to 5 wells using the QuantArray®-Chlor prepared by Microbial Insights of Knoxville, Tennessee. Quantifying Dehalococcoides will determine the amount of Carbstrate© product needed, instead of applying the same amount of product in each cell, resulting in a focused and cost-savings approach to our remedial strategy. Other not currently known bacteria may also be found at the Site from these analyses, which will assist in the remediation design.

Due to the public nature of the Site, security fencing will need to be erected around the remedial enclosure(s) and associated above ground poly tanks to be installed on the Site. This will prevent damage to equipment and limit public exposure to any materials contained within.

In order to monitor the progress of the bioremediation and groundwater recirculation system, groundwater samples will be collected from Site monitoring wells on a quarterly basis and analyzed for Site COCs and additional chemical parameters. Quarterly performance monitoring will be conducted at the Site for one year, after which, bi-annual performance monitoring will be conducted for the remainder of the system operation. Bi-annual Performance monitoring will be conducted until the Site-specific cleanup levels have been achieved for all Site COCs. After the completion of performance monitoring, two years of quarterly groundwater compliance monitoring will be conducted. Once groundwater compliance has been achieved, and with the concurrence of Ecology, Site groundwater monitoring wells, and injection and extraction wells, will then be decommissioned. The performance and compliance groundwater monitoring plan will be included in the Engineering Design Report.

The estimated restoration timeframe for the bioremediation and groundwater recirculation component of this alternative is five years.

3.3 Post-Remediation

The Bioremediation with Carbstrate© or similar bioremediation product, and Groundwater Recirculation Combined with Soil Vapor Extraction is expected to attain MTCA cleanup levels for Site COCs in soil and groundwater within approximately five years. If areas of the Site are not in compliance with cleanup levels despite remediation efforts in the CAP, engineering and/or institutional controls (environmental covenant) in order to be protective, may be added to compliance groundwater monitoring. This alternative is protective of human health and the environment, considers public concerns through a public comment period, complies with applicable state and federal laws, includes performance and compliance monitoring, provides a permanent solution to the maximum extent practicable at the Site within a reasonable timeframe, and was evaluated using disproportionate cost analysis.

3.4 Permitting

The installation of the SVE and bioremediation and groundwater recirculation systems will be properly permitted through the appropriate regulatory agencies. The Site already receives electrical service for the interim action pump and treat system currently located on the Site. Any alterations to this service to facilitate implementation of the SVE and groundwater bioremediation and recirculation system will be properly permitted. In addition, UIC registration and approval from the Washington State Department of Ecology will be required to re-inject extracted and treated groundwater containing Carbstrate®.

3.5 System Performance Criteria and Performance Monitoring

During the operation of the SVE system, air samples will periodically be collected and analyzed for:

- Halogenated volatile organic compounds (HVOCs) by EPA Method TO15;

For baseline and bioremediation and groundwater recirculation system performance monitoring data, groundwater samples will be collected from the Site monitoring wells and analyzed for the following:

- HVOCs by EPA Method 8260;
- Ammonia-nitrogen by EPA Method 350.1;
- Sulfate-sulfur (EPA 375.4 MOD).
- Methane/ethene/ethane
- Total organic carbon (TOC).
- Dissolved iron and chloride

In addition, groundwater quality parameters including temperature, conductivity, oxidation reduction potential (ORP), dissolved oxygen (DO) and pH should be taken during sampling events.

4.0 HEALTH AND SAFETY PLAN

A Site-Specific Health and Safety Plan (HASP) will be followed when performing field activities. The HASP will comply with the requirements of Title 29 of the Code of Federal Regulations, Part 1910 (20 CFR 1910), collectively referred to as "Hazardous Waste Operations and Emergency Response (HAZWOPER)". The HASP identifies physical, industrial, chemical and biological hazards, establishes hazard monitoring action levels, specifies the required Personal Protective Equipment (PPE), and includes a map showing the route to the nearest hospital with an emergency medical facility. The HASP will be in the Engineering Design Report. A copy of the HASP will be maintained at the work area, and all visitors will be provided a health and safety briefing prior to commencing with their activities.

5.0 APPLICABLE, RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Potential ARARs were identified for each medium of potential concern. The primary ARARs relating to the cleanup action include:

- Cleanup Regulations, WAC 173-340;
- Clean Water Act, 33 U.S.C. §1251 et seq.;
- Dangerous Waste Regulations, WAC 173-303;
- Clean Air Act (42 USC 7401);
- Safe Drinking Water regulations, 40 CFR 141; and,
- Washington Underground Injection Control Program, WAC 173-218.

These primary ARARs are anticipated to be the most applicable to the cleanup action because they provide the framework for the cleanup action, including applicable and relevant regulatory guidelines, cleanup standards, waste disposal criteria, references for additional ARARs, and standards for documentation of the cleanup action.

Other applicable ARARs and guidance documents for cleanup of the Site may include:

- Washington Clean Air Act and Implementing Regulations, (RCW 70.94); WAC 173-400; WAC 173-460; WAC 173-490; WAC 173-340-750;
- Occupational Safety and Health Act, Part 1910 of Title 29 of the Code of Federal Regulations (29 USC 653, 655, 657 and WAC 296-62;
- Safety Standards for Construction Work, WAC 296-155; and Washington Industrial Safety & Health Act (RCW 49.17);
- Resource Conservation and Recovery Act (42 USC 6921-6949a: 40 CFR Part 268, Subtitles C and D);
- Solid Waste Disposal Act (42 USC Sec. 325103259, 6901-6991;40 CFR 257,258) and Federal Land Disposal Requirements (40 CFR part 268);
- Solid Waste Management, Reduction and Recycling, RCW 70.95;
- Minimum Functional Standards for Solid Waste Handling, WAC 173-304;
- Criteria for Municipal Solid Waste Landfills, WAC 173-350 and 173-351;
- Minimum Standards for Construction and Maintenance of Wells, WAC 173-160;

- Accreditation of Environmental Laboratories, WAC 173-50;
- National Recommended Water Quality Standards (40 CFR 131)
- Regulation and Licensing of Well Contractors and Operators (WAC 173-162);
- Drinking Water Standards – State MCLs (WAC 246-290-310);
- Washington State Maximum Contaminant Levels (WAC 246-290-310), and
- SEPA Rules (RCW 43.21C, WAC 197-11);
- Exemption from Substantial Development Permit (City of Bothell), and
- Right of Way Permit (City of Bothell).

6.0 RESTORATION TIMEFRAME

The SVE and bioremediation and groundwater recirculation system components of the remedial action will be conducted simultaneously. Performance air sampling and groundwater monitoring will be conducted during the remedial action activity. Compliance soil sampling will be conducted following the completion of the SVE portion of the remedial activity and compliance groundwater monitoring will be conducted after completion of the performance groundwater monitoring. The estimated timeframe for the SVE portion of the remedial action is two to three years. The estimated timeframe for the bioremediation and groundwater recirculation system portion of the remedial action is five years.

7.0 PERFORMANCE AND COMPLIANCE MONITORING

Performance air sampling and groundwater monitoring will be conducted during the remedial action activity. Confirmation soil sampling will be conducted following the conclusion of the SVE portion of the remedial action and confirmation groundwater sampling will be conducted following the conclusion of the bioremediation and groundwater recirculation portion of the remedial action.

During the SVE system operation, influent vapor samples will be collected from the SVE combined extraction inlet prior to treatment. Samples will be collected using a photoionization detector (PID) or using tedlar bags for laboratory analysis. Performance air sampling will be conducted on a monthly basis until concentrations have stabilized to asymptotic conditions. Once vapor concentrations have reached the asymptotic lower limit, confirmation soil sampling will be conducted within the area of the SVE system. Soil borings will be advanced using a direct push drill rig and vadose zone soils samples will be collected for analysis to confirm that HVOC concentrations have been reduced to concentrations below their cleanup levels in Site vadose zone soils.

Quarterly groundwater performance monitoring will be conducted in Site wells during the first year of operation of the bioremediation and groundwater recirculation system. After the first year of quarterly groundwater performance monitoring, bi-annual groundwater performance monitoring will be conducted for the remainder of the system operation. Groundwater samples will be analyzed for Site COCs as well as analytes used to monitor Site groundwater conditions and asses the progress of the anaerobic breakdown. Once performance groundwater samples indicate that concentrations of Site COCs have decreased to below their Site-specific cleanup levels, groundwater compliance monitoring will be conducted quarterly for two years. If Site COCs remain in groundwater at concentrations greater than Site-specific cleanup levels following two years of compliance groundwater sampling, a contingency for one additional year of quarterly sampling will be introduced. If Site COC groundwater cleanup levels have still not been achieved after the one additional year of compliance monitoring, an environmental covenant be placed on the Site which will include a compliance sampling event every five years for periodic review for the duration of the environmental covenant.

The results of the remedial action and subsequent compliance monitoring will be documented in a Site Cleanup Action Report, which will be submitted to Ecology.

8.0 SCHEDULE FOR REMEDIATION SYSTEMS IMPLEMENTATION

The proposed schedule is provided in Table 1 below:

Table 1
Site Schedule of Work and Deliverables

	Deliverables	Due (Calendar Days)
	A. Administrative	
A.1	Effective Date	Date Agreed Order is signed by Ecology
A.2	Progress Reports	Quarterly on the 10th of the month beginning after the Effective Date
	B. Design	
B.1	Draft Pre-Remedial Design Investigation (PRDI) Project Plans [1]	Within 60 days of the Effective Date
B.2	Draft PRDI Data Report and Draft Engineering Design Report (EDR) [2]	Within 90 days of Ecology approval of Final PRDI Project Plans
B.3	Final PRDI Data Report and EDR Report	Within 30 days of receipt of Ecology's final comments on the Draft PRDI Data and EDR Reports[3]
B.4	90 % Plans and Specs [per WAC 173-340-400(4)(b)]	Within 30 days of receipt of Ecology final comments on Final EDR Report
B.5	100 % Plans and Specs	Within 15 days of receipt of Ecology final comments on 90% plans and specifications
	C. System Construction and Operation	
C.1	Phase 1 Remedial Action Construction: Install and begin operation of Soil Vapor Extraction and Initial Phase of Bioremediation/Groundwater Recirculation System	Within 180 days following receipt of Ecology final comments on 90% plans and specifications
C.2	Install compliance monitoring well network	Within 180 days following receipt of Ecology final comments on 90% plans and specifications
C.3	Phase 1 Construction Summary and As-Built Drawings	90 days following Phase 1 Construction
C.4	Contingent Phase 2 Remedial Action Construction	Contingent on results of evaluation[5] of Phase 1 compliance, performance, and confirmation sampling. If Phase 2 is determined to be necessary, initiate within 120 days following evaluation of Phase 1 to proceed.
C.5	Cleanup Action Report and As-Built Drawings and Report; Draft Environmental Covenant(s); and an updated Title Report	Within 120 days of Construction Completion[4]

D. Post Construction Work		
D.1	Final Environmental Covenant(s)	Within 30 days of receipt of Ecology comments on the Draft Environmental Covenant.
D.2	Record Final Environmental Covenant(s) with King County Auditor	Within 15 days after Ecology's signature as grantee of the Final Environmental Covenant
D.3	<u>Performance Groundwater Monitoring</u> Quarterly Performance Monitoring Biannual Performance Monitoring	Quarterly performance groundwater monitoring for one year starting Fall 2023 After completing one year of quarterly performance groundwater monitoring, biannual performance groundwater monitoring until groundwater meets applicable cleanup levels in CAP
D.4	Decommission Soil Vapor Extraction and Bioremediation/Groundwater Recirculation system	Upon attainment of cleanup levels in performance groundwater monitoring wells
D.5	<u>Groundwater Confirmation Monitoring</u> Quarterly Compliance Monitoring	Quarterly for two years following completion of performance monitoring.
D.6	Five Year Compliance Monitoring and Periodic Review reports	To follow Groundwater compliance monitoring (D.5). Groundwater monitoring required once every five years for the duration of the institutional controls on groundwater (if present) under the environmental covenant.

1) *Project Plans include the following: Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan, and Health and Safety Plan, to be submitted for Ecology review and approval. All plans will include a schedule for implementation as applicable.*

2) *The Engineering Design Report includes: Construction Quality Assurance Project Plan, Compliance Monitoring and Contingency Response Plan, Proposed Best Management Practices, Water Quality Monitoring Plan, and Substantive Requirements of Procedurally Exempt Permits. Ecology will not approve the Final EDR until the required permits have been obtained.*

3) *Note: Assume 30-days for each round of Ecology comments for draft and final documents*

4) *Construction completion is defined as: completion of Phase 1 construction and compliance, performance, and confirmation sampling and evaluation or completion of contingency Phase 2 construction, if Phase 2 is determined to be necessary.*

5) *Timing of the Phase 1 Evaluation will be determined and presented in the EDR.*

A groundwater compliance sampling contingency, which would extend the groundwater compliance monitoring for one year, will be started at the end of the proposed compliance monitoring if Site COC groundwater cleanup levels have not been reached. After the one additional year, if Site COC groundwater cleanup levels have still not been reached, an environmental covenant will include a compliance sampling event every five years for periodic review for the duration of the environmental covenant.

9.0 INSTITUTIONAL/ENGINEERING CONTROLS

If COCs remain in Site soil or groundwater after cleanup, or any of the other criteria for triggering an institutional control under WAC 173-340-440 are met, institutional controls may be implemented, which may include an environmental covenant. Vapor intrusion risks will be addressed by the active remediation of contaminated soil and groundwater at the site. Engineering controls, such as vapor barriers, or other vapor intrusion mitigation methods, will be implemented for development of new structures and included in the environmental covenant.

10.0 PUBLIC PARTICIPATION

This criterion considers 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, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site. A Public Participation Plan and Fact Sheet for the 30-day comment period will be prepared for review for the amended Agreed Order as required under MTCA.

11.0 REFERENCES

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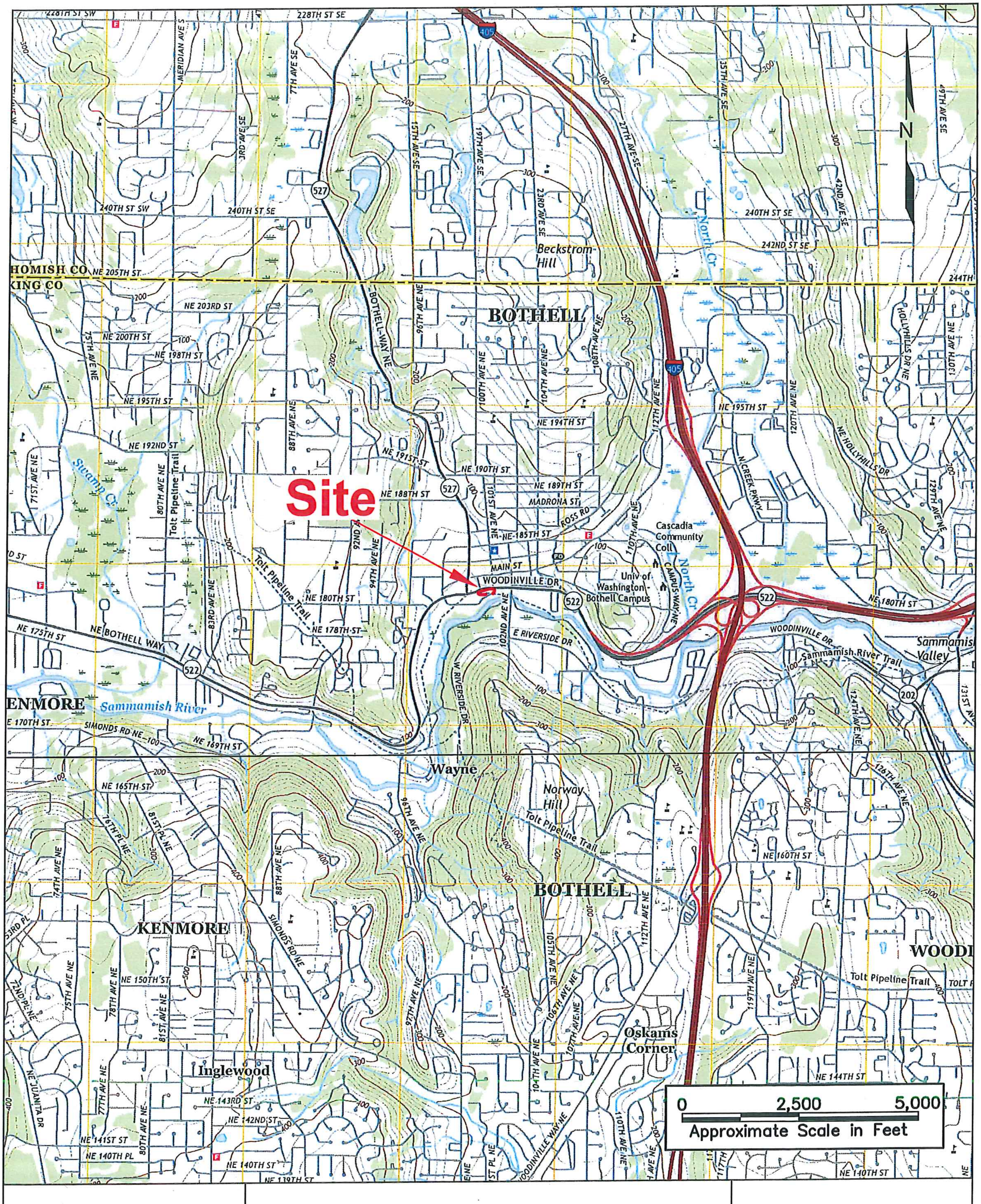
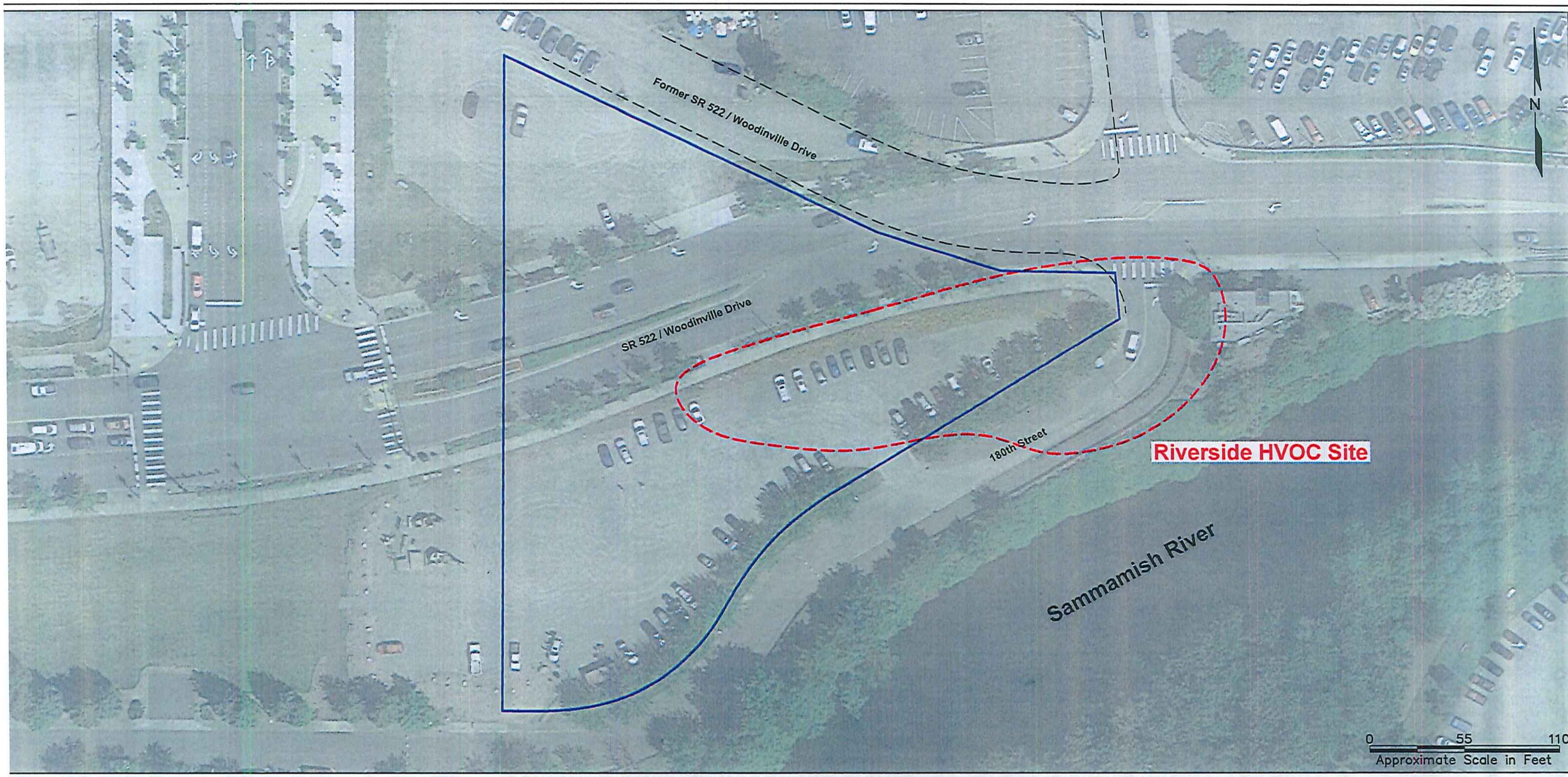
Figures



Cleanup Action Plan
Riverside HVOC Site
Bothell, Washington 98011

Figure 1
Vicinity Map



LEGEND

- Approximate location of historical Riverside property
- Approximate location of Riverside HVOC Site Boundary

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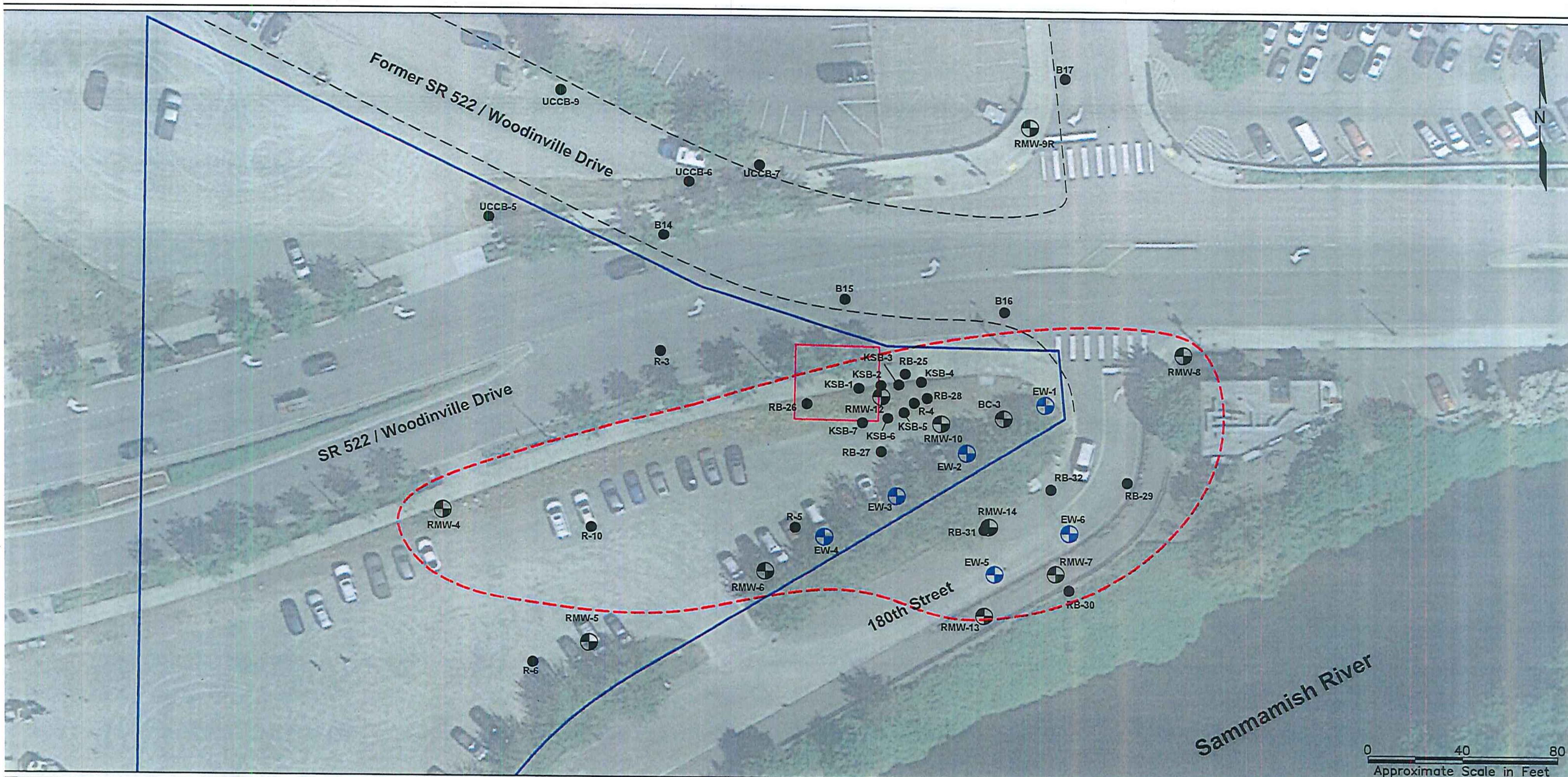
Cleanup Action Plan
Riverside HVOC Site
Bothell, Washington 98011

Figure 2
Area Site Plan



LEGEND

- Approximate location of monitoring well
- Approximate location of extraction well
- Approximate location of soil boring
- Approximate location of historical machine shop
- Approximate location of historical Riverside property
- Approximate location of Riverside HVOC Site Boundary

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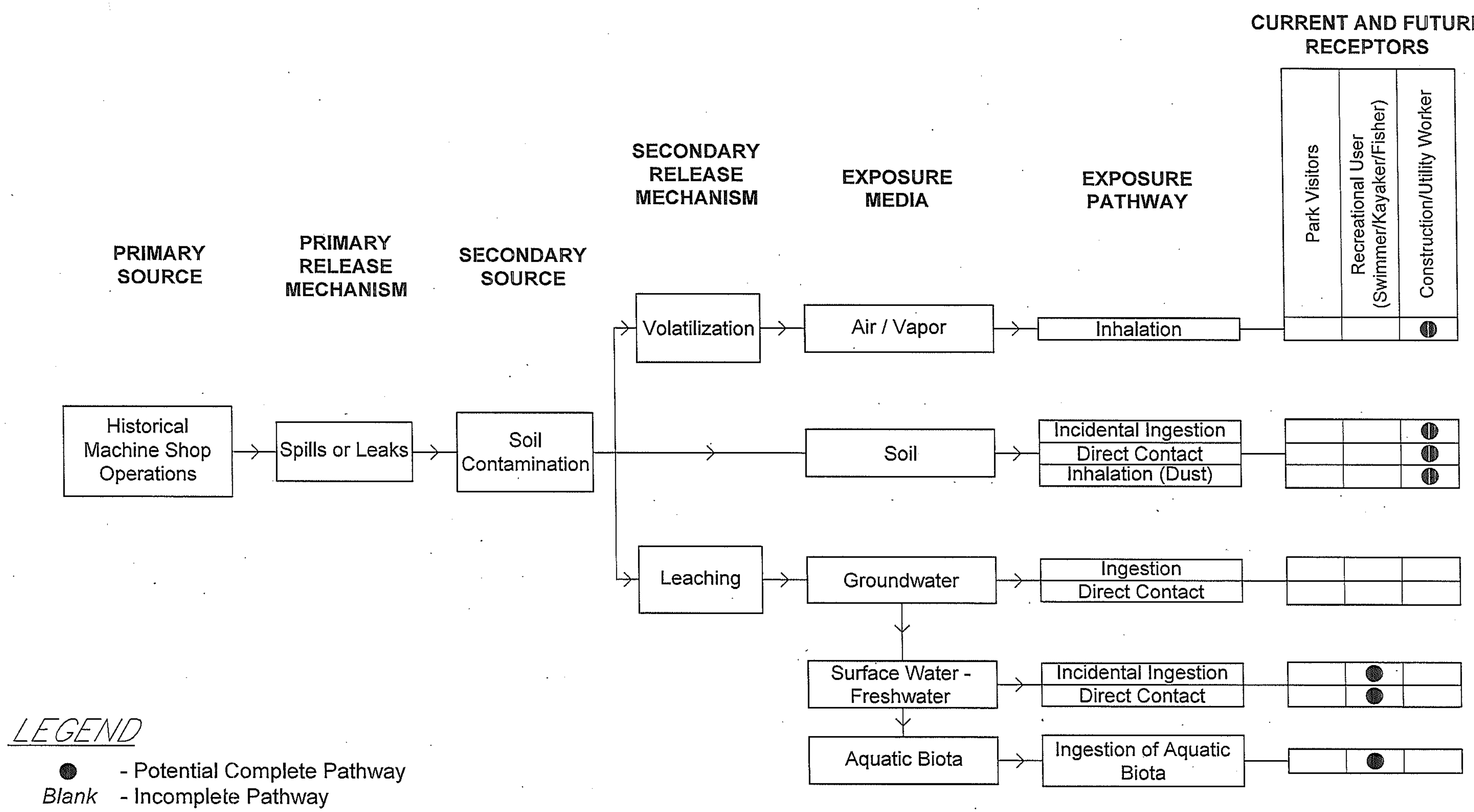
Cleanup Action Plan
Riverside HVOC Site
Bothell, Washington 98011

Figure 3
Site Plan



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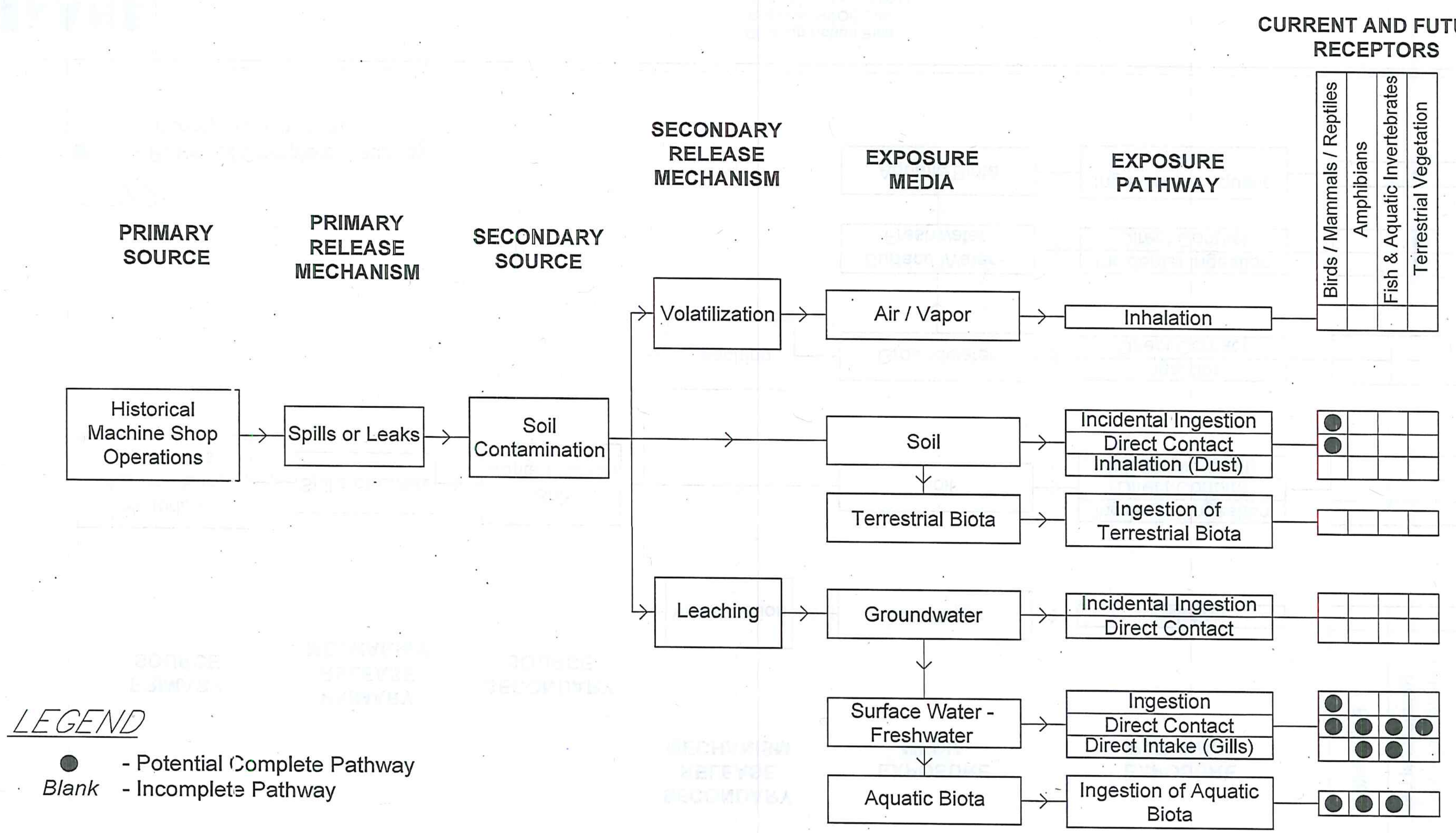
Cleanup Action Plan
Riverside HVOC Site
Bothell, Washington 98011

Figure 4
Conceptual Site Model
For Human Exposures



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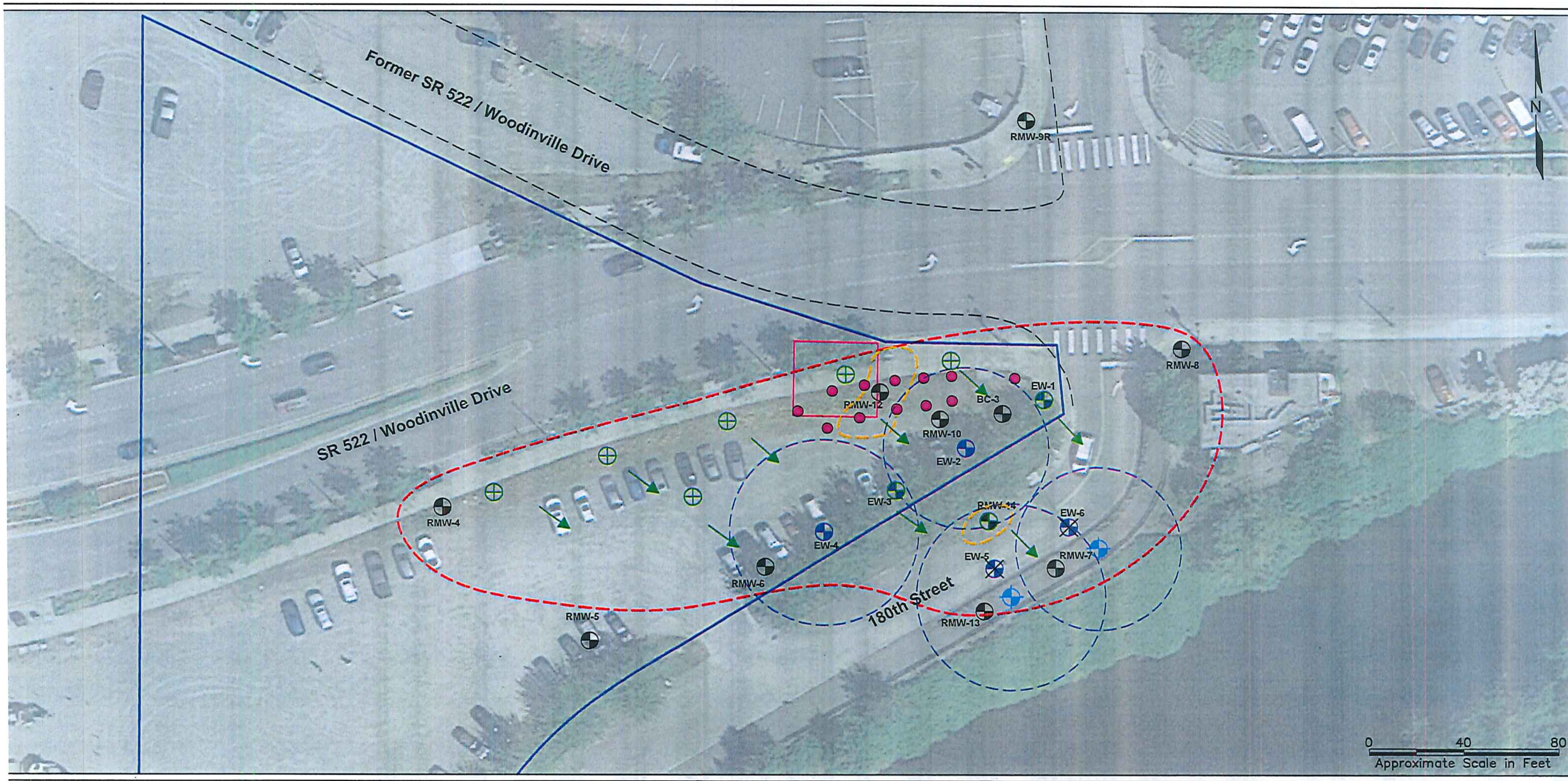
Cleanup Action Plan
Riverside HVOC Site
Bothell, Washington 98011

Figure 5
Conceptual Site Model For Ecological Exposures



LEGEND

- Approximate location of monitoring well
- Approximate location of extraction well
- Approximate location of historical machine shop
- Approximate location of historical Riverside property
- Approximate location of Riverside HVOC Site Boundary and approximate extent of groundwater containing HVOCs contaminants above Site-specific cleanup levels
- Approximate extent of soil containing HVOC contaminants at concentrations exceeding MTCA Method A/B Cleanup Levels
- Approximate location of new bioremediation injection well
- Approximate location of existing monitoring/extraction well to be converted to bioremediation injection well
- Approximate location of existing extraction well to be used as monitoring well
- Approximate location of new extraction well
- Approximate location of soil vapor extraction well
- Simulated groundwater injection product path
- Simulated groundwater extraction radius of influence

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Cleanup Action Plan
Riverside HVOC Site
Bothell, Washington 98011

Figure 6
Preferred Remedial Alternative

Exhibit C Schedule of Work and Deliverables

Deliverables		Due (Calendar Days)
A. Administrative		
A.1	Effective Date	Date Agreed Order Amendment is signed by Ecology
A.2	Progress Reports	Quarterly on the 10th of the month. beginning after the Effective Date
B. Design		
B.2	Draft Engineering Design Report (EDR) and Project Plans [1,2]	Within 90 days of Effective Date
B.3	Final EDR Report	Within 30 days of receipt of Ecology's final comments on the Draft EDR Report[3]
B.4	90 % Plans and Specs [per WAC 173-340-400(4)(b)]	Within 30 days of receipt of Ecology final comments on Final EDR Report
B.5	100 % Plans and Specs	Within 15 days of receipt of Ecology final comments on 90% plans and specifications
C. Remedial Action Construction and Operation		
C.1	Decommission existing groundwater extraction system	No more than 30 days prior to initiating Remedial Action construction
C.2	Phase 1 Remedial Action Construction: Implement in situ groundwater treatment	Within 180 days following receipt of Ecology final comments on 90% plans and specifications
C.3	Install compliance monitoring well network	Within 180 days following receipt of Ecology final comments on 90% plans and specifications
C.4	Phase 1 Construction Summary and As-Built Drawings	90 days following Phase 1 Construction
C.5	Contingent Phase 2 Remedial Action Construction	Contingent on results of evaluation[5] of Phase 1 compliance, performance, and confirmation sampling. If Phase 2 is determined to be

		necessary, initiate within 120 days following evaluation of Phase 1 to proceed.
C.6	Cleanup Action Report and As-Built Drawings and Report; Draft Environmental Covenant(s); and an updated Title Report (if required)	Within 120 days of Construction Completion[4]
	D. Post-Construction Work	
D.1	Final Environmental Covenant(s) (if required)	Within 30 days of receipt of Ecology comments on the Draft Environmental Covenant.
D.2	Record Final Environmental Covenant(s) with King County Auditor (if required)	Within 15 days after Ecology's signature as grantee of the Final Environmental Covenant
D.3	Performance Groundwater Monitoring • Quarterly Performance Monitoring • Biannual Performance Monitoring	Quarterly performance groundwater monitoring for one year after implementation of Remedial Action. After completing one year of quarterly performance groundwater monitoring, biannual performance groundwater monitoring until groundwater meets applicable cleanup levels in CAP.
D.5	Groundwater Confirmation Monitoring[6] Quarterly Compliance Monitoring	Quarterly for two years following completion of performance monitoring.
D.6	Five Year Compliance Monitoring and Periodic Review reports (if required)	To follow Groundwater compliance monitoring (D.5). Groundwater monitoring required once every five years for the duration of the institutional controls on groundwater (if present) under the environmental covenant (if required).

1) *Project Plans include the following: Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan, and Health and Safety Plan, to be submitted for Ecology review and approval. All plans will include a schedule for implementation as applicable.*

2) *The Engineering Design Report includes: Construction Quality Assurance Project Plan, Compliance Monitoring and Contingency Response Plan, Proposed Best Management Practices, Water Quality Monitoring Plan, and Substantive Requirements of Procedurally Exempt Permits. Ecology will not approve the Final EDR until the required permits have been obtained.*

3) *Note: Assume 30-days for each round of Ecology comments for draft and final documents*

4) *Construction completion is defined as: completion of Phase 1 construction and compliance, performance, and confirmation sampling and evaluation or completion of contingency Phase 2 construction, if Phase 2 is determined to be necessary.*

5) *Timing of the Phase 1 Evaluation will be determined and presented in the EDR.*

6) *Groundwater Confirmation Monitoring plan will be included in the Cleanup Action Report*

Exhibit D
List of ARARs and Permits

Standard, Requirement, or Limitation	Description	Permit Required?
Action-Specific Requirements (1)		
Construction and Maintenance of Wells		
Washington Administrative Code: UIC Program (WAC 173-218)	Establishes requirements to protect groundwater by regulating the discharge of fluids from injection wells. The UIC program is administered under Title 40 CFR parts 144, 145, 146, and 147 and authorized by the SDWA.	Yes
Washington Administrative Code: Minimum Standards for Construction and Maintenance of Wells (WAC 173-160)	Establishes requirements for construction, abandonment, and decommissioning of monitoring wells and soil borings.	No
Washington Administrative Code: Regulation and Licensing of Well Contractors and Operators (WAC 173-162)	Establishes requirements for licensing and training well contractors and operators.	No
Upland Disposal of Investigation-Derived Waste		
Resource Conservation and Recovery Act (42 USC 6921-6949a; 40 CFR Part 268, Subtitles C and D)	Establishes requirements for the identification, handling, and disposal of hazardous and nonhazardous waste.	No
Dangerous Waste Regulations (RCW 70.105; WAC 173-303)	Establishes regulations that are the state equivalent of RCRA requirements for determining whether a waste is a state dangerous waste. This regulation also provides requirements for the management of dangerous wastes.	No
Solid Waste Disposal Act (42 USC Sec. 325103259, 6901-6991; 40 CFR 257,258) Federal Land Disposal Requirements (40 CFR part 268)	Protects health and the environment and promotes conservation of valuable material and energy resources.	No
Minimum Functional Standards for Solid Waste Handling (WAC 173-304)	Sets minimum functional standards for the proper handling of all solid waste materials originating from residences, commercial, agricultural, and industrial operations as well as other sources.	No
Solid Waste Handling Standards (WAC 173-350 and WAC 173-351)	Establishes minimum standards for handling and disposal of solid waste. Solid waste includes wastes that are generated by site remediation, including contaminated soils, construction and demolition wastes, and garbage. Soils classified as "contained-in-waste" must be delivered to a solid waste landfill permitted under WAC 173-351 inside Washington State.	Yes; contained-in determination from Ecology required
Worker Safety		
Occupational Health and Safety Standards: Hazardous Waste Operations and Emergency Response/General Occupational Health Standards (Health and Safety 29 CFR 1901.120; and WAC 296-62)	The HAZWOPER standard regulates health and safety operations for hazardous waste sites. The health and safety regulations describe federal requirements for health and safety training for workers at hazardous waste sites.	No
Occupational Safety and Health Act (29 USC 653, 655, 657) Occupational Safety and Health Standards (29 CFR 1910)	Employee health and safety regulations for construction activities and general construction standards as well as regulations for fire protection, materials handling, hazardous materials, personal protective equipment, and general environmental controls. Hazardous waste site work requires employees to be trained prior to participation in site activities, medical monitoring, monitoring to protect employees from excessive exposure to hazardous substances, and decontamination of personnel and equipment.	No
Washington Industrial Safety and Health Act (RCW 49.17) Washington Safety Standards for Construction Work/General Occupational Health Standards (WAC 296-62, WAC 296-155)	Adopts the OSHA standards that govern the conditions of employment in all workplaces. The regulations encourage efforts to reduce safety and health hazards in the workplace and set standards for safe work practices for dangerous areas such as trenches, excavations, and hazardous waste sites.	No
Federal, State, and Local Air Quality Protection Programs State Implementation of Ambient Air Quality Standards NWAPA Ambient and Emission Standards Regional Standards for Fugitive Dust Emissions Toxic Air Pollutants	Regulations promulgated under the federal Clean Air Act (42 USC 7401) and the Washington State Clean Air Act (RCW 70.94) govern the release of airborne contaminants from point and non-point sources. Local air pollution control authorities such as the PSCAA have also set forth regulations for implementing these air quality requirements. These requirements may be applicable to the Site for the purposes of dust control should the selected remedial alternatives require excavation activities. WAC 173-340-750 establishes air cleanup standards, which applies to concentrations of hazardous substances in the air originating from a remedial action at the Site.	No
Chemical-Specific Requirements (2)		
Groundwater Requirements		
Drinking Water Standards—State MCLs (WAC 246-290-310)	Establishes standards for contaminant levels in drinking water for water system purveyors.	No
National Recommended Water Quality Standards 40 CFR 131 and Safe Drinking Water Regulation, 40 CFR 141	These water quality standards define the water quality goals of the water body by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses. States adopt water quality standards from 40 CFR 131 to protect public health or welfare, enhance the quality of water, and serve the purposes of the CWA. Washington State water quality standards (MCLs) are presented in WAC.	No
Washington State Maximum Contaminant Levels (MCLs) (WAC 246-290-310)		No
City of Bothell Permits		
Exemption from Substantial Development Permit	No development to be considered	No
Right of Way Permit	Permit to drill in roadway	Yes

Notes:

1 Action-specific requirements are applicable to certain types of activities that occur or technologies that are used during the implementation of cleanup actions.

2 Chemical-specific requirements are applicable to the types of contaminants present at the Site. The cleanup of contaminated media at the Site must meet the CULs developed under MTCA; these CULs are considered chemical-specific requirements.

Abbreviations:

BMC	Bothell Municipal Code
CFR	Code of Federal Regulations
CWA	Clean Water Act
HAZWOPER	Health and Safety for Hazardous Waste Operations and Emergency Management
MCL	Maximum Contaminant Level
MTCA	Model Toxics Control Act
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NWAPA	Northwest Air Pollution Authority
OSHA	Occupational Safety and Health Act
PSCAA	Puget Sound Clean Air Authority
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act
Site	Ultra Custom Care Cleaners Site

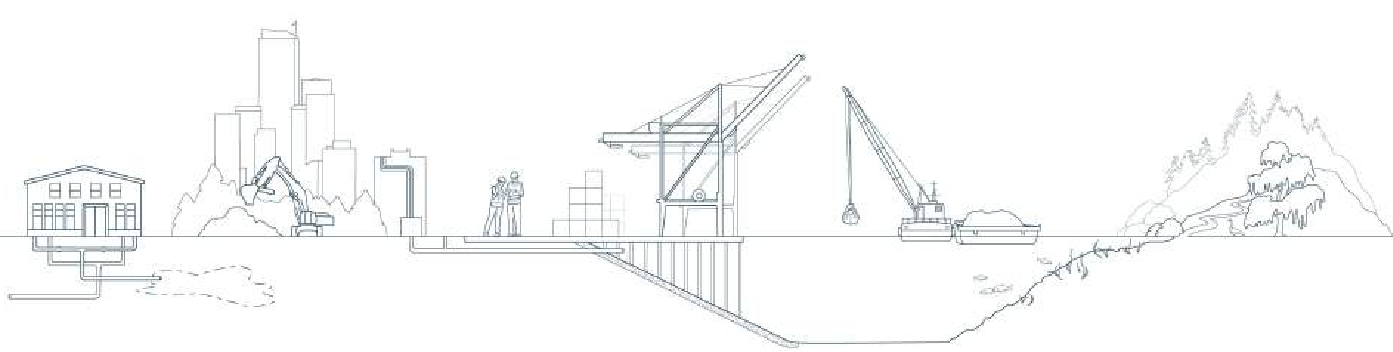
UIC	Underground Injection Control
USC	United States Code
WAC	Washington Administrative Code

Cleanup Action Plan Addendum

Riverside HVOC Site

Prepared for
City of Bothell

February 2025 DRAFT



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LIMITATIONS

This report has been prepared for the exclusive use of the City of Bothell, their authorized agents, and regulatory agencies. It has been prepared following the described methods and information available at the time of the work. No other party should use this report for any purpose other than that originally intended, unless Floyd|Snider agrees in advance to such reliance in writing. The information contained herein should not be utilized for any purpose or project except the one originally intended. Under no circumstances shall this document be altered, updated, or revised without written authorization of Floyd|Snider.

The interpretations and conclusions contained in this report are based in part on site characterization data collected by others and provided by the City of Bothell. Floyd|Snider cannot assure the accuracy of this information.

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List of Abbreviations

Abbreviation	Definition
ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
CAP	Cleanup Action Plan
CUL	Cleanup level
Ecology	Washington State Department of Ecology
HVOC	Halogenated volatile organic compound
µg/L	Micrograms per liter
MTCA	Model Toxics Control Act
PCE	Tetrachloroethene
PDI	Pre-engineering design investigation
RAO	Remedial action objective
RI/FS	Remediation Investigation and Feasibility Study
Site	Riverside Halogenated Volatile Organic Compound Site
SVE	Soil vapor extraction
TCE	Trichloroethene
WAC	Washington Administrative Code
ZVI	Zero-valent iron

1.0 Introduction

This document is an addendum to the Washington State Department of Ecology's (Ecology's) Cleanup Action Plan (CAP) for the Riverside Halogenated Volatile Organic Compound (HVOC) Site (Site) issued by Ecology in March 2023 as Exhibit B of Agreed Order No. DE 21531 (Ecology 2023). This addendum provides details for a revised cleanup action to address Site conditions observed during the pre-engineering design investigation, which was conducted in 2024 as documented in the Pre-Engineering Design Investigation (PDI) Data Report (Appendix A). The cleanup action described in the CAP is superseded by this document.

1.1 DECLARATION

Ecology has revised the selected cleanup action based on current Site conditions to be protective of human health and the environment and to minimize cost, treatment time, and impact to the environment during cleanup action implementation. Furthermore, the selected cleanup action is consistent with the State of Washington's preference for permanent solutions, as stated in RCW 70A.305.040(1)(b). Ecology will consider all public input received during the public comment period for this CAP Addendum to the extent possible.

1.2 CLEANUP STANDARDS

Site-specific cleanup standards were developed in the CAP as a part of an overall remediation process under Ecology oversight for this Site using the authority of the Model Toxics Control Act (MTCA). The two primary components of cleanup standards are cleanup levels (CULs) and points of compliance.

There are no changes to the cleanup standards presented in the CAP. However, because soil contamination exceedances of tetrachloroethene (PCE) and trichloroethene (TCE) CULs are all in the saturated zone and soil cleanup standards for these COCs were developed for protection of groundwater, compliance with soil cleanup standards can be empirically demonstrated by meeting groundwater cleanup standards for the Site. Table 1.1 presents a summary of the cleanup standards for Site soil and groundwater.

Table 1.1
Cleanup Standards from the 2023 Cleanup Action Plan

Analyte	Unit	Cleanup Level
Soil		
PCE	mg/kg	0.05
TCE	mg/kg	0.03
cis-1,2-DCE	mg/kg	160
Vinyl chloride	mg/kg	0.67
Groundwater		
PCE	µg/L	4.9
TCE	µg/L	0.38
cis-1,2-DCE	µg/L	16
Vinyl chloride	µg/L	0.02

Notes:
cis-1,2-DCE *cis*-1,2-Dichloroethene
µg/L Micrograms per kilogram
mg/kg Milligrams per kilogram

1.3 UPDATES TO THE ADMINISTRATIVE RECORD

The documents used to make the decisions discussed in the CAP and this CAP Addendum are on file in the administrative record for the Site. Major documents supporting this CAP Addendum are listed in the References section or attached as Appendix A. The entire administrative record for the Site is available for public review by appointment at Ecology's Northwest Regional Office, located at 15700 Dayton Avenue N, Shoreline, Washington 98133. Results from applicable studies and reports are summarized to provide background information related to the CAP Addendum. These studies and reports include the following:

- Pre-Engineering Design Investigation Data Report, Riverside HVOC Site, December 2024
- Supplemental Remedial Investigation & Feasibility Study, Riverside HVOC Site, Bothell, Washington, February 2022

2.0 Supplemental Data Collection

In 2024, additional soil and groundwater data were collected to inform design of the cleanup action for the Site:

- Hydrogeologic data were collected to inform the suitability of the conceptual bio-recirculation system design (or other variations of groundwater pump and treat systems) and to inform any necessary adjustments to support engineering design and injection parameters such as rates and quantities of treatment materials.
- Data on HVOC distribution and geochemistry in groundwater were collected to confirm the current horizontal extents of the HVOC plume, to assess the vertical distribution and flux of HVOCs in groundwater, and to assess geochemical parameters such as redox conditions to inform efficient formulation and delivery of treatment materials.
- Data on HVOC distribution in soil were collected to inform the likely mass of HVOCs in the vadose zone that would need to be targeted by soil vapor extraction (SVE) and to more precisely delineate the extent of HVOCs in the presumed source area to inform design of soil treatment in the saturated zone.

All results discussed in this section, as well as laboratory analytical reports for 2024 sampling, are presented in the PDI Data Report (Appendix A).

2.1 GROUNDWATER

Prior to 2024, the most recent groundwater sampling occurred in 2020. In 2024, groundwater samples were collected to document current HVOC concentrations after continued groundwater extraction since 2020[1] and to further refine the lateral extent of HVOCs in groundwater exceeding CULs. In general, the most recent 2024 results collected from monitoring wells Site-wide show HVOC concentrations have reduced since 2020 and prior results that were used to inform the selected cleanup action in the CAP:

- **PCE** concentrations ranged from not detected to 9.8 micrograms per liter (µg/L), compared with the 2020 maximum concentration of 26 µg/L (CUL: 4.9 µg/L).
- **TCE** concentrations ranged from not detected to 3.4 µg/L, compared with the 2020 maximum concentration of 23 µg/L (CUL: 0.38 µg/L).
- **Vinyl chloride** concentrations ranged from not detected to 6.2 µg/L, compared with the 2020 maximum concentration of 28 µg/L (CUL: 0.020 µg/L). Although the most elevated concentration of vinyl chloride remains at the farthest downgradient monitoring point (RMW-7), a declining trend has been observed in this area.

[1] Groundwater extraction continues to be performed as part of an interaction required by Agreed Order No. DE 6295 and its Amendment No. 2.

The 2024 geochemical results confirm that site conditions are favorable for anaerobic biodegradation of HVOCs by reductive dechlorination (Appendix A). Anaerobic biodegradation remains the preferred primary treatment technology for HVOCs in Site groundwater.

Because of the groundwater extraction pumping between 2020 and 2024, groundwater source contamination mass has been reduced as described above. These reductions are such that remaining source contamination can be addressed by a single treatment event using direct-push drilling, instead of the continuous injection, extraction, and recirculation treatment presented in the CAP.

The PDI additionally documented that downgradient migration of vinyl chloride appeared to be exacerbated by groundwater extraction pumping. Addition of an in situ treatment barrier is recommended to fully treat vinyl chloride at the point of discharge to the Sammamish River.

2.2 SOIL

Soil samples were collected to inform design of SVE in the vadose zone and soil treatment in the saturated zone.

HVOCs that exceed CULs in soil include PCE and TCE. Based on PDI sample results and historical sample results, the shallowest occurrences of HVOC CUL exceedances in soil occurred at the water table (approximately 12 to 13 feet below ground surface [bgs] at sample location SB-06), and concentrations in shallower (vadose zone) samples were less than CULs. Data indicate that vadose soil does not require SVE treatment; SVE would not remove the soil contaminant mass located in the saturated zone.

The PDI determined that vertical and horizontal extents of PCE and TCE exceeding CULs are sufficiently defined in the vicinity of the former machine shop, and the concentrations that occur in saturated soil are sufficiently low to be treated concurrently with in situ groundwater treatment.

2.3 RISKS TO HUMAN HEALTH AND ENVIRONMENT

PDI samples from 2024 indicated no CUL exceedances of HVOCs in vadose zone soil above 12 feet bgs; therefore, the soil direct contact pathway for terrestrial biota no longer applies, because soil to the point of compliance for terrestrial biota (6 feet bgs) meets Site CULs. The soil direct contact pathway should be considered complete only for human exposures with a point of compliance to 15 feet bgs. However, Site soil PCE and TCE CULs are based on protection of groundwater quality and the groundwater to surface water pathway, and this finding does not impact the application of the Site CULs. HVOC concentrations in Site soil do not exceed the MTCA Method B CULs for direct contact in any samples (Ecology 2025).

3.0 Cleanup Action Selection

The following sections describe the proposed changes to the 2023 CAP cleanup action based on the findings of the PDI.

3.1 SUMMARY OF 2023 CAP CLEANUP ACTION

The 2023 CAP cleanup action includes SVE and Site-wide recirculation of groundwater amended with a soluble organic carbon substrate electron donor (CarBstrate™) to enhance biodegradation of HVOCs (Ecology 2023). The elements of the 2023 CAP cleanup action are shown on Figure 3.1, which is reproduced from the CAP.

The 2023 CAP cleanup action included proposed installation of the following components:

- 12 soil vapor extraction wells
- Vapor collection piping and blowers and a vapor treatment system to remove HVOCs prior to discharge
- Six injection wells and two extraction wells (plus conversion of two existing extraction/monitoring wells for injection)
- Injection delivery and recovery piping, groundwater treatment system to remove remaining HVOCs prior to reinjection, and injection delivery control system

Implementation of the cleanup action would include regular operation and maintenance including weekly application of CarBstrate and periodic changeout of carbon vessels for both the SVE and bio-recirculation systems. It was estimated that the SVE system would run for 3 years and that the bio-recirculation system would run for 2 years. The estimated restoration time frame for this cleanup action is 5 years. The estimated cost for this cleanup action, adjusted to present value costs estimated in December 2024, is $2,732,602 (Appendix A).

3.2 EVALUATION OF 2023 CAP CLEANUP ACTION

In response to the finding of the PDI, which concluded that HVOC concentrations in groundwater have decreased due to ongoing groundwater extraction, a re-evaluation of remedial alternatives was performed as described in the PDI Report. This evaluation included the 2023 CAP cleanup action as well as two new alternatives that were developed based on current HVOC conditions at the Site.

3.2.1 Achievement of Remedial Action Objectives

Remedial action objectives (RAOs) describe the actions necessary to protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route. They identify goals that should be accomplished to meet the requirements of the MTCA Cleanup Regulations (Washington Administrative Code [WAC] 173-340).

RAOs may be informed by current or future property use. RAOs were not previously defined for the Site; therefore, the following RAOs are defined for the Site:

- Protect humans and the environment (ecological receptors) from exposure to Site contamination that exceeds applicable CULs.
    - Achieve CULs in groundwater to protect surface water quality of the adjacent Sammamish River, prioritizing rapid achievement of CULs at the point of discharge to surface water.
    - Address residual contaminated soil to reduce exposure to hazardous substances via leaching to groundwater.
- Comply with local, state, and federal laws and other applicable or relevant and appropriate requirement (ARARs; WAC 173-340-710) and Site-specific cleanup standards. ARARs are limited to applicable federal and state laws and those that Ecology determines are relevant and appropriate.
- Remediate contaminants in a manner that minimizes impacts to public use of park space at the Site.
- Provide compliance monitoring to evaluate (1) the effectiveness of the preferred cleanup action and (2) when the cleanup standards are met.

Some elements of the 2023 CAP cleanup action may not support progress toward achieving these RAOs.

- The available soil data suggest that SVE will not reduce exposures to contaminated soil because it will not reach the contaminated soil mass that lies fully below the groundwater table.
- The available groundwater data suggest that Site-wide groundwater recirculation, which includes downgradient groundwater extraction, may not achieve CULs at the point of discharge to the Sammamish River because extraction could exacerbate migration of vinyl chloride toward the river.
- Aerobic conditions that may be created by the remediation technologies and compete with the desired anaerobic biodegradation process in groundwater are also of concern, primarily for SVE but also potentially for the mechanical process of extraction and injection.

Site soil data demonstrate that excavation and SVE with air sparging, technologies considered in the Remedial Investigation and Feasibility Study (RI/FS; Kane 2022), remain impractical at the Site; excavation to depths of almost 20 feet below the water table is cost prohibitive and unsafe adjacent to State Route 522, and air sparging would create adverse geochemical conditions for anaerobic biodegradation of HVOCs in groundwater.

Another treatment technology for groundwater considered in the RI/FS included injection of organic carbon (edible oil) without recirculation. The Site groundwater data suggest that treatment of groundwater cleanup via passive migration is a viable alternative technology because it would not exacerbate downgradient vinyl chloride migration.

3.3 OVERVIEW OF REVISED CLEANUP ACTION

The 2024 PDI data indicate that vadose soil does not require treatment and that the remaining source contamination in saturated soil and groundwater is reduced from 2020 concentrations and is able to be treated with a single treatment event using direct-push drilling, instead of continuous injection, extraction, and recirculation treatment. The revised cleanup action makes the following adjustments to adapt the remedial action to current Site conditions based on the findings of the PDI:

- SVE is eliminated.
- Soluble organic carbon and *Dehalococcoides* treatment in the source area is achieved by direct-push injection, which is supplemented with zero-valent iron (ZVI). A lesser amount of supplemental ZVI is also added in the western plume.
- Downgradient soluble organic carbon and *Dehalococcoides* treatment are supplemented with ZVI and colloidal activated carbon (such as PlumeStop) to form in situ treatment barriers.
- A controlled-release source of organic carbon is used.

The elements of the revised cleanup action are shown on Figure 3.2. This alternative supplements source area treatment with ZVI to achieve prompt abiotic degradation of PCE and TCE and ensure ongoing reducing conditions to promote anaerobic biodegradation. The addition of ZVI, combined with a controlled-release form of organic carbon, allows for a single direct-push application of the treatment materials in lieu of recirculation to degrade the remaining HVOC mass. The addition of colloidal activated carbon downgradient is designed to adsorb HVOCs and allow longer contact time with the treatment materials, which will allow for more rapid cleanup of downgradient groundwater. A double row of injections is assumed in order to form a highly effective barrier. The estimated restoration time frame for this cleanup action is 3 years. The estimated cost for this cleanup action is $1,655,362.

ARARs were established in the CAP for the 2023 CAP cleanup action. The same ARARs generally apply to the revised cleanup action; however, SVE was eliminated for the revised cleanup action and ARARs presented in the CAP related to air quality and air permitting are no longer applicable.

Institutional controls are not anticipated to be required at the Site.

Additional details about the revised cleanup action including remedial design, monitoring, and reporting as required by MTCA; remedy costs; and disproportionate cost analysis for the revised cleanup action will be implemented as described in the PDI Data Report (Appendix A).

3.4 DECISION

Based on the analysis described in the previous sections, Ecology has eliminated SVE treatment of vadose soil and revised the in situ groundwater treatment as shown on Figure 3.2 to address contamination in saturated soil and groundwater at the Site. This revised cleanup action will remediate contaminants in saturated soil and groundwater, treat contaminated groundwater flowing through downgradient in situ treatment barriers before reaching the Sammamish River, and protect human health and the environment at reduced cost and faster restoration time frame than the 2023 CAP cleanup action.

Consistent with the CAP and MTCA, the revised cleanup action will include compliance monitoring, including protection, performance, and confirmation monitoring, as further detailed in the PDI Data Report (Appendix A). Compliance monitoring will be further described in a Construction Compliance Monitoring Plan as part of the Engineering Design Report and a post-remedy Long-Term Compliance Monitoring Plan, which will include a Groundwater Monitoring Plan.

4.0 References

Kane Environmental, Inc. (Kane). 2022. *Supplemental Remedial Investigation & Feasibility Study, Riverside HVOC Site, Bothell, Washington.* Prepared for City of Bothell. 22 February.

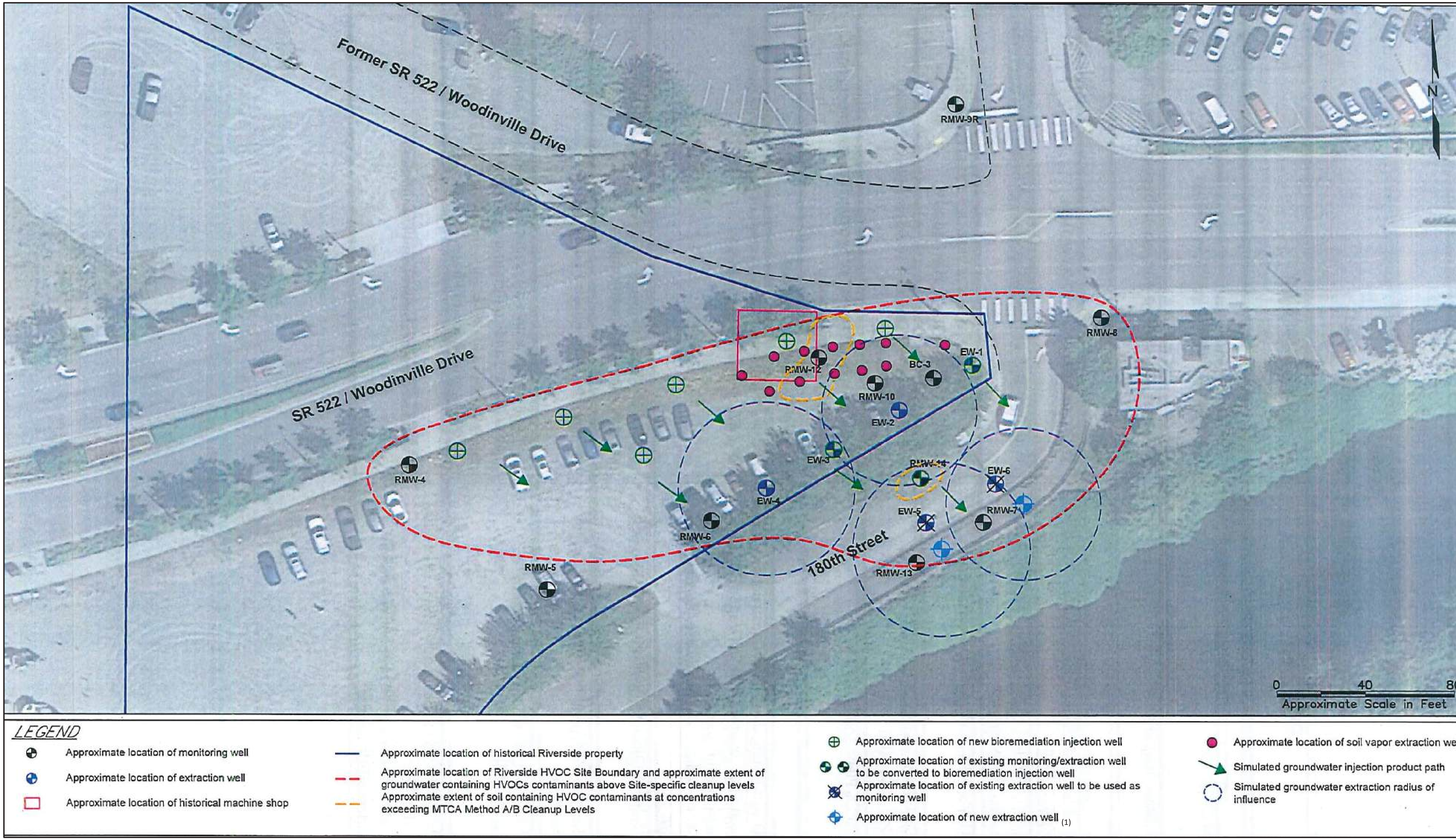
Washington State Department of Ecology (Ecology). 2023. *Agreed Order No. DE 21531.* 22 March.

____. 2025. Cleanup Levels and Risk Calculation (CLARC) Workbook. January. Available: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC/Data-tables

Cleanup Action Plan Addendum

Riverside HVOC Site

Figures



Note:
1 An equal number of injection and extraction wells are assumed for alternatives evaluation.

Source: Cleanup Action Plan Figure 6 (Ecology 2023)

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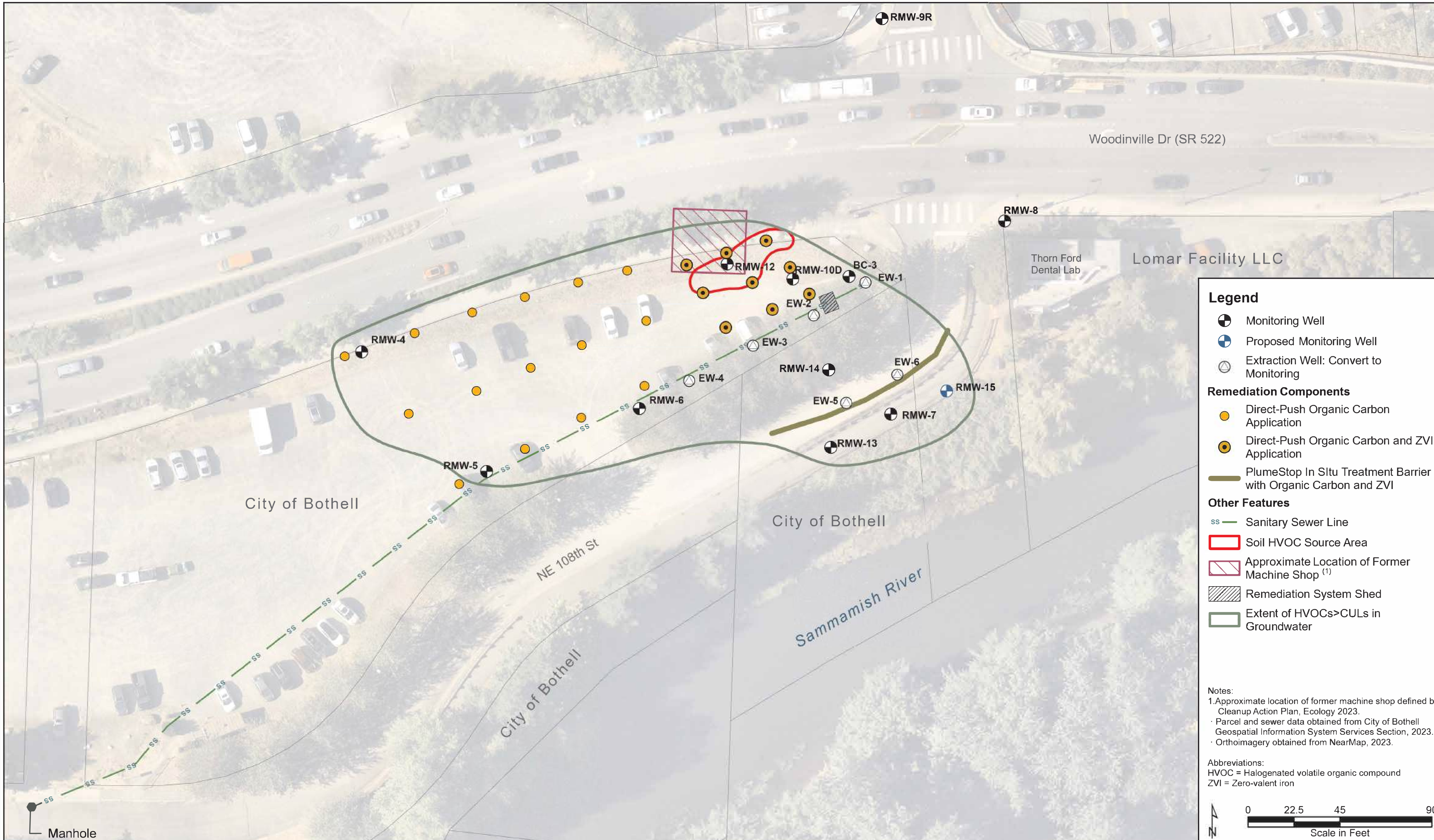
Cleanup Action Plan Addendum
Riverside HVOC Site
Bothell, Washington

Figure 3.1
2023 CAP Cleanup Action

1/15/2025



Notes:
1. Approximate location of former machine shop defined by Cleanup Action Plan, Ecology 2023.
· Parcel and sewer data obtained from City of Bothell Geospatial Information System Services Section, 2023.
· Orthoimagery obtained from NearMap, 2023.

Abbreviations:
HVOC = Halogenated volatile organic compound
ZVI = Zero-valent iron

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Cleanup Action Plan Addendum
Riverside HVOC Site
Bothell, Washington

Figure 3.2
Revised Cleanup Action

I:\GIS\Projects\COBothell-Riverside\02-Map Documents\03-Pre-Engineering Design Data Summary Report\01 - HVOC\HVOC.aprx
12/16/2024

Cleanup Action Plan Addendum

Riverside HVOC Site

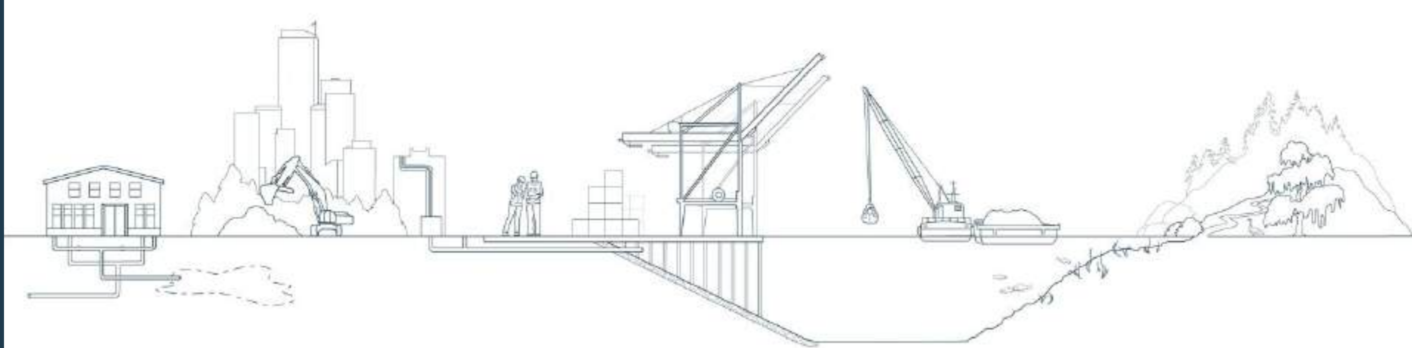
Appendix A
Pre-Engineering Design
Investigation Data Report

Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Prepared for
City of Bothell

December 2024 DRAFT



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LIMITATIONS

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The interpretations and conclusions contained in this report are based in part on Site characterization data collected by others and provided by the City of Bothell. Floyd|Snider cannot assure the accuracy of this information.

Pre-Engineering Design Investigation Data Report

This document was prepared for
The City of Bothell
under the supervision of:

Name: Kristin Anderson
Date: 12/17/2024

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List of Abbreviations

Abbreviation	**Definition**
AO	Agreed Order
ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
CAP	Cleanup Action Plan
CCMP	Construction Compliance Monitoring Plan
City	City of Bothell
cm/day	Centimeters per day
COC	Contaminant of concern
CUL	Cleanup level

Abbreviation	Definition
DCE	Dichloroethene
DO	Dissolved oxygen
Ecology	Washington State Department of Ecology
ft/ft	Feet per foot
g/mol	Grams per mole
GMP	Groundwater monitoring plan
HASP	Health and Safety Plan
HVOC	Halogenated volatile organic compound
HWA	HWA Geosciences
IC	Institutional control
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
MTCA	Model Toxics Control Act
mV	Millivolts
NAVD 88	North American Vertical Datum of 1988
O&M	Operation and maintenance
ORP	Oxidation–reduction potential
PCE	Tetrachloroethene
PDI	Pre-Engineering Design Investigation
PDI Data Report	Pre-Engineering Design Investigation Data Report
PDI Work Plan	Pre-Design Investigation Work Plan
PFM	Passive flux meter
RAO	Remedial action objective
RI/FS	Remediation Investigation and Feasibility Study
ROW	Right-of-way
Site	Riverside Halogenated Volatile Organic Compound Site
SR	State Route
SVE	Soil vapor extraction

Abbreviation	Definition
TCE	Trichloroethene
TOC	Total organic carbon
ZVI	Zero-valent iron

1.0 Introduction

1.1 BACKGROUND

This Pre-Engineering Design Investigation (PDI) Data Report (PDI Data Report) has been prepared on behalf of the City of Bothell (City) for the Riverside Halogenated Volatile Organic Compound (HVOC) Site (Site) located at NE 108th Street and Woodinville Drive (State Route [SR] 522) in Bothell, Washington (refer to Figure 1.1). This PDI Data Report presents the results of the sampling conducted as presented in the Pre-Design Investigation Work Plan (PDI Work Plan; Floyd|Snider 2024) to inform the design and modification of the cleanup action for the Site.

1.1.1 Site Regulatory History

The Site is located on the eastern portion of King County Assessor's parcel 082605-9120 (the Site property), which is currently owned by the City. The Site is located in the easternmost portion of the City's Park at Bothell Landing administered by the Parks and Recreation Department and is currently used as a public, unpaved parking lot. The Site is bounded to the north by SR 522 and to the south by the Sammamish River (refer to Figure 1.1).

The Site is defined by the extents of soil and groundwater contamination likely resulting from releases of tetrachloroethene (PCE) to the ground at a former machine shop (Figure 1.1) that operated in the northeast portion of the current parking area from 1944 until 1973.

An interim action for the Site was approved by the Washington State Department of Ecology (Ecology) to temporarily address HVOC groundwater discharge to the Sammamish River using groundwater extraction. In 2013, the groundwater extraction system was installed by HWA Geosciences (HWA), consisting of four extraction wells (EW-1 through EW-4) that discharge to the sanitary sewer under a King County Industrial Waste discharge permit. In 2016, HWA installed two more extraction wells (EW-5 and EW-6) in closer proximity to the river (refer to Figure 1.1). This system is still in operation in a limited capacity.

A Supplemental Remedial Investigation/Feasibility Study was completed for the Site in 2022 (Kane 2022) and a Cleanup Action Plan (CAP) was issued by Ecology in March 2023 as Exhibit B of Agreed Order (AO) No. DE 21531 (Ecology 2023). The CAP defines the extent of HVOC contamination, contaminants of concern (COCs), and cleanup levels (CULs) for the Site. The COCs in soil and groundwater are PCE, trichloroethene (TCE), *cis*-1,2-dichloroethene (DCE), and vinyl chloride. Due to the proximity of the HVOC-contaminated groundwater to the Sammamish River, CULs were selected to be protective of surface water. The selected cleanup alternative summarized in the CAP is a combination of soil vapor extraction (SVE) in the presumed PCE source area near the former machine shop and Site-wide groundwater treatment by bio-recirculation with an organic carbon amendment to promote anaerobic biodegradation of HVOCs.

As required by the AO, Floyd|Snider prepared a PDI Work Plan for the Site, which was approved by Ecology in June 2024.

1.1.2 Purpose of the Pre-Engineering Design Investigation

The PDI Work Plan presented a revised scope for investigation to support design and implementation of cleanup at the Site. It provided details for additional proposed soil and groundwater data collection that will inform the design of the cleanup action. The following additional data collection objectives were identified, and the data obtained are summarized in this PDI Data Report:

Hydrogeologic study: More hydrogeologic data were needed to inform the suitability of the conceptual bio-recirculation system design (or other variations of groundwater pump and treat systems) and any necessary adjustments to support engineering design, as well as to inform injection parameters such as rates and quantities of treatment materials.

HVOC distribution and geochemistry in groundwater: More recent data were needed to confirm the current horizontal extents of the HVOC plume, and additional data were needed to assess the vertical distribution and flux of HVOCs in groundwater and geochemical parameters such as redox conditions that will inform the efficient formulation and delivery of treatment materials.

HVOC distribution in soil: Additional data were needed to inform the likely mass of HVOCs in the vadose zone that would be targeted by SVE and to more precisely delineate the extent of HVOCs in the presumed source area to inform the design of soil treatment in the saturated zone.

1.2 REPORT OUTLINE

The remaining sections of this report are organized as follows:

- **Section 2.0 Pre-Engineering Design Investigation Summary.** Discusses the scope and results of pre-engineering design data collection. Includes supporting Appendices A (Hydrogeologic Study Results), B (Laboratory Reports), and C (Field Boring Logs)
- **Section 3.0 Updated Conceptual Site Model**. Incorporates the findings of the PDI into a more thorough understanding of the nature, extent, and behavior of HVOC contamination at the Site.
- **Section 4.0. Identification of Supplemental Cleanup Action Alternatives.** Presents potential amendments to the 2023 CAP Cleanup Action responsive to the findings of the PDI and evaluates the cost-benefit of potential alternatives to the cleanup action to identify a Preferred Revised Cleanup Action. Includes supporting Appendix D (Detailed Costs).
- **Section 5.0 Preferred Revised Cleanup Action**. Describes the elements of a revised preferred cleanup action, including compliance with the Model Toxics Control Act, applicable or relevant and appropriate requirements (ARARs), and remedial action objectives (RAOs).
- **Section 6.0 References.** Provides reference information for documents cited in this report.

2.0 Pre-Engineering Design Investigation Summary

2.1 HYDROGEOLOGIC STUDY

Hydrogeologic study activities included groundwater extraction system maintenance, synoptic water level measurement, and water level measurement during pumping and non-pumping conditions. The scope and results of hydrogeologic study are discussed in the following sections.

2.1.1 Groundwater Extraction System Maintenance

Prior to the implementation of the PDI Work Plan, several maintenance and repair tasks were addressed so that the groundwater extraction system was operating as intended for the hydrogeologic study. In 2023, decreases in sewer discharge rates combined with increased electrical power usage indicated that pump failure was likely occurring at upgradient extraction wells. Additionally, the downgradient extraction wells had both become stuck in the well screens at EW-5 and EW-6 and ceased to properly function sometime before 2023. To address this issue, a secondary pump was placed on top of the stuck pump in EW-6 in late 2023 and pumps in EW-1, EW-3, and EW-4 were replaced in early 2024; however, pump performance did not improve acceptably after replacement.

In coordination with the City and Ecology, it was determined that EW-2, EW-3, and EW-6 in the most contaminated portion of the HVOC plume would be prioritized for maintenance.

The original extraction well pumps were inspected and found to be severely damaged by siltation, which is expected when pumps are set at the base of the well. The manufacturer specifications require a minimum distance of 10 feet between the base of the well and pump inlet. The pump rotors were replaced, and the motors were serviced to improve pump functionality.

After completing repairs, the rigid polyvinyl chloride piping was replaced with more flexible hose and the pumps were set at a shallower depth in the well to operate within the manufacturer's recommended installation guidelines. An exception to this is EW-6, which could only be set just below the water level due to the former extraction pump and inactive discharge line stuck in the well.

In addition to these in-well changes, flow control globe valves were also added inside the remediation shed. The globe valves are intended to appropriately slow flow from the extraction pumps and work with the existing check valves to create uniform flow through the extraction system.. The flow controls were added because surplus pump capacity was found to cause excess drawdown and cycling of the pumps in the generally fine-grained saturated zone at the Site. The drawdown may also be partially addressed by periodic redevelopment of the extraction wells.

2.1.2 Hydrogeologic Study Field Investigation

2.1.2.1 Synoptic Water Levels

Four rounds of synoptic water levels were collected at the Site in accordance with the PDI Work Plan between July 25 and August 22, 2024:

- As a baseline with the system operating under normal pumping conditions (completed July 25)
- After downgradient extraction well EW-6 had been shut off for at least 48 hours (completed July 29)
- After upgradient extraction wells EW-2 and EW-3 had been shut off for at least 48 hours (completed July 31)
- Under baseline non-pumping conditions prior to Site-wide groundwater monitoring (completed August 22)

A survey of horizontal position, top of casing elevation, and ground surface elevation was additionally completed by a licensed surveyor for all monitoring and extraction wells during the hydrogeologic study.

2.1.2.2 Transducer Study

A transducer study was conducted at monitoring wells adjacent to groundwater extraction wells to monitor water level responses during baseline pumping conditions, the phased downgradient and upgradient shut-off, and post-shut-off conditions as described in Section 2.1.2.1.

Transducers were set in RMW-10D and BC-3 (nearest to EW-2), RMW-7 and RMW-14 (nearest to EW-6) and RMW-13 (downgradient west of EW-5) and set to record at 0.5-second intervals during each pump shut-off event. The transducers were set to begin recording, then the pumps were turned off in series while monitoring the water level manually within the well casing. A representative pumping to shut-off period could not be obtained for EW-6, however, because the water level was close to the pump intake and triggered an automatic dry-run condition circuit fault of the pump controller.

During the equilibration periods between shut-off events, the transducers were reset to record at 5-minute intervals.

2.1.3 Hydrogeologic Study Findings

2.1.3.1 Groundwater Occurrence and Flow Directions

Depth to groundwater varied at the Site between approximately 10 and 20.5 feet below ground surface (bgs) during the four synoptic water level events. These measurements were generally consistent with previous depth to water measurements collected at the Site. A summary of monitoring well construction details and available depth-to-water measurements is provided in Table 2.1.

The direction of groundwater flow was to the southeast toward the Sammamish River, consistent with Site topography, as shown in Figure 2.1. Groundwater elevations ranged from approximately 26 to 19 feet North American Vertical Datum of 1988 (NAVD 88) within the Site boundary, resulting in measured horizontal gradients of 0.06 to 0.07 feet per foot (ft/ft).

2.1.3.2 Groundwater Extraction System Evaluation

Water level responses measured during phased shut-off of the extraction well system showed limited influence at adjacent well locations, as shown on the hydrogeologic study plots presented in Appendix A. During the first downgradient shut-off at EW-6, water level trends were not discernable at RMW-7 or RMW-13; however, the groundwater level increased slightly at RMW-14 after shut-off. During the upgradient shut-off at EW-2 and EW-3, water levels appeared to decrease slightly at BC-3 and RMW-10D. However, because the changes are on the order of hundredths of a foot, these observations may reflect normal variability rather than responses to the pumping system.

During the first downgradient equilibration period, uniform fluctuations in water levels were observed at all shallow well locations for approximately the first day of the period. The cause of this fluctuation is unknown and not correlated with rainfall or related water level impacts to the Sammamish River and were not replicated during the second upgradient equilibration period.

The inconclusive results of the hydrogeologic study are likely due to the limitations of the current extraction pumping system, which uses high-capacity pumps that cause rapid drawdown in the relatively fine-grained saturated zone despite the flow control measures that were added during 2024 maintenance. This rapid drawdown causes frequent on/off cycles at the extraction well pumps and limits the radius of influence of pumping.

2.2 GROUNDWATER MONITORING

Groundwater monitoring activities included sample collection from reconnaissance borings and permanent wells for HVOCs and geochemical parameters and measurement of HVOC flux at targeted locations. The scope and results of groundwater monitoring are discussed in the following sections.

2.2.1 Groundwater Monitoring Field Investigation

The most recent comprehensive groundwater sampling event before the implementation of the PDI Work Plan was completed in 2020.

Therefore, groundwater samples were collected to document current HVOC concentrations after continued groundwater extraction between 2020 and 2024 and to further refine the lateral extent of HVOCs in groundwater exceeding CULs. These samples were collected from existing monitoring wells, passive flux meters (PFMs), and temporary borings.

2.2.1.1 Low-Flow Groundwater Sampling

As described in the PDI Work Plan, groundwater samples were collected from the Site wells during three separate events. Sampling events were conducted at targeted wells concurrently with the hydrogeologic study and during a Site-wide sampling event.

During the first targeted sampling event, HVOC samples and field water quality parameters were collected from extraction wells EW-5 and EW-6 at the wellhead, downgradient well RMW-7 and upgradient well RMW-12 via low-flow sampling while the extraction system was running. Field water quality parameters were additionally collected from extraction wells EW-2 and EW-3 at the wellhead via low-flow sampling after a 48-hour equilibration period with EW-6 shut off but with the upgradient extraction system running.

Finally, after another 48-hour equilibration period with the extraction system fully shut off, EW-5, EW-6, RMW-7, and RMW-12 were sampled again for HVOCs, as described above.

The PDI was then paused to allow HVOC conditions to equilibrate without pumping prior to collecting groundwater data to define the current baseline conditions. The equilibration period is the estimated time for groundwater to migrate from the upgradient extraction wells to the farthest downgradient monitoring well (RMW-7), a distance of approximately 60 feet. The seepage velocity of groundwater was estimated from previous slug testing data collected at the Site, where an average groundwater flow of 2.5 feet per day was established (HWA 2013). The resulting calculated equilibration period was 3 weeks. After this equilibration time, a Site-wide groundwater sampling event was conducted via low-flow sampling at all monitoring and extraction wells to establish current baseline groundwater HVOC and geochemical condition data.

2.2.1.2 Groundwater Reconnaissance Sampling

Groundwater samples were collected from temporary soil borings using retractable direct-push screens. Angled borings were implemented to collect samples in locations with limited access, specifically beneath the sidewalk that is located closest to the Sammamish River. A total of six direct-push borings were advanced for collection of groundwater reconnaissance samples to delineate the current extent of the HVOC plume exceeding CULs, as shown on Figure 2.2 and summarized in Table 2.2, including the following:

- Four borings at the presumed downgradient edge of the plume to inform the extent of potential groundwater treatment (GWB-03 through GWB-06), with samples for HVOC analysis collected from the 15- to 20-, 20- to 25-, and 25- to 30-foot intervals except where groundwater was not present in the 15- to 20-foot interval at GWB-05 and GWB-06.
- One boring to vertically delineate HVOCs within the plume downgradient of the source area (GWB-07), with samples collected from the 35- to 40- and 40- to 45-foot intervals.

- One contingency boring was drilled to delineate cross-gradient HVOCs to the west (GWB-08) after a review of the updated baseline groundwater sample results. A groundwater sample was collected from the 15- to 20-foot interval.
- Originally, two borings were also planned to determine current groundwater HVOC conditions in the upgradient direction to the north (GWB-01, GWB-02), but due to the close proximity to Puget Sound Energy power lines running under the north-adjacent sidewalk where the borings were planned and the observed declining PCE results from RMW-12, these locations were removed from the sampling plan. Contingency borings GWB-10 and GWB-11 on the eastern side of the Site were also determined not to be necessary based on results at EW-1 and RWM-8.

2.2.1.3 Passive Flux Meter Sampling

As described in the PDI Work Plan, PFMs were deployed on August 26 and retrieved on September 16, 2024, for a sampling period of 3 weeks. Two 5-foot PFM samplers were installed in each well screen; however, the upper 2 feet of the well screen at RWM-7 (from 15 to 17 feet bgs) was likely not saturated for most of the sampling based on depth to water measurements collected during the synoptic water level events. The extraction system remained off during PFM deployment to capture baseline groundwater and HVOC flux conditions. After retrieval, samples of the PFM media were collected from 2-foot intervals and analyzed for HVOC flux and Darcy velocity. PFM samplers were provided and analyzed by EnviroFlux, Inc., and the resulting data are presented in Appendix B.

2.2.2 Groundwater Monitoring Results

Groundwater monitoring results for monitoring well and reconnaissance water samples and passive flux meter media samples are summarized in the following sections. Laboratory analytical reports are provided in Appendix B.

2.2.2.1 HVOC Results

Groundwater samples were analyzed for PCE, TCE, *cis*- and *trans*-1,2-DCE, and vinyl chloride. Groundwater monitoring results for the PDI and all available historical sampling events are shown in Table 2.2. Key groundwater results for PCE and vinyl chloride (the final toxic degradation product of PCE) are also shown in Figure 2.2.

PCE: PCE concentrations at monitoring wells ranged from not detected to a maximum detection of 9.8 micrograms per liter (µg/L) at downgradient well RMW-14, compared to a Site-wide maximum concentration in 2020 of 26 µg/L at EW-3. PCE exceedances of the CUL of 4.9 µg/L were detected at RMW-12 in the presumed upgradient source area, upgradient extraction well EW-2 and downgradient extraction well EW-6. PCE was also detected at reconnaissance borings GWB-05 and GWB-06 to the southeast of the current permanent well network. The extents of PCE concentrations exceeding the CUL are well-defined to the west, east, south, and southwest; however, the southeastern extent of PCE in the vicinity of GWB-06 is a potential data gap for installation of a permanent monitoring well to assess compliance with CULs and complete engineering design in this area.

TCE: TCE concentrations at monitoring wells ranged from not detected to a maximum detection of 3.4 µg/L at EW-3, compared to a Site-wide maximum concentration in 2020 of 23 µg/L at EW-3. TCE exceedances of the CUL of 0.38 µg/L were also detected at upgradient source area well RMW-12 and downgradient wells RMW-14 and RMW-7, as well as at RMW-4 and RMW-5 cross-gradient to the west of the presumed source area. Similar to PCE, TCE was also detected at GWB-05 and GWB-06 as well as at GWB-04. The extents of TCE concentrations exceeding the CUL are delineated to the east and southwest, and are sufficiently defined for engineering design by low-level exceedances to the west and south. The southeastern extent of TCE is not fully delineated and is a potential data gap for engineering design.

***cis*-1,2-DCE:** *cis*-1,2-DCE concentrations exceeded the CUL of 16 µg/L only at downgradient monitoring well RMW-7 and was additionally detected at GWB-06. *cis*-1,2-DCE concentrations exceeding the CUL are sufficiently defined for engineering design with low-level exceedances to the east/southeast.

Vinyl chloride: Vinyl chloride concentrations at monitoring and extraction wells ranged from not detected to a maximum detection of 6.2 µg/L at RMW-7, compared to a Site-wide maximum concentration in 2020 of 28 µg/L at RMW-7. Vinyl chloride exceedances of the CUL of 0.020 µg/L were also detected at upgradient source area well RMW-12, upgradient extraction wells EW-3 and EW-4, downgradient wells RMW-13 and RMW-16, and cross-gradient wells RMW-5 and RMW-6 to the west-southwest. Vinyl chloride was additionally detected at reconnaissance borings GWB-04 and GWB-06 downgradient and GWB-08 to the west. Vinyl chloride concentrations are generally well-defined for the purposes of engineering design; the most elevated concentrations of vinyl chloride remain at the farthest available downgradient monitoring point (RMW-7); however, a trend of declining vinyl chloride has been observed in this area since 2020.

The vertical extent of all HVOCs exceeding CULs is well-defined above 35 feet bgs by samples collected at RMW-10D (screened 32 to 42 feet bgs) and at GWB-07 (collected from 35 to 40 feet bgs and 40 to 45 feet bgs), which had non-detect results for all HVOCs.

2.2.2.2 HVOC Flux

Flux refers to the mass of water and contaminants flowing per unit area at a measured point in a well screen, averaged over the time during which the samples were collected. Groundwater flux is measured by tracers in the PFM media, whose rate of consumption can be used to determine the rate of groundwater flow through the sample interval.

The average ambient groundwater flux, or Darcy velocity, ranged from 3.0 to 5.4 centimeters per day (cm/day) at RMW-12 and 0.7 to 4.0 cm/day at RMW-7. Darcy velocity was generally uniform across the screened intervals and between the wells except in the water table interval at RMW-7, where the minimum value of 0.7 cm/day was observed.

Contaminant flux values for HVOC, which are defined as contaminant mass/unit area/time, were calculated for the HVOCs vinyl chloride, *cis*-1,2-DCE, TCE, and PCE. The HVOC flux values are calculated using the HVOC mass sorbed to the PFM media combined with the groundwater flux described above; the HVOC flux values are additionally averaged over the width of the aquifer to obtain an average flux in micrograms per liter.

At upgradient well RMW-12, HVOC flux values were uniformly low, ranging from 0.9 to 3.4 µg/L for PCE, TCE, and *cis*-1,2-DCE at all intervals. There was only measurable vinyl chloride flux in the 19- to 21-foot interval, which was also the most transmissive interval (i.e., maximum observed Darcy velocity).

At downgradient well RMW-7, HVOC flux values were greater overall compared to upgradient flux values, which also increased with the relative mobility of the HVOCs. The greatest fluxes at RMW-7 were vinyl chloride, which ranged from 16 to 186 µg/L.

2.2.2.3 Geochemistry

Key geochemical data suggest that current conditions at the Site are favorable for anaerobic biodegradation of HVOCs by reductive dechlorination. Key geochemical parameters include the following, which are summarized in Table 2.3:

Dissolved oxygen (DO): DO measures the amount of oxygen, an electron acceptor, available in groundwater. DO was generally low within the plume, with values of 0.5 milligrams per liter (mg/L) or less. Typical target DO concentrations for anaerobic biodegradation are less than 1.0 mg/L (Arcadis 2002). DO concentrations greater than 1 mg/L were measured in the upgradient and deep wells that are not impacted by HVOCs (RMW-9R and RMW-10D). Greater DO was also measured at EW-6, which is attributed to localized perturbations caused by frequent on/off cycles with the pump inlet set near the groundwater table during the sampling period, because DO was significantly lower at adjacent non-pumping well EW-5.

Oxidation–reduction potential (ORP): ORP measures the capacity for electron transfer in groundwater in millivolts (mV); positive ORP indicates that conditions are oxidizing (i.e., groundwater has a tendency to lose electrons), whereas negative ORP indicates that conditions are reducing (i.e., groundwater has a tendency to accept electrons). At the Site, ORP values were generally near zero or negative within the HVOC plume, indicating that baseline conditions are reducing and conducive to anaerobic biodegradation. More strongly positive ORP values were measured at MR-9R, MW-10D, and EW-6, consistent with greater DO at these locations. More strongly positive ORP was also measured at RMW-12, indicating that this well is likely near the upgradient edge of the HVOC plume.

pH: pH across the Site ranged from 5.95 to 7.10. Most biological activity in groundwater, including biodegradation, is most effective in near-neutral pH conditions consistent with those observed at the Site.

Nitrate and sulfate: Nitrate and sulfate ions are electron acceptors that, along with DO, may compete with HVOCs for electrons and inhibit reducing processes that degrade HVOCs. Nitrate concentrations in Site groundwater ranged from 0.052 to 2.6 mg/L, and sulfate concentrations in Site groundwater ranged from not detected to 34 mg/L. These values are generally low; USEPA drinking water standards are 10 mg/L for nitrate 250 mg/L for sulfate. This result indicates limited potential for background electron acceptors to inhibit reduction.

Total organic carbon (TOC): Organic carbon acts as an electron donor that can facilitate anaerobic biodegradation by the process of reductive dechlorination. TOC concentrations in Site groundwater were relatively low, ranging from not detected to 11 µg/L. TOC concentrations of approximately 50 mg/L are required to sustain biodegradation and initial TOC concentrations up to 500 mg/L are generally targeted when soluble organic carbon is added as a treatment material to facilitate biodegradation (Arcadis 2002).

Dissolved gases (ethene, ethane, and methane): Dissolved gases are the end products of anaerobic biodegradation. Of the dissolved gases, ethene and ethane are shorter-lived in the environment and detection of these gases indicates that more rapid biodegradation is occurring, whereas methane is longer-lived and indicates slower rates of biodegradation. At the Site, ethene and ethane were not detected but methane ranged between 2,200 µg/L and 8,200 µg/L at downgradient wells including EW-5, EW-6, RMW-7, and RMW-14. These methane detections indicate that anaerobic biodegradation, likely at slow rates, is occurring in the downgradient portion of the HVOC plume. Target dissolved gas concentrations for anaerobic biodegradation are generally greater than 1,000 µg/L (USEPA 2023).

Calcium, iron, and magnesium: The presence of metals including calcium, iron, and magnesium is an indicator of hardness in groundwater. Hardness inhibits the migration of some treatment materials such as activated carbon and zero-valent iron, and therefore, calcium is often added to in situ treatment barriers to ensure their accurate placement. Total calcium concentrations in Site groundwater ranged from 38,000 to 64,000 µg/L (38 to 64 mg/L), total iron concentrations ranged from not detected to 31,000 µg/L (31 mg/L), and total magnesium concentrations ranged from 11,000 to 19,000 µg/L (11 to 19 mg/L). Similar values were observed for dissolved metals. Combined, the detected metals in Site water classify it as moderately hard (USGS 2018). These results indicate that other treatment materials, if needed, could be injected with accuracy at the Site.

Other parameters such as alkalinity, chloride, nitrite, and sulfide provide useful baseline measurements for comparison during future groundwater treatment. Increases in concentrations of these parameters are indicators of the occurrence of biodegradation by reductive dechlorination (ITRC and RTDF 1999).

2.3 SOIL SAMPLING

Soil samples were collected from direct-push soil borings for HVOC and grain size analysis. The scope and results of soil sampling are discussed in the following sections.

2.3.1 Soil Sampling Field Investigation

The conceptual design of the SVE system presented in the CAP includes treatment of vadose zone soil in the presumed source area to the depth of the water table, which is encountered at approximately 8 feet bgs on the northern portion of the Site and deepens to approximately 16 feet bgs on the southern portion of the Site. The depth to water table varies by approximately 2 to 5 feet seasonally at individual well locations. There were limited existing soil data in the target SVE treatment zone, and additional data were needed to determine the mass of HVOCs that may be mobilized and recovered by SVE. Additionally, more precise horizontal and vertical delineation of HVOCs in the saturated zone within the source area was needed to determine the extent of soil to be targeted by treatment. Soil grain size data were also needed to inform injection rates and quantities of groundwater treatment materials.

Collection of additional HVOC data in soil was proposed to update current conditions and refine current understanding of the lateral and vertical extent of soil with HVOC concentrations exceeding CULs. The implemented soil quality assessment included nine direct-push borings for collection of soil samples to delineate HVOCs. Two of the originally planned direct-push borings were removed from the soil quality assessment due to their proximity to Puget Sound Energy electrical feeder lines that run underneath the north-adjacent sidewalk at the Site.

2.3.2 Soil Sampling Results

Field geological observations for soil and results for soil laboratory analysis are summarized in the following sections. Soil analytical data are presented in Table 2.4 and Figure 2.3, and a cross-section of Site soil types and the occurrence of HVOC contamination is presented in Figure 2.4. Laboratory analytical reports are provided in Appendix B and observations for individual borings are described in detail in the soil boring logs provided in Appendix C.

2.3.2.1 Geology

Soils encountered at the Site consisted of an uppermost fill unit underlain by alluvium deposits. The fill was composed of varying amounts of well-graded sand, silty sand, and gravel and contained occasional anthropogenic debris. The contact between the fill and native alluvium was characterized by a peaty silt consistent with marsh deposits approximately 2 feet thick. Below the peaty deposit, soils consisted of interbedded fine sand and silty sand. Alluvium was observed to the deepest depth of 40 feet bgs explored during the PDI. Historical boring logs noted deeper occurrences of a stiff silt (for example, beginning at 40 feet bgs at RMW-10), which was interpreted to be a glacially deposited unit in prior reports.

The results of qualitative grain size analysis showed that saturated soils consisted primarily of fine to very fine sand with at least 20% silt and an average of approximately 30% silt. These results were confirmed with laboratory grain size analyses that showed similar grain size distribution.

2.3.2.2 Vertical and Horizontal Extents of HVOCs

Soil samples were analyzed for PCE, TCE, *cis*- and *trans*-1,2-DCE, and vinyl chloride, as shown in Table 2.4. Key soil results are also shown in Figures 2.3 and 2.4.

PCE exceeding the CUL of 0.05 milligrams per kilogram (mg/kg) was detected only in the 12- to 14-foot-bgs and 24- to 26-foot-bgs samples at SB-06 in the presumed source area of the former machine shop. Samples above 12 feet bgs, between 14 and 24 feet bgs, and between 28 and 40 feet bgs at SB-06 had HVOC concentrations that were not detected or were less than CULs.

HVOCs did not exceed CULs in any samples collected at SB-03, SB-04, SB-05, and SB-08, which were collected to verify the lateral extents of the upgradient PCE source area. HVOCs also did not exceed CULs at SB-07, SB-09, SB-10, or SB-11, which were sampled to investigate a potential secondary HVOC source area in the downgradient direction that was suggested by the historical soil dataset.

The vertical and horizontal extents of HVOCs exceeding CULs in soil are well-defined in the vicinity of the former machine shop. As shown in Figure 2.3, a limited area of contamination appears to extend into the City right-of-way (ROW) in the vicinity of RB-25, where PCE exceeding the CUL was detected at 13 feet bgs.

3.0 Updated Conceptual Site Model

The results of the PDI sampling provide key updates to the understanding of the nature and extent of HVOC contamination in groundwater and soil at the Site, as well as the mechanisms of migration and potential degradation of HVOCs.

3.1 NATURE AND EXTENT OF HVOCS IN GROUNDWATER

The most recent data show that the overall magnitude of HVOC source mass in groundwater has decreased significantly within the footprint of the groundwater extraction interim action since the extraction system began running in 2013. This is demonstrated by declining PCE and other HVOC concentrations at most Site wells, as shown in Table 2.2.

For consideration of nature and extent of HVOCs, as well as migration and degradation mechanisms, the Site HVOC plume can be subdivided into four subareas (refer to HVOC results presented in Figure 2.2):

- HVOC source area and upgradient plume
  - Within the former machine shop source area and the assumed pumping footprint of the upgradient extraction well row: RMW-12, BC-3, EW-1 through EW-4, and deep well RMW-10D
  - Immediately adjacent to the assumed extraction pumping footprint: RMW-6, RMW-8
- Downgradient HVOC plume
  - Within the assumed pumping footprint of downgradient extraction well row: RMW-14, EW-5, EW-6, RMW-7, and PDI reconnaissance samples from GWB-07
  - Immediately adjacent to the extraction pumping radius: RMW-13
- Western HVOC plume
  - Cross-gradient and farther outside the footprint of groundwater extraction: RMW-4, RMW-5, and PDI reconnaissance sample from GWB-08
- Riverbank area of the Sammamish River
  - Reconnaissance samples from GWB-03 through GWB-06

The current HVOC conditions and trends in each subarea are described in the following sections.

For the permanent monitoring and extraction wells, the progress of mass removal and contaminant degradation within each subarea of the HVOC plume discussed above are further illustrated by analyzing changes in total HVOC molar concentrations and molar fractions of individual HVOCs over time. A molar concentration is a measure of the number of molecules of a given contaminant in a sample, which is obtained by normalizing the bulk concentration reported by the laboratory (in micrograms per liter) with the molecular weight of the compound (in grams per mole [g/mol]). Molar weights are useful for compounds such as HVOCs that undergo a degradation process (dechlorination) that produces toxic daughter products with lesser molecular weights than the source contaminant. Molar concentrations of HVOCs in a sample, therefore, provide more precise information versus bulk concentrations to determine whether dechlorination is occurring, as well as the relative contributions of dechlorination versus physical extraction to the removal of HVOC molecules from Site groundwater.

3.1.1 HVOC Source Area and Upgradient Plume

Within the source area and upgradient portions of the plume, the total molar concentration of HVOCs has declined since the start of groundwater extraction pumping. Prior to the start of active groundwater treatment, a maximum PCE concentration during low-flow sampling of 170 µg/L was detected at BC-3 in 2009. As shown on the total HVOC mass trend plots in Figure 3.1, most wells have experienced an approximately 10-fold decrease in HVOC concentrations since their first year of monitoring data. In PDI sample results, the maximum detected PCE concentration in this area is 9.6 µg/L at RMW-12, 2 times the Site CUL. The vertical extent of HVOCs in groundwater is presumed to extend from the water table to approximately 35 feet bgs or less in this area, based on non-detect results at RMW-10D, which is screened 32 to 42 feet.

The HVOC contamination within the source area (i.e., at RMW-12, BC-2, and EW-1 through EW-4) prior to groundwater extraction was composed primarily of PCE, with lesser fractions of TCE and *cis*-1,2-DCE and small amounts of vinyl chloride, as shown on the HVOC distribution trend plots in Figure 3.1. At the nearby wells on the plume edges (i.e., RMW-6 and RMW-8), the more mobile degradation products TCE, *cis*-1,2-DCE, and vinyl chloride made up most of the HVOC mixture. The distribution of HVOCs in the source plume has remained largely consistent over the duration of groundwater extraction while the overall concentrations have decreased, indicating that removal by pumping has caused most of the reduction of HVOC mass. There is also some evidence of dechlorination, for example at RMW-3 where the HVOC molar mass is now primarily *cis*-1,2-DCE; however, this appears to be a lesser contribution to overall mass reduction. There is some observed fluctuation of total HVOC molar mass between wet and dry seasons at RMW-8 during more recent sampling events; however, these potential fluctuations are within the context of overall low and relatively stable HVOC mass.

3.1.2 Downgradient HVOC Plume

Within the downgradient portion of the plume, the total molar concentrations of HVOCs have declined at a rate similar to the upgradient areas as shown on the mass trend plots in Figure 3.2. Prior to the start of active downgradient groundwater treatment, the maximum PCE concentration during low-flow sampling of 50 µg/L was detected at RMW-7 in 2009. In PDI sample results, the maximum detected PCE concentration in this area is 9.8 µg/L at RMW-14, 2 times the Site CUL. The vertical extent of HVOCs in groundwater is presumed to extend from the water table to approximately 35 feet bgs based on non-detect results from 35 to 40 feet bgs and 40 to 45 feet bgs at GWB-07.

The initial distribution of HVOCs in the downgradient plume was more variable prior to pumping, with fractions of more highly mobile degradation products (i.e., *cis*-1,2-DCE and vinyl chloride) increasing with distance downgradient from the source area as shown on the distribution trend plots on Figure 3.2.

Similar to the source area and upgradient portions of the plume, the distribution of HVOCs has remained relatively consistent while overall concentrations have decreased, indicating that pumping has caused most of the mass reductions. However, farthest downgradient at RMW-7, remaining HVOCs are primarily *cis*-1,2-DCE and vinyl chloride, suggesting that dechlorination has also occurred.

An additional trend that is demonstrated on Table 2.2 is a positive correlation between mobile HVOC concentrations at the farthest downgradient well RMW-7 and groundwater extraction at EW-5 and EW-6. During upgradient-only groundwater extraction between 2013 and 2017, vinyl chloride was highly variable at RMW-7, but evidence of a decreasing trend began to emerge in late 2016/early 2017. After downgradient extraction began in 2017, vinyl chloride was consistently elevated at concentrations between 25 and 27 µg/L. Declining pump performance at EW-5 and EW-6 ultimately resulted in pump failure in both wells between approximately 2020 and 2023; during the same period, vinyl chloride decreased to less than 10 µg/L. This trend suggests that steeper horizontal gradients created by groundwater extraction downgradient facilitated downgradient migration of mobile HVOCs. There is some fluctuation observed in overall HVOC mass observed at RMW-7 during more recent sampling events; however, these fluctuations do not appear to have any seasonality and likely reflect the overall analytical variability and heterogeneity of HVOCs in Site groundwater.

3.1.3 Western HVOC Plume

An additional western lobe of the groundwater HVOC plume is represented by RMW-4, RMW-5, and GWB-08, which are farther outside the potential influence of extraction pumping. HVOC concentrations in this area are less elevated relative to the main plume, with PCE concentrations less than the Site CUL and exceedances of CULs only for TCE and vinyl chloride.

Overall HVOC mass has been stable to slightly increasing at the permanent wells in this area as shown on the mass trend plots in Figure 3.3. The HVOC distribution trend suggests that dechlorination has occurred, as illustrated by increases in *cis*-1,2-DCE fractions at both wells and vinyl chloride fraction at EW-5; however, degradation appears to be slow and incomplete based on the relatively flat trends in HVOC concentrations during recent sampling events.

The source of PCE in the western plume is uncertain; however, there is no evidence of upgradient PCE contamination in groundwater or contamination in soil in this area (refer to Section 3.2). Because the footprint of former machine shop operations is not well defined, it is assumed that incidental historical releases to soil may have occurred to the west of the machine shop that have now fully leached into groundwater. It is likely that some PCE mass remains sorbed to fine-grained soil in the saturated zone and will continue to diffuse to groundwater over time until it is depleted.

3.1.4 Riverbank Area of the Sammamish River

Reconnaissance groundwater samples in the riverbank area are intended as a screening tool to demonstrate the presence or absence of the HVOC plume. Because reconnaissance samples are generally biased high due to inherent turbidity associated with grab sample collection, they do not define the extents of HVOC CUL exceedances in groundwater.

The western extent of the HVOC plume at the riverbank is well-defined by non-detect results at GWB-03. HVOC concentrations were found to be increasing from west to east in the riverbank area with the most elevated results at GWB-06, indicating that the most concentrated area of the downgradient plume may lie to the east of the existing permanent well network. As discussed in Section 2.2.2.1, this is a minor data gap for engineering design to treat the horizontal extent of groundwater exceeding CULs.

3.2 NATURE AND EXTENT OF HVOCS IN SOIL

Soil sampling conducted during the PDI provides a more detailed understanding of the vertical and horizontal extents of historical PCE releases to soil, which acted as a source of HVOC contamination to groundwater.

Based on samples collected continuously from above the water table to 40 feet bgs at SB-06 within the source area, there appears to be a stratified PCE soil source remaining at the Site. The shallowest occurrence of PCE concentrations exceeding the Site CULs coincided with the approximate seasonal low water table of 12 to 14 feet bgs, and the overlying vadose zone and underlying saturated zone samples did not have PCE exceedances. This is consistent with the historical soil dataset, which did not have any vadose zone soil exceedances and had one isolated exceedance at 13 feet bgs. This shallower saturated source is correlated with the observed the contact between fill and marsh deposits, which may preferentially sorb PCE due to the presence of organic carbon.

A deeper and more concentrated source zone of PCE occurs in the saturated zone from approximately 20 to 30 feet bgs. This zone is vertically delineated by multiple samples without detectable PCE or other HVOCs to 40 feet bgs at SB-06. The vertical extent of the soil source zone is generally consistent with the vertical extent of groundwater contamination in this area, which is presumed to be 35 feet bgs or less (refer to Section 3.1.2).

The lateral extents of the PCE soil source area were confirmed by PDI borings and are largely consistent with the source area presented in the Supplemental Remediation Investigation & Feasibility Study (RI/FS; Kane 2022) and CAP. The PDI borings downgradient of the soil source area did not have HVOC exceedances in soil, in contrast to the previous low-level exceedances of PCE and TCE at RMW-14 (just over 2 times the CUL for PCE) in the historical dataset. Because historical groundwater concentrations of HVOCs during soil sample collection were several orders of magnitude greater than current conditions, the exceedances in soil at RMW-14 near the centerline of the plume were likely caused by back-diffusion from highly contaminated groundwater. There is not a suspected secondary soil source area in the vicinity of RMW-14.

3.3 EXPOSURE PATHWAYS AND CLEANUP STANDARDS

The exposure pathways identified in the 2023 CAP as complete or potentially complete under future scenarios include the following:

- Direct contact with contaminated soils by humans and terrestrial biota
- Direct contact/ingestion of surface water and ingestion of organisms in impacted surface water by humans and aquatic biota
- Inhalation of soil vapors by humans

The findings of the PDI and the historical dataset generally support these conclusions, with the exception of the soil direct contact pathway. The point of compliance for direct contact with soil is 15 feet bgs for human receptors and 6 feet bgs for terrestrial biota; therefore, the soil direct contact pathway is only complete for human exposures. However, the Site CULs are based on protection of surface water quality, which are more stringent than criteria for direct contact exposures, and this finding does not impact the application of the Site CULs. Site soils do not exceed the Model Toxics Control Act (MTCA) Method B CULs for direct contact in any samples (Ecology 2024).

3.4 IMPLICATIONS FOR CLEANUP ACTION

The updated conceptual site model regarding the nature and extent of HVOC contamination has implications for both cleanup action technologies proposed by the 2023 CAP cleanup action as described in the following sections.

3.4.1 Soil Vapor Extraction

The proposed SVE system would be installed only in the vadose zone of the PCE source area, which extends to approximately 12 to 13 feet bgs based on recent depth to water measurements at RMW-12. During the PDI and in historical samples, the shallowest occurrences of HVOC CUL exceedances in soil occurred at the water table (approximately 12 to 13 feet bgs) and concentrations in shallower samples were less than CULs. Therefore, SVE in the vadose zone would not accomplish the goal of soil source mass removal.

3.4.2 Groundwater Bio-Recirculation

The proposed groundwater bio-recirculation with soluble organic carbon treatment is designed to enhance biodegradation via introduction of an electron donor and to increase horizontal groundwater gradients to ensure rapid distribution of the treatment materials.

The results of recent groundwater sampling for HVOCs and geochemical parameters indicate that soluble organic carbon is likely to be an effective treatment technology for stimulating anaerobic biodegradation; the conditions in groundwater naturally trend toward reducing conditions and there are few naturally occurring electron acceptors that would compete with HVOCs for soluble electron donors. The efficacy of soluble organic carbon would likely be enhanced by a minor adjustment of additionally injecting cultures of *Dehalococcoides* bacteria, which degrade HVOCs. Given the relatively low concentrations of HVOCs in saturated soil, this treatment technology is also expected to result in elimination of the remaining soil source over time as HVOCs are depleted from groundwater, facilitating further diffusion of any sorbed soil mass.

The current nature and extent of HVOCs in groundwater, HVOC flux, and observed historical distribution and trends of HVOCs indicate that a groundwater recirculation system would have mixed results for groundwater treatment.

In the upgradient source plume, HVOC fluxes are generally low, and recirculation is likely to accelerate anaerobic biodegradation by steepening horizontal gradients and resultant groundwater flow velocities, moving the treatment materials more quickly through the saturated zone. Given the small amount of PCE source mass remaining, CULs would likely be achieved rapidly where treatment materials are distributed throughout the saturated zone. However, the fine-grained nature of the saturated zone and limited observed radius of influence of the existing extraction wells indicate that it may not be the most practical and efficient approach to deliver treatment materials evenly into the formation with a limited number of larger diameter extraction wells. The mechanical processes of groundwater extraction and recirculation may additionally increase dissolved oxygen in the recirculation, which would require management to ensure that in situ conditions remain favorable for anaerobic biodegradation.

In downgradient areas of the plume, recirculation may make achieving CULs more difficult. The flux of the most mobile HVOCs is already greater downgradient than in other areas of the Site under baseline conditions, and the historical groundwater data trends additionally indicate that increased downgradient pumping is correlated with downgradient increases in vinyl chloride concentrations. The migration of mobile HVOCs induced by injection and pumping would likely make it more difficult to achieve groundwater CULs at the point of discharge to the Sammamish River by decreasing the time that vinyl chloride is in contact with the treatment materials.

Lastly, the estimated pumping and injection radius of the current extraction system potentially would not reach the eastern portion of the riverbank area in the vicinity of GWB-06, and therefore, an expansion of the system would be needed to treat the area.

4.0 Identification of Supplemental Cleanup Action Alternatives

The data collected during the PDI support reevaluation of the cleanup action to ensure that remediation efficiently and thoroughly addresses the remaining Site HVOC contamination. The following sections present and evaluate potential adjustments to the 2023 CAP cleanup action to most efficiently achieve the RAOs for the Site.

4.1 SUMMARY OF 2023 CAP CLEANUP ACTION

The 2023 CAP cleanup action includes soil vapor extraction and Site-wide recirculation of groundwater amended with a soluble organic carbon substrate electron donor (CarBstrate) to enhance biodegradation of HVOCs (Ecology 2023). The elements of the 2023 CAP cleanup action are shown on Figure 4.1, which is reproduced from the CAP.

The 2023 CAP cleanup action would include installation of the following components:

- 12 soil vapor extraction wells
- Vapor collection piping and blowers and a vapor treatment system to remove HVOCs prior to discharge
- Six injection wells and two extraction wells (plus conversion of two existing extraction/monitoring wells for injection)
- Injection delivery and recovery piping, groundwater treatment system to remove remaining HVOCs prior to reinjection, and injection delivery control system

For this analysis, a revised assumption of an equal number of injection and extraction wells was used to evaluate cost-benefit.

Implementation of the cleanup action would include regular operation and maintenance (O&M) including weekly application of CarBstrate and periodic changeout of carbon vessels for both the SVE and bio-recirculation systems. The SVE system is designed to run for 3 years, and the bio-recirculation system is designed to run for 2 years. Progress of the groundwater cleanup would be evaluated through regular groundwater monitoring at existing wells. After completion of bio-recirculation and SVE, compliance with soil CULs would be demonstrated by collecting soil samples in the source area via direct-push drilling. The estimated restoration time frame for this cleanup action is 5 years.

4.2 REMEDIAL ACTION OBJECTIVES AND TECHNOLOGIES

RAOs identify goals that should be accomplished to meet the minimum requirements of the MTCA Cleanup Regulations (WAC 173-340). RAOs may also be informed by current or future property use. RAOs were not previously defined for the Site. To help guide the evaluation of remedial actions, the following RAOs are defined for the Site:

- Protect humans and the environment (ecological receptors) from exposure to Site contamination that exceeds applicable CULs.
  - Achieve CULs in groundwater to protect surface water quality of the adjacent Sammamish River, prioritizing rapid achievement of CULs at the point of discharge to surface water.
  - Address residual contaminated soil to reduce exposure to hazardous substances via leaching to groundwater.
- Comply with local, state, and federal laws and other ARARs (WAC 173-340-710) and Site-specific cleanup standards. ARARs are limited to applicable federal and state laws and those that Ecology determines are relevant and appropriate.
- Remediate contaminants in a manner that minimizes impacts to public use of park space at the Site.
- Provide compliance monitoring to evaluate the effectiveness of the preferred cleanup action and to evaluate when the cleanup standards are met.

As discussed in Section 3.4, some elements of the 2023 CAP cleanup action may not support progress toward achieving the RAOs. The available soil data suggest that SVE will not reduce exposures to contaminated soil because it will not reach the contaminated soil mass that lies fully below the groundwater table. The available groundwater data suggest that Site-wide groundwater recirculation, which includes downgradient groundwater extraction, may not achieve CULs at the point of discharge to the Sammamish River because extraction could exacerbate migration of vinyl chloride toward the river. Aerobic conditions that may be created by the remediation technologies and compete with the desired anaerobic biodegradation process in groundwater are also of concern, primarily for SVE but also potentially for the mechanical process of extraction and injection.

The other treatment technologies for saturated soil considered in the RI/FS included excavation and SVE with the addition of air sparge. The Site soil data demonstrate that these technologies remain impractical at the Site; excavation to depths of almost 20 feet below the water table is cost prohibitive and unsafe adjacent to SR 522, and air sparging would create adverse geochemical conditions for anaerobic biodegradation of HVOCs in groundwater. The other treatment technology for groundwater considered in the RI/FS included injection of organic carbon (edible oil) without recirculation. The Site groundwater data suggest that treatment of groundwater cleanup via passive migration is a viable alternative technology because it would not exacerbate downgradient vinyl chloride migration. Treatment via passive migration is incorporated into the revised alternatives discussed in the following sections, and additional treatment components to further stimulate biodegradation are also considered in these alternatives.

4.3 REVISED CLEANUP ALTERNATIVE 1: TARGETED BIO-RECIRCULATION WITH IN SITU TREATMENT INJECTION

The first revised alternative to the 2023 CAP cleanup action makes the following adjustments to adapt the remediation to current Site conditions based on the findings of the PDI:

- SVE is eliminated.
- Groundwater bio-recirculation with soluble organic carbon (such as CarBstrate) is retained in the upgradient HVOC source area only. The bio-recirculation is enhanced with an initial introduction of *Dehalococcoides* bacterial culture.
- Groundwater treatment with soluble organic carbon and supplemental *Dehalococcoides* in the downgradient plume is achieved via passive treatment using rows of direct-push injection points. It is assumed that two injection events would be completed approximately 1 to 1.5 years apart to treat the remaining downgradient plume. The western plume, where the overall HVOC source mass is low, is treated with a single direct-push application of the treatment materials.

The elements of Alternative 1 are shown on Figure 4.2. This alternative retains groundwater treatment with a soluble organic carbon electron donor, which is expected to be effective in achieving anaerobic biodegradation of HVOCs at the Site, and supplements this alternative with beneficial cultures of bacteria that degrade HVOCs. It additionally addresses potential downgradient vinyl chloride migration by using the alternate technology of passive treatment in the direction of groundwater flow.

Implementation of the cleanup action would include regular O&M including weekly application of soluble organic carbon and periodic changeout of activated carbon vessels used to remove HVOCs from extracted groundwater prior to recirculation. The bio-recirculation system is designed to run for 2 years. The estimated restoration time frame for this cleanup action is 5 years, because the organic carbon added during active recirculation is expected to form biomass that will continue to provide donor electrons to complete the process of anaerobic degradation.

4.4 REVISED CLEANUP ALTERNATIVE 2: IN SITU TREATMENT INJECTION

The second revised alternative to the 2023 CAP cleanup action makes additional adjustments to Alternative 1 to further adapt the remedial action to current Site conditions based on the findings of the PDI. Additional adjustments include the following:

- Soluble organic carbon and *Dehalococcoides* treatment in the source area is achieved by direct-push injection, which is supplemented with zero-valent iron (ZVI). A lesser amount of supplemental ZVI is also added in the western plume.
- Downgradient soluble organic carbon and *Dehalococcoides* treatment are supplemented with ZVI and colloidal activated carbon (such as PlumeStop) to form in situ treatment barriers.
- A controlled-release source of organic carbon is used.

The elements of Alternative 2 are shown on Figure 4.3. This alternative supplements source area treatment with ZVI to achieve prompt abiotic degradation of PCE and TCE and ensure ongoing reducing conditions to promote anaerobic biodegradation. The addition of ZVI, combined with a controlled-release form of organic carbon, allows for a single direct-push application of the treatment materials in lieu of recirculation to degrade the remaining HVOC mass. The addition of colloidal activated carbon downgradient is designed to adsorb HVOCs and allow longer contact time with the treatment materials, which will allow for more rapid cleanup of downgradient groundwater. A double row of injections is assumed in order to form a highly effective barrier. The estimated restoration time frame for this cleanup action is 3 years.

4.5 SUPPLEMENTAL ALTERNATIVES ANALYSIS

This section provides a supplemental analysis of each cleanup action alternative in accordance with MTCA per WAC 173-340-360(3). Each of the proposed alternatives fulfills the mandatory MTCA general requirements for cleanup action:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws
- Prevent or minimize present and future releases of hazardous substances in the environment
- Provide resilience to climate change impacts
- Provide for compliance monitoring
- Not rely primarily on institutional controls (ICs) or dilution and dispersion
- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
    - The predicted restoration time frame for groundwater to meet proposed cleanup standards for HVOCs for each Alternative is as follows:
        - 2023 CAP Cleanup Action: 5 years
        - Alternative 1: 5 years
        - Alternative 2: 3 years

4.5.1 Supplemental Disproportionate Cost Analysis

The MTCA disproportionate cost analysis (DCA) procedure is used to evaluate whether a cleanup action uses permanent solutions to the maximum extent practicable as determined by the level of attainment of specific criteria defined in WAC 173-340-360(5)(d) and also factoring public concerns (WAC 173-340-360(5)(c)(i)(C). For the DCA, each alternative is assigned a numerical score for each DCA criterion on a scale of 1 to 10 and then multiplied by a weighting value, and the scores are summed to determine the total alternative benefit score. Finally, the ratio of the cost of each alternative to its total benefit score is calculated.

An evaluation of each of the alternatives relative to the MTCA criteria and the weighting of each of the criteria is summarized as follows:

- **Protectiveness (30%).** Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, the time required to reduce these risks, and the overall improvement in environmental quality. All the alternatives are protective of human health and the environment. All the alternatives are expected to be equally protective in the HVOC source area, where rapid degradation of HVOCs can be achieved either by bio-recirculation or by addition of ZVI to supplement treatment with abiotic degradation. Alternative 2 has the highest degree of protectiveness for discharges to surface water because it uses an in situ treatment barrier to trap and fully degrade HVOCs. Overall, Alternative 2 is considered the most protective. The 2023 CAP cleanup action is considered the least protective of surface water receptors due to concerns with downgradient vinyl chloride migration during groundwater extraction.
- **Permanence (20%).** The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances. All of the alternatives are designed to achieve CULs Site-wide through degradation of HVOCs and are, therefore, considered permanent. However, because the current alternative would install the greatest number of permanent injection and extraction wells that could be operated indefinitely if needed, this alternative is considered the most permanent. Alternative 2, which uses only direct-push injection, is the least permanent and may require more than one injection event to achieve CULs.
- **Effectiveness over the long term (20%).** Long-term effectiveness consists of the degree of certainty that the alternative will be successful, the reliability of the alternative during the time during that hazardous substances are expected to remain at the Site at concentrations greater than CULs, the magnitude of the residual risk with the alternatives in place, and the effectiveness of controls in place to control risk while contaminants remain at the Site. All the alternatives are designed to fully degrade HVOCs; however, Alternative 2 is expected to be most effective because it includes the most aggressive downgradient treatment.
- **Management of short-term risks (10%).** Short-term risks comprise the risk to human health and the environment associated with the alternative during construction and implementation and the effectiveness of measures taken to control those risks. The 2023 CAP cleanup alternative poses the most short-term risk because it involves the most ground-disturbing construction, production of waste soils and waters, and installation of permanent infrastructure such as conveyance piping and underground power in close proximity to the Sammamish River. Alternative 2 poses the least short-term risk because it involves the least ground disturbance and includes limited permanent infrastructure.

- **Technical and administrative implementability (10%).** The ability of the alternative to be implemented is based on whether the alternative is technically possible and meets administrative and regulatory requirements, and if all necessary services, supplies, and facilities are readily available. The 2023 CAP cleanup action is the most technically difficult to implement because it involves multiple types of equipment and construction methodologies. Alternative 2 is the least technically difficult to implement because it involves the fewest types of equipment and methodologies. The necessary materials and facilities for all alternatives are readily available.
- **Consideration of public concerns and tribal rights and interests (10%).** These considerations take into account whether the community has concerns regarding the alternative and if so, to what extent the alternative addresses those concerns. The alternatives all address public concerns regarding contamination with equal effectiveness. The 2023 CAP cleanup action is expected to raise more public concerns due to more permanent cleanup infrastructure that would be constructed in a public park space that may limit Site use and potential short-term surface water impacts from vinyl chloride. Alternative 2 has the least permanent infrastructure and poses the fewest limitations on Site use and additionally prioritizes cleanup at the point of groundwater discharge to surface water.
- **Cost.** The cost to implement the alternative consists of construction, net present value of any long-term costs, and agency oversight costs that are recoverable. Detailed costs for the alternatives are presented in Appendix D and summarized as follows:
  - 2023 CAP Cleanup Action: $2,732,602
  - Alternative 1: $1,648,059
  - Alternative 2: $1,655,362

A summary of the scoring for each criterion, including the estimated costs for each alternative, is presented in Table 4.1. A full description of all aspects evaluated under each criterion for the alternatives is included in Table 4.2.

The cost-benefit score is calculated by dividing the total weighted benefit score by the estimated alternative cost (standardized by dividing by $1.5 million[1]) for that alternative. Total benefits per unit cost scores are presented in Table 4.2. Based on the alternatives evaluation presented in the previous sections and in Tables 4.1 and 4.2, the total benefit per unit cost achieved are as follows:

- 2023 CAP Cleanup Action: 3.40
- Alternative 1: 6.19
- Alternative 2: 7.70

[1] The method for calculation of cost benefit is not specified in MTCA. A divisor of $1.5 million for estimated alternative cost was selected to obtain cost-benefit scores between 0 and 10 for the alternatives.

4.5.2 Preferred Cleanup Action Alternative

Based on the results of the supplemental DCA, selection of a revised cleanup action is warranted for the Site. To determine a revised preferred alternative, the step-wise DCA procedures was followed per MTCA to select a baseline for comparison. First, a baseline was selected from the most permanent alternatives. Both the 2023 CAP cleanup action and Alternative 2 are considered permanent (WAC 173-340-200) because construction of further remedial action components is not anticipated to be needed after they are installed. Alternative 2 was selected as the baseline because it has the greatest cost-benefit score of the permanent alternatives (WAC 173-340-360(5)(c)(iii)(B).

Alternative 2 was then weighed against the next-most permanent alternative (Alternative 1) to determine whether the incremental costs of the baseline alternative are disproportionate to the incremental benefits (WAC 173-340-360(5)(c)(iv).

The costs of Alternative 1 and Alternative 2 are approximately the same. Alternative 2 scored most highly for protectiveness because it prioritizes improvement of groundwater quality to reach CULs downgradient at the point of discharge to the Sammamish River and additionally is expected to have the shortest restoration time frame. It also causes the least disruption to use of public space at the Site. Protection of surface water in the river and preservation of public use of the Site are key RAOs for the City. Because Alternative 2 achieves these key RAOs most effectively, it has a cost benefit of 7.70 versus a cost benefit of 6.19 for Alternative 1.

Given these considerations, Alternative 2 is the Preferred Revised Cleanup Action. Section 5.0 describes the Preferred Revised Cleanup Action in greater detail.

5.0 Preferred Revised Cleanup Action

The Preferred Revised Cleanup Action for the remediation of soil and groundwater at the Site, which is proposed by the City to Ecology for selection and implementation at the Site, is described in Section 5.1. Sections 5.4, 5.5, and 5.6 describe how the Preferred Revised Cleanup Action complies with MTCA, ARARs, and Site RAOs, respectively.

5.1 DESCRIPTION OF PREFERRED REVISED CLEANUP ACTION

Alternative 2, which is permanent to the maximum extent practicable out of all the alternatives discussed in Section 4.0, is selected as the Preferred Revised Cleanup Action for the Site, and is shown on Figure 4.3. This remedy includes the following components:

- In situ groundwater treatment using soluble organic carbon, ZVI, and colloidal activated carbon treatment barriers
- Monitored natural attenuation (MNA) for groundwater recovery and groundwater monitoring to determine compliance with Site cleanup standards

Together, the individual technologies remove contaminant mass in saturated zone soil and groundwater through a combination of anaerobic biodegradation and abiotic degradation of source mass. The Preferred Revised Cleanup Action is a comprehensive final remedy for the Site that is compliant with all the applicable remedy selection requirements under MTCA.

5.1.1 In Situ Groundwater Treatment

In situ groundwater treatment will be conducted throughout the groundwater plume to address HVOCs at concentrations that are greater than their respective CULs. Remediation will be achieved using a combination of soluble organic carbon electron donors and *Dehalococcoides* culture Site-wide, with ZVI to promote reducing conditions and achieve abiotic degradation, and a proprietary mixture of liquid colloidal activated carbon, such as PlumeStop, to provide sorption of contamination and more rapid and complete treatment in the downgradient portion of the HVOC plume. Treatment materials will be injected under low pressure into the subsurface using a direct-push drill rig to provide even distribution within the target groundwater treatment zones. The target treatment zone is expected to range from approximately 12 to 32 feet bgs within the source area to approximately 15 to 35 feet bgs in the downgradient portion of the HVOC plume. Upgradient injection points using soluble treatment materials will be installed at approximately 15-foot spacing. The downgradient treatment with additional colloidal activated carbon will be implemented as a double row of closely spaced injection points to ensure creation of a full barrier.

5.1.2 Groundwater Monitoring

MNA for groundwater is a component of the Preferred Revised Cleanup Action after the completion of active treatment to degrade source contamination. As part of MNA, post-remedy groundwater monitoring throughout the plume in accordance with a groundwater monitoring plan (GMP) will be required after cleanup action implementation. The GMP will describe long-term post-construction groundwater monitoring, including specific monitoring locations and frequency, and adaptive management to ensure the long-term protectiveness of the Preferred Revised Cleanup Action. Groundwater compliance will be determined based on a comparison of groundwater data to Site CULs.

5.1.3 Institutional Controls

ICs are not anticipated to be required at the Site. In situ treatment would address remaining soil that is a source of groundwater contamination, and HVOC concentrations do not exceed screening levels for worker protection in any Site soil.

Additionally, the City has implemented a ROW contamination protocol that is incorporated into the City parcel mapping system and triggered by applications for ROW work permits adjacent to contaminated sites. The ROW contamination protocol identifies requirements for design review and City consultation prior to construction, material handling, material disposal, record-keeping, and worker safety.

5.2 COMPLIANCE MONITORING REQUIREMENTS

Compliance monitoring to ensure the protectiveness of the Preferred Revised Cleanup Action will be implemented in accordance with WAC 173-340-410, Compliance Monitoring Requirements. Detailed monitoring elements for construction will be described in a Construction Compliance Monitoring Plan (CCMP), which will be prepared as part of remedial design. The CCMP will include a Health and Safety Plan (HASP), Sampling and Analysis Plan, and Quality Assurance Project Plan for monitoring and sample collection during cleanup action implementation. The CCMP will be included as an appendix to the Engineering Design Report, which will describe the approach and criteria for the engineering design of soil and groundwater cleanup actions at the Site. A post-remedy Long-Term Compliance Monitoring Plan will describe required long-term operations, maintenance, and monitoring after remedy implementation to ensure the long-term protectiveness of the remedy and will include a GMP and an updated HASP.

The purpose of the three types of compliance monitoring identified in WAC 173-340-410, with respect to how they will be implemented as part of the proposed alternative, is described as follows.

- **Protection monitoring** is used to confirm that human health and the environment are adequately protected during construction of the cleanup action and post-construction monitoring. Protection monitoring requirements will be described in Site-specific HASPs that address worker activities during remedy construction and post-construction monitoring.
- **Performance monitoring** is used to confirm that the cleanup action has attained cleanup standards and other performance standards. Performance monitoring will be conducted to document that remedial goals are being achieved, including HVOC reduction in groundwater after treatment injections. The combined soluble organic carbon, *Dehalococcoides* culture, and ZVI throughout the plume are designed to

address groundwater contamination through abiotic degradation and biodegradation of PCE and its breakdown products. Additional of colloidal activated carbon will additionally provide adsorption in the downgradient portion of the plume to increase contact time with the treatment materials. Remediation of HVOC contamination in the saturated zone soil, where CULs are designed to be protective of groundwater quality, will also be assessed by groundwater performance monitoring because the soil CULs are based on groundwater protection.

- **Confirmation monitoring** is used to confirm the long-term effectiveness of the cleanup action after completion of the preferred cleanup action. Confirmation groundwater monitoring would be conducted after results from performance monitoring that verify that groundwater concentrations of HVOCs are less than CULs. Long-term monitoring of groundwater may be required to verify that the remedy remains effective. This is likely to be conducted through periodic reviews of the Site overseen by Ecology.

5.3 CONTINGENCY ACTIONS

Contingency actions may be considered if groundwater does not achieve CULs within the restoration time frame. Because all HVOC contamination is currently situated in the saturated zone and soil CULs are based on groundwater protection, groundwater quality will dictate the potential implementation of contingencies.

5.4 COMPLIANCE WITH THE MODEL TOXIC CONTROL ACT

The Preferred Revised Cleanup Action meets the MTCA requirements for selection of a cleanup action as described in Section 4.5.

- Protect human health and the environment: Risk to human health during construction would be minimized by use of in situ treatment methodologies and long-term risk due to contamination to surface water would be mitigated by achieving Site CULs in groundwater.
- Comply with cleanup standards: Cleanup standards for the Site, which are designed to be protective of surface water, would be achieved Site-wide.
- Comply with applicable state and federal laws: The action will meet the ARARs discussed further in Section 5.5.
- Prevent or minimize present and future releases of hazardous substances in the environment: Future releases of hazardous substances, particularly to surface water, would be prevented by complete degradation of HVOCs.
- Provide resilience to climate change impacts: The action would not change the natural Site topography and would install no permanent structures that would be vulnerable to climate change.

- Provide for compliance monitoring: Compliance monitoring would be achieved through sampling of existing and proposed wells under a GMP.
- Not rely primarily on ICs or dilution and dispersion: No ICs are proposed and remediation relies on destruction of contaminants.
- Use permanent solutions to the maximum extent practicable: The Preferred Revised Cleanup Action was identified as a permanent alternative and also achieved the highest cost benefit of the alternatives considered.
- Provide for a reasonable restoration time frame: The estimated restoration time frame is 3 years.

Exposure pathways will be addressed through in situ groundwater treatment and MNA.

5.5 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Compliance with ARARs is a requirement for cleanup actions. ARARs are often categorized as location-specific, action-specific, or chemical-specific.

- **Location-specific ARARs** are requirements that are applicable to the specific area where the site is located and can restrict the performance of activities, including cleanup actions, solely because they occur in specific locations.
- **Action-specific ARARs** are requirements that are applicable to certain types of activities or technologies that are used during the implementation of cleanup actions. Waste disposal regulations are an example of an action-specific ARAR.
- **Chemical-specific ARARs** are applicable to the types of contaminants present at the site. The cleanup of contaminated media at the Site must meet the proposed CULs developed under MTCA; these CULs are considered chemical-specific ARARs.

ARARs were established in the CAP for the 2023 CAP cleanup action. The same ARARs generally apply to the Preferred Revised Cleanup Action; however, SVE was eliminated for the Preferred Revised Cleanup Action and ARARs presented in the CAP related to air quality and air permitting are no longer applicable.

Location-specific ARARs will be met through compliance with all applicable local, state, and federal regulations based on the physical location of the Site. Action-specific ARARs will be met through implementation of construction activities in compliance with all applicable construction-related requirements such as disposal for excavated soil and compliance with all applicable drilling-related requirements. Chemical-specific ARARs will be met through compliance with proposed CULs.

Implementation of the Preferred Revised Cleanup Action would typically trigger a suite of environmental permits; however, cleanup actions conducted under an AO with Ecology are exempt from the state and local ARAR procedural requirements, such as permitting and approval requirements (WAC 173-340-710(9)(b)). Cleanup actions must, however, demonstrate compliance with the substantive requirements of those ARARs (WAC 173-340-710(9)(c)). This exemption applies to procedural permitting requirements under the Washington State Water Pollution Control Act, the Solid Waste Management Act, the Shoreline Management Act, and local laws requiring permitting such as City municipal codes and regulations. Cleanup actions are not exempt from procedural requirements of federal ARARs.

5.6 COMPLIANCE WITH REMEDIAL ACTION OBJECTIVES

The Preferred Revised Cleanup Action achieves the RAOs through the following actions:

- Protection of human health and the environment from Site contamination that exceeds applicable CULs protective of surface water quality by attenuation of HVOCs throughout the saturated zone
- Prevention of migration of contaminants from the Site via groundwater transport by installation of in situ downgradient treatment barriers
- Proper management of contaminated soil or groundwater generated during Site cleanup by implementing construction protection monitoring
- Compliance with ARARs as described in Section 5.5
- Provision for compliance monitoring to evaluate the effectiveness of the Preferred Revised Cleanup Action and to determine that the cleanup standards are met by implementation of a GMP

5.7 TYPES AND AMOUNTS OF HAZARDOUS SUBSTANCES TO REMAIN IN PLACE

No hazardous substances exceeding CULs are anticipated to remain in place after implementation of the Preferred Revised Cleanup Action.

The Preferred Revised Cleanup Action addresses all groundwater HVOC contamination and associated HVOC contamination in saturated soil. HVOC contamination in groundwater will be addressed with in situ treatment and is expected to achieve CULs. Groundwater will achieve CULs throughout the standard point of compliance, which is Site-wide, and soil concentrations will be demonstrated to be protective of groundwater quality through monitoring. Therefore, no groundwater contamination that exceeds CULs will remain in place after implementation of the Preferred Revised Cleanup Action.

5.8 RESTORATION TIME FRAME

The restoration time frame for HVOCs to achieve groundwater CULs Site-wide is approximately 3 years after injections are complete. The restoration time frame reflects the time expected for complete degradation of HVOCs in the source area and treatment of all groundwater flowing through the downgradient in situ treatment barriers.

5.9 SUMMARY OF THE ESTIMATED REMEDY COSTS

Estimated remedial costs for the Preferred Revised Cleanup Action are presented in Appendix D. The costs associated with remedy implementation consist of capital construction costs, groundwater confirmation monitoring and reporting following remedy completion, and agency oversight that would include periodic reviews of the constructed remedy. The estimated costs for remedy construction are as follows:

- Construction costs include construction materials and services; engineering design, oversight, and reporting; agency oversight; and permitting costs associated with remedy implementation are estimated to be approximately $1,437,152.
- Long-term groundwater monitoring costs were estimated based on quarterly monitoring for 2 years after remedy implementation, then semiannual monitoring for a period of 1 year. The groundwater monitoring costs, including well installation and decommissioning, were estimated to be $218,210.

The total project cost for the Preferred Revised Cleanup Action, which includes a 20% construction contingency cost and sales tax for construction materials and services, is estimated to be $1,655,362.

6.0 References

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Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Tables

Table 2.1
Well Construction and Water Level Data

Well ID	X Coordinate (feet NAD 83 WA State Plane N)	Y Coordinate (feet NAD 83 WA State Plane N)	Top of Casing Elevation (feet NAVD 88)	Ground Surface Elevaiton (feet NAVD 88)	Casing Type	Screened Interval (feet bgs)	Date	Depth to Water (feet below top of casing)	Measured By
BC-3	300020	1302930.5	279935.8	37.34	2-inch PVC	15 to 25	5/24/2013	12.95	HWA
							6/24/2014	14.41	HWA
							12/19/2014	15.61	HWA
							6/23/2015	18.30	HWA
							12/8/2015	15.30	HWA
							6/29/2016	16.95	HWA
							12/21/2016	14.25	HWA
							6/28/2017	16.43	HWA
							9/27/2019	16.08	Kane
							2/4/2020	15.05	Kane
							5/6/2020	13.81	Kane
							7/25/2024	14.73	Floyd|Snider
							7/29/2024	13.92	Floyd|Snider
							7/31/2024	13.95	Floyd|Snider
							8/22/2024	14.22	Floyd|Snider
RMW-4	300001	1302692.0	279898.8	38.48	2-inch PVC	15 to 25	12/19/2014	12.20	HWA
							6/23/2015	13.09	HWA
							12/8/2015	11.95	HWA
							6/29/2016	12.22	HWA
							12/21/2016	11.48	HWA
							6/28/2017	11.48	HWA
							9/26/2019	12.24	Kane
							1/31/2020	10.72	Kane
							5/4/2020	11.09	Kane
							7/25/2024	11.16	Floyd|Snider
							7/29/2024	11.16	Floyd|Snider
							7/31/2024	11.20	Floyd|Snider
							8/22/2024	11.22	Floyd|Snider
RMW-5	300003	1302753.1	279840.3	35.58	2-inch PVC	12 to 22	5/24/2013	11.51	HWA
							6/24/2014	14.51	HWA
							12/19/2014	13.61	HWA
							6/23/2015	14.26	HWA
							12/8/2015	13.29	HWA
							6/29/2016	13.41	HWA
							12/22/2016	13.01	HWA
							6/29/2017	13.26	HWA
							9/26/2019	13.53	Kane
							1/31/2020	9.82	Kane
							5/4/2020	12.34	Kane
							7/25/2024	12.36	Floyd|Snider
							7/29/2024	12.40	Floyd|Snider
							7/31/2024	12.43	Floyd|Snider
							8/22/2024	12.55	Floyd|Snider
RMW-6	300007	1302827.904	279871.0979	34.520827	2-inch PVC	15 to 25	5/24/2013	10.42	HWA
							6/24/2014	14.79	HWA
							12/19/2014	13.31	HWA
							6/23/2015	13.65	HWA
							12/8/2015	12.46	HWA
							6/29/2016	13.14	HWA
							12/21/2016	12.21	HWA
							6/29/2017	12.68	HWA
							9/26/2019	12.67	Kane
							1/31/2020	10.85	Kane
							5/4/2020	11.11	Kane
							7/25/2024	11.33	Floyd|Snider
							7/29/2024	11.35	Floyd|Snider
							7/31/2024	11.39	Floyd|Snider
							8/22/2024	11.49	Floyd|Snider

Table 2.1
Well Construction and Water Level Data

Well ID	X Coordinate (feet NAD 83 WA State Plane N)	Y Coordinate (feet NAD 83 WA State Plane N)	Top of Casing Elevation (feet NAVD 88)	Ground Surface Elevaiton (feet NAVD 88)	Casing Type	Screened Interval (feet bgs)	Date	Depth to Water (feet below top of casing)	Measured By
RMW-7	300042	1302951.009	279868.3275	35.512833	2-inch PVC	15 to 25	5/24/2013	16.31	HWA
							4/4/2014	16.65	HWA
							6/25/2014	16.55	HWA
							9/22/2014	17.54	HWA
							12/19/2014	17.49	HWA
							3/18/2015	16.66	HWA
							6/23/2015	17.41	HWA
							9/11/2015	18.5	HWA
							12/8/2015	15.97	HWA
							3/31/2016	16.94	HWA
							6/29/2016	17.11	HWA
							9/30/2016	18.28	HWA
							12/22/2016	15.89	HWA
							4/5/2017	16.43	HWA
							6/28/2017	16.65	HWA
							10/10/2017	18.26	HWA
							9/27/2019	17.6	Kane
							2/3/2020	16.27	Kane
							5/5/2020	16.49	Kane
							7/25/2024	17.19	Floyd|Snider
							7/29/2024	17.26	Floyd|Snider
							7/31/2024	17.30	Floyd|Snider
							8/22/2024	17.44	Floyd|Snider
RMW-8	300013	1303006.8	279962.8225	40.61165	2-inch PVC	20 to 30	5/24/2013	18.81	HWA
							6/24/2014	19.62	HWA
							12/19/2014	20.63	HWA
							6/23/2015	20.87	HWA
							12/8/2015	19.42	HWA
							6/29/2016	20.5	HWA
							12/22/2016	20.58	HWA
							6/28/2017	19.73	HWA
							9/27/2019	21.10	Kane
							2/3/2020	19.56	Kane
							5/6/2020	19.52	Kane
							7/25/2024	20.14	Floyd|Snider
							7/29/2024	20.21	Floyd|Snider
							7/31/2024	20.28	Floyd|Snider
							8/22/2024	20.51	Floyd|Snider
RMW-9R	300040	1302946.715	280061.9349	43.912907	2-inch PVC	20 to 30	12/19/2014	15.31	HWA
							6/23/2015	4.00	HWA
							12/8/2015	15.92	HWA
							6/29/2016	15.31	HWA
							12/22/2016	14.78	HWA
							6/29/2017	13.55	HWA
							9/27/2019	16.61	Kane
							2/4/2020	15.10	Kane
							5/7/2020	14.48	Kane
							7/25/2024	15.09	Floyd|Snider
							7/29/2024	15.14	Floyd|Snider
							7/31/2024	15.19	Floyd|Snider
							8/22/2024	15.41	Floyd|Snider

Table 2.1
Well Construction and Water Level Data

Well ID	X Coordinate (feet NAD 83 WA State Plane N)	Y Coordinate (feet NAD 83 WA State Plane N)	Top of Casing Elevation (feet NAVD 88)	Ground Surface Elevaiton (feet NAVD 88)	Casing Type	Screened Interval (feet bgs)	Date	Depth to Water (feet below top of casing)	Measured By
RMW-10D	300021	1302902.913	279934.4964	36.775746	2-inch PVC	32 to 42	5/24/2013	11.85	HWA
							6/24/2014	15.00	HWA
							12/19/2014	14.80	HWA
							6/23/2015	20.40	HWA
							12/8/2015	19.69	HWA
							6/29/2016	13.60	HWA
							12/21/2016	13.63	HWA
							6/28/2017	14.05	HWA
							9/27/2019	15.99	Kane
							2/4/2020	15.56	Kane
							5/5/2020	12.48	Kane
							7/25/2024	12.92	Floyd|Snider
							7/29/2024	12.97	Floyd|Snider
							7/31/2024	13.00	Floyd|Snider
							8/22/2024	13.14	Floyd|Snider
RMW-12	300025	1302870.828	279941.8863	38.872699	2-inch PVC	15 to 25	7/25/2016	16.25	HWA
							12/21/2016	13.1	HWA
							6/28/2017	13.1	HWA
							9/27/2019	14.52	Kane
							2/4/2020	12.47	Kane
							5/6/2020	12.24	Kane
							7/25/2024	12.64	Floyd|Snider
							7/29/2024	12.68	Floyd|Snider
							7/31/2024	12.71	Floyd|Snider
							8/22/2024	12.81	Floyd|Snider
RMW-13	300009	1302921.615	279852.0768	34.144621	2-inch PVC	15 to 25	7/25/2016	14.95	HWA
							12/22/2016	16.61	HWA
							6/28/2017	15.23	HWA
							9/27/2019	16.2	Kane
							2/3/2020	14.94	Kane
							5/5/2020	15.22	Kane
							7/25/2024	15.95	Floyd|Snider
							7/29/2024	16.05	Floyd|Snider
							7/31/2024	16.09	Floyd|Snider
							8/22/2024	16.22	Floyd|Snider
RMW-14	300027	1302920.611	279889.9609	34.225634	4-inch PVC	15 to 25	5/5/2020	12.36	Kane
							7/25/2024	12.94	Floyd|Snider
							7/29/2024	12.98	Floyd|Snider
							7/31/2024	13.04	Floyd|Snider
							8/22/2024	13.27	Floyd|Snider
EW-1	300016	1302938.645	279932.8205	36.252622	4-inch PVC	12.5 to 32.5	7/25/2024	13.84	Floyd|Snider
							7/29/2024	13.87	Floyd|Snider
							7/31/2024	13.92	Floyd|Snider
							8/22/2024	14.02	Floyd|Snider
EW-2	300038	1302913.3	279916.7	35.45	4-inch PVC	15 to 35	7/29/2024	12.75	Floyd|Snider
EW-3	300030	1302883.6	279901.9	33.78	4-inch PVC	14 to 34	7/29/2024	10.98	Floyd|Snider
EW-4	300034	1302852.3	279884.7	34.55	4-inch PVC	11 to 31	---	--	--
EW-5	300046	1302929.192	279873.8944	34.099437	4-inch PVC	15 to 35	7/25/2024	13.82	Floyd|Snider
							7/29/2024	13.69	Floyd|Snider
							7/31/2024	13.75	Floyd|Snider
							8/22/2024	13.90	Floyd|Snider
EW-6	300049	1302954.181	279887.7261	35.601836	4-inch PVC	15 to 35	7/29/2024	15.73	Floyd|Snider
							7/31/2024	15.82	Floyd|Snider
							8/22/2024	15.96	Floyd|Snider

Note:

-- Not measured

Abbreviations:

bgs Below ground surface
HWA HWA GeoSciences, Inc.
Kane Kane Environmental, Inc.
NAD 83 North American Datum of 1983
NAVD 88 North American Vertical Datum of 1988
PVC Polyvinyl chloride

Table 2.2
Groundwater HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	127-18-4	79-01-6	156-59-2	156-60-5	75-01-4
		CUL [1]	4.9	0.38	16	--	0.020
		Unit	µg/L	µg/L	µg/L	µg/L	µg/L
Sample Name	Sample Date	Sample Depth/ Screen Interval (feet bgs)					
BC-3							
BC-3D-092008	9/5/2008	15–25	**110**	**120**	**46**	1.0 U	1.0 U
BC-3D-092009	9/15/2009		**130**	**120**	**49**	1.0 U	1.0 U
BC-3D-122009	12/16/2009		**170**	**130**	**48**	1.0 U	1.0 U
BC-3-052013	5/24/2013		**25**	**11**	4.0		0.20 U
BC-3-062014	6/24/2014		**11**	**4.0**	0.75		0.20 U
BC-3D-122014	12/19/2014		**7.7**	**2.1**	0.44	0.20 U	0.20 U
BC-3D-062015	6/23/2015		3.8	**0.90**	0.20 U	0.20 U	0.20 U
BC-3D-122015	12/8/2015		**5.3**	**1.3**	0.29	0.20 U	0.20 U
BC-3D-062016	6/29/2016		3.7	**0.93**	0.20 U	0.20 U	0.20 U
BC-3D-122016	12/21/2016		**5.9**	**1.5**	0.57	0.20 U	0.20 U
BC-3-062017	6/28/2017		**6.8**	**1.9**	0.80		0.20 U
BC-3-092019	9/27/2019		4.3	**1.0**	0.34	0.20 U	0.20 U
BC-3-022020	2/4/2020		**5.2**	**1.3**	0.43	0.20 U	0.020 U
BC-3-052020	5/6/2020		**6.7**	**1.7**	0.52	0.20 U	0.020 U
EW-1							
EW-1-042014	4/4/2014	12.5–32.5	**17**	**3.0**	1.2		0.20 U
EW-1-062014	6/25/2014		**27**	**8.1**	6.5		0.20 U
EW-1-122014	12/19/2014		**21**	**2.6**	0.82	0.20 U	0.20 U
EW-1-032015	3/18/2015		2.8	0.27	0.20 U	0.20 U	0.20 U
EW-1-062015	6/23/2015		**22**	**2.0**	0.95	0.20 U	0.20 U
EW-1-092015	9/11/2015		**41**	**2.2**	0.79	0.20 U	0.20 U
EW-1-032016	3/31/2016		**22**	**2.8**	2.5	0.20 U	0.20 U
EW-1-062016	6/29/2016		**24**	**4.2**	4.5	0.20 U	0.20 U
EW-1-092016	9/30/2016		**20**	**2.0**	2.3	0.20 U	0.20 U
EW-1-012017	1/5/2017		1.1	0.20 U	0.20 U	0.20 U	0.20 U
EW-1-042017	4/5/2017		**13**	**1.2**	0.85		0.20 U
EW-1-062017	6/29/2017		**8.9**	**0.77**	0.70		0.20 U
EW-1-102017	10/10/2017		**15**	**0.81**	0.50		0.20 U
EW-1-082324	8/23/2024		3.2	0.20 U	0.20 U	0.20 U	0.020 U
EW-2							
EW-2-042014	4/4/2014	15–35	**13**	**2.8**	1.5		
EW-2-062014	6/25/2014		**28**	**3.8**	1.5		0.20 U
EW-2-092014	9/22/2014		**66**	**16**	12		0.40 U
EW-2-122014	12/19/2014		**44**	**12**	12	0.40 U	0.40 U
EW-2-032015	3/18/2015		**22**	**6.5**	4.3	0.20 U	0.20 U
EW-2-062015	6/23/2015		**8.6**	**2.4**	1.8	0.20 U	0.20 U
EW-2-092015	9/11/2015		**6.5**	**0.62**	0.40	0.20 U	0.20 U
EW-2-122015	12/8/2015		**16**	**2.6**	2.4	0.20 U	0.20 U
EW-2-032016	3/31/2016		**16**	**4.0**	3.7	0.20 U	0.20 U
EW-2-062016	6/29/2016		**17**	**4.1**	3.2	0.20 U	0.20 U
EW-2-092016	9/30/2016		**21**	**6.2**	5.6	0.20 U	0.20 U
EW-2-012017	1/5/2017		**24**	**3.6**	1.7	0.20 U	0.20 U
EW-2-042017	4/5/2017		**11**	**3.2**	2.2		0.20 U
EW-2-062017	6/29/2017		**16**	**4.8**	3.6		0.20 U
EW-2-102017	10/10/2017		3.0	**0.45**	0.23		0.20 U
EW-2-092019	9/27/2019		**16**	**4.7**	3.2	0.20 U	0.20 U
EW-2-022020	2/5/2020		**26**	**7.9**	6.2	0.20 U	**0.39**
EW-2-082324	8/23/2024		**7.8**	0.27	0.20 U	0.20 U	0.020 U
EW-3							
EW-3-042014	4/4/2014	14–34	**49**	**14**	7.2		**0.61**
EW-3-062014	6/25/2014		**41**	**14**	12		0.40 U
EW-3-092014	9/22/2014		**190**	**59**	**33**		**1.1**
EW-3-122014	12/19/2014		**21**	**6.4**	6.0	0.20 U	0.20 U
EW-3-032015	3/18/2015		**140**	**46**	**29**	1.0 U	1.0 U
EW-3-062015	6/23/2015		**87**	**24**	9.0	0.40 U	0.40 U
EW-3-092015	9/11/2015		**81**	**28**	14	0.40 U	0.40 U
EW-3-122015	12/8/2015		**33**	**11**	7.8	0.20 U	**0.38**
EW-3-032016	3/31/2016		**72**	**21**	16	0.40 U	**0.64**
EW-3-062016	6/29/2016		**79**	**24**	14	0.40 U	**0.43**
EW-3-092016	9/30/2016		**50**	**18**	10	0.20 U	**0.63**
EW-3-012017	1/5/2017		**95**	**30**	**20**	0.40 U	**0.46**
EW-3-042017	4/5/2017		**150**	**57**	**30**		**1.3**
EW-3-062017	6/29/2017		**270**	**79**	**59**		**1.4**
EW-3-102017	10/10/2017		**69**	**25**	16		**0.41**
EW-3-052020	5/7/2020		**25**	**23**	11	0.20 U	**0.023**
EW-3-082224	8/22/2024		3.7	**3.4**	12	0.21	**0.42**

Table 2.2
Groundwater HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	127-18-4	79-01-6	156-59-2	156-60-5	75-01-4
		CUL [1]	4.9	0.38	16	--	0.020
		Unit	µg/L	µg/L	µg/L	µg/L	µg/L
Sample Name	**Sample Date**	**Sample Depth/ Screen Interval (feet bgs)**					
EW-4							
EW-4-062014	6/25/2014		1.7	**1.8**	1.1		**0.38**
EW-4-092014	9/22/2014		**45**	**10**	7.4		**0.87**
EW-4-122014	12/19/2014		1.2	**1.6**	1.1	0.20 U	**0.27**
EW-4-032015	3/18/2015		**15**	**4.8**	3.2	0.20 U	*0.20 U*
EW-4-062015	6/23/2015		0.85	**2.8**	1.7	0.20 U	**0.37**
EW-4-092015	9/11/2015		1.8	**2.1**	0.92	0.20 U	**0.28**
EW-4-122015	12/8/2015	11–31	0.20 U	**1.6**	2.9	0.20 U	**0.85**
EW-4-032016	3/31/2016		0.20 U	**2.5**	2.0	0.20 U	**0.31**
EW-4-062016	6/29/2016		0.20 U	**1.2**	3.5	0.20 U	**0.61**
EW-4-092016	9/30/2016		0.20 U	**0.88**	4.0	0.20 U	**0.75**
EW-4-012017	1/5/2017		0.33	**3.2**	1.8	0.20 U	**0.29**
EW-4-042017	4/5/2017		0.20	**3.0**	1.7		**0.25**
EW-4-062017	6/29/2017		0.20	**0.90**	2.6		**0.24**
EW-4-082324	8/23/2024		0.20 U	0.20 U	1.3	0.20 U	**0.34**
EW-5							
EW-5D-012017	1/5/2017		**5.0**	**4.0**	9.4	0.20 U	**2.5**
EW-5D-042017	4/5/2017		**6.9**	**5.2**	15		**3.8**
EW-5D-062017	6/29/2017		**8.6**	**3.8**	10		**0.49**
EW-5D-102017	10/10/2017	15–35	0.36	**0.94**	8.6		**1.8**
EW-5-072524	7/25/2024		0.26	0.20 U	0.20 U	0.20 U	*0.20 U*
EW-5-073124	7/31/2024		0.25	0.20 U	0.20 U	0.20 U	*0.20 U*
EW-5-082324	8/23/2024		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
EW-6							
EW-6D-012017	1/5/2017		2.4	**0.54**	0.20 U	0.20 U	*0.20 U*
EW-6D-042017	4/5/2017		2.1	**0.94**	1.2		*0.20 U*
EW-6D-062017	6/29/2017		0.56	**0.63**	2.0		**0.31**
EW-6D-102017	10/10/2017		**20**	**7.2**	**18**		**0.46**
EW-6D-092019	9/27/2019	15–35	4.7	**1.4**	4.2	0.20 U	*0.20 U*
EW-6D-022020	2/5/2020		3.1	**1.0**	4.0	0.20 U	**0.16**
EW-6D-052020	5/7/2020		**12**	**5.3**	7.6	0.20 U	**0.36**
EW-6-072524	7/25/2024		0.27	0.20 U	0.20 U	0.20 U	*0.20 U*
EW-6-073124	7/31/2024		1.5	0.20 U	0.20 U	0.20 U	*0.20 U*
EW-6-082324	8/23/2024		**8.8**	0.23	0.20 U	0.20 U	0.020 U
RMW-4							
RMW-4D-122014	12/19/2014		0.79	0.33	0.20 U	0.20 U	*0.20 U*
RMW-4D-062015	6/23/2015		0.52	**0.72**	0.20 U	0.20 U	*0.20 U*
RMW-4D-122015	12/8/2015		2.2	**0.56**	0.20 U	0.20 U	*0.20 U*
RMW-4D-062016	6/29/2016		3.6	**0.46**	0.20 U	0.20 U	*0.20 U*
RMW-4D-122016	12/21/2016	15–25	4.3	**0.51**	0.20 U	0.20 U	*0.20 U*
RMW-4-062017	6/28/2017		3.9	**0.49**	0.20 U		*0.20 U*
RMW-4-092019	9/26/2019		2.5	**0.45**	0.20 U	0.20 U	*0.20 U*
RMW-4-012020	1/31/2020		3.7	**0.54**	0.20 U	0.20 U	0.020 U
RMW-4-052020	5/4/2020		3.2	**0.82**	0.20 U	0.20 U	0.020 U
RMW-4-082324	8/23/2024		3.3	**0.96**	0.33	0.20 U	0.020 U
RMW-5							
RMW-5-052013	5/24/2013		1.7	0.20 U	0.20 U		*0.20 U*
RMW-5-062014	6/24/2014		1.4	**0.40**	0.20 U		*0.20 U*
RMW-5D-122014	12/19/2014		1.3	0.32	0.22	0.20 U	*0.20 U*
RMW-5D-062015	6/23/2015		0.66	0.36	0.20 U	0.20 U	*0.20 U*
RMW-5D-122015	12/8/2015		1.6	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-5D-062016	6/29/2016	12–22	1.1	0.31	0.20 U	0.20 U	*0.20 U*
RMW-5D-122016	12/22/2016		1.0	0.20 U	0.23	0.20 U	*0.20 U*
RMW-5-062017	6/29/2017		2.0	0.20 U	0.20 U		*0.20 U*
RMW-5-092019	9/26/2019		2.1	**0.39**	0.22	0.20 U	*0.20 U*
RMW-5-012020	1/31/2020		2.5	0.21	0.20 U	0.20 U	**0.024**
RMW-5-052020	5/4/2020		2.3	0.20 U	0.20 U	0.20 U	0.020 U
RMW-5-082224	8/22/2024		3.5	**0.55**	0.43	0.20 U	**0.036**
RMW-6							
RMW-6D-092009	9/14/2009		0.20 U	0.27	3.6	0.20 U	**5.3**
RMW-6-052013	5/24/2013		0.20 U	0.20 U	2.7		**3.4**
RMW-6-062014	6/24/2014		0.34	**0.60**	0.42		*0.20 U*
RMW-6D-122014	12/19/2014		0.47	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-6D-062015	6/23/2015		0.20 U	**1.4**	0.88	0.20 U	*0.20 U*
RMW-6D-122015	12/8/2015		0.20 U	**2.7**	1.0	0.20 U	*0.20 U*
RMW-6D-062016	6/29/2016	15–25	0.20 U	**2.5**	1.3	0.20 U	*0.20 U*
RMW-6D-122016	12/21/2016		0.20 U	**0.39**	0.50	0.20 U	*0.20 U*
RMW-6-062017	6/29/2017		0.20 U	**0.41**	0.30		*0.20 U*
RMW-6-092019	9/26/2019		0.20 U	**1.7**	3.8	0.20 U	**0.57**
RMW-6-012020	1/31/2020		0.20 U	**0.52**	2.5	0.20 U	**0.70**
RMW-6-052020	5/4/2020		0.20 U	**0.45**	1.5	0.20 U	**0.21**
RMW-6-082224	8/22/2024		0.20 U	0.20 U	0.77	0.20 U	**0.79**

Table 2.2
Groundwater HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	127-18-4	79-01-6	156-59-2	156-60-5	75-01-4
		CUL [1]	4.9	0.38	16	--	0.020
		Unit	µg/L	µg/L	µg/L	µg/L	µg/L
Sample Name	Sample Date	Sample Depth/ Screen Interval (feet bgs)					
RMW-7							
RMW-7D-092009	9/15/2009	15–25	**50**	**120**	**190**	2.0	**22**
RMW-7-052013	5/24/2013		**9.0**	**33**	**65**		**9.3**
RMW-7-042014	4/4/2014		0.75	**3.8**	**35**		**8.3**
RMW-7-062014	6/25/2014		**5.2**	**24**	**80**		**9.9**
RMW-7-092014	9/22/2014		1.0 U	**3.2**	**170**		**47**
RMW-7D-122014	12/19/2014		2.9	**8.9**	**150**	1.4	**34**
RMW-7D-032015	3/18/2015		0.40 U	**1.5**	**57**	0.64	**20**
RMW-7D-062015	6/23/2015		0.40 U	**3.1**	**95**	1.2	**9.6**
RMW-7D-092015	9/11/2015		4.2	**23**	**110**	1.4	**14**
RMW-7D-122015	12/8/2015		3.5	**8.7**	**85**	0.87	**9.0**
RMW-7D-032016	3/31/2016		1.5	**6.8**	**84**	0.91	**35**
RMW-7D-062016	6/29/2016		2.3	**14**	**65**	0.68	**12**
RMW-7D-092016	9/30/2016		2.4	**7.8**	**89**	1.0 U	**13**
RMW-7D-122016	12/22/2016		1.1	**4.1**	**88**	0.93	**24**
RMW-7-042017	4/5/2017		1.2	**2.4**	12		**0.86**
RMW-7-062017	6/28/2017		1.3	**1.9**	**33**		**1.9**
RMW-7-102017	10/10/2017		1.0	**2.3**	**47**		**25**
RMW-7-092019	9/27/2019		0.51	**4.1**	**33**	0.39	**27**
RMW-7-022020	2/3/2020		0.20 U	0.22	16	0.28	**26**
RMW-7-052020	5/5/2020		0.32	**0.88**	**20**	0.31	**28**
RMW-7-072524	7/25/2024		0.45	**0.46**	**26**	0.22	**6.4**
RMW-7-073124	7/31/2024		0.38	**0.41**	**31**	0.29	**9.4**
RMW-7-082224	8/22/2024		0.48	**0.64**	**27**	0.28	**6.2**
RMW-8							
RMW-8D-092009	9/15/2009	20–30	0.46	**2.6**	1.3	0.36	*0.20 U*
RMW-8D-Dup-092009	9/15/2009		0.48	**2.6**	1.3	0.36	*0.20 U*
RMW-8D-122009	12/16/2009		0.91	**3.0**	1.4	0.40	*0.20 U*
RMW-8D-052013	5/24/2013		0.50	**0.85**	0.44		*0.20 U*
RMW-8D-062014	6/24/2014		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-8D-122014	12/19/2014		0.70	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-8D-062015	6/23/2015		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-8D-122015	12/8/2015		0.20 U	**0.39**	0.47	0.20 U	*0.20 U*
RMW-8D-062016	6/29/2016		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-8D-122016	12/22/2016		0.31	**0.66**	0.37	0.20 U	*0.20 U*
RMW-8D-062017	6/28/2017		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-8D-092019	9/27/2019		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-8D-022020	2/3/2020		0.20 U	**0.40**	0.28	0.20 U	0.020 U
RMW-8D-052020	5/6/2020		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
RMW-8-082324	8/23/2024		0.20 U	0.20 U	0.81	0.20 U	0.020 U
RMW-9							
RMW-9D-092009	9/15/2009	20–30	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9D-122009	12/16/2009		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9D-052013	5/24/2013		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-9R							
RMW-9RD-122014	12/19/2014	20–30	0.79	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9D-062015	6/23/2015		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9D-122015	12/8/2015		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9D-062016	6/29/2016		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9D-122016	12/22/2016		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9RD-062017	6/29/2017		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-9RD-092019	9/27/2019		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-9RD-022020	2/4/2020		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
RMW-9RD-052020	5/7/2020		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
RMW-9R-082224	8/22/2024		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
RMW-10D							
RMW-10D-092009	9/15/2009	32–42	0.24	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-122009	12/16/2009		0.35	0.27	0.20 U	0.20 U	*0.20 U*
RMW-10D-Dup-122009	12/16/2009		0.28	0.23	0.20 U	0.20 U	*0.20 U*
RMW-10D-052013	5/24/2013		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-10D-062014	6/24/2014		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-10D-122014	12/19/2014		0.69	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-062015	6/23/2015		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-122015	12/8/2015		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-062016	6/29/2016		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-122016	12/21/2016		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-062017	6/28/2017		0.20 U	0.20 U	0.20 U		*0.20 U*
RMW-10D-092019	9/27/2019		0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
RMW-10D-022020	2/4/2020		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
RMW-10D-052020	5/5/2020		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U
RMW-10D-082324	8/23/2024		0.20 U	0.20 U	0.20 U	0.20 U	0.020 U

Table 2.2
Groundwater HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	127-18-4	79-01-6	156-59-2	156-60-5	75-01-4
		CUL [1]	4.9	0.38	16	--	0.020
		Unit	µg/L	µg/L	µg/L	µg/L	µg/L
Sample Name	Sample Date	Sample Depth/ Screen Interval (feet bgs)					
RMW-12							
RMW-12D-072016	7/25/2016	15–25	**120**	**19**	14	1.0 U	*1.0 U*
RMW-12D-122016	12/21/2016		**61**	**14**	**21**	0.34	**1.6**
RMW-12D-062017	6/28/2017		**130**	**27**	**29**		*1.0 U*
RMW-12D-092019	9/27/2019		**15**	**3.1**	6.5	0.20 U	**0.87**
RMW-12D-022020	2/4/2020		**13**	**3.7**	6.1	0.20 U	**2.8**
RMW-12D-052020	5/6/2020		**19**	**4.6**	5.4	0.20 U	**0.50**
RMW-12-072524	7/25/2024		**9.6**	**1.7**	1.2	0.20 U	*0.20 U*
RMW-12-073124	7/31/2024		**8.2**	**1.7**	1.5	0.20 U	**0.22**
RMW-12-082224	8/22/2024		**8.8**	**1.8**	1.4	0.20 U	**0.19**
RMW-112-082224	8/22/2024		**9.2**	**1.9**	1.4	0.20 U	**0.21**
RMW-13							
RMW-13D-072016	7/25/2016	15–25	0.20 U	0.20 U	1.8	0.20 U	**0.24**
RMW-13D-122016	12/22/2016		0.20 U	0.20 U	1.2	0.20 U	*0.20 U*
RMW-13D-062017	6/28/2017		0.20 U	0.20 U	0.50		*0.20 U*
RMW-13D-092019	9/27/2019		0.20 U	0.20 U	0.97	0.20 U	*0.20 U*
RMW-13D-022020	2/3/2020		0.20 U	0.20 U	0.31	0.20 U	**0.095**
RMW-13D-052020	5/5/2020		0.20 U	0.20 U	0.30	0.20 U	**0.060**
RMW-13-082224	8/22/2024		0.20 U	0.20 U	0.48	0.20 U	**0.16**
RMW-14							
RMW-14D-052020	5/5/2020	15–25	**15**	**5.6**	4.0	0.20 U	**0.15**
RMW-14-082224	8/22/2024		**9.8**	**2.7**	0.58	0.20 U	**0.032**
CDM-B14							
CDM-B14-W	4/3/2009	9–9	**5.9**	**0.54**	0.33	0.20 U	*0.20 U*
CDM-B15							
CDM-B15-W	4/3/2009	10–10	3.9	**1.8**	1.4	0.20 U	*0.20 U*
CDM-B16							
CDM-B16-W	4/3/2009	13–13	0.21	0.20 U	0.20 U	0.20 U	*0.20 U*
CDM-B17							
CDM-B17-W	4/2/2009	11–11	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
GWB-03							
GWB-03-15-20	9/4/2024	15–20	0.20 U	0.20 U	0.68	0.20 U	*0.20 U*
GWB-03-20-25	9/4/2024	20–25	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
GWB-03-25-30	9/4/2024	25–30	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
GWB-04							
GWB-04-15-20	9/4/2024	15–20	0.20 U	**0.50**	3.6	0.20 U	**1.4**
GWB-04-20-25	9/4/2024	20–25	0.63	**0.61**	7.1	0.20 U	*0.20 U*
GWB-04-25-30	9/5/2024	25–30	0.20 U	0.20 U	0.32	0.20 U	*0.20 U*
GWB-05							
GWB-05-20-25	9/5/2024	20–25	1.2	**1.5**	12	0.20 U	*0.20 U*
GWB-05-25-30	9/5/2024	25–30	**8.6**	**21**	2.6	0.20 U	*0.20 U*
GWB-06							
GWB-06-20-25	9/5/2024	20–25	**11**	**18**	**21**	0.47	**0.43**
GWB-06-25-30	9/5/2024	25–30	**18**	**18**	11	0.29	*0.20 U*
GWB-07							
GWB-07-35-40	9/6/2024	35–40	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
GWB-07-40-45	9/6/2024	40–45	0.26	0.20 U	0.20 U	0.20 U	*0.20 U*
GWB-08-15-25							
GWB-08-15-25	9/5/2024	15–25	0.20 U	0.20 U	0.20 U	0.20 U	**0.29**
RB-25							
RB-25-102018	10/24/2018	15–25	**200**	**88**	**92**		**1.0**
RB-26							
RB-26-102018	10/24/2018	15–25	2.4	**1.6**	3.5		0.020 U
RB-27							
RB-27-102018	10/24/2018	15–25	**29**	**19**	7.1		**1.0**
RB-28							
RB-28-102018	10/24/2018	10–20	**15**	**6.4**	4.7		**0.34**
RB-29							
RB-29-102018	10/24/2018	15–25	2.6	**1.0**	1.4		0.020 U
RB-30							
RB-30-102018	10/24/2018	15–25	0.56	**1.3**	8.1		**0.28**
RB-31							
RB-31-102018	10/25/2018	15–25	**63**	**11**	**43**		**13**
RB-32							
RB-32-102018	10/25/2018	15–25	**110**	**44**	**76**		0.020 U
UCCB-5							
UCCB5-15-GW	3/22/2017	10–20	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB5-32-GW	3/22/2017	29–34	4.2	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB5-43-GW	3/22/2017	40–45	1.5	0.20 U	0.20 U	0.20 U	*0.20 U*

Table 2.2
Groundwater HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	**127-18-4**	**79-01-6**	**156-59-2**	**156-60-5**	**75-01-4**
		CUL (1)	**4.9**	**0.38**	**16**	**--**	**0.020**
		Unit	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Sample Name	**Sample Date**	**Sample Depth/ Screen Interval (feet bgs)**					
UCCB-6							
UCCB6-9-GW	3/23/2017	7–12	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB6-22-GW	3/23/2017	20–25	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB6-36-GW	3/23/2017	33–38	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB-7							
UCCB7-17-GW	3/23/2017	14–19	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB7-28-GW	3/23/2017	25–30	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB7-38-GW	3/23/2017	35–40	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB-9							
UCCB9-18-GW	3/22/2017	15–20	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB9-31-GW	3/22/2017	28–33	0.61	0.20 U	0.20 U	0.20 U	*0.20 U*
UCCB9-41-GW	3/23/2017	39–44	0.20 U	0.20 U	0.20 U	0.20 U	*0.20 U*

Notes:

All results are rounded to two significant figures.
Blank cells are intentional.
-- Not established.
Italic Analyte was not detected at a reporting limit greater than the CUL.
RED/BOLD Analyte was detected at a concentration greater than the CUL.
1 CULs are established in the Cleanup Action Plan (Exhibit B of Ecology 2023).

Abbreviations:

bgs Below ground surface
CAS Chemical Abstracts Service
CUL Cleanup level
HVOC Halogenated volatile organic compound
µg/L Micrograms per liter

Qualifier:

U Analyte was not detected at the associate reporting limit.

Table 2.3
Groundwater Geochemical Parameter Results

	Analyte	Dissolved Oxygen	ORP	pH	Specific Conductance	Temperature	Turbidity	Alkalinity, Total	Chloride	Nitrate	Nitrite	Sulfate	Sulfide
	CAS No.	--	--	pH	--	--	--	--	16887-00-6	14797-55-8	14797-65-0	14808-79-8	18496-25-8
	Unit	mg/L	mV	pH	µS/cm	°C	NTU	mg-$CaCO_3$/L	mg/L	mg-N/L	mg-N/L	mg/L	mg/L
Sample Location	**Sample Date**												
Extraction Wells													
EW-1	8/23/2024	0.36	168.3	6.43	240.0	14.9	1.10						
EW-2	8/23/2024	0.68	23.1	6.47	246.5	14.4	7.45						
EW-3	8/22/2024	0.22	-6.8	6.36	437.8	14.7	2.90	220 J	31 J	0.16	0.020 U	12	0.080
EW-4	8/23/2024	0.25	-31.6	6.57	377.7	14.7	16.10						
EW-5	7/25/2024	0.24	81.5	6.92	262.3	16.1	1.99						
	7/31/2024	0.26	114.3	7.10	260.1	16.8	0.87						
	8/23/2024	0.41	-47.5	6.89	252.5	16.1	0.81						
EW-6	7/25/2024	2.12	88.1	6.43	212.0	15.8	2.64						
	7/31/2024	2.15	88.6	6.52	207.2	16.3	2.37						
	8/23/2024	1.18	126.8	6.35	224.0	16.7	1.40						
Monitoring Wells													
RMW-4	8/23/2024	0.37	-78.1	6.27	394.2	14.8	0.97						
RMW-5	8/22/2024	0.22	-80.8	6.50	540.0	15.6	1.24	210 J	14 J	0.21	0.020 U	18	0.050 U
RMW-6	8/22/2024	0.56	-98.7	6.68	510.0	14.8	3.43	280 J	28 J	0.13	0.020 U	5.0 U	0.050 U
RMW-7	7/25/2024	0.24	-3.6	6.66	418.7	16.7	1.86						
	7/31/2024	0.27	4.6	6.69	440.9	17.6	1.25						
	8/22/2024	0.22	13.7	6.38	400.8	17.7	0.97	190 J	15 J	0.19	0.020 U	14	0.050 U
RMW-8	8/23/2024	0.40	-83.1	6.22	659.0	15.1	2.12						
RMW-9R	8/22/2024	5.00	166.4	5.95	506.0	16.6	0.60	40 J	140 J	2.6	0.020 U	23	0.050 U
RMW-10D	8/23/2024	2.39	161.8	6.24	217.9	15.2	1.13						
RMW-12	7/25/2024	0.48	113.0	6.16	380.0	15.1	1.77						
	7/31/2024	0.36	140.4	6.11	385.0	16.2	7.64						
	8/22/2024	0.36	125.0	6.00	420.8	16.3	1.26	190 J	34 J	0.052	0.020 U	16	0.050 U
RMW-13	8/22/2024	0.31	-7.6	6.32	399.7	17.9	1.35	200 J	14 J	0.21	0.020 U	34	0.050 U
RMW-14	8/22/2024	0.34	-6.9	6.34	339.1	15.8	1.50	160 J	12 J	0.97	0.020 U	20	0.050 U
Reconnaissance Samples													
GWB-03-15-20	9/4/2024	3.95	-41.7	6.70	294.3	19.7	80.30						
GWB-03-20-25	9/4/2024	4.58	-72.8	7.10	314.2	20.1	454.00						
GWB-03-25-30	9/4/2024	0.46	-207.4	7.99	301.9	19.1	368.00						
GWB-04-15-20	9/4/2024	3.12	-34.6	6.55	545.0	24.6	7.15						
GWB-04-20-25	9/4/2024	5.04	-49.9	7.25	322.8	23.8	47.30						
GWB-04-25-30	9/5/2024	2.54	-54.0	6.99	303.3	24.8	49.30						
GWB-05-20-25	9/5/2024	3.53	-27.4	6.69	280.6	21.9	40.00						
GWB-05-25-30	9/5/2024	2.74	-48.1	6.87	284.5	23.1	41.80						
GWB-06-20-25	9/5/2024	3.74	4.1	6.70	303.4	24.2	47.40						
GWB-06-25-30	9/5/2024	3.96	-35.3	6.83	302.4	23.7	61.70						
GWB-07-35-40	9/6/2024	2.64	-99.4	8.24	256.1	24.7	181.00						
GWB-08-15-25	9/5/2024	2.70	-67.4	6.84	497.2	24.1	48.00						

Notes:

All chemistry results are rounded to two significant figures. Field parameters are reported as displayed by the instrument.
Blank cells are intentional.
-- Not established.

Abbreviations:

°C Degrees Celsius
CAS Chemical Abstracts Service
µg/L Micrograms per liter
µS/cm Microsiemens per centimeter
mg-$CaCO_3$/L Milligrams of calcium carbonate per liter
mg-N/L Milligrams of nitrogen per liter
mg/L Milligrams per liter
mV Millivolts
NTU Nephelometric turbidity units
ORP Oxidation–reduction potential

Qualifier:

J Analyte was detected; concentration is an estimate.
U Analyte was not detected at the associate reporting limit.
UJ Analyte was not detected at the associate reporting limit, which is an estimate.

Table 2.3
Groundwater Geochemical Parameter Results

	Analyte	Total Organic Carbon	Ethane	Ethene	Methane	Calcium	Iron	Magnesium	Calcium	Iron	Magnesium
	CAS No.	TOC	74-84-0	74-85-1	74-82-8	7440-70-2	7439-89-6	7439-95-4	7440-70-2	7439-89-6	7439-95-4
	Unit	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Sample Location	**Sample Date**										
Extraction Wells											
EW-1	8/23/2024										
EW-2	8/23/2024										
EW-3	8/22/2024	5.8	0.56 UJ	0.58 UJ	410	50,000	13,000	20,000	45,000	14,000	19,000
EW-4	8/23/2024										
EW-5	7/25/2024										
	7/31/2024										
	8/23/2024										
EW-6	7/25/2024										
	7/31/2024										
	8/23/2024										
Monitoring Wells											
RMW-4	8/23/2024										
RMW-5	8/22/2024	11	0.56 UJ	0.58 UJ	1,300	37,000	18,000	15,000	39,000	24,000	14,000
RMW-6	8/22/2024	11	0.56 UJ	0.58 UJ	2,200	54,000	31,000	19,000	53,000	31,000	19,000
RMW-7	7/25/2024										
	7/31/2024										
	8/22/2024	3.9	0.56 UJ	0.58 UJ	580	49,000	3,900	11,000	49,000	4,100	11,000
RMW-8	8/23/2024										
RMW-9R	8/22/2024	1.0 U	0.56 UJ	0.58 UJ	0.55 U	40,000	56 U	17,000	38,000	50 U	17,000
RMW-10D	8/23/2024										
RMW-12	7/25/2024										
	7/31/2024										
	8/22/2024	4.4	0.56 UJ	0.58 UJ	76	52,000	94	15,000	51,000	220	13,000
RMW-13	8/22/2024	4.9	0.56 UJ	0.58 UJ	26	65,000	1,900	14,000	64,000	1,900	14,000
RMW-14	8/22/2024	2.4	0.56 UJ	0.58 UJ	820	44,000	2,200	14,000	38,000	2,400	13,000
Reconnaissance Samples											
GWB-03-15-20	9/4/2024										
GWB-03-20-25	9/4/2024										
GWB-03-25-30	9/4/2024										
GWB-04-15-20	9/4/2024										
GWB-04-20-25	9/4/2024										
GWB-04-25-30	9/5/2024										
GWB-05-20-25	9/5/2024										
GWB-05-25-30	9/5/2024										
GWB-06-20-25	9/5/2024										
GWB-06-25-30	9/5/2024										
GWB-07-35-40	9/6/2024										
GWB-08-15-25	9/5/2024										

Notes:

All chemistry results are rounded to two significant figures. Field parameters are reported as displayed by the instrument.

Blank cells are intentional.

-- Not established.

Abbreviations:

°C Degrees Celsius

CAS Chemical Abstracts Service

µg/L Micrograms per liter

µS/cm Microsiemens per centimeter

mg-$CaCO_3$/L Milligrams of calcium carbonate per liter

Qualifier:

J Analyte was detected; concentration is an estimate.

U Analyte was not detected at the associate reporting limit.

UJ Analyte was not detected at the associate reporting limit, which is an estimate.

Table 2.4
Soil HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	127-18-4	79-01-6	156-59-2	156-60-5	75-01-4
		CUL (1)	0.05	0.03	160	--	0.67
		Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample Name	Sample Date	Sample Depth (feet bgs)					
EW-5D-18	10/11/2016	18–18	0.00092 U	0.00092 U	0.0015	0.00092 U	0.00092 U
EW-5D-21	10/11/2016	21–21	0.00081 U	0.00081 U	0.0023	0.00081 U	0.0020
EW-6D-19	10/12/2016	19–19	0.00070 U	0.00070 U	0.00070 U	0.00070 U	0.00070 U
EW-6D-21	10/12/2016	21–21	0.0038	0.0052	0.050	0.0014 U	0.0028
RMW-12D-5'	9/22/2016	5–5	0.00088 U	0.00088 U	0.00088 U	0.00088 U	0.00088 U
RMW-12D-12.5'	9/22/2016	12.5–12.5	0.012	0.0061	0.0029	0.00091 U	0.00091 U
RMW-12D-17.5'	9/22/2016	17.5–17.5	0.024	0.0025	0.0011	0.00099 U	0.00099 U
RMW-12D-22.5'	9/22/2016	22.5–22.5	**0.59**	0.0058	0.0010 U	0.0010 U	0.0010 U
RMW-13D-5'	9/22/2016	5–5	0.00092 U	0.00092 U	0.00092 U	0.00092 U	0.00092 U
RMW-13D-12.5'	9/22/2016	12.5–12.5	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U
RMW-13D-17.5'	9/22/2016	17.5–17.5	0.00096 U	0.00096 U	0.0014	0.00096 U	0.00096 U
RMW-13D-22.5'	9/22/2016	22.5–22.5	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
RMW-14:6ft	4/27/2020	6–6	0.00077 U	0.00077 U	0.00077 U	0.00077 U	0.00077 U
RMW-14:11.5ft	4/27/2020	11.5–11.5	0.0073	0.00080 U	0.00080 U	0.00080 U	0.00080 U
RMW-14:15ft	4/27/2020	15–15	0.00093	0.00075 U	0.00075 U	0.00075 U	0.00075 U
RMW-14:20ft	4/27/2020	20–20	0.0012	0.00074 U	0.00074 U	0.00074 U	0.00074 U
RMW-14:21.5ft	4/27/2020	21.5–21.5	**0.13**	**0.27**	0.029	0.0012	0.0017
RMW-14:26ft	4/27/2020	26–26	0.0014	0.00087	0.00086 U	0.00086 U	0.00086 U
CDM-B15-10	4/3/2009	10–10	0.027	0.0017 U	0.0017 U	0.0017 U	0.0017 U
CDM-B16-13	4/3/2009	13–13	0.0041	0.0010 U	0.0010 U	0.0010 U	0.0010 U
R-3-8	2/12/2008	8–8	0.0057 U				
R-4-8	2/12/2008	8–8	0.0090				
RB-25-13	10/24/2018	13–13	**0.46**	**0.052**	0.0016 U		0.0016 U
RB-26-8.5	10/24/2018	8.5–8.5	0.00094 U	0.00094 U	0.00094 U		0.00094 U
RB-27-10	10/24/2018	10–10	0.0011 U	0.0011 U	0.0011 U		0.0011 U
RB-28-10	10/24/2018	10–10	0.0017	0.00078 U	0.00078 U		0.00078 U
RB-29-8	10/24/2018	8–8	0.00082 U	0.00082 U	0.00082 U		0.00082 U
RB-30-9	10/24/2018	9–9	0.00077 U	0.00077 U	0.00077 U		0.00077 U
RB-31-7.75	10/24/2018	7.75–7.75	0.0010 U	0.0010 U	0.0010 U		0.0010 U
RB-32-15	10/24/2018	15–15	0.00080 U	0.00080 U	0.00080 U		0.00080 U
KSB-1:12ft	2/24/2020	12–12	0.00099 U	0.00099 U	0.00099 U	0.00099 U	0.0014 U
KSB-1:15ft	2/24/2020	15–15	0.0013 U	0.0013 U	0.0014	0.0013 U	0.0018 U
KSB-1:23ft	2/24/2020	23–23	0.0052	0.00094 U	0.00094 U	0.00094 U	0.0013 U
KSB-2:12ft	2/24/2020	12–12	0.0017	0.00096 U	0.00096 U	0.00096 U	0.0013 U
KSB-2:18.75ft	2/24/2020	18.75–18.75	0.0051	0.0012	0.00093 U	0.00093 U	0.00093 U
KSB-2:25ft	2/24/2020	25–25	**0.055**	0.0020	0.00088 U	0.00088 U	0.0012 U
KSB-3:11.5ft	2/24/2020	11.5–11.5	0.0074	0.00095 U	0.00095 U	0.00095 U	0.0013 U
KSB-3:19ft	2/24/2020	19–19	**0.058**	0.029	0.033	0.0010 U	0.0048
KSB-3:25.5ft	2/24/2020	25.5–25.5	**1.0**	0.0061	0.00090 U	0.00090 U	0.0013 U
KSB-4:12ft	2/24/2020	12–12	0.021	0.00089 U	0.00089 U	0.00089 U	0.0013 U
KSB-4:23.5ft	2/24/2020	23.5–23.5	0.0028	0.00085 U	0.00085 U	0.00085 U	0.0012 U
KSB-4:30ft	2/24/2020	30–30	**0.13**	0.0018	0.00096 U	0.00096 U	0.0013 U
KSB-5:8ft	2/24/2020	8–8	0.0011	0.00085 U	0.00085 U	0.00085 U	0.0012 U
KSB-5:11.5ft	2/24/2020	11.5–11.5	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.0046
KSB-5:13ft	2/24/2020	13–13	0.00097 U	0.00097 U	0.0012	0.00097 U	0.00097 U
KSB-6:15.5ft	2/24/2020	15.5–15.5	**1.5**	**0.30**	0.020	0.0014 U	0.0014 U
KSB-6:24ft	2/24/2020	24–24	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
KSB-7:11ft	2/24/2020	11–11	0.0045 U	0.0045 U	0.0045 U	0.0045 U	0.0045 U
KSB-7:17ft	2/24/2020	17–17	**0.17**	0.011	0.00095 U	0.00095 U	0.00095 U
KSB-7:22ft	2/24/2020	22–22	0.00081 U	0.00081 U	0.00081 U	0.00081 U	0.00081 U
UCCB5-36.0	3/22/2017	36–36	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U
UCCB6-25.5	3/23/2017	25.5–25.5	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
UCCB7-20.0	3/23/2017	20–20	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
UCCB9-35.5	3/22/2017	35.5–35.5	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
SB-03-16-19	9/3/2024	16–19	0.0022 U	0.0022 U	0.0022 U	0.0022 U	0.0022 U
SB-03-19-22	9/3/2024	19–22	0.0063	0.0011 U	0.0011 U	0.0023	0.0011 U
SB-03-25-28	9/4/2024	25–28	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0019 U
SB-04-16-19	9/4/2024	16–19	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
SB-04-19-22	9/4/2024	19–22	0.0015 U	0.0015 U	0.0015 U	0.0027	0.0015 U
SB-04-25-28	9/4/2024	25–28	0.0011 UJ	0.0011 UJ	0.0011 UJ	0.0011 UJ	0.0017 UJ
SB-05-16-19	9/3/2024	16–19	0.0027	0.0010 U	0.0010 U	0.0012	0.0010 U
SB-05-19-22	9/3/2024	19–22	0.0021	0.0010 U	0.0010 U	0.0010 U	0.0010 U
SB-05-25-28	9/3/2024	25–28	0.0068	0.0011 U	0.0011 U	0.0011 U	0.0011 U
SB-06R-8-10	9/6/2024	8–10	0.0025	0.0012 U	0.0012 U	0.0012 U	0.0012 U
SB-06R-12-14	9/3/2024	12–14	**0.073**	0.0016 U	0.0016 U	0.0095	0.0016 U

Table 2.4
Soil HVOC Results

		Analyte	Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
		CAS No.	127-18-4	79-01-6	156-59-2	156-60-5	75-01-4
		CUL (1)	0.05	0.03	160	--	0.67
		Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample Name	Sample Date	Sample Depth (feet bgs)					
SB-06-14.5-16	9/3/2024	14.5–16	0.0031	0.00089 U	0.00089 U	0.0015	0.00089 U
SB-06-16-18	9/3/2024	16–18	0.0032	0.0010 U	0.0010 U	0.0010 U	0.0010 U
SB-06-18-20	9/3/2024	18–20	0.0060	0.0012 U	0.0012 U	0.0012 U	0.0012 U
SB-06-20-22	9/3/2024	20–22	0.012	0.0011 U	0.0011 U	0.0011 U	0.0011 U
SB-06-22-24	9/3/2024	22–24	0.041	0.0012 U	0.0012 U	0.0012 U	0.0012 U
SB-06-24-26	9/3/2024	24–26	**0.14**	0.0011 U	0.0011 U	0.0026	0.0011 U
SB-06-28-30	9/3/2024	28–30	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U
SB-06-30-32	9/3/2024	30–32	0.00084 U	0.00084 U	0.00084 U	0.00084 U	0.00084 U
SB-06-30-32-D	9/3/2024	30–32	0.00072 U	0.00072 U	0.00072 U	0.00072 U	0.00072 U
SB-06-32-34	9/3/2024	32–34	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
SB-06-34-36	9/3/2024	34–36	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
SB-06-36-38	9/3/2024	36–38	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U
SB-06-38-40	9/3/2024	38–40	0.0014 U	0.0014 U	0.0014 U	0.0014 U	0.0014 U
SB-07-16-19	9/6/2024	16–19	0.0016 U	0.0016 U	0.014	0.0056	0.0016 U
SB-07-16-19-D	9/6/2024	16–19	0.0011 U	0.0011 U	0.0053	0.0018	0.0011 U
SB-07-25-28	9/6/2024	25–28	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0017 U
SB-08-19-22	9/3/2024	19–22	0.025	0.00098 U	0.00098 U	0.0016	0.00098 U
SB-08-25-28	9/3/2024	25–28	0.0098 J	0.0012 UJ	0.0012 UJ	0.0012 UJ	0.0019 UJ
SB-09-16-19	9/6/2024	16–19	0.0032 U	0.0032 U	0.0089	0.0032 U	0.0032 U
SB-09-25-28	9/6/2024	25–28	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0017 U
SB-10-16-19	9/6/2024	16–19	0.0014 U	0.0018	0.11	0.039	0.0075
SB-10-25-28	9/6/2024	25–28	0.0085	0.00094 U	0.00094 U	0.00094 U	0.0015 UJ
SB-11-21-23	9/4/2024	21–23	0.0068	0.0011 U	0.0050	0.0017	0.0011 U

Notes:
All results are rounded to two significant figures.
Blank cells are intentional.
-- Not established.
RED/BOLD Analyte was detected at a concentration greater than the CUL.
1 CULs are established in the Cleanup Action Plan (Exhibit B of Ecology 2023).

Abbreviations:
bgs Below ground surface
CAS Chemical Abstracts Service
CUL Cleanup level
HVOC Halogenated volatile organic compound
mg/kg Milligrams per kilogram

Qualifiers:
J Analyte was detected; concentration is an estimate.
U Analyte was not detected at the associate reporting limit.
UJ Analyte was not detected at the associate reporting limit, which is an estimate.

Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Alternative Description	The 2023 CAP Cleanup Action consists of the following: • Soil source treatment by SVE with ex situ soil vapor treatment using activated carbon • Groundwater treatment by recirculation of groundwater amended with a soluble organic carbon substrate electron donor (CarBstrate) to enhance biotic dechlorination of the HVOCs The 2023 CAP Cleanup Action would support site-wide groundwater recovery through the treatment of the HVOC source area and recirculation of CarBstrate to treat HVOCs across the entire groundwater plume extent. Groundwater monitoring would be implemented to evaluate groundwater compliance with CULs site-wide. Soil confirmation monitoring would additionally be implemented following SVE to evaluate soil compliance with CULs. The anticipated restoration time frame is 5 years. ICs would not be required, because soil and groundwater would achieve CULs site-wide.	Alternative 1 consists of the following: • Limited groundwater treatment by recirculation of groundwater amended with a soluble organic carbon substrate electron donor (CarBstrate) to enhance biotic dechlorination of HVOCs in the upgradient portion of the Site • Injection of soluble organic carbon in situ treatment in four focused areas along the length of the HVOC groundwater plume to enhance biotic dechlorination of HVOCs Alternative 1 would support soil and groundwater recovery through treatment of the source area and recirculation and injection of CarBstrate to treat HVOCs throughout the groundwater plume. Groundwater monitoring would be implemented to evaluate groundwater compliance with CULs site-wide. The anticipated restoration time frame is 5 years. ICs would not be required, because soil and groundwater would achieve CULs site-wide.	Alternative 2 consists of the following: • Injection of in situ groundwater treatment in four treatment zones: ○ HVOC Source Area Plume: Soluble organic carbon to enhance biotic dechlorination with S-mZVI to achieve abiotic degradation and continued reducing conditions ○ Downgradient HVOC Plume and Riverbank: Soluble organic carbon to enhance biotic dechlorination with S-mZVI to achieve abiotic degradation and continued reducing conditions and PlumeStop colloidal active carbon to increase contact time with treatment materials ○ Western Plume: Soluble organic carbon with ZVI to promote reducing conditions Alternative 2 would support site-wide groundwater recovery through treatment of the HVOC source zone and downgradient treatment by enhanced biodegradation with supplemental adsorption by PlumeStop colloidal activated carbon. Groundwater monitoring would be implemented to evaluate groundwater compliance with CULs site-wide. The anticipated restoration time frame is 3 years. ICs would not be required, because soil and groundwater would achieve CULs site-wide.

Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

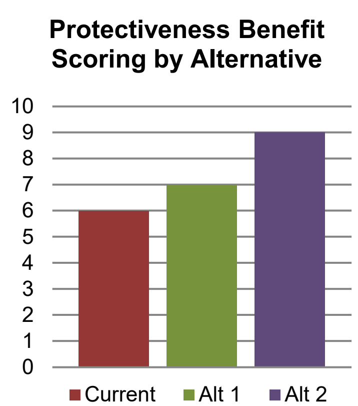
Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Overall Protectiveness • Degree to which existing risks to human health and the environment are reduced • Time required to reduce risks and attain cleanup standards • On-site and off-site risks resulting from alternative implementation • Improvement in overall environmental quality 	• Risks associated with groundwater would be eliminated by plume-wide treatment. However, downgradient risks to the adjacent Sammamish River would be higher in the short term due to downgradient groundwater extraction pumping. This alternative also relies on ambient geochemical conditions being conducive to anaerobic degradation. • The time frame for achievement of CULs site-wide is anticipated to be 5 years. • On-site risks during construction, trenching, and well installation would be managed by proper H&S protocols and site security. Additionally, with the operation of the SVE system, an air discharge permit would be obtained for the discharge of treated soil vapor. • The off-site risks associated with contaminated material transport and disposal are negligible and would be managed using licensed operators and permitted disposal facilities. • The alternative relies on a mechanical system which could experience breakdowns resulting in temporary gaps in groundwater treatment. • The 2023 CAP Cleanup Action achieves desired protectiveness to human health and the environment by degradation of HVOCs utilizing bio-recirculation. This alternative addresses contamination exceeding CULs by promoting microbial activity in the breakdown of the HVOC mass.	• Risks associated with contaminated groundwater would be eliminated by plume-wide treatment. However, the treatment relies on ambient geochemical conditions being conducive to anaerobic degradation. • The time frame for achievement of groundwater CULs site-wide is anticipated to be 5 years. • On-site risks during construction, trenching, well installation, direct push injection and system operation would be managed by proper H&S protocols and site security. There are no other added on-site risks. • The off-site risks associated with contaminated material transport and disposal are negligible and would be managed using licensed operators and permitted disposal facilities. • The alternative relies partially on a mechanical system which could experience breakdowns resulting in temporary gaps in groundwater treatment. • Alternative 1 achieves improvement in overall environmental quality because it is expected to fully achieve CULs in groundwater. This alternative has a similar anticipated restoration time frame for groundwater compared to the 2023 CAP cleanup action, which includes SVE operation.	• Risks associated with contaminated groundwater would be eliminated by plume-wide treatment. The treatment would include optimization of geochemical conditions and addition of materials to adsorb and then both biotically and abiotically degrade the extent of the current HVOC plume. • The time frame for achievement of groundwater CULs site-wide is anticipated to be 3 years. • No ground-disturbing construction would be necessary for this alternative because all treatment will be applied via direct push drilling. On-site H&S protocols and site security would still need to be managed for the duration of the injections. There are no other added on-site risks. The off-site risks associated with contaminated material transport would be limited to incidental investigation-derived waste because no soil excavation is proposed. • Alternative 2 achieves the highest improvement in overall environmental quality because it is has the highest degree of protectiveness for discharges to surface water, utilizing an in situ treatment barrier to trap and fully degrade HVOCs and controlled-release sources of organic carbon to address sorbed HVOC mass in soil.

Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

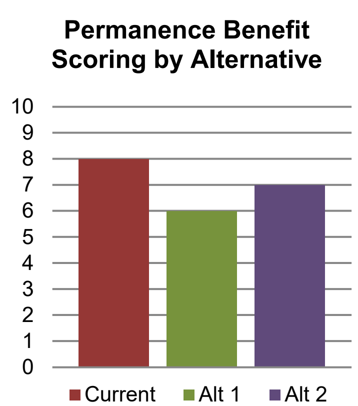
Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Permanence • Degree of reduction of contaminant toxicity, mobility, and volume • Adequacy of destruction of hazardous substances • Reduction or elimination of substance release, and source of release • Degree of irreversibility of waste treatment processes • Volume and characteristics of generated treatment residuals 	• The 2023 CAP Cleanup Action has a high degree of permanence because bio- recirculation of groundwater is designed to reduce contaminated groundwater concentrations of HVOCs via degradation to less than CULs over the restoration time frame. It is scored most highly of the alternatives for permanence because it would install the greatest number of permanent injection and extraction wells, which could be operated indefinitely if needed, without requiring further action at the Site. • The primary sources of contamination would be reduced and extracted by the treatment technologies and in situ biodegradation. • Bioremediation is irreversible but does involve the production of breakdown products, such as vinyl chloride, as part of the dechlorination process. • Treatment residuals associated with implementation of this technology include spent activated carbon, which can be disposed a licensed facilities. Treatment residuals would be generated ex situ and do not pose a risk of Site recontamination.	• Alternative 1 is likely to be permanent at the end of the restoration time frame because bio-recirculation and in situ treatment of groundwater are designed to reduce contaminated groundwater concentrations of HVOCs via degradation to less than CULs over the restoration time frame. However, it is assumed that carbon injection may need to be repeated to reach CULs site-wide and address rebound of contamination; this alternative is, therefore, not fully permanent. • The remaining plumes of contamination would be reduced under anerobic conditions created by the injected organic carbon treatment material. Remaining soil contamination continuing to diffuse to groundwater would be controlled by continued recirculation and by biomass produced by carbon injection that decays and provides donor electrons over time. • Bioremediation is irreversible but does involve the production of breakdown products, such as vinyl chloride, as part of the dechlorination process. • Treatment residuals associated with implementation of this technology include spent activated carbon, which can be disposed of at licensed facilities. Treatment residuals would be generated ex situ and do not pose a risk of Site recontamination.	• Alternative 2 has a high degree of permanence because in situ treatment of groundwater is designed to reduce contaminated groundwater concentrations of HVOCs via degradation to less than CULs over the restoration time. The technologies used for in situ treatment in Alternative 2 have a long lifespan and further action is unlikely to be needed after installation. • The primary sources of contamination would be removed from the site by in situ biotic and abiotic degradation. Remaining soil contamination would be controlled by controlled-release organic carbon sources and a downgradient barrier wall of colloidal active carbon to enhance contact time with treatment materials before groundwater discharges to surface waters. • Bioremediation is irreversible but does involve the production of breakdown products, such as vinyl chloride, as part of the dechlorination process. • There are no treatment residuals associated with implementation of this technology.

Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

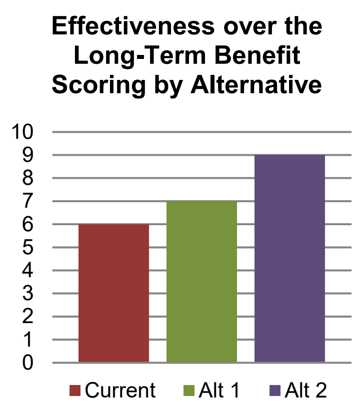
Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Effectiveness over the Long-Term • Degree of certainty of alternative success • Reliability while contaminants on-site remain greater than CULs • Magnitude of residual risk • Effectiveness of controls implemented to manage residual risk  	• The 2023 CAP Cleanup Action is designed to fully degrade HVOCs and provides a reasonable certainty of success to achieve groundwater CULs within a restoration time frame of 5 years site-wide. • Bio-recirculation treatment is also an effective and reasonably common technology to implement and would remove contamination in groundwater. • Degree of certainty for success to remediate groundwater site-wide is moderately high because of SVE and aggressive groundwater treatment; however, success is less certain downgradient compared to the other alternatives. • No residual risk would remain in soil. • The risk from groundwater contamination remaining during the restoration time frame would be monitored by routine groundwater monitoring events until compliance with CULs was achieved. • Residual risk to groundwater would remain due to the potential rebound of contamination due to diffusion of soil mass. This risk is managed over the long term by formation of biomass to continue to provide donor electrons after completion of active treatment. • Aerobic conditions caused by SVE may compete with the goal of anaerobic biodegradation in the bio-recirculation system. • Additional construction of a surface seal would be necessary to ensure the effectiveness of the SVE system, which may be complicated by site topography.	• Alternative 1 is designed to fully degrade HVOCs and provides some certainty of success to achieve groundwater CULs within a restoration time frame of 5 years site-wide. • Bio-recirculation and in situ treatment are also effective and reasonably common technologies to implement and would remove contamination in groundwater. • Degree of certainty for success to remediate groundwater site-wide is moderately high because of targeted groundwater treatment and generally favorable Site conditions. • No residual risk would remain in soil. • The risk from groundwater contamination remaining during the restoration time frame would be monitored by routine groundwater monitoring events until compliance with CULs was achieved. • Residual risk to groundwater would remain due to the potential rebound of contamination due to diffusion of soil mass. This risk is managed over the long term by formation of biomass to continue to provide donor electrons after completion of active treatment. • Localized aerobic conditions may be created by groundwater extraction and redox conditions may require additional management in the bio-recirculation system.	• Alternative 2 is designed to rapidly and fully degrade HVOCs and provides high certainty of success to achieve CULs within a restoration time frame of 3 years site-wide. • In situ treatment is an effective and reasonably common technology to implement and would remove contamination in groundwater. • Degree of certainty for success to remediate groundwater site-wide is the highest because this alternative includes the most aggressive in situ treatment and prioritizes immediate cleanup of the downgradient portions of the HVOC plume. • No residual risk would remain in soil. • The risk from groundwater contamination during the restoration time frame would be monitored by routine groundwater monitoring events until compliance with CULs was achieved. • Residual risk to groundwater would remain due to the potential rebound of contamination due to diffusion of soil mass. This risk is managed over the long term by use of long-acting treatment materials including colloidal activated carbon which will continue to release into the subsurface over approximately 10 years.

Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

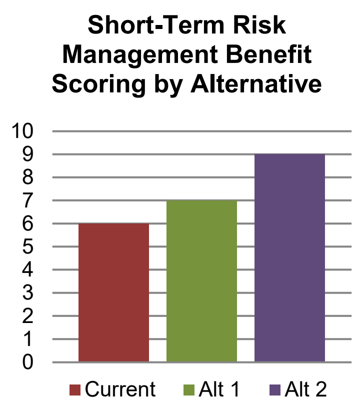
Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Short-Term Risk Management • Risk to human health and the environment associated with alternative construction • The effectiveness of controls in place to manage short-term risks  	• The 2023 CAP Cleanup Action has a moderate short-term risk to human health and the environment during implementation. There are residual risks to human health posed by drilling, trenching, and electrical installation. These risks would be managed by proper BMPs, worker H&S protocols, and site security. • This alternative would require the largest amount of construction and trenching, increasing risks due to equipment, traffic, and exposure to contaminated groundwater. Pollution control measures would also need to be implemented during construction of this alternative to prevent water quality impacts to the Sammamish River. • There is some risk for public exposure with this alternative due to construction and trenching for the installation of pressurized treatment systems, injection wells, and extraction wells that will take place in a public parking lot. • There is a low risk to site workers during handling of CarBstrate for injection. • Site activities would require appropriate PPE, BMPs, site controls to restrict site access, traffic control, and appropriate training requirements for management of risk. These controls are highly effective and anticipated to adequately manage short-term risk.	• Alternative 1 has a low to moderate short-term risk to human health and the environment during implementation. There are residual risks to human health posed by drilling, trenching, and electrical installation. These risks would be managed by proper BMPs, worker H&S protocols, and site security. • This alternative would include construction and trenching for the groundwater recirculation system piping. Fewer trenches and wells are required for this alternative than for the 2023 CAP cleanup action. • There is some risk for public exposure with this alternative due to construction and trenching for treatment system installation that will take place in a public parking lot. • There is a low risk to site workers during handling of CarBstrate for injection. • Site activities would require appropriate PPE, BMPs, site controls to restrict site access, traffic control, and appropriate training requirements for management of risk. These controls are highly effective and anticipated to adequately manage short-term risk.	• Alternative 2 has low short-term risk to human health and the environment during implementation primarily due to the fact that no trenching or treatment system installation will be required. Risks associated with direct-push drilling would be managed by proper H&S procedures and site security. • This alternative would not involve earthwork. • There is de minimis risk for public exposure with this alternative due to drilling. • There is a low risk to site workers during handling of organic carbon, ZVI, and PlumeStop for injection. • Site activities would require appropriate PPE, BMPs, site controls to restrict site access, traffic control, and appropriate training requirements for management of risk. These controls are highly effective and anticipated to adequately manage short-term risk.

Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Technical and Administrative Implementability *Ability of alternative to be implemented considering the following:* • Technical possibility • Availability of off-site facilities, services, and materials • Administrative and regulatory requirements • Schedule, size, and complexity of construction • Monitoring requirements • Site access for construction, operations, and monitoring • Integration with existing site operations or other current and potential future remedial action	• The 2023 CAP Cleanup Action is the most difficult to implement because it involves multiple types of equipment and construction methodologies. SVE and bio-recirculation are somewhat specialized construction elements; however, many licensed contractors in the region are qualified to safely perform this work. This alternative can be implemented in a single construction season. • Additional technical and administrative controls would be required in this alternative to prevent water quality impacts due to invasive construction activities to nearby Sammamish River. • All necessary off-site facilities, materials, and services are available within the region. • Site access during most of the work should include only the closure of a City-owned gravel parking lot that can be closed for the duration of construction work. Sidewalks may be closed for part of the work. • Monitoring requirements include protection monitoring for workers during construction, performance monitoring during SVE, and groundwater monitoring during and after bio-recirculation. • This alternative would moderately impede current or future property use due to the construction of additional structures in public park space. It would not preclude potential future remedial action.	• Alternative 1 is the second largest in scale and includes some technical construction elements. Bio-recirculation and in situ injection are somewhat specialized construction elements; however, many licensed drillers in the region are qualified to safely perform this work. This alternative can be implemented easily in a single construction season; however, additional site access and permitting work would be needed if a second round of downgradient injection is completed. • All necessary off-site facilities, materials, and services are available within the region. • Site access during most of the work should include only the closure of a City-owned gravel parking lot that can be closed for the duration of construction work. Sidewalks may be closed for part of the work. • Monitoring requirements include protection monitoring for workers during construction and groundwater monitoring after bio-recirculation and direct push injection. • This alternative would moderately impede current or future property use due to the construction of additional structures in public park space; however, it includes fewer permanent structures than the 2023 CAP cleanup action. It would not preclude potential future remedial action.	• Alternative 2 is the smallest in scale. In situ injection is a somewhat specialized construction element; however, many licensed drillers in the region are qualified to safely perform this work. This alternative can be implemented in a single construction season. • All necessary off-site facilities, materials, and services are available within the region. • Site access during most of the work should include only the closure of a City-owned gravel parking lot that can be closed for the duration of construction work. Sidewalks may be closed for part of the work. • Monitoring requirements include performance monitoring during injection and groundwater monitoring after injection. • This alternative would not impede current property use and would cause minimal impediment to future property use. This alternative would not preclude potential future remedial action.

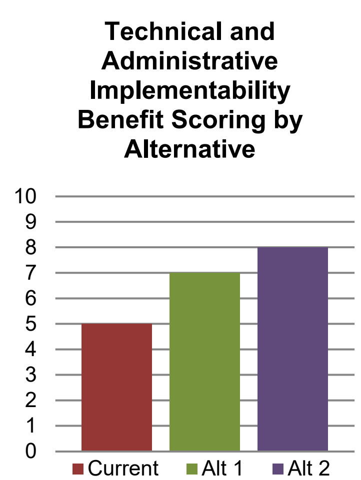
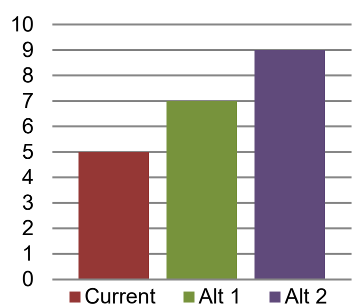


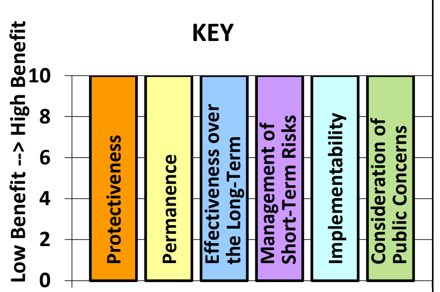
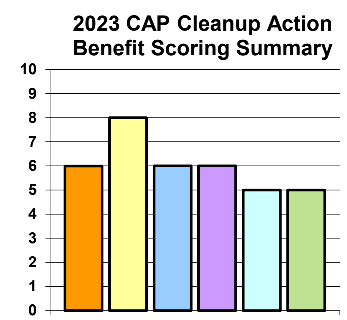
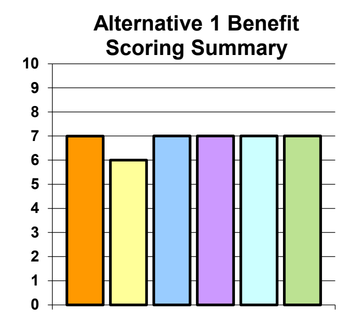
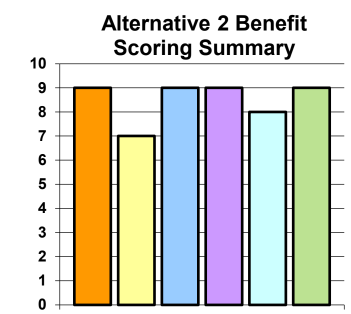
Table 4.1
Disproportionate Cost Analysis Alternative Evaluation

Criteria	2023 CAP Cleanup Action	Alternative 1	Alternative 2
Consideration of Public Concerns and Tribal Rights and Interests • Whether the community has concerns • Degree to which the alternative addresses those concerns **Consideration of Public Concerns and Tribal Rights and Interests Benefit Scoring by Alternative** 	• The 2023 CAP Cleanup Action addresses public concerns regarding contaminated groundwater impacts with groundwater and soil vapor treatment. • The installation of an SVE system may raise concerns with members of the public who walk through the area surrounding the site because the equipment associated with an SVE can cause noise pollution. • Disturbance to parking and sidewalks is also expected to be of concern to the City and the public. The current cleanup action involves a high degree of temporary disturbance to the Site and surrounding sidewalks during remedy implementation and some permanent loss of parking space due to added structures. • The treatment systems will be pressurized and will routinely have contaminated soil vapor or groundwater flowing through mechanical components. The public could perceive this as a potential risk if the systems were to fail or leak. • Public concerns will be reviewed after the public comment period and will be addressed as part of the final remedial alternative selection and design.	• Alternative 1 addresses public concerns regarding contaminated groundwater impacts with targeted groundwater treatment. • Disturbance to parking and sidewalks is also expected to be of concern to the City and the public. Alternative 1 involves less disturbance than the 2023 CAP cleanup action, but more than Alternative 2 during remedy implementation. • The treatment systems will be pressurized and will routinely have contaminated soil vapor or groundwater flowing through mechanical components. The public could perceive this as a potential risk if the systems were to fail or leak. • Public concerns will be reviewed after the public comment period and will be addressed as part of the final remedial alternative selection and design.	• Alternative 2 addresses public concerns regarding contaminated groundwater impacts with aggressive groundwater treatment. Tribal concerns are addressed by prioritizing rapid cleanup of groundwater discharging to surface water to protect all uses of the Sammamish River. • Disturbance to parking and sidewalks is also expected to be of concern to the City and the public. Alternative 2 involves a minimal amount of temporary disturbance compared to the other alternatives during remedy implementation. • Public concerns will be reviewed after the public comment period and will be addressed as part of the final remedial alternative selection and design.
Cost	**2023 CAP Cleanup Action**	**Alternative 1**	**Alternative 2**
• Cost of construction • Long-term monitoring, operations, and maintenance costs • Agency oversight costs	Total cost: $2,732,602 • Includes construction, long-term monitoring, and agency oversight costs • Includes tax • Includes 20% contingency	Total cost: $1,669,059 • Includes construction, long-term monitoring, and agency oversight costs • Includes tax • Includes 20% contingency	Total cost: $1,673,963 • Includes construction, long-term monitoring, and agency oversight costs • Includes tax • Includes 20% contingency

Abbreviations:

BMP	Best management practice
CAP	Cleanup Action Plan
City	City of Bothell
CUL	Cleanup level
H&S	Health and safety
HVOC	Halogenated volatile organic compound
IC	Institutional control
PPE	Personal protective equipment
S-mZVI	Sulfidated micro zero-valent iron
Site	Riverside Halogenated Volatile Organic Compound Site
SVE	Soil vapor extraction
ZVI	Zero-valent iron

Table 4.2
Disproportionate Cost Analysis Summary

Alternative	**2023 CAP Cleanup Action** **SVE, Groundwater Recirculation with CarBstrate**	**Alternative 1** **Groundwater Recirculation with CarBstrate, Direct-Push Injections of CarBstrate**	**Alternative 2** **In Situ Bioremediation using CarBstrate, PlumeStop, and S-mZVI**
Alternative Description	The 2023 CAP cleanup action includes: • Soil source treatment by SVE with ex situ soil vapor treatment using activated carbon • Groundwater treatment by recirculation of groundwater amended with a soluble organic carbon substrate electron donor (CarBstrate) to enhance biotic dechlorination of HVOCs	Alternative 1 includes: • Limited groundwater treatment by recirculation of groundwater amended with a soluble organic carbon substrate electron donor (CarBstrate) to enhance biotic dechlorination of HVOCs in the upgradient portion of the Site • Injection of CarBstrate in situ treatment in four focused areas along the length of the HVOC groundwater plume to enhance biotic dechlorination of HVOCs	Alternative 2 includes: • Injection of in-situ groundwater treatment in three treatment zones: ○ HVOC Source Area Plume: Soluble organic carbon to enhance biotic dechlorination with S-mZVI to achieve abiotic degradation and continued reducing conditions ○ Downgradient HVOC Plume and Riverbank: Soluble organic carbon to enhance biotic dechlorination with S-mZVI to achieve abiotic degradation and continued reducing conditions and PlumeStop colloidal active carbon to increase contact time with treatment materials ○ Western Plume: Soluble organic carbon with ZVI to promote reducing conditions
			
Complies with MTCA Requirements	Yes	Yes	Yes
Restoration Time Frame	5 Years	5 Years	3 Years
Protectiveness (30%)	6	7	9
Permanence (20%)	8	6	7
Effectiveness over the Long Term (20%)	6	7	9
Management of Short-Term Risks (10%)	6	7	9
Technical and Administrative Implementability (10%)	5	7	8
Consideration of Public Concerns and Tribal Rights and Interests (10%)	5	7	9
Total Weighted Benefit Score (Relative Benefit Ranking)	**6.2**	**6.8**	**8.5**
Estimated Total Alternative Cost [1]	$2.7 million	$1.7 million	$1.7 million
Benefit per Unit Cost Ratio [2]	**3.40**	**6.19**	**7.70**

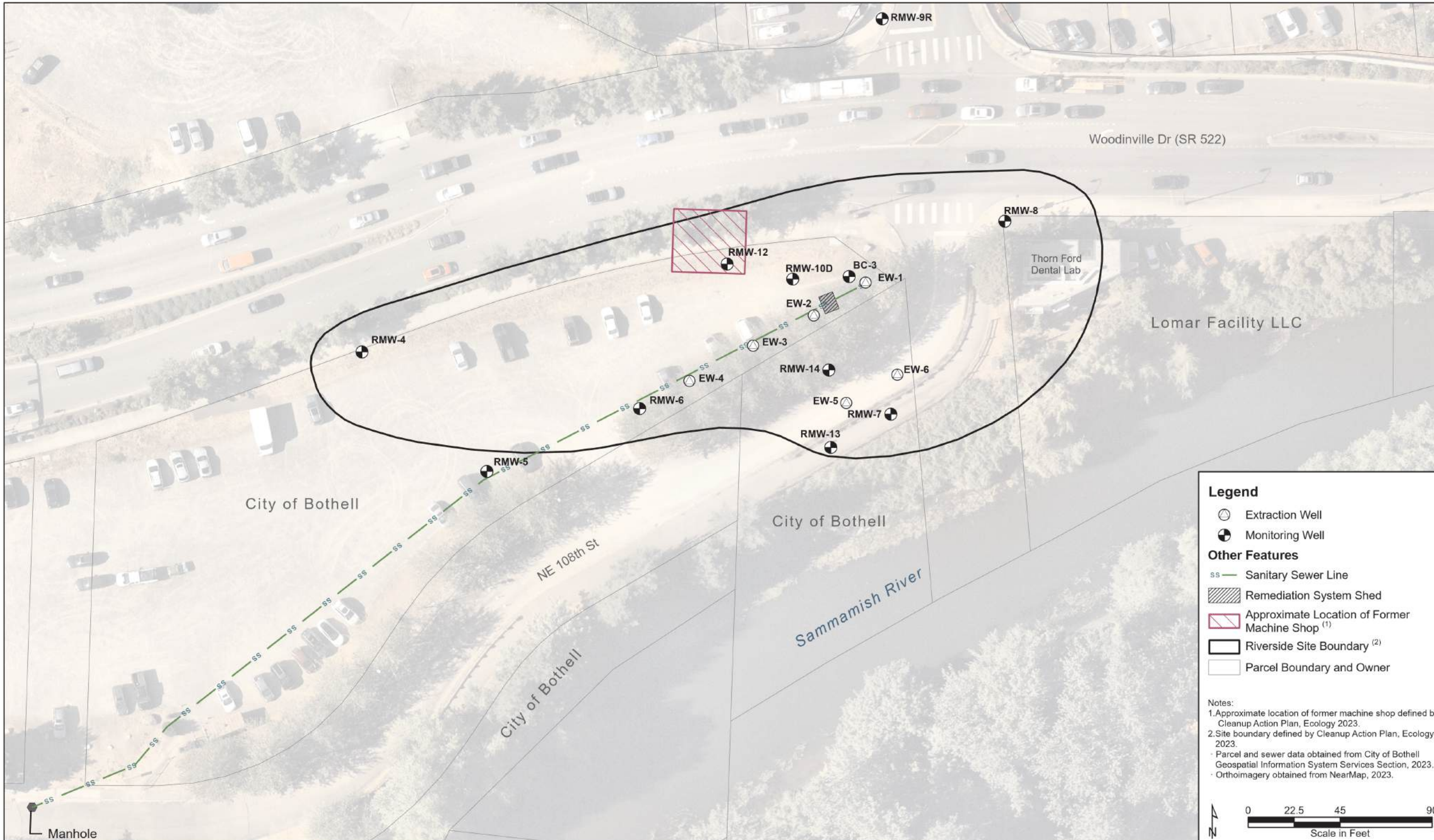
Notes:
1 Specific cost estimate information is provided in Appendix D.
2 Benefit per Unit Cost Ratio calculated by dividing the Total Weighted Benefit Score by the Estimated Total Alternative Cost (standardized by dividing by $1.5 million). Higher value indicates the most benefit per unit cost.

Abbreviations:
CUL Cleanup level
HVOC Halogenated volatile organic compound
MTCA Model Toxics Control Act
S-mZVI Sulfidated micro zero-valent iron
SVE Soil vapor extraction
Site Riverside Halogenated Volatile Organic Compound Site

Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Figures



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Pre-Engineering Design Investigation Data Report
Riverside HVOC Site
Bothell, Washington

Figure 1.1
Site Map

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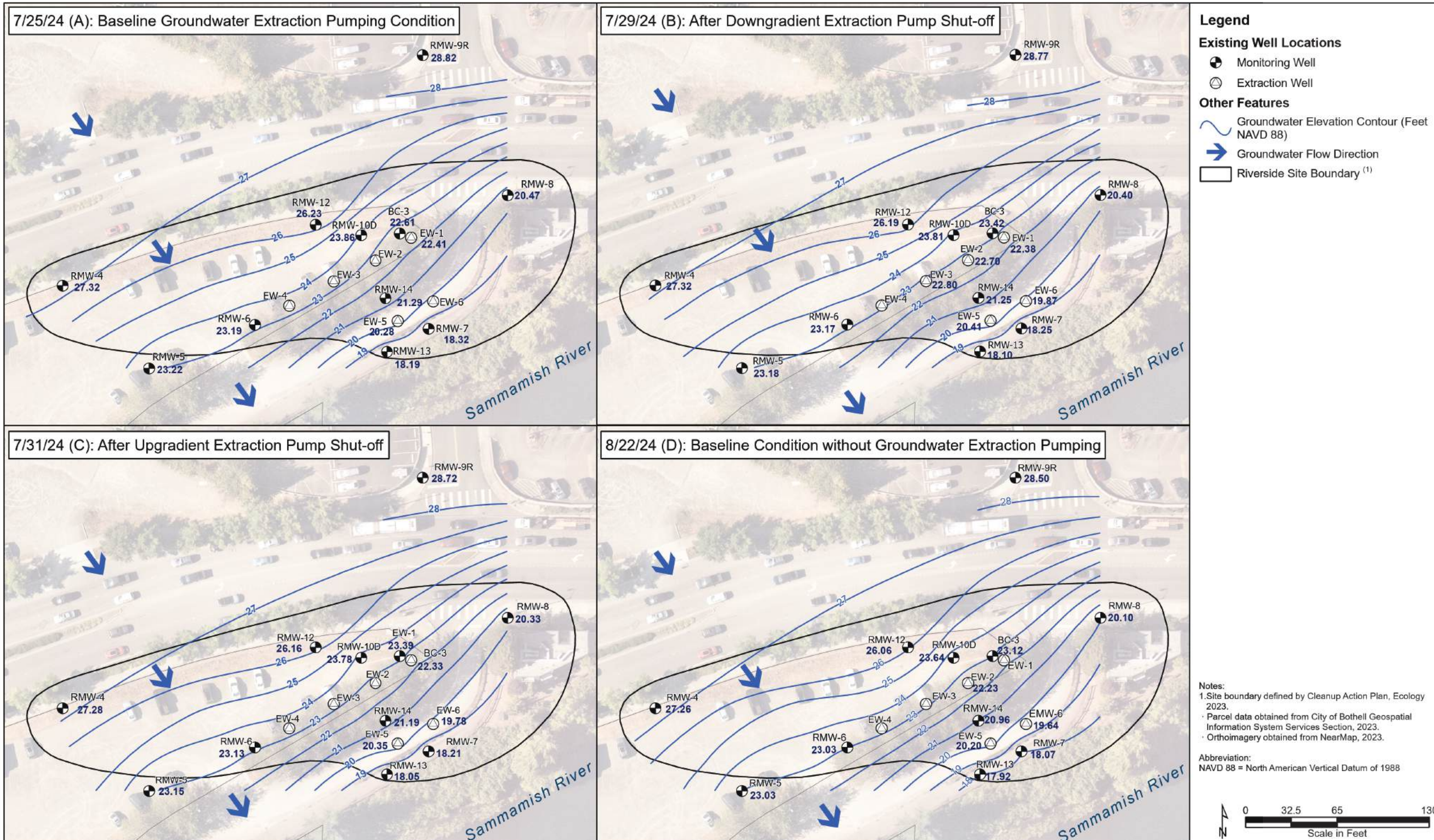
12/16/2024



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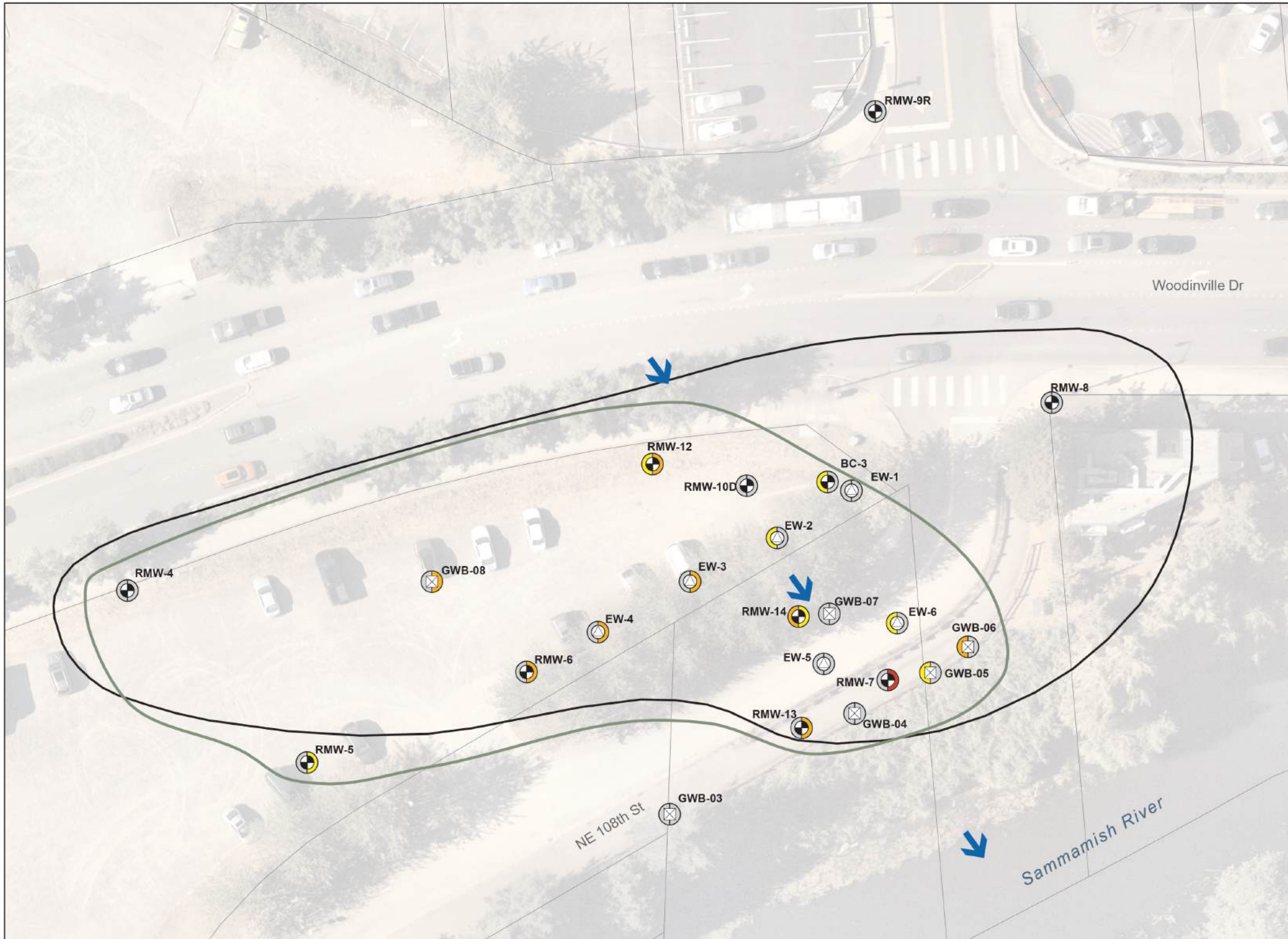
Pre-Engineering Design Investigation Data Report
Riverside HVOC Site
Bothell, Washington

Figure 2.1
Groundwater Elevations

Docusign Envelope ID: 4D1E174F-3D46-4280-9A84-92189A7BA52E



Legend

Groundwater Sample Result (1)

PCE Result | Vinyl Chloride Result
ND or ≤ CUL | ND or ≤ CUL
> CUL – < 2x CUL | > CUL – < 5x CUL
≥ 2xCUL – < 10x CUL | ≥ 5xCUL – < 50x CUL
≥ 10x CUL | ≥ 50x CUL

Sample Location
Monitoring Well
Reconnaissance Boring
Extraction Well

Other Features
Groundwater Flow Direction
Riverside Site Boundary (2)
Extent of HVOCs>CULs in Groundwater
Parcel Boundary

Cleanup Levels
PCE = 4.9 µg/L
Vinyl chloride = 0.02 µg/L

Notes:
1. For reconnaissance boring samples with multiple sample depths, the maximum result is shown. HVOC results shown are the maximum detection in samples collected from July-September 2024, except at BC-3 where the most recent result collected in May 2020 is shown.
2. Site boundary defined by Cleanup Action Plan, Ecology 2023.
- Parcel data obtained from City of Bothell Geospatial Information System Services Section, 2023.
- Orthoimagery obtained from NearMap, 2023.

Abbervations:
CUL = Cleanup level
HVOC = Halogenated volatile organic compound
µg/L = Micrograms per liter
ND = Non-detect
PCE = Tetrachloroethene

N
0 17.5 35 70
Scale in Feet

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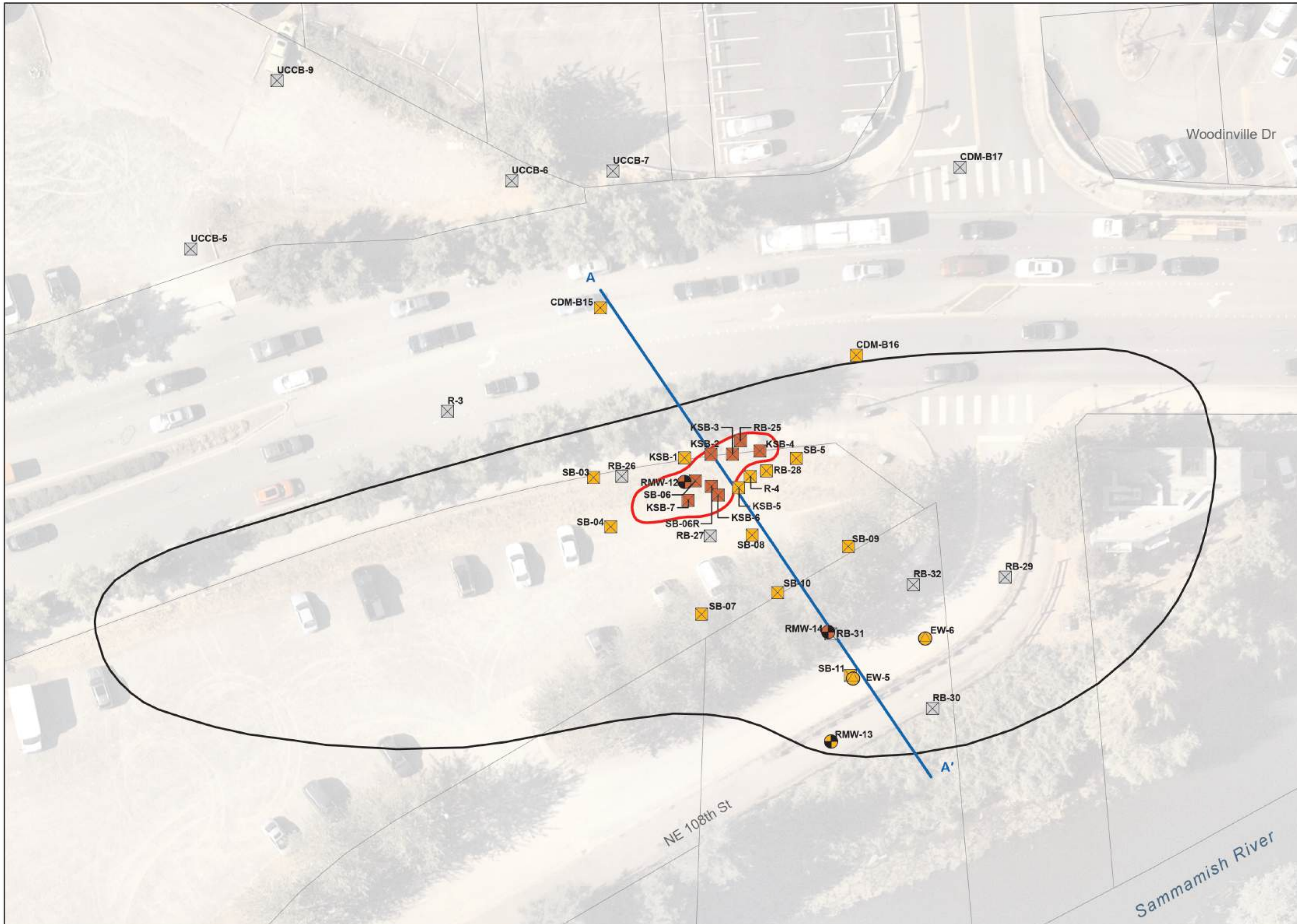
Riverside HVOC Site
Bothell, Washington

Figure 2.2
Groundwater HVOC Conditions

I:\GIS\Projects\COBothell-Riverside\02-Map Documents\03-Pre-Engineering Design Data Summary Report\01 - HVOC\HVOC.aprx
12/16/2024



Legend

Existing Sample Location Type (1)

- Soil Boring
- Extraction Well Boring
- Monitoring Well Boring

HVOC Results

- Non-detect
- One or More HVOCs Detected, All Results Less Than CULs
- One or More Results Exceed CUL

Other Features

- Cross-Section Transect
- Approximate Extent of Soil HVOCs Exceeding CULs
- Riverside Site Boundary (2)
- Parcel Boundary

Cleanup Levels
Tetrachloroethene = 0.05 mg/kg
Trichloroethene = 0.03 mg/kg
cis-1,2-Dichloroethene = 160 mg/kg
Vinyl chloride = 0.67 mg/kg

Notes:
1. Site soil samples were colelcted between 2008 and 2024, with most samples collected between 2017 and 2024. Refer to Table 2.4 for a full summary of soil sample collection dates and HVOC results.
2. Site boundary defined by Cleanup Action Plan, Ecology 2023.
· Parcel data obtained from City of Bothell Geospatial Information System Services Section, 2023.
· Orthoimagery obtained from NearMap, 2023.

Abbrevations:
CUL = Cleanup level
HVOC = Halogenated volatile organic compound
mg/kg = Milligrams per kilogram

N

0 17.5 35 70
Scale in Feet

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Riverside HVOC Site
Bothell, Washington

Figure 2.3
Soil HVOC Conditions

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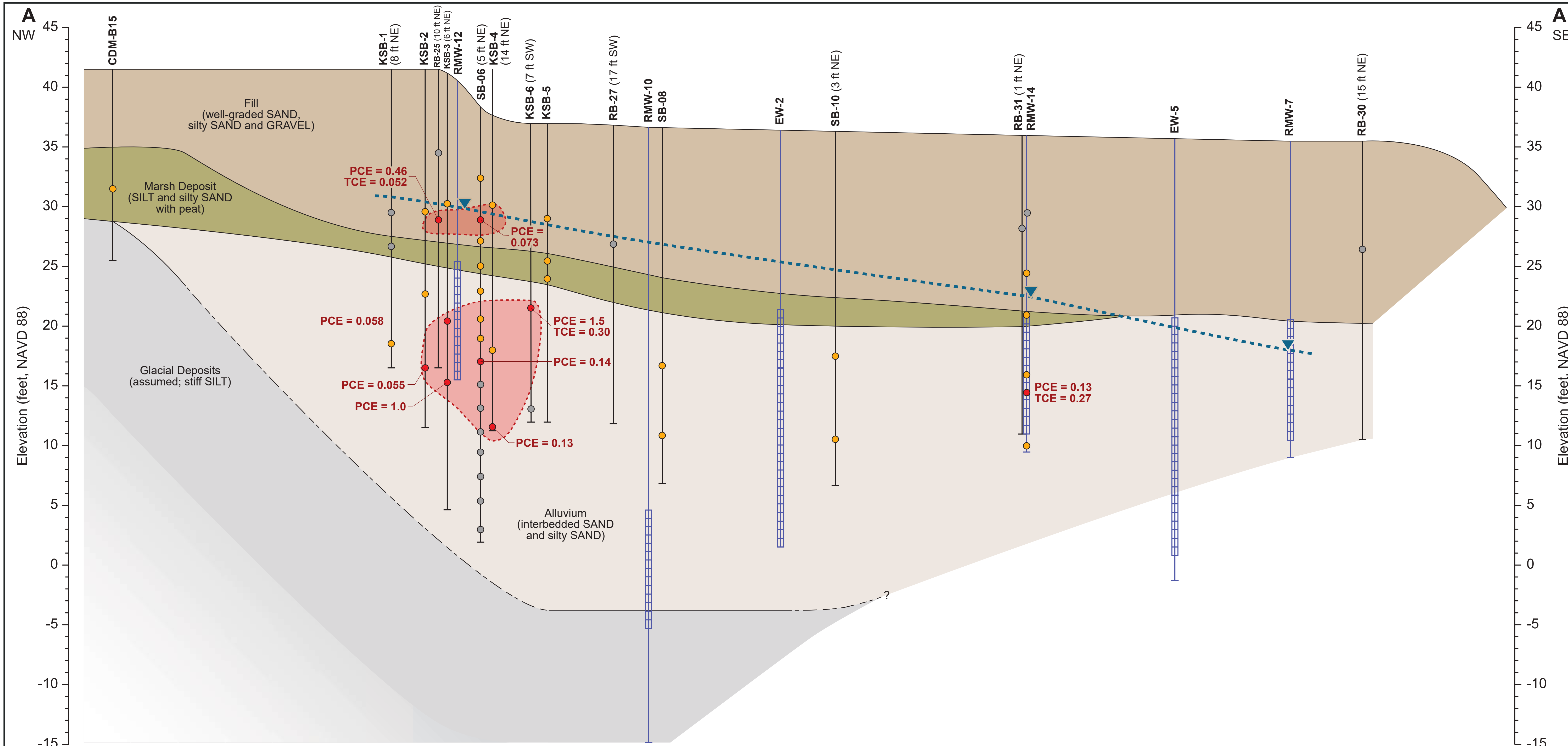
12/12/2024

Docusign Envelope ID: 4D1E174F-3D46-4280-9A84-92189A7BA52E



Legend

KSB-1 (8 ft NE) Identifier (bolded) and Offset (in parentheses if applicable)

Soil Sample

Boring

Well Screen Interval on Well Casing

Groundwater Elevation, Aug/Sep 2024

Groundwater Table, Aug/Sep 2024

Contact Boundary Between Lithologies (dashed where inferred)

Soil Analytical Results

HVOC contaminant detected greater than Site cleanup levels (refer to table to right) in soil sample.

HVOC contaminant detected less than Site cleanup levels (refer to table to right) in soil sample.

HVOC contaminants not detected in soil sample.

Approximate Extent of Soil PCE Source Area

Cleanup Levels
PCE = 0.05 mg/kg
TCE = 0.03 mg/kg
DCE = 160 mg/kg
VC = 0.67 mg/kg

Note: Soil analytical results listed in mg/kg. Site soil samples were collected between 2008 and 2024, with most samples collected between 2017 and 2024. Refer to Table 2.4 for a full summary of soil sample collection dates and HVOC results.

0 13 26

Approximate Horizontal Scale in Feet
Vertical Exaggeration = 1.5x

Abbreviations: DCE = cis-1,2-Dichloroethene, ft = Feet, HVOC = Halogenated volatile organic compound, mg/kg = Milligrams per kilogram, NAVD 88 = North American Vertical Datum of 1988, PCE = Tetrachloroethene, Site = Riverside HVOC Site, TCE = Trichloroethene, VC = Vinyl chloride

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Bothell, Washington

Figure 2.4
Cross Section A-A′

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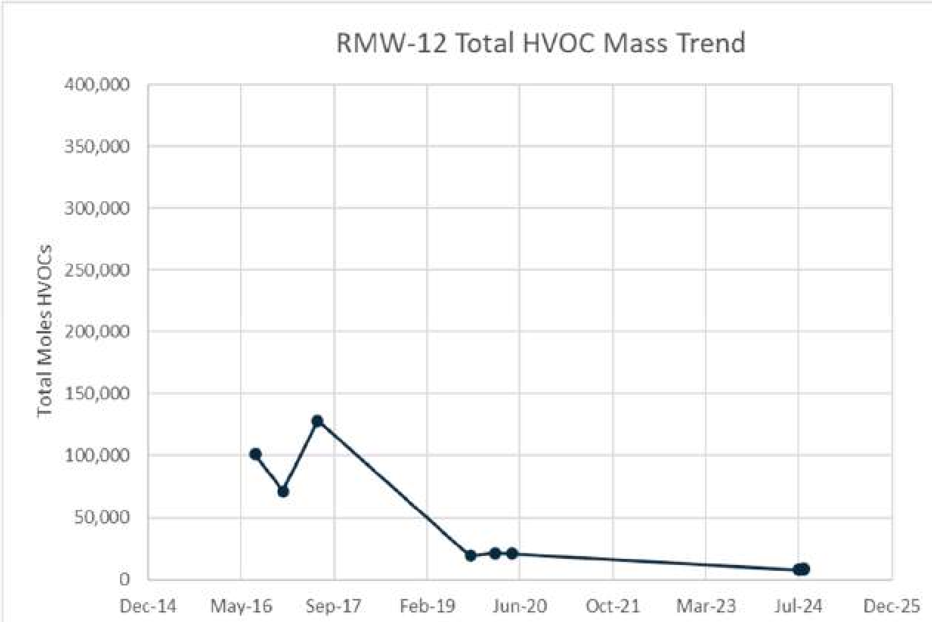
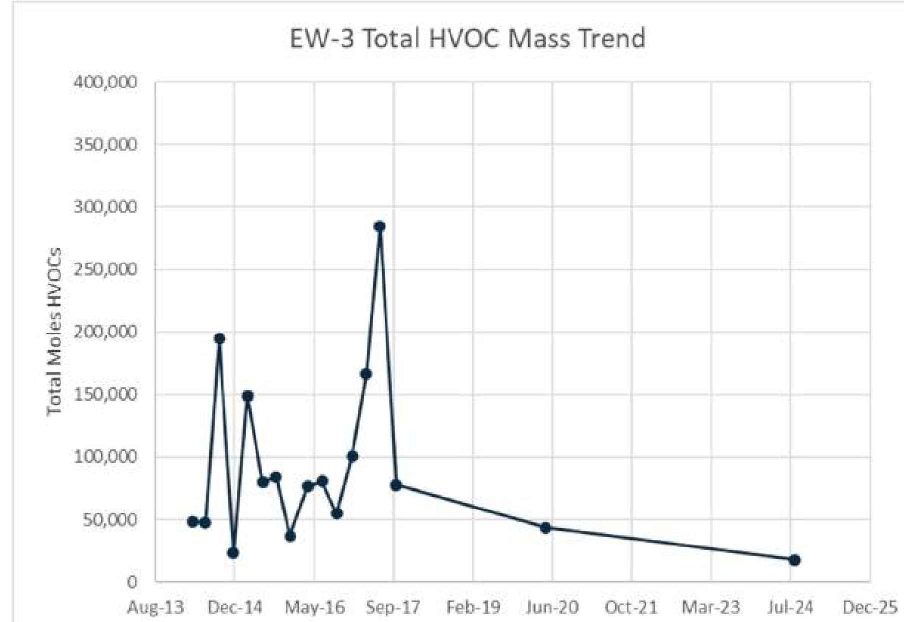
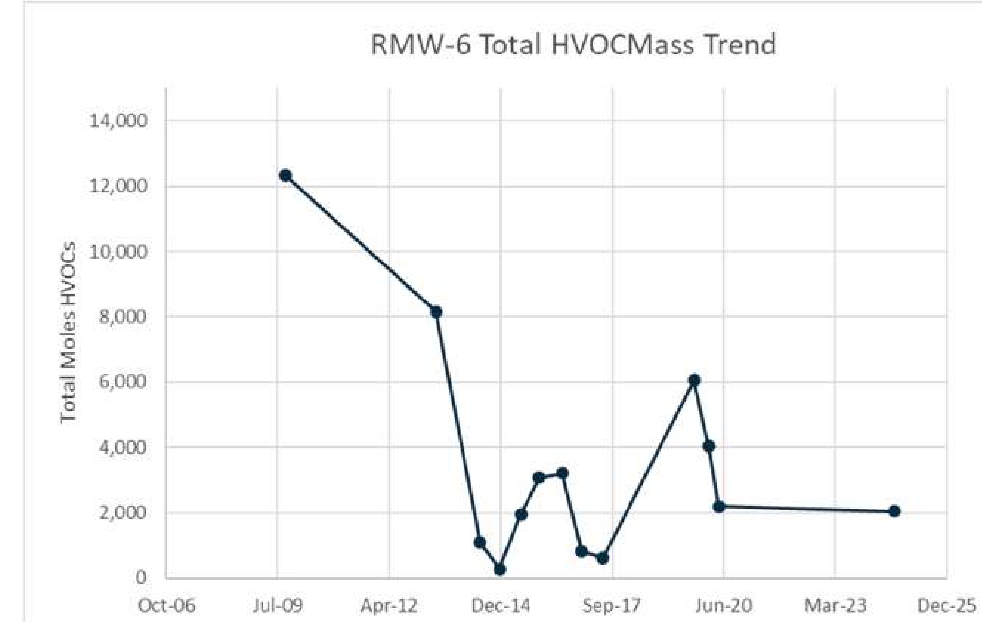
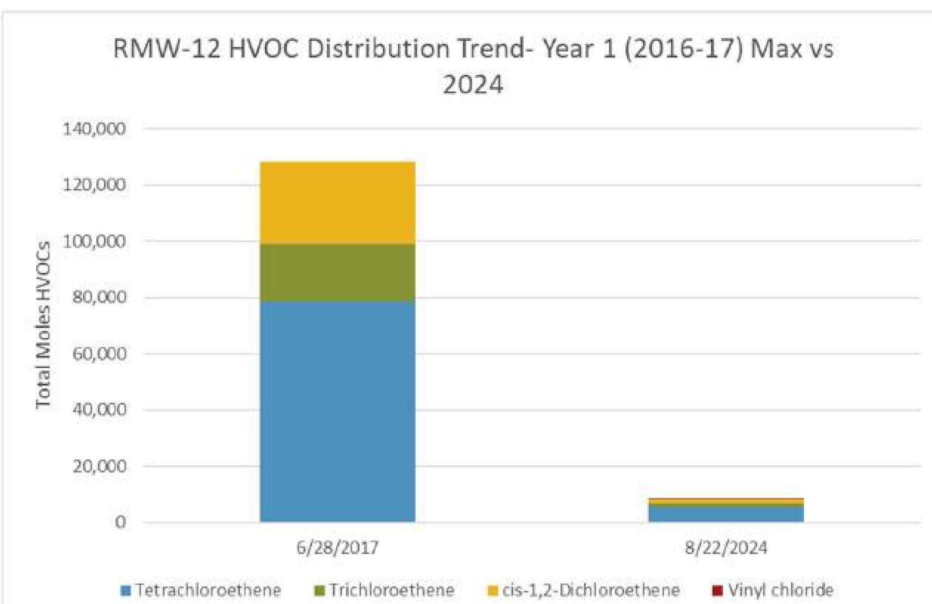
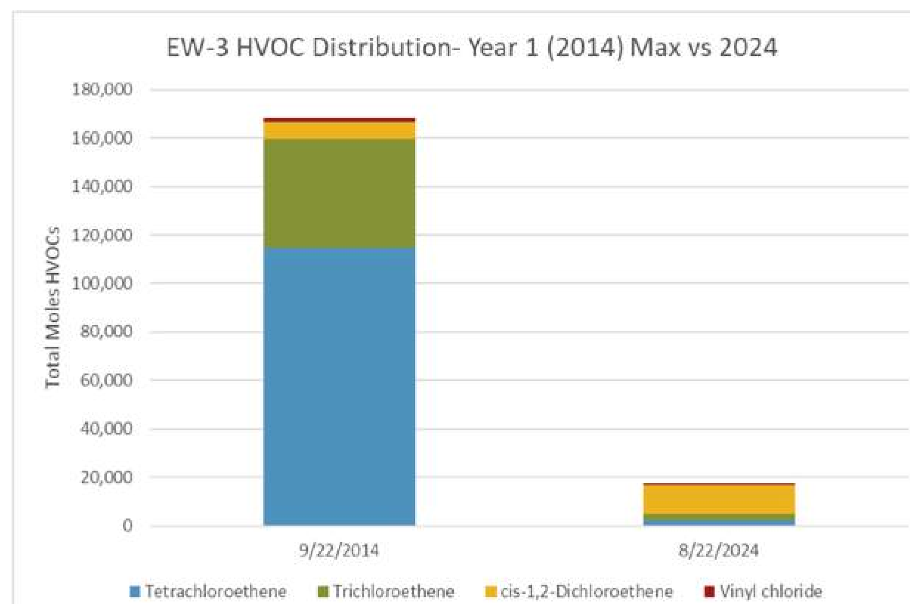
12/12/2024

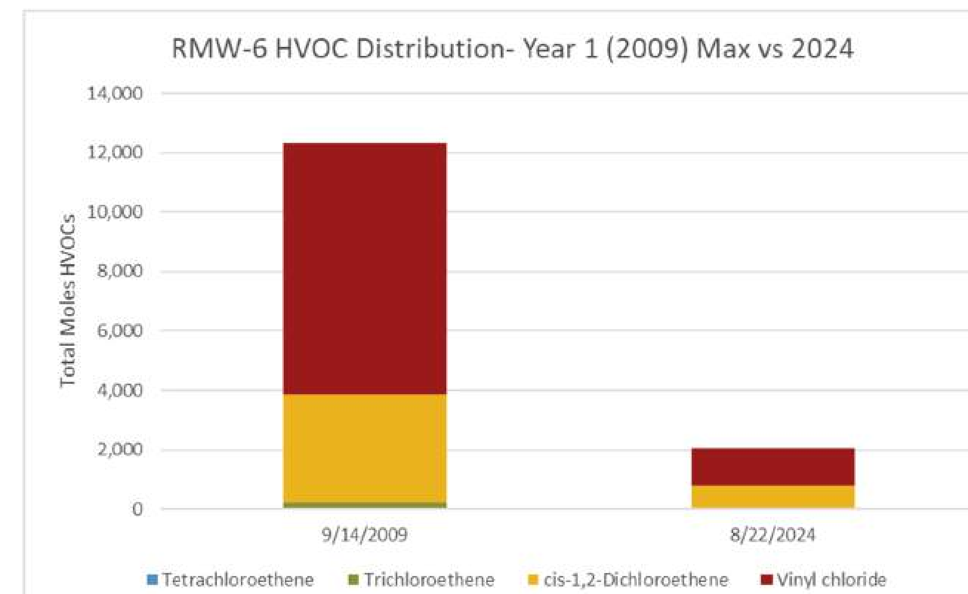












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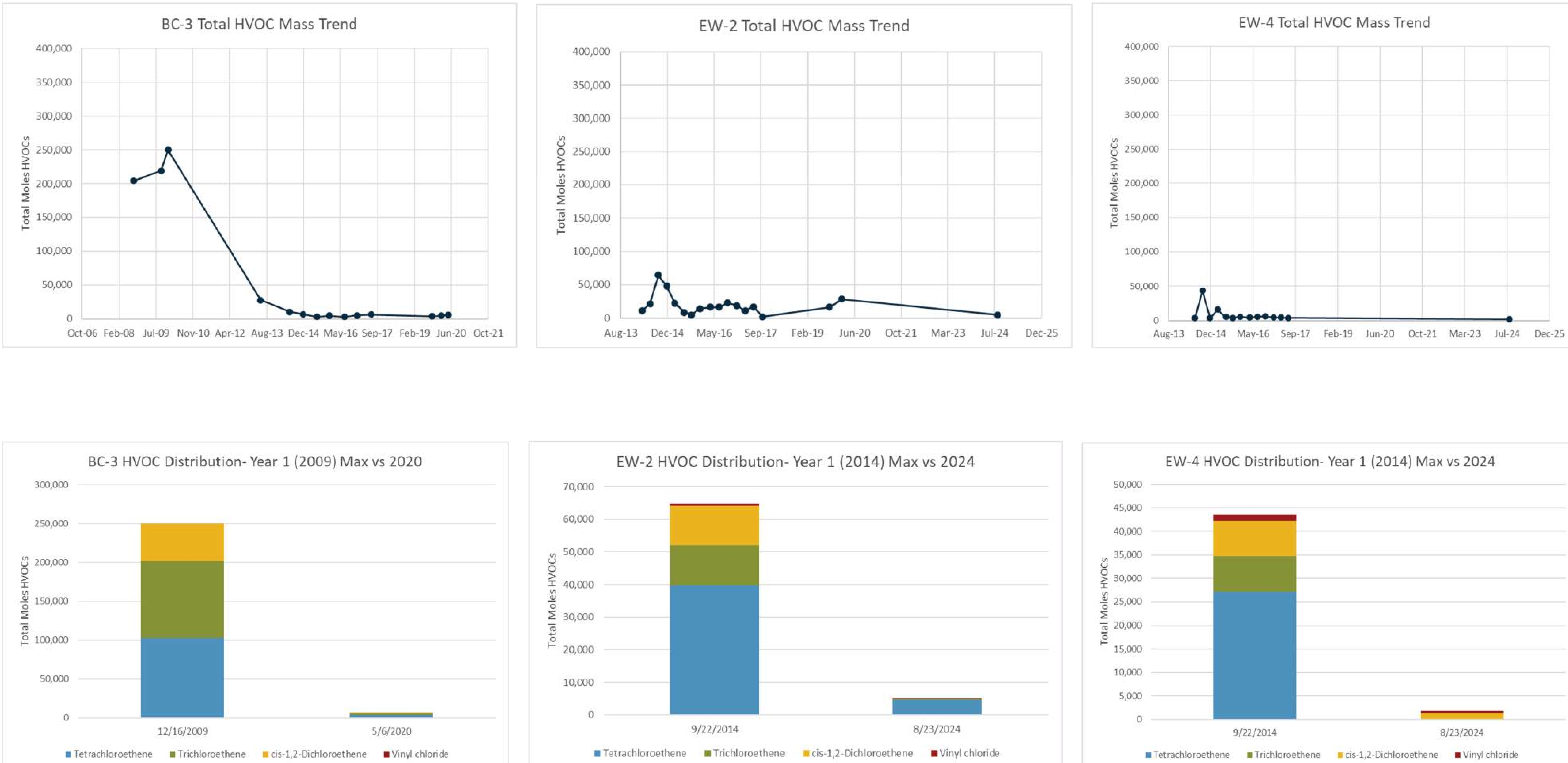
Bothell, Washington

Figure 3.1
HVOC Molar Concentrations: Source Area and Upgradient Plume (Sheet 1 of 3)

12/4/2024



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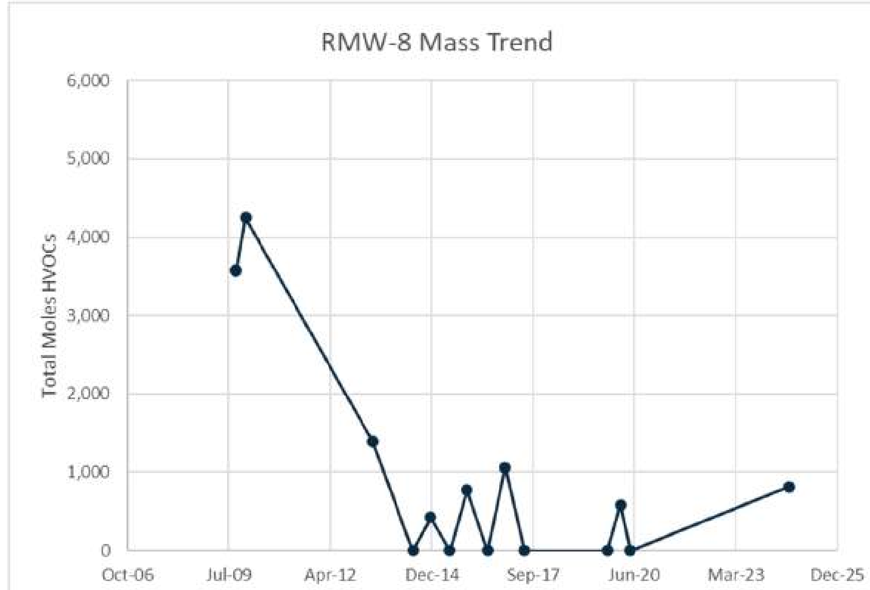
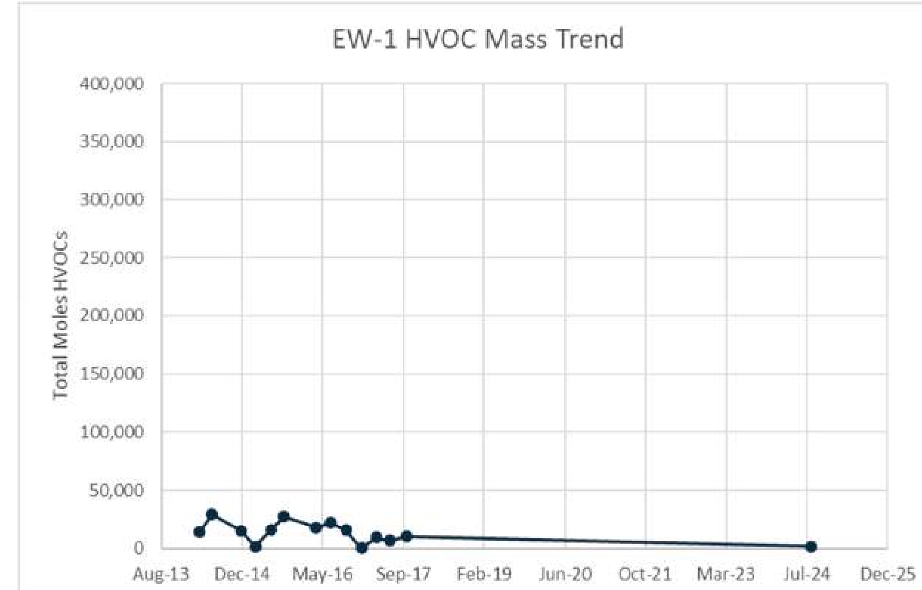
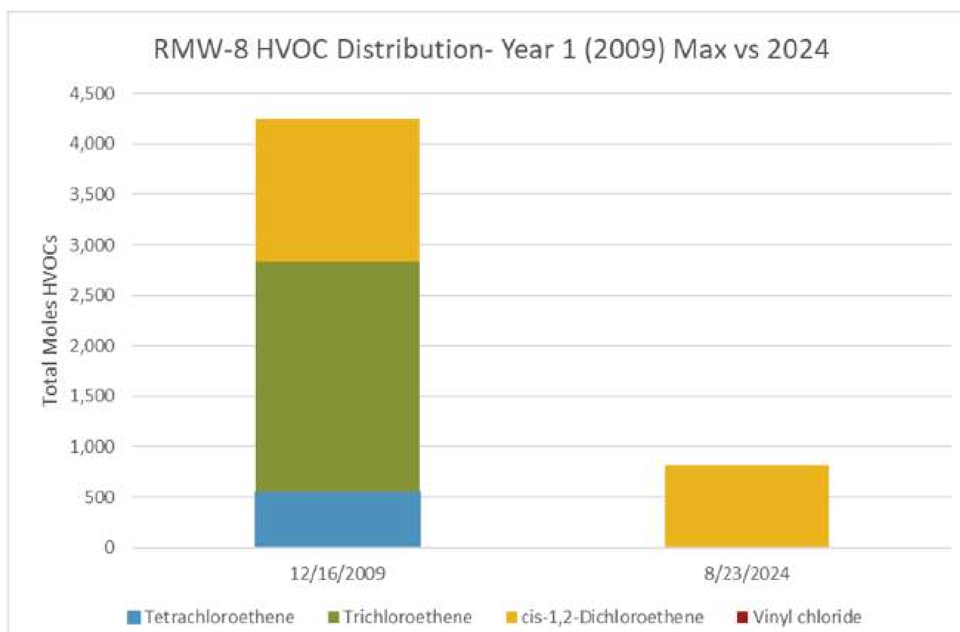
Riverside HVOC Site
Bothell, Washington

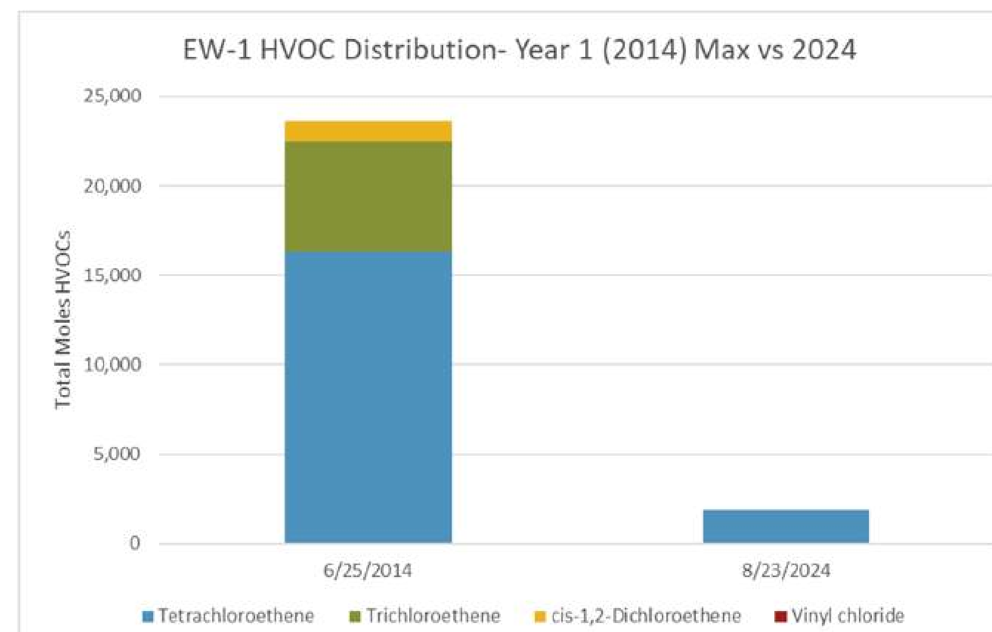
Figure 3.1
HVOC Molar Concentrations: Source Area and Upgradient Plume (Sheet 2 of 3)

12/4/2024









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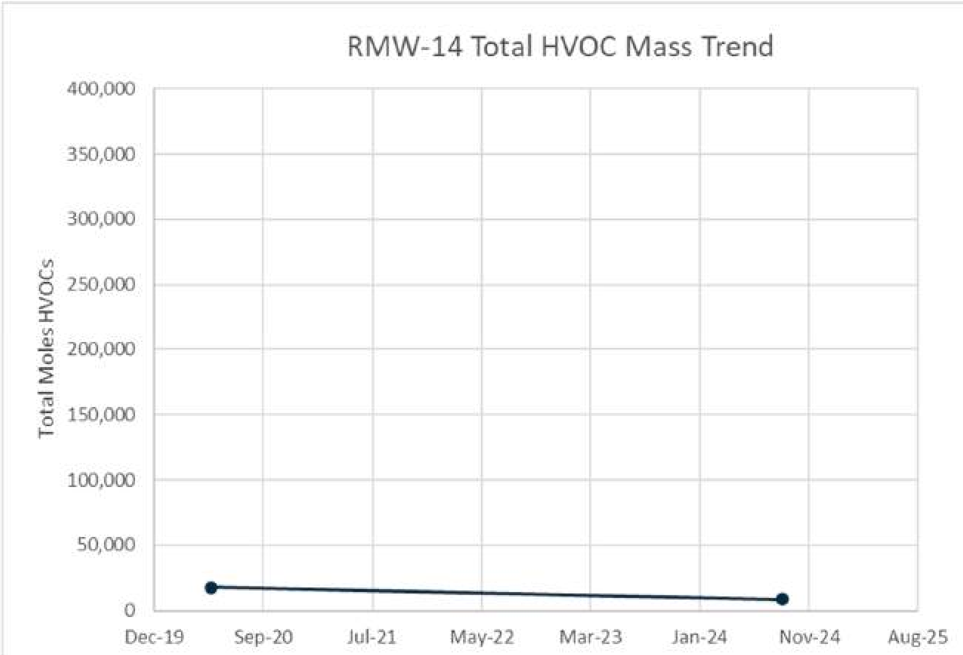
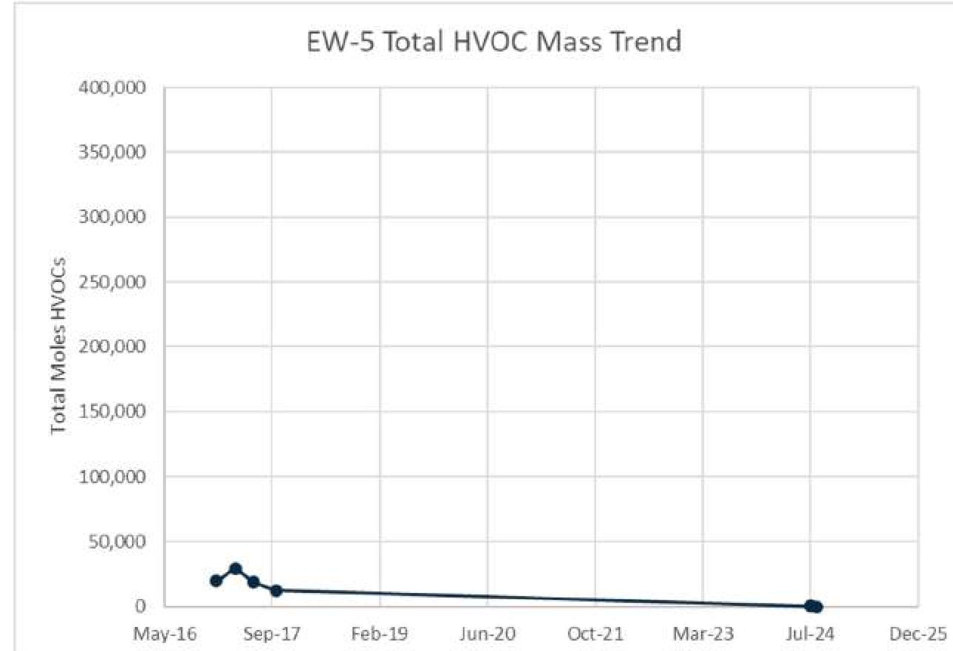
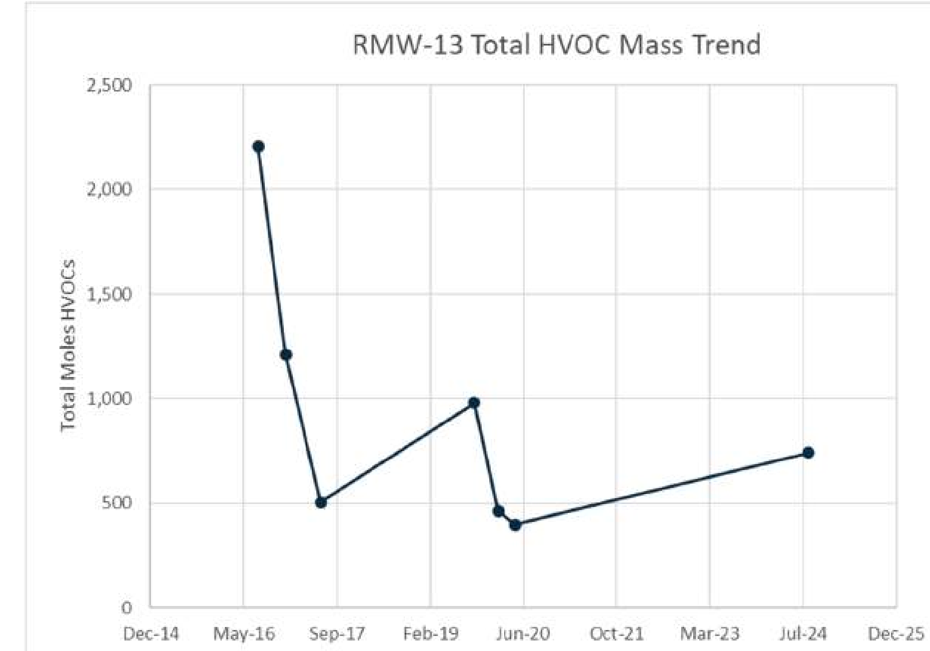
Riverside HVOC Site
Bothell, Washington

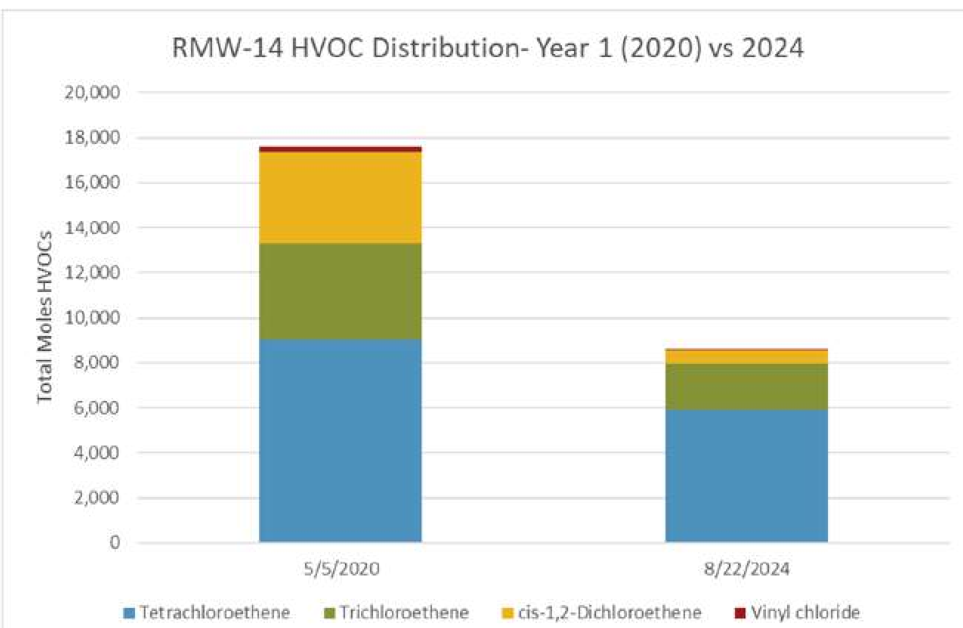
Figure 3.1
HVOC Molar Concentrations: Source Area and Upgradient Plume (Sheet 3 of 3)

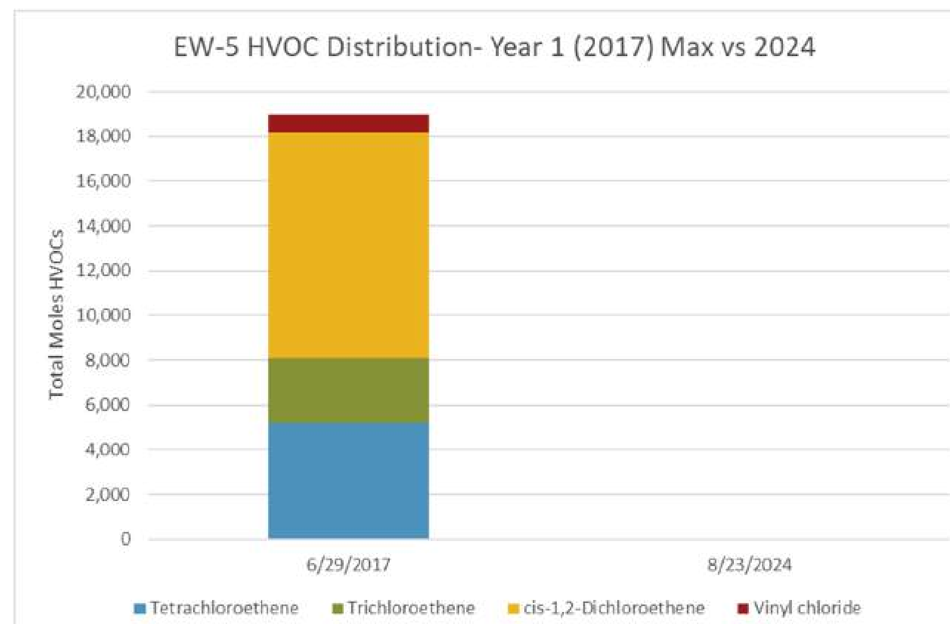
12/4/2024

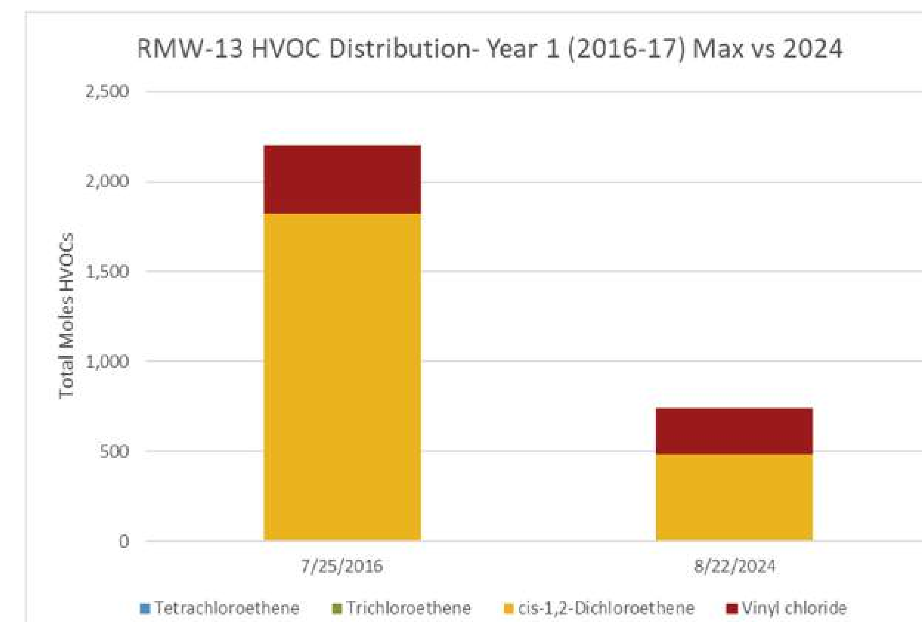












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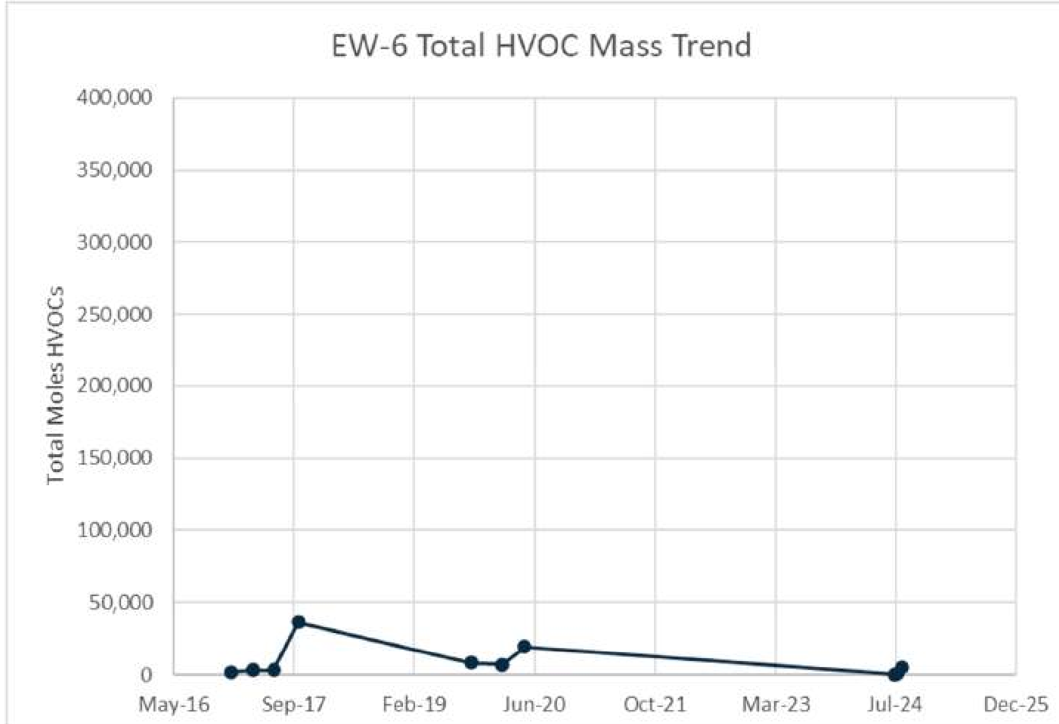
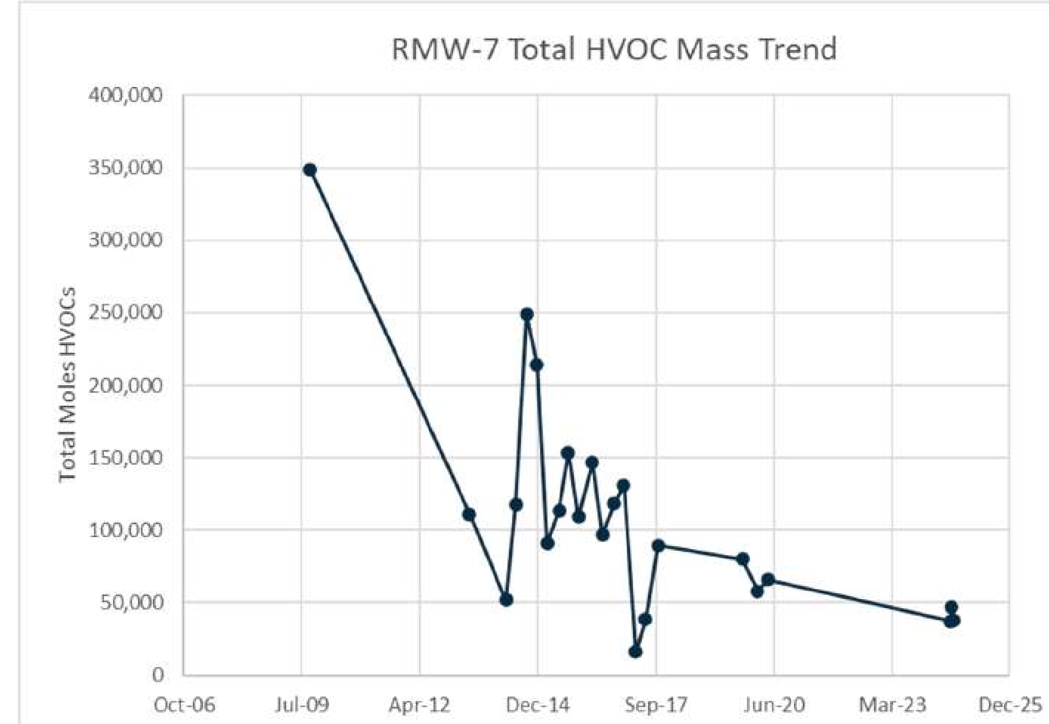
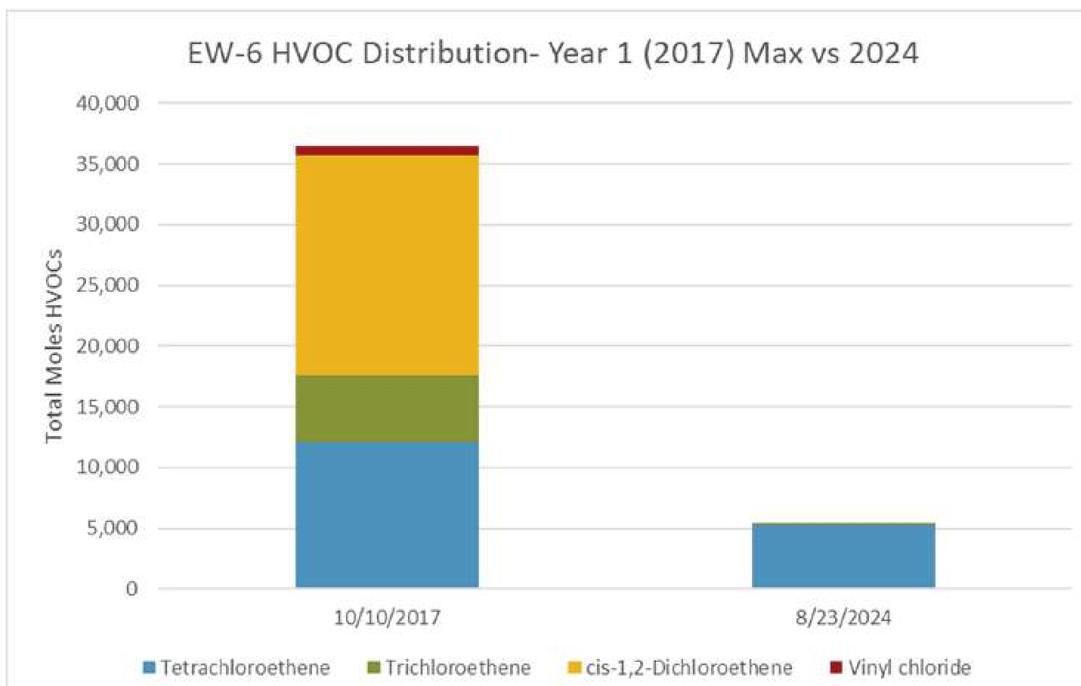
Riverside HVOC Site
Bothell, Washington

Figure 3.2
HVOC Molar Concentrations: Downgradient Plume
(Sheet 1 of 2)

12/4/2024







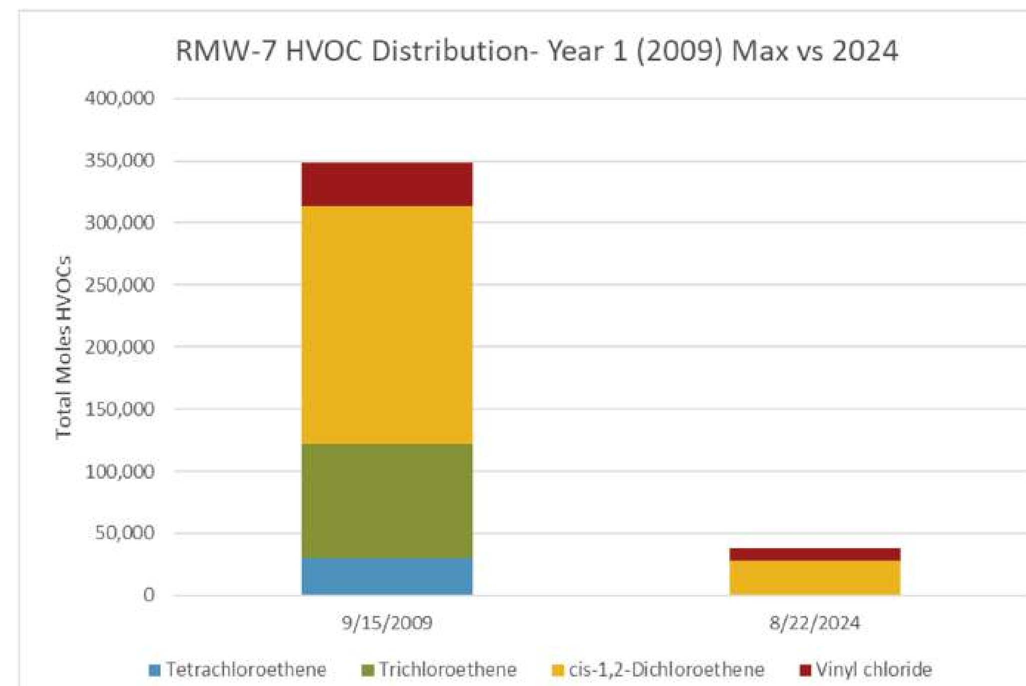


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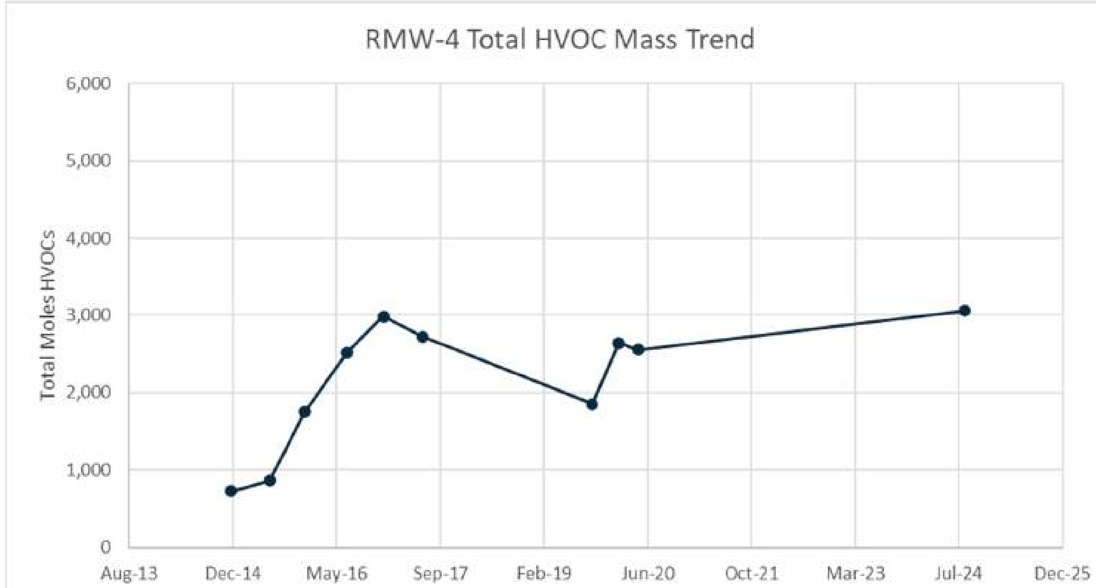
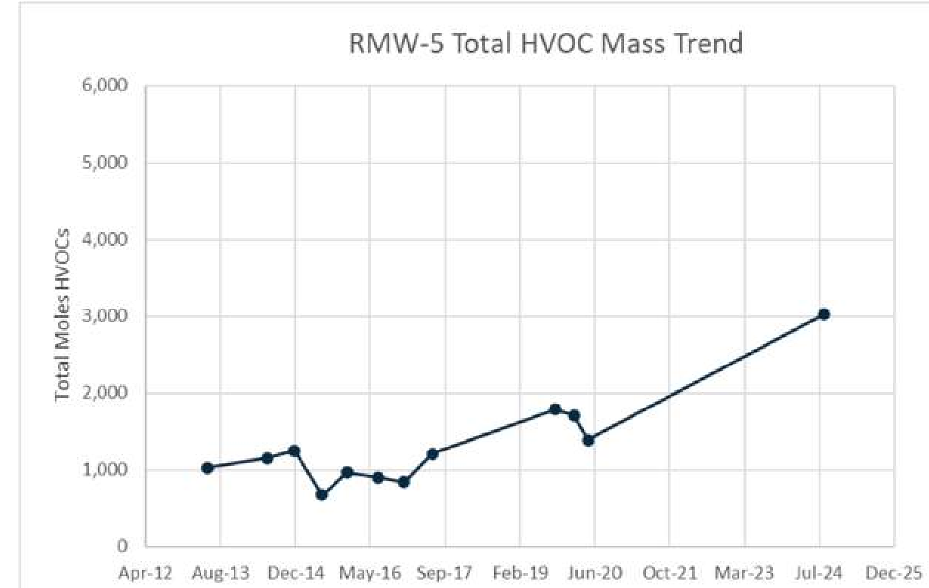
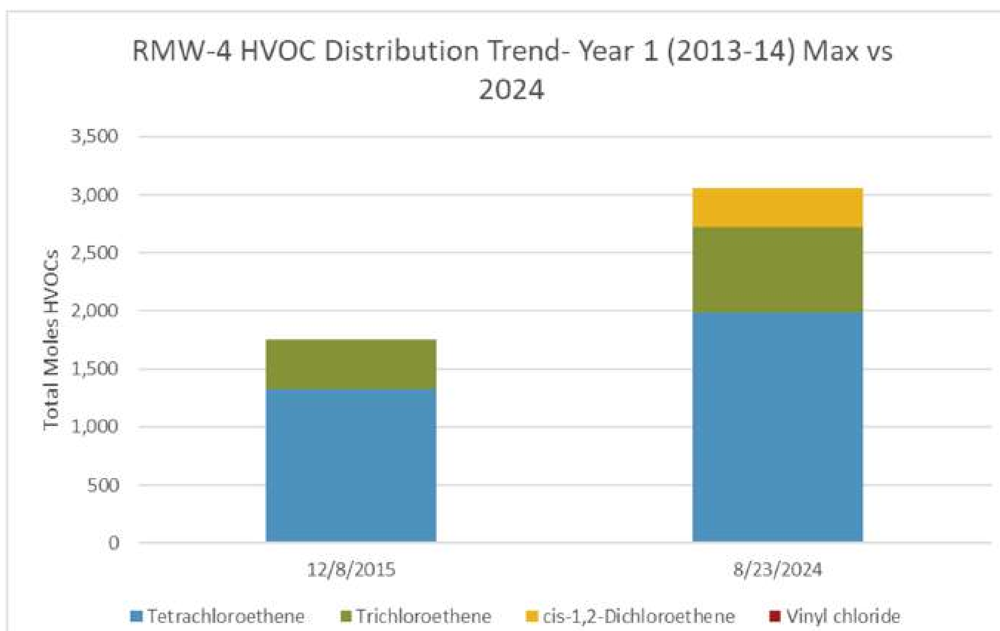
Figure 3.2
HVOC Molar Concentrations: Downgradient Plume
(Sheet 2 of 2)

12/4/2024







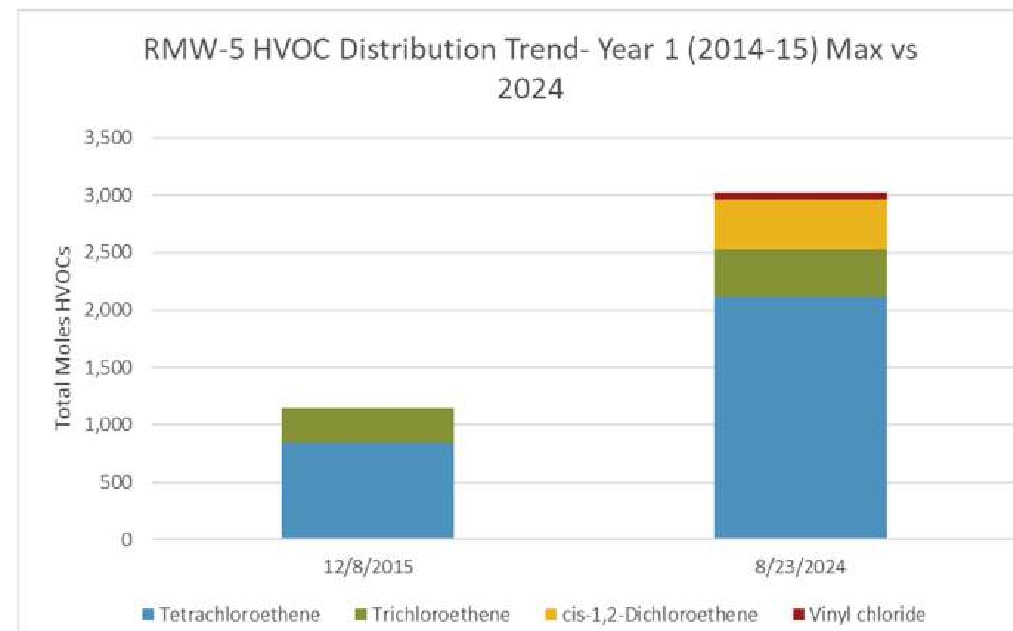


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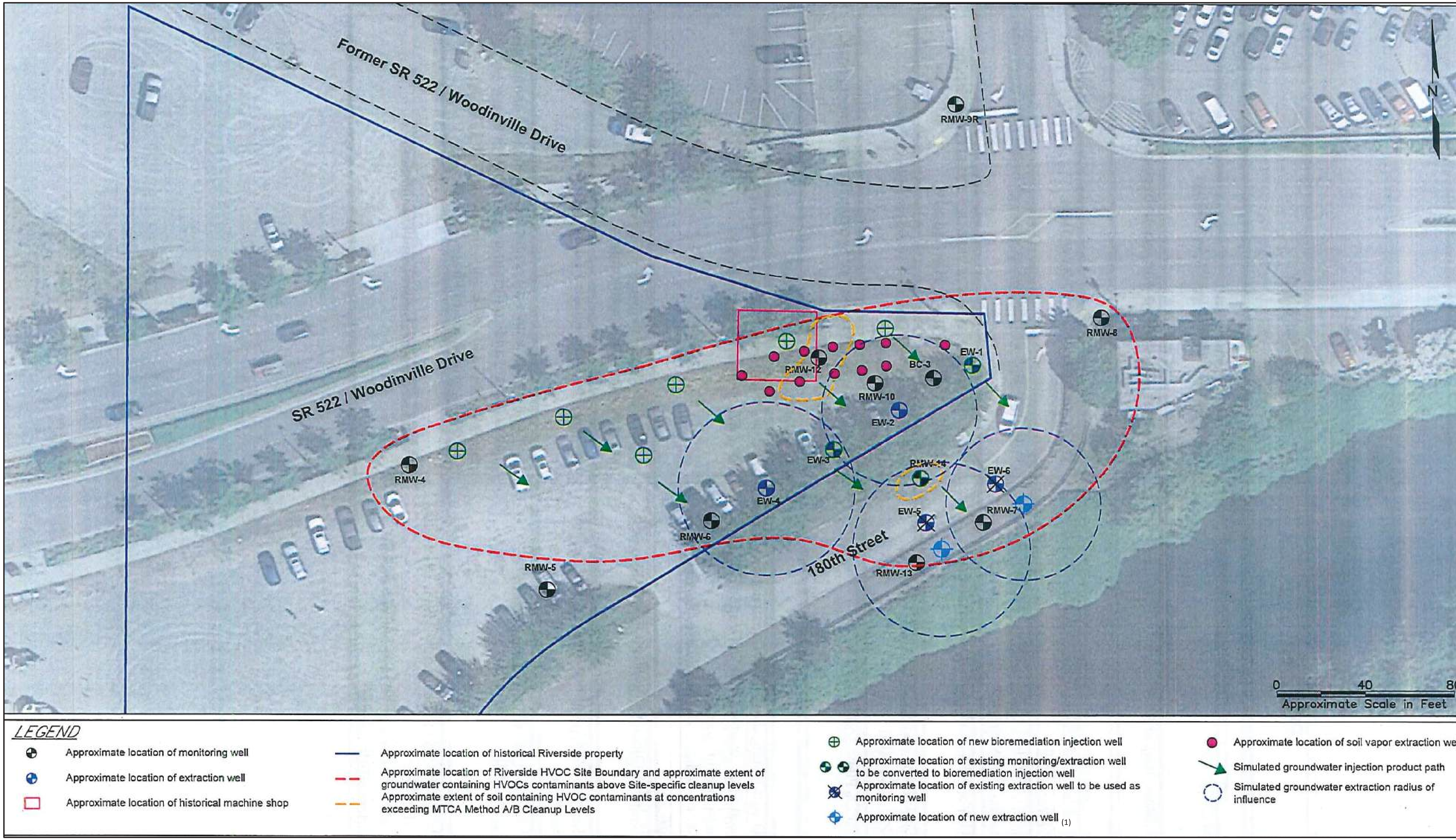
Figure 3.3
HVOC Molar Concentrations: Western Plume

12/4/2024



Note:
1 An equal number of injection and extraction wells are assumed for alternatives evaluation.

Source: Cleanup Action Plan Figure 6 (Ecology 2023)

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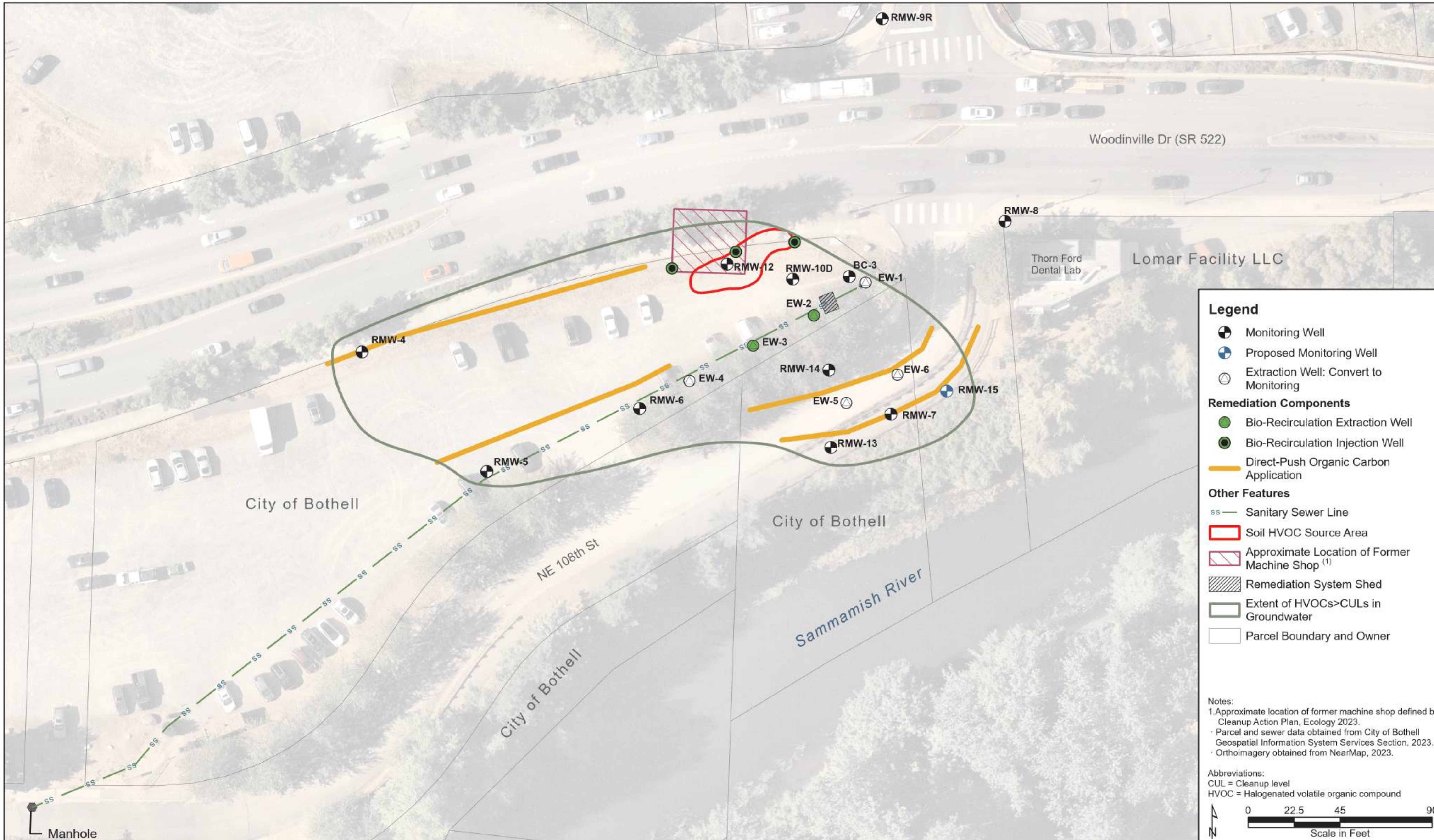
Figure 4.1
2023 CAP Cleanup Action



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Bothell, Washington

Figure 4.2
Revised Alternative 1

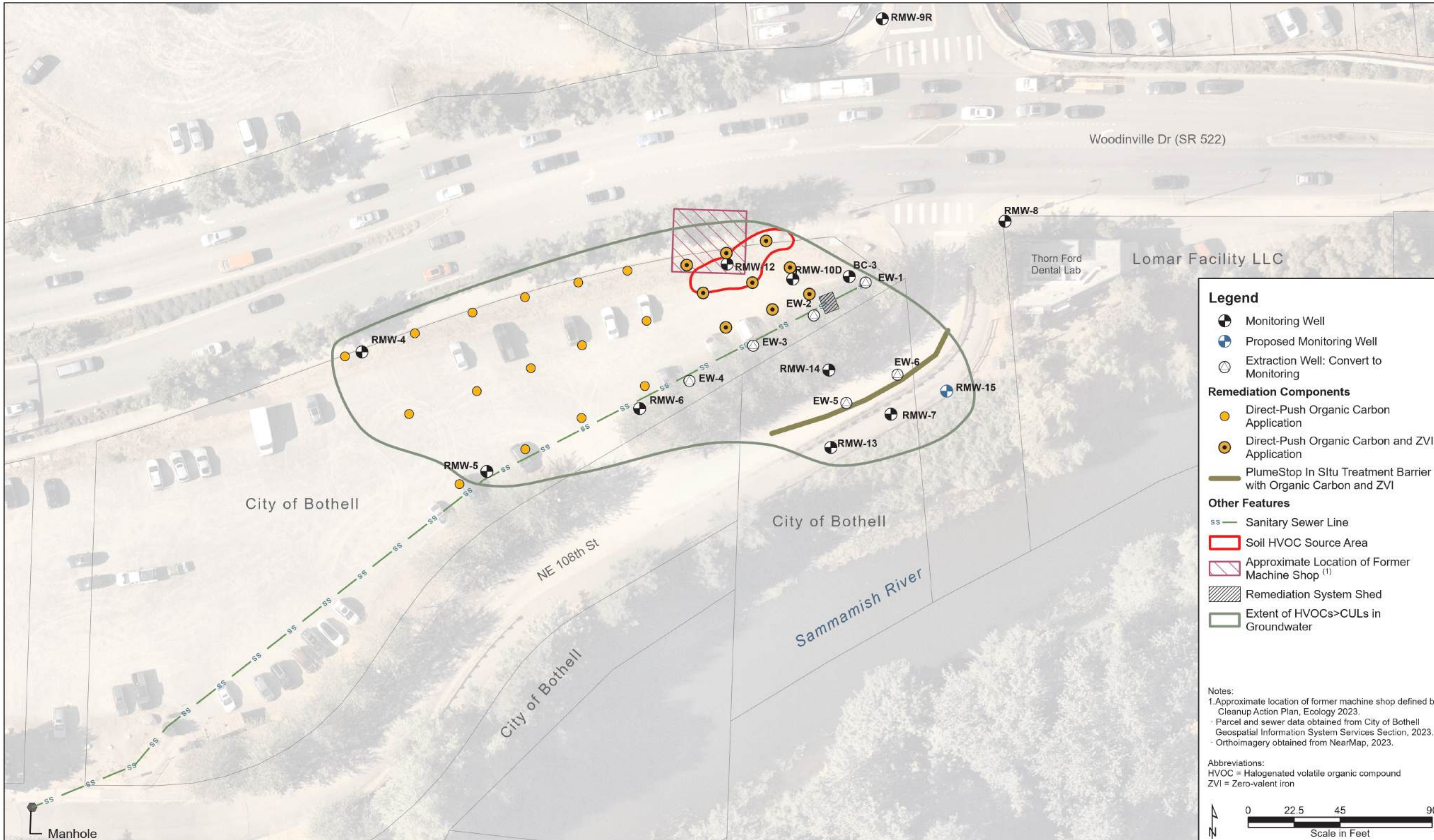

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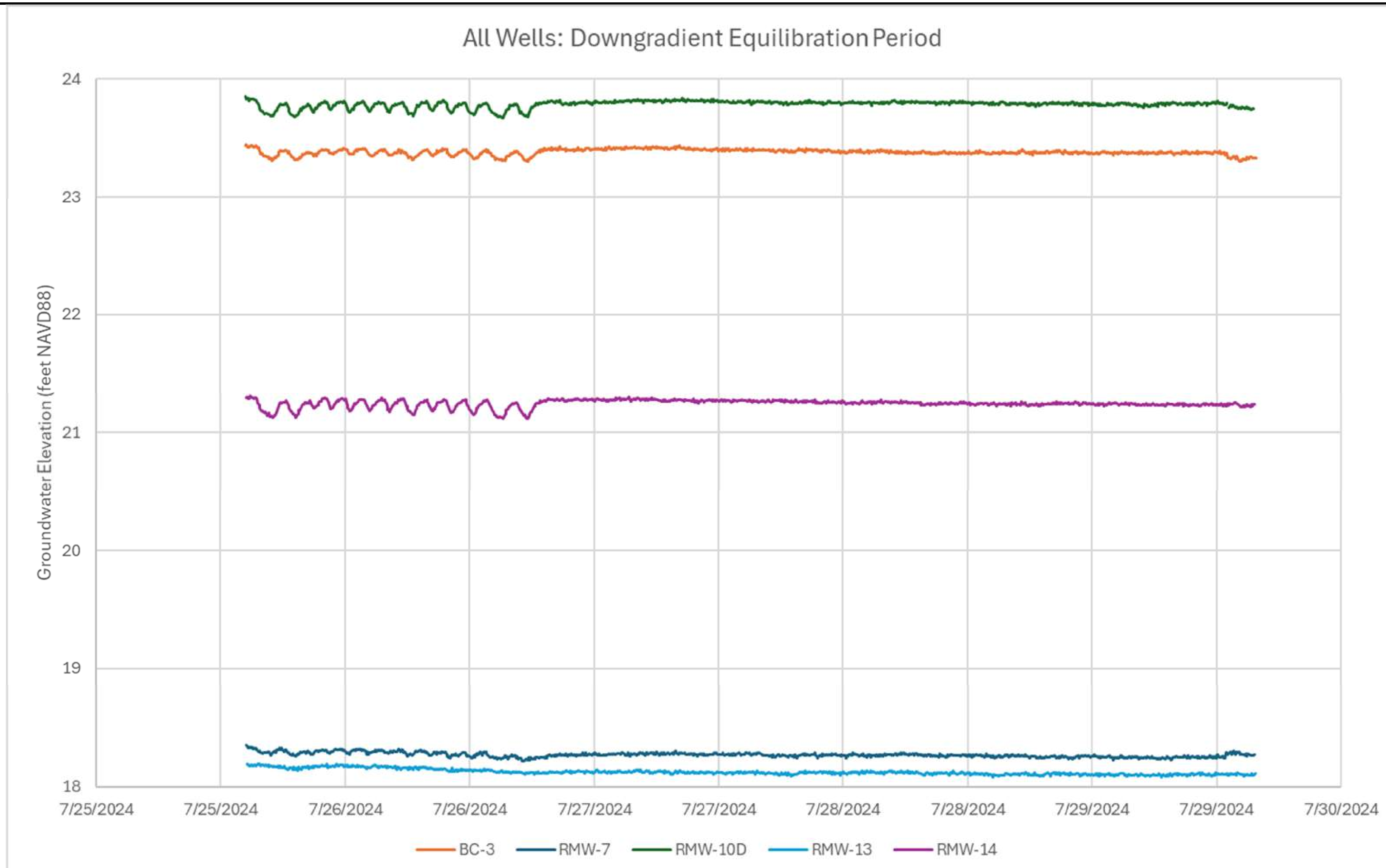
Figure 4.3
Revised Alternative 2

Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Appendix A
Hydrogeologic Study Results



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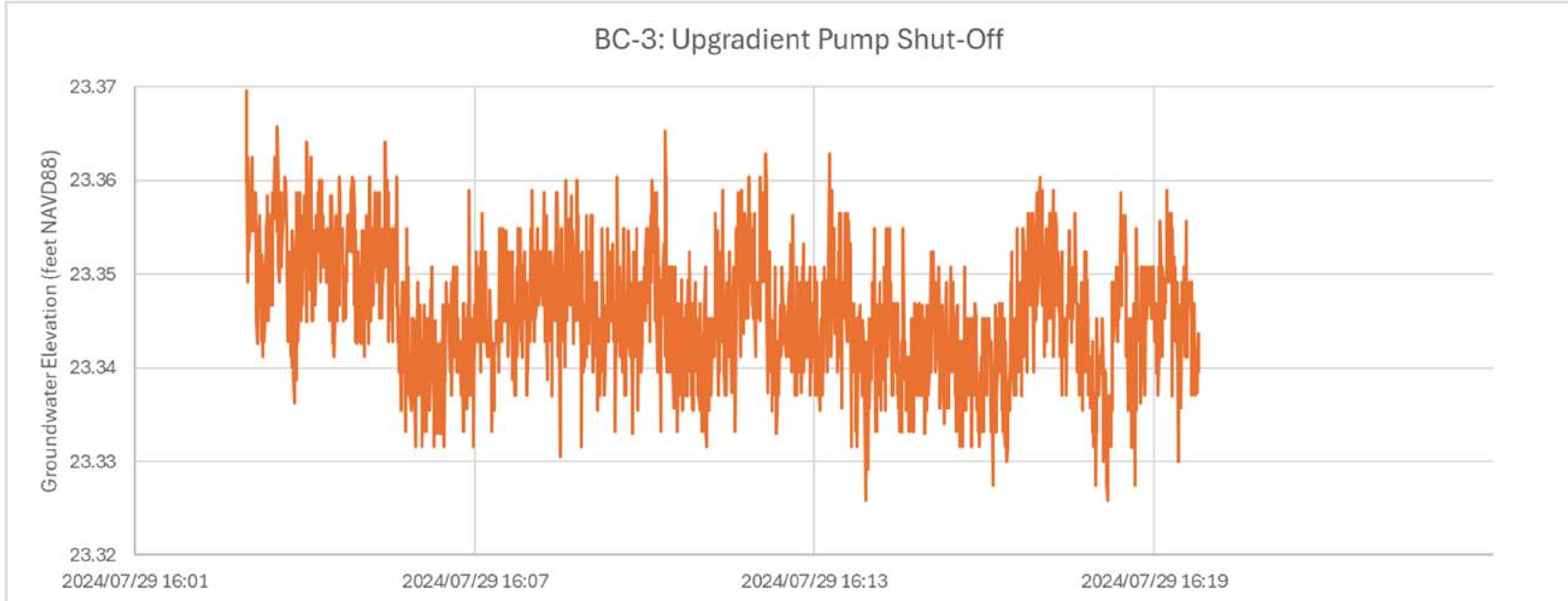
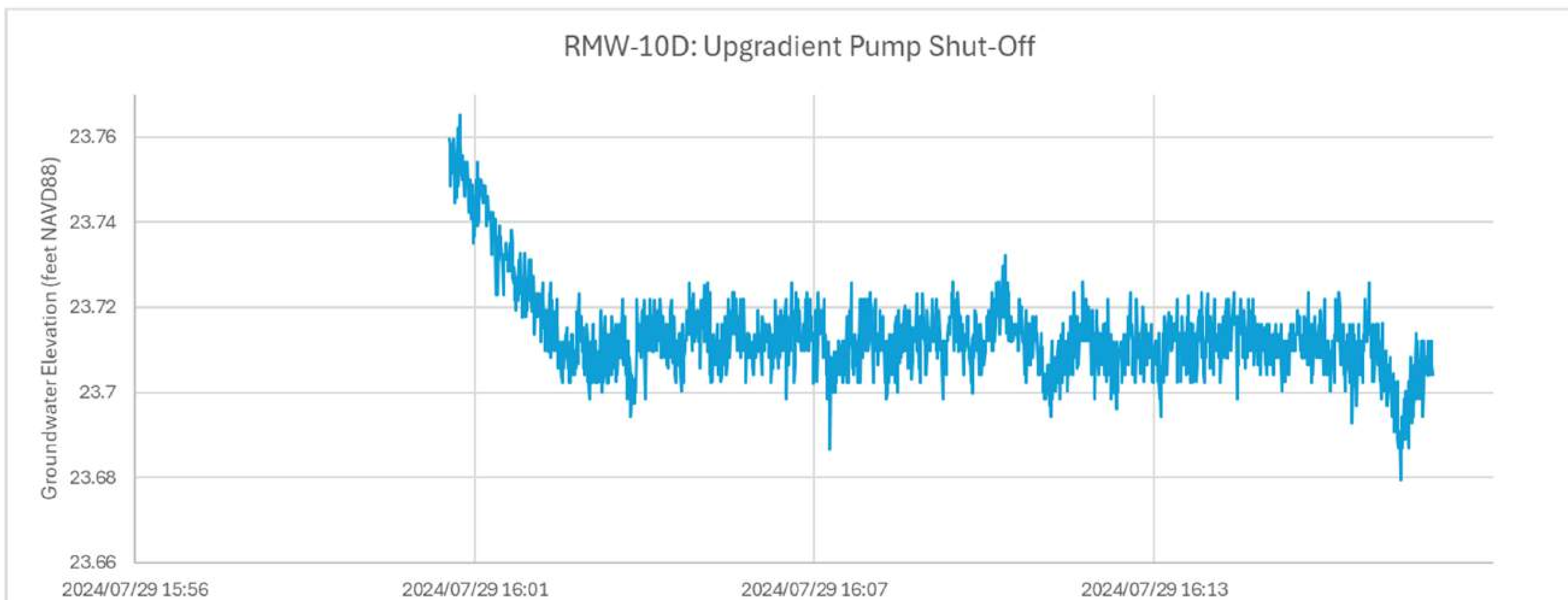
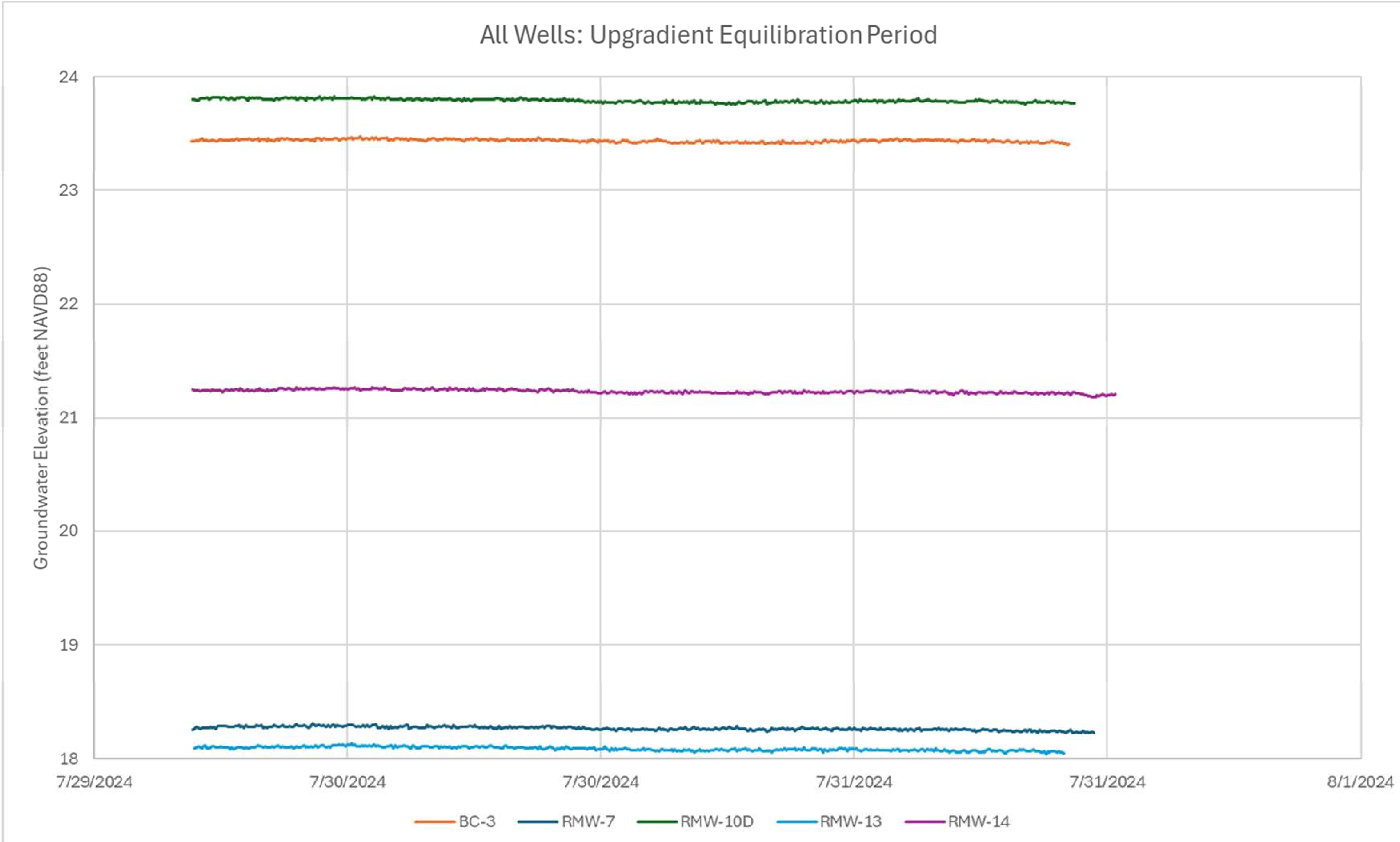
Pre-Engineering Design Investigation Data Report
Appendix A: Hydrogeologic Study Results

12/3/2024


BC-3: Upgradient Pump Shut-Off
Groundwater Elevation (feet NAVD88)
23.37
23.36
23.35
23.34
23.33
23.32
2024/07/29 16:01
2024/07/29 16:07
2024/07/29 16:13
2024/07/29 16:19


RMW-10D: Upgradient Pump Shut-Off
Groundwater Elevation (feet NAVD88)
23.76
23.74
23.72
23.7
23.68
23.66
2024/07/29 15:56
2024/07/29 16:01
2024/07/29 16:07
2024/07/29 16:13



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Pre-Engineering Design Investigation Data Report
Appendix A: Hydrogeologic Study Results

Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Appendix B
Laboratory Reports

Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Appendix C
Field Boring Logs

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011		BORING ID: **SB-03**
LOGGED BY: Ryne Adams	BORING LOCATION: W of Former Machine Shop		
DRILLED BY: Holocene	NORTHING:	EASTING:	
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:	
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 10	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/3/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, well graded **SAND** with silt.			
				0.4	
2					
				0.3	
4					
6		Gravel present.		0.2	
8				0.9	
10				0.9	
12				0.4	
14					
	GW-GM	Brown, well graded **GRAVEL** with silt and trace fines, saturated.			

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
ppm = parts per million ▼ = denotes groundwater table

NOTES:

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PROJECT: COB-Riverside	**SITE ADDRESS:** Bothell, WA 98011		**BORING ID:** **SB-03**
LOGGED BY: Ryne Adams	**BORING LOCATION:** W of Former Machine Shop		
DRILLED BY: Holocene	**NORTHING:**	**EASTING:**	
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**	
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 30	**DEPTH TO WATER (ft bgs):** 10	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/3/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
	ML	Black, medium plasticity **SILT**, with organic woody material from 15 to 16 ft., saturated, no odor.		0.5	
16					
				0.6	SB-03-16-19
18	SP-SM	Brown, poorly garded **SAND** with silt and gravel, saturated.			
		Iron oxide present.		0.5	
20	SW-SM	Brown, well graded **SAND** with silt, saturated, iron oxide present, no odor.			SB-03-19-22
				0.2	
22					
		Transitions to gray.		0.3	SB-03-22-25
24				0.5	
26				0.2	SB-03-25-28
				0.2	
28					
				0.2	
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
ppm = parts per million ▼ = denotes groundwater table

NOTES:

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-04**
LOGGED BY: Ryne Adams	BORING LOCATION: SW of Former Machine Shop	

DRILLED BY: Holocene	**NORTHING:**	**EASTING:**
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 30	**DEPTH TO WATER (ft bgs):** 8
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/4/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, well graded **SAND** with silt and trace gravel, no odor.			
2				0.2	
4		Becomes moist.		0.3	
6				0.4	
8				0.5	
		Organic woody debris (about 4”) present.		0.2	
10	SP	Gray, poorly graded medium **SAND**, trace fines, wet, no odor.			
	SM	Brown **silty SAND** no odor, wet.		0.4	
12		Trace gravel present.		0.4	
		Organic woody debris present.			
14				0.5	
					SB-04-13-16

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

NOTES:

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-04**
LOGGED BY: Ryne Adams	BORING LOCATION: SW of Former Machine Shop	
DRILLED BY: Holocene	NORTHING:	EASTING:
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 8
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/4/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
	GW-GM	Drark brown well graded sub angular **GRAVEL**, with silt and medium to coarse sand, wet, no odor.			
16				0.3	
		Pocket of silty sand present.		0.3	SB-04-16-19
18					
		Iron oxide present.		0.3	
20	SW-SM	Dark brown well graded **SAND** with silt, medium to dense, wet, no odor.			SB-04-19-22
				0.4	
22		Trace cobbles present.		0.3	
		Transitions to light brown with high dilatancy.			
24				0.3	
					SB-04-22-25
26				0.3	
				0.2	
28				0.3	SB-04-25-28
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

NOTES:

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-05**	
LOGGED BY: Ryne Adams	BORING LOCATION: E of Former Machine Shop		
DRILLED BY: Holocene	NORTHING:	EASTING:	
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:	
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 13	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/3/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, well graded medium to coarse **SAND** with silt, organics at surface, wet, no odor,			
1				0.5	
4				0.4	
6.25		Trace gravel at 6.25 ft.		0.4	
8.5				0.3	
9		Cobbles present.			
9.5		Red brick present.			
11				0.3	
13.5		Iron oxide present.		0.5	
15					SB-05-13-16

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

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PROJECT: COB-Riverside	**SITE ADDRESS:** Bothell, WA 98011		**BORING ID:** **SB-05**
LOGGED BY: Ryne Adams	**BORING LOCATION:** E of Former Machine Shop		
DRILLED BY: Holocene	**NORTHING:**	**EASTING:**	
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**	
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 30	**DEPTH TO WATER (ft bgs):** 13	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/3/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
	SW-SM	Brown/orange well graded **SAND** with silt, trace gravel 0.1 to 0.3", wet, no odor, dilatancy			
16				0.4	
					SB-05-16-19
18	SP-SM	Light brown, poorly graded **SAND** with silt, wet, dilatancy.		0.4	
					SB-05-19-22
20					
				0.4	
22		Pockets of coarse **SAND** present.			
				0.6	
					SB-05-22-25
24					
				0.3	
	SM	Brown **silty SAND**, wet, iron-oxidized layers present, dilatancy			
26				0.5	
					SB-05-25-28
				0.5	
28					
				0.5	
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
ppm = parts per million ▼ = denotes groundwater table

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-06**
LOGGED BY: Ryne Adams	BORING LOCATION: Former Machine Shop	
DRILLED BY: Holocene	NORTHING:	EASTING:
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 40	DEPTH TO WATER (ft bgs): 10
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/3/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown well graded **SAND** with silt and gravel, sand medium to coarse, gravel sub-angular 0.5" to 1", dry, no odor.grass and at surface.			
2				0.3	
4		Becomes moist.			
6				0.3	
8					SB-06-8.5-10.5
10	GP	Gray, poorly graded sub-angular **GRAVEL** ~ 0.5 to 1.25", wet, no odor.		0.5	
12	SM	Brown-black, **SILTY SAND**, trace gravel, orange iron-oxide patches, wet, no odor.		0.4	SB-06-13-14.5
14	SW-SM	Brown, well graded medium to coarse **SAND** with silt, trace fine gravel, wet, no odor.			

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

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PROJECT: COB-Riverside	**SITE ADDRESS:** Bothell, WA 98011	**BORING ID:** **SB-06**
LOGGED BY: Ryne Adams	**BORING LOCATION:** Former Machine Shop	
DRILLED BY: Holocene	**NORTHING:**	**EASTING:**
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 40	**DEPTH TO WATER (ft bgs):** 10
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/3/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
15–19	SP-SM	Brown, poorly graded fine **SAND** with silt, iron-oxide streaks, wet, no odor.		0.5	
16					
				0.5	SB-06-16-18
18					
19–20	SW-SM	Brown/orange well graded fine to coarse **SAND** with silt, iron oxide present, wet, no odor.		0.5	SB-06-18-20
20–30	SM	Brown silty **SAND**, fine **SAND**, iron oxide present, loose, wet, high dilatancy, no odor		0.3	SB-06-20-22
22				0.3	SB-06-22-24
24		Becomes gray with lower dilatancy, medium stiff.			SB-06-24-26
				0.3	
26		Brown and light brown, **silty SAND**, medium stiff, wet, high dilatancy, no odor.		0.3	SB-06-26-28
28				0.3	SB-06-28-30
30					

ABBREVIATIONS:
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PROJECT: COB-Riverside		SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-06**
LOGGED BY: Ryne Adams		BORING LOCATION: Former Machine Shop	
DRILLED BY: Holocene		NORTHING:	EASTING:
DRILLING EQUIPMENT: Geoprobe LAR		GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:
DRILLING METHOD: Direct push		TOTAL DEPTH (ft bgs): 40	DEPTH TO WATER (ft bgs): 10
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner		BORING DIAMETER: 2"	DRILL DATE: 9/3/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
30	SP-SM	Brown, poorly graded fine to medium **SAND** with silt, medium dense iron oxide present, wet, high dilatancy, no odor..		0.2	SB-06-30-32
				0.3	SB-06-32-34
		Grain size begins to coarsen.			
				0.5	SB-06-34-36
		Iron oxide pocket present.			
					SB-06-36-38
				0.4	
		Iron oxide pocket present.			
					SB-06-38-40
				0.2	
		Bottom of Boring = 40 ft bgs			

ABBREVIATIONS:
ft bgs = feet below ground surface   USCS = Unified Soil Classification System
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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-07**	
LOGGED BY: Ryne Adams	BORING LOCATION: Upgradient Extraction Well Row		
DRILLED BY: Holocene	NORTHING:	EASTING:	
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:	
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 12	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/6/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, silty **SAND**, loose, dry, no odor,			
1				0.2	
3.5				0.3	
10	SW	Brown, well graded fine to coarse **SAND** with trace silt. Cobble present.			
11				0.3	
12	SM	Brown **silty SAND**, medium dense, trace gravel ~0.5", wet, no odor.			
13				0.6	
14.5				0.3	

ABBREVIATIONS:
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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-07**	
LOGGED BY: Ryne Adams	BORING LOCATION: Upgradient Extraction Well Row		
DRILLED BY: Holocene	NORTHING:	EASTING:	
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:	
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 12	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/6/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
	SW-SM	Dark brown well graded fine to coarse **SAND** with silt and trace gravel ~0.2 to 0.3", wet, no odor.			
16				0.3	
17				0.3	SB-07-16-19
18					
19				0.2	
20	SP-SM	Gray, poorly graded fine **SAND** with silt, medium dense, wet, dilatancy.			
21				0.3	SB-07-19-22
22					
23				0.2	
23.5					SB-07-22-25
24		Becomes brown.		0.2	
26				0.2	
26.5					SB-07-25-28
27.5				0.2	
29				0.1	
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
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ppm = parts per million
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= denotes groundwater table

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011	BORING ID: **SB-08**	
LOGGED BY: Ryne Adams	BORING LOCATION: S of Former Machine Shop		
DRILLED BY: Holocene	NORTHING:	EASTING:	
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:	
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 10.5	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/3/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SM	Light brown, fine **silty SAND**, trace sub-angular gravel ~0.25-0.5", very loose, dry, no odor.			
				0.1	
2					
				0.3	
4		Trace organics present.			
	SP-SM	Brown, poorly graded **SAND** with silt, no odor, moist.			
6					
8					
	SP	Brown, poorly graded **SAND** with trace siltmoist, no odor.,			
				0.1	
10	SM	Dark brown, fine **silty SAND** with trace gravel ~0.5-1.5" and trace organics medium stiff.			
				0.1	
12		Cement fiber board present.			
		Becomes black, peat present.		0.2	
14		Becomes stiff.			

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
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PROJECT:	SITE ADDRESS:	BORING ID:
COB-Riverside	Bothell, WA 98011	SB-08

LOGGED BY:	BORING LOCATION:
Ryne Adams	S of Former Machine Shop

DRILLED BY:	NORTHING:	EASTING:
Holocene		
DRILLING EQUIPMENT:	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**
Geoprobe LAR		
DRILLING METHOD:	**TOTAL DEPTH (ft bgs):**	**DEPTH TO WATER (ft bgs):**
Direct push	30	10.5
SAMPLING METHOD/SAMPLER LENGTH:	**BORING DIAMETER:**	**DRILL DATE:**
5' x 2" disposable poly liner	2"	9/3/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
15–19	SW-SM	Brown, medium to coarse well graded **SAND** with silt and trace gravel 0.2-0.5", wet, no odor, iron oxide present.		0.1, 0.2, 0.3	SB-08-15-16.5
19–20	SP	Light brown, poorly graded fine **SAND** with trace silt, wet, no odor.			
20–25	SP-SM	Brown, poorly graded fine **SAND** with silt, wet, no odor, iron oxide streaks. Interspersed silt pockets present.		0.3, 0.3, 0.2	SB-08-19-22, SB-08-22-25
25–30	SP-SM	Grain size coarsens and increased silt present, high dilatancy.		0.2	SB-08-25-28
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
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PROJECT:	SITE ADDRESS:	BORING ID:
COB-Riverside	Bothell, WA 98011	SB-09
LOGGED BY: Ryne Adams	BORING LOCATION: Upgradient Extraction Well Row	

DRILLED BY: Holocene	NORTHING:	EASTING:
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 16
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/6/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, well graded **SAND** with silt, loose, dry, no odor.			
				0.1	
2					
				0.1	
4					
6				0.2	
8					
		Cobble present.		0.1	
10					
12					
				0.1	
14		Becomes moist and very loose.			

ABBREVIATIONS:
ft bgs = feet below ground surface
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▼ = denotes groundwater table

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PROJECT: COB-Riverside	SITE ADDRESS: Bothell, WA 98011		BORING ID: **SB-09**
LOGGED BY: Ryne Adams	BORING LOCATION: Upgradient Extraction Well Row		
DRILLED BY: Holocene	NORTHING:	EASTING:	
DRILLING EQUIPMENT: Geoprobe LAR	GROUND SURFACE ELEVATION:	COORDINATE SYSTEM:	
DRILLING METHOD: Direct push	TOTAL DEPTH (ft bgs): 30	DEPTH TO WATER (ft bgs): 16	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	BORING DIAMETER: 2"	DRILL DATE: 9/6/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
	SM	Dark brown, fine **silty SAND** with peat, medium dense.		0.4	
16 ▼					
				0.4	SB-09-16-19
18					
		1” lense of gray poorly graded fine sand.		0.4	
20	SW	Brown, well graded fine to coarse **SAND**, wet, no odor.			SB-09-19-22
	SM	Brown, fine **SILTY SAND], loose, wet, no odor.**		0.2	
22					
				0.3	SB-09-22-25
24					
	SP-SM	Brown, poorly graded fine **SAND** with silt, medium dense wet, high dilatancy no odor. ,			
26				0.3	SB-09-25-28
28				0.3	
				0.3	
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
ft bgs = feet below ground surface   USCS = Unified Soil Classification System
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PROJECT: COB-Riverside		**SITE ADDRESS:** Bothell, WA 98011		**BORING ID:** **SB-10**
LOGGED BY: Ryne Adams		**BORING LOCATION:** Upgradient Extraction Well Row		
DRILLED BY: Holocene		**NORTHING:**	**EASTING:**	
DRILLING EQUIPMENT: Geoprobe LAR		**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**	
DRILLING METHOD: Direct push		**TOTAL DEPTH (ft bgs):** 30	**DEPTH TO WATER (ft bgs):** 14.5	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner		**BORING DIAMETER:** 2"	**DRILL DATE:** 9/6/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, well graded medium to coarse **SAND** with silt, very loose, dry, no odor, , trace iron oxide			
2					
4					
6					
8					
10					
12					
14		Cobble present.			

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
ppm = parts per million ▼ = denotes groundwater table

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PROJECT: COB-Riverside	**SITE ADDRESS:** Bothell, WA 98011		**BORING ID:** SB-10
LOGGED BY: Ryne Adams	**BORING LOCATION:** Upgradient Extraction Well Row		
DRILLED BY: Holocene	**NORTHING:**	**EASTING:**	
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**	
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 30	**DEPTH TO WATER (ft bgs):** 14.5	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/6/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
16	SM	Dark brown, **silty SAND** with organic matter, loose, saturated, no odor.			
18	SP-SM	Brown-gray, poorly graded fine **SAND** with silt, fine sand, wet, no odor, loose, iron oxide pockets at 19 ft			SB-10-16-19
		Iron oxide pockets present			
20		Becomes light brown with high dilatancy.			SB-10-19-22
22					
24					SB-10-22-25
26					SB-10-25-28
28					
30		Bottom of Boring = 30 ft bgs			

ABBREVIATIONS:
ft bgs = feet below ground surface   USCS = Unified Soil Classification System
ppm = parts per million   = denotes groundwater table

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PROJECT: COB-Riverside	**SITE ADDRESS:** Bothell, WA 98011	**BORING ID:** **SB-11**
LOGGED BY: Ryne Adams	**BORING LOCATION:** Downgradient Extraction Well Row	
DRILLED BY: Holocene	**NORTHING:**	**EASTING:**
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 25	**DEPTH TO WATER (ft bgs):** 8.5
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/4/2024

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
0	SW-SM	Brown, well graded medium to coarse **SAND** with silt and fine gravel 0.2-0.5", loose , moist, , no odor. Asphalt present at surface.			
				0.2	
2					
				0.2	
4					
				0.3	
6				0.3	
				0.3	
8					
		Black, well graded fine to medium **SAND** with silt and gravel 0.2-0.3", loose tomedium dense, wet, no odor.		0.4	
10					
				0.3	
12	SW-SM	Gray, well graded **SAND** with silt, loose, wet, no odor.			
				0.3	
14				0.3	

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
ppm = parts per million ▼ = denotes groundwater table

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PROJECT: COB-Riverside	**SITE ADDRESS:** Bothell, WA 98011		**BORING ID:** SB-11
LOGGED BY: Ryne Adams	**BORING LOCATION:** Downgradient Extraction Well Row		
DRILLED BY: Holocene	**NORTHING:**	**EASTING:**	
DRILLING EQUIPMENT: Geoprobe LAR	**GROUND SURFACE ELEVATION:**	**COORDINATE SYSTEM:**	
DRILLING METHOD: Direct push	**TOTAL DEPTH (ft bgs):** 25	**DEPTH TO WATER (ft bgs):** 8.5	
SAMPLING METHOD/SAMPLER LENGTH: 5' x 2" disposable poly liner	**BORING DIAMETER:** 2"	**DRILL DATE:** 9/4/2024	

Depth (feet)	USCS Symbol	Soil Description and Observations (color, texture, moisture, **MAJOR CONSTITUENT**, odor, staining, sheen, debris, etc.)	Drive/ Recovery	PID (ppm)	Sample ID
16	SW-SM	Gray, well graded, fine to medium **SAND** with silt, saturated.		0.2	
				0.3	
18	SM	Brown, fine **silty SAND**, dense, wet, no odor			
	SP	Gray, poorly graded **SAND**, trace fines, dense, wet, no odor		0.3	
20	GP	Brown, poorly graded fine **GRAVEL**, no odor.		0.3	
22	SP-SM	Brown, poorly graded fine **SAND** with silt, medium dense, wet, high dilatency, , no odor.		0.2	SB-11-21-23
24				0.2	
		Bottom of Boring = 25 ft bgs			
26					
28					
30					

ABBREVIATIONS:
ft bgs = feet below ground surface
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NOTES:

Pre-Engineering Design Investigation Data Report

Riverside HVOC Site

Appendix D
Detailed Cost Estimates

Table D.1
Summary of Cleanup Action Alternative Costs

Alternative	Restoration Time Frame (years) (1)	Construction Cost	Long-Term Monitoring	Cost (2)
2023 CAP Cleanup Action	5	$2,103,940	$630,362	$2,734,302
Alternative 1	5	$1,129,072	$630,362	$1,648,059
Alternative 2	3	$1,437,152	$218,210	$1,655,362

Notes:

1 Includes remedy implementation in time frame.

2 Includes total of construction costs, professional services (including long-term monitoring), sales tax, and a 20% contingency.

Table D.2
Detailed Costs for 2023 CAP Cleanup Action

Item	Qty	Unit	Unit Cost	Cost	Notes and Assumptions
CONSTRUCTION CAPITAL COSTS					
Soil Vapor Extraction System					
Permitting	1	LS	$ 6,000	$ 6,000	State air permit; state, county, and local construction and grading permits if applicable.
Mobilization	5	%		$ 44,287	5% of total construction costs.
Utility clearance	1	LS	$ 1,200	$ 1,200	Includes travel, conductible and non-conductible.
Paving	84	Tons	$ 250	$ 21,000	Based on needing to pave a 115' x 40' area for SVE effectiveness.
Well installation	180	FT	$ 145	$ 26,100	12 SVE wells to depth of 15 feet.
SVE piping	12	LF	$ 7,610	$ 91,323	Assumes each location has their own separate piping, as shown in Figure 6 of the CAP.
Electrical	1	LS	$ 18,618	$ 18,618	Assumes that current electrical is sufficient, but would need to be rewired by a certified electrician.
SVE system rental	36	Months	$ 19,712	$ 709,640	Assumes that the system will be rented for 3 years (per CAP).
SVE system startup	2	DAY	$ 4,930	$ 9,860	Assumes 2 days by technician.
Site cleanup and demob	2	DAY	$ 4,000	$ 8,000	Assumes 2 days by technician.
			SUBTOTAL CAPITAL COSTS	**$ 936,027**	
Bio-Reciuculation System					
Permitting	8	LS	$ 100	$ 800	UIC permit, 8 injection wells proposed in CAP.
Mobilization/setup of system	1	LA	$ 53,482	$ 53,482	ETEC quote.
Utility clearance	1	LS	$ 1,200	$ 1,200	From ULS Quote.
Well installation	490	FT	$ 145	$ 71,050	Assumes layout presented in Figure 6 of the CAP and 35 ft wells.
Well decommissioning	70	FT	$ 145	$ 10,150	Assumes EW-5 and EW-6 are overdrilled due to stuck pumps.
System piping	16	EA	$ 7,610	$ 121,760	Assumes each location has their own separate piping, as shown in Figure 6 of the CAP: 6 injection, 2 new extraction.
Electrical	1	LS	$ 28,618	$ 28,618	Assumes new electrical panel required, price equal to SVE electrical.
Recirculation system rental	24	Months	$ 5,000	$ 120,000	From ETEC quote, assumes 2 years of operation.
Site cleanup and demob	1	LS	$ 4,000	$ 4,000	From ETEC quote.
			SUBTOTAL CAPITAL COSTS	**$ 411,060**	
Indirect Costs					
Engineering design	1	LS	$ 161,050	$ 161,050	From Cost Projection Worksheet - Tasks 6 and 7.
Construction management	5	%	DC	$ 93,002.69	Assumes 10% of construction costs, minus waste T&D.
Soil drum disposal	20	EA	$ 350.00	$ 8,000	Assumes 1 drum per well installed and 2.5 each for over drilling EW-5 and EW-6.
Water drum disposal	15	EA	$ 350.00	$ 5,250	Includes purge water to develop all injetion, extraction and new monitoring wells.
Field oversight - system installation	180	Hours	$ 175	$ 31,500	Assumes between 1 and 2 employees over 12 days (10 hour days).
Completion report	1	LS	$23,750.00	$ 23,750	Per MTCA requirements. Includes as-built drawings, O&M manual.
			Subtotal	**$ 1,669,640**	
Sales tax		%	10.2	$ 137,403	Applied to construction; does not apply to indirect costs.
			Capital Costs	**$ 1,807,042**	
Contingency		%	20	$ 296,898	Contingency based on inflation on equipment and construction work.
			Capital Costs with Contingency	**$ 2,103,940**	
Annual O&M, Groundwater Monitoring, and Closure Costs					
Project management	14	Event	$ 3,000	$ 42,000	Assumes quarterly monitoring for years 1-2 and semiannual monitoring years 3-5.
Groundwater monitoring well installation	70	FT	$ 145	$ 10,150	Assumes new well at GWB-6 and one well east GWB-6.
Groundwater monitoring and sampling	14	Event	$ 9,741	$ 136,374	Assumes two 10-hour days for two employees; up to 11 wells will be sampled. Based on Cost Projection Worksheet.
Groundwater analytical costs	14	Event	$ 6,160	$ 86,240	Includes COCs and select MNA parameters.
System air samples	12	Event	$ 610	$ 7,320	Includes COCs analysis in influent and effluent air samples.
Waste disposal	3	Event	$ 1,700.00	$ 5,100.00	Disposal of purged water drums and spent media. Assume yearly during system operation.
Annual reporting	4	YEAR	$ 11,875.00	$ 47,500.00	Based on costs provided in Remedial Action Grant funding estimate.
Completion reporting	1	LS	$ 11,875	$ 11,875	Draft and final based on Ecology comments.
Confirmation soil sampling	1	LS	$8,225.00	$ 8,225.00	Includes one day of direct push soil sampling, analysis of 15 samples, 2 employees.
System O&M	36	Months	$ 2,880	$ 103,680	Assumes Weekly O&M for labor, repair, and maintenance for 12 months. 1 employee for 4 hours for each O&M trip once a week.
Electricity	36	Months	$ 400	$ 14,400	Estimated; could be more or less depends on system usage.
GAC media	7	Events	$ 7,740	$ 54,180	Based on BSC system changeout and additional event for the SVE carbon.
CarBstrate media	24	Months	$ 3,155	$ 75,718	Assumes 400 lbs of CarBstrate/month per ETEC quote.
Well abandonment	1	LS	$ 7,000	$ 7,000	Assumes cost of $300 per well for injection and SVE wells plus $1,000 mobilization fee.
Annual equipment replacement costs	2	Events	$ 10,000	$ 20,000	Assumes replacement and reinstallation of compressors, blower, pumps, misc. components, and additional support.
Annual air permit	3	Year	$ 200	$ 600	Local Air Discharge Fees, if applicable.
			Subtotal	**$ 630,362**	Total costs for O&M, groundwater monitoring, and closure costs.
			Total Present Value Cost for Alternative	**$ 2,734,302**	

Table D.3
Detailed Costs for Alternative 1

Item Description	Quantity	Unit	Unit Cost	Cost	Notes
CONSTRUCTION CAPITAL COSTS					
Bio-Reciuculation System					
Permitting	53	LS	$ 100	$ 5,300	UIC permit, assumed 31 direct push injections at 15-ft spacings and 7 permanent injection wells during initial round, 15 direct push borings during second round.
Mobilization/ System Startup	1	LS	$ 53,482	$ 53,482	Costs from ETEC quote.
Utility Clearance	1	LS	$ 1,200	$ 1,200	From ULS Quote.
Well Installation	245	FT	$ 145.00	$ 35,525	Assumes two new extraction wells, up to three injection wells and two monitoring wells. Assumes all wells are 35 feet deep.
Well Decommissioning	60	FT	$ 145.00	$ 8,700	Assumes EW-5 and EW-6 are over-drilled due to stuck pumps.
System piping	11	LF	$ 7,610	$ 83,710	Costs from ETEC quote.
Electrical	1	LS	$ 28,618	$ 28,618	Assumes new electrical panel required, price equal to SVE electrical.
Recirculation system rental	24	Months	$ 5,000	$ 120,000	Costs from ETEC quote.
Site Cleanup and Demob	1	LS	$ 4,000	$ 4,000	Costs from ETEC quote.
SUBTOTAL CAPITAL COSTS				**$ 340,535**	
Supplemental Injections					
Hydrant permit	2	LS	$ 20,000	$ 40,000	Assumes that hydrant costs are not included in ETEC quote; 2 injection events
Direct Push Injection Drilling- Sitewide	1	LS	$ 61,680	$ 61,680	Assumes 1 injection event in western plume and 2 downgradient injection events.
Direct Push Injection Drilling- additional downgradient	1	LS	$ 30,000	$ 30,000	
CarBstrate media- Sitewide	16,000	lbs	$ 6	$ 101,280	Assumes 1 injection event in western plume and 2 downgradient injection events.
CarBstrate media- additional downgradient	8,000	lbs	$ 6	$ 50,640	
Bacterial culture- Sitewide	36	liters	$ 667	$ 24,003	Assumes 1 injection event in western plume and 2 downgradient injection events.
Bacterial culture- additional downgradient	18	liters	$ 667	$ 12,002	
Injection Equipment	2	LS	$ 7,550	$ 15,100	Holocene injection equipment costs quote; assumes 2 injection events
SUBTOTAL CAPITAL COSTS				**$ 334,705**	
Indirect Costs					
Engineering Design	1	LS	$ 161,050	$ 161,050	From Cost Projection Worksheet - Tasks 6 and 7.
Construction management	5	%	DC	$ 16,735	Assumes 10% of construction costs, minus waste T&D.
Soil drum disposal	12	EA	$ 350	$ 5,200	Assumes 1 drum per well installed and 2.5 each for over drilling EW-5 and EW-6.
Water drum disposal	9	EA	$ 350	$ 3,150	Includes purge water to develop all injetion, extraction and new monitoring wells.
Field oversight	150	Hours	$ 175	$ 26,250	Assumes between 1 and 2 employees over 10 days (10 hour days).
Completion report	1	LS	$23,750	$ 23,750	Per MTCA requirements. Includes as-built drawings, O&M manual.
Subtotal				**$ 911,375**	
Sales tax		%	10.2	$ 68,874	Applied to construction; does not apply to indirect costs.
Capital Costs				**$ 980,249**	
Contingency		%	20	$ 148,823	Contingency based on inflation on equipment and construction work.
Capital Costs with Contingency				**$ 1,129,072**	
Annual O&M, Groundwater Monitoring, and Closure Costs					
Project Management	14	Event	$ 3,000	$ 42,000	Assumes quarterly monitoring for years 1-2 and semiannual monitoring years 3-5.
Groundwater monitoring and sampling	14	Event	$ 9,741	$ 136,374	Assumes two 10-hour days for two employees; up to 11 wells will be sampled. Based on Cost Projection Worksheet.
Groundwater analytical costs	14	Event	$ 6,160	$ 86,240	Includes COCs and select MNA parameters.
Waste Disposal	2	Event	$ 1,700	$ 3,400	Disposal of purged water drums and spent GAC media from extraction system. Assume yearly during system operation.
Annual reporting	4	LS	$ 11,875	$ 47,500	Based on costs provided in Remedial Action Grant funding estimate.
Completion Reporting	1	LS	$ 11,875	$ 11,875	Draft and final based on Ecology comments.
System O&M	24	Months	$ 2,880	$ 69,120	Assumes Weekly O&M for labor, repair, and maintenance for 12 months. 1 employee for 4 hours for each O&M trip once a week.
Electricity	24	Months	$ 200	$ 4,800	Estimated; Could be more or less depends on system usage.
Well abandonment	1	LS	$ 4,000	$ 4,000	Assumes cost of $300 per well for injection and extraction wells plus $1,000 mobilization fee.
CarBstrate media	24	Months	$ 3,155	$ 75,718	Based on ETEC quote.
GAC media	4	Events	$ 7,740	$ 30,960	Assumes twice yearly changeout.
Annual equipment replacement costs	1	Events	$ 10,000	$ 7,000	Assumes replacement and reinstallation of pumps,piping, misc. components, and additional support.
Subtotal				**$ 518,987**	
Total Present Value Cost for Alternative				**$ 1,648,059**	

Table D.4
Detailed Costs for Alternative 2

Item Description	Quantity	Unit	Unit Cost	Cost	Notes
CONSTRUCTION CAPITAL COSTS					
Source Area PlumeStop Injections					
Hydrant permit	1	LS	$ 20,000.00	$ 20,000	Assumes that hydrant costs are not included in Regenesis quote.
Permit for injection of PlumeStop: UIC Permit	64	borings	$ 100.00	$ 6,400	15A NCAC 02C.0200 Well Construction Standards: Criteria and Standards Applicable to Injection Wells; State charges $100 per boring.
Direct Injection Push Drilling	1	LS	$ 104,585.00	$ 104,585	Costs from Regenesis quote.
Well Decommissioning	60	FT	$ 145.00	$ 8,700	Assumes EW-5 and EW-6 are overdrilled due to stuck pumps.
All Regenesis Products and Professional Services	1	LS	$ 516,445.00	$ 740,640	Costs from Regenesis quote.
Soil/water drum disposal	1	LS	$ 3,000.00	$ 3,000	Assumes that no soil will be generated and very little water.
SUBTOTAL CONSTRUCTION CAPITAL COSTS				**$ 884,000**	
Indirect Costs					
Engineering Design	1	LS	$ 161,050	$ 161,050	From Cost Projection Worksheet - Tasks 6 and 7.
Construction management	5	%	DC	$ 44,200.00	Assumes 5% of construction costs, minus waste T&D.
Soil drum disposal	6	EA	$ 350.00	$ 3,100	Assumes 1 drum per well installed and 2.5 each for overdrilling EW-5 and EW-6.
Water drum disposal	3	EA	$ 350.00	$ 1,050	Includes purge water to develop new monitoring wells.
Field oversight	200	Hours	$ 175	$ 35,000	Assumes between 1 and 2 employees over 15 days (10 hour days).
Completion report	1	LS	$23,750.00	$ 23,750	Per MTCA requirements. Includes as-built drawings, O&M manual.
Subtotal				**$ 1,152,150**	
Sales tax		%	10.2	$ 90,168	Applied to construction; does not apply to indirect costs.
Capital Costs				**$ 1,242,318**	
Contingency		%	20	$ 194,834	Contingency based on inflation on equipment and construction work.
Capital Costs with Contingency				**$ 1,437,152**	
Annual O&M, Groundwater Monitoring, and Closure Costs					
Project Management	10	Event	$ 1,000	$ 10,000	Assumes quarterly monitoring for years 1-2 and semiannual monitoring year 3.
Groundwater monitoring and sampling	10	Event	$ 9,741	$ 97,410	Assumes two 10-hour days for two employees; up to 11 wells will be sampled. Based on Cost Projection Worksheet.
Groundwater analytical costs	10	Event	$ 6,160	$ 61,600	Includes COCs and select MNA parameters.
Waste Disposal	1	Event	$ 1,700.00	$ 1,700	Disposal of purged water drums.
Annual reporting	3	LS	$ 11,875.00	$ 35,625	Based oncosts provided in Remedial Action Grant funding estimate.
Completion Reporting	1	LS	$ 11,875.00	$ 11,875	Draft and final based on Ecology comments.
Subtotal				**$ 218,210**	
Total Present Value Cost for Alternative				**$ 1,655,362**	

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