UPDATED CLEANUP ACTION PLAN

LILYBLAD CLEANUP SITE

Prepared for

Washington Department of Ecology
300 Desmond Drive SE
Lacey, Washington 98503

Prepared by

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Lilyblad
2244 Port of Tacoma Road, Tacoma, WA
Project Number: PNR0697
Facility Site ID #1239
Cleanup Site ID #4329
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March 20, 2024

Geosyntec consultants

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

1,4-DCB	1,4-dichlorobenzene
2004 Supplemental RI	*Supplemental Remedial Investigation Report*
AO	Agreed Order
bgs	below ground surface
CAP	Cleanup Action Plan
CDM	Camp Dresser & McKee Inc
COCs	constituents of concern
CSM	conceptual Site model
CUL	cleanup level
DO	dissolved oxygen
DPE	dual vapor extraction
Ecology	Washington Department of Ecology
FFS	Focused Feasibility Study
Geosyntec	Geosyntec Consultants, Inc.
IC	Institutional Control
ISCO	in situ chemical oxidation
JM Eagle	JM Eagle Manufacturing
Lilyblad	Lilyblad Petroleum Inc.
MNA	monitored natural attenuation
MTCA	Model Toxics Control Cleanup Act
NSZD	natural source zone depletion
Pacific Fluids	Pacific Fluids LLC
PCE	tetrachloroethene
RCRA	Resource Conservation and Recovery Act
SRR	*Site Remedy Review Report*
SVOCs	semi-volatile organic compounds
the Site	the Lilyblad Cleanup Site
TPH	total petroleum hydrocarbons
VC	vinyl chloride
VOCs	volatile organic compounds

WAC	Washington Administrative Code

EXECUTIVE SUMMARY

This document presents the Updated Cleanup Action Plan (Updated CAP) for the Former Lilyblad Cleanup Site (the Site) in Tacoma, Washington. This Updated CAP was prepared by the Washington State Department of Ecology (Ecology) in collaboration with Geosyntec Consultants, Inc. (Geosyntec). This Updated 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 Updated CAP describes Ecology's proposed cleanup action and sets forth the requirements that the cleanup must meet.

The Site addressed in this Updated CAP historically served as a distributor of gasoline, diesel, solvents, and packaged petroleum products and experienced releases of petroleum compounds into the soil and groundwater as a result of operations. The selected remedy described in the following report is biosparging combined with monitored natural attenuation, natural source zone depletion, and institutional controls.

1. INTRODUCTION

This *Updated Cleanup Action Plan* (Updated CAP) for the Former Lilyblad Cleanup Site (the Site) was prepared by Geosyntec Consultants, Inc. (Geosyntec) at the request of the Washington Department of Ecology (Ecology). The Site is located at 2244 Port of Tacoma Road in Tacoma, Washington. The Site location map is provided in Figure 1.1. The purpose of this Updated CAP is to provide a proposed cleanup action to address constituents of concern (COCs) in soil and groundwater remaining at the Site, following the completion of previous corrective actions established in 2007 and the recommendations outlined in the *Site Remedy Report Review Report* (SRR) *and Proposed Updated Focused Feasibility Study* (Updated FFS) (Geosyntec 2022a).

1.1 Regulatory Framework

In 1981, Lilyblad Petroleum Inc. (Lilyblad) notified Ecology of on-Site waste management activities, applied for an Ecology Resource Conservation and Recovery Act (RCRA) permit, and was granted interim status. By November 1994, Ecology received authorization for RCRA corrective action and notified Lilyblad it would proceed with corrective action via the MTCA process, and in 1995, an Agreed Order (AO) was signed for the facility (Ecology 1995). In 2000, Ecology issued the *First Amendment to MTCA Agreed Order No DE 95HS-S292* (Ecology 2000). In 2006, Ecology issued the *Second Amendment Agreed Order* (Order) *No. DE 95HS-S292* (Ecology 2006).

COCs were initially proposed in a 2001 *Interim Action Final Work Plan* (Camp Dresser & McKee Inc [CDM] 2001) and were established in the Second Amendment to the AO No. DE95HS-S292 (Ecology 2006). These COCs included: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPH). Based on the conceptual Site model (CSM) presented in the 2004 *Supplemental Remedial Investigation Report* (2004 Supplemental RI) and the preliminary MTCA Method B cleanup levels (prior to the 2000 MTCA Rule Amendments), Site-specific soil and groundwater cleanup levels (CULs) were established in the Second Amendment to the AO No. DE95HS-S292 (Ecology 2006) and revised in Exhibit A, Enforcement Order No. 4515: CAP (Ecology 2007). CULs were established for the protection of human health and potential downgradient ecological receptors.

In January 2007, a Feasibility Study was completed, followed by a CAP in October 2007. The approved cleanup action of dual-phase extraction (DPE) was subsequently implemented, and intermittent operation continued from 2009 through 2019. From 2020 through 2022, a review of DPE effectiveness and current Site conditions was conducted, and based on the results of the review, the SSR and Updated FFS were completed and issued for public comment in April 2022. Please refer to Section 3 below for more information on the previous remedial action that has occurred.

1.2 Purpose

A CAP is required as part of the Site cleanup process under Chapter 173-340 Washington Administrative Code (WAC), Model Toxics Control Act (MTCA) Cleanup Regulations. The purpose of a CAP is to identify the proposed cleanup action and to provide an explanatory document for public review. In the context of this Updated CAP, the purpose is to identify the proposed cleanup action to address remaining COCs at the Site, after past cleanup actions have been completed. More specifically, this plan

- describes the Site;
- summarizes current Site conditions after the completion of previous cleanup actions;
- summarizes the cleanup action alternatives considered in the remedy selection process from the SRR and Updated FFS (Geosyntec 2022a);
- describes the selected cleanup action and the rationale for selecting this alternative from the Updated FFS;
- describes design considerations for the selected remedial alternative based on the results of recent pilot studies;
- 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;
- discusses compliance monitoring requirements; and
- presents the schedule for implementing the Updated CAP.

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

1.3 Previous Studies

After the initial AO of 1995, there have been multiple studies and remedial actions performed at the Site. The results are summarized in the following reports:

- *Supplemental Remedial Investigation Report*, Lilyblad Petroleum Inc. (CH2M Hill 2004)
- *Interim Soil and Groundwater Sampling Event: MPE Treatment Area, PW Eagle Property*, Lilyblad Pilot Test Areas (Terra Vac 2006)
- *Cleanup Action Plan* (Ecology 2007)
- *Site Remedy Review Report and Proposed Updated Focused Feasibility Study* (Geosyntec 2022a)

2. SITE DESCRIPTION

This section includes the historical and current uses of the Site and the surrounding properties, followed by a summary of the Site's geological features as presented in the 2004 Supplemental RI and 2022 SRR. Subsequent sections discuss the Site COCs, including their environmental and health concerns as well as CULs.

2.1 Site History and Current Use

The Site is located at 2244 Port of Tacoma Road in Tacoma, Washington, and consists of the Lilyblad property and adjacent properties that have been affected by historical releases from the Lilyblad facility. The Site and adjacent properties are shown in Figure 1.1 and the Site vicinity layout is shown in Figure 2.1. The historical Lilyblad facility is currently occupied by Pacific Fluids LLC (Pacific Fluids), and adjoining properties are industrial and include the following features:

- Northeast: Port of Tacoma Road, followed by the Port of Tacoma and the Blair Waterway
- Southeast: TriPak Total Transportation Services (TriPak), which was formerly JM Eagle Manufacturing (JM Eagle)
- Southwest: United Motor Freight Tacoma, which was also formerly JM Eagle
- Northwest: Ara Realty, followed by Tacoma Screw; Ara Realty was formerly Chambers Bay RV and formerly referred to as the Nelson property

Lilyblad began operation in 1972 as a distributor of gasoline, diesel, solvents, and packaged petroleum products. Between 1978 and 1991, the Site was used as a solvent recycling facility. Since 1983, the Site has been used as a chemical storage, blending, and distribution facility. During these various Site activities, releases and potential releases of solvents and hydrocarbons from the main Site building, tank farms, fuel island, loading rack, and other operative areas were identified (CH2M Hill 2004).

In 2003, Pacific Fluids purchased Lilyblad's assets, which include accounts receivable and inventory, equipment, and the water treatment system. Pacific Fluids currently operates the facility to store, blend, repackage and distribute chemical and petroleum products. Lilyblad Petroleum Inc. is no longer in business. M&G Holdings currently owns the property.

2.2 Site Geologic Summary

In 2004, CH2M Hill prepared a detailed *Supplemental Remedial Investigation Report* (CH2M Hill 2004). As part of the 2022 SRR, Geosyntec prepared an updated CSM (Geosyntec 2022a), which included geological and hydrogeological findings from recent groundwater monitoring data and other data collected since the 2004 Supplemental RI. Geological and hydrogeological findings from the 2004 Supplemental RI and updated 2022 CSM are summarized in this section. Cross-sections prepared as part of the 2004 Supplemental RI are included in Appendix A.

The Site is fully covered with asphalt and concrete, which is underlain by a structural fill unit consisting of sandy, gravelly silt to slightly silty, sandy gravel. The ground surface elevation ranges from approximately 14 to 18 feet (North American Vertical Datum of 1988 [NAVD88]; CH2M Hill 2004). This structural fill unit is typically observed within the upper 10 feet underlying the Site (Northwest Archaeological Associates, Inc. 2009). Directly below the structural fill layer is an upper sand layer. This layer consists of clean to silty sand with some shell fragments and gravel. This unit becomes finer with depth, was reported to have a thickness of 2 to 8 feet, and is generally present up to a depth of 8 to 12 feet below ground surface (bgs) throughout the Site. First encountered groundwater is observed in the upper sand layer, and the saturated portion of the upper sand layer has been historically referred to as the "shallow aquifer."

The upper sand layer and shallow aquifer is underlain by a silt layer consisting of clayey silt to silty clay with low permeability. This layer forms an aquitard approximately 10 to 15 feet thick, extending between 12 and 33 feet bgs. Underneath the silt layer is a second sand layer generally comprised of clean to silty-fine sand. This second sand layer is saturated, confined or semi-confined, and referred to as the "second aquifer."

During the March 2020, December 2020, and June 2021 groundwater monitoring events, depth to water in the shallow aquifer was measured at up to 35 groundwater monitoring wells. The groundwater elevations and the elevation of the silt aquitard are found to be above median sea level, and therefore, the aquifer is likely perched. The results showed that groundwater elevations in the shallow aquifer were generally consistent among events with elevations (i.e., no seasonal variation observed) ranging from approximately 9.8 to 13.5 feet above mean sea level (NAVD88; Geosyntec 2022a).

Groundwater gradients are divided across the monitoring well network during groundwater monitoring events, with generally higher groundwater elevations in the southern portion of the Pacific Fluids site and lower elevations radially outward from this area. In general, this results in northward gradients on the northern portion of the monitoring network and southward gradients in the southern portion (CH2M Hill 2004, Geosyntec 2022a, 2023a).

In the 2004 Supplemental RI, a potential pathway was conceptualized via groundwater interception of a stormwater sewer installed below the groundwater table at approximately 15 feet bgs in the north-adjoining Port of Tacoma Road. Groundwater flowing north from the Site could infiltrate into the sewer or flow along the sewer bedding to the Lincoln Avenue Ditch and then flow into the Blair Waterway (Figures 2.1, Appendix A).

2.3 Human Health and Environmental Concerns

Potential human health and ecological receptors were evaluated in the SRR and Updated FFS and included potential pathways of contact with impacted groundwater, soil, and soil vapor. The secondary pathway of groundwater migration to the Blair Waterway was also identified as a potential pathway for aquatic/ecological receptors. The receptors are outlined in the Risk Assessment CSM shown in Figure 2.2.

As shown on Figure 2.2, exposure pathways were identified for the following:

- Human health risk via vapor intrusion to indoor air for the commercial/industrial worker, construction worker, and hypothetical future commercial/industrial worker and to outdoor air for the construction worker if trenching is conducted. The potential source of vapor would be from volatilization of COCs from soil and groundwater matrices to soil vapor and then migration to indoor or outdoor air.
- Human health risk via ingestion or dermal contact with soil under the construction worker scenario.
- Potential ecological risk via groundwater migration to the Blair Waterway.

Ingestion of contaminated groundwater was not evaluated to be a likely human exposure pathway, as drinking water wells are not present in this area. In addition, groundwater pump tests onsite also demonstrated that site groundwater is not a viable drinking water source (CH2M Hill 2004). However, as noted in the SRR and Updated FFS, while the potential receptor pathways for human health include soil as the source matrix of COCs, the highest concentrations of COCs and COCs typically over the CULs in soil samples are typically associated with saturated soil or soil at the capillary fringe. As such, remediation of the saturated zone was the focus in the Updated FFS and this Updated CAP.

2.4 Cleanup Standards

2.4.1 Cleanup Levels

Table 1.1 presents the current COCs and associated soil and groundwater CULs, as established in the Second Amendment to the AO (Ecology 2006) and revised in the CAP (Ecology 2007). Except for TPHs CULs, which are based on MTCA Method A, the CULs were developed based on surface water criteria, which are typically more stringent than the MTCA Method A or B levels that are protective of human health. Soil CULs were developed based on the groundwater CULs using estimated three phase partitioning. Ecology reviewed the Site CULs against current MTCA CULs for soil, groundwater, and soil vapor as part of the September 2022 periodic review (Ecology 2022) and found that they continue to remain protective of human health and the environment, given the current Site conditions.

2.4.2 Constituents of Concern

COCs were initially proposed in the 2001 *Interim Action Final Work Plan* (CDM 2001) and were established in the Second Amendment to the Agreed Order No. DE95HS-S292 (Ecology 2006). These COCs included VOCs, SVOCs, and TPH. The current list of Site COCs is provided in Table 1.1. While the COCs listed on Table 1.1 continue to be monitored at the Site, many have declined to levels below their respective CULs.

The 2022 SRR presented an updated CSM, describing the nature and extent of COCs in soil and groundwater, hydrogeology, geochemistry, fate and transport, and potential receptors based on recent groundwater monitoring data and other data collected since the 2004 Supplemental RI. Based on recent groundwater and soil concentrations in comparison to Site CULs, the SRR identified the following current COCs as remaining at concentrations consistently over Site CULs:

- TPH, including gasoline, diesel, and motor oil range organics
- VOCs, primarily 1,4-dichlorobenzene (1,4-DCB) and vinyl chloride (VC), with limited detections of tetrachloroethene (PCE)

A review of the spatial distribution of these COCs was performed as part of the SRR and indicated that while VOCs are present in groundwater above the CULs, their extent is limited, and petroleum hydrocarbons, mainly diesel and motor oil, are the primary COCs remaining (Geosyntec 2022a).

3. CLEANUP ACTION ALTERNATIVES AND ANALYSIS

In 2009, Ecology's contractor implemented the CAP, including construction and operation of a DPE system. This system consists of a series of extraction wells, vapor extraction system, and an on-Site water treatment system. The system operated until 2019, when Ecology shut down the system to re-evaluate the Site conditions.

Between 2020 and 2021, Geosyntec performed the SRR and Updated FFS at the request of Ecology. The purpose of the SRR and Updated FFS was to provide a comprehensive review of the remedial progress to address COCs in soil and groundwater and to develop a strategic path forward for remediation.

The Site remedy review began in 2020 with a performance review of the existing DPE system, including a field test of the system, an evaluation of the CSM based on sampling and monitoring data through 2020, and preparation of a draft FFS to compare remedial alternatives. The results of the 2020 evaluation identified several issues and uncertainties with continued operations of the DPE system and the importance of collecting additional data associated with natural attenuation of COCs, primarily natural source zone depletion (NSZD) of petroleum hydrocarbons, and to evaluate biosparge as a remedial alternative. As a result, in late 2020 through mid-2021, Geosyntec collected additional parameters to evaluate monitored natural attenuation (MNA), conducted an NSZD evaluation, and conducted a six-week pilot study to evaluate biosparge as a remedial technology.

The results of these additional activities indicated the following:

- While VOCs 1,4-DCB, VC, benzene, and PCE are present in groundwater, their extent is limited, and petroleum hydrocarbons, mainly diesel and motor oil, are the primary COCs remaining.
- NSZD is occurring within areas that have relatively high levels of petroleum hydrocarbons (the eastern portion of the Site).
- Within six weeks of the biosparge pilot study operations, increased TPH biological degradation rates were observed in proximity to the biosparge wells. Combined with additional field data that showed shifts in microbial populations, geochemistry, and COC concentrations after pilot study implementation, these results indicate that biosparging may be an effective technology to enhance the natural attenuation processes. However, given the limited duration and footprint of this pilot study, additional pilot study operations that include an extended operational timeframe and footprint (i.e., addition of more biosparge wells) would be beneficial in confirming COC mass removal in groundwater outside the biosparge injections wells and to refine the scope, cost, and remedial timeframe of full-scale implementation of this remedial technology.
- While some microbial toxicity was observed in subareas that generally align with detections of 1,4-DCB and VC in groundwater, biosparge is expected to promote air stripping and/or aerobic degradation of these VOCs. Once VOC concentrations are

reduced in these areas, petroleum hydrocarbon biological degradation rates are expected to increase.

Based on the above, Geosyntec conducted an FFS evaluation, screening alternative remediation technologies in comparison to continuing the current DPE remedy (Geosyntec 2022a). The technologies evaluated in the FFS include the following:

- Alternative 1: DPE with Transition to MNA and Institutional Controls (ICs) (i.e., continuation of current remedy)
- Alternative 2: MNA/NSZD with ICs
- Alternative 3: Biosparging with NSZD/MNA and ICs, with options below:
  - Alternative 3a: With Concurrent Soil Vapor Extraction
  - Alternative 3b: With Concurrent Groundwater Extraction
  - Alternative 3c: Followed by In Situ Chemical Oxidation (ISCO)/Aerobic Biodegradation
  - Alternative 3d: Expanded Biosparge Operations
- Alternative 4: Excavation with MNA and ICs
- Alternative 5: Groundwater Containment via Extraction and Treatment with ICs
- Alternative 6: Biosparging Treatment Zone at Downgradient Site Boundary with ICs

Each remedial alternative was evaluated and compared using the Feasibility Study Checklist (Ecology 2016). These alternatives were evaluated against criteria including protection of human health and the environment, permanence, effectiveness, management of short-term risks, implementability, public acceptance, and cost. Based on these criteria, Alternative 3c was the highest (most favorable) scoring remediation technology.

The FFS recommended Ecology revise its corrective action from DPE to an alternative that combined biosparge with NSZD/MNA with eventual implementation of ICs (Alternative 3c; Geosyntec 2022a). Under this recommended alternative, ISCO/Aerobic Biodegradation would be retained as a contingency measure.

The FFS recommended expanded operations of the biosparge pilot study before and during preparation of an updated CAP to obtain information to refine the full-scale biosparge scope of work and collect information for the engineering design. An extended 13-month biosparge pilot study was completed from March 2022 into March 2023. Activities completed as part of the extended biosparge pilot study are summarized in five Extended Biosparge Pilot Study Progress Reports (Progress Reports, Geosyntec 2022b, 2022c, 2022d, 2023b, 2023c). A comprehensive overview of the findings from the extended biosparge pilot study and important considerations for full-scale remedial design is provided in Appendix B.

4. SELECTED REMEDY: BIOSPARGE WITH NATURAL SOURCE ZONE DEPLETION AND INSTITUTIONAL CONTROLS

4.1 Site Description

This Updated CAP addresses areas where COCs in shallow groundwater remain above their respective CULs. The treatment area boundary is shown in Figure 3.1 and is based on groundwater monitoring conducted in 2022 and 2023 (Appendix B and Geosyntec 2023a). The extent of the treatment area is present on the Pacific Fluids LLC, TriPak, Inc., Tacoma Screw, Ara Realty, and United Motor Freight Tacoma properties.

4.2 Description of the Cleanup Action

The proposed Site cleanup action is biosparge with NSZD/MNA and ICs. Biosparge involves injecting air into the saturated zone to increase the dissolved oxygen (DO) concentration in the groundwater. This process can decrease the concentration of COCs in the groundwater by two means. Petroleum hydrocarbons concentrations can be remediated by promoting aerobic biodegradation and increasing the NSZD rate. In addition, VOCs can be remediated by air stripping as the injected air bubbles through the groundwater. To prevent vapor migration into the enclosed office space, a vapor mitigation system may be installed within, and/or around, the office building footprint, if needed based on performance monitoring results.

NSZD is the naturally-occurring process of volatilization and biodegradation of petroleum hydrocarbon constituents in the subsurface. This process is promoted by biosparge and will continue during periods where biosparge is not operating or in areas outside the radius of influence from the biosparge system. Once COCs reach asymptotic conditions from biosparge, biosparge will be shut down and all areas of the plume will transition to MNA and NSZD (referred to herein simply as MNA). Existing monitoring wells will be sampled regularly to evaluate groundwater COC concentrations until the Site-specific CULs are routinely met.

Nearing project closure, ICs will be implemented to provide ongoing protection of human health and the environment. Potential ICs are discussed in Section 4.8.

4.2.1 Contingency

ISCO/Aerobic Biodegradation has been retained as a contingency measure for remediation of COCs in groundwater. ISCO could be used after implementation of full-scale biosparge to target areas that have not yet reached their Site-specific CULs. These areas may include where biosparging was insufficient to bring concentrations below the Site-specific CULs and/or where statistical analyses suggest that MNA is not expected to bring concentrations below the CULs within a reasonable timeframe. The need for ISCO/Aerobic Biodegradation will be evaluated around year six of the expected eight-year biosparging operation (Geosyntec 2022a).

4.3 Cleanup Standards and Point of Compliance

The cleanup standards to be used for the Updated CAP are the Site CULs (Section 2.4.1; Table 1.1). The point of compliance for this remedy is groundwater located in the “shallow aquifer" as described in Section 2.2. COCs above the CULs have not been identified in the lower "second aquifer" (Geosyntec 2022a).

TPH results with silica gel cleanup may be used to evaluate and demonstrate compliance with the Site CULs for diesel and motor oil range, using the methods in Ecology's Guidance for Silica Gel Cleanup in Washington State (November 2023).

4.4 Applicable, Relevant, and Appropriate Requirements (ARARs)

Under WAC 173-340-710, MTCA requires that cleanup actions comply with all legally applicable local, state, and federal laws, and requirements identified by Ecology to be applicable, relevant, and appropriate requirements (ARARs).

"Relevant and appropriate" requirements include those cleanup standards, standards of control, and other human health and environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance, address problems or situations sufficiently similar to those encountered that their use is well suited to the particular Site.

As part of the cleanup standards determination, the MTCA Method A and B CULs were compared to applicable local, state, and federal requirements. The regulations reviewed for determining Site CULs are summarized in Section 2.4. The proposed cleanup action is expected to comply with cleanup standards and applicable laws and regulations. Permits may not be needed for full-scale implementation depending on the final engineering design and will be identified during engineering design. Permits relevant to DPE operation will be removed with implementation of biosparge.

4.5 Restoration Timeframe

As required by WAC 173-340-360(2.b.ii), a cleanup shall provide for a reasonable restoration time frame by considering the following factors (WAC 173-340-360(4.b)):

1. Potential risks posed
2. Practicability of achieving shorter restorations time frame
3. Current Site uses
4. Potential future Site uses
5. Availability of alternative water supplies
6. Effectiveness and reliability of institutional controls
7. Ability to control and monitor migration of constituents
8. Toxicity of the hazardous substances
9. Natural processes that reduce concentrations of the hazardous substances

The proposed cleanup takes into consideration the above criteria and is the remedial alternative most likely to remediate groundwater within a reasonable time frame while reducing risks.

Assuming continuous operations, the biosparge remedy is expected to take approximately 8 years, followed by approximately 10 years of MNA (Geosyntec 2022a).

4.6 Compliance Monitoring

Compliance monitoring will be conducted in accordance with WAC 173-340-410, which addresses three types of compliance monitoring:

- **Protection monitoring**, which confirms that human health and the environment are adequately protected. For this Site, protection wells will include groundwater monitoring wells located along the outer edge of the COC plume, as well as select wells interior to the plume. Groundwater data from the perimeter wells will be reviewed to assess plume stability and potential migration downgradient, and groundwater data from the select interior wells will be used to confirm protection of human health via the vapor intrusion pathway to indoor air. Based on the results of the vapor intrusion risk evaluation, soil vapor probes may also be monitored.
- **Performance monitoring**, which confirms the cleanup action has attained cleanup standards. For this Site, groundwater wells within the treatment area will be considered performance monitoring. Data collected from these wells will be evaluated for changes in COC concentrations to observe the performance of the remedy.
- **Confirmation monitoring**, which confirms the long-term effectiveness of the cleanup action. Confirmation monitoring will be achieved through long-term evaluation of monitoring results to observe the effectiveness of the remedy.

Details on the monitoring program will be included in an update to the Site's Sampling and Analysis/Quality Assurance Project Plan (SAP/QAPP). During biosparge operation, compliance monitoring is anticipated to include, but not limited to, semiannual groundwater monitoring and encompass the following:

- approximately 15 wells monitored during one event and 35 wells monitored during the second event;
- monitoring depth to groundwater, total depth of the well, and light nonaqueous phase liquid (LNAPL) thickness; and
- collecting groundwater samples for the following:
  - field parameters;
  - general chemistry parameters; and
  - constituents of concern.

In addition, as noted above, protection monitoring may also consist of screening vapor probes to assess vapor intrusion risk. Vapor probes may be screened for pressure and total VOCs using field meters and collecting samples for laboratory analysis.

Once COCs reach asymptotic conditions in the groundwater during biosparge, the remedial approach will transition to MNA. As part of the MNA remedy, groundwater monitoring will be conducted annually for an assumed 10 years. Approximately 20 wells will be monitored in the first two years of MNA and approximately 10 wells will be monitored in the next eight years. During each event, the existing monitoring wells that were used during system operation will be used with the following additions to the analytical list: total and dissolved iron and manganese, methane, and total organic carbon. In addition, approximately 25% of wells will be monitored for volatile fatty acids and presence of biodegrading bacteria.

Annual groundwater monitoring reports will be prepared to evaluate plume stability and remedial progress toward the reduction of Site COCs to concentrations below the CULs. These reports will include an annual assessment of groundwater gradients, COC distribution, COC trends over time, and a discussion of other evidence of successful remedy performance (e.g., operational up time and evidence of ongoing NSZD and MNA).

In addition to an annual assessment of remedy performance, a remedy review will be completed less frequently (e.g., every 4 years) to evaluate the long-term performance in achieving CULs. This assessment will supplement the annual groundwater monitoring. The performance metrics and assessment frequency will be established during the remedial design (Engineering Design). Remedial performance metrics will be specific, measurable, attainable, relevant, time-bound, and demonstrate progress toward long-term remedial objectives.

4.7 Schedule for Implementation

The following table outlines the proposed schedule for installation of the full-scale biosparge remediation system.

Period after Updated CAP Finalization	**Task**
Within one year	Submit SAP/QAPP (may be updated, as needed, according to engineering design).
Within one year	Submit Full-Scale Engineering Design for Ecology approval. The Engineering Design will include a Health and Safety Plan.
Period after Full-Scale Engineering Design Approval	**Task**
One month	Begin permitting process (if needed) and request bids from subcontractors and vendors.
Three months	Accept bids and order remediation equipment.
Six months	Begin drilling new biosparge injection wells and rehabilitating necessary DPE wells.
One year	Install remediation equipment, disassemble DPE system, and close out DPE system permits.
One and a half years	Collect baseline measurements and perform system startup.
Two and a half years	Submit first annual compliance monitoring report.

4.8 Institutional Controls

According to WAC 173-340-440, ICs are “measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or cleanup action or that may result in exposure to hazardous substances at a Site." Proposed ICs include soil and groundwater use restrictions. Nearing project closure, the ICs may be implemented to provide ongoing protection of human health and the environment. Future on-Site land use may be limited to commercial/industrial use, groundwater use would be restricted, and a Site Management Plan may be implemented to ensure the effectiveness of ICs and to outline procedures for notification and response actions in the event of subsurface work, such as trenching.

4.9 Public Participation

Ecology will hold a public notice period on the Updated CAP before making a final decision.

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TABLES

Table 1.1
Site Constituents of Concern and Associated Clean Up Levels
Lilyblad Site
Tacoma, Washington

Constituent of Concern	CAS Number	Groundwater Units	Groundwater CUL	Soil Units	Soil CUL
Petroleum Compounds (Ecology Method NWTPH-Dx or -Gx)					
Motor Oil (>C24-C36)	C24-C36	mg/L	1	mg/kg	2,000
#2 Diesel (C10-C24)	68476-30-2	mg/L	1	mg/kg	2,000
TPH as Gasoline	TPH-g	mg/L	1	mg/kg	100
Semivolatile Organic Compounds (SVOCs; EPA Method 8270E)					
2-Methylnaphthalene	91-57-6	µg/L	23	µg/kg	-
bis(2-ethylhexyl)phthalate	117-81-7	µg/L	2.2	µg/kg	4,400
Pentachlorophenol	87-86-5	µg/L	3	µg/kg	37.97
Volatile Organic Compounds (VOCs; EPA Method 8260D)					
1,1,1-Trichloroethane	71-55-6	µg/L	230	µg/kg	1,144
1,1,2-Trichloroethane	79-00-5	µg/L	16	µg/kg	54.1
1,1-Dichloroethane	75-34-3	µg/L	52,000	µg/kg	164,000
1,1-Dichloroethene	75-35-4	µg/L	2	µg/kg	8
1,2-Dichloroethane	107-06-2	µg/L	37	µg/kg	101
1,4-Dichlorobenzene	106-46-7	µg/L	4.86	µg/kg	64.6
1,2,4-Trimethylbenzene	95-63-6	µg/L	26,000	µg/kg	10,350,000
Benzene	71-43-2	µg/L	23	µg/kg	75
cis-1,2-Dichloroethene	156-59-2	µg/L	5,200	µg/kg	14,880
Ethylbenzene	100-41-4	µg/L	6,900	µg/kg	41,130
m&p-Xylenes	179601-23-1	µg/L	26,000	µg/kg	58,400
Methylene Chloride	75-09-2	µg/L	590	µg/kg	1,332
Naphthalene	91-20-3	µg/L	4,900	µg/kg	115,900
Tetrachloroethene (PCE)	127-18-4	µg/L	3.3	µg/kg	24.5
Toluene	108-88-3	µg/L	15,000	µg/kg	71,340
Trichloroethene (TCE)	79-01-6	µg/L	30	µg/kg	121.7
Vinyl Chloride	75-01-4	µg/L	2.4	µg/kg	7.91

Notes

mg/L - milligrams per liter
µg/L - micrograms per liter

FIGURES

Legend
- Fence
- Rail Line
- Road
- Approximate Site Boundary
- Tax Lot
- Building
- Tank

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
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N

0 50 Feet

Site Location Map

Site Review Report
2244 Port of Tacoma Road,
Tacoma, Washington

Geosyntec consultants

Figure 1.1

PNR0697 | March 2024

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Site Review Report\Figure 1 Site Location.mxd 10/13/2021 12:13:38 PM

Legend

- Potential Outfall
- Storm Sewer Location (Approximate)
- Approximate Site Boundary
- Building
- Tank

Service Layer Credits: © 2021 Microsoft Corporation © 2021 Maxar ©CNES (2021) Distribution Airbus DS

Notes:
The 2004 Supplemental Remedial Investigation Report (CH2M Hill, 2004) identified a potential groundwater discharge pathway to Blair Waterway via the Port of Tacoma storm sewer bedding and the Lincoln Avenue Ditch.

Site and Vicinity Layout

Site Review Report
2244 Port of Tacoma Road,
Tacoma, Washington

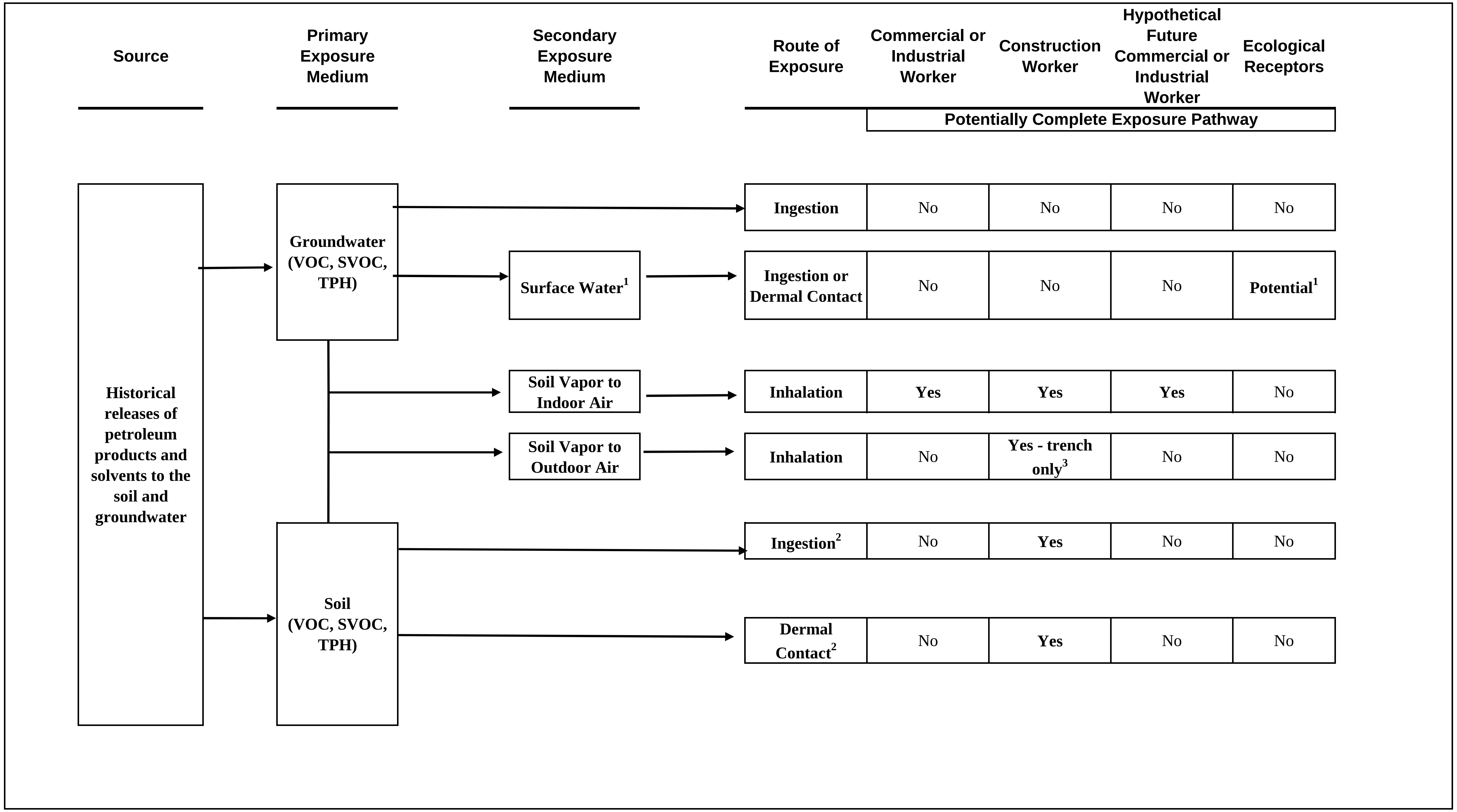
Geosyntec consultants

PNR0697 | March 2024

Figure 2.1

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Site Review Report\Figure 2 Site Layout Map.mxd 10/13/2021 12:20:42 PM

Figure 2.2
Risk Assessment Conceptual Site Model
Former Lilyblad Cleanup
Site Tacoma, Washington



Notes:

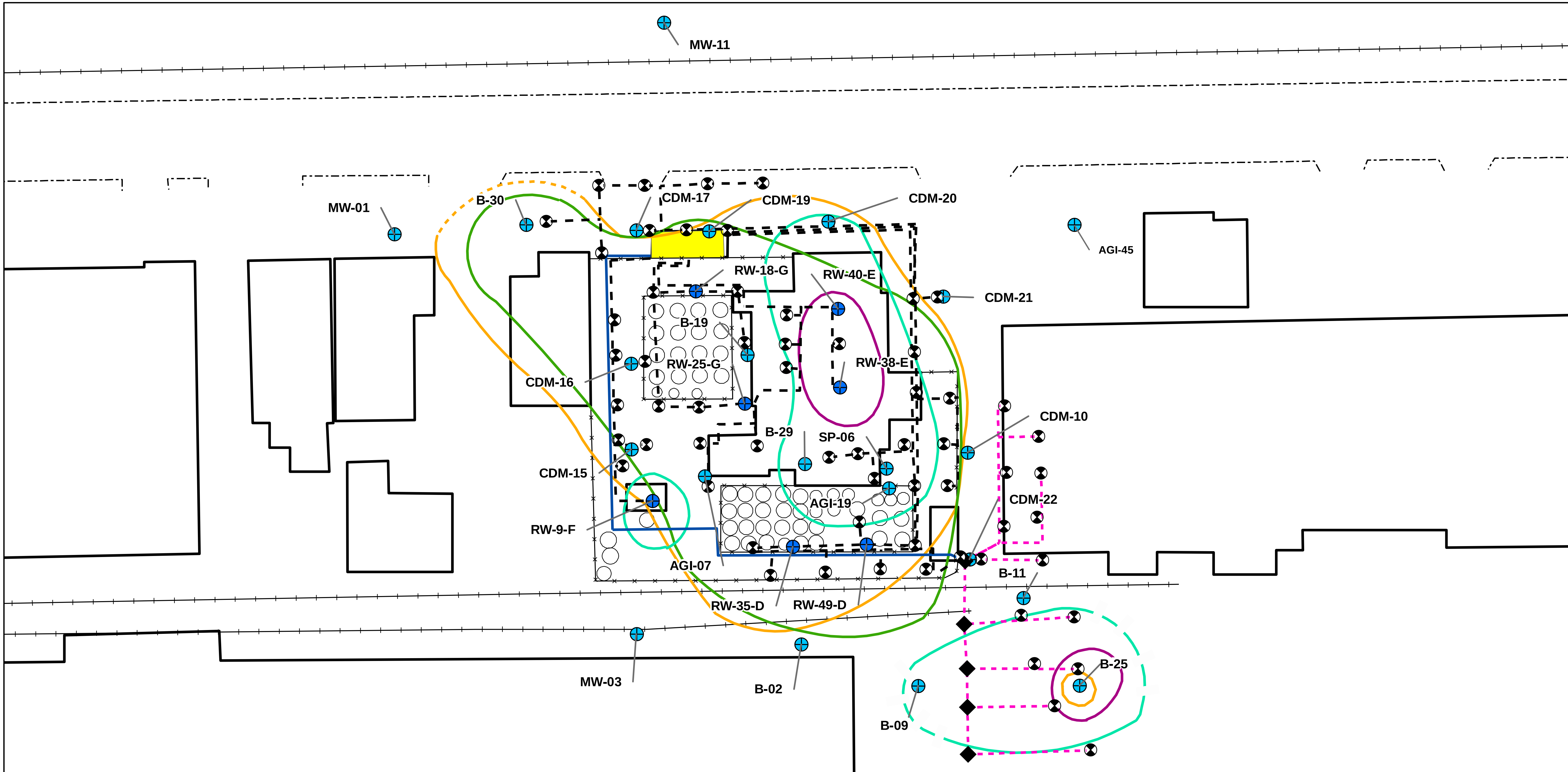
[1]Surface Water is included for consideration due to potential impacts to the Blair Waterway, via groundwater discharge through the Port of Tacoma storm storm sewer line and bedding.

[2]Ingestion of soil and dermal contact with soil by a Commercial or Industrial Worker are not complete exposure pathways because the site is paved. However, ingestion is included in WAC Method C in a typical Commercial or Industrial Worker scenario at a nominal amount of 50 mg/day. This is consistent with USEPA guidance.

[3]Construction Worker exposure to soil vapor in outdoor air would not be significant, with the possible exception of a trenching scenario.

Note that residential exposure is not included because the site is zoned as commercial and industrial.

Complete or potential exposure pathways are shown in bold text.



Notes:
µg/L = micrograms per liter
mg/L = milligrams per liter
Samples were collected between 10/20 and 10/21, 2022, and 4/24 and 4/28, 2023.

Legend

- October 2022 Groundwater Monitoring Location
- April 2023 Groundwater Monitoring Location
- DPE Recovery Wells
- DPE Vault
- Conveyance Piping
- Fence
- Rail Line
- Road
- Building
- Tank
- Remedial Treatment System Compound
- > 4.86 1,4-Dichlorobenzene Groundwater Isoconcentration Contours (µg/L)
- > 1 Motor Oil (>C24-C36) Groundwater Isoconcentration Contours (mg/L)
- > 1 #2 Diesel (C10-C24) Groundwater Isoconcentration Contours (mg/L)
- > 1 TPH as Gasoline Groundwater Isoconcentration Contours (mg/L)

Constituents of Concern over Cleanup Levels in Groundwater (October 2022 and April 2023)

2244 Port of Tacoma Road,
Tacoma, Washington

Geosyntec consultants

PNR0697 | March 2024

Figure 4.1

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Q2_2023\Figure 8 All Interpolated Concentrations.mxd 8/15/2023 9:58:43 AM

APPENDIX A
Generalized Cross Sections

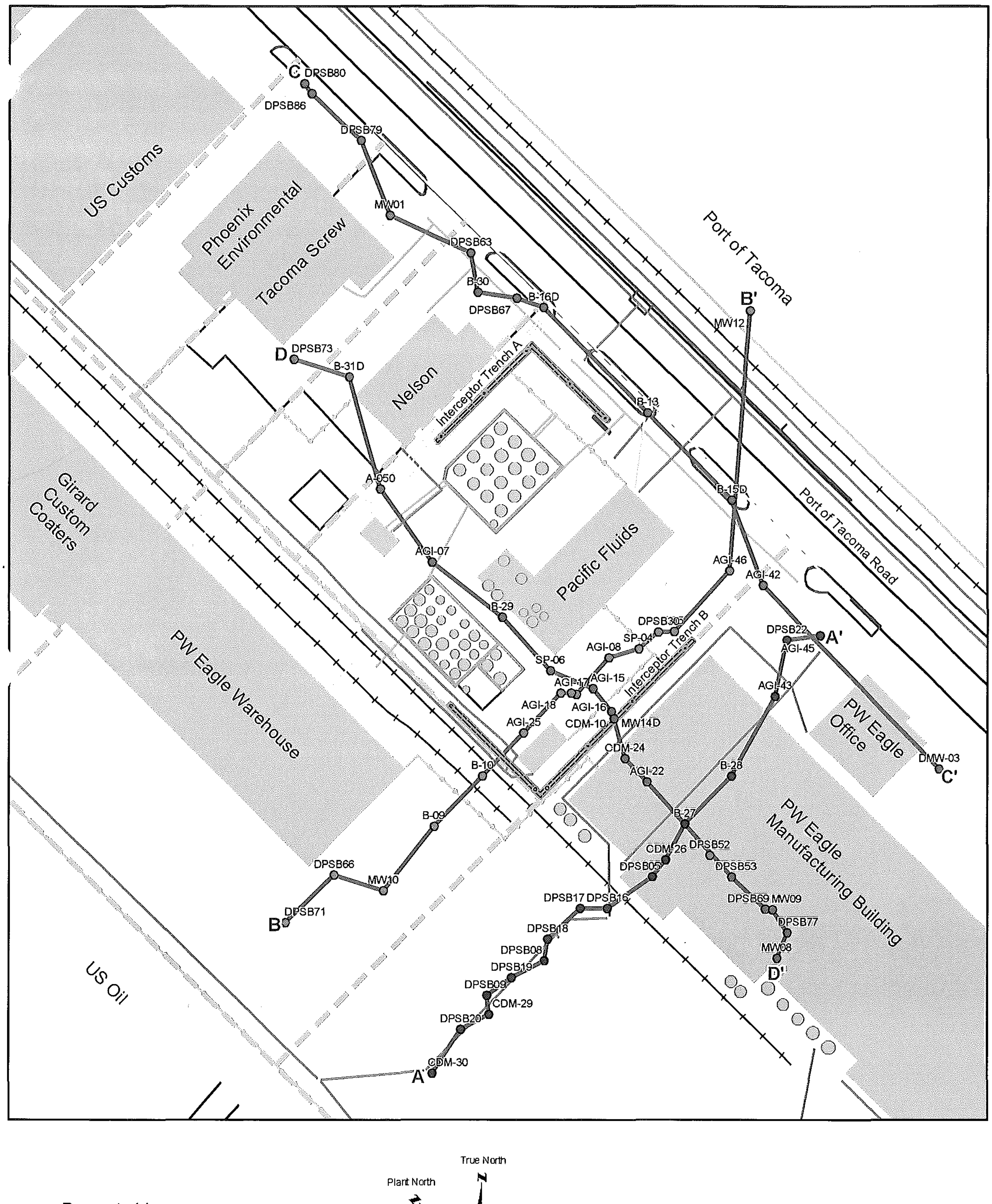


Figure 3-2. **Geologic Cross Section Locations**

Supplemental Remedial Investigation Report
Lilyblad Petroleum, Tacoma, WA

File Path: \\simba\proj\LilybladPetroleum\177582\GIS\MapDocuments\SupplementalRI\CrossSectionLocations_Fig3-2.mxd

CH2M Hill, 2004. Supplemental Remedial Investigation Report.

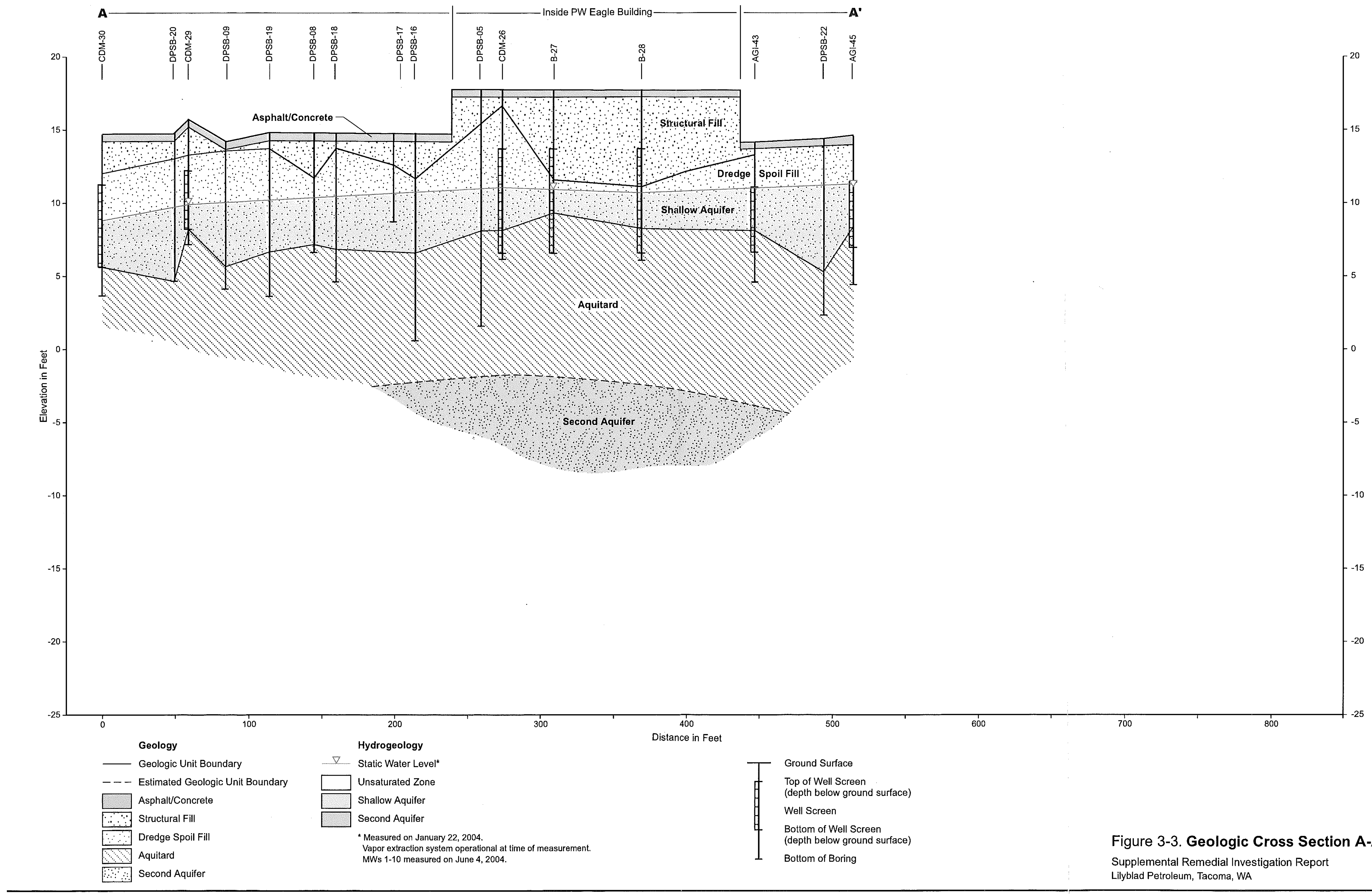


Figure 3-3. **Geologic Cross Section A-A′**

Supplemental Remedial Investigation Report
Lilyblad Petroleum, Tacoma, WA

CH2M Hill, 2004. Supplemental Remedial Investigation Report.

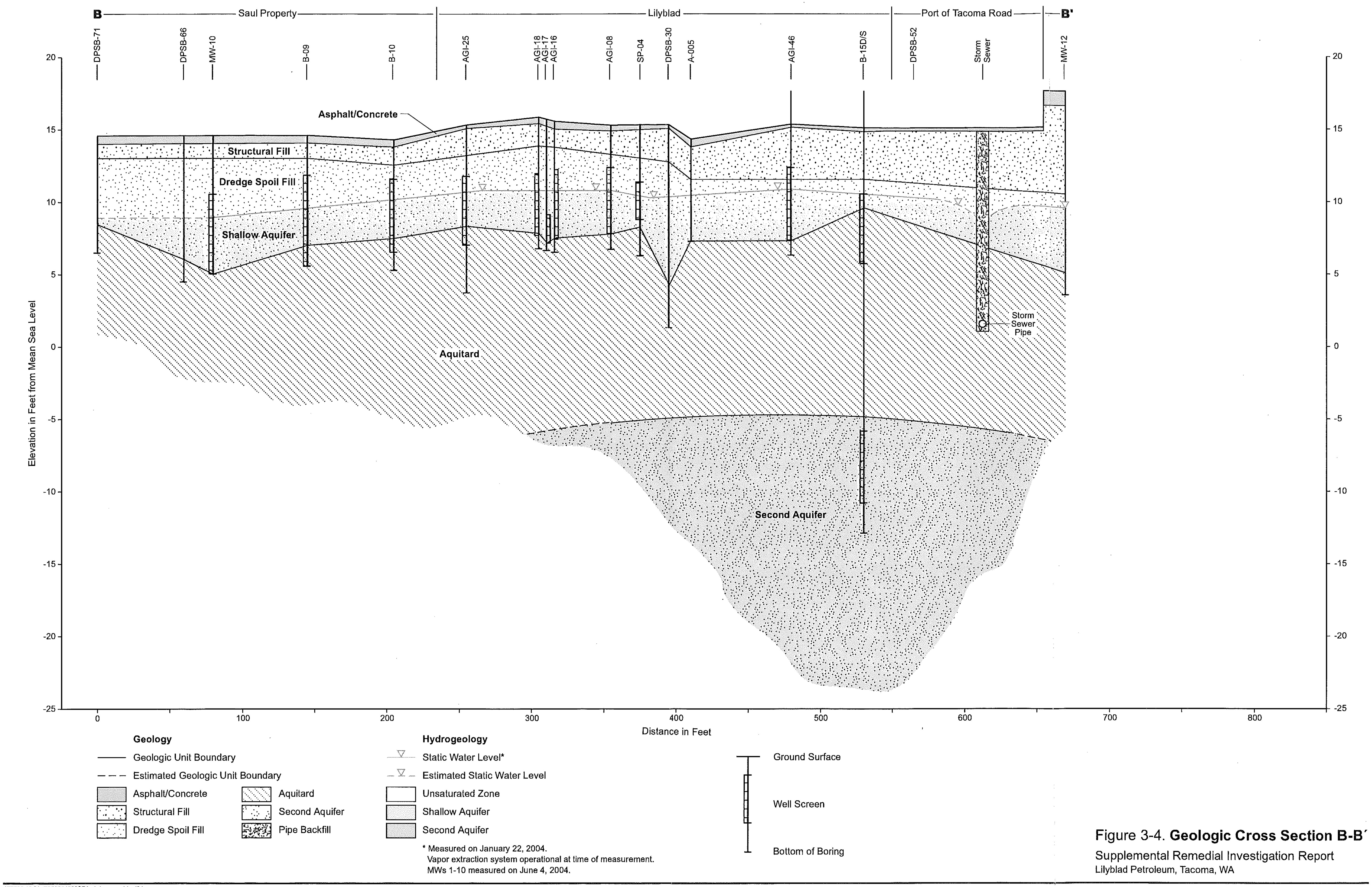


Figure 3-4. **Geologic Cross Section B-B′**
Supplemental Remedial Investigation Report
Lilyblad Petroleum, Tacoma, WA

CH2M Hill, 2004. Supplemental Remedial Investigation Report.

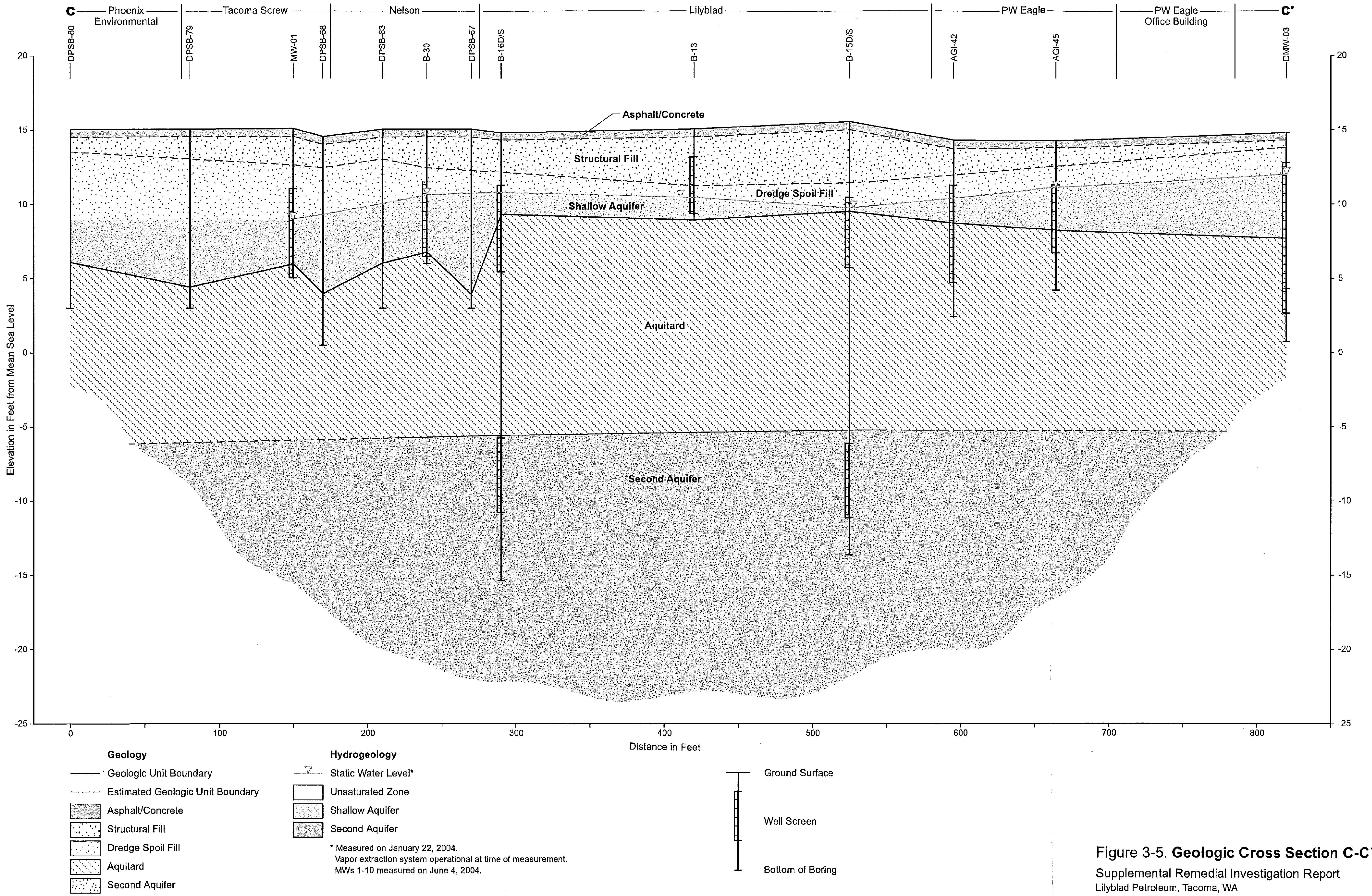


Figure 3-5. **Geologic Cross Section C-C′**

Supplemental Remedial Investigation Report

Lilyblad Petroleum, Tacoma, WA

177582.12.01_E092004000SEA . c-c xsec . 4oct04

CH2M Hill, 2004. Supplemental Remedial Investigation Report.

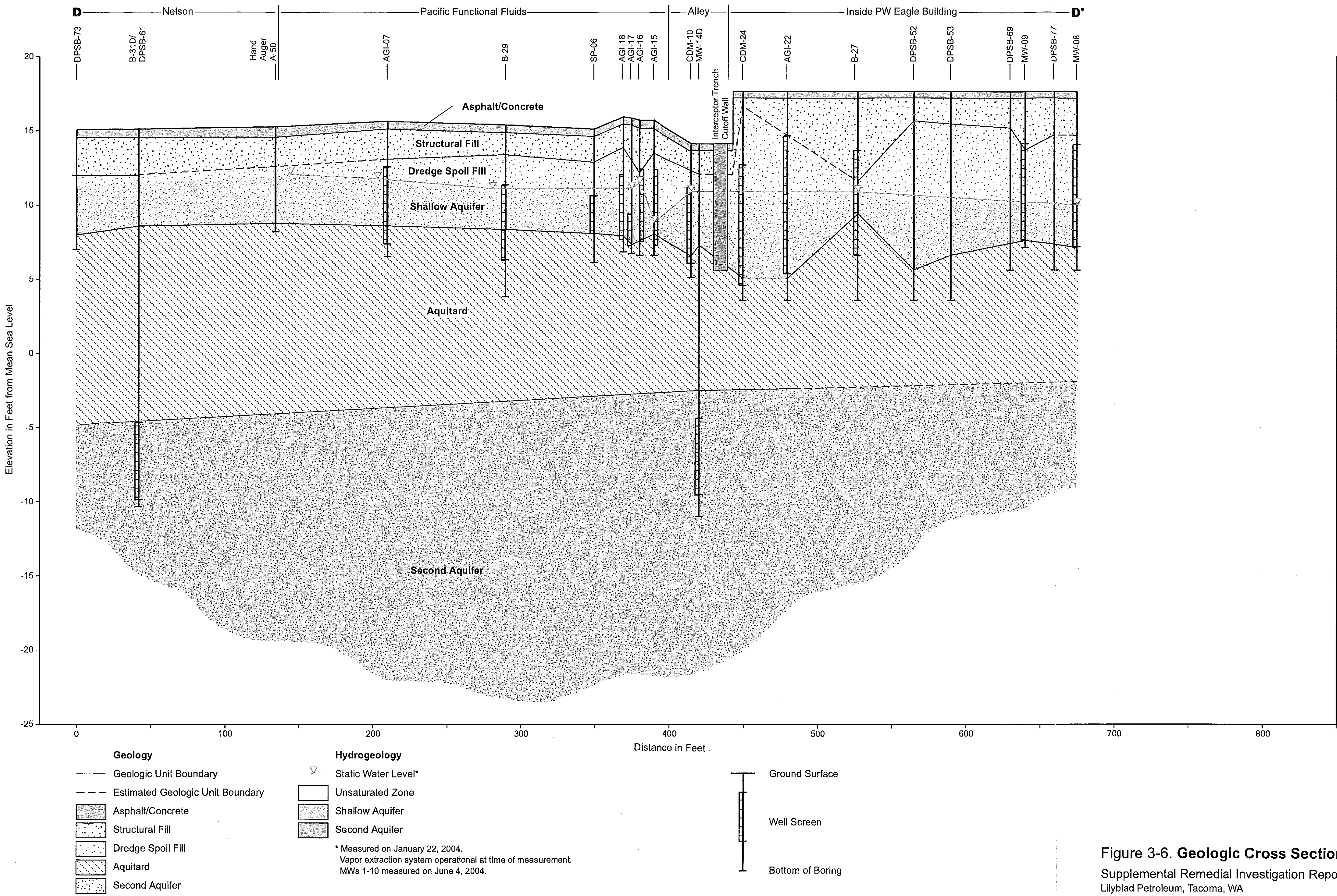


Figure 3-6. **Geologic Cross Section D-D′**

Supplemental Remedial Investigation Report

Lilyblad Petroleum, Tacoma, WA

177582.12.01_E092004000SEA . d-d xsec . 14oct04

CH2M Hill, 2004. Supplemental Remedial Investigation Report.

APPENDIX B
Extended Biosparge Pilot Study Summary Report

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

CAP	cleanup action plan
COCs	constituents of concern
CUL	cleanup level
DO	dissolved oxygen
DPE	dual phase extraction
Ecology	Washington Department of Ecology
Geosyntec	Geosyntec Consultants, Inc.
MNA	monitored natural attenuation
NSZD	natural source zone depletion
ORP	oxidation reduction potential
Progress Reports	*Extended Biosparge Pilot Study Progress Update Reports*
Report	*Extended Biosparge Pilot Study Summary Report*
ROI	radius of influence
SRR	*Site Remedy Review*
SVOCs	semi-volatile organic compounds
the Site	the former Lilyblad site
TPH	total petroleum hydrocarbons
Updated FFS	*Updated Focused Feasability Study*
VOCs	volatile organic compounds

1. INTRODUCTION

Geosyntec Consultants, Inc. (Geosyntec) has prepared this *Extended Biosparge Pilot Study Summary Report* (Report) to support the Washington State Department of Ecology (Ecology) in designing a biosparge remedy at the former Lilyblad site (the Site) located at 2244 Port of Tacoma Road, Tacoma, Washington (Figure A-1). This Report summarizes the findings of an extended pilot study conducted between March 2022 and March 2023 to build on the knowledge collected during an initial six-week biosparge pilot study performed in 2021 and summarized in the *Site Remedy Report Review Report* (SRR) *and Proposed Updated Focused Feasibility Study* (Updated FFS) (Geosyntec 2022a). The findings of the extended biosparge pilot study will be used to support preparation of the Engineering Design. This report is included as an appendix to the 2023 *Updated Cleanup Action Plan*.

1.1 Background

In 2009, Ecology's contractor implemented a cleanup action plan (CAP; Ecology 2007) for the Site, including construction and operation of a dual phase extraction (DPE) system. This system consists of a series of extraction wells, vapor/groundwater extraction system, and an on-site treatment system. The system operated until 2019, when Ecology suspended operations to conduct a thorough reassessment of the Site’s conditions.

Subsequently, between 2020 and 2021, Geosyntec conducted a SRR and Updated FFS at Ecology’s request (Geosyntec 2022a). The primary objective of the SRR and Updated FFS was to conduct a comprehensive review of the progress made in remedying constituents of concern (COCs) present in the soil and groundwater. Moreover, it aimed to devise a strategic course of action to move forward with remediation efforts.

The SRR commenced in 2020 with a performance review of the existing DPE system. This evaluation included a field test of the system, analyzing available data to evaluate the conceptual site model, and preparing a draft Updated FFS to compare remedial alternatives. The results of the 2020 evaluation identified several issues and uncertainties with continued operations of the DPE system. It underscored the importance of collecting additional data related to natural attenuation of COCs, particularly the natural source zone depletion (NSZD) of petroleum hydrocarbons, and to evaluate biosparge as a remedial alternative. As a result, in late 2020 through mid-2021, Geosyntec collected additional parameters to evaluate monitored natural attenuation (MNA), performed an NSZD evaluation, and conducted a six-week pilot study to evaluate the effectiveness of biosparge as a remedial technology.

Concurrently with the SRR, Geosyntec conducted an Updated FFS evaluation comparing alternative remediation technologies with the continuation of the current DPE remedy (Geosyntec 2022a). The Updated FFS recommended that Ecology revise its corrective action, moving away from DPE and considering a combined approach of biosparge with NSZD/MNA, along with the eventual implementation of institutional controls (Geosyntec 2022a).

Furthermore, the SRR and Updated FFS recommended expanded operations of the biosparge pilot study before and during preparation of an Updated CAP to collect additional information to support a full-scale engineering design. As a result, an extended 13-month biosparge pilot study was carried out from March 2022 to March 2023, consistent with the *Biosparge Pilot Startup Plan* dated February 25, 2022, the *Work Plan for Biosparge Pilot Test* dated June 2, 2022, and the *Addendum to the Biosparge Pilot Extension Work Plan* dated October 24, 2022 (Geosyntec 2022b-2022d). The activities completed as part of the extended biosparge pilot study are summarized in five *Extended Biosparge Pilot Study Progress Update Reports* (Progress Reports) (Geosyntec 2023a-2023e).

This Report provides a comprehensive overview of the findings from the extended biosparge pilot study and outlines important considerations for full-scale remedial design.

2. OBJECTIVES

Specific objectives for the extended biosparge pilot study were set forth in the *Work Plan for Biosparge Pilot Test* and *Addendum to the Biosparge Pilot Extension Work Plan* (Geosyntec 2022c, 2022d) and included the following:

- Evaluate the extent of the Site COC plume in areas with limited coverage (e.g., under buildings or parts of the plume where recent groundwater samples have not been collected) and further define the full-scale remedy treatment area
- Assess the radius of influence (ROI) of biosparge in different areas by evaluating water quality trends and COC[1] concentrations in groundwater at wells in proximity to injection locations
- Estimate COC rebound potential after injections have been stopped by collecting post-injection analytical samples and monitoring water quality trends
- Increase statistical confidence with respect to the ROI and rate of rebound by testing the biosparge remedy in additional locations where site COCs remain above the cleanup level (CUL), as well as replicating tests to assess seasonal variance and repeatability
- Evaluate the efficacy of DPE wells to be used for biosparge injection (e.g., ability of packers to maintain tight seals and ability to inject at DPE wells that have not been redeveloped), and the assess whether existing DPE piping can be used for injection
- Assess blower capacity requirements by testing the number of wells that can be placed online and the average overbearing pressures and target flow rates observed
- Identify mechanical issues that may arise after prolonged system operation to better understand routine operation and maintenance (O&M) requirements

[1] COCs include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pentachlorophenol and bis(2-ethylhexyl) phthalate only), total petroleum hydrocarbons (TPH) in the gasoline range (NWTPH-GX), and TPH in the diesel range and motor oil range (NWTPH-DX).

3. FINDINGS

Data collected during the extended biosparge pilot study is presented in the Progress Reports (Geosyntec 2023a-2023e). These reports summarize work performed, areas tested, operational issues observed, field and analytical results, and data quality for each reporting period (approximately 3 months). The following sections present the findings of the extended biosparge pilot study based on the data presented in the Progress Reports.

3.1 Estimated Treatment Area

In October 2022, groundwater samples were collected from a subset of monitoring wells and DPE wells that were not included in the annual groundwater monitoring efforts to better define the extent of COCs in groundwater above the CULs. The data collected in October 2022 was combined with data collected as part of the April 2023 annual groundwater monitoring event (Geosyntec 2023f) to create updated plume maps showing the extents of COCs that currently remain above the CULs, including: 1,4-dicholorobenzene (Figure A-2a), #2 diesel (Figure A-2b), motor oil (Figure A-2c), and gasoline (Figure A-2d). Other Site COCs include pentachlorophenol, vinyl chloride, and benzene which have been detected above the CUL in select few wells (Table A-1). These plumes were overlayed on Figure A-3 to show the target treatment area in addition to the existing DPE infrastructure that is available for use in future biosparge operations.

3.2 Water Quality Trends Observed

Throughout the extended biosparge operation, water quality parameters pH, oxidative reduction potential (ORP), dissolved oxygen (DO), and temperature were regularly monitored at both the injection wells and nearby monitoring wells. This data, combined with analytical data obtained from samples taken from the monitoring wells, provided valuable insight into the potential ROI of the injection wells.

In general, baseline conditions at the on-site wells displayed a neutral pH, low to negative ORP, and low to zero DO. When the injections were occurring, monitoring wells within 7 to 20 feet from the injection well displayed increases in ORP and decreases in pH. These changes varied with distance from the injection wells. Wells closer to the injection wells experienced faster and more significant changes, while monitoring wells further from the injection wells showed slower and smaller changes. Changes in DO and ORP were negligible or not observed in monitoring wells located 20 feet and further from the injection wells. Nevertheless, the increases observed in ORP were not consistent across the monitoring wells, which could be attributed to the presence of high concentrations of organic compounds, including COCs and naturally-occurring organic material, that results in a high chemical oxygen demand.

The decreases observed in pH are suspected to be attributed to the biologic activity stimulated by the biosparging activities. This biologic activity increases the production and presence of carbon dioxide in the groundwater. The carbon dioxide then reacts to form carbonic acid, leading to a decrease in pH. Another possible factor contributing to the observed decreases in pH could be the breakdown of VOCs, resulting in carbon dioxide and hydrochloric acid, as a result of injecting air during the biosparge activities. However, concentrations of VOCs observed at the Site have been relatively low, making this less likely to account for the observed decreases in pH. For more detailed information on the pH, ORP, DO, and temperature trends, please refer to the Progress Reports (Geosyntec 2023a-2023e).

3.3 Analytical Trends Observed

During the pilot study, groundwater samples were collected from monitoring and injection wells and analyzed for Site-specific COCs: VOCs (method 8260D); SVOCs (method 8270E SIM, pentachlorophenol and bis2-ethylhexylphthalate only); and total petroleum hydrocarbons (TPH) in the gasoline range (method NWTPH-GX) and the diesel and motor oil range (method NWTPH-DX). Analytical results are included in Table A-1.

Petroleum compounds, both motor oil and diesel, decreased in all groundwater samples collected from injection wells. In groundwater samples from most injection wells, concentrations of petroleum compounds, as well as VOCs and SVOCs, decreased below the CULs. The reduction of VOCs and SVOCs is likely attributed to direct air-sparging, while reductions in petroleum compounds are believed to result from biological degradation processes.

Furthermore, motor oil and diesel generally decreased in monitoring wells situated up to 14 to 16 feet away from the injection locations within 2 months of injection. After biosparge injection stopped, COC concentrations were observed to return to near baseline concentrations within another 2 months. These findings were replicated at five of the same locations over the course of the extended biosparge pilot study to increase statistical confidence in the radius of influence and rebound timeframe. These trends are graphed in Attachment A-A.

In some groundwater samples within the estimated ROI, COC concentrations increased or stayed the same. This was observed at wells AGI-15, CDM-16, and P-1A. The lack of COC reductions at these locations is likely due to system shutdowns, when brief increases of COC concentrations were observed as rebound occurs, or due to preexisting precipitation/scaling issues observed in the nearby DPE wells that were repurposed as biosparge injection wells. In the areas where precipitation/scaling issues have been observed in DPE wells, it is anticipated that new wells will be installed for the purpose of biosparge injection, in order to provide a more effective biosparge ROI.

3.4 Estimated Radius of Influence

Table A-2 summarizes primary COC and ORP trend observations during or immediately following biosparge injections relative to baseline and recent historical results (over the last 5 years). Based on analytical data and water quality trends, the ROI of biosparge wells is estimated to be approximately 15 feet. The ROI assumed in the Updated FFS was 7.5 feet (Geosyntec, 2022a). The effective ROI has been observed to vary across different injection wells and is likely due to well conditions, preferential pathways, dissolved iron present in the groundwater, and soil type. The ROI may be greater than 15 feet in eastern portions and less than 15 feet in the northwest portion where scaling and iron oxide fouling is present (discussed below).

3.5 Operation

The following sections summarize system maintenance and operations findings from the extended biosparge pilot study. Additional details and operational data are provided in the Progress Reports (Geosyntec 2023a-2023e).

3.5.1 System Shutdowns

During the 2021 biosparge pilot study, there were no system shutdowns or maintenance issues. During the extended 2022 biosparge pilot study, system shutdowns occurred, resulting in a total system downtime of approximately 76 total days, which accounts for about 20% of the extended pilot study timeframe. Unplanned system shutdowns included:

- A manual shutdown occurred to repair a leak in one of the flow controllers. Upon discovery of the leak, the system was shut down and the flow controller was replaced. During the replacement and system check that followed, Geosyntec also discovered that one of the solenoid valves controlling the pulsing was malfunctioning. The flow controller and solenoid valve breakage were likely due to an increase in the flow and pressure beyond the specifications of the equipment when too many injection locations pulsed offline at the same time.
- A system shutdown occurred when the blades of the blower fan broke and sufficient air flow could not be delivered to the injection wells.

To reduce system downtime in the future, routine maintenance activities and checks can be performed on the system as follows:

- To reduce malfunctions associated with the blower, regular temperature checks and greasing should occur; this will improve performance by preventing overheating and breakage. Additionally, the blower vanes should be replaced approximately every 3,000 hours of operation or yearly, whichever occurs first.
- To address issues associated with the solenoid valves and flowmeters, regular visual inspection of the system components is necessary. The valves and flow meters must be properly rated for the design pressures and flows, and the system should be operated such that surges in pressure and flow do not occur.

3.5.2 Blower Capacity

To approximate the number of injection wells that can be run simultaneously while still maintaining the desired flowrates and pressures, a one-day test was performed on March 4, 2023. During this test, nine wells were opened for injection and then closed one at a time until the desired flowrates and pressures were reached. From this, it was observed that the current blower can support the operation of seven injection wells simultaneously.

3.5.3 Injection Line Operation and Maintenance

As part of the Extended Pilot Study, the existing on-site injection lines and DPE wells were evaluated to assess the condition of the injection wells and their viability to be used for the proposed biosparge treatment system.

The performance of biosparge in modified DPE wells was found to be comparable to that in newly installed injection wells. However, the operation of some DPE wells is believed to be limited in some areas due to poor well condition and iron scaling over well screens. A survey of down-well conditions using a camera revealed that approximately 13 DPE wells have scaling over more than 50% of their well screens. Table A-3 includes a summary of observed well conditions.

Injection lines testing was performed on the GS-01, C-, D-, E-, F-, and G-lines. These lines were able to receive target air flows at the downstream wellheads with the exception of the F-Line, where no air flow was observed at any of the DPE wells. A test of the F-line was conducted on March 4, 2023, where temporary injection lines were installed to bypass the underground section of the F-line. Flow at F-line injection well heads was successfully achieved. Based on these results, there is likely a clog or a break in the underground section of the F-line located between the blower and the first injection well in the F-line, RW-4-F (Figure A-4). The F-line will need to be investigated and repaired if it is to be used as part of the full-scale biosparge treatment system.

3.5.4 Injection Wellhead Configuration

During the extended pilot study, K-packers were used for the majority of the study and were rotated between the injection wells. Due to routinely moving them between wells and poor injection well conditions, the K-packers were unable to remain inflated and had to be reinflated on the biweekly field visits. Geosyntec tested another method of injecting air involving a long polyvinyl chloride pipe lowered into the well and had similar success to wells that had K-packers. For more information on the limited-space well injection setup, please refer to the Fourth Progress Report (Geosyntec 2023d).

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TABLES

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				GS-01	GS-02	GS-03	CDM-17	CDM-17	CDM-17	CDM-17	CDM-18	CDM-18	CDM-18	CDM-18	SP-04	SP-04	B-04
				3/7/2022	3/9/2022	3/9/2022	3/7/2022	4/25/2022	11/21/2022	2/20/2023	3/8/2022	5/17/2022	7/14/2022	11/21/2022	3/8/2022	5/18/2022	3/9/2022
Closest Injection Well				--	--	--	GS-01	GS-01	GS-01	GS-01	GS-01	GS-01	GS-01	GS-01	GS-02	GS-02	GS-03
Distance from Injection Well (ft)				--	--	--	12.8	12.8	12.8	12.8	28.3	28.3	28.3	28.3	31.8	31.8	32.5
Days since Injection Start				Pre-Injections	Pre-Injections	Pre-Injections	Pre-Injections	52	255	297	Pre-Injections	24	130	255	Pre-Injections	73	Pre-Injections
Days since Injection Ended				--	--	--	--	--	--	--	--	--	--	--	--	--	--
Injection Time Period				3/10/22-Present	3/10/22-9/28/22	3/10/22-8/17/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22 - 12/09/22	3/10/22-9/28/22	3/10/22-9/28/22	3/10/22-8/17/22
Field Parameters	Units	CAS Number	CUL														
Dissolved Oxygen	mg/L	-	-	4.83	1.01	3.24	6.40	0.06	2.26	1.17	1.50	0.57	0.48	-0.20	1.90	0.73	0.87
pH	s.u.	-	-	6.56	5.20	6.28	7.16	7.59	7.05	7.73	6.70	6.71	6.79	6.82	6.16	5.98	6.66
Conductivity	us/cm	-	-	1,577.0	5,003.7	3,203.0	453.7	1,031.7	620.3	565.3	357.6	562.3	711.7	1,916.0	374.6	304.2	283.0
Oxidation Reduction Potential	mV	-	-	-76.27	61.07	-63.53	-60.77	10.70	25.40	115.03	-72.97	-67.9	-96.7	-104.0	12.83	0.40	-9.97
Turbidity	NTU	-	-	121	54	38	5	20	2	15	13.98	6.45	1.79	2.80	21	8	5
Temperature	C	-	-	9.67	8.63	11.47	10.17	13.09	14.80	9.57	9.6	14.8	22.0	13.6	9.80	15.30	10.60
Semivolatile Organic Compounds Method 8270E																	
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<1.7	<1.7	<1.7	<1.7	<0.25	<0.93	<0.088	<1.7	<0.083	<0.25	<0.83	<1.7	<0.084	<1.7
Pentachlorophenol	µg/L	87-86-5	3	**0.38 J**	**0.88 J**	<2.9	<0.96	<0.51	<7.7	**0.29 J**	**0.21 J**	<0.17	<0.52	<6.9	**0.28 J**	**0.59 J**	<2.9
Volatile Petroleum Products NWTPH-Gx																	
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.016**	**0.093**	<0.050	<0.050	<0.014	R	**<0.014**	**0.024 J**	**0.17 J**	**0.18 J**	R	<0.050	**0.068 J**	<0.050
Semivolatile Petroleum Products NWTPH-Dx																	
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**2.7**	**0.35**	**0.58**	**0.23**	**0.58**	**0.55**	**0.31**	**1.5**	**1.1**	**3.2**	**3.1**	**0.12 J**	<0.066	**0.24 J**
Motor Oil (>C24-C36)	mg/L		1	**2.0**	<0.098	<0.1	**0.58**	**0.82**	**0.70**	**0.54**	**0.93**	**0.69**	**1.1**	**2.1**	<0.1	<0.098	**0.62**
Volatile Organic Compounds Method 8260D																	
Total Detected VOC	µg/L	-	-														
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<0.18	<0.18	<0.18	<0.18	<0.18	<0.3	--	<0.18	<0.18	<0.3	<0.3	<0.18	<0.18	<0.18
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.39	<0.39	<0.39	<0.39	<0.39	<0.3	<0.39	<2	<0.39	<0.3	<0.3	<0.39	<0.39	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<0.52	<0.52	<0.52	<0.52	<0.52	<0.3	--	<2.6	<0.52	<0.3	<0.3	<0.52	<0.52	<0.52
1,1-Dichloroethane	µg/L	75-34-3	52,000	<0.22	**2.2**	<0.22	<0.22	<0.22	<0.3	<0.22	<1.1	**0.34 J**	**0.9 J**	**0.76 J**	**1.0**	**1.7**	<0.22
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<0.61	<0.61	<0.61	<0.61	<0.61	<1	<0.61	<3.1	<0.61	<1	<1	<0.61	<0.61	<0.61
1,2-Dichlorobenzene	µg/L	95-50-1	-	<0.46	<0.46	<0.46	<0.46	<0.46	<0.2	--	<2.3	<0.46	**0.6 J**	**0.53 J**	<0.46	**0.65 J**	<0.46
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<0.55	<0.55	<0.55	<0.55	<0.55	<0.3	--	<2.8	<0.55	<0.3	<0.3	<0.55	<0.55	<0.55
1,3-Dichlorobenzene	µg/L	541-73-1	-	<0.48	<0.48	<0.48	<0.48	<0.48	<0.68	--	<2.4	<0.48	<0.68	<0.68	<0.48	<0.48	<0.48
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	<0.46	<0.46	<0.46	<0.46	<0.46	<0.3	<0.46	<2.3	<0.46	<0.3	**0.32 J**	<0.46	<0.46	<0.46
2-Chlorotoluene	µg/L	95-49-8	-	<0.51	<0.51	<0.51	<0.51	<0.51	<0.3	--	<2.6	<0.51	<0.3	<0.3	<0.51	<0.51	<0.51
Benzene	µg/L	71-43-2	22.7	<0.24	**0.99 J**	<0.24	<0.24	<0.24	<0.3	<0.24	<1.2	<0.24	<0.3	<0.3	<0.24	<0.24	<0.24
CFC-11	µg/L	75-69-4	-	<0.36	<0.36	<0.36	<0.36	<0.36	<0.2	--	<1.8	<0.36	<0.2	<0.2	<0.36	<0.36	<0.36
Chlorobenzene	µg/L	108-90-7	-	<0.44	**12**	<0.44	<0.44	<0.44	<0.3	--	<2.2	<0.44	**0.49 J**	**0.63 J**	**0.66 J**	**2.2**	<0.44
Chloroethane	µg/L	75-00-3	-	<0.35	<2.6 J	<0.35	<0.35	<0.35	<0.2 J	--	<1.8	<0.35	<0.2	<0.2 J	<0.35	<0.35	<0.35
Chloroform	µg/L	67-66-3	-	<0.26	<0.26	<0.26	<0.26	<0.26	<0.3	--	<0.26	<0.26	<0.3	<0.3	<0.26	<0.26	<0.26
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.35	<0.35	<0.35	<0.35	<0.35	<0.3	<0.35	<0.35	<0.35	<0.3	**0.44 J**	<0.35	**1.9**	<0.35
Cumene	µg/L	98-82-8	-	<0.44	<0.44	<0.44	<0.44	<0.44	<0.2	--	<0.44	<0.44	<0.2	<0.2	<0.44	<0.44	<0.44
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<0.5	<0.5	<0.5	<0.5	<0.4	<0.5	<2.5	<0.5	<0.4	<0.4	<0.5	<0.5	<0.5
m, p-Xylene	µg/L	179601-23-1	-	<0.53	<0.53	<0.53	<0.53	<0.53	<2	<0.53	<2.7	<0.53	<2	<2	<0.53	<0.53	<0.53
Naphthalene	µg/L	91-20-3	4,940	<0.93	<0.93	<0.93	<0.93	<0.93	<1	<0.93	<0.93 J	<0.93	<1	<1	<0.93 J	<0.93	<0.93
n-Butylbenzene	µg/L	104-51-8	-	<0.44	<0.44	<0.44	<0.44	<0.44	<0.3	--	<2.2	<0.44	<0.3	<0.3	<0.44	<0.44	<0.44
n-Propylbenzene	µg/L	103-65-1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.3	--	<2.5	<0.5	<0.3	<0.3	<0.5	<0.5	<0.5
o-Xylene	µg/L	95-47-6	-	<0.39	<0.39	<0.39	<0.39	<0.39	<0.4	--	<2	<0.39	<0.4	<0.4	<0.39	<0.39	<0.39
p-Isopropyltoluene	µg/L	99-87-6	-	<0.28	<0.28	<0.28	<0.28	<0.28	<0.3	--	<1.4	<0.28	<0.3	<0.3	<0.28	<0.28	<0.28
Sec-Butylbenzene	µg/L	135-98-8	-	<0.49	<0.49	<0.49	<0.49	<0.49	<0.3	--	<2.5	<0.49	<0.3	<0.3	<0.49	<0.49	<0.49
Styrene	µg/L	100-42-5	-	<0.53	<0.53	<0.53	<0.53	<0.53	<0.3	--	<2.7	<0.53	<0.3	<0.3	<0.53	<0.53	<0.53
Tert-Butylbenzene	µg/L	98-06-6	-	<0.58	<0.58	<0.58	<0.58	<0.58	<0.3	--	<2.9	<0.58	<0.3	<0.3	<0.58	<0.58	<0.58
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<0.41	<0.41	<0.41	<0.41	<0.3	<0.41	<2.1	<0.41	<0.3	<0.3	**0.59 J**	**1.3**	<0.41
Toluene	µg/L	108-88-3	15,000	<0.39	<0.39	<0.39	<0.39	<0.39	<0.2	<0.39	<2	<0.39	<0.2	<0.2	<0.39	<0.39	<0.39
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<0.39	<0.39	<0.39	<0.39	<0.39	<0.7	--	<0.39	<0.39	<0.7	<0.7	<0.39	<0.39	<0.39
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<0.41	<0.41	<0.41	<0.41	<0.41	<0.2	--	<2.1	<0.41	<0.2	<0.2	<0.41	<0.41	<0.41
Trichloroethene	µg/L	79-01-6	30.00	<0.26	**0.32 J**	<0.26	<0.26	<0.26	<0.3	<0.26	<1.3	<0.26	<0.3	<0.3	**0.37 J**	**0.89 J**	<0.26
Vinyl Chloride	µg/L	75-01-4	2.4	<0.22	<0.22	<0.22	<0.22	<0.22	<0.2 J	<0.22	<1.1	<0.22	**0.5 J**	<0.2 J	<0.22	<0.22	<0.22

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				RW-19-G	RW-19-G	RW-19-G-DUP	RW-19-G	RW-47-D	RW-47-D-DUP	RW-47-D	RW-47-D	P-1A	P-1A	P-1A-DUP	P-1A	P-1A	P-1A
				3/7/2022	5/17/2022	5/17/2022	9/15/2022	3/8/2022	3/8/2022	5/18/2022	9/15/2022	3/8/2022	4/11/2022	4/11/2022	10/20/2022	1/26/2023	3/24/2023
Closest Injection Well				--	--	--	--	--	--	--	--	RW-12-G	RW-12-G	RW-12-G	RW-12-G	RW-12-G	RW-12-G
Distance from Injection Well (ft)				--	--	--	--	--	--	--	--	15.9	15.9	15.9	15.9	15.9	15.9
Days since Injection Start				Pre-Injections	74	74	Post-Injections	Pre-Injections	Pre-Injections	--	--	Pre-Injections	36	36	Pre-Injection	57	114
Days since Injection Ended				--	--	--	155	--	--	36	155	--	--	--	--	--	--
Injection Time Period				3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	10/27/22-3/24/23	10/27/22-3/24/23	10/27/22-3/24/23
Field Parameters	Units	CAS Number	CUL														
Dissolved Oxygen	mg/L	-	-	0.73	0.75	0.75	0.00	0.87	0.87	1.03	0.00	1.05	0.55	0.55	0.06	0.84	1.55
pH	s.u.	-	-	6.10	5.06	5.06	5.82	6.34	6.34	6.50	6.30	6.53	6.41	6.41	7.17	6.58	6.61
Conductivity	us/cm	-	-	1,219.3	2,952.0	2,952.0	2,253.7	611.7	611.7	403.1	582.0	893.0	1,416.0	1,416.0	1,144.3	1,325.0	1,360.3
Oxidation Reduction Potential	mV	-	-	-17.23	73.20	73.20	-55.40	-137.97	-137.97	62.97	-62.4	-122.07	-120.20	-120.20	48.60	-105.50	-107.93
Turbidity	NTU	-	-	215	27	27	87	49	49	8	122	16	9	9	11	14	1
Temperature	C	-	-	11.50	15.10	15.10	21.50	10.10	10.10	13.10	19.50	9.67	11.63	11.63	19.25	11.20	10.20
Semivolatile Organic Compounds Method 8270E																	
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<1.7	<0.083	<0.083	<0.25	<1.7	<1.7	<0.083	<0.25	<1.7	<1.7	<1.7	<0.084	<0.083	<0.85
Pentachlorophenol	µg/L	87-86-5	3	**0.25 J**	**0.24 J**	**0.34 J**	<0.51	**3.5 J**	**3.5 J**	**0.25 J**	**0.9 J**	**4.8 J**	**0.24 J**	<3.5	<0.17	<3.5	<1.8
Volatile Petroleum Products NWTPH-Gx																	
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.18**	**0.17 J**	**0.18 J**	**0.48**	**0.15 J**	<0.50 J	<0.019	**0.14 J**	**0.38 J**	**1.6 J**	**1.1**	<0.14	**0.54**	**0.53**
Semivolatile Petroleum Products NWTPH-Dx																	
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**5.3**	**0.21**	**0.23**	**7.8**	**4.1**	**4.0**	**0.31**	**2.5**	**5.6**	**14**	**14**	**10**	**16**	**11**
Motor Oil (>C24-C36)	mg/L		1	**2.9**	**0.45**	**0.31 J**	**0.49**	**2.6**	**2.6**	**3.1**	**0.54**	**3.2**	**9**	**9.3**	**5.2**	**5.2**	**5.2**
Volatile Organic Compounds Method 8260D																	
Total Detected VOC	µg/L	-	-														
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<0.18	<0.18	<0.18	<1.5	<1.8	<1.8	<0.18	<1.5	<0.9	<0.18	<0.18	<1.8	--	--
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.39	<0.39	<0.39	<1.5	<3.9	<3.9	<0.39	<1.5	<2	<0.39	<0.39	<3.9	<2	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<0.52	<0.52	<0.52	<1.5	<5.2	<5.2	<0.52	<1.5	<2.6	<0.52	<0.52	<5.2	--	--
1,1-Dichloroethane	µg/L	75-34-3	52,000	**0.44 J**	<0.22 J	**0.22 J**	<1.5	<2.2	<2.2	**0.3 J**	<1.5	<1.1	**1.1**	**1.1**	<2.2	<1.1	**0.55 J**
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<0.61	<0.61	<0.61	<5	<6.1	<6.1	<0.61	<5	<3.1	<0.61	<0.61	<6.1	<3.1	<0.61
1,2-Dichlorobenzene	µg/L	95-50-1	-	<0.46	<0.46	<0.46	<1	<4.6	<4.6	<0.46	**1.8 J**	<2.3	**2.5**	**2.3**	<4.6	--	--
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<0.55	<0.55	<0.55	<1.5	<5.5	<5.5	<0.55	<1.5	<2.8	<0.55	<0.55	<5.5	--	--
1,3-Dichlorobenzene	µg/L	541-73-1	-	<0.48	<0.48	<0.48	<3.4	<4.8	<4.8	<0.48	<3.4	<2.4	<0.48	<0.48	<4.8	--	--
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	<0.46	<0.46	<0.46	<1.5	<4.6	<4.6	<0.46	<1.5	<2.3	<0.46	<0.46	<4.6	**2.4**	**2.4**
2-Chlorotoluene	µg/L	95-49-8	-	<0.51	<0.51	<0.51	<1.5	<5.1	<5.1	<0.51	<1.5	<2.6	<0.51	<0.51	<5.1	--	--
Benzene	µg/L	71-43-2	22.7	<0.24	<0.24	<0.24	<1.5	<2.4	<2.4	<0.24	<1.5	**3.3 J**	**4.4**	**4**	**3.5 J**	**4.6 J**	**2.7**
CFC-11	µg/L	75-69-4	-	<0.36	<0.36	<0.36	<1	<3.6	<3.6	<0.36	<1	<1.8	<0.36	<0.36	<3.6	--	--
Chlorobenzene	µg/L	108-90-7	-	<0.44	<0.44	<0.44	<1.5	**21**	**23**	<0.44	**3.6 J**	<2.2	<0.44	<0.44	<4.4	--	--
Chloroethane	µg/L	75-00-3	-	**8.8 J**	**2.2**	**2.1**	**10**	<3.5	<3.5	<0.35	<1	**29**	**19**	**20**	**63**	--	--
Chloroform	µg/L	67-66-3	-	<0.26	<0.26	<0.26	<1.5	<2.6	<2.6	<0.26	<1.5	<1.3	<0.26	<0.26	<2.6	--	--
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.35	<0.35	<0.35	<1.5	<3.5	<3.5	<0.35	<1.5	<1.8	**2.1**	**1.7**	<3.5	<1.8	**0.55 J**
Cumene	µg/L	98-82-8	-	<0.44	<0.44	<0.44	<1	<4.4	<4.4	<0.44	<1	<2.2	**1.1**	**1.1**	<4.4	--	--
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<0.5	<0.5	<2	<5	<5	<0.5	<2	<2.5	**0.65 J**	**0.6 J**	<5	<2.5	<0.5
m, p-Xylene	µg/L	179601-23-1	-	<0.53	<0.53	<0.53	<10	<5.3	<5.3	<0.53	<10	<2.7	<0.53	<0.53	<5.3	<2.7	<0.53
Naphthalene	µg/L	91-20-3	4,940	<0.93	**1.9 J**	<0.93 J	<5	<9.3 J	<9.3	<0.93	<5	<4.7 J	<0.93	<0.93	<9.3	<4.7	<0.93
n-Butylbenzene	µg/L	104-51-8	-	<0.44	<0.44	<0.44	<1.5	<4.4	<4.4	<0.44	<1.5	<2.2	<0.44	<0.44	<4.4	--	--
n-Propylbenzene	µg/L	103-65-1	-	<0.5	<0.5	<0.5	<1.5	<5	<5	<0.5	<1.5	<2.5	**0.75 J**	**0.72 J**	<5	--	--
o-Xylene	µg/L	95-47-6	-	<0.39	<0.39	<0.39	<2	<3.9	<3.9	<0.39	<2	<2	<0.39	<0.39	<3.9	--	--
p-Isopropyltoluene	µg/L	99-87-6	-	<0.28	<0.28	<0.28	<1.5	<2.8	<2.8	<0.28	<1.5	<1.4	<0.28	<0.28	<2.8	--	--
Sec-Butylbenzene	µg/L	135-98-8	-	<0.49	<0.49	<0.49	<1.5	<4.9	<4.9	<0.49	<1.5	<2.5	<0.49	<0.49	<4.9	--	--
Styrene	µg/L	100-42-5	-	<0.53	<0.53	<0.53	<1.5	<5.3	<5.3	<0.53	<1.5	<2.7	<0.53	<0.53	<5.3	--	--
Tert-Butylbenzene	µg/L	98-06-6	-	<0.58	<0.58	<0.58	<1.5	<5.8	<5.8	<0.58	<1.5	<2.9	**2.6**	**2.8**	<5.8	--	--
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<0.41	<0.41	<1.5	<4.1	<4.1	<0.41	<1.5	<2.1	<0.41	<0.41	<4.1	<2.1	<0.41
Toluene	µg/L	108-88-3	15,000	**0.98 J**	**0.41 J**	<0.39 J	<1	**7.5 J**	**8.7**	<0.39	**2 J**	<2	**0.4 J**	<0.39 J	<3.9	<2	<0.39
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<0.39	<0.39	<0.39	<3.5	<3.9	<3.9	<0.39	<3.5	<2	<0.39	<0.40	<3.9	--	--
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<0.41	<0.41	<0.41	<1	<4.1	<4.1	<0.41	<1	<2.1	<0.41	<0.41	<4.1	--	--
Trichloroethene	µg/L	79-01-6	30.00	<0.26	<0.26	<0.26	<1.5	<2.6	<2.6	<0.26	<1.5	<1.3	**1.2**	<0.42	<2.6	<1.3	<0.26
Vinyl Chloride	µg/L	75-01-4	2.4	<0.22	<0.22	<0.22	<1	<2.2	<2.2	<0.22	<1	<1.1	<0.22	<0.43	<2.2	<1.1	**0.39 J**

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				SP-06	SP-06	SP-06	SP-06	SP-06	SP-06	SP-06	SP-06	SP-06	SP-06	SP-06 DUP	SP-06
				3/8/2022	4/11/2022	4/26/2022	5/18/2022	7/14/2022	10/21/2022	11/21/2022	12/13/2022	1/26/2023	2/22/2023	2/22/2023	4/26/2023
Closest Injection Well				RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D	RW-47-D
Distance from Injection Well (ft)				7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Days since Injection Start				Pre-Injections	36	--	Post Injection	Post Injection	Pre-Injection	25	Post Injection	Post Injection	Post Injection	Post Injection	Post Injection
Days since Injection Ended				--	--	13	36	92	--	--	22	66	93	93	156
Injection Time Period				3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	3/10/22-4/13/22	10/27/22-11/21/22	10/27/22-11/21/22	10/27/22-11/21/22	10/27/22-11/21/22	10/27/22-11/21/22	10/27/22-11/21/22
Field Parameters	Units	CAS Number	CUL												
Dissolved Oxygen	mg/L	-	-	0.96	0.71	0.09	0.74	3.20	0.03	0.02	0.07	0.90	0.57	0.57	0.17
pH	s.u.	-	-	6.06	6.05	7.84	5.96	5.85	6.38	6.09	6.11	6.06	10.89	10.89	6.16
Conductivity	us/cm	-	-	568.7	339.4	442.0	736.3	453.7	438.3	423.9	539.0	589.7	697.7	697.7	665.7
Oxidation Reduction Potential	mV	-	-	-73.10	-61.10	12.6	-62.1	-86.3	72.03	-76.77	-26.60	-51.73	-21.50	-21.50	-115.13
Turbidity	NTU	-	-	25	2	32	18	29	23	26	15	11	32	32	6
Temperature	C	-	-	9.50	12.60	12.06	14.4	20.7	15.84	14.00	11.17	9.70	7.77	7.77	11.40
Semivolatile Organic Compounds Method 8270E															
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<1.7	<1.7	<0.082	<0.083	<0.25	<0.083	<0.91	<0.83	<0.083	<0.1	<0/9	<0.84
Pentachlorophenol	µg/L	87-86-5	3	<0.97	<3.5	**0.3 J**	**3.0 J**	<0.52	<0.17	<1.9	**2.5 J**	<3.4	**17 J**	**18 J**	**1.8 J +**
Volatile Petroleum Products NWTPH-Gx															
Gasoline (C4-C10)	mg/L	86290-81-5	1	**1.5**	**2.2**	**3.3**	**2.6**	**2.5**	**1.3**	**0.64 J-**	**1.2**	**0.88**	**1.5**	**1.4**	**0.71**
Semivolatile Petroleum Products NWTPH-Dx															
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**12**	**9.9**	**11 J**	<0.066	**10**	**17**	**10**	**21**	**17**	**21**	**24**	**14**
Motor Oil (>C24-C36)	mg/L		1	**4.4**	**4**	**3.4 J**	**0.29**	**2.1**	**6.9**	**2.3**	**4.5**	**4.3**	**6**	**6.8**	**5.4**
Volatile Organic Compounds Method 8260D															
Total Detected VOC	µg/L	-	-												
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<1.8	<1.8	<0.18	<0.18	<0.3	<0.18	<0.3	<0.18	--	--	--	--
1,1,1-Trichloroethane	µg/L	71-55-6	227	<3.9	<3.9	<0.39	<0.39	<0.3	<0.39	**0.68 J**	<0.39	<3.9	<0.4	<3.9	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<5.2	<5.2	<0.52	<0.52	<0.3	<0.52	<0.3	<0.52	--	--	--	--
1,1-Dichloroethane	µg/L	75-34-3	52,000	<2.2	<2.2	**1.8**	**1.5**	**1.6**	**1.1**	**5.1**	**3.1**	**2.5 J**	**3.5**	**4 J**	**2.2**
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	**45**	**55**	**63**	**22**	**45**	**41**	**40**	**43**	**24 J**	**34**	**33**	**9.4**
1,2-Dichlorobenzene	µg/L	95-50-1	-	**12**	**27**	**25**	**20**	**20**	**15**	**8.9**	**8.6**	--	--	--	--
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	**15**	**23**	**22**	**20**	**19**	**12**	**24**	**22.0**	--	--	--	--
1,3-Dichlorobenzene	µg/L	541-73-1	-	<4.8	**7.8 J**	**5.9**	**4.8**	**5.8**	**4.9**	**6.6**	**6.3**	--	--	--	--
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	**37**	**47**	**47**	**38**	**41**	**34**	**48**	**50**	**39**	**53**	**58**	**45**
2-Chlorotoluene	µg/L	95-49-8	-	<5.1	<5.1	<0.51	**1.1**	**1.3 J**	<0.51	**1.3 J**	**1.3**	--	--	--	--
Benzene	µg/L	71-43-2	22.7	<2.4	<2.4	**1.6**	**1.1**	**1.6**	**1.5**	**3.6**	**1.8**	<2.4	**1.3**	<2.4	**0.66 J**
CFC-11	µg/L	75-69-4	-	<3.6	<3.6	<0.36	<0.36	<0.2	<0.36	<0.2	<3.6	--	--	--	--
Chlorobenzene	µg/L	108-90-7	-	**330**	**240**	**400 J**	<0.44	**340**	**250 J**	**290**	**320**	--	--	--	--
Chloroethane	µg/L	75-00-3	-	<3.5	<3.5	**0.54**	**0.66 J**	**0.36 J**	<0.35	<0.2 J	<0.35	--	--	--	--
Chloroform	µg/L	67-66-3	-	<2.6	<2.6	<0.26	<0.26	<0.3	<0.26	<0.3	<0.26	--	--	--	--
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<3.5	<3.5	**0.7 J**	**1.0**	**1.5**	**1.6**	**0.97 J**	**0.9 J**	<3.5	**1.6**	<3.5	**0.98 J**
Cumene	µg/L	98-82-8	-	<4.4	**5.7 J**	**1.6**	**1.5**	**1.6 J**	**1.6**	**2 J**	**2.0**	--	--	--	--
Ethylbenzene	µg/L	100-41-4	6,910	**25 J**	**38**	**32**	**25**	**28**	**22**	**17**	**18**	**13**	**18.0**	**17**	**7.4**
m, p-Xylene	µg/L	179601-23-1	-	<5.3	**170**	**190 J**	<0.53	**130**	**96**	**50**	**26**	**12 J**	**9.3**	**9.1 J**	**6.6**
Naphthalene	µg/L	91-20-3	4,940	<9.3 J	**13 J**	**15**	**14**	**9.1**	**10**	**4.3 J**	<9.3	<9.3	**9.5**	<9.3	**2.9 J**
n-Butylbenzene	µg/L	104-51-8	-	<4.4	<4.4	**5.2**	**4.4**	<0.3	<0.44	<0.3	<0.44	--	--	--	--
n-Propylbenzene	µg/L	103-65-1	-	<5	<5	**2.2**	**1.9 J**	**2.1 J**	**1.8**	**2 J**	**2.4**	--	--	--	--
o-Xylene	µg/L	95-47-6	-	**140 J**	**130**	**130 J**	<0.39	**110**	**88**	**41**	**45**	--	--	--	--
p-Isopropyltoluene	µg/L	99-87-6	-	<2.8	<2.8	**0.83 J**	**0.83 J**	**0.81 J**	**0.65 J**	**1.7 J**	**2.3**	--	--	--	--
Sec-Butylbenzene	µg/L	135-98-8	-	<4.9	<4.9	<0.49	<0.49	<0.3	<0.49	<0.3	<0.49	--	--	--	--
Styrene	µg/L	100-42-5	-	<5.3	**10**	**3.8**	**3.4**	<0.3	**2.5**	<0.3	**1.3**	--	--	--	--
Tert-Butylbenzene	µg/L	98-06-6	-	<5.8	<5.8	<0.58	<0.58	<0.3	<0.58	<0.3	<0.58	--	--	--	--
Tetrachloroethene	µg/L	127-18-4	3.30	<4.1	<4.1	<0.41	<0.41	<0.3	<0.41	<0.3	<0.41	<4.1	<0.4	<4.1	<0.41
Toluene	µg/L	108-88-3	15,000	<3.9	**6.3 J**	**3.5**	**3**	**3.2**	**3.2**	**1.4**	**2.1**	<3.9	**1.7**	<3.9	**0.62 J**
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<3.9	<3.9	<0.39	<0.39	<0.7	<0.39	<0.7	<0.39	--	--	--	--
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<4.1	**4.8**	<0.41	<0.41	<0.2	<0.41 *-	<0.2	<0.41	--	--	--	--
Trichloroethene	µg/L	79-01-6	30.00	<2.6	<2.6	<0.26	<0.26	<0.3	<0.26	<0.3	**0.35 J**	<2.6	**0.5 J**	<2.6	**0.43 J**
Vinyl Chloride	µg/L	75-01-4	2.4	<2.2	<2.2	**0.61 J**	**0.82 J**	**0.65 J**	**0.86 J**	<0.2 J	<0.22	<2.2	**0.34 J**	<2.2	**0.43 J**

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				CDM-16	CDM-16	RW-56-C	RW-56-C	RW-56-C	AGI-15	AGI-15	AGI-15 DUP	AGI-15	AGI-15	AGI-15	AGI-15	AGI-15	AGI-15
				4/27/2022	8/17/2022	4/12/2022	7/14/2022	8/18/2022	4/12/2022	6/15/2022	6/15/2022	8/18/2022	10/21/2022	11/21/2022	1/26/2023	2/22/2023	3/23/2023
Closest Injection Well				RW-12-G	RW-12-G	--	--	--	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C
Distance from Injection Well (ft)				12.0	12.0	--	--	--	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
Days since Injection Start				--	Pre-Injection	Pre-Injections	Post Injection	Post Injection	Pre-Injections	65	65	Post -Injection	Pre-Injection	25	56	83	112
Days since Injection Ended				14	--	--	57	91	--	--	--	33	--	--	--	--	--
Injection Time Period				3/10/22-4/13/22	3/10/22-4/13/22	4/13/22-5/18/22	4/13/22-5/18/22	4/13/22-5/18/22	4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	10/27/22-3/24/23	10/27/22-3/24/23	10/27/22-3/24/23	10/27/22-3/24/23	10/27/22-3/24/23
Field Parameters	Units	CAS Number	CUL														
Dissolved Oxygen	mg/L	-	-	0.09	0.71	0.56	0.40	0.31	0.51	1.54	1.54	0.58	0.14	-0.82	1.12	2.12	1.70
pH	s.u.	-	-	6.91	6.66	6.14	6.88	6.89	5.97	6.01	6.01	6.05	6.92	6.18	6.08	10.70	6.17
Conductivity	us/cm	-	-	648.0	911.0	919.0	719.7	709.7	427.5	418.5	418.5	373.1	552.7	437.9	442.4	425.0	385.3
Oxidation Reduction Potential	mV	-	-	84.10	-115.10	-97.77	-138.57	-135.27	-70.73	-79.47	-79.47	-65.27	150.13	-83.10	-29.23	-13.53	-87.47
Turbidity	NTU	-	-	118	418	4	30	29	20	19	19	26	29	29	10	45	9
Temperature	C	-	-	11.96	29.40	10.17	18.10	24.07	11.57	16.70	16.70	23.27	17.96	13.73	9.83	8.59	9.50
Semivolatile Organic Compounds Method 8270E																	
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<0.25	<0.83	<1.7	<0.25	<0.084	<1.7	<0.25	<0.25	<0.083	<0.084	<0.093	<0.083	<0.087	<0.85
Pentachlorophenol	µg/L	87-86-5	3	**0.64 J**	<1.7	<3.4	**0.55 J**	**0.18 J**	<3.4	**0.76**	**0.77 J**	**0.2 J**	<0.17	<0.19	**0.36 J**	<0.18	<1.8
Volatile Petroleum Products NWTPH-Gx																	
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.19**	**0.2**	**0.1**	**0.084 J**	**0.025 J**	**0.67**	**2.0**	**1.9**	**0.36 J**	**1.8**	**0.23 J-**	**0.79**	**0.77**	**0.96**
Semivolatile Petroleum Products NWTPH-Dx																	
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**3.1 J**	**7.7**	**1.0**	**10**	**1.6 J**	**3.5**	**2.6**	**2.4**	**3.2 J**	**3.7**	**3.7**	**3.1**	**3**	**2.9**
Motor Oil (>C24-C36)	mg/L		1	**4.2 J**	**3.9**	**2.3**	**1.0**	**2.7 J**	**3.8**	**0.52 J**	**0.54 J**	**2.7 J**	**2.5**	**2.4**	**1.7**	**2.2**	**1.6**
Volatile Organic Compounds Method 8260D																	
Total Detected VOC	µg/L	-	-														
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<0.18	<0.24	<0.18	<0.3	R	<0.18	<0.3	<0.3	R	<0.18	<0.3	--	--	--
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.39	<0.39	**0.44 J**	<0.3	R	**0.43 J**	<0.3	<0.3	R	<0.39	<0.3	<3.9	<0.39	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<0.52	<0.52	<0.52	<0.3	R	<0.52	<0.3	<0.3	R	<0.52	<0.3	--	--	--
1,1-Dichloroethane	µg/L	75-34-3	52,000	**1.5**	**1.4**	**1.2**	**0.53 J**	**1 J**	**1.3 J**	<0.3	**0.36**	**0.48 J**	<0.22	<0.3	<2.2	**0.86 J**	**0.76 J**
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<0.61	<0.61	<0.61	<1	R	**21**	**15**	**16**	**10 J**	**21**	**6.7**	**16 J**	**9.7**	**12**
1,2-Dichlorobenzene	µg/L	95-50-1	-	<0.46	**2**	**0.7 J**	<0.2	R	**10**	**8.4**	**8.8**	**7.3 J**	**1.6**	**6.1**	--	--	--
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<0.55	<0.55	<0.55	<0.3	R	**7.2**	**5.3**	**5.6**	**3.6 J**	<0.55	**1.6 J**	--	--	--
1,3-Dichlorobenzene	µg/L	541-73-1	-	<0.48	**0.52 J**	**1.0**	<0.68	R	**10**	**8.2**	**8.4**	**6.7 J**	**6.9**	**9.1**	--	--	--
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	<0.46	**2.6**	**6.5**	**3.0 J**	**2.6 J**	**62**	**59**	**60**	**49 J**	**56**	**70**	**91**	**93**	**95**
2-Chlorotoluene	µg/L	95-49-8	-	<0.51	<0.51	<0.51	<0.3	R	<2.6	**1.3 J**	**1.3 J**	**1.2 J**	**2**	**1.8 J**	--	--	--
Benzene	µg/L	71-43-2	22.7	**0.68 J**	**0.7 J**	**0.85 J**	**0.3 J**	**0.43 J**	**4.9**	**4.3**	**4.5**	**3.9 J**	**15**	**6.4**	**6.8 J**	**6.2**	**7**
CFC-11	µg/L	75-69-4	-	<0.36	0.36 J	<0.36	<0.2	<0.36 J	<0.36	<0.2	<0.2	**0.36J**	<0.36	<0.2	--	--	--
Chlorobenzene	µg/L	108-90-7	-	<0.44	**0.88 J**	**23**	**12**	**14 J**	**450**	**600**	**670**	**590 J**	**290**	**800**	--	--	--
Chloroethane	µg/L	75-00-3	-	<0.35	**2.7**	<0.35	<0.2	R	**1.0**	<0.2	<0.2	**0.37 J**	<0.35	<0.2 J	--	--	--
Chloroform	µg/L	67-66-3	-	<0.26	<0.26	**0.39 J**	<0.3	R	**0.39 J**	<0.3	<0.3	R	<0.26	<0.3	--	--	--
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.35	**1.1**	**7.2**	**1.8**	**2.7 J**	**1.8 J**	<0.3	<0.3	R	<0.35	<0.3	<3.5	<0.35	<0.35
Cumene	µg/L	98-82-8	-	<0.44	<0.44	**0.77 J**	**0.21 J**	R	**6.6**	**4.7 J**	**4.9 J**	**4 J**	**11**	**7.3**	--	--	--
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<0.5	<0.5	<0.4	R	**4.9**	**4.1**	**4.3**	**2.7 J**	**1.7**	**5.5**	**14**	**12**	**18**
m, p-Xylene	µg/L	179601-23-1	-	<0.53	<0.53	<0.53	<2	R	**2.2**	<2	<2	R	<0.53	<2	<5.3	<0.53	**0.71 J**
Naphthalene	µg/L	91-20-3	4,940	<0.93	<0.93	<0.93 J	<1	R	**11 J**	**9.6**	**9.9**	**12 J**	**15**	**11.0**	**24 J**	**24**	**23**
n-Butylbenzene	µg/L	104-51-8	-	<0.44	<0.44	<0.44	<0.3	R	<0.44	<0.3	<0.3	R	<0.44	**0.4**	--	--	--
n-Propylbenzene	µg/L	103-65-1	-	<0.5	<0.5	<0.5	<0.3	R	**8.3**	**6.8**	<7.3	**5.5 J**	**21**	**11.0**	--	--	--
o-Xylene	µg/L	95-47-6	-	<0.39	<0.39	<0.39	<0.4	R	**1.6**	**1.0**	**0.99 J**	**0.86 J**	**1.3**	**1.0**	--	--	--
p-Isopropyltoluene	µg/L	99-87-6	-	<0.28	<0.28	<0.28	<0.3	R	<1.4	<0.3	<0.3	**0.32 J**	<0.28	<0.3	--	--	--
Sec-Butylbenzene	µg/L	135-98-8	-	<0.49	<0.49	<0.49	<0.3	R	<0.49	**0.44 J**	**0.44 J**	R	<0.49	**0.71 J**	--	--	--
Styrene	µg/L	100-42-5	-	<0.53	<0.53	**0.59 J**	<0.3	R	**0.67 J**	<0.3	<0.3	R	<0.53	<0.3	--	--	--
Tert-Butylbenzene	µg/L	98-06-6	-	<0.58	<0.58	<0.58	<0.3	R	<2.9	<0.3	<0.3	R	**1.5 J**	<0.3	--	--	--
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<0.41	<0.41	<0.3	R	<2.1	<0.3	<0.3	R	<0.41	<0.3	<4.1	<0.41	<0.41
Toluene	µg/L	108-88-3	15,000	<0.39	<0.39	<0.39	<0.2	R	**2.6**	**1.6**	**1.7**	**1.4 J**	<0.39	**1.1**	<3.9	**1.3**	**1.5**
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<0.39	<0.39	<0.39	<0.7	R	<0.39	<0.3	<0.3	R	<0.39	<0.7	--	--	--
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<0.41	<0.41	**0.48 J**	<0.2	R	**0.48 J**	<0.2	<0.2	R	<0.41	<0.2	--	--	--
Trichloroethene	µg/L	79-01-6	30.00	<0.26	**0.62 J**	**1.5**	**0.34 J**	**0.43 J**	**0.73 J**	<0.3	<0.3	R	<0.26	<0.3	<2.6	<0.26	<0.26
Vinyl Chloride	µg/L	75-01-4	2.4	<0.22	**0.24 J**	**5.0**	**1.1**	**1.6 J**	<0.22	<0.2	<0.2	**0.43 J**	<0.22	<0.2 J	<2.2	**0.35 J**	**0.62 J**

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				CDM-19	**CDM-19**	**CDM-19**	**CDM-19**	**AGI-05**	**AGI-05**	**AGI-05**	**AGI-05**	**AGI-05**	**AGI-05**	**AGI-25**	**RW-23-D**	**RW-48-D**	**RW-48-D**
				3/9/2022	4/27/2022	6/15/2022	8/17/2022	3/9/2022	6/15/2022	8/18/2022	10/21/2022	2/22/2023	3/23/2023	5/18/2022	6/15/2022	6/15/2022	9/15/2022
Closest Injection Well				RW-28-H	RW-28-H	RW-28-H	RW-28-H	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-55-C	RW-51-D		GS-03	GS-03
Distance from Injection Well (ft)				14.2	14.2	14.2	14.2	20.2	20.2	20.2	20.2	20.2	20.2	3.0	--		
Days since Injection Start				Pre-Injections	16	67	Post Injection	Pre-Injections	34	Post Injection	Pre-Injection	83	112	Pre-Injection	Pre-Injection	Pre-Injection	Post-Injection
Days since Injection Ended				--	--	--	33	--	--	33	--	--	--	--	--	--	64
Injection Time Period				4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	4/13/22-7/13/22	10/27/22-3/24/23	10/27/22-3/24/23	10/27/22-3/24/23	5/18/22-7/13/22	5/18/22-7/13/22	5/18/22-7/13/22	5/18/22-7/13/22
Field Parameters	Units	CAS Number	CUL														
Dissolved Oxygen	mg/L	-	-	8.27	0.11	1.70	0.52	1.21	1.47	0.90	0.03	0.48	1.61	3.91	1.39	1.58	0.05
pH	s.u.	-	-	6.57	7.19	6.53	6.39	6.21	5.88	5.64	6.40	11.43	6.02	6.69	6.68	6.23	6.40
Conductivity	us/cm	-	-	111.1	345.0	90.7	809.0	478.2	292.1	397.9	357.7	500.0	411.3	262.6	134.5	967.0	996.3
Oxidation Reduction Potential	mV	-	-	-3.77	78.07	-10.13	29.00	-86.40	22.03	92.60	71.70	52.33	0.87	54.17	-35.70	-82.63	-152.50
Turbidity	NTU	-	-	5	42	57	22	15	5	26	30	22	8	38	2	6	15
Temperature	C	-	-	8.70	11.33	16.10	23.00	9.13	18.90	25.13	16.78	8.12	9.60	13.90	17.40	14.40	18.63
Semivolatile Organic Compounds Method 8270E																	
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<1.7	<0.083	<0.25	<0.083	<1.7	<0.25	<0.083	<0.087	<0.084	<0.83	<0.11	<0.25	<0.25	<0.25
Pentachlorophenol	µg/L	87-86-5	3	<2.9	**0.17 J**	<0.52	**0.19 J**	**1.3 J**	**0.94 J**	**0.24 J**	**1.1**	**17 J**	<1.7	<0.23	<0.52	<0.52 J	<0.52
Volatile Petroleum Products NWTPH-Gx																	
Gasoline (C4-C10)	mg/L	86290-81-5	1	<0.050	<0.014	**0.022 J**	**0.18**	**0.13**	**0.088 J**	**0.034 J**	**0.43**	**0.081**	**0.3**	<0.019	**0.22 J**	**3.9**	**2.1**
Semivolatile Petroleum Products NWTPH-Dx																	
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**0.23 J**	**0.9**	**0.37**	**5.9**	**3.3**	**1.8**	**1.4 J**	**3.9**	**3**	**3.1**	**0.31**	**0.21**	**8.5**	**6.1**
Motor Oil (>C24-C36)	mg/L		1	**0.37**	**1.3**	<0.1 J	**6.5**	**4.0**	**0.43 J**	**1.3 J**	**3.2**	**1.7**	**1.4**	**0.53**	**0.13 J**	**1.3 J**	**1.0**
Volatile Organic Compounds Method 8260D																	
Total Detected VOC	µg/L	-	-														
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<0.18	<0.18	<0.3	<0.28	<0.18	<0.3	R	<0.18	--	--	<0.18	<0.3	<0.3	<3
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.39	<0.39	<0.3	<0.39	<0.39	<0.3	R	<0.39	<0.39	<0.39	<0.39	<0.3	<0.3	<3
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<0.52	<0.52	<0.3	<0.52	<0.52	<0.3	R	<0.52	--	--	<0.52	<0.3	<0.3	<3
1,1-Dichloroethane	µg/L	75-34-3	52,000	<0.22	<0.22	<0.3	**0.43 J**	**3.5**	<0.3	**0.48 J**	**0.45 J**	**1**	**0.97 J**	<0.22	<0.3	**1.1**	<3
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<0.61	<0.61	<1	<0.61	<0.61	<1	R	<0.61	<0.61	<0.61	<0.61	<1	**280**	**58**
1,2-Dichlorobenzene	µg/L	95-50-1	-	<0.46	<0.46	<0.2	<0.46	<0.46	**0.38**	R	**1.1**	--	--	<0.46	**1.1**	**26**	**2.6 J**
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<0.55	<0.55	<0.3	<0.55	<0.55	<0.3	R	<0.55	--	--	<0.55	<0.3	**40**	**11 J**
1,3-Dichlorobenzene	µg/L	541-73-1	-	<0.48	<0.48	<0.3	<0.48	<0.48	**1.1 J**	**0.54 J**	**3.8**	--	--	<0.48	<0.3	**6**	<6.8
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	<0.46	<0.46	<0.3	<0.46	**8.1**	**5.3**	**1.4 J**	**28**	**2.9**	**2.6**	<0.46	**0.94 J**	**41**	**24 J**
2-Chlorotoluene	µg/L	95-49-8	-	<0.51	<0.51	<0.3 J	<0.51	<0.51	<0.3	R	<0.51	--	--	<0.51	<0.3	**2.4 J**	<3
Benzene	µg/L	71-43-2	22.7	<0.24	<0.24	<0.3	**0.32 J**	**0.36 J**	<0.3	R	**2.7**	**0.37 J**	**0.51 J**	<0.24	<0.3	**6.1**	**4 J**
CFC-11	µg/L	75-69-4	-	<0.36	<0.36	<0.2	0.36 J	<0.36	<0.2	<0.36 J	<0.36	--	--	<0.36	<0.2	<0.2	<2
Chlorobenzene	µg/L	108-90-7	-	<0.44	<0.44	<0.3	**2.5**	**45**	**29**	**6.4 J**	**260**	--	--	<0.44	<0.3	**160**	**72**
Chloroethane	µg/L	75-00-3	-	<0.35	<0.35	<0.2 J	<0.35	<0.35	<0.2	R	<0.35	--	--	<0.35	<0.2	**0.81 J**	<2
Chloroform	µg/L	67-66-3	-	<0.26	<0.26	<0.3	<0.26	<0.26	<0.3	R	<0.26	--	--	<0.26	<0.3	<0.3	<3
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.35	<0.35	<0.3	**0.77 J**	**5.8**	<0.3	R	<0.35	<0.35	<0.35	<0.35	<0.3	<0.3	<3
Cumene	µg/L	98-82-8	-	<0.44	<0.44	<0.2 J	<0.44	<0.44	**0.37**	R	<0.44	--	--	<0.44	<0.2	**18**	**6.5 J**
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<0.5	<0.4	<0.5	<0.5	<0.4	R	**0.78 J**	<0.5	<0.5	<0.5	<0.4	**1.4**	<4
m, p-Xylene	µg/L	179601-23-1	-	<0.53	<0.53	<2	<0.53	<0.53	<2	R	<0.53	<0.53	<0.53	<0.53	<2	**27**	<20
Naphthalene	µg/L	91-20-3	4,940	<0.93	<0.93	<1	<0.93	<0.93	<1	R	**1.2 J**	<0.93	<0.93 J	<0.93	<1	<1	<10
n-Butylbenzene	µg/L	104-51-8	-	<0.44	<0.44	<0.3	<0.44	<0.44	<0.3	R	<0.44	--	--	<0.44	<0.3	**6.6**	**3.3 J**
n-Propylbenzene	µg/L	103-65-1	-	<0.5	<0.5	<0.3 J	<0.5	**0.6 J**	**0.41**	R	**5.8 J**	--	--	<0.5	<0.3	**35**	**14 J**
o-Xylene	µg/L	95-47-6	-	<0.39	<0.39	<0.4	<0.39	<0.39	<0.4	R	<0.39	--	--	<0.39	**0.63 J**	**8.1**	<4
p-Isopropyltoluene	µg/L	99-87-6	-	<0.28	<0.28	<0.3 J	<0.28	<0.28	<0.3	R	<0.28	--	--	<0.28	<0.3	**4.1 J**	<3
Sec-Butylbenzene	µg/L	135-98-8	-	<0.49	<0.49	<0.3	<0.49	<0.49	<0.3	R	<0.49	--	--	<0.49	<0.3	**8.3**	**3.9 J**
Styrene	µg/L	100-42-5	-	<0.53	<0.53	<0.3	<0.53	<0.53	<0.3	R	<0.53	--	--	<0.53	<0.3	<0.3	<3
Tert-Butylbenzene	µg/L	98-06-6	-	<0.58	<0.58	<0.3	<0.58	<0.58	<0.3	R	<0.58	--	--	<0.58	<0.3	**1.3 J**	<3
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<0.41	<0.3	<0.41	<0.41	<0.3	R	<0.41	<0.41`	<0.41	<0.41	<0.3	<0.3	<3
Toluene	µg/L	108-88-3	15,000	<0.39	<0.39	<0.2	<0.39	<0.39	<0.2	R	**0.75 J**	<0.39	<0.39	<0.39	<0.2	**1.3**	<2
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<0.39	<0.39	<0.3	<0.39	<0.39	<0.3	R	<0.39	--	--	<0.39	<0.3	<0.3	<7
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<0.41	<0.41	<0.2	<0.41	<0.41	<0.2	R	<0.41	--	--	<0.41	<0.2	<0.2	<2
Trichloroethene	µg/L	79-01-6	30.00	<0.26	<0.26	<0.3	<0.26	**0.42 J**	<0.3	R	<0.26	<0.26	<0.26	<0.26	<0.3	<0.3	<3
Vinyl Chloride	µg/L	75-01-4	2.4	<0.22	<0.22	<0.2 J	**0.34 J**	**1.6 J**	<0.2	R	<0.22	<0.22	<0.22	<0.22	<0.2	**2.1**	<2

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				B-29	B-29 DUP	B-29	B-29	B-29 DUP	B-29	B-29 DUP	B-29	B-29	B-29	AGI-19	AGI-19
				7/13/2022	7/13/2022	8/18/2022	9/14/2022	9/14/2022	12/13/2022	12/13/2022	2/22/2023	3/23/2023	4/26/2023	7/14/2022	8/18/2022
Closest Injection Well				RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-34-D	RW-52-D	RW-52-D
Distance from Injection Well (ft)				6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	20.3	20.3
Days since Injection Start				Pre-Injection	Pre-Injection	36	63	63	Pre-Injection	Pre-Injection	41	70	--	Pre-Injection	35
Days since Injection Ended				--	--	--	--	--	--	--	--	--	35	--	--
Injection Time Period				7/13/22-9/28/22	7/13/22-9/28/22	7/13/22-9/28/22	7/13/22-9/28/22	7/13/22-9/28/22	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	7/13/22-10/27/23	7/13/22-10/27/23
Field Parameters	Units	CAS Number	CUL												
Dissolved Oxygen	mg/L	-	-	3.62	3.62	0.34	0.00	0.00	0.10	0.10	8.99	1.99	-1.03	0.52	0.40
pH	s.u.	-	-	6.38	6.38	6.37	6.00	6.00	6.32	6.32	4.84	4.81	6.19	5.91	6.30
Conductivity	us/cm	-	-	1,252.0	1,252.0	871.3	1,190.0	1,190.0	2,122.7	2,122.7	1,393.7	1,765.3	2,798.7	837.7	846.0
Oxidation Reduction Potential	mV	-	-	-119.7	-119.7	-32.6	-87.4	-87.4	-106.8	-106.8	196.5	171.1	-97.7	-141.4	-34.2
Turbidity	NTU	-	-	25	25	28	24	24	16	16	95	292	78	17	29
Temperature	C	-	-	17.67	17.67	25.77	22.50	22.50	13.77	13.77	11.21	12.40	12.67	17.07	25.17
Semivolatile Organic Compounds Method 8270E															
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<0.25	<0.25	<0.083	.<0.25	<0.25	<0.82	0.8	<0.82	<0.89	<0.83	<0.25	<0.084
Pentachlorophenol	µg/L	87-86-5	3	**0.88 J**	**0.75 J**	**0.67 J**	**0.77 J**	**0.75 J**	**2.4 J**	**2.4 J**	**16 J**	<1.8	**2.6 J +**	<0.52	**0.2 J**
Volatile Petroleum Products NWTPH-Gx															
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.51**	**0.55**	**0.17 J**	**0.56**	**0.62**	**0.22**	**0.22 J**	**1.5**	**0.6**	**0.54**	**0.59**	**0.097 J**
Semivolatile Petroleum Products NWTPH-Dx															
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**11**	**12**	**9.9 J**	**4.1**	**4.2**	**13**	**12**	**7**	**8.6**	**13**	**6.0**	**7.1 J**
Motor Oil (>C24-C36)	mg/L		1	**3.7**	**3.9**	**4.9 J**	**0.64**	**0.64**	**3.8**	**4**	**1.6**	**2.7**	**4.4**	**2.4**	**6.7 J**
Volatile Organic Compounds Method 8260D															
Total Detected VOC	µg/L	-	-												
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<0.3	<0.3	R	<0.3	<0.3	<0.18	<1.8	--	--	--	<0.3	R
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.3	<0.3	R	<0.3	<0.3	<0.39	<3.9	<0.39	<0.39	<0.39	<0.3	R
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<0.3	<0.3	R	<0.3	<0.3	<0.52	<5.2	--	--	--	<0.3	R
1,1-Dichloroethane	µg/L	75-34-3	52,000	<0.3	<0.3	**0.61 J**	<0.3	<0.3	<0.22	<2.2	<0.22	<0.22	<0.22	**1.1**	R
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<1	<1	R	**1.1 J**	<1	<0.61	<6.1	**11**	**2.4 J**	**2.9 J**	**19**	**2.2 J**
1,2-Dichlorobenzene	µg/L	95-50-1	-	**1.5**	**1.6 J**	**3.9 J**	**68**	**68**	**16 J**	**32**	--	--	--	**1.2 J**	R
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<0.3	<0.3	R	**2.1 J**	**2.2 J**	**0.6 J**	<5.5	--	--	--	**9.2**	**1.1 J**
1,3-Dichlorobenzene	µg/L	541-73-1	-	<0.68	<0.68	R	**4 J**	**4 J**	**1.0**	<4.8	--	--	--	**1.3 J**	R
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	**2.7 J**	**2.6 J**	**2.7 J**	**23**	**23**	**8.7 J**	**16 J**	**96**	**26**	**29**	**9.0**	**1.6 J**
2-Chlorotoluene	µg/L	95-49-8	-	<0.3	<0.3	R	**0.51 J**	**0.51 J**	<0.51	<5.1	--	--	--	**0.47 J**	R
Benzene	µg/L	71-43-2	22.7	**0.5**	**0.55 J**	**0.59 J**	**0.77 J**	**0.74 J**	**2.6 J**	<2.4 J	**0.44 J**	**0.87 J**	**0.84 J**	**1.4**	**0.41 J**
CFC-11	µg/L	75-69-4	-	<0.2	<0.2	<0.36J	<0.2	<0.2	<0.36	<3.6	--	--	--	<0.2	R
Chlorobenzene	µg/L	108-90-7	-	**23**	**24**	**27 J**	**66**	**70**	**77**	**140 J**	--	--	--	**32**	**8.2 J**
Chloroethane	µg/L	75-00-3	-	**0.76 J**	**0.77 J**	**1.1 J**	<0.2	<0.2	**0.65 J**	<3.5	--	--	--	<0.2	R
Chloroform	µg/L	67-66-3	-	<0.3	<0.3	R	<0.3	<0.3	<0.26	<2.6	--	--	--	<0.3	R
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.3	<0.3	R	<0.3	<0.3	<0.35	<3.5	<0.35	<0.35	<0.35	**0.61 J**	R
Cumene	µg/L	98-82-8	-	<0.2	<0.2	R	<0.2	<0.2	<0.44	<4.4	--	--	--	**1.2 J**	R
Ethylbenzene	µg/L	100-41-4	6,910	<0.4	<0.4	R	<0.4	<0.4	<0.5	<5	<0.5	<0.5	<0.5	**0.85 J**	R
m, p-Xylene	µg/L	179601-23-1	-	<2	<2	R	<2	<2	<0.53	<5.3	**3.9**	**0.64 J**	**0.62 J**	<2	R
Naphthalene	µg/L	91-20-3	4,940	<1	<1	R	**2.2 J**	**1.2 J**	<0.93	<9.3	**3.3**	**1.1 J**	**2.4 J**	**2.3 J**	R
n-Butylbenzene	µg/L	104-51-8	-	<0.3	<0.3	R	<0.3	<0.3	<0.44	<4.4	--	--	--	**0.4 J**	**0.73 J**
n-Propylbenzene	µg/L	103-65-1	-	<0.3	<0.3	R	<0.3	<0.3	<0.5	<5	--	--	--	**2.3 J**	R
o-Xylene	µg/L	95-47-6	-	**0.45 J**	**0.48 J**	**0.79 J**	**6**	**6.1**	**1.1**	<3.9	--	--	--	**2.0**	**0.44 J**
p-Isopropyltoluene	µg/L	99-87-6	-	<0.3	<0.3	R	<0.3	<0.3	<0.28	<2.8	--	--	--	**1.2 J**	R
Sec-Butylbenzene	µg/L	135-98-8	-	<0.3	<0.3	R	<0.3	<0.3	<0.49	<4.9	--	--	--	**0.75 J**	R
Styrene	µg/L	100-42-5	-	<0.3	<0.3	R	<0.3	<0.3	<0.53	<5.3	--	--	--	<0.3	R
Tert-Butylbenzene	µg/L	98-06-6	-	<0.3	<0.3	R	<0.3	<0.3	<0.58	<5.8	--	--	--	<0.3	R
Tetrachloroethene	µg/L	127-18-4	3.30	<0.3	<0.3	R	<0.3	<0.3	<0.41	<4.1	<0.41	<0.41	<0.41	<0.3	R
Toluene	µg/L	108-88-3	15,000	<0.2	<0.2	R	**0.36 J**	**0.38 J**	<0.39	<3.9	**0.7 J**	<0.39	<0.39	**0.91**	R
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<0.7	<0.7	R	<0.7	<0.7	<0.39	<3.9	--	--	--	<0.7	R
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<0.2	<0.2	R	<0.2	<0.2	<0.41	<4.1	--	--	--	<0.2	R
Trichloroethene	µg/L	79-01-6	30.00	<0.3	<0.3	R	<0.3	<0.3	<0.26	<2.6	<0.26	<0.26	<0.26	<0.3	R
Vinyl Chloride	µg/L	75-01-4	2.4	<0.2	<0.2	R	<0.2	<0.2	<0.22	<2.2	<0.22	<0.22	<0.22	**0.21 J**	R

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				B-19	B-19	B-19	B-19 DUP	B-19	B-19 DUP	B-19	B-19	B-19 DUP	B-01	CDM-15	RW-33-E	RW-33-E DUP	RW-7-F
				3/8/2022	4/27/2022	11/21/2022	11/21/2022	1/26/2023	1/26/2023	2/21/2023	3/23/2023	3/23/2023	3/7/2022	4/27/2022	8/17/2022	8/17/2022	8/17/2022
Closest Injection Well				RW-33-E	RW-33-E	RW-26-G	RW-26-G	RW-26-G	RW-26-G	RW-26-G	RW-26-G	RW-26-G	RW-5-F	RW-7-F	--	--	--
Distance from Injection Well (ft)				38.2	38.2	20.0	20.0	20.0	20.0	20.0	20.0	20.0	14.2	25.4	--	--	--
Days since Injection Start				Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	14	14	40	70	70	Pre-Injection	Pre-Injection	Not Started	Not Started	Pre-Injection
Days since Injection Ended				--	--	--	--	--	--	--	--	--	--	--	--	--	--
Injection Time Period				Not started	Not started	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	1/12/23-3/24/23	Not started	Not Started	Not Started	Not Started	8/31/22-9/02/22
Field Parameters	Units	CAS Number	CUL														
Dissolved Oxygen	mg/L	-	-	0.93	0.07	-0.14	-0.14	0.84	0.84	1.06	1.56	1.56	1.29	0.03	0.48	0.48	0.19
pH	s.u.	-	-	6.53	7.28	6.67	6.67	6.69	6.69	7.90	6.74	6.74	6.12	6.92	6.85	6.85	6.84
Conductivity	us/cm	-	-	1,435.0	1,512.0	3,262.3	3,262.3	1,620.0	1,620.0	1,534.7	1,319.3	1,319.3	666.7	449.7	1,009.0	1,009.0	472.3
Oxidation Reduction Potential	mV	-	-	-116.97	80.0	-88.8	-88.8	-39.7	-39.7	19.7	-42.9	-42.9	-89.43	88.3	-129.7	-129.7	373.1
Turbidity	NTU	-	-	0	85	36	36	38	38	39	49	49	86	46	29	29	190
Temperature	C	-	-	10.83	11.79	14.50	14.5	11.5	11.5	8.9	11.0	11.0	10.33	13.09	20.07	20.07	22.51
Semivolatile Organic Compounds Method 8270E																	
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<1.7	<0.25	<0.83	<0.083	<0.082	<0.083	<4.2	<0.85	<0.85	<1.7	<0.25	<0.083	<0.084	<0.087
Pentachlorophenol	µg/L	87-86-5	3	**3.6 J**	**0.6 J**	**0.25 J**	**0.26 J**	<3.4	<3.4	**17 J**	<1.8	<1.8	**0.23 J**	**0.6 J**	<0.17	<0.17	<0.18
Volatile Petroleum Products NWTPH-Gx																	
Gasoline (C4-C10)	mg/L	86290-81-5	1	<2.5	**0.79**	**0.15 J-**	**0.16 J-**	**0.65**	**0.62**	**0.75**	**27 J**	**0.58 J**	**0.12 J**	**0.3 J**	**0.43**	**0.49**	**0.056**
Semivolatile Petroleum Products NWTPH-Dx																	
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**9.7**	**11**	**11 J**	**16 J**	**15**	**13**	**15**	**15**	**15**	**2.5**	**4.3**	**7.0**	**7.2**	**1.1**
Motor Oil (>C24-C36)	mg/L		1	**3.3**	**3.6**	**3.5 J**	**6 J**	**4.1**	**4.1**	**4.9**	**5.1**	**5.5**	**1.8**	**2.8**	**3.9**	**4.2**	**0.55**
Volatile Organic Compounds Method 8260D																	
Total Detected VOC	µg/L	-	-														
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<9	<0.18	<0.3	<0.3	--	--	--	--	--	<0.18	<0.36	<0.18	<0.18	<0.18
1,1,1-Trichloroethane	µg/L	71-55-6	227	<2	<0.39	<0.3	<0.3	<0.39	<0.39	<0.39	<20	<0.4	<0.39	<0.78	<0.39	<0.39	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<2.6	**1.0**	<0.3	<0.3	--	--	--	--	--	<0.52	<1	<0.52	<0.52	<0.52
1,1-Dichloroethane	µg/L	75-34-3	52,000	<1.1	<0.22	<0.3	<0.3	<0.22	<0.22	<0.22	<11	<0.2	<0.22	<0.44	<0.22	<0.22	**0.28 J**
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<3.1	<0.61	<1	<1	<0.61	<0.61	<0.61	<31	<0.6	<0.61	<1.2	1.6 J	**1.4 J**	<0.61
1,2-Dichlorobenzene	µg/L	95-50-1	-	<2.3	**5.6**	**6.1**	**5.9**	--	--	--	--	--	<0.46	<0.92	**15**	**15**	<0.46
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<2.8	<0.55	<0.3	<0.3	--	--	--	--	--	<0.55	<1.1	<0.55	<0.55	<0.55
1,3-Dichlorobenzene	µg/L	541-73-1	-	<2.4	<0.48	<0.68	<0.68	--	--	--	--	--	<0.48	<0.96	**3.8**	**3.7**	<0.48
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	<2.3	<0.46	**1.1 J**	**1 J**	**1.4**	**1.4**	**1.3**	**75 J**	**1.1 J**	<0.46	<0.92	**41**	**41**	<0.46
2-Chlorotoluene	µg/L	95-49-8	-	<2.6	<0.51	<0.3	<0.3	--	--	--	--	--	<0.51	<1	<0.51	<0.51	<0.51
Benzene	µg/L	71-43-2	22.7	<1.2	**0.96 J**	**2.8**	**2.5**	**4.5**	**4.5**	**2.6**	**40 J**	**0.99 J**	<0.24	<0.48	**13**	**13**	<0.24
CFC-11	µg/L	75-69-4	-	<1.8	<0.36	<0.2	<0.2	--	--	--	--	--	<0.36	<0.72	**0.36**	0.36 J	**0.36 J**
Chlorobenzene	µg/L	108-90-7	-	<7.7	**9.2**	**11**	**10**	--	--	--	--	--	<0.44	<0.88	**600 J**	**610 J**	**1.0**
Chloroethane	µg/L	75-00-3	-	**980 J**	**410 J**	**230 J**	**220 J**	--	--	--	--	--	**0.74 J**	<0.7	**12**	**15**	<0.35
Chloroform	µg/L	67-66-3	-	<13	<0.26	<0.3	<0.3	--	--	--	--	--	<0.26	<0.52	<0.26	<0.26	<0.26
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<18	<0.35	<0.3	<0.3	<0.35	<0.35	<0.35	<18	<0.4	**0.49 J**	<0.7	<0.35	<0.35	<0.35
Cumene	µg/L	98-82-8	-	<22	**0.44 J**	**0.76 J**	**0.73 J**	--	--	--	--	--	<0.44	<0.88	**6.5**	**6.6**	<0.44
Ethylbenzene	µg/L	100-41-4	6,910	<2.5	<0.5	<0.4	<0.4	<0.5	<0.5	<0.50	<25	<0.50	<0.5	<1	**1.5**	**1.4**	<0.5
m, p-Xylene	µg/L	179601-23-1	-	<2.7	<0.53	<2	<2	<0.53	<0.53	<0.53	<27	<0.53	<0.53	<1.1	**8.1**	**7.4**	<0.53
Naphthalene	µg/L	91-20-3	4,940	<47 J	<0.93	<1	<1	<0.93	<0.93	<0.93	<47	<0.93	<0.93	<1.9	**2.8 J**	**2.7 J**	<0.93
n-Butylbenzene	µg/L	104-51-8	-	<2.2	<0.44	<0.3	<0.3	--	--	--	--	--	<0.44	<0.88	**2.2**	**1.4**	<0.44
n-Propylbenzene	µg/L	103-65-1	-	<2.5	**0.56 J**	**1.1 J**	**1.1 J**	--	--	--	--	--	<0.5	<1	**10**	**9.9**	<0.5
o-Xylene	µg/L	95-47-6	-	<2	<0.39	<0.4	<0.4	--	--	--	--	--	<0.39	<0.78	**5.7**	**5.5**	<0.39
p-Isopropyltoluene	µg/L	99-87-6	-	<1.4	<0.28	<0.3	<0.3	--	--	--	--	--	<0.28	<0.56	<0.28	<0.28	<0.28
Sec-Butylbenzene	µg/L	135-98-8	-	<2.5	<0.49	**0.56 J**	**0.52 J**	--	--	--	--	--	<0.49	<0.98	**2.1**	**2.1**	<0.49
Styrene	µg/L	100-42-5	-	<2.7	<0.53	<0.3	<0.3	--	--	--	--	--	<0.53	<1.1	<0.53	<0.53	<0.53
Tert-Butylbenzene	µg/L	98-06-6	-	<2.9	<0.58	**0.41 J**	**0.39 J**	--	--	--	--	--	<0.58	<1.2	<0.58	<0.58	<0.58
Tetrachloroethene	µg/L	127-18-4	3.30	<2.1	<0.41	<0.3	<0.3	<0.41	<0.41	<0.41	<21	<0.41	<0.41	<0.82	<0.41	<0.41	<0.41
Toluene	µg/L	108-88-3	15,000	<2	<0.39	<0.2	<0.2	<0.39	<0.39	<0.39	<20	<0.39	<0.39	<0.78	**0.47 J**	**0.42 J**	0.61 J
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	<20	**0.55 J**	**1.8 J**	**1.8 J**	--	--	--	--	--	<0.39	<0.78	**0.58 J**	**0.64 J**	<0.39
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<2.1	<0.41	<0.2	<0.2	--	--	--	--	--	<0.41	<0.82	<0.41	<0.41	<0.41
Trichloroethene	µg/L	79-01-6	30.00	<1.3	<0.26	<0.3	<0.3	<0.26	<0.26	<0.26	<13	<0.26	<0.26	<0.52	<0.26	<0.26	<0.26
Vinyl Chloride	µg/L	75-01-4	2.4	<1.1	<0.22	<0.2 J	<0.2 J	<0.22	<0.22	<0.22	<11	<0.22	<0.22	<0.44	<0.22	<0.22	**0.26 J**

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				RW-25-G	RW-38-E	RW-38-E DUP	RW-38-E	RW-38-E	RW-39-E	RW-39-E	RW-40-E	RW-40-E	RW-40-E	AGI-07	AGI-07	AGI-07
				10/21/2022	10/20/2022	10/20/2022	2/21/2023	3/24/2023	11/21/2022	2/21/2023	10/20/2022	2/21/2023	4/27/2023	10/20/2022	12/13/2022	2/21/2023
Closest Injection Well				--	RW-39-E	RW-39-E	RW-39-E	RW-39-E	--	--	--	--	--	RW-21-E	RW-21-E	RW-21-E
Distance from Injection Well (ft)				--	40.0	40.0	40.0	40.0	--	--	--	--	--	5.0	5.0	5.0
Days since Injection Start				Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	Pre-Injection	Post-Injection	Pre-Injection	Pre-Injection	40
Days since Injection Ended				--	--	--	--	--	--	--	--	--	34	--	--	--
Injection Time Period				Not Started	Not Started	Not Started	Not Started	Not Started	Not Started	Not Started	Not Started	Not Started	3/6/23-3/24/23	Not Started	1/12/23-3/24/23	1/12/23-3/24/23
Field Parameters	Units	CAS Number	CUL													
Dissolved Oxygen	mg/L	-	-	0.02	0.05	0.05	0.42	1.35	-0.10	0.26	0.08	0.24	-0.20	0.06	0.18	0.53
pH	s.u.	-	-	6.36	6.46	6.46	7.55	6.55	6.53	7.63	6.57	7.82	7.55	6.42	6.62	6.15
Conductivity	us/cm	-	-	926.7	657.3	657.3	833.3	1,010.7	510.3	420.0	688.0	810.0	1,694.7	794.3	508.3	710.0
Oxidation Reduction Potential	mV	-	-	79.40	114.77	114.77	-77.67	-101.33	-110.13	-2.33	174.40	-31.37	-155.33	64.07	-24.10	186.97
Turbidity	NTU	-	-	350	21	21	32	2	13	25	24	43	13.76	13	20	47
Temperature	C	-	-	16.64	20.03	20.03	15.83	16.23	18.00	14.38	17.86	14.02	14.50	17.82	12.13	9.71
Semivolatile Organic Compounds Method 8270E																
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<1.7	<0.083	<0.083	<0.082	<0.88	<0.92	<0.083	<0.083	<0.085	<0.084	<0.084	<0.83	<0.083
Pentachlorophenol	µg/L	87-86-5	3	<3.5	<0.17	<0.17	**16 J**	<1.8	<1.9	**0.23 J**	<0.17	**2.5 J**	<0.17	<0.17 J	**2.4 J**	**0.24 J**
Volatile Petroleum Products NWTPH-Gx																
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.24**	**1.4 J**	**0.54 J**	**0.62**	**0.54**	**0.28 J-**	**0.32**	**1.2**	**0.81**	**0.18**	**0.24 J**	**0.33 J**	**<0.14**
Semivolatile Petroleum Products NWTPH-Dx																
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**11**	**8.8 J**	**5.7 J**	**9.4**	**10**	**1.9**	**1.5**	**3.2**	**3.2**	**3.7**	**11**	**6.1**	**3.2**
Motor Oil (>C24-C36)	mg/L		1	**7.8**	**20 J**	**3.9 J**	**3.3**	**3.4**	**0.83**	**0.64**	**2.6**	**1.3**	**1.6**	**6.1**	**3.6**	**1.3**
Volatile Organic Compounds Method 8260D																
Total Detected VOC	µg/L	-	-													
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	<0.18	<1.8	<0.18	--	--	<0.3	--	<1.8	--	--	<1.8	<1.8	--
1,1,1-Trichloroethane	µg/L	71-55-6	227	**2.1**	<3.9	<0.39	<3.9	<0.39	<0.3	<0.39	<3.9	<0.39	<0.39	<3.9	<3.9	<3.9
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	<0.52	<5.2	<0.52	--	--	<0.3	--	<5.2	--	--	<5.2	<5.2	--
1,1-Dichloroethane	µg/L	75-34-3	52,000	**17**	<2.2	<0.22	<2.2	**0.79 J**	**0.8**	**1.5**	<2.2	<0.22	<0.22	<2.2	<2.2	<2.2
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	**8.4**	**16 J**	**15**	<6.1	**6**	**23**	**4.9**	<6.1	**28**	**10**	<6.1	<6.1	<6.1
1,2-Dichlorobenzene	µg/L	95-50-1	-	**0.55 J**	**20**	**19**	--	--	**6.9**	--	**17**	--	--	<4.6	<4.6	--
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	<0.55	<5.5	**2.6**	--	--	**1.7 J**	--	<5.5	--	--	<5.5	<5.5	--
1,3-Dichlorobenzene	µg/L	541-73-1	-	<0.48	**13**	**13**	--	--	**5.0**	--	**10**	--	--	<4.8	<4.8	--
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	<0.46	**68**	**68**	**63**	**69**	**50**	**23**	**61**	**62**	**8.5**	<4.6	<4.6	<4.6
2-Chlorotoluene	µg/L	95-49-8	-	<0.51	<5.1	<0.51	--	--	<0.3	--	<5.1	--	--	<5.1	<5.1	--
Benzene	µg/L	71-43-2	22.7	**2.5**	<2.4 J	**3.4 J**	**4.2 J**	**3.7**	**6.2**	**3.3**	**8.8 J**	**20**	**4.2**	<2.4	<2.4	<2.4
CFC-11	µg/L	75-69-4	-	<0.36	<3.6	<0.36	--	--	<0.2	--	<3.6	--	--	<3.6	<3.6	--
Chlorobenzene	µg/L	108-90-7	-	<0.44	**1400**	**1300**	--	--	**530**	--	**950**	--	--	<4.4	<4.4	--
Chloroethane	µg/L	75-00-3	-	**61**	<3.5	**2.9**	--	--	**73 J**	--	**44**	--	--	**290**	**14**	--
Chloroform	µg/L	67-66-3	-	<0.26	<2.6	<0.26	--	--	<0.3	--	<2.6	--	--	<2.6	<2.6	--
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	**26**	<3.5	<0.35	<3.5	**0.61 J**	**1.2**	**0.54 J**	<3.5	<0.35	<0.35	<3.5	<3.5	<3.5
Cumene	µg/L	98-82-8	-	**0.53 J**	<4.4	<0.44	--	--	**4.2 J**	--	<4.4	--	--	<4.4	<4.4	--
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<5	**3.8**	<5	**3.4**	**1.5**	**1.2**	<5	**2.0**	**0.63 J**	<5	<5	<5
m, p-Xylene	µg/L	179601-23-1	-	**0.93 J**	**5.5 J**	**4.6**	<5.3	**2.2**	**13**	**1.5 J**	<5.3	**0.74 J**	<0.53	<5.3	<5.3	<5.3
Naphthalene	µg/L	91-20-3	4,940	<0.93	<9.3	**3.9**	<9.3	**4.1**	**7.2**	**3.7**	<9.3	**14**	**2.8 J**	<9.3	<9.3	<9.3
n-Butylbenzene	µg/L	104-51-8	-	<0.44	<4.4	<0.44	--	--	**0.3 J**	--	<4.4	--	--	<4.4	<4.4	--
n-Propylbenzene	µg/L	103-65-1	-	**2.0**	<5 J	<0.5 J	--	--	**8.0**	--	<5 J	--	--	**5.3 J**	<5	--
o-Xylene	µg/L	95-47-6	-	**0.71 J**	**7.7 J**	**6.8**	--	--	**9.7**	--	**7.2 J**	--	--	<3.9	<3.9	--
p-Isopropyltoluene	µg/L	99-87-6	-	**0.7 J**	<2.8	<0.28	--	--	<0.3	--	<2.8	--	--	<2.8	<2.8	--
Sec-Butylbenzene	µg/L	135-98-8	-	<0.49	<4.9	<0.49	--	--	**0.89 J**	--	<4.9	--	--	<4.9	<4.9	--
Styrene	µg/L	100-42-5	-	<0.53	<5.3	<0.53	--	--	<0.3	--	<5.3	--	--	<5.3	<5.3	--
Tert-Butylbenzene	µg/L	98-06-6	-	<0.58	<5.8	<0.58	--	--	**0.39 J**	--	<5.8	--	--	<5.8	<5.8	--
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<4.1 J	<0.41 J	<4.1	<0.41	<0.3	<0.41	<4.1 J	<0.41	<0.41	<4.1	<4.1	<4.1
Toluene	µg/L	108-88-3	15,000	**3.7**	<3.9	**1.1**	<3.9	**0.7 J**	**3.2**	**0.6 J**	<3.9	**1.2**	**2.9**	<3.9	<3.9	<3.9
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	**3.8**	<3.9	<0.39	--	--	**0.71 J**	--	<3.9	--	--	<3.9	<3.9	--
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	<0.41 J	<4.1 J	<0.41 J	--	--	<0.2	--	<4.1 J	--	--	<4.1	<4.1	--
Trichloroethene	µg/L	79-01-6	30.00	**0.43 J**	<2.6	<0.26	<2.6	<0.26	<0.3	**0.36 J**	<2.6	<0.26	<0.26	<2.6	<2.6	<2.6
Vinyl Chloride	µg/L	75-01-4	2.4	**13**	<2.2	<0.22	<2.2	**0.76 J**	<0.2 J	<0.22	<2.2	**0.49 J**	<0.22	<2.2	<2.2	<2.2

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				AGI-07	AGI-07	RW-18-G	RW-18-G	RW-9-F	RW-35-D	RW-49-D	RW-5-F	CDM-15	CDM-15 DUP
				3/24/2023	4/26/2023	10/20/2022	2/21/2023	10/21/2022	10/20/2022	10/20/2022	2/21/2023	4/27/2023	4/27/2023
Closest Injection Well				RW-21-E	RW-21-E	--	--	--	--	--	--	--	--
Distance from Injection Well (ft)				5.0	5.0	--	--	--	--	--	--	--	--
Days since Injection Start				72	--	--	--	--	--	--	--	--	--
Days since Injection Ended				--	33	--	--	--	--	--	--	--	--
Injection Time Period				1/12/23-3/24/23	1/12/23-3/24/23	--	--	--	--	--	--	--	--
Field Parameters	Units	CAS Number	CUL										
Dissolved Oxygen	mg/L	-	-	1.59	0.26	0.05	0.55	0.09	0.04	0.05	8.00	0.15	0.15
pH	s.u.	-	-	5.92	6.14	6.90	7.41	6.28	6.64	7.09	8.03	6.07	6.07
Conductivity	us/cm	-	-	891.0	1,235.0	1,509.7	1,382.0	810.3	507.0	1,807.3	533.3	333.0	333.0
Oxidation Reduction Potential	mV	-	-	-45.83	-96.87	76.03	-65.47	116.57	22.70	75.80	21.43	-50.13	-50.13
Turbidity	NTU	-	-	7	7	29	70	27	95	128	45	2	2
Temperature	C	-	-	9.93	11.90	16.05	9.51	17.44	20.08	19.42	9.23	12.63	12.63
Semivolatile Organic Compounds Method 8270E													
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	<0.88	<0.84	<0.085	<4.3	<0.084	<0.084	<0.084	<0.086	<0.083	<0.084
Pentachlorophenol	µg/L	87-86-5	3	<1.8	<1.7	<0.17	**17 J**	<0.17	<0.17 J	**0.96**	0.26 J	<0.17 J	**0.17 J**
Volatile Petroleum Products NWTPH-Gx													
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.3**	**0.23**	**0.53**	**0.25**	**0.17**	**0.42**	<0.014	<0.14	**0.074**	**0.058**
Semivolatile Petroleum Products NWTPH-Dx													
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**6.7**	**13**	**20**	**7.7**	**1.2**	**5.5**	**3.7**	**1.8**	**2.7**	**3.4**
Motor Oil (>C24-C36)	mg/L		1	**3.5**	**7.4**	**13**	**6.6**	**0.77**	**3.2**	**6.7**	**1.7**	**1.3 J**	**1.9 J**
Volatile Organic Compounds Method 8260D													
Total Detected VOC	µg/L	-	-										
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	--	--	<0.18	--	<0.18	<0.18	<0.18	--	--	--
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<3.9	<0.39	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	--	--	<0.52	--	<0.52	<0.52	<0.52	--		--
1,1-Dichloroethane	µg/L	75-34-3	52,000	**0.31 J**	**36**	<0.22	<0.22	<0.22	<0.22	<0.22	<2.2	**0.27 J**	**0.28 J**
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<6.1	<0.61	<0.61
1,2-Dichlorobenzene	µg/L	95-50-1	-	--	--	**9.7**	--	<0.46	**1.6**	<0.46	--	--	--
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	--	--	<0.55	--	<0.55	**1.6**	<0.55	--	--	--
1,3-Dichlorobenzene	µg/L	541-73-1	-	--	--	<0.48	--	**0.87 J**	<0.48	<0.48	--	--	--
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	**2.9**	**2.6**	<0.46	<0.46	**8.6**	**4**	<0.46	<4.6	**3.2**	**3.0**
2-Chlorotoluene	µg/L	95-49-8	-	--	--	<0.51	--	<0.51	<0.51	<0.51	--	--	--
Benzene	µg/L	71-43-2	22.7	<2.4	<0.24	**2.3**	**3**	<0.24	**1.5**	<0.24	<2.4	**0.3 J**	**0.25 J**
CFC-11	µg/L	75-69-4	-	--	--	<0.36	--	<0.36	<0.36	<0.36	--	--	--
Chlorobenzene	µg/L	108-90-7	-	--	--	**13 J+**	--	**6.2**	**9.8 J+**	<0.44	--	--	--
Chloroethane	µg/L	75-00-3	-	--	--	**1.2**	--	<0.35	**2.7**	<0.35	--	--	--
Chloroform	µg/L	67-66-3	-	--	--	<0.26	--	<0.26	<0.26	<0.26	--	--	--
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.35	**1.1**	<0.35	**0.54 J**	<0.35	<0.35	**1.1**	<3.5	**0.5 J**	**0.52 J**
Cumene	µg/L	98-82-8	-	--	--	**1.4**	--	**0.64 J**	**1.6**	<0.44	--	--	--
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5
m, p-Xylene	µg/L	179601-23-1	-	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	<5.3	<0.53	<0.53
Naphthalene	µg/L	91-20-3	4,940	<0.93	<0.93	<0.93	<0.93	<0.93	<0.93	<0.93	<9.3	<0.93	<0.93
n-Butylbenzene	µg/L	104-51-8	-	--	--	<0.44	--	<0.44	<0.44	<0.44	--	--	--
n-Propylbenzene	µg/L	103-65-1	-	--	--	<0.5 J	--	<0.5	**2.6 J**	<0.5 J	--	--	--
o-Xylene	µg/L	95-47-6	-	--	--	<0.39	--	<0.39	**2.3**	<0.39	--	--	--
p-Isopropyltoluene	µg/L	99-87-6	-	--	--	<0.28	--	<0.28	<0.28	<0.28	--	--	--
Sec-Butylbenzene	µg/L	135-98-8	-	--	--	<0.49	--	<0.49	<0.49	<0.49	--	--	--
Styrene	µg/L	100-42-5	-	--	--	<0.53	--	<0.53	<0.53	<0.53	--	--	--
Tert-Butylbenzene	µg/L	98-06-6	-	--	--	<0.58	--	**0.65 J**	<0.58	<0.58	--	--	--
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<0.41	<0.41 J	<0.41	<0.41	<0.41 J	<0.41 J	<4.1	<0.41	<0.41
Toluene	µg/L	108-88-3	15,000	<0.39	<0.39	<0.39	<0.39	<0.39	**0.8**	<0.39	<3.9	<0.39	<0.39
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	--	--	<0.39	--	<0.39	<0.39	<0.39	--	--	--
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	--	--	<0.41 J	--	<0.41 J	<0.41 J	<0.41 J	--	--	--
Trichloroethene	µg/L	79-01-6	30.00	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<2.6	<0.26	<0.26
Vinyl Chloride	µg/L	75-01-4	2.4	<0.22	**1.3**	<0.22	<0.22	<0.22	<0.22	<0.22	<2.2	**0.23 J**	**0.25 J**

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

				CDM-20	CDM-20 DUP	MW-3	MW-3 DUP
				4/25/2023	4/25/2023	4/25/2023	4/25/2023
			Closest Injection Well	--	--	--	--
			Distance from Injection Well (ft)	--	--	--	--
			Days since Injection Start	--	--	--	--
			Days since Injection Ended	--	--	--	--
			Injection Time Period	Not Started	Not Started	Not Started	Not Started
Field Parameters	Units	CAS Number	CUL				
Dissolved Oxygen	mg/L	-	-	0.17	0.17	0.44	0.44
pH	s.u.	-	-	6.31	6.31	6.89	6.89
Conductivity	us/cm	-	-	524.0	524.0	280.0	280.0
Oxidation Reduction Potential	mV	-	-	-123.73	-123.73	-88.67	-88.67
Turbidity	NTU	-	-	4	4	6	6
Temperature	C	-	-	11.30	11.30	10.07	10.07
Semivolatile Organic Compounds Method 8270E							
Bis(2-ethylhexyl) phthalate	µg/L	117-81-7	2.2	**0.42 J**	<0.083 J	<0.083	<0.083
Pentachlorophenol	µg/L	87-86-5	3	<0.17	<0.17	<0.17	<0.17
Volatile Petroleum Products NWTPH-Gx							
Gasoline (C4-C10)	mg/L	86290-81-5	1	**0.35**	**0.38**	<0.014	<0.014
Semivolatile Petroleum Products NWTPH-Dx							
#2 Diesel (C10-C24)	mg/L	68476-34-6	1	**1.9**	**2.1**	<0.066 J	**0.19 J**
Motor Oil (>C24-C36)	mg/L		1	**0.33 J**	**0.5 J**	<0.098 J	**0.18 J**
Volatile Organic Compounds Method 8260D							
Total Detected VOC	µg/L	-	-				
1,1,1,2-Tetrachloroethane	µg/L	630-20-6	-	--	--	--	--
1,1,1-Trichloroethane	µg/L	71-55-6	227	<0.39	<0.39	<0.39	<0.39
1,1,2,2-Tetrachloroethane	µg/L	79-34-5	-	--	--	--	--
1,1-Dichloroethane	µg/L	75-34-3	52,000	<0.22	<0.22	<0.22	<0.22
1,2,4-Trimethylbenzene	µg/L	95-63-6	26,000	<0.61	<0.61	<0.61	<0.61
1,2-Dichlorobenzene	µg/L	95-50-1	-	--	--	--	--
1,3,5-Trimethylbenzene	µg/L	108-67-8	-	--	--	--	--
1,3-Dichlorobenzene	µg/L	541-73-1	-	--	--	--	--
1,4-Dichlorobenzene	µg/L	106-46-7	4.86	**3.6 J**	**5.3 J**	<0.46	<0.46
2-Chlorotoluene	µg/L	95-49-8	-	--	--	--	--
Benzene	µg/L	71-43-2	22.7	**1.0**	**1.2**	<0.24	<0.24
CFC-11	µg/L	75-69-4	-	--	--	--	--
Chlorobenzene	µg/L	108-90-7	-	--	--	--	--
Chloroethane	µg/L	75-00-3	-	--	--	--	--
Chloroform	µg/L	67-66-3	-	--	--	--	--
Cis-1,2-Dichloroethene	µg/L	156-59-2	5,200	<0.35	<0.35	<0.35	<0.35
Cumene	µg/L	98-82-8	-	--	--	--	--
Ethylbenzene	µg/L	100-41-4	6,910	<0.5	<0.5	<0.5	<0.5
m, p-Xylene	µg/L	179601-23-1	-	<0.53	<0.53	<0.53	<0.53
Naphthalene	µg/L	91-20-3	4,940	<0.93	<0.93	<0.93	<0.93
n-Butylbenzene	µg/L	104-51-8	-	--	--	--	--
n-Propylbenzene	µg/L	103-65-1	-	--	--	--	--
o-Xylene	µg/L	95-47-6	-	--	--	--	--
p-Isopropyltoluene	µg/L	99-87-6	-	--	--	--	--
Sec-Butylbenzene	µg/L	135-98-8	-	--	--	--	--
Styrene	µg/L	100-42-5	-	--	--	--	--
Tert-Butylbenzene	µg/L	98-06-6	-	--	--	--	--
Tetrachloroethene	µg/L	127-18-4	3.30	<0.41	<0.41	<0.41	<0.41
Toluene	µg/L	108-88-3	15,000	<0.39	<0.39	<0.39	<0.39
Trans-1,2-Dichloroethene	µg/L	156-60-5	-	--	--	--	--
Trans-1,3-Dichloropropene	µg/L	10061-02-6	-	--	--	--	--
Trichloroethene	µg/L	79-01-6	30.00	<0.26	<0.26	<0.26	<0.26
Vinyl Chloride	µg/L	75-01-4	2.4	**0.27 J**	**0.37 J**	<0.22	<0.22

Table A-1
Analytical Data
Lilyblad Cleanup Site, Tacoma, Washington

Notes
Bolded values indicate a detection above the laboratory method detection limit.
Highlighted values indicate a detection above the Site clean up level.
J : The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J+ : The analyte was positively identified; however, the associated numerical value is likely to be higher than the concentration of the analyte in the sample due to positive bias of associated QC or calibration data or attributable to matrix interference.
J- : The analyte was positively identified; however, the associated numerical value is likely to be lower than the concentration of the analyte in the sample due to negative bias of associated QC or calibration data or attributable to matrix interference.
R: Data rejected during validation.

C - celsius
DO - dissolved oxygen
ft - feet
mg/L - milligrams per liter
mV - millivolts
NTU - nephelometric turbidity unit
µs/cm - microsiemen per centimeter
µg/L - microgram per liter
s.u. - standard units
CUL - Cleanup Level
CAS - Chemical Abstract Service

Table A-2
Observed Trend Summary
Lilyblad Cleanup Site, Tacoma, Washington

				COC Reductions Observed?				
Injection Location	Monitoring Location	Distance (feet)	Months before COC Reduction Observed	Gasoline	#2 Diesel	Motor Oil	ORP Trend	Months to Rebound[1]
Wells with baseline concentrations above CUL								
RW-34-D	B-29	6.4	2	-	Decrease	Decrease	Increase	3
RW-47-D	SP-06	7.8	1	Increase	Decrease	Decrease	Increase	1
RW-12-G	P-1A	15.9	-	Increase	-	-	Increase	-
RW-21-E	AGI-07	5	3	-	Decrease	Decrease	Increase	1
RW-55-C	AGI-15	11.2	2	Increase	Decrease	Decrease	Increase	Not observed
RW-55-C	AGI-05	20.2	4	-	Decrease	Decrease	Increase	Not observed
RW-26-G	B-19	20	-	Increase	-	-	-	Not observed

Notes
COC observed trends relative to baseline sampling results.
1 - Months after injection ended before COC concentrations were observed to return to baseline levels.
"-" - Not applicable

Acronyms
COC - constituent of concern
CUL - cleanup level
ORP - oxidative reductive potential

Table A-3
Well Condition Summary
Lilyblad Cleanup Site, Tacoma, Washington

Well	Installation Date	Well Screen Scaling Observed	Approximate Percent Well Screen Visible
Dual Phase Extraction Wells			
RW-22-C	3/21/2009	---	---
RW-36-C	3/21/2009	---	---
RW-43-C	3/10/2009	---	---
RW-44-C	3/10/2009	---	---
RW-50-C	3/21/2009	---	---
RW-53-C	3/10/2009	---	---
RW-55-C	3/9/2009	---	---
RW-56-C	3/9/2009	Yes	95%
RW-57-C	3/21/2009	---	---
RW-58-C	3/21/2009	---	---
RW-23-D	3/23/2009	Yes	90%
RW-34-D	3/17/2009	---	---
RW-35-D	3/21/2009	Yes	95%
RW-45-D	3/9/2009	Yes	95%
RW-46-D	3/17/2009	Yes	75%
RW-47-D	3/18/2009	Yes	90%
RW-48-D	3/21/2009	Yes	0%
RW-49-D	---	Yes	95%
RW-51-D	3/11/2009	Yes	10%
RW-52-D	3/9/2009	Yes	90%
RW-20-E	3/14/2009	---	---
RW-21-E	3/14/2009	---	---
RW-24-E	3/21/2009	Yes	75%
RW-31-E	3/23/2009	---	---
RW-32-E	3/23/2009	Yes	75%
RW-33-E	3/20/2009	---	---
RW-38-E	3/20/2009	---	---
RW-39-E	3/20/2009	---	---
RW-40-E	3/20/2009	---	---
RW-4F	3/14/2009	Yes	0%
RW-5-F	3/14/2009	Yes	0%
RW-6-F	3/14/2009	Yes	0%
RW-7-F	3/13/2009	Yes	0%
RW-8-F	3/13/2009	Yes	0%
RW-9-F	3/6/2009	---	---
RW-10-F	3/6/2009	Yes	10%
RW-11-G	---	---	---
RW-12-G	3/14/2009	---	---
RW-13-G	3/10/2009	Yes	10%
RW-18-G	3/10/2009	Yes	30%
RW-19-G	3/13/2009	Yes	90%
RW-25-G	---	Yes	90%
RW-26-G	3/17/2009	---	---
RW-27-G	3/10/2009	Yes	50%
RW-14-H	3/6/2009	Yes	10%
RW-17-H	3/6/2009	Yes	10%
RW-28-H	3/5/2009	---	---
RW-30-H	3/5/2009	---	---
RW-41-H	3/5/2009	---	---
RW-42-H	3/6/2009	Yes	95%
RW-54-H	3/6/2009	---	---
RW-1-I	---	Yes	0%
RW-15-I	3/6/2009	---	---
RW-16-I	3/5/2009	---	---
RW-29-I	3/5/2009	---	---

Notes:
Less than 50% of well screen visible
"---" indicates information not available or well not evaluated

FIGURES

Legend

- Fence
- Rail Line
- Road
- Approximate Site Boundary
- Tax Lot
- Building
- Tank

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
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Site Location Map

Site Review Report
2244 Port of Tacoma Road,
Tacoma, Washington

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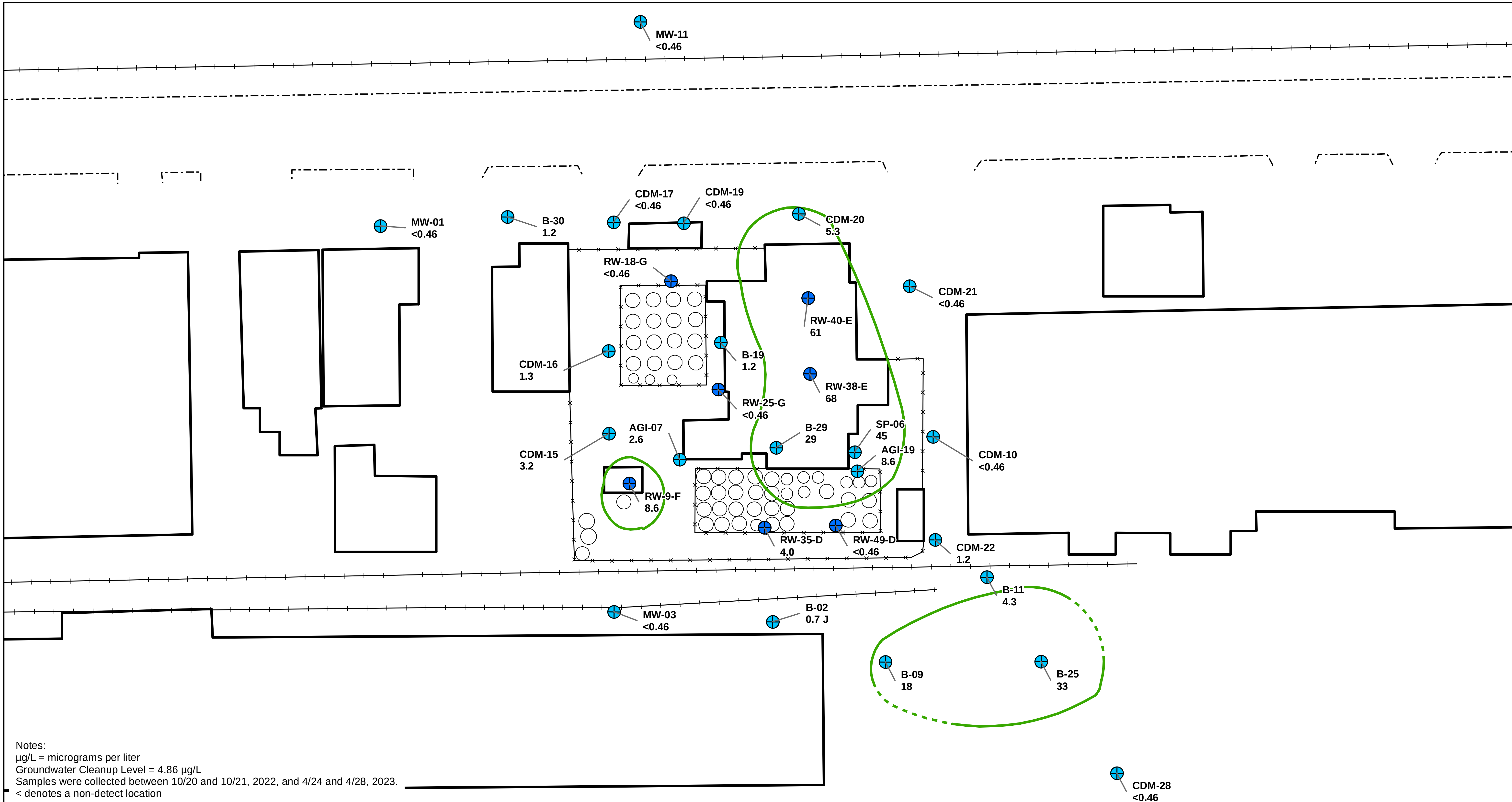
Figure A-1

PNR0697 | March 2024

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Site Review Report\Figure 1 Site Location.mxd 10/13/2021 12:13:38 PM



Notes:
µg/L = micrograms per liter
Groundwater Cleanup Level = 4.86 µg/L
Samples were collected between 10/20 and 10/21, 2022, and 4/24 and 4/28, 2023.
< denotes a non-detect location

Legend

- October 2022 Groundwater Monitoring Location
- April 2023 Groundwater Monitoring Location
- Fence
- Rail Line
- Road
- Building
- Tank

1,4-Dichlorobenzene
Groundwater Isoconcentration Contours (µg/L)
> 4.86

CDM-20 - Monitoring Location ID
5.3 - Concentration of 1,4-dichlorobenzene (µg/L)

Groundwater Concentrations
1,4-Dichlorobenzene (October 2022 and April 2023)

2244 Port of Tacoma Road,
Tacoma, Washington

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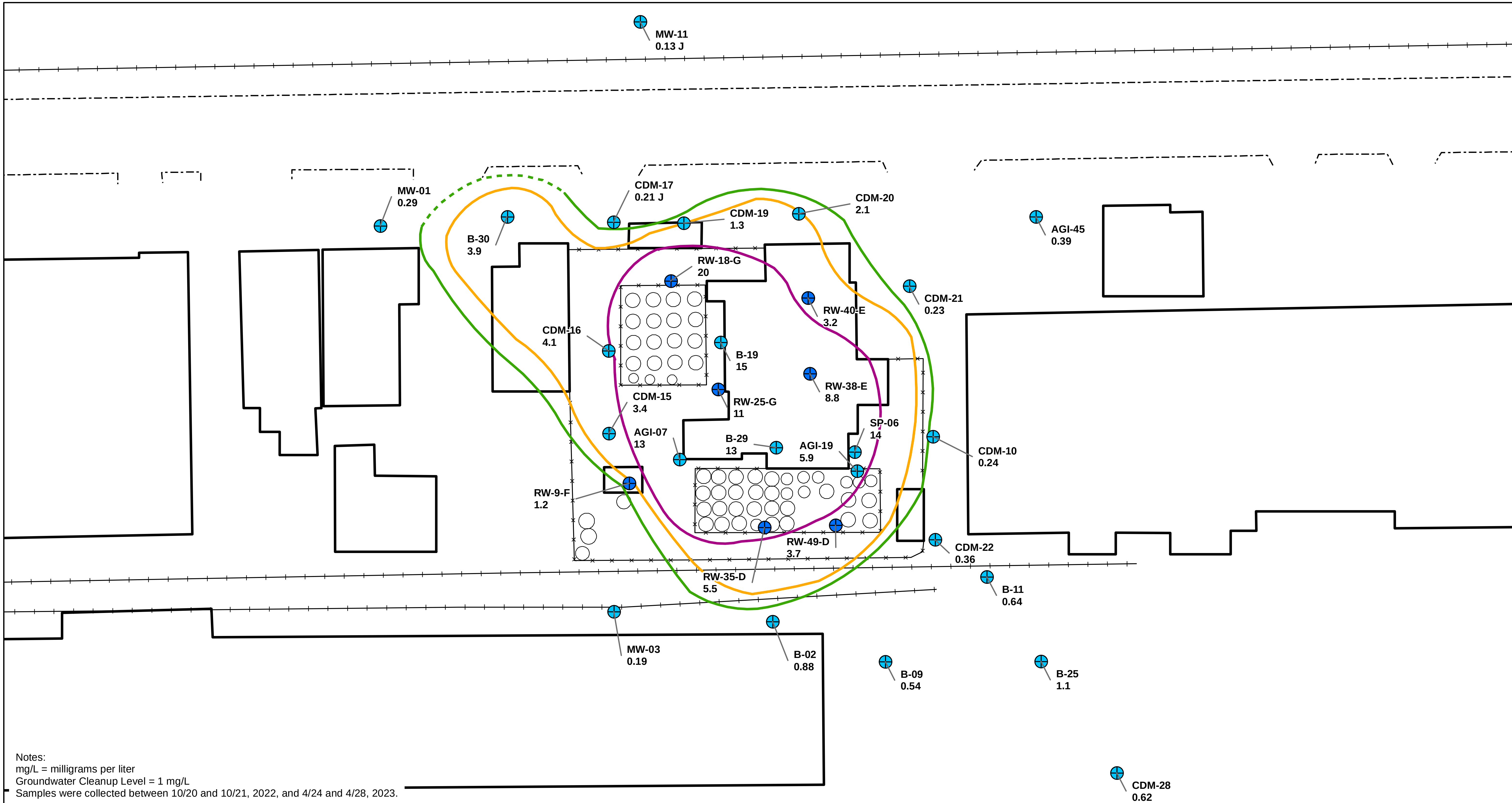
PNR0697 | March 2024

Figure A-2a

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Q2_2023\Figure 2 Interpolated 1,4-Dichlorobenzene Concentration.mxd 8/15/2023 9:53:13 AM



Notes:
mg/L = milligrams per liter
Groundwater Cleanup Level = 1 mg/L
Samples were collected between 10/20 and 10/21, 2022, and 4/24 and 4/28, 2023.

Legend

- October 2022 Groundwater Monitoring Location
- April 2023 Groundwater Monitoring Location
- Fence
- Rail Line
- Road
- Building
- Tank

#2 Diesel (C10-C24)
Groundwater Isoconcentration Contours (mg/L)

- > 1
- > 2
- > 5

CDM-20 - Monitoring Location ID
2.1 - Concentration of #2 Diesel (C10-C24) (mg/L)

N

0 75 Feet

Groundwater Concentrations #2 Diesel (C10-C24) (October 2022 and April 2023)
2244 Port of Tacoma Road,
Tacoma, Washington

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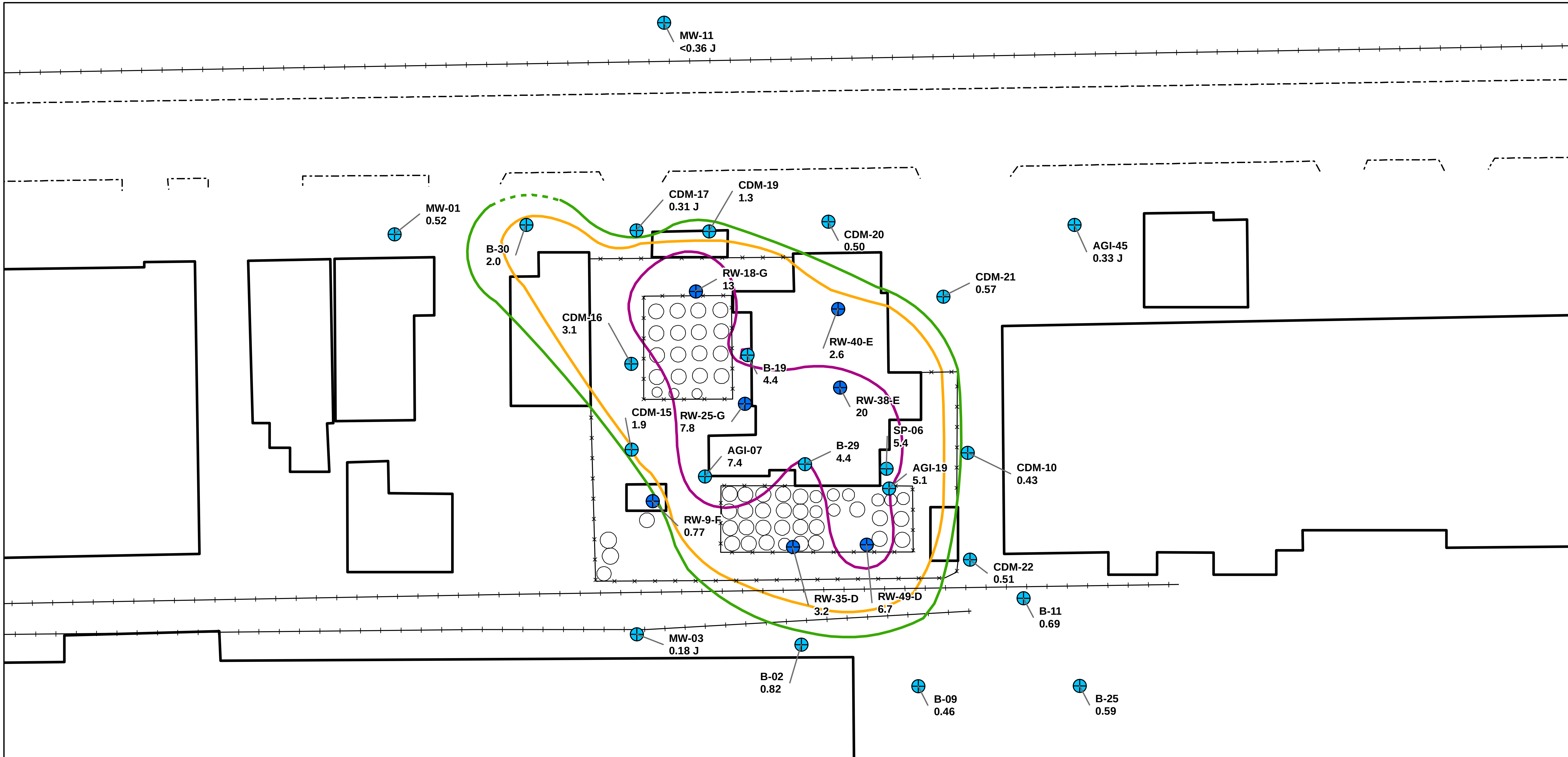
PNR0697	March 2024	**Figure A-2b**

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Q2_2023\Figure 4 Interpolated Diesel Concentration.mxd 8/15/2023 9:30:47 AM



Notes:
mg/L = milligrams per liter
Groundwater Cleanup Level = 1.0 mg/L
Samples were collected between 10/20 and 10/21, 2022, and 4/24 and 4/28, 2023.
< denotes a non-detect location

Legend

- October 2022 Groundwater Monitoring Location
- April 2023 Groundwater Monitoring Location
- Fence
- Rail Line
- Road
- Building
- Tank

Motor Oil (>C24-C36)
Groundwater Isoconcentration Contours (mg/L)
- > 1
- > 2
- > 5

CDM-20 - Monitoring Location ID
0.50 - Concentration of Motor Oil (>C24-C36) (mg/L)

0 75 Feet

N

Groundwater Concentrations Motor Oil (C24-C3)
(October 2022 and April 2023)

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Tacoma, Washington

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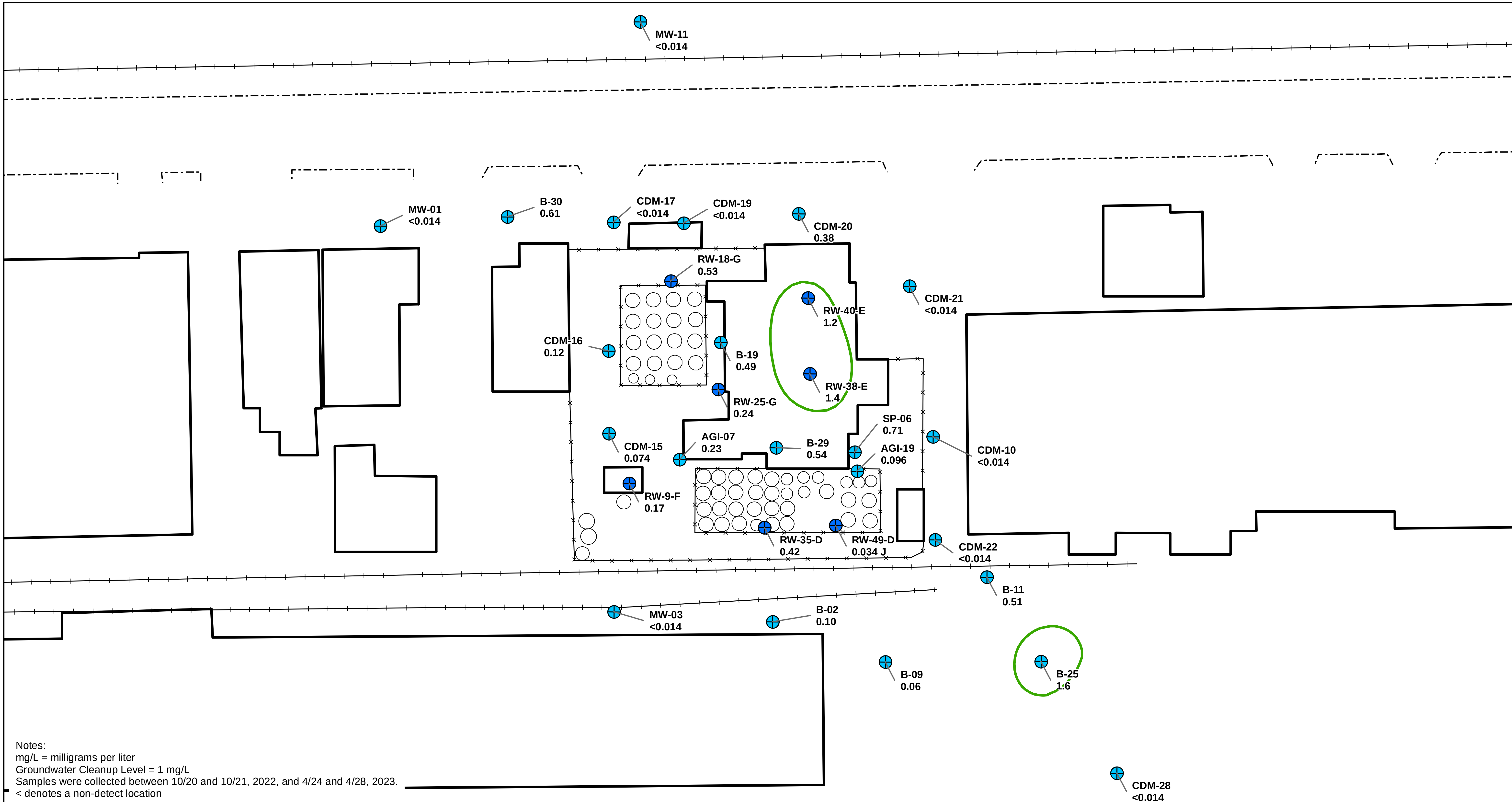
PNR0697 | March 2024

Figure
A-2c

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Q2_2023\Figure 3 Interpolated Motor Oil Concentration.mxd 8/15/2023 8:54:50 AM



Notes:
mg/L = milligrams per liter
Groundwater Cleanup Level = 1 mg/L
Samples were collected between 10/20 and 10/21, 2022, and 4/24 and 4/28, 2023.
< denotes a non-detect location

Legend

- October 2022 Groundwater Monitoring Location
- April 2023 Groundwater Monitoring Location
- Fence
- Rail Line
- Road
- Building
- Tank

TPH as Gasoline
Groundwater Isoconcentration Contours (mg/L)
> 1

CDM-20 - Monitoring Location ID
0.38 - Concentration of TPH as Gasoline (mg/L)

Groundwater Concentrations
TPH as Gasoline (October 2022 and April 2023)
2244 Port of Tacoma Road,
Tacoma, Washington

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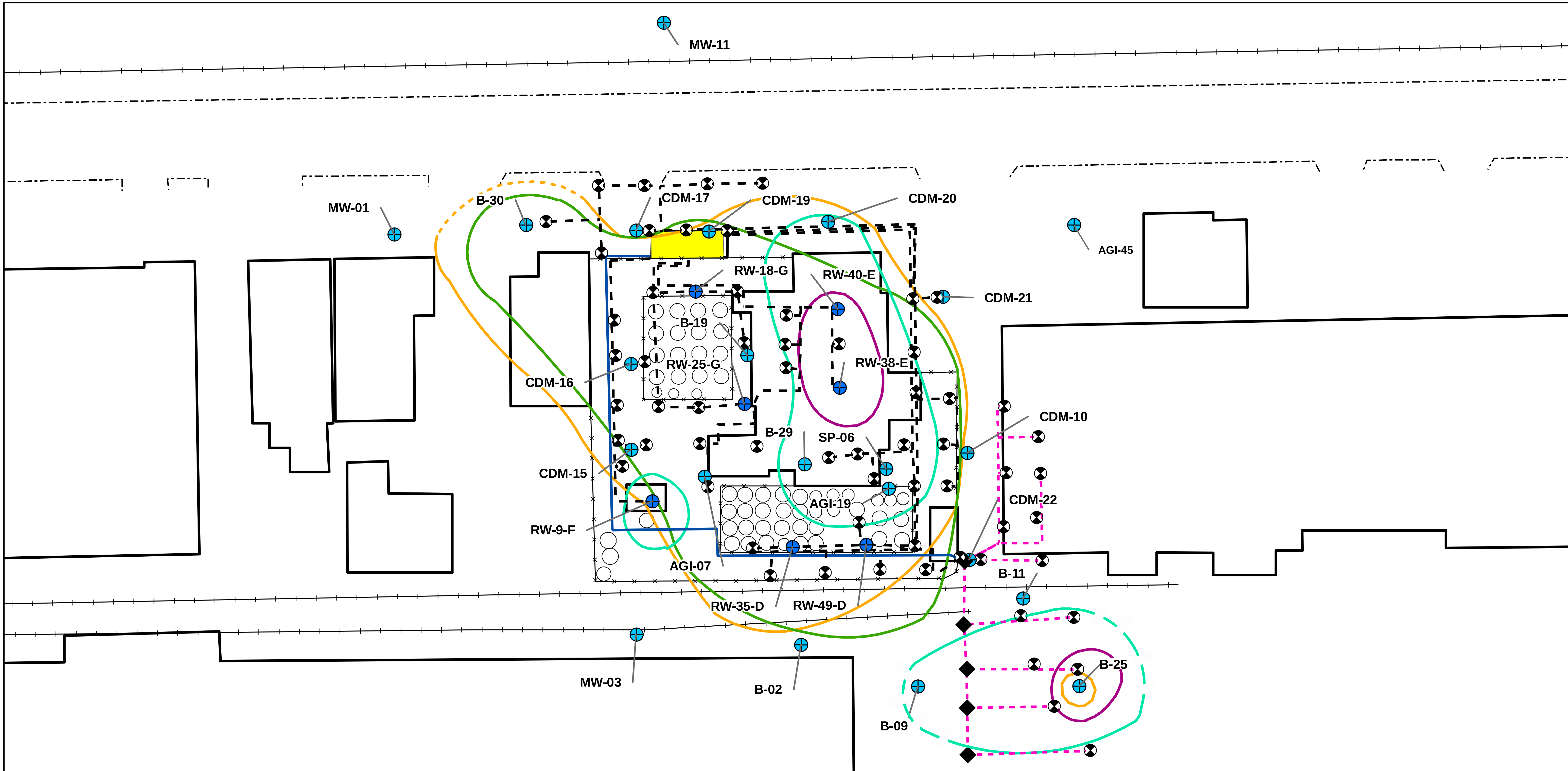
PNR0697	March 2024	**Figure A-2d**

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Q2_2023\Figure 5 Interpolated TPH as Gasoline Concentration.mxd 8/15/2023 8:58:05 AM



Notes:
µg/L = micrograms per liter
mg/L = milligrams per liter
Samples were collected between 10/20 and 10/21, 2022, and 4/24 and 4/28, 2023.

Legend

- October 2022 Groundwater Monitoring Location
- April 2023 Groundwater Monitoring Location
- DPE Recovery Wells
- DPE Vault
- Conveyance Piping
- Fence
- Rail Line
- Road
- Building
- Tank
- Remedial Treatment System Compound
- > 4.86 1,4-Dichlorobenzene Groundwater Isoconcentration Contours (µg/L)
- > 1 Motor Oil (>C24-C36) Groundwater Isoconcentration Contours (mg/L)
- > 1 #2 Diesel (C10-C24) Groundwater Isoconcentration Contours (mg/L)
- > 1 TPH as Gasoline Groundwater Isoconcentration Contours (mg/L)

Constituents of Concern over Cleanup Levels in Groundwater (October 2022 and April 2023)

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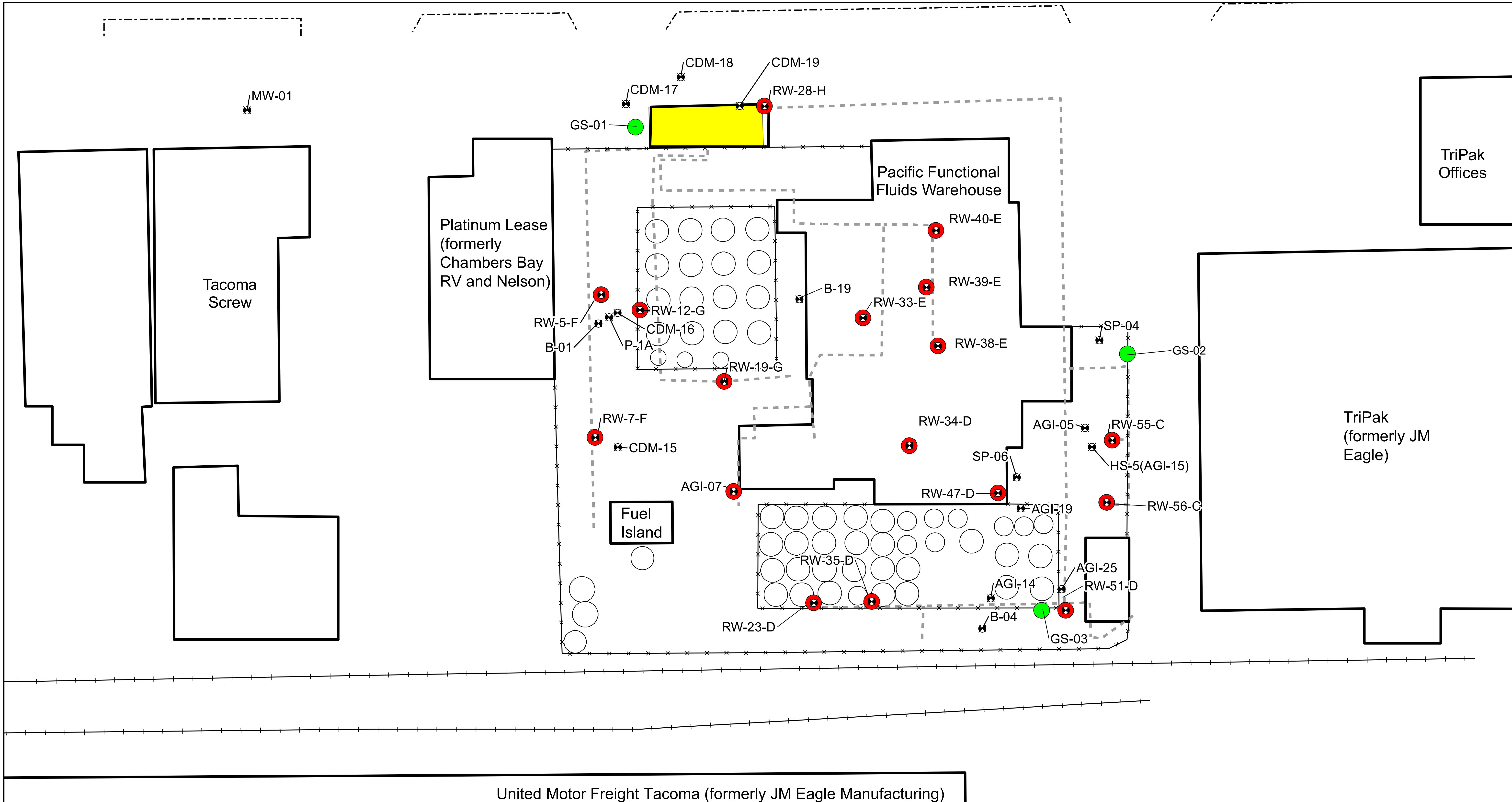
PNR0697	March 2024	Figure A-3

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Q2_2023\Figure 8 All Interpolated Concentrations.mxd 8/15/2023 9:58:43 AM



Legend

- Biosparge Well
- Retrofitted DPE Well
- Biosparge Monitoring Well Location
- Fence
- Rail Line
- Road
- Conveyance Line
- Building/Structure
- Tank
- Remedial Equipment Compound

N

0 40 Feet

2022-2023 Extended Biosparge Pilot Study
Injection Well Network
2244 Port of Tacoma Road, Tacoma, Washington

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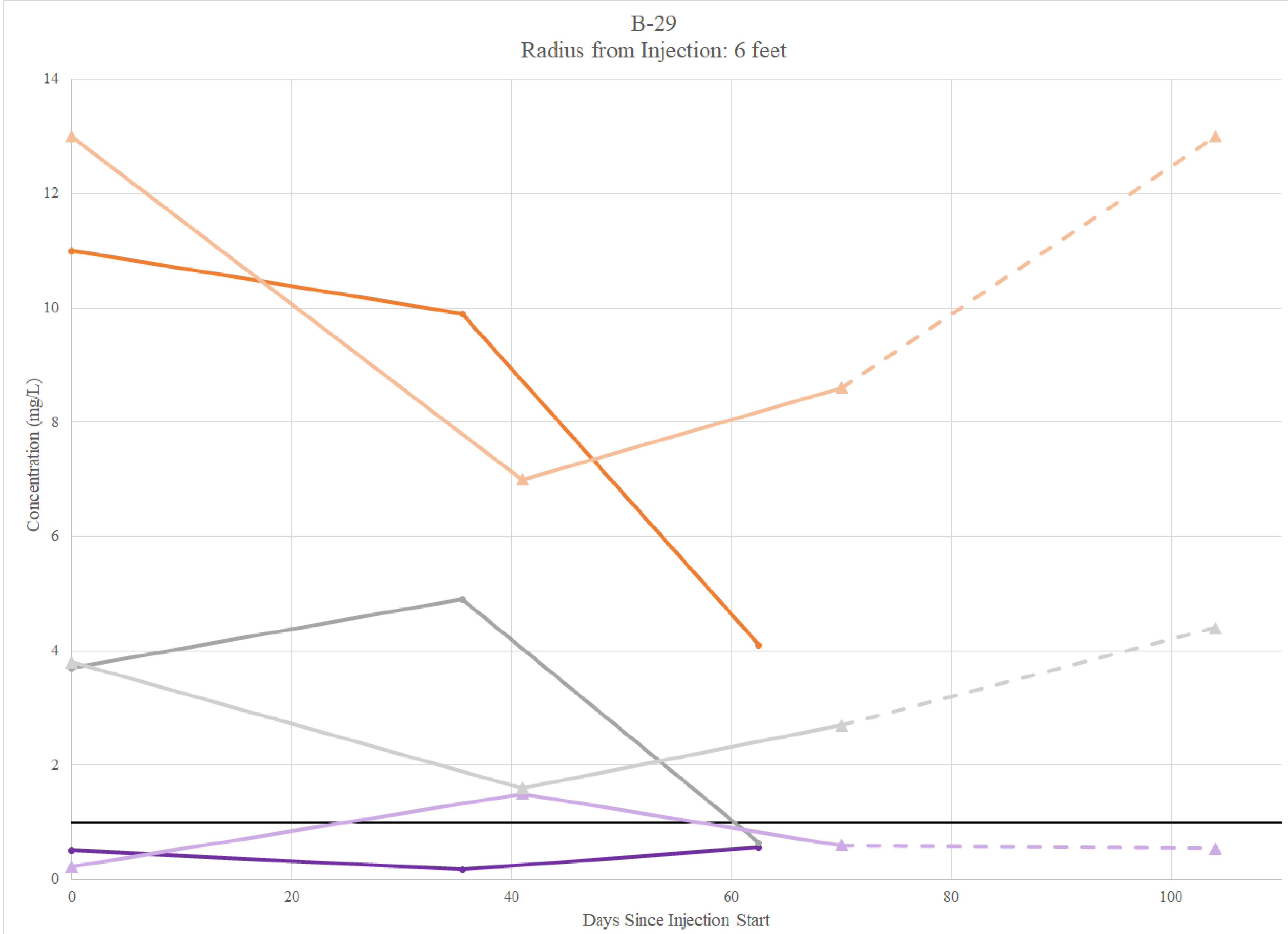
PNR0697	March 2024

Figure A-4

P:\Projects\Lilyblad\PNR0697_LILYBLAD CLEANUP OMM\900 GIS and CAD\920 GIS\MXDs\Biosparge Locations 2022.mxd 2/25/2022 9:13:35 AM

APPENDIX A-A
Monitoring Well Trend Plots



Legend

CUL	Gasoline Test 1	Gasoline Test 2
During Injection	Diesel Test 1	Diesel Test 2
Post Injection	Motor Oil Test 1	Motor Oil Test 2

Note:
This figure presents data collected during the 2022-2023 Biosparge pilot studies and compares analytical data collected from monitoring wells near injection wells where injection tests were repeated.

Injection Test Data Comparison

B-29

2244 Port of Tacoma Road, Tacoma, Washington

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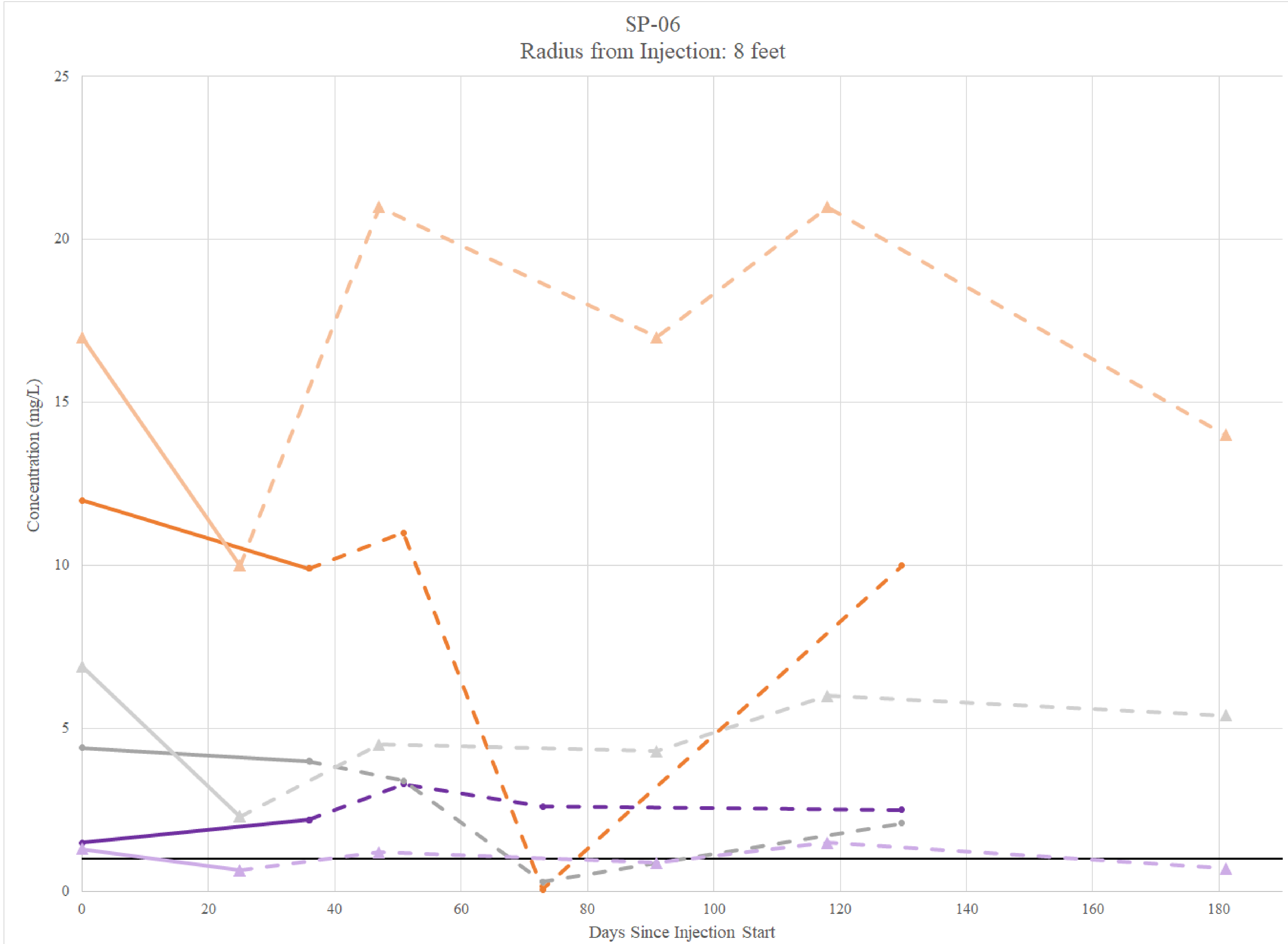
PNR0697 | August 2023

Figure 2A



Legend

CUL	Gasoline Test 1	Gasoline Test 2
During Injection	Diesel Test 1	Diesel Test 2
Post Injection	Motor Oil Test 1	Motor Oil Test 2

Note:
This figure presents data collected during the 2022-2023 Biosparge pilot studies and compares analytical data collected from monitoring wells near injection wells where injection tests were repeated.

Injection Test Data Comparison

SP-06

2244 Port of Tacoma Road, Tacoma, Washington

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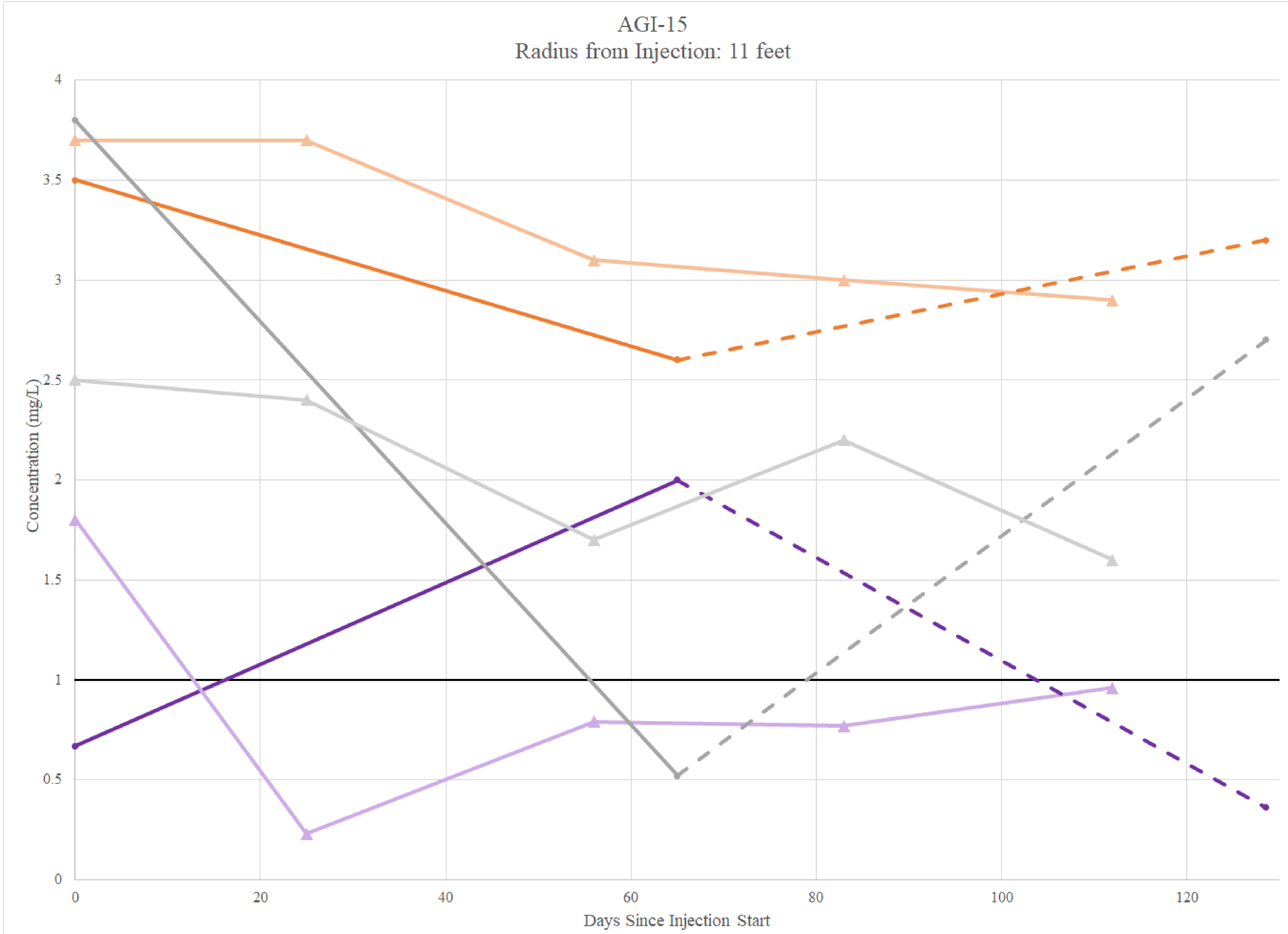
Figure 2B



Legend

CUL
During Injection
Post Injection
Gasoline Test 1
Diesel Test 1
Motor Oil Test 1
Gasoline Test 2
Diesel Test 2
Motor Oil Test 2

Note:
This figure presents data collected during the 2022-2023 Biosparge pilot studies and compares analytical data collected from monitoring wells near injection wells where injection tests were repeated.

Injection Test Data Comparison

AGI-15

2244 Port of Tacoma Road, Tacoma, Washington

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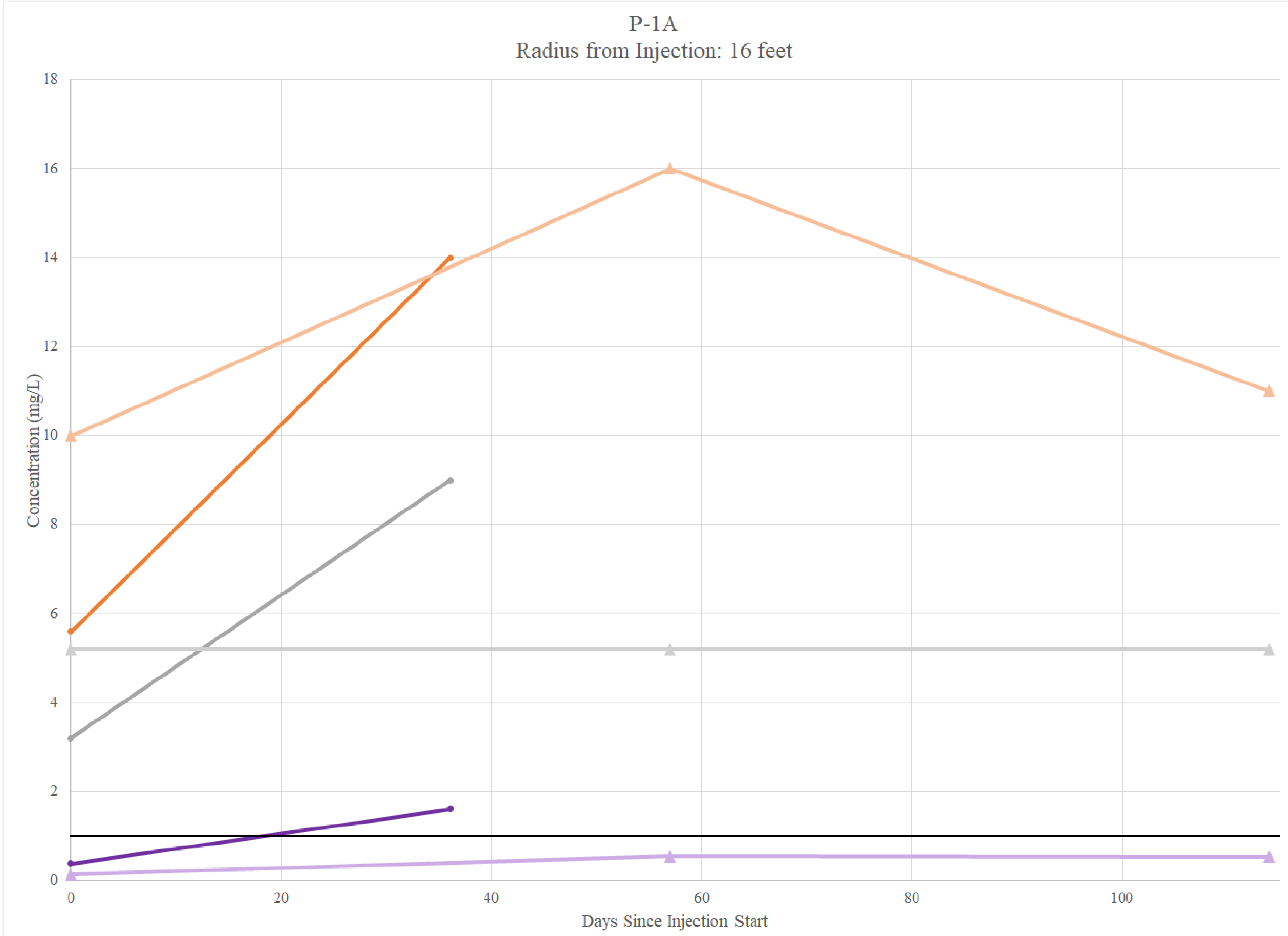
PNR0697 | August 2023

Figure 2C



Legend

CUL
During Injection
Post Injection
Gasoline Test 1
Diesel Test 1
Motor Oil Test 1
Gasoline Test 2
Diesel Test 2
Motor Oil Test 2

Note:
This figure presents data collected during the 2022-2023 Biosparge pilot studies and compares analytical data collected from monitoring wells near injection wells where injection tests were repeated.

Injection Test Data Comparison

P-1A

2244 Port of Tacoma Road, Tacoma, Washington

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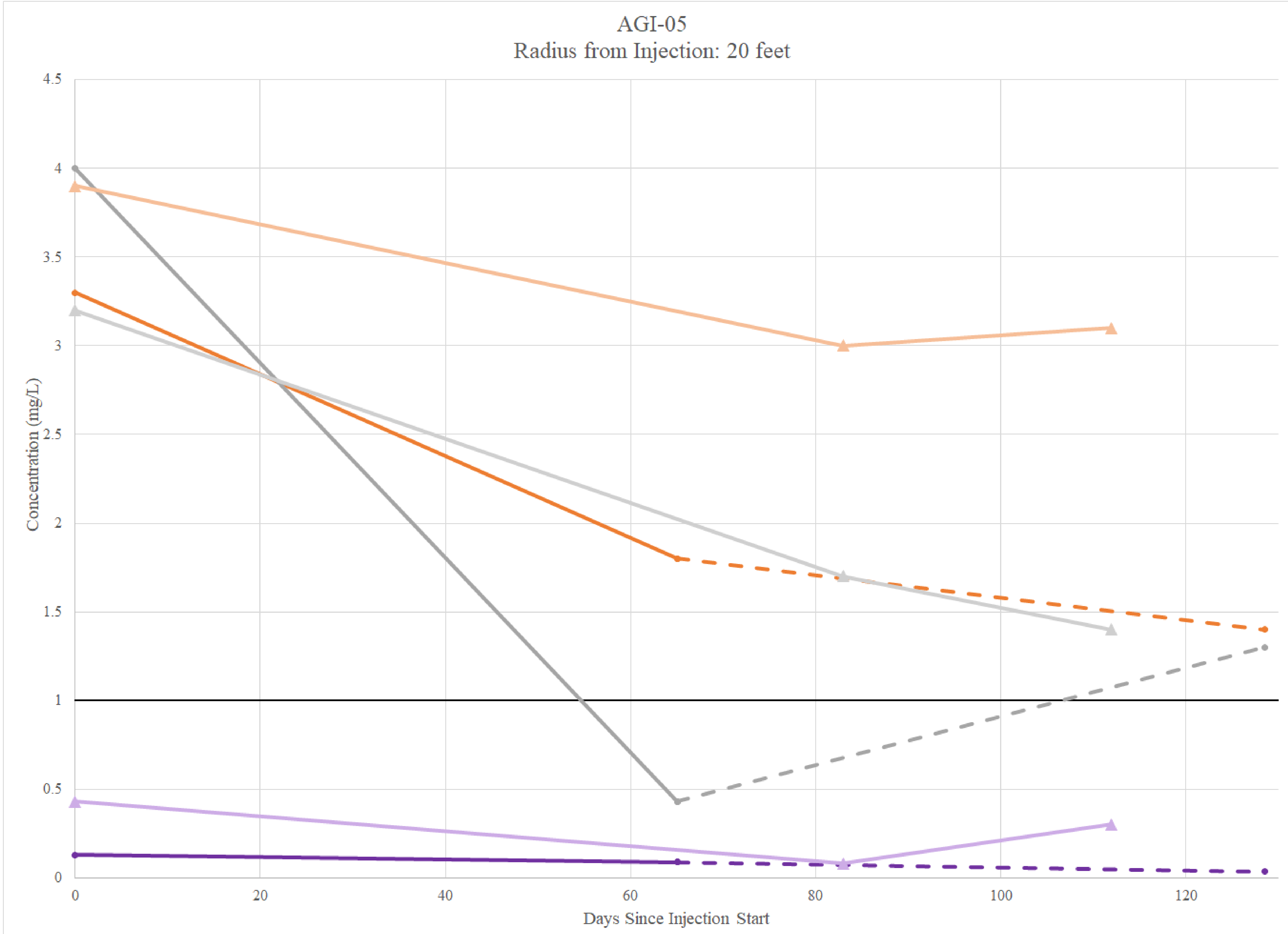
PNR0697

August 2023

Figure 2D



Legend

CUL
During Injection
Post Injection
Gasoline Test 1
Diesel Test 1
Motor Oil Test 1
Gasoline Test 2
Diesel Test 2
Motor Oil Test 2

Note:
This figure presents data collected during the 2022-2023 Biosparge pilot studies and compares analytical data collected from monitoring wells near injection wells where injection tests were repeated.

Injection Test Data Comparison

AGI-05

2244 Port of Tacoma Road, Tacoma, Washington

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Figure 2E